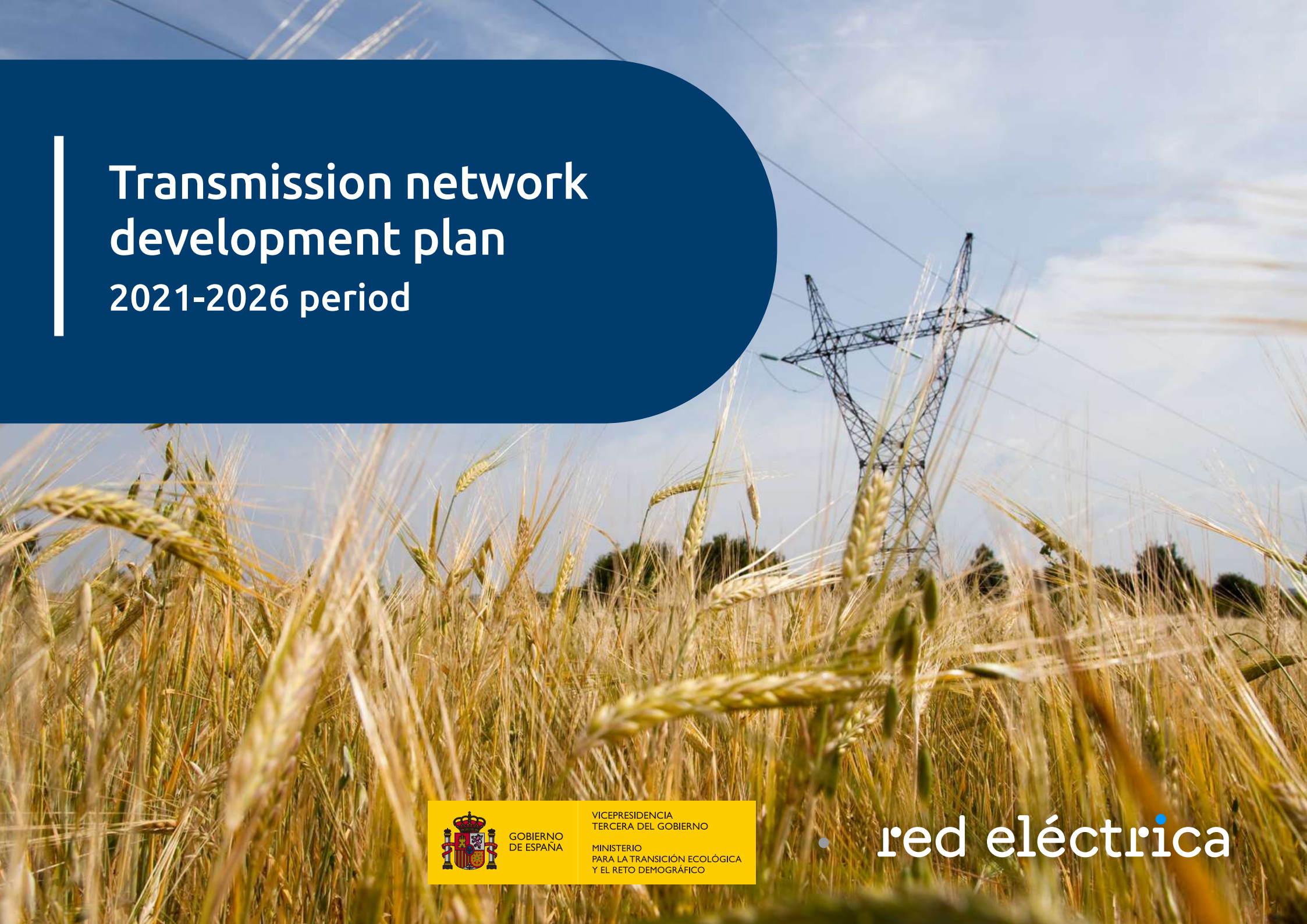
# Transmission network development plan

## 2021-2026 period



GOBIERNO DE ESPAÑA

VICEPRESIDENCIA TERCERA DEL GOBIERNO

MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO

red eléctrica







# 1. Introduction

1.1. Context for the transmission network development plan

1.2. Indicative energy planning

1.3. Binding energy planning: transmission grid

1.3.1. A process of continuous improvement. New approaches compared to previous plans

1.4. Planning process

1.4.1. Proposals stage

# 2. Indicative Planning (NECP): study scenario

2.1. Demand

2.2. Generation

2.2.1. Estimated location of renewable energy sources for the 2026 scenario

# 3. Analysis methodology

3.1. The analysis grid or starting grid

3.2. Identification of needs

3.3. Use of new components in the network

3.4. Analysis of alternatives

3.5. Selection/prioritisation criteria

3.6. Cost-benefit analysis

3.6.1. Investment evaluation methodology

3.6.2. Indicators of the investment evaluation methodology

# 4. Results

4.1. What would happen if no transmission network is built beyond the starting grid?

4.2. What would happen with an unconstrained transmission network?

4.3. Design of the planned transmission network

4.4. Analysis of the new needs of the transmission network

4.5. Main planned investments

4.6. Impact of the development of the Transmission Network

4.7. Key data of the development plan 2021-2026

4.8. Projects required beyond 2026

# 5. Modification of specific items (MAP)

# 6. Maps

6.1. Spanish mainland

6.2. Spanish mainland detail

6.3. Baleares

6.4. Canarias

# 7. Annexes

I: Starting Grid

II: New reinforcements

III: Technical annexes

1

# 1. Introduction

1.1. Context for the transmission network development plan

1.2. Indicative energy planning

1.3. Binding energy planning: transmission grid

1.3.1. A process of continuous improvement. New developments compared to previous planning

1.4. Planning process

1.4.1. Proposals stage

# 1.1. Context for the transmission network development plan

## REGULATORY CONTEXT

The General State Administration, through the current Ministry for the Ecological Transition and the Demographic Challenge (MITERD, for its acronym in Spanish), is responsible for designing the Spanish energy policy. To this end, it establishes energy planning which, among other aspects, defines the objectives in the medium and long term regarding the integration of renewable energies, decarbonisation and security of supply at the minimum cost to the consumer. All of this is set out in the Electricity Sector Act, Law 24/2013, article 4.

The transmission network development plan is an exercise carried out under a regulated framework led by the Ministry for the Ecological Transition and the Demographic Challenge.

In the context of energy planning, the transmission network development plan, which is developed in collaboration with the Autonomous Communities and autonomous cities, is aimed at identifying the modernisation needs of existing facilities as well as the new transmission infrastructures that are necessary in order to guarantee the supply of electricity for the entire Spanish territory in the future target scenario, while also considering aspects of environmental, social and economic sustainability. Furthermore, considering that the integration of these infrastructures into the environment is essential, energy planning is accompanied by a Strategic Environmental Assessment.

## SOCIO-POLITICAL CONTEXT: THE ENERGY TRANSITION

The energy and climate policy framework in Spain is guided by international agreements under the United Nations Framework Convention on Climate Change (UNFCCC), especially the Kyoto Protocol and the Paris Agreement, as well as policies agreed within the European Union.



The European Union (EU) has shown ample evidence of its concern to achieve a sustainable energy system capable of combining economic growth and competitiveness with the reduction of greenhouse gas (GHG) emissions and adequate protection of the environment in the medium and long term.

The European energy and climate strategy currently defines targets for 2020, 2030 and 2050 for all EU countries in conjunction, but it does not establish long-term objectives for each Member State individually.

Europe and Spain are firmly committed to the energy transition.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

Thus, by 2030 the climate and energy targets[1] set for the EU as a whole are:

- At least a 55% reduction in greenhouse gas (GHG) emissions compared to 1990[2] (binding target).
- 32% of renewable energy sources as a proportion of total gross final energy consumption (binding target).
- 32.5% improvement in energy efficiency.
- 15% electricity interconnection of Member States.

The ambitious energy and climate objectives set by the European Union, together with international undertakings in this area, establish the goal of achieving a practically decarbonised economy by 2050, where the same level of welfare is achieved for society with hardly any emissions. The energy transition should be understood as the path of transformation of all sectors of the economy in order to achieve the aforementioned decarbonisation objective by 2050.

It is important to note that, among the different sectors of activity, the first and second largest GHG emitters are transport and power generation. Therefore, a process of decarbonisation of the economy requires a significant effort towards the transformation of these sectors, including a change of energy vector towards electricity, considering its current greater capacity for the incorporation of renewable energy sources and greater efficiency in the final use of energy through the implementation of technologies that make better use of primary energy, such as heat and cold pumps in air conditioning, or electric mobility. Increased electrification of the economy together with the growing integration of renewable energy sources will lead to a reduction in external dependence on the supply of energy commodities. In the transport sector, electric mobility (electrification of the rail network and development of the high-speed infrastructure, the transition to electric vehicles and the electrification of seaports, among others) is key to the decarbonisation of both passenger and freight transport.

A greater degree of electrification of society entails raising, if possible, the importance of the security of electricity supply and, therefore, makes it essential both to adequately design the networks and to implement on time the infrastructures identified as necessary in the transmission network development plan.

In compliance with international commitments and the European legislative framework, Spain has adopted minimum objectives, without prejudice to the competences of the Autonomous Communities, together with the definition of a set of policies and measures designed to achieve them. The commitments undertaken by Spain are described in the National Energy and Climate Plan (NECP) called "Plan Nacional Integrado de Energia y Clima (NECP)".



1 Defined in Article 2(11) of Regulation (EU) 2018/1999 on the governance of the Energy Union and Climate Action (Governance Regulation). On 14 July 2021 the EC published a set of regulatory proposals ("Fit for 55 Package") with the aim of revising some of the existing legislation in order to adapt it to the new EU climate objectives. The proposed amendments include the Renewable Energy Directive and the Energy Efficiency Directive, amending the respective targets for 2030.

2 Target set out in Article 4 of Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality ("European Climate Legislation").

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 1.2. Indicative energy planning

In energy planning, a distinction is made between binding planning, which refers to the development of the transmission network and is the one that concerns us in this document; and indicative planning, which establishes potential scenarios for the evolution of demand and target generation fleet in terms of electricity generation and supply without taking into account the capacity of the electricity networks. The indicative planning is fully described in the Spanish NECP (Plan Nacional Integrado de Energía y Clima 2030 or NECP). The NECP also serves as an instrument for achieving the national objectives proposed in Article 3 of the Climate Change and Energy Transition Law[3], Law 7/2021:

- To reduce greenhouse gas emissions in the Spanish economy as a whole by at least 23% by 2030 compared to 1990.
- To achieve a penetration of renewable energy sources in final energy consumption of at least 42% by 2030.
- To achieve an electricity system with at least 74% of generation from renewable energy sources by 2030.
- To improve energy efficiency by reducing primary energy consumption by at least 39.5% compared to the baseline in accordance with European legislation.
- Spain should achieve climate neutrality before 2050 and, in any case, in the shortest possible time, furthermore, the electricity system should be based exclusively on renewable energy sources.

## The SpanishNational Energy and Climate Plan (NECP) 2030 constitutes the indicative energy planning.

Regulation (EU) 2018/1999 establishes in Article 3 that each member state must communicate to the European Commission a first National Energy and Climate Plan for the period from 2021 to 2030, including national contributions in terms of decarbonisation, improving energy efficiency and increasing the share of renewables in final energy consumption. These plans help the European Union plan to meet its climate change objectives and targets in line with the Paris Agreement.

On 25 March 2021, the Spanish Council of Ministers approved the final version of the PNIEC[4]. This plan is divided into two main blocks: the first one describes the process, the national objectives, the existing policies and measures as well as those necessary to achieve the objectives of the plan, and the analysis of the economic, employment, distributional and health welfare impact. The second block integrates the analytical part, which details the projections of both a Trend Scenario and a Target Scenario, as well as descriptions of the different models that have made the prospective analysis possible and that provide robustness to the results.



3 https://www.boe.es/eli/es/l/2021/05/20/7.
4 https://www.boe.es/diario_boe/txt.php?id=BOE-A-2021-5106.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 1.3. Binding energy planning: transmission grid

The regulation of the electricity sector contemplates the liberalisation of certain activities, such as electricity production or supply, while others, such as the development of the transmission network, are regulated and subject to a binding planning due to their strategic nature.

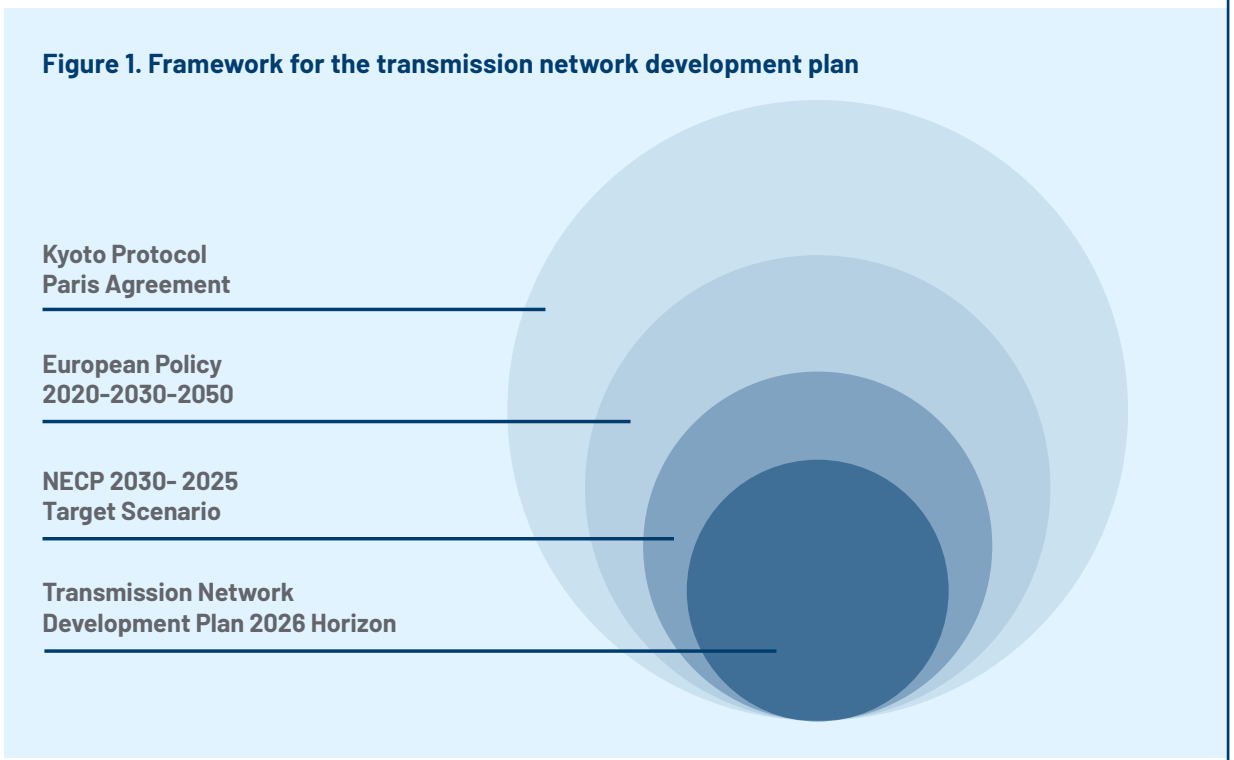
In order to ensure that the electricity supply is reliable and efficient for consumers in a new energy transition scenario, it is essential to have a correctly designed electricity system and, in particular, an electricity transmission network designed for this purpose.

The NECP itself establishes the adaptation of electricity networks for the integration of renewable energy sources as one of the measures required to achieve its objectives, identifying the 2021-2026 transmission network development plan as a mechanism for investment, which must take into account the framework in which the system will operate as a result of achieving the objectives of the NECP. In addition, to address the implementation of the measure to reduce dependence on coal and oil, or for the integration of renewable energy sources in the systems of non-peninsular territories, links between electricity systems have been included in this plan as a mechanism for investment.

As indicated in the NECP itself, the transmission network development plan for the 2021-2026 horizon must be based on the target scenario of the NECP, according to the regulations established by the indicative planning. For this reason, the plan is based on the forecasts for electricity consumption, generation and the composition of installed generation capacity of the NECP, although they are adapted to the planning horizon, i.e. the year 2026.

Transmission network planning is a fundamental tool for ensuring the energy transition.

**Figure 1. Framework for the transmission network development plan**




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

Thus, this new transmission network development plan takes into account the substantial changes resulting from the energy transition, the fulfilment of energy efficiency, renewable energy and climate change objectives, and the increase in the level of electrification of the economy. Within the 2021-2026 timeframe of this plan, the foundations of the transmission network of the future are established, which must fulfil its function of connecting generation and consumption in scenarios with a high variability of energy flows between different areas of our country, with maximum respect for the environment and providing value for both consumers and new generators, all within the investment cost limits established in the applicable regulations.

The future network development plan is governed by the guiding principles set out in Order TEC/212/2019, of 25 February, which initiated the procedure for presenting proposals for the development of the electricity transmission network with a 2026 horizon:

a) Fulfilment of the energy and climate commitments that will be specified at the national level in the NECP 2021-2030.

b) Maximising the penetration of renewables in the electricity system, minimising the risk of curtailment, in a way that is compatible with the security of the electricity system.

c) The evacuation of renewable energies in those areas with high availability of renewable resources and where it is environmentally possible to exploit and transport the energy generated.

d) The contribution, with regard to the electricity transmission network, to guaranteeing the security of supply of the electricity system.

e) Making the development of the electricity transmission network compatible with environmental constraints.

f) The elimination of existing technical constraints in the electricity transmission network.

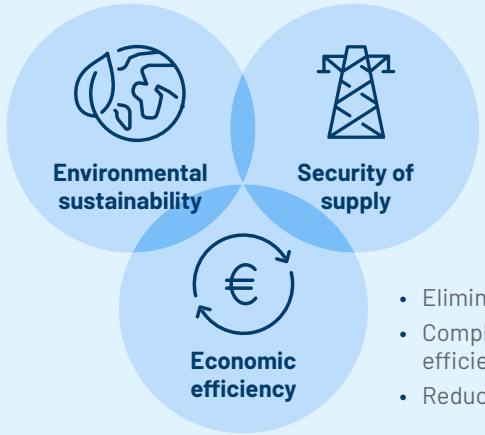
g) Compliance with the principles of economic efficiency and the principle of economic and financial sustainability of the electricity system.

h) Maximisation of the utilisation of the existing network by renovating, uprating, using new technologies and reusing existing facilities.

i) Minimisation of losses in the transmission of electricity to consumption points.

**Figure 2. Guiding principles of the Network Development Plan 2021-2026**

**Compliance with the energy and climate commitments established by the NECP 2021-2030 (decarbonisation, efficiency and interconnections)**




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

Therefore, the 2021-2026 plan aims to identify the transmission network development needs for several purposes:

- To enable the massive integration of new renewable generation at the rate necessary to achieve the NECP objectives in the medium and long term.
- To maintain and improve the security of supply of the Spanish electricity system in compliance with applicable legislation.
- To respond to the new demand needs that are identified, including those relating to the supply of transport infrastructures such as railways or the electrification of seaports.
- To reduce the structural technical limitations of the transmission network that make it necessary to schedule generation due to technical constraints
- To respond to the needs of international interconnection and connection with and between non-peninsular territories.

The investments to respond to the needs identified must respect environmental protection and, at the same time, guarantee the principle of efficiency and economic and financial sustainability of the electricity system, respecting the established investment limits. In relation to this last aspect, a cost-benefit analysis of the proposed investments has been carried out from the point of view of the system, including the optimum alternative to meet the identified needs in the development plan. The cost-benefit analysis applied is inspired by the methodology used by ENTSO-E[5] and endorsed by the European Commission, and considers both monetized and non-monetized benefits and costs through a set of indicators. The search for efficiency, among other aspects, translates into the incorporation of modernisation and digitalisation solutions for the existing network to maximise its use, as an previous alternative to proposing new developments, and to finally select the set of alternatives that provide the greatest value as planned investments.

The implementing legislation establishes the mechanisms for modifying specific aspects or technical adaptations to make it possible to adjust the transmission network development plan once it has been approved.

Technical adaptations should allow the planned investments to be implemented, particularly in the event of the detection of identified infeasibilities, for example, in the environmental impact assessment process for projects.

Modifications to specific aspects should allow the development plan to be adjusted in order to respond to unforeseen events affecting the guarantee and security of supply, the need to feed new supplies from the transmission network, the concurrence of reasons of economic efficiency of the system or the need to deploy critical facilities for the energy transition not contemplated in the approved plan.

**Planning must be a living process under constant review, especially in the context of the energy transition.**



5 European Network Transmission System Operators for Electricity, the association of European TSOs.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 1.3.1. A process of continuous improvement. New approaches compared to previous plans

The 2015-2020 plan introduced some new approaches, which the 2021-2026 planning maintains and reinforces:

- Consideration of a smaller starting grid than the planned grid. The investments already planned that are not yet in service are reviewed under objective criteria to check whether they are sufficiently advanced to be incorporated into the starting grid and to be the basis or starting point for studying the needs of the transmission network. The rest of the investments are re-evaluated by applying the criteria and principles established for the current process.

- Cost-benefit evaluation of investments with a multi-criteria approach.

- Identification of investments that are considered necessary beyond the planning horizon. While the planning horizon is six years, the deployment of some transmission network infrastructures requires long periods of study and administrative and environmental permitting, the resolution of technical difficulties and coordination between different agents. All these factors make it advisable to consider longer-term horizons on a preliminary basis. In accordance with sector legislation, the identification of an investment for a date later than the planning time horizon does not make it binding, but it does allow the relevant administrative procedures to begin as long as they do not directly affect the property and rights of third parties.

The current plan allows progress to be made on approaches already introduced in the 2015-2020 plan and incorporates new ones for the sake of greater transparency and objectivity.

On the other hand, new approaches derived from the context of the energy transition and the search for greater transparency and objectivity are incorporated:

- Estimation of the location of new renewable generation established in the NECP. In this planning process, the volume of both access requests and proposals from subjects for the connection of renewable energy sources far exceeds the target generation capacity value at the 2026 horizon. The developed methodology allows the identification of the areas with the highest resource and lowest environmental impact for the installation of renewable energy sources. The design of the future transmission network focuses on enabling the integration of the generation potentially located in these sites, but without forgetting that the future deployment of generation will be defined by the developers, who will continue to have the possibility of connecting to the network through the processing of the necessary permits.



Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

- Analysis of system needs in the scenario defined for the 2026 horizon, considering only the study's base network, or starting grid, to be in service.

- Application of a clearly defined methodology for analysing the proposals submitted by the different parties involved in the planning process, and the use of tools based on an exhaustive analysis of possible situations in the transmission network at all times of the year, as opposed to the conventional deterministic analyses that are traditionally used.

- Incorporation of new elements in the transmission network that take advantage of the latest technological developments available, in response to the system's need for flexibility and greater use of the existing network.

- Improved communication and dissemination in the different phases of the process. Efforts have been made to simplify the network development plan document in order to make it easier to read and understand, especially for the non-technical public. The traditional tables have been replaced by project sheets incorporating the concept of investment as a grouping of facilities with a joint electrical sense and that respond as such to an identified need. In addition, a public hearing process has been carried out on the Initial Proposal, beyond the hearing period for the Autonomous Communities to submit their allegations established in the regulation[6]. The aim of all this is to involve and increase the participation of citizens and the different administrations in the process, in order to obtain a more consensual plan that is easier to implement.



6 Art. 11 of Royal Decree 1955/2000, of 1 December, which regulates the activities of transmission, distribution, commercialisation, supply and authorisation procedures for electrical energy installations.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 1.4. Planning process

The planning process[7] is open to the participation of all parties with an interest in the electricity sector and of all administrations due to its territorial, environmental and social implications. The participation of any entity or individual who wishes to do so is also allowed.

## The planning process is a regulated process open to the participation of society.

The entire process consists of the following phases that have been completed between March 2019 and March 2022:

- **Proposals phase** (3 months). From the time of publication of the start of the planning process in the BOE, which took place on 01 March 2019, the Autonomous Communities and stakeholders in the sector drew up their transmission network development proposals and submitted them to MITERD and the System Operator, Red Eléctrica de España (REE).

- **Study phase** (6 months). Based on the information collected in the previous phase and the information derived from the access requests, Red Eléctrica de España (REE), as System Operator, carries out the relevant technical studies and prepares the initial proposal, in accordance with the criteria established by MITERD.

- The National Markets and Competition Commission (CNMC, for its acronym in Spanish) prepares a report containing its recommendations on the economic implications of the planned investments and their impact on the economic-financial sustainability of the electricity system, published on 2 July 2020.

- **Public consultation phase.** The public consultation phase of the Proposal for the Transmission Network Development Plan 2021-2026 took place between 15 February and 12 April 2021. This phase was launched simultaneously with the public consultation of the Strategic Environmental Study. Both consultations (substantive and environmental) were opened to the general public in the interests of transparency in the process, without it being a requirement imposed by current legislation.

- **CNMC Report.** The MITERD submitted the Initial Development Proposal to the CNMC, which published its report on 7 June 2021 in which it evaluated the initial proposal positively and made a series of recommendations.

- **Second study phase** (2 months). The MITERD transferred all the considerations received to the System Operator as well as the criteria for dealing with the allegations, and the System Operator prepared the proposal for the Transmission Network Development Plan by 23 June 2021 on this basis.

- **Consolidation phase.** Once the allegations and recommendations have been analysed and incorporated into the Transmission Network Development Plan Proposal and its Strategic Environmental Study, and the Strategic Statement issued by the environment area of the MITERD on 9 December 2021, the proposal is consolidated in the Transmission Network Development Plan.

- **Approval phase.** Finally, the Transmission Network Development Plan 2021-2026 is submitted to the Council of Ministers for referral to the Congress of Deputies prior to its approval by the Government.

7 Find more information on the process at https://www.ree.es/es/actividades/planificacion-electrica.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

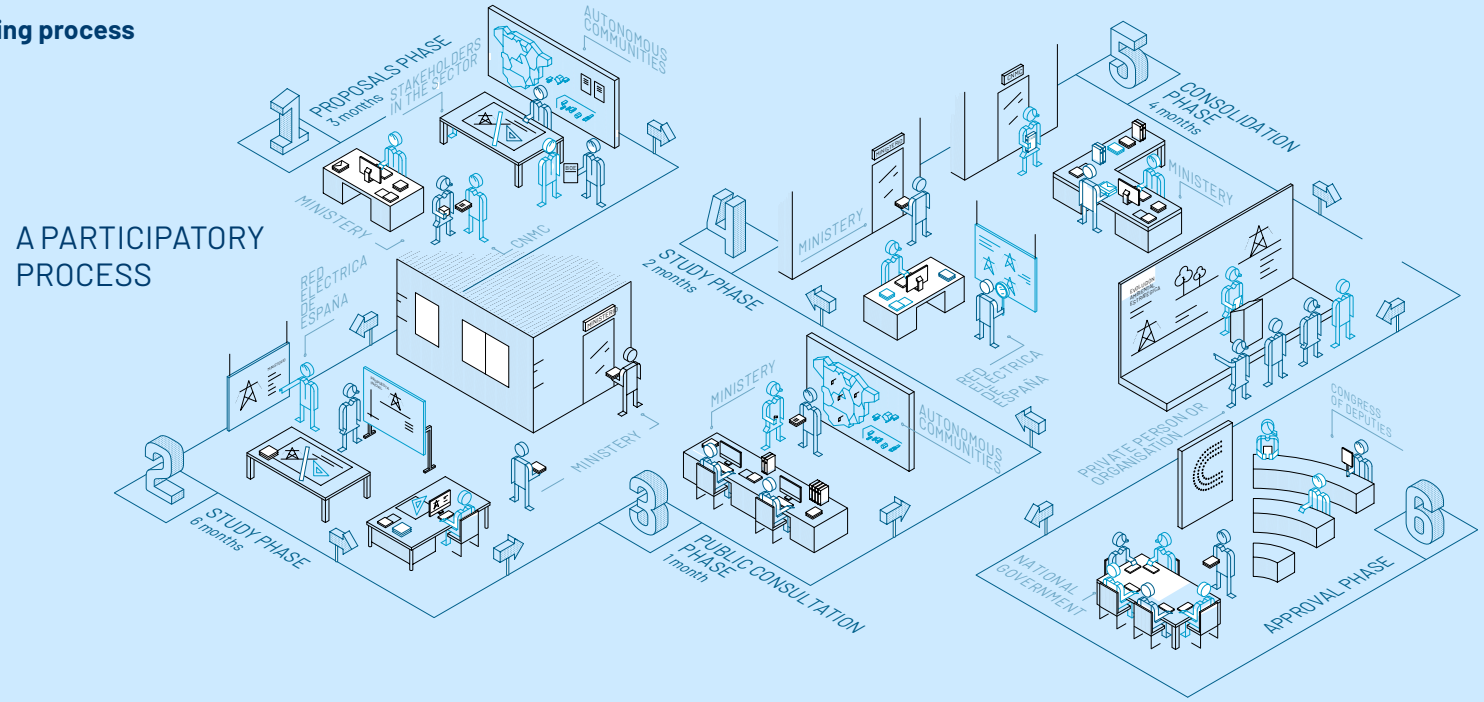
The Strategic Environmental Assessment (SEA) is a parallel process regulated by Law 21/2013 of 9 December on environmental assessment. The process started in August 2020 with the request to initiate and submit the strategic document and the draft plan.

In November 2020, the Secretary of State for the Environment of the MITERD published the scope document of the Strategic Environmental Assessment which sets out the conditions of the Strategic Environmental Study of the planning, as well as the definition of its alternatives. This document includes recommendations received from different stakeholders in the preliminary consultation phase held between 7 August and 7 October 2020.

From this point onwards, the MITERD Secretariat of State for Energy, as the promoting body, prepares the Strategic Environmental Study, which defines and analyses different macro alternatives for the plan as a whole, in accordance with the philosophy and criteria established in the scope document. The specific evaluation of the particular investments is outside the scope of this study as it is dealt with in the Environmental Impact Statement during the permitting phase of each project.

The Strategic Environmental Study, together with the version of the plan, is submitted for public information for a minimum period of 45 working days between 15 February and 21 April 2021, and following the analysis of the allegations, the full plan file is prepared. After the technical analysis of the complete plan file, the Directorate General for Environmental Quality and Assessment of the MITERD signed the Strategic Environmental Declaration of the energy planning on 9 December 2021.

**Figure 3. Planning process**




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 1.4.1. Proposals stage

A total of 1,335 proposals were received from 177 subjects during the proposals phase. Of these, 1,207 proposals have been satisfactorily evaluated in relation to the requirements for the provision of information required in Order TEC/212/2019 on the start of Planning. The following figures summarise the nature of the proposals received, their distribution by Autonomous Communities, by the type of agent that submitted them and by their motivation (renewable generation access, distribution support...).

The volume of proposals received and their typology highlight the great interest aroused by the 2021-2026 planning process in the context of the energy transition. As can be deduced from the above figures, a large number of the proposals have been submitted by renewable generation promoters or are linked to the implementation of new facilities included in the NECP such as storage systems (pumped storage and batteries) and new power supply points for railway lines and the electrification of seaports. As part of the information required by the order to initiate planning, REE, in its capacity as transmission operator, submitted proposals for the renewal and improvement of the existing network, its forecast for the commissioning of the investments included in the 2015-2020 plan that are under construction or in permitting, as well as the identification of those whose deployment has been unfeasible so that, should the need for them remain, possible alternatives can be evaluated. Each proposal has been taken into consideration in the study phase and, depending on its nature, it has been subject to a process of analysis and decision guided by the MITERD, which is detailed in the description of the methodology.

**The proposals phase revealed a great deal of interest in this planning exercise within the framework of the Energy Transition.**

**Figure 4. Distribution of proposals received by Autonomous Communities**

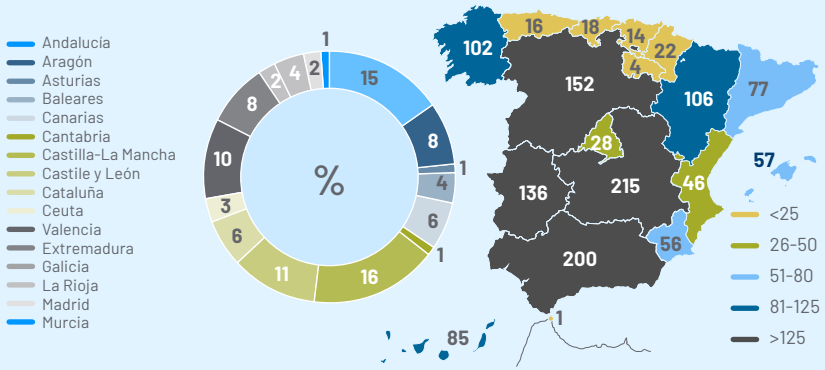
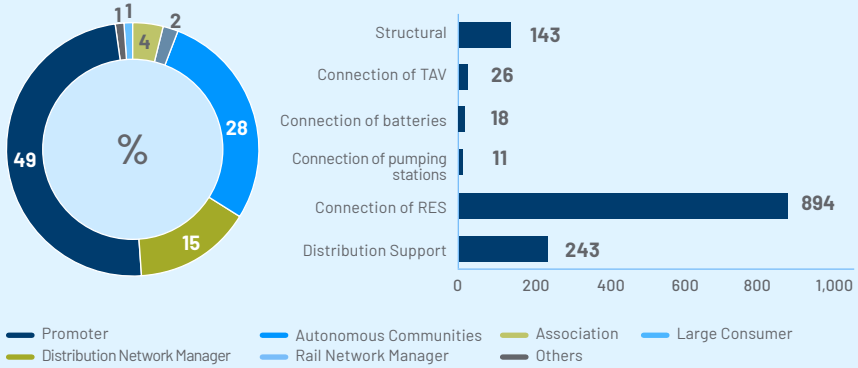



**Figure 5. Distribution of the proposals received by type of agent and motivation**




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

2

# 2. Indicative Planning (NECP): study scenario

2.1. Demand

2.2. Generation

2.2.1. Estimated location of renewable energy sources for the scenario foreseen in 2026

Introduction

**Indicative Planning (NECP): study scenario**

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

The National Energy and Climate Plan 2021-2030 establishes the roadmap for the national energy system designed in coherence with the objective of reaching emission neutrality in 2050 from a cost-efficient point of view in order to achieve the following results in 2030:

- A 23% reduction in greenhouse gas (GHG) emissions compared to 1990.
- 42% of renewable energy sources as a proportion of total gross final energy consumption.
- 39.5% improvement in energy efficiency.
- 74% of electricity generation from renewable sources.

The NECP establishes both forecasts and projections for the different sectors of activity in terms of energy as a framework for indicative energy planning. For the electricity system in particular, the target scenario of the NECP foresees both the evolution of the generation fleet in the whole of Spain and the final electricity demand for the period 2021-2030.

The NECP also establishes as an objective the development of interconnections as a means of achieving a single European market in which the Spanish peninsular electricity system reaches a level of integration that is consistent with the objectives set at European Union level. To make this objective possible, the transmission network development plan considers these projects in order to identify potential internal network reinforcement needs that could limit commercial exchange capacity and, consequently, the efficient use of the planned interconnections. Therefore, the following interconnection projects already foreseen in the 2015-2020 planning are considered in the 2026 scenario:

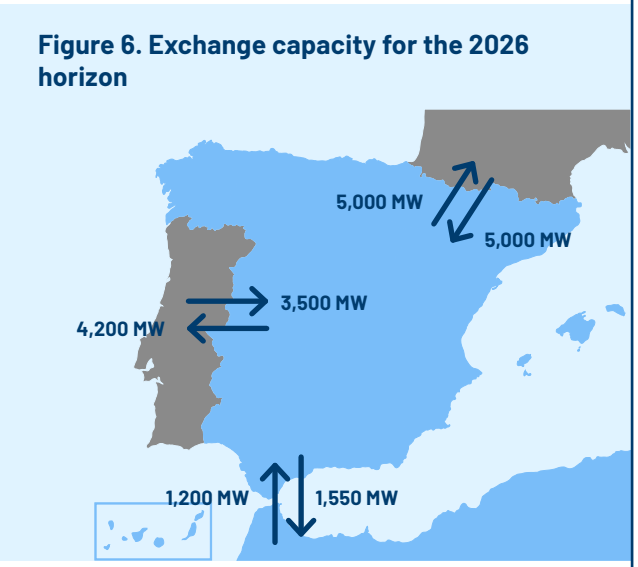
**The study scenario is established by the indicative plan contained in the NECP (NECP) 2021-2030.**

- Northern interconnection with Portugal, with commissioning in 2023-2024.
- Interconnection of the Bay of Biscay with France, with commissioning in 2026-2027.

Both projects are included and evaluated in the European Ten Year Network Development Plan 2020[8]. In addition, due to their key role in achieving European energy policy, they are classified as Projects of Common Interest by the European Commission (a label formally endorsed for the last time in the fourth list published in October 2019)[9].

Likewise, the strengthening of the interconnection with Morocco has been considered in the study scenario, enabling the agreement with the Kingdom of Morocco for the development of a third electricity interconnection and a strategy for collaboration in the field of energy by 2026, established in February 2019[10].

**Figure 6. Exchange capacity for the 2026 horizon**




8 https://tyndp.entsoe.eu/documents.
9 https://ec.europa.eu/energy/sites/ener/files/c_2019_7772_1_annex.pdf. The fifth list, published on 19 November 2021 by the European Commission, which also includes these projects, will be submitted for approval during 2022.
10 https://www.lamoncloa.gob.es/serviciosdeprensa/notasprensa/ecologica/Paginas/2019/140219-energiamarruecos.aspx.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 2.1. Demand

As with the rest of the variables established in the indicative planning, the demand scenario used in the process of drawing up the transmission network development plan for the 2026 horizon must be derived from the target scenario set out in the NECP.

The demand of the electricity system is strongly linked to the evolution of the economy and its forecast is therefore subject to the uncertainty of long-term macroeconomic forecasts. For this reason, additional electricity demand projections have been made for two scenarios of GDP evolution.

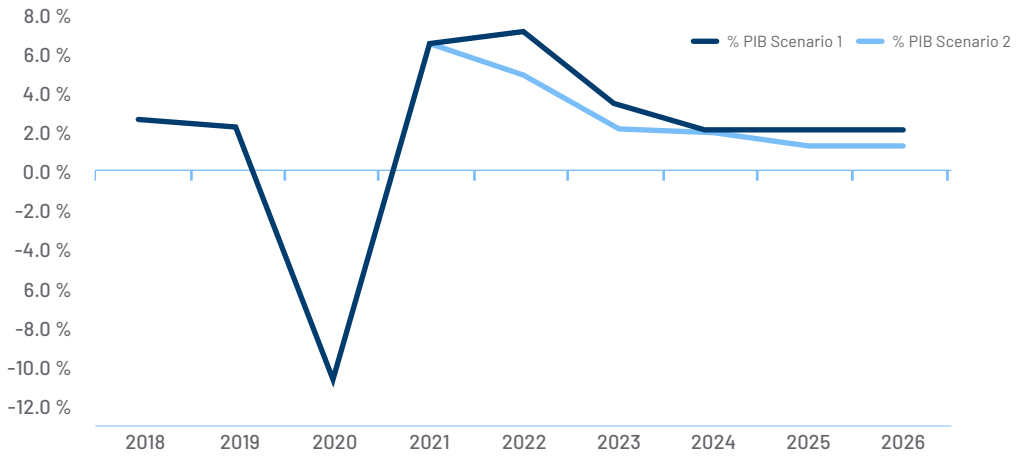
The figure above depicts two possible scenarios for long-term GDP developments: Scenario 1 assumes a significant fall in GDP in 2020 with a moderate recovery from 2021 onwards. Scenario 2 is based on the GDP developments projected in the "Stability programme update 2021" of April 2021. In this respect, the high uncertainty in the projected economic developments towards the 2026 horizon should be highlighted.

Based on these estimates, projected average GDP growth in the period 2020-2026 would be between 1.1% and 1.8%, depending on the scenario considered.

Demand growth until 2026 is limited. Although it is not the main driver of the 2026 plan, security of supply is a guiding principle and a core element of energy policy, and planning should contribute to ensuring it.

**Figure 7. Scenarios for the evolution of the annual change in GDP (%)**

| Year | Scenario 1 | Scenario 2 |
|---|---|---|
| 2018 | 2.4 % | 2.4 % |
| 2019 | 2.2 % | 2.2 % |
| 2020 | -10.8 % | -10.8 % |
| 2021 | 6.5 % | 6.5 % |
| 2022 | 4.9 % | 7.0 % |
| 2023 | 2.1 % | 3.5 % |
| 2024 | 1.9 % | 2.1 % |
| 2023 | 1.4 % | 2.1 % |
| 2026 | 1.5 % | 2.1 % |
| **2020-2026** | **1.1%** | **1.8%** |




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

The evolution of gross demand at the national level in the GDP scenarios proposed compared with the scenario derived from the NECP used for this planning is shown below. As can be seen in the figure, the value of national electricity demand obtained using the path defined in the NECP is slightly higher in the 2026 horizon than those resulting from the two GDP evolution scenarios described above.

The indicative planning (NECP) establishes the electricity demand projection in its target scenario, which serves as the basis for setting the demand value to be considered in the study scenario for the preparation of the transmission network development plan.

These medium and long-term demand forecasts have been made using a model that is not based exclusively on econometric methods, also incorporating the expected end uses of electricity. The input variables of the model used to make the forecast are economic growth, its division by sectors, energy prices and stock variables.

**Figure 8. Demand evolution scenarios (at power station busbars). National (TWh)**

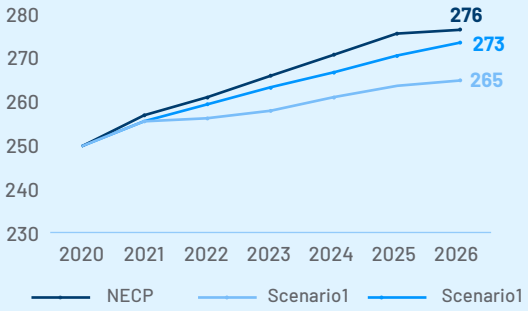
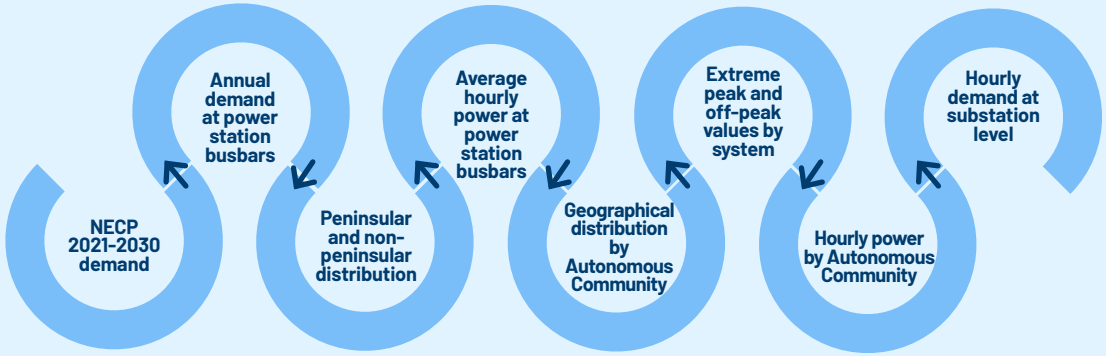



**Figure 9.Process for obtaining hourly demand at substation level**




In order to analyse the transmission network reinforcement needs at the 2026 horizon, it is necessary to break down the aggregate demand values corresponding to the hypotheses included in the target scenario at the nodes of the base study network. various forecasting models are used along with the information provided by system agents in order to establish hourly demand values, as well as their breakdown by network nodes.

The starting point for the process is the annual electricity demand values at power station busbars of the national electricity system foreseen in the NECP in the Objective 2025 and 2030 scenarios. The value for 2026 is established by means of a linear interpolation between the two years.

The value of peninsular and non-peninsular demand at power station busbars is obtained by applying the weights per Autonomous Communities resulting from an annual forecasting model at regional level to the national value.

Subsequently, and for each of the national electricity systems, the average hourly power forecast at power station busbars is made for the 8,760 hours of the year, using a model that projects the load curve for the scenario considered, taking into account the forecast annual demand per system at power station busbars.

Then, based on the forecast load curve, the extreme values (peak and off-peak) are determined for the analysis period for each electricity system.

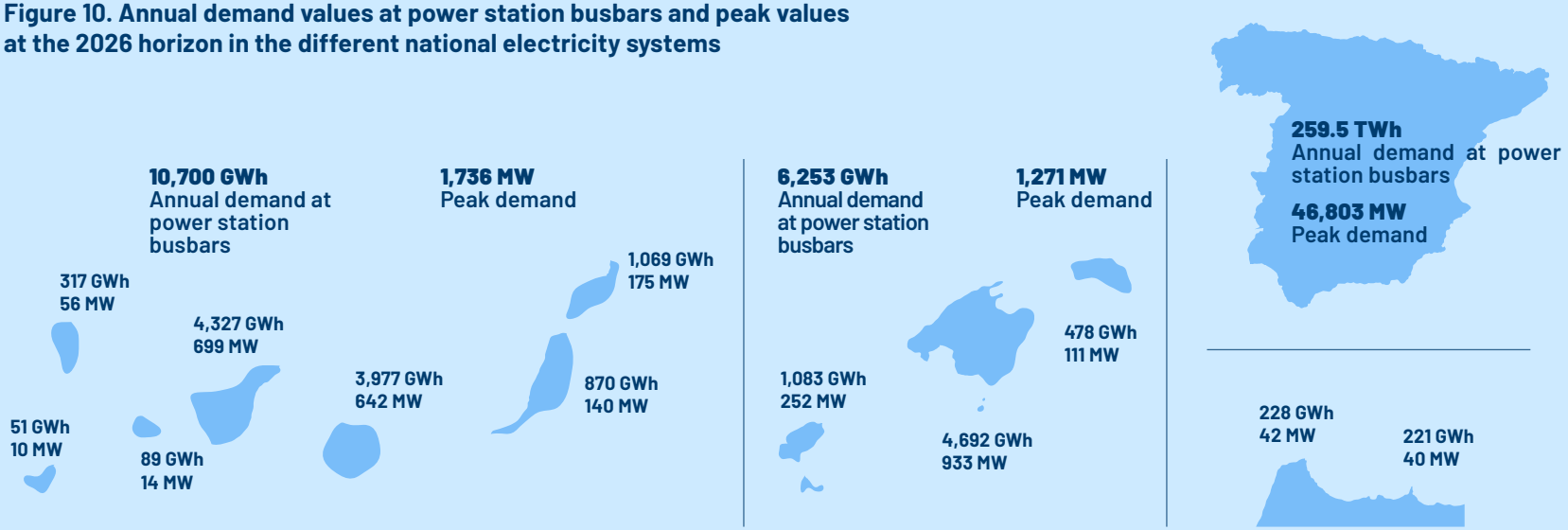
Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

The final step consists of distributing the demand at node level. To this end, the nodal demand value is obtained (400 kV, 220 kV and 132/110 kV in the Spanish mainland system and 132 kV and 66 kV in the non peninsular territories) based on the hourly demand forecast in power station busbars by Autonomous Community, considering losses, and subsequently applying a 2% increase to take into account the change from peak hourly average power to instantaneous. This step takes into account the information provided by the system agents –particularly the distribution companies– in the planning process (nodal weights by Autonomous Community).

Given that the NECP does not specify a self-consumption target and the approval of the Self-consumption Roadmap was published in December 2021, the studies to determine the development of the transmission network 2021-2026 –carried out in 2019– do not consider a differentiation of self-consumed demand.

Applying the methodology described above, the Spanish Peninsular Electricity System (SEPE,for its acronym in Spanish) has a forecast annual electricity demand at power station busbars of 259.5 TWh in the year 2026 (accumulated growth of 2.4% with respect to 2018) and peak demand of 46,803 MW of electricity (15% growth compared to peak demand in 2018). Figure 10 also shows the forecasts for the non-peninsular territories (TNP, for its acronym in Spanish).

**Figure 10. Annual demand values at power station busbars and peak values at the 2026 horizon in the different national electricity systems**




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

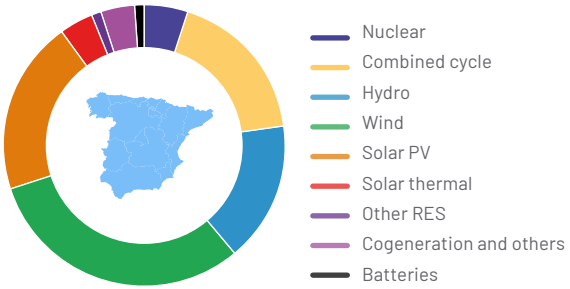
# 2.2. Generation

In order to establish the value of installed generation capacity by type of technology in the 2026 scenario, in general, the data set in the NECP in the 2025 and 2030 target scenarios have been linearly interpolated. As an exception to this consideration, the values corresponding to coal and nuclear generation have been established. Thus, although the NECP establishes values of 2,165 MW in 2025 and 0 MW in 2030 for coal generation, in order to adapt the transmission network so that the closure of coal plants does not pose any problem for security of supply and to identify potential needs caused by this closure, the decommissioning of all currently existing coal units has been considered for the 2026 horizon. On the other hand, it is considered that the decommissioning of existing nuclear power plants will occur after 2026, so that the generation study scenario includes the capacity currently in service.

## The shift in generation technologies towards mainly renewable generation is the main driver for the development of the transmission network by 2026.

**Figure 11. Installed generation capacity by technology in the 2026 study scenario. Spanish mainland**

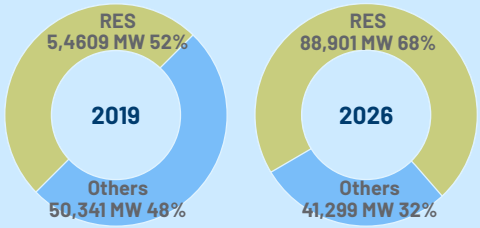
| Technology type | MW | % |
|---|---|---|
| Nuclear | 7,117 | 5 % |
| Coal | 0 | 0 % |
| Combined cycle | 24,560 | 19 % |
| Hydraulics | 21,260 | 16 % |
| Wind | 41,051 | 32 % |
| Solar photovoltaic | 24,532 | 19 % |
| Solar thermal | 5,300 | 4 % |
| Other RES | 1,220 | 1 % |
| Cogeneration and others | 4,660 | 4 % |
| Batteries | 500 | 0.4 % |
| **TOTAL** | **130,200** | **100 %** |




The installed generation capacity from renewable sources considered in the Spanish mainland system is 88,901 MW, i.e. 68% of the total. Installed generation capacity from emission-free technologies, i.e. renewables and nuclear energy, is 96,018 MW, representing 74% of the total.

## Emission-free installed generation capacity will account for 77% of the total in 2026 and non-hydro renewable generation will account for 56% of the total.

**Figure 12. Renewable energy sources capacity in 2019 (left) and in the 2026 study scenario (right)**

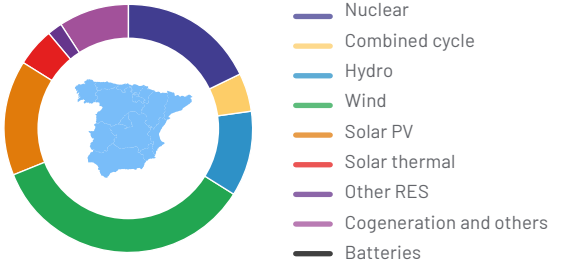



Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## Figure 13. Generation ratio by technology in the 2026 study scenario. Spanish mainland

| Technology type | GWh | % |
|---|---|---|
| Nuclear | 49,839 | 18 % |
| Coal | 0 | 0 % |
| Combined cycle | 14,634 | 5 % |
| Hydraulic[11] | 29,186 | 11 % |
| Wind | 96,671 | 35 % |
| Solar photovoltaic | 41,995 | 15 % |
| Solar thermal | 13,022 | 5 % |
| Other RES | 5,839 | 2 % |
| Cogeneration and others | 23,491 | 9 % |
| **TOTAL PRODUCTION** | **274,677** | **100%** |

| **Electricity production** | **274,677** | **GWh** |
|---|---|---|
| Balance ES-FR: | -1,110 | |
| Balance ES-PT: | 665 | |
| Balance ES-MAR: | 11,285 | |
| Balance Spanish Mainland-Baleares | 4,060 | |
| Balance Spanish Mainland-Ceuta | 228 | |
| **Spanish Mainland demand at power station busbars** | **259,549** | **GWh** |



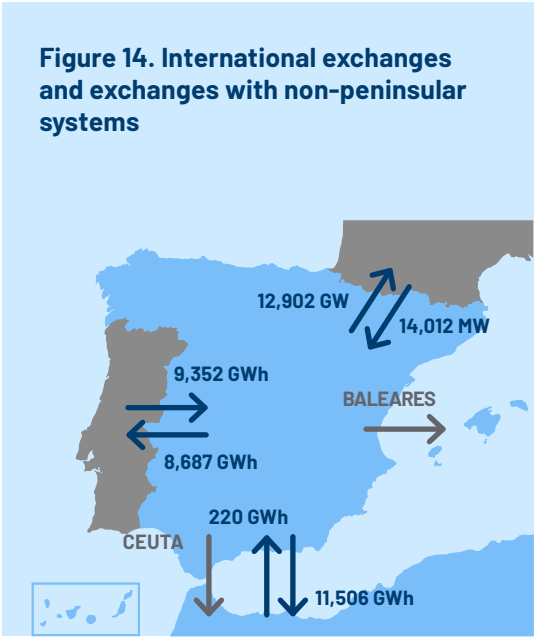

Note: in order to determine the needs for internal reinforcements, the study scenario for the Spanish mainland system considers the exchange balances resulting from the reinforcements included in the development plan of the interconnections. As a result, Spain will be a net exporter by 2026, with a net value of international exports of 10.8% TWh.

11 Net value.

The resulting generation balance for 2026 is obtained not from the interpolation of the NECP values but from market simulations specific to the study scenario. The results show a production ratio of 86% emission-free production in 2026.

In order to determine the needs for internal reinforcements, the study scenario for the Spanish mainland system considers the exchange balances resulting from the reinforcements included in the development plan of the interconnections. As a result, Spain will be a net exporter by 2026, with a net value of international exports of 10.8% TWh.

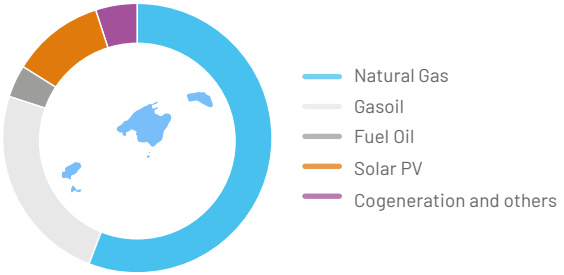
## Figure 14. International exchanges and exchanges with non-peninsular systems




In the Balearic system, the study scenario –which does not include a reinforcement of the link with the mainland– achieves a predominantly thermal generation balance in 2026. The current link with the mainland would allow only 29% of the demand of the Balearic system to be supplied with power from the mainland.

## Figure 15. Installed generation capacity by technology in the 2026 study scenario. Baleares

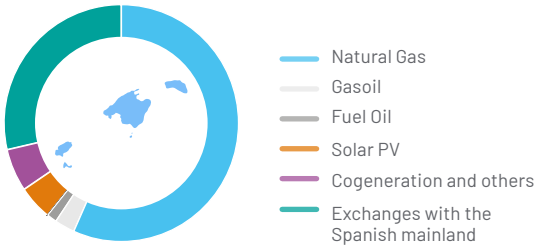
| Technology type | MW | % |
|---|---|---|
| Natural Gas | 977 | 56 % |
| Gas oil | 417 | 24 % |
| Fuel Oil | 70 | 4 % |
| Wind | 3 | 0 % |
| Solar photovoltaic | 201 | 11 % |
| Cogeneration and others | 80 | 5 % |
| **Total** | **1,748** | **100%** |




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

### Figure 16. Generation ratio by technology in the 2026 study scenario. Baleares

| Technology type | GWh | % |
|---|---|---|
| Natural Gas | 3,545 | 54 % |
| Gas oil | 175 | 3 % |
| Fuel Oil | 87 | 1 % |
| Wind | 4 | 0 % |
| Solar photovoltaic | 304 | 5 % |
| Cogeneration and others | 350 | 6 % |
| Exchange with the Spanish mainland | 1,788 | 31 % |
| **Total** | **6,253** | **100 %** |

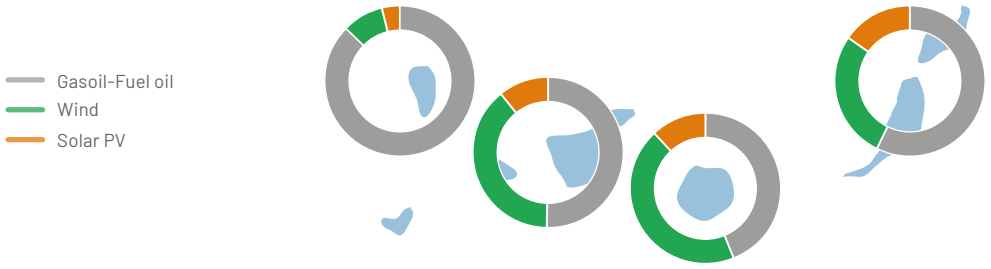



In the 2026 study scenario in the Canarias, the island of Gran Canaria has more installed renewable energy sources than thermal generation. In the Tenerife-La Gomera and Fuerteventura-Lanzarote systems, there is an even, or practically even, distribution of installed capacity between thermal and renewable energy sources, while La Palma is predominantly thermal.

In the generation balance derived from the study scenario in the Canarias, it can be seen that production with Gas oil - Fuel Oil is predominant (combined cycles, diesel engines, steam turbines and gas turbines).

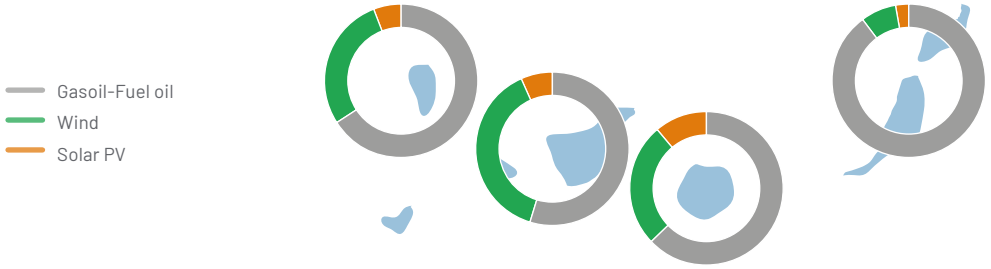
### Figure 17. Installed generation capacity by technology in the 2026 study scenario. Canarias

| Technology type | MW Tenerife -La Gomera | MW Gran Canaria | MW Fuerteventura -Lanzarote | MW La Palma | MW Canarias | % |
|---|---|---|---|---|---|---|
| Gas oil-Fuel oil | 776 | 679 | 398 | 96 | 1,949 | 50 % |
| Wind | 601 | 680 | 190 | 10 | 1,481 | 38 % |
| Solar photovoltaic | 164 | 180 | 105 | 4 | 453 | 12 % |
| TOTAL | 1,541 | 1,539 | 693 | 110 | 3,883 | 100% |




### Figure 18. Generation ratio by technology in the 2026 study scenario. Canarias

| Technology type | GWh Tenerife -La Gomera | GWh Gran Canaria | GWh Fuerteventura -Lanzarote | GWh La Palma | GWh Total | % |
|---|---|---|---|---|---|---|
| Gas oil-Fuel oil | 2,919 | 2,186 | 1,220 | 285 | 6,610 | 62 % |
| Wind | 1,243 | 1,527 | 506 | 24 | 3,300 | 31 % |
| Solar photovoltaic | 257 | 264 | 213 | 8 | 742 | 7 % |
| Total | 4,419 | 3,977 | 1,939 | 317 | 10,652[12] | 100% |




12 The difference between this total balance and the demand shown for the Canarias in Figure 10 corresponds to the island of El Hierro, where, as it does not have a transmission network, no studies are carried out in the field of transmission network planning.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

Beyond the generation balances shown above, the electricity system must be technically operable, i.e. capable of maintaining the frequency and voltage parameters in normal situations and in the event of severe contingencies and damping both local and global oscillatory phenomena.

However, the operability of the electricity system by 2026 will essentially be guaranteed by the operation of a certain number of generators, sometimes at the technical minimum, to maintain the correct operation of the system (this is what is known as "Must Run", referring to generation that "must run" as required by the system). In some cases, these may be synchronous generators of hydraulic and solar thermal technology, while in cases of insufficient hydraulic or solar resources, these services will be provided by natural gas combined cycle generators. The System Operator will periodically carry out operability analyses to identify the needs and characteristics of possible new services to guarantee this safe operability.

Another relevant aspect is to ensure demand adequacy, guaranteeing the necessary balance between generation and demand at all times, for which the System Operator has carried out the relevant analyses on the Objective 2030 scenario, which are included as Annex D.2 in the NECP itself. On the other hand, demand adequacy is analysed annually within the framework of ENTSO-E in the medium-term adequacy analysis "Mid-term Adequacy Forecast" (MAF)[13] until 2020 and, from 2021 onwards, in the "European Resource Adequacy Assessment" (ERAA) exercise. In 2021, the analysis published[14] for the National Estimates TY2025 scenario, in which the hypotheses of the 2025 target scenarios are? included in the National Energy and Climate Plans of the countries have been considered, showing that the exercise carried out in 2021 does not present appreciable risks for the adequacy of demand in Spain.

In non-peninsular systems, this adequacy is analysed in the Annual Report on Coverage of Non-Peninsular Territories Systems mentioned in article 44 of RD 738/2015, of 31 July, which regulates the electricity production activity and the dispatch procedure in the electricity systems of the non-peninsular territories. In the report prepared by the System Operator in January 2021 following the methodology established in said Royal Decree, it indicates the additional generation needs to the base generation in each of the non-peninsular electricity systems in the years 2022-2026, ensuring, in general, the adequacy of demand with the generation considered in this 2026 planning scenario. However, there are certain exceptions in the following scenarios in which there are additional power needs:



- Tenerife electricity system. Up to 93 MW of additional generation is required even considering those facilities that have completed their regulatory life span in 2026.
- La Gomera electricity system. Up to 3.5 MW of additional generation is required even considering those facilities that have completed their regulatory life span in 2026.
- Lanzarote electricity system. Up to 8 MW of additional generation is required even considering those facilities that have completed their regulatory life span in 2026.

13 https://www.entsoe.eu/outlooks/midterm/.
14 https://www.entsoe.eu/outlooks/eraa/.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 2.2.1. Estimated location of renewable energy sources for the 2026 scenario

In order to analyse the development of the transmission network required to integrate the amount of renewables included in the NECP, it is necessary to establish a hypothesis of the location of future renewable energy sources –mainly wind and solar photovoltaic generation facilities.

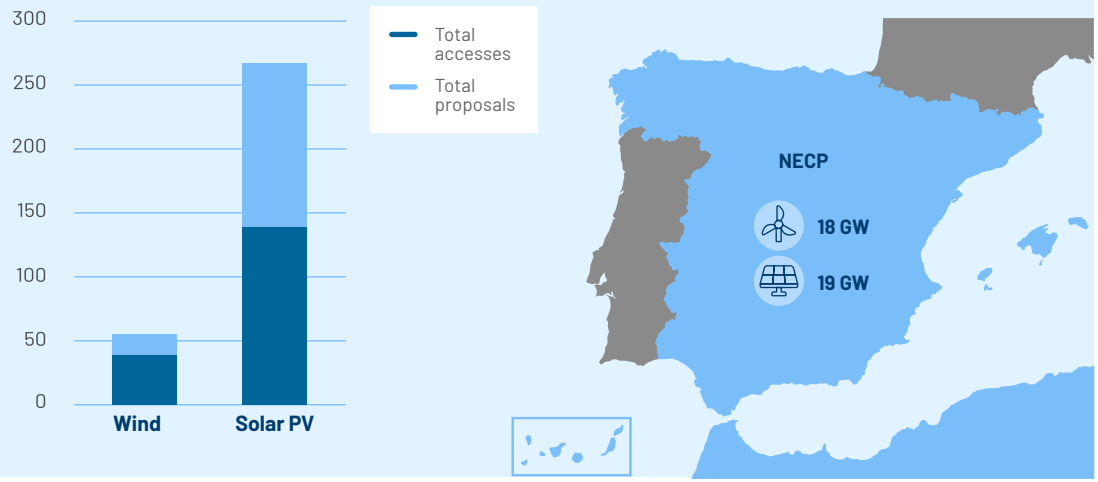
In the current planning process, unlike previous ones, the change in the generation fleet necessary for the energy transition is occurring very quickly and requests for network access, particularly for wind and photovoltaic generation, greatly exceed the values corresponding to the 2026 horizon consistent with the NECP target scenario.

Thus, in the case of future solar PV and wind generation facilities on the Spanish mainland, the expectations of developers of new generation, reflected in both the volume of access requests and the proposals submitted at the stage set aside for this purpose in the planning process, already far exceeded the renewable installation values of the NECP's target scenario for the 2026 study horizon and even for the 2030 horizon. Specifically, these expectations reflected in the access applications on 31 August 2019 were already more than three times higher than the new generation capacity to be installed by 2026 in the case of wind power and more than thirteen times higher in the case of solar PV.

It is therefore essential to estimate a deployment of these generation facilities on the Spanish mainland that is consistent with the corresponding generation mix for the year 2026. In the case of hydro and renewable energy sources in non-peninsular systems, there is a certain degree of consistency between the information on requests for access to the transmission network and the NECP target scenario, so it will be possible to use them as a reference.

In order to determine the future development needs of the transmission network, it is necessary to establish a probable scenario for the connection of renewable generation.

**Figure 19. Expectations (GW) of renewable wind and photovoltaic generation (31 August 2019) vs. the NECP target scenario for 2026**




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## SUMMARY OF THE METHODOLOGY FOR ESTIMATING THE LOCATION OF FUTURE PV AND WIND GENERATION ON THE SPANISH MAINLAND

This methodology is inspired by the guiding principles of maximising renewable production, resource-based evacuation of renewable energy sources, compatibility with environmental restrictions, maximising the use of the existing network and compliance with the principles of efficiency and economic sustainability.

Therefore, its objective is to estimate the most favourable locations for the deployment of the requested generation based on environmental viability and resource efficiency until reaching the values established by the NECP in 2026. In this way, the necessary network developments resulting from the studies will favour the evacuation of future renewable energy sources at the locations that are most consistent with the guiding principles of this plan.

**Location estimation for**

≈ 19,000 MW
**Photovoltaic**

≈ 18,000 MW
**Wind**

The established methodology consists of the four steps detailed below:

- Analysis and obtention of the geographical distribution of the resource.
- Analysis and obtention of the geographic distribution of the ease/difficulty of carrying out the permitting considering the absence of environmental restrictions and conditions for the implementation of photovoltaic or wind power plants.
- Analysis and obtention of the geographical distribution of the probability of success of the construction of photovoltaic or wind power plants based on the distributions of resource, production efficiency and ease of permitting.
- Allocation by node of new renewable capacity in the 2026 study scenario: estimation of the best locations requested (requests for access to the transmission network, both those granted and those denied and proposed in the planning process) based on the probability of success and weighted by the weight of the intentions of developers in each autonomous community.

It is important to note that the resulting location estimate does not limit access to the network at nodes where no generation is identified in the estimated scenario or for values higher than the values identified at a node, provided that there is capacity where access is requested. This estimate reflects the likelihood of permitting difficulties for projects with planned locations in more environmentally constrained areas or the lower expected interest in locations with lower resources.

Given that the expectations for renewable energy source development on the Spanish mainland far exceed the installation values set out in the NECP, it is necessary to estimate their location with the highest probability of success, while keeping it aligned with the guiding principles of the 2026 planning for renewable generation.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

In any case, if they are installed, they could be subject to real-time production limitations due to more recurrent and larger evacuation problems than those located in locations considered more favourable and estimated to be used to define the future development of the transmission network. However, future planning or modifications to the transmission network could adapt the transmission network to favour the integration of these facilities once they are commissioned and according to the guiding principles of application.

## ANALYSIS AND OBTENTION OF THE GEOGRAPHICAL DISTRIBUTION THE RESOURCE

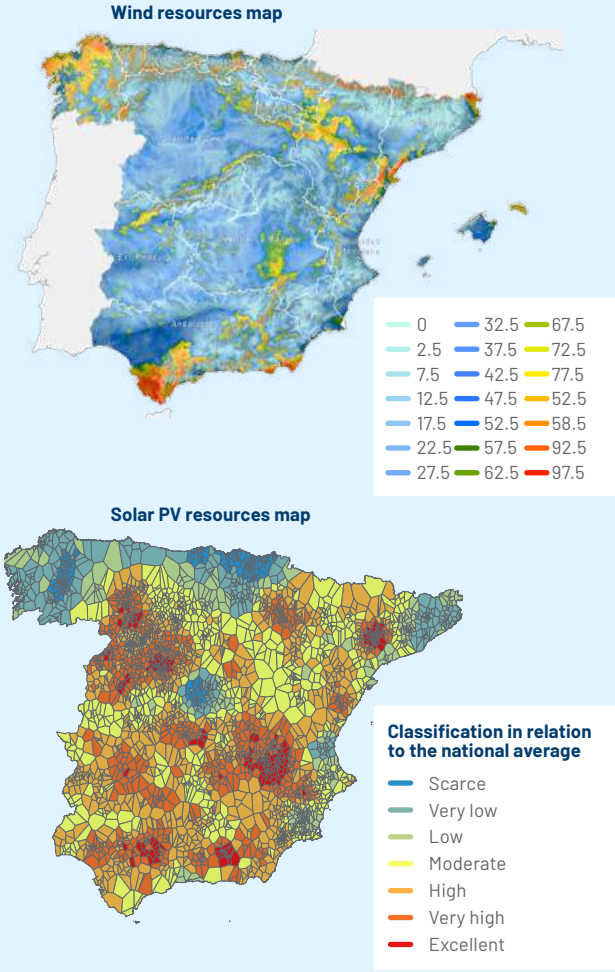
The purpose of this initial geographical distribution is to classify the Spanish mainland territory into geographical areas according to whether it is more or less efficient to implement a photovoltaic or wind power facility because it has a greater primary resource and because there are local conditions (temperature, non-pollution, etc.) that allow it to be used more efficiently.

For photovoltaic generation, the historical series of real production of the photovoltaic generators currently in service, which are available to the System Operator, have been used as a reliable and joint measure of the resource (sunlight together with the effect on production efficiency of other local conditions of real temperature, pollution, dust in suspension, etc.). For this purpose, the typology of the photovoltaic facilities for which historical series are available has been considered, due to the fact that, in general, those installed on roofs have a lower production at the same installed capacity than those implemented on the ground.

The resource maps characterise the territory on the basis of its wind or solar PV production capacity.

On the other hand, the wind resource is concentrated in certain production areas and is not distributed throughout the territory. In this case, the analysis was based on IDAE data (Wind Resource Study and preparation of the Spanish Wind Atlas) for identifying wind resources in Spain and a methodology based on the basins where wind resources exist and their degree of exploitation. In both cases, the annual number of equivalent hours of production was chosen in order to use a standardised indicator independent of the size of the facility. Once this indicator had been obtained, a geo-statistical analysis was carried out, focusing on the study of the geographical dispersion of the resource throughout the peninsular territory.

**Figure 20. Wind (up) and photovoltaic (down) resource maps. Source IDAE and REE**




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## IMPLEMENTATION. ENVIRONMENTAL RESTRICTIONS AND CONDITIONING FACTORS OF THE TERRAIN

The methodology for these maps is based on the "Environmental zoning for the implementation of renewable energies: wind and photovoltaic" study prepared by the Secretary of State for the Environment of the Ministry for Ecological Transition and Demographic Challenge (MITERD), which is conceived as a tool to help and complement the elements of judgement used in the decision-making process on the location of these energy infrastructures, which are precisely of a type that involves a significant use of territory[15].

This study aims to ensure the application of the principles of precaution and precautionary action, as well as preventive action against environmental impacts, also considering as more likely those generation sites that are not vulnerable to the impact of climate change.

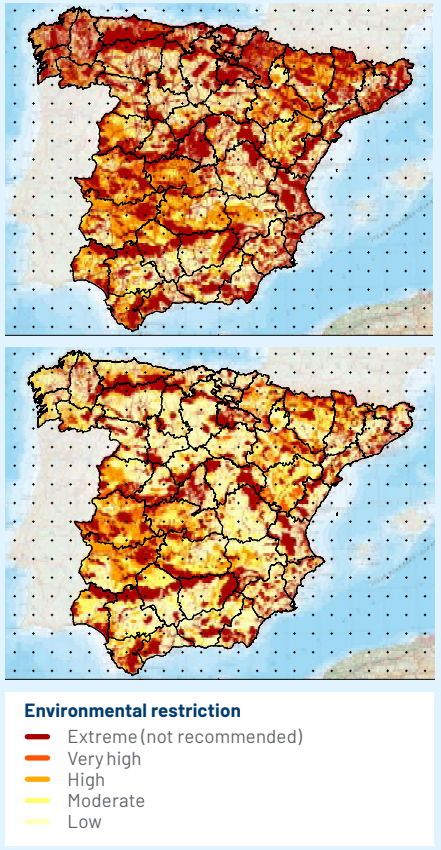
Using a multi-criteria assessment approach, all foreseeable environmental impacts, conditioning factors, and restrictions that developers of new photovoltaic and wind energy sources may face have been considered together, and environmental zoning has been established for the deployment of renewable energy facilities on the Spanish mainland.

Bearing in mind that there are conditioning factors and foreseeable impacts that affect photovoltaic and wind facilities differently, two maps have been drawn up, one for wind generation and the other for photovoltaic generation, classifying environmental sensitivity as low, moderate, high, very high and extreme.

The following figure shows the acceptance capacity maps for wind and photovoltaic facilities. A colour gradation distinguishes the areas according to their level of environmental sensitivity: red highlights those locations with extreme sensitivity where installation is not recommended, and yellow highlights those locations with low sensitivity, and therefore easier to deploy. The areas not recommended for wind and photovoltaic installations represent 48.06% and 30.53% of the Spanish mainland surface area respectively.

The acceptance maps characterise the territory on the basis of the ease of implementation of wind and photovoltaic plants.

**Figure 21. Maps of acceptance for wind (up) and photovoltaic (down) Source MITERD**




15 The mapping tool of this study is accessible to the general public at the following link: https://sig.mapama.gob.es/geoportal/.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## IDENTIFICATION OF AREAS WITH THE HIGHEST PROBABILITY OF DEPLOYMENT SUCCESS

In order to identify the areas in which future wind and photovoltaic plants are most likely to be installed for planning studies, a synthetic indicator has been developed by combining the previous indicators of production capacity (resource and efficiency) and ease of environmental permitting (acceptance map), which is an indicator of the probability of success of locating in a given area.

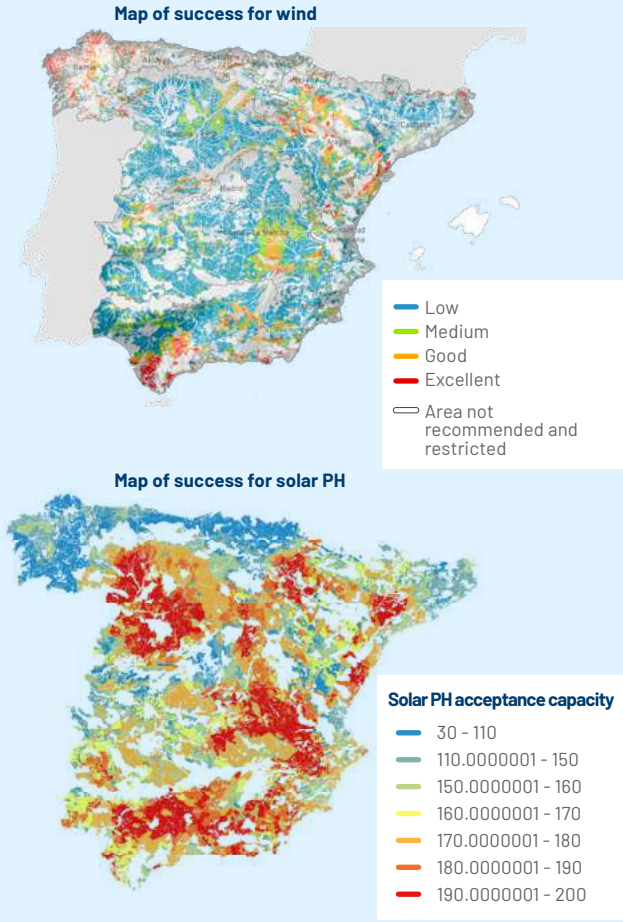
This indicator is the result of combining the production capacity indicators (standardised equivalent production hours) and the characterisation of the environmental zoning. For its preparation, the original series have been previously treated so that they have the same format and range of variation. In addition, for the specific case of environmental sensitivities, it is not considered advisable to install in areas of extreme environmental sensitivity. In addition, for the specific case of environmental sensitivities, installation in areas of extreme environmental sensitivity is not considered advisable, and therefore these areas have a combined success indicator of zero, which means that these locations are not considered in the exercise.

The following figure shows the probability of success maps for wind and photovoltaic generation where the areas are identified with a colour gradation according to their higher or lower probability of success of the location, i.e. the value of the combined indicator. Red areas are excellent areas and blue areas are areas with a low probability of success. On the other hand, white zones are the ones that are not recommended.

Probability of success maps combine resource, efficiency and ease of environmental permitting.



**Figure 22. Map of probability of success for wind (upper) and photovoltaic (lower) generation. Source: REE**




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

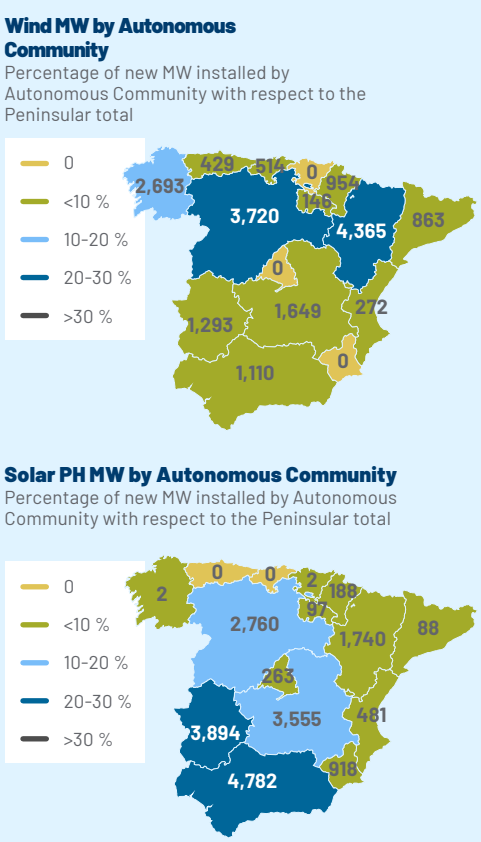
## DEVELOPMENT OF THE BASELINE SCENARIO HORIZON 2026 AND TRANSFER TO NODES

The allocation of capacity to create the most likely scenario for 2026 has been approached in two steps, first by autonomous community and then at substation level.

The allocation of new capacity to be considered by autonomous community and substation has been made according to the weight of the intentions of the promoters in each community modulated by the probability of success over the peninsular total. For this purpose, all the generation from all the proposals received in the planning process and from accesses with complete access requests (authorised and unauthorised) at the start of the studies on 31 August 2019 was considered, after filtering to eliminate all those that could be repeated (they were only 10%).

Although considering only the access requests could achieve the renewable generation value established for the 2026 scenario, these requests are subject to the existing or planned network in the 2015-2020 horizon. Therefore, considering only the access requests would not comply with the guiding principles of the 2021-2026 planning that establish the need to create new corridors that allow the integration of high resource areas without transmission network. In order to integrate this concept, all proposals from developers in the process of submitting proposals for the new planning have been incorporated into the analysis.

**Figure 23. Hypothesis of distribution of wind (top) and photovoltaic (bottom) capacity to be installed in the 2019-2026 period according to the study scenario**



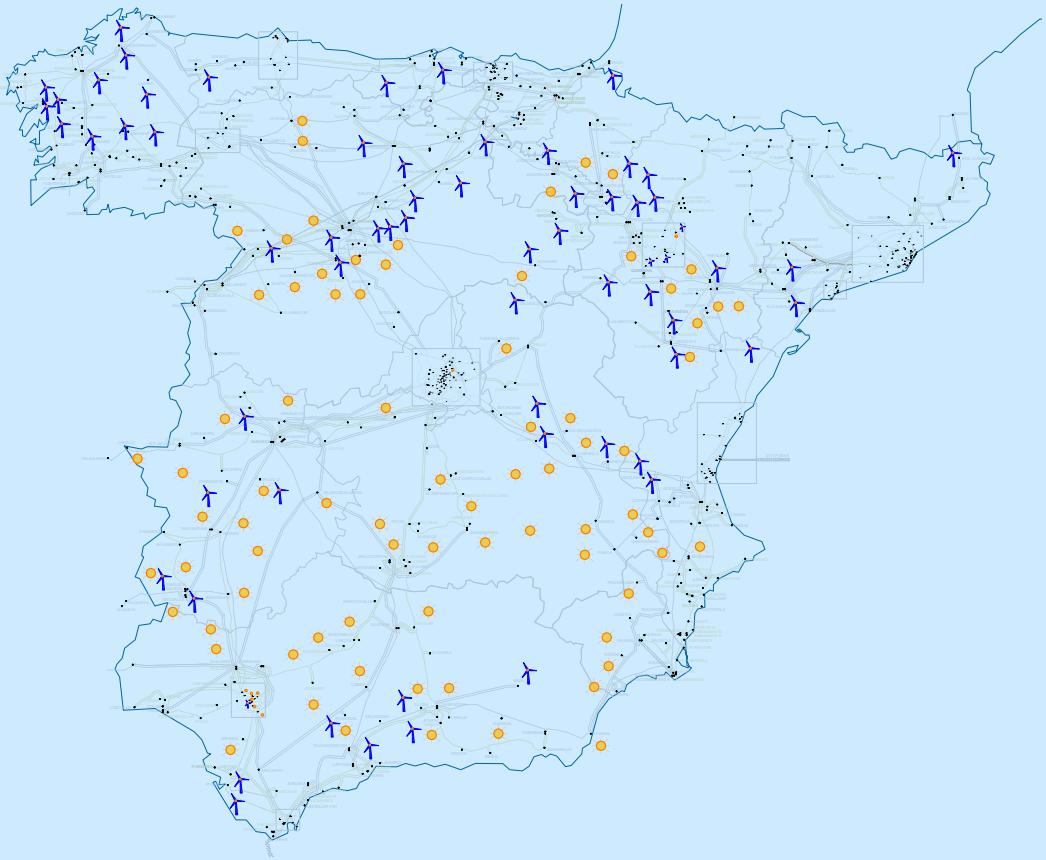

In addition, the maximum probability of success is given to those projects corresponding to the 2017 auctions (RD359/2017 and RD650/2017) that will contribute to achieving the 2020 renewables target, and therefore present a much lower degree of uncertainty in their installation.

The interest of developers in a given area reflects the influence of other relevant factors beyond environmental and resource aspects for the materialisation of a project.

The analysis of the results obtained shows that most of the installations with the highest probability of success (consistent with the guiding principles of maximising renewable production and compatibility with environmental restrictions) affect the starting network and granted accesses, but there is also room for proposals submitted and high resource areas without existing or planned transmission network. Specifically, 40% of new renewable energy sources correspond to proposals and 60% to accesses (consistent with the guiding

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

**Figure 24. Nodal distribution of new wind (18,000 MW) and photovoltaic (19,000 MW) generation in the study scenario**



principle of resource-based evacuation of renewables as it allows for new locations), and only 16% of new renewable energy sources make it necessary to define new locations for network connection compared to 84% that would be connected to the existing transmission or distribution network or to the already planned transmission network (consistent with the guiding principle of maximising the use of the existing network).

In order to analyse the needs of the base scenario, the selected generation is located in nearby nodes, resulting in a nodal distribution in the starting grid. The nodal allocation takes into account criteria such as short-circuit power per node, physical feasibility and the maximum and minimum power values established for connection to a transmission bay.

The future deployment of generation will be defined by the developers, who will continue to be able to connect to the grid by requesting the necessary permits.

Introduction

**Indicative Planning (NECP): study scenario**

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

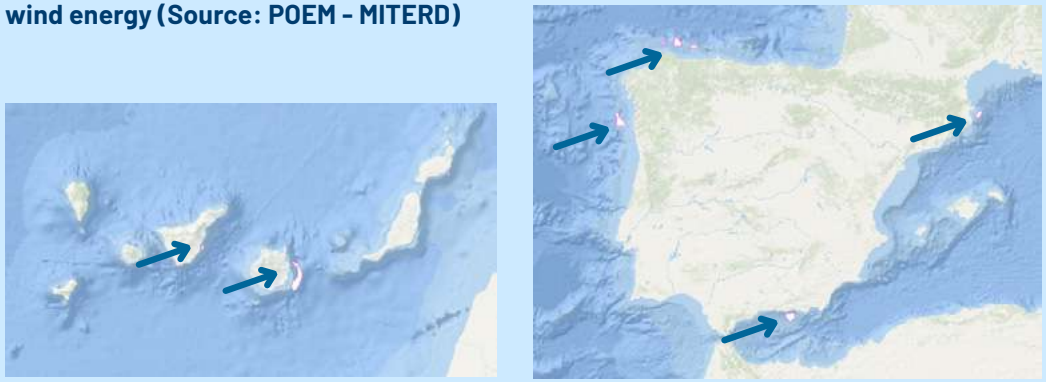
III: Technical annexes

## ESTIMATION OF THE LOCATION OF OFFSHORE WIND POWER

In order for the planning to respond to the need to evacuate future offshore wind projects, the "Roadmap for Offshore Wind and Offshore Energy Development"[16] and the "Maritime Spatial Plans" (Planes de Ordenación del Espacion Marítico or POEM as its acronym in Spanish)[17] have been taken into account. The latter include a zoning for future offshore wind projects in Spain, proposing 19 areas of high offshore wind potential in non-protected areas that comply with a wind resource greater than 7.5 m/s and where the depth does not exceed 100m. Within these, some are designated as priority use areas.

Applying a methodology consistent with that proposed for new onshore renewable generation, it is considered that the locations with the highest probability of success are those that are located in the priority use zones for offshore wind energy according to the POEM, as these already integrate resource and environmental criteria, and where there is also interest from developers to develop projects in these locations.

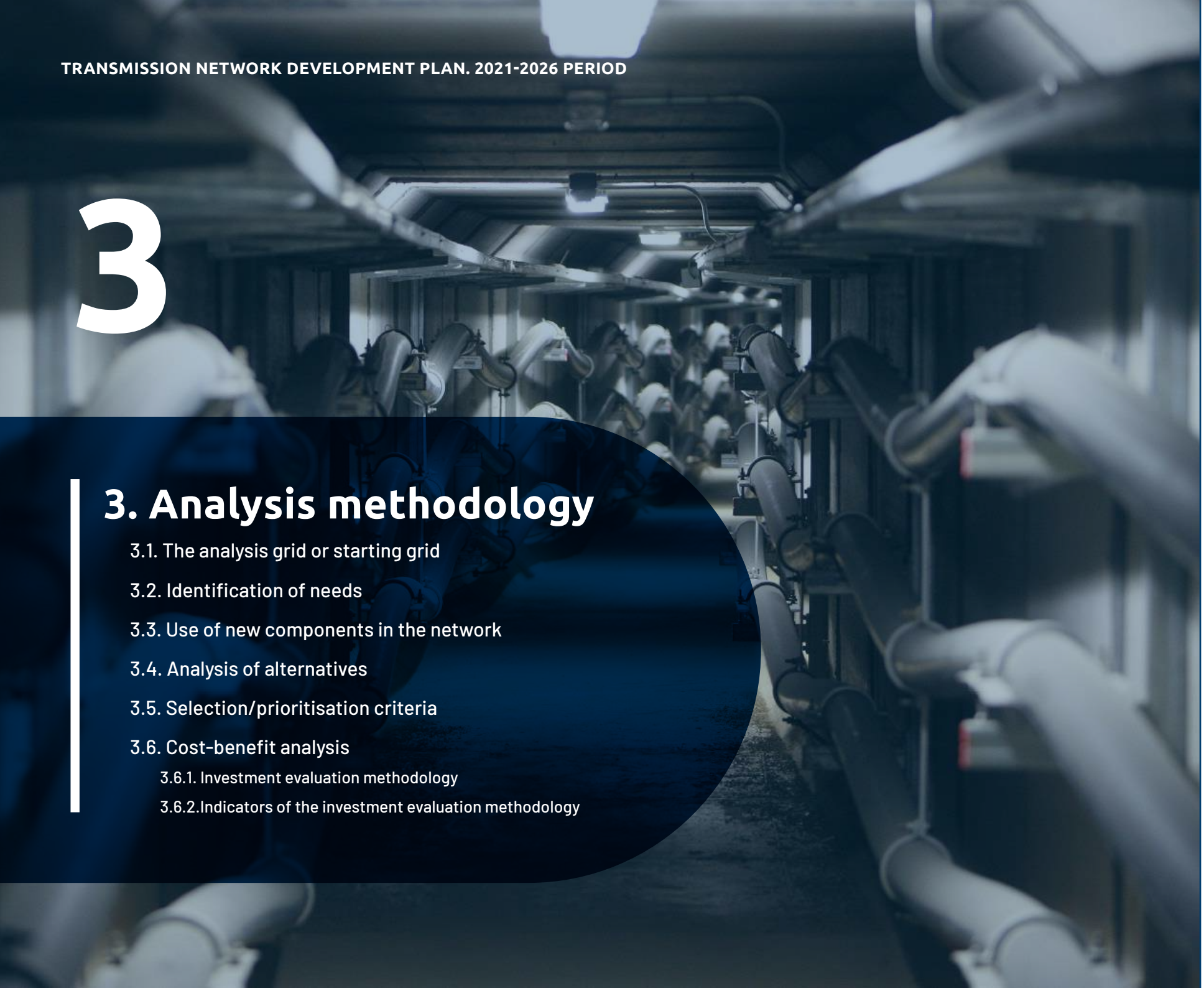
**Figure 25. Priority use areas for offshore wind energy (Source: POEM - MITERD)**



The locations with the highest probability of offshore wind success in the study scenario are aligned with the priority use areas for offshore wind energy set out in the draft Spanish Maritime Spatial Plans (POEM).

16 https://www.lamoncloa.gob.es/consejodeministros/resumenes/Documents/2021/101221-Hoja-ruta-eolica-marina.pdf.
17 https://www.miteco.gob.es/es/costas/temas/proteccion-medio-marino/ordenacion-del-espacio-maritimo/default.aspx
The draft plans were submitted for public consultation between 8 July and 8 September 2021, and are awaiting final approval.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes



# 3

# 3. Analysis methodology


3.1. The analysis grid or starting grid

3.2. Identification of needs

3.3. Use of new components in the network

3.4. Analysis of alternatives

3.5. Selection/prioritisation criteria

3.6. Cost-benefit analysis

3.6.1. Investment evaluation methodology

3.6.2.Indicators of the investment evaluation methodology

# 3.1. The analysis grid or starting grid

In order to completely establish the planning study scenario, it is necessary to define the transmission network to be used as the base or starting grid on which to establish the generation and demand hypotheses. This snapshot of the base or starting grid, prior to the introduction of development investments, is a concept widely used in European planning exercises[18]. Using this starting grid, the development needs of the transmission network are identified in order to subsequently propose solutions to these needs as investments that make up the development plan for the period 2021-2026.

Considering only the network currently in service as the starting grid is an excessively limited approach, since there are facilities already defined in the current plan which are under construction or at an advanced stage of permitting. On the other hand, it would be unrealistic to include all the investments defined in the current planning in the starting grid: in some cases, investments have been identified whose execution and commissioning present feasibility problems, either due to technical difficulties that have been detected after their planning or due to permitting difficulties, especially those related to environmental aspects or social acceptance. In both cases, their future commissioning would be highly improbable.

For this reason, the starting grid is defined as the set of transmission network elements that can be assumed to be in service with a very high probability in the time horizon 2021-2026. Based on this principle, in addition to the transmission network facilities currently in service, the starting grid includes the investments of the current 2015-2020 plan that meet the following criteria on 30 September 2019[19]:

- Investments with construction underway.
- Investments with commissioning planned by the Transmission Manager prior to the start of the study period 2021-2026 (commissioning in 2019 and 2020).
- Investments that have an Environmental Impact Statement (EIS).
- Investments that do not require an EIS and whose planned commissioning date is less than or equal to 2023.
- Access bays included in the 2015-2020 plan with permits granted.
- Access bays with permits granted under RDL15/2018.
- Interconnection investments between the systems of European Union member states analysed within the scope of the European Ten Years Network Development Plan with a positive cost-benefit analysis and a commissioning date in line with the planning horizon.

**The studies to identify the needs of the future transmission network are carried out on the basis of a network that is sufficiently advanced to be considered to be in service within the planning horizon.**

The demand and generation established in the indicative planning will be assigned based on this starting grid, as indicated in the previous chapter.

It should be noted that, in accordance with these criteria, both the investments defined in the current 2015-2020 planning, pending execution and which do not belong to the starting grid, and those included for a horizon beyond 2020, are studied with the same criteria as the rest of the new investments, to confirm that they are necessary in the study scenario and to ensure their alignment with the guiding principles of the plan.

The starting grid annex includes detailed information on these investments.

18 Referred to as the "reference grid" in TYNDP exercises, European planning.

19 The definition of the starting grid for all the needs studies and cost-benefit analyses was completed on the basis of the information available at that date for the investments included in the 2015-2020 plan.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 3.2. Identification of needs

Since their origin, electricity networks, and in particular the transmission network, have been the physical means that enables the safe and quality supply of electricity to society. Their role is to make it possible to transport the electrical energy produced by the generation units from their sites to the points of consumption, which are typically located at locations far from the generation sites. The situation foreseen for the electricity system at the 2026 horizon, consistent with the energy transition path established by the National Energy and Climate Plan (NECP), presents a fundamental change with respect to the current situation due to the high rate of installation of wind and solar energy sources expected. This change will bring along new needs in the electricity system which, in some cases, can be covered by transmission network planning, although it is also essential to provide other additional tools. Thus, the integration of renewable generation can be addressed through the development of the network when it is limited by its transmission capacity, and it is also essential to promote the deployment of the necessary flexibility tools, especially storage systems, as well as to provide the system operation with mechanisms for its dedication to the objective of maximising the integration of renewable energy.

The transmission network must continue to fulfil its backbone function, taking into account the evolution from an electricity system dominated by large thermal and hydroelectric generation units whose operating regime was established according to demand, to a new system in which electricity consumption will be fed from an essentially renewable and dispersed generation mix whose production depends on a non-storable primary resource and whose availability is decoupled from electricity demand. Therefore, the fundamental challenge of the 2021-2026 plan is to detect the limitations of the starting grid, and to propose the necessary investments to maintain the levels of quality and guarantee of supply while integrating the maximum possible amount of renewable energy sources available at any given time in the scenario envisaged for the system at the 2026 horizon.

Any investment for the development of the transmission network must respond to a necessity identified in the scenario foreseen for 2026.



Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## NEEDS ASSOCIATED WITH STARTING GRID RESTRICTIONS

The needs to guarantee the quality and security of electricity supply are assessed in the situations established by the operating procedures. The limitations that may arise in the starting grid consist mainly of overloads with respect to the thermal capacity of its elements, voltages outside the admissible range, non admissible short-circuit power values, oscillations, etc. The operating procedures set out in detail the admissible working ranges in the power system.

Firstly, current needs associated with the redispatching of generation units in certain areas are identified, which entail an additional cost for the system in terms of technical constraints. These are mainly focused on the need for additional resources for voltage control, although others related to the evacuation of renewable energy sources in some areas have already been detected.

In the 2026 horizon, some of them will be maintained and many new ones will appear associated with overloads in the evacuation and integration of new renewable energy sources in the scenario that require the application of the technical constraints mechanism. In the absence of new network developments beyond the starting grid, its resolution would only be possible by means of renewable energy sources and their substitution by conventional generation, which would simultaneously lead to a generation cost overrun for the system and move away from the renewable energy sources integration objectives.

On the other hand, an analysis of the impact of the degree of development of the system and the effects of the topological, structural and meshing characteristics of the network regarding the quality of service has been carried out in order to assess possible needs related to the quality of electricity supply. This analysis is attached as an appendix to the technical annexes document to facilitate the identification of the need for investments to improve the topological configuration of the transmission network and the substations themselves.

Finally, the starting grid limitations have been identified using tools that allow an exhaustive analysis of possible situations in the system (with details of each of the 8,760 hours in a year) as opposed to analysis of particular situations defined in advance (deterministic analysis). The main tool used allows the system security analysis to be carried out at the same time as calculating the generation dispatch in the study scenario with a 2026 horizon which, at a lower cost, makes it possible to comply with the admissible load ranges for the transmission network. The following information is required to carry out these studies in hourly detail:

- The complete transmission network in the Spanish mainland electricity system and island systems, considering their seasonal transmission capacities, the equivalents of the distribution networks and the transmission network of Portugal planned for the 2025 horizon.
- Hourly demand values at each substation.
- Hourly exchange values at borders with neighbouring electricity systems modelled in a reduced way (France and Morocco).
- Generation capacity of each technology at the different nodes of the modelled network.
- Hourly profiles of possible production for each renewable energy source.
- Fuel and emission costs by technology to be considered.
- Additional hypotheses relating to minimum operating conditions for synchronous generation to guarantee the stability of the electricity system ("must run").

As a result of the analysis described above, a large contingent of hourly data is obtained which, after appropriate processing, provides, for a yearly period, values of energy produced and cost by type of fuel and generation technology, value of $CO_2$ emissions, value of curtailments of renewable energy sources and energy not served, among other indicators. Regarding the restrictions identified in the network, it makes it possible to obtain statistics on the expected load levels of each of the network elements over the course of a full year.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

This analysis of the simulation results of the study scenario makes it possible to identify the needs for reinforcement and/or development of the transmission network. The analysis of the results of the simulations for each of the solution alternatives evaluated supports the decision-making process to select the investment that is optimal for the system from among the possible alternatives that resolve the need detected.

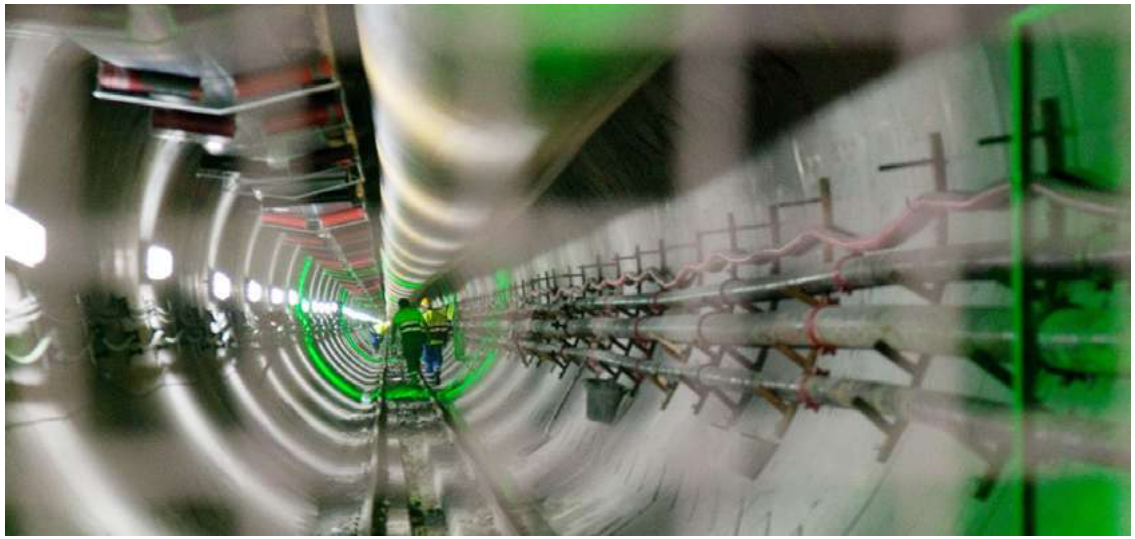
As a complement to these studies over a yearly period, static and dynamic simulations of different system situations have been carried out to determine the needs for voltage control and minimum generation connected to the system to guarantee its stability.

## OTHER NEEDS

The development of the transmission network must also respond to a set of additional needs that cannot be detected in the analyses described above. Some of these are established as objectives in the NECP, such as the electrification of rail transport, others derive from compliance with European Regulations and requirements established by the Electricity System Operating Procedures. The most significant needs within this group are:

- Increase in the level of interconnection between systems and international interconnections. These aspects are defined as objectives in the NECP and for the achievement of the objectives of integration of the Spanish mainland electricity system into the European internal electricity market (IEM), or by bilateral agreements.
- Electricity supply to rail corridors. This aspect is included in the scope of the electrification of passenger and freight transport established by the NECP.
- Compliance with the European "Network Code Emergency and Restoration", which requires guaranteeing that, in situations of loss of supply, power supply can be maintained for 24 hours to those substations that are required in the process of restoration service to the electricity system.
- Support needs for the distribution network from the transmission network or for supplying consumers directly connected to it.
- Renewal of lines and substations of the transmission network, within a continuous plan of renovations focused on a greater and better use of the existing infrastructures.

Due to their particular nature, some of the specific needs of the electricity system are described in greater detail below.



Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## CORRECT DAMPING OF INTER-AREA OSCILLATIONS

The small-signal stability of an electricity system defines its ability to operate in a stable manner during small natural disturbances arising from the normal evolution and operation of the system (variations in demand, generation, opening of lines, etc.). One of the phenomena associated with the lack of small-signal stability are the inter-area oscillations that appear in large electricity systems, such as the European continental synchronous system. When they occur, the electrical variables (frequency, capacity, voltage) typically fluctuate with frequencies of 0.1-0.5 Hz. If these fluctuations have a limited amplitude (size) and are transient (disappear after a few seconds), they have no impact on the safety of the system. However, if they have a large amplitude and/or are not damped (their amplitude increases over time), they can trigger a major incident. In a very simplified way, it can be stated that:

- Oscillations (frequency fluctuations) are greater at the extremes of an electrical system, and the capacity to control and damp these oscillations is also greater at the extremes.
- The probability of oscillations appearing is greater the more "extensive" the system is, the less meshed it is, and the greater the power flow between the ends of the system and the centre.

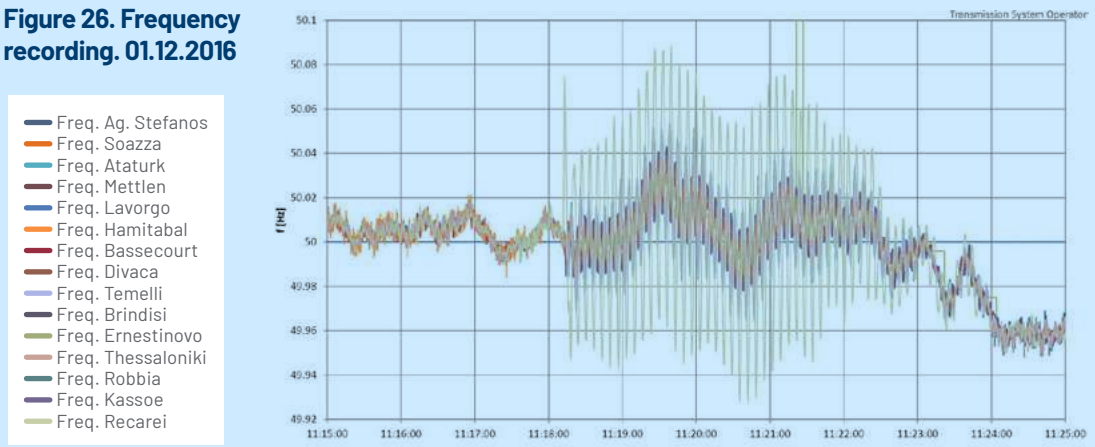
The Spanish mainland electricity system, due to its electrical and geographical location within the European synchronous system and the limited number of interconnection lines with the rest of the European synchronous system, is greatly affected by inter-area oscillation phenomena. This problem became evident on 1 December 2016 when undamped frequency fluctuations were recorded for about 5 minutes[20]. Following this situation, the System Operator has taken operational measures on generation and on the HVDC Spain-France.

However, additional measures are necessary to ensure compliance with operating procedure 13.1 about Transmission network development criteria, which sets a minimum damping threshold of 5% for oscillatory phenomena.

It is foreseen that by 2026, if no additional measures are taken, for about 10% of the time during which the exchange between the Spanish mainland and France is strongly export-oriented (> 4,000 MW), the damping of the system could be less than 5%.

**Poorly damped inter-area oscillations can trigger a widespread incident in the European synchronous system.**

**Figure 26. Frequency recording. 01.12.2016**




20 https://docstore.entsoe.eu/Documents/SOC %20documents/Regional_Groups_Continental_Europe/2017/CE_inter-area_oscillations_Dec_1st_2016_PUBLIC_V7.pdf.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## INCREASED INTERCONNECTIONS IN ISLAND ELECTRICITY SYSTEMS

Due to their small size and isolated nature, island systems are weaker and more unstable electricity systems. For this reason, the restriction of minimum coupled thermal generation, in these cases involving non-renewable technology, takes on special relevance in order to guarantee both the availability of short-circuit power and a sufficient value of coupled backup generation and spinning reserve, as well as an adequate system response in the event of contingencies. This constraint, whose value is directly linked to the net transfer capacity of each subsystem with others, must be considered for each subsystem or island, and has a great impact on the generation dispatch at all times.

The development or reinforcement of links between islands and, in the case of the Baleares, with the Spanish mainland, makes it possible to link up smaller electricity systems to form a larger, more robust system by aggregation.

Consequently, the interconnection of isolated systems offers the following advantages:

- Greater robustness of the aggregated set compared to previously isolated or sparsely interconnected systems. This robustness provides greater security of supply in the event of fortuitous failures of generating equipment and greater capacity to safely integrate renewable energy sources.
- Increased efficiency in generation scheduling and, as a result, reduced variable generation cost and emissions volume.
- Potential reduction in the minimum coupled generation requirements of the array compared to those required in the separate operation of its component subsystems.
- Potential improvement in the integration of renewable energy sources due to the higher demand of the combined system, as well as the reduction in the variability of the renewable energy sources when they are distributed over a larger geographical area.

In the case of the Baleares, the level of interconnection with the mainland is a necessary factor for achieving the objectives in terms of decarbonisation while maintaining the security of supply of the system. In recent years, investments such as the commissioning of the 2x200MW HVDC (High Voltage Direct Current) direct current link using LCC (Line Commutated Converter) technology, which links the Spanish mainland with the island of Mallorca, and the commissioning of the Mallorca-Ibiza and Mallorca-Menorca submarine links, have enabled the Baleares to be partially integrated into the European electricity market, significantly reducing generation costs on the islands, reducing emissions, and improving the reliability of their electricity supply.

Interconnection between systems is one of the objectives set by the NECP.



Introduction
Indicative Planning (NECP): study scenario
**Analysis methodology**
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

In the electricity systems of the Canarias, in order to achieve decarbonisation of electricity production and allow the integration of current renewable energy sources and those with planned deployment, especially wind power generation due to the high availability of raw resource on the islands, the development of inter-island links must be accompanied through the development of storage infrastructures (such as the Salto de Chira pumping project on the island of Gran Canaria) and the implementation of internal reinforcements to the network. This coordinated development is necessary to ensure fully combined contribution of infrastructures to the decarbonisation objective, but it will not be enough to achieve it.

It should be noted that an insufficient deployment of the network within the island systems would not allow full use of the rest of the infrastructures, with the consequent detriment in terms of integration of renewable energy sources and reduction of emissions.

Moreover, it should be borne in mind that the possibilities for interconnection between islands in the Canarias are generally subject to technical constraints due to the high depths of the seabed between islands. The decision on the deployment of these interconnections, which by their very nature are facilities requiring a high level of investment, must be based in particular on the results of the corresponding cost-benefit analysis.

## REINFORCEMENT OF INTERNATIONAL INTERCONNECTIONS

The reinforcement of interconnections is set by the indicative planning (NECP), in particular those of Portugal and France, in order to ensure that the Iberian Electricity Market (MIBEL) remains fully operational and to integrate the Iberian Peninsula into the Internal Electricity Market (IEM).

The European Council of March 2002 set the objective of reaching a minimum of a 10% interconnection ratio (being the sum of the import net transfer capacities divided by the installed generation capacity). In 2020, this ratio is 6% for the Spanish mainland electricity system and 2% for the Iberian Peninsula, both values far from this objective. In recent years, the European Commission has endorsed this target and the urgency of meeting it by 2020 on numerous occasions.

In the case of Spain, this target was not met in 2020. In 2026, with the planned increase in installed renewable generation capacity, it would be 5% if not accompanied by a reinforcement of interconnections. In March 2015, in the Madrid declaration signed by the governments of Spain, France and Portugal, the European Commission and the European Investment Bank, it was agreed that it was urgent to meet the 10% target and to continue analysing possibilities to reach a capacity of 8,000 MW between the Iberian Peninsula and France. A high-level group with representatives from the European Commission, national regulators and system operators systematically monitors progress towards this objective.

**The reinforcement of international interconnections, in particular with France, is necessary to boost integration in the Internal Energy Market (IEM) and to enable collaboration to achieve the renewable integration and decarbonisation objectives of the European Union.**

In addition to the aforementioned commitments, important economic reasons for progress towards this objective have been identified, as evidenced by the commissioning in 2015 of the interconnection between Spain and France through the eastern Pyrenees and its subsequent use, which represents a first step in reinforcing this border. However, during 2018 and

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

2019, congestion (hours in which the net transfer capacity is used to the maximum) was 77% on average, with an average price difference between countries of 10.4 €/MWh. In 2020, the year marked by COVID-19, congestion was 61%, with a price difference of 5.9 €/MWh. In the period from January to May 2021, although congestion remained at 60%, a value similar to that of 2020, the price difference exceeds the values recorded in 2018 and 2019, reaching 12.2 €/MWh. These indicators show that the system as a whole still cannot benefit from using the lowest cost generation at all times.

**Congestion at the Spain-France border**

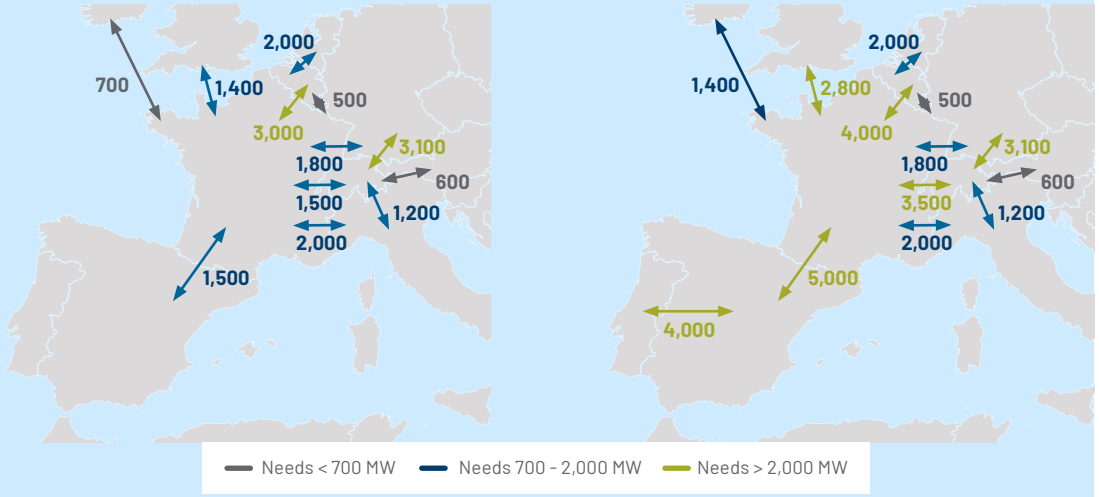
**61-78 % in 2018-2020**

On the Spain-Portugal border, the average congestion in recent years is around 5%, and the average price difference between countries is less than €0.3/MWh. The biggest problems are detected in the northern area. The new interconnection already planned on this border will allow Portugal to reach the target interconnection ratio and will allow a full integration of MIBEL in the short term.

Both borders have been studied within the scope of European planning (TYNDP[21]) and both the suitability of the planned interconnection projects and the consequences of not carrying them out have been assessed, quantifying the benefits derived from the integration of markets, in terms of integration of renewable energies and reduction of emissions. In addition, the "Identification of System Needs" exercise assesses the needs for 2030 and 2040 beyond the Bay of Biscay project and the Northern interconnection with Portugal, the results of which are shown in the following Figure.

Finally, the development plan assesses the needs for reinforcement of interconnection with Morocco and Andorra derived from commitments adopted with both countries.

**Figure 27. Capacity increase needs beyond the Bay of Biscay and Northern Interconnection in 2030 (left) and 2040 (right)**




21 https://tyndp.entsoe.eu/documents.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 3.3. Use of new components in the network

The transmission network in the Spanish electricity system is already equipped with a high degree of monitoring and control. However, the evolution of the electricity system makes it necessary to consider both the possibility of incorporating new elements and to consider new uses of elements already known in the development of the transmission network.

Although it does not fall within the scope of the transmission network development plan, it should be noted that the studies carried out for its preparation have considered the expected contribution of tools, currently under development, of advanced automatic systems for action in generation and networks that will allow a more intensive use of the grid, especially in the area of renewable energy integration. These automatic systems would avoid the adoption of preventive measures –reduction of available renewable energy sources and substitution by higher-cost generation– to ensure compliance with security criteria in the operation of the electricity system in the event of loss or failure of network elements.

Thus, prior to considering reinforcement or development alternatives in the transmission network, the future contribution of an advanced information and control system is being evaluated, which, as an additional tool to those already incorporated in the Electricity Control Centre (CECOEL), has its domain of application in the resolution of congestion in real time and is effective in a large number of situations and cases. However, it should be noted that this solution is limited by the maximum generation quota that can be reduced instantaneously.

Within the scope of the transmission network development plan, in line with the guiding principle of "maximising the use of the existing network, renewing, expanding capacity, using new technologies", the following additional options to the traditional elements are assessed:

- **Dynamic Line Rating (DLR):** this is one of the technological tools available to digitize the network and operate lines beyond their current transmission capacities, without exceeding the real thermal capacities of the facilities and complying with current regulations. These systems require sensors, telecommunications systems and data processing and analysis systems, as well as advanced algorithms for forecasting the future evolution of dynamic transmission capacities. These types of solutions are still at a very preliminary stage of technological development, so their deployment in this plan is aimed at better exploring their potential on lines that a priori have favourable conditions for their application. Thus, the application of DLR technology represents, in this plan, a first step in the large-scale deployment of these solutions.
- **Elements with the possibility to modify power flows:** these elements are used as an alternative to uprating or new axes to solve overload problems. The following elements, whose characteristics make them suitable for different locations and situations, will be used in this plan:
  - **Phase shifters:** these are types of transformers with the possibility of modifying the power flow that circulates through them, and therefore of the line on which they act.
  - **FACTS (Flexible AC Transmission System)**: power control equipment based on power electronics. Among them, both parallel FACTs and STATCOMs (Static Synchronous Condenser) will be taken into consideration.
  - **Mobile Overload Limiter (LMS)**: this element has as a differential characteristic, its compactness and its potential mobility.
- **Synchronous condensers:** these elements are fully integrated into the transmission network[22] and consist of synchronous machines which, unlike synchronous generators, do not inject

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

active power into the grid and, therefore, do not take away space for the integration of renewable energy sources. They are employed to make the system more robust, as they increase the short-circuit power and inertia of the system and, in addition, as a secondary function, they provide continuous voltage control in the area where they are installed.

- **Storage as a fully integrated element of the transmission network:** energy storage can maximise the use of network capacity by becoming, in this case, a fully integrated element of the network[23]. These capabilities are particularly interesting for maximising the use of submarine links, given their high cost.

In order to achieve the objectives established in the energy policy guidelines regarding the sustainability of the electricity system, security of supply and integration of renewable energy sources, it is necessary to have smart networks that include new elements and new ways of using already known elements so that, taking into account the degree of progress of each of the technologies, new solutions can be defined jointly, in a coordinated and efficient manner in those cases in which they constitute an efficient alternative to other types of reinforcement of the transmission network through conventional solutions.

An essential advantage of these new solutions, when applicable, compared to conventional network reinforcement alternatives, is their lower impact on the territory –these devices are deployed in substations– and the greater ease of permitting and authorisation that can be expected. This means that the time required for their deployment could be substantially reduced compared to the time required for the uprating of a line or the construction of a new line.

Information on some of the equipment mentioned is detailed below.

The guiding principles orient the 2021-2026 plan towards a standardised use of new technologies.



22/23 Royal Decree Law 29/2021 of 22 December introduces fully integrated network components, including storage facilities, into Art 34.1 of the Electricity Sector Law, as those used to guarantee the secure operation of the transmission network and not for balancing or congestion management purposes.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## SYNCHRONOUS CONDENSERS

### Canarias:

The isolated nature of electricity systems in the Canarias makes them more vulnerable to the challenges posed by the high penetration of renewables foreseen in the 2026 scenario. The robustness of the network, which can be measured in terms of short-circuit power, is a fundamental characteristic to guarantee the correct operation of the Power Park Modules (PPM), in particular wind and photovoltaic generators, connected to the electricity system by means of power electronics elements. The studies carried out by the System Operator show the need to incorporate, in addition to the interconnections between electricity systems and hydraulic storage systems such as Salto de Chira, synchronous condensers that provide the Gran Canaria, Tenerife and Lanzarote-Fuerteventura subsystems with new dynamic voltage control points and short-circuit and inertia current injection points, in order to strengthen the system and thus reduce the risk of potential interactions between the power electronics controls.

Specifically, the incorporation of synchronous condensers of 25 Mvar each in Gran Canaria, Tenerife and south Fuerteventura reduce the influence of voltage variation in one of the nodes on the rest of the nodes of the island, helping to guarantee the correct operation of existing and planned generation in these systems and reducing the risk of interactions between generation connected to the system via power electronics[24].

### Baleares:

In order to achieve a significant increase in the exchange from the mainland to the Baleares, in addition to the installation of a new link, it is necessary to reduce the operation of thermal generation in the Baleares. This requires covering the needs of the Baleares Electricity System (SEB, for its acronym in Spanish) which are currently met by coupling synchronous generators to the system. In particular, there is a need to cover inertia needs, short-circuit power for the correct operation of the HVDC LCC link in service and resources for dynamic voltage control.

Synchronous condensers are a mature technology, capable of providing inertia, voltage control and short-circuit power to the system, and thus enabling progress towards a 100% decarbonised SEB.



Synchronous condensers are essential to improve the possibilities of integrating renewable energy sources into the systems of the Canarias and help reduce the dependence of the Balearic system on thermal generation to ensure the correct operation of the existing HVDC link.

24 The detailed specifications for determining the access capacity consider the influence of the voltage variation in some nodes on others to ensure the correct operation of the electricity systems. (Resolution of 20 May 2021, of the National Markets and Competition Commission, which establishes the detailed specifications for the determination of generation access capacity to the transmission network and distribution networks).

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## DYNAMIC TRANSMISSION CAPACITY MONITORING SYSTEMS TO MAXIMISE THE USE OF THE EXISTING NETWORK

In order for the energy transition to be efficiently implemented, it requires maximising the use of the existing network, renewing, expanding capacity, using new technologies and reusing existing facilities.

DLR (Dynamic Line Rating), also known as RTTR (Real-Time Thermal Rating), is based on technologies that estimate in real time the transmision capacity values of power lines according to different measurable variables that allow their calculation. These variables include weather conditions in the vicinity of the line, real-time conductor temperature measurements and deflection of the line span being DLR-ed. In simplified terms, the DLR application consists of calculating the maximum current that a line can carry depending on the measured value of environmental variables,

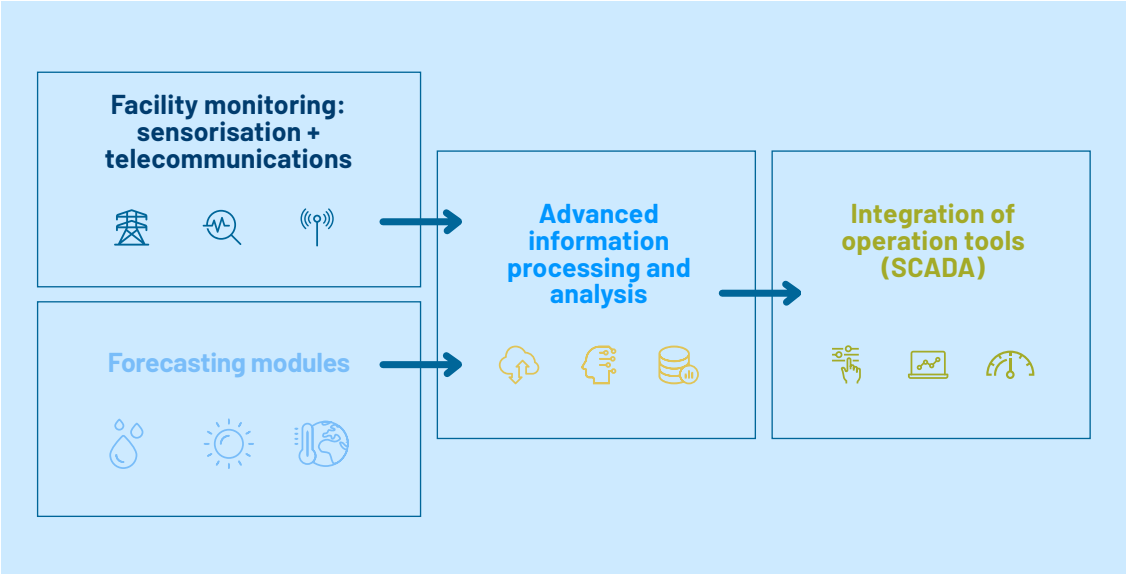
Dynamic line rating (DLR) enables greater utilisation of the existing transmission network at times when environmental conditions are favourable.

**Figure 28. Contribution of different technical possibilities in inertia, voltage control and Short Circuit power (Scc)**

| | Inertia | Voltage control | Scc | Technological maturity |
|---|---|---|---|---|
| Investments in the HVDC LCC | – | + | + | – |
| Synchronous condensers | + | ++ | ++ | ++ |
| FACTS | – | ++ | + | ++ |



Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes




respecting at all times the thermal limits of the installation and guaranteeing the safety distances established in the electrotechnical regulations. Therefore, the calculated current values would not cause degradation or premature ageing of the installation, as they guarantee operating conditions that do not exceed the technical (thermal) limits of the installation.

The thermal capacity of an overhead line will be marked by the line span (distance between two supports) that first fails to comply with the above-mentioned limits. Similarly for underground lines, the thermal capacity will be determined by the cable section where the admissible temperatures are exceeded first. Consequently, operating lines with DLR means monitoring and estimating the conditions of the line along its entire length, processing the information to determine the maximum admissible intensity at each instant, as well as the development of forecasting models that allow predicting the estimated values of transmission capacity for the next few hours.

In any case, the maximum potential benefit to be obtained by applying DLR is highly dependent on the particular element: the environmental conditions to which the specific line is subjected along its route and the safety margins in distances used in its design will determine it in each case. Thus, the length of the line, the orography of the terrain it crosses, the climatic conditions of its surroundings, etc. are factors that have an impact on the DLR, both in terms of the results that can be obtained and the level of monitoring required.

Currently, there are various technologies with different degrees of maturity and reliability for applying DLR to a circuit: there are technologies based on discrete or distributed monitoring methodologies, which measure or monitor only environmental variables and/or measure physical variables of the facility itself. The particular characteristics of each installation, its critical line spans, as well as the degree of technological development that DLR will undergo in the coming years, will ultimately determine the best solution for its application to transmission network circuits.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 3.4. Analysis of alternatives

Once the main needs had been detected in the study scenario with the starting grid,-mainly focused on congestions in the grid, curtailment and energy not supplied, possible solutions have been systematically evaluated from the lowest to the highest environmental and economic impact, trying first of all to maximise the use of the existing network until a viable and sufficient solution is found. Once this solution has been identified, alternatives with a higher cost or environmental impact are not evaluated. The order defined for the evaluation of possible solutions was as follows:

- Evaluation of the potential application of an automatic system acting on generation as an operating tool to circumvent the limitation observed.
- Dynamic monitoring of the line.
- Line uprating. In this case, an assessment was made of whether conventional uprating (increase in the thermal capacity of the line) by retensioning conductors and raising the pylons to increase the distance to the ground would increase the admissible flow on the line, resolving the need detected. If conventional uprating is not sufficient, the next step is to study uprating by changing the conductor, also considering advanced high-temperature conductors among the alternatives.

If none of these solutions resolves the needs detected, the following portfolio of solutions is considered:

- FACTs, phase shifters or other flow control equipment.
- Support from higher voltage networks (400/220 kV transformers on the mainland or 220/132 kV on islands).
- Installation of second circuits, if possible.



- Voltage changes of existing circuits to higher voltage circuits. These require the existing line to be removed and replaced by a new line with the necessary capacity. Although this type of investment involves a higher cost, it has the advantage of avoiding the increased impact on the territory that the development of new lines entails.
- New substations at the base of the transmission line.
- New axes.

In order to resolve the identified needs, alternatives have been considered, from the lowest to the highest environmental and economic impact, until a valid and sufficient one is found.

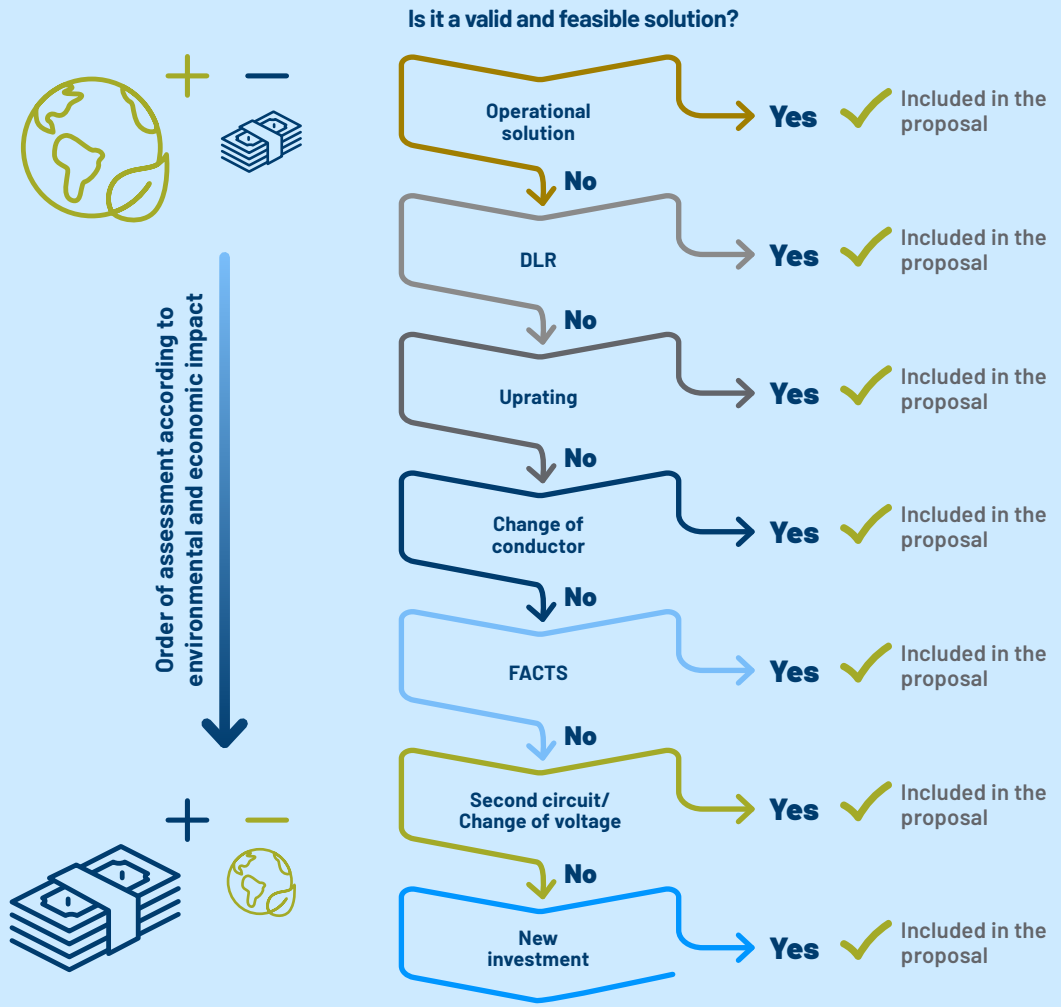
Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

Depending on the type of problem or the topology of the grid (limitation of renewable energy evacuation due to short-circuit power, existence of parallel corridors, inter-zonal flows, etc.), the most appropriate solutions are different. In order to compare these types of alternatives and select the most appropriate one, technical and environmental feasibility criteria are applied, as well as cost-benefit analysis (described in detail in section 1.5 of this document) and the contribution to the guiding principles of the network development plan is assessed. This methodology maximises the use of existing facilities, prioritising upratings and change of conductors on existing lines over the construction of new routes, or extensions of existing substations over new substations in new locations.

On the other hand, beyond its strict application to the study scenario, this methodology must also conceptually consider longer-term horizons in which, in some cases, additional benefits of some alternatives can be identified over others, which may justify a higher cost and/or impact.

The figure below shows an outline of the decision flowchart applied in the preparation of the development plan. Each of the steps considers the new solution proposed or a combination with the solutions proposed in the previous steps.

**Figure 29. Flowchart for the selection of alternatives for the resolution of network problems**




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 3.5. Selection/prioritisation criteria

During the phase prior to the study phase of the 2021-2026 planning process, proposals have been received to respond to needs that do not arise from the safety analysis of the study scenario, are not explicitly included in the NECP or are required by the regulations. Objective criteria have been established to evaluate and prioritise these investments proposed by the subjects.

## CRITERIA FOR SELECTING NEEDS ASSOCIATED WITH SUPPORT FOR THE DISTRIBUTION NETWORK

The proposals received for support to the distribution network have been prioritised according to the following criteria:

- Compliance with operating procedures, specifically PO.13.1 of Criteria for the development of the transmission network. Special relevance is attached to compliance with reaching a minimum demand to connect to the transmission network according to the voltage level, to not opening interconnection lines and to avoid incorporating voltage steps from the 400 kV level below 132 kV.
- Proof of a solid justification demonstrating that development alternatives in the distribution network are less suitable in terms of cost or functionality. Priority is assigned to those investments in which there is a technical-economic study of the transmission network-distribution network prepared jointly by the operators of the distribution network and the transmission network. The contribution of at least one study of the same characteristics as the aforementioned study is valued over those proposals in which no alternative is identified, or insufficient data is provided for its evaluation.
- Demand support category. Priority is assigned to the resolution of problems of demand supply or quality of service already existing at present and relating to singular consumption as opposed to vegetative growth and new demands, assessing their level of uncertainty. The growth in demand, in general, is not the main driver of the 2021-2026 planning due to the contained level of growth that the scenario under study entails. Nonetheless, it is necessary to address the cases of areas with particular needs or developments.
- Compatibility with the success indicator value for the deployment of renewable energy sources described in section 2.2, in those proposals where a reinforcement of the transmission-distribution interface is justified by the integration of renewable energy sources in the distribution network.
- Special contribution to the guiding principles.
- Compatibility with the secure operation of the transmission network.
- Physical and environmental feasibility.



Objective criteria have been established for the selection of proposals submitted by the system agents whose analysis is not possible only with the system security studies from the point of view of the transmission network.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## CRITERIA FOR SELECTION OF NEEDS ASSOCIATED WITH CONSUMERS CONNECTED TO THE TRANSMISSION NETWORK

The supply of rail corridors has been incorporated in its entirety into the plan provided that the date indicated in the proposal was within the planning horizon.

On the other hand, supply from the transmission network to major consumers has been incorporated when it has been possible to verify compliance with operating procedures and the viability of the connection. In the case of unfeasible connections, an alternative has been proposed.

## CRITERIA FOR THE SELECTION OF PROPOSALS FOR THE RENEWAL OF TRANSMISSION NETWORK FACILITIES

The proposals for the renewal of elements of the transmission network in service received during the proposal phase were analysed and prioritised according to the following criteria:

- Facilities with an impact on exchange capacity in international interconnections or links between systems to ensure mutual support for security of supply and guarantee exchange capacity values.
- Criticality of the element for the security of supply of a large area of the system.
- Potential impact of the element on the environment in particular due to the use of insulation technologies using oil in the case of underground cables.
- In the case of overhead lines or underground cables, possibilities that with the renewal of the asset there will be a significant increase in transmission capacity in those lines where the analysis of the base scenario with the starting grid identifies reinforcement needs.
- In the case of substations, the factors considered are topology and configuration, criticality of the substation taking into account the demand supplied from it, generation coupled into the system through it, number of bays, usefulness of the substation during restoration service processes, ease of granting work guaranteeing compliance with the operating and safety criteria of the electricity system, short-circuit power and critical time.
- Degree of ageing and/or technological obsolescence of the element and availability of spare parts.

In accordance with these criteria, part of the renewal proposals received are included in the transmission network development plan for 2021-2026. In some cases, the renewal of the installation will be complete, while in other cases its scope will be limited to the partial renewal of its components. These investments also allow for greater and better use of existing infrastructures.



Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 3.6. Cost-benefit analysis

The assessment of the investments for the preparation of the network development plan for 2021-2026, in line with the best international practices, has been approached with a combination of cost-benefit analysis (monetised indicators) and multi-criteria evaluation (non-monetised indicators), incorporating indicators that make it possible to evaluate the degree of compliance with the guiding principles defined for the Plan. The indicators used are mostly inspired by the ENTSO-E CBA 2.0[25] methodology approved by the European Commission in 2018 after public consultation. It is important to note that the analyses always have a societal approach, i.e. the benefits and costs for society are assessed, understanding society as the set of users of the electricity system. The costs considered reflect the costs of investment in the transmission network, which would be remunerated in accordance with the applicable regulations in force.

A multi-criteria cost-benefit analysis makes it possible to evaluate different dimensions of the benefits of an investment in the transmission network.

25 https://tyndp.entsoe.eu/cba/.

## 3.6.1. Investment evaluation methodology

The cost-benefit analysis is carried out on investments or sets of various facilities that provide an aggregate functionality to the system and not on individual facilities. This evaluation method ensures that the benefits are identified in their entirety, which would not be possible if any of the installations that form part of the group were not considered in the analysis, as in this case their functionality would not be complete.

The evaluation is based on a PINT (Put IN one at the Time) methodology commonly used in ENTSOE in which the contribution of each investment is evaluated by comparing the main benefit indicators in two scenarios, a reference scenario in which the reference network is modelled and another in which the investment being evaluated is added.

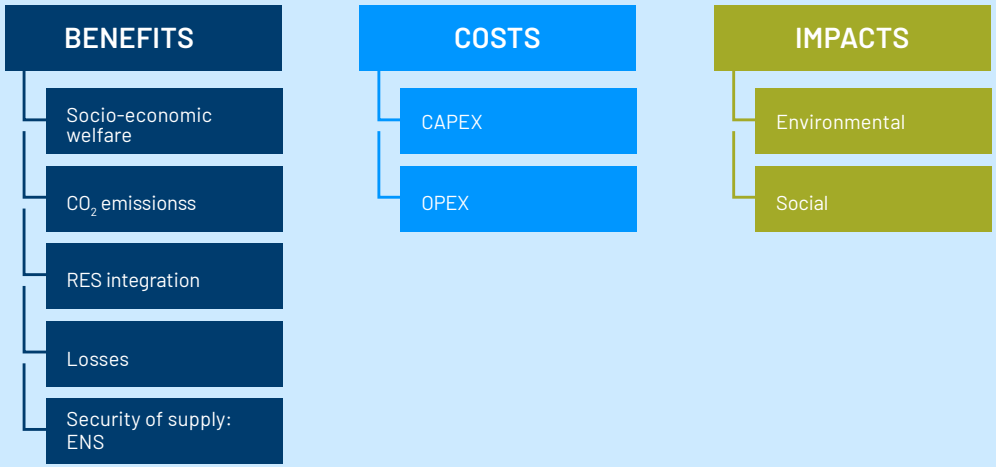
In some particular cases, when the investment under study, due to its complexity, can be evaluated in phases or when it is conditioned or closely related to other investments that can significantly distort a PINT analysis, a sequential PINT methodology is selected. In this case, the benefits of each phase of a complex investment or those derived from an investment are evaluated with respect to a reference network in which, in addition to the starting grid, the prior commissioning of interrelated investments or those which affect the benefits of the investment under study are considered. The sequential PINT methodology has been applied to the Tenerife-La Gomera link, taking into account that the Tenerife west ring actions are already in service, to the new link with Morocco, taking into account that the rest of the Spanish mainland actions are already in service, and to the phases in the project to reinforce the mainland-Baleares interconnection.

The ENTSOE CBA methodology is not applicable in the case of investments designed to meet demand-side supply needs, except in cases where the investment resolves a situation where energy is not supplied in accordance with operating procedures. Specifically, within the framework of this methodology, it is not possible to assess investments aimed at responding to problems in the distribution network, to projects facilitating the supply of consumers from the transmission network or those improving the security of large industrial consumption already connected to the transmission network. The same applies to investments designed to guarantee security of supply.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 3.6.2. Indicators of the investment evaluation methodology

**Figure 30. Indicators in multi-criteria cost-benefit analysis**




The indicators for evaluating investments can be grouped into welfare, costs and impacts.

## 3.6.2.1. Welfare

### SOCIO-ECONOMIC WELFARE

The socio-economic welfare is evaluated as the reduction of the variable cost of generation provided by an investment in the transmission network: the reduction of unacceptable overloads in the system results in the reduction of generation scheduled specifically to alleviate unacceptable situations which, in general, represents a cost overrun for the system. In the case of limitations to the integration of renewable energy sources, the investment reduces the curtailments of primary energy sources and, at the same time, reduces the need to replace this generation –which has a lower variable cost– with thermal generation. In principle, the reduction of renewable energy sources also reduces the need to replace renewable energy sources with other technologies with a higher variable cost.

The monetisation of the socio-economic welfare is made up of the monetisation of the reduction indicators of: variable generation costs, system losses, renewable energy curtailments, $CO_2$ emissions and energy not supplied. All of these are interrelated and are considered simultaneously in the optimisation process so that it is not possible to disaggregate the individual monetised effect of each of them.

Therefore, to calculate the socio-economic welfare, the difference between the value of the variable generation cost without and with the investment being evaluated is calculated. For the evaluation of the variable generation cost of the system, the fuel, $CO_2$ and operation and maintenance costs obtained from the NECP are used. The power plants start-up costs considered are those used in European planning prior to the start of this planning (TYNDP 2018).

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

**Figure 31. Variable generation cost hypotheses. Fuel, $CO_2$ emissions and O&M costs considered in the evaluation of investments**

| | Spanish mainland system | Baleares system | Canarias systems | Ceuta system |
|---|---|---|---|---|
| Price of emissions (€/kg) | | | | |
| | 0.0233 | 0.0233 | 0.0233 | 0.0233 |
| Price of fuel (€/kg) | | | | |
| Nuclear | 0.5 | | | |
| Natural Gas | 8.2 | 7.8 | | |
| Fuel oil | | 11.7 | 11.5 | 11.6 |
| Gasoil | | 16.5 | 15.2 | 15.3 |
| Diesel | | | 15.3 | |
| Variable O&M costs (€/MWh) | | | | |
| Nuclear | 9 | | | |
| Combined cycle | 2.3 | 22.6 | 18.1 | |
| Diesel engine | | 16.5 | 23.7 | 34.6 |
| Steam turbine | | | 5.4 | |
| Gas turbine | | 21.6 | 27.5 | 32.8 |

Note: the data on fuel and operation and maintenance costs of non-peninsular systems are based on the recognised costs according to current legislation, RD 738/2015 and subsequent updates. Since there are values by technologies and groups, an average value per system is presented.

## VARIATION IN $CO_2$ EMISSIONS

The $CO_2$ emissions variation indicator quantifies the change in the volume of $CO_2$ emissions in the system as a result of the welfare provided by the investment analysed.

The investments to be evaluated can enable the production of lower-cost generation, mainly from renewable energy sources, which would replace higher-cost generation and, generally, with higher $CO_2$ emissions.

To calculate the variation in $CO_2$ emissions, the difference between the value of $CO_2$ emissions without and with the investment being evaluated is calculated. Its monetisation is already included in the socio-economic welfare indicator.



Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## INTEGRATION OF RENEWABLE ENERGY SOURCES

The renewable energy sources integration indicator quantifies the contribution of the investment under evaluation to the integration of renewable energy sources into the system and to the minimisation of primary energy curtailments caused by the starting grid. It represents the value of RES curtailment avoided (MWh/year) due to the fact that the investment reduces or avoids the need to apply the mechanism of technical constraints due to grid overloads or voltage control and the substitution of renewable energy sources by conventional generation.

To calculate the renewable energy sources integration indicator, a comparison is made between the avoided curtailment due to technical constraints with and without the evaluated investment, which is equivalent to the increase in the integration of renewable energy sources achieved with the investment. Its monetisation is included in the socio-economic welfare indicator.

## LOSSES

The transmission network losses indicator is used to measure the energy efficiency of an investment in terms of the reduction of losses in the network. In general terms, investments could be considered to bring generation closer to consumption by reducing losses and increasing the efficiency of the system. It should be noted that, in systems with a high proportion of renewable energy sources, this is usually concentrated in areas with a high level of resources that are not necessarily located close to the consumption supply points. This circumstance increases the transport of this renewable energy to the consumption points and, consequently, results in an increase in the overall losses of the system.

To calculate the loss indicator, the variation in losses without and with the investment evaluated is calculated. Its monetisation is included in the socio-economic welfare indicator.

## SECURITY OF SUPPLY: REDUCTION OF ENS

The security of supply indicators evaluate and quantify the contribution of an investment to guarantee supply in the analysis period, either by reducing the energy not supplied or by reducing the necessary generation.

The ENS reduction indicator is calculated by comparing the results of the value of Energy Not Supplied (ENS in MWh/year) without and with the evaluated investment. The monetisation of the ENS will be obtained by multiplying it by a value of demand not supplied or VOLL (Value of Lost Load) for a price of 6,350 €/MWh, based on the best reference currently available for Spain[26].

## SECURITY OF SUPPLY: REDUCTION OF GENERATION NEEDED IN ISLAND SYSTEMS

In the particular case of non-peninsular systems in which guaranteeing demand adequacy requires the installation of new generation, investments consisting of interconnecting systems can have the benefit of reducing the amount of generation needed to guarantee demand adequacy.

Thus, in some isolated systems –Ceuta, Tenerife and La Gomera– additional generation is required to achieve the degree of demand adequacy established in the regulations[27]. The proposed interconnection investments in these systems reduce the amount of additional generation required since, in the system resulting from the interconnection, generation management makes it possible to share the available generation and, consequently, reduce the needs that were present in isolation.

For interconnection investments between isolated systems, this indicator is calculated as the difference between the value of new generation required to be installed in the systems in order to guarantee demand adequacy as isolated systems, with respect to the required generation value when they are interconnected once the investment is in service.

It is measured in MW and is defined as the generation capacity that would not need to be installed as a result of considering the investment being evaluated to be in service. This indicator is particularly relevant when links interconnecting two systems or islands are evaluated, such as the Peninsula-Ceuta link or the Tenerife-La Gomera link. The monetisation of this indicator is calculated as the annual savings corresponding to the remuneration, both for investment and for operation and maintenance –according to the standard values set out in RD/738/2015, of 31 July–, which would correspond to the additional generation capacity that is saved with the action under study.

26 "The costs of electricity interruptions in Spain. Are we sending the right signals?" Pedro Linares, Luis Rey, Alco Foundation, 2012".
27 Royal Decree 738/2015 establishes a maximum monthly LOLE value of 0.2 hours/month for systems in non-peninsular territories.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## 3.6.2.2. Costs

### CAPEX

The CAPEX (Capital Expenditure) considers the investment costs (M€) associated with the evaluated investment and considers both the investment associated with new facilities and the reinforcement of existing facilities.

Given that the approach of the CBA analysis, as mentioned above, is from the point of view of the system, the cost used for investments in the transmission network has been calculated on the basis of the costs recognised for transmission facilities as indicated in Order IET/2659/2015. For those investments that do not have a remuneration standard, the investment cost calculated with the best information available and provided by the transmission network owner is used.

### OPEX

The OPEX (Operational Expenditure) considers the operation and maintenance costs (M€/year) associated with the investments for new facilities or for the reinforcement of existing infrastructures that make up the transmission network development investment under evaluation. The costs identified for transmission facilities in accordance with CNMC Circular 7/2019[28] have been taken into account.

For those facilities that do not have a recognised remuneration standard, an operation and maintenance cost is considered based on the best available information provided by the transmission network owner.

## 3.6.2.3. Impacts

The environmental impact characterises the potential impact of the project by providing a measure of the environmental sensitivity associated with the project. The social impact characterises the impact of the project on the population, with the purpose of reflecting a measure of the social sensitivity associated with the project. Both indicators are considered in a qualitative and simplified manner and will take into account the philosophy embodied in the Strategic Environmental Assessment.

The specific assessment of the environmental and social impact of the plan as a whole and its alternatives will correspond to the Strategic Environmental Assessment of the plan. On the other hand, the specific assessment of each planned project is carried out in the Environmental Impact Statement during the permitting phase.

## 3.6.2.4. Profitability of the investment for the system: NPV

The calculation of the Net Present Value (NPV) of the investments analysed is governed by the following principles:

- The result obtained from the simulations with a 2026 horizon has been considered for the monetised indicators (benefits and costs), applied on a constant basis during all the years of the useful life of the project.
- The benefits and costs are calculated at nominal costs of 2021.
- The analysis period starts with the estimated commissioning date of the project.
- Discount rate (return on investment) of 4%, using the recommendations of the Agency for the Cooperation of Energy Regulators (ACER), for electricity transmission network projects.
- The life span of the facilities has been considered according to their typology. In general, 40 years are considered for transmission network projects, except for synchronous condensers, for which 25 years are considered, and 12 years in the case of DLRs.
- Residual value of the project at the end of its life span: 0.

In general, an investment could be considered economically justified if its NPV is positive. However, if an investment does not have a positive NPV, it cannot be concluded directly that the project is dispensable. In this case, it will be necessary to assess other possible non-monetised benefits complementing the justification of the investment.

28 Note 7/2019, of 5 December, of the National Commission for Markets and Competition, which approves the standard facilities and the unit reference values for operation and maintenance per fixed asset element to be used in the calculation of the remuneration of companies owning electricity transmission facilities.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes



# 4

# 4. Results


4.1. What would happen if no transmission network is built beyond the starting grid?

4.2. What would happen with an unconstrained transmission network?

4.3. Design of the planned transmission network

4.4. Analysis of the new needs of the transmission network

4.5. Main planned investments

4.6. Impact of the development of the transmission network

4.7. Key data of the development plan 2021-2026

4.8. Projects required beyond 2026

# 4.1. What would happen if no transmission network is built beyond the starting grid?

## SPANISH MAINLAND ELECTRICITY SYSTEM

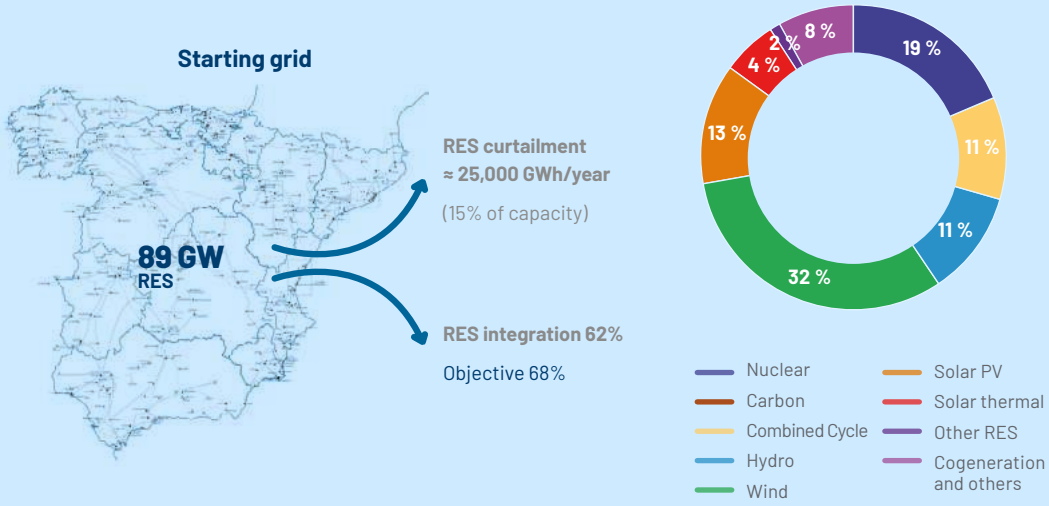
From the analysis of the results obtained considering the study scenario (demand and generation of the indicative planning) without additional transmission network developments beyond the starting grid, it can be seen that the possibilities of the electricity system achieving the energy policy objectives established in the NECP would be significantly reduced.

## Without grid development, energy policy objectives would not be met.

The starting grid could offer connection possibilities for most of the renewable energy sources considered. However, limitations in the network would make it impossible to achieve an integration value in line with the targets and would result in significant curtailment. In addition, it would instead require the scheduling of a high quota of thermal generation due to technical constraints, with the associated increased emissions and variable costs. In future scenarios, the integration of renewable energy sources and the resolution of technical constraints are closely related, and in most cases, it is very difficult to distinguish between them.

In short, if only the starting grid was available, in 2026 it would not be possible to integrate 25,000 GWh/year of renewable energy production due to limitations in the transmission network, and renewable energy curtailment would account for around 15% of potential production. The share of renewable energy sources would be 62% of the total value of electricity generation, 6 percentage points below the 68% value that would mark the NECP compliance path in 2026. Due to these values of reduced production and, therefore, reduced profitability of renewable energy sources, the absence of a transmission network development in addition to the starting grid could lead to the decision by developers of future renewable energy sources to reduce their generation deployment plans, which would slow down the energy transition.

**Figure 32. Main results of a starting grid only scenario. The pie chart represents the contribution of each technology to the system balance**




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

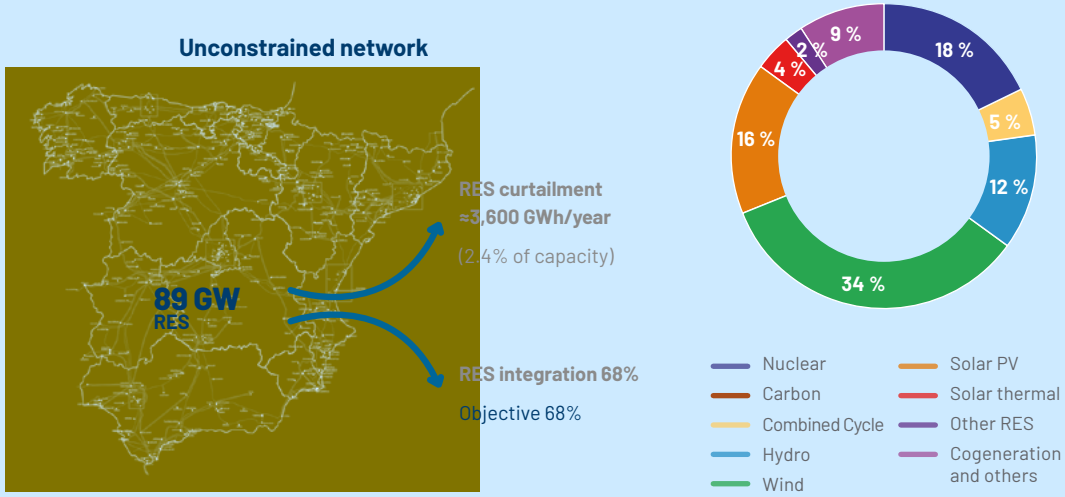
# 4.2. What would happen with an unconstrained transmission network?

## SPANISH MAINLAND ELECTRICITY SYSTEM

In order to assess the maximum potential for improvement that could be achieved through an ideal development of the transmission network, the above situation is compared with the optimal situation in which the network does not pose any restriction to energy flows, i.e. a network without constraints. In this ideal grid, RES curtailment is drastically reduced, allowing the energy policy objectives set out in the NECP to be met.

A greater integration of renewable energy sources is not possible only through the development of the transmission network, and it is necessary to have complementary tools, in particular managed storage, in order to maximise the use of the renewable resource as a whole.

**Figure 33. Main results of a scenario with only an unconstrained grid. The pie chart represents the contribution of each technology to the system balance**



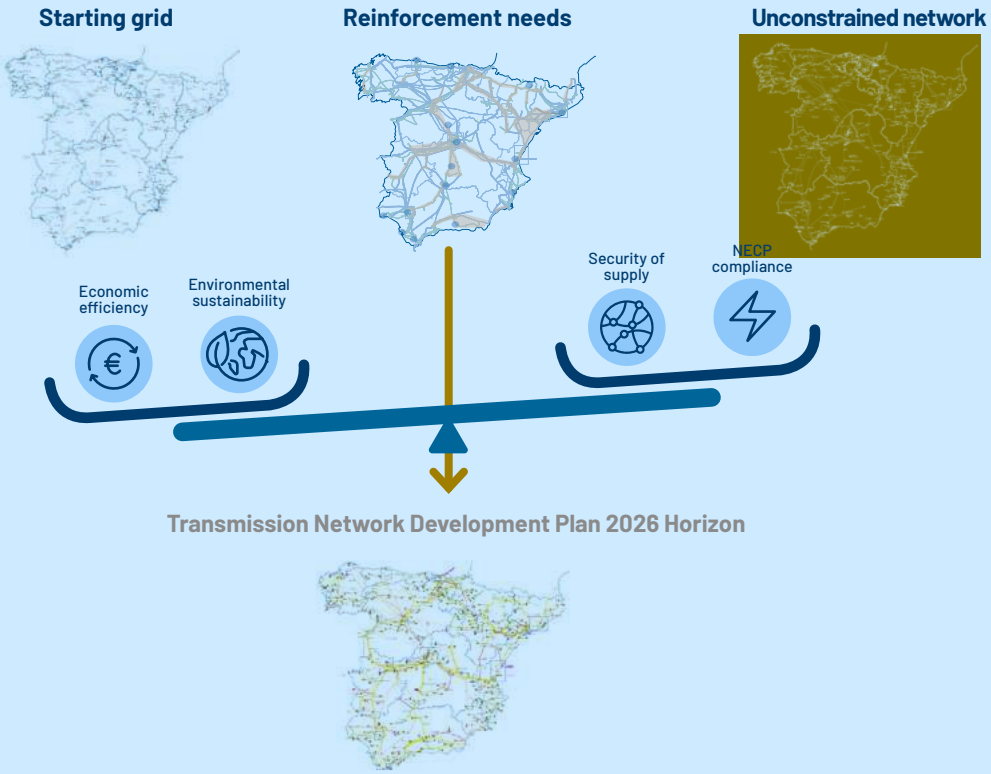

A network without limitations would allow energy policy objectives to be met, although its development would have a high social and environmental impact and the investment costs would exceed the established limits.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 4.3. Design of the planned transmission network

An unconstrained transmission network such as the one described above would allow compliance with the projected path of the NECP for the evolution of the electricity system and ensure security of supply. However, to achieve this, there is a need to construct a significant number of new investments whose environmental and social impact and investment cost could affect the balance of the guiding principles. Therefore, based on the analysis of the limitations and flows observed in the study scenario with the starting grid, the possible alternative investments that could resolve them have been evaluated in order to finally incorporate into the development plan only those alternatives that allow a balance between the achievement of the energy, security of supply, environmental sustainability and economic efficiency objectives.

**Figure 34. Design process of the transmission network development plan for the 2026 horizon**




The planned network constitutes a middle-ground between the starting grid and the aforementioned unconstrained grid, in order to allow a balance between energy policy objectives, security of supply, economic sustainability and environmental commitment.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 4.4. Analysis of the new needs of the transmission network

## SPANISH MAINLAND ELECTRICITY SYSTEM

The study scenario for the 2026 horizon shows a substantial change in the operation level required of the transmission network as new generation injection zones appear. Indeed, the substitution of the energy generated by coal and combined cycle facilities by that provided by renewable energy sources not only leads to a change in generation technologies but also in the location of the main points at which generation is injected. However, no relevant changes in the geographical distribution of consumption are observed over the study horizon. Consequently, new energy transport flows appear from the large renewable energy basins to the areas where electricity consumption is concentrated.

The change in transmission flows is not limited to a modification of the general geographical distribution, but rather, due to the variability of renewable energy sources, a greater variability in the needs imposed on the transmission network is observed; a much more pronounced variability than that which until now characterised the operating situations of the electricity system. Thus, from a scenario that could clearly be identified with known daily patterns according to electricity demand (peak, flat, valley, weekend), we will move on to a scenario in which the potential production of renewable energy sources and their location will fundamentally characterise the flows that should be supported by the transmission network. There will be a wide variety of situations: high photovoltaic in the southern area with high wind generation in the north-western area, low photovoltaic and high wind generation in the north-eastern area...

In addition to the multiplication of the number of patterns in the operation of the system, the transition from one situation to another will occur much more frequently. While the patterns known so far are mainly of a daily nature, in the study scenario, radically different operating situations will occur on the same day, which will pose a challenge for the operation of the system.

The large transmission flows from generation to consumption change geographically and are variable throughout the day.



Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

In the 2026 study scenario, the overall effect of the new renewable energy sources on the main system flows translates into an increase in the number of hours in which the up to now usual North-South and West-East flows are inverted by South-North and East-West flows. Thus, there are areas of the grid whose generation-demand balance is significantly modified, becoming more importing (less exporting), such as Asturias, the País Vasco and Cataluña, while others are becoming clearly exporting areas, such as Andalucía, Aragón, Castilla-La Mancha and Extremadura.

In some cases, this change results in a reduction of transmission network flows, for example in hours with high photovoltaic generation connected in areas close to large consumption centres. However, a significant increase in transmission network flows is observed in a significant number of hours due to lower generation in combined cycle plants located close to significant demand, such as Cataluña. The aforementioned production is replaced by renewable energy sources that must be transported from more distant areas: on some occasions from Eastern Andalucía and Levante, and on others from Aragón, Castilla-La Mancha or Navarra.

The starting grid, which at the time was designed for a very different composition of generation to that now being considered, allows the flows between generation and short-term demand to be met with sufficient solvency. However, it does not present the same degree of preparedness to support the new energy flows derived from the injection of generation from the new renewable facilities in the study scenario (approx. 18 GW of new wind generation and 19 GW of new photovoltaic generation).

For example, the increase in wind generation in Galicia can be met by the starting grid as the replacement of coal-fired generation in the area by wind generation does not bring new transmission network development needs. At the opposite extreme are, for example, Castilla-La Mancha and Andalucía, which, with the installation of large photovoltaic generation volumes, need to make possible the transmission of this renewable energy sources in daytime scenarios, which brings significant needs to reinforce the transmission network in these areas consequently.



**Figure 35. Predominant flows on the Spanish mainland in the study scenario**



Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## INTERNATIONAL INTERCONNECTIONS

In addition, the consideration of reinforcements of international interconnections in the study scenario in order to advance in the integration of the European Internal Energy Market leads to changes in transmission flows, especially in the north and northwest of the Spanish mainland, which must be addressed through the development of the planned transmission network. The 2026 horizon includes the reinforcement of the northern interconnection between Spain and Portugal, as well as the construction of a new interconnection between Spain and France via the Biscay gulf; a new Spain-Andorra interconnection and a new circuit in the Spain-Morocco interconnection in accordance with governmental agreements and European energy policy guidelines.

## NON-PENINSULAR SYSTEMS

Regarding the non-peninsular systems, the thermal generation fleet generally has a significantly higher cost than in the mainland system, so that the integration of renewables is, in addition to its contribution to the decarbonisation objectives, very advantageous in terms of reducing generation costs.

However, as the electricity systems are small in size, and in some cases weakly interconnected, their possibilities for integrating relevant renewable energy sources are more limited. Thus, additional development of the transmission network in the non-peninsular systems and, in particular, the development of links between islands plays an essential role in enabling their evolution along the lines defined by the NECP.

In this respect, the plan includes the reinforcement of the existing interconnection between the mainland and the Baleares and between the islands of the Balearic system, as well as the construction of the first link between the mainland and Ceuta and between Tenerife and La Gomera.

In the particular case of the Baleares, it should be noted that the planned investment to strengthen their interconnection with the mainland comprises a set of complementary elements: a new HVDC link between the mainland and Mallorca together with components fully integrated into the network[29] such as synchronous condensers on Mallorca and a battery system on the islands of Menorca and Ibiza. In addition to the additional electricity connection between systems, this investment will maximise its use to increase the exchange from the mainland –a system with a high degree of renewable energy participation– to the Baleares, improving the efficiency, cost and security of supply of the Balearic system. With the incorporation of both the investment to reinforce the interconnection with the mainland and the new Ibiza-Formentera links, there are no significant changes in the flows in the internal network of the islands compared to the current ones. This effect is a consequence of the choice of the connection point of the new HVDC link between the mainland and Mallorca, which will replace the contribution of coal generation from the Alcudia groups.

Regarding the electricity systems of the Canarias, given the deployment of renewable energy sources that has already been carried out, as well as the potential development until 2026 of renewable generation, there are significant transmission limitations between the areas with high renewable potential, southeast of Tenerife and southeast of Gran Canaria, and the north of both islands, which see a concentration of consumption not only at the capitals but also in other areas.

In the Baleares, there are no major changes in flows due to the appropriate selection of the point of arrival of the second link with the Spanish mainland.In the Canarias, the north-south flows in the large islands should be reinforced.

29 Royal Decree Law 29/2021 of 22 December introduces fully integrated network components, including storage facilities, into Art 34.1 of the Electricity Sector Law as those used to guarantee the secure operation of the transmission network and not for balancing or congestion management purposes.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 4.5. Main planned investments

Following the analysis of the needs of the network and the exhaustive study of the different alternatives that make it possible to address them from the point of view of economic and environmental sustainability, a set of investments are proposed for the development of the transmission network in the 2021-2026 horizon, in addition to the starting grid. Those investments are detailed below by category:

### Assets Renewal

**1** RdT_RENOVE: Transmission Assets Renewal

### Operational requirements

**2** AUT24: Service replenishment plan: 24 hour autonomy requirement

**3** COMP_ICA. Support to renewable integration with synchronous condensers

**4** DESP_TELE. Tele-control systems and control centres

**5** FACTS. Transmission network support with FACTS

**6** PEN_REAS: Reactances for voltage control in the Spanish Mainland Electricity System (SEPE)[30]

**7** TNP_REAS: Reactances for voltage control in the Baleares

### Railway axis power supply

**8** AF_01. Bobadilla-Algeciras

**9** AF_02. Burgos-Vitoria

**10** AF_04. Granada-Almería

**11** AF_05. Madrid-Albacete-Alicante-Valencia

**12** AF_06. Murcia-Almería

**13** AF_07. Murcia-Cartagena

**14** AF_08. Palencia-Santander

**15** AF_09. Puertollano-Mérida

**16** AF_10. Sevilla-Huelva

**17** AF_11. Toledo-Navalmoral-Cáceres-Badajoz

**18** AF_12. Vigo-Orense-Lugo-A Coruña

**19** AF_13. Zaragoza-Teruel-Sagunto

**20** AF_14. Alicante-Crevillente

### Distribution network support

**21** APD-AND: Distribution network support in Andalucía

**22** APD-ARA: Distribution network support in Aragón

**23** APD-AST: Distribution network support in Asturias

**24** APD-CAN: Distribution network support in Cantabria

**25** APD-CAT: Distribution network support in Cataluña

**26** APD-CLM: Distribution network support in Castilla-La Mancha

**27** APD-CVA: Distribution network support in Valencia

**28** APD-CYL: Distribution network support in Castile y León

**29** APD-EXT: Distribution network support in Extremadura

**30** APD-GAL: Distribution network support in Galicia

**31** APD-IBA: Distribution network support in Baleares

**32** APD-ICA: Distribution network support in Canarias

**33** APD-MAD_1: Distribution network support in Madrid

**34** APD-MAD_2: Distribution network support in East Madrid. Henares corridor

**35** APD-MUR: Distribution network support in Murcia

**36** APD-NAV: Distribution network support in Navarra

30 The main function of the reactances is to resolve technical constraints associated with voltage control.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

**37** APD-PVA: Distribution network support in País Vasco

**38** APD-RIO: Distribution network support in La Rioja

### Supply of consumers connected to TN

**39** CONSUM: Consumers connected to the transmission network

### International interconnections

**40** INT_ESP-FRA_1: Interconnection Spain-France via the Bay of Biscay

**41** INT_ESP-FRA_2: Reinforcement of the Spain - France interconnection (Gatica)

**42** INT_ESP-FRA_3: Reinforcement of the Spain-France (Hernani-Argia)

**43** INT_ESP-FRA_4: Spain-France interconnection between Navarra and Landes

**44** INT_ESP-FRA_5: Spain-France via the Aragón Pyrenees-Atlantic Pyrenees

**45** INT_ESP-MAR: Interconnection with Morocco

**46** INT_ESP_AND: Interconnection with Andorra

**47** INT_ESP_POR: Spain-Portugal interconnection, Beariz-Fontefria-Ponte de Lima

### Links between systems

**48** ENL_PEN-IBA: Reinforcement of interconnection between the Spanish mainland and the Baleares

**49** ENL_IBA: IB-FO: Ibiza-Formentera 132 kV links

**50** ENL_ICA: TE-LG: Tenerife-La Gomera links

**51** ENL_PEN-CEU: Spanish Mainland-Ceuta links

### RES integration and resolution of technical constraints

**52** PEN_USO_RdT: Increased use of the Transmission Network

**53** CENTRO_1: La Mancha-Madrid Corridor

**54** CENTRO_2:Reinforcement Andalucía - Extremadura - Madrid Corridor

**55** ESTE_1: New Aragón-Levante Corridor

**56** ESTE_2: Connection at Abanilla

**57** ICA_1: Reinforcement of the north-south axis of Gran Canaria

**58** ICA_2: Reinforcement of the north-south axis in the east of Tenerife

**59** ICA_3: Reinforcement of the southern axis Tenerife and new San Isidro



Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

**Results**

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

**60** N_ESTE_1: Aragón-Navarra Reinforcement

**61** N_ESTE_2: Aragón - Southern Cataluña Reinforcement

**62** N_ESTE_3: Aragón - Central Cataluña Reinforcement

**63** N_ESTE_4: Connection at Almendrales 400 kV

**64** N_ESTE_5: Topological modification of the Pyrenean network

**65** N_ESTE_6: New Isona 400/220 kV substation

**66** N_OESTE_1: Asturias 400 kV Reinforcement

**67** N_OESTE_2: Connection at Briviesca

**68** N_OESTE_3: Connection at Villalbilla

**69** N_OESTE_4: Connection at Urueña

**70** N_OESTE_5: Connection at Piedrahita

**71** N_OESTE_6: Connection at Abegondo

**72** N_OESTE_7: Reinforcement of the Soria network

**73** NORTE_1: New Navarra - País Vasco axis

**74** SUR_1: New corridors in Andalucía

**75** GEN_ALM: Connection of renewables and storage

**Security of supply**

**76** SoS_CENTRO: Reliability of supply Madrid

**77** SoS_CENTRO_Pcc: Reliability of supply Madrid (Short Circuit Current)

**78** SoS_IBA_1: Reinforcement of the southern network of the island of Ibiza

**79** SoS_IBA_2: Dynamic Line Rating at Llucmajor-Orlandis 66 kV

**80** SoS_ICA_1: Reinforcement of Tenerife West Ring

**81** SoS_ICA_2: Reinforcement of La Palma network

**82** SoS_ISLAS: Increased security of supply in non-peninsular systems

**83** SoS_N_ESTE: Refurbishment of Cinca 220 kV

**84** SoS_N_ESTE_Pcc: Topological modification in Gramanet (Short Circucit Current)

**85** SoS_N_OESTE: New Substation Abades 400 kV (Formerly Herreros)

**86** SoS_SUR_1: Supply reinforcement in Huelva (Costa de la Luz)

**87** SoS_SUR_2: Puerto de Santa María 220 kV

**88** SoS_SUR_3: Reliability of supply in Saleres

**89** SoS_SUR_Pcc: Double bus in Don Rodrigo

For more detailed information on each of the above investments, please refer to the new reinforcements Annex.

It is important to mention that the present plan does not include reservations of bays or references to specific agents or facilities identified by their access codes, since the planning process is a different, albeit coordinated, process to the access and connection process. Therefore, for planned bays with a connection reason that does not have access granted and connection in progress, the relevant accesses must be formalised through the processes established for this purpose in the regulations, mainly in Royal Decree 1183/2020 and Circular 1/2021 and its implementing regulations.



Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

**Results**

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

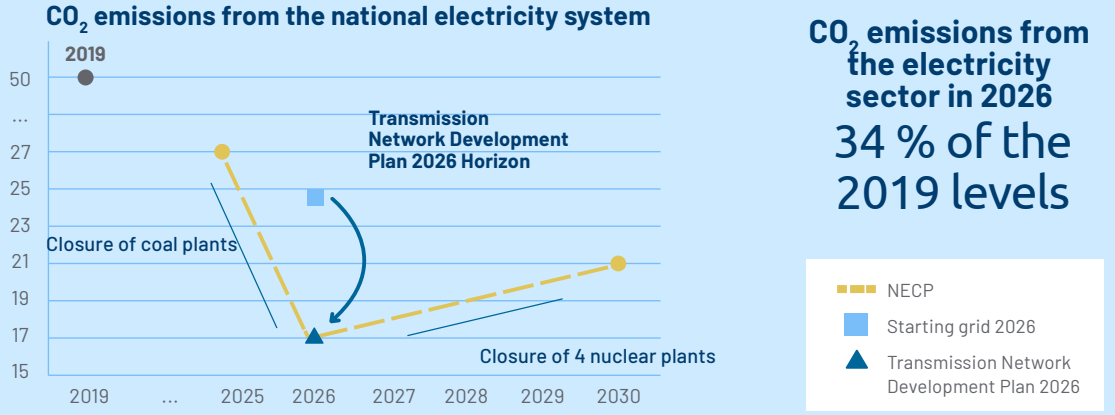
# 4.6. Impact of the development of the Transmission Network

The analysis of a final scenario including both the starting grid and the set of new planned investments leads to the conclusion that the development plan presented is necessary to meet the energy policy objectives set out in the NECP in terms of $CO_2$ emissions and the integration of renewable energy sources for the electricity sector, as well as international interconnections.

At the national level, $CO_2$ emissions in 2026 would stand at 17 $MtCO_2$, i.e. 34% of the emissions of the electricity system in 2019, and the integration of renewables at 67%, compared to 38% in 2019. As can be seen in the attached figure, both values are on the right path towards achieving the objectives set out in the NECP for 2030.

In terms of the improvement compared to the situation with the starting grid, the set of new investments planned would allow a 31% reduction in $CO_2$ emissions from the electricity sector compared to the situation with the starting grid, which is very close to the situation without network constraints.

**Figure 36. Estimated evolution path of the $CO_2$ emissions of the national electricity system: planned network for H2026 vs. starting grid**







**The planned network captures**

80 - 90 % of the welfare

**that would be achieved with an unconstrained network**

The transmission network planned for 2026 is essential to achieve the decarbonisation path set out in the NECP.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

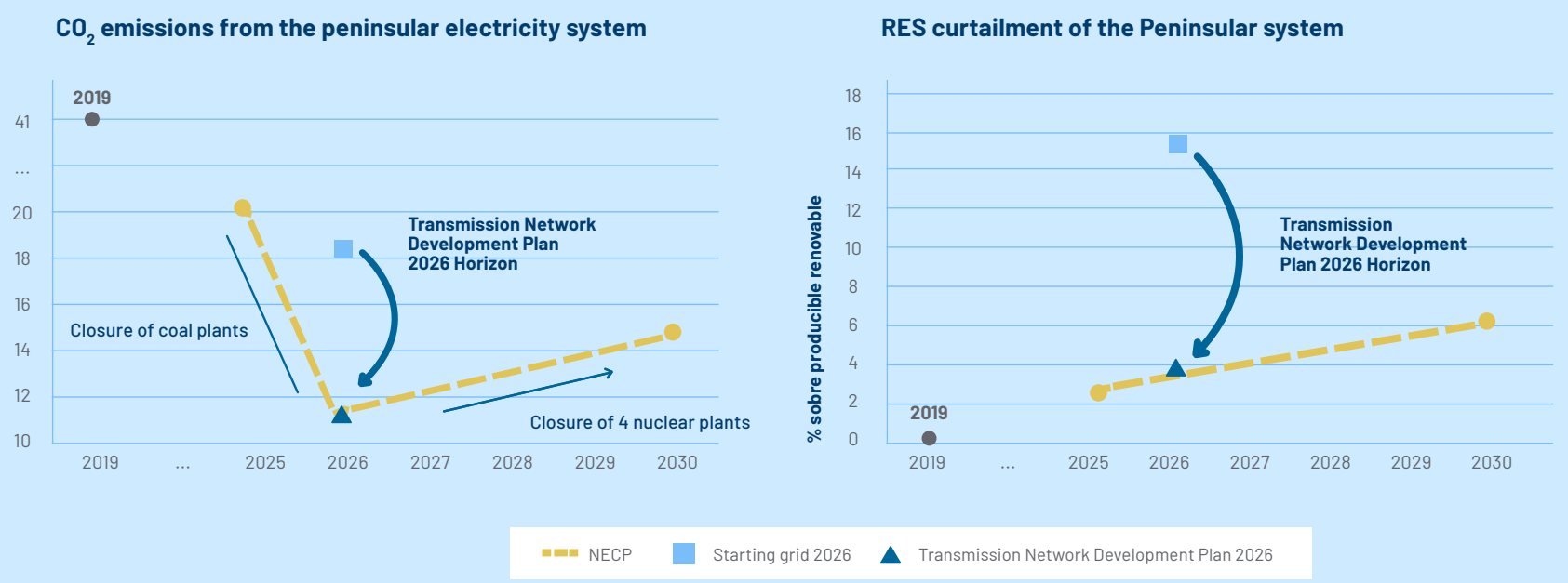
## SPANISH MAINLAND SYSTEM

At the mainland level, the set of new planned investments will reduce annual $CO_2$ emissions from the mainland electricity system by 72% compared to 2019, bringing them down to 11 Mt/year.

The share of renewable energy sources in the mainland generation mix would reach 68%. Both the reduction of $CO_2$ emissions and RES integration are on the linear path that would allow the NECP targets to be met in 2030.

The set of planned facilities allows achieving a 68% RES integration in the mainland system, in accordance with the path established in the NECP.

**Figure 37. Estimated evolution path of $CO_2$ emissions and RES curtailment of the Spanish mainland electricity system: planned grid for H2026 vs starting grid**

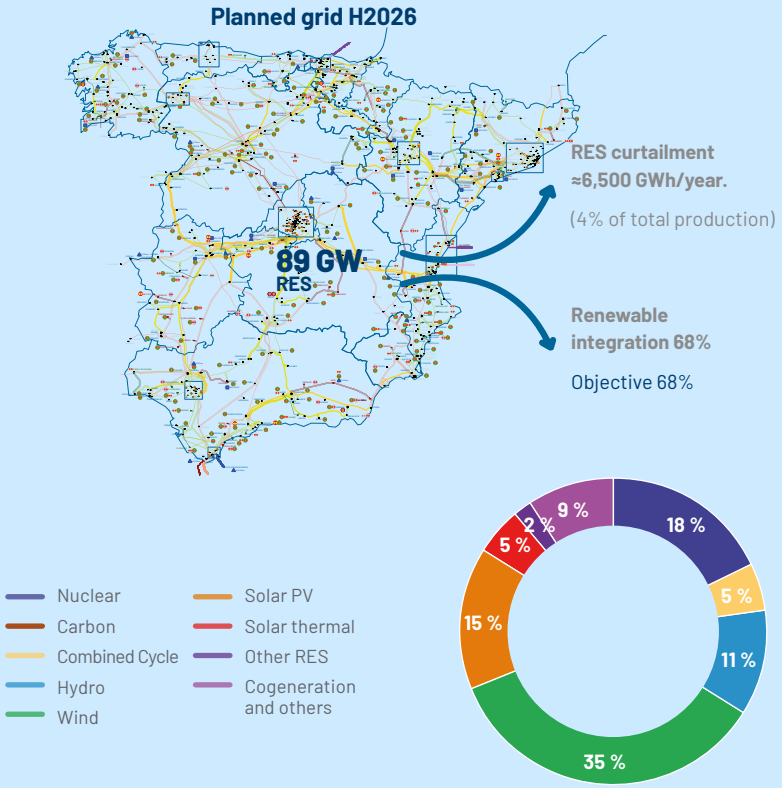



Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

Compared to the situation where there are no transmission network developments beyond the starting grid, the transmission network development plan allows for a 32% reduction in $CO_2$ emissions associated with the electricity sector. Furthermore, the new developments maximise RES integration with a considerable reduction of curtailment, from 15% in the starting grid case to 4% in the planned scenario; this value is consistent with the recommendations of Art 13.5 of the European regulation on the internal electricity market (EU Regulation 2019/943) and close to the theoretical minimum of the case in which the transmission network would not present any limitation.

The new planned developments allow for a substantial improvement in RES integration, with a 74% reduction in renewable energy sources generation curtailment compared to the starting grid.

**Figure 38. Main results of the scenario with the transmission network included in the 2021-2026 development plan. The pie chart represents the contribution of each technology to the system balance**




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

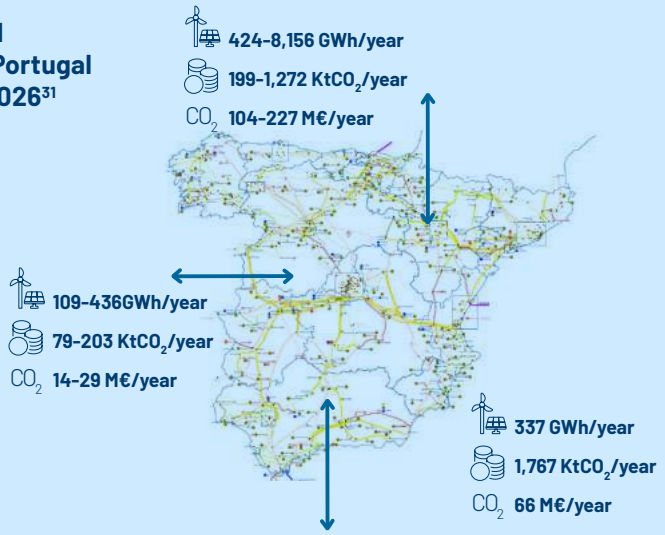
## INTERNATIONAL INTERCONNECTIONS

The transmission network development plan is aligned with the energy policy objectives set out in the NECP in terms of international interconnections. It includes the new interconnection between Spain and France in the Biscay Gulf and the northern interconnection between Spain and Portugal, investments that will enable progress towards a true Internal Energy Market in Europe.

The assessment of interconnections is carried out within the scope of ENTSO-E in European planning (TYNDP), as a coordinated analysis and simulations considering the whole of continental Europe with its demand and generation evolution forecasts are necessary. The latest edition of the TYNDP2020 assesses the consequences of not carrying out these projects in 2025 and 2030, and quantifies the benefits derived from market integration, in terms of RES integration and decarbonisation.

On the other hand, the development plan also includes the reinforcement of the interconnection with Morocco that allows for the fulfilment of the agreement with the Kingdom of Morocco for the development of a third electricity interconnection and a strategy for collaboration in the field of energy by 2026 established in February 2019[32]. The reinforcement of the interconnection with Morocco by means of a third circuit results in a greater flow of exchange between the Spanish and Moroccan systems, which practically doubles in both directions. The net balance of exchange is clearly an exporter from Spain to Morocco, which allows a significant part of the RES from the south of the peninsula to be sold. It should be noted that, as this is a project that has already been incorporated late in the planning analysis process, the benefits of this last interconnection have been assumed once all the other investments in the development plan for 2026[33] have been developed. Finally, it should be noted that the assessment has adopted as a hypothesis a cost of $CO_2$ emissions in Morocco equivalent to that of the rest of Europe, a factor that still requires regulatory developments aimed at harmonising the market environment.

**Figure 39. Welfare of reinforced interconnections with France, Portugal and Morocco included in the H2026[31] development plan**




The planned reinforcement of international interconnections allows for greater coupling with the European single market and a substantial improvement in RES integration.

31 The benefits of interconnections with France and Portugal are the maximum and minimum values of those obtained in the TYNDP2020 in the National Trends 2025 and 2030 scenarios. The welfare of Morocco corresponds to the simulations to 2026 in the scope of this planning.

32 https://www.lamoncloa.gob.es/serviciosdeprensa/notasprensa/ecologica/Paginas/2019/140219-energiamarruecos.aspx.

33 Sequential PINT methodology, discussed in section 3.6.1.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## NON-PENINSULAR SYSTEMS

In the non-peninsular systems, the set of new investments planned will also enable the NECP targets to be met by 2026.

With respect to the electricity system in the Baleares, the set of new investments planned, in particular the second mainland-Baleares link, will maximise the integration of the Baleares system into the mainland system, as stipulated by the NECP. The contribution of the mainland system to covering demand in the Baleares will increase from 28% in 2019 to 65% in 2026, which will reduce Balearic supply costs by more than 138 M€/year, i.e. 61% compared to the variable cost of the Balearic system in 2019, as well as significantly reducing $CO_2$ emissions associated with Balearic supply to reach a level of emissions of less than 25% of those in 2019 in 2026.

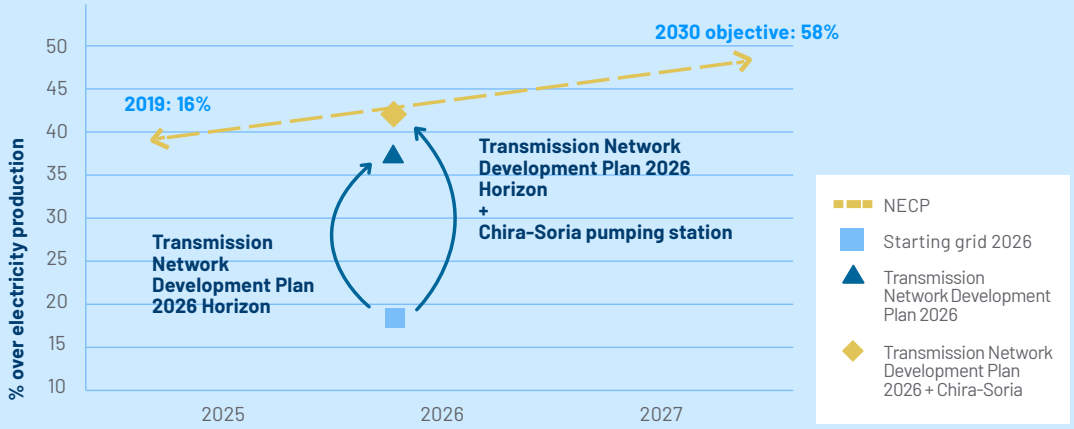
At the level of the electricity systems in the Canarias, the set of new planned investments will substantially increase security of supply and reduce the variable cost associated with conventional generation in the Canarias by 7% compared to the starting grid, a reduction of more than 30% compared to 2019.

In the final scenario, progress is made towards meeting the targets indicated in the NECP, with more than double the level of RES integration in the generation mix in 2026 compared to 2019. To achieve this, in addition to the planned development of the transmission network, it is necessary to provide the planned set of synchronous condensers, as well as an adequate adaptation of the oldest renewable facilities. However, in these systems, compliance with the RES integration path in accordance with the objectives set by the NECP for 2030 also requires the availability of storage systems. At the 2026 horizon, this need is already clearly detected: the NECP RES integration target, established at around 42% for 2026 can only be achieved through the development of the transmission network, the provision of the planned condensers and the commissioning of the Salto de Chira pumping station.

**65% of Balearic supply will be met from the Spanish mainland, leading to a substantial reduction in costs and emissions associated with Balearic supply.**

**In the Canarias, RES integration is doubled and the variable cost of generation is reduced by 30% compared to 2019.**

**Figure 40. Estimated evolution path of RES integration for the Canarias electricity system as a whole: planned grid for H2026 vs. starting grid. Impact of Salto de Chira**



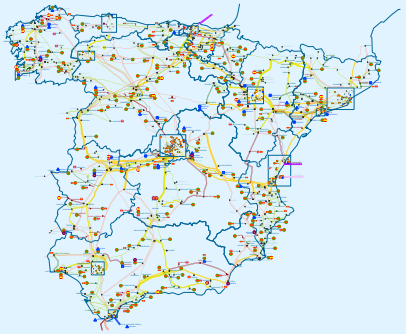

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## PROFITABILITY OF THE DEVELOPMENT PLAN

The welfare provided by the set of new investments planned for the different Spanish electricity systems have been evaluated following the cost-benefit analysis methodology explained above. The evaluation includes all the investments in which the welfare can be quantified, except for demand support investments and the reinforcement of international interconnections, the welfare of which have been included in a previous section.

The welfare provided by the new planned network investments allow the system to depreciate the associated investment and provide a benefit to the system of more than €1,440 million per year.

### Mainland and Ceuta electricity system



**PROFIT**

Reduction of $CO_2$ emissions
**5,300 kt/year**

RES integration
**18,500 GWh/year**

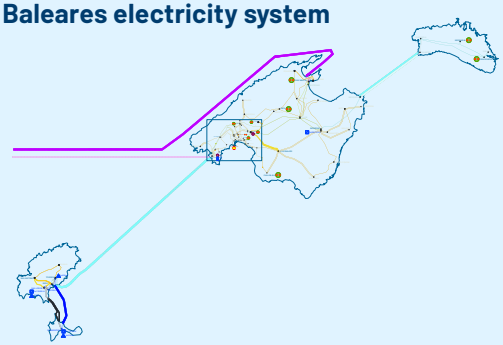
Total investment
**2,160 M€**

Annual profit
**980 M€/year**

NPV
**17,200 M€**

Annual profit/investment year1
**5.5**

### Baleares electricity system



**PROFIT**

Reduction of $CO_2$ emissions
**314 kt/year**

RES integration
**280 GWh/year**

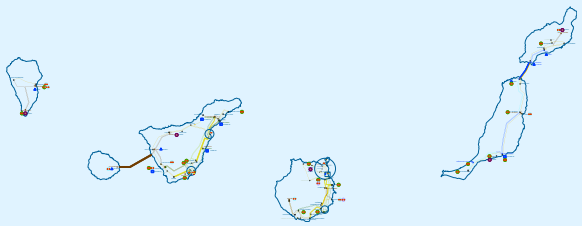
Total investment
**1,166 M€**

Annual profit
**138 M€/year**

NPV
**1,251 M€**

Annual profit/investment year1
**1.6**

### Canarias electricity systems



**PROFIT**

Reduction of $CO_2$ emissions
**1,240 kt/year**

RES integration
**2,015 GWh/year**

Total investment
**385 M€**

Annual profit
**325 M€/year**

NPV
**6,040 M€**

Annual profit/investment year1
**10**

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
**Results**
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 4.7. Key data of the development plan 2021-2026

The estimated investment cost of all the investments included in the 2021-2026 transmission network development plan is 6,964 M€, of which 1,260 M€ correspond to investments that are not subject to the investment limit established in Art. 13 of Royal Decree 1047/2015 and DA 2ª of Royal Decree-Law 23/2020, to reinforce international interconnections with France, Portugal, Andorra and Morocco, and €5,704 M to investments to reinforce the transmission networks that make up the national electricity system, both the starting grid and new facilities.

## The greatest investment effort is earmarked for the integration of renewables and the resolution of technical constraints.

The limit value of investment in the period 2021-2026 is determined by the evolution of the Spanish gross domestic product forecast by the Ministry of Economic Affairs and Digital Transformation in the 2021-2024 Stability Programme, which, for the years 2025 and 2026, considers the same evolution of GDP as in the year 2024. The total investment limit value in the period amounts to €5,705 million, so the planned investment plan practically exhausts this limit value for the period; respecting the allowed annual investment limit value.

**Figure 41. Investment value included in the plan for each year of the period 2021-2026 and annual investment limit value**

| | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|---|---|
| GDP (billions of €) | 1,122 | 1,209 | 1,313 | 1,381 | 1,437 | 1,494 | 1,554 |
| Nominal GDP growth (%) | -9.9 | 7.8 | 8.6 | 5.2 | 4.0 | 4.0 | 4.0 |
| Annual investment limit value (€ million) | | 907 | 985 | 898 | 934 | 971 | 1,010 |
| Annual investment limit value *1.2 (million €) | | 1,088 | 1,182 | 1,078 | 1,121 | 1,165 | 1,212 |
| Planned annual investment value (million €) | | 318 | 823 | 1,074 | 1,120 | 1,165 | 1,204 |

**Figure 42. Total investment cost of the 2021-2026 development plan: starting grid, new investments to reinforce national networks and reinforcements of international interconnections[34] (M€)**




34 This includes the investments in international interconnections that do not count towards the investment limit value, part of which are in the starting grid.

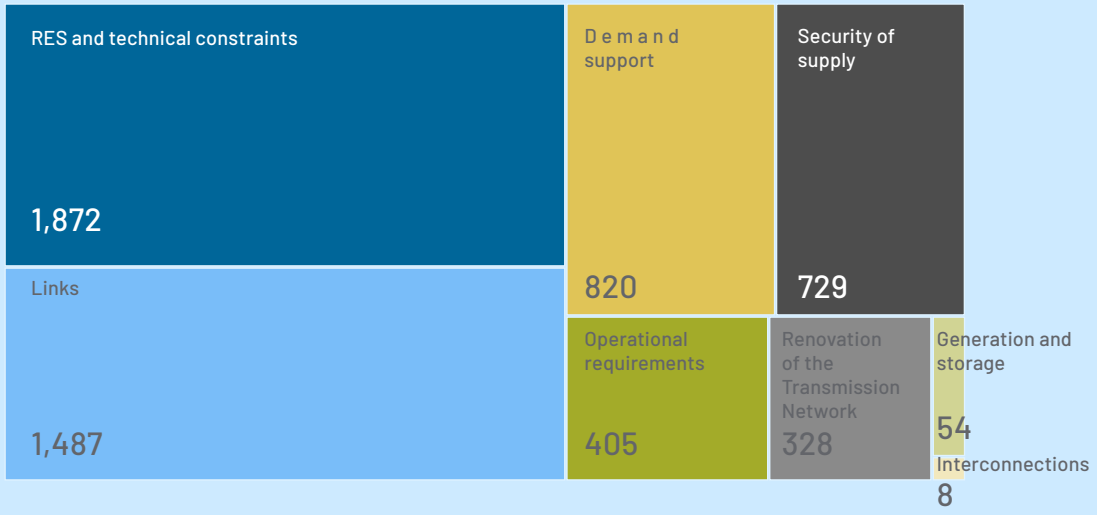
Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

Of all the investments aimed at reinforcing the national networks that are subject to the investment limit of €5,704 million, the largest volume of investment, almost 33%, corresponds to RES integration and the resolution of technical constraints, in accordance with a planning focused on adapting the transmission network to facilitate the process of decarbonisation and the massive implementation of renewable energy sources in the system. The links section is the second in terms of investment volume due to the intensive cost of submarine links which, however, is compensated by the advantages it brings to isolated systems in terms of security of supply, reduction of generation costs and RES integration.

**Figure 43. Total investment cost of the 2021-2026 development plan: breakdown of starting grid investments, new investments to reinforce national networks and reinforcements of international interconnections according to whether they are subject to the investment limit value or not (M€)[35]**

| CAPEX In M€ | Counts towards the limit of Investment | Does not count towards the limit of investment | TOTAL |
|---|---|---|---|
| International Interconnections | 3 | 1,190 | 1,193 |
| Starting grid | 1,103 | 51 | 1,154 |
| New investments | 4,598 | 18 | 4,616 |
| | **5,704** | **1,260** | **6,964** |

**Figure 44. Total investment cost of the 2021-2026 plan subject to investment limit value per driver (M€)**




35 New investments include the renewal of international interconnection lines that do not count towards the investment limit (18 M€). Internal reinforcements to achieve the net transfer capacity values not included in the TYNDP2020 Biscay Gulf project do count towards the investment limit (3 M€). The starting grid includes the investment to reinforce the interconnection with Portugal, which is not included in the investment limit (51 M€).

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## DISTRIBUTION BY ZONES

The following figures represent the planned distribution of investment by Autonomous Communitie by driver. The distribution reflects, on the one hand, the specificity of the non-peninsular systems, which are the focus of significant investment items; the total amount of which amounts to around 2,200 M€ This is mainly due to the investment effort in submarine links that reduce the vulnerability of these systems, while at the same time bring a substantial reduction in supply costs.

On the other hand, the zonal distribution of the planned investment in the Spanish mainland system reflects the new electricity transmission needs in order to integrate the planned amount of renewable energy sources and meet the flows from the high density renewable energy regions to the consumption areas, i.e. from Andalucía, Extremadura and Castilla-La Mancha to Madrid, as well as the flows of renewable energy evacuation from Aragón and Navarra to the Mediterranean coast.

Proper RES integration requires the reinforcement of the network between the new production areas and the consumption areas.

**Figure 45. Total investment cost of the 2021-2026 plan by Autonomous Community : starting grid/planned new investments/links (without international interconnections)**

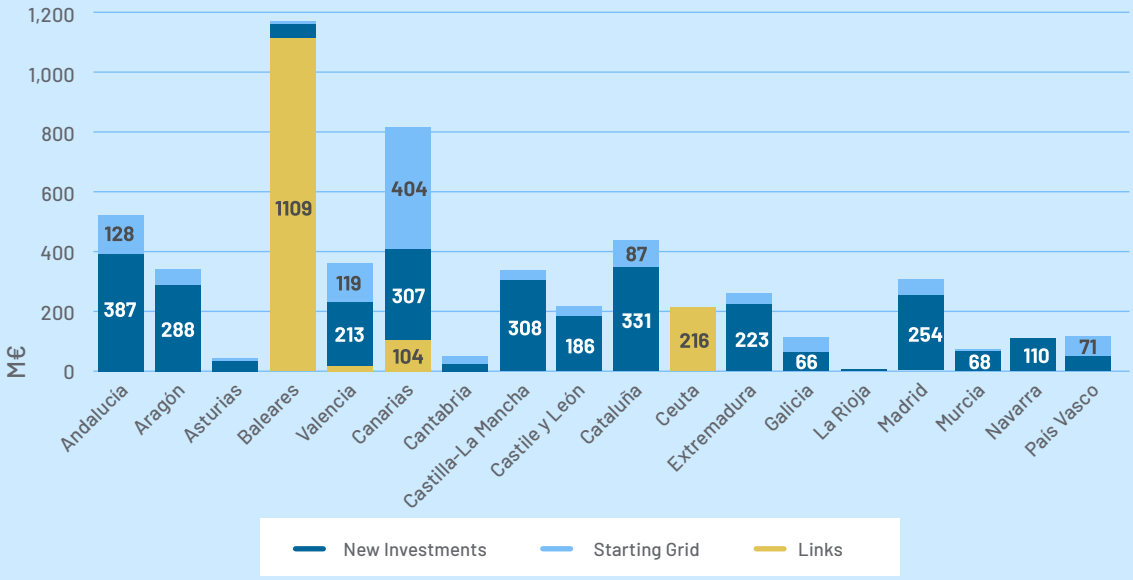
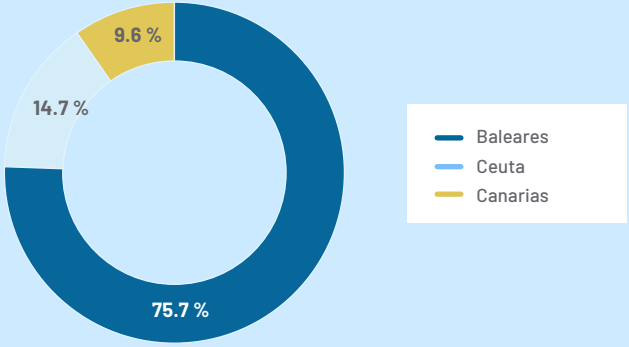


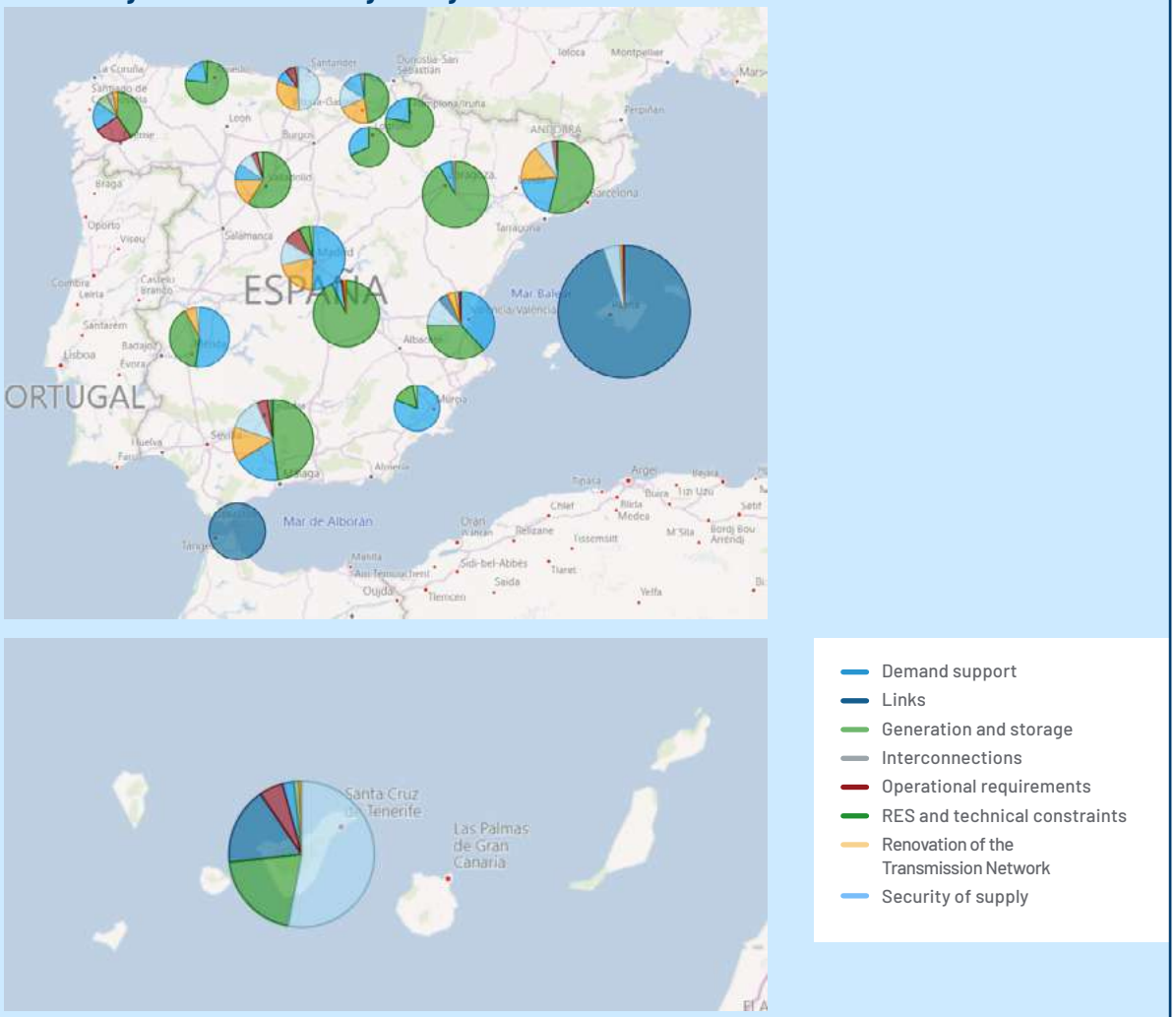

**Figure 46. Distribution of costs by Autonomous Community or Autonomous City associated with the plan for the development of links between Spanish electricity systems**




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes



**Figure 47. Distribution of the total investment cost of the 2021-2026 plan by Autonomous Community or Autonomous City and by driver**



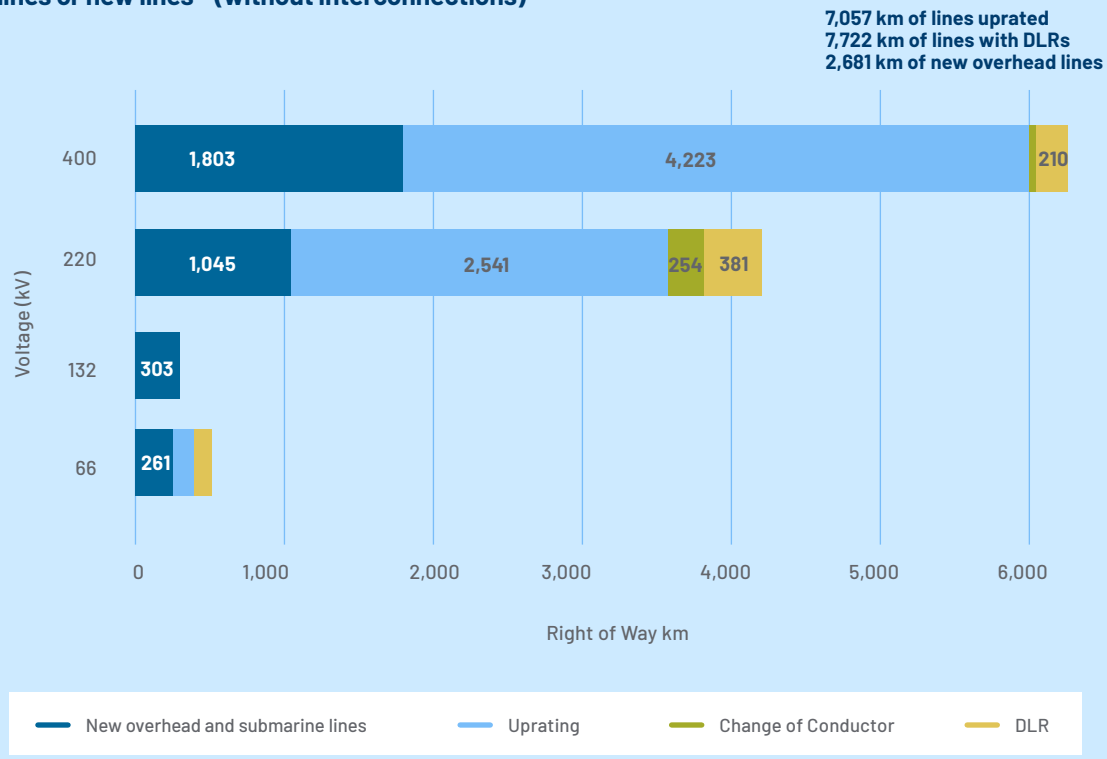

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## LEVERAGING THE EXISTING TRANSMISSION NETWORK

In line with the planning guiding principle of maximising the use of the existing grid, the development plan contains, excluding interconnections, 7,057 km of uprating, the replacement of conductors on 300 km of existing lines and the provision of dynamic transmission capacity monitoring (DLR) systems on 722 km of existing lines. The length of new lines included in the new line development plan is much smaller, comprising 2,681 km of new axes and 733 km[36] of submarine cables.

The transmission network development plan encourages the use and improvement of the existing network while minimising the environmental impact of the plan.

**Figure 48. Planned investments in lines by type: installation of DLRs, uprating of existing lines or new lines[37] (without interconnections)**

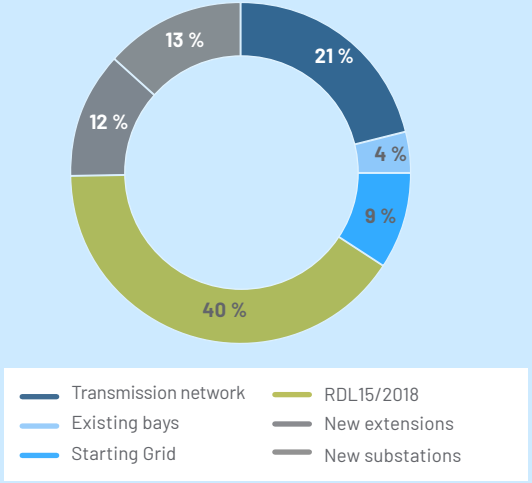



36 For the calculation of this figure, the double circuits of a power line are considered as different lines.
37 This graph does not include investments in international interconnections.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

Similarly, the connection of new wind and photovoltaic renewable energy sources (approx. 18 GW of new wind generation and 19 GW of new photovoltaic generation) is planned in the most efficient way possible, taking advantage of existing or planned bays and substations wherever feasible. As shown in the figure attached, only 13% of the necessary connections require the development of new substations, while 12% require new substation extensions. The rest of the connections are made at starting grid bays, as they have accesses granted and are investments considered in the 2015-2020 plan or planned under RDL 15/2018. 21% is considered to be connected to the distribution network via the existing transmission-distribution interface or via newly planned reinforcements.

**Figure 49. Breakdown of connection types of renewable energy sources in the study scenario**




53% of the connection of new renewable energy sources is made at pre-planned transmission bays.



Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 4.8. Projects required beyond 2026

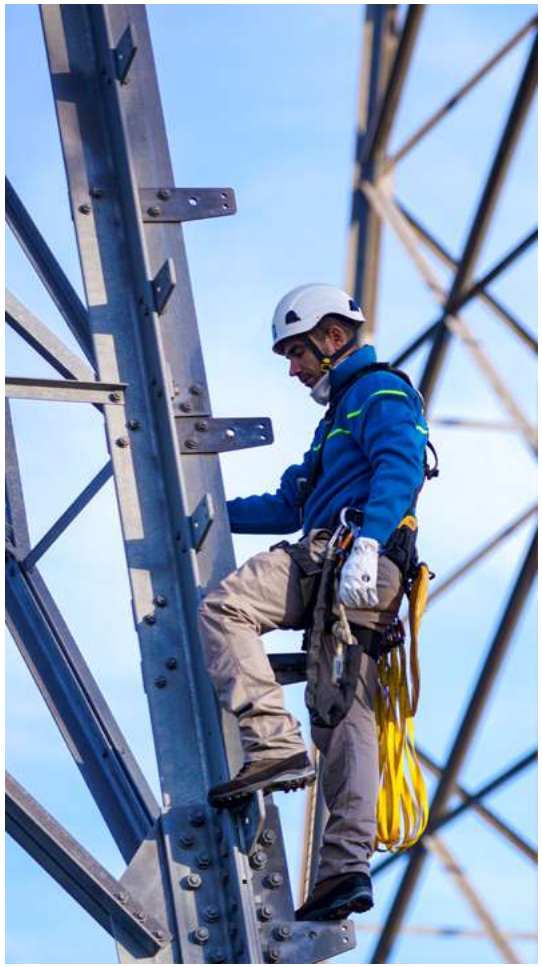
In addition to the necessary infrastructures for the 2021-2026 period, which would constitute the binding planning, a series of actions have been identified which, although necessary and beneficial within the planning horizon to 2026, are not feasible within that horizon due to construction or economic reasons. This is the case, among others, of some of the second or third phases of the major renewable collector axes.

On the other hand, it is also considered relevant to include in this group the Spain-France interconnections via Navarra and Aragón, which are expected to be commissioned after the planning horizon and always after the commissioning of the interconnection in the Biscay Gulf.

In addition, it also includes those investments which, while not forming part of the study scenario, are endorsed by the European Commission as European Projects of Common Interest.

A list of these investments, which are proposed for indicative purposes, with a commissioning date after 2026, is included in the Annex Investments beyond the 2026 Horizon.

Given that the permitting times for transmission network infrastructures are often longer than the six-year horizons contemplated in national planning, it is necessary to define them early enough to have solutions ready for the time horizon in which the need is identified. Certain infrastructures require long periods of study, administrative and environmental permitting, the resolution of technical difficulties and coordination between different agents, which makes it necessary to contemplate time periods longer than six years. In accordance with sector legislation, the inclusion of an investment in this list will allow the relevant administrative permitting procedures to be initiated, provided that they do not directly affect the property and rights of third parties.

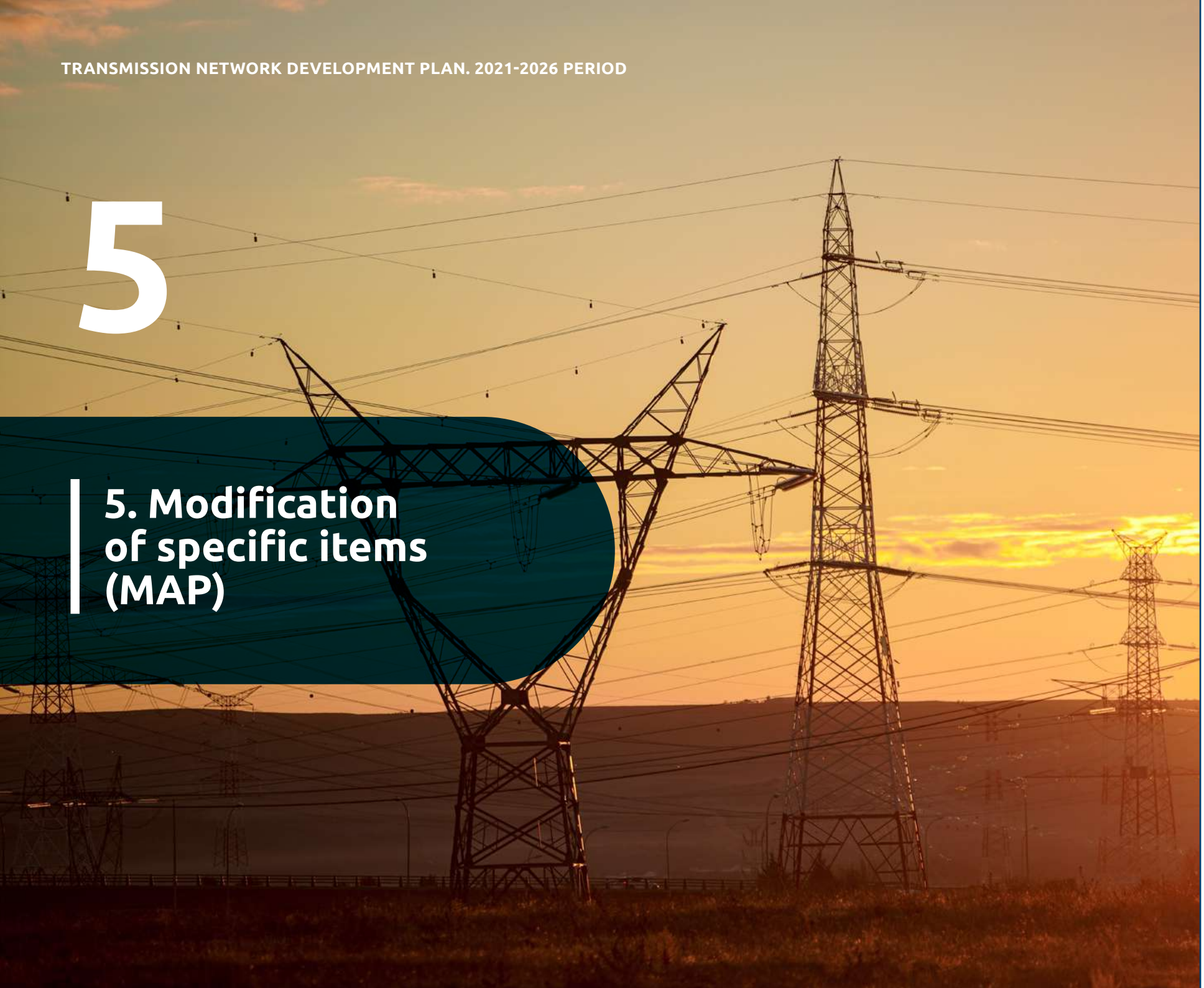


Given the average permitting times for transmission facilities, it is necessary to lay the foundations for meeting the NECP's 2030 objectives.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 5

# 5. Modification of specific items (MAP)



Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

**Modification of specific items**

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

Article 4 of Law 24/2013 of 26 December, of the Electricity Sector, stipulates that, as an exception, by Agreement of the Council of Ministers, following a hearing, reports from the National Commission for Markets and Competition and from the Autonomous Communities and Cities of Ceuta and Melilla in question, and having consulted the System Operator, modification of specific items in the development plans may be carried out in the event of any of the following situations:

**a)** According to the established planning criteria, an unforeseen event has occurred that could significantly affect the guarantee and security of supply.

**b)** New demands emerge which, for technical reasons, can only be supplied from the transmission grid and this cannot be accommodated within the current development plan.

**c)** There are considerations related to the system's economic efficiency.

**d)** The construction of certain transmission grid elements is critical for the energy transition and electrification of the economy, and this is not provided for in the existing planning document.



Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

**Modification of specific items**

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# 5.1. MAP - April 2024

In accordance with the previous, on 16 April 2024, a Modification of Specific Items as part of the Electricity Transmission Network Development Plan 2021-2026 was approved, which includes in the applicable Development Plan a set of new investments to meet the needs of the electricity system that have emerged since the plan's approval in March 2022 and which, in conformity with the exceptional nature defined previously, require short-term attention for one of the following reasons:

- They allow to address the urgent needs related to security of supply.
- They allow to address new demands that have emerged following the approval of the current plan which, for technical reasons, can only be supplied from the transmission grid.
- They substantially reduce costs due to technical restrictions that are currently in place, promoting the system's economic efficiency.
- They allow for the construction of certain transmission grid elements that are critical for the energy transition and electrification of the economy, and this was not provided for in the existing planning document.
- They make viable future developments necessary to achieve the established objectives of cross-border capacity with neighboring systems.
- They make viable certain transmission grid elements that are critical for the energy transition and tlectrification of economy, which are provided for in the current planning document.

With all this, a set of modifications has been included, which have been grouped into the following categories:

- New demands: set of grid developments that allow for new high-power supplies.
- Renewable generation and storage: set of grid developments that allow the connection of new storage facilities and renewable generators, as well as to make viable some already incorporated in the current plan.
- New operational needs for the inclusion of voltage control elements to reduce technical restrictions, to include monitored switch relays, and to comply with granted access permits.
- Modifications to ensure the viability of the existing development plan and, therefore, to guarantee appropriate energy transition.




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
**Modification of specific items**
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

The set of modifications of specific items, for which a summary is included in the table attached, represents a variation in the investment cost associated with the existing planning of +489 M€. The information related to these modifications is listed in *Annex I- Starting grid* and *Annex II - New reinforcements*.

| Modification proposal | Justification* | Cost variation (M€) |
|---|---|---|
| **New demands** (*Annex II - New reinforcements, Investments approved by Modification of Specific Items of April 2024, investment – MAP_CONSUM*) | | **342.9** |
| New demands in the region of Huelva | New supplies / Energy Trans. | 0.1 |
| New demands in the region of Algeciras | New supplies / Energy Trans. | 7.9 |
| New demands in the region of Noreste | New supplies / Energy Trans. | 84.6 |
| New demand in Verneda 220 kV | New supplies / Energy Trans. | 10.0 |
| New demand in Sagunto 220/400 kV | New supplies / Energy Trans. | 62.1 |
| New demand in Fausita 220 kV | New supplies / Energy Trans. | 1.1 |
| New demand in El Serrallo 220 kV | New supplies / Energy Trans. | 9.4 |
| New demand in Algete 220 kV | New supplies | 0.0 |
| New demand in Calera y Chozas 220 kV | New supplies | 2.7 |
| New demands in Asturias | New supplies / Energy Trans. | 2.9 |
| New demand in Nuevo Vigo 220 kV | New supplies / Energy Trans. | 72.0 |
| New demands and pumped storage in the region of As Pontes | New supplies / Energy Trans. | 13.0 |
| New demands in the region of Ferrol | New supplies / Energy Trans. | 20.3 |
| New demand in Meirama 220 kV | New supplies / Energy Trans. | 0.0 |
| New demands in Castilla y León | New supplies / Energy Trans. | 0.0 |
| New demand in Río Caya 400 kV | New supplies / Energy Trans. | 0.0 |
| New demands in Arrigorriaga | New supplies / Energy Trans. | 6.5 |
| New demands in Álava | New supplies / Energy Trans. | 10.4 |
| New demand in Santurce 220 kV | New supplies / Energy Trans. | 0 |
| New demand in Piélagos 220 kV | New supplies / Energy Trans. | 6.9 |
| New demand in Puerto de Palma 66 kV | New supplies / Energy Trans. | 7.6 |
| New demand in Riudarenes 220 kV | New supplies / Energy Trans. | 24.3 |
| New demand in Brazatortas 400 kV | New supplies / Energy Trans. | 1.1 |

| Modification proposal | Justification* | Cost variation (M€) |
|---|---|---|
| **Renewable generation and storage** (*Annex II - New reinforcements, Investments approved by Modification of Specific Items of April 2024, investment MAP_ALM_GEN and MAP_NFT*) | | **61.7** |
| Pumped storage in Viana 400 kV | Energy Trans. | 5.7 |
| Pumped storage in Plaza II 220 kV | Energy Trans. | 26.5 |
| Pumped storage in Budía 400 kV | Energy Trans. | 7.3 |
| Pumped storage in Pesoz 400 kV | Energy Trans. | 1.1 |
| Connection to NFT in Lancha | Energy Trans. | 0.0 |
| Connection to NFT in La Robla | Energy Trans. | 0.0 |
| Connection to NFT in Compostilla | Energy Trans. | 0.0 |
| Connection to NFT in Mudéjar | Energy Trans. | 0.0 |
| Connecting renewable generation in Fuencaliente 66 kV | Energy Trans. | 21.1 |
| **New operational requirements** (*Annex II - New reinforcements, Investments approved by Modification of Specific Items of April 2024, investment –MAP_OS*) | | **20.4** |
| Connecting to renewable generation with access granted | Energy Trans. | 0.0 |
| Need to control voltage | Sec. Sup. /Eco Eff. | 14.6 |
| Need to include controlled switch relays | Sec. Sup. | 5.8 |

*Acronyms: MAP: Modification of specific items; Energy Trans.: Energy transition; Sec. Sup.: Security of Supply; Eco Eff.: Economic efficiency.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
**Modification of specific items**
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

| Modification proposal | Justification* | Cost variation (M€) |
|---|---|---|
| **Viability of scheduled investments** *(Annex I – Starting grid and Annex II - New reinforcements - several)* | | **64** |
| Need for an additional central switch bay | Energy Trans. | 23.5 |
| Needs associated with distribution support accesses | Energy Trans. | 40.5 |
| Technology type incompatibility in substations | Energy Trans. | -3.3 |
| Variation in the number of planned bays | Energy Trans. | -12.9 |
| Transformer capacity correction in Abades | Energy Trans. | 4.3 |
| Review works with AE/PES prior to 2021 | Energy Trans. | -66.8 |
| Technology update in line works | Energy Trans. | -20.7 |
| Update to lengths in line works | Energy Trans. | -55.1 |
| Update to the type of circuit in line works | Energy Trans. | 10.1 |
| Update to substation configuration in planned works | Energy Trans. | 0.0 |
| Update to the short circuit current in substation works | Energy Trans. | 3.4 |
| Change in name of planned works | Energy Trans. | 0.0 |
| Update to planned transmission capacities | Energy Trans. | -5.3 |
| Update to planned line renewals | Energy Trans. | 44.6 |
| Works that should have been identified as starting grid | Energy Trans. | 6.3 |
| New DLR in Ibiza-Bossa 66 kV line | Energy Trans. | 0.2 |
| Update to the Otero-Abades 220 kV line works | Energy Trans. | 14.1 |
| Update to the new DC Mangraners-Penedés-Begues 220 kV | Energy Trans. | 2.7 |
| Update to the works in the New Barrundia 220 kV | Energy Trans. | 3.1 |
| Update to the works in La Sagra 400/220 kV | Energy Trans. | -8.7 |
| Need for new cable sections in substations | Energy Trans. | 23.5 |
| Removal of reactance Santa Ponsa 132 kV REA 3 | Energy Trans. | -1.5 |
| Update to substation upgrade works | Energy Trans. | 2.9 |
| Modification to the adjustment to O.P. SE Adrall 220 kV | Energy Trans. | 3.1 |
| Modification to the adjustment to O.P. SE Cinca 220 kV | Energy Trans. | 8.5 |
| Modification to the adjustment to O.P. SE Abrera 220 kV | Energy Trans. | 0 |
| Modification to the adjustment to O.P. | Energy Trans. | 28.7 |
| Works to enable uprating and conductor replacement | Energy Trans. | 4.4 |
| New substation in Las Palmas Oeste 66 kV | Sec. Sup. | 8.3 |
| Substation Son Pardo 66 kV | Energy Trans. | -0.5 |
| Upgrade to Valladolid-Nueva Zaratán 220 kV line | Energy Trans. | 0.0 |
| Change in topology DC Rubí-Gramanet 220 kV | Energy Trans. | 1.6 |
| Expansion of Fuendetodos 400 kV | Energy Trans. | 0.0 |
| Modification I/O in Puerto del Rosario 66 kV | Energy Trans. | -2.3 |
| Spain – France interconnection via the Bay of Biscay | Energy Trans. | 5.2 |
| Change in ownership | Energy Trans. | 0.0 |
| I/O Aldea Blanca 66 kV from Bco Tirajana-Escobar 66 kV | Energy Trans. | 0.6 |
| Peninsula-Baleares interconnection | Energy Trans. | 1.4 |
| **Total** | | **489** |

*Acronyms: MAP: Modification of specific items; Energy Trans.: Energy transition; Sec. Sup.: Security of Supply; Eco Eff.: Economic efficiency.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
**Modification of specific items**
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 5.2. MAP - July 2025

In response to the power system collapse on 28 April 2025, a series of measures were proposed to strengthen system stability, particularly focused on voltage control, reactive power compensation, and service restoration. Key recommendations are structured around the following two pillars:

**Modernisation of reactive power compensation systems.**
Reactances are currently one of the main tools integrated into the transmission grid to control voltage through reactive power absorption/generation. However, their binary operation—limited to full on/off states—restricts their ability to make precise or gradual voltage adjustments. Therefore, complementary devices with dynamic voltage control capabilities such as synchronous compensators, FACTS (Flexible AC Transmission Systems), or STATCOMs are essential to improve the system's response to rapid voltage variations or oscillations. These technologies also help reduce the costs associated with technical constraints caused by the need to dispatch synchronous generating units.

**Stabilisation systems installation and configuration plan.**
A dedicated plan is proposed for the deployment and proper tuning of stabilisation systems like PSS (Power System Stabilisers) and POD (Power Oscillation Damping) devices to dampen oscillations and enhance grid strength.

Accordingly, on 8 July 2025, the second amendment of specific aspects of the 2021–2026 Electricity Transmission Grid Development Plan was approved. This second modification incorporates new initiatives aimed at enhancing system stability and voltage control.

Specifically, a set of reactances has been added to allow stepwise voltage reduction at certain times of day in areas with moderate power flows or long/underground transmission paths. This includes 10 new reactances totalling 833 Mvar, improving security of supply by preventing overvoltages in the transmission grid.

To address dynamic voltage variations, 11 synchronous compensators (2,135 Mvar total) will also be incorporated. These devices facilitate precise and dynamic voltage control. Eight of them are located within the mainland electricity system, with sufficient geographic distribution to support different areas of the grid in local voltage control, complementing both the equipment currently installed and those already planned for this purpose. Two are in Islas Canarias (Fuerteventura and La Palma), complementing the three already planned for the larger islands. One of them, located in Islas Baleares, was previously scheduled for beyond 2026 and has now been brought forward.

The amendment also includes the advancement of the Pierola series FACTS device — previously scheduled beyond 2026 — contribute to the damping of inter-area oscillations that may occur within the interconnected European power system.

Additionally, the amendment includes further controlled switching relays, supplementing those already planned for the national electical system. These relays would help reduce the time required to restore service following an incident.

Finally, to ensure the connection of new emergency generation in Islas Canarias—identified as necessary under the declared energy emergency based on system operator coverage reports—2 new substation bays and 2 upgrades are planned to integrate this generation.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
**Modification of specific items**
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

The group of modifications of specific items, for which a summary is included in the table attached, represents a variation in the investment cost associated with the existing planning of +€750M. The information related to these modifications is listed in Annex I- Starting grid and Annex II - New reinforcements.

| Modification proposal | Justification | Cost variation (M€) |
|---|---|---|
| **New compensation elements** (Annex II - New reinforcements incorporated by MAP, July 2025, Chapter MAP25_NOS_TENSION_SEPE) | | **646.1** |
| Synchronous compensator at Almaraz 400 kV | Voltage control | 71.1 |
| Synchronous compensator at Beariz 400 kV | Voltage control | 71.1 |
| Synchronous compensator at Belinchón 400 kV | Voltage control | 71.1 |
| Synchronous compensator at Brovales 400 kV | Voltage control | 71.1 |
| Synchronous compensator at Cabra 400 kV | Voltage control | 71.1 |
| Synchronous compensator at Litoral 400 kV | Voltage control | 71.1 |
| Synchronous compensator at Rocamora 400 kV | Voltage control | 71.1 |
| Synchronous compensator at Santa María de Grado 400 kV | Voltage control | 72.7 |
| New reactance at Almendrales 400 kV | Voltage control | 3.7 |
| New reactance at Calatorao 220 kV | Voltage control | 2.4 |
| New reactance at Castellbisbal 220 kV | Voltage control | 2.4 |
| New reactance at Sant Fost 220 kV | Voltage control | 2.4 |
| New reactance at Nueva Meco 220 kV | Voltage control | 2.4 |
| New reactance at Plaza 220 kV | Voltage control | 2.4 |
| New reactance at Torrejón de Velasco 400 kV | Voltage control | 3.7[1] |
| Reactance upgrade at Groijota 400 kV | Voltage control | 2.5 |
| Reactance upgrade at Guadame 400 kV | Voltage control | 2.5 |
| Reactance upgrade at Herrera 400 kV | Voltage control | 2.5 |
| Reactance upgrade at Litoral 400 kV | Voltage control | 2.5 |
| Reactance upgrade at Olmedilla 400 kV | Voltage control | 2.5 |
| Reactance upgrade at Pierola 400 kV | Voltage control | 2.5 |
| Series FACTS at Pierola 400 kV | Voltage control | 41.3[1] |

| Modification proposal | Justification | Cost variation (M€) |
|---|---|---|
| **New compensation elements** (Annex II - New reinforcements incorporated by MAP, July 2025, Chapter MAP25_NOS_TENSION_TNP) | | **97** |
| New reactance at San Jorge 66 kV | Voltage control | 1.9 |
| New reactance at Las Breñas 66 kV | Voltage control | 1 |
| New reactance at Playa Blanca 132 kV | Voltage control | 1.4 |
| Synchronous compensator at Fuencaliente 66 kV | Voltage control | 15.1 |
| Synchronous compensator at Haría 66 kV | Voltage control | 19.4 |
| Synchronous compensator at Son Orlandis 220 kV | Voltage control | 37[1] |
| New Haría 66 kV substation | Voltage control | 21.2 |

| Modification proposal | Justification | Cost variation (M€) |
|---|---|---|
| **New system operation needs** (Annex II - New reinforcements incorporated by MAP, July 2025, Chapter MAP25_NOS_ESTABILIDAD) | | **6.4** |
| Controlled switching relays – Mainland | Service restoration | 6 |
| Controlled switching relays – Islas Canarias | Service restoration | 0.4 |

| Modification proposal | Justification | Cost variation (M€) |
|---|---|---|
| **New system operation needs** (Annex II - New reinforcements incorporated by MAP, July 2025, Chapter MAP25_NOS_SEC_GEN) | | **0** |
| New bay at Dique del Este 66 kV | Emergency generation | 0 |
| New bay at Cinsa 66 kV | Emergency generation | 0 |
| Bay upgrade at Granadilla 66 kV | Emergency generation | 0 |
| Bay upgrade at Puerto del Rosario 66kV | Emergency generation | 0 |

1. Reinforcement ahead of the horizon beyond 2026 to 2026.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
**Modification of specific items**
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 6

# 6. Maps

6.1. Spanish mainland

6.2. Spanish mainland detail

6.3. Baleares

6.4. Canarias

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

**Maps**

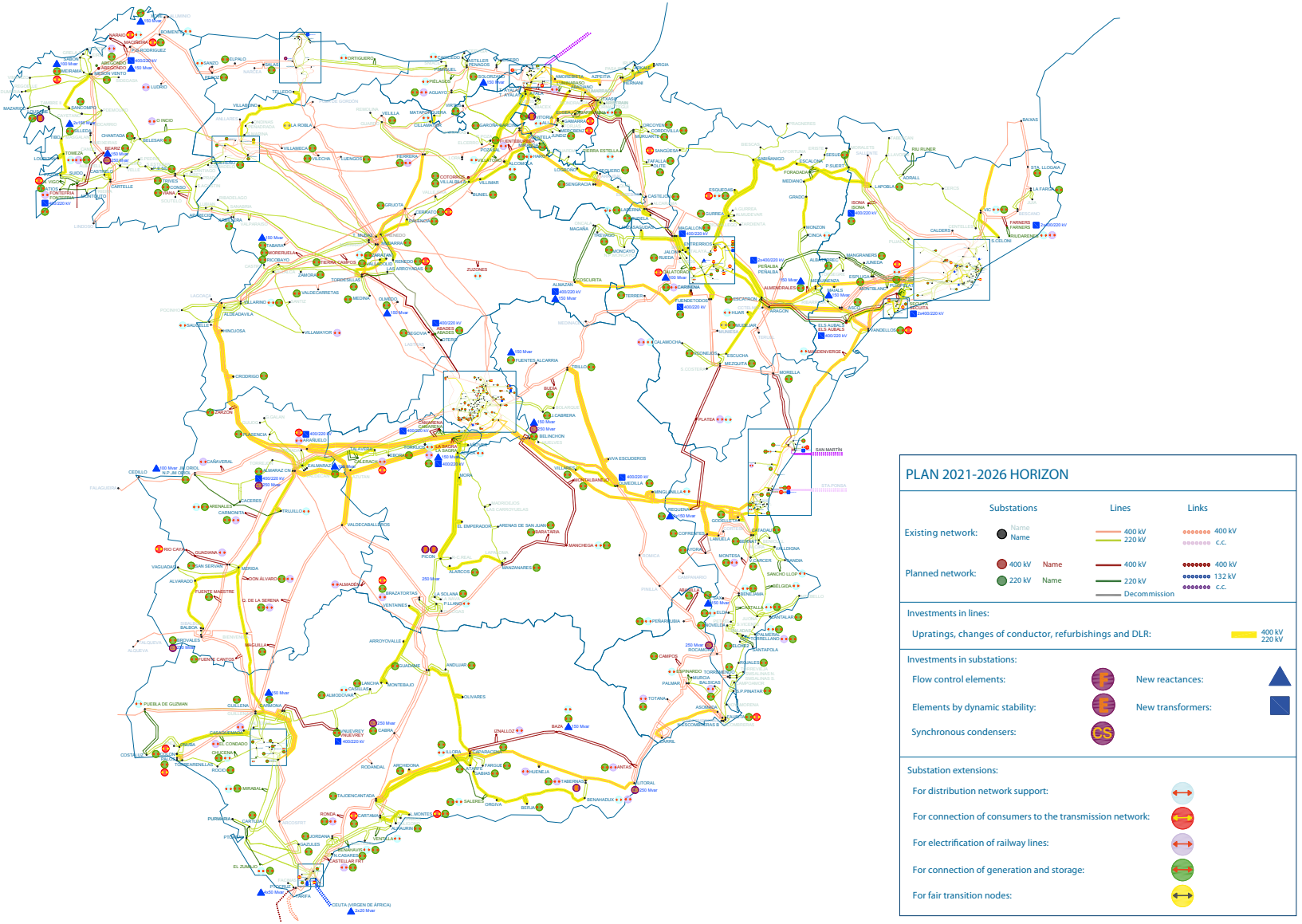
Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

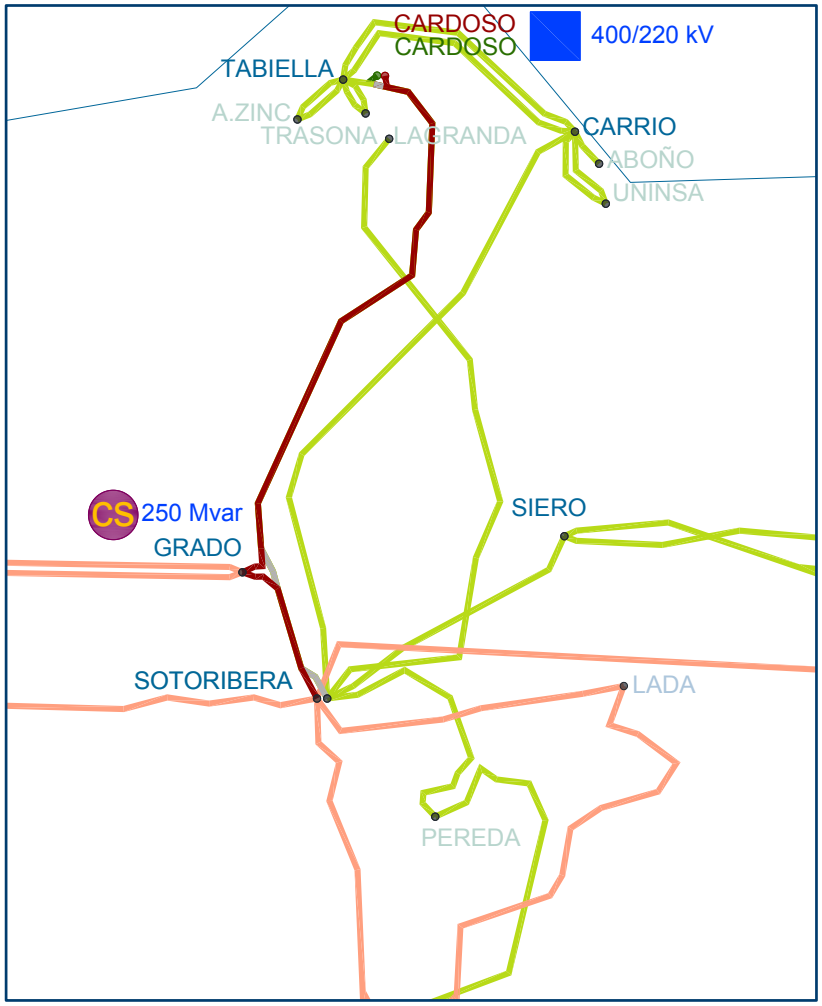
# 6.1. Spanish mainland



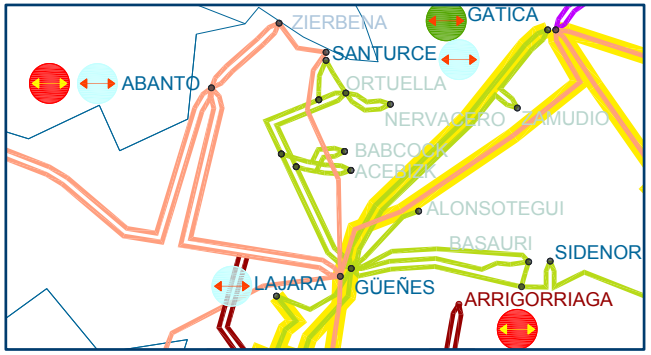

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 6.2. Spanish mainland detail

**Asturias detail**




**País Vasco detail**

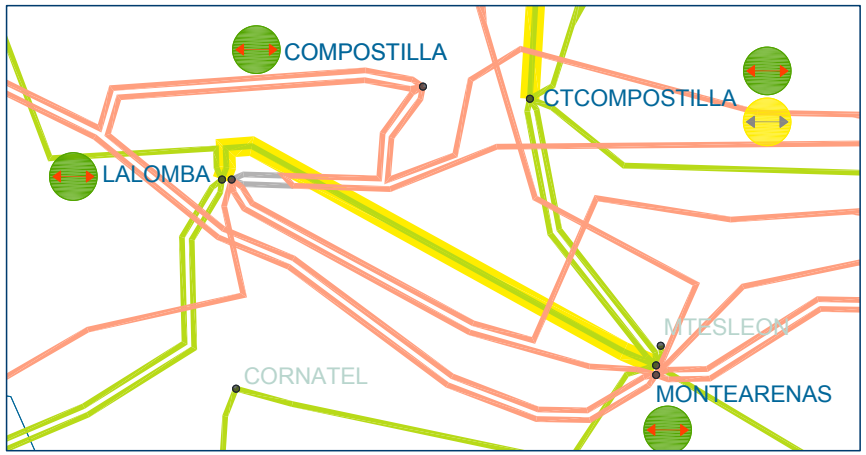



Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

**Aragón detail**

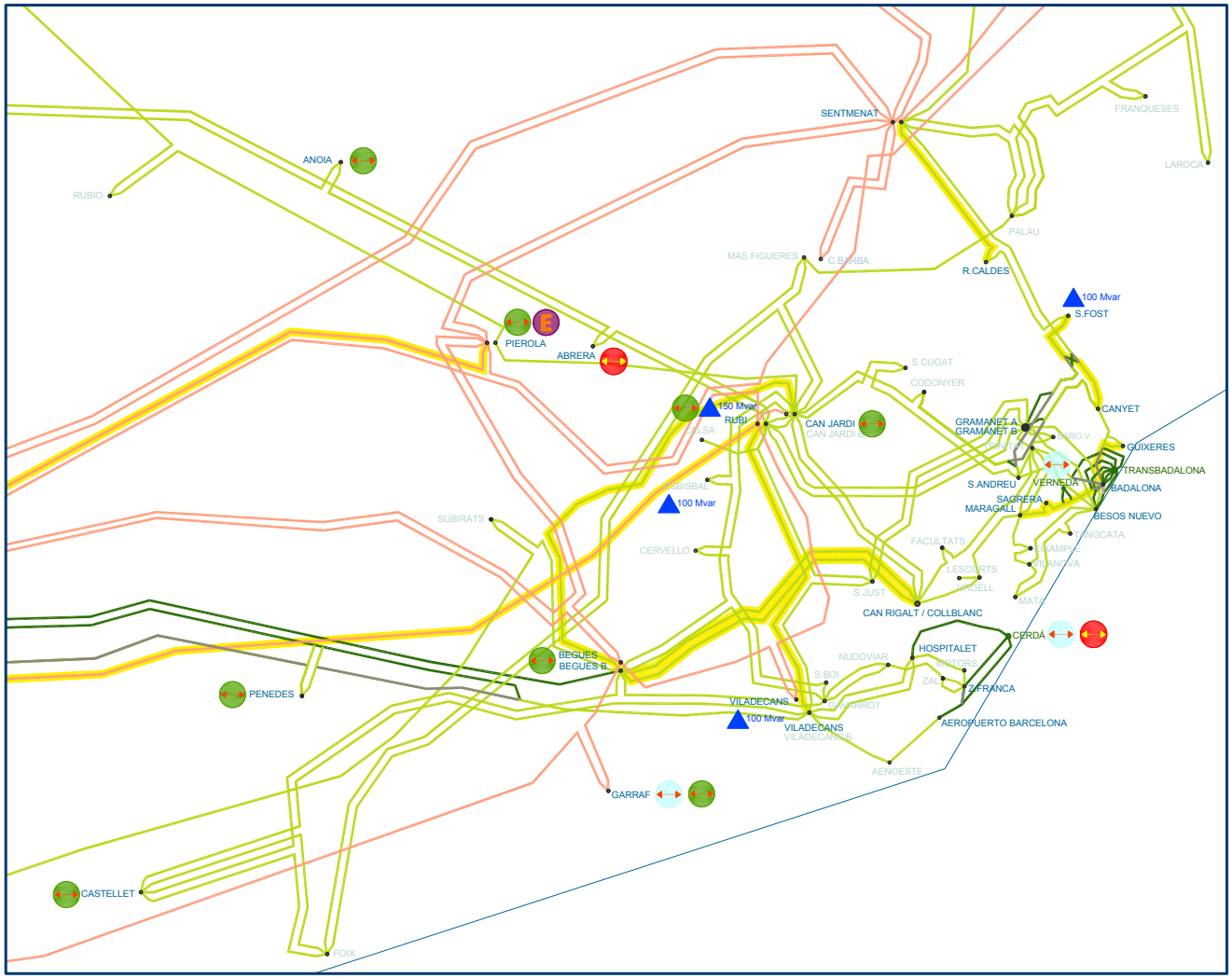



**Castilla y León detail**



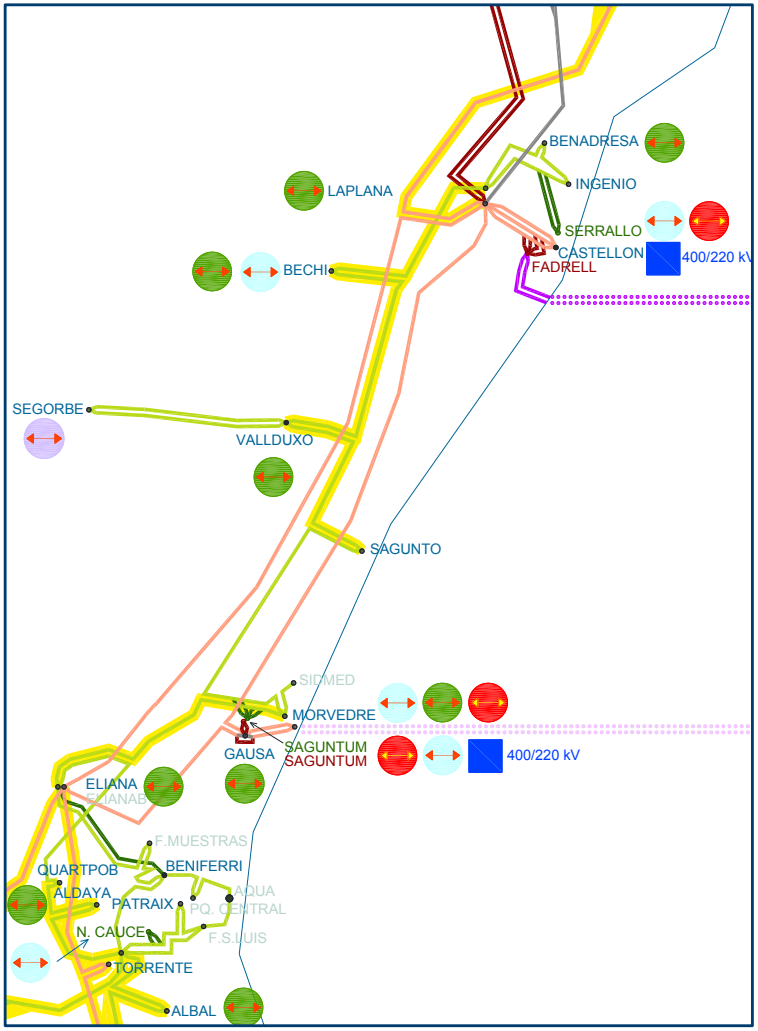

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## Cataluña detail



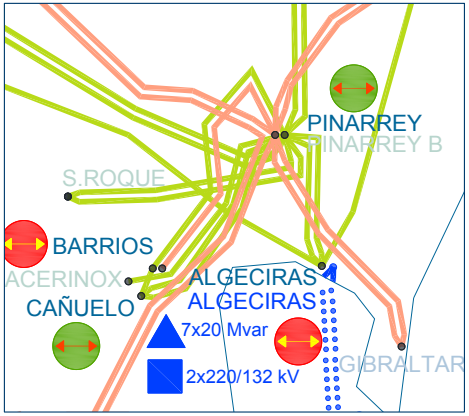

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

### Valencia detail



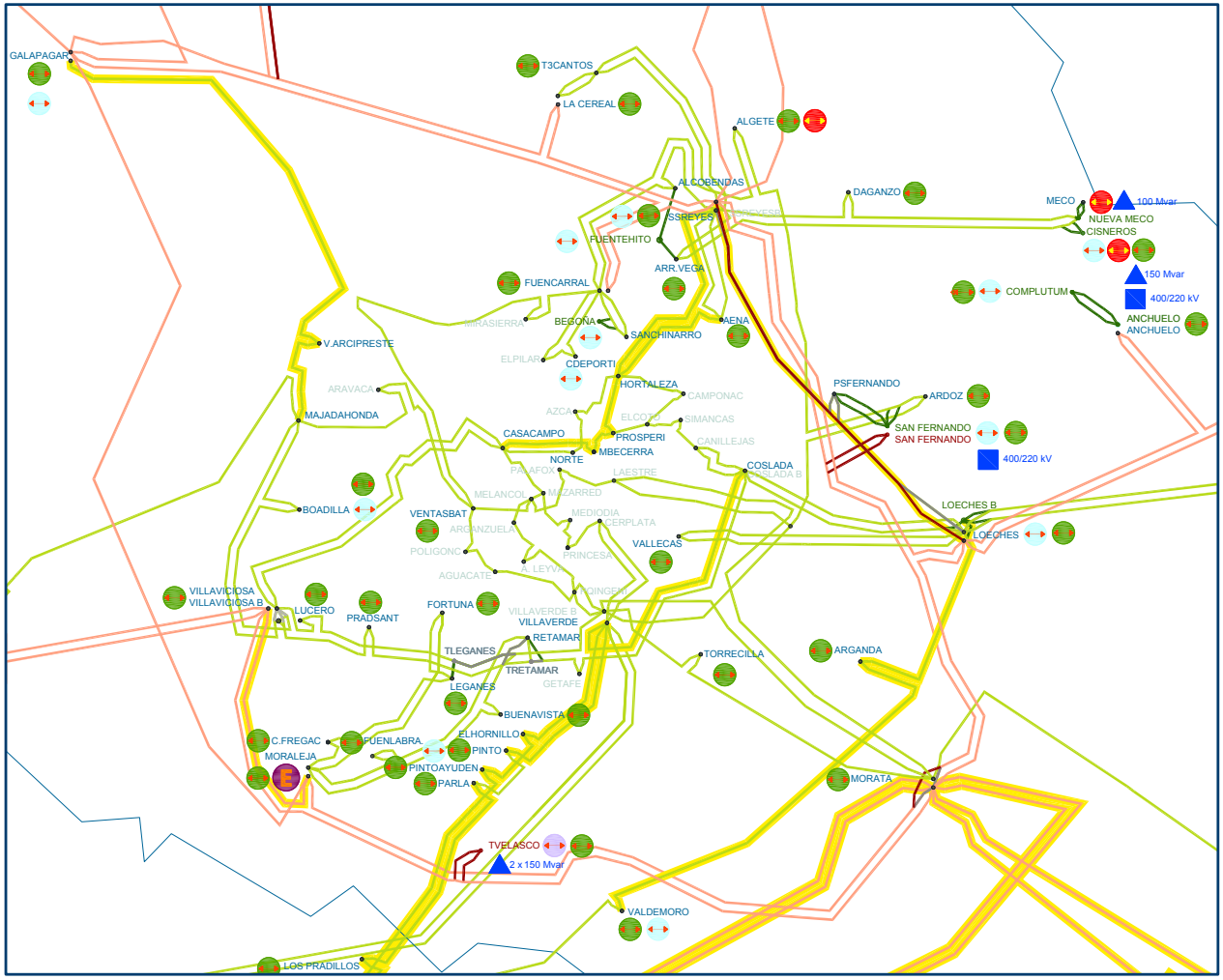

### Andalucía detail



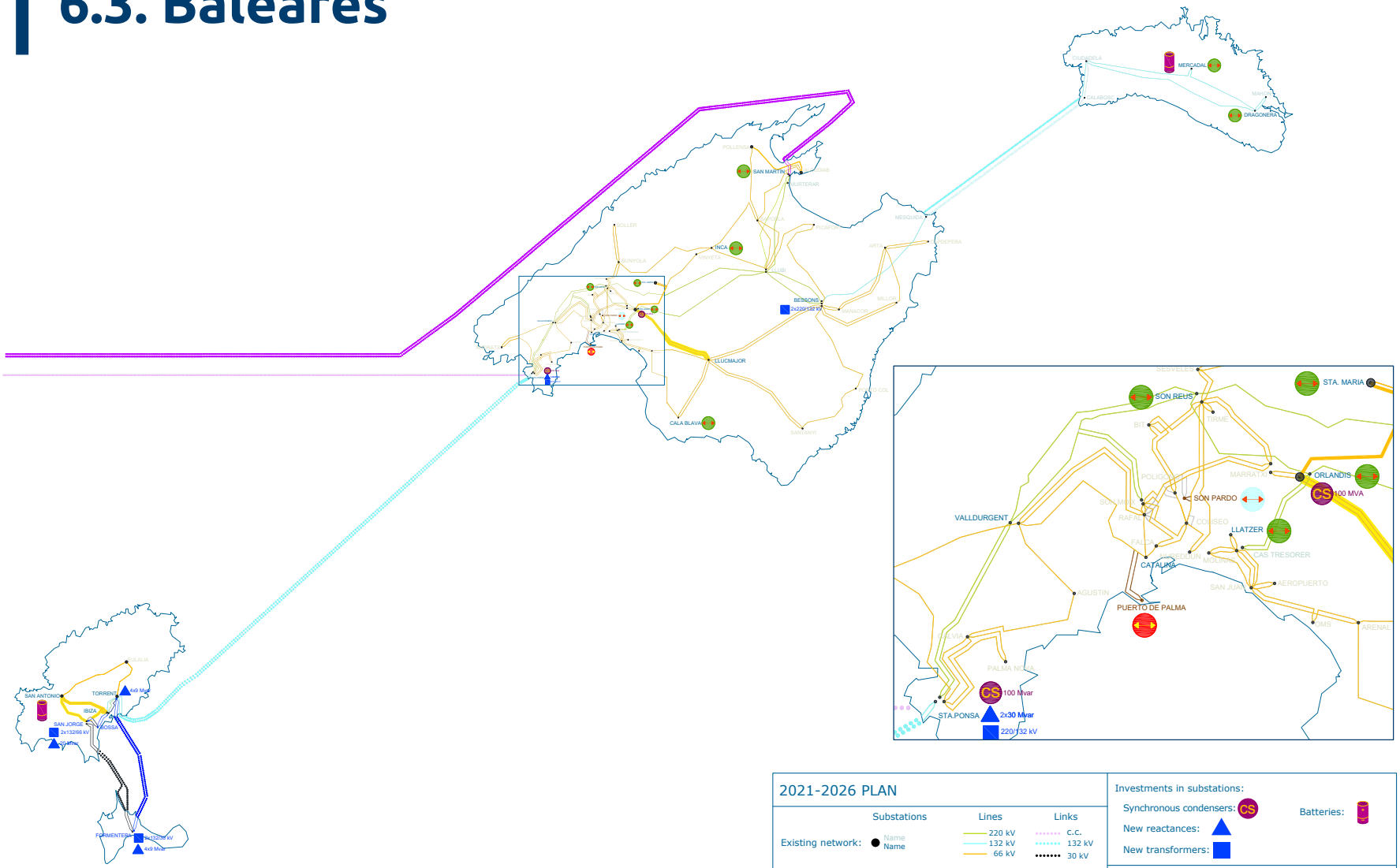

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## Community of Madrid detail




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# 6.3. Baleares




2021-2026 PLAN

| | Substations | Lines | Links |
|---|---|---|---|
| Existing network: | Name<br>Name | 220 kV<br>132 kV<br>66 kV | c.c.<br>132 kV<br>30 kV |
| Planned network: | 132 kV Name<br>66 kV Name | 132 kV<br>66 kV<br>Decommisioning | c.c.<br>132 kV<br>66 kV |

Investments in lines:
Upratings, changes of conductor, refurbishings and Dynamic Line Rating (DLR):

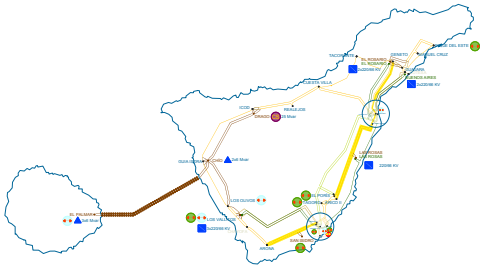
Investments in substations:
Synchronous condensers: CS
Batteries:
New reactances:
New transformers:

Substation extensions:
For distribution network support:
For consumer connection to the Transmission Network:
For connection between generation and storage:

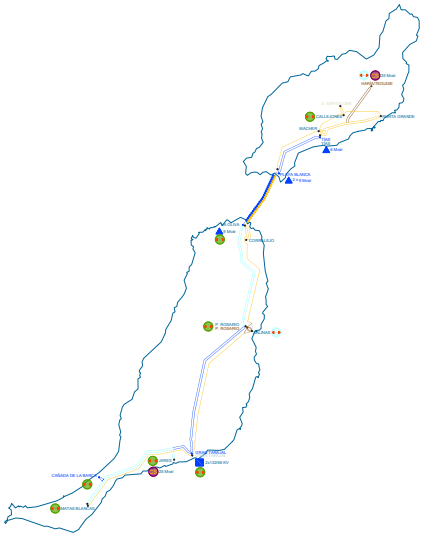
Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

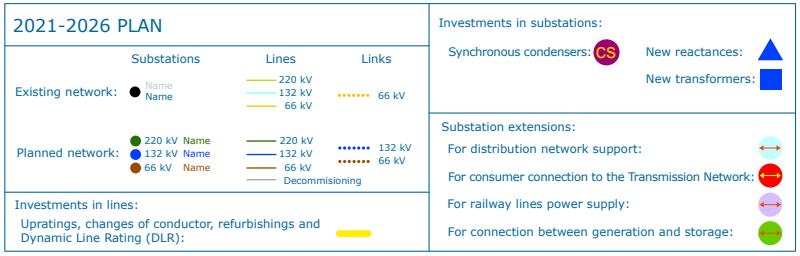
# 6.4. Canarias





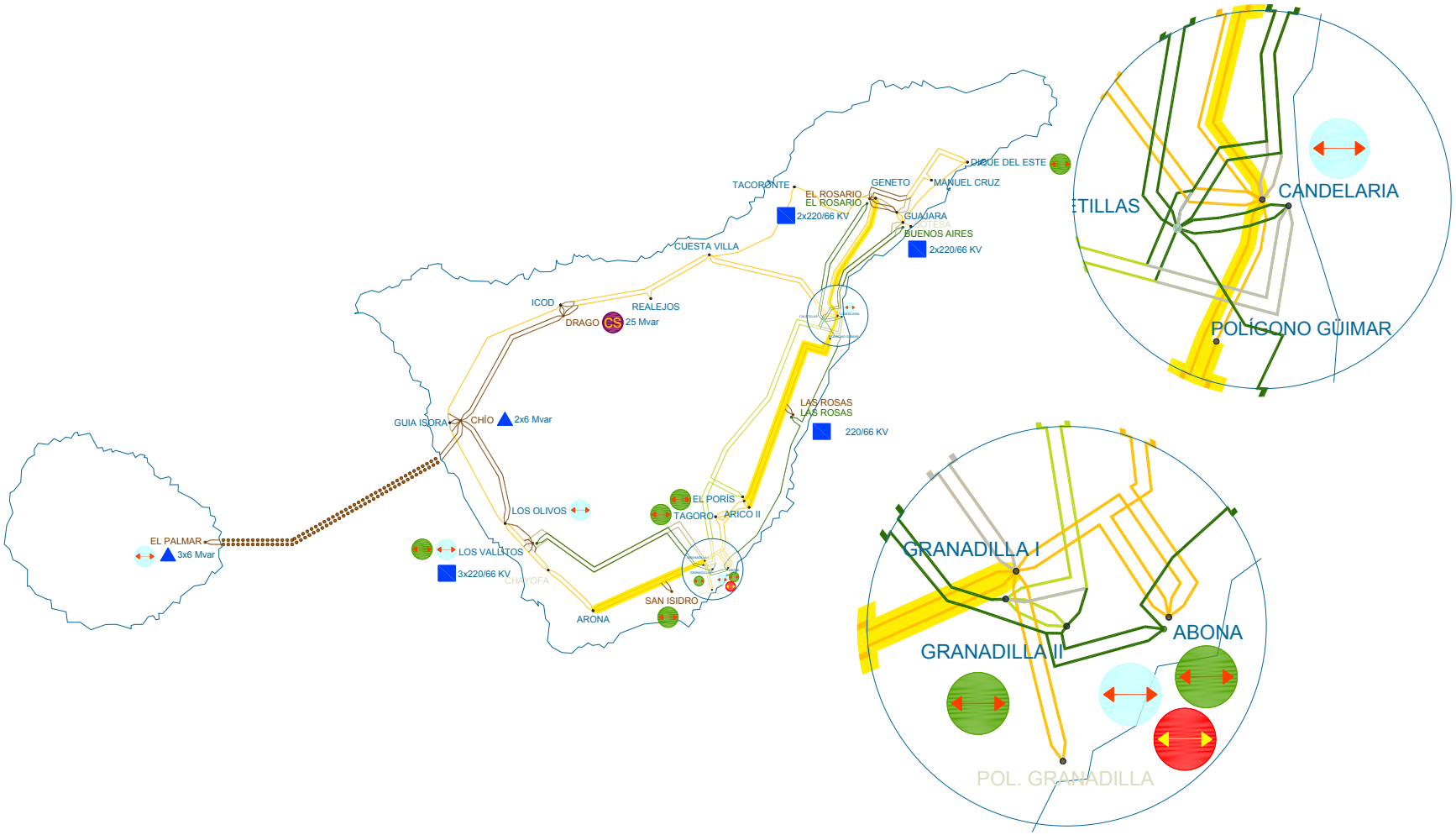







Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## Tenerife detail



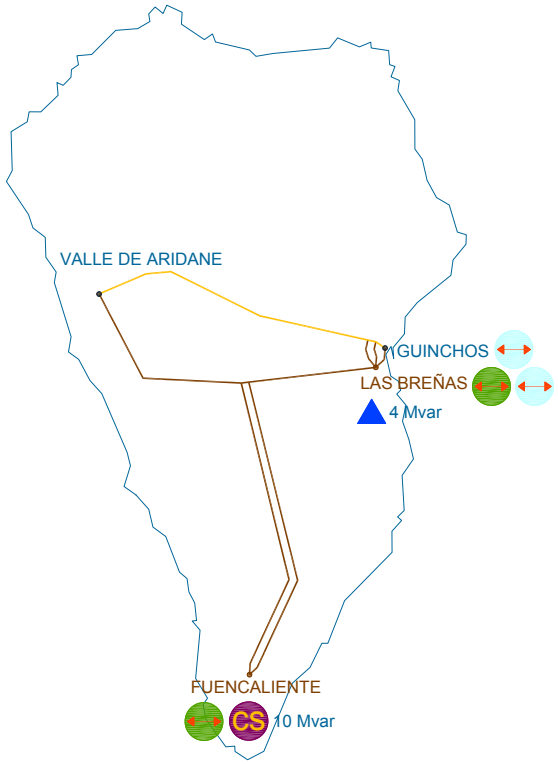

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## Gran Canaria detail

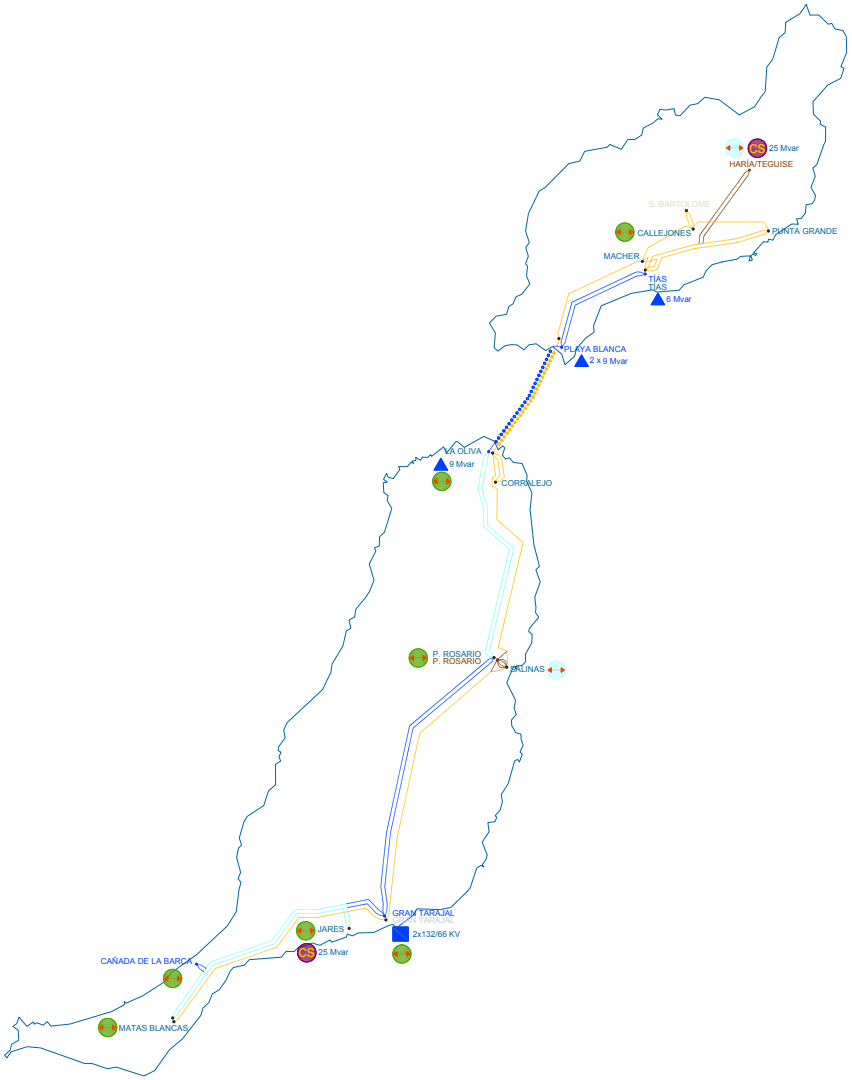



Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

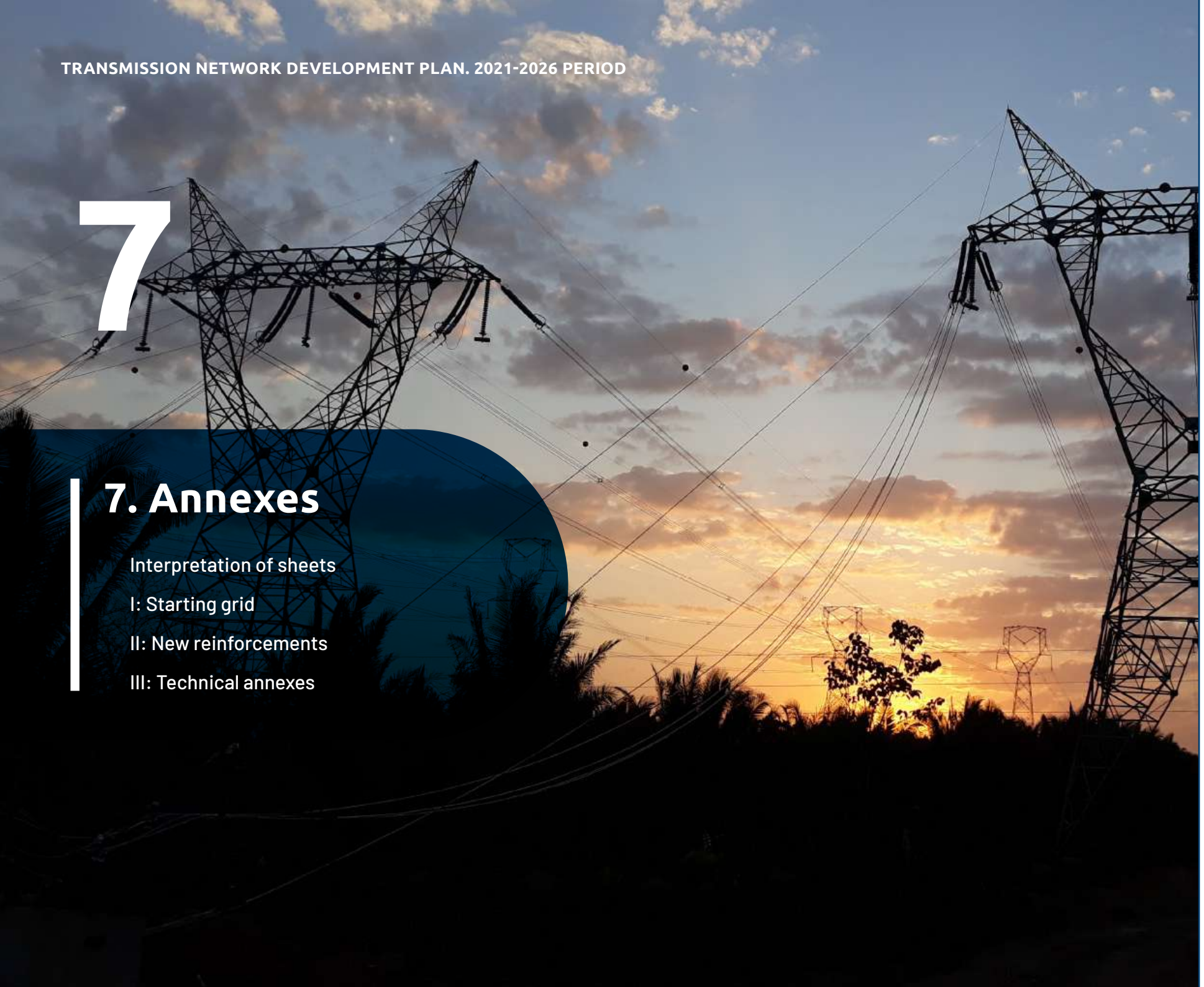
## La Palma detail




## Lanzarote and Fuerteventura detail




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
**Maps**
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes



# 7

# 7. Annexes

Interpretation of sheets

I: Starting grid

II: New reinforcements

III: Technical annexes

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

III: Technical annexes



# INTERPRETATION OF SHEETS



## I Reinforcement Code
Project type **Specific name of the project under analysis**

**I General description:** General description of the project.

**I Drivers / Objectives:** The main drivers or motivation(s) for the project are described in detail. For some projects, the drivers include the contribution to solving internal interconnection capacity constraints, which were identified in the ENTSOE bidding zone configuration technical report - 2018, also taking into account the obligation to offer a minimum of 70% of the interconnection capacity for cross-border transactions derived from Art. 16(8) of the European Regulation 2019/943 on the internal energy market contained in the Clean Energy Package.

**I Alternatives:** The alternatives that have been considered and analysed to solve the same identified need as the proposed reinforcements and the reasons why they have been discarded are indicated. Where no viable alternatives have been identified, it is indicated.

**I European dimension:** It is indicated whether the project is part of the European planning, i.e. the "Ten Year Network Development Plan" (TYNDP) of ENTSO-E or of the list of Projects of Common Interest (PCI) of the European Commission, and the project codes are identified in order to facilitate their monitoring.

**I Map:** The map of the area in which the project is located is included, together with the key that allows its correct interpretation.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# I Reinforcement Code
## Project type **Specific name of the project under analysis**

### Cost-Benefit Multi-Criteria Analysis

For a detailed explanation of each of the concepts mentioned here, please refer to the "Cost-Benefit Analysis" chapter of the Methodology and Results Module.

**I Benefits:** No calculation of benefits is made for the reinforcements included in the starting grid.

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

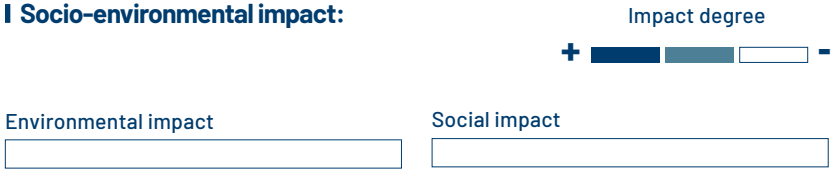
**I Costs:**

| CAPEX | OPEX |
|---|---|
| - M€ | - M€/year |

The reinforcements costs of the project (Capital Expenditure or CAPEX) and the operation and maintenance costs (Operational Expenditure or OPEX) are described in detail. In the particular case of interconnections, the part assumed by the Spanish electricity system is included, if there is already a cost sharing agreement in this respect (otherwise, it is expressly indicated). However, the results of the cost-benefit analysis consider both the costs and benefits of the interconnected system, following the methodology used in ENTSOE. A breakdown of the 10-year remuneration costs is also included.

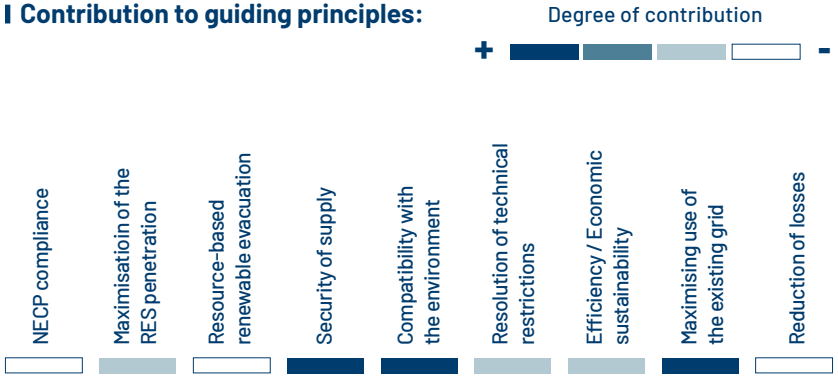
**I Profitability:** No calculation of profitability is made for the reinforcements included in the starting grid.

**I Socio-environmental impact:**




The level of environmental and social impact of the project is assessed on a 3-level scale from low impact (white) to high impact (dark blue).

**I Contribution to guiding principles:**




The contribution of the project to each of the nine guiding principles is assessed on a 4-level scale from low contribution (white) to high contribution (dark blue).

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
II: New reinforcements
III: Technical annexes

# I Reinforcement Code
## Project type **Specific name of the project under analysis**

### I Table of physical units:

A summary of all the physical units of the reinforcements included in the project is provided, regardless of the commissioning date (which is detailed in the following point) and whether they involve costs for the system or for third parties. Those reinforcements that have a shared purpose for the cost-benefit assessment are grouped under the same project, although they are commissioned in phases depending on their priority, and some of them even form part of the group of reinforcements to be commissioned beyond the 2026 horizon.

The number of bays, the kilometres of circuit of overhead lines and cables, the capacity in MVA of the transformer units, the kilometres of uprated lines or changes of conductor or lines with capacity monitoring devices (dynamic rating), the reactances in MVar, and other grid elements (phase shifting transformers, FACTS, synchronous condensers, batteries) are detailed in aggregate form according to their voltage levels.

### I Detailed list of assets:

Details are provided for all the assets included in the project. Different tables are included for each of the asset typologies:

- New substations
- Substation extension
- New lines/cables
- Line uprating
- Changes of conductor
- Dynamic Line Rating (DLR)
- New transformers

### I Detailed list of assets (continued):

- New reactances
- FACTs
- STATCOM
- Phase shifters
- Limiters
- Etc.

For each of the assets, the relevant units of measurement are indicated:

- Units= In substation extensions, the number of bays is included. In FACTs, STATCOMs and limiters, the number of elements is included.
- MVA= In transformers and phase shifters the nominal power of the element is included. For lines, the transmission capacity for winter MVA[win.] and summer MVA[sum.] is included.
- Mvar= In reactances, the capacity of the reactance is included.
- km= In new lines, uprating, conductor changes or DLRs, the length in kilometres of the line or cable route is reported. It differs from the information provided in physical units where kilometres of right of way are indicated, as the trace provides information on the right of way (ROW). The values shown here can be affected by the natural evolution of the projects and their processing or detailed engineering, so it should be noted that they may have a variation range of up to 10%, which may increase or decrease the final value of the length of the asset. The value of 10% is adopted in accordance with the value indicated in article 161 of RD 1955/2000.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement Code
## Project type **Specific name of the project under analysis**

### I Detailed list of assets (continued):

Type= in substations it is differentiated whether the substation is outdoors or in a building, in the extensions of all substations, whether new or existing, it is distinguished whether the extension is in conventional or shielded technology (GIS), in lines it is differentiated whether it is an overhead line or cable and in transformers whether they are single-phase units (Monophase) or three-phase units (Triph.), or a three-phase bank (Triph. B.) with a single-phase unit for each phase.

Drivers (Driv.) = Motivations for each individual asset.

- Rail.: Railway Axis Power Supply
- SuD: Distribution Support
- Consum: Consumers
- Link: Interconnections between systems
- Gen./Sto.: Generation and Storage
- INT: International interconnections
- N_SO: Needs of the System Operator
- RES: Integration of renewables and technical constraints
- TN: Transmission grid (under this heading are grouped all the bays associated with the transmission network, such as line bays, machine bays, central substation switches for the connection of access points, bays affected by changes of ownership, etc.)
- RenovTN: Renewal of the transmission network
- SoS: Security of Supply

For those bays associated with the connection of third parties to the transmission network, the usefulness of the bay included in planning:

- SuD: distribution support connection
- Consum.: connection of consumers directly connected to the transmission network
- Gen./Sto.: connection of generation facilities, including renewables and storage facilities

It is important to mention that the present planning does not reflect reservations of bays or references to specific subjects or facilities identified by their access codes, since the planning process is a different, albeit coordinated, process to the access and connection process. Therefore, for planned bays with a connection motivation that do not have access granted and connection in progress, the relevant accesses must be formalised through the processes established for this purpose in the regulations, mainly in Royal Decree 1183/2020 and in Circular 1/2021 and its development regulations.

Year= Best estimate of the commissioning year.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

III: Technical annexes



# Annexes
# I: Starting Grid

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes



## TABLE OF CONTENTS

Definition of the starting grid
Starting grid sheets
- Andalucía
- Aragón, Cataluña
- Asturias, Cantabria, Castilla y León
- Islas Baleares
- Islas Canarias
- Castilla-La Mancha, Madrid
- Extremadura
- Galicia
- Navarra, País Vasco, La Rioja
- Murcia, Valencia
- Spain-Portugal interconnection
- Connecting renewables
- Changes of ownership



# DEFINITION OF THE STARTING GRID

Once the forecast scenario for generation, ofmand and interconnection capacity has been determined, it is necessary to define the base transmission network or starting grid in order to identify the future development needs of the transmission network and subsequently propose solutions to these needs through reinforcements that make up the initial development proposal for the 2021-2026 period.

Considering only the network in service as the starting grid is an excessively limited approach since, in addition to these facilities, there are also elements already defined in the current plan which are under construction or at an advanced stage of processing. For this reason, the starting grid is defined as the set of transmission network elements that can be assumed to be in service with a very high probability in the 2021-2026 time horizon. Based on this principle, in addition to the transmission network facilities currently in service, the starting grid includes the reinforcements of the current 2015-2020 plan that meet the following criteria by 30 September 2019[1]:

- Reinforcements with construction underway.
- Reinforcements with commissioning planned by the carrier prior to the start of the study period 2021-2026 (in 2019 and 2020).
- Reinforcements that have an Environmental Impact Statement (EIS). For those reinforcements that consist of a set of reinforcements with a joint electrical direction which should therefore not be dissociated, they are considered in the starting grid if the critical and majority part of the reinforcements has an EIS. For example, in the case of a new power line, if the line has the EIS but the extension at one end does not have it yet, the entire reinforcements is included in the starting grid.
- Reinforcements that do not require an EIS and whose planned commissioning date is less than or equal to 2023.
- Access bays included in the 2015-2020 plan with permits granted.
- Interconnection reinforcements between the systems of European Union member states analysed within the scope of the European Ten Years Network Development Plan with a positive cost-benefit analysis and a commissioning date in line with the planning horizon.

In addition, all the access bays with permits granted under Royal Decree-Law 15/2018, of 5 October, on urgent measures for energy transition and consumer protection, and which are still in force on 31 May 2021, are included in the starting grid.

The following is a list of reinforcements which, although not currently in service, are considered to be part of the starting grid.

1. The definition of the starting grid for all the needs studies and cost-benefit analyses was completed based on the information available at that date for the reinforcements included in the 2015-2020 plan.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_ANDALUCIA
## Starting grid **Andalucía**

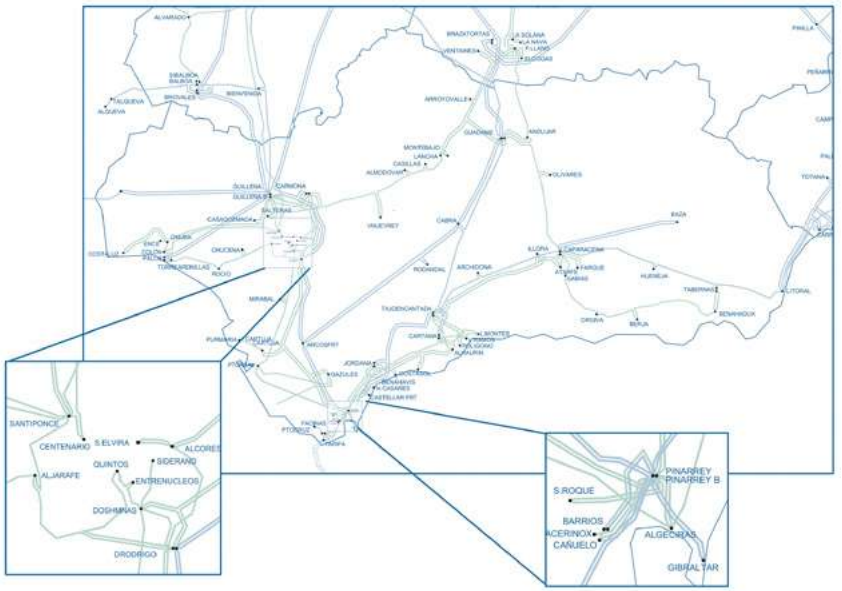
**I General description:** List planned reinforcements in Andalucía that are included in the starting grid according to the established criteria.

**I Drivers / Objectives:** To ensure that the reinforcements included in the 2015-2020 Transmission Network Development Plan are carried out, the commissioning of which is very likely to take place within the study horizon and whose specific motivations are detailed in the following tables.

**I Alternatives:** Following the Transmission Network Development Plan principles, alternatives to the reinforcements included in the starting grid were not evaluated.

**I European dimension:** No

**I Map:**




PLAN H2021-2026

| | Substations | Lines | Links |
|---|---|---|---|
| Starting Grid: | Name | 400 kV<br>220 kV<br>132 kV<br>66 kV<br>30 kV | 400 kV<br>132 kV<br>30 kV |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_ANDALUCIA
## Starting grid **Andalucía**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 130.2 M€ | 1.86 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 12.4 | 12.2 | 12.0 | 11.8 | 11.7 | 11.5 | 11.3 | 11.1 | 10.9 |

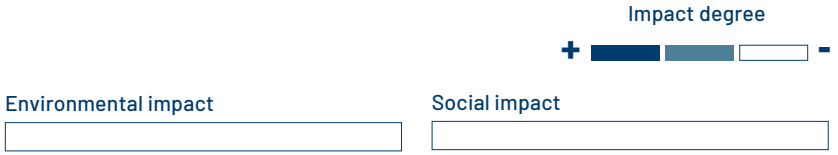
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

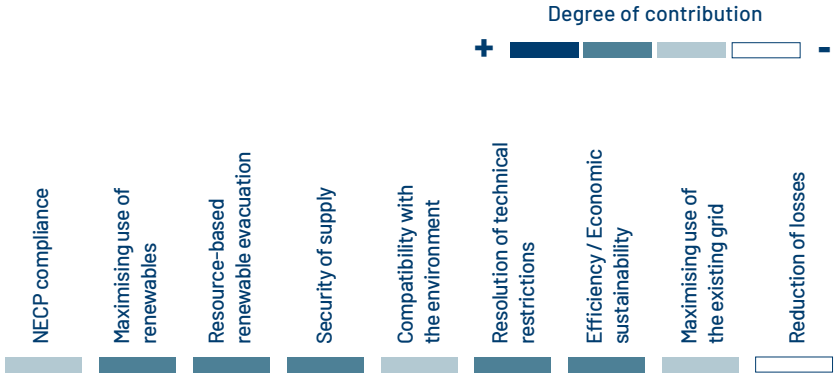
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
**I: Staritng grid**
II: New reinforcements
III: Technical annexes

# I Reinforcement RDP_ANDALUCIA
## Starting grid **Andalucía**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 19 | 19 |
| Overhead line (km) | 13 | 246 |
| Cables (km) | 3 | |
| Uprating (km) | 267 | |
| Change of conductor (km) | 7 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Baza REE 400 kV | Outdoor. | 2021 |
| Benahavis 220 kV | Building | 2018 |
| Castellar de La Frontera 400 kV [1] | Outdoor. | 2022 |
| Chucena 220 kV | Outdoor. | 2022 |
| Mirabal 220 kV | Outdoor. | 2020 |

Notes:
1. Former Marchenilla 400.

### I Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Almodóvar del Rio 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Baza REE 400 kV | 1 | AIS | Gen./Sto. | 2022 |
| Baza REE 400 kV | 4 | AIS | TN | 2022 |
| Benahavis 220 kV | 1 | GIS | SuD | 2018 |
| Benahavis 220 kV | 3 | GIS | TN | 2018 |
| Caparacena 400 kV | 4 | AIS | TN | 2021 |
| Carmona 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Cartuja 220 kV | 1 | AIS | Gen./Sto. | 2021 |
| Castellar de La Frontera 400 kV | 5 | AIS | TN | 2022 |
| Castellar de La Frontera 400 kV | 2 | AIS | Rail. | 2022 |
| Chucena 220 kV | 1 | AIS | SuD | 2022 |
| Chucena 220 kV | 3 | AIS | TN | 2022 |
| Don Rodrigo 400 kV | 1 | AIS | TN | 2022 |
| Don Rodrigo 400 kV | 1 | AIS | Gen./Sto. | 2022 |
| Íllora 220 kV | 1 | AIS | Gen./Sto. | 2021 |
| Mirabal 220 kV | 1 | AIS | SuD | 2020 |
| Mirabal 220 kV | 3 | AIS | TN | 2020 |
| Palos de la Frontera 220 kV | 1 | GIS | TN | 2021 |
| Pinar del Rey 220 kV | 2 | GIS | TN | 2021 |
| Torrearenillas 220 kV | 1 | AIS | TN | 2021 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_ANDALUCIA
## Starting grid **Andalucía**

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Caparacena - Baza REE 400 kV | 2,370 | 1,910 | 122 | Line | RES | 2022 |
| I/O in Benahavis, of Costasol - Jordana 220 kV, circuit 1 | 420 | 370 | 3 | Line | SuD | 2022 |
| I/O in Benahavis, of Costasol - Jordana 220 kV, circuit 1 | 516 | 516 | 0.2 | Cable | SuD | 2022 |
| I/O in Castellar de La Frontera, of Jordana - Pinar del Rey 400 kV, circuit 1[1] | 1,692 | 1,527 | 1 | Line | Rail. | 2022 |
| I/O in Chucena, of Aljarafe - Rocío 220 kV, circuit 1 | 840 | 700 | 0.2 | Line | SuD | 2022 |
| I/O in Mirabal, of Dos Hermanas - Puerto Real 220 kV, circuit 1 | 420 | 340 | 4 | Line | SuD | 2021 |
| Palos de la Frontera - Torrearenillas 220 kV, circuit 2 | 548 | 548 | 3 | Cable | RES | 2021 |

Notes: 1. Section line capacity in DC for I/O 2330/2140 MVA

| Changes of conductor | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Atarfe - Caparacena 220 kV, circuit 1 | 430 | 350 | 7 | Line | RES | 2023 |

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Alcores - Carmona 220 kV, circuit 1 | 420 | 340 | 30 | Line | RES | 2021 |
| Alcores - Don Rodrigo 220 kV, circuit 1 | 420 | 340 | 44 | Line | RES | 2021 |
| Atarfe - Olivares 220 kV, circuit 1 | 421 | 345 | 74 | Line | RES | 2020 |
| Cártama - Los Montes 220 kV, circuit 1 | 420 | 360 | 15 | Line | RES | 2021 |
| Casaquemada - Onuba 220 kV, circuit 1 | 423 | 363 | 63 | Line | RES | 2023 |
| Gabias - Órgiva 220 kV, circuit 1 | 428 | 353 | 42 | Line | RES | 2021 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_NORESTE
## Starting grid **Aragón and Cataluña**

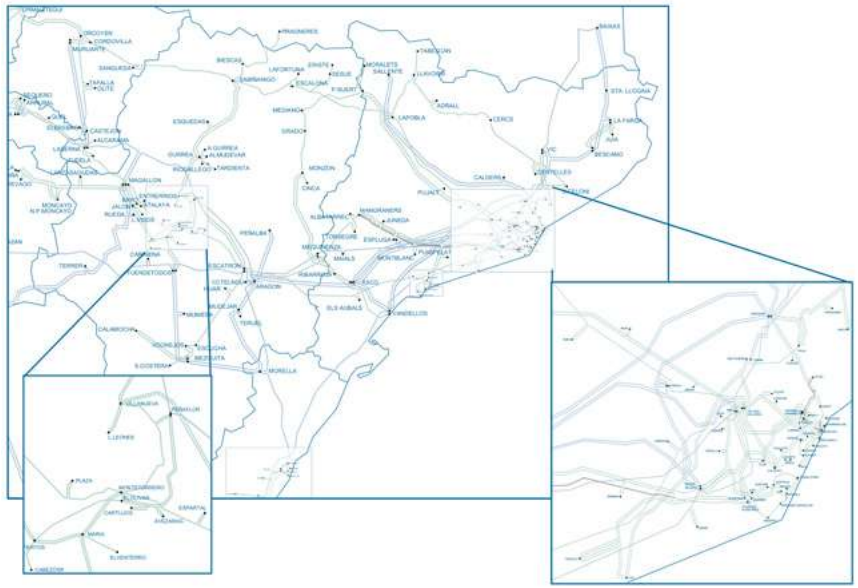
**I General description:** List planned reinforcements in Aragón and Cataluña that are included in the starting grid according to the established criteria.

**I Drivers / Objectives:** To ensure that the reinforcements included in the 2015-2020 Transmission Network Development Plan are carried out, the commissioning of which is very likely to take place within the study horizon and whose specific motivations are detailed in the following tables.

**I Alternatives:** Following the Transmission Network Development Plan principles, alternatives to the reinforcements included in the starting grid were not evaluated.

**I European dimension:** No

**I Map:**



PLAN H2021-2026

| | Substations | Lines | Links |
|---|---|---|---|
| Starting Grid: | Name | 400 kV<br>220 kV<br>132 kV<br>66 kV<br>30 kV | 400 kV<br>132 kV<br>30 kV |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_NORESTE
## Starting grid **Aragón and Cataluña**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 144.9 M€ | 1.43 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 13.1 | 12.9 | 12.7 | 12.5 | 12.3 | 12.1 | 11.9 | 11.7 | 11.5 |

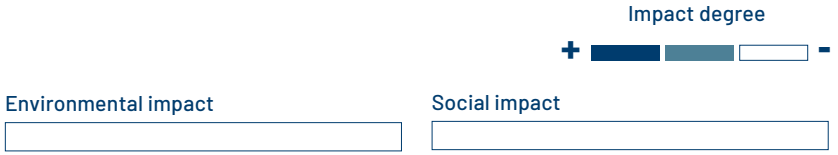
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

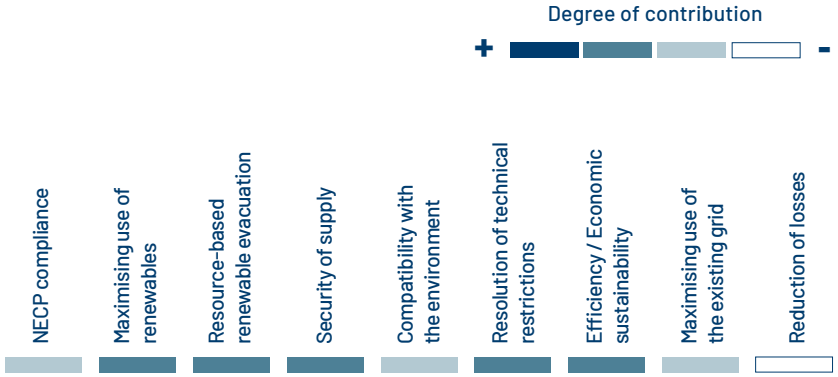
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_NORESTE
## Starting grid **Aragón and Cataluña**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 30 | 9 |
| Overhead line (km) | 48 | 1 |
| Cables (km) | 33 | |
| Uprating (km) | 27 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Cariñena 400 kV | Outdoor. | 2021 |
| Cerdá 220 kV | Building | 2022 |
| Transbadalona 220 kV | Building | 2023 |

### I Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Cariñena 400 kV | 5 | AIS | TN | 2021 |
| Cariñena 400 kV | 2 | AIS | Rail. | 2021 |
| Cerdá 220 kV | 1 | GIS | SuD | 2022 |
| Cerdá 220 kV | 3 | GIS | TN | 2022 |
| Cerdá 220 kV | 1 | GIS | TN | 2023 |
| Gramanet 220 kV | 1 | GIS | TN | 2020 |
| Gurrea de Gallego 220 kV | 1 | AIS | Gen./Sto. | 2022 |
| Hospitalet 220 kV | 1 | AIS | TN | 2022 |
| Mas Figueres 220 kV | 2 | AIS | TN | 2018 |
| Mezquita 220 kV | 2 | AIS | TN | 2018 |
| Mudejar 400 kV | 1 | AIS | Gen./Sto. | 2022 |
| Mudejar 400 kV | 1 | AIS | TN | 2022 |
| Palau 220 kV | 1 | AIS | TN | 2018 |
| Tarragona 220 kV | 1 | AIS | TN | 2019 |
| Transbadalona 220 kV | 11 | GIS | TN | 2023 |
| Valdeconejos 220 kV | 3 | AIS | TN | 2022 |
| Villanueva de Gallego 220 kV | 2 | AIS | TN | 2020 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_NORESTE
## Starting grid **Aragón and Cataluña**

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Barcelona Airport - Cerdá 220 kV, circuit 1 [1] | 314 | 314 | 3 | Cable | SuD | 2023 |
| Besos Nuevo - Transbadalona 220 kV, circuit 2 [2] | 342 | 342 | 0.5 | Cable | SoS | 2023 |
| Besos Nuevo - Transbadalona 220 kV, circuit 3 [3] | 540 | 540 | 0.6 | Cable | SoS | 2023 |
| Canyet - Gramanet 220 kV, circuit 1 [4] | 970 | 840 | 0.3 | Cable | RES | 2023 |
| Cerdá - Cerdá 220 kV, circuit [5] | | | 1 CT | Cable | SuD | 2022 |
| DC Escucha - Valdeconejos 220 kV [6] | 360 | 300 | 4 | Line | RES | 2019 |
| DC Escucha - Valdeconejos 220 kV [7] | 360 | 300 | 3 | Line | RES | 2022 |
| DC Los Leones - Villanueva de Gallego 220 kV | 385 | 385 | 7 | Cable | RES | 2021 |
| DC Mezquita - Valdeconejos 220 kV | 400 | 330 | 1 | Line | RES | 2022 |
| DC Mezquita - Valdeconejos 220 kV | 400 | 330 | 3 | Line | RES | 2019 |
| DC Mezquita - Valdeconejos 220 kV [8 9] | 400 | 330 | 18 | Line | RES | 2020 |
| I/O in Cariñena, of Almazán - Fuendetodos 400 kV, circuit 1 | 1,769 | 1,504 | 0.5 | Line | Rail. | 2022 |
| Guixeres - Sant Andreu 220 kV, circuit 1 [10] | 450 | 450 | 0.4 | Cable | RES | 2023 |
| Guixeres - Transbadalona 220 kV, circuit 1 [11] | 415 | 415 | 0.2 | Cable | SoS | 2023 |
| Hospitalet - Cerdá 220 kV, circuit 1 | 432 | 432 | 5 | Cable | SuD | 2022 |
| La Sagrera - Transbadalona 220 kV, circuit 1 [12] | 415 | 415 | 0.6 | Cable | SoS | 2023 |
| Mas Figueres - Palau 220 kV, circuit 1 | 360 | 260 | 0.8 | Line | RES | 2022 |
| Mas Figueres - Palau 220 kV, circuit 1 | 360 | 260 | 16 | Line | RES | 2016 |
| Mas Figueres - Palau 220 kV, circuit 1 | 360 | 260 | 0.6 | Cable | RES | 2022 |
| Sant Andreu - Transbadalona 220 kV, circuit 1 [13] | 414 | 414 | 0.9 | Cable | SoS | 2023 |
| Sentmenat - Gramanet 220 kV, circuit 1 [14] | 970 | 840 | 0.5 | Cable | RES | 2023 |
| Transbadalona - Badalona 220 kV, circuit 1 | 270 | 270 | 1 | Cable | SoS | 2023 |
| Transbadalona - Badalona 220 kV, circuit 2 | 270 | 270 | 1 | Cable | SoS | 2023 |
| Transbadalona - Badalona 220 kV, circuit 3 | 270 | 270 | 1 | Cable | SoS | 2023 |
| Zona Franca - Cerdá 220 kV, circuit 1 | 460 | 460 | 3 | Cable | SuD | 2023 |

Notes:
1. AEBarcelona is disconnected from Zona Franca and connects with Cerdá.
2. Besos Nuevo is disconnected from Badalona and connects with Transbadalona 1.
3. Besos Nuevo is disconnected from Badalona and connects with Transbadalona 1.
4. DC crossover: Codonyers-Canyet and S. Fost-S. Andreu 220 kV are removed and Canyet-GramanetB, Sentmenat-GramanetA, S.Fost-Canyet, and Codonyers-Sant Andreu 220 kV are implemented.
5. Short section of cable inside the substation.
6. Double circuit with first circuit laid out.
7. Double circuit with first circuit laid out.
8. Double circuit with first circuit laid out.
9. Double circuit with second circuit laid out.
10. Operable bypass.
11. Guixeres is disconnected from Badalona and connects with Transbadalona 1.
12. Sagrera is disconnected from Badalona and connects with Transbadalona 1.
13. Sant Andreu is disconnected from Badalona and connects with Transbadalona 1.
14. DC crossover: Codonyers-Canyet and S. Fost-S. Andreu 220 kV are removed and Canyet-GramanetB, Sentmenat-GramanetA, S.Fost-Canyet, and Codonyers-Sant Andreu 220 kV are implemented.

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Begues - Can Jardi 220 kV, circuit 1 | 580 | 510 | 27 | Line | RES | 2019 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_NOROESTE
## Starting grid **Asturias, Cantabria, and Castilla y León**

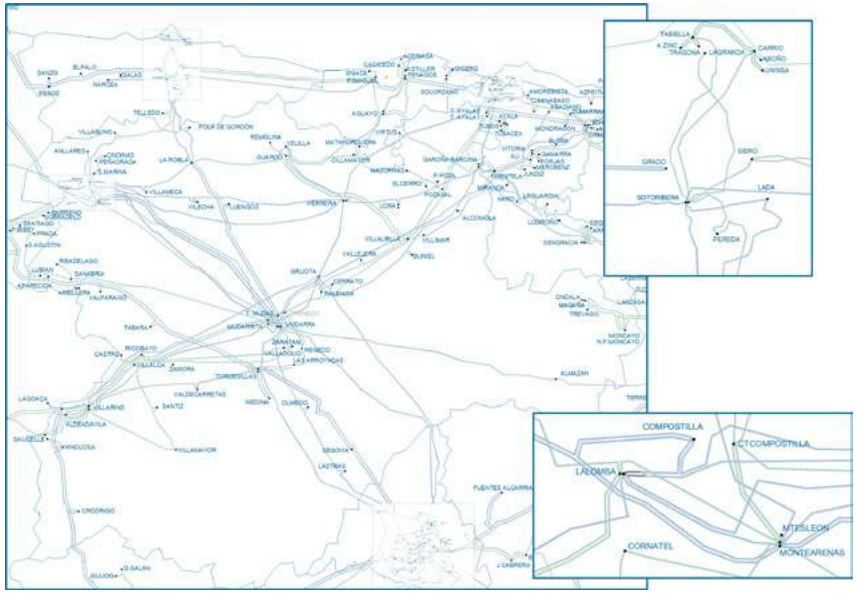
**I General description:** List planned reinforcements in Asturias, Cantabria and Castilla y León that are included in the starting grid according to the established criteria.

**I Drivers / Objectives:** To ensure that the reinforcements included in the 2015-2020 Transmission Network Development Plan are carried out, the commissioning of which is very likely to take place within the study horizon and whose specific motivations are detailed in the following tables.

**I Alternatives:** Following the Transmission Network Development Plan principles, alternatives to the reinforcements included in the starting grid were not evaluated.

**I European dimension:** No

**I Map:**




PLAN H2021-2026

| | Substations | Lines | Links |
|---|---|---|---|
| Starting Grid: | Name | 400 kV<br>220 kV<br>132 kV<br>66 kV<br>30 kV | 400 kV<br>132 kV<br>30 kV |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_NOROESTE
## Starting grid **Asturias, Cantabria, and Castilla y León**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 50.9 M€ | 0.52 M€/year |

Remuneration costs

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| M€ | 0.0 | 4.6 | 4.6 | 4.5 | 4.4 | 4.3 | 4.3 | 4.2 | 4.1 | 4.1 |

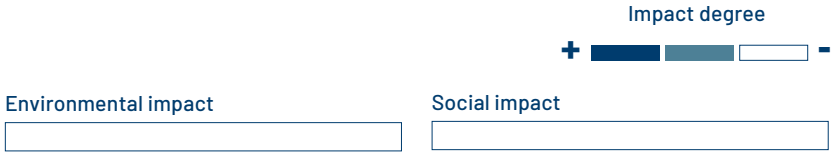
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

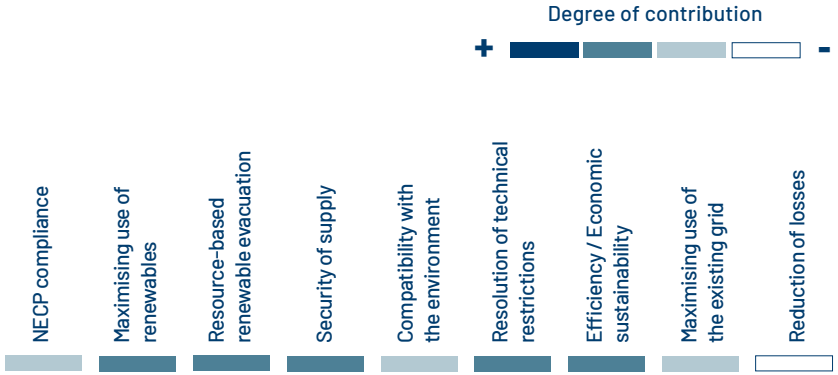
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# I Reinforcement RDP_NOROESTE
## Starting grid **Asturias, Cantabria, and Castilla y León**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 10 | 2 |
| Overhead line (km) | 32 | 6 |
| Cables (km) | 9 | |
| Uprating (km) | 49 | 405 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Aguayo 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Astillero 220 kV | 1 | AIS | TN | 2021 |
| Buniel 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Cacicedo 220 kV [1] | 2 | GIS | TN | 2022 |
| Cerrato 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Cicero 220 kV [2] | 1 | GIS | SuD | 2012 |
| Las Arroyadas 220 kV | 1 | GIS | Gen./Sto. | 2021 |
| Renedo 220 kV | 1 | AIS | TN | 2018 |
| Tordesillas 220 kV | 1 | AIS | Gen./Sto. | 2019 |
| Villamayor 220 kV | 2 | AIS | Rail. | 2020 |

Notes:
1. Fluid pipeline for the longitudinal connection of AIS/GIS busbars is required.
2. Pending connection of the distribution transformer.

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Astillero - Cacicedo 220 kV, circuit 1 | 500 | 500 | 8 | Cable | SoS | 2022 |
| Cacicedo - Cacicedo 220 kV [1] | | | 1 SSC | Cable | SuD | 2022 |
| Soto de Ribera - La Robla 400 kV [2,3] | 1,270 | 1,080 | 2 | Line | RES | 2020 |
| Renedo - T de Mudarrita 1 220 kV, circuit 1 [4] | 570 | 500 | 32 | Line | RES | 2021 |
| Soto de Ribera - Carrió 220 kV, circuit 1 [2,5] | 590 | 530 | 0.3 | Cable | RES | 2021 |
| Soto de Ribera - Salas 400 kV, circuit 1 [2,3] | 1,350 | 1,090 | 1 | Line | RES | 2020 |
| Soto de Ribera - Tabiella 220 kV, circuit 1 [2,5] | 650 | 530 | 0.7 | Line | RES | 2020 |

Notes:
1. Short section of cable inside the substation.
2. Compacting of 400 kV Robla and Narcea and 220 kV Carrió and Tabiella lines at the entrance to the Soto de Ribera substation.
3. Section line capacity 1768/1635 MVA.
4. Removal of T Renedo 220 kV, leaving the T Mudarra-Renedo 220 kV and Palencia-Renedo 220 kV lines. Section line capacity 773/667.
5. Section line capacity 972/899 MVA.

| Elimination of T | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|
| DC T de Udalla - T de Udalla 400 kV | 2 | Line | SoS | 2023 |

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Aldeadávila - Arañuelo 400 kV, circuit 1 | 1,745 | 1,441 | 204 | Line | RES | 2022 |
| Aldeadávila - Hinojosa 400 kV, circuit 1 | 1,795 | 1,517 | 22 | Line | RES | 2022 |
| Compostilla - Villablino 220 kV, circuit 1 | 330 | 281 | 49 | Line | RES | 2020 |
| Hinojosa - Almaraz CN 400 kV, circuit 1 | 1,745 | 1,441 | 179 | Line | RES | 2022 |

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
**I: Staritng grid**
II: New reinforcements
III: Technical annexes

# I Reinforcement RDP_BALEARES
## Starting grid **Islas Baleares**

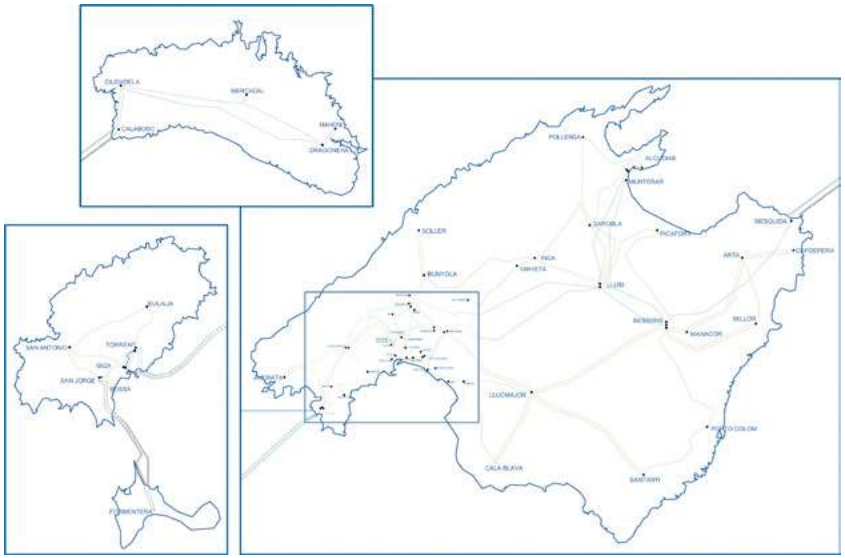
**I General description:** List planned reinforcements in the Islas Baleares that are included in the starting grid according to the established criteria.

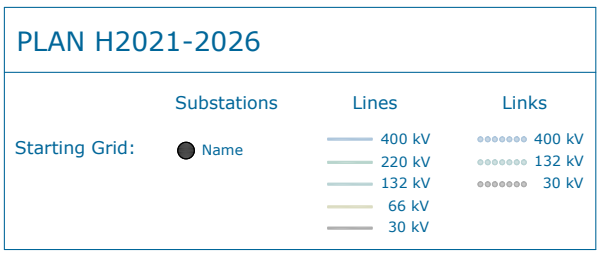
**I Drivers / Objectives:** To ensure that the reinforcements included in the 2015-2020 Transmission Network Development Plan are carried out, the commissioning of which is very likely to take place within the study horizon and whose specific motivations are detailed in the following tables.

**I Alternatives:** Following the Transmission Network Development Plan principles, alternatives to the reinforcements included in the starting grid were not evaluated.

**I European dimension:** No

**I Map:**






Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_BALEARES
## Starting grid **Islas Baleares**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 13.6 M€ | 0.24 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 |

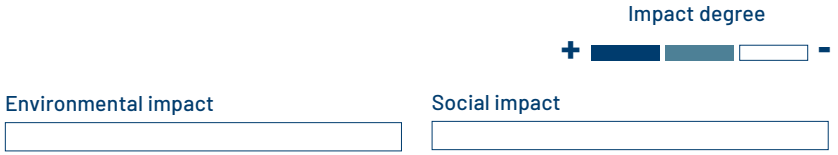
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

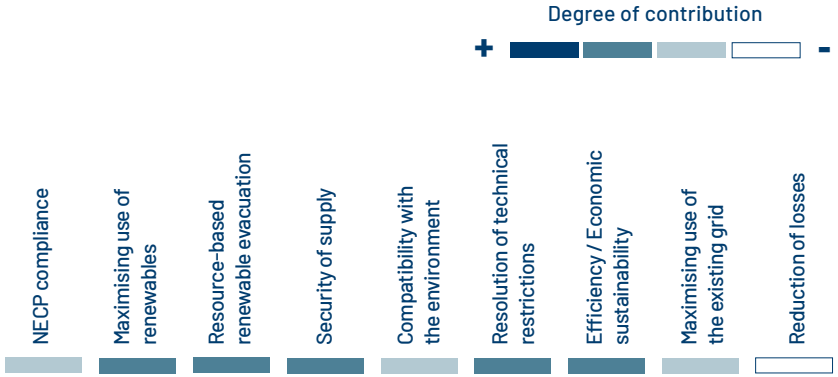
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
**I: Staritng grid**
II: New reinforcements
III: Technical annexes

# I Reinforcement RDP_BALEARES
## Starting grid **Islas Baleares**

### Table of physical units:

| | 66 kV | 132 kV | 220 kV |
|---|---|---|---|
| Bays (units) | 4 | 4 | |
| Overhead line (km) | 0.3 | | 0.3 |
| Cables (km) | 4 | 0.2 | |
| Total renewal of 132 kV transformers (MVA) | | | 320 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Son Pardo, of Coliseo - Son Reus 66 kV, circuit 1 | 80 | 55 | 2 | Cable | SoS | 2023 |
| I/O in Son Pardo, of Coliseo - Son Reus 66 kV, circuit 1 | 80 | 55 | 0.1 | Line | SoS | 2023 |
| Es Bessons - Es Bessons 132 kV [1] | | | 1 SSC | Cable | SoS | 2023 |
| Es Bessons - Llubi 220 kV, circuit 1 | | | 0.3 | Line | TN | 2023 |

Notes:
1.Short section of cable inside the ES.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Son Pardo 66 kV | Building | 2023 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Cala Blava 132 kV | 1 | GIS | Gen./Sto. | 2020 |
| Ciudadela 132 kV | 1 | AIS | Gen./Sto. | 2021 |
| Es Bessons 132 kV [1,2] | 2 | AIS | TN | 2023 |
| San Martín Islas Baleares 66 kV | 1 | GIS | Gen./Sto. | 2021 |
| Son Pardo 66 kV | 3 | GIS | TN | 2023 |

Notes:
1. Coupling circuit breaker to be adapted to the Operational Procedure (O.P.)
2. Coupling circuit breaker to the Mesquida 132 kV line to be adapted to the O.P.

| Total renewal of transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Es Bessons 220/132 kV, TF1 | 160 | Triph. B. | SoS | 2023 |
| Es Bessons 220/132 kV, TF2 | 160 | Triph. B. | SoS | 2023 |

| New adjustments to OP | Year |
|---|---|
| Bessons 132 kV [1] | 2026 |
| San Jorge 66 kV [1] | 2023 |

Notes:
1. Additional assets required to adjust to the O.P.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_CANARIAS
## Starting grid **Islas Canarias**

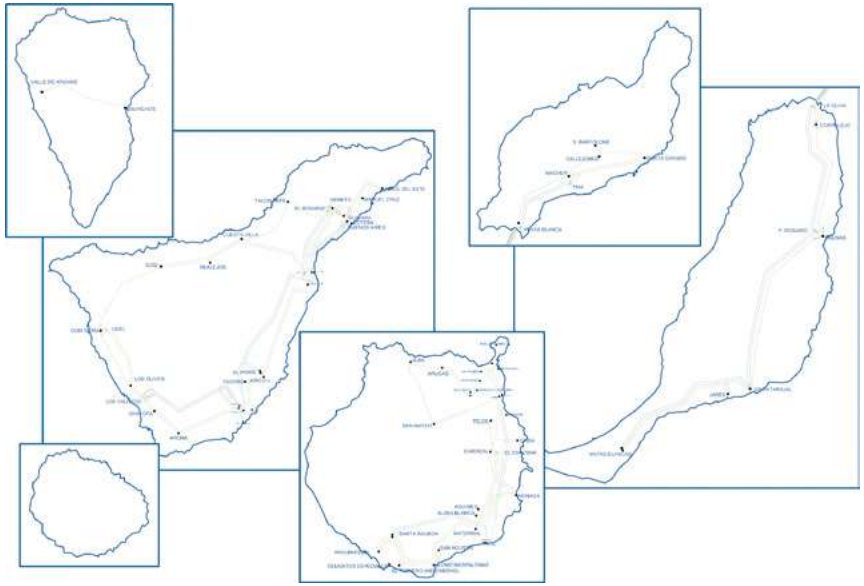
**I General description:** List planned reinforcements in the Islas Canarias that are included in the starting grid according to the established criteria.

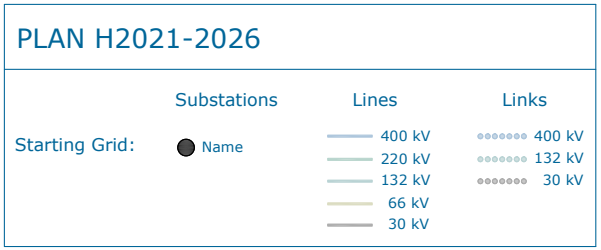
**I Drivers / Objectives:** To ensure that the reinforcements included in the 2015-2020 Transmission Network Development Plan are carried out, the commissioning of which is very likely to take place within the study horizon and whose specific motivations are detailed in the following tables.

**I Alternatives:** Following the Transmission Network Development Plan principles, alternatives to the reinforcements included in the starting grid were not evaluated.

**I European dimension:** No

**I Map:**






Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_CANARIAS
## Starting grid **Islas Canarias**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 438.2 M€ | 4.97 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 40.4 | 39.8 | 39.2 | 38.5 | 37.9 | 37.3 | 36.7 | 36.1 | 35.5 |

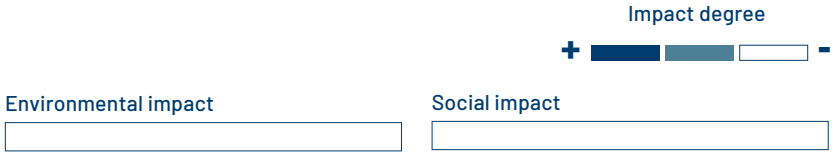
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

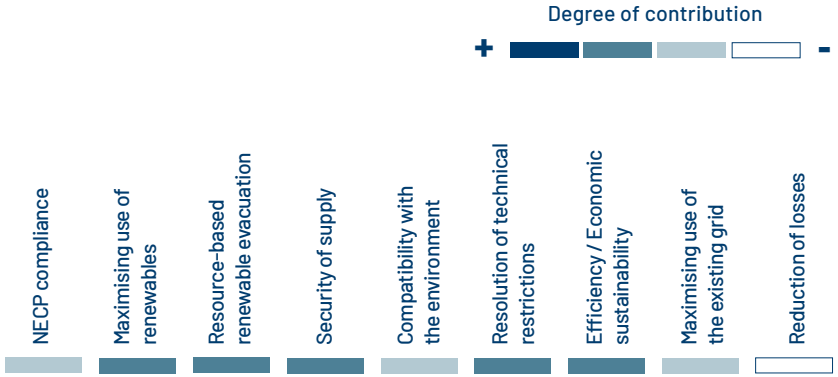
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
**I: Staritng grid**
II: New reinforcements
III: Technical annexes

# I Reinforcement RDP_CANARIAS
## Starting grid **Islas Canarias**

### I Table of physical units:

| | 66 kV | 132 kV | 220 kV |
|---|---|---|---|
| Bays (units) | 100 | 28 | 37 |
| Overhead line (km) | 52 | 118 | 33 |
| Cables (km) | 86 | 9 | 9 |
| Transformed to 132 kV (MVA) | | | 90 |
| Transformed to 66 kV (MVA) | | 240 | 1,000 |
| Uprating (km) | 12 | | |
| Reactance (Mvar) | | 18 | |
| Submarine Link (km) | | 17 | |
| Voltage change (km) | | | 27 |
| Renewal of bays (units) | 1 | | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Barranco de Tirajana II 220 kV | Building | 2022 |
| Buenos Aires 220 kV | Building | 2022 |
| Cañada de La Barca 132 kV | Building | 2023 |
| Chío 66 kV | Building | 2023 |
| El Rosario 220 kV | Building | 2021 |
| El Rosario 66 kV | Building | 2021 |

| New substations | Type | Year |
|---|---|---|
| Escobar 66 kV | Building | 2020 |
| Gran Tarajal 132 kV | Building | 2023 |
| Las Caletillas 220 kV | Building | 2022 |
| Vallitos 220 kV | Building | 2023 |
| Vallitos 66 kV | Building | 2023 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Abona 66 kV | 1 | GIS | Gen./Sto. | 2021 |
| Arinaga 66 kV | 1 | GIS | Rail. | 2023 |
| Arinaga 66 kV | 2 | GIS | TN | 2019 |
| Barranco de Tirajana 220 kV | 1 | GIS | TN | 2022 |
| Barranco de Tirajana 220 kV | 1 | GIS | TN | 2020 |
| Barranco de Tirajana 66 kV | 2 | AIS | TN | 2020 |
| Barranco de Tirajana 66 kV | 1 | AIS | TN | 2021 |
| Barranco de Tirajana II 220 kV | 2 | GIS | TN | 2020 |
| Buenos Aires 220 kV | 6 | GIS | TN | 2022 |
| Buenos Aires 66 kV | 2 | AIS | TN | 2020 |
| Cañada de la Barca 132 kV | 1 | GIS | Gen./Sto. | 2023 |
| Cañada de la Barca 132 kV | 4 | GIS | TN | 2023 |
| Chío 66 kV | 10 | GIS | TN | 2023 |
| Cinsa 66 kV | 1 | AIS | Gen./Sto. | 2023 |
| El Matorral 66 kV | 1 | GIS | Gen./Sto. | 2021 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_CANARIAS
## Starting grid **Islas Canarias**

### I Detailed list of assets (continued):

| Substation extension (cont.) | units | Type | Driv. | Year |
|---|---|---|---|---|
| El Porís 66 kV | 1 | GIS | Gen./Sto. | 2021 |
| El Porís 66 kV | 1 | GIS | TN | 2018 |
| El Rosario 220 kV | 4 | GIS | TN | 2022 |
| El Rosario 220 kV | 2 | GIS | TN | 2021 |
| El Rosario 66 kV | 14 | GIS | TN | 2021 |
| El Tablero 66 kV | 2 | GIS | TN | 2022 |
| Escobar 66 kV | 3 | GIS | TN | 2020 |
| Gran Tarajal 132 kV | 10 | GIS | TN | 2023 |
| Gran Tarajal 132 kV | 1 | GIS | Gen./Sto. | 2023 |
| Gran Tarajal 66 kV | 2 | GIS | TN | 2023 |
| Granadilla 220 kV | 1 | GIS | TN | 2023 |
| Granadilla II 220 kV | 1 | GIS | TN | 2023 |
| Guía 66 kV | 1 | AIS | Gen./Sto. | 2023 |
| Jares 132 kV | 1 | GIS | Gen./Sto. | 2022 |
| Jares 132 kV | 1 | GIS | TN | 2022 |
| La Oliva 132 kV | 2 | GIS | TN | 2017 |
| La Oliva 66 kV | 3 | GIS | TN | 2019 |
| La Oliva 66 kV | 3 | GIS | TN | 2018 |
| Las Caletillas 220 kV [1] | 9 | GIS | TN | 2022 |
| Las Salinas 66 kV | 1 | GIS | TN | 2022 |
| Las Salinas 66 kV | 1 | Mobile | TN | 2022 |
| Los Guinchos 66 kV | 1 | AIS | TN | 2023 |
| Los Guinchos 66 kV [2] | 1 | Mobile | TN | 2023 |
| Los Olivos 66 kV | 4 | AIS | TN | 2023 |
| Matas Blancas 132 kV | 1 | GIS | TN | 2017 |
| Matas Blancas 66 kV | 1 | AIS | TN | 2017 |
| Mobile 66 kV | 1 | Mobile | TN | 2022 |
| Playa Blanca 132 kV | 5 | GIS | TN | 2019 |
| Puerto del Rosario 66 kV | 3 | GIS | Gen./Sto. | 2017 |
| Puerto del Rosario 66 kV | 9 | GIS | TN | 2017 |
| Sabinal 220 kV | 4 | GIS | TN | 2023 |
| Sabinal 66 kV | 1 | GIS | TN | > 2026 |
| Sabinal 66 kV | 12 | GIS | TN | 2023 |
| Santa Águeda 66 kV | 1 | GIS | Gen./Sto. | 2020 |
| Santa Águeda 66 kV | 1 | GIS | TN | 2019 |
| Tagoro 66 kV | 1 | GIS | Gen./Sto. | 2023 |
| Telde 66 kV | 1 | AIS | Rail. | 2023 |
| Telde 66 kV | 1 | AIS | Gen./Sto. | 2021 |
| Tías 132 kV | 2 | GIS | TN | 2020 |
| Vallitos 220 kV | 6 | GIS | TN | 2020 |
| Vallitos 66 kV | 9 | GIS | TN | 2020 |

Notes:
1. Commissioning of DC Granadilla I-Buenos Aires/ Granadilla II-Caletillas 220 kV and decommissioning of DC Granadillal/ Granadilla I-Candelaria.
2. Reconfiguration of the substation to be adapted to the Operational Procedure (O.P.)

| Renewal of bays | units | Type | Driv. | Year |
|---|---|---|---|---|
| Arguineguín 66 kV | 1 | AIS | TN | 2022 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_CANARIAS
## Starting grid **Islas Canarias**

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Arguineguín - Santa Águeda 66 kV, circuit 3 | 82 | 82 | 0.1 | Cable | SoS | 2022 |
| Barranco de Calderina - Sabinal 66 kV, circuit 1 [1] | 76 | 76 | 0.3 | Cable | SoS | 2023 |
| Buenavista G.C. - Sabinal 66 kV, circuit 1 [2] | 60 | 60 | 0.5 | Cable | SoS | 2023 |
| Chío - Icod de los Vinos 66 kV, circuit 1 [3] | 46 | 43 | 0.5 | Cable | SoS | 2023 |
| Chío - Icod de los Vinos 66 kV, circuit 1 [4] | 46 | 43 | 0.1 | Line | SoS | 2023 |
| Chío - Los Olivos 66 kV, circuit 1 [5] | 52 | 48 | 0.5 | Cable | SoS | 2023 |
| Chío - Los Olivos 66 kV, circuit 1 [6] | 52 | 48 | 0.2 | Line | SoS | 2023 |
| DC Arguineguín - Santa Águeda 66 kV [7] | 74 | 74 | 1 | Line | SoS | 2022 |
| DC Arinaga - Escobar 66 kV | 67 | 67 | 5 | Line | RES | 2023 |
| DC Arinaga - Escobar 66 kV | 75 | 75 | 3 | Cable | RES | 2023 |
| DC Barranco de Calderina - Sabinal 66 kV | 76 | 76 | 0.2 | Cable | SoS | 2023 |
| DC Buenavista G.C. - Sabinal 66 kV [8] | 72 | 72 | 0.1 | Cable | SoS | 2023 |
| DC Buenos Aires - Las Caletillas 220 kV | 342 | 342 | 0.3 | Line | SoS | 2022 |
| DC Buenos Aires - Las Caletillas 220 kV | 395 | 395 | 0.3 | Cable | SoS | 2022 |
| DC Candelaria - Las Caletillas 220 kV | 459 | 459 | 0.4 | Cable | SoS | 2022 |
| DC Chío - Guía de Isora 66 kV | 80 | 80 | 0.3 | Cable | SoS | 2023 |
| DC Chío - Los Olivos 66 kV [9] | 76 | 76 | 12 | Line | SoS | 2023 |
| DC Chío - Los Olivos 66 kV [10] | 82.5 | 80 | 0.6 | Cable | SoS | 2023 |
| DC El Rosario - Dique del Este 66 kV [11] | 66 | 66 | 6 | Cable | SoS | 2022 |
| DC El Rosario - Guajara 66 kV | 69 | 69 | 8 | Cable | SoS | 2022 |

| New lines/cables (cont.) | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Geneto - El Rosario 66 kV | 76 | 76 | 5 | Cable | SoS | 2021 |
| DC Gran Tarajal - Matas Blancas 132 kV | 190 | 190 | 0.1 | Cable | SoS | 2023 |
| DC Guanarteme - Sabinal 66 kV [12] | 58 | 58 | 0.1 | Cable | SoS | 2023 |
| DC La Oliva - Corralejo 66 kV | 80 | 80 | 5 | Cable | SoS | 2020 |
| DC Las Caletillas - El Rosario 220 kV | 303 | 303 | 8 | Line | SoS | 2022 |
| DC Las Caletillas - El Rosario 220 kV | 303 | 303 | 2 | Cable | SoS | 2022 |
| DC Las Caletillas - Granadilla 220 kV [13] | 290 | 290 | 0.5 | Line | SoS | 2022 |
| DC Las Salinas - Puerto del Rosario 66 kV | 80 | 80 | 4 | Cable | SoS | 2022 |
| DC Puerto del Rosario - Gran Tarajal 132 kV [14] | 160 | 160 | 44 | Line | SoS | 2023 |
| DC Puerto del Rosario - Gran Tarajal 132 kV | 160 | 160 | 0.3 | Cable | SoS | 2023 |

Notes:
1. Change in topology with decommissioning of the Jinamar-Bco Seco and Jinamar- Bco de Calderina 66kV lines, and commissioning of the Sabinal-Bco Seco and Sabinal-Bco de Calderina 66kV lines.
2. Change in topology with decommissioning of the Jinamar-Buenavista and Jinamar- La Paterna 1 66kV lines, and commissioning of the Sabinal-Buenavista and Sabinal-La Paterna 1 66kV lines.
3. Change in topology with commissioning of Chío-Icod 66 kV and decommissioning of Guía Isora-Icod 66 kV.
4. Change in topology with commissioning of Chío-Icod 66 kV and decommissioning of Guía Isora-Icod 66 kV.
5. Change in topology with commissioning of Chío-Los Olivos 66 kV and decommissioning of Guía Isora-Los Olivos 66 kV.
6. Change in topology with commissioning of Chío-Los Olivos 66 kV and decommissioning of Guía Isora-Los Olivos 66 kV.
7. Double circuit with first circuit laid out. Decommissioning of part of the current circuits with input at Arguineguín is required.
8. Section line capacity for this route is 72/72 MVA.
9. Decommissioning of the Icod de Los Vinos-Guía de Isora 66 kV line is required.
10. Decommissioning of the Icod de Los Vinos-Guía de Isora 66 kV line is required.
11. Change in topology of DC Dique del Este/Manuel Cruz-Geneto to DC Dique del Este/Manuel Cruz-El Rosario 66 kV.
12. Section line capacity for this route is 72/72 MVA.
13. Former Granadilla-Candelaria circuit. 1 220 kV.
14. After the commissioning of the entire 132 kV axis between Tías-Playa Blanca and La Oliva-Matas Blancas, Macher-Playa Blanca 66 kV and Corralejo-Salinas-Gran Tarajal-Matas Blancas 66 kV will be decommissioned.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_CANARIAS
## Starting grid **Islas Canarias**

### I Detailed list of assets (continued):

| New lines/cables (cont.) | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Santa Águeda - Barranco de Tirajana II 220 kV | 323 | 323 | 0.5 | Cable | SoS | 2022 |
| DC Santa Águeda - Cementos Especiales 66 kV [15] | 40 | 40 | 0.5 | Line | SoS | 2022 |
| DC Tías - Playa Blanca 132 kV | 190 | 190 | 3 | Cable | SoS | 2023 |
| DC Tías - Playa Blanca 132 kV [16] | 190 | 190 | 14 | Line | SoS | 2023 |
| DC Vallitos - Granadilla 220 kV | 200 | 200 | 3 | Line | SoS | 2023 |
| DC Vallitos - Granadilla 220 kV | 200 | 200 | 0.2 | Cable | SoS | 2023 |
| I/O in Abona, of Granadilla II - Vallitos 220 kV, circuit 1 | 393 | 360 | 1 | Cable | RES | 2020 |
| I/O in Cañada de la Barca, of Gran Tarajal - Matas Blancas 132 kV, circuit 1 | 160 | 160 | 0.5 | Line | RES | 2023 |
| I/O in Cañada de la Barca, of Gran Tarajal - Matas Blancas 132 kV, circuit 1 | 160 | 160 | 0.5 | Cable | RES | 2023 |
| I/O in Escobar, of Agüimes - Cinsa 66 kV, circuit 1 | 55 | 55 | 0.2 | Cable | RES | 2021 |
| I/O in Escobar, of Carrizal - Barranco de Tirajana 66 kV, circuit 1 | 77 | 77 | 0.2 | Cable | RES | 2021 |
| I/O in Escobar, of Carrizal - Telde 66 kV, circuit 1 | 77 | 77 | 0.2 | Cable | RES | 2021 |
| I/O in Vallitos, of Chayofa - Los Olivos 66 kV, circuit 1 | 62 | 62 | 1 | Line | SoS | 2023 |
| I/O in Vallitos, of Chayofa - Los Olivos 66 kV, circuit 1 | 62 | 62 | 2 | Cable | SoS | 2023 |
| I/O in Vallitos, of Chayofa - Los Olivos 66 kV, circuit 2 | 62 | 62 | 1 | Cable | SoS | 2023 |

| New lines/cables (cont.) | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Vallitos, of Chayofa - Los Olivos 66 kV, circuit 2 | 62 | 62 | 2 | Line | SoS | 2023 |
| El Rosario - Tacoronte 66 kV, circuit 1 [17] | 66 | 66 | 0.4 | Cable | SoS | 2022 |
| El Tablero - Lomo Maspalomas 66 kV, circuit 2 [18] | 80 | 80 | 0.1 | Line | SoS | 2022 |
| El Tablero - Lomo Maspalomas 66 kV, circuit 2 | 80 | 80 | 5 | Cable | SoS | 2022 |
| El Tablero - Santa Águeda 66 kV, circuit 2 | 80 | 80 | 5 | Cable | SoS | 2022 |
| El Tablero - Santa Águeda 66 kV, circuit 2 [19] | 80 | 80 | 5 | Line | SoS | 2022 |
| Gran Tarajal-Gran Tarajal 66 kV [24] | | | 2 SSC | Cable | SoS | 2023 |
| Gran Tarajal-Gran Tarajal 132 kV [24] | | | 2 SSC | Cable | SoS | 2023 |
| Guanarteme - Sabinal 66 kV, circuit 1 [20] | 58 | 58 | 0.2 | Cable | SoS | 2023 |
| La Oliva - Playa Blanca 132 kV, circuit 1 | 120 | 120 | 17 | Subm. | Link | 2022 |
| La Oliva - Playa Blanca 66 kV, circuit 1 [21] | 60 | 60 | 0.5 | Cable | Link | 2022 |
| La Oliva - Puerto del Rosario 66 kV, circuit 1 [22] | 60 | 60 | 0.5 | Cable | Link | 2020 |

Notes:
15. Change in topology with decommissioning of the Sta Águeda-Arguineguín 1 and Arguineguín Cementos Eseciales lines, and decommissioning of Sta Águeda-C Especiales 1 66 kV.
16. Section line capacity for overhead section of Line 210/210.
17. Change in topology from Tacoronte-Geneto to Tacoronte-El Rosario 66 kV.
18. The line capacity in the overhead section is 85 MVA.
19. The line capacity in the overhead section is 90 MVA.
20. Change in topology with decommissioning of the Jinamar-Guanarteme and Jinamar- La Paterna 2 66kV lines, and commissioning of the Sabinal-Guanarteme and Sabinal-La Paterna 2 66kV lines.
21. Commissioning of the La Oliva-Playa Blanca 66 kV and La Oliva-Puerto del Rosario 66 kV due to topology change in the current Corralejo-Playa Blanca 66 kV link and the Corralejo-Puerto del Rosario 66 kV line-cable
22. Commissioning of the La Oliva-Playa Blanca 66 kV and La Oliva-Puerto del Rosario 66 kV due to topology change in the current Corralejo-Playa Blanca 66 kV link and the Corralejo-Puerto del Rosario 66 kV line-cable.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_CANARIAS
## Starting grid **Islas Canarias**

### I Detailed list of assets (continued):

| New lines/cables (cont.) | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Lomo Apolinario - Sabinal 66 kV, circuit 1 [23] | 76 | 76 | 0.8 | Cable | SoS | >2026 |
| Los Guinchos - Los Guinchos 66 kV, circuit [24] | | | 4 SSC | Cable | TN | 2023 |
| Puerto del Rosario - Las Salinas 66 kV, circuit 1 [25] | 80 | 80 | 0.2 | Cable | SoS | 2022 |
| Puerto del Rosario - Las Salinas 66 kV, circuit 2 [26] | 80 | 80 | 0.1 | Cable | SoS | 2022 |
| Sabinal - Sabinal 220 kV, circuit 1 [24] | | | 2 SSC | Cable | SoS | 2023 |
| San Agustín (Gran Canaria) - El Tablero 66 kV, circuit 1 [27] | 66 | 66 | 0.5 | Cable | SoS | 2022 |
| La Paterna - Sabinal 66 kV, circuit 2 | 76 | 76 | 0.8 | Cable | SoS | 2023 |

Notes:
23. Topological change with decommissioning of the Jinamar-Lomo Apolinario 66kV line and commissioning of the Sabinal-Lomo Apolinario 66kV line.
24. Short section of cable inside the substation.
25. Topological change with commissioning of Salinas-Puerto del Rosario 1 66 kV and decommissioning of Salinas-Corralejo 66 kV.
26. Topological change with commissioning of Salinas-Puerto del Rosario 2 66 kV and decommissioning of Salinas-Gran Tarajal 66 kV
27. Non-operable bypass in Lomo Maspalomas de San Agustín-Lomo Maspalomas and Lomo Maspalomas-El Tablero ct2 66kV.

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Jinámar - Lomo Apolinario 66 kV, circuit 1 [1] | 72 | 72 | 7 | Line | SoS | 2023 |
| Sabinal - Barranco Seco 66 kV, circuit 1 | 76 | 76 | 4 | Line | SoS | 2023 |

Notes:
1. Line capacity in the repowered 99/99 MVA overhead section.

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Buenos Aires 220/66 kV, TF1 | 125 | Triph. B. | SoS | 2019 |
| Buenos Aires 220/66 kV, TF2 | 125 | Triph. B. | SoS | 2022 |
| El Rosario 220/66 kV, TF1 | 125 | Triph. B. | SoS | 2021 |
| El Rosario 220/66 kV, TF2 | 125 | Triph. B. | SoS | 2021 |
| Gran Tarajal 132/66 kV, TF1 | 80 | Triph. B. | SoS | 2023 |
| Gran Tarajal 132/66 kV, TF2 | 80 | Triph. B. | SoS | 2023 |
| Matas Blancas 132/66 kV, TF2 | 80 | Triph. B. | SoS | 2017 |
| Mobile 220/132 kV, TF1 | 30 | Triph. B. | SoS | 2023 |
| Mobile 220/132 kV, TF2 | 30 | Triph. B. | SoS | 2023 |
| Mobile 220/132 kV, TF3 | 30 | Triph. B. | SoS | 2023 |
| Sabinal 220/66 kV, TF3 | 125 | Triph. B. | SoS | 2023 |
| Sabinal 220/66 kV, TF4 | 125 | Triph. B. | SoS | 2023 |
| Vallitos 220/66 kV, TF1 | 125 | Triph. B. | SoS | 2020 |
| Vallitos 220/66 kV, TF2 | 125 | Triph. B. | SoS | 2020 |

| New reactances | MVAr | Type | Driv. | Year |
|---|---|---|---|---|
| La Oliva 132 kV, REA1 | 9 | - | Link | 2017 |
| Playa Blanca 132 kV, REA1 | 9 | - | Link | 2019 |

| Voltage changes | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Buenos Aires - Caletillas 220 kV | 400 | 400 | 14 | Line | SoS | 2023 |
| DC Buenos Aires - Caletillas 220 kV | 400 | 400 | 6 | Cable | SoS | 2023 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_CENTRO
## Starting grid **Castilla-La Mancha and Madrid**

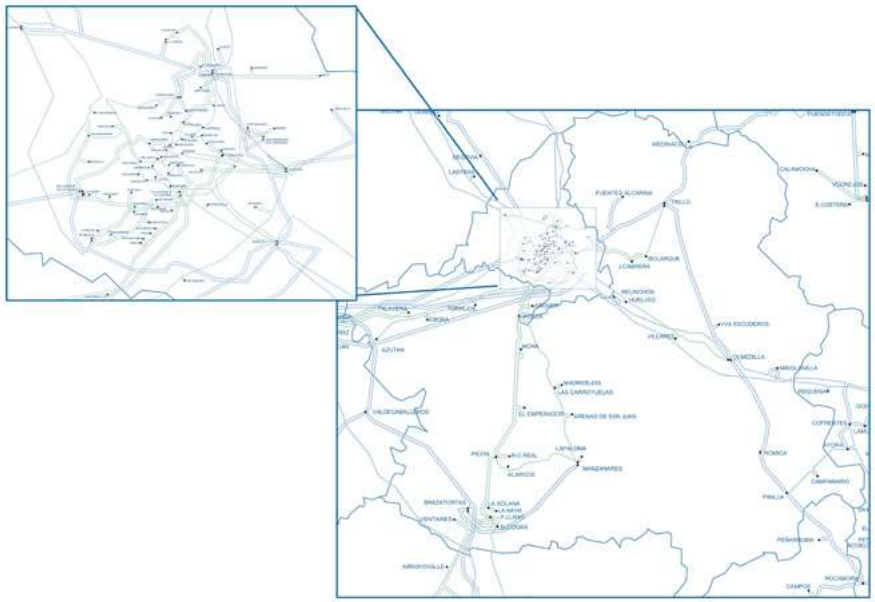
**I General description:** List planned reinforcements in Castilla-La Mancha and Madrid that are included in the starting grid according to the established criteria.

**I Drivers / Objectives:** To ensure that the reinforcements included in the 2015-2020 Transmission Network Development Plan are carried out, the commissioning of which is very likely to take place within the study horizon and whose specific motivations are detailed in the following tables.

**I Alternatives:** Following the Transmission Network Development Plan principles, alternatives to the reinforcements included in the starting grid were not evaluated.

**I European dimension:** No

**I Map:**



PLAN H2021-2026

| | Substations | Lines | Links |
|---|---|---|---|
| Starting Grid: | Name | 400 kV<br>220 kV<br>132 kV<br>66 kV<br>30 kV | 400 kV<br>132 kV<br>30 kV |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_CENTRO
## Starting grid **Castilla-La Mancha and Madrid**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 100.5 M€ | 1.41 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 9.5 | 9.4 | 9.3 | 9.1 | 9.0 | 8.8 | 8.7 | 8.6 | 8.4 |

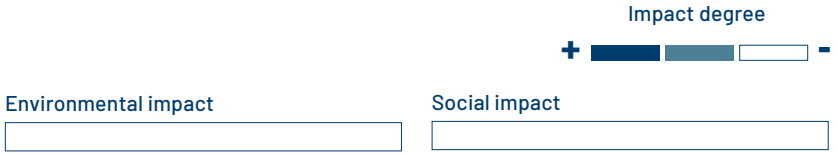
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

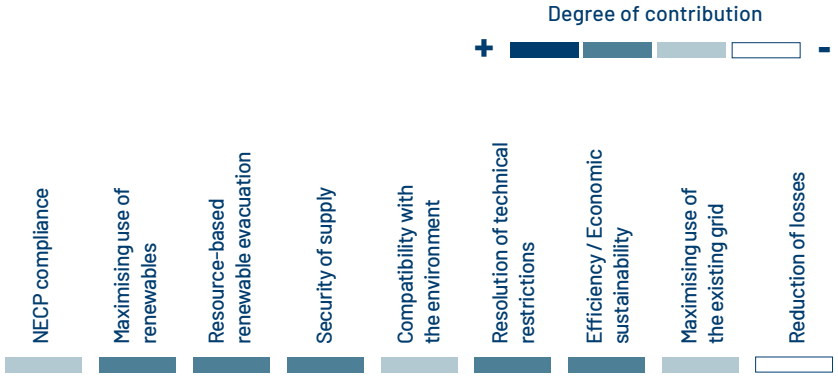
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_CENTRO
## Starting grid **Castilla-La Mancha and Madrid**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 16 | 18 |
| Overhead line (km) | 4 | 4 |
| Cables (km) | 11 | |
| Transformed to 220 kV (MVA) | | 1,200 |
| Uprating (km) | 125 | 264 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Olmedilla 220 kV | Outdoor. | 2022 |
| San Fernando 220 kV | Building | 2022 |
| San Fernando 400 kV | Building | 2023 |

### I Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Aena (Madrid) 220 kV | 1 | GIS | TN | > 2026 |
| Brazatortas 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Brazatortas 400 kV | 1 | AIS | TN | 2023 |
| Campo Naciones 220 kV | 1 | GIS | TN | > 2026 |
| Coslada 220 kV [1] | 3 | AIS | TN | 2020 |
| José Cabrera 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Loeches 400 kV [2] | 2 | AIS | TN | 2022 |
| Minglanilla 400 kV | 1 | AIS | Gen./Sto. | 2020 |
| Olmedilla 220 kV | 3 | AIS | TN | 2022 |
| Olmedilla 400 kV | 3 | AIS | TN | 2022 |
| Olmedilla 400 kV | 1 | AIS | Gen./Sto. | 2022 |
| San Fernando 220 kV | 3 | GIS | TN | 2022 |
| San Fernando 220 kV | 3 | GIS | TN | 2023 |
| San Fernando 400 kV | 7 | GIS | TN | 2023 |
| San Fernando 400 kV | 1 | GIS | Gen./Sto. | 2023 |
| San Sebastián de los Reyes 400 kV [3] | 1 | AIS | TN | 2022 |
| Villares del Saz 220 kV | 1 | AIS | Gen./Sto. | 2021 |

Notes:
1. Coslada B 220 kV with connection to Coslada 220 kV circuits 1 and 2 (Longitudinal coupling of busbars. AIS technology), and connection with Getafe and Loeches bays previously connected to Coslada. Expansion of the Coslada B 220 kV substation for transverse coupling.
2. Change in voltage and topology for the Loeches-Puente San Fernando 220 kV and Puente San Fernando-San Sebastián de los Reyes 220 kV lines, with decommissioning of the Loeches-San Sebastián de los Reyes 2 400 kV line.
3. Change in voltage and topology for the Loeches-Puente San Fernando 220 kV and Puente San Fernando-San Sebastián de los Reyes 220 kV lines, with decommissioning of the Loeches-San Sebastián de los Reyes 2 400 kV line.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_CENTRO
## Starting grid **Castilla-La Mancha and Madrid**

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Aena (Madrid) - Campo Naciones 220 kV, circuit 1 | 443 | 443 | 7 | Cable | RES | >2026 |
| DC San Fernando - Puente San Fernando 220 kV | 440 | 440 | 1 | Cable | SuD | 2022 |
| I/O in Ébora, of Torrijos - Almaraz E.T. 220 kV, circuit 1 | 770 | 630 | 2 | Line | SuD | 2020 |
| I/O in San Fernando, of Algete - Ardoz 220 kV, circuit 1 | 470 | 390 | 0.4 | Cable | SuD | 2023 |
| I/O in San Fernando, of Morata E.T. - Morata 400 kV, circuit 1 | 1,773 | 1,456 | 0.9 | Line | SuD | 2023 |
| Loeches - San Sebastián de los Reyes 400 kV, circuit 2 [1] | 1,490 | 1,490 | 2 | Line | SuD | 2022 |
| Olmedilla - Olmedilla 220 kV, circuit 1 [2] | | | SSC | Cable | RES | 2022 |

Notes:
1. Change in voltage and topology: Loeches-San Sebastián de los Reyes 400 kV line increases route length by 2 km.
2. For connection to the transformer, which connects to the 220 kV grid via cable (0.8 km).

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Huelves - Villares del Saz 220 kV, circuit 1 | 464 | 384 | 43 | Line | RES | 2020 |
| Olmedilla - Trillo 400 kV, circuit 1 | 2,631 | 2,171 | 131 | Line | RES | 2023 |
| Olmedilla - Villanueva de los Escuderos 400 kV, circuit 1 | 2,631 | 2,171 | 48 | Line | RES | 2023 |
| Puertollano - Venta de la Inés 220 kV, circuit 1 | 434 | 355 | 31 | Line | RES | 2020 |
| Villanueva de los Escuderos - Trillo 400 kV, circuit 1 | 2,631 | 2,171 | 85 | Line | RES | 2023 |
| Villares del Saz - Olmedilla 220 kV, circuit 1 | 464 | 384 | 51 | Line | RES | 2021 |

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Olmedilla 400/220 kV, TF1 | 600 | Triph. | RES | 2022 |
| San Fernando 400/220 kV, TF1 | 600 | Triph. B. | SuD | 2023 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_EXTREM
## Starting grid **Extremadura**

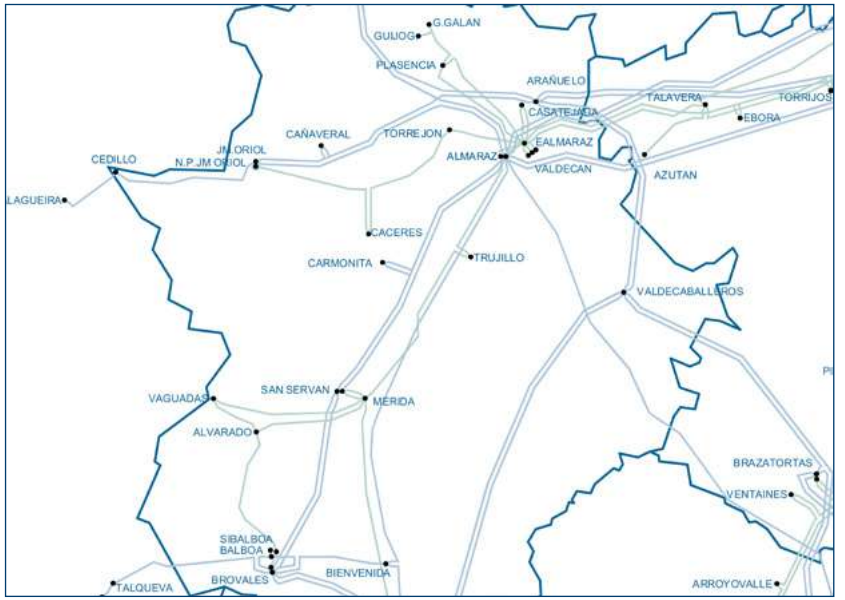
**I General description:** List planned reinforcements in Extremadura that are included in the starting grid according to the established criteria.

**I Drivers / Objectives:** To ensure that the reinforcements included in the 2015-2020 Transmission Network Development Plan are carried out, the commissioning of which is very likely to take place within the study horizon and whose specific motivations are detailed in the following tables.

**I Alternatives:** Following the Transmission Network Development Plan principles, alternatives to the reinforcements included in the starting grid were not evaluated.

**I European dimension:** No

**I Map:**




PLAN H2021-2026

| | Substations | Lines | Links |
|---|---|---|---|
| Starting Grid: | Name | 400 kV<br>220 kV<br>132 kV<br>66 kV<br>30 kV | 400 kV<br>132 kV<br>30 kV |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_EXTREM
## Starting grid **Extremadura**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 37.3 M€ | 0.81 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 3.8 | 3.8 | 3.7 | 3.7 | 3.6 | 3.6 | 3.5 | 3.5 | 3.4 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

Profitability: NPV

- M€

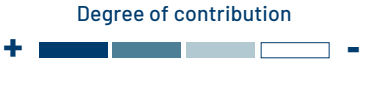
### I Socio-environmental impact:

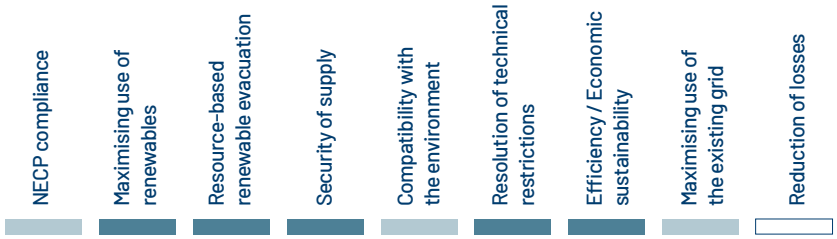



Environmental impact

Social impact

### I Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_EXTREM
## Starting grid **Extremadura**

### Table of physical units:

| | 66 kV | 220 kV | 400 kV |
|---|---|---|---|
| Bays (units) | 2 | 6 | 9 |
| Overhead line (km) | 0.1 | 2 | 2 |
| Transformed to 220 kV (MVA) | | | 1,100 |
| Uprating (km) | | | 338 |
| Reactance (Mvar) | | 200 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Carmonita 400 kV | Outdoor. | 2021 |
| Jose María de Oriol NP 220 kV | Outdoor. | 2021 |

### Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Almaraz ET 220 kV | 1 | AIS | TN | 2022 |
| Carmonita 400 kV | 2 | AIS | Rail. | 2021 |
| Carmonita 400 kV | 5 | AIS | TN | 2021 |
| Carmonita 400 kV | 1 | AIS | Gen./Sto. | 2021 |
| Jose María de Oriol NP 220 kV [1] | 5 | AIS | TN | 2021 |
| Río Caya 66 kV | 2 | AIS | INT | 2021 |
| San Servan 400 kV | 1 | AIS | Gen./Sto. | 2023 |

Notes:
1. Bay relocation in Cáceres from J.M. Oriol to J.M. Oriol NP 220 kV.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Cáceres - Jose María de Oriol N.P. 220 kV [1] | 430 | 350 | 0.6 | Line | RES | 2020 |
| DC Jose María de Oriol - Jose María de Oriol N.P. 220 kV | 860 | 730 | 0.2 | Line | RES | 2021 |
| I/O in Carmonita, of Almaraz CN - San Serván 400 kV, circuit 1 | 2,343 | 1,942 | 1 | Line | Rail. | 2021 |
| Río Caya - Alcáçova 66 kV, circuit 1 [2] | | | 0.1 | Line | INT | 2021 |

Notes:
1. Bay relocation in Cáceres from J.M. Oriol to J.M. Oriol NP 220 kV.
2. Topology change for the Badajoz - Frontera Portuguesa a Río Caya - Frontera Portuguesa line.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
**I: Staritng grid**
II: New reinforcements
III: Technical annexes

# I Reinforcement RDP_EXTREM
## Starting grid **Extremadura**

### I Detailed list of assets (continued):

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Almaraz CN - Villaviciosa 400 kV, circuit 1 | 1,756 | 1,445 | 169 | Line | RES | 2022 |
| Almaraz CN - Villaviciosa 400 kV, circuit 2 | 1,756 | 1,445 | 169 | Line | RES | 2022 |

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Almaraz CN 400/220 kV, TF1 | 600 | Triph. B. | RES | 2021 |
| Arañuelo 400/220 kV, TF1 [1] | 500 | Triph. | RES | 2022 |

Notes:
1. Strategic reserve. Previously planned in Almaraz CN.

| New reactances | MVAr | Type | Driv. | Year |
|---|---|---|---|---|
| Almaraz ET 220 kV, REA1 | 100 | - | SoS | 2022 |
| Jose María de Oriol NP 220 kV, REA1 | 100 | - | SoS | 2021 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_GALICIA
## Starting grid **Galicia**

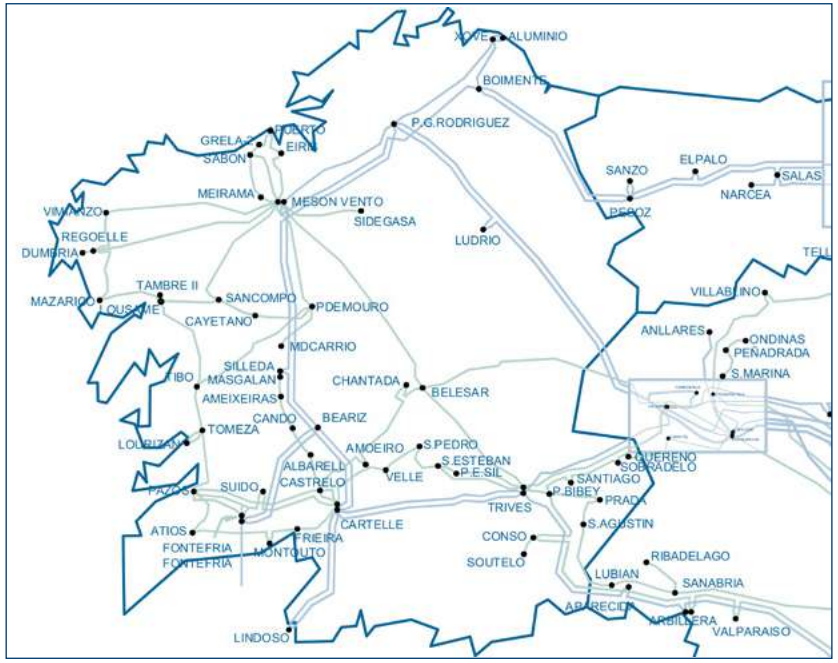
**I General description:** List planned reinforcements in Galicia that are included in the starting grid according to the established criteria.

**I Drivers / Objectives:** To ensure that the reinforcements included in the 2015-2020 Transmission Network Development Plan are carried out, the commissioning of which is very likely to take place within the study horizon and whose specific motivations are detailed in the following tables.

**I Alternatives:** Following the Transmission Network Development Plan principles, alternatives to the reinforcements included in the starting grid were not evaluated.

**I European dimension:** No

**I Map:**




PLAN H2021-2026

| | Substations | Lines | Links |
|---|---|---|---|
| Starting Grid: | Name | 400 kV<br>220 kV<br>132 kV<br>66 kV<br>30 kV | 400 kV<br>132 kV<br>30 kV |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_GALICIA
## Starting grid **Galicia**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 61.2 M€ | 0.82 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 5.8 | 5.7 | 5.6 | 5.5 | 5.4 | 5.3 | 5.2 | 5.2 | 5.1 |

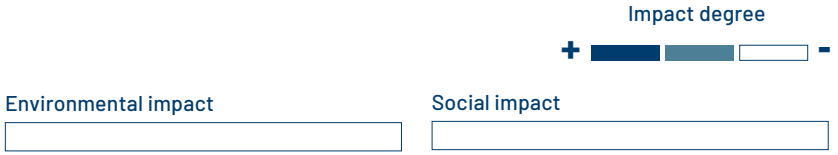
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

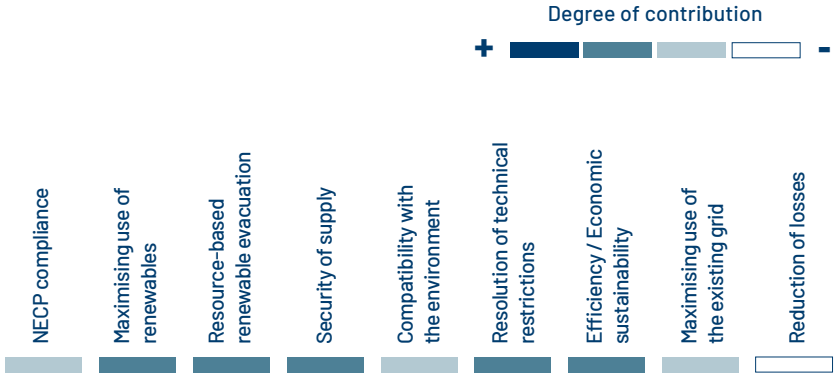
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
**I: Staritng grid**
II: New reinforcements
III: Technical annexes

# I Reinforcement RDP_GALICIA
## Starting grid **Galicia**

### I Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 23 |
| Overhead line (km) | 102 |
| Cables (km) | 0.4 |
| Uprating (km) | 49 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Tomeza 220 kV | Building | 2021 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Atios 220 kV | 1 | AIS | TN | 2010 |
| Chantada 220 kV | 1 | GIS | Gen./Sto. | 2021 |
| Fontefría 220 kV | 1 | AIS | Gen./Sto. | 2024 |
| Fontefría 220 kV | 3 | AIS | TN | 2024 |
| Lousame 220 kV | 2 | AIS | TN | 2019 |
| Mazaricos 220 kV | 1 | AIS | TN | 2019 |
| Montouto 220 kV | 1 | AIS | TN | 2010 |
| Pazos de Borbén 220 kV | 1 | AIS | TN | 2024 |
| Regoelle 220 kV | 2 | GIS | TN | 2016 |
| Santiago de Compostela 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Tibo 220 kV | 1 | AIS | Gen./Sto. | 2022 |
| Tibo 220 kV | 1 | AIS | TN | 2011 |
| Tomeza 220 kV | 2 | GIS | Rail. | 2021 |
| Tomeza 220 kV | 5 | GIS | TN | 2021 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_GALICIA
## Starting grid **Galicia**

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Atios - Montouto 220 kV, circuit 1 | 576 | 526 | 0.4 | Cable | RES | 2021 |
| Atios - Montouto 220 kV, circuit 1 | 440 | 440 | 4 | Line | RES | 2021 |
| Atios - Montouto 220 kV, circuit 1 | 440 | 440 | 24 | Line | RES | 2013 |
| DC Lousame - Mazaricos 220 kV [1] | 860 | 750 | 28 | Line | RES | 2021 |
| DC Lousame - Tibo 220 kV [1] | 860 | 750 | 41 | Line | RES | 2022 |
| I/O in Fontefría, of Suido - Pazos de Borbén 220 kV, circuit 1 | 979 | 831 | 2 | Line | INT | 2024 |
| I/O in Regoelle, of Dumbría - Mesón do Vento 220 kV, circuit 1 [2] | 320 | 270 | 2 | Line | RES | 2022 |
| I/O in Tomeza, of Lourizán - Pazos de Borbén 220 kV, circuit 1 | 320 | 240 | 0.1 | Line | Rail. | 2021 |
| I/O in Tomeza, of Lourizán - Tibo 220 kV, circuit 1 | 320 | 240 | 0.1 | Line | Rail. | 2021 |
| Fontefría - Pazos de Borbén 220 kV, circuit 2 [3] | 979 | 831 | 0.1 | Line | INT | 2024 |

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Pazos de Borbén - Tomeza 220 kV, circuit 1 | 438 | 374 | 22 | Line | RES | 2021 |
| Tibo - Tomeza 220 kV, circuit 1 | 438 | 374 | 27 | Line | RES | 2021 |

Notes:
1. Double circuit with first circuit laid out.
2. Section line capacity in DC for I/O 890/790 MVA.
3. The new line uses part of the existing circuit.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_NORTE
## Starting grid **Navarra, País Vasco and La Rioja**

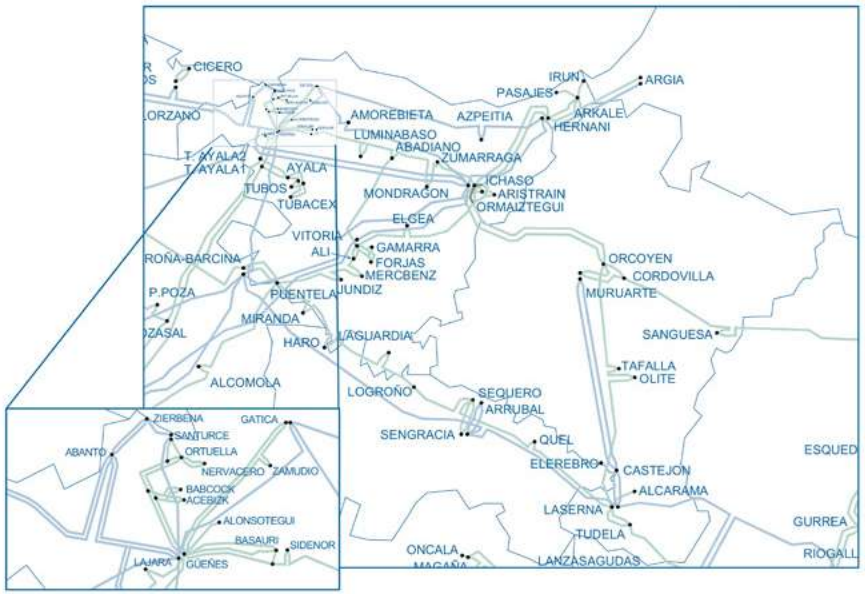
**I General description:** List planned reinforcements in Navarra, País Vasco and La Rioja that are included in the starting grid according to the established criteria.

**I Drivers / Objectives:** To ensure that the reinforcements included in the 2015-2020 Transmission Network Development Plan are carried out, the commissioning of which is very likely to take place within the study horizon and whose specific motivations are detailed in the following tables.

**I Alternatives:** Following the Transmission Network Development Plan principles, alternatives to the reinforcements included in the starting grid were not evaluated.

**I European dimension:** No

**I Map:**




PLAN H2021-2026

| | Substations | Lines | Links |
|---|---|---|---|
| Starting Grid: | Name | 400 kV<br>220 kV<br>132 kV<br>66 kV<br>30 kV | 400 kV<br>132 kV<br>30 kV |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_NORTE
## Starting grid **Navarra, País Vasco and La Rioja**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 76 M€ | 0.99 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 7.1 | 7.0 | 6.9 | 6.8 | 6.7 | 6.6 | 6.5 | 6.4 | 6.3 |

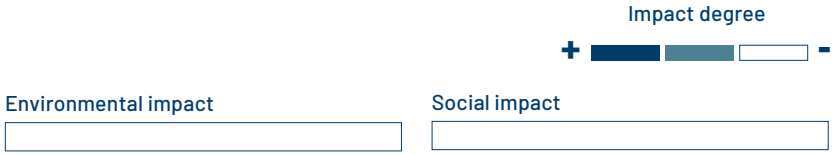
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

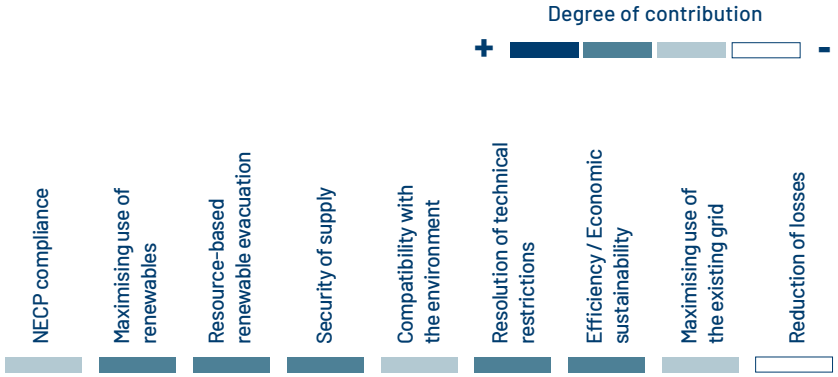
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# I Reinforcement RDP_NORTE
## Starting grid **Navarra, País Vasco and La Rioja**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 8 | 3 |
| Overhead line (km) | 1 | 147 |
| Cables (km) | 0.1 | |
| Uprating (km) | 50 | |
| STATCOM (units) | 150 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Luminabaso 220 kV | Outdoor. | 2023 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Itxaso 400 kV | 3 | AIS | TN | 2021 |
| La Serna 220 kV | 1 | AIS | SuD | 2023 |
| Luminabaso 220 kV | 2 | GIS | Rail. | 2023 |
| Luminabaso 220 kV | 3 | GIS | TN | 2023 |
| Olite 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Vitoria 220 kV | 1 | AIS | SoS | 2022 |

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Güeñes - Itxaso 400 kV | 2,412 | 2,129 | 74 | Line | RES | 2021 |
| I/O in Luminabaso, of Abadiano - Sidenor 220 kV, circuit 1 | 880 | 790 | 0.7 | Line | Rail. | 2023 |
| La Serna - La Serna 220 kV [1] | | | 1 SSC | Cable | SuD | 2023 |

Notes:
1. Short section of cable inside the substation.

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Hernani - Arkale 220 kV, circuit 2 | 640 | 580 | 12 | Line | RES | 2021 |
| La Serna - Quel 220 kV, circuit 1 | 403 | 347 | 37 | Line | RES | 2020 |

| New STATCOMs | units | Type | Driv. | Year |
|---|---|---|---|---|
| Vitoria 220 kV | 150 | - | SoS | 2022 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_ESTE
## Starting grid **Valencia and Murcia**

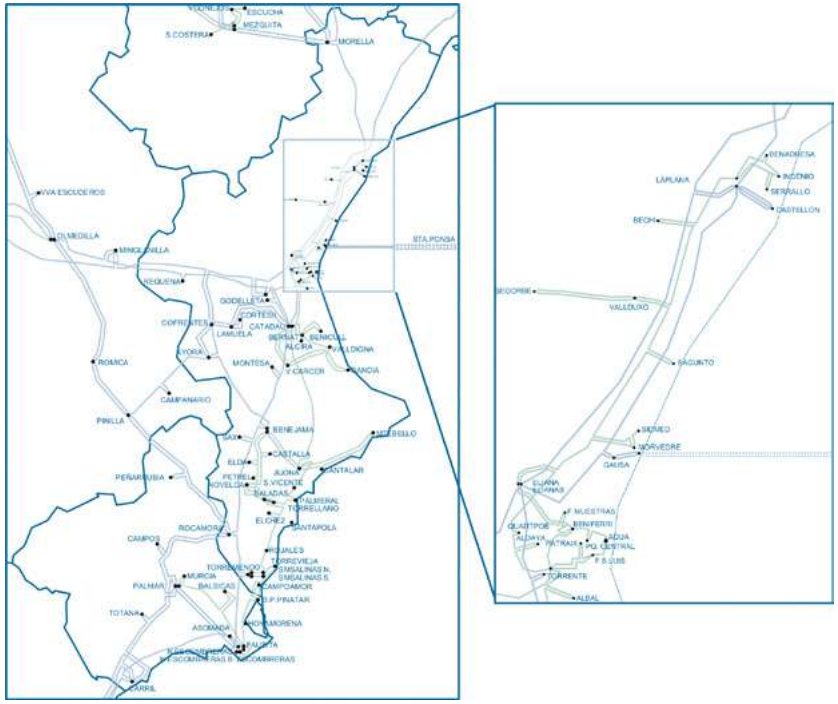
**I General description:** List planned reinforcements in Valencia and Murcia that are included in the starting grid according to the established criteria.

**I Drivers / Objectives:** To ensure that the reinforcements included in the 2015-2020 Transmission Network Development Plan are carried out, the commissioning of which is very likely to take place within the study horizon and whose specific motivations are detailed in the following tables.

**I Alternatives:** Following the Transmission Network Development Plan principles, alternatives to the reinforcements included in the starting grid were not evaluated.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_ESTE
## Starting grid **Valencia and Murcia**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:

Impact degree + -

| Environmental impact | Social impact |
|---|---|
| | |

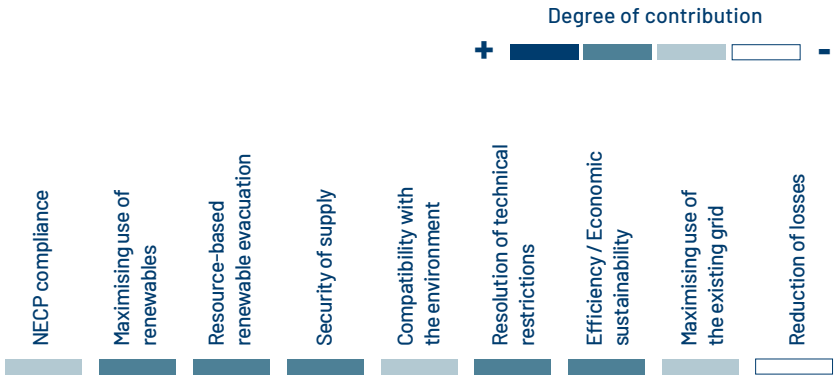
### I Costs:

| CAPEX | OPEX |
|---|---|
| 101.6 M€ | 1.39 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 9.6 | 9.5 | 9.3 | 9.2 | 9.0 | 8.9 | 8.7 | 8.6 | 8.5 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
**I: Staritng grid**
II: New reinforcements
III: Technical annexes

# I Reinforcement RDP_ESTE
## Starting grid **Valencia and Murcia**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 17 | 17 |
| Overhead line (km) | 18 | 42 |
| Cables (km) | 16 | |
| Uprating (km) | | 63 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Campos 400 kV | Outdoor. | 2023 |
| Castalla 220 kV | Outdoor. | 2022 |
| El Serrallo 220 kV | Building | 2022 |
| Elda 220 kV | Building | 2019 |
| Montesa 400 kV | Outdoor. | 2021 |

### I Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Ayora 400 kV | 2 | AIS | TN | 2020 |
| Beniferri 220 kV | 1 | GIS | TN | 2019 |
| Campos 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Campos 400 kV | 4 | AIS | TN | 2023 |
| Castalla 220 kV | 1 | AIS | SuD | 2022 |
| Castalla 220 kV | 3 | AIS | TN | 2022 |
| Cofrentes 400 kV | 1 | AIS | TN | 2023 |
| El Serrallo 220 kV | 2 | GIS | SuD | 2022 |
| El Serrallo 220 kV | 3 | GIS | TN | 2022 |
| Elda 220 kV | 3 | GIS | SuD | 2019 |
| Elda 220 kV | 3 | GIS | TN | 2019 |
| La Eliana 220 kV | 1 | GIS | TN | 2020 |
| Montesa 400 kV | 2 | AIS | Rail. | 2021 |
| Montesa 400 kV | 4 | AIS | TN | 2021 |
| Morella 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Totana 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Totana 400 kV | 1 | AIS | TN | 2023 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDP_ESTE
## Starting grid **Valencia and Murcia**

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Beniferri - La Eliana 220 kV, circuit 1 | 500 | 500 | 16 | Cable | SoS | 2021 |
| DC Ayora - Cofrentes 400 kV [1] | 2,334 | 2,030 | 20 | Line | RES | 2023 |
| I/O in Campos, of El Palmar - Rocamora 400 kV, circuit 1 [2] | 1,745 | 1,470 | 0.3 | Line | RES | 2023 |
| I/O in Castalla, of Novelda - Benejama 220 kV, circuit 1 [3] | 460 | 300 | 2 | Line | SuD | 2022 |
| I/O in El Serrallo, of El Ingenio - La Plana 220 kV, circuit 1 | 460 | 310 | 2 | Line | SuD | 2022 |
| I/O in Elda, of Benejama - El Petrel 220 kV, circuit 1 | 460 | 380 | 0.1 | Cable | SuD | 2022 |
| I/O in Elda, of Benejama - El Petrel 220 kV, circuit 1 | 460 | 380 | 5 | Line | SuD | 2022 |
| I/O in Montesa, of Catadau - Benejama 400 kV, circuit 1 | 1,670 | 1,490 | 0.6 | Line | Rail. | 2021 |
| El Serrallo - El Serrallo 220 kV [4] | | | 1 SSC | Cable | SuD | 2022 |

Notes:
1. Decommissioning of the current Ayora-Cofrentes 400kV line is required.
2. Section line capacity in DC for I/O 2240/1886 MVA.
3. Section line capacity in DC for I/O 874/748 MVA.
4. Short section of cable inside the substation.

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Cofrentes - Godelleta 400 kV, circuit 1 | 1,730 | 1,490 | 63 | Line | SoS | 2022 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement INT_ESP-POR
## International interconnections **Northern Spain-Portugal**

**I General description:**

The project consists of a new 400 kV interconnection between Spain and Portugal and the associated internal reinforcements in Spain for its integration into the existing grid:

- New Beariz 400 kV substation, with input-output in the Cartelle-Mesón do Vento 2 400 kV line.
- New Fontefría 400/220 kV substation with new transformer, 1 Fontefría 400/220 kV with 600 MVA.
- New double circuit Beariz- Fontefría 400 kV.
- New Fontefría 400 kV-Purtuguese Border line.

**I Drivers / Objectives:**

- Increasing the transfer capacity with Portugal to serve the Iberian Electricity Market (Mercado Ibérico de la Electricidad - MIBEL).
- Contributing to the integration of existing and future renewable energy in the Iberian Peninsula, avoiding curtailment.
- Improving the level of interconnection in Spain in order to comply with the objectives set by the EU.
- Complying with intergovernmental agreements from the Madrid Declaration.

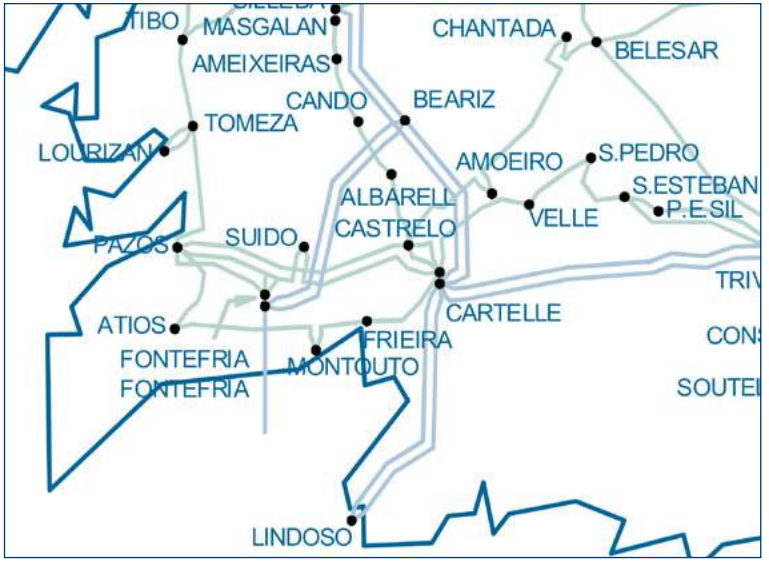
**I Alternatives:**

The reinforcements are presented as the most appropriate reinforcement for good flow distribution in the Spain-Portugal interconnection. The alternative parallel solutions studied in the Duero region do not allow for the expected exchange capacity gains. Alternative routes closer to the coast are not viable due to the increased social and environmental impact and submarine routes involve a much greater reinforcements cost.

**I European dimension:**

Yes / Project 4 from TYNDP 2020 and Project PIC 2.17 in the 2019 list.

**I Map:**




PLAN H2021-2026

| | Substations | Lines | Links |
|---|---|---|---|
| Starting Grid: | Name | 400 kV<br>220 kV<br>132 kV<br>66 kV<br>30 kV | 400 kV<br>132 kV<br>30 kV |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement INT_ESP-POR
International interconnections **Northern Spain-Portugal**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 22 M€/year | Reduction of $CO_2$ emissions: 150 kt/year* |
| Additional RES integration: 293,000 MWh/year | Reduction of system losses: -12,000 MWh/year* |
| Reduction of ENS: 766 MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 51.2 M€ | 0.82 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 5.0 | 4.9 | 4.8 | 4.7 | 4.7 | 4.6 | 4.5 | 4.5 | 4.4 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

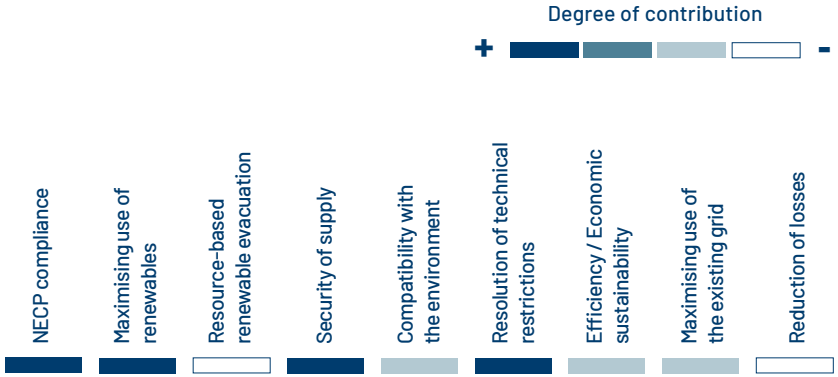
### I Profitability:

| Profitability: NPV |
|---|
| 365 M€ |

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# I Reinforcement INT_ESP-POR
## International interconnections **Northern Spain-Portugal**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 2 | 12 |
| Overhead line (km) | | 86 |
| Transformed to 220 kV (MVA) | | 600 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Beariz 400 kV | Outdoor. | 2024 |
| Fontefría 220 kV | Outdoor. | 2024 |
| Fontefría 400 kV | Outdoor. | 2024 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Beariz 400 kV | 6 | AIS | TN | 2024 |
| Fontefría 220 kV | 2 | AIS | TN | 2024 |
| Fontefría 400 kV | 6 | AIS | TN | 2024 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Beariz - Fontefría 400 kV | 2,391 | 2,034 | 30 | Line | INT | 2024 |
| DC Fontefría - Frontera Portuguesa 400 kV [1] | 1,784 | 1,517 | 22 | Line | INT | 2024 |
| I/O in Beariz, of Cartelle - Mesón do Vento 400 kV, circuit 1 | 1,779 | 1,513 | 2 | Line | INT | 2024 |

Notes:
1. Double circuit with first circuit laid out.

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Fontefría 400/220 kV, TF1 | 600 | Triph. B. | INT | 2024 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDL
## RES integration and resolution of technical constraints **Connection of renewables**

**I General description:** List the set of extensions planned when granting access in accordance with the fourth additional provision of RDL15/2018 (until 31 May 2020).

**I Drivers / Objectives:** Generation or storage connections at existing or planned substations in the 2015-2020 Transmission Network Development Plan.

**I Alternatives:** The reinforcements on the starting grid and potential alternatives were assessed during the creation of the Transmission Network Development Plan 2015-2020 or have been planned by means of the provisions of fourth additional provision of RDL 15/2018.

**I European dimension:** No

## Cost-Benefit Multi-Criteria Analysis

**I Benefits:**

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

**I Costs:**

| CAPEX | OPEX |
|---|---|
| 51.1 M€ | 11.27 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 15.4 | 15.4 | 15.3 | 15.2 | 15.1 | 15.1 | 15.0 | 14.9 | 14.9 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
**I: Staritng grid**
II: New reinforcements
III: Technical annexes

# I Reinforcement RDL
## RES integration and resolution of technical constraints **Connection of renewables**

### Cost-Benefit Multi-Criteria Analysis

**I Profitability:**

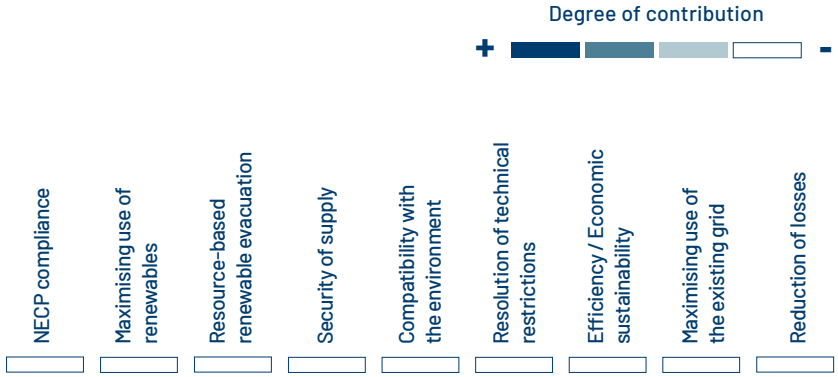
Profitability: NPV

- M€

**I Socio-environmental impact:**




**I Contribution to guiding principles:**




**I Table of physical units:**

| | 66 kV | 132 kV | 220 kV | 400 kV |
|---|---|---|---|---|
| Bays (units) | 9 | 6 | 160 | 123 |
| Cables (km) | | | 0.1 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

**I Detailed list of assets:**

| Substation extension | Uds. | Type. | Driv. | Year |
|---|---|---|---|---|
| Abades 400 kV | 1 | AIS | TN | 2024 |
| Abades 400 kV | 1 | AIS | Gen./Sto. | 2024 |
| Abegondo 220 kV | 1 | AIS | Gen./Sto. | 2024 |
| Abona 220 kV | 1 | GIS | TN | 2023 |
| Abona 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Aceca 220 kV | 1 | AIS | SuD | 2023 |
| Aena (Madrid) 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Aguayo 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Alarcos 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Albatarrec 220 kV | 1 | GIS | Gen./Sto. | 2022 |
| Alcocero de Mola 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Aldaia 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Algete 220 kV | 1 | GIS | Gen./Sto. | 2023 |

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## I Reinforcement RDL

RES integration and resolution of technical constraints **Connection of renewables**

### I Detailed list of assets (continued):

| Substation extension (cont.) | Uds. | Type. | Driv. | Year |
|---|---|---|---|---|
| Alhaurín 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Almaraz CN 400 kV | 1 | AIS | Gen./Sto. | 2021 |
| Almaraz E.T. 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Almendrales 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Almendrales 400 kV | 1 | AIS | TN | 2023 |
| Anchuelo 220 kV | 1 | AIS | Gen./Sto. | 2022 |
| Anchuelo 400 kV | 1 | AIS | Gen./Sto. | 2022 |
| Anchuelo 400 kV | 1 | AIS | TN | 2022 |
| Andújar 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Anoia 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Arbillera 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Arbillera 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Archidona 400 kV | 1 | AIS | TN | 2023 |
| Archidona 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Ardoz 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Arenas de San Juan 220 kV | 1 | AIS | Gen./Sto. | 2021 |
| Arganda 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Arroyo de la Vega 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Ascó 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Atarfe 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Ayora 400 kV | 1 | AIS | TN | 2023 |

| Substation extension (cont.) | Uds. | Type. | Driv. | Year |
|---|---|---|---|---|
| Ayora 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Balsicas 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Barcina 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Beariz 400 kV | 1 | AIS | TN | 2022 |
| Beariz 400 kV | 1 | AIS | Gen./Sto. | 2022 |
| Bechi 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Begues 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Belesar 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Belinchón 400 kV | 1 | AIS | Gen./Sto. | 2022 |
| Benadresa 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Benahavis 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Benejama 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Berja 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Bernat 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Boadilla 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Brazatortas 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Brovales 400 kV | 1 | AIS | Gen./Sto. | 2021 |
| Buenavista 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Cabra 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Camino de Fregacedos 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Can Jardi 220 kV | 1 | AIS | Gen./Sto. | 2023 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDL
## RES integration and resolution of technical constraints **Connection of renewables**

### I Detailed list of assets (continued):

| Substation extension (cont.) | Uds. | Type. | Driv. | Year |
|---|---|---|---|---|
| Caparacena 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Caparacena 400 kV | 1 | AIS | TN | 2023 |
| Cariñena 400 kV | 1 | AIS | Gen./Sto. | 2022 |
| Carmona 220 kV | 1 | GIS | Gen./Sto. | 2025 |
| Cártama 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Cártama 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Cartujos 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Casares N.P. 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Castalla 220 kV | 1 | AIS | Gen./Sto. | 2022 |
| Castejón 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Castellar de la Frontera 400 kV | 1 | AIS | Gen./Sto. | 2022 |
| Castellet 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Catadau 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Chucena 220 kV | 1 | AIS | Gen./Sto. | 2022 |
| Cisneros 220 kV | 1 | GIS | Gen./Sto. | 2024 |
| Cofrentes 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Cofrentes 400 kV | 1 | AIS | TN | 2023 |
| Complutum 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Compostilla 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Compostilla 400 kV | 1 | GIS | TN | 2023 |
| Compostilla 400 kV | 1 | GIS | Gen./Sto. | 2023 |

| Substation extension (cont.) | Uds. | Type. | Driv. | Year |
|---|---|---|---|---|
| Constanti 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Cordovilla 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Cristóbal Colón 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Daganzo 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Dos Hermanas 220 kV [1] | 1 | GIS | Gen./Sto. | 2023 |
| Dragonera 132 kV | 1 | AIS | Gen./Sto. | 2023 |
| Ébora 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| El Cantalar 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| El Cañuelo 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| El Palmeral 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| El Palo 400 kV | 1 | GIS | Gen./Sto. | 2023 |
| El Sequero 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Elche 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Elda 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Entrenúcleos 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Escatrón 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Escatrón 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Esquedas 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Fargue 220 kV | 1 | GIS | Gen./Sto. | 2023 |

Notes:
1. The current coupling position is reused for Generation/Storage. And a new coupling position is built.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

## I Reinforcement RDL
RES integration and resolution of technical constraints **Connection of renewables**

### I Detailed list of assets (continued):

| Substation extension (cont.) | Uds. | Type. | Driv. | Year |
|---|---|---|---|---|
| Fausita 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Fausita 400 kV | 1 | GIS | Gen./Sto. | 2023 |
| Fuencarral 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Fuencarral 400 kV | 1 | AIS | TN | 2023 |
| Fuencarral 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Fuendetodos 400 kV | 2 | GIS | Gen./Sto. | 2023 |
| Fuenlabrada 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Fuentes de la Alcarria 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Galapagar 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Garoña 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Garraf 400 kV | 1 | GIS | Gen./Sto. | 2023 |
| Gatica 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Gatica 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Gaussa 400 kV | 1 | GIS | Gen./Sto. | 2023 |
| Gazules 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Godelleta 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Godelleta 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Granadilla II 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Granadilla II 220 kV | 1 | GIS | TN | 2023 |
| Grijota 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Guadame 220 kV | 1 | AIS | Gen./Sto. | 2022 |

| Substation extension (cont.) | Uds. | Type. | Driv. | Year |
|---|---|---|---|---|
| Guadame 400 kV | 1 | AIS | TN | 2023 |
| Guadame 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Guillena 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Guillena 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Guillena 400 kV | 1 | AIS | TN | 2023 |
| Haro 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Herrera 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Herrera 400 kV | 1 | AIS | TN | 2023 |
| Inca 66 kV | 1 | AIS | Gen./Sto. | 2023 |
| Isona 220 kV | 1 | AIS | Gen./Sto. | 2025 |
| Isona 400 kV | 1 | AIS | Gen./Sto. | 2025 |
| Jordana 220 kV | 1 | GIS | Gen./Sto. | 2022 |
| Jordana 400 kV | 1 | GIS | Gen./Sto. | 2023 |
| Jose María de Oriol N.P. 220 kV | 1 | AIS | Gen./Sto. | 2021 |
| La Cereal 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| La Eliana 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| La Espluga 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| La Farga 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| La Fortuna 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| La Lomba 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| La Oliva 132 kV | 1 | GIS | TN | 2023 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

## I Reinforcement RDL
RES integration and resolution of technical constraints **Connection of renewables**

### I Detailed list of assets (continued):

| Substation extension (cont.) | Uds. | Type. | Driv. | Year |
|---|---|---|---|---|
| La Oliva 132 kV | 1 | GIS | Gen./Sto. | 2023 |
| La Plana 400 kV | 1 | AIS | TN | 2023 |
| La Plana 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| La Pobla de Segur 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| La Serna 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| La Solana 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| La Torrecilla 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Las Breñas 66 kV | 1 | GIS | Gen./Sto. | 2025 |
| Las Breñas 66 kV | 1 | GIS | TN | 2025 |
| Leganés 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Loeches 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Los Arenales 220 kV | 1 | AIS | Gen./Sto. | 2022 |
| Los Leones 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Los Montes 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Los Montes 220 kV | 1 | AIS | TN | 2023 |
| Los Pradillos 220 kV | 1 | GIS | Gen./Sto. | 2022 |
| Lousame 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Lucero 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Luengos 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Magallón 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Mangraners 220 kV | 1 | AIS | Gen./Sto. | 2023 |

| Substation extension (cont.) | Uds. | Type. | Driv. | Year |
|---|---|---|---|---|
| Manzanares 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Manzanares 400 kV | 1 | AIS | TN | 2023 |
| María 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Matas Blancas 132 kV | 1 | GIS | TN | 2023 |
| Matas Blancas 132 kV | 1 | GIS | Gen./Sto. | 2023 |
| Medina del Campo 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Meirama 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Mercadal 132 kV | 1 | AIS | Gen./Sto. | 2023 |
| Mesón Do Vento 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Mezquita 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Mirabal 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Miranda de Ebro 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Moncayo 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Montearenas 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Montesa 400 kV | 1 | AIS | Gen./Sto. | 2021 |
| Montesa 400 kV | 1 | AIS | TN | 2021 |
| Moraleja 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Moraleja 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Morata 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Morata 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Morata 400 kV | 1 | AIS | TN | 2023 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

## I Reinforcement RDL
RES integration and resolution of technical constraints **Connection of renewables**

### I Detailed list of assets (continued):

| Substation extension (cont.) | Uds. | Type. | Driv. | Year |
|---|---|---|---|---|
| Morvedre 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Mudarra 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Muruarte 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Muruarte 400 kV | 1 | AIS | TN | 2023 |
| Muruarte 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Novelda 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Olmedilla 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Olmedilla 220 kV [2] | 1 | AIS | TN | 2023 |
| Olmedo 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Olmedo 400 kV | 1 | AIS | TN | 2023 |
| Orcoyen 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Palencia 220 kV | 1 | AIS | Gen./Sto. | 2022 |
| Palos de la Frontera 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Palos de la Frontera 400 kV | 1 | GIS | Gen./Sto. | 2023 |
| Parla 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Parque Eólico Do Sil 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Penedés 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Peñaflor 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Peñaflor 400 kV | 1 | AIS | Gen./Sto. | 2022 |
| Peñaflor 400 kV | 1 | AIS | TN | 2022 |

| Substation extension (cont.) | Uds. | Type. | Driv. | Year |
|---|---|---|---|---|
| Peñarrubia 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Peñarrubia 400 kV | 1 | AIS | TN | 2023 |
| Perafort 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Pierola 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Pierola 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Pinar del Rey 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Pinar del Rey 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Pinto 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Pinto Ayuden 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Plasencia 220 kV | 1 | GIS | Gen./Sto. | 2022 |
| Prado de Santo Domingo 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Puigpelat 220 kV | 1 | GIS | Gen./Sto. | 2021 |
| Quereño 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Quintos 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Renedo 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Requena 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Requena 400 kV | 1 | AIS | TN | 2023 |
| Ricobayo 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Rocío 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Rojales 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Ronda 400 kV | 1 | AIS | Gen./Sto. | 2023 |

Notes:
2. Transversal position for the evolution of the double busbar configuration.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDL
## RES integration and resolution of technical constraints **Connection of renewables**

### I Detailed list of assets (continued):

| Substation extension (cont.) | Uds. | Type. | Driv. | Year |
|---|---|---|---|---|
| Rubí 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Rubí 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Rueda de Jalón 400 kV | 1 | AIS | Gen./Sto. | 2022 |
| Salas 400 kV | 1 | AIS | TN | 2023 |
| Salas 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Saleres 220 kV | 1 | AIS | Gen./Sto. | 2024 |
| San Pedro del Pinatar 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| San Sebastián de los Reyes 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| San Sebastián de los Reyes 400 kV | 1 | AIS | TN | 2023 |
| San Sebastián de los Reyes 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| San Serván 220 kV | 1 | AIS | Gen./Sto. | 2021 |
| Santa Águeda 66 kV | 1 | GIS | Gen./Sto. | 2022 |
| Santa Águeda 66 kV | 1 | GIS | TN | 2022 |
| Santa Elvira 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Santa Engracia 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Santa Engracia 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Santa Llogaia 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Santa Llogaia 400 kV | 1 | AIS | TN | 2023 |
| Santa María 66 kV | 1 | GIS | Gen./Sto. | 2023 |
| Santiponce 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Sax 400 kV | 1 | AIS | Gen./Sto. | 2023 |

| Substation extension (cont.) | Uds. | Type. | Driv. | Year |
|---|---|---|---|---|
| Sax 400 kV | 1 | AIS | TN | 2023 |
| Segovia 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Silleda 400 kV | 1 | AIS | Gen./Sto. | 2022 |
| Solorzano 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Son Orlandis 66 kV | 1 | AIS | Gen./Sto. | 2023 |
| Son Reus 66 kV | 2 | AIS | Gen./Sto. | 2023 |
| Tábara 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Tabernas 400 kV | 1 | AIS | TN | 2023 |
| Tabernas 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Tafalla 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Tajo de la Encantada 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Terrer 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Terrer 400 kV | 1 | AIS | TN | 2023 |
| Tomeza 220 kV | 1 | GIS | Gen./Sto. | 2022 |
| Tordesillas 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Torrejón de Velasco 400 kV | 2 | AIS | Gen./Sto. | 2025 |
| Torrejón de Velasco 400 kV | 1 | AIS | TN | 2025 |
| Torrellano 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Torremendo 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Torremendo 400 kV | 1 | AIS | TN | 2023 |
| Torrijos 220 kV | 1 | AIS | Gen./Sto. | 2022 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement RDL
## RES integration and resolution of technical constraints **Connection of renewables**

### I Detailed list of assets (continued):

| Substation extension (cont.) | Uds. | Type. | Driv. | Year |
|---|---|---|---|---|
| Tres Cantos Gis 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Trévago 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Trillo 400 kV | 1 | AIS | Gen./Sto. | 2022 |
| Trives 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Tudela 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Valdecarretas 400 kV | 1 | AIS | Gen./Sto. | 2021 |
| Valdemoro 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Vall D'Uxo 220 kV | 1 | AIS | Gen./Sto. | 2022 |
| Valladolid Nuevo 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Valle del Carcer 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Vallecas 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Vallitos 220 kV | 1 | GIS | TN | 2023 |
| Vallitos 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Vandellós 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Velilla 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Vic 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Vilecha 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Villalbilla 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Villameca 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Villanueva de Gallego 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Villarino 220 kV | 1 | AIS | Gen./Sto. | 2023 |

| Substation extension (cont.) | Uds. | Type. | Driv. | Year |
|---|---|---|---|---|
| Villarino de Conso 220 kV | 1 | AIS | Gen./Sto. | 2026 |
| Villaviciosa 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Villaviciosa 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Villaviciosa 400 kV | 1 | AIS | TN | 2023 |
| Virtus 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Vitoria 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Vitoria 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Xove 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Xove 400 kV | 1 | AIS | TN | 2023 |
| Zamora 220 kV | 1 | AIS | Gen./Sto. | 2022 |
| Zaratán 220 kV | 1 | AIS | Gen./Sto. | 2022 |
| Venta del Batán 220 kV | 1 | GIS | Gen./Sto. | 2023 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Daganzo - Daganzo 220 kV[1] | | | 1 SSC | Cable | Gen./Sto. | 2023 |

Notes:
1. Short section of cable inside the substation.

| Nuevas adecuaciones a PO | Year |
|---|---|
| Olmedilla 220 kV[1] | 2023 |

Notes:
1. Additional assets required to adjust to the Operational Procedure (O.P.)

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement OWNERSHIP
## Changes of ownership

**I General description:**

The reinforcements outline a series of changes in bay ownership in the transmission grid in favour of Red Eléctrica, as the only transmission system operator, specifically in relation to the Abrera 220 kV, Frieira 220 kV, La Torrecilla 220 kV, Monzón 220 kV, Besós 220 kV, La Serna 220 kV, Mahón 132 kV, and Punta Grande 66 kV substations.

**I Drivers / Objectives:**

- These reinforcements increase the reliability of transmission network assets, guarantying the security of supply. The main objective of the changes in ownership is to achieve high rates of availability in relation to transmission grid elements by applying unified criteria for maintenance and equipment upgrades, as well as facilitating interventions required while operating the grid, like line discharges.
- The proposed changes in ownership seek to achieve total fleet uniqueness in all affected substations, which allows higher rates of availability by facilitating discharges, interventions, and unified criteria for maintenance and equipment upgrades.

**I Alternatives:**

The potential alternative is to maintain current ownership of these bays, which would result in higher rates of unavailability and reduced security of supply.

As in other cases, like demand-side supply reinforcements, consumers directly connected to the transmission network or the reinforcements needed to guarantee the security of supply, the CBA methodology is difficult to apply when it comes to monetising the benefits of this reinforcements.

**I European dimension:** No

**I Map:**




PLAN H2021-2026

| | Substations | Lines | Links |
|---|---|---|---|
| Starting Grid: | Name | 400 kV<br>220 kV<br>132 kV<br>66 kV<br>30 kV | 400 kV<br>132 kV<br>30 kV |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes

# I Reinforcement OWNERSHIP
## Changes of ownership

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| - M€ | 0.44 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |

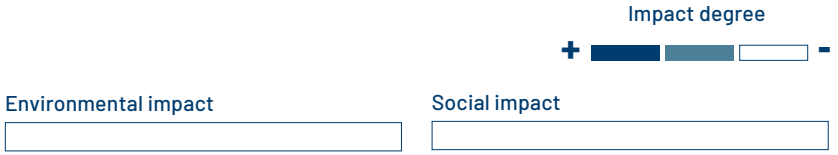
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

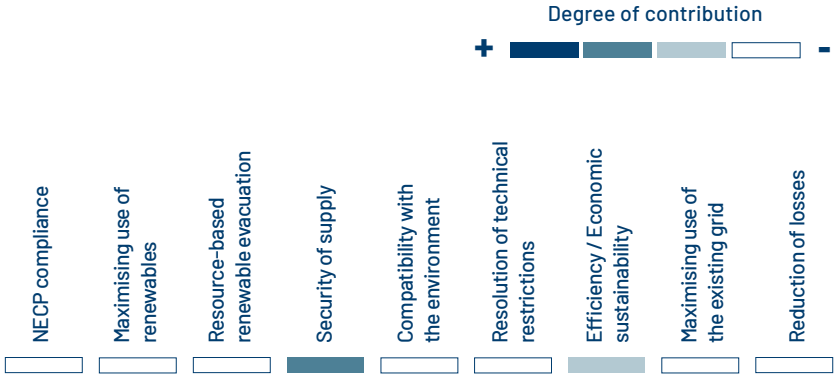
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# I Reinforcement OWNERSHIP
## Changes of ownership

### I Table of physical units:

| | 66 kV | 132 kV | 220 kV | 400 kV |
|---|---|---|---|---|
| Bays (units) | 1 | 2 | 9 | 1 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| Changes in the ownership of bays | Uds | Type. | Driv. | Year |
|---|---|---|---|---|
| Besos Nuevo 220 kV | 1 | GIS | TN | 2021 |
| El Sequero 220 kV | 1 | AIS | TN | 2026 |
| Frieira 220 kV | 1 | AIS | TN | 2022 |
| La Robla 400 kV | 1 | AIS | TN | 2026 |
| La Serna 220 kV | 1 | AIS | TN | 2021 |
| La Torrecilla 220 kV | 1 | GIS | TN | 2022 |
| Mahón 132 kV | 2 | GIS | TN | 2021 |
| Meirama 220 kV | 1 | AIS | TN | 2026 |
| Monzón 220 kV | 2 | AIS | TN | 2021 |
| Punta Grande 66 kV | 1 | AIS | TN | 2021 |
| Quel 220 kV | 1 | AIS | TN | 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

**I: Staritng grid**

II: New reinforcements

III: Technical annexes



# Annexes
# II: New reinforcements

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes



# TABLE OF CONTENTS

**REINFORCEMENTS FOR THE 2021-2026 TIMEFRAME**

**Assets Renewal**

RdT_RENOVE. Transmission Assets Renewal

**Operational requirements**

AUT24. Service replenishment plan: 24 hour autonomy requirement

COMP_ICA. Support to renewable integration with synchronous condensers

DESP_TELE. Tele-control systems and control centres

FACTS. Transmission network support with FACTS

PEN_REAS. Reactances for voltage control in SEPE

TNP_REAS. Reactance for voltage control in the Islas Baleares

**Railway line power supply**

AF_01. Bobadilla-Algeciras

AF_02. Burgos-Vitoria

AF_04. Granada-Almería

AF_05. Madrid-Albacete-Alicante-Valencia

AF_06. Murcia-Almería

AF_07. Murcia-Cartagena

AF_08. Palencia-Santander

AF_09. Puertollano-Mérida

AF_10. Sevilla-Huelva

AF_11. Toledo-Navalmoral-Cáceres-Badajoz

AF_12. Vigo-Orense-Lugo-A Coruña

AF_13. Zaragoza-Teruel-Sagunto

AF_14. Alicante-Crevillente

**Distribution network support**

APD-AND: Distribution network support in Andalucía

APD-ARA: Distribution network support in Aragón

APD-AST: Distribution network support in Asturias

APD-CAN: Distribution network support in Cantabria

APD-CAT: Distribution network support in Cataluña

APD-CLM: Distribution network support in Castilla-La Mancha

APD-CVA: Distribution network support in Valencia

APD-CYL: Distribution network support in Castilla y León

APD-EXT: Distribution network support in Extremadura

APD-GAL: Distribution network support in Galicia

APD-IBA: Distribution network support in Islas Baleares

APD-ICA: Distribution network support in Islas Canarias

APD-MAD_1: Distribution network support in Madrid

APD-MAD_2: Distribution network support in East Madrid. Henares corridor



APD-MUR: Distribution network support in Murcia

APD-NAV: Distribution network support in Navarra

APD-PVA: Distribution network support in País Vasco

APD-RIO: Distribution network support in La Rioja

**Supply of consumers connected to TN**

CONSUM: Consummers connected to the transmission network

**International interconnections**

INT_ESP-FRA_1: Interconnection Spain-France via the Bay of Biscay

INT_ESP-FRA_2: Reinforcement of the Spain - France interconnection (Gatica)

INT_ESP-FRA_3: Reinforcement of the Spain-France (Hernani-Argia)

INT_ESP-MAR: Interconnection with Morocco

INT_ESP_AND: Interconnection with Andorra

**Links between systems**

ENL_PEN-IBA: Reinforcement of interconnection between the Spanish mainland and the Islas Baleares

ENL_IBA: IB-FO: Ibiza-Formentera 132 kV links

ENL_ICA: TE-LG: Tenerife-La Gomera links

ENL_PEN-CEU: Spanish Mainland-Ceuta links

**RES integration and resolution of technical constraints**

PEN_USO_TN: Increased use of the Transmission Network

CENTRO_1: La Mancha-Madrid Corridor

CENTRO_2:Reinforcement Andalucía - Extremadura - Madrid Corridor

ESTE_1: New Aragón-Levante Corridor

ESTE_2: Connection at Abanilla

ICA_1: Reinforcement of the north-south axis of Gran Canaria

ICA_2: Reinforcement of the north-south axis in the east of Tenerife

ICA_3: Reinforcement of the southern axis Tenerife and new San Isidro

N_ESTE_1: Aragón-Navarra Reinforcement

N_ESTE_2: Aragón - Southern Cataluña Reinforcement

N_ESTE_3: Aragón - Central Cataluña Reinforcement

N_ESTE_4: Connection at Almendrales 400 kV

N_ESTE_5: Topological modification of the Pyrenean network

N_ESTE_6: New Isona 400/220 kV substation

N_OESTE_1: Asturias 400 kV Reinforcement

N_OESTE_2: Connection at Briviesca

N_OESTE_3: Connection at Villalbilla

N_OESTE_4: Connection at Urueña

N_OESTE_5: Connection at Piedrahita

N_OESTE_6: Connection at Abegondo

N_OESTE_7: Reinforcement of the Soria network

NORTE_1: New Navarra - País Vasco axis

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes



SUR_1: New corridors in Andalucía

GEN_ALM: Connection of renewables and storage

**Security of Supply**

SdS_CENTRO: Reliability of supply Madrid

SdS_CENTRO_Pcc: Reliability of supply Madrid (Short Circuit Current)

SdS_IBA_1: Reinforcement of the southern network of the island of Ibiza

SdS_IBA_2: Dynamic Line Rating at Llucmajor-Orlandis 66 kV

SdS_ICA_1: Reinforcement of Tenerife West Ring

SdS_ICA_2: Reinforcement of La Palma network

SdS_ISLAS: Increased security of supply in non-peninsular systems

SdS_N_ESTE: Refurbishment of Cinca 220 kV

SdS_N_ESTE_Pcc: Topological modification in Gramanet (Short Circucit Current)

SdS_N_OESTE: New Substation Abades 400 kV (Formerly Herreros)

SdS_SUR_1: Supply reinforcement in Huelva (Costa de la Luz)

SdS_SUR_2: Puerto de Santa María 220 kV

SdS_SUR_3: Reliability of supply in Saleres

SdS_SUR_Pcc: Double bus in Don Rodrigo

## REINFORCEMENTS APPROVED BY MODIFICATION OF SPECIFIC ITEMS

MAP_CONSUM: New consummers connected to the transmission network

MAP_ALM_GEN: New Connection of renewables and storage

MAP_NFT: Connecting nodes to ensure fair transition

MAP_OS: New operational requirements

MAP25_NOS_TENSION_SEPE: Elements for voltage control in SEPE

MAP25_NOS_TENSION_TNP: Elements for voltage control in NPT

MAP25_NOS_REPOSICION: Power service restoration plan

MAP25_NOS_SEC_GEN: Emergency generation in Islas Canarias

## REINFORCEMENTS BEYOND THE 2026 HORIZON

**Introduction**

**List of reinforcements with commissioning beyond 2026**

**Reinforcement sheets of the interconnection with France with commissioning after 2026**

INT_ESP-FRA_4: Spain-France interconnection between Navarra and Landes

INT_ESP-FRA_5: Spain-France via the Aragón Pyrenees-Atlantic Pyrenees

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement RdT_RENOVE: Transmission Assets Renewal

**I General description:**

Following an analysis of the proposals for upgrades to transmission grid assets, sent both by Red Eléctrica Spain and Unión Fenosa, those proposals that were deemed a priority in terms of environmental impact as well as impact on the security of supply in the 2026 study scenario have been included in the plan. The plan takes into account both total upgrades with the commissioning and decommissioning of transmission grid elements (cables, substation bays, transformers, and reactances), and upgrades of individual line components and substations bays.

**I Drivers / Objectives:**

- To improve the security of supply by increasing the reliability of the components of the transmission network.
- To mitigate the potential environmental impact as a consequence of possible incidents in the network components.

**I Alternatives:**

The alternative of delaying the equipment upgrades proposed by the transmission companies until subsequent plans has been assessed, prioritising those upgrades for which the delay would have a greater impact on the environment and security of supply based on the 2026 scenario.

**I European dimension:**

No

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 407.5 M€ | 1.51 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 34.4 | 33.9 | 33.3 | 32.7 | 32.2 | 31.6 | 31.0 | 30.5 | 29.9 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement RdT_RENOVE: Transmission Assets Renewal

## I Profitability:

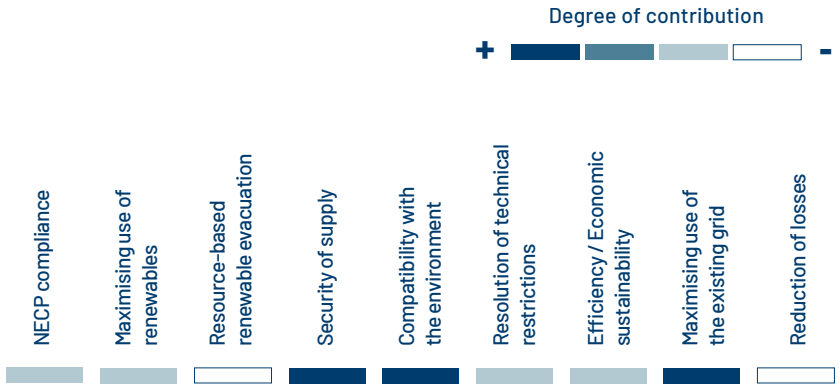
Profitability: NPV

- M€

## I Socio-environmental impact:




## I Contribution to guiding principles:




## I Table of physical units:

| | 66 kV | 220 kV | 400 kV |
|---|---|---|---|
| Total renewal of bays (units) | 6 | 13 | 10 |
| Partial renewal of bays (units) | 9 | 96 | 49 |
| Total renewal of overhead lines (km) | 21 | | |
| Partial renewal of overhead lines (km) | | 378 | 201 |
| Cables (km) | 0.4 | 0.4 | 0.1 |
| Total renewal of cables (km) | | 32 | |
| Total renewal of 220 kV transformers (MVA) | | | 4,200 |
| Total renewal of reactances (MVAr) | | | 150 |
| Overhead line (km) | | 46 | 7 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## I Detailed list of assets:

| Total renewal of bays | units | Type | Driv. | Year |
|---|---|---|---|---|
| Chayofa 66 kV [1] | 6 | GIS | RenovTN | 2025 |
| Litoral 400 kV | 10 | GIS | RenovTN | 2024 |
| Mataporquera 220 kV [1] | 6 | GIS | RenovTN | 2024 |
| Norte 220 kV | 7 | GIS | RenovTN | 2023 |

Notes:
1. Replacement with change to GIS double busbar configuration.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# I Reinforcement RdT_RENOVE:
## Transmission Assets Renewal

### I Detailed list of assets (continued):

| Partial renewal of bays | units | Type | Driv. | Year |
|---|---|---|---|---|
| Almaraz CN 220 kV | 3 | AIS | RenovTN | 2022 |
| Almaraz CN 220 kV | 4 | AIS | RenovTN | 2023 |
| Almaraz CN 400 kV | 1 | AIS | RenovTN | 2022 |
| Almaraz CN 400 kV | 4 | AIS | RenovTN | 2023 |
| Ayala 220 kV | 1 | AIS | RenovTN | 2023 |
| Catadau 400 kV | 3 | AIS | RenovTN | 2023 |
| Cofrentes 400 kV | 5 | AIS | RenovTN | 2023 |
| Gatica 220 kV | 4 | AIS | RenovTN | 2022 |
| Gatica 220 kV | 1 | AIS | RenovTN | 2023 |
| Gatica 400 kV | 6 | AIS | RenovTN | 2022 |
| Gatica 400 kV | 1 | AIS | RenovTN | 2023 |
| Grado 220 kV | 1 | AIS | RenovTN | 2023 |
| Grijota 400 kV | 3 | AIS | RenovTN | 2023 |
| Guadame 220 kV | 5 | AIS | RenovTN | 2022 |
| Guadame 220 kV | 3 | AIS | RenovTN | 2023 |
| Guadame 400 kV | 5 | AIS | RenovTN | 2022 |
| Güeñes 400 kV | 3 | AIS | RenovTN | 2023 |
| Guillena 220 kV | 1 | AIS | RenovTN | 2022 |
| Guillena 400 kV | 5 | AIS | RenovTN | 2022 |
| Itxaso 220 kV | 7 | AIS | RenovTN | 2023 |
| Itxaso 220 kV | 4 | AIS | RenovTN | 2022 |

| Partial renewal of bays | units | Type | Driv. | Year |
|---|---|---|---|---|
| Marratxí 66 kV | 3 | AIS | RenovTN | 2022 |
| Marratxí 66 kV | 6 | AIS | RenovTN | 2023 |
| Mediano 220 kV | 1 | AIS | RenovTN | 2023 |
| Mérida 220 kV | 1 | AIS | RenovTN | 2022 |
| Mesón Do Vento 220 kV | 9 | AIS | RenovTN | 2022 |
| Mesón Do Vento 220 kV | 1 | AIS | RenovTN | 2023 |
| Moraleja 220 kV | 2 | AIS | RenovTN | 2022 |
| Peñaflor 220 kV | 10 | AIS | RenovTN | 2026 |
| Pinar del Rey 220 kV | 7 | AIS | RenovTN | 2023 |
| Pinar del Rey 220 kV | 7 | AIS | RenovTN | 2022 |
| San Sebastián de los Reyes 220 kV | 6 | AIS | RenovTN | 2022 |
| Santiponce 220 kV | 6 | AIS | RenovTN | 2022 |
| Santiponce 220 kV | 3 | AIS | RenovTN | 2023 |
| Sentmenat 220 kV | 1 | AIS | RenovTN | 2023 |
| Tajo de la Encantada 400 kV | 2 | AIS | RenovTN | 2023 |
| Trillo 400 kV | 6 | AIS | RenovTN | 2023 |
| Vic 400 kV | 4 | AIS | RenovTN | 2022 |
| Vic 400 kV | 1 | AIS | RenovTN | 2023 |
| Villanueva de Gállego 220 kV | 6 | AIS | RenovTN | 2026 |
| Villaviciosa 220 kV | 2 | AIS | RenovTN | 2022 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement RdT_RENOVE: Transmission Assets Renewal

## I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Albal - Catadau 220 kV | | | 9 | Line | RenovTN | 2026 |
| Albal - Catadau 220 kV | | | 3 | Cable | RenovTN | 2026 |
| Alcocero de Mola - Puentelarra 220 kV | | | 0.6 | Line | RenovTN | 2025 |
| Alcocero de Mola - Villimar 220 kV | | | 2 | Line | RenovTN | 2025 |
| Aldaia - Quart de Poblet 220 kV | | | 2 | Line | RenovTN | 2023 |
| Aldaia - Quart de Poblet 220 kV | | | 0.6 | Cable | RenovTN | 2023 |
| Aldaia - Torrente 220 kV | | | 3 | Line | RenovTN | 2026 |
| Aldaia - Torrente 220 kV | | | 3 | Cable | RenovTN | 2026 |
| Arkale - Frontera Francesa 220 kV [1] | | | 5 | Line | RenovTN | 2023 |
| Arkale - Arkale 220 kV [2] | | | 1 SSC | Cable | RenovTN | 2023 |
| Bechi - Vall D'Uxo 220 kV | | | 2 | Line | RenovTN | 2025 |
| Bechi - Vall D'Uxo 220 kV | | | 0.7 | Cable | RenovTN | 2025 |
| Bechi - La Plana 220 kV | | | 5 | Line | RenovTN | 2026 |
| Chayofa - Chayofa 66 kV, cto [3] | | | 7 SSC | Cable | RenovTN | 2025 |
| Elgea - Itxaso 220 kV [1] | | | 4 | Line | RenovTN | 2025 |
| Güeñes - T Güeñes 220 kV [1] | | | 2 | Line | RenovTN | 2025 |
| Litoral - Litoral 400 kV [2] | | | 1 SSC | Cable | RenovTN | 2024 |
| Maials - Rubí 400 kV [4] | | | 7 | Line | RenovTN | 2026 |
| Mataporquera - Mataporquera 220 kV [3] | | | 5 SSC | Cable | RenovTN | 2024 |
| Rubí - Villadecans 220 kV [4] | | | 6 | Line | RenovTN | 2026 |
| Sagunto - Vall D'Uxo 220 kV | | | 2 | Line | RenovTN | 2026 |
| Sagunto - Vall D'Uxo 220 kV | | | 0.4 | Cable | RenovTN | 2026 |
| Villalbilla - T de Ayala 220 kV | | | 2 | Line | RenovTN | 2025 |
| Villalbilla - T de Ayala 220 kV | | | 0.8 | Cable | RenovTN | 2025 |
| Villalbilla - Villimar 220 kV | | | 3 | Line | RenovTN | 2025 |
| Villalbilla - Villimar 220 kV | | | 0.6 | Cable | RenovTN | 2025 |

Notes:
1. Route modification.
2. Short section of cable inside the substation.
3. Short section of cable inside the substation.
4. New specific route to complete the upgrades.

| Total renewal of lines/cables | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|
| Badalona - Guixeres 220 kV, circuit 1 | 5 | Cable | RenovTN | 2023 |
| Badalona - La Sagrera 220 kV, circuit 1 | 4 | Cable | RenovTN | 2023 |
| Bunyola - Inca 66 kV, circuit 1 [1] | 21 | Line | RenovTN | 2024 |
| Casa de Campo - Manuel Becerra 220 kV, circuit 1 | 9 | Cable | RenovTN | 2023 |
| DC Aena (Madrid) - Hortaleza 220 kV | 2 | Cable | RenovTN | 2023 |
| Hortaleza - San Sebastián de los Reyes 220 kV, circuit 1 | 1 | Cable | RenovTN | 2023 |
| Manuel Becerra - Prosperidad 220 kV, circuit 1 | 3 | Cable | RenovTN | 2023 |
| Maragall - La Sagrera 220 kV, circuit 1 | 3 | Cable | RenovTN | 2023 |
| Prosperidad - Hortaleza 220 kV, circuit 1 | 4 | Cable | RenovTN | 2023 |

Notes:
1.Transmission capacity with conductor installed at 85º

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement RdT_RENOVE: Transmission Assets Renewal

## I Detailed list of assets (continued):

| Partial renewal of lines/cables | km(±10%) | Type | Driv. | Year |
|---|---|---|---|---|
| Albal - Catadau 220 kV, circuit 1 [1] | 16 | Line | RenovTN | 2026 |
| Albal - Torrente 220 kV, circuit 1 [1] | 3 | Line | RenovTN | 2023 |
| Alcocero de Mola - Puentelarra 220 kV, circuit 1 [2] | 40 | Line | RenovTN | 2025 |
| Alcocero de Mola - Villimar 220 kV, circuit 1 [2] | 28 | Line | RenovTN | 2025 |
| Aldaia - Quart de Poblet 220 kV, circuit 1 [3] | 3 | Line | RenovTN | 2023 |
| Aldaia - Torrente 220 kV, circuit 1 [3] | 9 | Line | RenovTN | 2026 |
| Arkale - Frontera Francesa 220 kV, circuit 1 [4] | 9 | Line | RenovTN | 2023 |
| Bechi - La Plana 220 kV, circuit 1 [1] | 8 | Line | RenovTN | 2026 |
| Bechi - Vall D'Uxo 220 kV, circuit 1 [1] | 13 | Line | RenovTN | 2025 |
| Villalbilla - T de Ayala 1220 kV, circuit 1 [4] | 47 | Line | RenovTN | 2025 |
| Villalbilla - Villimar 220 kV, circuit 1 [5] | 11 | Line | RenovTN | 2025 |
| Elgea - Itxaso 220 kV, circuit 1 [4] | 28 | Line | RenovTN | 2025 |
| Godelleta - Torrente 220 kV, circuit 1 [6] | 1 | Line | RenovTN | 2024 |
| Güeñes - T de Güeñes 220 kV, circuit 1 [4] | 11 | Line | RenovTN | 2025 |
| Guillena - Mérida 220 kV, circuit 1 [4] | 95 | Line | RenovTN | 2026 |
| La Eliana - Morvedre B 220 kV, circuit 1 [3] | 18 | Line | RenovTN | 2026 |
| Maials - Mequinenza 400 kV, circuit 1 [5] | 20 | Line | RenovTN | 2026 |
| Maials - Rubí 400 kV, circuit 1 [5] | 132 | Line | RenovTN | 2026 |
| Rubí - Viladecans 220 kV, circuit 1 [4] | 18 | Line | RenovTN | 2026 |
| Sagunto - Vall D'Uxo 220 kV, circuit 1 [3] | 16 | Line | RenovTN | 2026 |

| Partial renewal of lines/cables | km(±10%) | Type | Driv. | Year |
|---|---|---|---|---|
| Valladolid Nuevo - Zaratán 220 kV, circuit 2 [6] | 5 | Line | RenovTN | 2023 |
| Vic - Frontera Francesa 400 kV, circuit 1 [4] | 49 | Line | RenovTN | 2026 |

Notes:
1. Upgrading sections of overhead line without replacing transmission towers. Same design temperature as that currently in place.
2. When upgraded with a change in transmission towers, the entire line will be repowered at 85 ºC.
3. This does not include upgrading the underground cable. Upgrading sections of overhead line without replacing transmission towers. Same design temperature as that currently in place.
4. Upgrading sections of overhead line by replacing transmission towers with a design temperature of 85 ºC.
5. When upgraded with a change in transmission towers, the entire line will be repowered at 85 ºC.
6. Upgrading sections of overhead line, including replacement of transmission towers. Same design temperature as that currently in place.

| Total renewal of transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Aguayo 400/220 kV, TF1 | 600 | Triph. B. | RenovTN | 2023 |
| Can Jardi 400/220 kV, TF4 | 600 | Triph. B. | RenovTN | 2024 |
| Gatica 400/220 kV, TF1 | 600 | Triph. B. | RenovTN | 2023 |
| Guadame 400/220 kV, TF1 | 600 | Triph. B. | RenovTN | 2023 |
| Montearenas 400/220 kV, TF2 | 600 | Triph. B. | RenovTN | 2024 |
| Moraleja 400/220 kV, TF1 | 600 | Triph. B. | RenovTN | 2024 |
| Vic 400/220 kV, TF9 | 600 | Triph. B. | RenovTN | 2024 |

| Total renewal of reactances | MVAr | Type | Driv. | Year |
|---|---|---|---|---|
| Herrera 400 kV, REA2 | 150 | - | RenovTN | 2024 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement AUT24

## Operational requirements

## Service replenishment plan: 24 hour autonomy requirement

**General description:**

The proposed reinforcements will provide 100-200 kVA generator sets with 24-hour autonomy in:

- Substations considered to be essential for service restoration that do not have this capability.
- Voice communication systems between the system operator and agents involved in emergency and restoration plans, belonging to the system operator.
- The system operator's critical tools that are involved in the emergency and restoration plans.

**Drivers / Objectives:**

Adaptation to the transmission grid in order to comply with the European network code, 'Network Code Emergency and Restoration', which regulates emergency situations and service restoration to the electricity system. This code came into force on the 18 December 2017 and compliance is mandatory by 18 December 2022.

**Alternatives:**

The use of batteries has been assessed as an alternative. 48 Vcc batteries have been ruled out due to incompatibility with the existing installations. 125 Vcc batteries and 125 Vcc/48 Vcc converters have also been assessed and were found to be more costly and would require a complete change in equipment and systems at existing installations.

**European dimension:**

No

## Cost-Benefit Multi-Criteria Analysis

**Benefits:**

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

**Costs:**

| CAPEX | OPEX |
|---|---|
| 15.7 M€ | 0.28 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement AUT24

## Operational requirements

## Service replenishment plan: 24 hour autonomy requirement

### Profitability:

Profitability: NPV

- M€

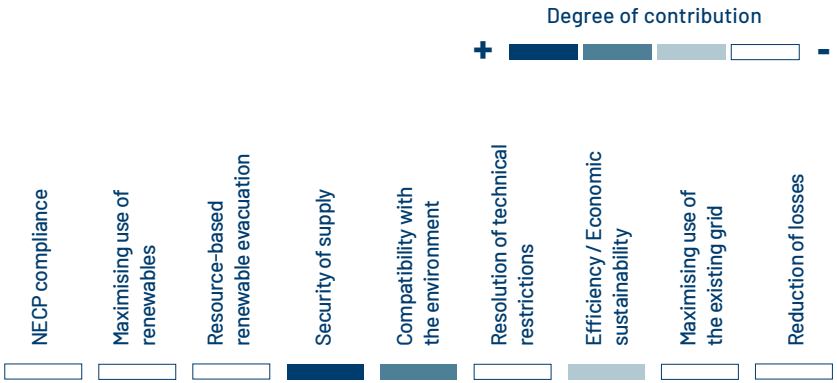
### Socio-environmental impact:




Environmental impact

Social impact

### Contribution to guiding principles:




### Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| 24 hour autonomy equipment (units) | 172 | 448 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| 24 hour autonomy equipment | units | Driv. | Year |
|---|---|---|---|
| Península 220 kV | 172 | N_S0 | 2022 |
| Península 400 kV | 448 | N_S0 | 2022 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement COMP_ICA

## Operational requirements

## Support to renewable integration with synchronous condensers

**I General description:**

The reinforcements consist of installing three synchronous condensers, each one 25 MVAr, as integral parts of the transmission grid, in accordance with that stipulated in Royal Decree-Law 29/2021, in Islas Canarias systems in the Drago 66 kV (Tenerife), Arucas 66 kV (Gran Canaria), and Jares 132 kV (Fuerteventura) substations.

**I Drivers / Objectives:**

- Provide short-circuit power to systems, incorporating short-circuit current injections into additional nodes to those with synchronous power generation.
- Enable greater access capacity to substation power modules by separating areas impacted by electricity provided through short-circuit power.
- Reduce interaction between electrical power systems of renewable energy generators in the region.

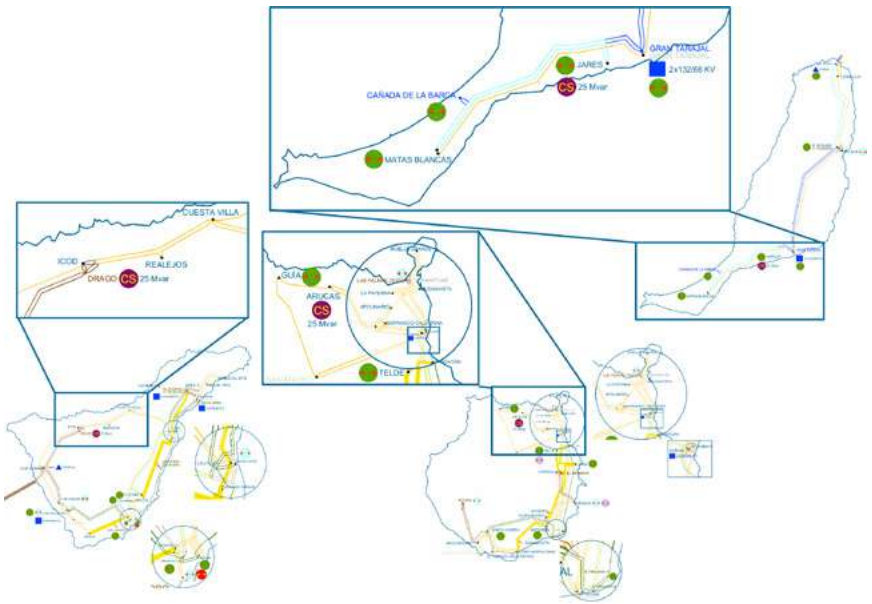
**I Alternatives:**

The alternative of not installing these synchronous condensers would result in limited renewable energy generation in practically all islands in which there are connections to guarantee security of supply due to the risk of interaction between electrical power systems of renewable energy generators.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement COMP_ICA
## Operational requirements
## Support to renewable integration with synchronous condensers

### Cost-Benefit Multi-Criteria Analysis

#### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 255.2 M€/year | Reduction of $CO_2$ emissions: 1,121 kt/year* |
| Additional RES integration: 1,687.975 MWh/year | Reduction of system losses: 257 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

#### I Costs:

| CAPEX | OPEX |
|---|---|
| 46.1 M€ | 0.97 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 4.7 | 4.6 | 4.6 | 4.5 | 4.4 | 4.4 | 4.3 | 4.2 | 4.2 |

Note: for the Tenerife-La Gomera system, a sequential cost-benefit analysis methodology was used. Firstly, the incorporation of synchronous condensers is analysed. Then, there is an assessment of the benefit of the rest of the scheduled reinforcements except for the TF-LG link, for which the benefit is analysed at a later stage considering the rest of the commissioning reinforcements.

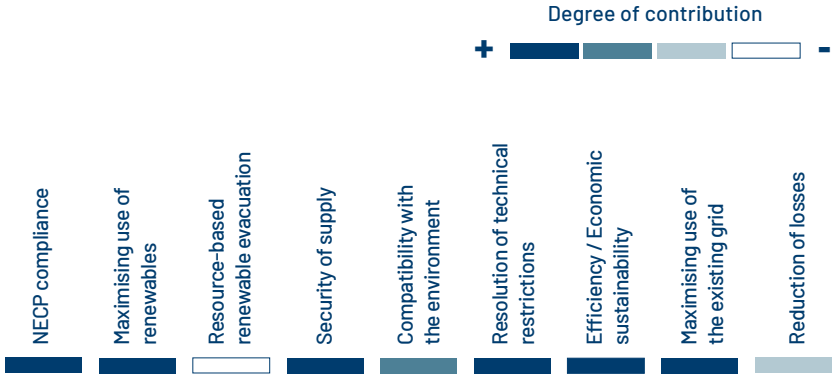
#### I Profitability:

| Profitability: NPV |
|---|
| 5,030 M€ |

#### I Socio-environmental impact:




#### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement COMP_ICA

## Operational requirements

## Support to renewable integration with synchronous condensers

### Table of physical units:

| | 66 kV | 132 kV |
|---|---|---|
| Bays (units) | 2 | 1 |
| Cables (km) | 1 | 0.5 |
| Synchronous condensers (MVAr) | 50 | 25 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Arucas 66 kV | 1 | AIS | TN | 2024 |
| Drago 66 kV | 1 | GIS | TN | 2024 |
| Jares 132 kV | 1 | GIS | TN | 2024 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Arucas - Arucas 66 kV [1] | | | 1 SSC | Cable | TN | 2024 |
| Drago - Drago 66 kV [1] | | | 1 SSC | Cable | TN | 2024 |
| Jares - Jares 132 kV [1] | | | 1 SSC | Cable | TN | 2024 |

Notes:
1. Short section of cable inside the substation.

| New synchronous condensers | MVAr | Type | Driv. | Year |
|---|---|---|---|---|
| Arucas 66 kV, CS1 | 25 | - | N_SO | 2024 |
| Drago 66 kV, CS1 | 25 | - | N_SO | 2024 |
| Jares 132 kV, CS1 | 25 | - | N_SO | 2024 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement DESP_TELE
## Operational requirements **Tele-control systems and control centre**

**General description:** The proposed reinforcements consist of the installation of remotely-controlled systems and offices and their telecommunication requirements. The purpose of these reinforcements is to guarantee the operability of their installations and of the transmission system as a whole, ensuring supply reliability. They consist of:

- New, remotely-controlled bays.
- Telecommunications systems.
- Remote control and security systems.
- Protection systems.

**Drivers / Objectives:**

- Remotely-control installations in the transmission grid, integrating them into the centralised management, communication, and monitoring office for these assets.
- Digitalisation of the transmission grid to develop the most efficient and safe technologies.
- Update protection systems with analogue technology, thus avoiding spare part shortages, as well as insufficient technical support from manufacturers.

**Alternatives:** New bays scheduled must be managed from the offices, with the alternative being local management, which entails greater costs and risks to security of supply. Not updating or digitalising the rest of the protection and telecommunications systems would result in their gradual deterioration and isolation issues in the event of grid faults.

**European dimension:** No

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Costs:

| CAPEX | OPEX |
|---|---|
| 232 M€ | - M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 18.7 | 18.4 | 18.1 | 17.8 | 17.4 | 17.1 | 16.8 | 16.5 | 16.2 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement DESP_TELE
## Operational requirements **Tele-control systems and control centre**

### I Profitability:

Profitability: NPV

- M€

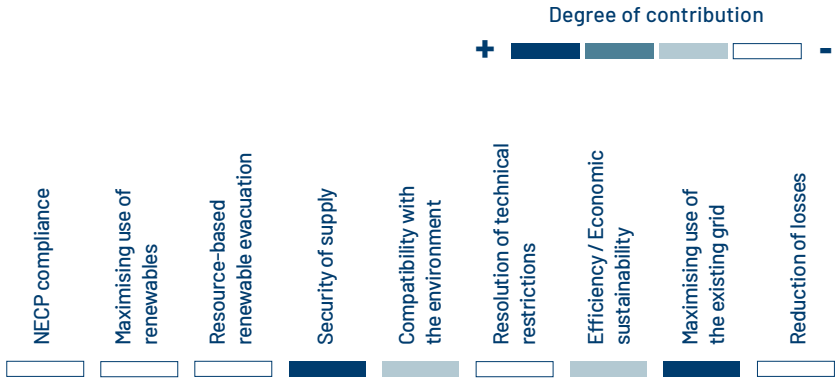
### I Detailed list of assets:

| Tele-control systems and control centre | (M€) | Driv. | Year |
|---|---|---|---|
| Tele-control systems and control centre | 33.6 | N_SO | 2021 |
| Tele-control systems and control centre | 45.6 | N_SO | 2022 |
| Tele-control systems and control centre | 44.1 | N_SO | 2023 |
| Tele-control systems and control centre | 36.6 | N_SO | 2024 |
| Tele-control systems and control centre | 36.5 | N_SO | 2025 |
| Tele-control systems and control centre | 35.5 | N_SO | 2026 |

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement FACTS

## Operational requirements **Transmission network support with FACTS**

**I General description:**

The proposed reinforcements consist of incorporating equipment based on power electronics to improve damping of the system when there are inter-area oscillations. Specifically, it is proposed to install:

- FACTS equipment in Pierola 400 kV (2026).
- STATCOM 150 MVAr in Tabernas 220 kV.
- STATCOM 150 MVAr in Moraleja 400 kV.
- STATCOM 150 MVAr in Lousame 220 kV.

**I Drivers / Objectives:**

- This equipment improves damping of inter-area oscillations, which results in greater security of supply for the entire peninsular system.
- Increasing the system's continuous voltage control, which also increases security of supply.

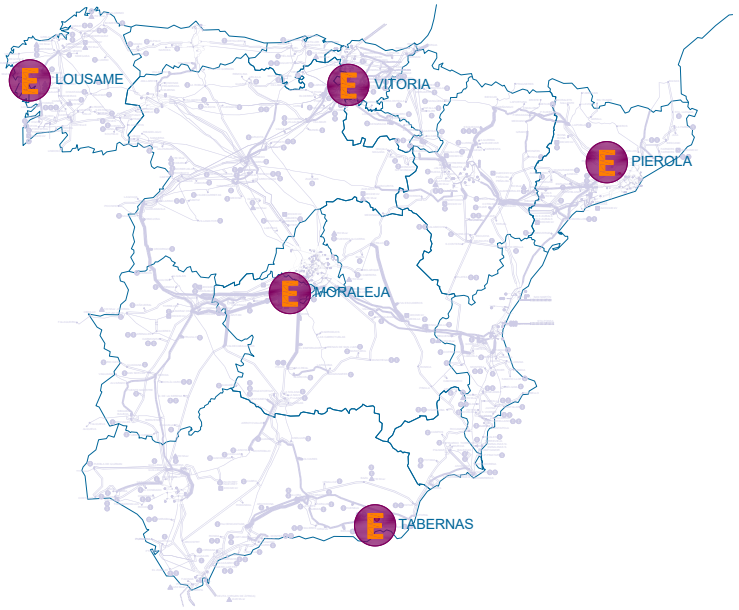
**I Alternatives:**

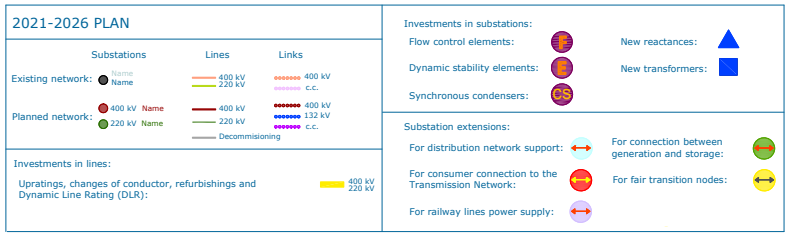
The following alternatives have been assessed in relation to damping inter-area oscillations:

- Implementation of operational measures proved to be insufficient to meet the needs of the estimated oscillations.
- Installation of power system stabilisation equipment in nuclear plants (commonly known as PSS) was assessed in the system operator's working groups with the nuclear plant managers, and was eventually considered unfeasible.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement FACTS
## Operational requirements **Transmission network support with FACTS**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 104.2 M€ | 2.11 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 10.5 | 10.4 | 10.2 | 10.1 | 9.9 | 9.8 | 9.7 | 9.5 | 9.4 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

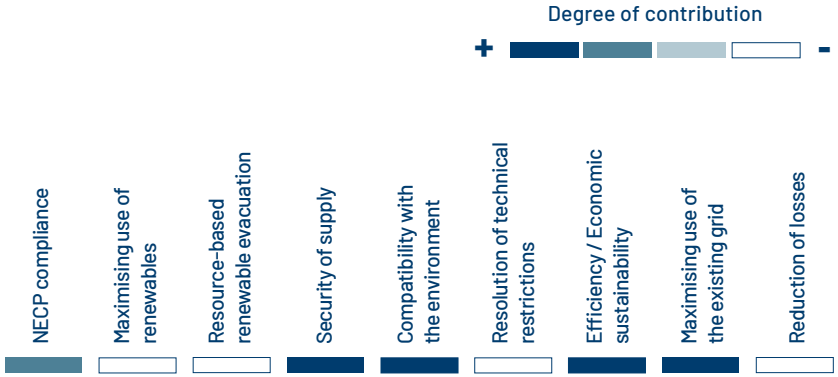
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement FACTS

## Operational requirements **Transmission network support with FACTS**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 2 | 3 |
| Cables (km) | 1 | |
| STATCOM (units) | 2 | 1 |
| FACTS (units) | | 1 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Lousame 220 kV | 1 | AIS | TN | 2026 |
| Moraleja 400 kV | 1 | AIS | TN | 2025 |
| Pierola 400 kV | 2 | AIS | TN | 2026 |
| Tabernas 220 kV | 1 | GIS | TN | 2024 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Lousame - Lousame 220 kV [1] | | | 1 SSC | Cable | N_SO | 2026 |
| Tabernas - Tabernas 220 kV [1] | | | 1 SSC | Cable | N_SO | 2024 |

Notes:
1. Short section of cable inside the substation.

| New STATCOMs | units | Type. | Driv. | Year |
|---|---|---|---|---|
| Lousame 220 kV | 1 | - | N_SO | 2026 |
| Moraleja 400 kV | 1 | - | N_SO | 2025 |
| Tabernas 220 kV | 1 | - | N_SO | 2024 |

| New FACTS | units | Type. | Driv. | Year |
|---|---|---|---|---|
| Pierola 400 kV [1] | 1 | - | N_SO | 2026 |

Notes:
1. Located at the Vic output.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement PEN_REAS

## Operational requirements **Reactances for voltage control in SEPE**

**I General description:**

The reinforcements consist of the installation of 15 new reactances in the peninsular system. Specifically, 13 reactances with 150 MVAr in Silleda, Xove, Solórzano, Almazán, Tábara, Maials, Rubí, Torrejón de Velasco (two here), Fuentes de la Alcarria, Requena, Anchuelo, and Carmona 400 kV and two 100 MVAr reactances in Sabón and Viladecans 220 kV.

**I Drivers / Objectives:**

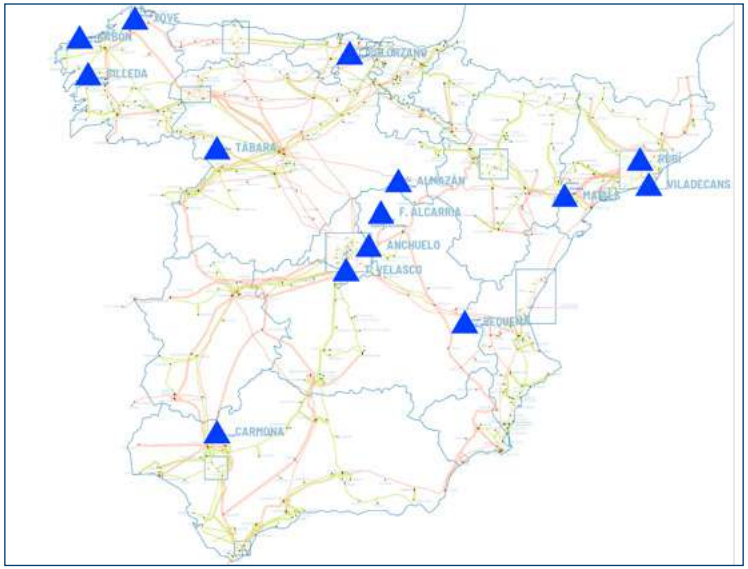
- Improving security of supply via increased a better voltage control, avoiding overvoltages in the transmission grid.
- Reducing technical constraints extra cost in the day-ahead market due to voltage control. In 2019, the technical constraints cost overruns in the day-ahead market due to voltage control amounted to €96 M. Had this group of reactances been commissioned, the cost would have decreased to €18 M. Energy redispatched by voltage control in the day-ahead market technical constraints process was 2,791 GWh, and would have decreased to 606 GWh.
- Allowing a greater amount of renewable energy to be integrated when there are curtailment.

**I Alternatives:**

- A greater number of lines open for voltage control to maintain adequate voltage levels may result in a decrease in transmission grid mesh reaching unacceptable levels.
- The coupling of thermal generators in the area due to technical constraints linked to voltage control is a solution with a much greater cost. In addition, there is not sufficient geographical distribution for optimal voltage control.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement PEN_REAS
## Operational requirements **Reactances for voltage control in SEPE**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 78 M€/year | Reduction of $CO_2$ emissions: 35 kt/year* |
| Additional RES integration: 97,778 MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 53.1 M€ | 0.72 M€/year |

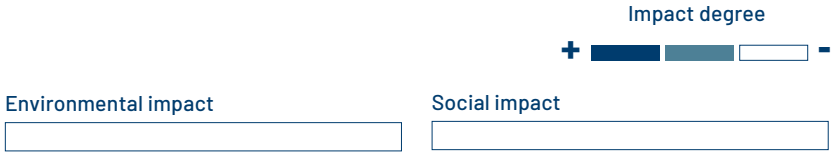
| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 5.0 | 4.9 | 4.9 | 4.8 | 4.7 | 4.6 | 4.6 | 4.5 | 4.4 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

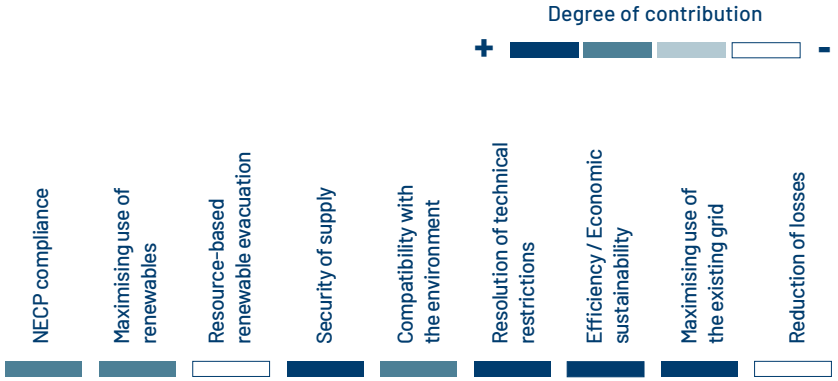
### I Profitability:

| Profitability: NPV |
|---|
| 1,485 M€ |

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# I Reinforcement PEN_REAS
## Operational requirements **Reactances for voltage control in SEPE**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 2 | 13 |
| Cables (km) | 0.2 | |
| Reactance (Mvar) | 200 | 1,950 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Almazán 400 kV | 1 | AIS | TN | 2023 |
| Anchuelo 400 kV | 1 | AIS | TN | 2023 |
| Carmona 400 kV | 1 | AIS | TN | 2025 |
| Fuentes de La Alcarria 400 kV | 1 | AIS | TN | 2023 |
| Maials 400 kV | 1 | AIS | TN | 2023 |
| Requena 400 kV | 1 | AIS | TN | 2023 |
| Rubí 400 kV | 1 | AIS | TN | 2024 |
| Sabón 220 kV | 1 | AIS | TN | 2024 |
| Silleda 400 kV | 1 | AIS | TN | 2023 |
| Solorzano 400 kV | 1 | AIS | TN | 2023 |
| Tábara 400 kV | 1 | AIS | TN | 2024 |
| Torrejón de Velasco 400 kV | 1 | AIS | TN | 2025 |
| Torrejón de Velasco 400 kV | 1 | AIS | TN | 2026 |
| Viladecans 220 kV [1] | 1 | AIS | TN | 2023 |
| Xove 400 kV | 1 | AIS | TN | 2024 |

Notes:1. The reactance is installed in busbar A.

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Viladecans - Viladecans 220 kV [1] | | | 1 SSC | Cable | TN | 2023 |

Notes:
1. Short section of cable inside the substation.

| New reactances | MVAr. | Type | Driv. | Year |
|---|---|---|---|---|
| Almazán 400 kV, REA1 | 150 | - | N_SO | 2023 |
| Anchuelo 400 kV, REA1 | 150 | - | N_SO | 2023 |
| Carmona 400 kV, REA1 | 150 | - | N_SO | 2025 |
| Fuentes de La Alcarria 400 kV, REA1 | 150 | - | N_SO | 2023 |
| Maials 400 kV, REA1 | 150 | - | N_SO | 2023 |
| Requena 400 kV, REA2 | 150 | - | N_SO | 2023 |
| Rubí 400 kV, REA1 | 150 | - | N_SO | 2024 |
| Sabón 220 kV, REA1 | 100 | - | N_SO | 2024 |
| Silleda 400 kV, REA1 | 150 | - | N_SO | 2023 |
| Solorzano 400 kV, REA1 | 150 | - | N_SO | 2023 |
| Tábara 400 kV, REA1 | 150 | - | N_SO | 2024 |
| Torrejón de Velasco 400 kV, REA1 | 150 | - | N_SO | 2025 |
| Torrejón de Velasco 400 kV, REA2 | 150 | - | N_SO | 2026 |
| Viladecans 220 kV, REA[1] | 100 | - | N_SO | 2023 |
| Xove 400 kV, REA1 | 150 | - | N_SO | 2024 |

Notes:1. The reactance is installed in busbar A.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement TNP_REAS

## Operational requirements **Reactance for voltage control in the Islas Baleares**

**I General description:**

These reinforcements consist of a change in the location of reactances in order to optimise their use as reactive power compensation components in the Islas Baleares' electricity system. More specifically, these reinforcements involve the location change of reactances 1 and 2 of 30 MVAr from Cala Mesquida 132 kV to Sta. Ponsa 132 kV.

**I Drivers / Objectives:**

Maintain adequate voltage levels in the Islas Baleares' system.

**I Alternatives:**

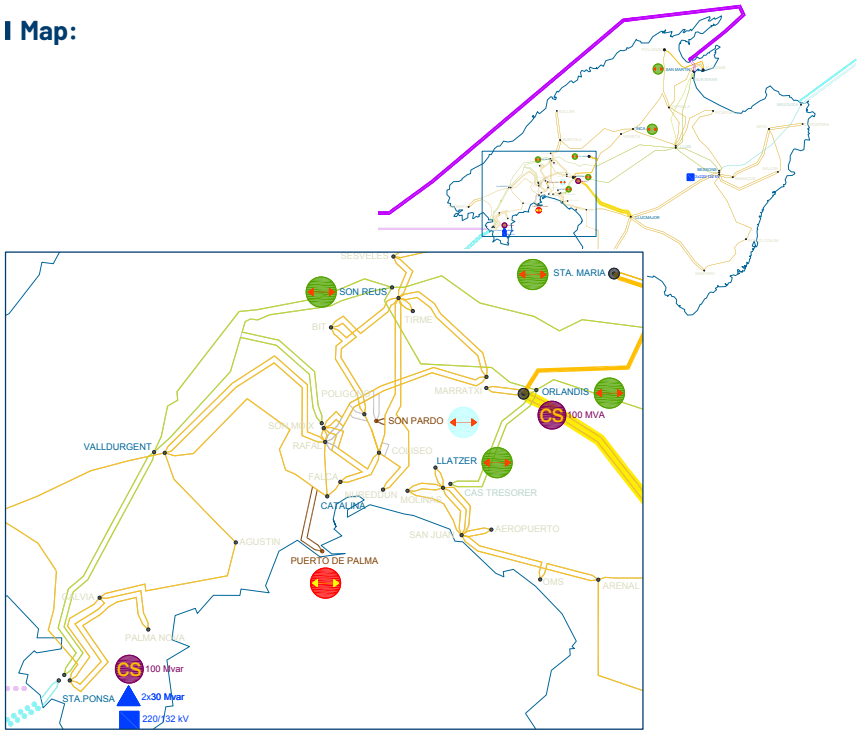
The alternative consists of coupling additional thermal generators in the area due to technical constraints by voltage control. This is a solution that entails a greater cost.

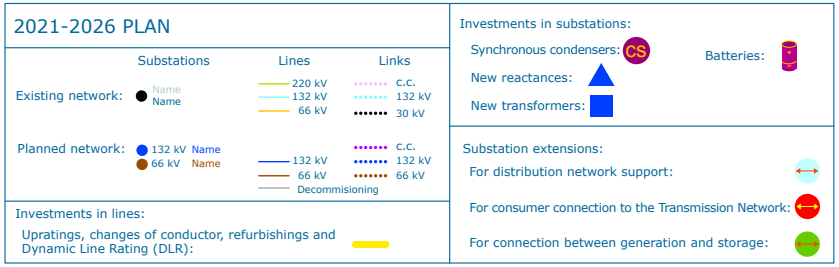
Based on simulations of the weekly scheduling in the Islas Baleares' system with and without reactances, or rather, considering these generation constraints gives an estimation of the cost overrun of €168,000 per week that would be required in the system for at least 30 weeks of the year. Therefore, the annual savings gained as a result of the relocation of the reactances would be €5.04 M/year in 2024, 2025, and 2026 as, after 2026, the synchronous condenser from Sta. Ponsa 220 kV will replace this function.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement TNP_REAS
## Operational requirements **Reactance for voltage control in the Islas Baleares**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 5 M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 2.7 M€ | 0.07 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

| Profitability: NPV |
|---|
| 96 M€ |

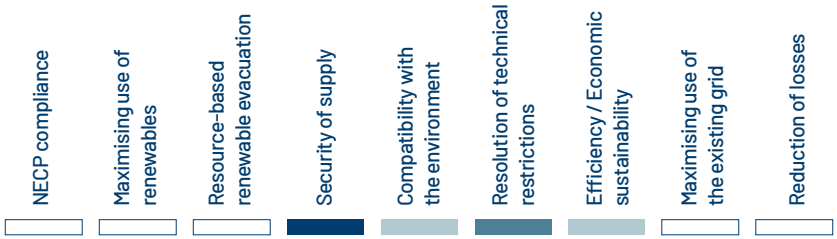
### I Socio-environmental impact:




| Environmental impact | Social impact |
|---|---|
| | |

### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# Reinforcement TNP_REAS
## Operational requirements **Reactance for voltage control in the Islas Baleares**

### Table of physical units:

| | 132 kV |
|---|---|
| Bays (units) | 2 |
| Cables (km) | 0.3 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Santa Ponsa 132 kV | 2 | AIS | TN | 2022 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Santa Ponsa - Santa Ponsa 132 kV [1] | | | 2 SSC | Cable | N_SO | 2022 |

Notes:
1. Short section of cable inside the substation.

| New reactances | MVAr. | Type | Driv. | Year |
|---|---|---|---|---|
| Santa Ponsa 132 kV, REA1 [1] | 30 | - | N_SO | 2022 |
| Santa Ponsa 132 kV, REA1 [2] | 30 | - | N_SO | 2022 |

Notes:
1. Relocation of the REA1 reactance from Mesquida 132 kV to Santa Ponsa 132kV.
2. Relocation of the REA2 reactance from Mesquida 132 kV to Santa Ponsa 132kV.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF-01
## Railway line power supply **Bobadilla-Algeciras**

**I General description:**

The reinforcements involves the necessary components for the power supply from the transmission network to the traction substations of the Bobadilla-Algeciras railway line:

- New Ronda 400 kV substation
- New input-output at the Ronda 400 kV substation on the Jordana-Tajo 400 kV line.

**I Drivers / Objectives:**

This reinforcements allows transport electrification, contributing to achieving the objectives set out in the NECP.

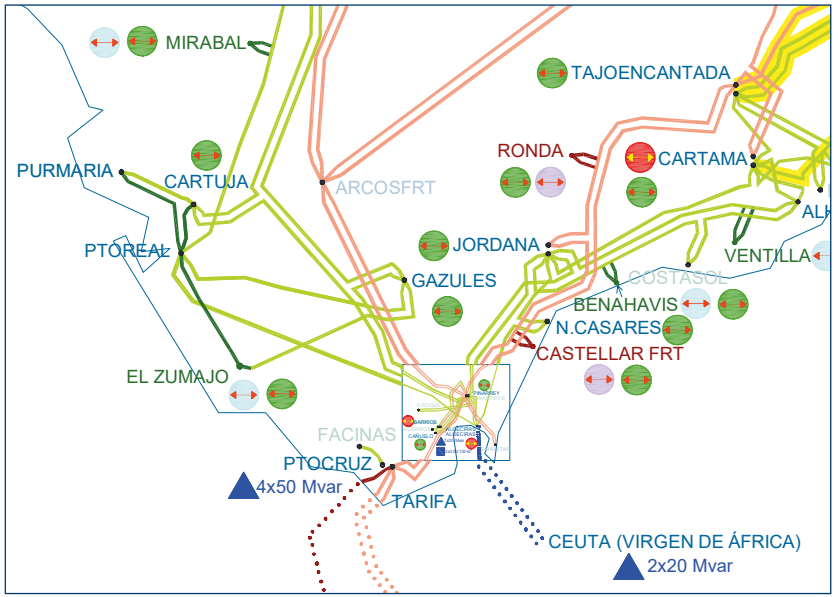
**I Alternatives:**

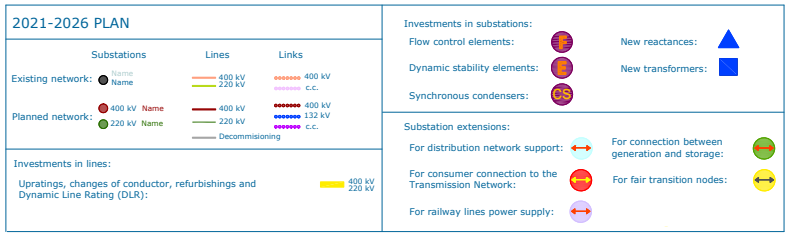
The power supply points for the railway line have been defined in coordination with ADIF, minimising to the extent possible the distance of the traction substations from existing transmission network infrastructures.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF-01
## Railway line power supply **Bobadilla-Algeciras**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 8.9 M€ | 0.34 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

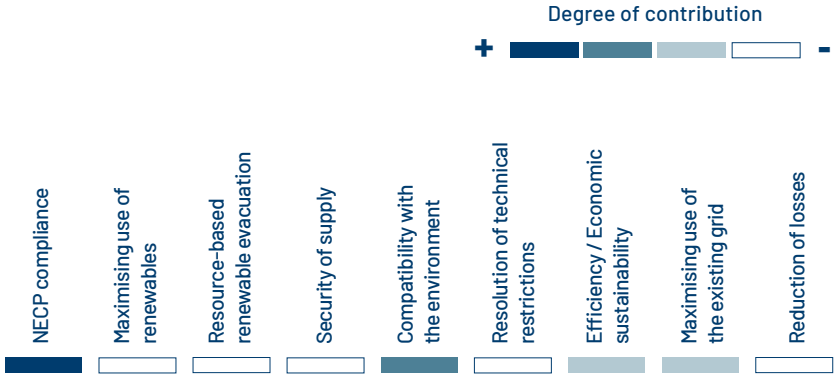
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement AF-01
## Railway line power supply **Bobadilla-Algeciras**

### Table of physical units:

| | 400 kV |
|---|---|
| Bays (units) | 7 |
| Overhead line (km) | 8 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Ronda, of Jordana - Tajo de la Encantada 400 kV, circuit 1 [1] | 1,730 | 1,420 | 4 | Line | TN | 2023 |

Notes:
1. Section line capacity in DC for I/O 2350/1930 MVA.

| New substations | Type | Year |
|---|---|---|
| Ronda 400 kV | Outdoor. | 2023 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Ronda 400 kV | 5 | AIS | TN | 2023 |
| Ronda 400 kV | 2 | AIS | Rail. | 2023 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_02
## Railway line power supply **Burgos-Vitoria**

**I General description:** The reinforcements involves the necessary components for the power supply from the transmission network to the traction substations of the Burgos-Vitoria railway line:

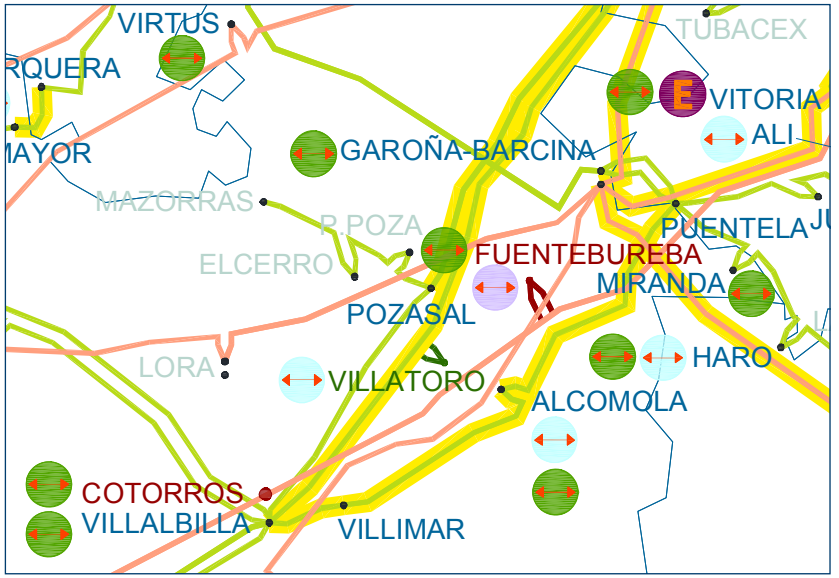
- Expansion of the Fuentebureba 400 kV substation.

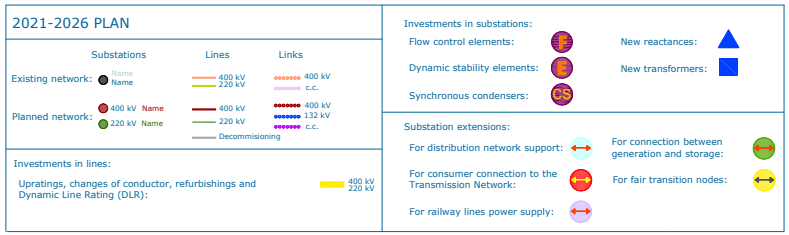
**I Drivers / Objectives:** This reinforcements allows transport electrification, contributing to achieving the objectives set out in the NECP.

**I Alternatives:** The power supply points for the railway line have been defined in coordination with ADIF, minimising to the extent possible the distance of the traction substations from existing transmission network infrastructures.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_02
Railway line power supply **Burgos-Vitoria**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 1.1 M€ | 0.14 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:




Environmental impact

Social impact

### I Contribution to guiding principles:







Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement AF_02
## Railway line power supply **Burgos-Vitoria**

### Table of physical units:

| | 400 kV |
|---|---|
| Bays (units) | 3 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Fuentebureba* 400 kV | 1 | AIS | TN | 2025 |
| Fuentebureba* 400 kV | 2 | AIS | Rail. | 2025 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_04
## Railway line power supply **Granada-Almería**

**I General description:**

The reinforcements involves the necessary components for the power supply from the transmission network to the traction substations of the Granada-Almería railway line:

- New 400 kV Iznalloz substation.
- New input-output at the 400 kV Iznalloz substation on the 400 kV Caparacena-Baza line.
- Expansion of the Hueneja 400 kV substation.
- Expansion of the Benahadux 220 kV substation.

**I Drivers / Objectives:**

This reinforcements allows transport electrification, contributing to achieving the objectives set out in the NECP.

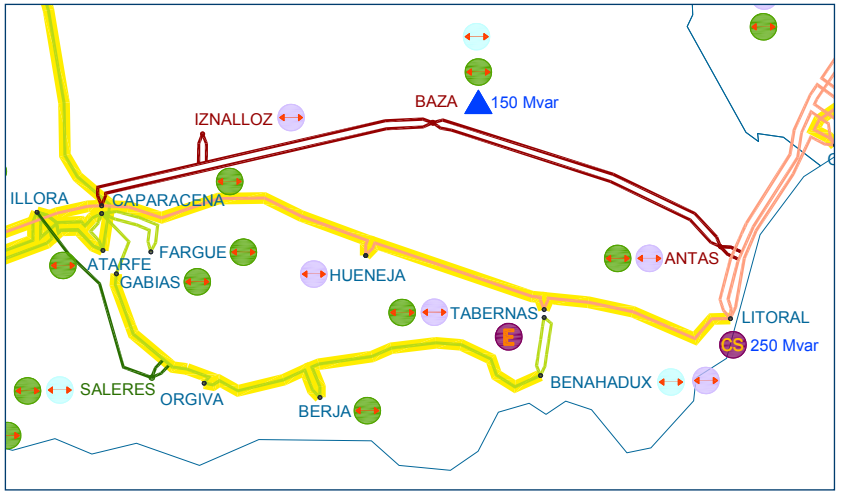
**I Alternatives:**

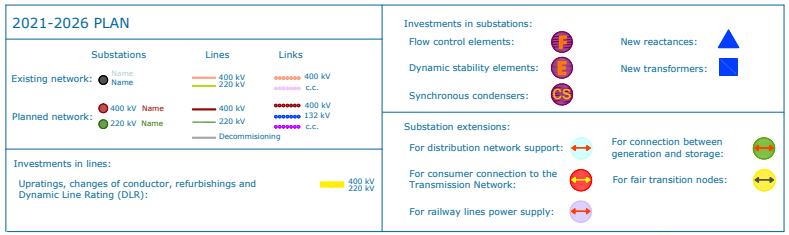
The power supply points for the railway line have been defined in coordination with ADIF, minimising to the extent possible the distance of the traction substations from existing transmission network infrastructures.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_04
## Railway line power supply **Granada-Almería**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

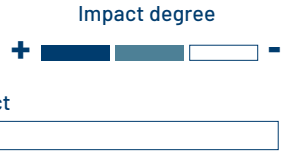
Note: * a negative value means existing increased emissions, losses or ENS.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:



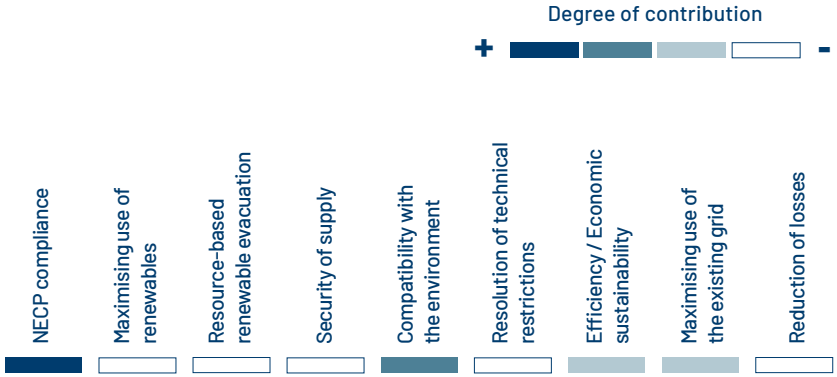

### I Costs:

| CAPEX | OPEX |
|---|---|
| 8.5 M€ | 0.53 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement AF_04
## Railway line power supply **Granada-Almería**

### Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 2 | 10 |
| Overhead line (km) | | 2 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Iznalloz 400 kV | Outdoor. | 2024 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Benahadux 220 kV | 2 | GIS | Rail. | 2024 |
| Hueneja 400 kV | 2 | AIS | Rail. | 2024 |
| Hueneja 400 kV | 1 | AIS | TN | 2024 |
| Iznalloz 400 kV | 2 | AIS | Rail. | 2024 |
| Iznalloz 400 kV | 5 | AIS | TN | 2024 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Iznalloz, of Caparacena - Baza REE 400 kV, circuit 2 [1] | 2,370 | 1,910 | 1 | Line | TN | 2024 |

Notes:
1. Section line capacity for I/O 2420/1950 MVA.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_05
## Railway line power supply **Madrid-Albacete-Alicante-Valencia**

**I General description:**

The reinforcements involves the necessary components for the power supply from the transmission network to the traction substations of the Madrid-Albacete-Alicante-Valencia railway line:

- New Torrejón de Velasco 400 kV substation.
- New input-output at the 400 kV Torrejón de Velasco substation on the 400 kV Morata-Villaviciosa line.

**I Drivers / Objectives:**

This reinforcements allows transport electrification, contributing to achieving the objectives set out in the NECP.

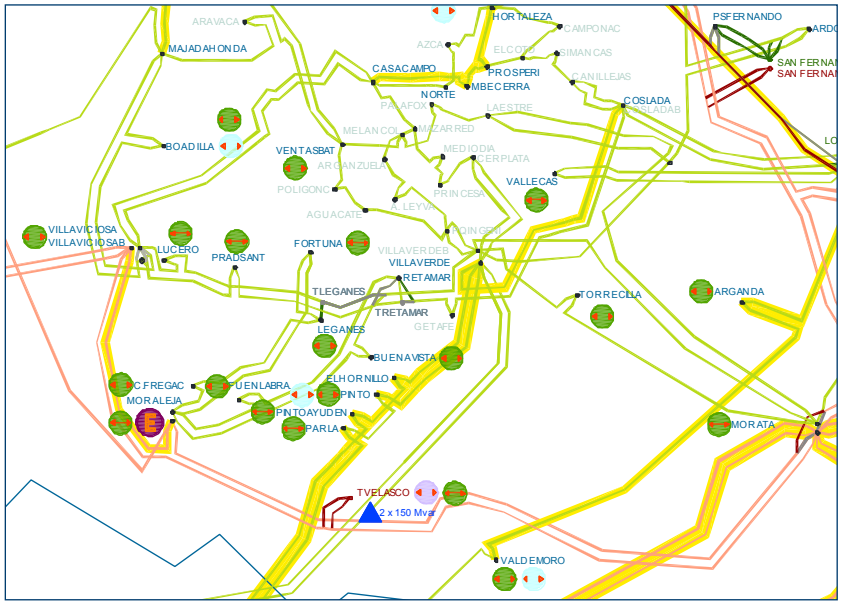
**I Alternatives:**

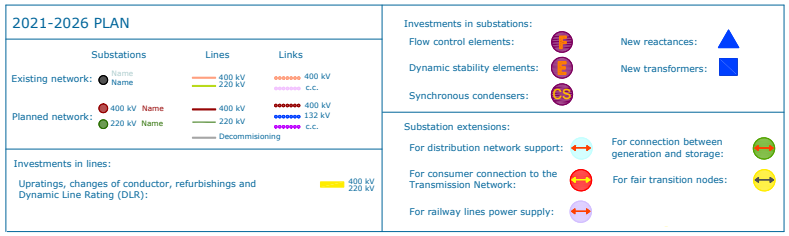
The power supply points for the railway line have been defined in coordination with ADIF, minimising to the extent possible the distance of the traction substations from existing transmission network infrastructures.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_05
Railway line power supply **Madrid-Albacete-Alicante-Valencia**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 6.8 M€ | 0.29 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

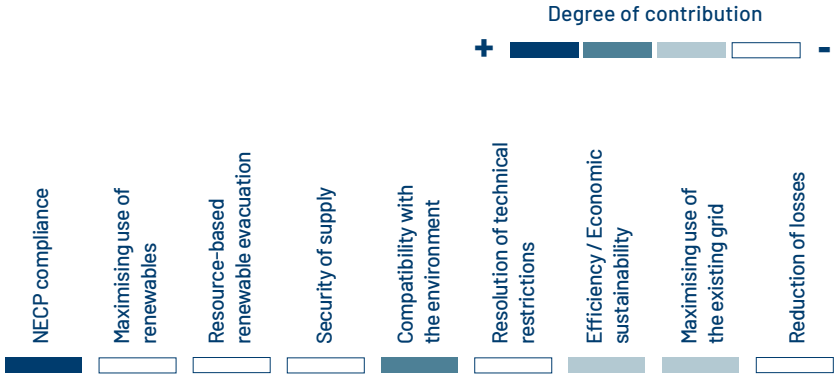
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement AF_05
## Railway line power supply **Madrid-Albacete-Alicante-Valencia**

### Table of physical units:

| | 400 kV |
|---|---|
| Bays (units) | 6 |
| Overhead line (km) | 4 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Torrejón de Velasco 400 kV | Outdoor. | 2025 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Torrejón de Velasco 400 kV | 2 | AIS | Rail. | 2025 |
| Torrejón de Velasco 400 kV | 4 | AIS | TN | 2025 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Torrejón de Velasco, of Morata - Villaviciosa 400 kV, circuit 1 [1] | 1,310 | 750 | 2 | Line | Rail. | 2025 |

Notes:
1. Section line capacity in DC for I/O 2400/1960 MVA.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_06
## Railway line power supply **Murcia-Almería**

**I General description:**

The reinforcements involves the necessary components for the power supply from the transmission network to the traction substations of the Murcia-Almería railway line:

- Expansion of the Totana 400 kV substation.
- Expansion of the Tabernas 400 kV substation.
- Expansion of the Antas 400 kV substation.

**I Drivers / Objectives:**

This reinforcements allows transport electrification, contributing to achieving the objectives set out in the NECP.

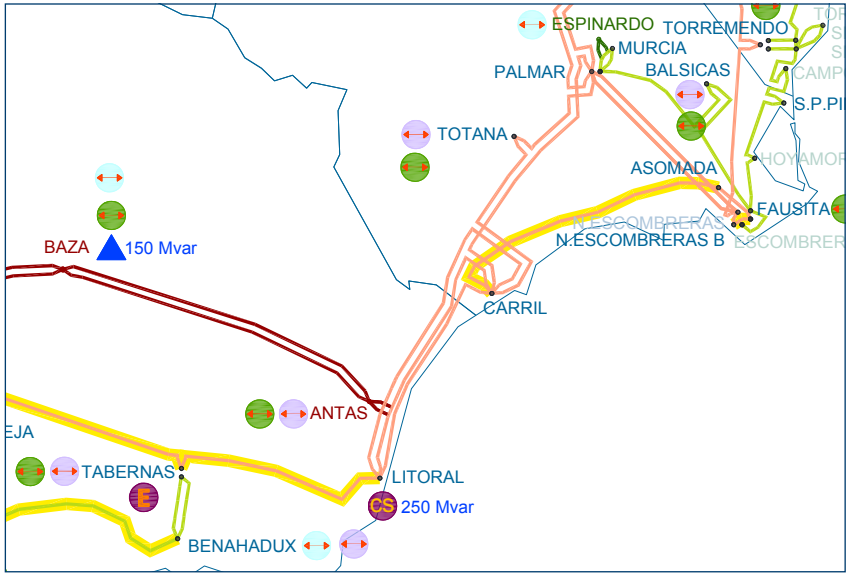
**I Alternatives:**

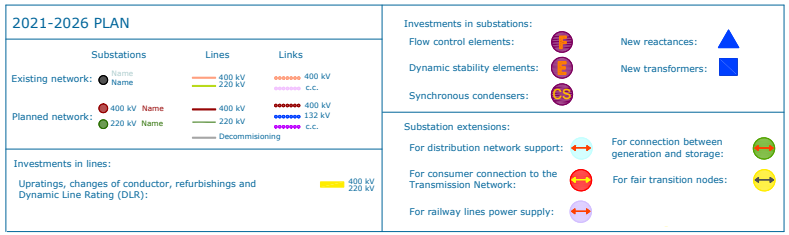
The power supply points for the railway line have been defined in coordination with ADIF, minimising to the extent possible the distance of the traction substations from existing transmission network infrastructures.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_06
## Railway line power supply **Murcia-Almería**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 3.4 M€ | 0.43 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

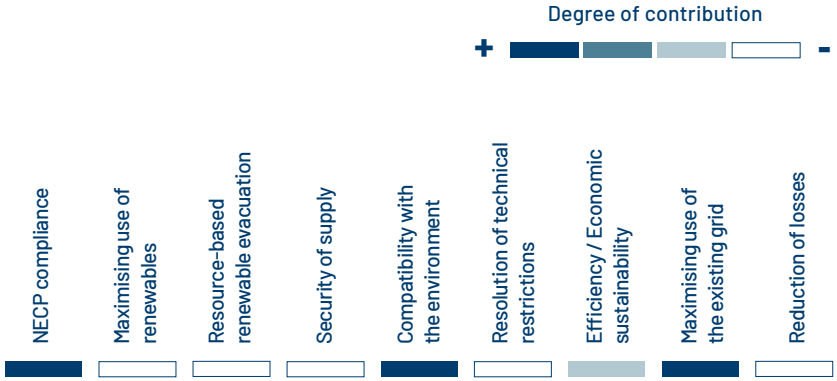
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement AF_06
## Railway line power supply **Murcia-Almería**

### Table of physical units:

| | 400 kV |
|---|---|
| Bays (units) | 9 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Antas* 400 kV | 2 | AIS | Rail. | 2024 |
| Antas* 400 kV | 1 | AIS | TN | 2024 |
| Tabernas 400 kV | 2 | AIS | Rail. | 2023 |
| Tabernas 400 kV | 1 | AIS | TN | 2023 |
| Totana 400 kV | 2 | AIS | Rail. | 2020 |
| Totana 400 kV | 1 | AIS | TN | 2020 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_07
## Railway line power supply **Murcia-Cartagena**

**I General description:**

The reinforcements involves the necessary components for the power supply from the transmission network to the traction substations of the Murcia-Cartagena railway line:

- Expansion of the Balsicas 220 kV substation.

**I Drivers / Objectives:**

This reinforcements allows transport electrification, contributing to achieving the objectives set out in the NECP.

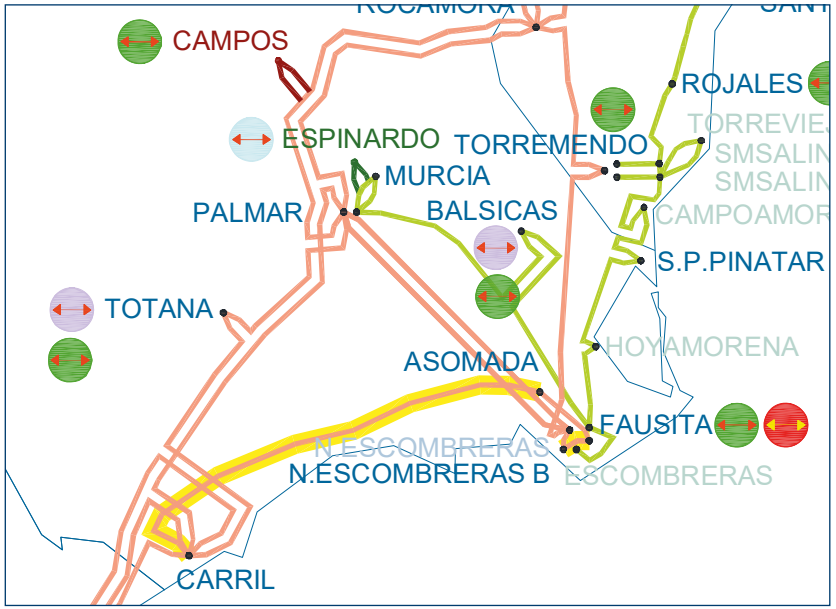
**I Alternatives:**

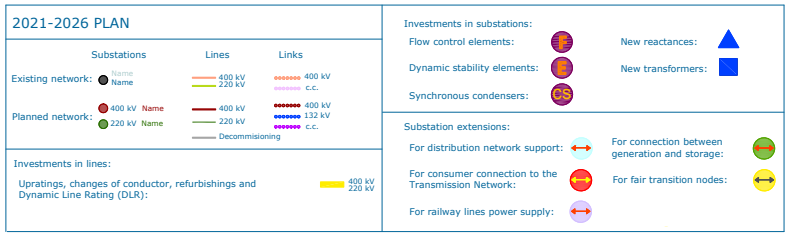
The power supply points for the railway line have been defined in coordination with ADIF, minimising to the extent possible the distance of the traction substations from existing transmission network infrastructures.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_07
## Railway line power supply **Murcia-Cartagena**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| - M€ | 0.05 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

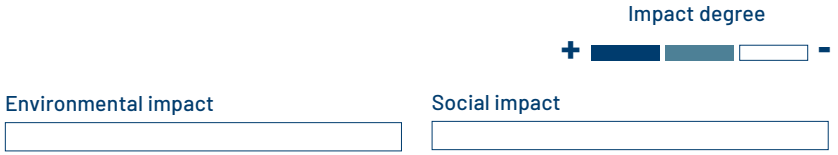
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

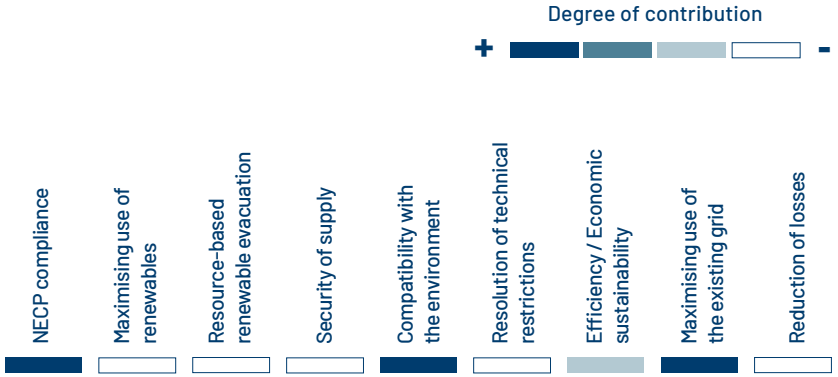
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement AF_07
## Railway line power supply **Murcia-Cartagena**

### Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 2 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Balsicas 220 kV | 2 | GIS | Rail. | 2020 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_08
## Railway line power supply **Palencia-Santander**

**I General description:**

The reinforcements involves the necessary components for the power supply from the transmission network to the traction substations of the Palencia-Santander railway line:

- Expansion of the Herrera 400 kV substation.
- Expansion of the Aguayo 400 kV substation.

**I Drivers / Objectives:**

This reinforcements allows transport electrification, contributing to achieving the objectives set out in the NECP.

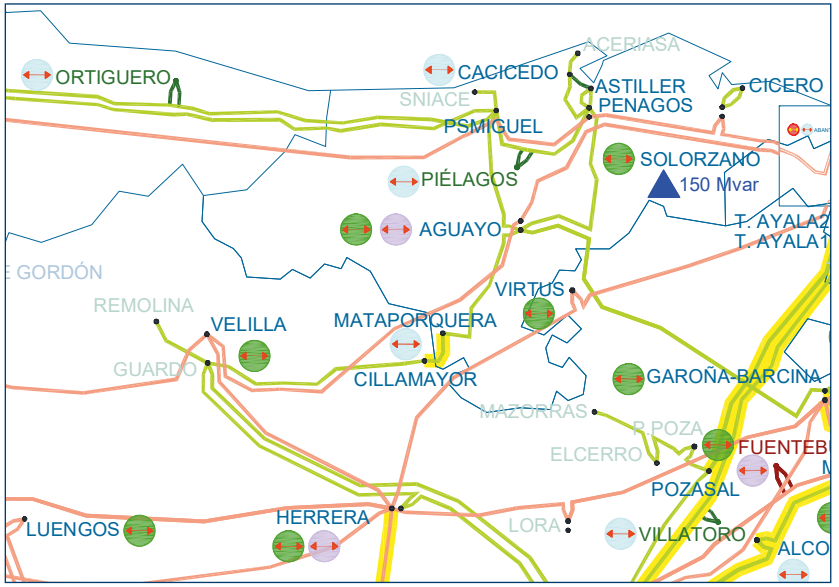
**I Alternatives:**

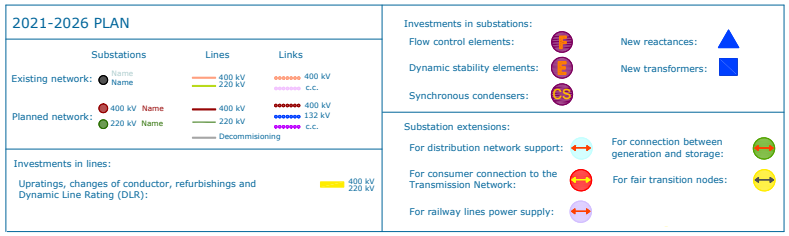
The power supply points for the railway line have been defined in coordination with ADIF, minimising to the extent possible the distance of the traction substations from existing transmission network infrastructures.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_08
## Railway line power supply **Palencia-Santander**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 2.3 M€ | 0.28 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:




Environmental impact

Social impact

### I Contribution to guiding principles:







Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement AF_08
## Railway line power supply **Palencia-Santander**

### Table of physical units:

| | 400 kV |
|---|---|
| Bays (units) | 6 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Aguayo 400 kV | 1 | AIS | TN | 2024 |
| Aguayo 400 kV | 2 | AIS | Rail. | 2024 |
| Herrera 400 kV | 2 | AIS | Rail. | 2024 |
| Herrera 400 kV | 1 | AIS | TN | 2024 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_09
## Railway line power supply **Puertollano-Mérida**

**I General description:**

The Reinforcements involves the necessary components for the power supply from the transmission network to the traction substations of the Puertollano- Mérida railway line:

- New Almadén 400 kV substation in I/O of the Guadame-Almaraz 400 kV line.
- New Quintana de la Serena 400 kV substation in I/O of the Valdecaballeros-Carmona 400 kV line, circuit 1.
- New Don Álvaro 400 kV substation in I/O of the Bienvenida-Almaraz 400 kV line, circuit 1.
- Substation expansion in Brazatortas 220 kV, Almadén 400 kV, Quintana de La Serena 400 kV, and Don Álvaro 400 kV.

**I Drivers / Objectives:**

This reinforcements allows transport electrification, contributing to achieving the objectives set out in the NECP.

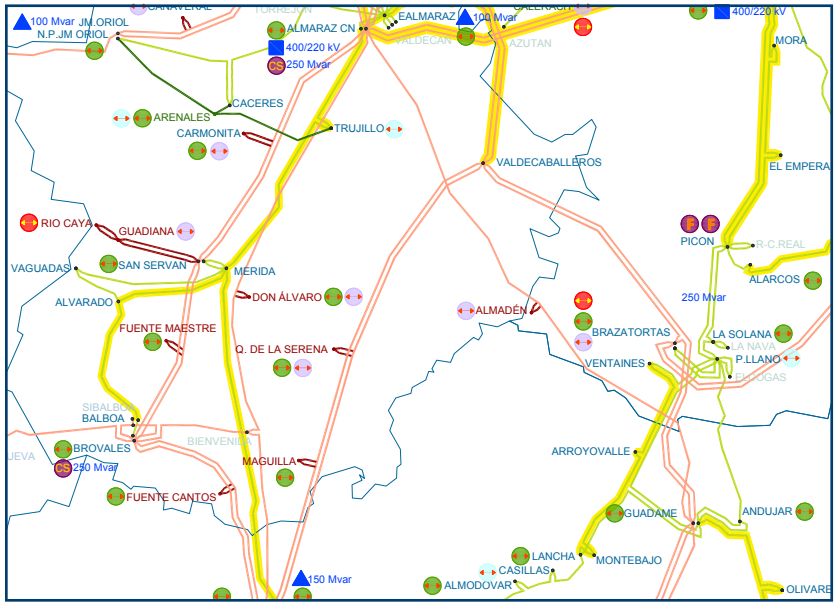
**I Alternatives:**

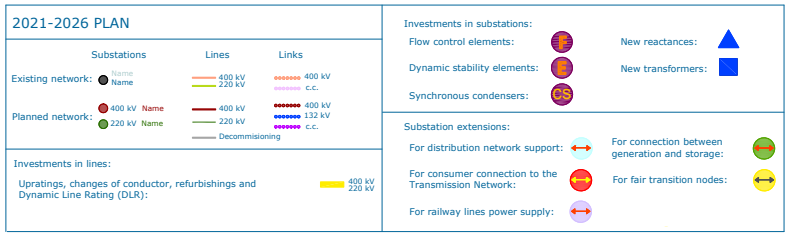
The power supply points for the railway line have been defined in coordination with ADIF, minimising to the extent possible the distance of the traction substations from existing transmission network infrastructures.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_09
## Railway line power supply **Puertollano-Mérida**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:

Impact degree + -

| Environmental impact | Social impact |
|---|---|
| | |

### I Costs:

| CAPEX | OPEX |
|---|---|
| 26.1 M€ | 1.1 M€/year |

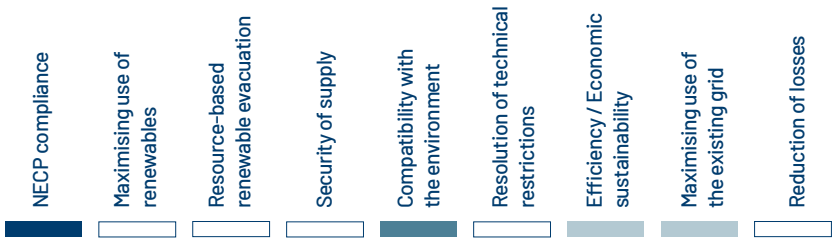
Remuneration costs

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| M€ | 0.0 | 3.2 | 3.2 | 3.1 | 3.1 | 3.1 | 3.0 | 3.0 | 3.0 | 2.9 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Contribution to guiding principles:

Degree of contribution + -




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# Reinforcement AF_09
## Railway line power supply **Puertollano-Mérida**

### Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 2 | 21 |
| Overhead line (km) | | 22 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Almadén 400 kV | Outdoor. | 2024 |
| Don Álvaro* 400 kV | Outdoor. | 2024 |
| Quintana de La Serena 400 kV | Outdoor. | 2024 |

### Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Almadén 400 kV | 5 | AIS | TN | 2024 |
| Almadén 400 kV | 2 | AIS | Rail. | 2024 |
| Brazatortas 220 kV | 2 | AIS | Rail. | 2024 |
| Don Álvaro* 400 kV | 2 | AIS | Rail. | 2024 |
| Don Álvaro* 400 kV | 5 | AIS | TN | 2024 |
| Quintana de La Serena 400 kV | 2 | AIS | Rail. | 2024 |
| Quintana de La Serena 400 kV | 5 | AIS | TN | 2024 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Almadén, of Guadame - Almaraz CN 400 kV, circuit 1 | 1,280 | 720 | 2 | Line | TN | 2024 |
| I/O in Don Álvaro*, of Bienvenida - Almaraz CN 400 kV, circuit 1 [1] | 1,750 | 1410 | 3 | Line | TN | 2024 |
| I/O in Quintana de La Serena, of Valdecaballeros - Carmona 400 kV, circuit 1 [2] | 1,760 | 1,420 | 6 | Line | TN | 2024 |

Notes:
1. Section line capacity in DC for I/O 2370/1920 MVA.
2. Section line capacity in DC for I/O 2380/1930 MVA.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_10
## Railway line power supply **Sevilla-Huelva**

**I General description:**

The reinforcements involves the necessary components for the power supply from the transmission network to the traction substations of the Sevilla-Huelva railway line:

- New Palma del Condado 220 kV substation.
- New input-output at the Palma del Condado 220 kV substation on the Colon- Santiponce 220 kV line.
- Substation expansion in Casaquemada 220 kV and Palma del Condado 220 kV.

**I Drivers / Objectives:**

This reinforcements allows transport electrification, contributing to achieving the objectives set out in the NECP.

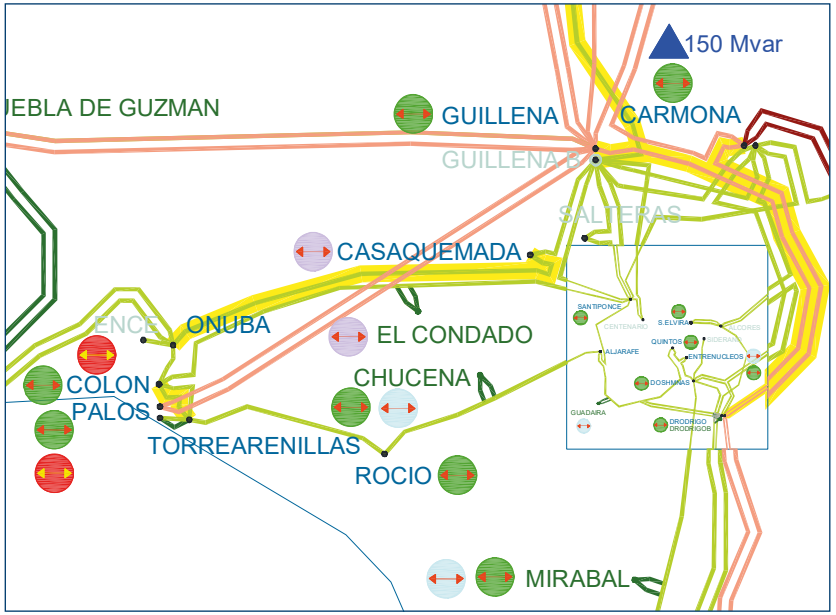
**I Alternatives:**

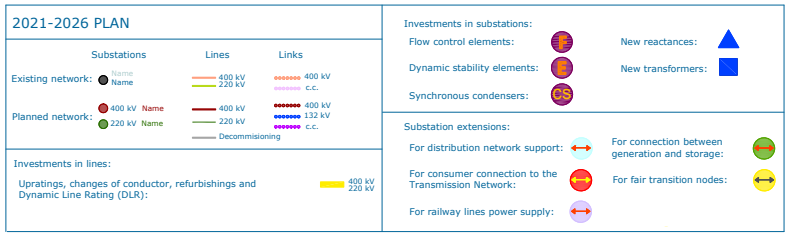
The power supply points for the railway line have been defined in coordination with ADIF, minimising to the extent possible the distance of the traction substations from existing transmission network infrastructures.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_10
## Railway line power supply **Sevilla-Huelva**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 3.4 M€ | 0.25 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:




Environmental impact

Social impact

### I Contribution to guiding principles:







Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement AF_10
## Railway line power supply **Sevilla-Huelva**

### Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 7 |
| Overhead line (km) | 2 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| El Condado 220 kV [1] | Outdoor. | 2024 |

Notes:
1. Former Palma del Condado.

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Casaquemada 220 kV | 2 | GIS | Rail. | 2024 |
| El Condado 220 kV [1] | 3 | AIS | TN | 2024 |
| El Condado 220 kV [1] | 2 | AIS | Rail. | 2024 |

Notes:
1. Former Palma del Condado.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in El Condado, of Colon - Santiponce 220 kV, circuit 1 [1] | 420 | 350 | 1 | Line | TN | 2024 |

Notes:
1. Section line capacity in DC for I/O 850/720 MVA.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_11
## Railway line power supply **Toledo-Navalmoral-Cáceres-Badajoz**

**I General description:**

The reinforcements involves the necessary components for the power supply from the transmission network to the traction substations of the Toledo-Navalmoral-Cáceres-Badajoz railway line:

- Expansion of the Torrijos 220 kV substation.
- New Calera y Chozas 220 kV substation in I/O for the Almaraz-Talavera 220 kV line and expansion of the Calera y Chozas substation.
- Expansion of the Arañuelo 400 kV substation.
- Expansion of the Guadiana 400 kV substation.

**I Drivers / Objectives:**

This reinforcements allows transport electrification, contributing to achieving the objectives set out in the NECP.

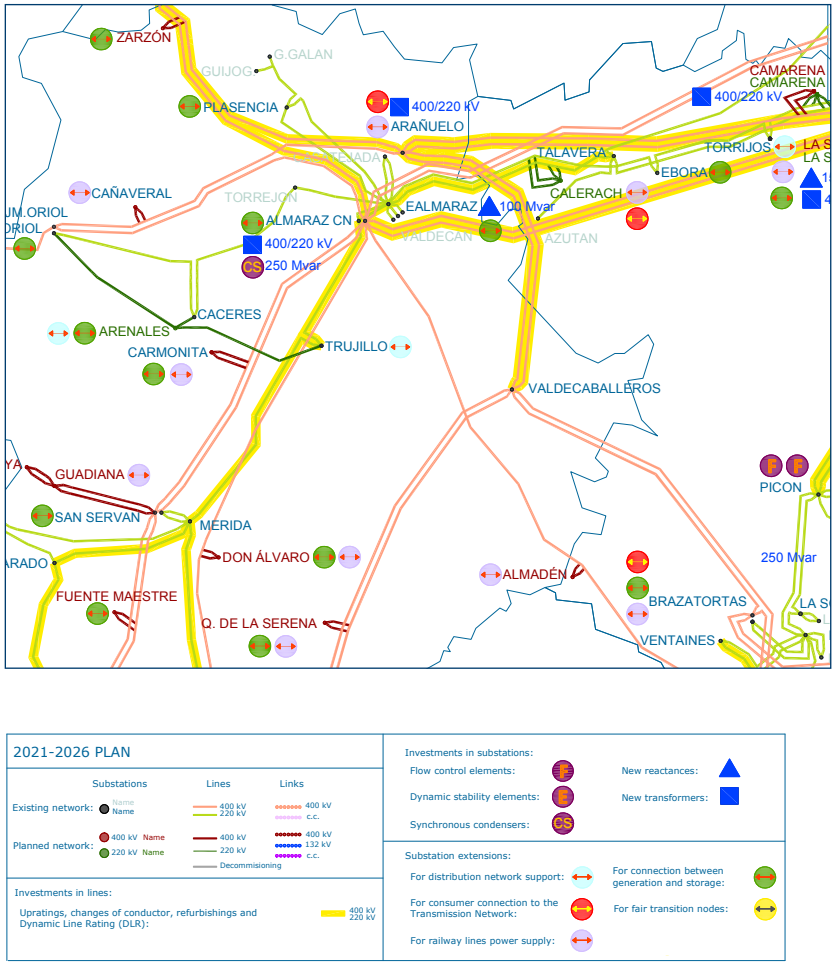
**I Alternatives:**

The power supply points for the railway line have been defined in coordination with ADIF, minimising to the extent possible the distance of the traction substations from existing transmission network infrastructures.

**I European dimension:**

No

**I Map:**







Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_11
Railway line power supply **Toledo-Navalmoral-Cáceres-Badajoz**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 5.7 M€ | 0.56 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

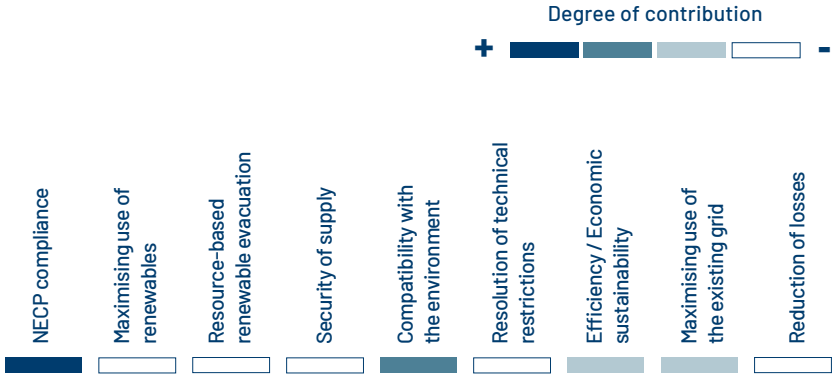
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement AF_11
## Railway line power supply **Toledo-Navalmoral-Cáceres-Badajoz**

### Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 7 | 6 |
| Overhead line (km) | 2 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Calera y Chozas 220 kV | Outdoor. | 2024 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Arañuelo 400 kV | 2 | AIS | Rail. | 2023 |
| Arañuelo 400 kV | 1 | AIS | TN | 2023 |
| Calera y Chozas 220 kV | 2 | AIS | Rail. | 2024 |
| Calera y Chozas 220 kV | 3 | AIS | TN | 2024 |
| Guadiana* 400 kV | 2 | AIS | Rail. | 2024 |
| Guadiana* 400 kV | 1 | AIS | TN | 2024 |
| Torrijos 220 kV | 2 | AIS | Rail. | 2024 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Calera y Chozas, of Talavera - Almaraz ET 220 kV, circuit 1 | 770 | 630 | 1 | Line | TN | 2024 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_12
## Railway line power supply **Vigo-Orense-Lugo-A Coruña**

**I General description:**

The reinforcements involves the necessary components for the power supply from the transmission network to the traction substations of the Vigo-Orense-Lugo-A Coruña railway line:

- Expansion of the Fontefría 220 kV substation.
- New O Incio 220 kV substation in I/O of the La Lomba-Belesar 220 kV line. Expansion of the O Incio 220 kV substation.
- Expansion of the Ludrio 400 kV substation.
- New Abegondo 400 kV substation in I/O of the PG Rodríguez-Mesón do Vento 400 kV line. Expansion of the Abegondo 400 kV substation.

**I Drivers / Objectives:**

This reinforcements allows transport electrification, contributing to achieving the objectives set out in the NECP.

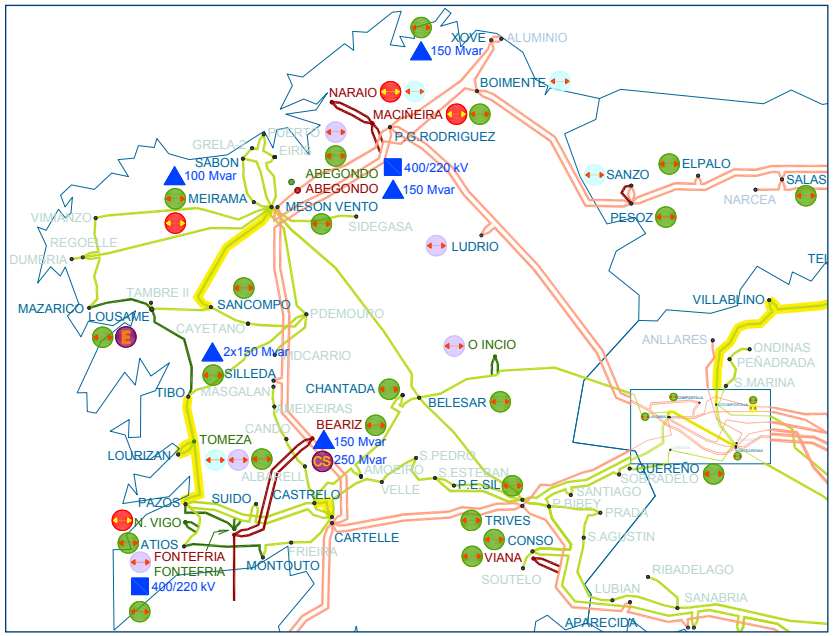
**I Alternatives:**

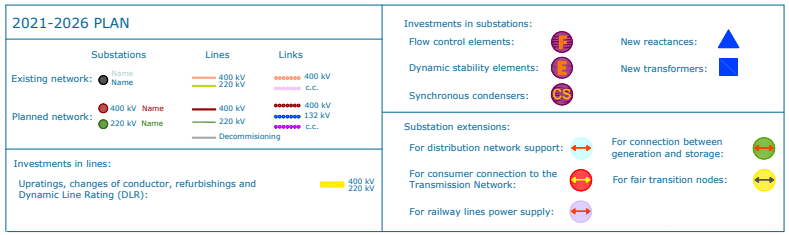
The power supply points for the railway line have been defined in coordination with ADIF, minimising to the extent possible the distance of the traction substations from existing transmission network infrastructures.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_12
## Railway line power supply **Vigo-Orense-Lugo-A Coruña**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 11.5 M€ | 0.75 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 |

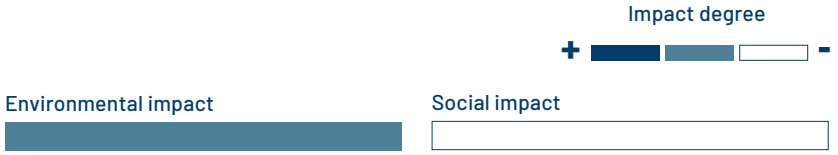
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

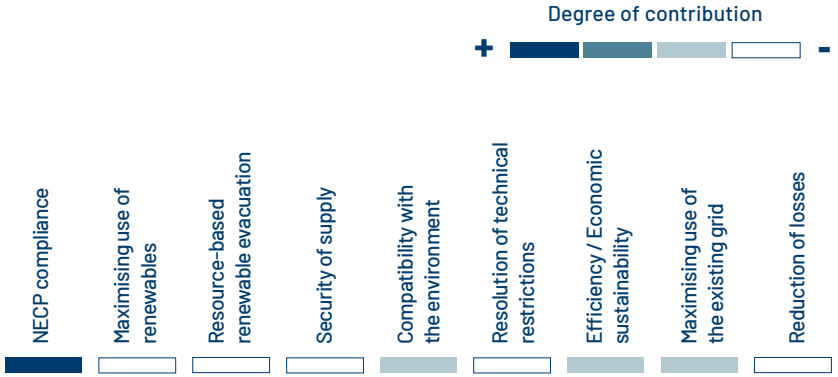
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_12
## Railway line power supply **Vigo-Orense-Lugo-A Coruña**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 7 | 10 |
| Overhead line (km) | 1 | 1 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Abegondo 400 kV | Outdoor. | 2024 |
| O Incio 220 kV [1] | Outdoor. | 2023 |

Notes:
1. Previously called SE Oural 220 kV.

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Abegondo 400 kV | 5 | AIS | TN | 2024 |
| Abegondo 400 kV | 2 | AIS | Rail. | 2024 |
| Fontefría 220 kV | 2 | AIS | Rail. | 2022 |
| Ludrio 400 kV | 2 | AIS | Rail. | 2022 |
| Ludrio 400 kV | 1 | AIS | TN | 2022 |
| O Incio 220 kV | 2 | AIS | Rail. | 2023 |
| O Incio 220 kV | 3 | AIS | TN | 2023 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Abegondo, of Mesón do Vento - Puentes García Rodríguez 400 kV, circuit 1 [1] | 1,805 | 1,612 | 0.7 | Line | Rail. | 2024 |
| I/O in O Incio, of Belesar - La Lomba 220 kV, circuit 1 [2] | 440 | 390 | 0.5 | Line | Rail. | 2023 |

Notes:
1. Section line capacity in DC for I/O 2390/2200.
2. Section line capacity in DC for I/O 440/390 MVA.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_13
## Railway line power supply **Zaragoza-Teruel-Sagunto**

**I General description:**

The reinforcements involves the necessary components for the power supply from the transmission network to the traction substations of the Zaragoza-Teruel-Sagunto railway line:

- Expansion of the Calamocha 220 kV substation.
- Expansion of the Platea 400 kV substation.
- Expansion of the Segorbe 220 kV substation.

**I Drivers / Objectives:**

This reinforcements allows transport electrification, contributing to achieving the objectives set out in the NECP.

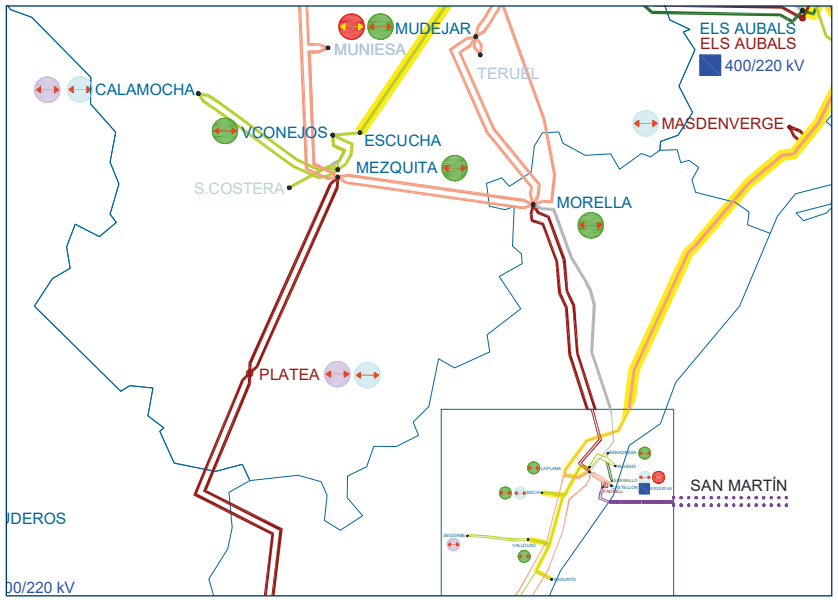
**I Alternatives:**

The power supply points for the railway line have been defined in coordination with ADIF, minimising to the extent possible the distance of the traction substations from existing transmission network infrastructures.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_13
Railway line power supply **Zaragoza-Teruel-Sagunto**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

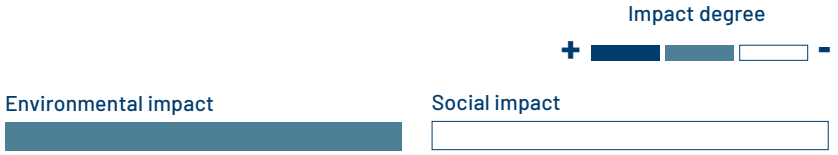
Note: * a negative value means existing increased emissions, losses or ENS.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:



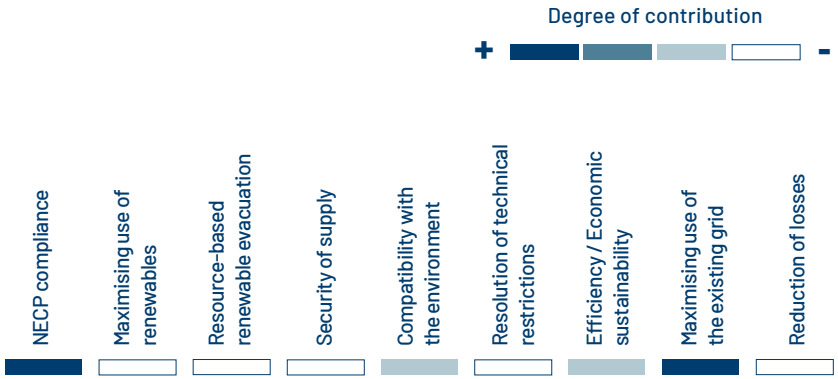

### I Costs:

| CAPEX | OPEX |
|---|---|
| 1.1 M€ | 0.3 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement AF_13
## Railway line power supply **Zaragoza-Teruel-Sagunto**

### Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 4 | 3 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Calamocha 220 kV | 2 | AIS | Rail. | 2024 |
| Platea 400 kV | 2 | AIS | Rail. | 2024 |
| Platea 400 kV | 1 | AIS | TN | 2024 |
| Segorbe 220 kV | 2 | AIS | Rail. | 2023 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_14
## Railway line power supply **Alicante-Crevillente**

**I General description:**

The Reinforcements involves supply from the transmission network to the traction substations of the Alicante- Crevillente railway line:

- Extension of Torrellano 220 kV substation.

**I Drivers / Objectives:**

This reinforcements allows transport electrification, contributing to achieving the objectives set out in the NECP.

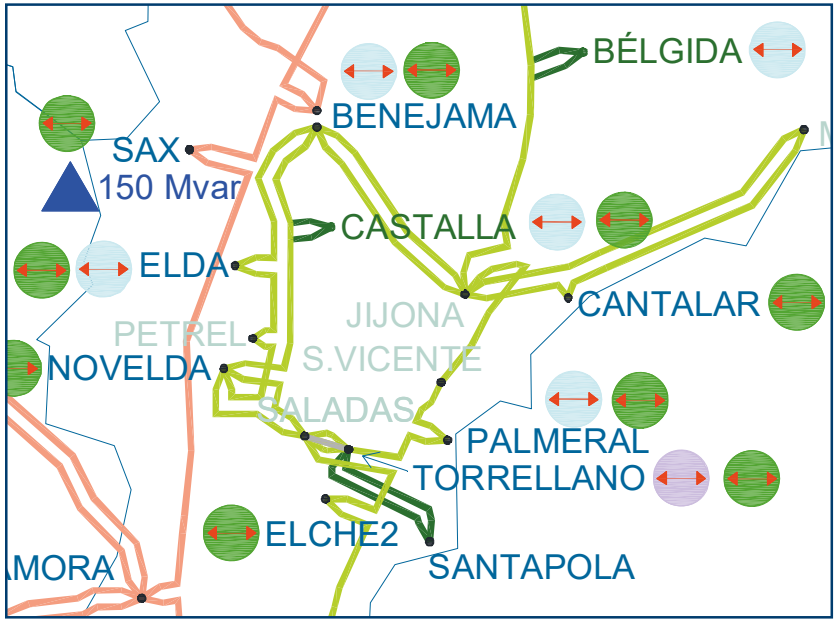
**I Alternatives:**

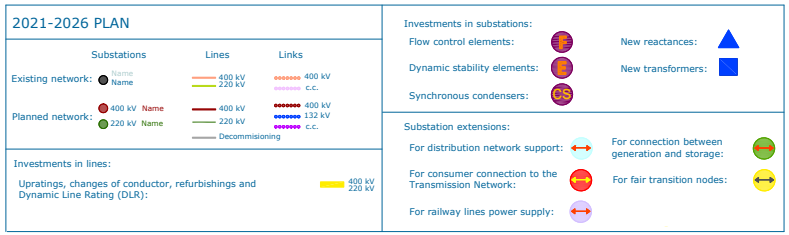
The power supply points for the railway line have been defined in coordination with ADIF, minimising to the extent possible the distance of the traction substations from existing transmission network infrastructures.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement AF_14
## Railway line power supply **Alicante-Crevillente**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| - M€ | 0.05 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:




Environmental impact

Social impact

### I Contribution to guiding principles:







Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement AF_14
## Railway line power supply **Alicante-Crevillente**

### Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 2 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Torrellano 220 kV | 2 | GIS | Rail. | 2024 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-AND
## Distribution network support **Andalucía**

**I General description:**

The development included allows improving the transmission-distribution interface in Andalucía. The following actions are included:

- Extensions of the Baza REE 400 kV, Casillas, Íllora, Guadaira (2), El Zumajo, Saleres (2), Ventilla, Puebla de Guzmán, Entrenúcleos, Benahadux and Chucena 220 kV substations.
- New Guadaira 220 kV substation on I/O of the Don Rodrigo-Aljarafe line.
- New Ventilla 220 kV substation on I/O of the Alhaurín-Jordana line.
- New El Zumajo 220 kV substation and new El Zumajo-Gazules and El Zumajo-Puerto Real lines, which require rearrangement and compacting at the Puerto Real 220 kV exit.
- Change in the layout of the Casillas 220 kV substation.

**I Drivers / Objectives:**

- To improve the security of supply in the Saleres and Íllora area.
- To support future demand in the Chucena, Entrenúcleos, Ventilla, Guadaira and Benahadux areas.
- To provide support for singular demands in the Puebla de Guzmán area.
- To support demand in the Baza area and to facilitate the evacuation of renewables in the distribution network.

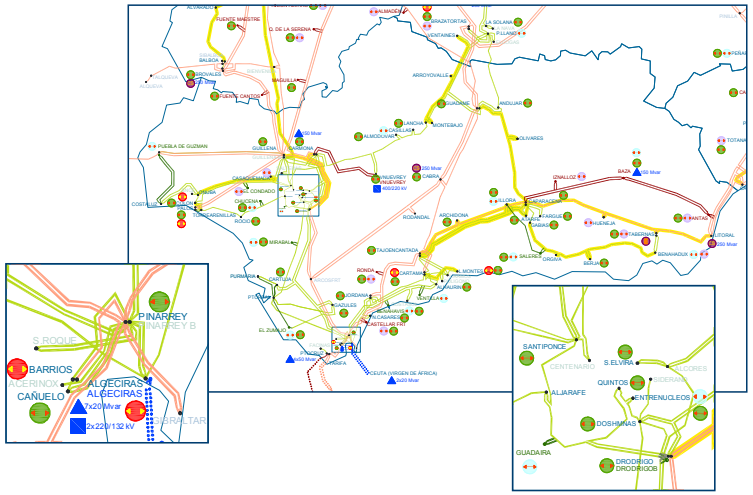
**I Alternatives:**

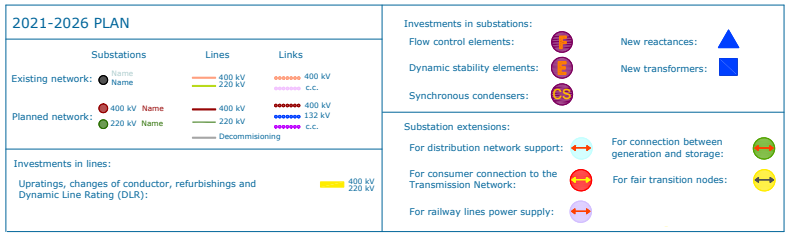
The distribution network manager has assessed alternatives that are more expensive than those proposed. The El Zumajo-Gazules line is built using the 220 kV renewable energy sources evacuation line from the Parralejo substation, therefore requiring a connection to El Zumajo.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-AND
## Distribution network support **Andalucía**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 54.6 M€ | 1.11 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 5.5 | 5.5 | 5.4 | 5.3 | 5.2 | 5.1 | 5.1 | 5.0 | 4.9 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

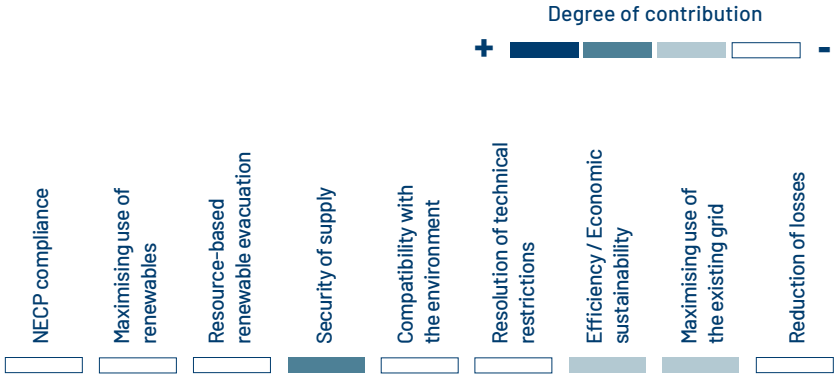
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement APD-AND
## Distribution network support **Andalucía**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 25 | 2 |
| Overhead line (km) | 80 | |
| Cables (km) | 2 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| El Zumajo 220 kV | Outdoor | 2022 |
| Guadaira 220 kV | Outdoor | 2023 |
| Ventilla 220 kV | Building | 2023 |

### I Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Baza REE 400 kV | 1 | AIS | SuD | 2022 |
| Baza REE 400 kV | 1 | AIS | TN | 2022 |
| Benahadux 220 kV | 1 | GIS | SuD | 2020 |
| Casillas 220 kV | 1 | AIS | TN | 2022 |
| Casillas 220 kV | 1 | AIS | SuD | 2022 |
| Chucena 220 kV | 1 | AIS | SuD | 2022 |
| El Zumajo 220 kV | 1 | AIS | SuD | 2022 |
| El Zumajo 220 kV [1] | 1 | AIS | Gen./Sto. | 2022 |
| El Zumajo 220 kV | 3 | AIS | TN | 2022 |
| Entrenúcleos 220 kV | 1 | AIS | SuD | 2022 |
| Guadaira 220 kV | 2 | AIS | SuD | 2023 |
| Guadaira 220 kV | 3 | AIS | TN | 2023 |
| Íllora 220 kV | 1 | AIS | SuD | 2022 |
| Puebla de Guzmán 220 kV | 1 | AIS | SuD | 2022 |
| Puerto Real 220 kV | 2 | AIS | TN | 2022 |
| Saleres 220 kV | 2 | AIS | SuD | 2024 |
| Ventilla 220 kV | 1 | GIS | SuD | 2023 |
| Ventilla 220 kV | 3 | GIS | TN | 2023 |

Notes:
1. Due to the use of Parralejo-Gazules for the new El Zumajo-Gazules 220 kV line.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-AND
## Distribution network support **Andalucía**

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Casillas - Almodóvar del Rio 220 kV, circuit 1 [1] | 440 | 340 | 0.1 | Cable | TN | 2026 |
| Casillas - Lancha 220 kV, circuit 1 [2] | 440 | 340 | 0.1 | Cable | TN | 2026 |
| DC El Zumajo - Gazules 220 kV [3] | 396 | 290 | 0.2 | Line | TN | 2022 |
| DC Puerto Real - Puerto Real 220 kV [4 5] | | | 3 | Line | TN | 2022 |
| I/O in Guadaira, of Aljarafe - Don Rodrigo 220 kV, circuit 1 [6] | 420 | 340 | 4 | Line | TN | 2023 |
| I/O in Ventilla, of Alhaurín - Jordana 220 kV, circuit 1 | 420 | 360 | 0.5 | Cable | TN | 2023 |
| I/O in Ventilla, of Alhaurín - Jordana 220 kV, circuit 1 [7] | 420 | 360 | 13 | Line | TN | 2023 |
| El Zumajo - Puerto Real 220 kV, circuit 1 [8] | 600 | 600 | 38 | Line | TN | 2022 |
| Puebla de Guzmán - Puebla de Guzmán 220 kV [9] | | | 1 SSC | Cable | TN | 2022 |
| Puerto Real - Puerto Real 220 kV, circuit 1 [10] | | | 1 | Line | TN | 2022 |
| Ventilla - Ventilla 220 kV [9] | | | 1 SSC | Cable | TN | 2023 |

| New adjustments to OP | Year |
|---|---|
| Casillas 220 kV | |

Notes:
1. Cable connection of a section at the entrance of the Casillas 220 kV substation (Casillas - Almodóvar 220 kV).
2. Cable connection of a section at the entrance of the Casillas 220 kV substation (Casillas - Lancha 220 kV).
3. Use of Parralejo-Gazules 220 kV. Double circuit with installation of the first circuit.
4. Compacting on arrival at SE Puerto Real 220 kV from Algeciras - Puerto Real 220 kV and Gazules - Puerto Real 220 kV.
5. Compacting on arrival at the Dos Hermanas-Puerto Real 220 kV Dos Hermanas-Puerto Real 220 kV and El Zumajo-Puerto Real 220 kV substations in SE Puerto Real 220 kV.
6. Section line capacity in DC for I/O 850/700 MVA.
7. Section line capacity in DC for I/O 850/730 MVA.
8. Lines rearrangement and compacting in the area surrounding SE Puerto Real 220 kV required.
9. Short section of cable inside the substation.
10. New section of line required at the Puerto Real end of Algeciras-Puerto Real 220 kV to reach the junction point with Gazules-Puerto Real 220 kV.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-ARA
## Distribution network support **Aragón**

**I General description:**

The development included allows improving the transmission-distribution interface in Aragón:

- Expansion of the Peñaflor 220 kV substation.
- Expansion of the Hijar 220 kV substation.
- Expansion of the Cinca 220 kV substation.
- Expansion of the Esquedas 220 kV substation.
- Expansion of the Calamocha 220 kV substation.
- Expansion of the Los Vientos 220 kV substation.
- Expansion of the Platea 400 kV substation.

**I Drivers / Objectives:**

- To support demand in Cinca when there are faults in the existing transmission-distribution network.
- To support unique demand in the area of the Esquedas distribution network.
- To support demand in the areas of Peñaflor, Hijar, Calamocha, Los Vientos and Platea, and facilitating the evacuation of renewable energy into the distribution network.

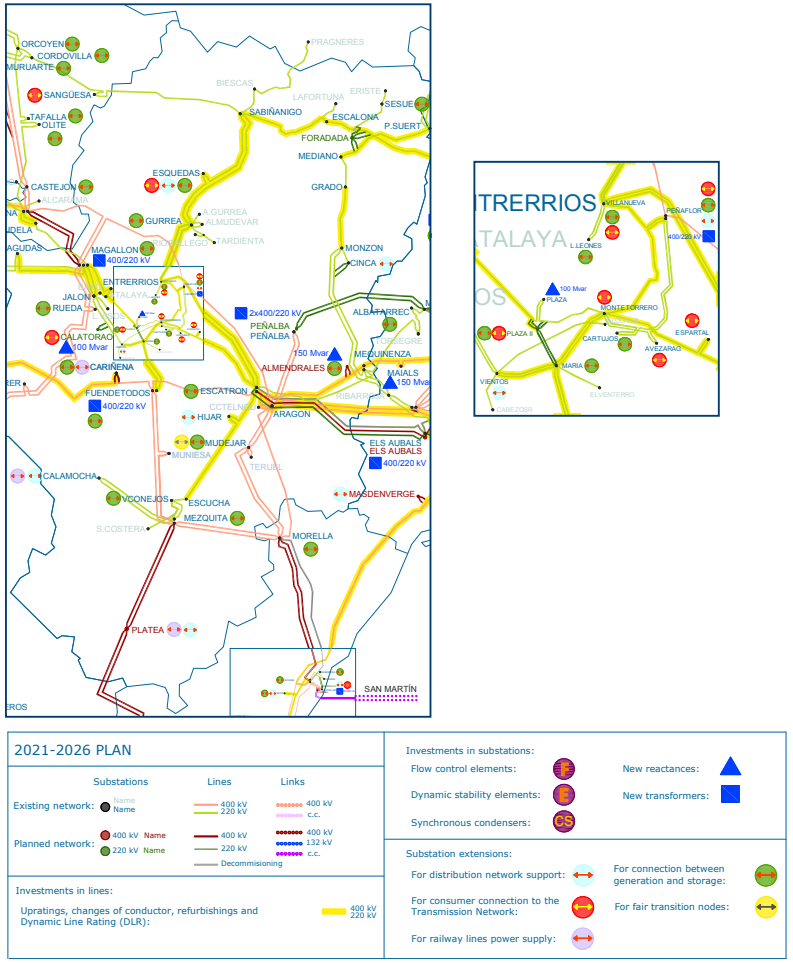
**I Alternatives:**

No feasible alternatives have been identified in the distribution network by the distribution network manager in any of the cases.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-ARA
## Distribution network support **Aragón**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 13.9 M€ | 0.34 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 |

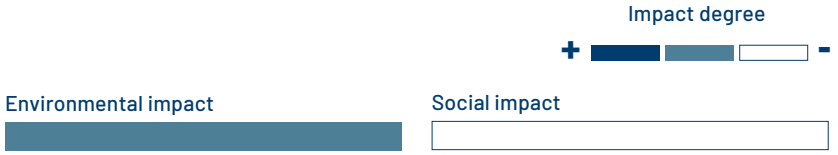
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

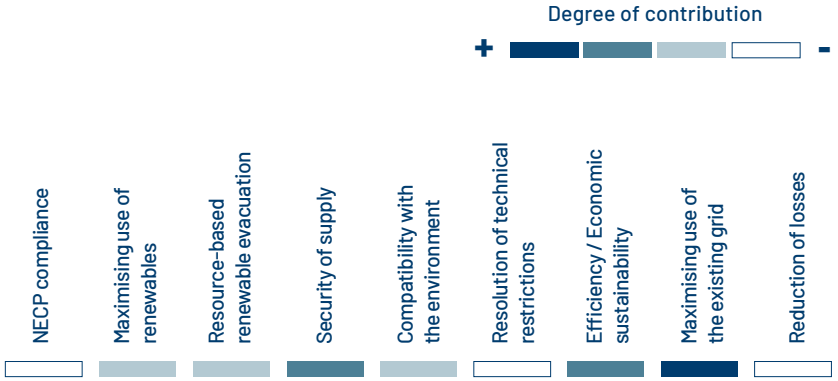
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-ARA
## Distribution network support **Aragón**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 7 | 2 |
| Overhead line (km) | 0.2 | 0.5 |
| Cables (km) | 1 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Calamocha 220 kV | 1 | AIS | SuD | 2022 |
| Cinca 220 kV | 1 | GIS | SuD | 2022 |
| Cinca 220 kV | 1 | GIS | SuD | 2025 |
| Esquedas 220 kV | 1 | AIS | SuD | 2022 |
| Hijar 220 kV | 1 | AIS | SuD | 2022 |
| Los Vientos 220 kV | 1 | AIS | SuD | 2022 |
| Peñaflor 220 kV | 1 | AIS | SuD | 2022 |
| Platea 400 kV | 1 | AIS | SuD | 2024 |
| Platea 400 kV | 1 | AIS | TN | 2024 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Calamocha - Calamocha 220 kV [1] | | | 1 SSL | Line | SuD | 2024 |
| Cinca - Cinca 220 kV [2] | | | 1 SSC | Cable | SuD | 2022 |
| Cinca - Cinca 220 kV [2] | | | 1 SSC | Cable | SuD | 2025 |
| Esquedas - Esquedas 220 kV [2] | | | 1 SSC | Cable | SuD | 2022 |
| Los Vientos - Los Vientos 220 kV [2] | | | 1 SSC | Cable | SuD | 2022 |
| Platea - Platea 400 kV [1] | | | 1 SSL | Line | SuD | 2024 |

Notes:
1. Short section of line inside the substation.
2. Short section of cable inside the substation.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-AST
## Distribution network support **Asturias**

**I General description:**

The development included allows improving the transmission-distribution interface in Asturias:

- Expansion of the Pesoz 400 kV substation and the new Pesoz-Sanzo 400 kV line.
- New Ortiguero 220 kV substation in I/O of the Siero-Puente San Miguel 220 kV line.
- Expansion of the Ortiguero 220 kV substation.

**I Drivers / Objectives:**

To improve the security of supply as well as to facilitate the evacuation of renewables in the distribution network in the western part of Asturias.

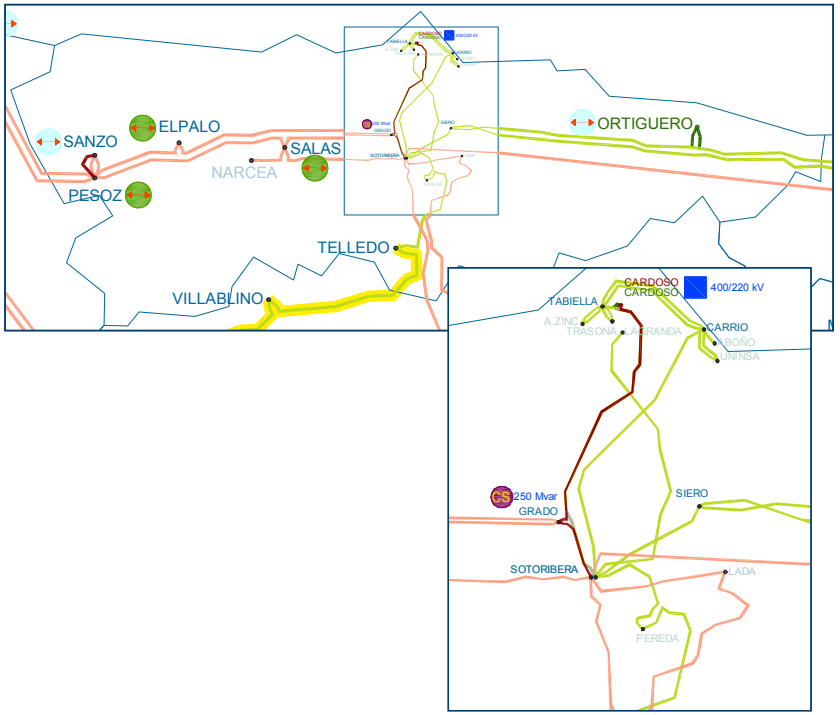
**I Alternatives:**

Alternatives in the distribution network have been assessed by the distribution network managers at a higher cost than the alternatives proposed in the transmission network.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-AST
## Distribution network support **Asturias**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 9.7 M€ | 0.16 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.8 | 0.8 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

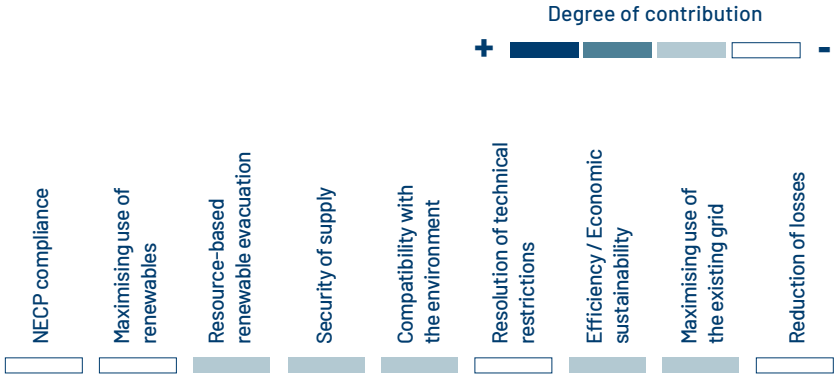
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement APD-AST
## Distribution network support **Asturias**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 4 | 1 |
| Overhead line (km) | 4 | 2 |
| Cables (km) | 0.1 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Ortiguero 220 kV | Building | 2023 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Ortiguero 220 kV | 1 | GIS | SuD | 2023 |
| Ortiguero 220 kV | 3 | GIS | TN | 2023 |
| Pesoz 400 kV | 1 | AIS | TN | 2022 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Ortiguero, of Siero - Puente San Miguel 220 kV, circuit 1 [1] | 470 | 380 | 2 | Line | SuD | 2023 |
| Ortiguero - Ortiguero 220 kV [2] | | | 1 SSC | Cable | SuD | 2023 |
| Pesoz - Sanzo 400 kV, circuit 3 | 2,430 | 2,230 | 2 | Line | SuD | 2023 |

Notes:
1. Section line capacity in DC for I/O 880/800 MVA.
2. Short section of cable inside the substation.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-CAN
## Distribution network support **Cantabria**

**I General description:**

The development included allows improving the transmission-distribution interface in Cantabria area:

- Expansion of the Cacicedo 220 kV substation.
- Expansion of the Mataporquera 220 kV substation.

**I Drivers / Objectives:**

- Enabling the improvement of the security of supply of the city of Santander and supporting the natural growth of demand even when there are faults in the existing transmission-distribution system.
- Facilitating the evacuation of renewables into the distribution network in the region of Mataporquera.

**I Alternatives:**

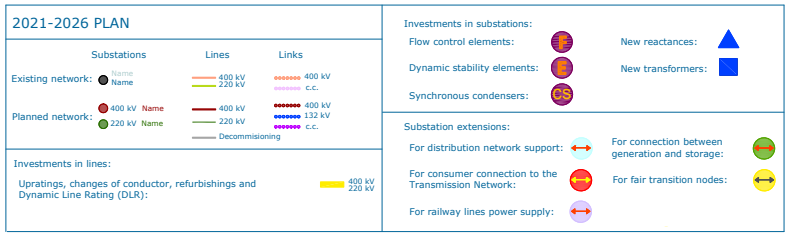
Alternatives in the distribution network have been assessed by the distribution network managers at a higher cost than the Alternatives proposed in the transmission network.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-CAN
## Distribution network support **Cantabria**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 5.5 M€ | 0.12 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.6 | 0.6 | 0.6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:




Environmental impact

Social impact

### I Contribution to guiding principles:







Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement APD-CAN
## Distribution network support **Cantabria**

### Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 5 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Cacicedo 220 kV | 1 | GIS | SuD | 2022 |
| Cacicedo 220 kV | 1 | GIS | TN | 2022 |
| Cacicedo 220 kV [1,2] | 2 | GIS | TN | 2023 |
| Mataporquera 220 kV | 1 | GIS | SuD | 2022 |

Notes:
1. Additional circuit breaker to complete TB1.
2. Additional circuit breaker to complete TB2.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-CAT
## Distribution network support **Cataluña**

**I General description:**

The development included allows improving the transmission-distribution interface in Cataluña:

- Expansion of the Puigpelat, Vic and Cerdá 220 kV substations.
- New Masdenverge 400 kV substation with input-output in Vandellós-La Plana.
- New Valdonzella 220 kV substation and expansion. Input-output in Valldonzella 220 kV for Vilanova-Mata 220 kV (>2026).
- Expansion of the Garraf and Masdenverge 400 kV substation.
- Relocation of ES Collblanc 220 kV to Can Rigalt 220 kV, on the condition that the party interested in the transfer covers the entirety of the reinforcements costs, in accordance with section 3 of article 154 of Royal Decree 1955/2000 of 1 December.

**I Drivers / Objectives:**

- Supporting existing and future demand, including unique consumption in Puigpelat, Masdenverge and Garraf to enable their suitable supply.
- Supporting the supply and natural growth of demand in the region of Cerdá and Valdonzella.
- Bolstering the transmission-distribution interface to cover demand in the Vic area.

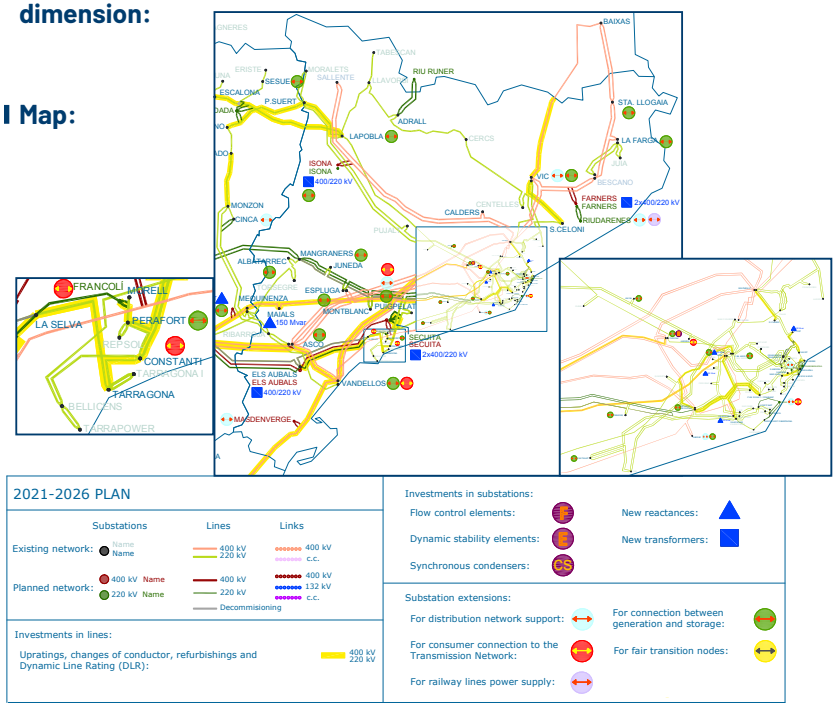
**I Alternatives:**

The distribution network operator has assessed alternatives in the Riudarenes, Camarles and Valdonzella distribution network, which proved to be more costly than those considered for the transmission grid. In Camarles, the selected alternative was found to be the optimum choice following a joint study with the distribution network operator. In all other reinforcements, the distribution network operator did not identify viable alternatives in the distribution network.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-CAT
## Distribution network support **Cataluña**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 26.2 M€ | 0.75 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 2.9 | 2.8 | 2.8 | 2.8 | 2.7 | 2.7 | 2.6 | 2.6 | 2.6 |

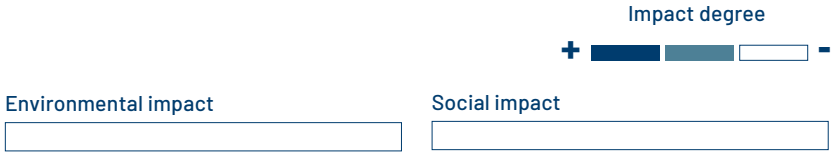
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

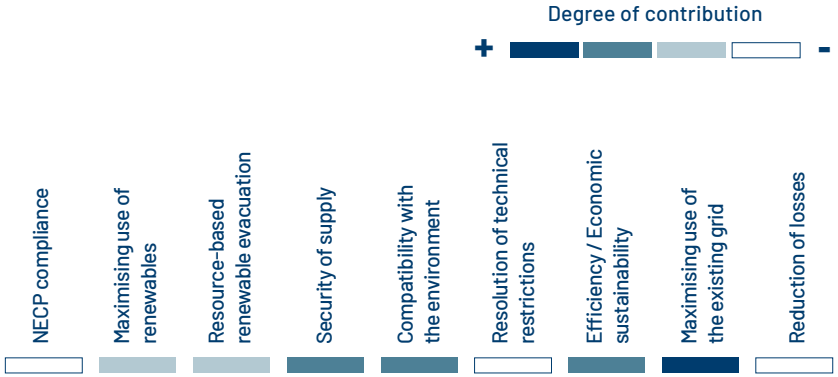
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement APD-CAT
## Distribution network support **Cataluña**

### Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 18 | 6 |
| Overhead line (km) | | 0.5 |
| Cables (km) | 6 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Can Rigalt 220 kV [1] | Building | 2026 |
| Masdenverge* 400 kV | Outdoor | 2022 |
| Valldonzella 220 kV | Building | > 2026 |

Notes:
1. On the condition that the party interested in the transfer covers the entirety of the reinforcements costs, in accordance with that stipulated in section 3 of article 154 of Royal Decree 1955/2000 of 1 December. Requiring the decommissioning of the Collblanc 220 kV ES.
* Name of the electrical substation (ES) updated in the modifications of specific items.

### Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Can Rigalt 220 kV [1] | 4 | GIS | SuD | 2026 |
| Can Rigalt 220 kV [2] | 6 | GIS | TN | 2026 |
| Cerdá 220 kV | 1 | GIS | SuD | 2022 |
| Garraf 400 kV | 1 | AIS | SuD | 2022 |
| Masdenverge* 400 kV | 4 | AIS | TN | 2022 |
| Masdenverge* 400 kV | 1 | AIS | SuD | 2022 |
| Puigpelat 220 kV | 1 | GIS | SuD | 2021 |
| Valldonzella 220 kV | 2 | GIS | SuD | > 2026 |
| Valldonzella 220 kV | 3 | GIS | TN | > 2026 |
| Vic 220 kV | 1 | AIS | SuD | 2019 |

Notes:
1. Expansion of the ES via relocation from Collblanc 220 kV to Can Rigalt 220 kV.
2. Bays required for the topological changes.
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-CAT
## Distribution network support **Cataluña**

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Begues - Can Rigalt 220 kV, circuit 1 [1] | 500 | 500 | 0.5 | Cable | TN | 2026 |
| Begues - Can Rigalt 220 kV, circuit 2 [2] | 500 | 500 | 0.5 | Cable | TN | 2026 |
| Can Jardi - Can Rigalt 220 kV, circuit 1 [3] | 500 | 500 | 0.5 | Cable | TN | 2026 |
| I/O in Masdenverge*, of Vandellós - La Plana 400 kV, circuit 1 [4 5] | | | 0.5 | Line | SuD | 2022 |
| I/O in Valldonzella, of Vilanova - Mata 220 kV, circuit 1 | 400 | 400 | 2 | Cable | SuD | >2026 |
| Facultats - Can Rigalt 220 kV, circuit 1 [6] | 500 | 500 | 0.5 | Cable | TN | 2026 |
| Urgell - Can Rigalt 220 kV, circuit 1 [7] | 500 | 500 | 0.5 | Cable | TN | 2026 |

Notes:
1. Topological change with commissioning at Begues-Can Rigalt 1 220 kV and decommissioning at Begues-Collblanc 1 220 kV.
2. Topological change with commissioning at Begues-Can Rigalt 2 220 kV and decommissioning at Begues-Collblanc 2 220 kV.
3. Topological change with commissioning at Can Jardi-Can Rigalt 220 kV and decommissioning at Can Jardi-Collblanc 220 kV.
4. No line capacity (VD) indicated as it has a dynamic monitoring system. I/O is executed via two single circuit sections.
5. No line capacity (VD) indicated as it has a dynamic monitoring system. I/O is executed via two single circuit sections.
6. Topological change with commissioning at Facultat-Can Rigalt 220 kV and decommissioning at Facultat-Collblanc 220 kV.
7. Topological change with commissioning at Urgell-Can Rigalt 220 kV and decommissioning at Urgell-Collblanc 220 kV.

* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-CLM
## Distribution network support **Castilla-La Mancha**

**I General description:**

The development included allows improving the transmission-distribution interface in Castilla-La Mancha:

- Expansion of the Manchega and Minglanilla 400kV substations.
- Expansion of the Torrijos and Puertollano 220kV substations.
- Expansion of the Huelves and Talavera 220kV substations (>2026).

**I Drivers / Objectives:**

- Facilitating improved security of supply in Torrijos, Puertollano, Huelves and Talavera.
- Supporting demand in the areas of Manchega and Minglanilla, and facilitating the evacuation of renewable energy into the distribution network.

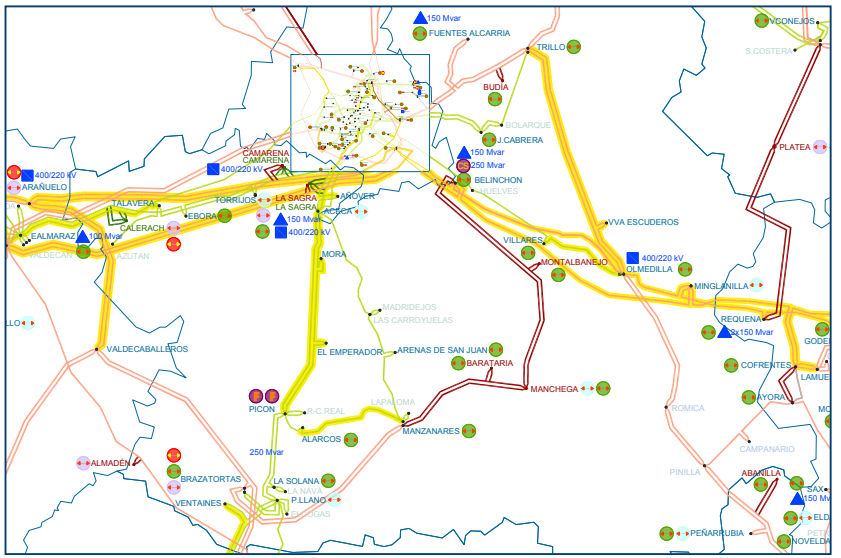
**I Alternatives:**

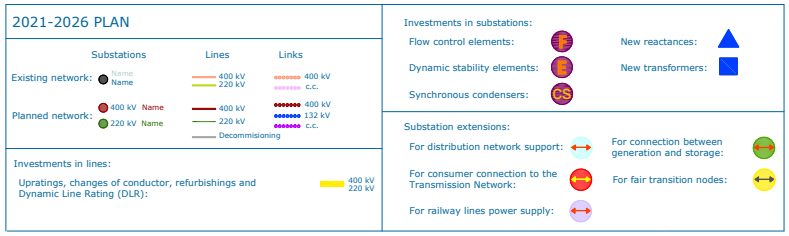
The distribution network operator assessed alternatives in the distribution network. These either proved to be more costly than those considered for the transmission grid or no viable alternatives were identified.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-CLM
## Distribution network support **Castilla-La Mancha**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 9.6 M€ | 0.3 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:




Environmental impact

Social impact

### I Contribution to guiding principles:







Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-CLM
## Distribution network support **Castilla-La Mancha**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 4 | 3 |
| Cables (km) | 0.2 | 0.3 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Huelves 220 kV | 1 | AIS | SuD | > 2026 |
| Manchega 400 kV | 1 | AIS | SuD | 2025 |
| Minglanilla 400 kV | 1 | AIS | SuD | 2022 |
| Minglanilla 400 kV | 1 | AIS | TN | 2022 |
| Puertollano 220 kV | 1 | AIS | SuD | 2022 |
| Talavera 220 kV | 1 | AIS | SuD | > 2026 |
| Torrijos 220 kV | 1 | AIS | SuD | 2022 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Minglanilla - Minglanilla 400 kV [1] | | | 1 SSC | Cable | SuD | 2022 |
| Torrijos - Torrijos 220 kV [1] | | | 1 SSC | Cable | SuD | 2022 |

Notes:
1. Short section of cable inside the substation.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-CVA
## Distribution network support **Valencia**

**I General description:**

The development included allows improving the transmission-distribution interface in Valencia:

- Expansion of the Sagunto GIS, Morvedre and Bechí (2) 220 kV, El Palmeral and Benejama 400 kV substations.
- New Sancho Llop 220 kV substation in I/O in the Gandía-Valldigna cable, Benilloba 220 kV in I/O in the Jijona-Catadau line and Nuevo Cauce 220 kV in I/O in the Torrente-Patraix cable.
- New Assegador 220 kV substation in I/O in the La Plana-Bechí 220 kV cable and the new La Plana-Assegador 2 line (>2026).
- New double circuit Santa Pola-Torrellano 220 kV.
- Expansion of the Aldaia 220 kV substation (>2026).

**I Drivers / Objectives:**

- Facilitating improved security of supply in Valencia.
- Supporting the natural growth in demand even when there are faults in the existing transmission-distribution system.
- Supplying new unique demand in the region of Morvedre.
- Facilitating the evacuation of renewables into the distribution network.

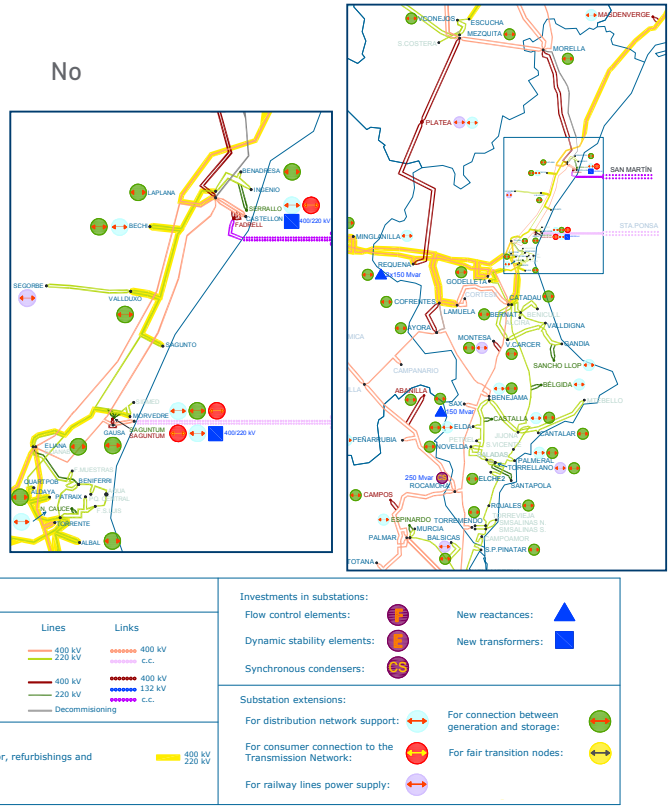
**I Alternatives:**

There are studies undertaken jointly between the system operator and the distribution network operator which conclude that the alternatives included are optimal in Sagunto, Nuevo Cauce and Benilloba. In other reinforcements, the distribution network operator did not identify any viable alternatives.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-CVA
## Distribution network support **Valencia**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

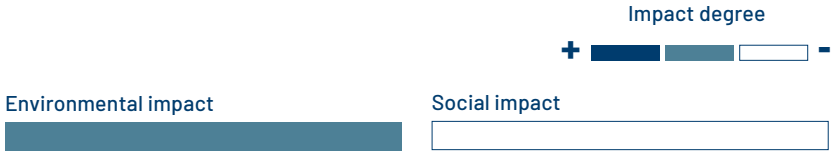
Note: * a negative value means existing increased emissions, losses or ENS.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:



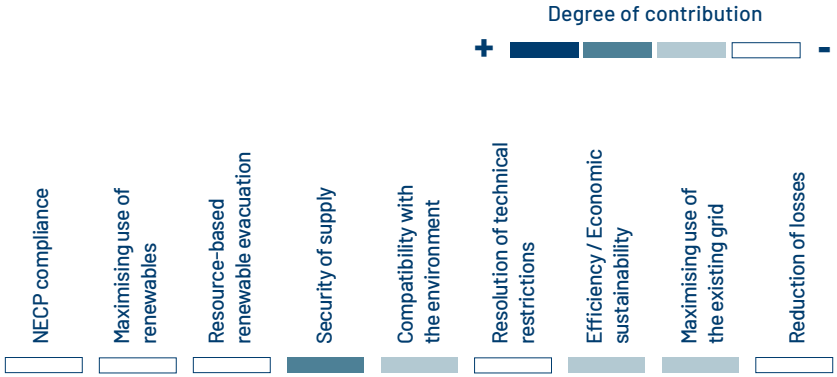

### I Costs:

| CAPEX | OPEX |
|---|---|
| 101.7 M€ | 0.94 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 9.2 | 9.0 | 8.9 | 8.7 | 8.6 | 8.4 | 8.3 | 8.2 | 8.0 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement APD-CVA
## Distribution network support **Valencia**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 29 | 2 |
| Overhead line (km) | 33 | |
| Cables (km) | 20 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Assegador 220 kV | Building | > 2026 |
| Bélgida* 220 kV | Outdoor | 2023 |
| Nuevo Cauce 220 kV | Building | 2023 |
| Sancho Llop 220 kV | Building | 2022 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

### I Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Aldaia 220 kV | 1 | GIS | SuD | > 2026 |
| Assegador 220 kV | 2 | GIS | SuD | > 2026 |
| Assegador 220 kV | 4 | GIS | TN | > 2026 |
| Bechi 220 kV | 2 | GIS | SuD | 2020 |
| Bélgida* 220 kV | 1 | AIS | SuD | 2023 |
| Bélgida* 220 kV | 3 | AIS | TN | 2023 |
| Benejama 400 kV | 1 | AIS | TN | 2022 |
| Benejama 400 kV | 1 | AIS | SuD | 2022 |
| El Palmeral 220 kV | 1 | GIS | SuD | 2022 |
| La Plana 220 kV | 1 | AIS | TN | > 2026 |
| Morvedre 220 kV | 1 | GIS | SuD | 2020 |
| Nuevo Cauce 220 kV | 2 | GIS | SuD | 2023 |
| Nuevo Cauce 220 kV | 3 | GIS | TN | 2023 |
| Sagunto Gis 220 kV | 1 | GIS | TN | 2022 |
| Sancho Llop 220 kV | 2 | GIS | SuD | 2022 |
| Sancho Llop 220 kV | 3 | GIS | TN | 2022 |
| Torrellano 220 kV | 2 | GIS | TN | 2023 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-CVA
## Distribution network support **Valencia**

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Aldaia - Aldaia 220 kV [1] | | | 1 SSC | Cable | SuD | > 2026 |
| Bechi-Bechi 220 kV [1] | | | 1 SSC | Cable | SuD | 2022 |
| DC Nuevo Cauce - Nuevo Cauce [1] | | | 1 SSC | Cable | SuD | 2023 |
| DC Santa Pola - Torrellano 220 kV | 450 | 450 | 9 | Line | SuD | 2023 |
| DC Santa Pola - Torrellano 220 kV | 450 | 450 | 4.5 | Cable | SuD | 2023 |
| El Palmeral-El Palmeral [1] | | | 1 SSC | Cable | SuD | 2022 |
| I/O in Assegador, of La Plana - Bechi 220 kV, circuit 1 | 460 | 320 | 1 | Cable | SuD | > 2026 |
| I/O in Bélgida*, of Jijona - Catadau 220 kV, circuit 1 | 340 | 230 | 3 | Line | SuD | 2023 |
| I/O in Nuevo Cauce, of Torrente - Patraix 220 kV, circuit 1 | 468 | 468 | 2 | Cable | SuD | 2023 |
| I/O in Sancho Llop, of Gandía - Valldigna 220 kV, circuit 1 | 460 | 300 | 2 | Cable | SuD | 2022 |
| La Plana - Assegador 220 kV, circuit 2 | 460 | 320 | 0.2 | Cable | SuD | > 2026 |
| La Plana - Assegador 220 kV, circuit 2 | 460 | 320 | 9 | Line | SuD | > 2026 |
| Morvedre - Morvedre 220 kV [1] | | | 1 SSC | Cable | SuD | 2022 |
| Sagunto GIS - Sagunto 220 kV, circuit 1 | | | 0.3 | Cable | SuD | 2022 |
| Sancho Llop - Sancho Llop 220 kV [1] | | | 1 SSC | Cable | SuD | 2022 |

Notes:
1. Short section of cable inside the substation.
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-CYL
## Distribution network support **Castilla y León**

**I General description:**

The development included allows improving the transmission-distribution interface in Castilla y León:

- Expansion of the Villarino 220 kV, Alcocero de Mola 220 kV, Zaratán 220 kV, Vilecha 400 kV (>2026) and Saucelle 220 kV substations.
- New Zuzones 400 kV substation with input-output in the La Mudarra-Almazán 400 kV line. Expansion of the Zuzones 400 kV substation.
- New Villatoro 220 kV substation with input-output in the Villalbilla-T Ayala 220 kV line.

**I Drivers / Objectives:**

Enable improved reliability and security of supply in the regions of Villarino, Alcocero de Mola, Vilecha, Villatoro y Zuzones, and facilitate the evacuation of renewables into the distribution network.

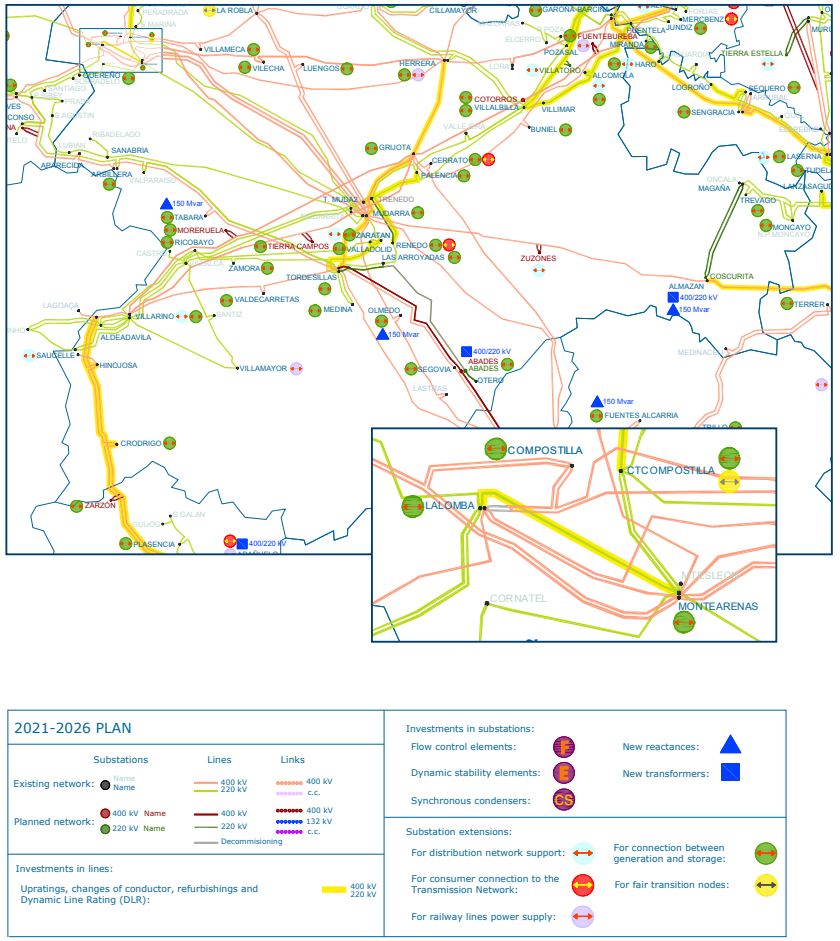
**I Alternatives:**

The distribution network operators assessed alternatives which proved to be more costly than those considered to support for the transmission grid.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-CYL
Distribution network support **Castilla y León**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 21.9 M€ | 0.6 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 2.4 | 2.3 | 2.3 | 2.3 | 2.3 | 2.2 | 2.2 | 2.2 | 2.1 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

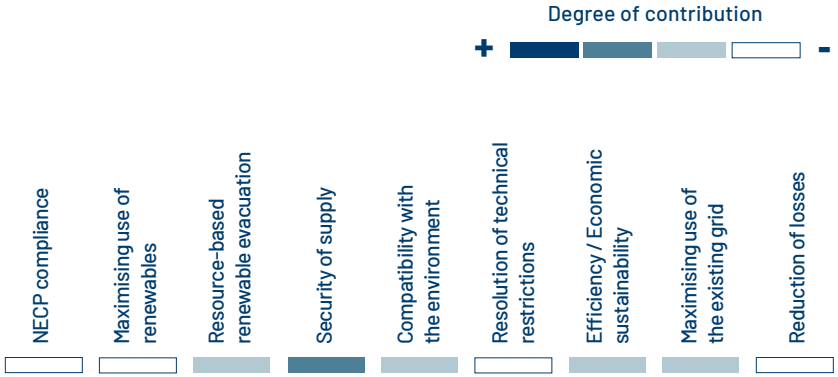
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement APD-CYL
## Distribution network support **Castilla y León**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 8 | 7 |
| Overhead line (km) | 6 | 7 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

| New substations | Type | Year |
|---|---|---|
| Villatoro 220 kV | Building | 2023 |
| Zuzones* 400 kV | Outdoor | 2023 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

### I Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Alcocero de Mola 220 kV | 1 | AIS | SuD | 2022 |
| Ciudad Rodrigo 400 kV | 1 | AIS | TN | 2026 |
| Saucelle 220 kV | 1 | AIS | SuD | 2022 |
| Vilecha 400 kV | 1 | AIS | SuD | > 2026 |
| Villarino 220 kV | 1 | AIS | SuD | 2022 |
| Villatoro 220 kV | 3 | GIS | TN | 2023 |
| Villatoro 220 kV | 1 | GIS | SuD | 2023 |
| Zaratán 220 kV | 1 | AIS | SuD | 2022 |
| Zuzones* 400 kV | 4 | AIS | TN | 2023 |
| Zuzones* 400 kV | 1 | AIS | SuD | 2023 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Villatoro, de Villalbilla - T de Ayala 1 220 kV, circuit 1 | 500 | 420 | 3 | Line | SuD | 2023 |
| I/O in Zuzones *, of Almazán - Mudarra 400 kV, circuit 1[1] | 1,830 | 1,540 | 3 | Line | SuD | 2023 |
| DC Zuzones - Zuzones 400 kV[2] | | | 1 SSL | Line | SuD | 2023 |

Notes:
1. Section line capacity in DC for I/O 2400/2000 MVA.
2. Short section of cable inside the substation.
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-EXT
## Distribution network support **Extremadura**

**I General description:**

The development included allows improving the transmission-distribution interface in Extremadura:

- New Los Arenales 220 kV substation and new Cáceres-Los Arenales 220 kV and Los Arena- les-Trujillo 220 kV cables-lines.
- New Los Arenales-José María Oriol NP 220 kV line.
- Expansion of the Los Arenales 220 kV substation.
- Expansion of the Trujillo 220 kV substation.
- Expansion of the Quintana de La Serena 400 kV substation (>2026).

**I Drivers / Objectives:**

- Supporting demand in the region of Cáceres that cannot be met by the distribution network as a result of the use of the Cáceres-Trujillo 132 kV line for the new Los Arena- les-Trujillo 220 kV line.
- Supporting the transmission-distribution interface to ensure supply for new demand in the region of Quintana de La Serena, as well as allowing for the integration of existing and future renewables in the region.

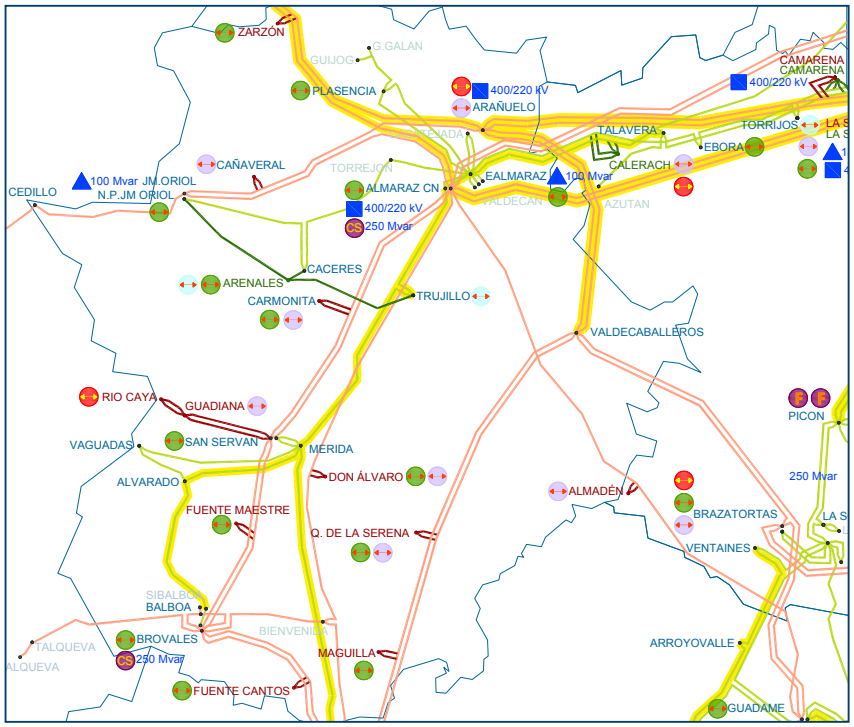
**I Alternatives:**

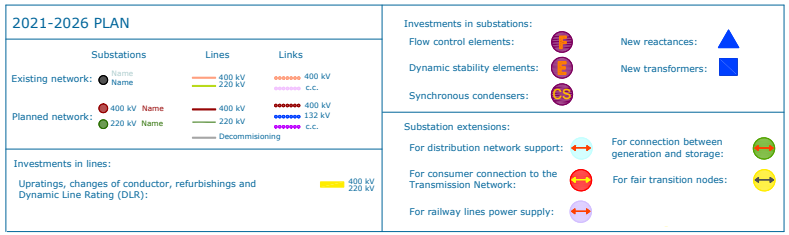
Alternatives in the distribution network have been assessed by the distribution network managers at a higher cost than the Alternatives proposed in the transmission network.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-EXT
## Distribution network support **Extremadura**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 67.7 M€ | 0.49 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 6.0 | 5.9 | 5.8 | 5.7 | 5.6 | 5.5 | 5.4 | 5.3 | 5.2 |

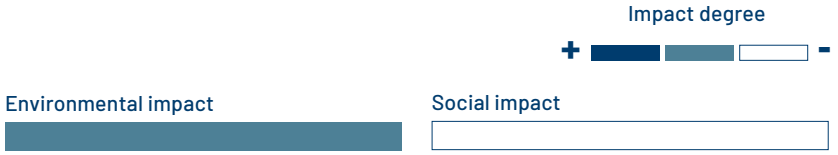
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

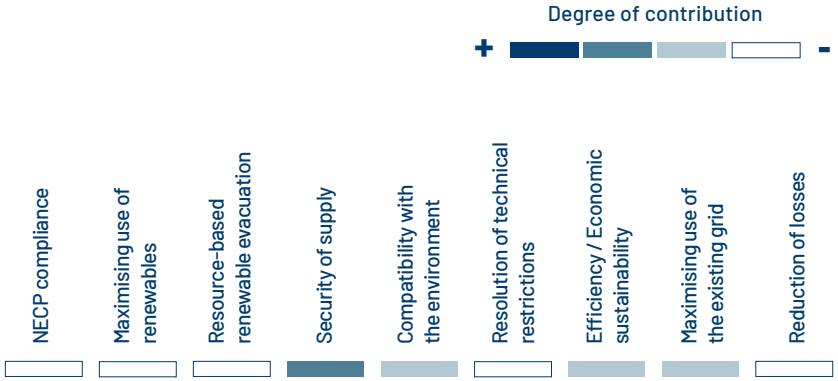
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement APD-EXT
## Distribution network support **Extremadura**

### I Table of physical units:

| | 220 kV | 400 KV |
|---|---|---|
| Bays (units) | 9 | 1 |
| Overhead line (km) | 102 | |
| Cables (km) | 9 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Los Arenales 220 kV | Outdoor | 2021 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Cáceres 220 kV | 1 | AIS | TN | 2022 |
| José María de Oriol N.P. 220 kV | 1 | AIS | TN | 2021 |
| Los Arenales 220 kV | 1 | AIS | SuD | 2022 |
| Los Arenales 220 kV | 2 | AIS | TN | 2022 |
| Los Arenales 220 kV | 2 | AIS | TN | 2021 |
| Trujillo 220 kV | 1 | GIS | TN | 2022 |
| Trujillo 220 kV | 1 | GIS | SuD | 2022 |
| Quintana de La Serena 400 kV | 1 | AIS | SuD | >2026 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Cáceres - Los Arenales 220 kV, circuit 1 | 374 | 374 | 4 | Cable | TN | 2022 |
| Cáceres - Los Arenales 220 kV, circuit 1 | 374 | 374 | 5 | Line | TN | 2022 |
| DC Jose María de Oriol N.P. - Los Arenales 220 kV [1] | 863 | 714 | 50 | Line | TN | 2021 |
| Trujillo - Los Arenales 220 kV, circuit 1 | 450 | 450 | 4 | Cable | TN | 2022 |
| Trujillo - Los Arenales 220 kV, circuit 1 | 450 | 450 | 47 | Line | TN | 2022 |
| Trujillo - Trujillo 220 kV [2] | | | 1 SSC | Cable | SuD | 2022 |

Notes:
1. Double circuit with first circuit laid.
2. Short section of line inside the substation.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-GAL
## Distribution network support **Galicia**

**I General description:**

The development included allows improving the transmission-distribution interface in Galicia:

- Expansion of the Tomeza 220 kV substation.
- Expansion of the Boimente 400 kV substation.

**I Drivers / Objectives:**

To improve security of supply in the Tomeza area and facilitate the evacuation of renewables from the distribution network in the Boimente area.

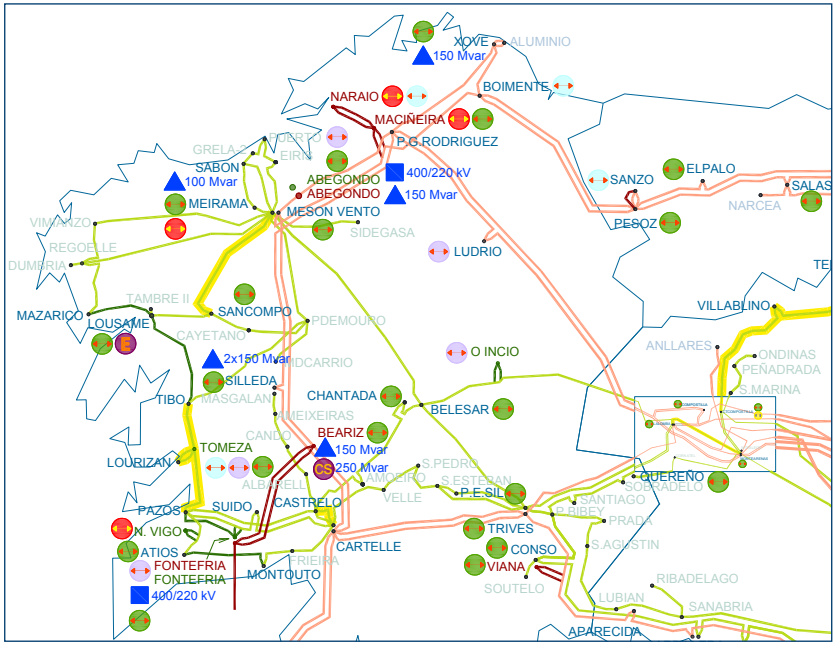
**I Alternatives:**

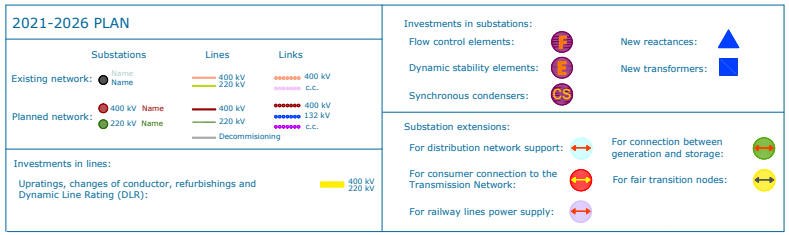
Alternatives in the distribution network have been assessed by the distribution network managers at a higher cost than the alternatives proposed in the transmission network.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-GAL
Distribution network support **Galicia**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 6.7 M€ | 0.07 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.5 | 0.5 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:




Environmental impact

Social impact

### I Contribution to guiding principles:







Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement APD-GAL
## Distribution network support **Galicia**

### Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 1 | 1 |
| Cables (km) | 0.1 | 0.2 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Boimente 400 kV | 1 | AIS | SuD | 2020 |
| Tomeza 220 kV | 1 | GIS | SuD | 2022 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Boimente - Boimente 400 kV, circuit [1] | | | 1 SSC | Cable | TN | 2022 |
| Tomeza - Tomeza 220 kV [1] | | | 1 SSC | Cable | SuD | 2022 |

Notes:
1. Short section of cable inside the substation.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-IBA
## Distribution network support **Islas Baleares**

**I General description:** The development included allows improving the transmission-distribution interface in Islas Baleares:

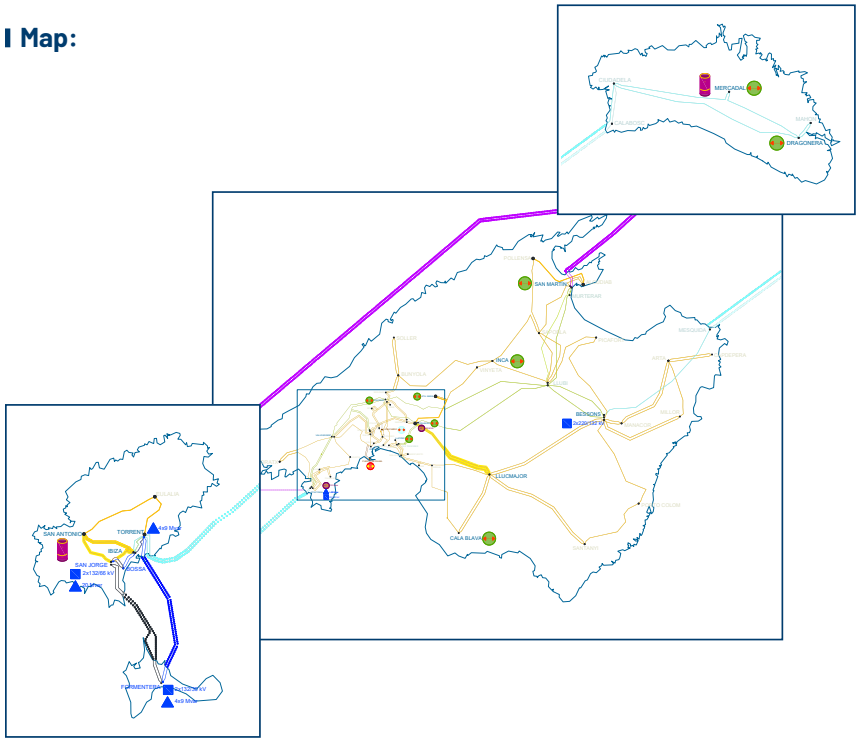
- Expansion of the Son Pardo 66 kV substation.
- New Son Noguera 66kV substation with input-output in the Arenal-Lluçmajor line (> 2026).

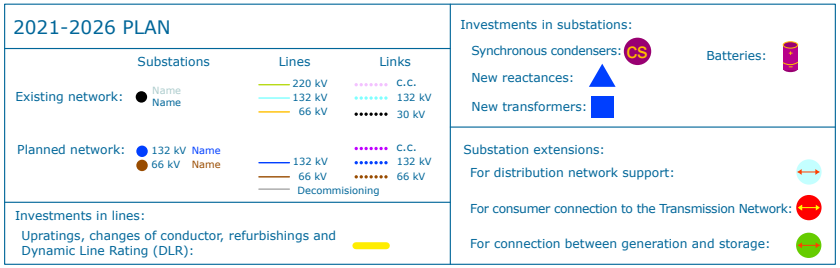
**I Drivers / Objectives:** Supporting existing demand and natural growth in the concerned areas.

**I Alternatives:** For Son Pardo and Son Noguera, the distribution network operators assessed alternatives to strengthen the distribution network which proved to be more costly than those considered to support for the transmission grid.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-IBA
## Distribution network support **Islas Baleares**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 7.5 M€ | 0.08 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:




Environmental impact

Social impact

### I Contribution to guiding principles:







Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-IBA
## Distribution network support **Islas Baleares**

### I Table of physical units:

| | 66 kV | 132 kV |
|---|---|---|
| Bays (units) | 1 | 3 |
| Overhead line (km) | | 2 |
| Cables (km) | | 2 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Son Noguera 132 kV [1] | Building | > 2026 |

Notes:
1. Prepared with 132 kV insulation although initially operating at 66 kV.

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Son Noguera 132 kV [1] | 2 | GIS | TN | > 2026 |
| Son Noguera 132 kV [1] | 1 | GIS | SuD | > 2026 |
| Son Pardo 66 kV | 1 | GIS | SuD | 2023 |

Notes:
1. Prepared with 132 kV insulation although initially operating at 66 kV.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Son Noguera, of Arenal - Llucmajor 132 kV, circuit 1 [1] | 82 | 55 | 0.9 | Line | SuD | > 2026 |
| I/O in Son Noguera, of Arenal - Llucmajor 132 kV, circuit 1 [1] | 82 | 55 | 1 | Cable | SuD | > 2026 |

Notes:
1. Prepared with 132 kV insulation although initially operating at 66 kV.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-ICA
## Distribution network support **Islas Canarias**

**I General description:**

The development included allows improving the transmission-distribution interface in Islas Canarias:

- Expansion of the Salinas 66 kV, Haría 66 kV (H>2026), El Palmar 66kV, Los Olivos 66 kV, Candelaria 66 kV, Los Vallitos 66 kV, Arinaga 66 kV and Abona 66 kV substations (see table for comments).
- New Mogán 66 kV substation, new Mogán-Arguineguín 66 kV double circuit and second DC Sta Águeda-Arguineguín 66kV circuit (H>2026).
- New Las Palmas Oeste 66 kV due to relocation of the Guanarteme 66 kV substation.

**I Drivers / Objectives:**

- Improving support for existing demand in the regions of Salinas, Candelaria and Las Palmas Oeste when there are faults in the existing transmission-distribution system.
- Supporting natural growth in the western region of Tenerife (Los Vallitos and Los Olivos) and the west of Gran Canaria (Arinaga).
- Creating new transmission-distribution support in areas with potential future growth in demand: western Gran Canaria (Mogán), La Gomera (El Palmar), northern Lanzarote (Haría) and Tenerife (Abona).
- Enabling suitable connection and evacuation of renewables generated in future in northern Lanzarote.

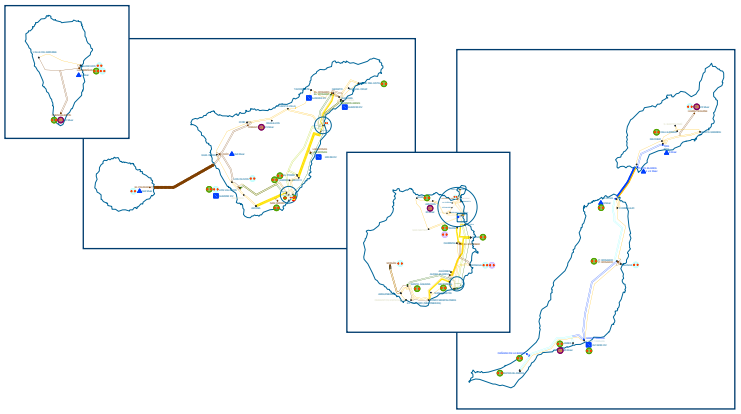
**I Alternatives:**

The distribution network operator assessed alternatives in the distribution network which proved to be more costly than those included in the transmission grid. For El Palmar and Guanarteme, no viable alternatives for development of the distribution network were identified.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-ICA
## Distribution network support **Islas Canarias**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 34.2 M€ | 0.5 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 3.3 | 3.2 | 3.2 | 3.1 | 3.1 | 3.0 | 3.0 | 2.9 | 2.9 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

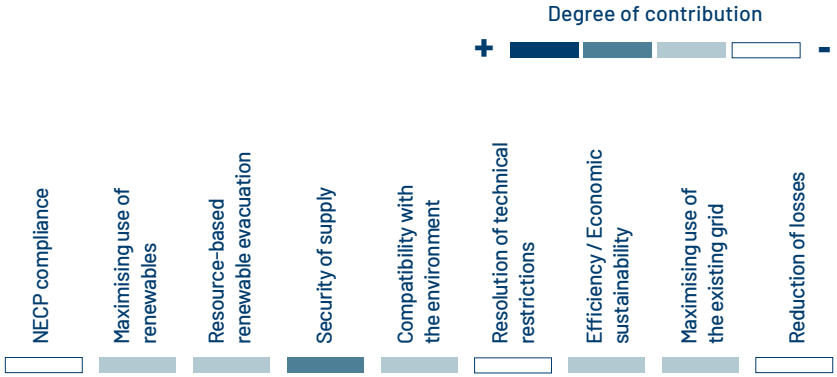
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement APD-ICA
## Distribution network support **Islas Canarias**

### I Table of physical units:

| | 66 kV |
|---|---|
| Bays (units) | 24 |
| Overhead line (km) | 33 |
| Cables (km) | 4 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Las Palmas Oeste 66 kV | Building | 2024 |
| Mogán 66 kV | Building | 2024 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Abona 66 kV [1] | 1 | GIS | Consum. | 2022 |
| Abona 66 kV | 1 | GIS | TN | 2022 |
| Arinaga 66 kV | 1 | GIS | SuD | 2022 |
| El Palmar de la Gomera N.P. 66 kV | 2 | GIS | SuD | 2026 |
| El Palmar de la Gomera N.P. 66 kV | 1 | GIS | TN | 2026 |
| Haria 66 kV | 1 | GIS | SuD | > 2026 |
| Las Palmas Oeste 66 kV [2] | 4 | GIS | TN | 2024 |
| Las Palmas Oeste 66 kV | 3 | GIS | SuD | 2024 |
| Las Salinas 66 kV | 1 | GIS | SuD | 2022 |
| Los Olivos 66 kV | 2 | AIS | SuD | 2023 |
| Mogán 66 kV | 1 | GIS | SuD | 2024 |
| Mogán 66 kV | 3 | GIS | TN | 2024 |
| Santa Águeda 66 kV | 2 | GIS | TN | > 2026 |
| Vallitos 66 kV | 1 | GIS | SuD | 2020 |

Notes:
1. Power supply to a port. Pending allocation.
2. New ES 66 kV Las Palmas Oeste to replace Guanarteme.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-ICA
## Distribution network support **Islas Canarias**

### I Detailed list of assets (continued):

| Total renewal of bays | units | Type | Driv. | Year |
|---|---|---|---|---|
| Arguineguin 66 kV | 1 | AIS | TN | 2024 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Arinaga - Arinaga 66 kV [1] | | | 1 SSC | Cable | SuD | 2022 |
| DC Arguineguín - Mogán 66 kV | 67 | 67 | 13 | Line | SuD | 2024 |
| DC Arguineguín - Mogán 66 kV | 80 | 80 | 0.5 | Cable | SuD | 2024 |
| DC Santa Águeda - Arguineguín 66 kV [2] | 74 | 74 | 6 | Line | SuD | > 2026 |
| El Palmar de la Gomera N.P. - El Palmar de la Gomera N.P. 66 kV [3] | | | 3 SSC | Cable | SuD | 2026 |
| La Paterna - Las Palmas Oeste 66 kV, circuit 1 [4] | 58 | 58 | 0.5 | Cable | SuD | 2024 |
| Mogán - Mogán 66 kV [1] | | | 1 SSC | Cable | SuD | 2024 |
| Muelle Grande - Las Palmas Oeste 66 kV, circuit 1 [5] | 62 | 62 | 0.5 | Cable | SuD | 2024 |
| Sabinal - Las Palmas Oeste 66 kV, circuit 1 [6] | 58 | 58 | 0.5 | Cable | SuD | 2024 |
| Santa Águeda - Arguineguín 66 kV, circuit 4 | 82 | 82 | 0.2 | Cable | SuD | > 2026 |
| Santa Águeda - Mogán 66 kV, circuit 1 [7] | 67 | 67 | 1 | Line | SuD | 2024 |

Notes:
1. Short section of cable inside the substation.
2. Double circuit with second circuit laid out.
3. Short section of cable inside the substation.
4. Topological change with commissioning of La Paterna-Las Palmas Oeste 66 kV and decommissioning of La Paterna-Guanarteme 66 kV.
5. Topological change with commissioning of Muelle Grande-Las Palmas Oeste 66 kV and decommissioning of Muelle Grande-Guanarteme 66 kV.
6. Topological change with commissioning of Sabinal-Las Palmas Oeste 66 kV and decommissioning of Sabinal-Guanarteme 66 kV.
7. Topological change with commissioning of Sta Águeda-Mogán 66 kV and decommissioning of Sta Águeda-Arguineguín 4 66 kV and Arguineguín-Mogán 2 66 kV.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement APD-MAD_1
## Distribution network support **Madrid**

**I General description:**

The development included allows improving the transmission-distribution interface in Madrid:

- New Fuente Hito 220 kV, Begoña 220 kV substations with input-output in the Fuencarral-Sanchinarro cable and Cristo de Rivas with input-output in the Loeches-Vallecas line (H>2026).
- New Alcobendas-Fuente Hito cable and FuenteHito-Arroyo de la Vega line-cable.
- Expansion of the Fuente Hito (2), Begoña, Ciudad Deportiva, Boadilla, Loeches, Valdemoro, Galapagar(2), Pinto y Morata 220 kV substations (>2026).
- New Begoña- Fuente Hito 220 kV cable (>2026).
- Change in the layout of the Valdemoro 220 kV substation.

**I Drivers / Objectives:**

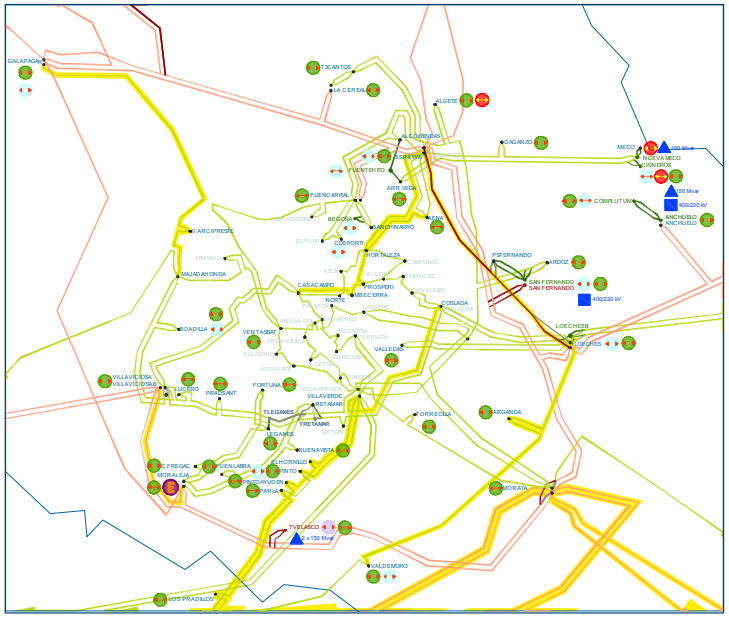
Enabling improved security of supply, as well as supply for new, specific demand in the city of Madrid.

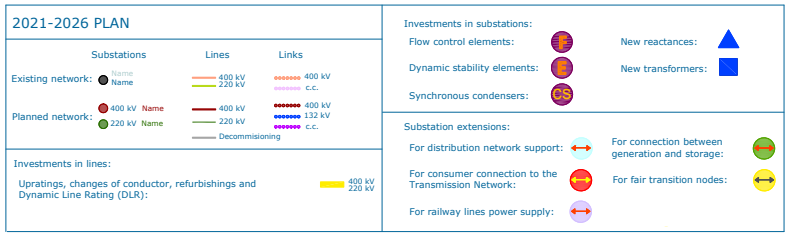
**I Alternatives:**

The distribution network operators assessed alternatives to strengthen the distribution network which proved to be more costly than those included in the transmission grid. In some cases, there are joint studies between the system operator and the distribution network operator that have concluded that the alternative proposed is the optimal choice.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-MAD_1
## Distribution network support **Madrid**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:



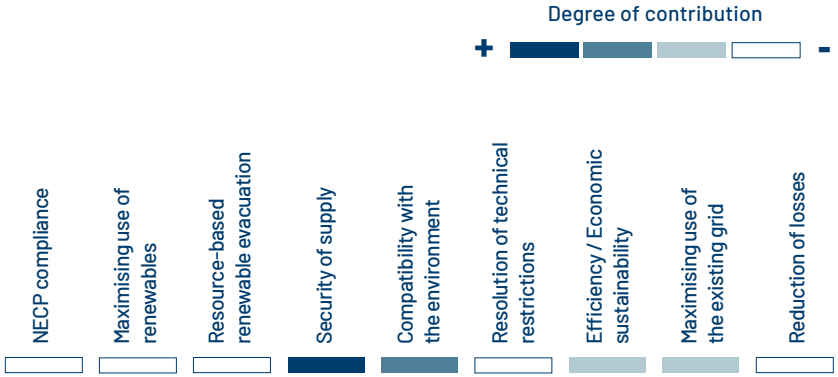

### I Costs:

| CAPEX | OPEX |
|---|---|
| 111.4 M€ | 0.77 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 9.8 | 9.6 | 9.5 | 9.3 | 9.1 | 9.0 | 8.8 | 8.7 | 8.5 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement APD-MAD_1
## Distribution network support **Madrid**

### Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 25 |
| Partial renewal of bays (units) | 0.1 |
| Overhead line (km) | 2 |
| Cables (km) | 33 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Begoña 220 kV | Building | 2024 |
| Cristo de Rivas 220 kV | Building | > 2026 |
| Fuente Hito 220 kV | Building | 2025 |

### Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Alcobendas 220 kV | 1 | GIS | TN | 2021 |
| Arroyo de la Vega 220 kV | 1 | AIS | TN | 2025 |
| Begoña 220 kV | 1 | GIS | TN | > 2026 |
| Begoña 220 kV | 3 | GIS | TN | 2024 |
| Begoña 220 kV | 1 | GIS | SuD | 2024 |
| Boadilla 220 kV | 1 | GIS | SuD | 2023 |
| Ciudad Deportiva 220 kV | 1 | GIS | SuD | 2023 |
| Cristo de Rivas 220 kV | 1 | GIS | SuD | > 2026 |
| Cristo de Rivas 220 kV | 3 | GIS | TN | > 2026 |
| Fuente Hito 220 kV | 2 | GIS | SuD | 2025 |
| Fuente Hito 220 kV | 3 | GIS | TN | 2025 |
| Fuente Hito 220 kV | 1 | GIS | TN | > 2026 |
| Galapagar 220 kV | 2 | AIS | SuD | 2020 |
| Loeches 220 kV [1] | 1 | AIS | SuD | 2022 |
| Morata 220 kV | 1 | AIS | SuD | > 2026 |
| Pinto 220 kV | 1 | AIS | SuD | 2022 |
| Valdemoro 220 kV | 1 | AIS | SuD | 2024 |

Notes:
1. In double double bus A.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-MAD_1
## Distribution network support **Madrid**

### I Detailed list of assets (continued):

| Partial renewal of bays | units | Type | Driv. | Year |
|---|---|---|---|---|
| Valdemoro 220 kV | 0.1 | AIS | TN | 2022 |

| New adjustments to OP | Year |
|---|---|
| Valdemoro [1] | 2026 |

Notes:
1. Additional assets required to adjust to the Operational Procedure (O.P.)

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Alcobendas - Fuente Hito 220 kV, circuit 1 | 510 | 510 | 6 | Cable | SuD | 2025 |
| Arroyo de la Vega - Fuente Hito 220 kV, circuit 1 | 500 | 500 | 2 | Cable | SuD | 2025 |
| Arroyo de la Vega - Fuente Hito 220 kV, circuit 1 | 500 | 500 | 2 | Line | SuD | 2025 |
| Begoña-Begoña 220 kV[1] | | | 1 SSC | Cable | SuD | 2024 |
| Begoña - Fuente Hito 220 kV, circuit 1 | 470 | 470 | 16 | Cable | SuD | >2026 |
| FuenteHito-FuenteHito 220 kV[1] | | | 1 SSC | Cable | SuD | 2025 |
| Ciudad Deportiva - Ciudad Deportiva 220 kV[1] | | | 1 SSC | Cable | SuD | 2023 |
| I/O in Begoña, of Fuencarral - Sanchinarro 220 kV, circuit 2 | 450 | 450 | 2 | Cable | SuD | 2024 |
| I/O in Cristo de Rivas, of Loeches - Vallecas 220 kV, circuit 1 | 310 | 310 | 3 | Cable | SuD | >2026 |
| Loeches - Loeches 220 kV[1] | | | 1 SSC | Cable | SuD | 2022 |

Notes:
1. Short section of cable inside the substation.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-MAD_2
## Distribution network support **East Madrid. Corredor del Henares**

**I General description:**

The development included allows improving the transmission-distribution interface in the region of corredor del Henares in Madrid:

- New Complutum 220 kV substation and new Anchuelo-Complutum 220 kV double circuit.
- New Anchuelo 220 kV substation and new transformer 1 in Anchuelo 400/220.
- New Cisneros 220 kV substation with input-output in the Arroyo de la Vega-Meco line.
- Expansion of the Complutum, San Fernando y Cisneros (2) 220 kV substations.
- New Complutum-Cisneros 220 kV double circuit (>2026).

**I Drivers / Objectives:**

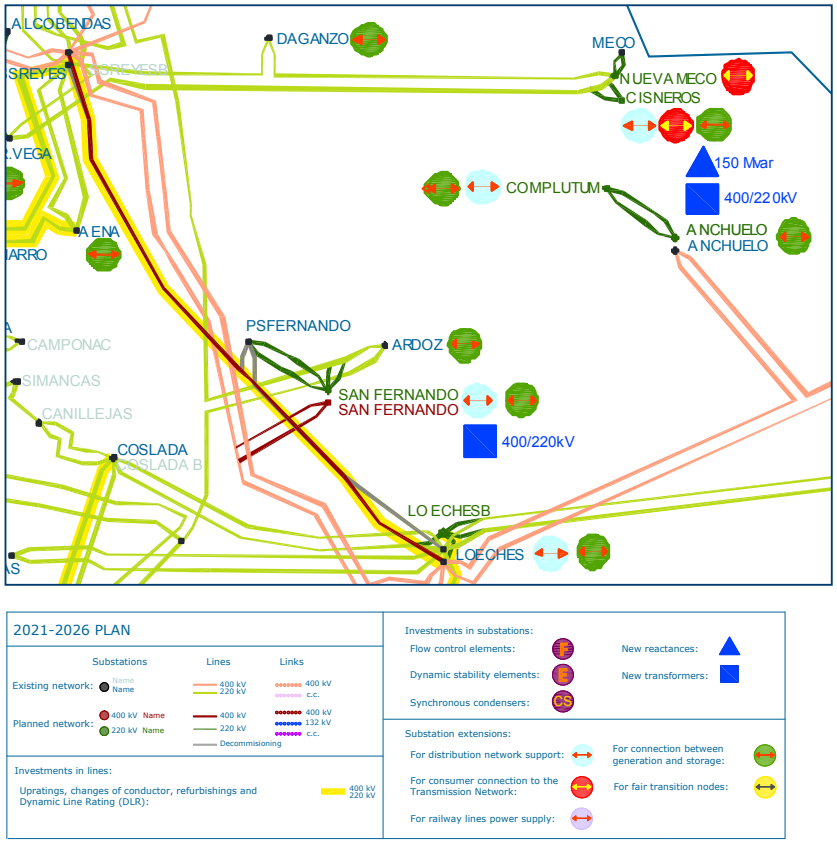
Enabling improved security of supply, as well as supply for new, unique demand in the region of corredor del Henares in Madrid.

**I Alternatives:**

The distribution network operator has assessed alternatives to strengthen the distribution network, which proved to be more costly than those considered to support the transmission grid. Additionally, in some cases, there are studies undertaken jointly between the system operator and the distribution network operator which conclude that the alternatives included are optimal to meet the needs of the distribution network.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-MAD_2
## Distribution network support **Madrid este. Corredor del Henares**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 79.5 M€ | 0.66 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 7.1 | 7.0 | 6.9 | 6.8 | 6.6 | 6.5 | 6.4 | 6.3 | 6.2 |

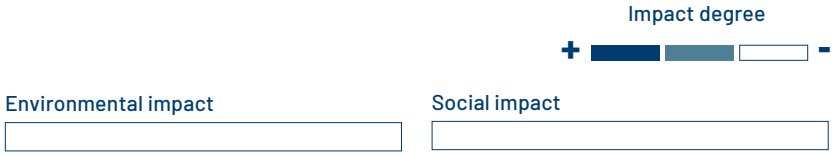
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

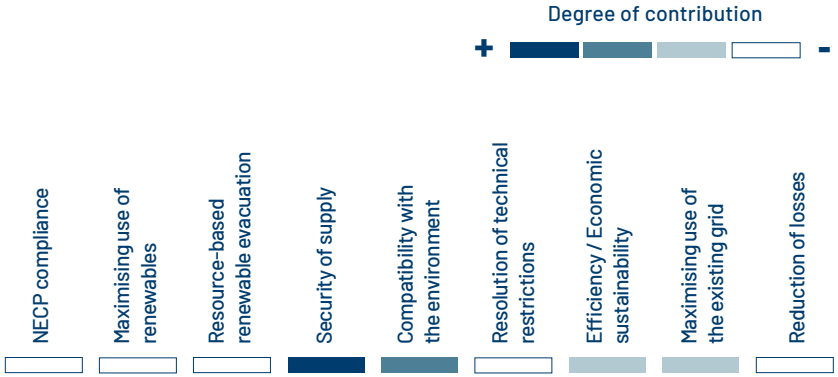
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement APD-MAD_2
## Distribution network support **Madrid este. Corredor del Henares**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 18 | 1 |
| Overhead line (km) | 27 | |
| Cables (km) | 18 | |
| Transformed to 220 kV (MVA) | | 600 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Anchuelo 220 kV | Outdoor | 2022 |
| Cisneros 220 kV | Building | 2024 |
| Complutum 220 kV | Building | 2023 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Anchuelo 220 kV | 2 | AIS | TN | 2023 |
| Anchuelo 220 kV | 2 | AIS | TN | 2022 |
| Anchuelo 400 kV | 1 | AIS | TN | 2022 |
| Cisneros 220 kV | 2 | GIS | SuD | 2024 |
| Cisneros 220 kV | 2 | GIS | TN | > 2026 |

### I Detailed list of assets (continued):

| Substation extension (cont.) | units | Type | Driv. | Year |
|---|---|---|---|---|
| Cisneros 220 kV | 3 | GIS | TN | 2024 |
| Complutum 220 kV | 1 | GIS | SuD | 2023 |
| Complutum 220 kV | 2 | GIS | TN | > 2026 |
| Complutum 220 kV | 3 | GIS | TN | 2023 |
| San Fernando 220 kV | 1 | GIS | SuD | 2022 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Cisneros - Cisneros 220 kV [1] | | | 1 SSC | Cable | SuD | 2024 |
| Complutum - Complutum 220 kV [1] | | | 1 SSC | Cable | SuD | 2023 |
| DC Anchuelo - Complutum 220 kV | 450 | 450 | 10 | Line | SuD | 2023 |
| DC Anchuelo - Complutum 220 kV | 450 | 450 | 1 | Cable | SuD | 2023 |
| DC Cisneros - Complutum 220 kV | 410 | 410 | 4 | Cable | SuD | > 2026 |
| I/O in Cisneros, of Arroyo de la Vega - Nueva Meco 220 kV, circuit 1 | 470 | 320 | 3 | Cable | SuD | 2024 |
| I/O in Cisneros, of Arroyo de la Vega - Nueva Meco 220 kV, circuit 1 | 470 | 320 | 4 | Line | SuD | 2024 |
| San Fernando - San Fernando 220 kV [1] | | | 1 SSC | Cable | SuD | 2022 |

Notes:
1. Short section of cable inside the substation.

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Anchuelo 400/220 kV, TF1 | 600 | Triph. B. | SuD | 2022 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-MUR
## Distribution network support **Murcia**

**I General description:**

The development included allows improving the transmission-distribution interface in the Region of Murcia:

- New Espinardo 220 kV substation in I/O in the El Palmar-Murcia 220 kV cable.
- Expansion of the Espinardo 220 kV substation.
- Expansion of the Peñarrubia 400 kV substation.

**I Drivers / Objectives:**

Enable improved security of supply in the city of Murcia, supporting natural growth when there are faults in the existing transmission-distribution network, as well as facilitating the evacuation of renewables into the distribution network.

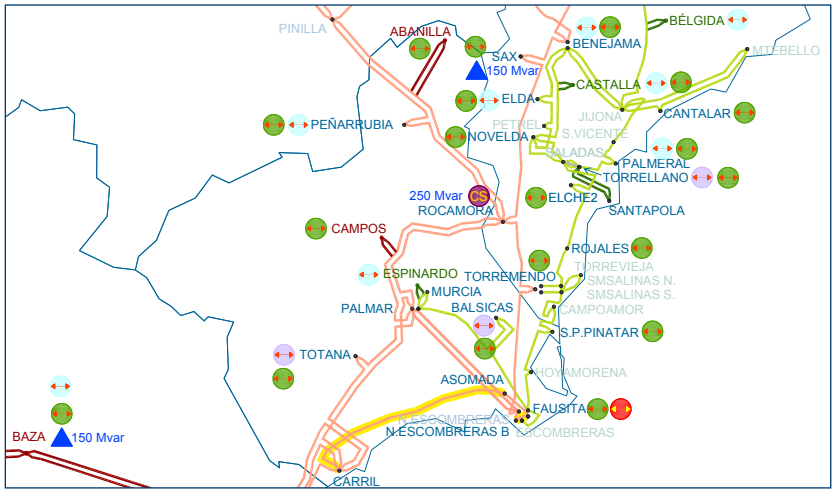
**I Alternatives:**

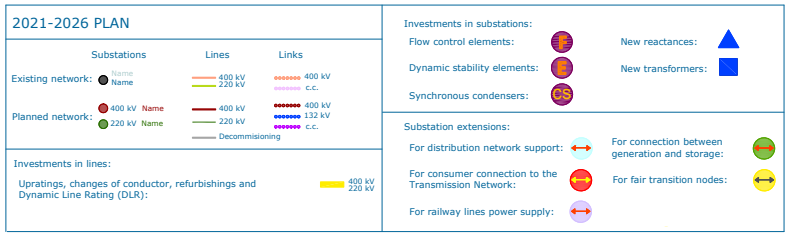
The distribution network operator did not find viable alternatives to bolster the distribution network in order to ensure that the needs identified are met.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-MUR
## Distribution network support **Murcia**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 58.9 M€ | 0.21 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 5.0 | 4.9 | 4.8 | 4.7 | 4.6 | 4.6 | 4.5 | 4.4 | 4.3 |

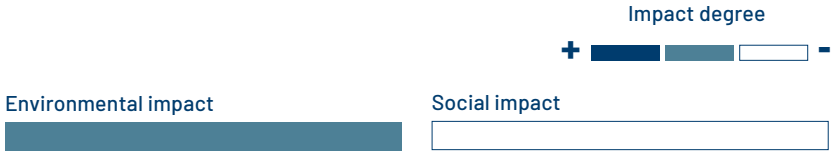
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

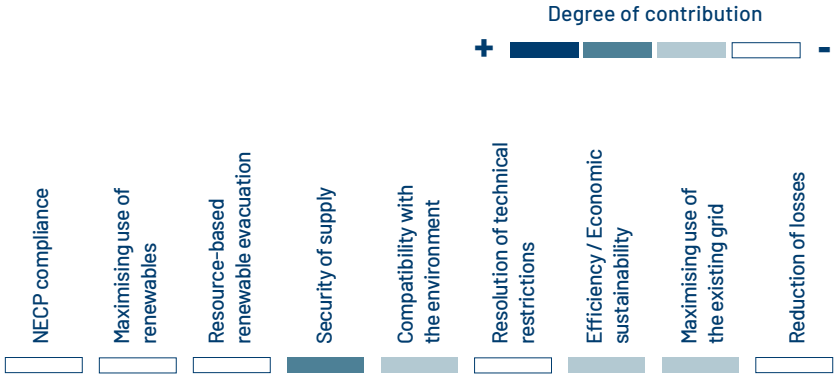
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement APD-MUR
## Distribution network support **Murcia**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 4 | 2 |
| Cables (km) | 22 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Espinardo 220 kV | Building | 2023 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Espinardo 220 kV | 1 | GIS | SuD | 2023 |
| Espinardo 220 kV | 3 | GIS | TN | 2023 |
| Peñarrubia 400 kV | 1 | AIS | TN | 2023 |
| Peñarrubia 400 kV | 1 | AIS | SuD | 2023 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Espinardo, of El Palmar - Murcia 220 kV, circuit 1 | 450 | 450 | 11 | Cable | SuD | 2023 |
| Espinardo-Espinardo 220 kV [1] | | | 1 SSC | Cable | SuD | 2023 |

Nota:
1. Short section of cable inside the substation.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-NAV
## Distribution network support **Navarra**

**I General description:**

The development included allows improving the transmission-distribution interface in Navarra:

- New Tierra Estella 220 kV substation and new Muruarte-Tierra Estella 220 kV double circuit.
- Expansion (2) of the Tierra Estella 220 kV substation.

**I Drivers / Objectives:**

Facilitating improved security of supply in the region of Tierra Estella.

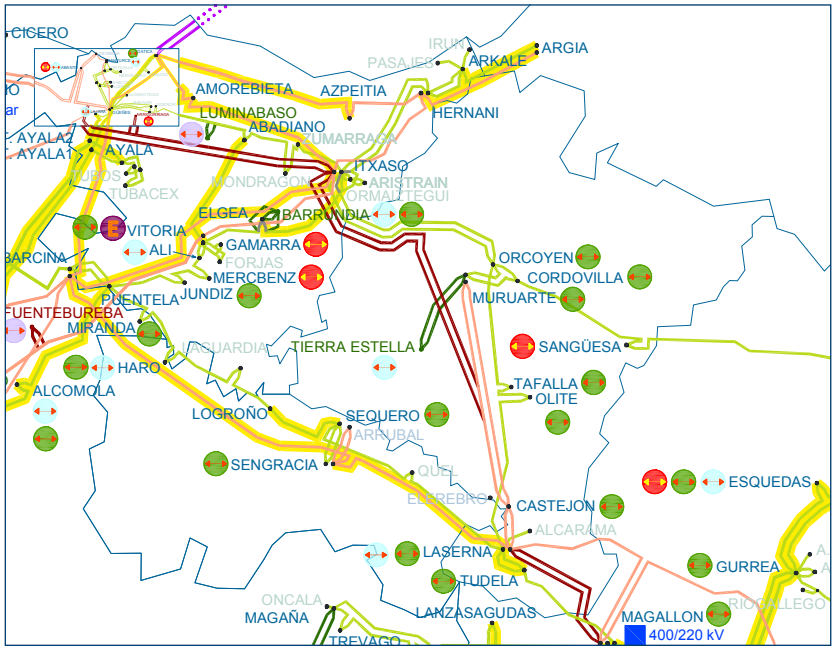
**I Alternatives:**

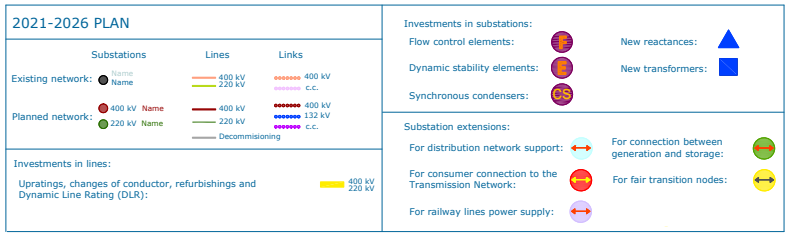
The distribution network operators assessed alternatives to strengthen the distribution network which proved to be more costly than those considered to support for the transmission grid. Additionally, the reinforcements will allow for greater integration of renewables generated in the area into the distribution network.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-NAV
## Distribution network support **Navarra**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 23.7 M€ | 0.34 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 2.3 | 2.2 | 2.2 | 2.2 | 2.1 | 2.1 | 2.1 | 2.0 | 2.0 |

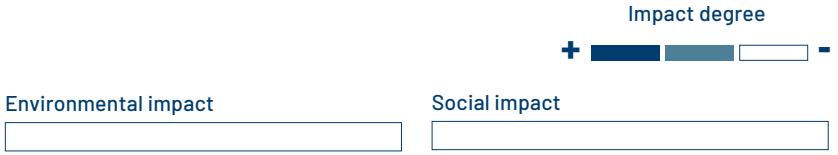
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

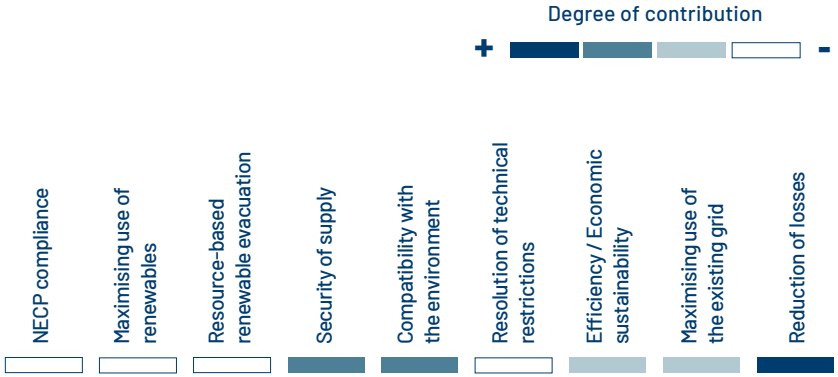
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement APD-NAV
## Distribution network support **Navarra**

### I Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 7 |
| Overhead line (km) | 70 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Tierra Estella 220 kV | Outdoor | 2023 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Muruarte 220 kV | 2 | AIS | TN | 2023 |
| Tierra Estella 220 kV | 1 | AIS | SuD | 2023 |
| Tierra Estella 220 kV [1] | 1 | AIS | SuD | > 2026 |
| Tierra Estella 220 kV | 3 | AIS | TN | 2023 |

Notes:
1. Final scope requested by the distributor is two bays.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Muruarte - Tierra Estella 220 kV | 900 | 770 | 35 | Line | SuD | 2023 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-PVA
## Distribution network support **País Vasco**

**I General description:**

The development included allows improving the transmission-distribution interface in the País Vasco area:

- New Barrundia 220 kV substation and connection with Elgea 220 kV.
- Expansion of the Ali and Barrundia 220 kV substations.
- Expansion of the Abanto 400 kV substation.
- Expansion of the Jundiz 220 kV substation (>2026).
- Expansion of the La Jara 220 kV substation to complete installation of the bays supporting distribution (H>2026).

**I Drivers / Objectives:**

- Guarantee supply in the face of the natural growth in demand in Vitoria by improving the Ali, Barrundia and Jundiz substations.
- Enabling improved security of supply with reinforcements on the Abanto and La Jara substations.

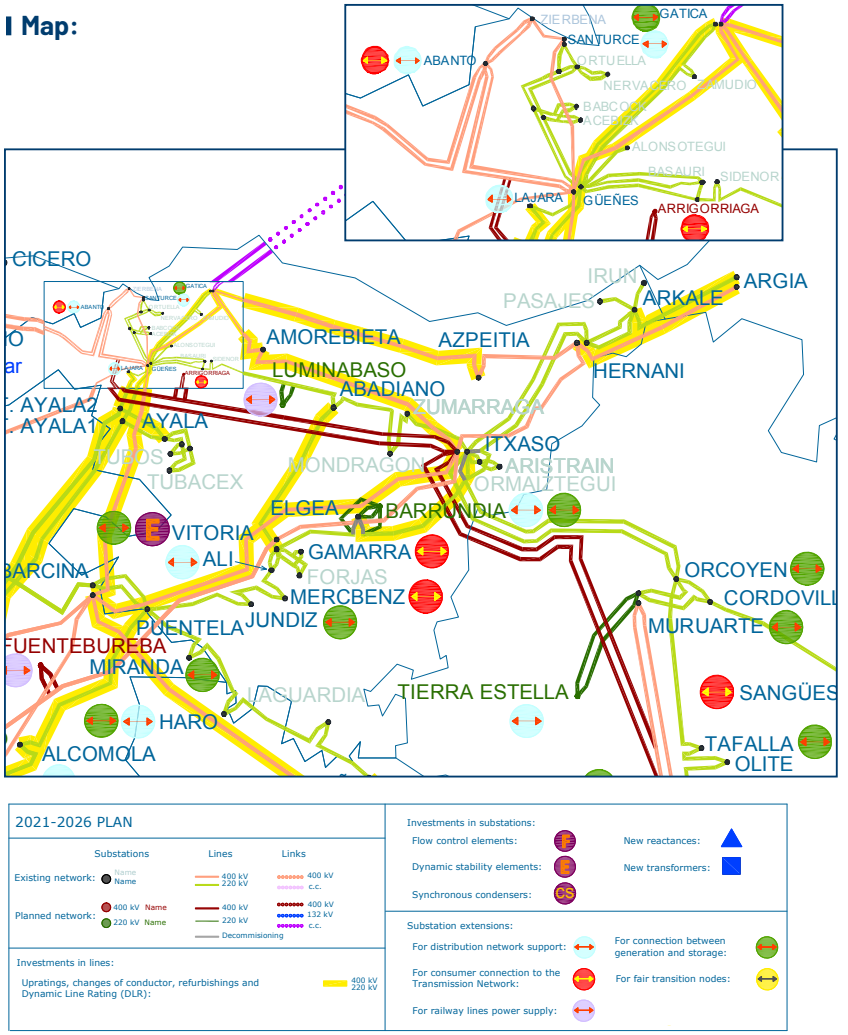
**I Alternatives:**

The distribution network operators assessed alternatives to strengthen the distribution network which proved to be more costly than support for the transmission grid.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-PVA
## Distribution network support **País Vasco**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 30.8 M€ | 0.73 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 3.2 | 3.2 | 3.1 | 3.1 | 3.0 | 3.0 | 3.0 | 2.9 | 2.9 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:




Environmental impact

Social impact

### I Contribution to guiding principles:







Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-PVA
## Distribution network support **País Vasco**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 19 | 1 |
| Overhead line (km) | 4 | |
| Cables (km) | 1 | 0.1 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Barrundia 220 kV | Outdoor | 2023 |

| New adjustments to OP | Year |
|---|---|
| Alí 220 kV | 2025 |

### I Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Abanto 400 kV [1] | 1 | AIS | SuD | 2022 |
| Ali 220 kV [1] | 7 | AIS | SuD | 2023 |
| Barrundia 220 kV | 2 | AIS | SuD | 2023 |
| Barrundia 220 kV | 1 | AIS | Gen./Sto. | 2023 |
| Barrundia 220 kV [2 3] | 5 | AIS | TN | 2023 |
| Jundiz 220 kV | 1 | GIS | SuD | > 2026 |
| La Jara 220 kV | 1 | GIS | TN | 2023 |
| La Jara 220 kV | 2 | AIS | SuD | 2023 |

Notes:
1. Bays required to adjust to the Operational Procedure (Operational Procedure (O.P.))
2. Vitoria-Elgea 220 bypasses Elgea and is connected in Barrundia.
3. Itxaso-Elgea 220 bypasses Elgea and is connected in Barrundia.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Abanto - Abanto 400 kV [1] | | | 1 SSC | Cable | SuD | 2022 |
| Ali - Ali 220 kV [4] | | | 5 SSC | Cable | SuD | 2023 |
| Barrundia - Itxaso 220 kV, circuit 1 [2] | | | 1 | Line | TN | 2023 |
| Barrundia - Vitoria 220 kV, circuit 1 [3] | | | 1 | Line | TN | 2023 |
| DC Elgea - Barrundia 220 kV | | | 1 | Line | TN | 2023 |

Notes:
1. Short section of cable inside the substation.
2. Itxaso-Elgea 220 bypasses Elgea and is connected in Barrundia.
3. Vitoria-Elgea 220 bypasses Elgea and is connected in Barrundia.
4. Short sections of cable inside the substation.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-RIO
## Distribution network support **La Rioja**

**I General description:** The development included allows improving the transmission-distribution interface in La Rioja:

- Expansion of the Haro 220 kV substation.

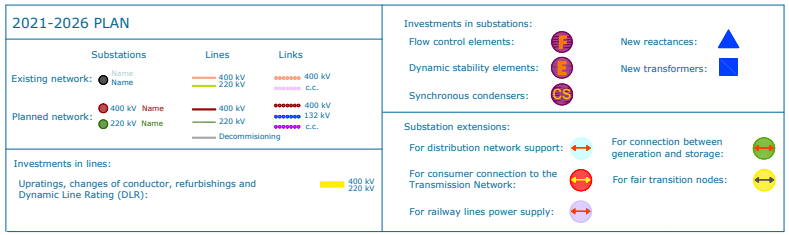
**I Drivers / Objectives:** Enabling security of supply to be improved in the region of Haro when there are faults in the existing transmission-distribution system.

**I Alternatives:** The distribution network operator did not identify any viable alternatives to strengthen the distribution network.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement APD-RIO
## Distribution network support **La Rioja**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 1.8 M€ | 0.02 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:




Environmental impact

Social impact

### I Contribution to guiding principles:







Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement APD-RIO
## Distribution network support **La Rioja**

### Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 1 |
| Cables (km) | 0.1 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Haro 220 kV | 1 | GIS | SuD | 2022 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Haro - Haro 220 kV [1] | | | 1 SSC | Cable | SuD | 2022 |

Notes:
1. Short section of cable inside the substation.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement CONSUM
## Consumers connected to the transmission network

**I General description:**

The following reinforcements are included to provide power to consumers connected to the transmission grid:

- New Francolí 220 kV substation with I/O in the Perafort-Morell 220 kV line. New Francolí-La Selva 220 kV line.
- New Sagrajas and Rio Caya 400 kV substations and new DC San Serván-Guadiana and Guadiana-Rio Caya 400 kV lines.
- New Calatorao 220 kV substation with I/O in the Jalón - Los Vientos 220 kV line.
- New Nueva Meco 220 kV substation with connection to Meco, Arroyo de la Vega and Daganzo 220 kV.
- Expansion and change in layout of the Abrera 220 kV and El Espartal 220 kV substations.
- Expansion of the Los Barrios, Sangüesa, Cártama, Constantí, Los Montes, Cisneros, Cerdá, Francolí, Puigpelat and Calera y Chozas 220 kV, Abanto, Arañuelo, Morvedre and Peñaflor 400 kV and Abona 66 kV substations.

**I Drivers / Objectives:**

Providing power to consumers directly connected to the transmission grid.

**I Alternatives:**

Several alternatives for connection to other substations have been assessed. Specifically:

- Alternative connections in Morell 220 kV are not viable.
- Alternative connections in Esquedas and Abrera 220 kV without substation upgrades are not viable.
- Alternative connections in Ave Zaragoza 220 kV do not meet the needs identified.
- Alternative connections in Neja as an input/output for Los Montes-Saleres 220 kV are not viable due to the environmental and social complications associated with the implementation of this line.

**I European dimension:**

No

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

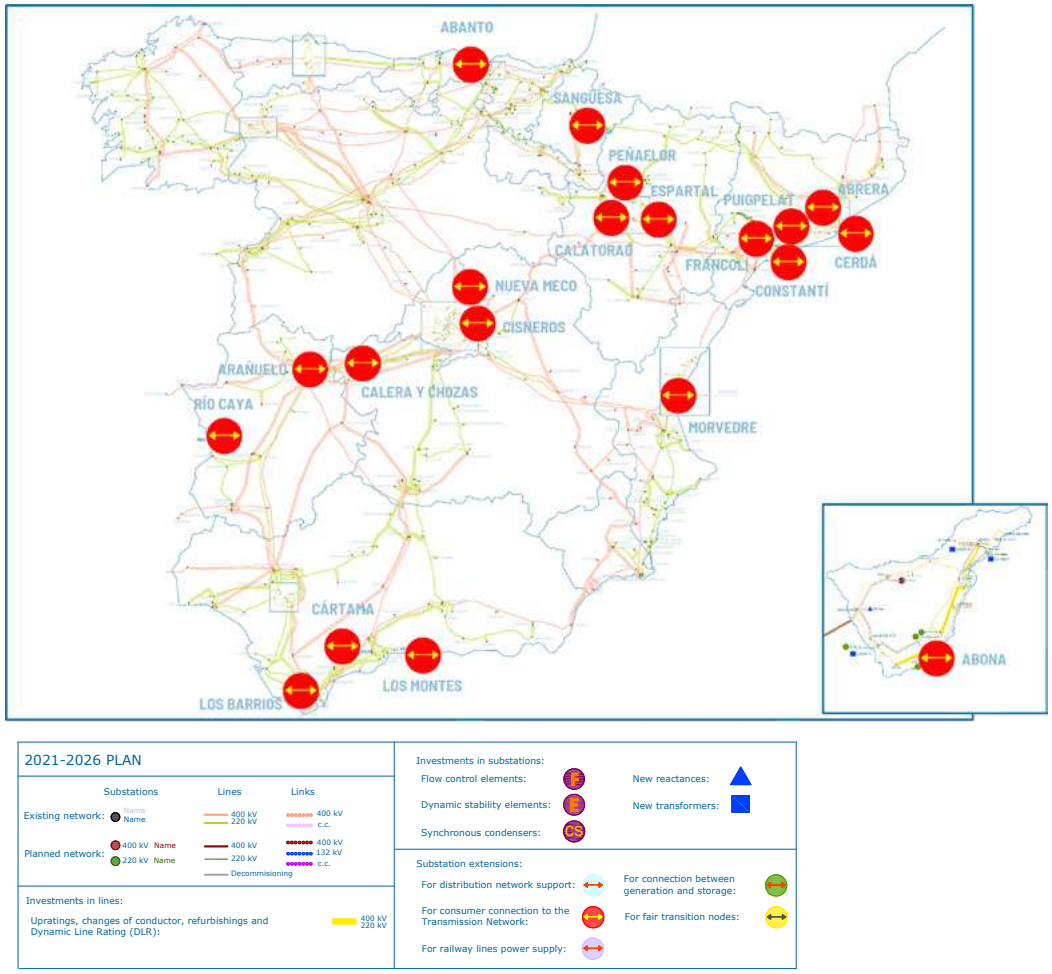
**II: New reinforcements**

III: Technical annexes

# I Reinforcement CONSUM

## Consumers connected to the transmission network

### I Map:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement CONSUM

## Consumers connected to the transmission network

### Cost-Benefit Multi-Criteria Analysis

#### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

#### I Costs:

| CAPEX | OPEX |
|---|---|
| 91.4 M€ | 2.94 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 10.3 | 10.2 | 10.1 | 9.9 | 9.8 | 9.7 | 9.6 | 9.4 | 9.3 |

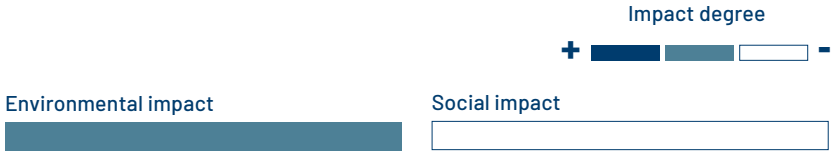
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

#### I Profitability:

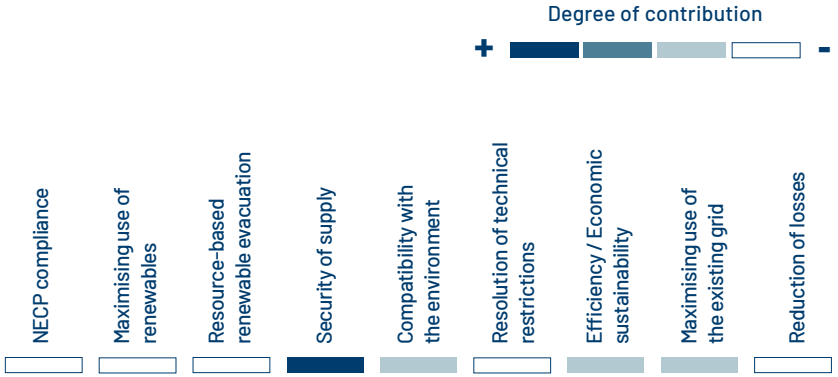
Profitability: NPV

- M€

#### I Socio-environmental impact:




#### I Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement CONSUM

## Consumers connected to the transmission network

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 48 | 23 |
| Overhead line (km) | 18 | 122 |
| Cables (km) | 1 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Abrera 220 kV | Building | 2024 |
| Calatorao 220 kV | Outdoor | 2025 |
| Francolí 220 kV [1] | Outdoor | 2024 |
| Guadiana* 400 kV | Outdoor | 2024 |
| Nueva Meco 220 kV | Outdoor | 2024 |
| Río Caya 400 kV | Outdoor | 2024 |

Notes:
1. Also called Nueva Morell.
* Name of the electrical substation (ES) updated in the modifications of specific items.

### I Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Abanto 400 kV | 1 | AIS | Consum. | 2023 |
| Abrera 220 kV | 2 | GIS | Consum. | 2024 |
| Abrera 220 kV | 3 | GIS | SuD | 2024 |
| Abrera 220 kV | 3 | GIS | TN | 2024 |
| Arañuelo 400 kV | 2 | AIS | Consum. | 2024 |
| Arañuelo 400 kV | 1 | AIS | TN | 2024 |
| Calatorao 220 kV | 4 | AIS | Consum. | 2025 |
| Calatorao 220 kV | 3 | AIS | TN | 2025 |
| Calera y Chozas 220 kV | 4 | AIS | Consum. | 2024 |
| Cártama 220 kV | 1 | GIS | Consum. | 2023 |
| Cerdá 220 kV | 1 | GIS | Consum. | 2022 |
| Cisneros 220 kV | 2 | GIS | Consum. | 2024 |
| Constanti 220 kV | 1 | AIS | Consum. | 2023 |
| Espartal 220 kV | 3 | AIS | TN | 2024 |
| Espartal 220 kV | 2 | AIS | Consum. | 2024 |
| Francolí 220 kV | 2 | AIS | Consum. | 2024 |
| Francolí 220 kV | 1 | AIS | Consum. | 2023 |
| Francolí220 kV | 4 | AIS | TN | 2024 |
| Guadiana* 400 kV | 6 | AIS | TN | 2024 |
| La Selva 220 kV | 1 | GIS | TN | 2024 |
| Los Barrios 220 kV | 1 | AIS | Consum. | 2023 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement CONSUM

## Consumers connected to the transmission network

### I Detailed list of assets (continued):

| Substation extension (cont.) | units | Type | Driv. | Year |
|---|---|---|---|---|
| Los Montes 220 kV | 1 | AIS | Consum. | 2023 |
| Morvedre 400 kV | 2 | AIS | Consum. | 2024 |
| Nueva Meco 220 kV | 2 | AIS | Consum. | 2024 |
| Nueva Meco 220 kV | 5 | AIS | TN | 2024 |
| Peñaflor 400 kV | 2 | AIS | Consum. | 2024 |
| Peñaflor 400 kV | 1 | AIS | TN | 2024 |
| Puigpelat 220 kV | 1 | GIS | Consum. | 2024 |
| Río Caya 400 kV | 1 | AIS | Consum. | 2024 |
| Río Caya 400 kV | 4 | AIS | TN | 2024 |
| San Serván 400 kV | 3 | AIS | TN | 2020 |
| Sangüesa 220 kV | 1 | AIS | Consum. | 2023 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Abrera - Abrera 220 kV [1] | | | 5 SSC | Cable | Consum. | 2024 |
| DC Espartal - Espartal 220 kV [5] | | | 1 SSL | Line | Consum. | 2024 |
| DC Guadiana*- Río Caya 400 kV | 2,370 | 1,920 | 31 | Line | Consum. | 2024 |
| DC Meco - Nueva Meco 220 kV | | | 0.2 | Line | TN | 2024 |
| DC Nueva Meco - Arroyo de la Vega 220 kV [2] | | | 0.2 | Line | TN | 2024 |
| DC San Serván - Guadiana* 400 kV | 2,370 | 1,920 | 30 | Line | Consum. | 2024 |
| I/O in Abrera, of Pujalt - Rubí 220 kV, circuit 1 [3] | 360 | 250 | 0.2 | Cable | Consum. | 2024 |
| I/O in Calatorao, of Jalón - Los Vientos 220 kV, circuit 1 | | | 4 | Line | TN | 2025 |
| I/O in Francolí de Perafort - El Morell 220 kV, circuit 1 [4] | 190 | 170 | 0.5 | Line | Consum. | 2024 |
| Francolí - La Selva 220 kV, circuit 1 | 880 | 760 | 8 | Line | Consum. | 2024 |

Notes:
1. Short section of cable inside the substation.
2. Change in topology with commissioning of Nueva Meco-Arroyo de la Vega 220 kV and decommissioning of Meco-Arroyo de la Vega 220 kV.
3. A new section of line in the I/O in Abrera 220 kV de Pujalt-Rubí 220 kV is required.
4. Section line capacity in DC for I/O 870/760 MVA.
5. Short section of line inside the substation.

* Name of the electrical substation (ES) updated in the modifications of specific items.

| New adjustments to OP | Year |
|---|---|
| Espartal 220 kV[1] | 2026 |

Notes:
1. Additional assets required to adjust to the Operational Procedure (O.P.)

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement INT_ESP-FRA_1
## International interconnections **Spain-France via the Bay of Biscay**

**I General description:**

The project consists of a new submarine interconnection between Spain and France, direct current, with VSC technology and composed of two symmetrical 400 kV and 1,000 MW monopoles. This interconnection will connect to the existing Gatica 400 kV substation via a 400 kV double circuit.

**I Drivers / Objectives:**

- Integration of the peninsular electricity system into the European single market, contributing to reducing price differences between countries.
- Contributing to the integration of existing and future renewable energy across Europe, particularly in Spain and the Iberian Peninsula.
- Reducing electrical isolation in Spain and the Iberian Peninsula, and improving the level of interconnection in order to comply with the objectives set by the EU.
- Complying with intergovernmental agreements from the Madrid Declaration.

**I Alternatives:**

After the commissioning of the eastern interconnection in 2015, optimal reinforcement for appropriate distribution of flows should be located in the western part of the Spanish-French border. Other terrestrial solutions, whether overhead or underground, are not viable due to their physical installation and a much greater social and environmental impact.

**I European dimension:**

Yes / Project 16 from TYNDP 2020 and Project PIC 2.7 in the 2019 list.

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement INT_ESP-FRA_1
International interconnections **Spain-France via the Bay of Biscay**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 221 M€/year | Reduction of $CO_2$ emissions: 1,225 kt/year* |
| Additional RES integration: 7,431.000 MWh/year | Reduction of system losses: –2,711.000 MWh/year* |
| Reduction of ENS: 7,470 MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:



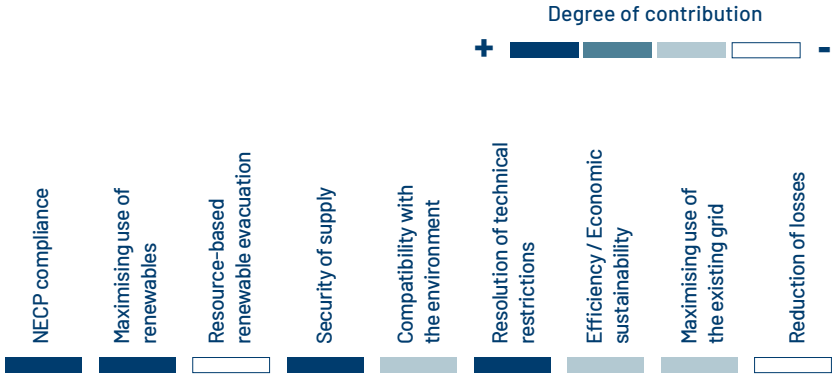

### I Costs:

| CAPEX | OPEX |
|---|---|
| 939.6 M€ | 9.29 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 85.2 | 83.9 | 82.6 | 81.3 | 80.0 | 78.6 | 77.3 | 76.0 | 74.7 |

Note: The CAPEX indicated represents the part of the reinforcements incurred by the Spanish system. Nonetheless, the results of the cost-benefit analysis are those corresponding to the "National Trends 2030" scenario of the European ten-year Network Development Plan 2020 (TYNDP 2020) and include both the costs and benefits of the interconnected system, following the methodology used in ENTSOE.

### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement INT_ESP-FRA_1
## International interconnections **Spain-France via the Bay of Biscay**

### Table of physical units:

| | 400 kV |
|---|---|
| Bays (units) | 6 |
| Overhead line (km) | 1 |
| Submarine Link (km) | 390 |
| Cables (km) | 2 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Gatica 400 kV 1 | 6 | AIS | TN | 2026 |

Notes:
1. Relocation of TRP5 to free up a bay for the Gatica-Cubnezais link pole.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Gatica - Azpeitia 400 kV | 1,750 | 1,580 | 1 | Line | TN | 2026 |
| DC Gatica - Gatica E.C. 400 kV | | | 1 | Cable | INT | 2026 |
| Gatica - Cubnezais 400 kV, circuit 1[1] | 2,000 | 2,000 | 390 | Subm. | INT | 2026 |

Notes:
1. Submarine link with 2 symmetrical monopoles.

| New converter stations | Year |
|---|---|
| Gatica E.C. 400 kV[1] | 2026 |

Notes:
1. Singular cost included in the cost of the link.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement INT_ESP-FRA_2
## International interconnections
## Reinforcement of the Spain - France interconnection (Gatica)

**I General description:**

The project consists of internal reinforcements for the future submarine interconnection between Spain and France via the Bay of Biscay:

- Repowering of the Gatica-Gueñes 400kV, Gatica-Azpeitia 400kV, Gatica - Amorebieta, and Amorebieta-Itxaso 400kV lines.
- New 400/220 kV transformer in Gatica (>2026).

**I Drivers / Objectives:**

- Handling flows to/from France, that will rise due to the increase in transfer capacity as a result of the future Bay of Biscay link.
- Enabling the increase in transfer capacity.
- Reducing the need to apply technical constraints to achieve the objective of 70% of the available capacity in these elements for commercial transfer capacity in accordance with Art. 16(8) of Regulation 2019/943 of the interior energy market.

**I Alternatives:**

Operational solutions or DLR are not solutions that could replace these reinforcements as they would not reach sufficient capacity to ensure that these elements do not become a limitation on the net transfer capacity with France. Replacing the current 400/220 kV transformer in Gatica with a machine that has a greater capacity (600 MVA) allows the installation of a new transformer in Gatica to be postponed to a timeframe beyond 2026.

**I European dimension:**

Yes/ Projects 378 and 379 from TYNDP 2020.

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement INT_ESP-FRA_2

International interconnections

## Reinforcement of the Spain - France interconnection (Gatica)

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:



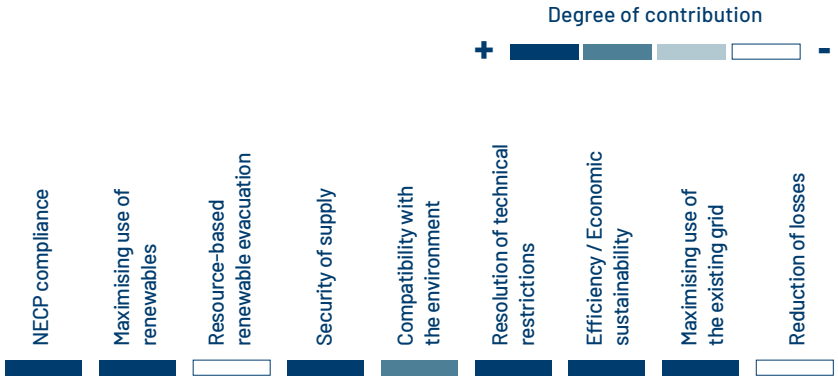

### I Costs:

| CAPEX | OPEX |
|---|---|
| 11 M€ | 0.16 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# Reinforcement INT_ESP-FRA_2

International interconnections

## Reinforcement of the Spain - France interconnection (Gatica)

### Table of physical units:

| | 200 kV | 400 kV |
|---|---|---|
| Bays (units) | 1 | 1 |
| Transformed to 220 kV (MVA) | | 600 |
| Uprating (km) | | 164 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Gatica 220 kV | 1 | AIS | TN | > 2026 |
| Gatica 400 kV | 1 | AIS | TN | > 2026 |

### Detailed list of assets (continued):

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Amorebieta - Itxaso 400 kV, circuit 1 | 1,760 | 1,588 | 50 | Line | INT | 2026 |
| Gatica - Amorebieta 400 kV, circuit 1 | 1,759 | 1,586 | 20 | Line | INT | 2026 |
| Gatica - Azpeitia 400 kV, circuit 1 | 1,750 | 1,580 | 56 | Line | INT | 2026 |
| Gatica - Güeñes 400 kV, circuit 1 | 1,757 | 1,584 | 39 | Line | INT | 2026 |

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Gatica 400/220 kV, TF2 | 600 | Triph. B. | INT | > 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement INT_ESP-FRA_3

International interconnections

## Reinforcement of the Spain - France interconnection (Hernani-Argia)

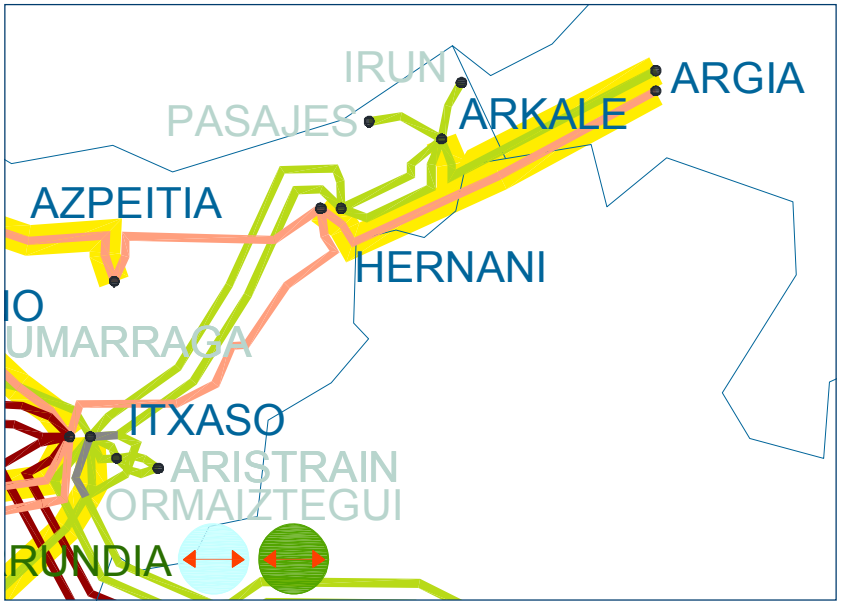
**I General description:** The project consists of replacing the conductor on the existing Hernani - French Border 400 kV section of the Hernani-Argia line.

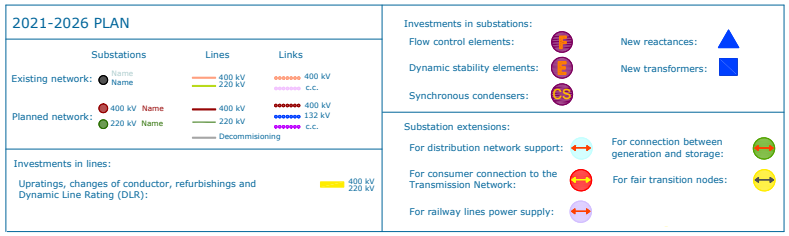
**I Drivers / Objectives:** Handling flows to/from France, enabling the increase in transfer capacity.

**I Alternatives:** The use of standard repowering won't achieve the capacity values necessary to allow increases in transfer capacity with France. Expansion of the DLR won't achieve a significant increase in capacity when this section is limiting.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement INT_ESP-FRA_3

International interconnections

## Reinforcement of the Spain - France interconnection (Hernani-Argia)

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 6.6 M€ | - M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

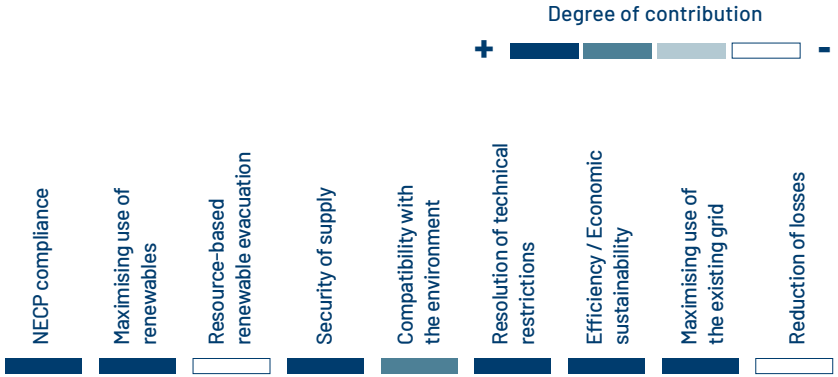
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# Reinforcement INT_ESP-FRA_3

International interconnections

## Reinforcement of the Spain - France interconnection (Hernani-Argia)

### Table of physical units:

| | 400 kV |
|---|---|
| Change of conductor (km) | 24 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Changes of conductor | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Hernani - Argia 400 kV, circuit 1 | 2,078 | 2,078 | 24 | Line | INT | 2024 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement INT_ESP-MAR
## International interconnections **Interconnection with Morocco**

**I General description:**

These reinforcements consist of building a third 400 kV axis between Spain and Morocco, comprising a new underground-submarine link between Puerto de la Cruz 400 kV and Beni Harchane 400 kV (Morocco) and four 50 MVAr reactances in Puerto de la Cruz 400 kV.

**I Drivers / Objectives:**

- Enabling transfer capacity to be increased between the Spanish and Moroccan electricity systems.
- A technical Annex is included with details on the Cost-Benefit analysis of these reinforcements.

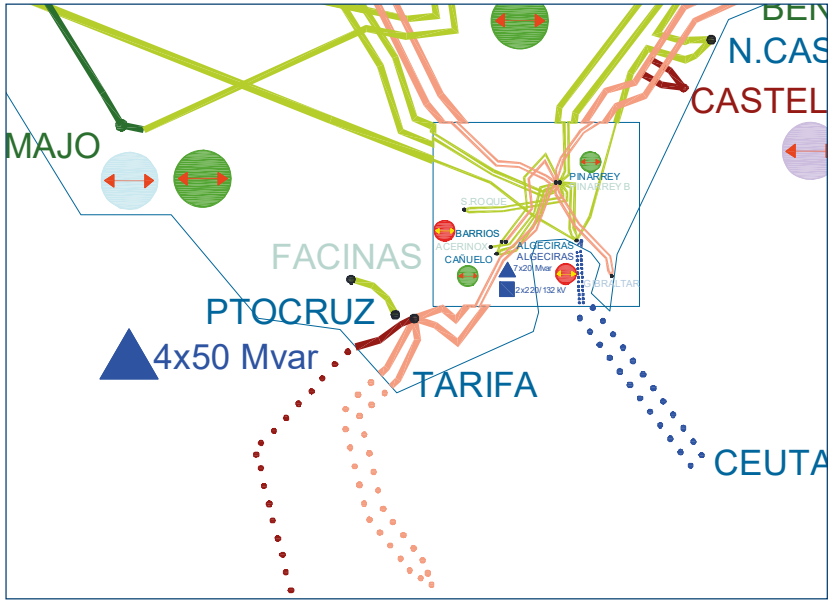
**I Alternatives:**

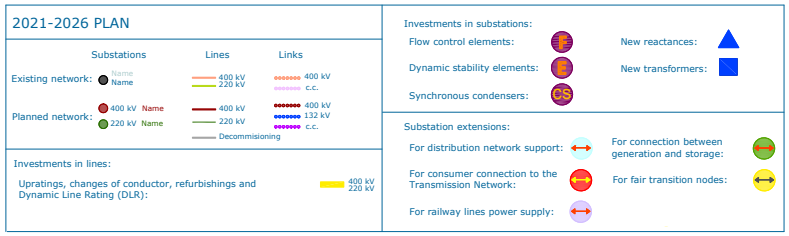
The alternative of the direct current link has been assessed, but the solution does not provide an equal contribution to the security of the Moroccan system and involves a greater reinforcements value.

**I European dimension:**

No

**I Map:**




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# I Reinforcement INT_ESP-MAR
International interconnections **Interconnection with Morocco**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 65.9 M€/year | Reduction of $CO_2$ emissions: 1,767 kt/year* |
| Additional RES integration: 337,024 MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 234.7 M€ | 4.29 M€/year |

Remuneration costs

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| M€ | 0.0 | 23.3 | 22.9 | 22.6 | 22.3 | 21.9 | 21.6 | 21.3 | 21.0 | 20.6 |

Note: The above CAPEX reflects the reinforcements for the entire interconnection project, notwithstanding the agreement reached on cost-allocation between the parties. The costbenefit analysis also includes both the costs and benefits of the interconnected system, following the methodology used in ENTSOE. It has been carried out using the PINT-sequential methodology, i.e. assessing the benefits generated by the reinforcement once the rest of the scheduled reinforcements in the Spanish Mainland network are commissioned.

### I Profitability:

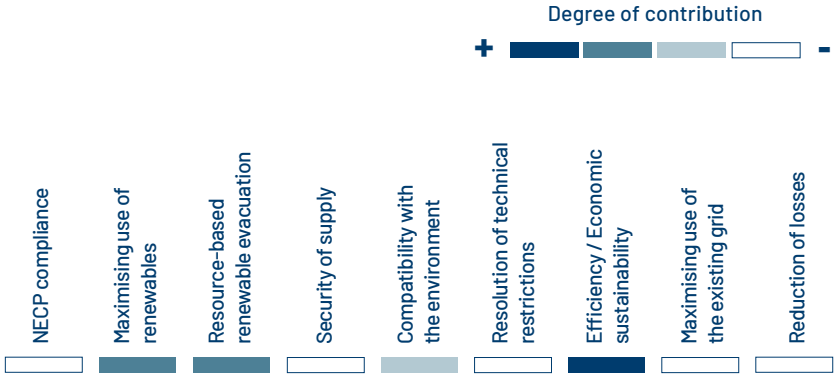
Profitability: NPV

966 M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement INT_ESP-MAR
International interconnections **Interconnection with Morocco**

## I Table of physical units:

| | 400 kV |
|---|---|
| Bays (units) | 6 |
| Reactance (Mvar) | 200 |
| Submarine Link (km) | 52 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## I Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Puerto de La Cruz 400 kV | 6 | AIS | TN | 2026 |

## I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Puerto de la Cruz - Beni Harchane 400 kV, circuit 1[1] | 700 | 700 | 52 | Subm. | INT | 2026 |

Notes:
1. For information purposes and until an agreement is made on cost-sharing between countries, the full length and cost of the submarine link is included.

| New reactances | MVAr | Type | Driv. | Year |
|---|---|---|---|---|
| Puerto de La Cruz 400 kV, REA4 [1] | 50 | - | INT | 2026 |
| Puerto de La Cruz 400 kV, REA5 [1] | 50 | - | INT | 2026 |
| Puerto de La Cruz 400 kV, REA6 [1] | 50 | - | INT | 2026 |
| Puerto de La Cruz 400 kV, REA7 [1] | 50 | - | INT | 2026 |

Notes:
1. Cable-supported reactance.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement INT_ESP-AND
## International interconnections **Interconnection with Andorra**

**I General description:**

These reinforcements consist of building a new interconnection between Spain and Andorra, including the following elements:

- New 220 kV double circuit from Adrall to the Andorra border.
- Expansion and adaptation of the Adrall 220 kV substation.
- Upgrade the Adrall-Llavorsí 220 kV and Adrall-Cercs 220 kV lines in the Adrall substation input.

**I Drivers / Objectives:**

To increase the net transfer capacity with Andorra system in order to keep up the expected demands of this system from the Spanish system.

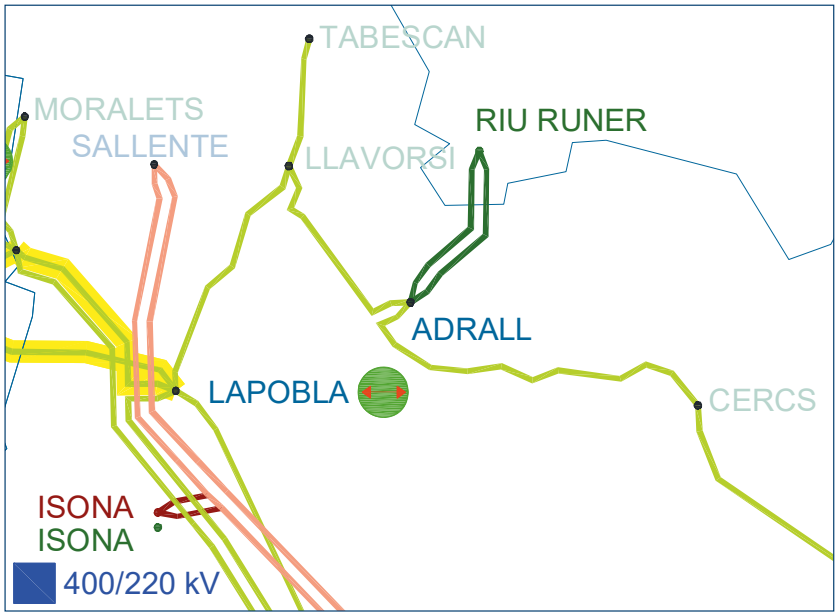
**I Alternatives:**

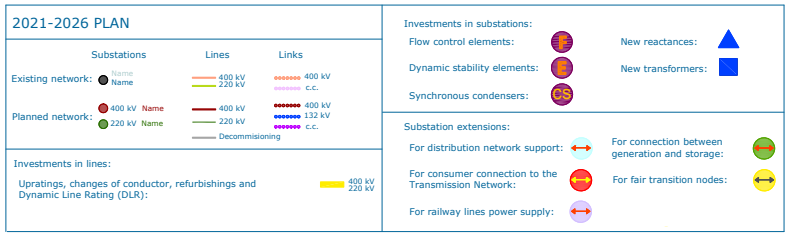
Uprating the existing 110 kV axis does not achieve sufficient capacity.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement INT_ESP-AND
International interconnections **Interconnection with Andorra**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 17.8 M€ | 0.18 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

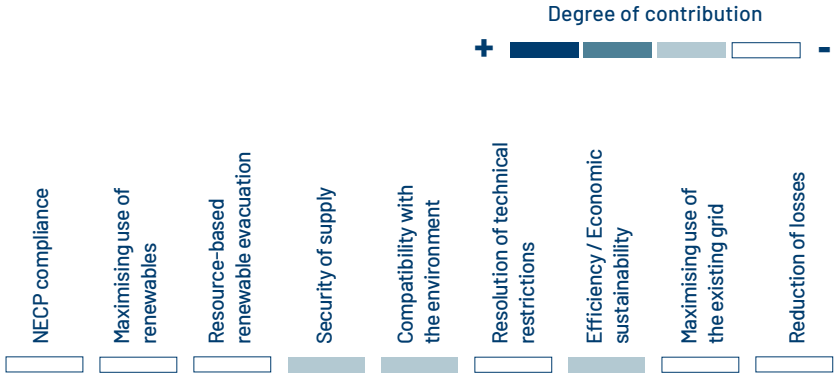
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement INT_ESP-AND
## International interconnections **Interconnection with Andorra**

### I Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 6 |
| Overhead line (km) | 33 |
| Cables (km) | 0.3 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Adrall 220 kV | 6 | GIS | TN | 2024 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Adrall - Adrall 220 kV [1] | | | 1 SSC | Cable | TN | 2024 |
| Adrall - Cercs 220 kV, circuit 1 [2] | 380 | 240 | 0.3 | Cable | INT | 2024 |
| DC Adrall - Frontera Andorra 220 kV [3] | 430 | 360 | 16 | Line | INT | 2024 |
| DC Adrall - Llavorsi 220 kV [4] | 380 | 250 | 0.7 | Line | INT | 2024 |

Notes:
1. Short section of cable inside the substation.
2. Modification in Adrall-Cercs.
3. The decommissioning of the current Adrall-Margineda 1 and 2 lines is required.
4. Modification in Adrall-Llavorsí/Cercs.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement ENL_PEN-IBA

## Interconnections between systems **Reinforcement of interconnection between the Spanish Mainland and the Islas Baleares**

**General description:**

The reinforcements consist of strengthening the connection between the Peninsula and the Islas Baleares with a direct current second link, 2x200MW, together with storage systems and synchronous condensers as elements completely integrated into the grid in accordance with Royal Decree-Law 29/2021. These reinforcements will lead to a significant increase in the percentage of Islas Baleares electricity demand met with more efficient energy generation and lower Peninsular emissions.

**Drivers / Objectives:**

- Making progression in terms of the electrical connections between non-peninsular territories and integrating the Islas Baleares system into the internal energy market, considering the European Commission's authorisation of the European Commission's tariff system SA.42270 (2016/NN).
- Increasing security of supply in the Islas Baleares electricity system.
- Replacing part of the higher-cost thermal power in the Balearic system with cheaper power generation that comprises more renewable energy from the Peninsula.
- Reducing the need for internal strengthening on the island of Mallorca.
- Ensuring safe operation and meeting the needs of voltage management in Mallorca.

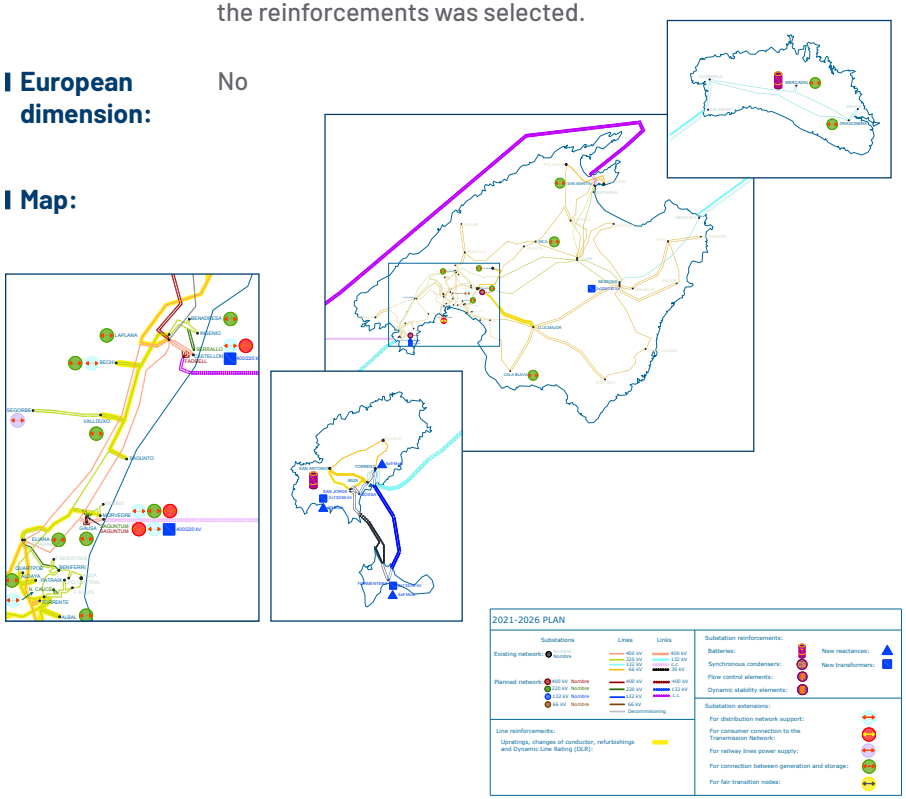
**Alternatives:**

Three different alternatives have been studied based on link capacity (2 x 500 MW, 2 x 200 MW, and 1 x 200 MW). Given that the three alternatives are viable from a technical perspective, the option with most value in terms of NPV compared to the reinforcements cost of the reinforcements was selected.

**European dimension:**

No

**Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement ENL_PEN-IBA

Interconnections between systems **Reinforcement of interconnection between the Spanish Mainland and the Islas Baleares**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 149 M€/year | Reduction of $CO_2$ emissions: 905 kt/year* |
| Additional RES integration: 236,000 MWh/year | Reduction of system losses: -2,551 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 1,165.4 M€ | 20.34 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 114.5 | 112.9 | 111.3 | 109.6 | 108.0 | 106.4 | 104.8 | 103.1 | 101.5 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

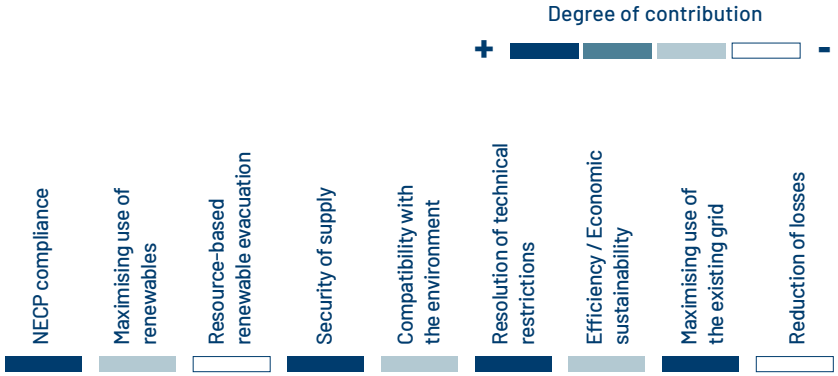
Profitability: NPV

1,248 M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement ENL_PEN-IBA

## Interconnections between systems **Reinforcement of interconnection between the Spanish Mainland and the Islas Baleares**

### Table of physical units:

| | 66 kV | 132 kV | 220 kV | 400 kV |
|---|---|---|---|---|
| Bays (units) | 2 | 4 | 15 | 10 |
| Overhead line (km) | 0.2 | | | 12 |
| Cables (km) | 2 | 2 | 6 | |
| Transformed to 132 kV (MVA) | | | 160 | |
| Submarine Link (km) | | | 420 | |
| Battery (MW) | 90 | 50 | | |
| Synchronous condensers (MVAr) | | | 500 | |
| Converter stations (units) | | | 2 | |

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Fadrell 400 kV | Outdoor | 2026 |

| New converter stations | Year |
|---|---|
| Fadrell E.C. 400 kV [1] | 2026 |
| San Martín de Islas Baleares E.C. 400 kV [1] | 2026 |

Notes:
1. One-off cost included in the cost of the link.

### Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Fadrell 400 kV | 10 | AIS | TN | 2026 |
| Llubi 220 kV | 4 | GIS | TN | > 2026 |
| Mercadal 132 kV | 2 | AIS | TN | 2024 |
| San Antonio 66 kV | 2 | AIS | TN | 2024 |
| San Martín Islas Baleares 220 kV | 4 | GIS | TN | 2026 |
| Santa Ponsa 132 kV | 2 | GIS | TN | 2026 |
| Santa Ponsa 220 kV | 3 | GIS | TN | 2026 |
| Santa Ponsa 220 kV | 2 | GIS | TN | > 2026 |
| Son Orlandis 220 kV | 2 | AIS | TN | 2030 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC San Martín Islas Baleares - San Martín Islas Baleares E.C. 220 kV | | | 1 | Cable | Link | 2026 |
| I/O in Fadrell, of La Plana - Castellón CT 400 kV, circuit 1 [1] | 1,280 | 850 | 3 | Line | Link | 2026 |
| I/O in Fadrell, of La Plana - Castellón CT 400 kV, circuit 2 [1] | 1,280 | 850 | 3 | Line | Link | 2026 |
| Fadrell - Fadrell EC 400 kV, circuit 1 | | | 0.2 | Line | Link | 2026 |
| Fadrell - Fadrell EC 400 kV, circuit 2 | | | 0.2 | Line | Link | 2026 |

Notes:
1. Section line capacity in DC for I/O 2348/1976 MVA.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement ENL_PEN-IBA

## Interconnections between systems **Reinforcement of interconnection between the Spanish Mainland and the Islas Baleares**

### I Detailed list of assets (continued):

| New lines/cables (cont.) | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Fadrell EC - San Martín Islas Baleares E.C. 220 kV, circuit 1 [2] | 400 | 400 | 420 | Subm. | Link | 2026 |
| Llubi - Llubi 220 kV [3] | | | 2 SSC | Cable | Link | > 2026 |
| Mercadal - Mercadal 132 kV [3] | | | 2 SSC | Cable | Link | 2024 |
| San Antonio - San Antonio 66 kV [3] | | | 2 SSC | Cable | Link | 2024 |
| San Martín Islas Baleares - Alcudia Islas Baleares 66 kV, circuit 1 | | | 0.6 | Cable | Link | 2026 |
| San Martín Islas Baleares - Alcudia Islas Baleares 66 kV, circuit 1 | | | 0.2 | Line | Link | 2026 |
| San Martín Islas Baleares - San Martín Islas Baleares E.C. 220 kV | | | 0.1 | Cable | Link | 2026 |
| Santa Ponsa - Santa Ponsa 132 kV [3] | | | 2 SSC | Cable | Link | 2026 |
| Santa Ponsa - Santa Ponsa 220 kV [4] | | | 1 SSC | Cable | Link | 2026 |
| Santa Ponsa - Santa Ponsa E.C. 220 kV, circuit 1 | | | 1 | Cable | Link | 2026 |
| Santa Ponsa - Santa Ponsa E.C. 220 kV, circuit 1 | | | 1 | Cable | Link | > 2026 |
| Son Orlandis - Son Orlandis 220 kV [4] | | | 1 SSC | Cable | Link | 2030 |

Notes:
2. Submarine Link HVDC-VSC 2 x 200 MW.
3. Short sections of cable inside the substation.
4. Short section of cable inside the substation.

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Santa Ponsa 220/132 kV, TF3 | 160 | Triph. B. | Link | 2026 |

| New synchronous condensers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Llubi 220 kV, CS1 | 100 | - | Link | > 2026 |
| Llubi 220 kV, CS2 | 100 | - | Link | > 2026 |
| Santa Ponsa 220 kV, CS1 | 100 | - | Link | 2026 |
| Santa Ponsa 220 kV, CS2 | 100 | - | Link | > 2026 |
| Son Orlandis 220 kV, CS1 | 100 | - | Link | 2026 |

| New batteries | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Mercadal 132 kV, BAT1 | 25 | - | Link | 2024 |
| Mercadal 132 kV, BAT2 | 25 | - | Link | 2024 |
| San Antonio 66 kV, BAT1 | 45 | - | Link | 2024 |
| San Antonio 66 kV, BAT2 | 45 | - | Link | 2024 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement ENL_IBA IB-FO
## Interconnections between systems **Ibiza-Formentera 132 kV links**

**I General description:**

The reinforcements consist of strengthening the connection between the islands of Ibiza and Formentera through the commissioning of two new 132 kV alternating current links between Torrent and Formentera.

**I Drivers / Objectives:**

- Making progress on the electrical connections between non-peninsular territories to facilitate the transition towards a decarbonised economy.
- Reducing the need for energy generation in Formentera for the island's demand peaks.
- Improve supply quality and security in Formentera's subsystem.

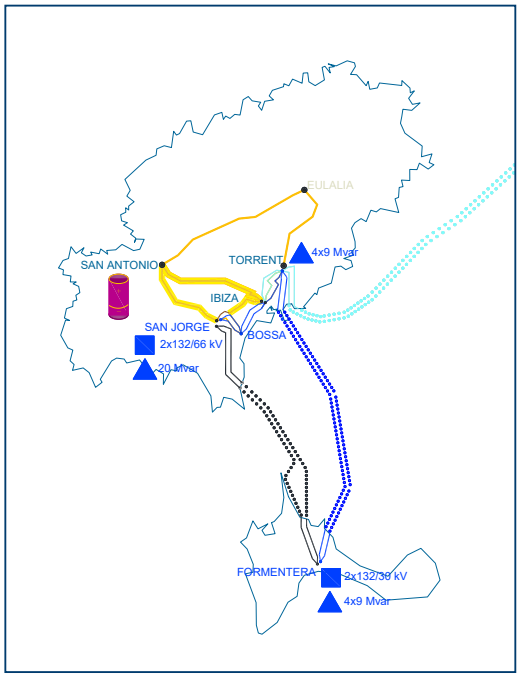
**I Alternatives:**

As an alternative to the proposed links, the thermal energy installation in Formentera could be expanded. However, this alternative significantly increases generations costs and $CO_2$ emissions.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement ENL_IBA IB-FO
## Interconnections between systems **Ibiza-Formentera 132 kV links**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 17.7 M€/year | Reduction of $CO_2$ emissions: -4 kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: -1,536 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Profitability:

Profitability: NPV

203 M€

### I Socio-environmental impact:



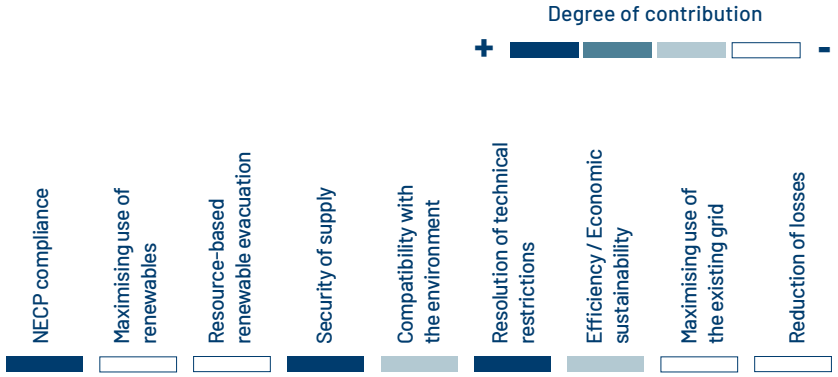

### I Costs:

| CAPEX | OPEX |
|---|---|
| 106.4 M€ | 1.45 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 10.0 | 9.9 | 9.7 | 9.6 | 9.5 | 9.3 | 9.2 | 9.0 | 8.9 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement ENL_IBA IB-FO
## Interconnections between systems **Ibiza-Formentera 132 kV links**

### I Table of physical units:

| | 30 kV | 132 kV |
|---|---|---|
| Bays (units) | 2 | 20 |
| Cables (km) | | 0.3 |
| Transformación a 30 kV (MVA) | | 60 |
| Reactance (Mvar) | | 72 |
| Submarine Link (km) | | 75 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Formentera 132 kV | Building | 2023 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Formentera 132 kV | 12 | GIS | TN | 2023 |
| Formentera 30 kV | 2 | GIS | Link | 2023 |
| Torrent 132 kV | 4 | GIS | TN | 2023 |
| Torrent 132 kV | 2 | GIS | TN | 2020 |
| Torrent 132 kV | 2 | AIS | TN | 2023 |

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Torrent - Formentera 132 kV, circuit 1 | 53 | 53 | 37 | Subm. | Link | 2023 |
| Torrent - Formentera 132 kV, circuit 2 | 53 | 53 | 37 | Subm. | Link | 2023 |
| Torrent - Torrent 132 kV [1 2] | | | 4 SSC | Cable | Link | 2023 |

Notes:
1. Cable to connect the REA with bays.
2. Short sections of cable inside the substation.

| New transformers | MVAr | Type | Driv. | Year |
|---|---|---|---|---|
| Formentera 132/30 kV, TF1 | 30 | Triph. B. | Link | 2023 |
| Formentera 132/30 kV, TF2 | 30 | Triph. B. | Link | 2023 |

| New reactances | MVAr | Type | Driv. | Year |
|---|---|---|---|---|
| Formentera 132 kV, REA1 | 9 | - | Link | 2023 |
| Formentera 132 kV, REA2 | 9 | - | Link | 2023 |
| Formentera 132 kV, REA3 | 9 | - | Link | 2023 |
| Formentera 132 kV, REA4 | 9 | - | Link | 2023 |
| Torrent 132 kV, REA10 | 9 | - | Link | 2023 |
| Torrent 132 kV, REA7 | 9 | - | Link | 2023 |
| Torrent 132 kV, REA8 | 9 | - | Link | 2023 |
| Torrent 132 kV, REA9 | 9 | - | Link | 2023 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement ENL_ICA TE-LG
## Interconnections between systems **Tenerife-La Gomera links**

**I General description:**

The proposed reinforcements consist of a submarine link between the electrical systems in Tenerife and La Gomera. This requires the following developments:

- New El Palmar 66 kV substation in La Gomera.
- New El Palmar-Chío 66 kV double-circuit submarine-cable link, alternating current, with 50 MVA capacity per circuit.
- Expansion of the 66 kV Chío substation in Tenerife.
- Five 66 kV, 6 MVAr reactances.

**I Drivers / Objectives:**

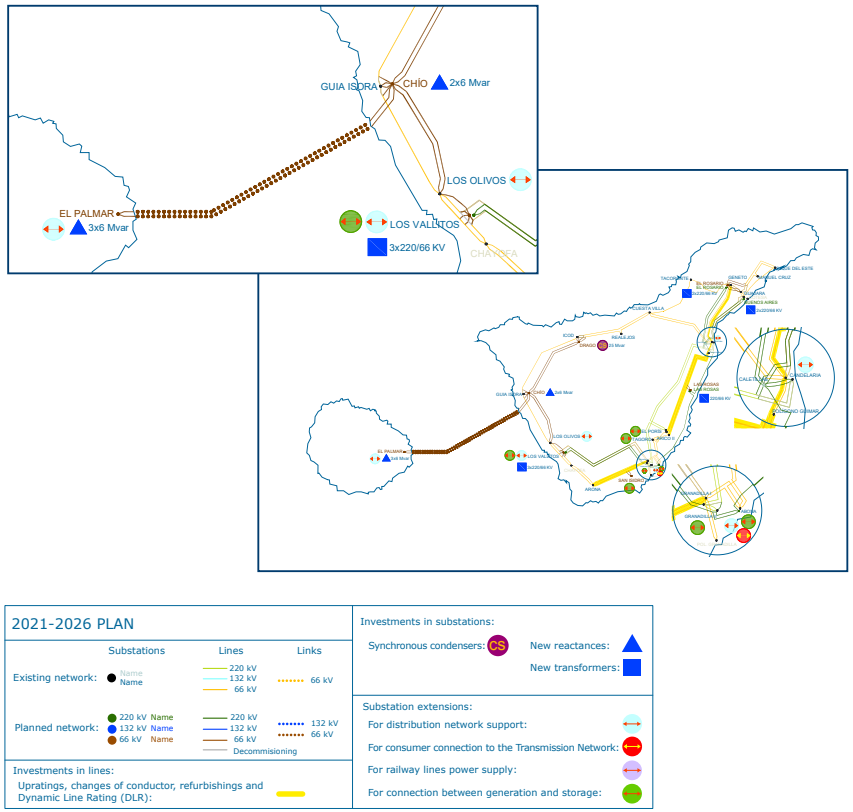
- Integrate currently independent electrical systems in La Gomera and Tenerife, increasing the quality and security of supply.
- Reducing overall production costs for the entire new system, thanks to improved generation efficiency.
- Enabling increased integration of renewables, particularly in La Gomera, and reducing $CO_2$ emissions.
- Reducing installed power generation requirements across the entire system.

**I Alternatives:**

As an alternative, keeping the systems isolated has been analysed, with a consequent increase in generation costs and emissions.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement ENL_ICA TE-LG
## Interconnections between systems **Tenerife-La Gomera links**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 8 M€/year | Reduction of $CO_2$ emissions: 16 kt/year* |
| Additional RES integration: 21,506 MWh/year | Reduction of system losses: -3,093 MWh/year* |
| Reduction of ENS: 208 MWh/year* | Reducción de generación necesaria: 14 MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 105.8 M€ | 2.01 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 10.6 | 10.4 | 10.3 | 10.1 | 10.0 | 9.8 | 9.7 | 9.5 | 9.4 |

Note: The Net Present Value (NPV) for these reinforcements has been calculated using the sequential PINT methodology, or rather, the benefits the link would provide have been assessed against a baseline scenario that includes all other planned reinforcements in the already commissioned-La Gomera system.

### I Profitability:

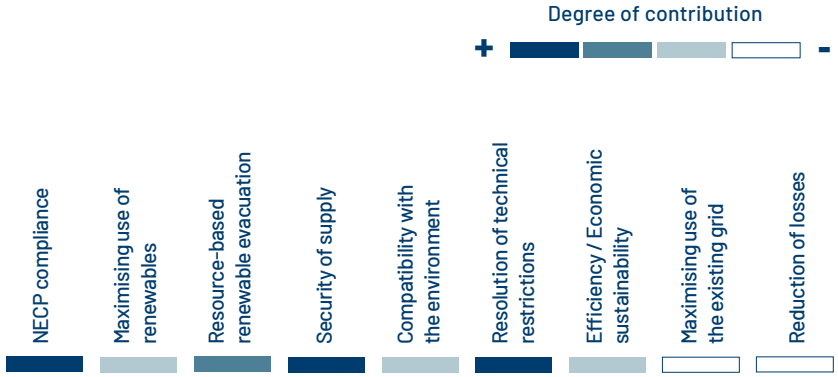
Profitability: NPV

82 M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement ENL_ICA TE-LG
## Interconnections between systems **Tenerife-La Gomera links**

### I Table of physical units:

| | 66 kV |
|---|---|
| Bays (units) | 14 |
| Cables (km) | 0.7 |
| Reactance (Mvar) | 30 |
| Submarine Link (km) | 84 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| El Palmar de la Gomera N.P. 66 kV | Building | 2025 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Chío 66 kV | 4 | GIS | TN | 2025 |
| Chío 66 kV | 2 | AIS | TN | 2025 |
| El Palmar de la Gomera N.P. 66 kV | 5 | GIS | TN | 2025 |
| El Palmar de la Gomera N.P. 66 kV | 3 | AIS | TN | 2025 |

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Chío - Chío 66 kV [1] [2] | | | 2 SSC | Cable | Link | 2025 |
| Chío - El Palmar de la Gomera N.P. 66 kV, circuit 1 | 50 | 50 | 42 | Subm. | Link | 2025 |
| Chío - El Palmar de la Gomera N.P. 66 kV, circuit 2 | 50 | 50 | 42 | Subm. | Link | 2025 |
| El Palmar de la Gomera N.P. - El Palmar de la Gomera N.P. 66 kV [1] | | | 3 SSC | Cable | Link | 2025 |

Notes:
1. Short section of cable inside the substation.
2. Bus bar reactance.

| New reactances | MVAr | Type | Driv. | Year |
|---|---|---|---|---|
| Chío 66 kV, REA1 [1] | 6 | - | Link | 2025 |
| Chío 66 kV, REA2 [1] | 6 | - | Link | 2025 |
| El Palmar de la Gomera N.P. 66 kV, REA1 [1] | 6 | - | Link | 2025 |
| El Palmar de la Gomera N.P. 66 kV, REA2 [1] | 6 | - | Link | 2025 |
| El Palmar de la Gomera N.P. 66 kV, REA3 [2] | 6 | - | Link | 2025 |

Notes:
1. Reactance associated with the link.
2. Bus bar reactance.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I ENL_PEN-CEU
## Interconnections between systems **Spanish Mainland-Ceuta links**

**I General description:**

The proposed reinforcements consist of a submarine link between electrical systems in the Peninsula and Ceuta. This requires the following developments:

- New Virgen de África 132 kV substation in Ceuta.
- New submarine link with two circuits in Algeciras-Virgen de África 132 kV, alternating current.
- Expansion of the Algeciras 220 kV substation.
- New Algeciras 132 kV substation with two transformers 220/132 kV.
- Each reactance 132 kV, 20 MVAr: 7 in Algeciras and 2 in Virgen de África.

**I Drivers / Objectives:**

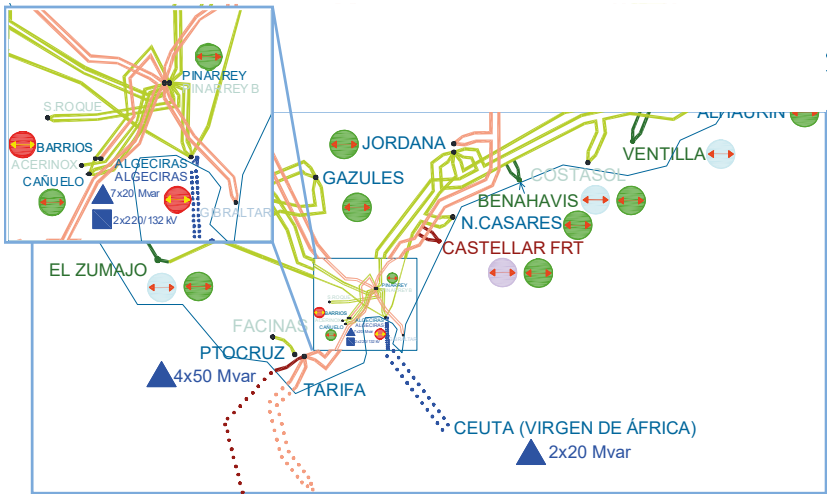
- Integrating Ceuta's electrical system into the Peninsular system with the aim of significantly increasing the security and quality of the supply in Ceuta.
- Reducing installed power generation requirements in Ceuta.
- Reducing overall generation costs and increasing the integration of renewables.

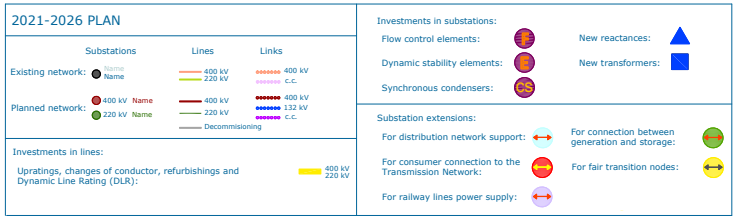
**I Alternatives:**

As an alternative, keeping Ceuta's supply under the same conditions has been assessed, which would involve the need to use less efficient generation with higher emissions than that in the Peninsula, as well as lower levels of security of supply in the Ceuta system.
In addition, the alternative of connecting the link to the Peninsula in a new substation instead of an existing substation was assessed, but there has been strong social opposition to potential locations.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I ENL_PEN-CEU
## Interconnections between systems **Spanish Mainland-Ceuta links**

### Cost-Benefit Multi-Criteria Analysis

#### I Benefits:

| | |
|---|---|
| Socio-economic welfare:<br>29.7 M€/year | Reduction of $CO_2$ emissions:<br>299 kt/year* |
| Additional RES integration:<br>473 MWh/year | Reduction of system losses:<br>- MWh/year* |
| Reduction of ENS:<br>51 MWh/year* | Reducción de generación necesaria:<br>10 MW |

Note: * a negative value means existing increased emissions, losses or ENS.

#### I Costs:

| CAPEX | OPEX |
|---|---|
| 222.5 M€ | 3.42 M€/year |

Remuneration costs

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| M€ | 0.0 | 21.4 | 21.1 | 20.8 | 20.5 | 20.2 | 19.8 | 19.5 | 19.2 | 18.9 |

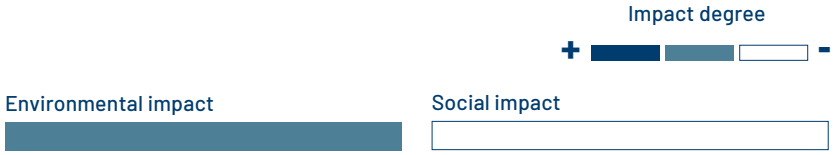
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

#### I Profitability:

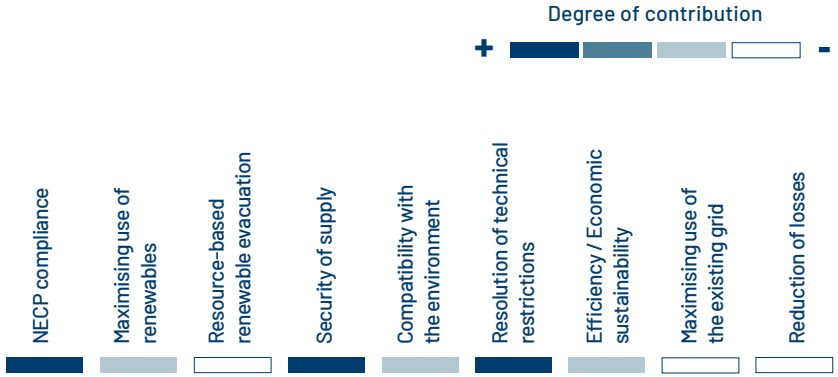
Profitability: NPV

301 M€

#### I Socio-environmental impact:




#### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I ENL_PEN-CEU
## Interconnections between systems **Spanish Mainland-Ceuta links**

### I Table of physical units:

| | 132 kV | 220 kV |
|---|---|---|
| Bays (units) | 21 | 2 |
| Total renewal of bays (units) | | 1 |
| Cables (km) | 4 | 1 |
| Transformed to 132 kV (MVA) | | 250 |
| Reactance (Mvar) | 180 | |
| Submarine Link (km) | 138 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Algeciras 132 kV [1] | Building | 2025 |
| Virgen de África 132 kV [1] | Building | 2025 |

Notes:
1. Non-standard cost included in total cost of project.

### I Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Algeciras 132 kV [1] | 6 | GIS | Link | 2025 |
| Algeciras 132 kV [1] | 7 | AIS | Link | 2025 |
| Algeciras 220 kV | 2 | GIS | Link | 2025 |
| Virgen de África 132 kV [1] | 2 | GIS | SuD | 2025 |
| Virgen de África 132 kV [1] | 4 | GIS | Link | 2025 |
| Virgen de África 132 kV [1] | 2 | AIS | Link | 2025 |

Notes:
1. Non-standard cost included in the link cost.

| Total renewal of bays | units | Type | Driv. | Year |
|---|---|---|---|---|
| Algeciras 220 kV | 1 | GIS | Link | 2025 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I ENL_PEN-CEU
## Interconnections between systems **Spanish Mainland-Ceuta links**

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Algeciras - Algeciras 132 kV [1] | | | 3 SSC | Cable | Link | 2025 |
| Algeciras - Virgen de África 132 kV, circuit 1 [2] | 80 | 80 | 69 | Subm. | Link | 2025 |
| Algeciras - Virgen de África 132 kV, circuit 2 | 80 | 80 | 69 | Subm. | Link | 2025 |
| DC Algeciras - Algeciras 132 kV | | | 0.3 | Cable | Link | 2025 |
| DC Algeciras - Algeciras 220 kV | | | 0.5 | Cable | Link | 2025 |
| Virgen de África - Virgen de África 132 kV, circuit 1 [3] | | | 2 | Cable | Link | 2025 |

Notes:
1. Short section of cable inside the substation.
2. Submarine - underground link. The cost includes all non-standard installations associated with the link.
3. Connection cables from transformers to distribution and from reactances with non-standard tariffs included in the cost of the link.

| New reactances | MVAr | Type | Driv. | Year |
|---|---|---|---|---|
| Algeciras 132 kV, REA1 [1] | 20 | - | Link | 2025 |
| Algeciras 132 kV, REA2 [1] | 20 | - | Link | 2025 |
| Algeciras 132 kV, REA3 [1] | 20 | - | Link | 2025 |
| Algeciras 132 kV, REA4 [1] | 20 | - | Link | 2025 |
| Algeciras 132 kV, REA5 [1] | 20 | - | Link | 2025 |
| Algeciras 132 kV, REA6 [1] | 20 | - | Link | 2025 |
| Algeciras 132 kV, REA7 [1] | 20 | - | Link | 2025 |
| Virgen de África 132 kV, REA1 [1] | 20 | - | Link | 2025 |
| Virgen de África 132 kV, REA2 [1] | 20 | - | Link | 2025 |

Notes:
1. Joint reactance in stages. Non-standard cost included in the cost of the link.

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Algeciras 220/132 kV, TF1 [1] | 125 | Triph. B. | Link | 2025 |
| Algeciras 220/132 kV, TF2 [1] | 125 | Triph. B. | Link | 2025 |

Notes:
1. Non-standard cost included in total cost of project.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement PEN_USO_RdT

RES integration and resolution of technical constraints **Increased use of the Transmission Network**

**I General description:**

These reinforcements include increasing the use of the existing grid via the installation of capacity monitoring equipment (Dynamic Line Rating - DLR), repowering, and increasing capacity with a conductor change on the 400 kV and 220 kV lines.

These reinforcements are to be carried out on 435 km of line with DLR equipment, close to 1700 km of repowering, and 137 km with increased capacity via high temperature conductor.

Additionally, a contingent is included for these types of woks in regional projects together with new developments for the 2021-2026 period.

**I Drivers / Objectives:**

Maximising the use of the existing grid with the aim of:

- Reducing the need for technical constraints due to overloads through the curtailment of existing and future renewable energy, resulting in improved integration of renewable energy.
- Improving security of supply.

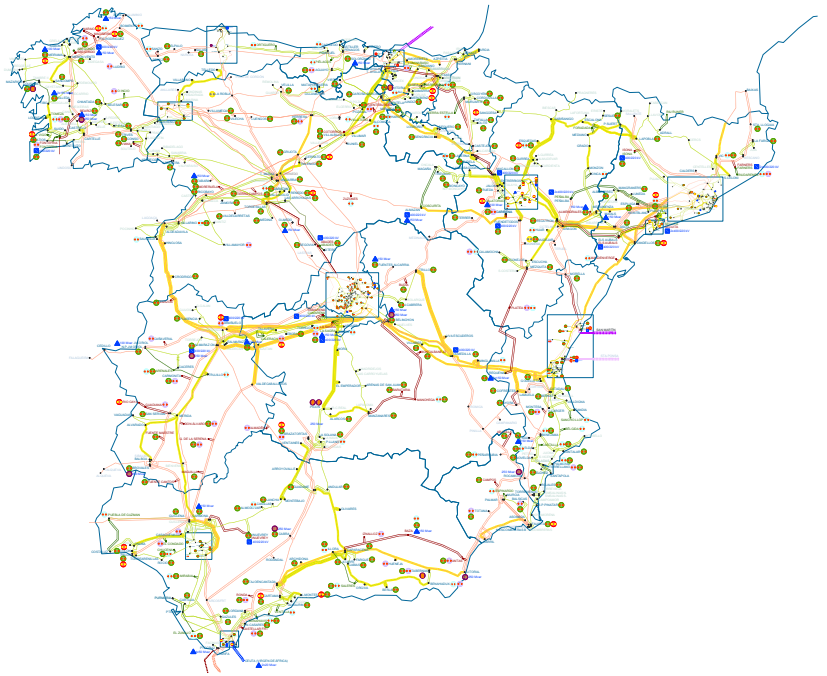
**I Alternatives:**

The alternative for these reinforcements consists of building new axes with a considerably greater social and environmental impact, as well as reinforcements cost.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement PEN_USO_RdT

RES integration and resolution of technical constraints **Increased use of the Transmission Network**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 27.3 M€/year | Reduction of $CO_2$ emissions: 174 kt/year* |
| Additional RES integration: 175,617 MWh/year | Reduction of system losses: -60,156 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 78.9 M€ | 0.14 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 6.5 | 6.4 | 6.3 | 6.2 | 6.1 | 6.0 | 5.9 | 5.7 | 5.6 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

Profitability: NPV

452 M€

### I Socio-environmental impact:




Environmental impact

Social impact

### I Contribution to guiding principles:







Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement PEN_USO_RdT

RES integration and resolution of technical constraints **Increased use of the Transmission Network**

## I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Uprating (km) | 934 | 519 |
| DLR (km) | 381 | 54 |
| Change of conductor (km) | 98 | 34 |
| Overhead line (km) | 3 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## I Detailed list of assets:

| Changes of conductor | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Cartelle - Castrelo 220 kV, circuit 2 [1] | 660 | 620 | 3 | Line | RES | 2023 |
| Coslada - Villaverde Bajo 220 kV, circuit 1 [2] | 460 | 460 | 16 | Cable | RES | > 2026 |
| Escatrón - Espartal 220 kV, circuit 1 [3] | 650 | 620 | 43 | Line | RES | 2024 |
| Espartal - Montetorrero 220 kV, circuit 1 [3] | 660 | 620 | 17 | Line | RES | 2023 |
| La Lomba - Montearenas 220 kV, circuit 1 [3] | 620 | 595 | 9 | Line | RES | 2026 |
| Mudarra - Tordesillas 400 kV, circuit 1 [3] | 2,267 | 2,149 | 34 | Line | RES | 2024 |
| Peñaflor - Villanueva de Gallego 220 kV, circuit 1 [4] | 634 | 604 | 11 | Line | RES | 2026 |

Notes:
1. Requires high temperature conductor change, on the current Condor simplex route.
2. The line capacity and cost are estimates. They will be determined following a more detailed study of the project.
3. Requires high temperature conductor change.
4. Requires high temperature conductor change. Includes a variant of 3 km of a route of 220-132 kV double circuit line route.

## I Detailed list of assets (continued):

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Abadiano - Vitoria 220 kV, circuit 1 | 488 | 440 | 34 | Line | RES | 2022 |
| Almazán - Cariñena 400 kV, circuit 1 | 1,790 | 1,500 | 116 | Line | RES | 2022 |
| Ayala - T de Ayala 2 220 kV, circuit 2 | 488 | 440 | 10 | Line | RES | 2022 |
| Barcina - Güeñes 400 kV, circuit 1 | 1,777 | 1,563 | 56 | Line | RES | 2022 |
| Barcina - Itxaso 400 kV, circuit 1 | 1,820 | 1,580 | 88 | Line | RES | 2022 |
| Cartelle - Castrelo 220 kV, circuit 2 [1] | 660 | 620 | 4 | Line | RES | 2023 |
| Cillamayor - Mataporquera 220 kV, circuit 1 | 425 | 373 | 9 | Line | RES | 2022 |
| Coslada - Villaverde Bajo 220 kV, circuit 1 | 430 | 350 | 15 | Line | RES | 2024 |
| Escalona - T de Escalona 220 kV, circuit 1 | 394 | 334 | 0.8 | Line | RES | 2022 |
| Escalona - T de Sesué 220 kV, circuit 1 | 394 | 334 | 20 | Line | RES | 2022 |
| Escatrón - Villanueva de Gallego 220 kV, circuit 1 | 426 | 363 | 72 | Line | RES | 2022 |
| Escatrón - Villanueva de Gallego 220 kV, circuit 2 | 426 | 363 | 72 | Line | RES | 2022 |
| Esquedas - Gurrea de Gallego 220 kV, circuit 1 | 428 | 363 | 27 | Line | RES | 2022 |
| Gatica - Güeñes 220 kV, circuit 1 | 482 | 409 | 33 | Line | RES | 2022 |
| Grado - Monzón 220 kV, circuit 1 | 480 | 400 | 26 | Line | RES | 2022 |
| Grijota - Herrera 400 kV, circuit 1 | 2,300 | 1,985 | 61 | Line | RES | 2022 |
| Grijota - Mudarra 400 kV, circuit 1 | 1,774 | 1,509 | 46 | Line | RES | 2022 |
| Gurrea de Gallego - Sabiñánigo 220 kV, circuit 2 | 428 | 363 | 69 | Line | RES | 2022 |

Notes:
1. Route constructed in Rail duplex. Line capacity in the repowered overhead section 994/864 MVA.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement PEN_USO_RdT

RES integration and resolution of technical constraints **Increased use of the Transmission Network**

## I Detailed list of assets (continued):

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Gurrea de Gallego - Villanueva de Gallego 220 kV, circuit 1 | 427 | 363 | 34 | Line | RES | 2022 |
| Gurrea de Gallego - Villanueva de Gallego 220 kV, circuit 2 | 427 | 363 | 34 | Line | RES | 2022 |
| La Jara - T de Ayala 2 220 kV, circuit 2 | 488 | 440 | 10 | Line | RES | 2022 |
| La Serna - Tudela 220 kV, circuit 1 | 492 | 425 | 9 | Line | RES | 2022 |
| La Serna - Tudela 220 kV, circuit 2 | 437 | 378 | 8 | Line | RES | 2022 |
| Los Vientos - María 220 kV, circuit 1 | 763 | 649 | 11 | Line | RES | 2022 |
| Los Vientos - María 220 kV, circuit 2 | 763 | 649 | 11 | Line | RES | 2022 |
| María - Montetorrero 220 kV, circuit 1 | 850 | 720 | 17 | Line | RES | 2022 |
| María - Montetorrero 220 kV, circuit 2 | 854 | 726 | 17 | Line | RES | 2022 |
| Mediano - Pont de Suert 220 kV, circuit 1 | 480 | 400 | 49 | Line | RES | 2022 |
| Mesón Do Vento - Santiago de Compostela 220 kV, circuit 1 | 441 | 394 | 48 | Line | RES | 2022 |
| Montetorrero - Peñaflor 220 kV, circuit 1 | 426 | 363 | 21 | Line | RES | 2022 |
| Palencia - T de Mudarrita 1 220 kV, circuit 1 | 773 | 667 | 57 | Line | RES | 2022 |
| Poza de la Sal - T de Ayala 2 220 kV, circuit 1 | 789 | 681 | 63 | Line | RES | 2022 |
| Sabiñánigo - T de Escalona 220 kV, circuit 1 | 382 | 324 | 48 | Line | RES | 2022 |
| Sant Celoni - Vic 220 kV, circuit 1 | 430 | 374 | 35 | Line | RES | 2022 |
| Santa Engracia - Barcina 400 kV, circuit 1 | 1,750 | 1,509 | 95 | Line | RES | 2022 |
| Santa Engracia - La Serna 400 kV, circuit 1 | 1,764 | 1,521 | 58 | Line | RES | 2022 |
| Telledo - Villablino 220 kV, circuit 1 | 323 | 279 | 40 | Line | RES | 2024 |
| Tordesillas - Zaratán 220 kV, circuit 1 | 440 | 368 | 30 | Line | RES | 2022 |

| Dynamic Line Rating | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|
| Aragón - Mequinenza 400 kV, circuit 1 | 54 | Line | RES | 2022 |
| Escatrón - Hijar 220 kV, circuit 1 | 16 | Line | RES | 2022 |
| Escucha - Hijar 220 kV, circuit 1 | 57 | Line | RES | 2022 |
| Fuendetodos - María 220 kV, circuit 1 | 30 | Line | RES | 2022 |
| Fuendetodos - María 220 kV, circuit 2 | 30 | Line | RES | 2022 |
| La Pobla de Segur - T de Sesué 220 kV, circuit 1 | 55 | Line | RES | 2022 |
| La Selva - Tarragona 220 kV, circuit 1 | 16 | Line | RES | 2022 |
| Logroño - El Sequero 220 kV, circuit 1 | 27 | Line | RES | 2022 |
| Palencia - Renedo 220 kV, circuit 1 | 65 | Line | RES | 2022 |
| Pazos de Borbén - Tomeza 220 kV, circuit 1 | 20 | Line | RES | 2022 |
| Pont de Suert - La Pobla de Segur 220 kV, circuit 1 | 29 | Line | RES | 2022 |
| Riera de Caldes - Sentmenat 220 kV, circuit 1 | 10 | Line | RES | 2022 |
| Tibo - Tomeza 220 kV, circuit 1 | 27 | Line | RES | 2022 |

| New lines/cables | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|
| Lomba - Montearenas 220 kV, circuit 1 | 2 | Line | RenovTN | 2026 |
| Telledo -Villablino 220 kV, circuit 1[1] | 1 | Line | RES | 2024 |

Notes:
1. New sections of line that make the planned reinforcements viable.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement CENTRO_1

## RES integration and resolution of technical constraints **La Mancha-Madrid Corridor**

**I General description:**

This corridor consists of a set of reinforcements that will allow the integration of renewable energy in Castilla-La Mancha via 400 kV axes that will facilitate its flow into Madrid.

Finally, by taking advantage of the existing 400 kV and 220 kV axes and using several inputs and outputs, it will be connected to the metropolitan area of Madrid's transmission grid.

**I Drivers / Objectives:**

- Connecting and integrating renewable energy, both solar and wind, in the areas of Castilla-La Mancha with significant resources.
- Facilitating the integration of renewable energy and its transmission into an area with a high level of electricity consumption, such as Madrid.

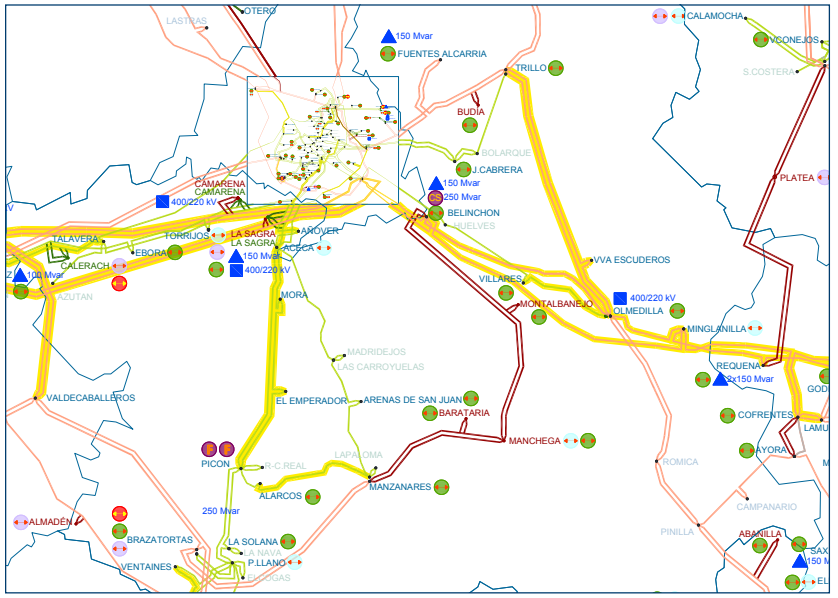
**I Alternatives:**

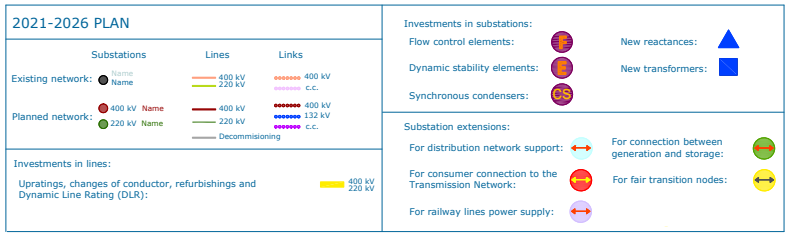
Even with operational measures implemented, the solutions based on strengthening existing axes, monitoring line capacity (DLR), and repowering of 400 kV and 220 kV axes do not meet the needs identified. Other solutions using additional 400 kV axes produced a similar result but were more costly in both financial and environmental terms.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement CENTRO_1

RES integration and resolution of technical constraints **La Mancha-Madrid Corridor**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 48 M€/year | Reduction of $CO_2$ emissions: 365 kt/year* |
| Additional RES integration: 1,002.021 MWh/year | Reduction of system losses: 148,424 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 415.2 M€ | 4.87 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 38.4 | 37.8 | 37.3 | 36.7 | 36.1 | 35.5 | 35.0 | 34.4 | 33.8 |

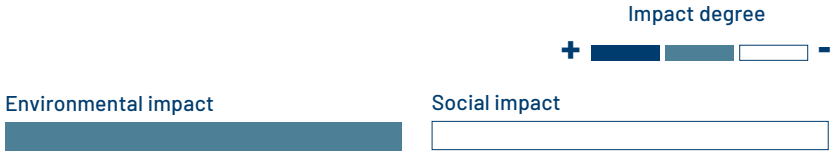
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

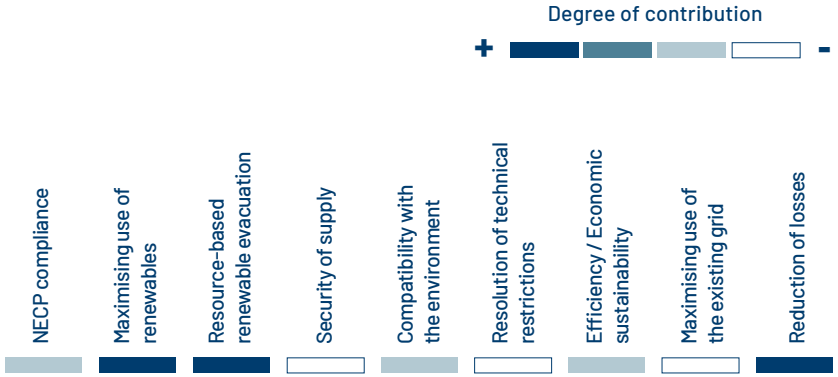
Profitability: NPV

388 M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement CENTRO_1

## RES integration and resolution of technical constraints **La Mancha-Madrid Corridor**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 13 | 57 |
| Overhead line (km) | 92 | 836 |
| Transformed to 220 kV (MVA) | | 1,800 |
| Uprating (km) | 402 | 344 |
| Reactance (Mvar) | | 450 |
| Mobile Overload Limiter (units) | 2 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Barataria* 400 kV | Outdoor | 2026 |
| La Sagra 220 kV | Outdoor | 2025 |
| La Sagra 400 kV | Outdoor | 2025 |
| Manchega 400 kV | Outdoor | 2025 |
| Montalbanejo* 400 kV | Outdoor | 2026 |
| Picón 400 kV | Outdoor | > 2026 |
| Camarena 220 kV | Outdoor | 2025 |
| Camarena 400 kV | Outdoor | 2025 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

### I Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Barataria*400 kV | 1 | AIS | Gen./Sto. | 2026 |
| Barataria* 400 kV | 4 | AIS | TN | 2026 |
| Belinchón 400 kV | 3 | AIS | TN | > 2026 |
| Belinchón 400 kV | 3 | AIS | TN | 2026 |
| Belinchón 400 kV | 1 | AIS | TN | 2025 |
| La Sagra 220 kV | 6 | AIS | TN | 2025 |
| La Sagra 400 kV | 5 | AIS | TN | 2025 |
| Manchega 400 kV | 1 | AIS | Gen./Sto. | 2025 |
| Manchega 400 kV | 4 | AIS | TN | 2025 |
| Manchega 400 kV | 3 | AIS | TN | 2026 |
| Manchega 400 kV | 4 | AIS | TN | > 2026 |
| Manzanares 400 kV | 3 | AIS | TN | 2025 |
| Manzanares 400 kV | 4 | AIS | TN | > 2026 |
| Montalbanejo* 400 kV | 4 | AIS | TN | 2026 |
| Montalbanejo* 400 kV | 1 | AIS | Gen./Sto. | 2026 |
| Morata 400 kV | 3 | AIS | TN | > 2026 |
| Picón 220 kV | 1 | AIS | TN | > 2026 |
| Picón 400 kV | 5 | AIS | TN | > 2026 |
| Romica 400 kV | 3 | AIS | TN | > 2026 |
| Camarena 220 kV | 6 | AIS | TN | 2025 |
| Camarena 400 kV | 5 | AIS | TN | 2025 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement CENTRO_1

## RES integration and resolution of technical constraints **La Mancha-Madrid Corridor**

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Camarena, of Arañuelo - Morata 400 kV circuit 1 [2] | 1,070 | 720 | 1 | Line | TN | 2025 |
| DC Belinchón - Morata 400 kV | 2,420 | 1,970 | 45 | Line | RES | > 2026 |
| DC Manchega - Belinchón 400 kV | 2,390 | 1,940 | 130 | Line | RES | 2026 |
| DC Manchega - Romica 400 kV | 2,440 | 1,970 | 91 | Line | RES | > 2026 |
| DC Manzanares - Manchega 400 kV | 2,440 | 1,970 | 65 | Line | RES | 2025 |
| DC Picón - Manzanares 400 kV | 2,440 | 1,970 | 80 | Line | RES | > 2026 |
| I/O in Camarena, of Talavera - Villaverde 220 kV circuit 1 | 780 | 630 | 3 | Line | TN | 2025 |
| I/O in Barataria*, of Manchega - Manzanares 400 kV, circuit 1 | 2,440 | 1,970 | 1 | Line | RES | 2026 |
| I/O in La Sagra, of Aceca - Los Pradillos 220 kV, circuit 1 | 780 | 630 | 20 | Line | RES | 2025 |
| I/O in La Sagra, of Añover - Pinto Ayuden 220 kV, circuit 1 | 780 | 630 | 20 | Line | RES | 2025 |
| I/O in La Sagra, of Morata - Almaraz CN 400 kV, circuit 2 [1] | 1,760 | 1,430 | 4 | Line | RES | 2025 |
| I/O in Montalbanejo*, of Manchega - Belinchón 400 kV, circuit 2 | 2,440 | 1,970 | 1 | Line | RES | 2026 |
| I/O in Camarena, of Torrijos - Villaverde 220 kV, circuit 1 | 780 | 630 | 3 | Line | TN | 2025 |

Notes:
1. Section line capacity in DC for I/O 2380/1920 MVA.
2.Section line capacity in DC for I/O 2360/1910 MV.
* Name of the electrical substation (ES) updated in the modifications of specific items.

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Aceca - Los Pradillos 220 kV, circuit 1 [1] | 780 | 630 | 22 | Line | RES | 2024 |
| Aceca - Mora 220 kV, circuit 1 | 430 | 350 | 36 | Line | RES | 2024 |
| Aceca - Picón 220 kV, circuit 1 | 433 | 354 | 108 | Line | RES | 2024 |
| Alarcos - Manzanares 220 kV, circuit 1 | 434 | 355 | 58 | Line | RES | 2024 |
| Añover - Pinto Ayuden 220 kV, circuit 1 | 780 | 630 | 38 | Line | RES | 2023 |
| Belinchón - Minglanilla 400 kV, circuit 1 | 1,730 | 1,422 | 146 | Line | RES | 2023 |
| Belinchón - Morata 400 kV, circuit 1 | 2,057 | 1,689 | 56 | Line | RES | 2023 |
| Belinchón - Morata 400 kV, circuit 2 | 1,714 | 1,399 | 41 | Line | RES | 2023 |
| Belinchón - Olmedilla 400 kV, circuit 1 | 2,086 | 1,725 | 101 | Line | RES | 2023 |
| El Emperador - Mora 220 kV, circuit 1 | 430 | 350 | 54 | Line | RES | 2024 |
| El Emperador - Picón 220 kV, circuit 1 | 440 | 350 | 44 | Line | RES | 2024 |
| El Hornillo - Pinto Ayuden 220 kV, circuit 1 | 762 | 626 | 2 | Line | RES | 2024 |
| El Hornillo - Villaverde Bajo 220 kV, circuit 1 [1] | 780 | 640 | 9 | Line | RES | 2024 |
| Los Pradillos - Parla 220 kV, circuit 1 [1] | 757 | 619 | 15 | Line | RES | 2024 |
| Pinto - Villaverde Bajo 220 kV, circuit 1 [1] | 780 | 640 | 13 | Line | RES | 2024 |

Notes:
1. Uprating of the overhead section to 85º.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement CENTRO_1
RES integration and resolution of technical constraints **La Mancha-Madrid Corridor**

## I Detailed list of assets (continued):

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| La Sagra 400/220 kV, TF1 | 600 | Triph. B. | RES | 2025 |
| Picón 400/220 kV, TF1 | 600 | Triph. B. | RES | > 2026 |
| Camarena 400/220 kV, TF1 | 600 | Triph. B. | RES | 2025 |

| New reactances | MVAr | Type | Driv. | Year |
|---|---|---|---|---|
| Belinchón 400 kV, REA1 | 150 | - | RES | 2025 |
| La Sagra 400 kV, REA1 | 150 | - | RES | 2025 |
| Manchega 400 kV, REA1 | 150 | - | RES | > 2026 |

| New Mobile Overload Limiter | uds | Type | Driv. | Year |
|---|---|---|---|---|
| Picón 220 kV [1] | 2 | - | RES | 2024 |

Notes:
1. One limiter at Picón-Aceca 220 kV and the other at Picón-El Emperador.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement CENTRO_2

## RES integration and resolution of technical constraints

## Reinforcement Andalucía - Extremadura - Madrid Corridor

**I General description:**

The reinforcements consist of strengthening the existing grid to facilitate the integration of renewable energies in the region, the inclusion of new substations, and the expansion of existing substations to enable the connection of new renewable energies generated or their storage. Several repowering reinforcements are included, as well as increases in line capacity in the region.

**I Drivers / Objectives:**

- Reducing technical constraints that result in renewable energy curtailments in the region, strengthening the 400 kV and 220 kV axes between Andalucía, Extremadura, and Madrid.
- Enabling the connection of future renewable energy generated in the areas with a high probability of successful deployment.

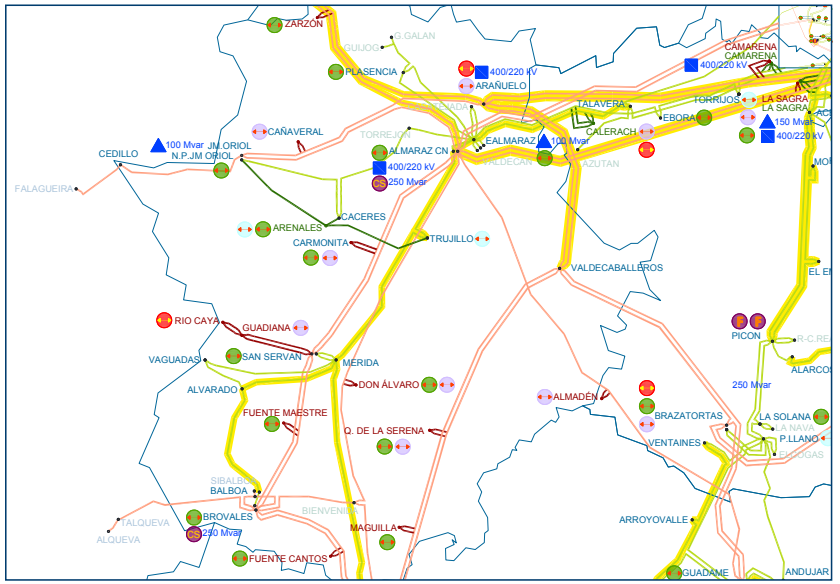
**I Alternatives:**

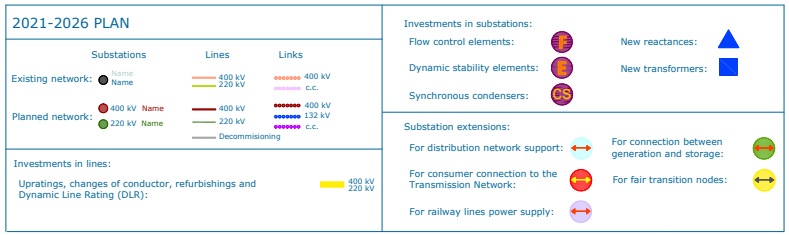
The construction of new 400 kV axes that would increase transmission capacity has been studied as an alternative, however, these reinforcements would result in environmental impacts and greater costs.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement CENTRO_2

RES integration and resolution of technical constraints

**Reinforcement Andalucía - Extremadura - Madrid Corridor**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 163.5 M€/year | Reduction of $CO_2$ emissions: 770 kt/year* |
| Additional RES integration: 5,225.246 MWh/year | Reduction of system losses: -472,896 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Profitability:

Profitability: NPV

3,128 M€

### Socio-environmental impact:



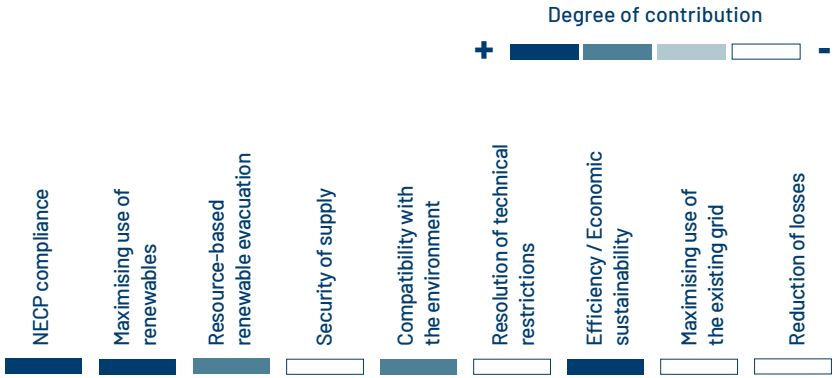

### Costs:

| CAPEX | OPEX |
|---|---|
| 101.1 M€ | 1.25 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 9.4 | 9.3 | 9.1 | 9.0 | 8.9 | 8.7 | 8.6 | 8.4 | 8.3 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement CENTRO_2

RES integration and resolution of technical constraints

**Reinforcement Andalucía - Extremadura - Madrid Corridor**

## Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | | 25 |
| Overhead line (km) | | 43 |
| Cables (km) | 0.6 | |
| Uprating (km) | 139 | 978 |
| Change of conductor (km) | 166 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Fuente de Cantos 400 kV | Outdoor | 2025 |
| Fuente del Maestre 400 kV | Outdoor | 2025 |
| Maguilla* 400 kV | Outdoor | 2025 |
| Zarzón* 400 kV | Outdoor | 2024 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

## Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Don Álvaro* 400 kV | 1 | AIS | Gen./Sto. | 2024 |
| Fuente de Cantos 400 kV | 4 | AIS | TN | 2025 |
| Fuente de Cantos 400 kV | 1 | AIS | Gen./Sto. | 2025 |
| Fuente del Maestre 400 kV | 1 | AIS | Gen./Sto. | 2025 |
| Fuente del Maestre 400 kV | 4 | AIS | TN | 2025 |
| Maguilla* 400 kV | 4 | AIS | TN | 2025 |
| Maguilla*400 kV | 1 | AIS | Gen./Sto. | 2025 |
| Quintana de La Serena 400 kV | 1 | AIS | Gen./Sto. | 2024 |
| Valdecaballeros 400 kV | 3 | AIS | TN | > 2026 |
| Zarzón* 400 kV | 1 | AIS | Gen./Sto. | 2024 |
| Zarzón* 400 kV | 4 | AIS | TN | 2024 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement CENTRO_2

RES integration and resolution of technical constraints

**Reinforcement Andalucía - Extremadura - Madrid Corridor**

## I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Almaraz CN - Trujillo 220 kV, circuit 1 [1] | 555 | 470 | 0.3 | Cable | TN | 2023 |
| I/O in Fuente de Cantos, of Brovales - Guillena 400 kV, circuit 1 | 2,330 | 1,890 | 1 | Line | TN | 2025 |
| I/O in Fuente del Maestre, of San Serván - Brovales 400 kV, circuit 1 | 2,330 | 1,890 | 1 | Line | TN | 2025 |
| I/O in Maguilla*, of Valdecaballeros - Guillena 400 kV, circuit 1 [2] | 1,760 | 1,420 | 1 | Line | TN | 2025 |
| I/O in Valdecaballeros, of Almaraz CN - Guadame 400 kV, circuit 1 | 1,760 | 1,420 | 18 | Line | TN | > 2026 |
| I/O in Zarzón*, of Aldeadávila - Arañuelo 400 kV, circuit 1 [3] | 1,760 | 1,420 | 0.4 | Line | TN | 2024 |
| Mérida - Trujillo 220 kV, circuit 1 [1] | 543 | 460 | 0.3 | Cable | TN | 2023 |

Notes:
1. Requires decommissioning of the existing cable.
2. Section line capacity in DC for I/O 2370/1920 MVA.
3. Section line capacity in DC for I/O 2380/1930 MVA.
* Name of the electrical substation (ES) updated in the modifications of specific items.

| Changes of conductor | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Almaraz CN - Trujillo 220 kV, circuit 1 [1] | 555 | 470 | 47 | Line | TN | 2023 |
| Alvarado - Mérida 220 kV, circuit 1 [1] | 480 | 440 | 44 | Line | TN | 2023 |
| Mérida - Trujillo 220 kV, circuit 1 [1] | 543 | 460 | 76 | Line | TN | 2024 |

Notes:
1. Requires change to high temperature conductor.

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Almaraz CN - Morata 400 kV, circuit 1 | 1,760 | 1,420 | 218 | Line | RES | 2022 |
| Almaraz CN - Morata 400 kV, circuit 2 | 1,760 | 1,420 | 218 | Line | RES | 2022 |
| Almaraz ET - Talavera 220 kV, circuit 1 | 770 | 630 | 80 | Line | RES | 2022 |
| Alvarado - Balboa 220 kV, circuit 1 | 430 | 350 | 59 | Line | RES | 2022 |
| Arañuelo - Morata 400 kV, circuit 1 | 1,760 | 1,420 | 194 | Line | RES | 2022 |
| Arañuelo - Morata 400 kV, circuit 2 | 1,760 | 1,420 | 194 | Line | RES | 2022 |
| DC Arañuelo - Valdecaballeros 400 kV | 1,760 | 1,420 | 102 | Line | RES | 2023 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement ESTE_1

## RES integration and resolution of technical constraints

## New Aragón-Levante Corridor

**I General description:** The reinforcements consist of implementing new 400 kV axes between Valencia and Aragón and strengthening 400 kV axes between Valencia and Castilla-La Mancha.

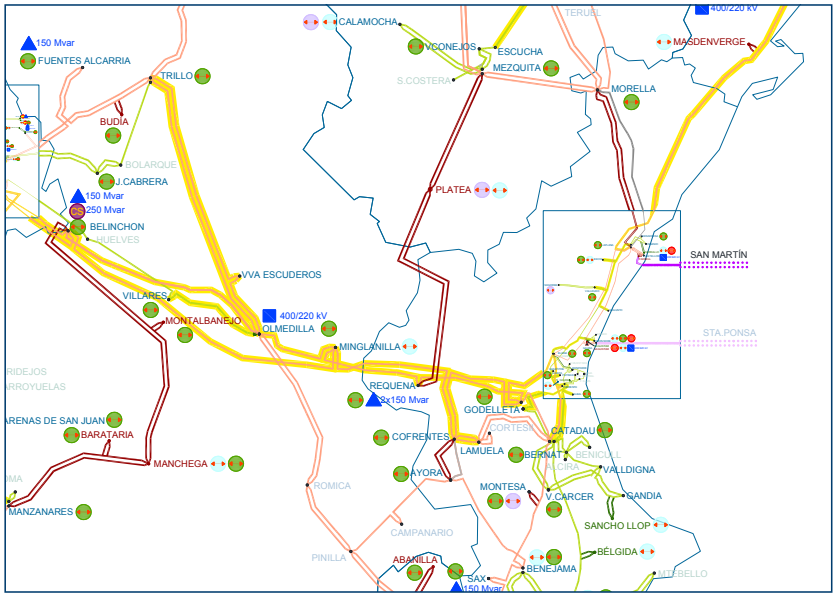
**I Drivers / Objectives:**

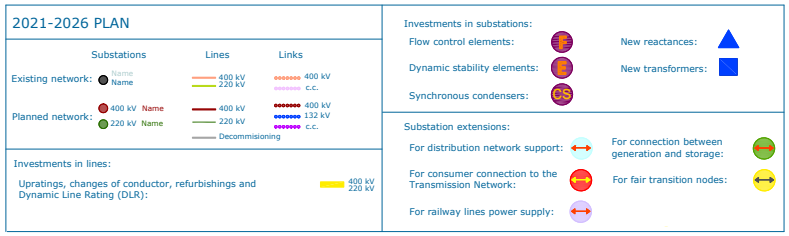
- Reducing technical constraints due to overloads in the area by strengthening the 400 kV grid.
- Integrating existing and future renewable energy generation in the region and reducing curtailments as an example of the aforementioned technical constraints.

**I Alternatives:** Only implementing operation solutions, capacity monitoring (DLR), repowering of existing lines or increases in their capacity does not sufficiently address the needs identified in the area.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement ESTE_1

RES integration and resolution of technical constraints

**New Aragón-Levante Corridor**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 81.1 M€/year | Reduction of $CO_2$ emissions: 490 kt/year* |
| Additional RES integration: 1,061.066 MWh/year | Reduction of system losses: 10,704 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Profitability:

Profitability: NPV

1,309 M€

### Socio-environmental impact:



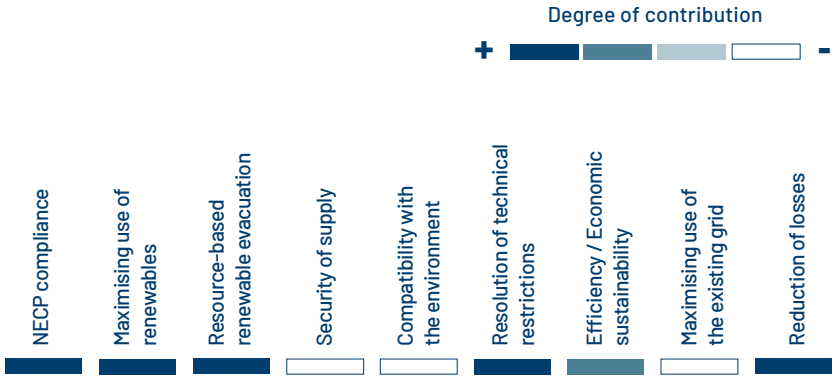

### Costs:

| CAPEX | OPEX |
|---|---|
| 237.9 M€ | 2.01 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 21.2 | 20.9 | 20.6 | 20.2 | 19.9 | 19.6 | 19.2 | 18.9 | 18.6 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement ESTE_1

RES integration and resolution of technical constraints

**New Aragón-Levante Corridor**

## Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 1 | 24 |
| Overhead line (km) | | 572 |
| Cables (km) | 0.5 | |
| Uprating (km) | | 436 |
| Reactance (Mvar) | | 450 |
| DLR (km) | | 156 |
| Phase shifters (units) | | 1 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Platea 400 kV | Outdoor | 2024 |

## Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| La Plana 400 kV | 4 | AIS | TN | 2023 |
| Godelleta 400 kV | 2 | AIS | TN | > 2026 |
| Mezquita 400 kV | 2 | AIS | TN | 2024 |
| Mezquita 400 kV | 1 | AIS | TN | 2020 |
| Morella 400 kV | 2 | AIS | TN | 2023 |
| Platea 400 kV | 3 | AIS | TN | 2024 |
| Platea 400 kV | 3 | AIS | TN | 2025 |
| Platea 400 kV | 1 | AIS | TN | > 2026 |
| Requena 400 kV | 4 | AIS | TN | 2025 |
| Requena 400 kV | 1 | AIS | TN | 2023 |
| Sax 400 kV | 1 | AIS | TN | 2023 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement ESTE_1

RES integration and resolution of technical constraints

**New Aragón-Levante Corridor**

## Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Mezquita - Platea 400 kV | 2,470 | 2,040 | 55 | Line | RES | 2024 |
| DC Morella - La Plana 400 kV [1] | 2,329 | 2,041 | 87 | Line | RES | 2023 |
| DC Platea - Requena 400 kV | 2,350 | 2,030 | 144 | Line | RES | 2025 |
| Godelleta - Godelleta 400 kV, circuit 1 | | | 0.2 | Line | RES | > 2026 |

Notes:
1. The decommissioning of the current Morella-La Plana 400kV line is required.

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Catadau - Torrente 400 kV, circuit 1 | 1,757 | 1,527 | 28 | Line | RES | 2025 |
| Cofrentes - La Muela 400 kV, circuit 1 | 2,384 | 2,069 | 14 | Line | RES | 2022 |
| Cofrentes - La Muela 400 kV, circuit 2 | 2,384 | 2,069 | 14 | Line | RES | 2022 |
| Cofrentes - Minglanilla 400 kV, circuit 1 | 1,712 | 1,489 | 76 | Line | RES | 2022 |
| Godelleta - Requena 400 kV, circuit 1 | 2,070 | 1,190 | 40 | Line | RES | 2022 |
| La Eliana - Godelleta 400 kV, circuit 1 | 1,753 | 1,524 | 21 | Line | RES | 2022 |
| La Eliana - Torrente 400 kV, circuit 1 | 1,757 | 1,527 | 29 | Line | RES | 2022 |
| Minglanilla - Olmedilla 400 kV, circuit 1 | 2,128 | 1,761 | 47 | Line | RES | 2022 |
| Pierola - Vandellós 400 kV, circuit 1 | 1,740 | 1,510 | 115 | Line | RES | 2022 |
| Requena - Minglanilla 400 kV, circuit 1 | 2,068 | 1,799 | 51 | Line | RES | 2022 |

## Detailed list of assets (continued):

| Dynamic Line Rating | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|
| Vandellós - La Plana 400 kV, circuit 1 | 156 | Line | RES | 2022 |

| New desfasadores | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Godelleta 400 kV | 1 | - | RES | > 2026 |

| New reactances | MVAr | Type | Driv. | Year |
|---|---|---|---|---|
| Platea 400 kV, REA1 | 150 | - | RES | > 2026 |
| Requena 400 kV, REA1 | 150 | - | RES | 2023 |
| Sax 400 kV, REA1 | 150 | - | RES | 2023 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement ESTE_2

## RES integration and resolution of technical constraints **Connection at Abanilla**

**I General description:**

The following reinforcements enable connection and integration of renewable energy in the Region of Murcia:

- New Abanilla 400 kV substation with input-output in the Pinilla-Rocamora line.
- Expansion of the Abanilla 400 kV substation by implementing connection for generation or storage.

**I Drivers / Objectives:**

Connection and integration of existing and future renewable energy generated in the region of Abanilla and Yecla.

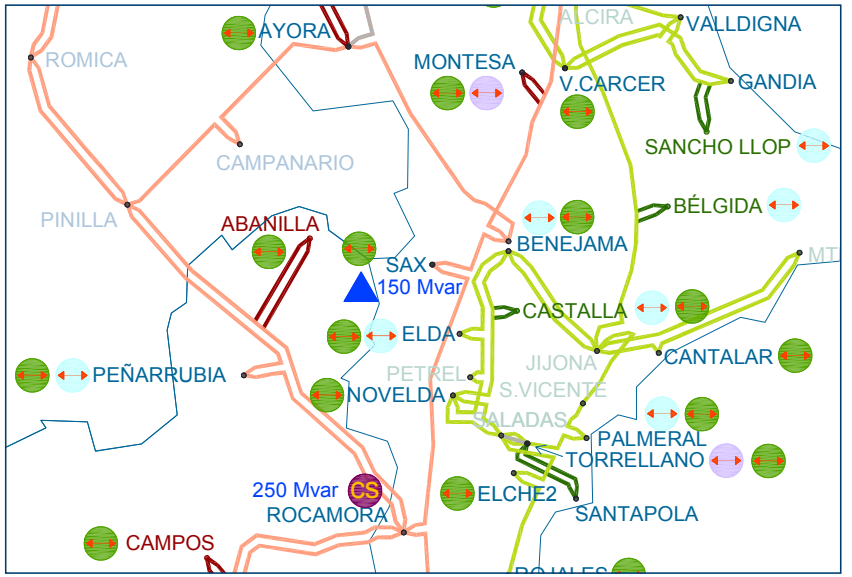
**I Alternatives:**

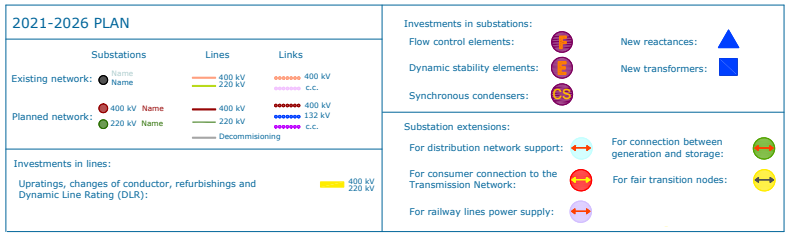
Maintaining the electricity distribution network only enables the connection of large quantities of renewable energy located in areas with a high probability of success in the distribution network.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement ESTE_2

## RES integration and resolution of technical constraints **Connection at Abanilla**

### Cost-Benefit Multi-Criteria Analysis

#### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 1.7 M€/year | Reduction of $CO_2$ emissions: 9 kt/year* |
| Additional RES integration: 58,866 MWh/year | Reduction of system losses: 159 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

#### I Costs:

| CAPEX | OPEX |
|---|---|
| 6.3 M€ | 0.24 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

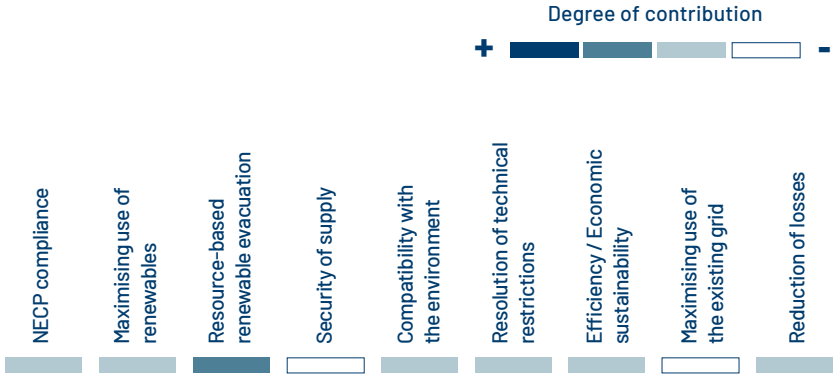
#### I Profitability:

| Profitability: NPV |
|---|
| 22 M€ |

#### I Socio-environmental impact:




#### I Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement ESTE_2

## RES integration and resolution of technical constraints **Connection at Abanilla**

### I Table of physical units:

| | 400 kV |
|---|---|
| Bays (units) | 5 |
| Overhead line (km) | 2 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Abanilla* 400 kV | Outdoor | 2025 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Abanilla* 400 kV | 1 | AIS | Gen./Sto. | 2025 |
| Abanilla* 400 kV | 4 | AIS | TN | 2025 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Abanilla*, of Rocamora - La Pinilla 400 kV, circuit 1 [1] | 1,730 | 1,440 | 1 | Line | RES | 2025 |

Notes:
1. Section line capacity in DC for I/O 2320/2010 MVA.
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement ICA_1

## RES integration and resolution of technical constraints

## Reinforcement of the north-south axis of Gran Canaria

**General description:**

The proposed reinforcements consist of the strengthening of the current north-south axis between Bco de Tirajana and Sabinal, by the following reinforcements:

- Uprating the lines El Escobar-Cinsa-Marzagán 66 kV, El Escobar-Telde 66 kV, and Matorral-Lomo Maspalomas 66 kV and installation of DLR equipment in Aldea Blanca-Agüimes-El Escobar 66 kV.
- Input-output in Aldea Blanca 66 kV for the Bco Tirajana-El Escobar 66 kV line.
- New Bco de Tirajana III 220 kV substation, connected by single-circuit overhead line/cable to Sabinal 220 kV and by double-circuit cable to Bco de Tirajana II 220 kV.

**Drivers / Objectives:**

- Enabling the appropriate integration of renewables connected to the north-south axis (including both existing and future installations, as well as potential offshore wind power).
- Strengthen the connection between the north and south of the island of Gran Canaria, which is necessary to guarantee the security and quality of supply in a scenario with a high concentration of the island's generation in the south-east.

**Alternatives:**

For the entire 66 kV north-south axis, the possibility to increase its utilisation through dynamic line rating (DLR), through uprating and through the installation of flow control systems (FACTS) has been assessed and solutions resulting feasible have been included in the proposal.

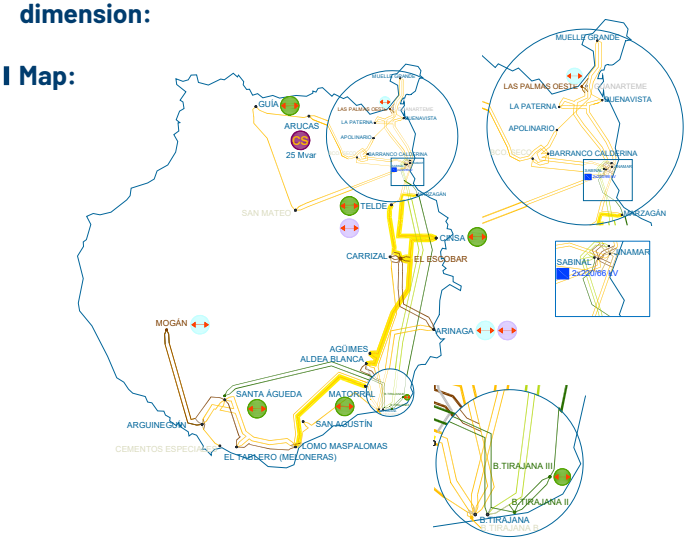
**Alternatives (cont.):**

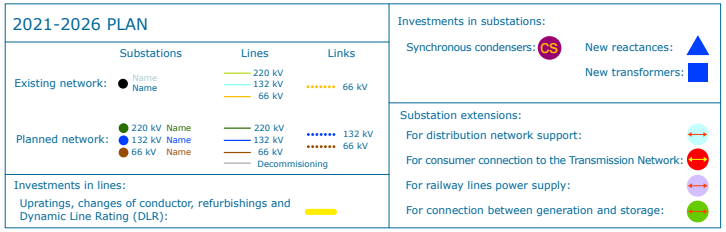
However, these measures are insufficient, so the reinforcement of the 220 kV line is also proposed. As an alternative to the latter, the possible closure of the meshed system in the western area (Mogán-La Aldea-Agaete 66 kV) has been analysed, but this solution has been discarded due to its high implementation risk and lower effectiveness for security of supply.

**European dimension:**

No

**Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement ICA_1

RES integration and resolution of technical constraints

**Reinforcement of the north-south axis of Gran Canaria**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 16.5 M€/year | Reduction of $CO_2$ emissions: 81 kt/year* |
| Additional RES integration: 110,284 MWh/year | Reduction of system losses: 2,173 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Profitability:

Profitability: NPV

243 M€

### Socio-environmental impact:



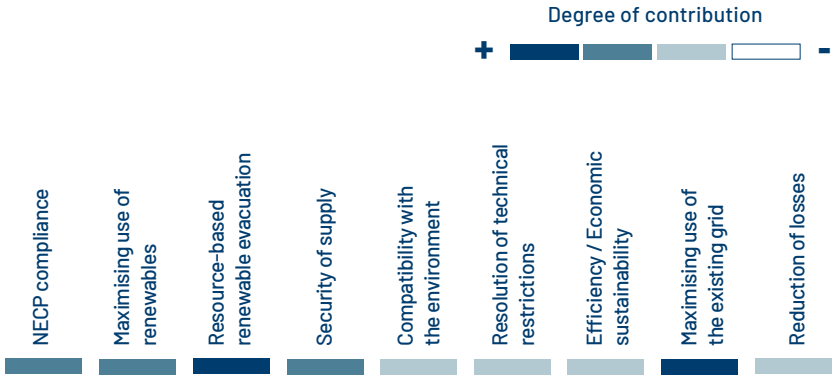

### Costs:

| CAPEX | OPEX |
|---|---|
| 68.4 M€ | 0.4 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 5.9 | 5.8 | 5.7 | 5.6 | 5.5 | 5.5 | 5.4 | 5.3 | 5.2 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement ICA_1

RES integration and resolution of technical constraints

**Reinforcement of the north-south axis of Gran Canaria**

## Table of physical units:

| | 66 kV | 220 kV |
|---|---|---|
| Bays (units) | 4 | 10 |
| Overhead line (km) | | 35 |
| Cables (km) | 11 | 7 |
| Uprating (km) | 56 | |
| DLR (km) | 10 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Barranco de Tirajana III 220 kV | Building | 2024 |

## Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Aldea Blanca 66 kV | 1 | AIS | TN | 2024 |
| Barranco de Tirajana II 220 kV | 2 | GIS | TN | 2024 |
| Barranco de Tirajana III 220 kV | 4 | GIS | TN | 2024 |
| Barranco de Tirajana III 220 kV | 2 | GIS | TN | 2025 |
| Barranco de Tirajana III 220 kV | 1 | GIS | Gen./Sto. | 2024 |
| Sabinal 220 kV | 1 | GIS | TN | 2025 |
| Sabinal 66 kV | 3 | GIS | TN | 2024 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement ICA_1

## RES integration and resolution of technical constraints

## Reinforcement of the north-south axis of Gran Canaria

### Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Barranco de Tirajana III - Sabinal 220 kV, circuit 1 | 290 | 290 | 5 | Cable | RES | 2025 |
| Cinsa - Marzagán 66 kV, circuit 1 | 77 | 77 | 0.4 | Cable | | 2024 |
| DC Barranco de Tirajana III - Barranco de Tirajana II 220 kV | 323 | 323 | 1 | Cable | RES | 2024 |
| DC Barranco de Tirajana III - Sabinal 220 kV [1] | 290 | 290 | 35 | Line | RES | 2025 |
| DC Telde - Sabinal 66 kV [2] | 80 | 80 | 0.7 | Cable | RES | 2024 |
| I/O in Aldea Blanca, of Barranco de Tirajana - Escobar 66 kV, circuit 1 | 60 | 60 | 0.5 | Cable | RES | 2024 |
| El Matorral - Lomo Maspalomas 66 kV, circuit 1 [3] | 77 | 77 | 7 | Cable | RES | 2024 |
| Escobar - Cinsa 66 kV, circuit 1 [3] | 77 | 77 | 0.3 | Cable | RES | 2024 |
| Marzagán - Sabinal 66 kV, circuit 1 [4] | 80 | 80 | 0.7 | Cable | RES | 2024 |

Notes:
1. Double circuit with first circuit laid.
2. Decommissioning of the Jinámar-Telde 66 kV line.
3. Requires decommissioning of the existing cable.
4. Topological change with decommissioning of the Jinamar-Marzagán 66kV line and commissioning of the Sabinal-Marzagán 66kV line.

### Detailed list of assets (continued):

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Cinsa - Marzagán 66 kV, circuit 1 | 77 | 77 | 14 | Line | RES | 2024 |
| El Matorral - Lomo Maspalomas 66 kV, circuit 1 [1] | 77 | 77 | 22 | Line | RES | 2024 |
| Escobar - Cinsa 66 kV, circuit 1 | 77 | 77 | 11 | Line | RES | 2024 |
| Escobar - Telde 66 kV, circuit 1 | 77 | 77 | 9 | Line | RES | 2024 |

Notes:
1. Line capacity of the repowered line section 90/90 MVA.

| Dynamic Line Rating | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|
| Agüimes - Escobar 66 kV, circuit 1 | 4 | Line | RES | 2023 |
| Aldea Blanca - Agüimes 66 kV, circuit 1 | 6 | Line | RES | 2023 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement ICA_2

## RES integration and resolution of technical constraints

## Reinforcement of the north-south axis in the east of Tenerife

**I General description:**

The proposed reinforcements enable the evacuation of existing and future renewable energy generated in the south-east of Tenerife in suitable security conditions and minimising curtailments that already occur today. It consists of strengthening the north-south axis between Granadilla and Candelaria by reinforcing the 220 kV axis and making greater use of the 66 kV axis. Specifically, it includes:

- Real-time dynamic line rating (DLR) of the Candelaria-Geneto 66 kV double circuit and the Arico II-Polígono de Güimar 66 kV line.
- New Abona-Caletillas 220 kV overhead line-cable circuit and 66 kV connection at the new Las Rosas substation.
- A third 220/66 kV transformer at Vallitos.

**I Drivers / Objectives:**

- Enabling appropriate evacuation and transmission of the renewable energy sources installed and planned in the south-east of the island to the north, as well as the foreseeable renewable energy source —including off-shore wind power—in the area of Las Rosas. Currently, curtailments from renewable generation already occur due to a lack of evacuation capacity in the area.
- Reducing the risk of load shedding and even the complete loss of supply to Tenerife which could occur in the event of a fault in the current 220 kV north-south axis. This risk will increase as the island's generation becomes more concentrated in the south-east of the island.

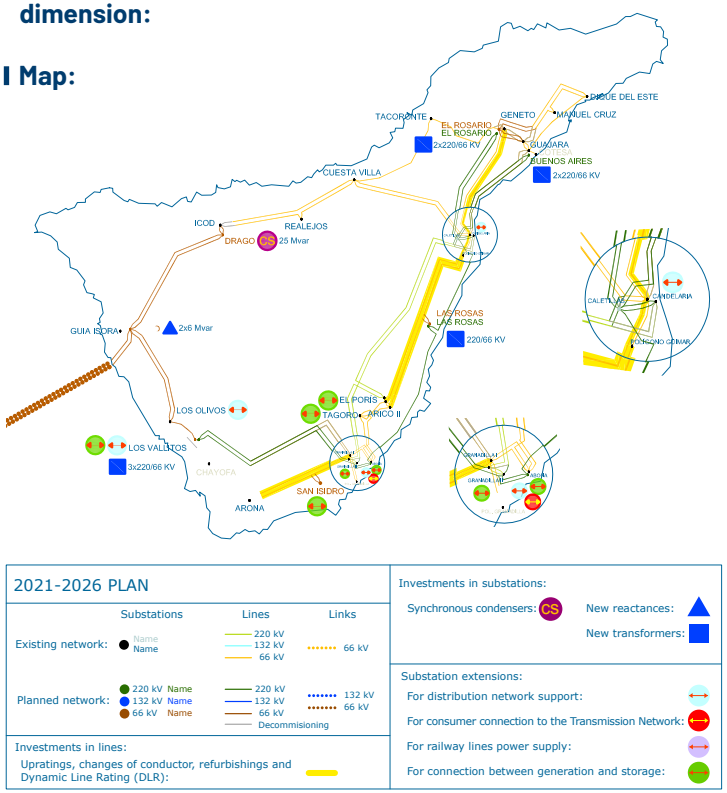
**I Alternatives:**

The option of repowering the current north-south 66 kV axis was assessed, however, this proved to be insufficient to securely evacuate the renewable energy capacity foreseen for the 2026 horizon. This solution won't resolve the risks of loss of supply in the event of the current 220 V north-south axis.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement ICA_2

RES integration and resolution of technical constraints

**Reinforcement of the north-south axis in the east of Tenerife**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 9.3 M€/year | Reduction of $CO_2$ emissions: 77 kt/year* |
| Additional RES integration: 75,791 MWh/year | Reduction of system losses: 11,386 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Costs:

| CAPEX | OPEX |
|---|---|
| 97.8 M€ | 1.16 M€/year |

Remuneration costs

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| M€ | 0.0 | 9.1 | 8.9 | 8.8 | 8.7 | 8.5 | 8.4 | 8.2 | 8.1 | 8.0 |

Note: A sequential cost-benefit analysis methodology has been used for the Tenerife-La Gomera system. Firstly, the benefit of the incorporation of synchronous condensers is analysed and then the benefit of the rest of the reinforcements planned except for the TF-LG link, the benefit of which is analysed in a final stage considering the rest of the reinforcements in service.

### Profitability:

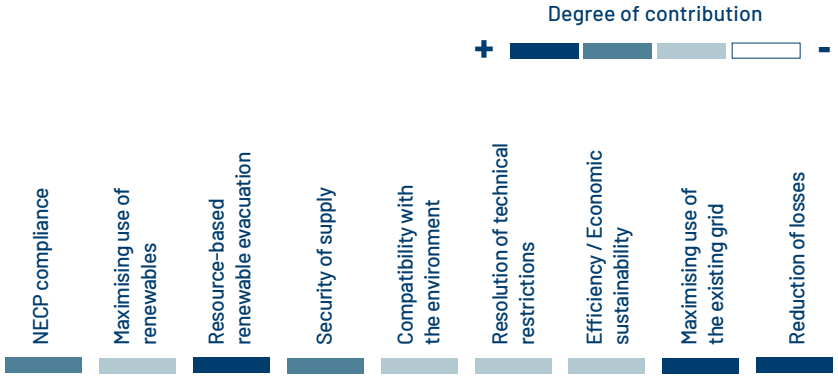
Profitability: NPV

51 M€

### Socio-environmental impact:




### Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement ICA_2

## RES integration and resolution of technical constraints

## Reinforcement of the north-south axis in the east of Tenerife

### Table of physical units:

| | 66 kV | 220 kV |
|---|---|---|
| Bays (units) | 12 | 24 |
| Overhead line (km) | 6 | 28 |
| Cables (km) | | 21 |
| Transformed to 66 kV (MVA) | | 375 |
| DLR (km) | 71 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Las Rosas 220 kV | Building | 2025 |
| Las Rosas 66 kV | Building | 2025 |

### Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Abona 220 kV | 1 | GIS | TN | 2025 |
| Las Caletillas 220 kV | 2 | GIS | TN | 2026 |
| Las Rosas 220 kV | 12 | GIS | TN | > 2026 |
| Las Rosas 220 kV | 4 | GIS | TN | 2025 |
| Las Rosas 220 kV | 2 | GIS | TN | 2026 |
| Las Rosas 220 kV | 1 | GIS | RES | 2026 |
| Las Rosas 66 kV | 5 | GIS | TN | 2025 |
| Las Rosas 66 kV | 5 | GIS | TN | > 2026 |
| Vallitos 220 kV | 2 | GIS | TN | 2024 |
| Vallitos 66 kV | 2 | GIS | TN | 2020 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement ICA_2

RES integration and resolution of technical constraints

**Reinforcement of the north-south axis in the east of Tenerife**

## Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Abona - Las Rosas 220 kV, circuit 1 | 290 | 290 | 26 | Line | RES | 2025 |
| Abona - Las Rosas 220 kV, circuit 1 | 290 | 290 | 9 | Cable | RES | 2025 |
| I/O in Las Rosas, of Arico II - Polígono de Güímar 66 kV, circuit 2 | 65 | 65 | 2 | Line | RES | 2025 |
| I/O in Las Rosas, of Buenos Aires - El Porís 220 kV, circuit 1 | 290 | 290 | 0.5 | Line | RES | > 2026 |
| I/O in Las Rosas, of Candelaria - El Porís 66 kV, circuit 1 | 65 | 65 | 2 | Line | RES | > 2026 |
| I/O in Las Rosas, of Granadilla - Las Caletillas 220 kV, circuit 2 | 290 | 290 | 0.5 | Line | RES | > 2026 |
| Las Caletillas - Las Rosas 220 kV, circuit 1 | 290 | 290 | 12 | Cable | RES | 2026 |
| Vallitos - Vallitos 220 kV [1] | | | 2 SSC | Cable | RES | 2024 |

Notes:
1. Short section of cable inside the substation.

## Detailed list of assets (continued):

| Dynamic Line Rating | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|
| Arico II - Polígono de Güímar 66 kV, circuit 1 | 28 | Line | RES | 2023 |
| Candelaria - Geneto 66 kV, circuit 1 | 10 | Line | RES | 2023 |
| Candelaria - Geneto 66 kV, circuit 2 | 10 | Line | RES | 2023 |
| El Porís - Candelaria 220 kV, circuit 1 | 22 | Line | RES | 2023 |

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Las Rosas 220/66 kV, TF1 | 125 | Triph. B. | RES | 2025 |
| Las Rosas 220/66 kV, TF2 | 125 | Triph. B. | RES | > 2026 |
| Vallitos 220/66 kV, TF3 | 125 | Triph. B. | RES | 2024 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement ICA_3

## RES integration and resolution of technical constraints

## Reinforcement of the Tenerife southern axis and new San Isidro substation

**I General description:**

The reinforcements consist of strengthening the 66 kV axis in the southern Tenerife between Granadilla and Arona, which is currently subject to overloads in certain situations, as well as the creation of a new renewable energy injection point in the region. Specifically, the reinforcements include:

- Repowering of the double circuit in Granadilla-Arona 66 kV.
- New input-output at the new San Isidro 66 kV substation on the double circuit line-cable Granadilla-Arona 66 kV. Expansion of the San Isidro 66 kV substation for generation or storage connection.

**I Drivers / Objectives:**

- Enabling the integration of renewable energies in the south-east region of the island, reducing axis loads.
- Eliminating the need, which currently exists, To connect the Arona gas turbine due to technical constraints to avoid overloading in this axis.
- Summarizing, it will reduce costs resulting from technical constraints and improve security of supply for the island of Tenerife.

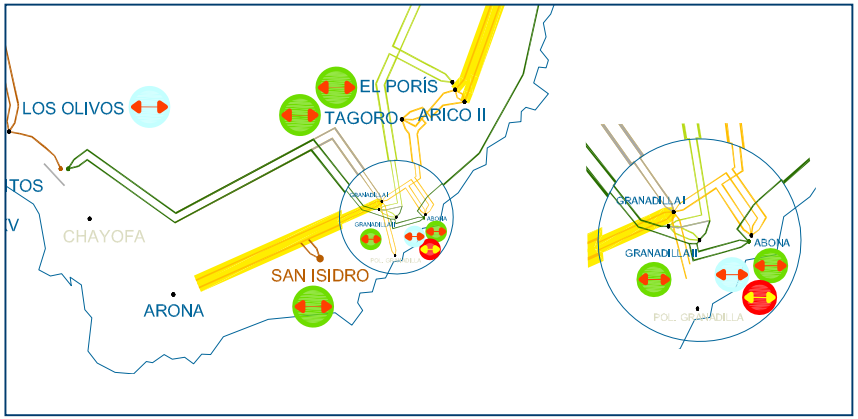
**I Alternatives:**

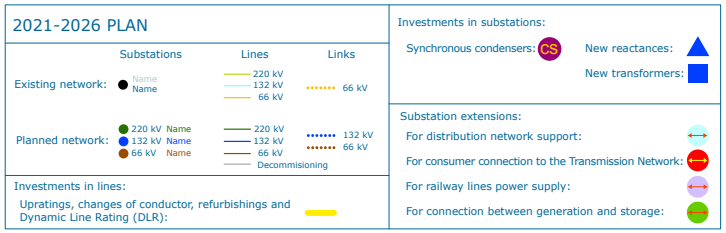
The dynamic line rating solution is not sufficient to address the aforementioned constraints.

Other alternative solutions of creating new, parallel axes were assessed, but have been discarded due to their higher cost and social and environmental impact.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement ICA_3

RES integration and resolution of technical constraints

**Reinforcement of the Tenerife southern axis and new San Isidro substation**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 0.7 M€/year | Reduction of $CO_2$ emissions: 3 kt/year* |
| Additional RES integration: 4,298 MWh/year | Reduction of system losses: -315 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Costs:

| CAPEX | OPEX |
|---|---|
| 7.7 M€ | 0.07 M€/year |

Remuneration costs

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| M€ | 0.0 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |

Note: a sequential cost-benefit analysis methodology has been used for the Tenerife-La Gomera system. Firstly, the benefit of the incorporation of synchronous condensers is analysed and then the benefit of the rest of the reinforcements planned except for the TF-LG link, the benefit of which is analysed in a final stage considering the rest of the reinforcements in service.

### Profitability:

Profitability: NPV

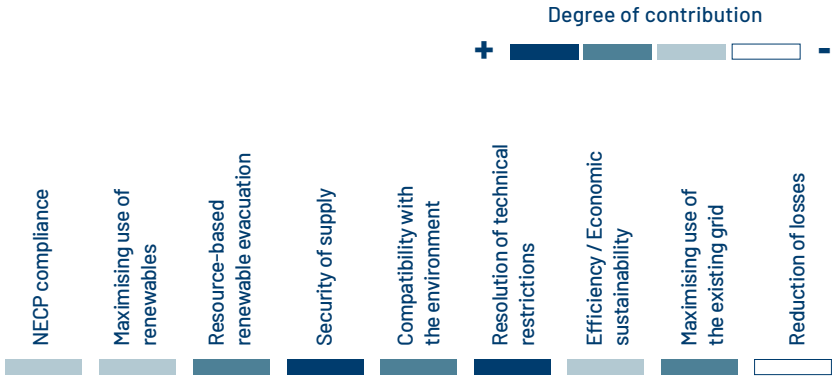
4 M€

### Socio-environmental impact:

Impact degree + -

| Environmental impact | Social impact |
|---|---|
| | |

### Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement ICA_3

## RES integration and resolution of technical constraints

## Reinforcement of the Tenerife southern axis and new San Isidro substation

### Table of physical units:

| | 66 kV |
|---|---|
| Bays (units) | 4 |
| Overhead line (km) | 0.5 |
| Cables (km) | 1 |
| Uprating (km) | 72 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| San isidro 66 kV | Building | 2026 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| San isidro 66 kV | 1 | GIS | Gen./Sto. | 2026 |
| San isidro 66 kV | 3 | GIS | TN | 2026 |

### Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Granadilla - Arona 66 kV circuit 1 [1] | 80 | 80 | 0.3 | Cable | RES | 2024 |
| DC Granadilla - Arona 66 kV circuit 2 [1] | 80 | 80 | 0.3 | Cable | RES | 2024 |
| I/O in San isidro, of Granadilla - Arona 66 kV, circuit 1 | 77 | 77 | 0.2 | Cable | RES | 2026 |
| I/O in San isidro, of Granadilla - Arona 66 kV, circuit 1 | 77 | 77 | 0.2 | Line | RES | 2026 |

Notes:
1. Short section of cable inside the substation.

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Granadilla - Arona 66 kV [1] | 80 | 80 | 36 | Line | RES | 2024 |

Notes:
1. Line capacity in the repowered 85/85 MVA overhead section.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement N_ESTE_1

## RES integration and resolution of technical constraints **Aragón - Navarra Reinforcement**

**I General description:**

These reinforcements consist of creating a new axis between Navarra and Aragón in 400 kV and the repowering of 220 kV lines close to Magallón:

- New 400 kV double circuit between La Serna and Magallón.
- Repowering of the Jalón-Magallón 1 and 2 220 KV lines, Lanzas Agudas-Magallón 220 kV, Tudela-Magallón 220 kV, and Magallón-Moncayo 220 kV.

**I Drivers / Objectives:**

- Reducing technical constraints due to line overloads in the area through the application of curtailment to renewable generation in the area.
- Improving integration of existing and future renewable energy in the area.

**I Alternatives:**

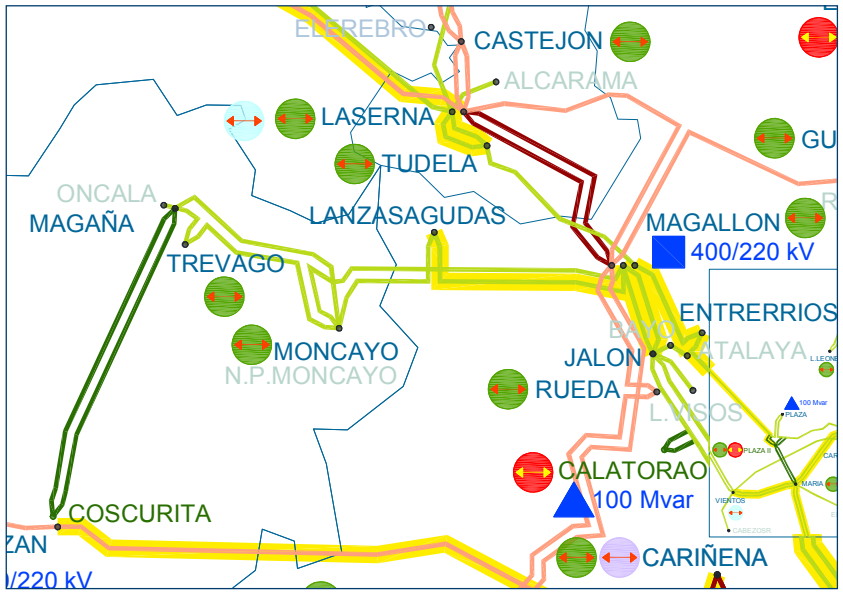
Additionally, an analysis was also conducted on the duplication of the existing line between La Serna and the interconnection between La Serna-Magallón 400 kV and Magallón-Peñaflor 400 kV. However, the analysis concludes that such an action has a high risk of being unfeasible.

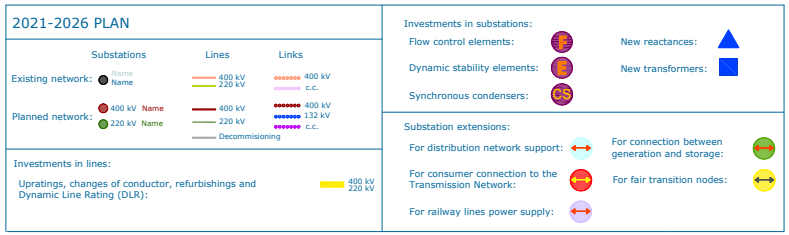
The use of DLR is not sufficient to address the needs identified in the area.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement N_ESTE_1

RES integration and resolution of technical constraints **Aragón - Navarra Reinforcement**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 34.3 M€/year | Reduction of $CO_2$ emissions: 173 kt/year* |
| Additional RES integration: 818,902 MWh/year | Reduction of system losses: -18,239 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 40.1 M€ | 0.41 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 3.7 | 3.6 | 3.5 | 3.5 | 3.4 | 3.4 | 3.3 | 3.3 | 3.2 |

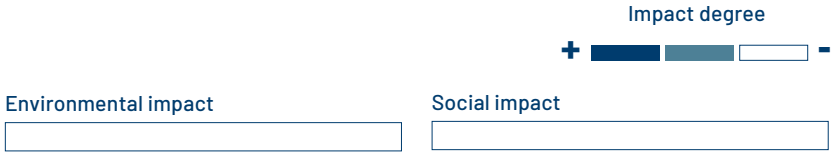
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

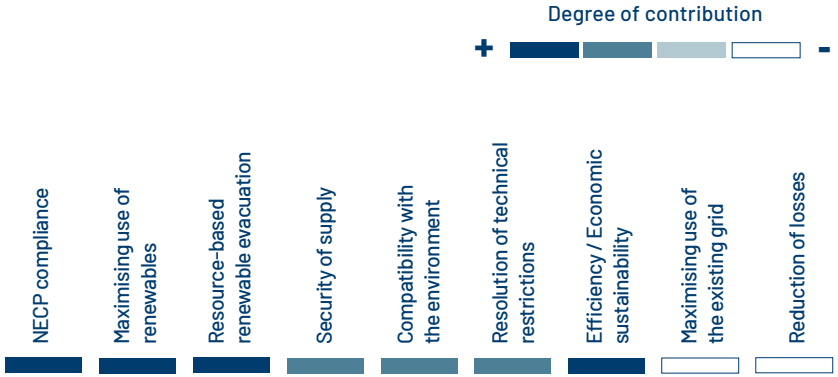
Profitability: NPV

631 M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement N_ESTE_1

## RES integration and resolution of technical constraints **Aragón - Navarra Reinforcement**

### Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | | 6 |
| Overhead line (km) | | 90 |
| Uprating (km) | 153 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| La Serna 400 kV | 3 | AIS | TN | 2025 |
| Magallón 400 kV | 3 | AIS | TN | 2025 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC La Serna - Magallón 400 kV | 2,400 | 2,000 | 45 | Line | RES | 2025 |

### Detailed list of assets (continued):

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Jalón - Magallón 220 kV, circuit 1 | 763 | 649 | 19 | Line | RES | 2024 |
| Jalón - Magallón 220 kV, circuit 2 | 763 | 649 | 19 | Line | RES | 2024 |
| Lanzas Agudas - Magallón 220 kV, circuit 1 | 763 | 649 | 27 | Line | RES | 2024 |
| Magallón - Moncayo 220 kV, circuit 1 | 763 | 649 | 57 | Line | RES | > 2026 |
| Tudela - Magallón 220 kV, circuit 1 | 434 | 370 | 30 | Line | RES | 2020 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement N_ESTE_2

## RES integration and resolution of technical constraints

## Aragón - Southern Cataluña Reinforcement

**I General description:**

These reinforcements consist of creating a new insulated 400 kV double circuit axis from Aragón to Cataluña, in which one circuit operates at 400 kV connecting the Escatrón, Els Aubals, and La Secuita substations, and the other operates at 220 kV connecting Escatrón, Els Aubals, and La Selva substations. This includes the repowering of the DC Aragón-Ascó 400 kV, DC Vandellós-Ascó 400 kV, Constantí-Tarragona 220 kV and Aragón-Mequinenza 400 kV lines, and the conductor change on the Escatrón-Aragón 400 kV line.

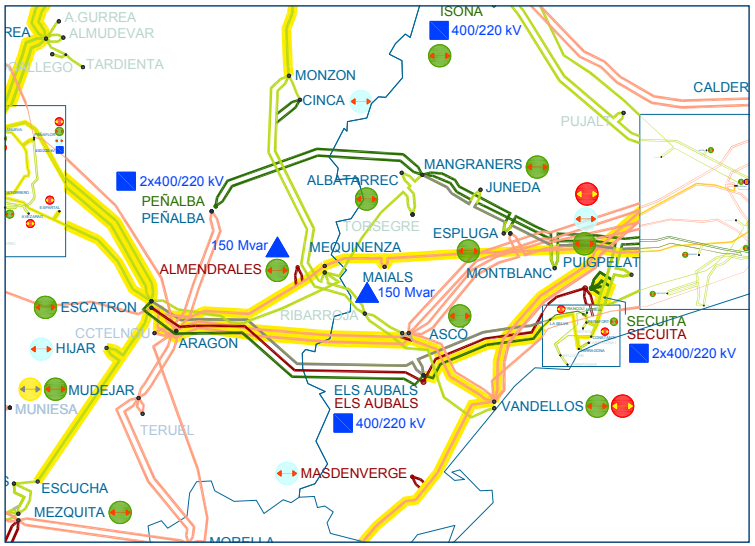
**I European dimension:**

No

**I Drivers / Objectives:**

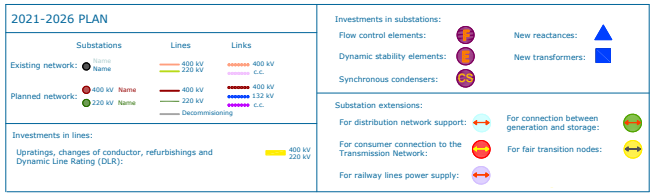
- Reducing technical constraints due to overloads resulting in the curtailment of renewable energy in the area by reinforcing the connection between Aragón and Cataluña.
- Increasing security and quality of the supply in the area.
- Improving integration of existing and future renewable energy in the area.

**I Map:**




**I Alternatives:**

An analysis has been conducted on repowering the 220 kV axis between Escatrón, Els Aubals, and La Selva but this would not adequately address the needs identified. Furthermore, as an alternative, construction of a 400 kV axis between Peñalba and Isona was considered, but this was met with strong social opposition.




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement N_ESTE_2

RES integration and resolution of technical constraints

**Aragón - Southern Cataluña Reinforcement**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 56.1 M€/year | Reduction of $CO_2$ emissions: 294 kt/year* |
| Additional RES integration: 718,179 MWh/year | Reduction of system losses: -2,802 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Costs:

| CAPEX | OPEX |
|---|---|
| 169.9 M€ | 1.69 M€/year |

Remuneration costs

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| M€ | 0.0 | 15.4 | 15.2 | 14.9 | 14.7 | 14.5 | 14.2 | 14.0 | 13.8 | 13.5 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Profitability:

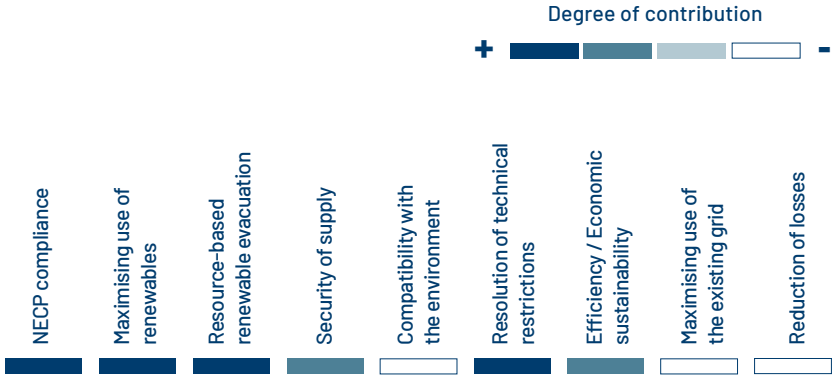
Profitability: NPV

893 M€

### Socio-environmental impact:




### Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement N_ESTE_2

RES integration and resolution of technical constraints

**Aragón - Southern Cataluña Reinforcement**

## Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 8 | 15 |
| Overhead line (km) | 12 | 314 |
| Cables (km) | 0.7 | |
| Transformed to 220 kV (MVA) | | 1,800 |
| Uprating (km) | 5 | 275 |
| Reactance (Mvar) | | 300 |
| Change of conductor (km) | | 13 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Els Aubals 400 kV | Outdoor | 2024 |
| La Secuita 220 kV | Outdoor | 2024 |
| La Secuita 400 kV | Outdoor | 2024 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Els Aubals 220 kV | 1 | GIS | TN | 2024 |
| Els Aubals 400 kV | 1 | AIS | TN | > 2026 |
| Els Aubals 400 kV | 5 | AIS | TN | 2024 |
| Escatrón 400 kV | 1 | AIS | TN | 2024 |
| Fuendetodos 220 kV | 1 | AIS | TN | 2023 |
| Fuendetodos 400 kV | 1 | GIS | TN | 2023 |
| La Secuita* 220 kV | 6 | AIS | TN | 2024 |
| La Secuita* 400 kV | 7 | AIS | TN | 2024 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement N_ESTE_2

## RES integration and resolution of technical constraints

## Aragón - Southern Cataluña Reinforcement

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Els Aubals - La Secuita 400 kV [1] | 2,380 | 2,000 | 60 | Line | RES | 2024 |
| DC Escatrón - Els Aubals 400 kV [1] | 2,380 | 2,000 | 95 | Line | RES | 2024 |
| E/S La Secuita, of Garraf - Vandellós 400 kV, circuit 1 [2] | 1,360 | 980 | 2 | Line | RES | 2024 |
| E/S La Secuita, of Juneda - Perafort 220 kV, circuit 1 [3] | 430 | 280 | 3 | Line | RES | 2024 |
| I/O in La Secuita, of Puigpelat - Constanti 220 kV, circuit 1 [4] | 430 | 430 | 3 | Line | RES | 2024 |
| Els Aubals - Els Aubals 220 kV 1 [5] | | | 1 SSC | Cable | RES | 2024 |
| Els Aubals - La Selva 220 kV, circuit 1 [6] | 605 | 605 | 0.5 | Cable | RES | 2024 |
| La Secuita - La Secuita 220 kV [7] | | | 1 SSL | Line | TN | 2024 |

Notes:
1. One of the two circuits operates at 220 V, Escatrón-Aubals-La Selva 220 kV. The decommissioning of the Escatrón-Aubals-La Selva 220 kV is required.
2. Section line capacity in DC for I/O 2370/2050 MVA.
3. Section line capacity in DC for I/O 870/750 MVA.
4. Section line capacity in DC for I/O 870/750 MVA.
5. Short section of cable inside the substation.
6. Section of cable to connect to La Selva.
7. Short section of line inside the substation.

| Changes of conductor | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Escatrón - Aragón 400 kV, circuit 1 [1] | 2,372 | 2,010 | 13 | Line | RES | 2025 |

Notes:
1. Requires change to high temperature conductor.

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Aragón - Ascó 400 kV, circuit 1 | 1,760 | 1,511 | 73 | Line | RES | 2022 |
| Aragón - Ascó 400 kV, circuit 2 | 1,760 | 1,511 | 73 | Line | RES | 2022 |
| Aragón - Mequinenza 400 kV, circuit 1 | 1,750 | 1,488 | 54 | Line | RES | 2022 |
| Constanti - Tarragona 220 kV, circuit 1 | 630 | 550 | 5 | Line | RES | 2022 |
| Vandellós - Ascó 400 kV, circuit 1 | 1,760 | 1,530 | 37 | Line | RES | 2022 |
| Vandellós - Ascó 400 kV, circuit 2 | 1,760 | 1,530 | 37 | Line | RES | 2022 |

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Els Aubals 400/220 kV, TF1 | 600 | Triph. B. | RES | 2024 |
| Fuendetodos 400/220 kV, TF2 | 600 | Triph. B. | RES | 2023 |
| La Secuita 400/220 kV, TF1 | 600 | Triph. B. | RES | 2024 |

| New reactances | MVAr | Type | Driv. | Year |
|---|---|---|---|---|
| Els Aubals 400 kV, REA1 | 150 | - | RES | > 2026 |
| La Secuita 400 kV, REA1 | 150 | - | RES | > 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement N_ESTE_3

## RES integration and resolution of technical constraints

## Aragón - Central Cataluña Reinforcement

**I General description:**

These reinforcements consist of creating a new 220 kV axis from Aragón to Cataluña, between the Peñalba and Mangraners substations. Including the transformation of the current 220 kV single circuit between Lérida and Tarragona into a double circuit from Mangraners to Begues/Viladecans.

**I Drivers / Objectives:**

- Reducing technical constraints due to overloads resulting in the curtailment of renewable energy in the area by reinforcing the connection between Aragón and Cataluña.
- Addressing the following capacity-limiting elements of the ES-FR interconnection identified in ENTSOE bidding zone configuration technical report - 2018: Torres de Segre-Albatarrec 220 kV and Mequinenza-Torres del Segre 220 kV.
- Reducing the need to apply technical constraints to achieve the objective of 70% of the available capacity in these elements for commercial transfer capacity in accordance with Art. 16(8) of Regulation 2019/943 of the interior energy market.

**I Alternatives:**

An analysis was conducted in relation to repowering the 220 kV axis between Escatrón, Mequinenza, Torres de Segre, Albatarrec, and Mangraners, but it was concluded that these reinforcements would not be viable. Furthermore, the alternative reinforcements consisting of the construction of a 400 kV axis between Peñalba e Isona were met with strong social opposition. For the connection between Mangraners and Begues/Viladecans, an analysis of the option for new developments further north was conducted, but this also involved a high risk of being unviable.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement N_ESTE_3

RES integration and resolution of technical constraints

**Aragón - Central Cataluña Reinforcement**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 70.2 M€/year | Reduction of $CO_2$ emissions: 367 kt/year* |
| Additional RES integration: 1,150.767 MWh/year | Reduction of system losses: -64,296 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Costs:

| CAPEX | OPEX |
|---|---|
| 128.1 M€ | 0.84 M€/year |

Remuneration costs

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| M€ | 0.0 | 11.2 | 11.0 | 10.8 | 10.6 | 10.5 | 10.3 | 10.1 | 9.9 | 9.8 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Profitability:

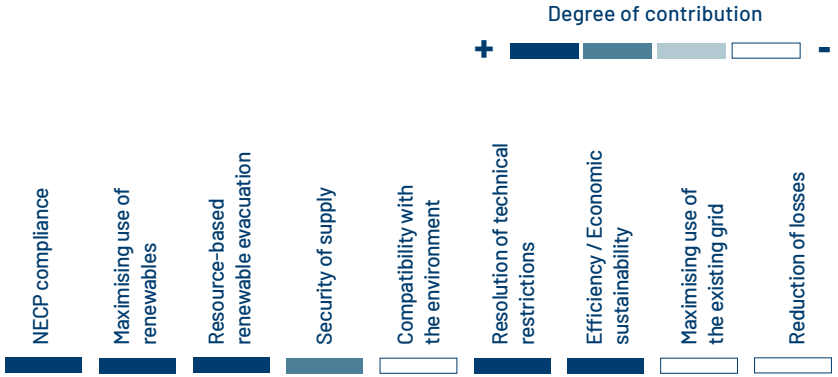
Profitability: NPV

1,239 M€

### Socio-environmental impact:




### Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement N_ESTE_3

RES integration and resolution of technical constraints

**Aragón - Central Cataluña Reinforcement**

## Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 8 | 2 |
| Overhead line (km) | 379 | |
| Cables (km) | 4 | |
| Transformed to 220 kV (MVA) | | 600 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Peñalba 220 kV | Outdoor | 2025 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Begues 220 kV | 1 | AIS | TN | 2025 |
| Mangraners 220 kV [1] | 3 | AIS | TN | 2025 |
| Peñalba 220 kV | 4 | AIS | TN | 2025 |
| Peñalba 400 kV | 2 | AIS | TN | 2025 |

Notes:
1. For all reinforcements, only one additional bay is needed in Mangraners and Begues. The current bays in Mangraners, Juneda, La Espluga, Perafort, Puigpelat Penedes, and ViladecansB are reused.

## Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Mangraners - Penedés 220 kV [1] | 864 | 766 | 115 | Line | RES | 2025 |
| DC Penedés - Begues 220 kV [2] | 864 | 766 | 3 | Line | RES | 2025 |
| DC Peñalba - Mangraners 220 kV [3] | 445 | 445 | 2 | Cable | RES | 2025 |
| DC Peñalba - Mangraners 220 kV | 445 | 445 | 70 | Line | RES | 2025 |
| Mangraners - Penedés 220 kV, circuit 1 [4] | 864 | 766 | 4 | Line | RES | 2025 |

Notes:
1. The I/O for Juneda, Perafort/Puigpelat and Penedes and the input for Viladecans is in one circuit, and the I/O for Espluga and Montblanc is in another circuit. In both cases, some of the current I/Os are used. The current single circuit route and the input at Viladecans are used for DC construction, requiring decommissioning of some of the current lines.
2. DC route in which only one circuit is installed.
3. A section of cable is needed on arrival at Mangraners.
4. Triple circuit route, combining two 220 kV circuits and one 400 kV circuit.

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Peñalba 400/220 kV, TF1 | 600 | Triph. B. | RES | 2025 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement N_ESTE_4

## RES integration and resolution of technical constraints

## Connection at Almendrales 400 kV

**I General description:** The reinforcements consist of the new Almendrales 400 kV substation, with an input-output in the Aragón-Mequinenza 400 kV line.

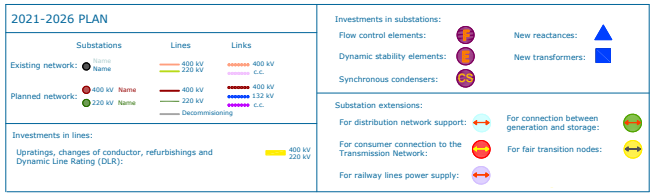
**I Drivers / Objectives:** Enabling the connection of new renewable generation with grid access granted.

**I Alternatives:** The accesses already grantes for this substation do not permit the replacement of said substation with any alternative.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement N_ESTE_4

RES integration and resolution of technical constraints

**Connection at Almendrales 400 kV**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Profitability:

Profitability: NPV

- M€

### Socio-environmental impact:



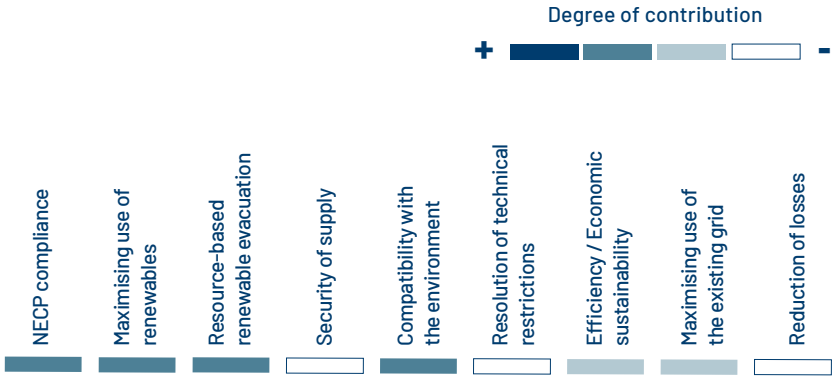

### Costs:

| CAPEX | OPEX |
|---|---|
| 6.9 M€ | 0.24 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement N_ESTE_4

## RES integration and resolution of technical constraints

## Connection at Almendrales 400 kV

### Table of physical units:

| | 400 kV |
|---|---|
| Bays (units) | 5 |
| Overhead line (km) | 3 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Almendrales 400 kV | Outdoor | 2023 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Almendrales 400 kV | 2 | AIS | Gen./Sto. | 2023 |
| Almendrales 400 kV | 3 | AIS | TN | 2023 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Almendrales, of Aragón - Mequinenza 400 kV, circuit 1 [1] | 1,601 | 1,548 | 3 | Line | RES | 2023 |

Notes:
1. Section line capacity for I/O 2360/1980 MVA.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement N_ESTE_5

## RES integration and resolution of technical constraints

## Topological modification of the Pyrenean network

**I General description:**

These reinforcements consist of creating a new substation in the Pirineo aragonés area that allows the 220 kV grid to be used in a decoupled way, which runs parallel to the Pyrenees and connects Aragón and Cataluña.

**I Drivers / Objectives:**

- Reducing technical constraints due to overloads resulting in the curtailment of renewable energy in the area by reinforcing the connection between Aragón and Cataluña.
- Improving security of supply by removing T Sesué 220 kV.
- Addressing the following capacity-limiting elements of the Spanish-French interconnection identified in ENTSOE bidding zone configuration technical report 2018: Pont de Suert-La Pobla 220 kV.
- Reducing the need to apply technical constraints to achieve the objective of 70% of the available capacity in these elements for commercial transfer capacity in accordance with Art. 16(8) of Regulation 2019/943 of the interior energy market.

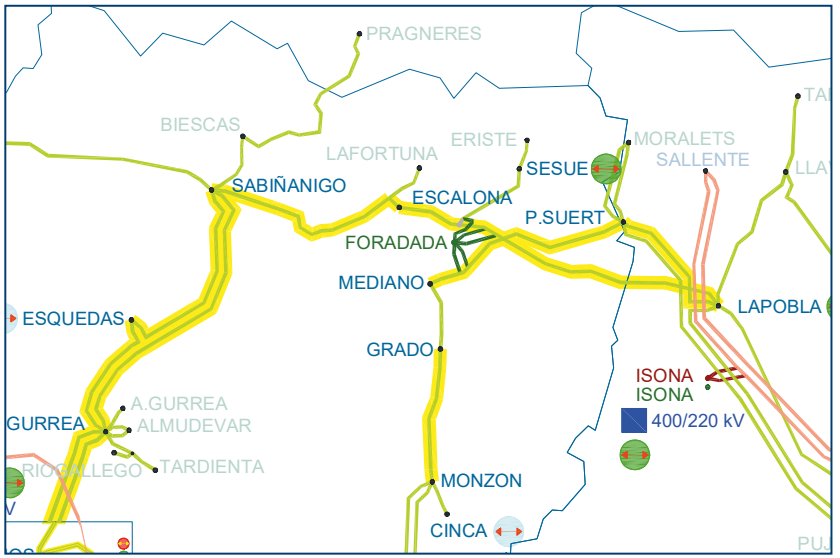
**I Alternatives:**

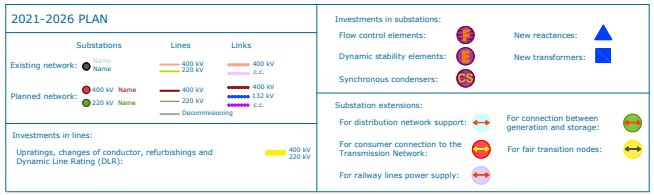
An analysis was conducted on the option to repower the 220 kV grid which runs parallel to the Pyrenees between Aragón and Cataluña, but it was concluded that this would not achieve the capacity values needed. Duplication of said axes is not viable.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement N_ESTE_5

RES integration and resolution of technical constraints

**Topological modification of the Pyrenean network**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 5.5 M€/year | Reduction of $CO_2$ emissions: 25 kt/year* |
| Additional RES integration: 133,057 MWh/year | Reduction of system losses: -14,245 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Profitability:

Profitability: NPV

88 M€

### Socio-environmental impact:



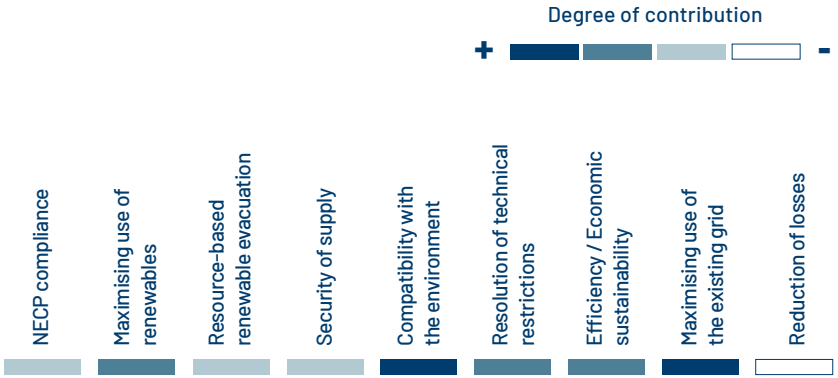

### Costs:

| CAPEX | OPEX |
|---|---|
| 15.7 M€ | 0.15 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement N_ESTE_5

RES integration and resolution of technical constraints

**Topological modification of the Pyrenean network**

## Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 6 |
| Overhead line (km) | 6 |
| Cables (km) | 0.5 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Foradada 220 kV [1] | Building | 2024 |

Notes:
1. These reinforcements require the decommissioning of Tsesue 220 kV.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Foradada, of Mediano - Pont de Suert 220 kV, circuit 1 [1] | 490 | 410 | 0.1 | Cable | RES | 2024 |
| I/O in Foradada, of Mediano - Pont de Suert 220 kV, circuit 1 [2] | 490 | 410 | 2 | Line | RES | 2024 |
| I/O in Foradada, of Sesué - Escalona 220 kV, circuit 1 | 390 | 330 | 0.5 | Line | RES | 2024 |
| I/O in Foradada, of Sesué - Escalona 220 kV, circuit 1 [1] | 390 | 330 | 0.1 | Cable | RES | 2024 |
| Foradada - La Pobla 220 kV, circuit 1 [3] | | | 0.5 | Line | RES | 2024 |
| Foradada - La Pobla 220 kV, circuit 1 [1] | | | 0.1 | Cable | RES | 2024 |

Notes:
1. Cable to connect to Foradada 220 kV.
2. Section line capacity in DC for I/O 740/890 MVA.
3. No line capacity (VD) indicated as it has a dynamic monitoring system.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement N_ESTE_6

RES integration and resolution of technical constraints

**New Isona 400/220 kV substation**

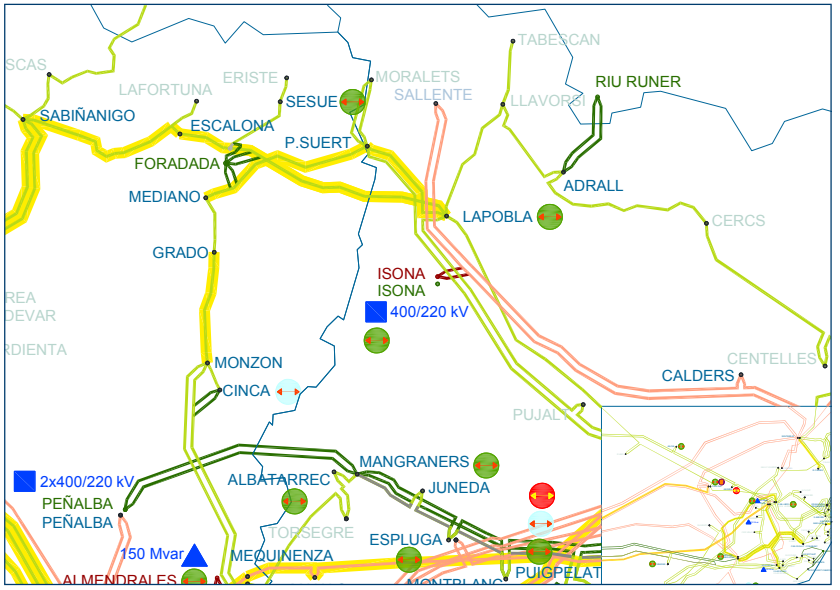
**I General description:** The reinforcements consist of the new Isona 400/220 Kv substation, with an input-output in the Sallente-Sentmenat 400 kV line.

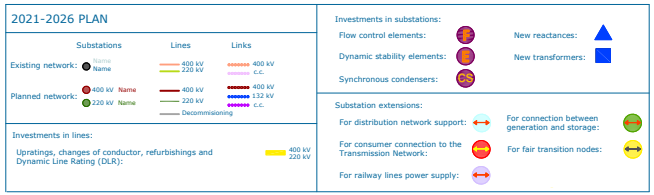
**I Drivers / Objectives:** Enabling the connection of new renewable generation with grid access granted.

**I Alternatives:** The accesses already granted for this substation do not permit the replacement of said substation with any alternative.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement N_ESTE_6

RES integration and resolution of technical constraints

**New Isona 400/220 kV substation**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Profitability:

Profitability: NPV

- M€

### Socio-environmental impact:



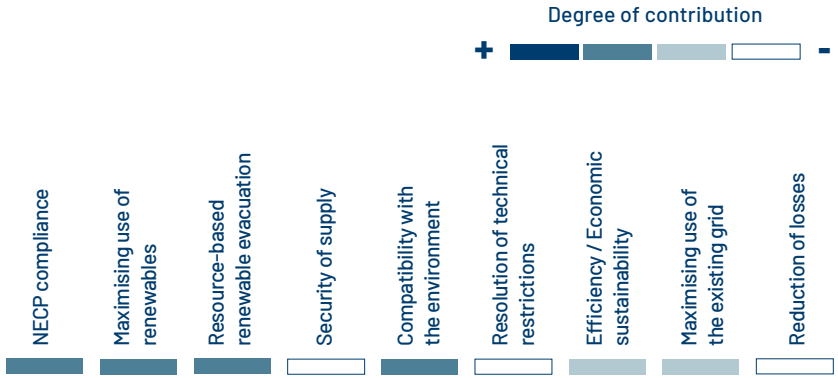

### Costs:

| CAPEX | OPEX |
|---|---|
| 15.7 M€ | 0.48 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 1.8 | 1.7 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement N_ESTE_6

RES integration and resolution of technical constraints

**New Isona 400/220 kV substation**

## Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 3 | 6 |
| Overhead line (km) | | 2 |
| Transformed to 220 kV (MVA) | | 600 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Isona 220 kV | Outdoor | 2025 |
| Isona 400 kV | Outdoor | 2025 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Isona 220 kV | 1 | AIS | Gen./Sto. | 2025 |
| Isona 220 kV | 2 | AIS | TN | 2025 |
| Isona 400 kV | 1 | AIS | Gen./Sto. | 2025 |
| Isona 400 kV | 5 | AIS | TN | 2025 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Isona, of Sallente - Sentmenat 400 kV, circuit 1 | 840 | 730 | 1 | Line | RES | 2025 |

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Isona 400/220 kV, TF1 | 600 | Triph. B. | RES | 2025 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement N_OESTE_1

## RES integration and resolution of technical constraints

## Asturias 400 kV Reinforcement

**General description:**

These reinforcements consist of a new 400 kV axis to guarantee supply, reducing the need for technical constraints in the area and improving the integration of renewable energy generation in Asturias:

- New Cardoso 400 kV substation and new Cardoso-Grado-Soto de Ribera 400 kV line.
- New Cardoso 220 kV substation.
- New Tabiella-Cardoso 220 kV line.
- New transformer 1 in Cardoso 400/220 kV.

**Drivers / Objectives:**

- Reducing generation restrictions in the area that are currently met via the scheduling of coal generation by reinforcing the network of Asturias with a new 400 kV axis.
- Increasing security and quality of the supply in the area of Asturias.
- Improving integration of existing and future renewable energy generation in the area.

**Alternatives:**

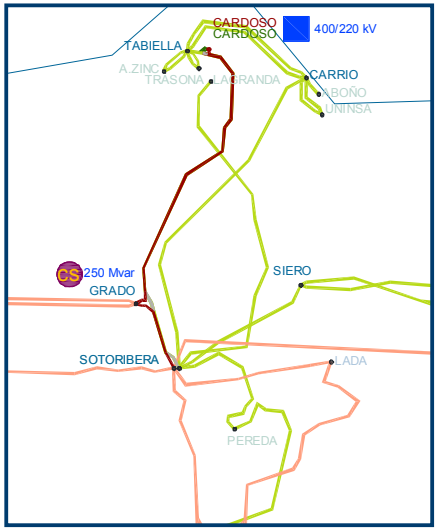
- Operational solutions, DLR, repowering of the existing 220 kV axis, and increasing its capacity do not resolve the issue in the area.
- Solutions that involve 400 kV to 220 kV support from Tabiella are difficult to implement and impede potential future developments.

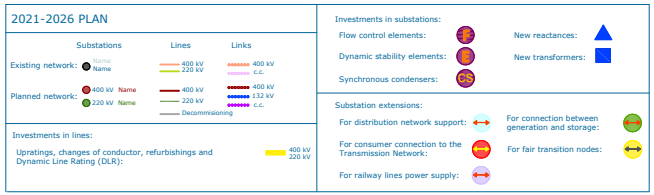
**Alternatives (cont.):**

- Keeping Aboño operational and its scheduling involves high cost overruns due to technical constraints and a considerable increase in emissions.

**European dimension:** No

**Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement N_OESTE_1

RES integration and resolution of technical constraints

**Asturias 400 kV Reinforcement**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 2.8 M€/year | Reduction of $CO_2$ emissions: 12 kt/year* |
| Additional RES integration: 101,779 MWh/year | Reduction of system losses: 54,756 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Profitability:

| Profitability: NPV |
|---|
| 12 M€ |

### Socio-environmental impact:



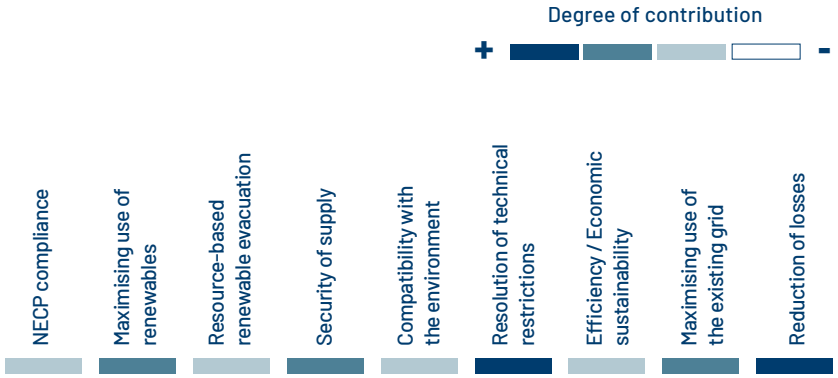

### Costs:

| CAPEX | OPEX |
|---|---|
| 33.2 M€ | 0.3 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 3.0 | 2.9 | 2.9 | 2.8 | 2.8 | 2.7 | 2.7 | 2.7 | 2.6 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement N_OESTE_1

RES integration and resolution of technical constraints

**Asturias 400 kV Reinforcement**

## Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 3 | 4 |
| Overhead line (km) | 0.5 | 2 |
| Transformed to 220 kV (MVA) | | 600 |
| Voltage change (km) | | 30 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Cardoso* 220 kV | Building | 2024 |
| Cardoso* 400 kV | Building | 2024 |

* Name of the electrical substation (ES) updated in the modifications of specific items.

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Cardoso* 220 kV | 3 | GIS | TN | 2024 |
| Cardoso* 400 kV | 3 | GIS | TN | 2024 |
| Soto de Ribera 400 kV | 1 | AIS | TN | 2020 |

* Name of the electrical substation (ES) updated in the modifications of specific items.

## Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Cardoso* - Tabiella 220 kV, circuit 1 [1] | 650 | 530 | 0.5 | Line | RES | 2024 |
| Santa María de Grado - Cardoso* 400 kV, circuit 1 [2] | 1,330 | 1,080 | 1 | Line | RES | 2024 |
| Soto de Ribera - Santa María de Grado 400 kV, circuit 1 [3] | 1,330 | 1,080 | 1 | Line | RES | 2020 |

Notes:
1. Section line capacity 980/890 MVA. Decommissioning of a section of the Tabiella-Soto 220 kV line is required.
2. Section line capacity 2400/2180 MVA.
3. Section line capacity 1780/1620 MVA
* Name of the electrical substation (ES) updated in the modifications of specific items.

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Cardoso* 400/220 kV, TF1 | 600 | Triph. B. | RES | 2024 |

* Name of the electrical substation (ES) updated in the modifications of specific items.

| Voltage changes | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Santa María de Grado - Cardoso* 400 kV, circuit 1 | 1,330 | 1,080 | 25 | Line | RES | 2024 |
| Soto de Ribera - Santa María de Grado 400 kV, circuit 1 | 1,330 | 1,080 | 5 | Line | RES | 2024 |

* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement N_OESTE_2

## RES integration and resolution of technical constraints

## Connection at Fuentebureba

**I General description:**

These reinforcements consist of a new substation for the integration of renewable energy in the area of Fuentebureba:

- New Fuentebureba 400 kV substation in I/O on the Grijota-Vitoria 400 kV line.

**I Drivers / Objectives:**

- Connecting existing and future renewable energy generation in the area, with a high probability of successful deployment.
- Using the transmission grid to power traction substations from the Burgos-Vitoria railway line.

**I Alternatives:**

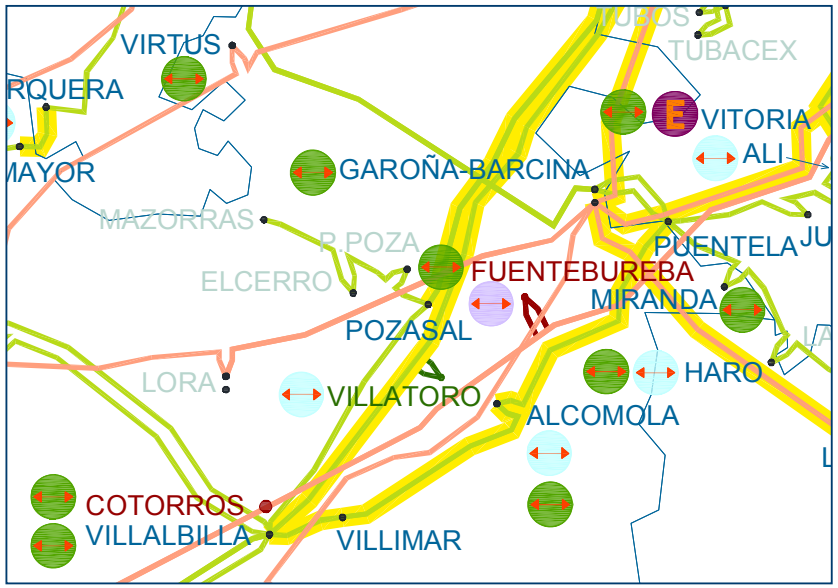
Operational solutions, DLR, repowering of the existing 220 kV axis, and increasing the capacity do not resolve the issue of increasing evacuation capacity in the area.

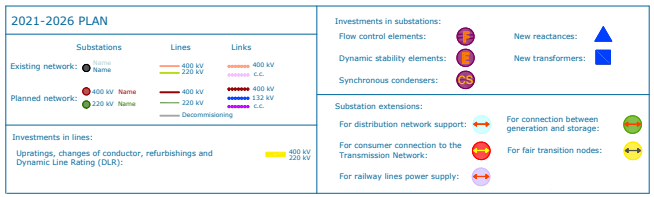
The alternative of connection to the Alcocero de Mola 220 kV substation is difficult in terms of integration as it would generate overloads on the 220 kV lines in the area.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement N_OESTE_2

RES integration and resolution of technical constraints

**Connection at Fuentebureba**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 6 M€/year | Reduction of $CO_2$ emissions: 28 kt/year* |
| Additional RES integration: 164,649 MWh/year | Reduction of system losses: 2,748 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Profitability:

Profitability: NPV

108 M€

### Socio-environmental impact:



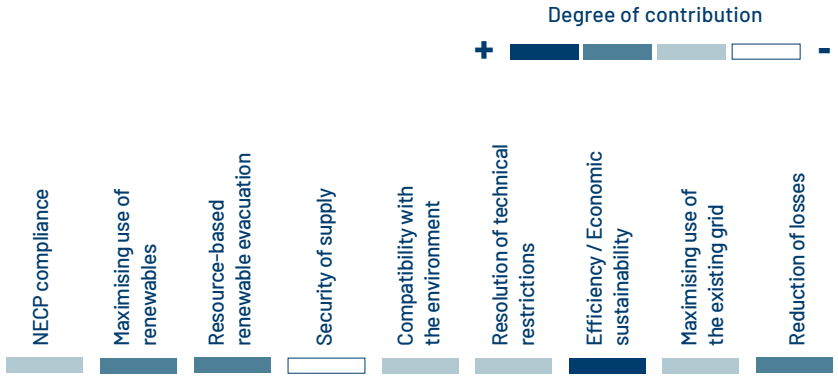

### Costs:

| CAPEX | OPEX |
|---|---|
| 6.6 M€ | 0.24 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# Reinforcement N_OESTE_2

RES integration and resolution of technical constraints

**Connection at Fuentebureba**

## Table of physical units:

| | 400 kV |
|---|---|
| Bays (units) | 5 |
| Overhead line (km) | 3 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Fuentebureba* 400 kV | Outdoor | 2025 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

## Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Fuentebureba* 400 kV | 4 | AIS | TN | 2025 |
| Fuentebureba* 400 kV | 1 | AIS | Gen./Sto. | 2025 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Fuentebureba*, of Grijota - Vitoria 400 kV, circuit 1 [1] | 1,830 | 1,540 | 2 | Line | RES | 2025 |

Notes:
1. Section line capacity in DC for I/O 2430/2070 MVA.
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement N_OESTE_3

## RES integration and resolution of technical constraints

## Connection at Cotorros

**I General description:**

These reinforcements consist of implementing a new 400 kV substation to support the 220 kV grid in the area of Burgos and increasing integration of renewable energy:

- New Cotorros 400 kV substation with I/O on the Grijota-Vitoria 400 kV line.
- New transformer 1 in Cotorros 400/220 kV (>2026).

**I Drivers / Objectives:**

- Connecting existing and future renewable energy generation in the area, with a high probability of successful deployment.
- Reducing technical constraints due to overloads that result in the curtailment of renewable energy in the area by supporting the 220 kV axis between Burgos and the País Vasco with the 400 kV grid.

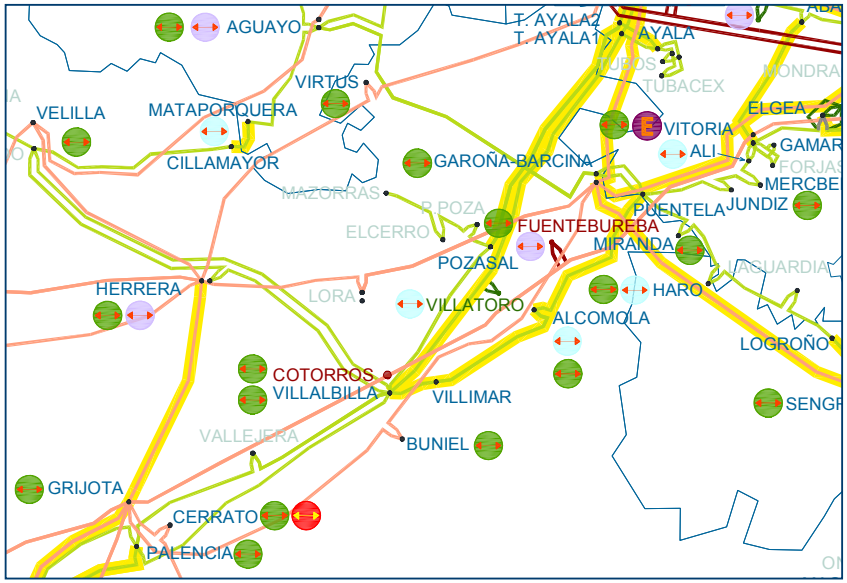
**I Alternatives:**

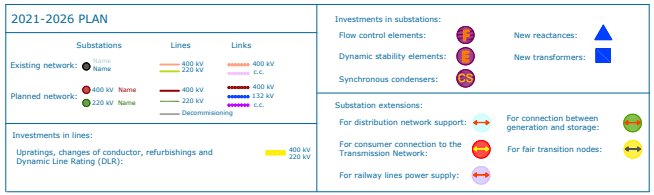
Operational solutions, DLR, repowering of the existing 220 kV axis, and increasing the capacity do not satisfactorily resolve the needs identified in the area.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement N_OESTE_3

RES integration and resolution of technical constraints

**Connection at Cotorros**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 7.8 M€/year | Reduction of $CO_2$ emissions: 37 kt/year* |
| Additional RES integration: 186,942 MWh/year | Reduction of system losses: 5,824 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Costs:

| CAPEX | OPEX |
|---|---|
| 16.2 M€ | 0.45 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 1.8 | 1.7 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Profitability:

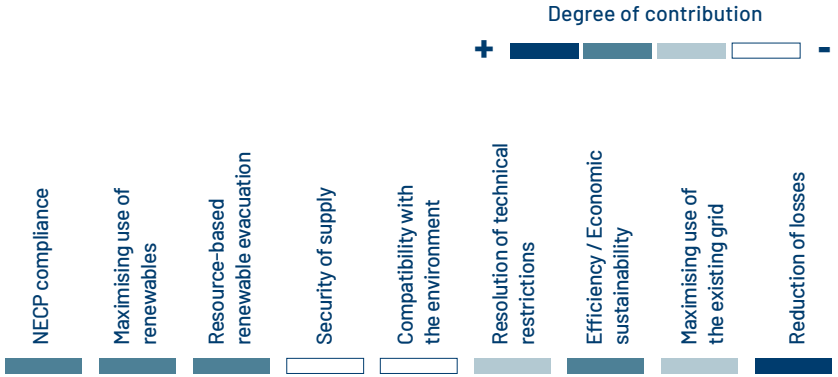
Profitability: NPV

128 M€

### Socio-environmental impact:




### Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement N_OESTE_3

## RES integration and resolution of technical constraints

## Connection at Cotorros

### Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 1 | 7 |
| Overhead line (km) | | 4 |
| Transformed to 220 kV (MVA) | | 600 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Cotorros* 400 kV | Outdoor | 2025 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

### Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Cotorros* 400 kV | 2 | AIS | TN | > 2026 |
| Cotorros* 400 kV | 4 | AIS | TN | 2025 |
| Cotorros* 400 kV | 1 | AIS | Gen./Sto. | 2025 |
| Villalbilla 220 kV | 1 | AIS | TN | > 2026 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Cotorros*, of Grijota - Vitoria 400 kV, circuit 1[1] | 1,830 | 1,540 | 2 | Line | RES | 2025 |

Notes:
1. Section line capacity in DC for I/O 2480/2090 MVA.
* Name of the electrical substation (ES) updated in the modifications of specific items.

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Cotorros* 400/220 kV, TF1 | 600 | Triph. B. | RES | > 2026 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement N_OESTE_4

## RES integration and resolution of technical constraints

## Connection at Tierra de Campos

**I General description:**

These reinforcements consist of a new substation for the integration of renewable energy in the area of Tordesillas:

- New Tierra de Campos 400 kV substation with input/output in the Villarino-Grijota 400 kV line.

**I Drivers / Objectives:**

- Connecting existing and future renewable energy generation in the area, with a high probability of successful deployment.

**I Alternatives:**

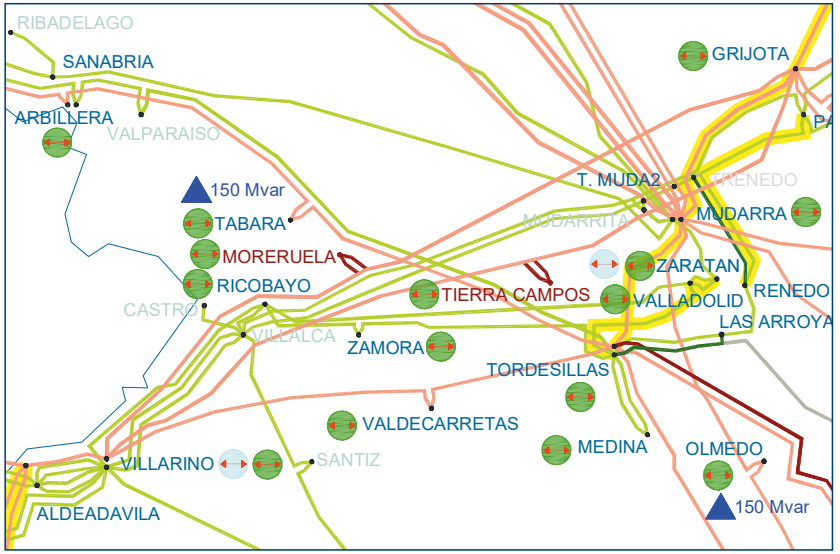
Operational solutions, DLR, repowering of the existing 220 kV axis, and increasing the capacity do not resolve the area's issues.

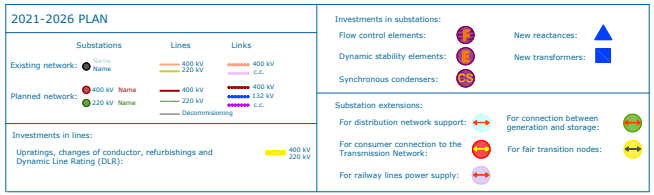
Solutions that involve expansion of 220 kV substations in the area of Tordesillas and Medina do not allow for the integration of a greater amount of renewable energy with a high probability of successful deployment.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement N_OESTE_4

RES integration and resolution of technical constraints

**Connection at Tierra de Campos**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 5.4 M€/year | Reduction of $CO_2$ emissions: 26 kt/year* |
| Additional RES integration: 138,152 MWh/year | Reduction of system losses: 5,633 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

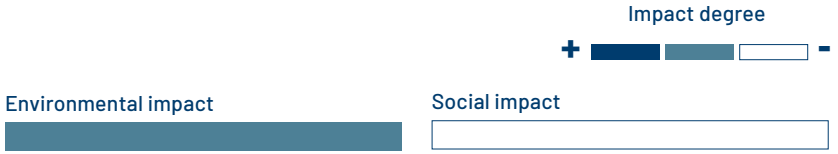
Note: * a negative value means existing increased emissions, losses or ENS.

### Profitability:

Profitability: NPV

95 M€

### Socio-environmental impact:



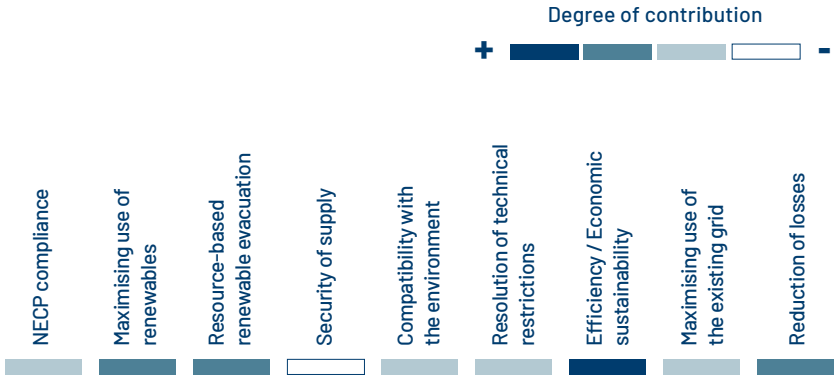

### Costs:

| CAPEX | OPEX |
|---|---|
| 7.3 M€ | 0.25 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# Reinforcement N_OESTE_4

RES integration and resolution of technical constraints

**Connection at Tierra de Campos**

## Table of physical units:

| | 400 kV |
|---|---|
| Bays (units) | 5 |
| Overhead line (km) | 6 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Tierra de Campos* 400 kV | Outdoor | 2025 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

## Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Tierra de Campos * 400 kV | 4 | AIS | TN | 2025 |
| Tierra de Campos* 400 kV | 1 | AIS | Gen./Sto. | 2025 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Tierra de Campos*, of Grijota - Villarino 400 kV, circuit 1 | 2,400 | 2,000 | 3 | Line | RES | 2025 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement N_OESTE_5

## RES integration and resolution of technical constraints

## Connection at Moreruela

**I General description:**

These reinforcements consist of a new substation for the integration of renewable energy in the area of Tábara (Zamora):

- New Moreruela 400 kV substation with I/O on the Villarino-Grijota 400 kV line.

**I Drivers / Objectives:**

- Connecting existing and future renewable energy generation in the area, with a high probability of successful deployment.

**I Alternatives:**

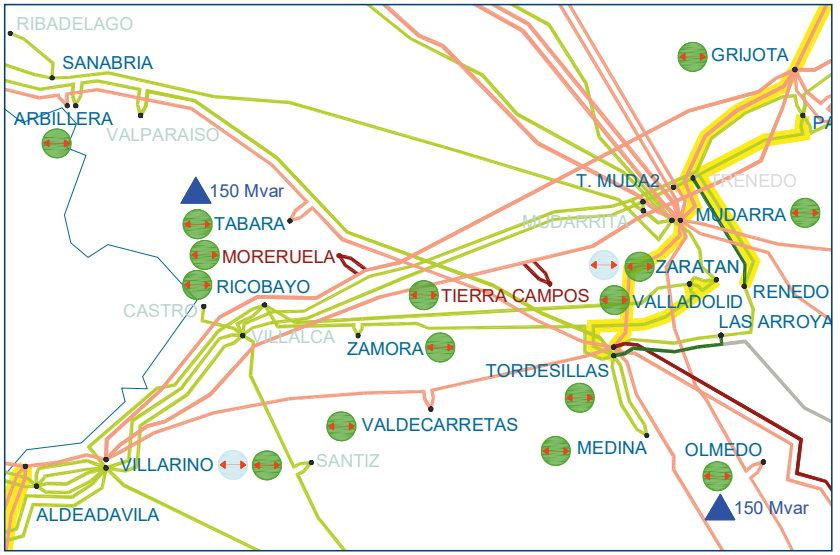
Operational solutions, DLR, repowering of the existing 220 kV axis, and increasing the capacity do not resolve the area's issues.

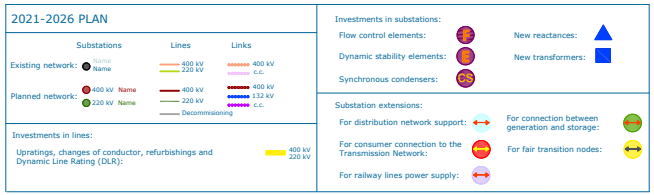
Solutions that involve expansion of 400 kV substations in the area of Tábara do not allow for the integration of a greater amount of renewable energy with a high probability of successful deployment.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement N_OESTE_5

RES integration and resolution of technical constraints

**Connection at Moreruela**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 42.3 M€/year | Reduction of $CO_2$ emissions: 234 kt/year* |
| Additional RES integration: 913,074 MWh/year | Reduction of system losses: 1,182 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

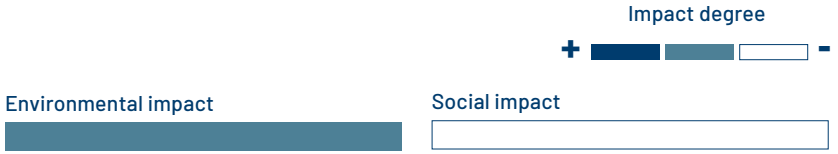
Note: * a negative value means existing increased emissions, losses or ENS.

### Profitability:

Profitability: NPV

833 M€

### Socio-environmental impact:



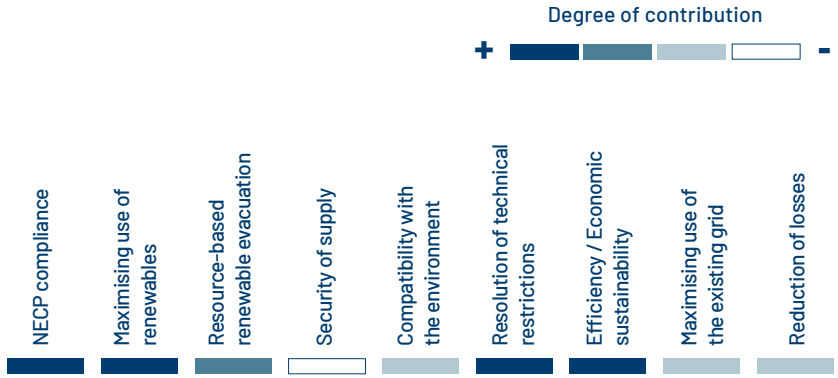

### Costs:

| CAPEX | OPEX |
|---|---|
| 6.8 M€ | 0.24 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# Reinforcement N_OESTE_5

## RES integration and resolution of technical constraints

## Connection at Moreruela

### Table of physical units:

| | 400 kV |
|---|---|
| Bays (units) | 5 |
| Overhead line (km) | 4 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Moreruela* 400 kV | Outdoor | 2025 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

### Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Moreruela* 400 kV | 1 | AIS | Gen./Sto. | 2025 |
| Moreruela* 400 kV | 4 | AIS | TN | 2025 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Moreruela*, of Grijota - Villarino 400 kV, circuit 2 | 2,420 | 2,030 | 2 | Line | RES | 2025 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement N_OESTE_6

## RES integration and resolution of technical constraints

## Connection at Abegondo 220 kV

**I General description:**

These reinforcements consist of a new substation for the connection of renewable energy in the north of A Coruña:

- New Abegondo 220 kV substation.
- New transformer 1 in Abegondo 400/220 kV.

**I Drivers / Objectives:**

- Enabling the connection of new renewable generation with grid access granted.

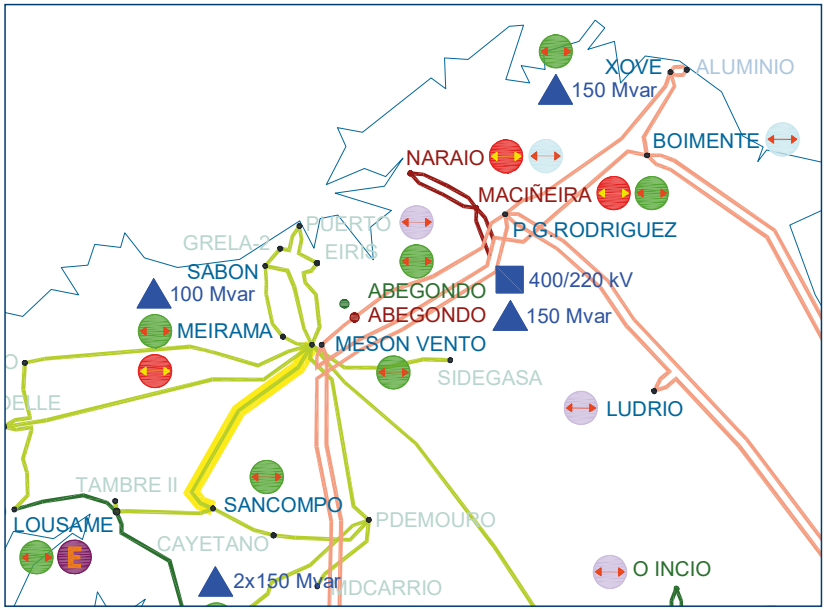
**I Alternatives:**

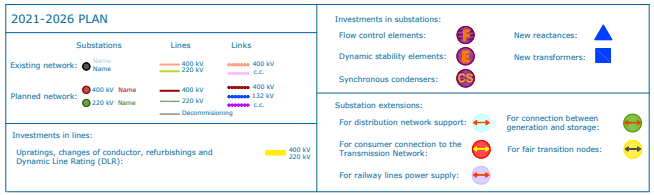
The accesses already granted for this substation do not permit the replacement of said substation with any alternative.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement N_OESTE_6

RES integration and resolution of technical constraints

**Connection at Abegondo 220 kV**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Profitability:

Profitability: NPV

- M€

### Socio-environmental impact:

Impact degree + -

| Environmental impact | Social impact |
|---|---|
| | |

### Costs:

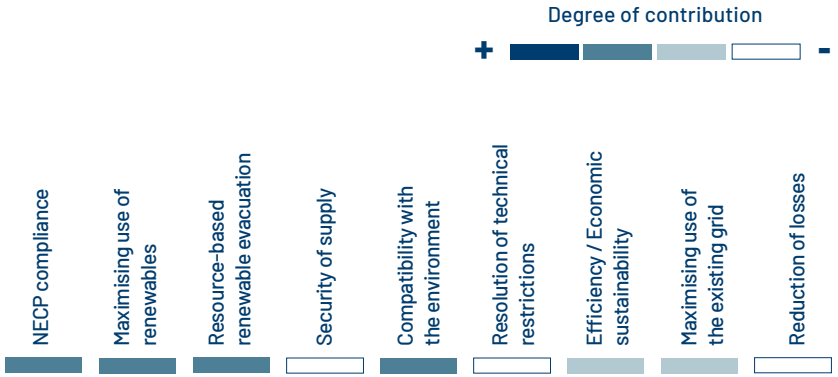
| CAPEX | OPEX |
|---|---|
| 9 M€ | 0.2 M€/year |

Remuneration costs

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| M€ | 0.0 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.8 | 0.8 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement N_OESTE_6

RES integration and resolution of technical constraints

**Connection at Abegondo 220 kV**

## Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 2 | 1 |
| Transformed to 220 kV (MVA) | | 600 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Abegondo 220 kV | Outdoor | 2024 |

## Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Abegondo 220 kV | 2 | AIS | TN | 2024 |
| Abegondo 400 kV | 1 | AIS | TN | 2024 |

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Abegondo 400/220 kV, TF1 | 600 | Triph. B. | RES | 2024 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement N_OESTE_7

## RES integration and resolution of technical constraints

## Reinforcement of the Soria network

**I General description:**

These reinforcements involve the electrical connection of the existing Magaña (Soria) substation and the 400 kV Mudarra-Zuzones-Almazán-Cariñena-Fuendetodos axis:

- New Coscurita 220 kV substation with Magaña-Coscurita 220 kV double circuit.
- New Coscurita 400/220 kV transformer.

**I Drivers / Objectives:**

- Increasing the meshing in the 220 kV grid in the area of Magaña (Soria) to reduce the need to use technical constraints to solve overloads through the curtailment of renewable energy in the area, primarily wind energy.

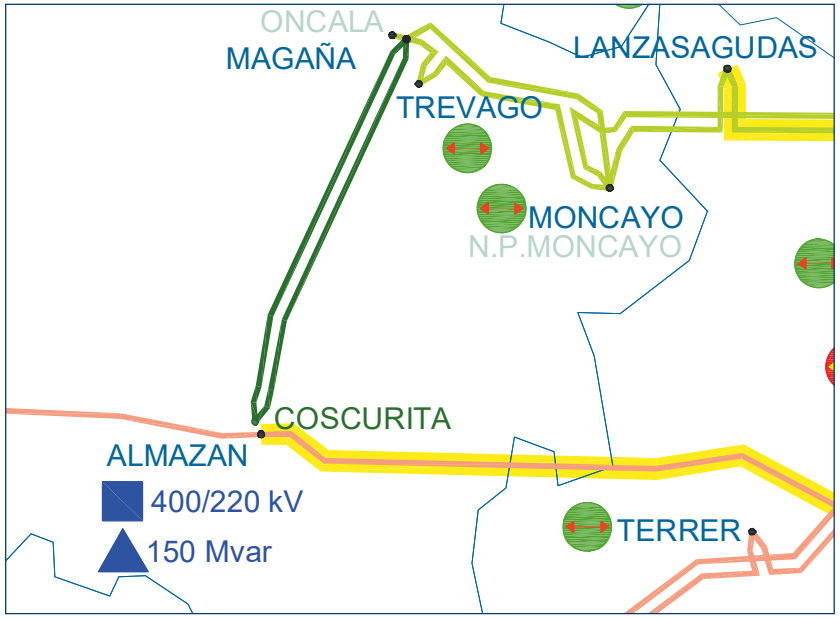
**I Alternatives:**

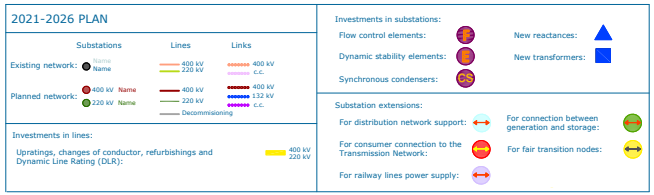
Although some repowering has already been carried out and further repowering has been scheduled in the 220 kV axes in the area, the high wind energy potential in the area of Soria and Aragón requires the construction of new infrastructures to achieve optimal performance.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement N_OESTE_7

RES integration and resolution of technical constraints

**Reinforcement of the Soria network**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 14 M€/year | Reduction of $CO_2$ emissions: 167 kt/year* |
| Additional RES integration: 3,321.979 MWh/year | Reduction of system losses: 206,028 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Profitability:

Profitability: NPV

214 M€

### Socio-environmental impact:



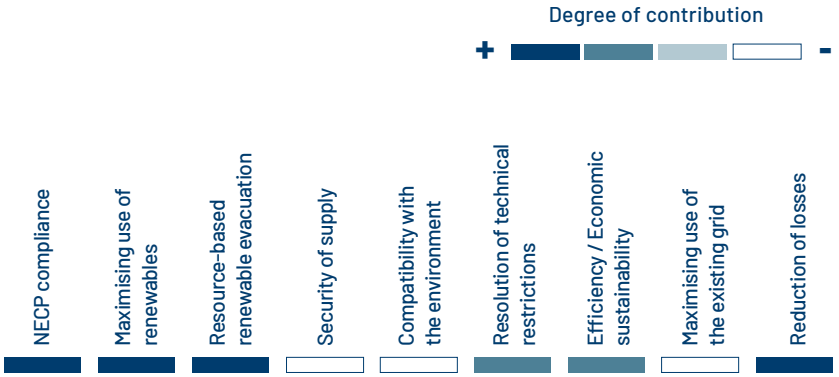

### Costs:

| CAPEX | OPEX |
|---|---|
| 48.5 M€ | 0.53 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 4.4 | 4.4 | 4.3 | 4.2 | 4.2 | 4.1 | 4.0 | 4.0 | 3.9 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement N_OESTE_7

RES integration and resolution of technical constraints

**Reinforcement of the Soria network**

## Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 6 | 2 |
| Overhead line (km) | 130 | 1 |
| Transformed to 220 kV (MVA) | | 600 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Coscurita* 220 kV | Outdoor | 2026 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

## Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Coscurita* 220 kV | 4 | AIS | TN | 2026 |
| Almazán 400 kV | 2 | AIS | TN | 2026 |
| Magaña 220 kV | 2 | AIS | TN | 2026 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Coscurita* - Almazán 400 kV, circuit 1 | | | 1 | Line | RES | 2026 |
| DC Coscurita* - Magaña 220 kV | 890 | 760 | 65 | Line | RES | 2026 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Coscurita* 400/220 kV, TF1 | 600 | Triph. B. | RES | 2026 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement NORTE_1

## RES integration and resolution of technical constraints

## New Navarra - País Vasco axis

**I General description:**

The reinforcements consist of strengthening the connection between the Itxaso (País Vasco) substation and the Muruarte - Castejón (Navarra) axis:

- New double circuit in Itxaso - Muruarte 400 kV and Itxaso - Castejón 400 kV.

**I Drivers / Objectives:**

- The current connection between Navarra and the País Vasco uses two 220 kV lines with limited capacity, which causes grid overloads that require the use of technical constraints for renewable energy generation in the area, increasing generation costs and causing curtailments.
- Reducing the need to apply technical constraints to achieve the objective of 70% of the available capacity in these elements for commercial transfer capacity in accordance with Art. 16(8) of Regulation 2019/943 of the interior energy market.

**I Alternatives:**

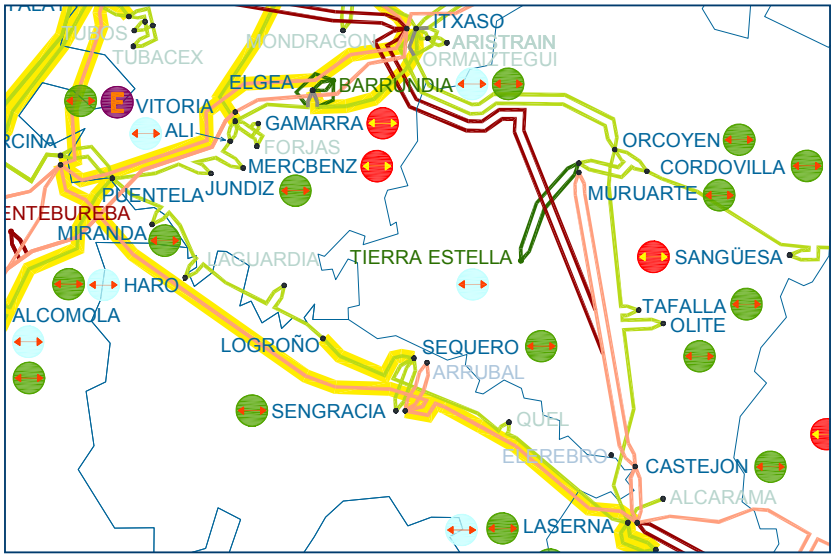
Other operational solutions, DLR, repowering of the existing lines, and increasing the capacity do not adequately resolve the area's issues.

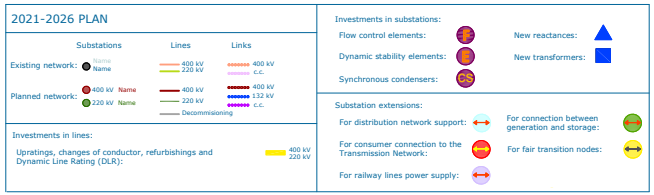
The reinforcements involve the decommissioning of the existing Itxaso - Orcoyen 220 kV 1 and 2 circuits, which contributes to reducing their environmental impact.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement NORTE_1

RES integration and resolution of technical constraints

**New Navarra - País Vasco axis**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 16.5 M€/year | Reduction of $CO_2$ emissions: 88 kt/year* |
| Additional RES integration: 663,054 MWh/year | Reduction of system losses: 51,506 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Profitability:

Profitability: NPV

246 M€

### Socio-environmental impact:




### Costs:

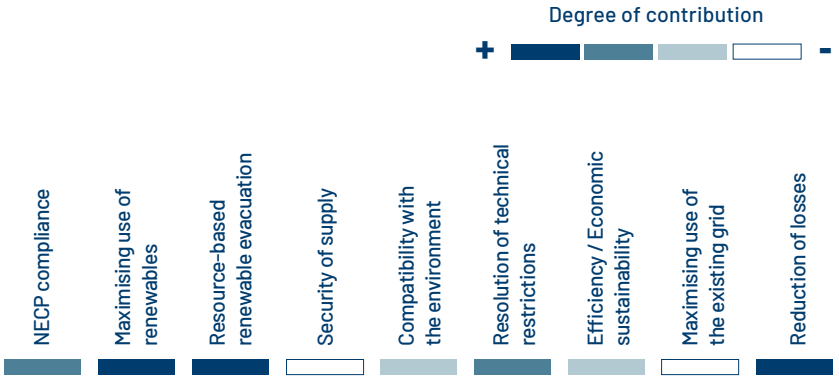
| CAPEX | OPEX |
|---|---|
| 65.2 M€ | 0.43 M€/year |

Remuneration costs

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| M€ | 0.0 | 5.7 | 5.6 | 5.5 | 5.4 | 5.3 | 5.2 | 5.2 | 5.1 | 5.0 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# Reinforcement NORTE_1

RES integration and resolution of technical constraints

**New Navarra - País Vasco axis**

## Table of physical units:

| | 400 kV |
|---|---|
| Bays (units) | 3 |
| Overhead line (km) | 200 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Itxaso 400 kV | 3 | AIS | TN | 2024 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Itxaso, of Muruarte - Castejón 400 kV, circuit 1 [1] | 2,440 | 2,080 | 100 | Line | RES | 2024 |

Notes:
1. Decommissioning of Itxaso-Orcoyen 220kV 1 and 2 is required.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SUR_1

## RES integration and resolution of technical constraints

## New corridors in Andalucía

**I General description:**

Reinforcement of the Andalusian transmission grid via new 400 kV axes (Baza-La Ribina, Seville-Córdoba and Andalucía-Castilla-La Mancha).

In addition, the reinforcements include repowering of the existing grid to maximise the benefits of the meshing, reactances in the new grid, and one transmission tower for the 220 kV grid.

**I Drivers / Objectives:**

- Reducing technical constraints due to overloads resulting in the renewable energy curtailments in the area by reinforcing the connection between Andalucía and Castilla-La Mancha and between Almería and the rest of Andalucía.
- Increasing security and quality of the supply in the area.
- Increasing integration of existing and future renewable energy in the area.

**I Alternatives:**

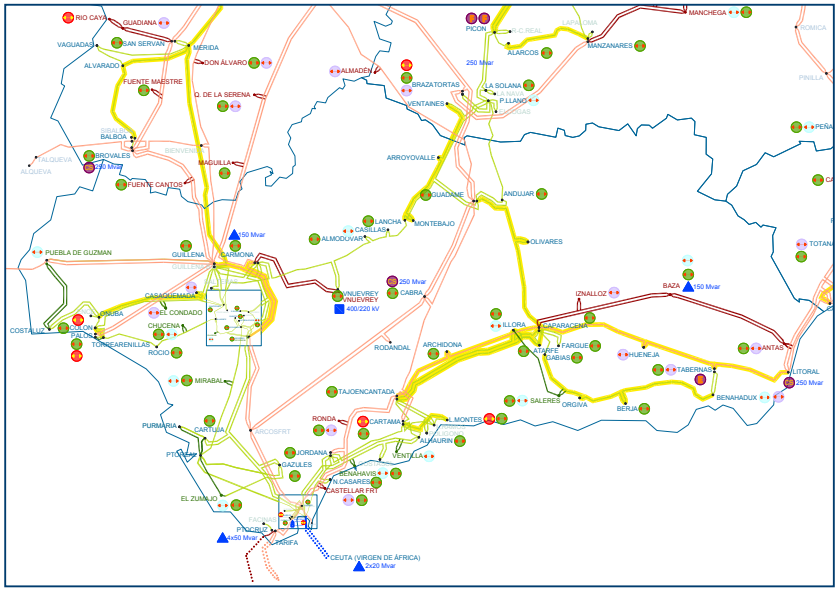
Alternative connections with Castilla-La Mancha or Extremadura from Puebla de Guzmán and Hornachuelos have been assessed, but they have a greater environmental impact.

An alternative to the Carmona-Guadame axis has been assessed, consisting of the Carmona-Cabra axis, although this has less benefits for the entire system.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement SUR_1

RES integration and resolution of technical constraints

**New corridors in Andalucía**

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: 110.9 M€/year | Reduction of $CO_2$ emissions: 603 kt/year* |
| Additional RES integration: 2,928.469 MWh/year | Reduction of system losses: -51,097 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Costs:

| CAPEX | OPEX |
|---|---|
| 362.2 M€ | 3.16 M€/year |

Remuneration costs

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| M€ | 0.0 | 32.4 | 31.9 | 31.4 | 30.9 | 30.4 | 29.9 | 29.4 | 28.9 | 28.4 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### Profitability:

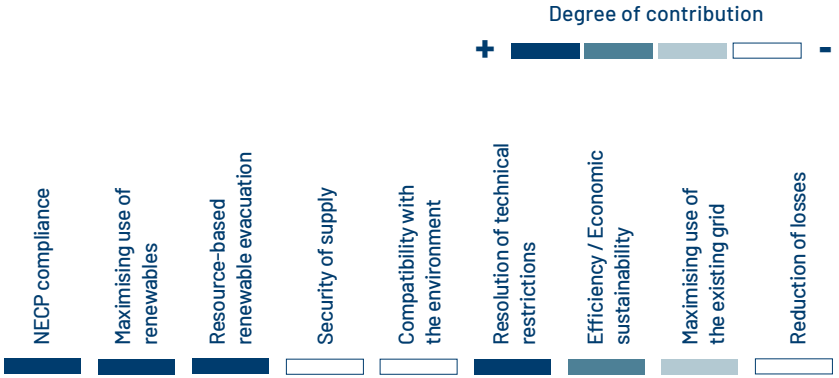
Profitability: NPV

1,738 M€

### Socio-environmental impact:




### Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement SUR_1

## RES integration and resolution of technical constraints

## New corridors in Andalucía

### Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 3 | 33 |
| Overhead line (km) | | 926 |
| Transformed to 220 kV (MVA) | | 1,200 |
| Uprating (km) | 502 | 470 |
| Reactance (Mvar) | | 450 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Antas* 400 kV | Outdoor | 2024 |
| Villanueva del Rey 400 kV | Outdoor | 2025 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Antas* 400 kV | 7 | AIS | TN | 2024 |
| Antas* 400 kV | 1 | AIS | Gen./Sto. | 2024 |
| Baza REE 400 kV | 1 | AIS | TN | 2022 |
| Baza REE 400 kV | 3 | AIS | TN | 2024 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

### Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Carmona 400 kV | 3 | AIS | TN | 2025 |
| Guadame 400 kV | 6 | AIS | TN | > 2026 |
| Manzanares 400 kV | 2 | AIS | TN | > 2026 |
| Villanueva del Rey 220 kV | 2 | AIS | TN | 2025 |
| Villanueva del Rey 220 kV | 1 | AIS | TN | > 2026 |
| Villanueva del Rey 400 kV | 1 | AIS | Gen./Sto. | 2025 |
| Villanueva del Rey 400 kV | 6 | AIS | TN | 2025 |
| Villanueva del Rey 400 kV | 3 | AIS | TN | > 2026 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Baza REE-Antas* 400 kV | 2,290 | 1,910 | 103 | Line | RES | 2024 |
| DC Carmona - Villanueva del Rey 400 kV | 2,310 | 1,910 | 55 | Line | RES | 2025 |
| DC Guadame - Manzanares 400 kV | 2,360 | 1,970 | 176 | Line | RES | > 2026 |
| DC Villanueva del Rey - Guadame 400 kV [1] | 2,330 | 1,920 | 124 | Line | RES | > 2026 |
| I/O in Antas*, of Carril - Litoral 400 kV, circuit 1 [2] | 1,700 | 1,470 | 5 | Line | RES | 2024 |

Notes:
1. The Guadame-Carmona 400 kV circuit uses one of the Carmona-Villanueva del Rey 400 kV circuits.
2. Section line capacity in DC for I/O 2300/2010 MVA.
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement SUR_1

## RES integration and resolution of technical constraints

## New corridors in Andalucía

### Detailed list of assets (continued):

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Archidona - Caparacena 400 kV, circuit 1 | 1,736 | 1,431 | 66 | Line | RES | 2025 |
| Archidona - Tajo de la Encantada 400 kV, circuit 1 | 1,718 | 1,504 | 42 | Line | RES | 2022 |
| Arroyo del Valle - Montecillo Bajo 220 kV, circuit 1 | 416 | 339 | 40 | Line | RES | 2022 |
| Arroyo del Valle - Venta de la Inés 220 kV, circuit 1 | 416 | 339 | 66 | Line | RES | 2022 |
| Asomada - Carril 400 kV, circuit 1 | 1,733 | 1,459 | 79 | Line | RES | 2023 |
| Atarfe - Íllora 220 kV, circuit 1 | 417 | 354 | 21 | Line | RES | 2022 |
| Benahadux - Berja 220 kV, circuit 1 | 413 | 353 | 67 | Line | RES | 2022 |
| Berja - Órgiva 220 kV, circuit 1 | 413 | 353 | 58 | Line | RES | 2022 |
| Caparacena - Hueneja 400 kV, circuit 1 | 1,717 | 1,414 | 73 | Line | RES | 2022 |
| Caparacena - Íllora 220 kV, circuit 1 | 417 | 354 | 16 | Line | RES | 2022 |
| Don Rodrigo - Carmona 400 kV, circuit 1 | 1,690 | 1,400 | 41 | Line | RES | 2023 |
| Don Rodrigo - Guillena 400 kV, circuit 1 | 1,690 | 1,400 | 72 | Line | RES | 2023 |
| Guadame - Olivares 220 kV, circuit 1 | 430 | 350 | 54 | Line | RES | 2023 |
| Hueneja - Tabernas 400 kV, circuit 1 | 1,732 | 1,427 | 59 | Line | RES | 2024 |

### Detailed list of assets (continued):

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Lancha - Montecillo Bajo 220 kV, circuit 1 | 416 | 339 | 3 | Line | RES | 2020 |
| Litoral - Tabernas 400 kV, circuit 1 | 1,685 | 1,492 | 38 | Line | RES | 2024 |
| Tajo de la Encantada - Íllora 220 kV, circuit 1 | 417 | 354 | 89 | Line | RES | 2022 |
| Tajo de la Encantada - Íllora 220 kV, circuit 2 | 417 | 354 | 89 | Line | RES | 2022 |

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Villanueva del Rey 400/220 kV, TF1 | 600 | Triph. B. | RES | 2025 |
| Villanueva del Rey 400/220 kV, TF2 | 600 | Triph. B. | RES | > 2026 |

| New reactances | MVAr | Type | Driv. | Year |
|---|---|---|---|---|
| Baza REE 400 kV, REA1 | 150 | - | RES | 2022 |
| Villanueva del Rey 400 kV, REA1 | 150 | - | RES | > 2026 |
| Villanueva del Rey 400 kV, REA2 | 150 | - | RES | > 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement GEN_ALM

## RES integration and resolution of technical constraints

## Connection of renewables and storage

**General description:**

Additional bays associated with the connection of new storage are included, as well as expansion for potential connection to offshore wind power in areas listed as priorities in the draft Maritime Spatial Planning (Plan de Ordenación del Espacio Marítimo - POEM):

- New Viana 400 kV substation with input-output in the Trives-Aparecida line.
- New Abres 400 kV substation with input-output in the Pesoz-Boimente 400 kV line.
- Expansions for power generation and storage in the Aguayo, Montearenas, Viana, Almendrales, Xove, Santa Llogaia 400 kV, and Atios 220 kV substations.

**Drivers / Objectives:**

Enabling connection and integration of power generation in the scenario outlined by the National Energy and Climate Plan (Plan Nacional Integrado de Energía y Clima).

**Alternatives:**

Connection through existing or previously planned bays for other purposes has proven to be a non-viable alternative.

**European dimension:**

No

## Cost-Benefit Multi-Criteria Analysis

### Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### Costs:

| CAPEX | OPEX |
|---|---|
| 19.5 M€ | 0.91 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 2.5 | 2.5 | 2.4 | 2.4 | 2.4 | 2.4 | 2.3 | 2.3 | 2.3 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Reinforcement GEN_ALM

RES integration and resolution of technical constraints

**Connection of renewables and storage**

## Profitability:

Profitability: NPV

- M€

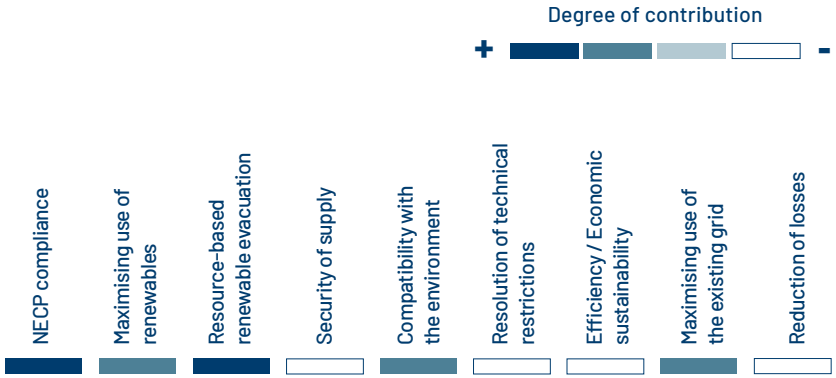
## Socio-environmental impact:




Environmental impact

Social impact

## Contribution to guiding principles:




## Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 1 | 18 |
| Overhead line (km) | | 14 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Abres 400 kV | Outdoor | > 2026 |
| Viana* 400 kV | Outdoor | 2026 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement GEN_ALM

RES integration and resolution of technical constraints

**Connection of renewables and storage**

## I Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Abres 400 kV | 1 | AIS | Gen./Sto. | > 2026 |
| Abres 400 kV | 4 | AIS | TN | > 2026 |
| Aguayo 400 kV | 1 | AIS | Gen./Sto. | 2023 |
| Aguayo 400 kV | 1 | AIS | TN | 2023 |
| Almendrales 400 kV | 1 | AIS | TN | 2026 |
| Atios 220 kV | 1 | AIS | Gen./Sto. | 2026 |
| Montearenas 400 kV | 1 | AIS | Gen./Sto. | 2025 |
| Santa Llogaia 400 kV | 1 | AIS | Gen./Sto. | 2026 |
| Viana* 400 kV | 2 | AIS | Gen./Sto. | 2026 |
| Viana* 400 kV | 4 | AIS | TN | 2026 |
| Xove 400 kV | 1 | AIS | Gen./Sto. | 2026 |
| Xove 400 kV | 1 | AIS | TN | 2026 |

Notes:
* Name of the electrical substation (ES) updated in the modifications of specific items.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Abres, of Pesoz - Boimente 400 kV, circuit 1 [1] | 2,430 | 2,240 | 2 | Line | Gen./Sto. | > 2026 |
| I/O in Viana*, of Trives - Aparecida 400 kV, circuit 1 [2] | 2,410 | 2,060 | 5 | Line | Gen./Sto. | 2026 |

Notes:
1. Section line capacity in DC for I/O 2430/2240 MVA.
2. Section line capacity in DC for I/O 2410/2060 MVA.
* Name of the electrical substation (ES) updated in the modifications of specific items.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_CENTRO
## Security of supply **Reliability of supply Madrid**

**I General description:**

The following reinforcements are included for security of supply of the transmission grid in the region of Madrid:

- Elimination of TLeganés 220 kV and TRetamar 220 kV, and corresponding topological changes.
- Repowering with a change of route on the Moraleja-Villaviciosa 400 kV line, with cable replacement on Arganda-Loeches 220 kV and Arganda-Valdemoro 220 kV, and an increase in capacity with a conductor change on the Galapagar-Valle del Arcipreste-Majadahonda 220 kV axis. Repowering Loeches-San Sebastian de los Reyes, 2400 kV.

**I Drivers / Objectives:**

- Improving reliability and security of supply in the metropolitan area of Madrid.
- Reducing the need for technical constraints to guarantee security of supply in the area.

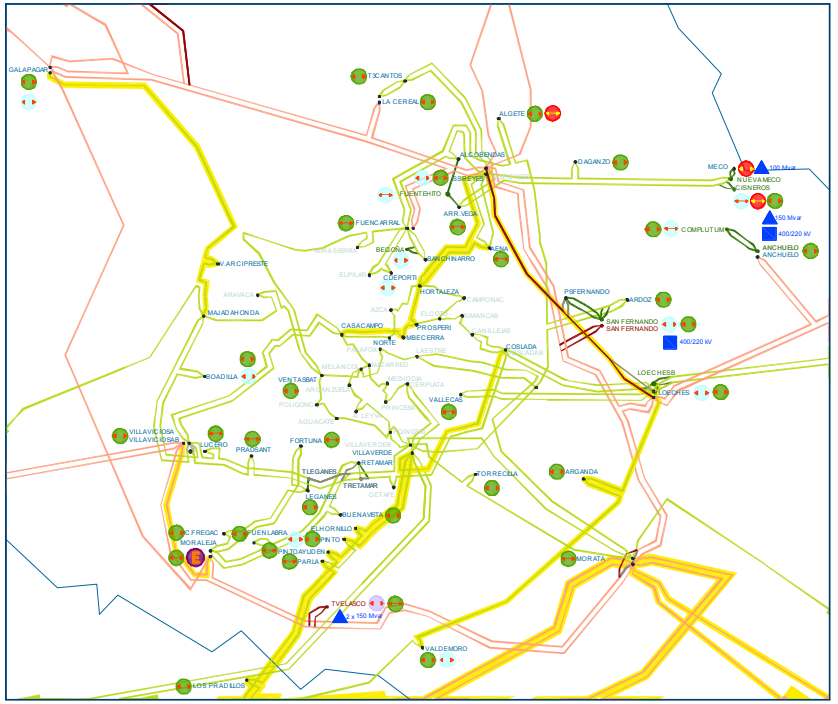
**I Alternatives:**

The potential alternatives would involve the implementation of a new grid, for which it would be more complex to ensure viability and would require a larger reinforcements.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_CENTRO
## Security of supply **Reliability of supply Madrid**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 28.8 M€ | 0.1 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 2.4 | 2.4 | 2.4 | 2.3 | 2.3 | 2.2 | 2.2 | 2.2 | 2.1 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

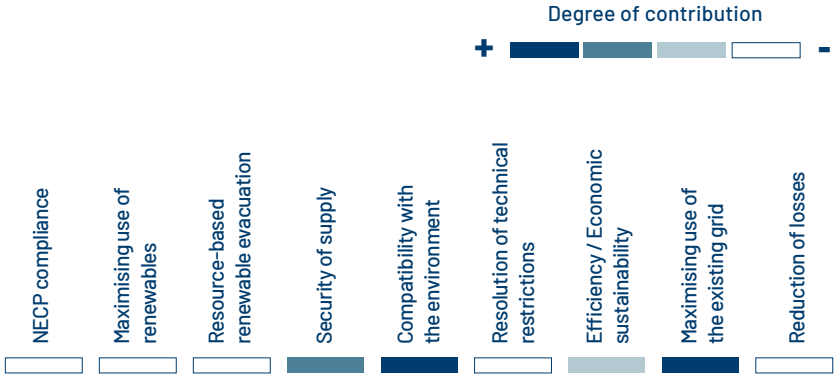
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement SdS_CENTRO
## Security of supply **Reliability of supply Madrid**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 2 | |
| Overhead line (km) | 5 | 24 |
| Cables (km) | 4 | |
| Uprating (km) | 61 | 33 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Parque Ingenieros 220 kV [1] | 2 | GIS | TN | > 2026 |

Notes:
1. Expansion for operable bypass on the Aguacate-Parque Ingenieros 220 kV circuit 1 and Parque Ingenieros-Villaverde Bajo B 220 kV circuit 2 lines.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Arganda - Loeches 220 kV, circuit 1 [1] | 568 | 568 | 2 | Cable | SoS | 2024 |
| Arganda - Valdemoro 220 kV, circuit 1 [1] | 568 | 568 | 2 | Cable | SoS | 2024 |
| DC Moraleja - Villaviciosa 400 kV [2] | 1,770 | 1,450 | 12 | Line | SoS | 2024 |
| Galapagar - Valle del Arcipreste 220 kV, circuit 1 | 466 | 466 | 2 | Line | SoS | 2024 |

### I Detailed list of assets (continued):

| New lines/cables (cont.) | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Getafe - Retamar 220 kV, circuit 1 [3] | 320 | 190 | 0.4 | Line | SoS | 2024 |
| Leganés - Lucero 220 kV, circuit 1 [4] | 439 | 361 | 0.7 | Line | SoS | 2024 |
| Majadahonda - Valle del Arcipreste 220 kV, circuit 1 | 466 | 466 | 2 | Line | SoS | 2024 |

Notes:
1. Requires decommissioning of the existing cable.
2. Share transmission towers with the L/Morata-Villaviciosa 400 kV.
3. The lines that link the decommissioned T Retamar 220 kV with Retamar 220 kV, Getafe 220 kV, and Prado de Santo Domingo 220 kV are decommissioned due to a topological change. Due to topological changes, the reinforcements involve the decommissioning of the Buenavista-Retamar 220 kV line, and commissioning of the Leganés-Lucero 220 kV, Buenavista-Villaverde Bajo 220 kV, Getafe-Retamar 220 kV, and Retamar-Prado de Santo Domingo 220 kV lines.
4. The lines that link the decommissioned T Leganés 220 kV with Leganés 220 kV, Lucero 220 kV, and Villaverde Bajo 220 kV are decommissioned due to a topological change. Due to topological changes, the reinforcements involve the decommissioning of the Buenavista-Retamar 220 kV line, and commissioning of the Leganés-Lucero 220 kV, Buenavista-Villaverde Bajo 220 kV, Getafe-Retamar 220 kV, and Retamar-Prado de Santo Domingo 220 kV lines.

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Arganda - Loeches 220 kV, circuit 1 [1] | 568 | 568 | 10 | Line | SoS | 2024 |
| Arganda - Valdemoro 220 kV, circuit 1 [2] | 568 | 568 | 22 | Line | SoS | 2022 |
| Galapagar - Valle del Arcipreste 220 kV, circuit 1 | 490 | 400 | 26 | Line | SoS | 2024 |
| Loeches - San Sebastián de los Reyes 400 kV, circuit 2 [3] | 1,490 | 1,490 | 26 | Line | SoS | 2022 |
| Majadahonda - Valle del Arcipreste 220 kV, circuit 1 | 430 | 360 | 2 | Line | SoS | 2024 |
| Moraleja - Villaviciosa 400 kV, circuit 1 | 1755 | 1441 | 7 | Line | SoS | 2022 |

Notes:
1. Line capacity in the repowered 600/600 MVA overhead section.
2. Line capacity in the repowered 780/640 MVA overhead section.
3. Repowering of the overhead section to 85º. Line capacity in the repowered 2079/1709 overhead section.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_CENTRO_Pcc

## Security of supply **Reliability of supply Madrid (Pcc)**

**I General description:**

The reinforcements increase supply reliability and security in the transmission grid in the region of Madrid, reducing short-circuit power in the area:

- Bushing operable in Loeches 220 kV.
- Operable bypass in Morata 400 kV, in the SSReyes-S. Fernando-Morata 400 kV and Morata-Moraleja 400 kV axes, creating an SSReyes-S.Fernando-Moraleja 400 kV axis.
- Operable bypass in Parque de Ingenieros 220 kV on the Parque Ingenieros-Villaverde Bajo,2 220 kV and Parque Ingenieros-Aguacate lines, creating a temporary Aguacate-Villaverde Bajo 220 kV line (>2026).

**I Drivers / Objectives:**

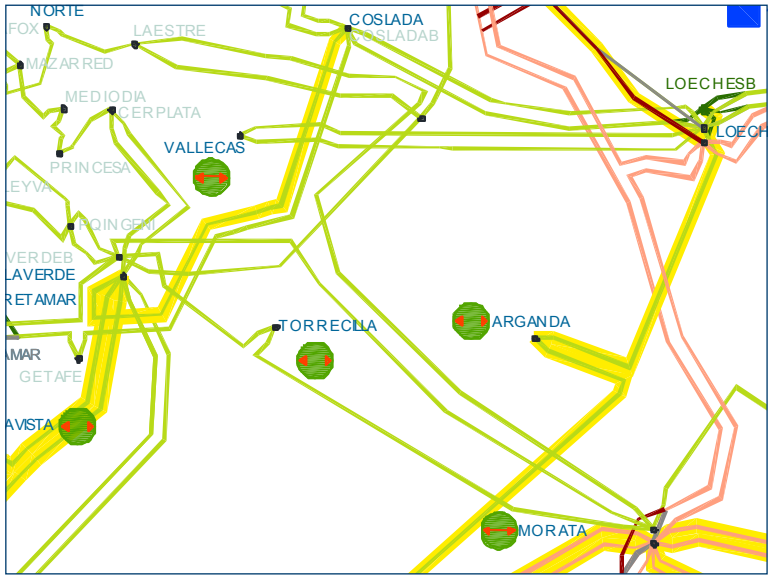
- These reinforcements allow the development of the transmission grid in urban areas while controlling short-circuit power and reducing flows on lines with potential overloads.
- Reducing the need to use technical constraints in the area to maintain security of supply.

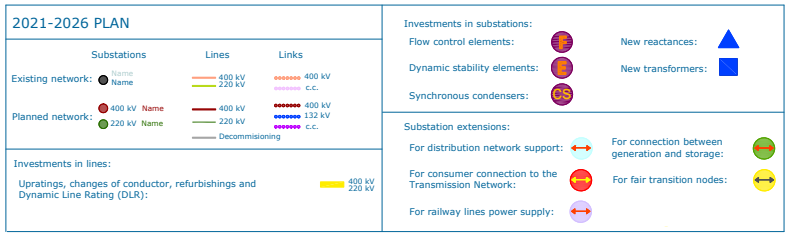
**I Alternatives:**

Potential alternatives involve the replacement of switchgear in numerous substations in the area so that they can withstand the short-circuit power values expected in the scenario studied. Additionally, new reinforcements have also been assessed in order to prevent potential overloads.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_CENTRO_Pcc
## Security of supply **Reliability of supply Madrid (Pcc)**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 6 M€ | 0.05 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

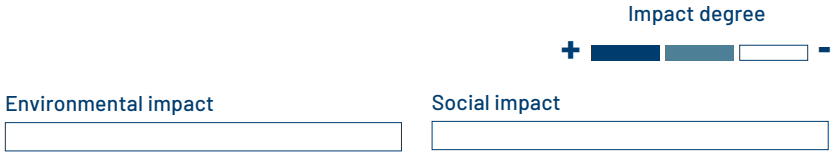
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

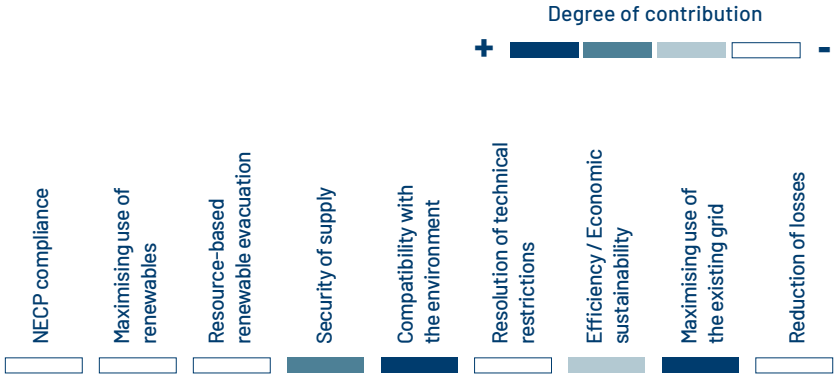
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement SdS_CENTRO_Pcc

## Security of supply **Reliability of supply Madrid (Pcc)**

### Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 2 | |
| Overhead line (km) | 0.6 | 1 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Loeches 220 kV | 2 | GIS | TN | 2024 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Loeches - Arganda kV, circuit 1[1] | 600 | 600 | 0.2 | Line | SoS | 2024 |
| Loeches - Coslada kV, circuit 1 | 315 | 315 | 0.2 | Line | SoS | 2024 |
| DC Loeches - José Cabrera kV | 580 | 320 | 0.1 | Line | SoS | 2024 |
| Moraleja - Morata 400 kV, circuit 1 | 1,270 | 750 | 0.5 | Line | SoS | 2024 |
| Morata - Belinchón 400 kV, circuit 1[2] | 2,057 | 1,686 | 0.5 | Line | SoS | 2024 |

Notes:
1. Expansion to make the double bus in Loeches 220 kV operable, further reinforcements in some lines.
2. Reinforcements are required on some lines to ensure that the bypass is operable.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_IBA_1
## Security of supply **Reinforcement of the southern network of Ibiza**

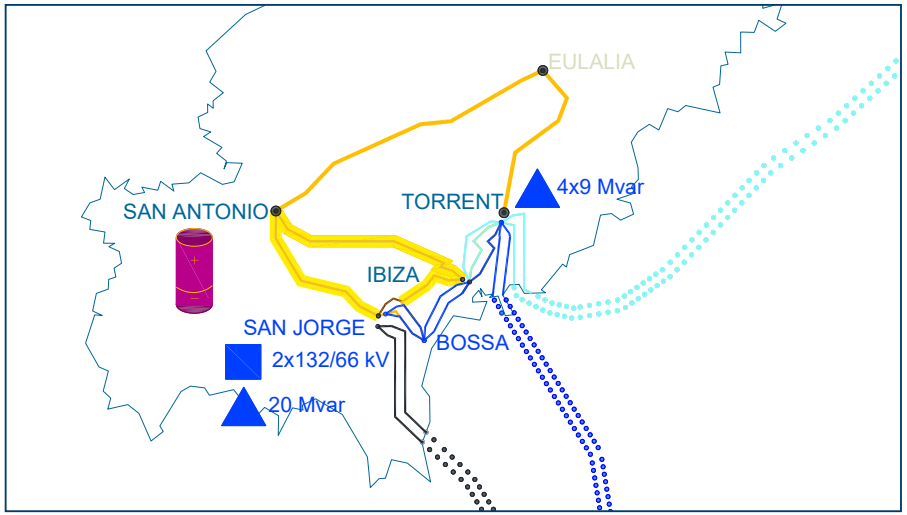
**I General description:** Upgrade the southern network of the island of Ibiza currently operated at 66 kV to 132 kV to improve the security of supply of the island and to create a new 132 kV axe, Torrent-Ibiza-Bossa-San Jorge.. The reinforcements also include repowering of the Ibiza-San Antonio, Ibiza-Bossa, and San Jorge-San Antonio 66 kV lines.

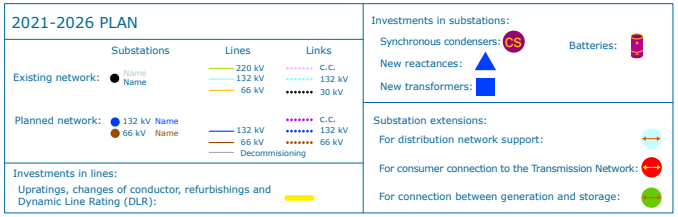
**I Drivers / Objectives:** Increasing security and quality of the supply in Ibiza.

**I Alternatives:** To resolve the current supply issue in the western part of Ibiza, various alternatives have been studied to reinforce the southern grid and increase the voltage to 132 kV in San Antonio, such as building a new double-circuit San Antonio-Torrent 132 kV substation via a new route and using the current San Antonio-Ibiza 66 kV substation route. Both alternatives are not viable due to great social opposition and environmental issues.

**I European dimension:** No

**I Map:**




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# I Reinforcement SdS_IBA_1
Security of supply **Reinforcement of the southern network of Ibiza**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 9.6 M€/year | Reduction of $CO_2$ emissions: -3 kt/year* |
| Additional RES integration: 1 MWh/year | Reduction of system losses: 2,440 MWh/year* |
| Reduction of ENS: 1,158 MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 31.6 M€ | 0.4 M€/year |

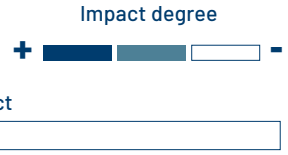
| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 3.0 | 2.9 | 2.9 | 2.8 | 2.8 | 2.7 | 2.7 | 2.6 | 2.6 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

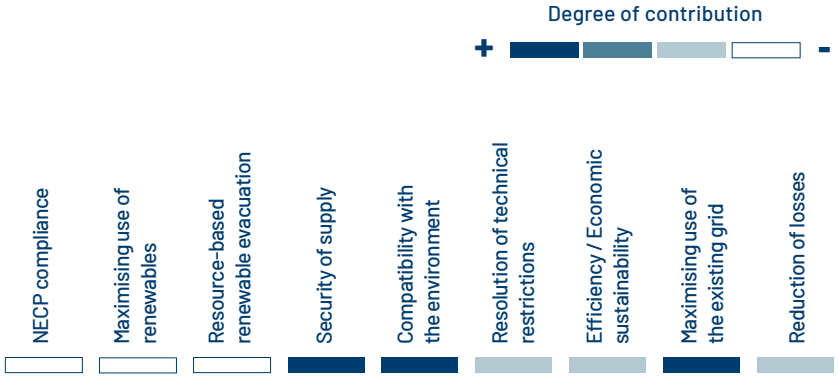
### I Profitability:

| Profitability: NPV |
|---|
| 148 M€ |

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement SdS_IBA_1
## Security of supply **Reinforcement of the southern network of Ibiza**

### I Table of physical units:

| | 66 kV | 132 kV |
|---|---|---|
| Bays (units) | 2 | 14 |
| Overhead line (km) | 0.1 | |
| Cables (km) | | 11 |
| Transformed to 66 kV (MVA) | | 160 |
| Uprating (km) | 24 | |
| DLR (km) | 20 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Bossa 132 kV | Building | 2021 |
| San Jorge 132 kV | Building | 2024 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Bossa 132 kV | 2 | GIS | SoS | 2021 |
| Ibiza 132 kV | 3 | GIS | SoS | 2024 |
| Ibiza 132 kV | 2 | GIS | SoS | 2020 |
| San Jorge 132 kV | 7 | GIS | SoS | 2024 |
| San Jorge 66 kV | 2 | AIS | SoS | 2024 |

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Bossa - San Jorge 132 kV [1] | 165 | 165 | 0.1 | Cable | SoS | 2024 |
| DC Ibiza - Bossa 132 kV | 165 | 165 | 5 | Cable | SoS | 2024 |
| Ibiza - Torrent 132 kV, circuit 2 | 165 | 165 | 0.3 | Cable | SoS | 2024 |
| Ibiza 23 - San Jorge 66 kV, circuit 1 | 80 | 80 | 0.1 | Line | SoS | 2024 |

Notes:
1. Change in voltage input/output in Bossa de Ibiza-San Jorge to 132 kV.

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Ibiza - San Antonio 66 kV, circuit 1 | 96 | 83 | 10 | Line | SoS | 2022 |
| Ibiza 23 - Bossa 66 kV, circuit 1 | 96 | 83 | 6 | Line | SoS | 2022 |
| San Antonio - San Jorge 66 kV, circuit 1 | 98 | 85 | 7 | Line | SoS | 2020 |

| Dynamic Line Rating | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|
| Ibiza - Bossa 66 kV, circuit 1 | 9 | Line | SoS | 2023 |
| Ibiza - San Antonio 66 kV, circuit 1 | 10 | Line | SoS | 2022 |

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| San Jorge 132/66 kV, TF1 | 80 | Triph. B. | SoS | 2024 |
| San Jorge 132/66 kV, TF2 | 80 | Triph. B. | SoS | 2024 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement SdS_IBA_2
## Security of supply **Dynamic Line Rating at Llucmajor-Orlandis 66 kV**

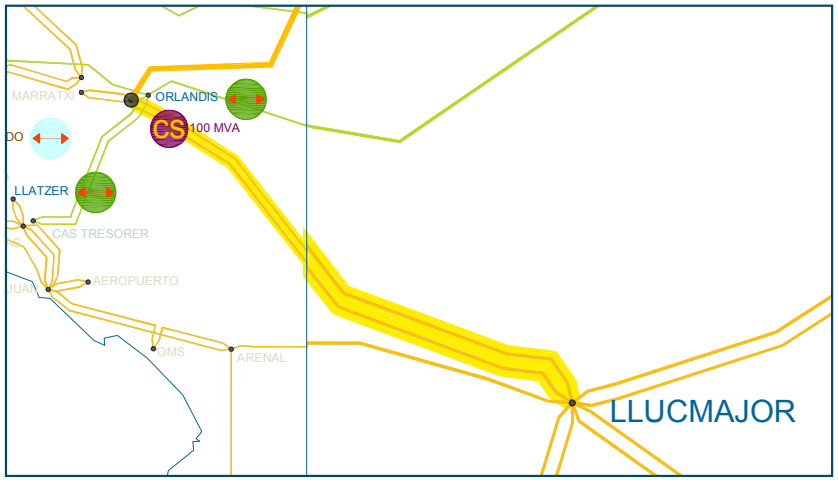
**I General description:** The reinforcements consist of installing a dynamic capacity monitoring system (Dynamic-Line-Rating - DLR) in the Llucmajor-Orlandis 66 kV double circuit.

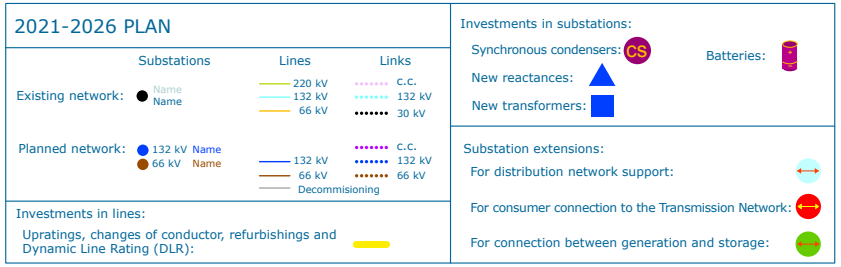
**I Drivers / Objectives:** Increasing security and quality of the supply in eastern Mallorca.

**I Alternatives:** Solutions that involve repowering the existing axis or replacing it for a different 220 kV axis come at a greater economic and environmental cost.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_IBA_2
## Security of supply **Dynamic Line Rating at Llucmajor-Orlandis 66 kV**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 0.6 M€ | 0.01 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

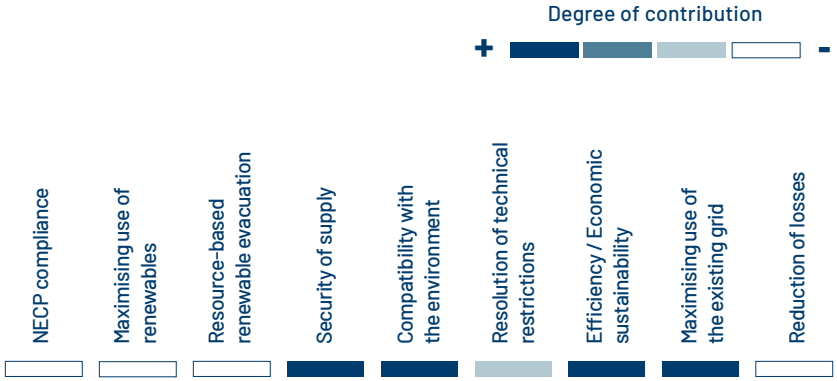
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement SdS_IBA_2
## Security of supply **Dynamic Line Rating at Llucmajor-Orlandis 66 kV**

### I Table of physical units:

| | 66 kV |
|---|---|
| DLR (km) | 36 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| Dynamic Line Rating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Llucmajor - Son Orlandis 66 kV, circuit 1 | 45 | 30 | 18 | Line | SoS | 2023 |
| Llucmajor - Son Orlandis 66 kV, circuit 2 | 45 | 30 | 18 | Line | SoS | 2023 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_ICA_1
## Security of supply **Reinforcement of Tenerife West Ring**

**I General description:**

The reinforcements proposed allow for reinforcement of the 66 kV ring in the west of the island in order to power a high-consumption area which currently presents overloads, and it is expected to grow. The entirety of the reinforcements include the following:

- New Drago 66 kV substation.
- New double circuit line-cable in Chío-Drago 66 kV.
- Input-output in Drago 66 kV of the Icod de los Vinos-Realejos/Icod de los Vinos-Cuesta Villa 66 kV double circuit.
- Third circuit in Los Olivos-Los Vallitos 66 kV.

**I Drivers / Objectives:**

- Eliminating the need for restricted connection of Guía de Isora 66 kV groups due to technical constraints to prevent overloads in the area.
- Allowing for adequate supply to La Gomera via the proposed Tenerife-La Gomera link.
- Improving security of supply in Tenerife, sustaining supply in the north of the island in the event of contingencies in the north-south axis between Granadilla and Caletillas/Candelaria.
- The values in the cost-benefit analysis indicators shown do not take into account commissioning of the Tenerife-La Gomera link.

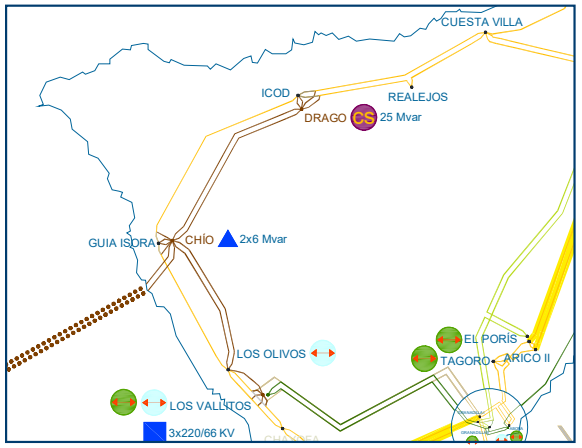
**I Alternatives:**

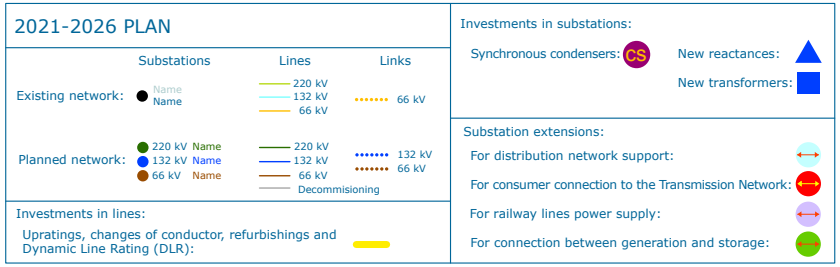
Currently, the alternative is the technically restricted connection of the Guía de Isora gas turbines. As alternatives for grid development, reinforcement of the northern section of the 220 kV grid up to Cuesta Villa, with a greater cost and social and environmental impact.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_ICA_1
## Security of supply **Reinforcement of Tenerife West Ring**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 29.9 M€/year | Reduction of $CO_2$ emissions: 64 kt/year* |
| Additional RES integration: 85,516 MWh/year | Reduction of system losses: -2,916 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 52.6 M€ | 0.33 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 4.6 | 4.5 | 4.4 | 4.4 | 4.3 | 4.2 | 4.1 | 4.1 | 4.0 |

Note: for the Tenerife-La Gomera system, a sequential cost-benefit analysis methodology was used. Firstly, the incorporation of synchronous compensators is analysed. Then, there is an assessment of the benefit of the rest of the scheduled reinforcements except for the TF-LG link, for which the benefit is analysed at a later stage considering the rest of the commissioning reinforcements.

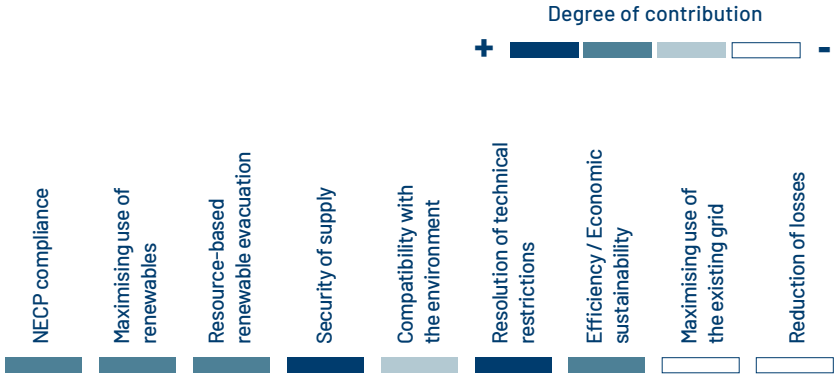
### I Profitability:

| Profitability: NPV |
|---|
| 530 M€ |

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement SdS_ICA_1
## Security of supply **Reinforcement of Tenerife West Ring**

### I Table of physical units:

| | 66 kV |
|---|---|
| Bays (units) | 13 |
| Overhead line (km) | 50 |
| Cables (km) | 30 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Drago 66 kV [1] | Building | 2023 |

Notes:
1. Previously called Nueva Icod de Los Vinos 66 kV.

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Chío 66 kV | 2 | GIS | TN | 2023 |
| Drago 66 kV | 7 | GIS | TN | 2023 |
| Los Olivos 66 kV | 2 | AIS | TN | 2025 |
| Vallitos 66 kV | 2 | GIS | TN | 2020 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Chío - Drago 66 kV [1] | 76 | 76 | 22 | Line | SoS | 2023 |
| DC Chío - Drago 66 kV | 80 | 80 | 0.3 | Cable | SoS | 2023 |
| I/O in Drago, of Icod de Los Vinos - Cuesta de La Villa 66 kV, circuit 1 | 64.5 | 64.5 | 6 | Cable | SoS | 2023 |
| I/O in Drago, of Icod de Los Vinos - Los Realejos 66 kV, circuit 1 | 64.5 | 64.5 | 6 | Cable | SoS | 2023 |
| Vallitos - Los Olivos 66 kV, circuit 3 | 66 | 66 | 6 | Cable | SoS | 2025 |
| Vallitos - Los Olivos 66 kV, circuit 3 | 66 | 66 | 6 | Line | SoS | 2025 |

Notes:
1. Decommissioning of the Guía de Isora-Icod de los Vinos 66kV line.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_ICA_2
## Security of supply **Reinforcement of La Palma network**

**I General description:**

The proposed reinforcements allow for reinforcement of the transmission in La Palma, which currently consists of a single circuit, with the goal of improving security and quality of supply. Specifically, the entirety of the reinforcements include the following:

- New Las Breñas 66 kV substation, with input-output in Las Breñas on the Valle de Aridane-Los Guinchos 66 kV line.
- New Las Breñas-Los Guinchos 2 66 kV line.
- New Las Breñas-Valle de Aridane 2 66 kV line.
- New Fuencaliente 66 kV substation, with I/O on the Las Breñas-Valle de Aridane 2 line.

**I Drivers / Objectives:**

Improving security and quality of the supply in La Palma. In the future, these reinforcements will allow for the connection of renewable energy in the south of the island.

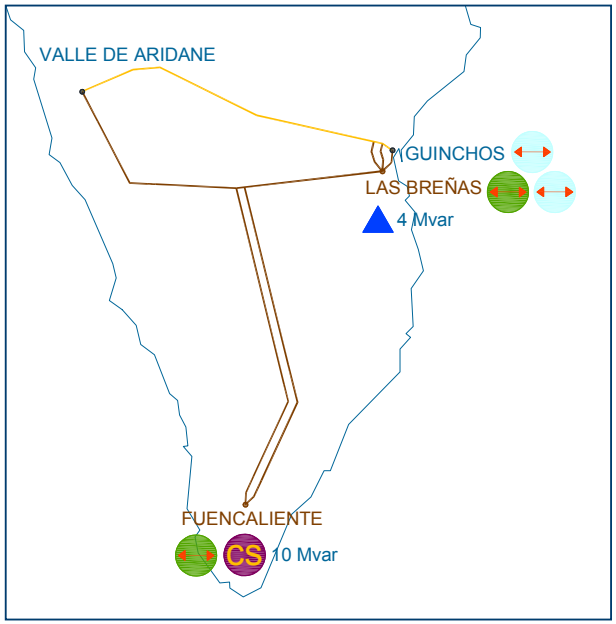
**I Alternatives:**

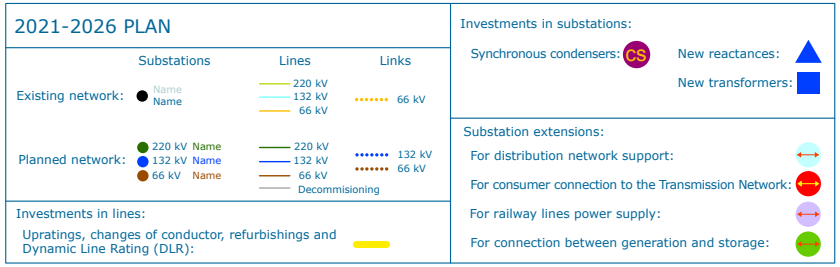
As there is just a single connected generation point on the island, the option of an additional power supply point in the west of the island is required in order to prevent power cuts in the event of faults or maintenance on the existing line.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_ICA_2
## Security of supply **Reinforcement of La Palma network**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 6.2 M€/year | Reduction of $CO_2$ emissions: 42 kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: 719 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 39 M€ | 0.33 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 3.5 | 3.4 | 3.4 | 3.3 | 3.3 | 3.2 | 3.2 | 3.1 | 3.0 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

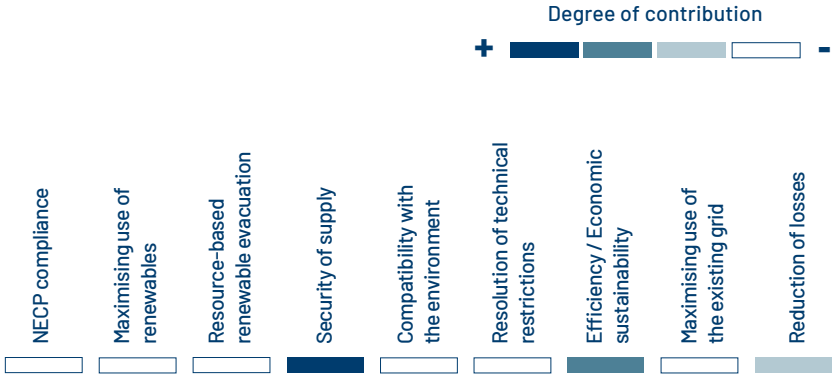
### I Profitability:

| Profitability: NPV |
|---|
| 72 M€ |

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement SdS_ICA_2
## Security of supply **Reinforcement of La Palma network**

### I Table of physical units:

| | 66 kV |
|---|---|
| Bays (units) | 11 |
| Overhead line (km) | 21 |
| Cables (km) | 14 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Las Breñas 66 kV | Building | 2025 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Las Breñas 66 kV | 1 | GIS | SuD | 2025 |
| Las Breñas 66 kV | 8 | GIS | TN | 2025 |
| Los Guinchos 66 kV | 1 | AIS | TN | 2025 |
| Valle de Aridane 66 kV | 1 | AIS | TN | 2025 |

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Las Breñas, of Valle de Aridane - Los Guinchos 66 kV, circuit 1 | 80 | 80 | 0.5 | Cable | SoS | 2025 |
| Las Breñas - Las Breñas 66 kV [1] | | | 1 SSC | Cable | SuD | 2025 |
| Las Breñas - Los Guinchos 66 kV, circuit 1 | 65 | 65 | 2 | Line | SoS | 2025 |
| Las Breñas - Los Guinchos 66 kV, circuit 2 [2] | 40 | 40 | 0.5 | Cable | SoS | 2025 |
| Las Breñas - Los Guinchos 66 kV, circuit 2 [3] | 60 | 60 | 2 | Line | SoS | 2025 |
| Las Breñas - Valle de Aridane 66 kV, circuit 1 | 65 | 65 | 0.5 | Line | SoS | 2025 |
| Las Breñas - Valle de Aridane 66 kV, circuit 2 | 80 | 80 | 15 | Line | SoS | 2025 |
| Las Breñas - Valle de Aridane 66 kV, circuit 2 | 80 | 80 | 12 | Cable | SoS | 2025 |
| I/O in Las Breñas, of Valle de Aridane - Los Guinchos 66 kV, circuit 1 | 65 | 65 | 0.5 | Line | SoS | 2025 |

Notes:
1. Short section of cable inside the substation.
2. Section line capacity for this new cable route is 85/85.
3. Section line capacity for section of overhead line 80/80 (in line with subsequent repowering).

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_ISLAS

## Security of supply **Increased security of supply in non-peninsular systems**

**I General description:**

In order to increase security of supply in the Balearic and Islas Canarias systems, the inclusion of a new reactance in Tías 66 kV is being considered, as well as configuration changes including busbar partitioning and new coupling switches in the following 66 kV substations with a single busbar configuration:

- Fuerteventura: Corralejo, Gran Tarajal, and Matas Blancas.
- Lanzarote: Macher.
- Gran Canaria: Telde and San Agustín.
- Mallorca: Cala Millor and Bunyola.

**I Drivers / Objectives:**

Increasing supply reliability in the Balearic and Islas Canarias' systems.

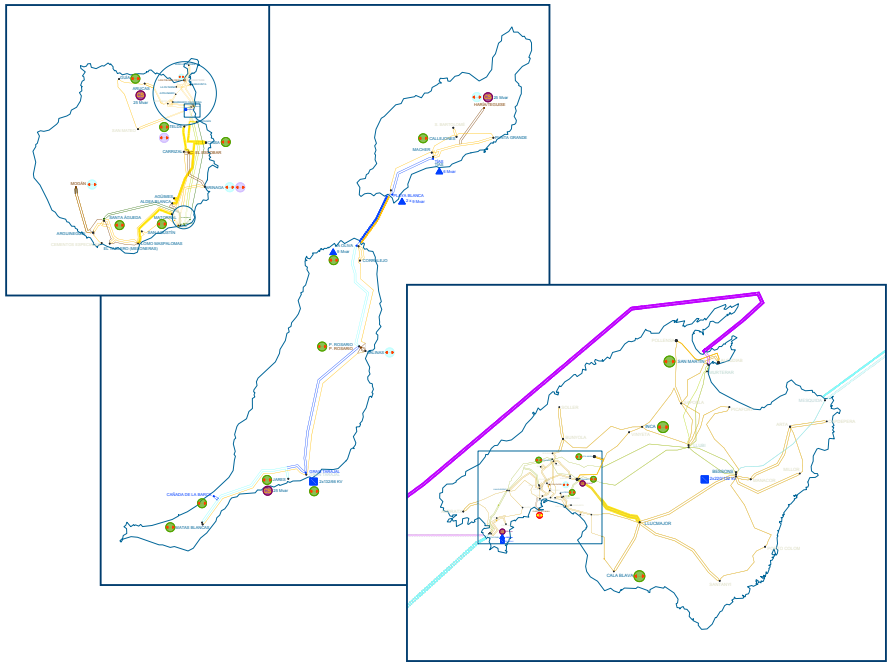
**I Alternatives:**

The alternative to the proposed reinforcements consists of planning new substations with a double busbar configuration with coupling resulting in greater environmental impact and reinforcements.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_ISLAS

Security of supply **Increased security of supply in non-peninsular systems**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 12.5 M€ | 0.25 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:




Environmental impact

Social impact

### I Contribution to guiding principles:







Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_ISLAS

## Security of supply **Increased security of supply in non-peninsular systems**

### I Table of physical units:

| | 66 kV |
|---|---|
| Bays (units) | 9 |
| Cables (km) | 0.8 |
| Reactance (Mvar) | 6 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Bunyola 66 kV [1,4] | 1 | AIS | TN | 2022 |
| Cala Millor 66 kV | 1 | AIS | TN | 2025 |
| Corralejo 66 kV [2] | 1 | AIS | TN | 2022 |
| Macher 66 kV [1] | 1 | AIS | TN | 2023 |
| Matas Blancas 66 kV [1] | 1 | AIS | TN | 2022 |
| San Agustín (Gran Canaria) 66 kV [1,3] | 2 | AIS | TN | 2023 |
| Telde 66 kV [1] | 1 | AIS | TN | 2023 |
| Tías 66 kV | 1 | GIS | TN | 2023 |

Notes:
1. Busbar partitioning and longitudinal coupling is required.
2. Busbar partitioning and longitudinal coupling is required (associated with the connection of the D/C Corralejo-Los Olivos 66 kV).
3. Additional bays required to adjust to the Operational Procedure (O.P.)
4. Adjustment of the connection bays to Vall de Soller.

### I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Bunyola - Bunyola 66 kV [1] | | | 1 SSC | Cable | TN | 2022 |
| Macher - Macher 66 kV [1] | | | 1 SSC | Cable | TN | 2023 |
| San Agustín (Gran Canaria) - San Agustín (Gran Canaria) 66 kV, circuit [1] | | | 1 SSC | Cable | TN | 2023 |
| Gran Tarajal - Gran Tarajal 66 kV [2] | | | 2 SSC | Cable | SoS | 2023 |

Notes:
1. Short section of cable inside the substation.
2. Short sections of cable inside the substation.

| New reactances | MVAr | Type | Driv. | Year |
|---|---|---|---|---|
| Tías 66 kV, REA4 | 6 | - | SoS | 2023 |

| New adjustments to OP | Year |
|---|---|
| Bunyola 66 kV [1] | 2026 |
| Cala Millor 66 kV [1] | 2025 |
| Corralejo 66 kV [1] | 2024 |
| Macher 66 kV [1] | 2023 |
| Matas Blancas 66 kV [1] | 2025 |

Notes:
1. Additional assets required to adjust to the O.P.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_N_ESTE
## Security of supply **Refurbishment of Cinca 220 kV**

**I General description:**

These reinforcements consist of adjusting the configuration of Cinca 220 kV substation to the OP and creating a second power supply.

- Change in configuration of the Cinca 220 kV substation to a double busbar.
- New I/O in Cinca, on the Monzón - Mequinenza 220 kV line, circuit 1.

**I Drivers / Objectives:**

Increasing security of supply in the area by implementing a change in configuration, installing a 2nd 220/132 kV unit to support distribution and substation meshing.

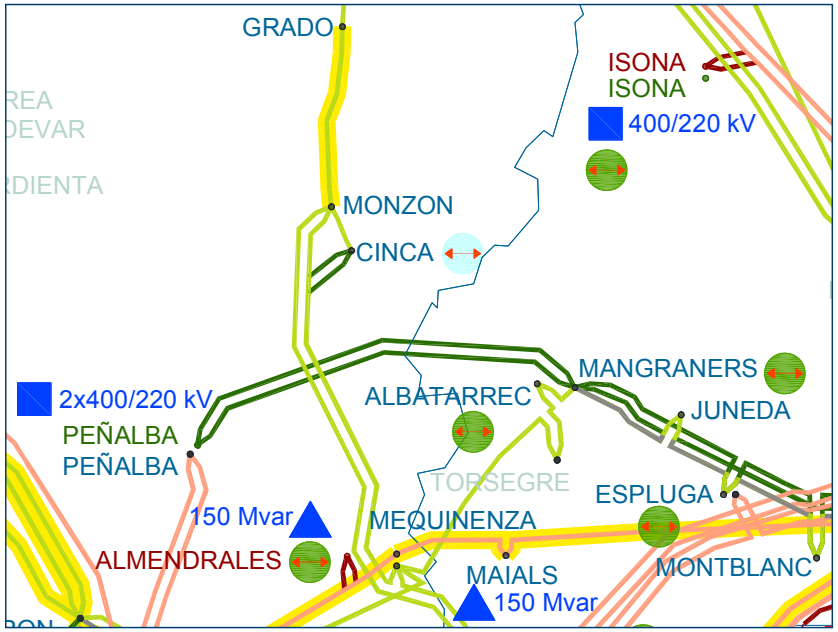
**I Alternatives:**

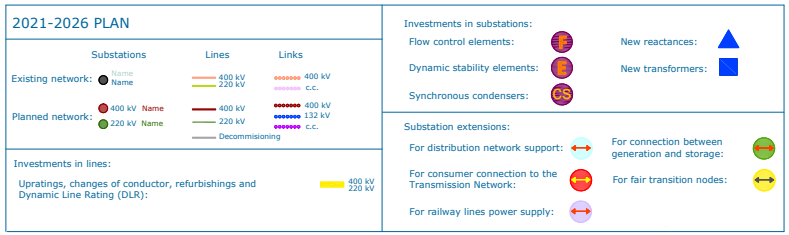
The alternative to these reinforcements would be the construction of a new, nearby substation as per the OP but with a greater reinforcements value. The alternative to the second power supply in Cinca 220 kV analysed consisted of building a second power supply from the Monzón 220 kV substation. However, the expansion required in Monzón was at high risk of being inviable.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_N_ESTE
Security of supply **Refurbishment of Cinca 220 kV**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

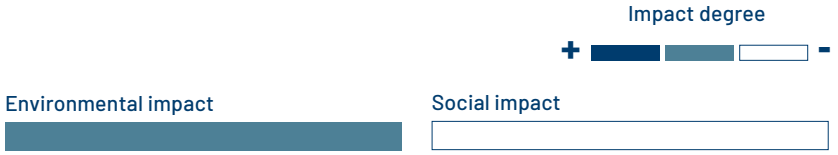
Note: * a negative value means existing increased emissions, losses or ENS.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:



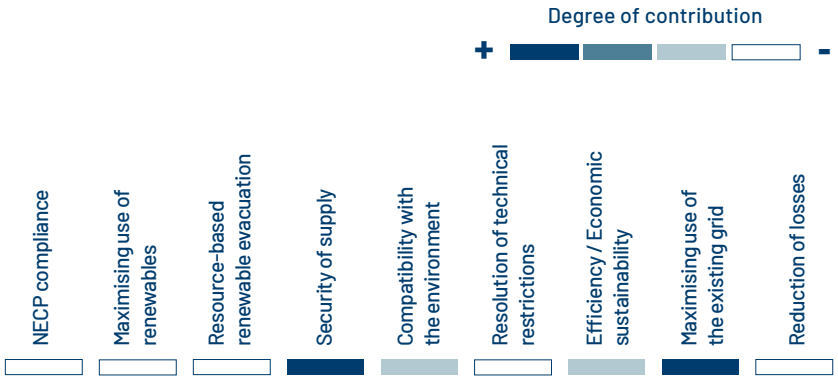

### I Costs:

| CAPEX | OPEX |
|---|---|
| 8.1 M€ | 0.09 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement SdS_N_ESTE
## Security of supply **Refurbishment of Cinca 220 kV**

### I Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 4 |
| Overhead line (km) | 18 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Cinca 220 kV | 2 | GIS | TN | 2024 |
| Cinca 220 kV | 2 | GIS | TN | 2026 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Cinca, of Monzón - Mequinenza 220 kV, circuit 1[1] | 310 | 250 | 9 | Line | SoS | 2026 |

Note:
1. Section line capacity in DC for I/O 870/720 MVA.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_N_ESTE_Pcc
## Security of supply **Topological modification in Gramanet (Pcc)**

**I General description:**

These reinforcements consist of changing the double circuit connection between Rubi - Gramanet B 220 kV within the Gramanet double bus to connect it to the busbars in Gramanet A and repowering of Collblanc-BeguesB 1 and 2 220 kV.

**I Drivers / Objectives:**

- Increasing supply quality and security in the area.
- Reducing the need to use technical constraints in the area.

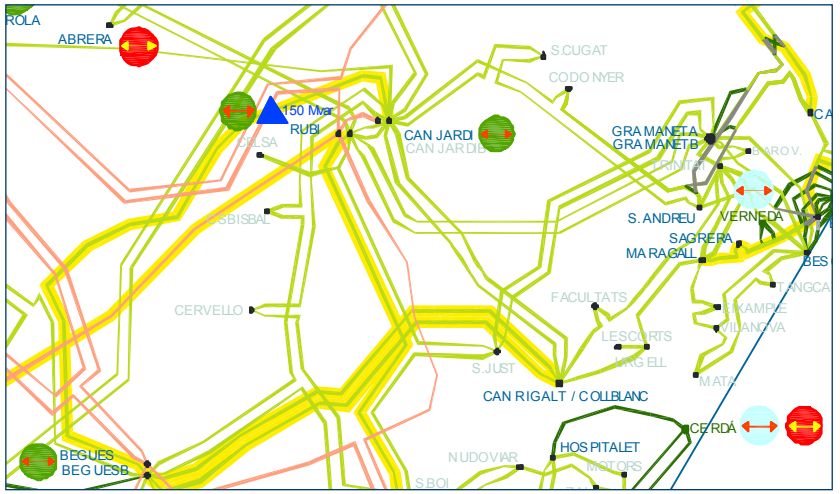
**I Alternatives:**

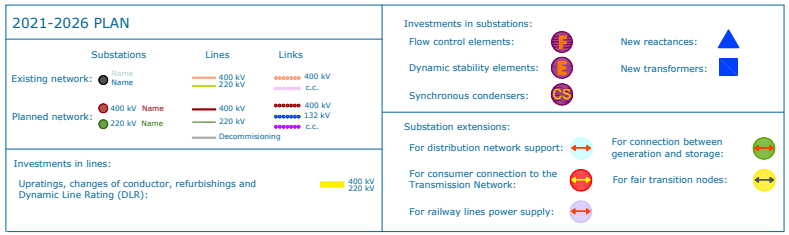
The alternative to these reinforcements that was analysed consists of building a new Gramanet 400 kV substation, but this would involve a greater social and environmental impact and a greater reinforcements value.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_N_ESTE_Pcc
Security of supply **Topological modification in Gramanet (Pcc)**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 5 M€/year | Reduction of $CO_2$ emissions: 0 kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: 1,602 MWh/year* |
| Reduction of ENS: 742 MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 8.9 M€ | 0.03 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

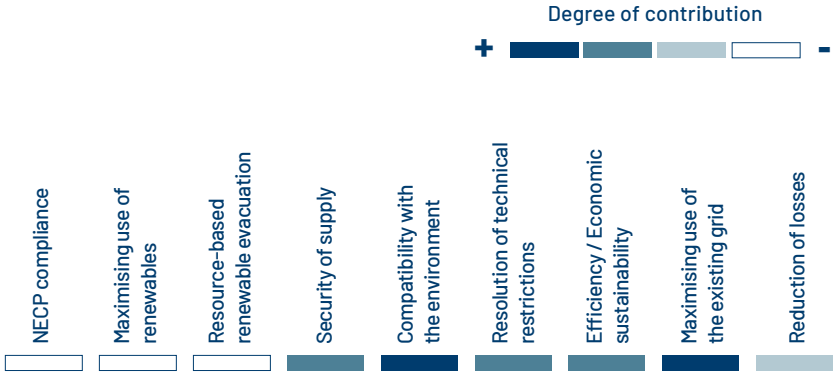
Profitability: NPV

88 M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement SdS_N_ESTE_Pcc
## Security of supply **Topological modification in Gramanet (Pcc)**

### I Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 1 |
| Line (km) | 0.8 |
| Cables (km) | 1 |
| Uprating (km) | 42 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Gramanet 220 kV [1] | 1 | GIS | TN | 2020 |

Notes:
1. Relocation of DC Rubí-Gramanet B to Gramanet A.

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Rubí - Gramanet 220 kV [1] | 500 | 430 | 0.4 | Cable | SoS | 2022 |
| Gramanet - Gramanet 220 kV, circuit 1 [2] | 500 | 430 | 1 SSC | Cable | SoS | 2022 |
| DC Gramanet - Gramanet 220 kV [2] | 440 | 390 | 1 SSL | Line | SoS | 2022 |

Notes:
1. Relocation of DC Rubí-Gramanet B to Gramanet A.
2. Short section of cable inside the substation.

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Collblanc - Begues 220 kV, circuit 1 [1] | 630 | 550 | 21 | Line | SoS | 2022 |
| Collblanc - Begues 220 kV, circuit 21 | 630 | 550 | 21 | Line | SoS | 2022 |

Notes:
1. Uprating of the overhead section to 85º.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_N_OESTE
## Security of supply **New Substation Abades 400 kV (Formerly Herreros)**

**I General description:**

These reinforcements consist of combining Tordesillas with Madrid 400 kV, including the following:

- New Abades 400 kV substation in I/O in the Tordesillas- La Cereal 400 kV line.
- New Abades 220 kV substation.
- New transformer 1 in Abades 400/220 kV.
- New Abades-Otero 220 kV line.
- New Tordesillas-Las Arroyadas 220 kV line.

**I Drivers / Objectives:**

- Increasing security and quality of the supply in the area of Madrid.
- Increasing integration of existing and future renewable energy generation in the area.
- Providing train power supply in Otero de Herreros 220 kV.

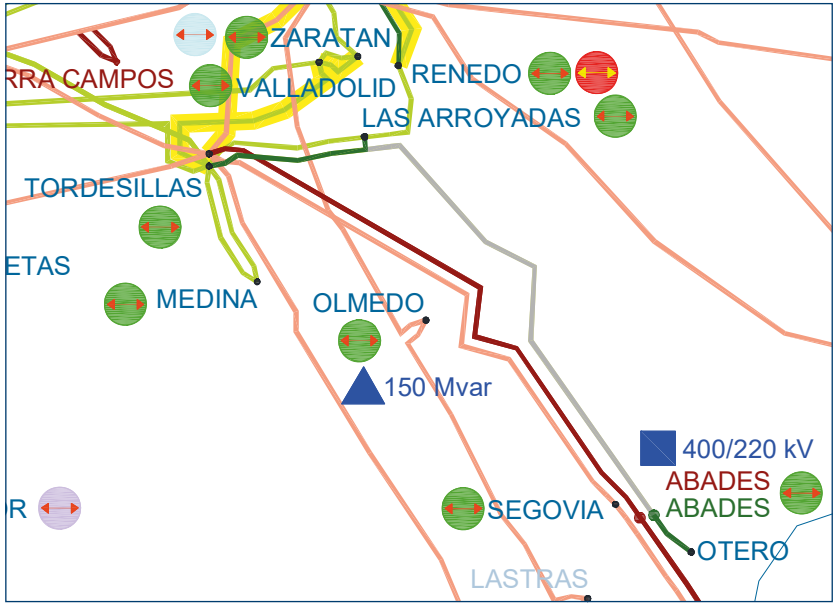
**I Alternatives:**

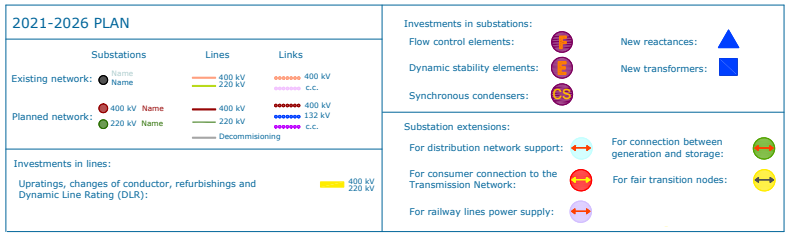
Solutions that involve new transmission substations in the area of Otero entail a greater risk of environmental inviability.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_N_OESTE
## Security of supply **New Substation Abades 400 kV (Formerly Herreros)**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 35.8 M€ | 0.47 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 3.4 | 3.3 | 3.3 | 3.2 | 3.2 | 3.1 | 3.1 | 3.0 | 3.0 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

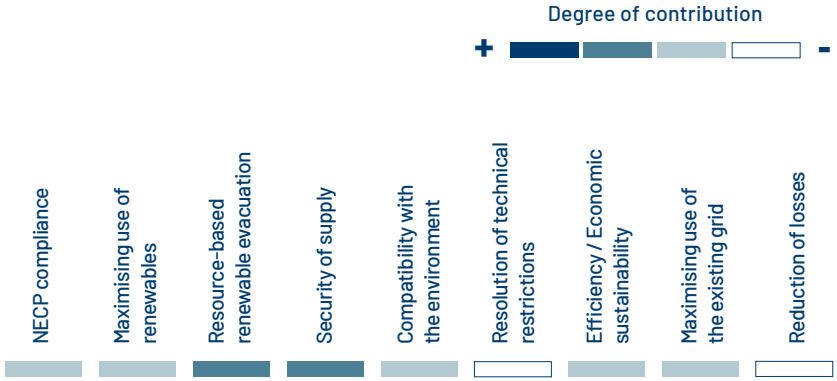
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement SdS_N_OESTE
## Security of supply **New Substation Abades 400 kV (Formerly Herreros)**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 4 | 5 |
| Overhead line (km) | 13 | 2 |
| Transformed to 220 kV (MVA) | | 600 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Abades 220 kV [1] | Outdoor | 2024 |
| Abades 400 kV [2] | Outdoor | 2024 |

Notes:
1. Former SE Herreros 220 kV.
2. Former SE Herreros 400 kV.

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Abades 220 kV | 3 | AIS | TN | 2024 |
| Abades 400 kV | 5 | AIS | TN | 2024 |
| Las Arroyadas 220 kV | 1 | GIS | TN | 2024 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Abades, of Tordesillas - La Cereal 400 kV, circuit 1 | 2,420 | 2,020 | 1 | Line | SoS | 2024 |
| Las Arroyadas - Tordesillas 220 kV, circuit 2 | 491 | 411 | 0.1 | Line | SoS | 2024 |
| Otero - Abades 220 kV, circuit 1 [1] | 363 | 239 | 13 | Line | SoS | 2024 |

Notes:
1. Requires compaction of a 10 km route with the existing DC La Cereal-Segovia 400 kV and Tordesillas-Otero 220 kV.

| New transformers | MVA | Type | Driv. | Year |
|---|---|---|---|---|
| Abades 400/220 kV, TF1 | 600 | Triph. B. | SoS | 2024 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_SUR_1

## Security of supply **Supply reinforcement in Huelva (Costa de la Luz)**

**I General description:**

Reinforce the power supply to the demand located in the Pyrite Belt, in Huelva:

- New double circuit Puebla de Guzmán-Costa de la Luz 220 kV.

**I Drivers / Objectives:**

- Increasing security and quality of the supply in the area of Huelva.
- Complying with operational procedures in terms of the meshing required in Puebla de Guzmán 220 kV.

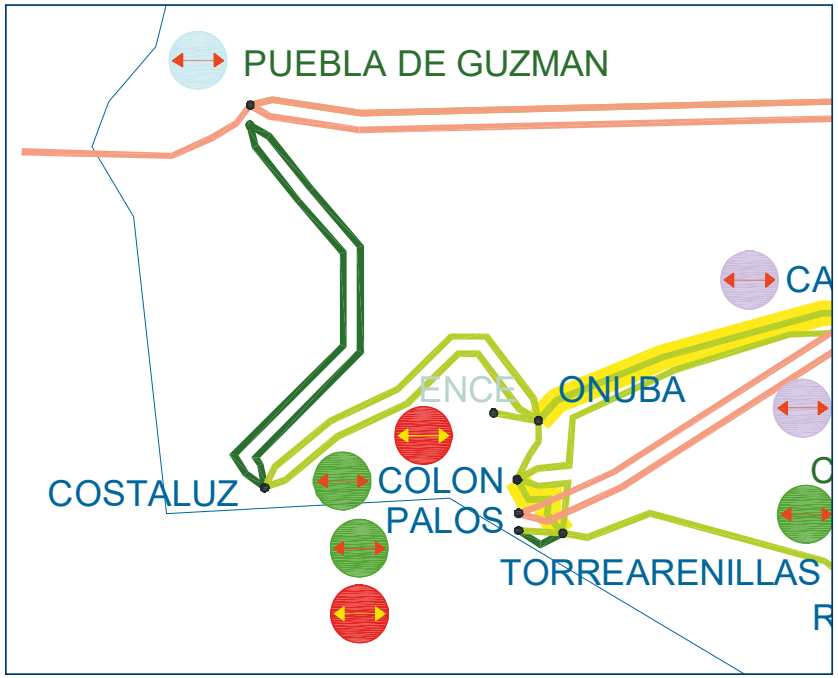
**I Alternatives:**

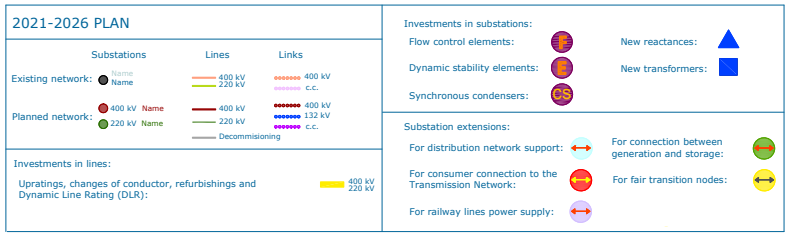
Operational solutions, DLR, repowering of the existing 220 kV axis, and increasing the capacity do not resolve the area's issues given that new connections are required in the Costa de la Luz and Puebla de Guzmán 220 kV substations. For the former, this will guarantee security of supply in the area and for the latter, this will ensure that the distribution network is powered via the substation meshing.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_SUR_1
Security of supply **Supply reinforcement in Huelva (Costa de la Luz)**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 26.6 M€ | 0.2 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 2.3 | 2.3 | 2.3 | 2.2 | 2.2 | 2.2 | 2.1 | 2.1 | 2.0 |

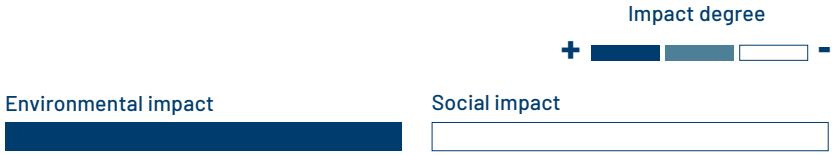
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

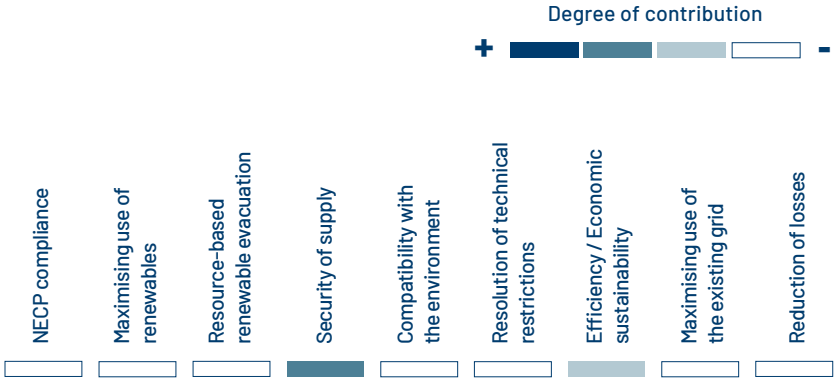
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# Reinforcement SdS_SUR_1

## Security of supply **Supply reinforcement in Huelva (Costa de la Luz)**

### Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 4 |
| Overhead line (km) | 74 |
| Cables (km) | 0.4 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Costa de La Luz 220 kV | 2 | GIS | TN | 2025 |
| Puebla de Guzmán 220 kV | 2 | AIS | TN | 2025 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Costa de La Luz - Puebla de Guzmán 220 kV | 850 | 720 | 0.2 | Cable | SoS | 2025 |
| DC Costa de La Luz - Puebla de Guzmán 220 kV | 850 | 720 | 37 | Line | SoS | 2025 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_SUR_2
## Security of supply **Puerto de Santa María 220 kV**

**I General description:**

Reinforcing the power supply to the Puerto de Santa María 220 kV substation:

- New Puerto Real-Cartuja and Puerto Real-Puerto de Santa María 220 kV circuits.

**I Drivers / Objectives:**

- Increasing security and quality of the supply in the area of Puerto de Santa María, currently connected to the system via a single 220 kV circuit.
- Complying with operational procedures in terms of the meshing required in Puerto de Santa María 220 kV.

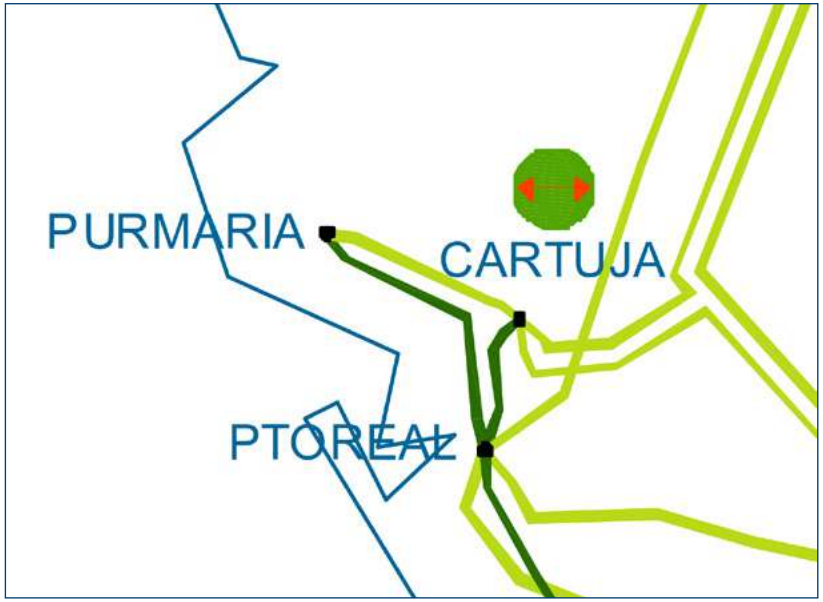
**I Alternatives:**

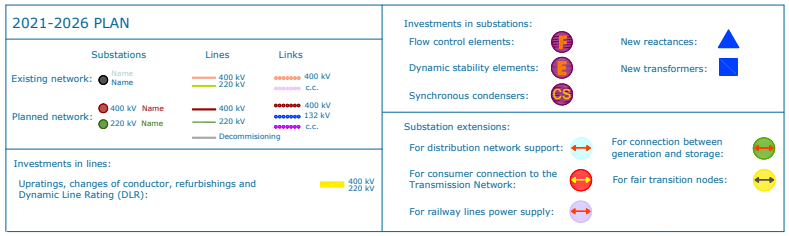
The meshing required can only be implemented through these reinforcements.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_SUR_2
## Security of supply **Puerto de Santa María 220 kV**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 13.1 M€ | 0.23 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

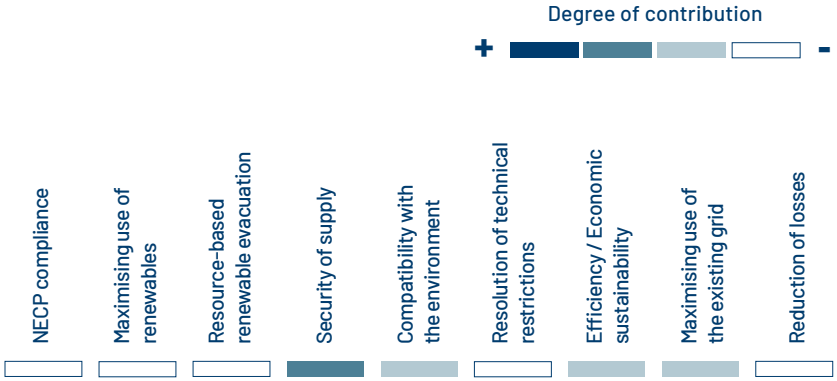
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement SdS_SUR_2
## Security of supply **Puerto de Santa María 220 kV**

### I Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 5 |
| Overhead line (km) | 36 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Cartuja 220 kV | 1 | AIS | TN | 2024 |
| Puerto de Santa María 220 kV | 1 | AIS | TN | 2024 |
| Puerto Real 220 kV | 3 | AIS | TN | 2024 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Puerto Real - Cartuja 220 kV | 840 | 720 | 18 | Line | SoS | 2024 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_SUR_3
## Security of supply **Reliability of supply in Saleres**

**I General description:**

These reinforcements consist of doubling the existing 220 kV axis between the city of Granada and Órgiva:

- New Saleres 220 kV substation in I/O on the Gabias-Órgiva 220 kV line.
- New Illora-Saleres 220 kV line (double circuit).

**I Drivers / Objectives:**

- Increasing the quality and security of electricity supply in substations dependent on the 220 kV axis between Caparacena and Tabernas.
- Providing a meshed connection point to the area supporting the distribution network.
- Enabling the connection of new renewable generation with grid access granted.

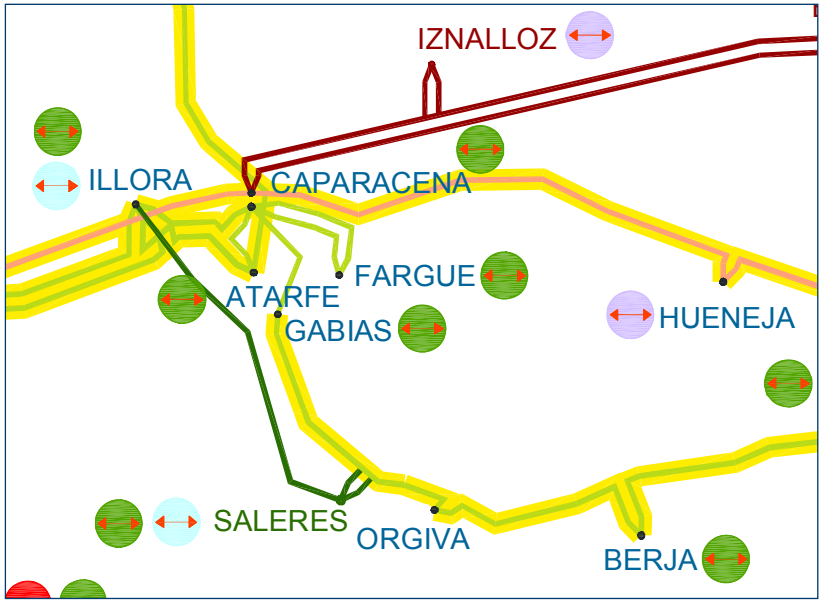
**I Alternatives:**

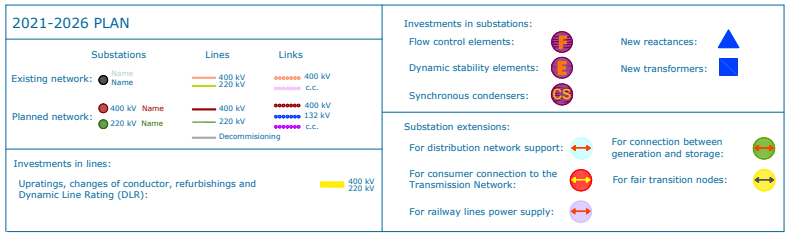
These reinforcements represent an alternative to the development of the transmission grid as outlined in the 2015-2020 Transmission network development plan, and they allow the transmission grid to be adapted to the needs identified in the area within the new plan's time frame via a solution with less environmental and social impact.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_SUR_3
## Security of supply **Reliability of supply in Saleres**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 26.5 M€ | 0.2 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 2.3 | 2.3 | 2.3 | 2.2 | 2.2 | 2.2 | 2.1 | 2.1 | 2.1 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

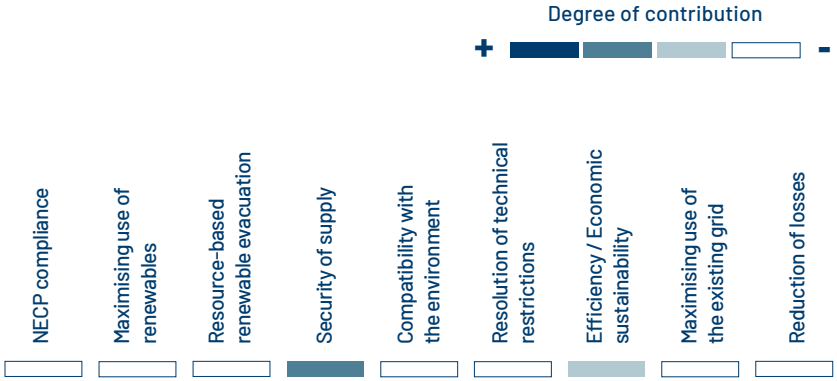
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement SdS_SUR_3
## Security of supply **Reliability of supply in Saleres**

### I Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 5 |
| Overhead line (km) | 56 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Saleres 220 kV | Outdoor | 2024 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Íllora 220 kV | 1 | AIS | TN | 2025 |
| Saleres 220 kV | 3 | AIS | TN | 2024 |
| Saleres 220 kV | 1 | AIS | TN | 2025 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Íllora - Saleres 220 kV [1] | 890 | 720 | 48 | Line | SoS | 2025 |
| I/O in Saleres, of Gabias - Órgiva 220 kV, circuit 1 [2] | 430 | 350 | 4 | Line | SoS | 2024 |

Notes:
1. Double circuit with first circuit laid.
2. Section line capacity in DC for I/O 880/710 MVA.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_SUR_Pcc
## Security of supply **Double bus in Don Rodrigo**

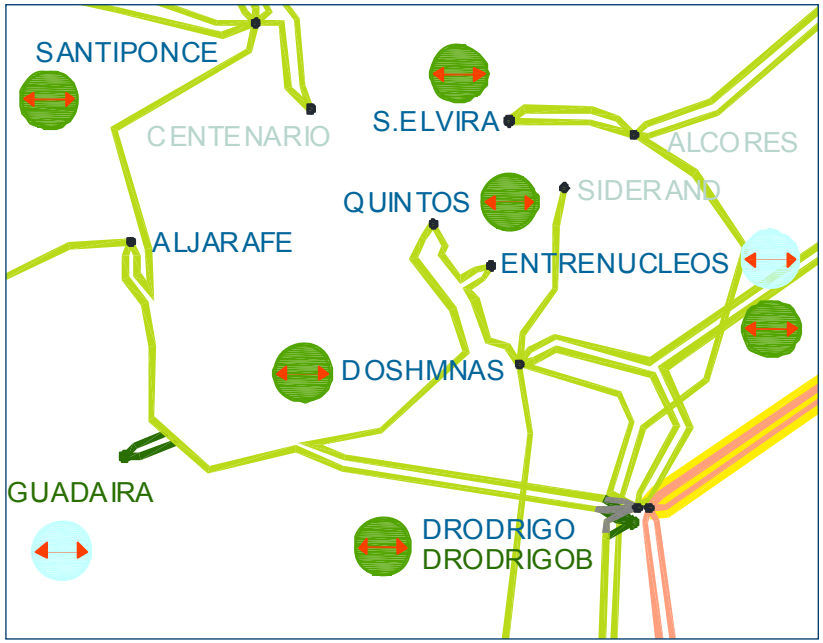
**I General description:** New double bus in the Don Rodrigo 220 kV substation with two longitudinal couplings.

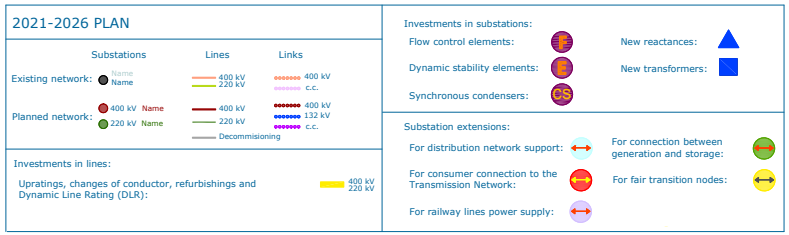
**I Drivers / Objectives:** Current and anticipated future generation in the vicinity of the city of Sevilla makes this double bus necessary to reduce the short circuit power in the area, thus increasing transmission grid reliability.

**I Alternatives:** The alternative would consist of replacing the switchgear with one that allows higher short circuit currents in numerous substations in the area, for which reason the reinforcements cost would be much greater.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement SdS_SUR_Pcc
Security of supply **Double bus in Don Rodrigo**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

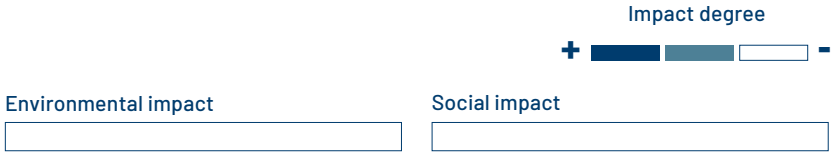
Note: * a negative value means existing increased emissions, losses or ENS.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:



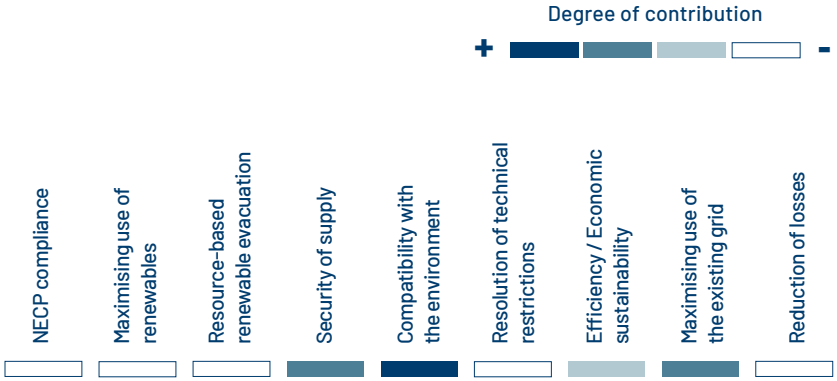

### I Costs:

| CAPEX | OPEX |
|---|---|
| 4.1 M€ | 0.05 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement SdS_SUR_Pcc
## Security of supply **Double bus in Don Rodrigo**

### I Table of physical units:

| | 220 kV |
|---|---|
| Bays (units) | 2 |
| Cables (km) | 1 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Don Rodrigo 220 kV | 2 | GIS | TN | 2024 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Don Rodrigo - Don Rodrigo 220 kV [1] | | | 1 SSC | Cable | TN | 2024 |

Notes:
1. Short section of cable inside the substation.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes



# Reinforcements approved by Modification of Specific Items of April 2024



## Reinforcement MAP_CONSUM

Consumers connected to the transmission network **New consumers connected to the TN (MAP 2024)**

## ANDALUCÍA

**General description:** The following reinforcements, included in the Development Plan for the existing transmission grid via the Modification of Specific Items approved in April 2024, make it possible to accommodate new supply points in Andalucía, which-due to technical constraints-can only be fed from the transmission grid:

- New expansion in the Algeciras 220 kV substation and the Barrios 220 kV substation, and reconfiguration to Double Busbar GIS at the Barrios 220 kV substation.
- New expansion in the Cristóbal Colón 220 kV ES and the Palos 220 kV ES, and uprating of L/C.Colón-Torrearenillas 220 kV circuit 2.
- In the post-2026 timeframe/Beyond 2026, new Parrales 400 kV ES as I/O for L/Guillena-Puebla de Guzmán 400 kV, new Villarrasa 400 kV ES as I/O for DC/Guillena-Puebla de Guzmán 400 kV, and I/O for DC/Guillena-Palos 400 kV, and new Fresón 400 kV ES as I/O for L/Guillena-Palos 400 kV.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_CONSUM

Consumers connected to the transmission network **New consumers connected to the TN (MAP 2024)**

**I Drivers / Objectives:**

The needs associated with the energy transition, electrification, and digitalisation of the economy are giving rise to new, large-scale industrial projects, strategic in nature, and have the potential to boost economic growth and employment. Many of them are characterised by significant electricity consumption, which is why they need to be supplied directly from the electricity transmission grid.

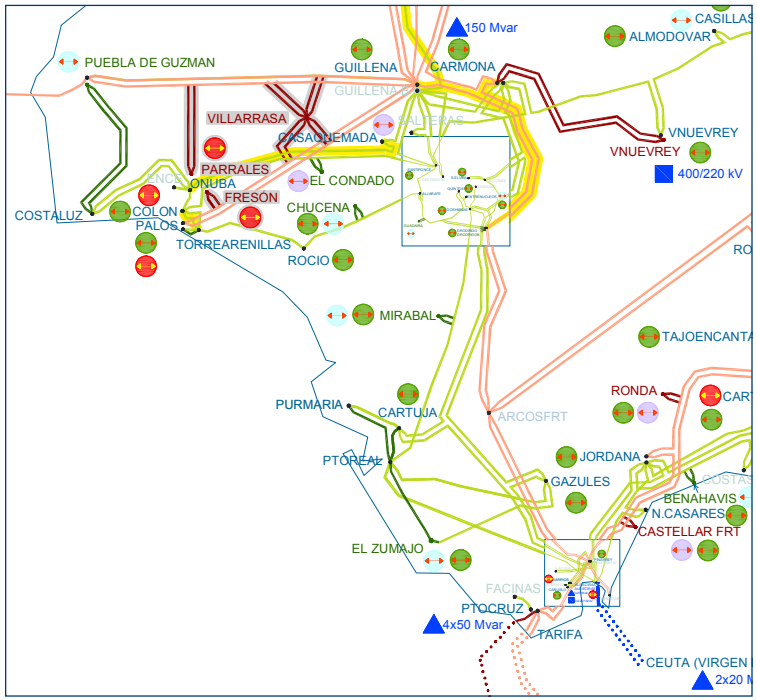
**I Alternatives:**

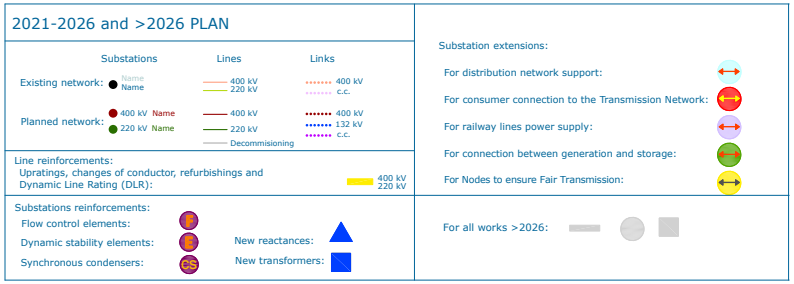
Connection through existing or previously planned bays for other purposes has proven to be a non-viable alternative.

**I European dimension:**

No.

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_CONSUM

Consumers connected to the transmission network **New consumers connected to the TN (MAP 2024)**

## EAST

**I General description:** The following reinforcements, included in the Development Plan for the existing transmission grid via the Modification of Specific Items approved in April 2024, make it possible to accommodate new supply points in the East, which-due to technical constraints-can only be fed from the transmission grid:

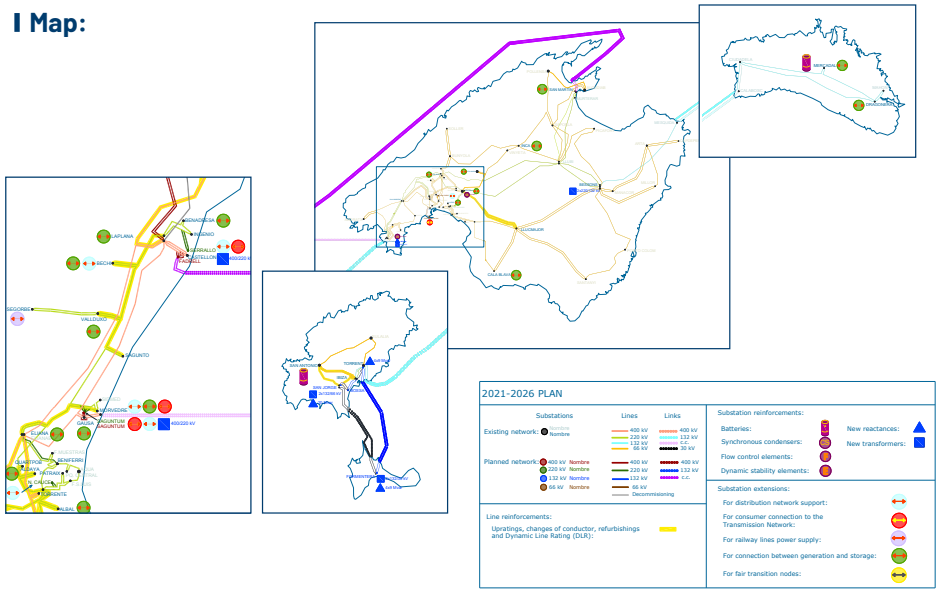
- New Saguntum 400/220 kV ES, DC Gaussa-Saguntum 400 kV ES, 400/220 kV transformer in Saguntum, change in topology DC Saguntum-Morvedre 220 kV and Saguntum-Eliana/Sagunto 220 kV, bypass lines in La Eliana-Gaussa and Gaussa-Morvedre 400 kV and expansion of the Saguntum 220 kV ES.
- Expansion of the El Serrallo 220 kV substation and 400/220 kV transformer in Castellón.
- Expansion of the Fausita 220 kV ES, repowering L/ Fausita-Nueva Escombreras 400 kV, conductor change in L/Fausita-Nueva Escombreras 400 kV and upgrade in Nueva Escombreras 400 kV ES.
- New Puerto de Palma 66 kV ES as I/O for L/Valldurgent-Santa Catalina 66 kV and expansion of the Puerto de Palma 66 kV ES.

**I Drivers / Objectives:** The needs associated with the energy transition, electrification, and digitalisation of the economy are giving rise to new, large-scale industrial projects, strategic in nature, and have the potential to boost economic growth and employment. Many of them are characterised by significant electricity consumption, which is why they to be supplied directly from the electricity transmission grid.

**I Alternatives:** Connection through existing or previously planned bays for other purposes has proven to be a non-viable alternative.

**I European dimension:** No.

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement MAP_CONSUM

Consumers connected to the transmission network **New consumers connected to the TN (MAP 2024)**

## NORTH EAST

**I General description:** The following reinforcements, included in the Development Plan for the existing transmission grid via the Modification of Specific Items approved in April 2024, make it possible to accommodate new supply points in the North East , which-due to technical constraints-can only be fed from the transmission grid:

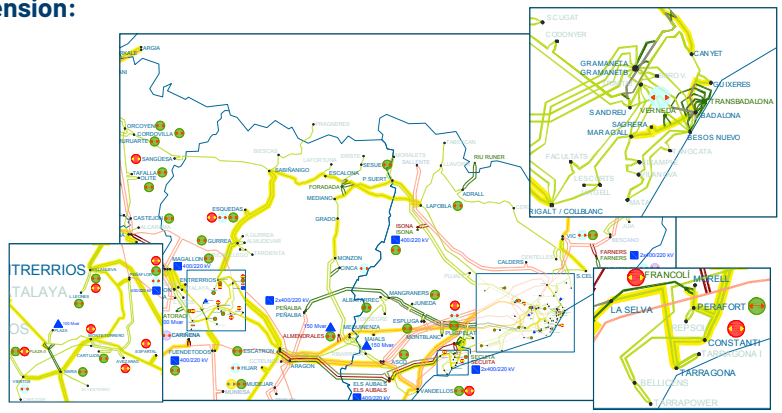
- New expansion in AVE-Zaragoza 220 kV substation, Esquedas 220 kV substation, Montetorrero 220 kV substation, Peñaflor 220 kV ES, Plaza II 220 kV ES, and Villanueva de Gállego 220 kV.
- Grid reinforcements by replacing the conductor with a high-temperature alternative for the DC Gurrea-Villanueva 220 kV and DC Escatrón-Villanueva 220 kV lines, repowering L/Esquedas-Sabiñánigo 220 kV, a third 400/220 kV transformer in Peñaflor and Magallón, a second 400/220 kV transformer in Peñalba, an upgrade in the components of existing bays in Peñaflor 220 kV and Villanueva 220 kV.
- New expansion in Vandellós 400 kV ES and reinforcements by replacing the conductor with a high-temperature alternative for the Secuita-Perafort 220 kV, Secuita-Constantí 220 kV, and Perafort-Francolí 220 kV lines, as well as a second 400/220 kV transformer in Secuita.
- New Verneda 220 kV ES as I/O for L/Badalona-Sagrera 220 kV, expansion of Verneda 220 kV ES.
- New Farners 400/220 kV ES, as I/O for Vic-Bescanó 400kV, new Riudarenes 220 kV, and new DC Farners-Riudarenes 220 kV.

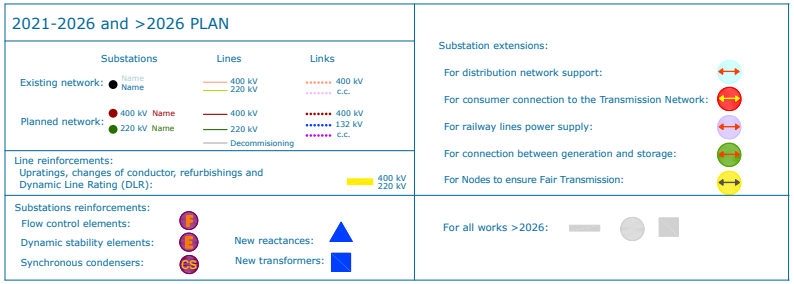
**I Drivers / Objectives:** The needs associated with the energy transition, electrification, and digitalisation of the economy are giving rise to new, large-scale industrial projects, strategic in nature, and have the potential to boost economic growth and employment. Many of them are characterised by significant electricity consumption, which is why they to be supplied directly from the electricity transmission grid.

**I Alternatives:** Connection through existing or previously planned bays for other purposes has proven to be a non-viable alternative.

**I European dimension:** No.

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement MAP_CONSUM

Consumers connected to the transmission network **New consumers connected to the TN (MAP 2024)**

## NORTH

**I General description:** The following reinforcements, included in the Development Plan for the existing transmission grid via the Modification of Specific Items approved in April 2024, make it possible to accommodate new supply points in the north, which-due to technical constraints-can only be fed from the transmission grid:

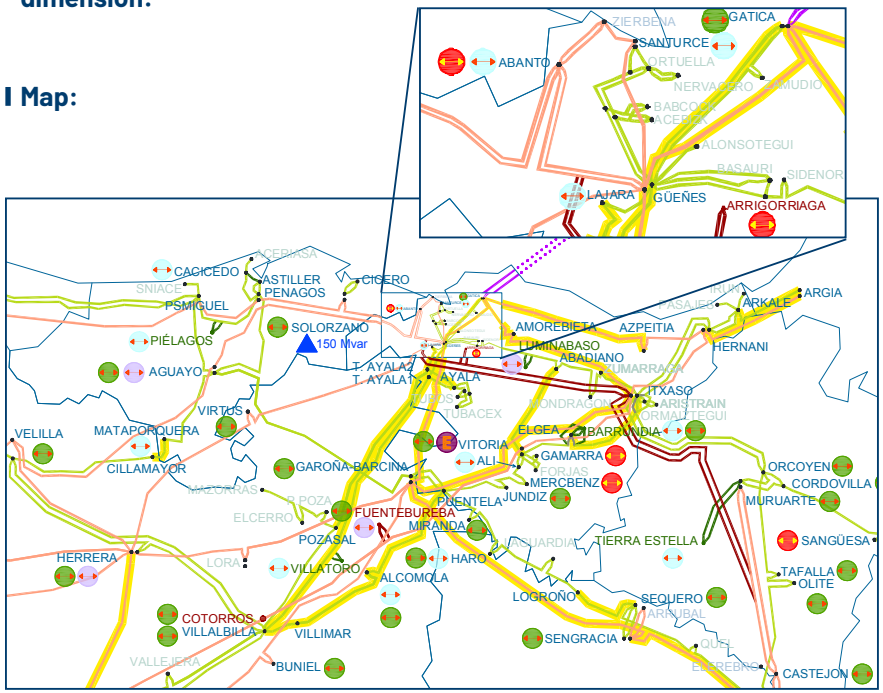
- New Piélagos 220 kV ES as I/O for L/Penagos-Puente San Miguel 220 kV, expansion of Piélagos 220kV ES.
- New Arrigorriaga 400 kV ES as I/O for L/Güeñes-Itxaso 400 kV, expansion of Arrigorriaga 400 kV.
- Adaptation to P.O. and expansion of the Mercedes 220 kV ES, upgrade in Gamarra 220 kV ES, and change in ownership of 1 bay in Santurce 220 kV.

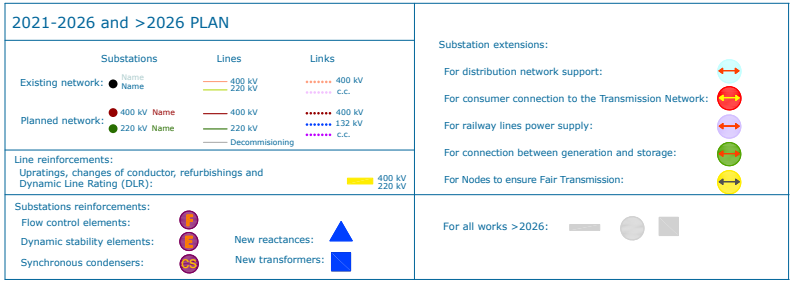
**I Drivers / Objectives:** The needs associated with the energy transition, electrification, and digitalisation of the economy are giving rise to new, large-scale industrial projects, strategic in nature, and have the potential to boost economic growth and employment. Many of them are characterised by significant electricity consumption, which is why they to be supplied directly from the electricity transmission grid.

**I Alternatives:** Connection through existing or previously planned bays for other purposes has proven to be a non-viable alternative.

**I European dimension:** No.

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_CONSUM

Consumers connected to the transmission network **New consumers connected to the TN (MAP 2024)**

## ASTURIAS

**I General description:** The following reinforcements, included in the Development Plan for the existing transmission grid via the Modification of Specific Items approved in April 2024, make it possible to accommodate new supply points in Asturias, which-due to technical constraints-can only be fed from the transmission grid:

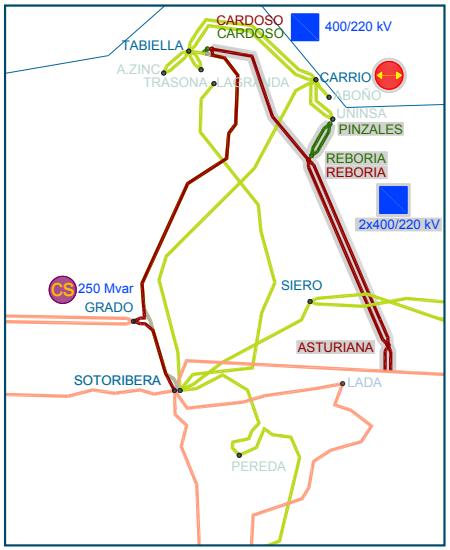
- Update to the name of the Gozón 400/220 kV ES to Cardoso 400/220 kV ES, change in type to GIS Cardoso 400/220 kV ES and decommission of the I/O in Gozón from L/Carrió-Tabiella 1 220 kV.
- Beyond 2026, new Reboria 400/220 kV ES and L/ Cardoso-Reboria 1 400 kV ES, two 400/220 kV transformers in Reboria, new Pinzales 220 kV ES, change in topology consisting of the relocation from Uninsa 220 kV ES to Pinzales 220 kV ES, DC Reboria-Pinzales 220 kV, expansion of Carrio 220 kV ES, new Asturiana 400 kV ES as I/O for L/Soto-Penagos 400 kV, and DC Reboria-Asturiana 400 kV.

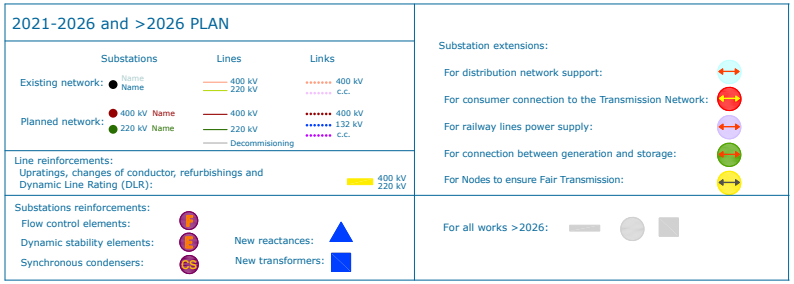
**I Drivers / Objectives:** The needs associated with the energy transition, electrification, and digitalisation of the economy are giving rise to new, large-scale industrial projects, strategic in nature, and have the potential to boost economic growth and employment. Many of them are characterised by significant electricity consumption, which is why they to be supplied directly from the electricity transmission grid.

**I Alternatives:** Connection through existing or previously planned bays for other purposes has proven to be a non-viable alternative.

**I European dimension:** No.

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement MAP_CONSUM

Consumers connected to the transmission network **New consumers connected to the TN (MAP 2024)**

## GALICIA

**I General description:** The following reinforcements, included in the Development Plan for the existing transmission grid via the Modification of Specific Items approved in April 2024, make it possible to accommodate new supply points in Galicia, which-due to technical constraints-can only be fed from the transmission grid:

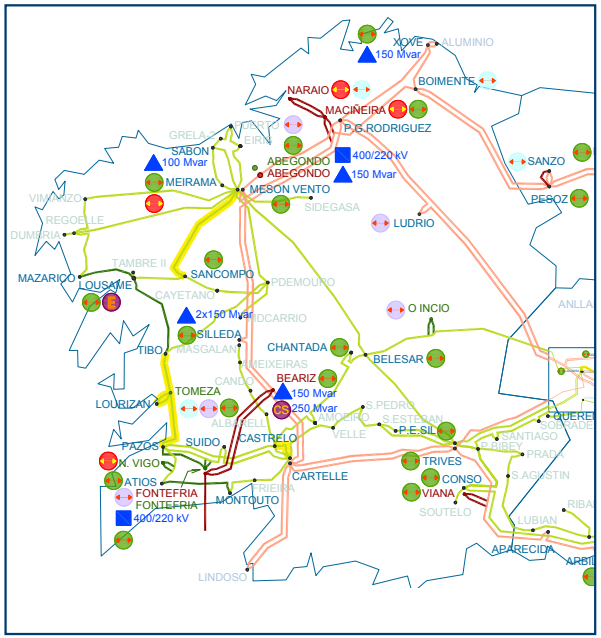
- New D/C Naraío-Maciñeira 400 kV, new Naraío 400 kV ES, and expansions in Naraío 400kV ES and in Maciñeira 400 kV ES.
- Nuevo Vigo 220 kV ES as I/O for L/Atios-Pazos de Borbén 220 kV and expansion of Nuevo Vigo 220 kV ES.
- Expansion of Meirama 220 kV ES.

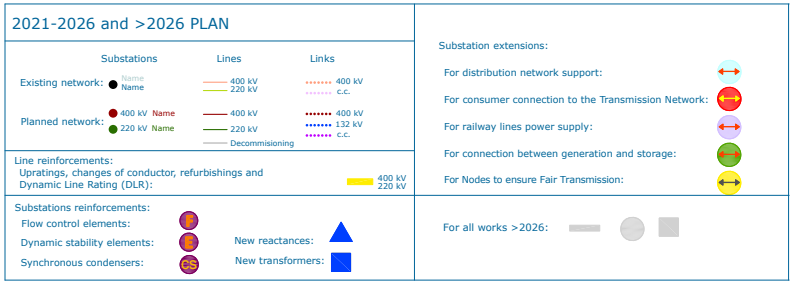
**I Drivers / Objectives:** The needs associated with the energy transition, electrification, and digitalisation of the economy are giving rise to new, large-scale industrial projects, strategic in nature, and have the potential to boost economic growth and employment. Many of them are characterised by significant electricity consumption, which is why they to be supplied directly from the electricity transmission grid.

**I Alternatives:** Connection through existing or previously planned bays for other purposes has proven to be a non-viable alternative.

**I European dimension:** No.

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement MAP_CONSUM

Consumers connected to the transmission network **New consumers connected to the TN (MAP 2024)**

## CENTRAL

**I General description:** The following reinforcements, included in the Development Plan for the existing transmission grid via the Modification of Specific Items approved in April 2024, make it possible to accommodate new supply points in la zona centro, which-due to technical constraints-can only be fed from the transmission grid:

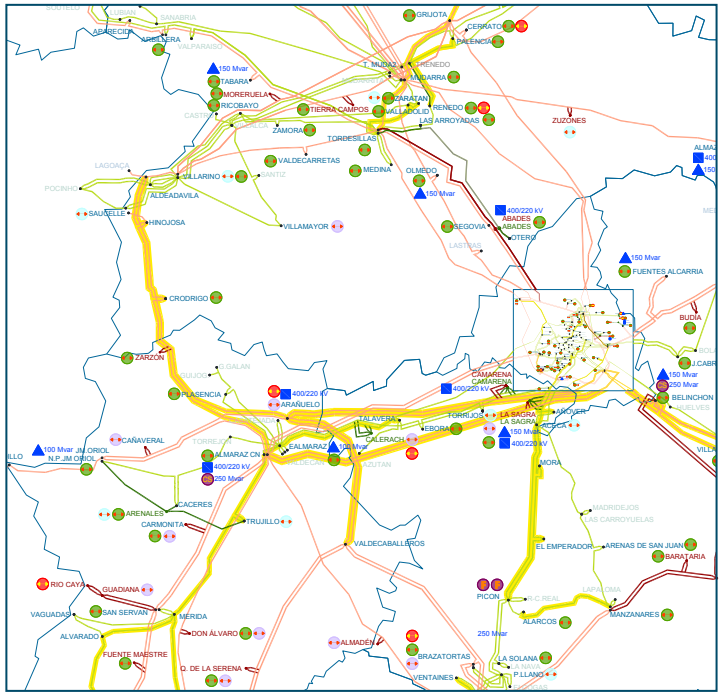
- Reinforcement of the grid to ensure consumption via a new I/O in Calera y Chozas 220 kV for Ébora-Almaraz E.T. 220 kV circuit 1
- Expansion in Cerrato 400 kV ES, Renedo 220 kV ES, Algete 220 kV ES, Brazatortas 400 kV, and Río Caya 400 kV ES.

**I Drivers / Objectives:** The needs associated with the energy transition, electrification, and digitalisation of the economy are giving rise to new, large-scale industrial projects, strategic in nature, and have the potential to boost economic growth and employment. Many of them are characterised by significant electricity consumption, which is why they to be supplied directly from the electricity transmission grid.

**I Alternatives:** Connection through existing or previously planned bays for other purposes has proven to be a non-viable alternative.

**I European dimension:** No.

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement MAP_CONSUM

Consumers connected to the transmission network **New consumers connected to the TN (MAP 2024)**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 479.1 M€ | 8.35 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 47.1 | 46.4 | 45.7 | 45.1 | 44.4 | 43.7 | 43.0 | 42.4 | 41.7 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

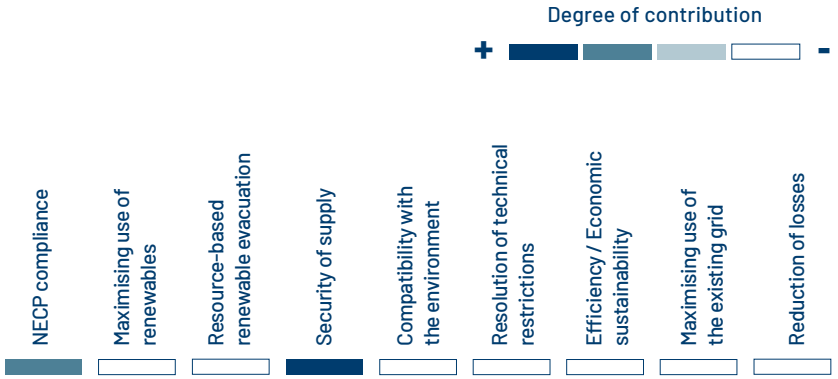
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# I Reinforcement MAP_CONSUM

Consumers connected to the transmission network **New consumers connected to the TN (MAP 2024)**

## I Table of physical units:

| | 60 kV | 220 kV | 400 kV |
|---|---|---|---|
| Bays (units) | 6 | 94 | 82 |
| Total renewal of bays (units) | | 1 | |
| Partial renewal of bays (units) | | | 1 |
| Change of ownership (units) | | 1 | |
| Overhead line (km) | | 90 | 208 |
| Partial renewal of overhead lines (km) | | 25 | |
| Cables (km) | 6 | 46 | |
| Transformed to 220 kV (MVA) | | | 6,000 |
| Uprating (km) | | 48 | 3 |
| Change of conductor (km) | | 474 | 29 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Arrigorriaga 400 kV | Outdoor | 2026 |
| Asturiana 400 kV | Outdoor | > 2026 |
| Farners 220 kV | Outdoor | 2026 |
| Farners 400 kV | Outdoor | 2026 |
| Fresón 400 kV | Outdoor | > 2026 |
| Naraío 400 kV | Outdoor | 2026 |
| Nuevo Vigo 220 kV | Building | 2026 |
| Parrales 400 kV | Outdoor | > 2026 |
| Piélagos 220 kV | Outdoor | 2026 |
| Pinzales 220 kV | Building | > 2026 |
| Puerto Palma 66 kV | Building | 2026 |
| Reboria 220 kV | Outdoor | > 2026 |
| Reboria 400 kV | Outdoor | > 2026 |
| Riudarenes 220 kV | Outdoor | 2026 |
| Saguntum 220 kV | Outdoor | 2026 |
| Saguntum 400 kV | Outdoor | 2026 |
| Verneda 220 kV [1] | Building | 2026 |
| Villarrasa 400 kV | Outdoor | > 2026 |

Notes:
1. To execute these reinforcements, prior upgrades to the Badalona Sagrera line are essential.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_CONSUM

Consumers connected to the transmission network **New consumers connected to the TN (MAP 2024)**

## I Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Algeciras 220 kV | 1 | GIS | Consum. | 2026 |
| Algete 220 kV | 2 | GIS | Consum. | 2024 |
| Arrigorriaga 400 kV | 4 | AIS | TN | 2026 |
| Arrigorriaga 400 kV | 2 | AIS | Consum. | 2026 |
| Asturiana 400 kV | 6 | AIS | TN | > 2026 |
| Ave Zaragoza 220 kV | 2 | AIS | Consum. | 2026 |
| Brazatortas 400 kV | 1 | AIS | TN | 2026 |
| Brazatortas 400 kV | 1 | AIS | Consum. | 2026 |
| Calera y Chozas 220 kV | 2 | AIS | TN | 2024 |
| Cardoso 400 kV | 2 | GIS | TN | > 2026 |
| Carrió 220 kV | 1 | AIS | Consum. | >2026 |
| Castellón C.T. 400 kV | 1 | AIS | TN | 2026 |
| Cerrato 400 kV | 1 | AIS | Consum. | 2026 |
| Colón 220 kV | 1 | GIS | Consum. | 2026 |
| El Serrallo 220 kV | 1 | GIS | TN | 2023 |
| El Serrallo 220 kV | 2 | GIS | Consum. | 2026 |
| Esquedas 220 kV | 2 | AIS | Consum. | 2026 |
| Farners 220 kV | 5 | AIS | TN | 2026 |
| Farners 400 kV | 7 | AIS | TN | 2026 |
| Fausita 220 kV | 1 | GIS | Consum. | 2026 |
| Fresón 400 kV | 4 | AIS | TN | > 2026 |
| Fresón 400 kV | 2 | AIS | Consum. | > 2026 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| La Secuita 220 kV | 1 | AIS | TN | 2026 |
| La Secuita 400 kV | 2 | AIS | TN | 2026 |
| Los Barrios 220 kV | 1 | GIS | Consum. | 2026 |
| Los Barrios 220 kV | 3 | GIS | TN | 2026 |
| Los Barrios 220 kV | 2 | GIS | SuD | 2026 |
| Maciñeira 400 kV | 2 | AIS | Consum. | 2026 |
| Maciñeira 400 kV | 3 | AIS | TN | 2026 |
| Magallón 220 kV | 1 | AIS | TN | 2026 |
| Magallón 400 kV | 2 | AIS | TN | 2026 |
| Meirama 220 kV | 1 | AIS | Consum. | 2026 |
| Mercedes Benz 220 kV [1] | 3 | GIS | TN | 2025 |
| Mercedes Benz 220 kV [1] | 3 | GIS | Consum. | 2025 |
| Montetorrero 220 kV | 2 | AIS | Consum. | 2026 |
| Naraío 400 kV | 4 | AIS | TN | 2026 |
| Naraío 400 kV | 1 | AIS | Consum. | 2026 |
| Naraío 400 kV | 1 | AIS | SuD | 2026 |
| Nuevo Vigo 220 kV | 3 | GIS | TN | 2026 |
| Nuevo Vigo 220 kV | 2 | GIS | Consum. | 2026 |
| Palos de la Frontera 220 kV | 1 | GIS | Consum. | 2026 |
| Parrales 400 kV | 4 | AIS | TN | > 2026 |
| Parrales 400 kV | 2 | AIS | Consum. | > 2026 |
| Peñaflor 220 kV | 4 | AIS | Consum. | 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_CONSUM

Consumers connected to the transmission network **New consumers connected to the TN (MAP 2024)**

## I Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Peñaflor 220 kV | 1 | AIS | TN | 2026 |
| Peñaflor 400 kV | 2 | AIS | TN | 2026 |
| Peñalba 220 kV | 1 | AIS | TN | 2026 |
| Peñalba 400 kV | 2 | AIS | TN | 2026 |
| Piélagos 220 kV | 3 | AIS | TN | 2026 |
| Piélagos 220 kV | 1 | AIS | SuD | 2026 |
| Pinzales 220 kV [2] | 5 | GIS | TN | > 2026 |
| Pinzales 220 kV [2] | 2 | GIS | Consum. | > 2026 |
| Plaza II 220 kV | 2 | AIS | Consum. | 2026 |
| Puerto Palma 66 kV | 3 | GIS | TN | 2026 |
| Puerto Palma 66 kV | 3 | GIS | Consum. | 2026 |
| Reboria 220 kV | 5 | AIS | TN | > 2026 |
| Reboria 400 kV | 8 | AIS | TN | > 2026 |
| Renedo 220 kV | 2 | AIS | Consum. | 2026 |
| Riudarenes 220 kV | 3 | AIS | TN | 2026 |
| Riudarenes 220 kV | 2 | AIS | Rail. | 2026 |
| Riudarenes 220 kV | 2 | AIS | SuD | 2026 |
| Río Caya 400 kV | 1 | AIS | Consum. | 2026 |
| Saguntum 220 kV | 4 | AIS | Consum. | 2026 |
| Saguntum 220 kV | 6 | AIS | TN | 2026 |
| Saguntum 220 kV | 1 | AIS | SuD | 2026 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Saguntum 400 kV | 5 | AIS | TN | 2026 |
| Vandellós 400 kV | 1 | AIS | Consum. | 2026 |
| Verneda 220 kV [3] | 3 | GIS | TN | 2026 |
| Verneda 220 kV | 2 | GIS | SuD | 2026 |
| Villanueva de Gállego 220 kV | 2 | AIS | Consum. | 2026 |
| Villarrasa 400 kV | 12 | AIS | TN | > 2026 |

Notes:
1. Adjustment to Operational Procedure (O.P.)
2. Relocation of the Uninsa 220 kV ES to Pinzales 220 kV ES.
3. To execute these reinforcements, prior upgrades to the Badalona Sagrera line are essential.

| Total renewal of bays | units | Type | Driv. | Year |
|---|---|---|---|---|
| Gamarra 220 kV | 1 | AIS | Consum. | 2026 |

| Partial renewal of bays | units | Type | Driv. | Year |
|---|---|---|---|---|
| Nueva Escombreras 400 kV | 1 | AIS | TN | 2026 |

| Changes in the ownership of bays | units | Type | Driv. | Year |
|---|---|---|---|---|
| Santurce 220 kV | 1 | GIS | SuD | 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_CONSUM

Consumers connected to the transmission network **New consumers connected to the TN (MAP 2024)**

## I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Cardoso - Reboria 400 kV [1] | | | 15 | Line | TN | > 2026 |
| DC Escatrón - Villanueva de Gállego 220 kV [2] | 660 | 620 | 2 | Line | TN | 2026 |
| DC Farners - Riudarenes 220 kV | 850 | 720 | 15 | Line | TN | 2026 |
| DC Gaussa - Saguntum 400 kV | 2,329 | 2,041 | 4 | Line | TN | 2026 |
| DC La Eliana - Godelleta 400 kV [3] | | | 2 | Line | TN | 2026 |
| DC La Eliana - Morvedre 220 kV | 620 | 540 | 8 | Line | TN | 2026 |
| DC La Secuita - Perafort 220 kV [4] | 660 | 620 | 2 | Line | TN | 2026 |
| DC Naraío - Maciñeira 400 kV | 2,380 | 2,180 | 20 | Line | TN | 2026 |
| DC Reboria - Asturiana 400 kV | | | 30 | Line | TN | > 2026 |
| DC Reboria - Pinzales 220 kV | | | 5 | Cable | TN | > 2026 |
| DC Saguntum - Morvedre 220 kV | 620 | 540 | 0.6 | Line | TN | 2026 |
| DC Saguntum - Saguntum 220 kV [5] | 530 | 520 | 1 SSL | Line | TN | 2026 |
| I/O in Arrigorriaga, of Itxaso - Güeñes 400 kV, circuit 1 [6] | 2,380 | 2,120 | 2 | Line | TN | 2026 |
| I/O in Asturiana, of Soto de Ribera - Penagos 400 kV, circuit 1 | | | 5 | Line | TN | > 2026 |
| I/O in Calera y Chozas, of Ébora - Almaraz E.T. 220 kV, circuit 1 [7] | 770 | 630 | 1 | Line | TN | 2024 |
| I/O in Farners, of Vic - Bescanó 400 kV, circuit 1 | 2,380 | 2,030 | 9 | Line | TN | 2026 |
| I/O in Fresón, of Guillena - Palos de la Frontera 400 kV, circuit 1 | | | 0.2 | Line | TN | > 2026 |
| I/O in Nuevo Vigo, of Atios - Pazos de Borbén 220 kV, circuit 1 | 320 | 250 | 14 | Cable | TN | 2026 |
| I/O in Nuevo Vigo, of Atios - Pazos de Borbén 220 kV, circuit 1 [8] | 320 | 250 | 8 | Line | TN | 2026 |
| I/O in Parrales, of Guillena - Puebla de Guzmán 400 kV, circuit 1 | | | 10 | Line | TN | > 2026 |
| I/O in Piélagos, of Penagos - Puente San Miguel 220 kV, circuit 1 [9] | 570 | 460 | 7 | Line | TN | 2026 |
| I/O in Puerto Palma, of Valldurgent - Santa Catalina 66 kV, circuit 1 [10] | 63 | 45 | 3 | Cable | TN | 2026 |
| I/O in Verneda, of La Sagrera - Badalona 220 kV, circuit 3 [11] | 415 | 415 | 0.5 | Cable | TN | 2026 |
| I/O in Villarrasa, of Guillena - Puebla de Guzmán 400 kV, circuit 1 | | | 1 | Line | TN | > 2026 |
| I/O in Villarrasa, of Guillena - Puebla de Guzmán 400 kV, circuit 2 | | | 1 | Line | TN | > 2026 |
| I/O in Villarrasa, of Palos de la Frontera - Guillena 400 kV, circuit 1 | | | 1 | Line | TN | > 2026 |
| I/O in Villarrasa, of Palos de la Frontera - Guillena 400 kV, circuit 2 | | | 1 | Line | TN | > 2026 |

Notes:
1. Double circuit with first circuit laid out.
2. Section of new line in DC to create a variant of the Escatrón-Villanueva 220 circuits, circuit 1 and circuit 2. Each circuit variant has a line capacity of 870/750 MVA.
3. The other circuit affected in DC from the output of the Eliana-Godelleta line is the Eliana-Torrente line as they currently share pylons. Section line capacity for this DC route is 2330/2010 MVA.
4. Section of new line in DC to create a variant of the Secuita-Constanti/Perafort 220 circuits. Each circuit variant has a line capacity of 870/750 MVA.
5. Short section of line inside the substation.
6. Section line capacity in DC for I/O 2380/2120 MVA.
7. Section line capacity in DC for I/O 770/630 MVA.
8. Section line capacity in DC for I/O 860/750 MVA.
9. Section line capacity in DC for I/O 890/780 MVA
10. Section line capacity in DC for I/O 80/80 MVA.
11. To execute these reinforcements, prior upgrades to the Badalona Sagrera line are essential. Section line capacity in DC for I/O 450/450 MVA.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_CONSUM

Consumers connected to the transmission network **New consumers connected to the TN (MAP 2024)**

## I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| El Serrallo - El Serrallo 220 kV [12] | | | 1 SSC | Cable | TN | 2026 |
| La Eliana - Godelleta 400 kV, circuit 1 [13] | | | 5 | Line | TN | 2026 |
| La Eliana - La Eliana 220 kV, circuit 1 | 620 | 540 | 4 | Cable | TN | 2026 |
| La Eliana - Morvedre 400 kV, circuit 1 [14] | 1,630 | 1,370 | 0.6 | Line | TN | 2026 |
| Magallón - Magallón 220 kV [12] | | | 1 SSC | Cable | TN | 2026 |
| Mercedes Benz - Mercedes Benz 220 kV [15] | | | 5 SSC | Cable | TN | 2025 |
| Morvedre - Morvedre 220 kV [12] | 620 | 540 | 1 SSC | Cable | TN | 2026 |
| Saguntum - La Eliana 220 kV, circuit 1 | 620 | 540 | 0.6 | Line | TN | 2026 |
| Saguntum - Sagunto 220 kV, circuit 1 | 530 | 520 | 0.5 | Line | TN | 2026 |
| Saguntum - Saguntum 220 kV [12] | | | 1 SSC | Cable | TN | 2026 |
| Uninsa - Pinzales 220 kV, circuit 1 [16] | | | 0.5 | Cable | TN | > 2026 |
| Uninsa - Pinzales 220 kV, circuit 2 [17] | | | 0.5 | Cable | TN | > 2026 |

12. Short section of cable inside the substation.
13. Section line capacity for this route is 2330/2010 MVA
14. The capacity for the new line is 2329/2041 but the result is a reduced capacity (L/La Eliana - Gaussa 400 kV)
15. Short section of cable inside the substation.
16. Topological change with commissioning of the Carrio-Pinzales 220 kV line, circuit 1 and decommissioning of the Carrio-Uninsa 220 kV line, circuit 1.
17. Topological change with commissioning of the Carrio-Pinzales 220 kV line, circuit 2 and decommissioning of the Carrio-Uninsa 220 kV line, circuit 2.

| Changes of conductor | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Escatrón - Villanueva de Gállego 220 kV | 660 | 620 | 144 | Line | TN | 2026 |
| DC Gurrea de Gállego - Villanueva de Gállego 220 kV | 660 | 620 | 67 | Line | TN | 2026 |
| DC La Secuita - Constantí 220 kV | 660 | 620 | 14 | Line | TN | 2026 |
| DC La Secuita - Perafort 220 kV | 660 | 620 | 9 | Line | TN | 2026 |
| DC Perafort - Francolí 220 kV | 660 | 620 | 3 | Line | TN | 2026 |
| Fausita - Nueva Escombreras 400 kV, circuit 1 [1] | 1,330 | 1,270 | 1 | Line | TN | 2026 |
| La Eliana - Godelleta 400 kV, circuit 1 [2] | 2,100 | 1,850 | 28 | Line | TN | 2026 |

Notes:
1. The line has a Simplex section, to increase section line capacity which is necessary for a change in conductor at 1.3 km.
2. Requires high temperature conductor change.

| Partial renewal of lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| La Eliana - Morvedre 220 kV, circuit 1 | 620 | 540 | 25 | Line | TN | 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_CONSUM

Consumers connected to the transmission network **New consumers connected to the TN (MAP 2024)**

## I Detailed list of assets (continued):

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Colón - Torrearenillas 220 kV, circuit 2 | 420 | 350 | 5 | Line | TN | 2025 |
| Esquedas - Sabiñánigo 220 kV, circuit 1 | 440 | 370 | 43 | Line | TN | 2026 |
| Fausita - Nueva Escombreras 400 kV, circuit 1 | 1,730 | 1,500 | 3 | Line | TN | 2026 |

| New transformers | units | Type | Driv. | Year |
|---|---|---|---|---|
| Castellón C.T. 400/220 kV, TF1 | 600 | Triph. B. | TN | 2026 |
| Farners 400/220 kV, TF1 | 600 | Triph. B. | TN | 2026 |
| Farners 400/220 kV, TF2 | 600 | Triph. B. | TN | 2026 |
| La Secuita 400/220 kV, TF2 | 600 | Triph. B. | TN | 2026 |
| Magallón 400/220 kV, TF3 | 600 | Triph. B. | TN | 2026 |
| Peñaflor 400/220 kV, TF3 | 600 | Triph. B. | TN | 2026 |
| Peñalba 400/220 kV, TF2 | 600 | Triph. B. | TN | 2026 |
| Reboria 400/220 kV, TF1 | 600 | Triph. B. | TN | > 2026 |
| Reboria 400/220 kV, TF2 | 600 | Triph. B. | TN | > 2026 |
| Saguntum 400/220 kV, TF1 | 600 | Triph. B. | TN | 2026 |

| New adjustments to OP | Year |
|---|---|
| Los Barrios 220 kV [1] | 2026 |

Notes:
1. Additional assets required to adjust to the O.P.

| Total infrastructure upgrade | Year |
|---|---|
| Mercedes Benz 220 kV | 2025 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_ALM_GEN

## RES integration and resolution of technical constraints

## New connection of renewables and storage (MAP 2024)

**I General description:**

The following reinforcements, included in the Transmission Network Development Plan through the Modification of Specific Items approved in April 2024, are critical for the energy transition as they enable the connection and integration of renewables and storage facilities:

- New Plaza II 220 kV substation as I/O of L/Entrerríos-Plaza 220 kV and I/O of L/Plaza-Monte- torrero 220 kV, DC Plaza II-María 220 kV, change of conductor L/Magallón-Entrerríos 220 kV, upgrade L/Entrerríos-Plaza 220 kV, and expansion of the Plaza II 220 kV ES.
- New Maciñeira 400 kV ES as I/O of L/Boimente-Mesón do Vento 400 kV and expansion of the Maciñeira 400 kV ES.
- New Budía 400 kV ES as I/O of the Fuentes de la Alcarria-Trillo 400 kV line and Expansion of the Budía 400 kV ES.
- New Fuencaliente 66 kV ES as I/O of the Las Breñas-Valle de Aridane circuit 2 line and expansion of the Fuencaliente 66 kV ES.
- New expansion reinforcements in the Viana 400 kV ES and Pesoz 400 kV ES.

**I Drivers / Objectives:**

Enabling connection and integration of renewable energy generation and storage in the case outlined by the National Energy and Climate Plan (Plan Nacional Integrado de Energía y Clima).

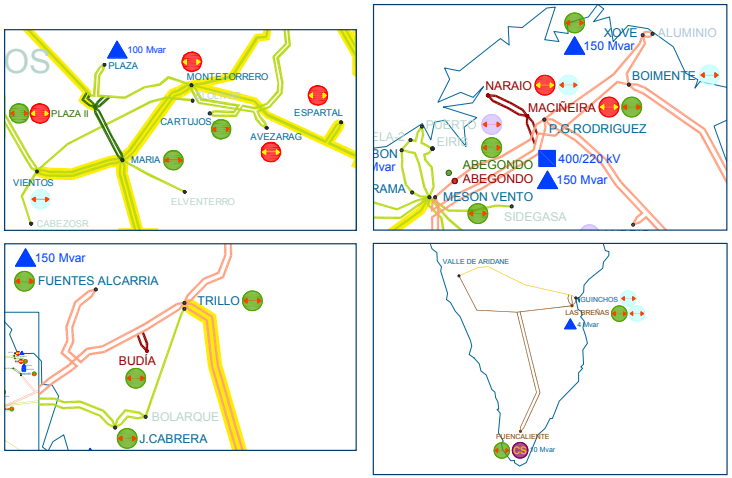
**I Alternatives:**

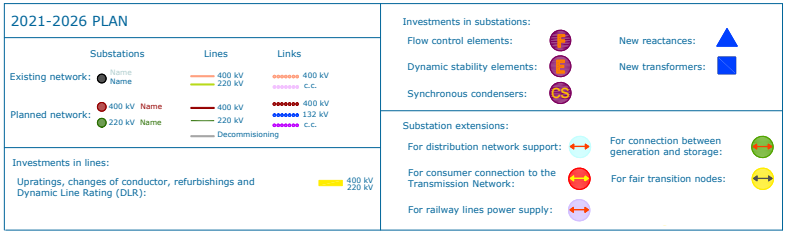
Connection through existing or previously planned bays for other purposes has proven to be a non-viable alternative.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement MAP_ALM_GEN

RES integration and resolution of technical constraints

**New connection of renewables and storage (MAP 2024)**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Profitability:

Profitability: NPV

- M€

### I Socio-environmental impact:



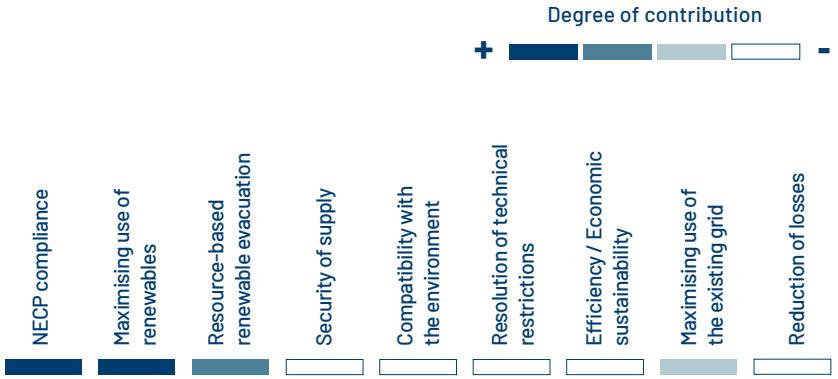

### I Costs:

| CAPEX | OPEX |
|---|---|
| 73.6 M€ | 1.72 M€/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 7.7 | 7.6 | 7.5 | 7.4 | 7.3 | 7.2 | 7.1 | 6.9 | 6.8 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_ALM_GEN

RES integration and resolution of technical constraints

**New connection of renewables and storage (MAP 2024)**

## I Table of physical units:

| | 60 kV | 220 kV | 400 kV |
|---|---|---|---|
| Bays (units) | 5 | 10 | 23 |
| Overhead line (km) | 36 | 48 | 26 |
| Cables (km) | 5 | | |
| Uprating (km) | | 29 | |
| Change of conductor (km) | | 27 | |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

## I Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Budía 400 kV | Outdoor | 2026 |
| Fuencaliente de la Palma 66 kV | Building | 2026 |
| Maciñeira 400 kV | Outdoor | 2026 |
| Plaza II 220 kV | Outdoor | 2026 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Budía 400 kV | 4 | AIS | TN | 2026 |
| Budía 400 kV | 1 | AIS | Gen./Sto. | 2026 |
| Fuencaliente de la Palma 66 kV | 4 | GIS | TN | 2026 |
| Fuencaliente de la Palma 66 kV | 1 | GIS | Gen./Sto. | 2026 |
| Maciñeira 400 kV | 5 | AIS | TN | 2026 |
| Maciñeira 400 kV | 1 | AIS | Gen./Sto. | 2026 |
| María 220 kV | 2 | AIS | TN | 2026 |
| Pesoz 400 kV | 2 | AIS | Gen./Sto. | 2026 |
| Pesoz 400 kV | 1 | AIS | TN | 2026 |
| Plaza II 220 kV | 7 | AIS | TN | 2026 |
| Plaza II 220 kV | 1 | AIS | Gen./Sto. | 2026 |
| Viana 400 kV | 5 | AIS | TN | 2026 |
| Viana 400 kV | 4 | AIS | Gen./Sto. | 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_ALM_GEN

RES integration and resolution of technical constraints

**New connection of renewables and storage (MAP 2024)**

## I Detailed list of assets (continued):

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| DC Plaza II - María 220 kV | 870 | 770 | 17 | Line | TN | 2026 |
| I/O in Budía, of Fuentes de la Alcarria - Trillo 400 kV, circuit 1 [1] | 2,440 | 1,970 | 3 | Line | TN | 2026 |
| I/O in Fuencaliente de la Palma, of Las Breñas - Valle de Aridane 66 kV, circuit 2 [2] | 80 | 80 | 5 | Cable | TN | 2026 |
| I/O in Fuencaliente de la Palma, of Las Breñas - Valle de Aridane 66 kV, circuit 2 [3] | 80 | 80 | 18 | Line | TN | 2026 |
| I/O in Maciñeira, of Boimente - Mesón Do Vento 400 kV, circuit 1 [4] | 1,310 | 1,100 | 10 | Line | TN | 2026 |
| I/O in Plaza II, of Entrerríos - Plaza 220 kV, circuit 1 [5] | 380 | 330 | 4 | Line | TN | 2026 |
| I/O in Plaza II, of Plaza - Montetorrero 220 kV, circuit 1 [5] | 400 | 370 | 4 | Line | TN | 2026 |

| Changes of conductor | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Magallón - Entrerríos 220 kV, circuit 1 | 600 | 600 | 27 | Line | TN | 2026 |

| Line uprating | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Entrerríos - Plaza II 220 kV, circuit 1 | 427 | 363 | 29 | Line | TN | 2026 |

Notes:
1. Section line capacity in DC for I/O 2440/1970 MVA.
2. Section line capacity in DC for I/O 70/70 MVA.
3. Section line capacity in DC for I/O 80/80 MVA.
4. Section line capacity in DC for I/O 2380/2180 MVA.
5. Section line capacity in DC for I/O 850/750 MVA.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_NFT

## Connection of renewables and consumers connected to the transmission network **Connecting nodes to ensure fair transition (MAP 2024)**

**I General description:**

The following reinforcements, included in the Transmission Network Development Plan through the Modification of Specific Items approved in April 2024, allow for the connection of new electricity transmission grid installations in the fair transition nodes of La Robla 400 kV, Mudéjar 400 kV, Compostilla 220 kV, and Lancha 220 kV (for the latter, the node is affected by the closure of the Puente Nuevo thermal plant closure).

**I Drivers / Objectives:**

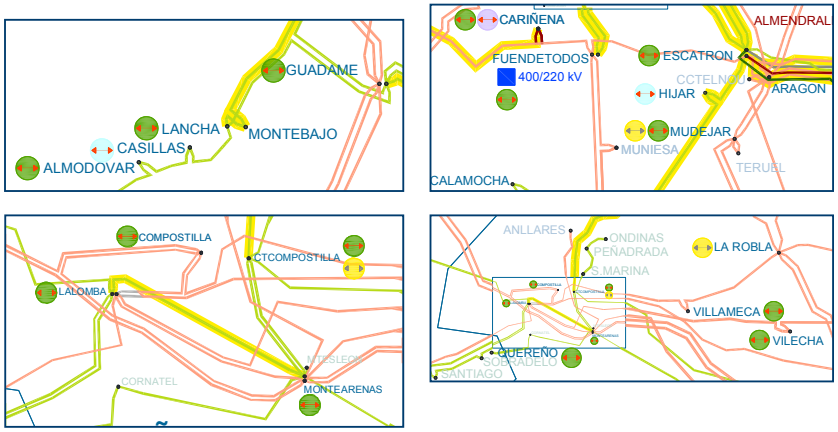
Facilitating connection options for new installations in the electricity transmission grid at specific fair transition nodes.

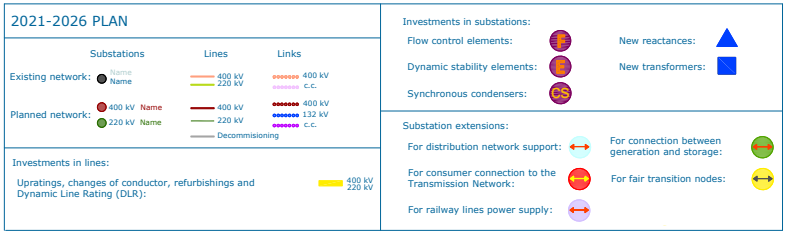
**I Alternatives:**

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_NFT

Connection of renewables and consumers connected to the transmission network **Connecting nodes to ensure fair transition (MAP 2024)**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| - M€ | 0.17 M€/year |

Remuneration costs

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| M€ | 0.0 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |

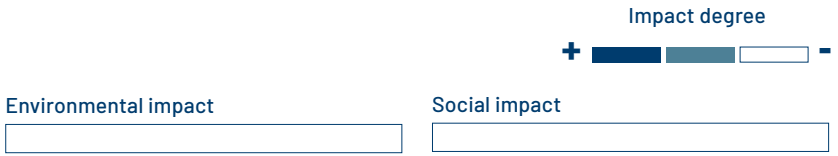
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

### I Profitability:

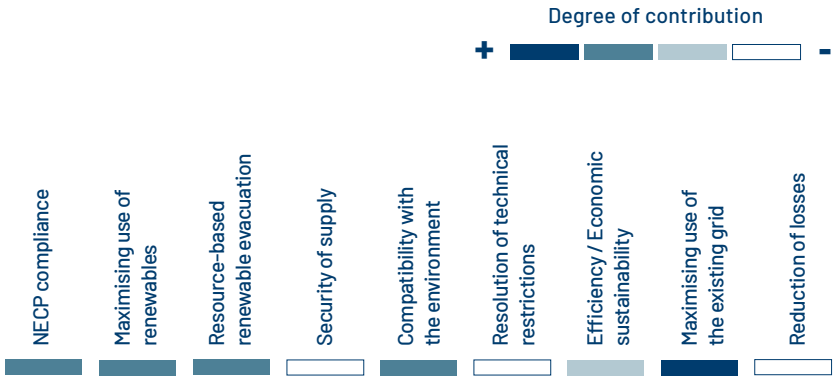
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

## I Reinforcement MAP_NFT

Connection of renewables and consumers connected to the transmission network **Connecting nodes to ensure fair transition (MAP 2024)**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 2 | 2 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### I Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Compostilla 220 kV | 1 | AIS | Gen/Alm/Consum | 2026 |
| La Robla 400 kV | 1 | AIS | Gen/Alm/Consum | 2026 |
| Lancha 220 kV | 1 | AIS | Gen/Alm | 2026 |
| Mudejar 400 kV | 1 | AIS | Gen/Alm/Consum | 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_OS

## Operational requirements **New operational requirements (MAP 2024)**

**I General description:**

The following reinforcements, included in the current Transmission Network Development Plan through the Modification of Specific Items approved in April 2024, make it possible to reduce the costs associated with the system voltage control restrictions, ensure operational security, and process a set of access and connection permits that have been granted.

- To reduce the costs of system voltage control restrictions, 4 new reactances have been planned for Abegondo 400 kV ES, Beariz 400 kV ES, Olmedo 400 kV ES, and Silleda 400 kV ES.
- To ensure service restoration under safe conditions, it is necessary to provide a set of transformers with controlled switch relays, and part of the associated switchgear must be adapted, both in the Islas Canarias and Peninsular systems.
- Finally, with the aim of ensuring access permits are granted, we have included expansions in Abona 220 kV ES, Callejones 66 Kv ES, Caparacena 220kV ES, Ciudad Rodrigo 400 kV ES, El Porís 66 kV ES, Gabias 220 kV ES, Jundiz 220 kV ES, Pesoz 400 kV ES, and Velilla 400 kV ES.

**I Drivers / Objectives:**

Ensure the safe operation of the system, both in situations involving service resumption and those involving voltage control, in order to achieve system economic efficiency; as well as allowing the connection of renewable energy with access permits granted.

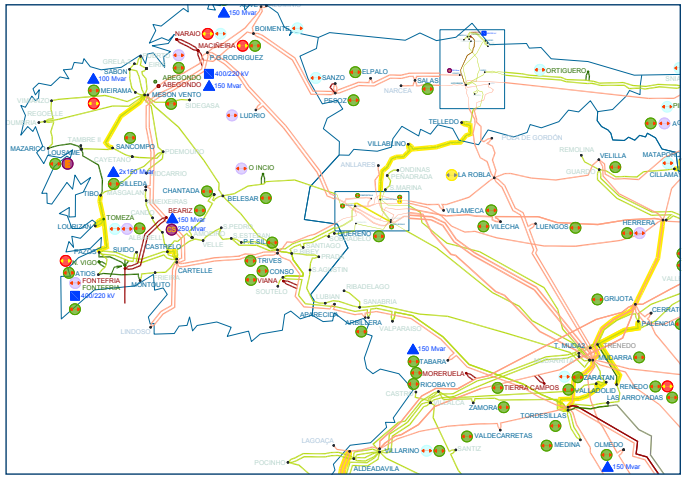
**I Alternatives:**

As a result of the technical-economic analyses carried out, it was concluded that the use of new reactances for voltage control is more efficient and involves substantially lower costs than those currently incurred by the coupling of thermal groups based on restrictions or based on the voltage control pilot currently available.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_OS

## Operational requirements **New operational requirements (MAP 2024)**

### Cost-Benefit Multi-Criteria Analysis

#### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - M€/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

#### I Costs:

| CAPEX | OPEX |
|---|---|
| 23.5 M€ | 0.58 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 2.5 | 2.4 | 2.4 | 2.4 | 2.3 | 2.3 | 2.3 | 2.2 | 2.2 |

Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including reinforcements that may be scheduled beyond 2026.

#### I Profitability:

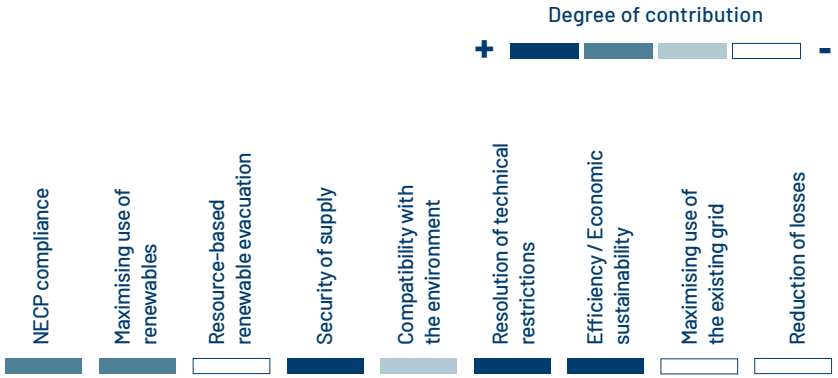
Profitability: NPV

1,528 M€

#### I Socio-environmental impact:




#### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement MAP_OS
## Operational requirements **New operational requirements (MAP 2024)**

### I Table of physical units:

| | 60 kV | 220 kV | 400 kV |
|---|---|---|---|
| Bays (units) | 1 | 7 | 7 |
| Reactance (Mvar) | | | 600 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

| New reactances | MVAr | Type | Driv. | Year |
|---|---|---|---|---|
| Abegondo 400 kV, REA1 | 150 | - | TN | 2026 |
| Beariz 400 kV, REA1 | 150 | - | TN | 2026 |
| Olmedo 400 kV, REA1 | 150 | - | TN | 2026 |
| Silleda 400 kV, REA2 | 150 | - | TN | 2026 |

### I Detailed list of assets:

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Abegondo 400 kV | 1 | AIS | TN | 2026 |
| Abona 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Abona 220 kV | 1 | GIS | Gen./Sto. | 2023 |
| Beariz 400 kV | 1 | AIS | TN | 2026 |
| Callejones 66 kV | 1 | GIS | Gen./Sto. | 2026 |
| Caparacena 220 kV | 1 | AIS | Gen./Sto. | 2026 |
| Ciudad Rodrigo 400 kV | 1 | AIS | Gen./Sto. | 2026 |
| El Porís 220 kV | 1 | GIS | Gen./Sto. | 2021 |
| El Porís 220 kV | 1 | GIS | TN | 2025 |
| Gabias 220 kV | 1 | AIS | Gen./Sto. | 2026 |
| Jundiz 220 kV | 1 | GIS | Gen./Sto. | 2026 |
| Olmedo 400 kV | 1 | AIS | TN | 2026 |
| Pesoz 400 kV | 1 | AIS | Gen./Sto. | 2026 |
| Silleda 400 kV | 1 | AIS | TN | 2026 |
| Velilla 400 kV | 1 | AIS | Gen./Sto. | 2026 |

| New controlled switch relays | Driv. | Year |
|---|---|---|
| Tirajana 220/66 kV | N_SO | 2026 |
| Jinamar 220/66 kV | N_SO | 2026 |
| Santa Águeda 220/66 kV | N_SO | 2026 |
| Sabinal 220/66 kV | N_SO | 2026 |
| Chira-Soria 220/20 kV | N_SO | 2026 |
| Granadilla/66 220 kV | N_SO | 2026 |
| Candelaria 220/66 kV | N_SO | 2026 |
| Porís 220/66 kV | N_SO | 2026 |
| Vallitos 220/66 kV | N_SO | 2026 |
| Abona 220/66 kV | N_SO | 2026 |
| Buenos Aires 220/66 kV | N_SO | 2026 |
| El Rosario 220/66 kV | N_SO | 2026 |
| El Palmar de la Gomera 66 kV | N_SO | 2026 |
| Guinchos 66 kV | N_SO | 2026 |
| Valle de Aridane 66 kV | N_SO | 2026 |
| Las Breñas 66 kV | N_SO | 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP_OS
## Operational requirements **New operational requirements (MAP 2024)**

### I Detailed list of assets (continued):

| New controlled switch relays | Driv. | Year |
|---|---|---|
| Soto 400/220 kV | N_SO | 2026 |
| Carrio 220/132 kV | N_SO | 2026 |
| Cartelle 400/220 kV | N_SO | 2026 |
| Mesón 400/220 kV | N_SO | 2026 |
| Sabón 220 kV | N_SO | 2026 |
| Aldeadávila 400/220 kV | N_SO | 2026 |
| Amorebieta 400 kV | N_SO | 2026 |
| Güeñes 400/220 kV | N_SO | 2026 |
| Magallón 400/220 kV | N_SO | 2026 |
| Mudarra 400/220 kV | N_SO | 2026 |
| Villarino 400/220 kV | N_SO | 2026 |
| Fuencarral 400/220 kV | N_SO | 2026 |
| J.M. Oriol 400/220 kV | N_SO | 2026 |
| Morata 400/220 kV | N_SO | 2026 |
| Arcos 400 kV | N_SO | 2026 |
| Palos 400 kV | N_SO | 2026 |
| Guillena 400/220 kV | N_SO | 2026 |
| Los Ramos 220/66 kV | N_SO | 2026 |
| Santiponce 220/132 kV | N_SO | 2026 |
| Tajo 400/220 kV | N_SO | 2026 |
| El Palmar 400/220 kV | N_SO | 2026 |
| La Eliana 400/220/132 kV | N_SO | 2026 |

| New controlled switch relays | Driv. | Year |
|---|---|---|
| Morvedre 400/20 kV | N_SO | 2026 |
| Nueva Escombreras 400 kV | N_SO | 2026 |
| Begues 400/220 kV | N_SO | 2026 |
| Escatrón 400/220 kV | N_SO | 2026 |
| Vic 400/220 kV | N_SO | 2026 |
| Mequinenza 400/220 kV | N_SO | 2026 |
| Castejón 400 kV | N_SO | 2026 |
| Aceca 220/132 kV | N_SO | 2026 |
| Catadau 400/220/132 kV | N_SO | 2026 |
| Sentmenat 400/220 kV | N_SO | 2026 |
| Villarino 400/220 kV | N_SO | 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP25_NOS_TENSION_SEPE

## Operational requirements **Elements for voltage control in SEPE**

**I General description:**

The project involves the installation of six new reactances, eight new synchronous compensators, and the upgrade of six existing reactances in the mainland electricity system. Specifically:

- One 150 Mvar reactance at Almendrales 400 kV, plus five 100 Mvar reactances at Plaza, Calatorao, Castell Bisbal, Sant Fost, and Nueva Meco 220 kV.
- The upgrade of six 150 Mvar reactances at the 400 kV substations of Guadame, Grijota, Herrera, Litoral, Olmedilla, and Pierola.
- Eight 250 Mvar synchronous compensators at the 400 kV substations of Cabra, Brovales, Litoral, Almaraz, Belinchón, Rocamora, Grado, and Beariz.

This project is complemented by the early implementation of assets already included in the current planning, originally set for beyond 2026. In particular, the series FACTS device at Pierola 400 kV and a reactance at Torrejón de Velasco 400 kV, both of which are listed in the corresponding records of the current plan.

**I Drivers / Objectives:**

To enhance system resources for continuous and dynamic voltage control by deploying synchronous compensators or STATCOMs. This approach supplements the contribution from generators instead of relying only on discrete devices such as reactances or capacitors.

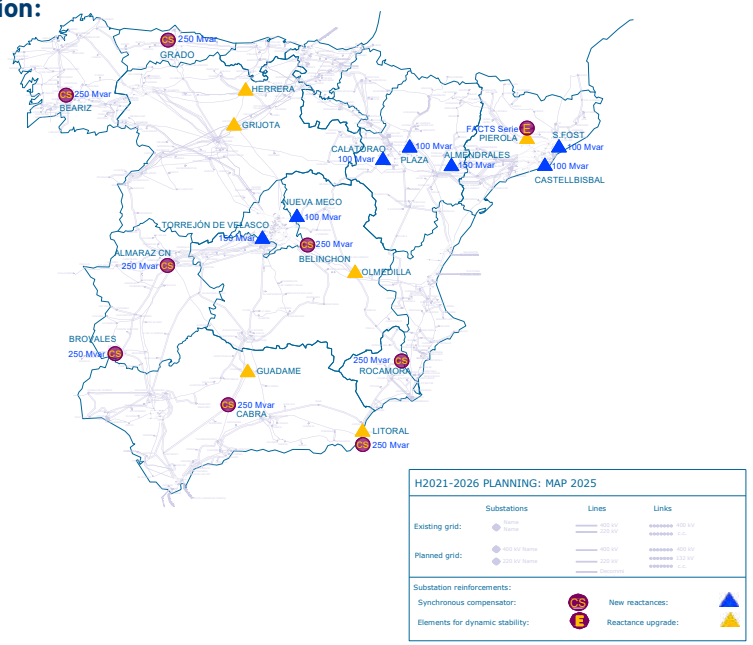
**I Alternatives:**

As an alternative to the planned reactances, which provide discrete voltage control, an increased number of line openings on the transmission grid could be considered. However, this approach may not be compatible with ensuring security of supply under certain operational scenarios. Synchronous compensators will serve as an additional resource from the transmission grid for dynamic voltage control, supplementing that provided by generation.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP25_NOS_TENSION_SEPE
## Operational requirements **Elements for voltage control in SEPE**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: €258.5 M/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| €601.4 M | €5.78 M/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 54.4 | 53.5 | 52.7 | 51.9 | 51.0 | 50.2 | 49.3 | 48.5 | 47.7 |

NOTE: The CAPEX used in the cost-benefit analysis takes into account the costs of the entire project under study, including the reinforcements that may be proposed beyond the planning horizon.

### I Profitability:

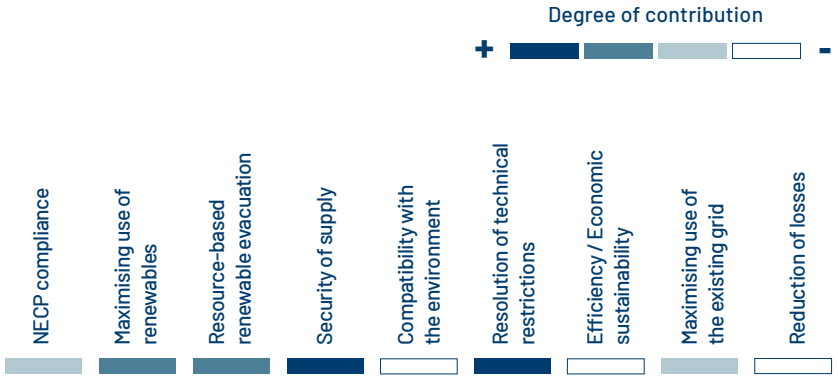
Profitability: NPV

€4,365M

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# I Reinforcement MAP25_NOS_TENSION_SEPE
## Operational requirements **Elements for voltage control in SEPE**

### I Table of physical units:

| | 220 kV | 400 kV |
|---|---|---|
| Bays (units) | 5 | 9 |
| Reactance (Mvar) | 500 | 150 |
| Total upgrade of reactances (MVAr) | | 900 |
| Synchronous compensators (MVAr) | | 2,000 |

NOTE: The table includes all assets involved in the reinforcements under study, regardless of the date of commissioning (detailed below), as well as whether they come with system or third-party costs. Kilometres of circuit are calculated, while the detailed table lists kilometres of route.

### I Detailed list of assets:

| Substation expansion | Units | Type | Driv. | Prev. |
|---|---|---|---|---|
| Almaraz C.N. 400 kV | 1 | AIS | TN | 2026 |
| Almendrales 400 kV | 1 | AIS | TN | 2026 |
| Beariz 400 kV | 1 | AIS | TN | 2026 |
| Belinchón 400 kV | 1 | AIS | TN | 2026 |
| Brovales 400 kV | 1 | AIS | TN | 2026 |
| Cabra 400 kV | 1 | AIS | TN | 2026 |
| Calatorao 220 kV | 1 | AIS | TN | 2026 |
| Castellbisbal 220 kV | 1 | AIS | TN | 2026 |
| Litoral 400 kV | 1 | AIS | TN | 2026 |
| Nueva Meco 220 kV | 1 | AIS | TN | 2026 |
| Plaza 220 kV | 1 | AIS | TN | 2026 |
| Rocamora 400 kV | 1 | AIS | TN | 2026 |
| Sant Fost 220 kV | 1 | AIS | TN | 2026 |
| Santa María de Grado 400 kV | 1 | GIS | TN | 2026 |

| New reactances | MVAr | Type | Driv. | Prev. |
|---|---|---|---|---|
| Almendrales 400 kV, REA1 | 150 | - | N_SO | 2026 |
| Calatorao 220 kV, REA1 | 100 | - | N_SO | 2026 |
| Castellbisbal 220 kV, REA1 | 100 | - | N_SO | 2026 |
| Nueva Meco 220 kV, REA1 | 100 | - | N_SO | 2026 |
| Plaza 220 kV, REA1 | 100 | - | N_SO | 2026 |
| Sant Fost 220 kV, REA1 | 100 | - | N_SO | 2026 |

| Total reactances upgrade | MVAr | Type | Driv. | Prev. |
|---|---|---|---|---|
| Grijota 400 kV, REA2 | 150 | - | TN | 2026 |
| Guadame 400 kV, REA2 | 150 | - | TN | 2026 |
| Herrera 400 kV, REA1 | 150 | - | TN | 2026 |
| Litoral 400 kV, REA1 | 150 | - | TN | 2026 |
| Olmedilla 400 kV, REA1 | 150 | - | TN | 2026 |
| Pierola 400 kV, REA1 | 150 | - | TN | 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

## I Reinforcement MAP25_NOS_TENSION_SEPE
Operational requirements **Elements for voltage control in SEPE**

### I Detailed list of assets (continued):

| New synchronous compensators | MVAr | Type | Driv. | Prev. |
|---|---|---|---|---|
| Almaraz C.N. 400 kV, SC1 | 250 | - | N_SO | 2026 |
| Beariz 400 kV, SC1 | 250 | - | N_SO | 2026 |
| Belinchón 400 kV, SC1 | 250 | - | N_SO | 2026 |
| Brovales 400 kV, SC1 | 250 | - | N_SO | 2026 |
| Cabra 400 kV, SC1 | 250 | - | N_SO | 2026 |
| Litoral 400 kV, SC1 | 250 | - | N_SO | 2026 |
| Rocamora 400 kV, SC1 | 250 | - | N_SO | 2026 |
| Santa María de Grado 400 kV, SC1 | 250 | - | N_SO | 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP25_NOS_TENSION_TNP
## Operational requirements **Elements for voltage control in TNP**

**I General description:**

The project involves the construction of a new 66 kV Haría substation with an I/O connection to the Punta Grande–Tías 66 kV line (circuit 1). It also includes the installation of three new reactances and two new synchronous compensators. Specifically:

- One step-controlled 20 Mvar reactance at San Jorge 132 kV, one 9 Mvar reactance at Playa Blanca 132 kV, and one 4 Mvar reactance at Las Breñas 66 kV.
- Two synchronous compensators: one 25 Mvar unit at the new Haría 66 kV substation and one 10 Mvar unit at Fuencaliente 66 kV.

This project is also complemented by the early implementation of assets already included in the current planning, originally set for beyond 2026. In particular, the synchronous compensator originally planned for Valldurgent 220 kV has been relocated to Son Orlandis 220 kV, as reflected in the corresponding entry of the current plan.

**I Drivers / Objectives:**

The installation of reactances enables stepwise voltage reduction during specific times of day and in targeted areas to compensate for reactive power in long and/or underground transmission lines.

Synchronous compensators will serve as an additional resource from the transmission grid for dynamic voltage control.

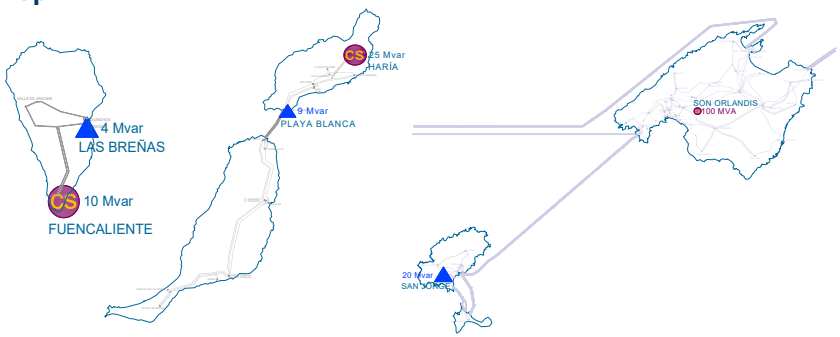
**I Alternatives:**

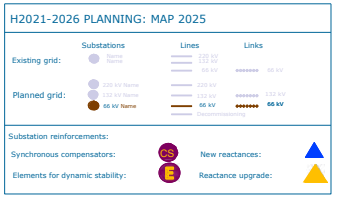
Alternative voltage control options in these electrical systems would involve either the installation or scheduling of new synchronous generation units or the opening of transmission lines. However, due to the small size and limited meshing of these systems, such alternatives are unfeasible.

**I European dimension:**

No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP25_NOS_TENSION_TNP
## Operational requirements **Elements for voltage control in TNP**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: €9.1 M/year | Reduction of $CO_2$ emissions: 6 kt/year* |
| Additional RES integration: 59,306 MWh/year | Reduction of system losses: 35 MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| €59.9 M | €1.35 M/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 6.2 | 6.1 | 6.0 | 5.9 | 5.9 | 5.8 | 5.7 | 5.6 | 5.5 |

NOTE: The CAPEX used in the cost-benefit analysis takes into account the costs of the entire project under study, including the reinforcements that may be proposed beyond the planning horizon.

### I Profitability:

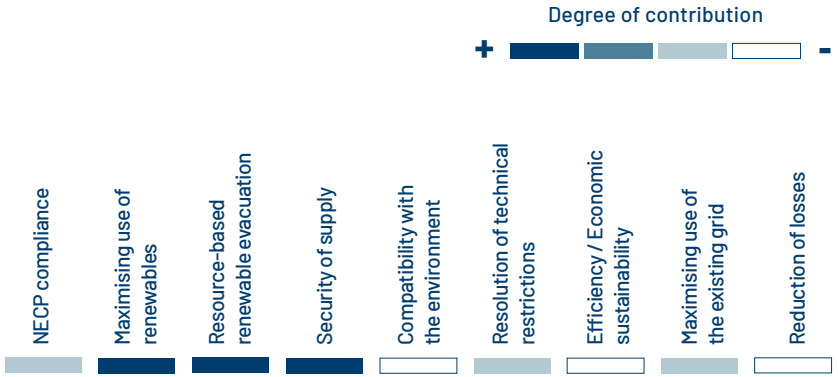
Profitability: NPV

€80M

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement MAP25_NOS_TENSION_TNP
## Operational requirements **Elements for voltage control in TNP**

### I Table of physical units:

| | 66 kV | 132 kV |
|---|---|---|
| Parks (Units) | 1 | |
| Bays (units) | 6 | 2 |
| Overhead Line (km) | 50 | |
| Cables (km) | 2 | |
| Reactance (Mvar) | 4 | 29 |
| Synchronous compensators (Mvar) | 35 | |

NOTE: The table includes all assets involved in the reinforcements under study, regardless of the date of commissioning (detailed below), as well as whether they come with system or third-party costs. Kilometres of circuit are calculated, while the detailed table lists kilometres of route.

### I Detailed list of assets:

| New substations | Type | Prev. |
|---|---|---|
| Haria 66 kV | Building | 2026 |

| Substation expansion | Units | Type | Driv. | Prev. |
|---|---|---|---|---|
| Fuencaliente 66 kV | 1 | GIS | TN | 2026 |
| Haria 66 kV | 4 | GIS | TN | 2026 |
| Las Breñas 66 kV | 1 | GIS | TN | 2026 |
| Playa Blanca 132 kV | 1 | GIS | TN | 2026 |
| San Jorge 132 kV | 1 | GIS | TN | 2026 |

| New lines/cables | MVA [win.] | MVA [sum.] | km* | Type | Driv. | Prev. |
|---|---|---|---|---|---|---|
| I/O in Haria, de Punta Grande–Tías 66 kV (circuit 1) | 80 | 80 | 1 | Cable | TN | 2026 |
| I/O in Haria, de Punta Grande–Tías 66 kV (circuit 1) | 80 | 80 | 25 | Line | TN | 2026 |

Notes: * The estimated length is ±10% for long lines and ±2km for short lines, complying with article 161 of Royal Decree 1955/2000.

| New reactances | MVAr | Type | Driv. | Prev. |
|---|---|---|---|---|
| Las Breñas 66 kV, REA1 | 4 | - | TN | 2026 |
| Playa Blanca 132 kV, REA2 | 9 | - | TN | 2026 |
| San Jorge 132 kV, REA1 1 | 20 | - | TN | 2026 |

Notes:
1. Stepped reactance.

| New synchronous compensators | MVAr | Type | Driv. | Prev. |
|---|---|---|---|---|
| Fuencaliente 66 kV, SC1 | 10 | - | TN | 2026 |
| Haria 66 kV, SC1 | 25 | - | TN | 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP25_NOS_REPOSICION
## Operational requirements **Power service restoration plan**

**I General description:** The project involves the installation of a set of controlled switching relays associated with transmission and generation transformers to ensure proper service restoration following an incident. Specifically, 60 devices will be installed in the mainland electricity system and 6 in the Islas Canarias system.

**I Drivers / Objectives:** Controlled switching relays are designed to ensure that circuit breakers on large power transformers close at optimal moments during switching operations. This prevents sudden inrush currents from the transformer and, consequently, avoids abrupt voltage drops during energisation.

**I Alternatives:** Failing to implement controlled switching relays would result in a slower service restoration process and a higher risk of system islanding.

**I European dimension:** No

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - €M/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| €22 M | €0.14 M/year |

| | Remuneration costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| M€ | 0.0 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 |

NOTE: The CAPEX used in the cost-benefit analysis takes into account the costs of the entire project under study, including the reinforcements that may be proposed beyond the planning horizon.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP25_NOS_REPOSICION
## Operational requirements **Power service restoration plan**

### I Profitability:

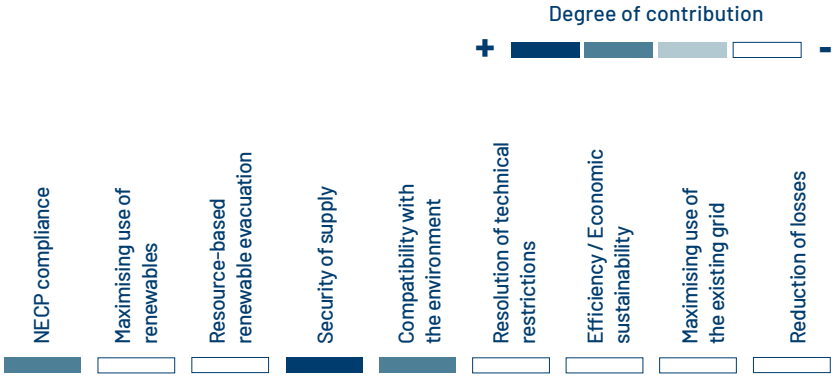
Profitability: NPV

- €M

### I Socio-environmental impact:




### I Contribution to guiding principles:




### I Table of physical units:

| | |
|---|---|
| Controlled switching relays (units) | 66 |

NOTE: The table includes all assets involved in the reinforcements under study, regardless of the date of commissioning (detailed below), as well as whether they come with system or third-party costs. Kilometres of circuit are calculated, while the detailed table lists kilometres of route.

### I Detailed list of assets:

| New controlled switch relays | Driv. | Prev. |
|---|---|---|
| Soto 400/220 kV | TN | 2026 |
| Penagos 400/220 kV | TN | 2026 |
| Puentes García Rodríguez 400 kV | TN | 2026 |
| La Lomba 400/220 kV | TN | 2026 |
| Aldeadávila 400/220 kV | TN | 2026 |
| Vitoria 400/220 kV | TN | 2026 |
| Barcina 400/220 kV | TN | 2026 |
| Hernani 400/220/132 kV | TN | 2026 |
| Ichaso 400/220 kV | TN | 2026 |
| Amorebieta 400 kV | TN | 2026 |
| Castejón 400kV | TN | 2026 |
| La Serna 400/220 kV | TN | 2026 |
| Ziérbena 400 kV | TN | 2026 |
| Santa Engracia 400/220 kV | TN | 2026 |

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
**II: New reinforcements**
III: Technical annexes

# I Reinforcement MAP25_NOS_REPOSICION
## Operational requirements **Power service restoration plan**

### I Detailed list of assets:

| New controlled switch relays | Driv. | Prev. |
|---|---|---|
| Almaraz 400/220 kV | TN | 2026 |
| Villaviciosa 400/220 kV | TN | 2026 |
| San Sebastián de los Reyes 400/220 kV | TN | 2026 |
| Galapagar 400/220 kV | TN | 2026 |
| Loeches 400/220 kV | TN | 2026 |
| Aceca 220 kV | TN | 2026 |
| Palos 400/220 kV | TN | 2026 |
| Pinar de Rey 400/220 kV | TN | 2026 |
| Don Rodrigo 400/220 kV | TN | 2026 |
| Arcos 400 kV | TN | 2026 |
| Guadame 400/220 kV | TN | 2026 |
| Caparacena 400/220 kV | TN | 2026 |
| Castellón 400/16 kV | TN | 2026 |
| Morvedre 400/20 kV | TN | 2026 |
| Benejama 400/220 kV | TN | 2026 |
| Torremendo 400/220 kV | TN | 2026 |
| Fausita 400/220 kV | TN | 2026 |
| Sagunto 400 kV | TN | 2026 |
| Nueva Escombreras 400 kV | TN | 2026 |
| Bescanó 400/220 kV | TN | 2026 |

| New controlled switch relays | Driv. | Prev. |
|---|---|---|
| Viladecans 400/220 kV | TN | 2026 |
| Rubí 400/220 kV | TN | 2026 |
| Peñaflor 400/220 kV | TN | 2026 |
| Escatrón 400/220 kV | TN | 2026 |
| La Espluga 400/220 kV | TN | 2026 |
| Pierola 400/220 kV | TN | 2026 |
| Canary Islands electricity system | TN | 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP25_NOS_SEC_GEN
## Operational requirements **Emergency generation in Islas Canarias**

**I General description:** The project involves the upgrade of 2 existing bays and the construction of 2 new ones to connect emergency generation.

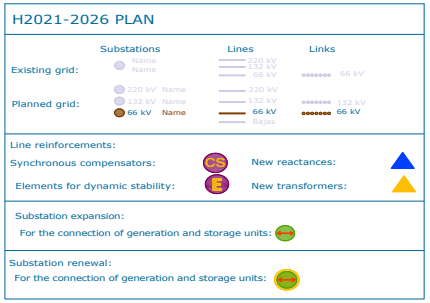
**I Drivers / Objectives:** The need to install emergency generation in Islas Canarias has been identified in system operator coverage reports. This approach is also part of the measures included under the declared energy emergency in the islands.

**I Alternatives:** No viable alternatives. Installing generation through a competitive bidding process would result in significantly longer lead times for deploying the required generation capacity.

**I European dimension:** No

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement MAP25_NOS_SEC_GEN
## Operational requirements **Emergency generation in Islas Canarias**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: - €M/year | Reduction of $CO_2$ emissions: - kt/year* |
| Additional RES integration: - MWh/year | Reduction of system losses: - MWh/year* |
| Reduction of ENS: - MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| - €M | €0.05 M/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |

NOTE: The CAPEX used in the cost-benefit analysis takes into account the costs of the entire project under study, including the reinforcements that may be proposed beyond the planning horizon.

### I Profitability:

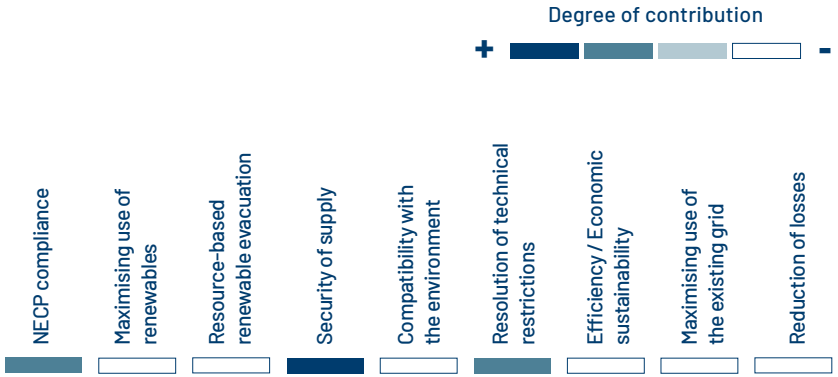
Profitability: NPV

- €M

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# I Reinforcement MAP25_NOS_SEC_GEN
## Operational requirements **Emergency generation in Islas Canarias**

### I Table of physical units:

| | 66 kV |
|---|---|
| Bays (units) | 2 |
| Partial bay upgrade (units) | 2 |

NOTE: The table includes all assets involved in the reinforcements under study, regardless of the date of commissioning (detailed below), as well as whether they come with system or third-party costs. Kilometres of circuit are calculated, while the detailed table lists kilometres of route.

### I Detailed list of assets:

| Partial bay replacement | Units | Type | Driv. | Prev. |
|---|---|---|---|---|
| Granadilla 66 kV | 1 | AIS | Gen./Sto. | 2026 |
| Puerto del Rosario 66 kV | 1 | GIS | Gen./Sto. | 2026 |

| Substation expansion | Units | Type | Driv. | Prev. |
|---|---|---|---|---|
| Cinsa 66 kV | 1 | AIS | Gen./Sto. | 2026 |
| Dique del Este 66 kV | 1 | AIS | Gen./Sto. | 2026 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes



# I Reinforcements beyond the 2026 horizon

## INTRODUCTION

Below is a list of the reinforcements that are expected to be necessary beyond the 2026 planning horizon in the different Autonomous Communities in order to meet the objectives established in the NCEP by 2030.

While the planning horizon is six years in accordance with current legislation, the deployment of some transmission network infrastructures requires extended periods of study and administrative and environmental process, of resolution of technical difficulties and of coordination between different stakeholders. These factors make it advisable to consider, on a preliminary basis, longer-term planning horizons. In accordance with sector legislation, the identification of an reinforcements for a date later than the planning period allows the initiation of the relevant administrative procedures as long as they do not directly affect the property and rights of third parties.

The following reinforcements include information on their drivers and observations. The drivers include:

- RES integration and resolution of technical constraints. These reinforcements reduce system costs. This group includes, among others, reinforcements for the integration of renewable energies and the resolution of overloads or voltage problems.
- Security of supply. These reinforcements prevent local or zonal outages and ensure the security of the system as a whole. This group would include reinforcements for the reduction of short-circuit current or the elimination of "T" configurations, among others.
- Support to the distribution network.
- Railway line power supply.
- Storage. Reinforcements needed for access to new energy storage facilities.
- International interconnections. These reinforcements are necessary for international connections.
- Links between systems. These are connections between Mainland and non-peninsular systems or interconnections between island systems.



Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# LIST OF REINFORCEMENTS WITH COMMISSIONING BEYOND 2026

## Andalucía

| ID | Reinforcements with commissioning beyond 2026 in Andalucía | Information | |
|---|---|---|---|
| | | Drivers | Observations |
| POS0 | New SE Parrales 400 kV, I/O in Parrales 400 kV de L/Guillena-Puebla de Guzmán 400 kV, New SE Villarrasa 400 kV, I/O in Villarrasa 400 kV de DC/ Guillena-Puebla de Guzmán 400 kV, I/O in Villarrasa 400 kV de DC/Guillena-Palos 400 kV, New SE Fresón 400 kV, I/O in Fresón 400 kV of L/Guillena-Palos 400 kV. SE Parrales 400 kV extension in 2 bays. SE Fresón 400 kV extension in 2 bays. | New demands | MAP April 2024 |
| POS1 | Double circuit Villanueva del Rey-Guadame 400 kV. One of the circuits has continuity to Carmona taking advantage of a Carmona-Villanueva del Rey circuit | RES integration and resolution of technical constraints | |
| POS2 | Double circuit Guadame-Manzanares 400 kV | RES integration and resolution of technical constraints | |
| POS3 | Reactances 1 and 2 Villanueva del Rey 400 kV of 150 Mvar | RES integration and resolution of technical constraints | |
| POS4 | New transformer 1 Villanueva del Rey 400/220 kV of 600MVA | RES integration and resolution of technical constraints | |

## Aragón

| ID | Reinforcements with commissioning beyond 2026 in Aragón | Information | |
|---|---|---|---|
| | | Drivers | Observations |
| POS5 | Interconnection Spain-France HVDC Aragón-Atlantic Pyrenees | International interconnections | TYNDP270 Project PCI 2.27.1 |
| POS6 | New input-output at the Ejea de los Caballeros 400 kV substation on the La Serna-Magallón and Magallón-Peñaflor 400 kV lines | RES integration and resolution of technical constraints | |
| POS8 | Uprating of Magallón-Moncayo 220 kV | RES integration and resolution of technical constraints | |
| POS9 | Double circuit Los Vientos-Cariñena and transformer Cariñena 400/220 kV AT1 | RES integration and resolution of technical constraints | |
| POS10 | Reactance 1 Platea 400 kV of 150 Mvar | RES integration and resolution of technical constraints | |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# LIST OF REINFORCEMENTS WITH COMMISSIONING BEYOND 2026

## Asturias

| ID | Reinforcements with commissioning beyond 2026 in Asturias | Information | |
|---|---|---|---|
| | | Drivers | Observations |
| POS11 | New input-output at the Abres 400 kV substation on the Boimente-Pesoz 400 kV line, circuit 1 | Distribution network support | Possible connection of offshore wind generation |
| POS12 | Gozón-Reboria 400 kV line, Reboria 400 and 220 kV substation. Transformer 400/220 kV Reboria | Security of Supply | |
| POS13 | Reboria-Sama 400 kV line and Sama 400 kV substation. Input-output at Sama 400 kV on the Lada-Pola de Gordón 400 kV line. | Security of Supply | |

## Islas Baleares

| ID | Reinforcements with commissioning beyond 2026 in Islas Baleares | Information | |
|---|---|---|---|
| | | Drivers | Observations |
| POS14 | Mallorca-Menorca 132 kV interconnection between San Martín and Oeste, and associated reactances. New 132 kV San Martín substation and 220/132 kV transformers. New input-output at the new Oeste 132 kV substation on the Ciudadela-Es Mercadal 132 kV line | Links between systems | Submarine alternating current cable |
| POS15 | Son Noguera 66 kV substation. Input-output at Son Noguera on the Arenal-Lluçmajor 1 66 kV line. | Distribution network support | Line prepared for 132 kV |
| POS16 | A 100 MVA synchronous condenser at Santa Ponsa 220 kV | Links between systems | |
| POS18 | Two 100 MVA synchronous condensers at Llubí 220 kV | Links between systems | |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# LIST OF REINFORCEMENTS WITH COMMISSIONING BEYOND 2026

## Islas Canarias

| ID | Reinforcements with commissioning beyond 2026 in Islas Canarias | Information | |
|---|---|---|---|
| | | Drivers | Observations |
| POS19 | Interconnection Gran Canaria-Fuerteventura | Links between systems | Technology to be defined |
| POS20 | Double input-output at Las Rosas 220 kV substation on the Granadilla-Caletillas 220 kV and El Porís-Buenos Aires 220 kV lines. Input-output at Las Rosas 66 kV on the Candelaria-Porís 66 kV line and new transformer Las Rosas 220/66 kV AT2. Double bus of Las Rosas 220 kV | RES integration and resolution of technical constraints | |
| POS21 | Second circuit of the Double Circuit Sta Águeda - Arguineguín 66 kV circuits 3 and 4 | Distribution network support | |
| POS22 | Topological change with disconnection of Jinamar-Lomo Apolinario and connection of Sabinal-Lomo Apolinario 66 kV | Security of Supply | |
| POS23 | New input-output at the Antigua 132 kV substation on the Pto del Rosario-Gran Tarajal 132 kV line circuit 1 | RES integration and resolution of technical constraints | |

## Cantabria

| ID | Reinforcements with commissioning beyond 2026 in Cantabria | Information | |
|---|---|---|---|
| | | Drivers | Observations |
| POS26 | Cacicedo-Puente de San Miguel 220 kV line/cable | Security of Supply | |

## Castilla-La Mancha

| ID | Reinforcements with commissioning beyond 2026 in Castilla-La Mancha | Information | |
|---|---|---|---|
| | | Drivers | Observations |
| POS27 | Doble circuit Manchega-Romica 400 kV | RES integration and resolution of technical constraints | |
| POS28 | Double circuit Belinchón-Morata 3 and 4 | RES integration and resolution of technical constraints | |
| POS29 | Manzanares-Picón 400 kV line, Picón 400 kV substation. Transformer 400/220 kV Picón | RES integration and resolution of technical constraints | |
| POS30 | Double circuit Guadame-Manzanares 400 kV | RES integration and resolution of technical constraints | |
| POS31 | Reactance 1 Manchega 400 kV of 150 Mvar | RES integration and resolution of technical constraints | |
| POS32 | Extension of the Talavera 220 kV substation | Distribution network support | |
| POS33 | Extension of the Huelves 220 kV substation | Distribution network support | |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# LIST OF REINFORCEMENTS WITH COMMISSIONING BEYOND 2026

## Castilla y León

| ID | Reinforcements with commissioning beyond 2026 in Castilla y León | Information | |
|---|---|---|---|
| | | Drivers | Observations |
| POS34 | Almazán-Medinaceli 400 kV double-circuit line | RES integration and resolution of technical constraints | |
| POS35 | Extension of the Vilecha 400 kV substation | Distribution network support | |
| POS36 | New transformer 1 Villalbilla 400/220 kV of 600MVA | RES integration and resolution of technical constraints | |

## Cataluña

| ID | Reinforcements with commissioning beyond 2026 in Cataluña | Information | |
|---|---|---|---|
| | | Drivers | Observations |
| POS37 | New input-output at the new Valdonzella 220 kV substation on the Vilanova-Mata 220 kV line. | Distribution network support | |
| POS38 | Reactance 1 Els Aubals 400 kV of 150 Mvar Reactance 1 La Secuita 400 kV of 150 Mvar | RES integration and resolution of technical constraints | |

## Valencia

| ID | Reinforcements with commissioning beyond 2026 in Valencia | Information | |
|---|---|---|---|
| | | Drivers | Observations |
| POS40 | New input-output at the new Assegador 220 kV substation on the La Plana-Bechí 220 kV cable. New line La Plana-Assegador 2 220 kV. | Distribution network support | |
| POS41 | Extension of the Aldaia 220 kV substation | Distribution network support | |
| POS43 | New phase shifter in Godelleta 400 kV substation | Security of Supply | |
| POS44 | New double bus in Torrente 220 kV substation | Security of Supply | |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# LIST OF REINFORCEMENTS WITH COMMISSIONING BEYOND 2026

## Extremadura

| ID | Reinforcements with commissioning beyond 2026 in Extremadura | Information | |
|---|---|---|---|
| | | Drivers | Observations |
| POS45 | New double circuit San Serván - Alange 400 kV | RES integration and resolution of technical constraints | |
| POS46 | New double circuit Alange -La Serena 400 kV | RES integration and resolution of technical constraints | |
| POS47 | New input-output at Valdecaballeros 400 kV on the Almaraz-Guadame 400 kV line | RES integration and resolution of technical constraints | |
| POS48 | New input-output at the Santos de Maimona 220 kV substation on Guillena - Mérida 220 kV | Distribution network support | |
| POS49 | Extension of the La Serena 400 kV substation | Distribution network support | |

## Galicia

| ID | Reinforcements with commissioning beyond 2026 in Galicia | Information | |
|---|---|---|---|
| | | Drivers | Observations |
| POS50 | Reinforcements in the transmission network for the integration of hydraulic storage in Galicia | RES integration and resolution of technical constraints/ Storage | |

## La Rioja

There are no reinforcements.

## Community of Madrid

| ID | Reinforcements with commissioning beyond 2026 in Community of Madrid | Information | |
|---|---|---|---|
| | | Drivers | Observations |
| POS51 | Double circuit Cisneros-Complutum 220 kV | Security of Supply | Requires 2,500 $mm^2$ copper cable section |
| POS52 | Aena-Campo de las Naciones 220 kV line/cable | Security of Supply | |
| POS53 | New Begoña-Fuente Hito 220 kV cable | Security of Supply | Requires 2,500 $mm^2$ copper cable section |
| POS54 | Operable bypass at Parque de Ingenieros 220 kV of the lines Parque Ingenieros-Villaverde Bajo 2 220 kV and Parque Ingenieros-Aguacate forming a provisional Aguacate-Villaverde Bajo 220 kV line | Security of Supply | |
| POS55 | Capacity increase with change of conductor on the Coslada-Villaverde 220 kV line | Security of Supply | |
| POS56 | New input-output at the new Cristo de Rivas 220 kV substation on the Loeches-Vallecas 220 kV line, circuit 1 | Distribution network support | |
| POS57 | Extension of the Morata 220 kV substation | Distribution network support | |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# LIST OF REINFORCEMENTS WITH COMMISSIONING BEYOND 2026

## Murcia

There are no reinforcements.

## Navarra

| ID | Reinforcements with commissioning beyond 2026 in Navarra | Information | |
|---|---|---|---|
| | | Drivers | Observations |
| POS59 | Spain-France HVDC interconnection Navarra-French border from new Olza 400 kV with input-output on the Ichaso-Muruarte/ Castejón 400 kV line | International interconnections | TYNDP276 PCI 2.27.2 Project |
| POS60 | Extension of the Olza 400 kV substation | Railway line power supply | Alternative to Irañeta 220kV I/O in the Ichaso-Orcoyen 220kV lines. |
| POS61 | Extension of the Tafalla 220 kV substation | Railway line power supply | |
| POS62 | New Tierra Estella-Laguardia 220 kV axis | Security of Supply | |
| POS63 | Extension of the Tierra Estella 220 kV substation | Distribution network support | |

## País Vasco

| ID | Reinforcements with commissioning beyond 2026 in País Vasco | Information | |
|---|---|---|---|
| | | Drivers | Observations |
| POS64 | New Tierra Estella - Laguardia 220 kV line. | Security of Supply | |
| POS65 | New cable line Arkale-Irún 220 kV, circuit 2 | Security of Supply | |
| POS66 | Extension of the Jundiz 220 kV substation | Distribution network support | |
| POS67 | ATP-2 400/220 kV 600 MVA transformer at the Gatica substation | RES integration and resolution of technical constraints/ International interconnections | TYNDP378 Project |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement INT_ESP-FRA_4

International interconnections

## Spain-France interconnection between Navarra and Landes

**I General description:**

The project consists of a new interconnection between Spain and France via the western region of the Pyrenees, between Olza in Spain and Cantegrit in France. This new interconnection will be in direct current, using VSC technology and two symmetrical 1,000 MW monopoles.

**I Drivers / Objectives:**

- Integration of Spain and the Iberian Peninsula into the European single market, contributing to reducing price differences between countries.
- Contributing to the integration of existing and future renewable energy across Europe, particularly in Spain and the Iberian Peninsula.
- Reducing electrical isolation in Spain and the Iberian Peninsula, and improving the level of interconnection in order to comply with the objectives set by the EU.
- Complying with intergovernmental agreements from the Madrid Declaration and the exchange values of the 2030 target scenario laid out in NECP (National energy and climate plans).

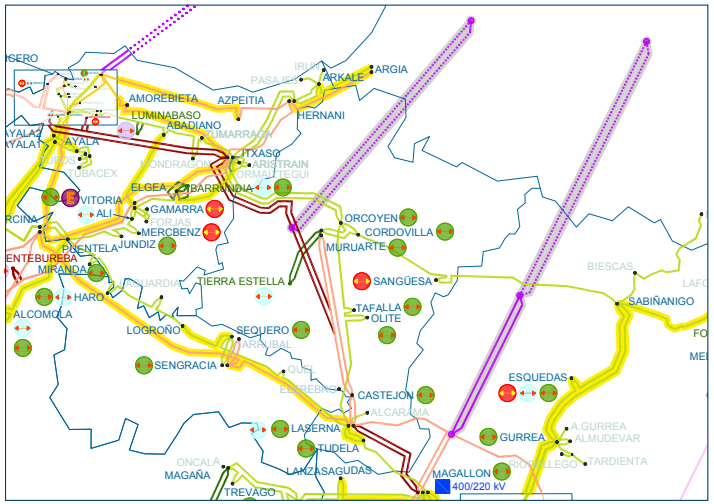
**I Alternatives:**

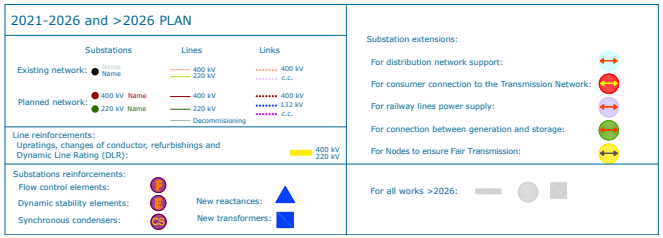
Two new projects that would go through the Pyrenees have been proposed to maintain balanced flow distribution between Spain and France after commissioning of the submarine interconnection in the Bay of Biscay and to achieve the target interconnection level of 8,000 MW. The interconnection will be underground and in direct current to increase project acceptance among local populations and maximise respect for the environment.

**I European dimension:**

Yes / Project 276 from TYNDP 2020 and Project PIC 2.27.2 in the 2019 list.

**I Map:**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# I Reinforcement INT_ESP-FRA_4

International interconnections

**Spain-France interconnection between Navarra and Landes**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 93 M€/year | Reduction of $CO_2$ emissions: 523 kt/year* |
| Additional RES integration: 3,628,000 MWh/year | Reduction of system losses: - 1,750,000 MWh/year* |
| Reduction of ENS: 3,623 MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 1,306.3 M€ | 5.76 M€/year |

| Remuneration costs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| M€ | 0.0 | 111.3 | 109.5 | 107.7 | 105.8 | 104.0 | 102.2 | 100.4 | 98.6 | 96.7 |

Note: The indicated CAPEX corresponds to the reinforcements of the complete interconnection project, without prejudice to the cost sharing agreement to be reached between the parties. The results of the cost-benefit analysis are those corresponding to the "National Trends 2030" scenario of the European 2020 ten-year planning (TYNDP 2020) and consider both the costs and benefits of the interconnected system, following the methodology used in ENTSOE.

### I Profitability:

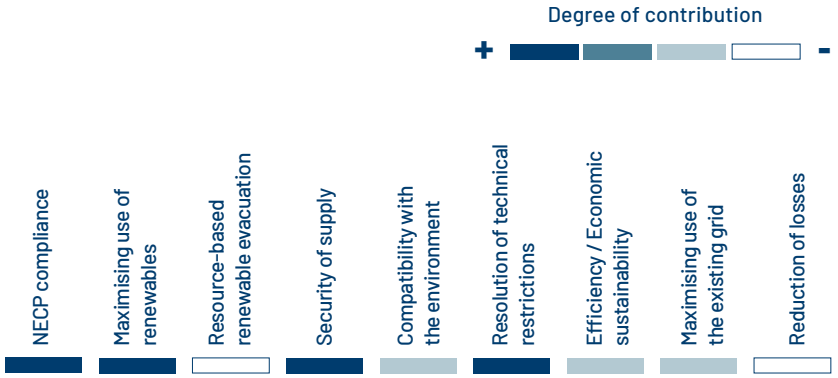
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement INT_ESP-FRA_4

International interconnections

## Spain-France interconnection between Navarra and Landes

### Table of physical units:

| | 400 kV |
|---|---|
| Bays (units) | 9 |
| Overhead line (km) | 2 |
| HVDC link (km) | 225 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Olza 400 kV | Outdoor | > 2026 |

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Olza 400 kV | 9 | AIS | TN | > 2026 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| I/O in Olza, of Itxaso - Castejón 400 kV, circuit 1 | | | 0.5 | Line | TN | > 2026 |
| I/O in Olza, of Itxaso - Muruarte 400 kV, circuit 1 | | | 0.5 | Line | TN | > 2026 |
| Olza - Cantegrit 400 kV, circuit 1[1] | 2,000 | 2,000 | 225 | Cable | INT | > 2026 |

Notes:
1. Submarine link with 2 symmetrical monopoles.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# I Reinforcement INT_ESP-FRA_5
## International interconnections
## Spain-France via the Aragón Pyrenees - Atlantic Pyrenees

**I General description:**

The project consists of a new interconnection between Spain and France via the central region of the Pyrenees between Aragón in Spain and Marsillon in France. This interconnection will be in direct current, with VSC technology, and will have two symmetrical 1,000 MW monopoles.

**I Drivers / Objectives:**

- Integration of Spain and the Iberian Peninsula into the European single market, contributing to reducing price differences between countries.
- Contributing to the integration of existing and future renewable energy across Europe, particularly in Spain and the Iberian Peninsula.
- Reducing electrical isolation in Spain and the Iberian Peninsula, and improving the level of interconnection in order to comply with the objectives set by the EU.
- Complying with intergovernmental agreements from the Madrid Declaration and the trade values of the 2030 target scenario laid out in NECP (Plan Nacional Integrado de Energía y Clima - National energy and climate plans).

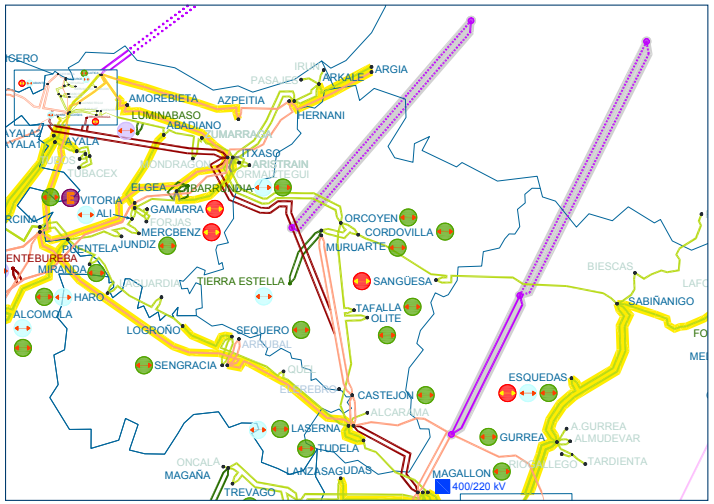
**I Alternatives:**

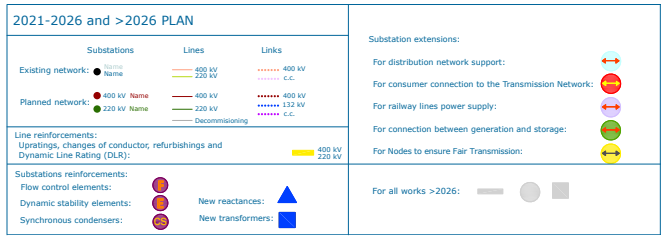
Two new projects that would go through the Pyrenees have been proposed to maintain balanced flow distribution between Spain and France after commissioning of the submarine interconnection in the Bay of Biscay and to achieve the target interconnection level of 8,000 MW. The interconnection will be underground and in direct current to increase project acceptance among local populations and maximise respect for the environment.

**I European dimension:**

Yes / Project 270 from TYNDP 2020 and Project PIC 2.27.1 in the 2019 list.

**I Map:**




Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

# I Reinforcement INT_ESP-FRA_5

International interconnections

**Spain-France via the Aragón Pyrenees - Atlantic Pyrenees**

## Cost-Benefit Multi-Criteria Analysis

### I Benefits:

| | |
|---|---|
| Socio-economic welfare: 93 M€/year | Reduction of $CO_2$ emissions: 523 kt/year* |
| Additional RES integration: 3,628,000 MWh/year | Reduction of system losses: - 1,750,000 MWh/year* |
| Reduction of ENS: 3,623 MWh/year* | Reduction of needed installed generation capacity: - MW |

Note: * a negative value means existing increased emissions, losses or ENS.

### I Costs:

| CAPEX | OPEX |
|---|---|
| 1,269.8 M€ | 1.03 M€/year |

Remuneration costs

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| M€ | 0.0 | 103.6 | 101.9 | 100.1 | 98.3 | 96.5 | 94.8 | 93.0 | 91.2 | 89.5 |

Note: The indicated CAPEX corresponds to the reinforcements of the complete interconnection project, without prejudice to the cost sharing agreement to be reached between the parties. The results of the cost-benefit analysis are those corresponding to the "National Trends 2030" scenario of the European 2020 ten-year planning (TYNDP 2020) and consider both the costs and benefits of the interconnected system, following the methodology used in ENTSOE.

### I Profitability:

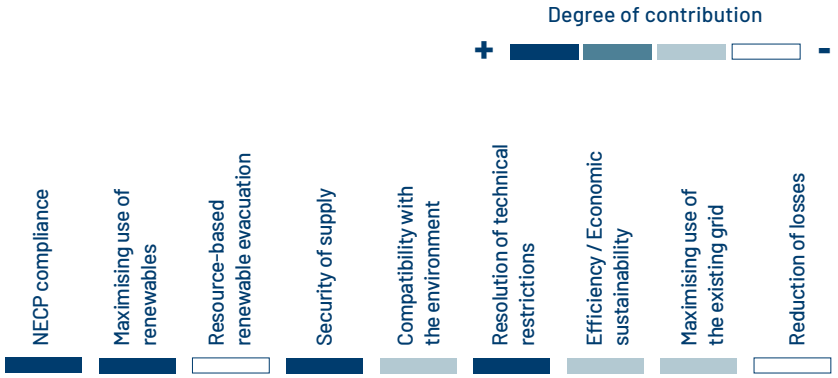
Profitability: NPV

- M€

### I Socio-environmental impact:




### I Contribution to guiding principles:




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

Annexes

I: Staritng grid

II: New reinforcements

III: Technical annexes

# Reinforcement INT_ESP-FRA_5

International interconnections

## Spain-France via the Aragón Pyrenees - Atlantic Pyrenees

### Table of physical units:

| | 400 kV |
|---|---|
| Bays (units) | 15 |
| Overhead line (km) | 222 |
| HVDC link (km) | 230 |

Note: The table covers all assets included in the reinforcements under study, regardless of the Year of commissioning (detailed below) and whether costs for the system or third parties are involved. This table shows circuit kilometres, whereas the detailed table shows power line clearance kilometres.

### Detailed list of assets:

| New substations | Type | Year |
|---|---|---|
| Aragón Región 400 kV | Outdoor | > 2026 |
| Ejea de los Caballeros 400 kV | Outdoor | > 2026 |

### Detailed list of assets (continued):

| Substation extension | units | Type | Driv. | Year |
|---|---|---|---|---|
| Aragón Región 400 kV | 6 | AIS | TN | > 2026 |
| Ejea de los Caballeros 400 kV | 9 | AIS | TN | > 2026 |

| New lines/cables | MVA [win.] | MVA [sum.] | km (±10%) | Type | Driv. | Year |
|---|---|---|---|---|---|---|
| Aragón Región - Marsillon E.C. 400 kV, circuit 1[1] | 2,000 | 2,000 | 230 | Cable | INT | > 2026 |
| DC Ejea de los Caballeros - Aragón Región 400 kV | | | 110 | Line | INT | > 2026 |
| I/O in Ejea de los Caballeros, of La Serna - Magallón 400 kV, circuit 1 | | | 0.5 | Line | INT | > 2026 |
| I/O in Ejea de los Caballeros, of Magallón - Peñaflor 400 kV, circuit 1 | | | 0.5 | Line | INT | > 2026 |

Notes:
1. Submarine link with 2 symmetrical monopoles.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

**II: New reinforcements**

III: Technical annexes

# Annexes
# III: Technical annexes

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# TABLE OF CONTENTS

**1. ANNEX - MINIMUM SYNCHRONOUS GENERATION REQUIREMENTS**

**1.1. Minimum synchronous generation requirements**

**2. ANNEX - ANALYSIS OF EQUIPMENT FOR DAMPING OF INTER-AREA OSCILLATION**

**2.1. Introduction**

**2.2. Analysis of equipment for damping of inter-area oscillations**

2.2.1. FACTS devices

2.2.2. Most effective location for FACTS devices

**2.3. Structural needs of the system to dampen inter-area oscillations**

**2.4. References**

**3. ANNEX - SYNCHRONOUS CONDENSERS IN THE BALEARIC ISLANDS ELECTRICITY SYSTEM: TECHNICAL JUSTIFICATION**

**3.1. Introduction**

**3.2. Operational issues associated to a 100% decarbonised SEB**

**3.3. Technological solutions available**

**3.4. Studies justifying the need for synchronous condensers**

**3.5. Conclusions**

**4. ANNEX - SYNCHRONOUS CONDENSERS IN THE CANARY ISLANDS ELECTRICITY SYSTEM: TECHNICAL JUSTIFICATION**

**4.1. MPE integration in weak networks**

**4.2. Influence of synchronous condensers on ZEI size**

**4.3 Conclusions**

**5. ANNEX - DYNAMIC TRANSMISSION CAPACITY**

**5.1. Dynamic Line Rating (DLR) as an alternative to the development of the transmission network**

**5.2. Criteria for identifying DLR as a solution for the network development plan 2021-2026. Benefits for the system**

**5.3. DLR applicability**

**6. ANNEX - QUALITY OF SERVICE AND RELATION WITH TRANSMISSION NETWORK CHARACTERISTICS**

**6.1. Historical situation of the quality of service of the transmission network in the Mainland, Balearic and Islas Canarias systems**

**6.2. Analysis of the influence of the topology and meshing of the transmission network on quality of service**

**7. ANNEX – CBA ANALYSIS WITH SEQUENTIAL PINT IN THE PROJECT FOR THE REINFORCEMENT OF THE ELECTRICITY CONNECTION BETWEEN THE MAINLAND AND THE BALEARIC ISLANDS**

**7.1. Introduction**

**7.2. Sequential PINT analysis of the reinforcements to reinforce the interconnection between the Mainland and the Islas Baleares**

7.2.1. CBA analysis of the battery storage systems

7.2.2. CBA analysis of synchronous condensers

7.2.3. CBA analysis of the second HVDC link between the Spanish Mainland and the Islas Baleares

7.2.4. Conclusions

**8.ANNEX- ANALYSIS OF THE REINFORCEMENT OF THE INTERCONNECTION BETWEEN SPAIN AND MOROCCO**

# 1. Annex - Minimum synchronous generation requirements

## 1.1. Minimum synchronous generation requirements

The energy transition and transformation from an electricity system based on conventional synchronous generators to an electricity system dominated by technologies such as wind and photovoltaics, not connected synchronously to the network, but through a power electronics (PE) interface, is an unprecedented paradigm shift.

Synchronous generators are rotating machines that convert mechanical energy into electrical energy. They rotate at a "constant" speed and maintain a rigid link to the frequency of the network. Their response to disturbances is essentially determined by electromagnetic physical laws, derived from their constructional characteristics. In this way, they are able to provide the system with specific properties (inertia, short-circuit power, etc.) in an intrinsic and instantaneous way.

Wind and photovoltaic technologies, which will dominate the generation mix in the coming years, are technologies that connect to the network through a power electronics interface between the generator and the network. This means that their response to disturbances is fundamentally derived from the design and programming of their controls. At present, and in general[1], this type of technology lacks the capacity to provide inertial response and to set the frequency. In addition, their short-circuit current injection differs from the inherent and natural response of synchronous generators, introducing delays in their response.

The electricity system, to operate safely and steadily, needs to have certain capabilities: inertial response, frequency setting (grid forming), minimum short-circuit power levels, dynamic voltage control... which, if not provided by technologies based on power electronics, have to be provided by synchronous technologies. Even under the assumption that future wind and photovoltaic generation provide certain technical requirements according to the Ministerial Order establishing the technical requirements for network connection necessary for the implementation of the network connection codes, TED/749/2020, it is identified that a minimum number of synchronous generators have to be kept coupled in the system. This minimum synchronous generation which is essential for the correct operation of the electricity system is known as "synchronous must-run" (SMR). The SMR is determined by the capacity, location and technology of the synchronous generators coupled in each scenario, as well as by the technical capacities of all the coupled generators (synchronous and non-synchronous). Given the different technical capabilities and particular characteristics of the various synchronous generation technologies, there is no single must-run solution. In other words, depending on the synchronous technology coupled, the number of synchronous coupled generators required may differ.

The case studies in the development plan have been generated considering an emission-free "synchronous must-run generation" based on nuclear, run-of-river hydro and solar thermal generation.

1 Both inertia emulation and grid forming technologies to set the frequency (current technology based on power electronics follows the network frequency set by synchronous generators), are currently not sufficiently mature developments, which are currently de facto incorporated into wind and PV generators installed in the system.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

The synchronous generation that is identified as belonging to the must-run is the one which should be permanently coupled in the system, and therefore, if the market itself does not guarantee it, it should be coupled as an ancillary service in the technical constraints process for stability reasons. From the "must-run" point of view, the power produced by the generators is not relevant, but rather the nominal synchronous power connected. In other words, once coupled, the generators could be at any output value.

Studies carried out by the system operator within the framework of the NECP scenarios have made it possible to identify different SMR configurations depending on the generation technologies. In particular, the following have been identified for the Spanish mainland electricity system:

- Thermal SMR: "must-run" consisting of large thermal generators (nuclear and combined cycle units), in accordance with the traditional practice in the operation of coupling thermal generators due to stability constraints.
- Emission-free SMR: "must-run" consisting of nuclear and renewable energy sources. In this "must-run", the participation of combined cycle plants is replaced by concentrated solar power (CSP) and hydraulic renewable energy sources. Within hydraulic, preference is given to run-of-river, followed by pumped storage, and lastly non-flowing and non-pumped hydraulics.
- For the transmission network development plan 2026 horizon, in the Spanish mainland electricity system, the Thermal SMR is made up of nuclear generation (at least 5 nuclear generators connected), and 5 thermal combined cycle generators distributed throughout the peninsular geography. The emission-free SMR would be made up of nuclear generation (at least 5 nuclear generators connected), together with the run-of-river hydro of the system (around 3,750 MW of coupled nominal capacity, regardless of its production, which could be much lower) and solar thermal generation (around 860 MW of connected nominal capacity, regardless of its production value, which could be much lower).
- As part of the studies for the transmission network development plan 2021-2026, all the case studies (8,760 hourly cases at the 2026 horizon) were generated taking into account the minimum synchronous generation required to meet the stability



Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

requirements of the system. The hourly case studies were generated under the premise of an emission-free SMR, although in those scenarios in which the emission-free synchronous generation connected did not meet the SMR requirement, the necessary equivalent thermal generators (combined cycles) were coupled simulating the effect of the technical constraints ancillary process.

- The main problem that can be foreseen in the face of reduced connected synchronous generation in the Spanish mainland electricity system is the massive disconnections of generation in the event of disturbances (short-circuits) in the network. There is a maximum generation disconnection upper limit of 3,000 MW corresponding to the generation-demand imbalance value for the sizing of primary regulation reserves (FCR – Frequency Containment Reserves) at European level. In any case, depending on the specific scenario, the limit may be lower due to national stability limitations. Reducing the presence of synchronous generators below the identified "must-run" levels leads to the propagation of voltage dips to larger extensions as well as a greater depth of the dips, resulting from the reduction of short-circuit power levels in the system. This situation causes a significant increase in PE generation that would be disconnected due to a lack of capacity to withstand voltage dips in the event of faults, compared to that which would be disconnected in scenarios with a greater participation of synchronous generation. In this regard, it is important to note that to make a very low "must-run" value possible, such as those considered for the studies of the transmission network development plan 2021-2026, and to increase production from renewable energy sources, it is necessary to provide or require the capacity to withstand voltage dips of the PE generation that does not have it:
  - It is necessary that future wind and photovoltaic generators type A (< 0.1 MW) have the capacity to withstand voltage dips as indicated for type B generators in the national development of Regulation (EU) 2016/631 of April 14.
  - The voltage dip adaptation of existing photovoltaic generators (at least facilities or clusters larger than 1 MW) as well as wind generators without voltage dip capability in Portugal is considered appropriate.

In the absence of these measures, the must-run values identified would not be valid. A greater presence of synchronous generators in the system would then be necessary, or, in order for them to be so, it might be necessary to limit the production of those generators without the capacity to withstand voltage dips to ensure at all times that generation losses due to voltage dips do not exceed the admissibility limits of the system. In any case, coupling a greater number of synchronous generators to reduce the generation that is disconnected due to voltage dips is not an effective solution, as the number of generators to be coupled would be high in comparison with the capacity whose disconnection would be avoided. In any case, it would only be achieved in the event of a limited number of disturbances.



Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 2. Annex - Analysis of equipment for damping of inter-area oscillations

## 2.1. Introduction

The small signal stability of a power system is defined as the ability of the system to maintain synchronism during small disturbances arising from variations in demand, generation, opening of lines, etc.

Electromechanical oscillation phenomena are intrinsic to the very nature of power systems. Inter-area oscillations, in which groups of generators oscillate coherently with other areas of the system, are particularly relevant in large electricity systems. This is the case of the European continental synchronous system, with the current situation of the interconnection of the Iberian system with France with high impedances between their ends and the centre.

These oscillations, with a typical frequency between 0.1 Hz and 0.5 Hz, are not a problem for the system if they are correctly damped. However, weak damping can cause the usual oscillation modes of the generators to become excited "spontaneously" (in the event of small, normal variations in system variables). Also, in the event of a disturbance and increasing oscillations in the operating parameters of the system –frequency, power flows, voltages– appear. If these "fluctuations" are not properly corrected, an incident can occur at the global level of the interconnected synchronous system.

Technical literature [1] as well as operating procedure 13.1 [2], establish a minimum damping threshold of 5% for oscillatory phenomena in the electricity system to guarantee its safety.

There are many factors that affect the oscillation mode of electricity systems and their ability to damp them correctly (structural characteristics of the system – level of meshing and "extension"– generation mix, load level on the lines, power flows between the ends of the system and the centre, etc.). Very simplistically, it can be said that oscillations are more likely to occur in situations where the systems are electrically further apart –the impedance between their ends being greater– and with higher power flows from the ends.

If we apply these premises to our system, it can be concluded that the reduced interconnection capacity of the Iberian Peninsula with France is a determining factor in the appearance of these oscillations, and that the greater the export from the Spanish mainland to France, the greater the risk of poor damping. On the other hand, due to the very physical nature of the phenomenon, it is at the extremes of the electricity systems where oscillations of greater frequency amplitude are recorded, and where corrective measures tend to be more efficient.

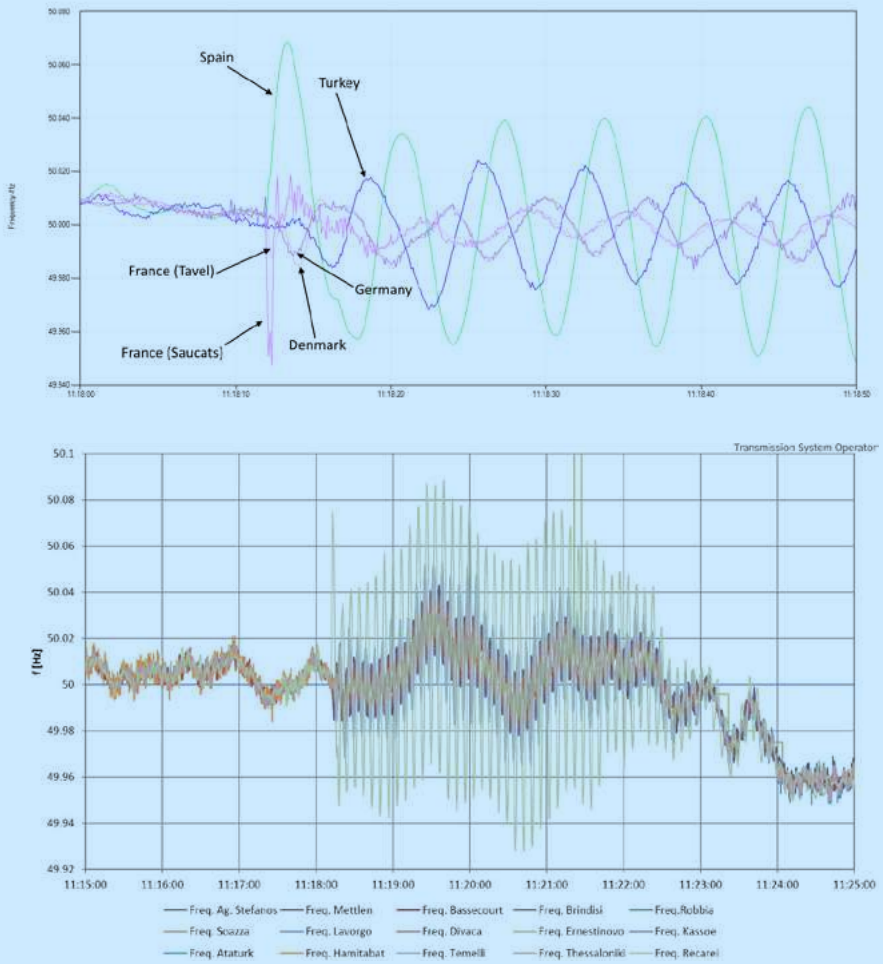
Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
Annexes
I: Staritng grid
II: New reinforcements
III: Technical annexes

At the level of the European continental electricity system, there are several oscillation modes, although the Spanish mainland is mainly affected by two of them:

- East-West mode: the generators at the western and eastern ends of the synchronous system oscillate against each other in counter-phase (Spanish mainland against Turkey). The usual frequency of this mode is in the range of 0.12-0.16 Hz. It can be claimed that, generally speaking, this mode is correctly damped.
- East-Centre-West mode: the generators at the western and eastern ends of the system (Spanish mainland and southern Balkan Peninsula and Turkey) oscillate almost in counter-phase with the generators in the centre of the European continent (Denmark, Germany, Poland, Switzerland, Czech Republic, and Italy). This mode usually manifests itself at oscillation frequencies in the range of 0.22-0.28 Hz and is generally worse damped than the East-West mode.

This latter oscillation mode, at a frequency different from the usual one, manifested itself on 1 December 2016 [3] in an undamped manner, Figure 1, which highlighted the need to improve the damping capacity of the system.

**Figure 1. Incident record 1 December 2016**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

Figure 2 below shows the detail of the active power of the 400 kV Baixas-Vic line, the interconnection line between the mainland system and the rest of the European synchronous system, during the aforementioned oscillatory event.

Alternatives considered to resolve the needs associated with small signal stability:

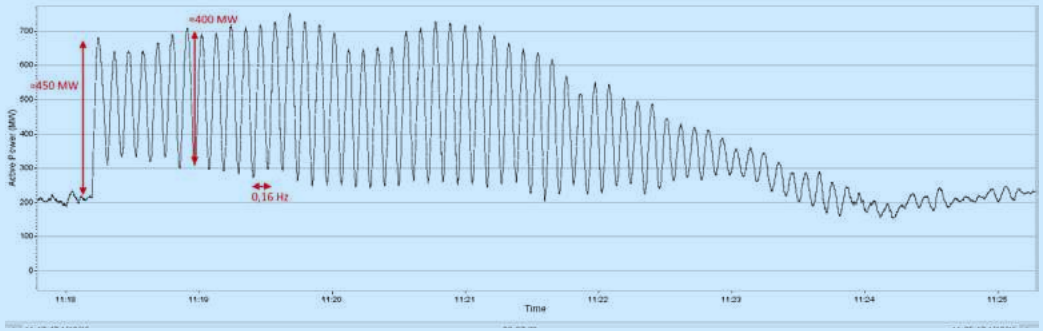
## OPERATIONAL MEASURES

Since December 1st 2016, many studies have been conducted (individually by REE and in coordination with neighbouring TSOs), different measures have been explored and finally implemented in the system. However, before the event of December 1st, small signal stability was already a deeply studied issue.

The main reinforcements carried out following the December 1st event are listed below:

- **Operational measures:**
  - Agreements between the Spanish and French System Operators not to perform certain topological manoeuvres near the Spain-France border that would have a negative impact on the small signal stability of the system.
  - Definition of agreed and joint procedures by the control centres of the Spanish and French System Operators in the event of undamped oscillatory events.

**Figure 2. Active power record on the Baixas-Vic 400 kV line. Incident on 1 December 2016**




  - Implementation in the control centre of REE (CECOEL) of a real-time monitoring system of the oscillatory behaviour of the electricity system through wide area systems based on the measurements provided by Phasor Measurement Units (PMU). As a result of this, CECOEL has become one of the first control centres in the world to have this technology for real-time operation, which provides information on the damping and amplitude values of the different oscillatory modes of the system. It is therefore a basic element for taking decisions in real time on preventive and remedial operational measures in the event of oscillatory phenomena in the system.

- **Measures on generation:**
  - Revision and improvement of the adjustment of the existing stabilisation means, mainly power stabilisers (PSS), in the generators of the relevant installed generation capacity system, so that they contribute to the damping of the inter-area oscillations of the European continental electricity system in the range between 0.15 Hz and 0.1 Hz.
  - Feasibility analysis of the installation of PSS equipment in nuclear power plants through a working group between the System Operator and the companies owning the units. The analyses did not show the feasibility of equipping these facilities with PSS [4].

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

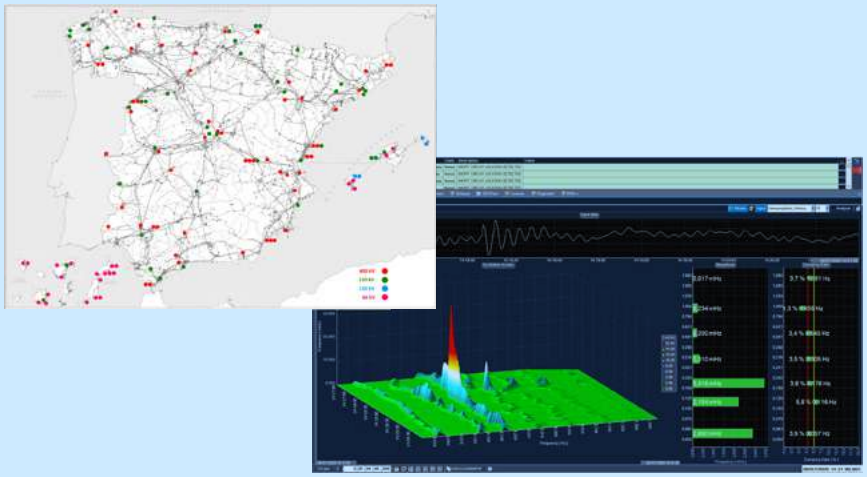
**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

**Figure 3. WAMS monitoring system**



- Requirements [5] related to the damping of oscillations in the national implementation of Reg. (EU) 2016/631 of the European Commission, establishing a network code on requirements for connection of generators to the network: mandatory PSS for all type D synchronous generators (>50MW) and a requirement not to contribute negatively to the damping of oscillations of 0.1 to 1.5 Hz, for type C and D power park modules (>5 MW or connected at >110kV).

- **Measures on the existing direct current interconnection (HVDC) between Spain and France to increase the benefit that this HVDC equipment can bring to improving system stability:**
  - Enablement, on the French side of the HVDC control, for damping of inter-area oscillations by reactive power modulation (POD-Q).
  - Agreements between system operators on the mode of operation of HVDC in low damping situations.
  - Changes of settings of HVDC "AC emulation" controls to improve HVDC response during oscillatory phenomena.
  - Specific functional specifications in the new HVDC project for the Bay of Biscay aimed at optimising the behaviour of the future HVDC in the event of oscillatory phenomena.

- **Coordination measures with other System Operators.** In addition to the joint studies carried out with the Portuguese (REN) and French (RTE) System Operators and the set of operational measures agreed with RTE, the following are being promoted:
  - The ongoing review by the Portuguese System Operator of the PSS equipment settings in the Portuguese electricity system generators.
  - The improvement of European models for small signal stability studies, within ENTSO-E.

Despite this wide range of measures, these are insufficient to ensure the minimum level of damping of oscillations (5%) established in the Operational Procedure (PO) 13.1. Structural solutions are therefore necessary, which must be considered in the planning exercise 2021-2026.

The purpose of this report is precisely to determine the structural needs of the system to meet the required damping according to the PO 13.1.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 2.2. Analysis of equipment for damping of inter-area oscillations

In order to assess the needs of the system to comply with the minimum damping requirement of 5% established in the PO 13.1, a maximum export peak scenario is taken as a reference scenario, which according to the studies carried out in [6] and [7] is the scenario with the worst damping. This scenario is based on the incident that occurred on 01/12/2016 11:10 h where poorly damped inter-area oscillations of 0.15 Hz were detected, projecting it to future scenarios in the 2026 horizon. This scenario, therefore, contemplates the development of the new HVDC interconnection through the Bay of Biscay and associated reinforcements.

## 2.2.1. FACTS devices

FACTS (Flexible AC Transmission System) devices are normally power electronics equipment connected to the Transmission Network (TN). They enable the resolution or reduction of important challenges that arise in an electricity system, such as those associated with the control of power flows through the lines, the voltages at the different nodes of the network or the damping of inter-area oscillations, thereby increasing the safety of the system and its transmission capacity.

This is achieved thanks to their different connection configurations to the electrical power system –parallel compensation, series or a combination of both– and the mode in which they work –current, voltage or impedance controller. A classification of the main devices is presented in Figure 4.

**Figure 4. Classification of FACTS devices according to their technology and configuration**

| | PARALLEL | SERIES | SERIES/PARALELL |
|---|---|---|---|
| **CONVENTIONAL** | L, C | L, C | Phase Shifting Transformer |
| **THYRISTORS** | Static var condenser (SVC) | Thyristor switched/controlled series condenser (TSSC/TCSC) | Dynamic power flow controller (DPFC) |
| | | | HVDC LCC (Line-conmutated) |
| **VSC** | Static synchronous condenser (STATCOM) | Static Synchronous Series Condenser (SSSC) | Unified/Interline power flow controller (UPFC/IPFC) |
| | | | HVDC VSC (Voltage-sourced) |
| **FERROMAGNETIC** | MCSR-based systems (MCSR/SCSR) | | Combination of CLR (current limiting reactances) and SCSR |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

As a summary, the impact of the most relevant FACTS elements on the system is depicted in Figure 5:

**Figure 5. System impact of each of the most relevant FACTS[2]**

| Device type | Device | Impact on the electricity system: Voltage control | Power flow control | Transient stability | Oscillation damping |
|---|---|---|---|---|---|
| Parallel | SVC | ✓✓✓ | ✓ | ✓✓ | ✓✓ |
| | STATCOM | | | | |
| | STATCOM with storage system | | | | |
| | MCSR-based systems | ✓✓✓ | ✓ | ✓✓ | ✓ |
| Series | TCSC (and its variants) | ✓ | ✓✓ | ✓✓✓ | ✓✓✓ |
| | SSSC | | | | |
| | SSSC with storage system | | | | |
| Series/Parallel | PST | ✓✓ | ✓✓ | ✓ | ✓ |
| | UPFC | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ |
| | HVDC back-to-back | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ |
| | Combination of CLRs (current limiting reactances) and SCSR | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓ |

✓ Very low or null impact ✓ low impact ✓✓ Medium impact ✓✓✓ High impact

2 Source: Siemens Power Academy TD – NA PSS/E – Advance Dynamic Simulation.

## PARALLEL FACTS

The most common devices are the SVC (*Static Var Compensator*) and the STATCOM (*Static Synchronous Condenser).* Their main applications in transmission networks are voltage regulation and control both under normal and contingency conditions, which improves stability in permanent and transient regimes. Another of its applications is the detection and damping of power oscillations with the injection of reactive power, this functionality is commonly known as POD-Q (*Power Oscillation Damping-Reactive Power*). In addition, STATCOMs can incorporate a battery, known as BESS (*Battery Energy Storage System*), which can damp oscillations by modulating active (POD-P) and reactive (POD-Q) power.

Although the SVC device provides fine and precise control, the STATCOM is preferred because it requires less space, meets power quality requirements perfectly without the need for filters and has better voltage dip behaviour.

Also, although MCSR-based systems are similar to VSC and STATCOM, there is no recognised experience of these devices with POD functions for damping inter-area oscillations in the transmission network, therefore, the STATCOM is preferred.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

## SERIES FACTS

The most common devices are TCSC (*Thyristor Controlled Series Capacitor*) and SSSC (*Static Synchronous Series Compensator*). Their main applications in transmission networks are active power flow control, increase of power transmission capacity and increase of transient and voltage stability limits. They can also improve oscillation damping.

TCSC is most used for oscillation damping, improving stability, and having some influence on power flows. SSSCs are not commonly applied at the transmission network level, since TCSC already fulfils the necessary requirements with lower costs.

## SERIES/PARALLEL FACTS

The most common devices are the PST (*Phase Shifting Transformer*), the UPFC (*Unified Power Flow Controller*) and the HVDC back-to-back. The PST does not use power electronics and therefore its main application is the control of active power flows in continuous operation. UPFCs can control both active and reactive power flows on the line, as well as the voltage at the node where they are connected with very low response times. UPFCs tend to be more costly and complex in that controls need to be coordinated between their parallel unit and their serial unit, although they also offer additional advantages by having these two branches. HVDC back-to-back converters are normally made using LCC technology as they are much cheaper than VSC converters for this particular application and can therefore only control the power flows on the relevant line.

PSTs are the most common, although they have the limitation of slow control speed and high maintenance requirements. Their application in terms of damping inter-area oscillations is irrelevant. The UPFC is fully controllable and, although it is not very widespread in practice, it has been tested in some facilities. Its disadvantages are cost and complexity. Finally, HVDC back-to-back systems based on VSC allow full dynamic controllability of active and reactive power on both sides of the link, however, their cost is very high compared to using STATCOM and TCSC for the same application. On the other hand, although the combination of CLR and SCSR would be interesting for the improvement of certain aspects of the system, it would not be convenient for the POD function, being at a disadvantage compared to other series/parallel FACTS equipment.



Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

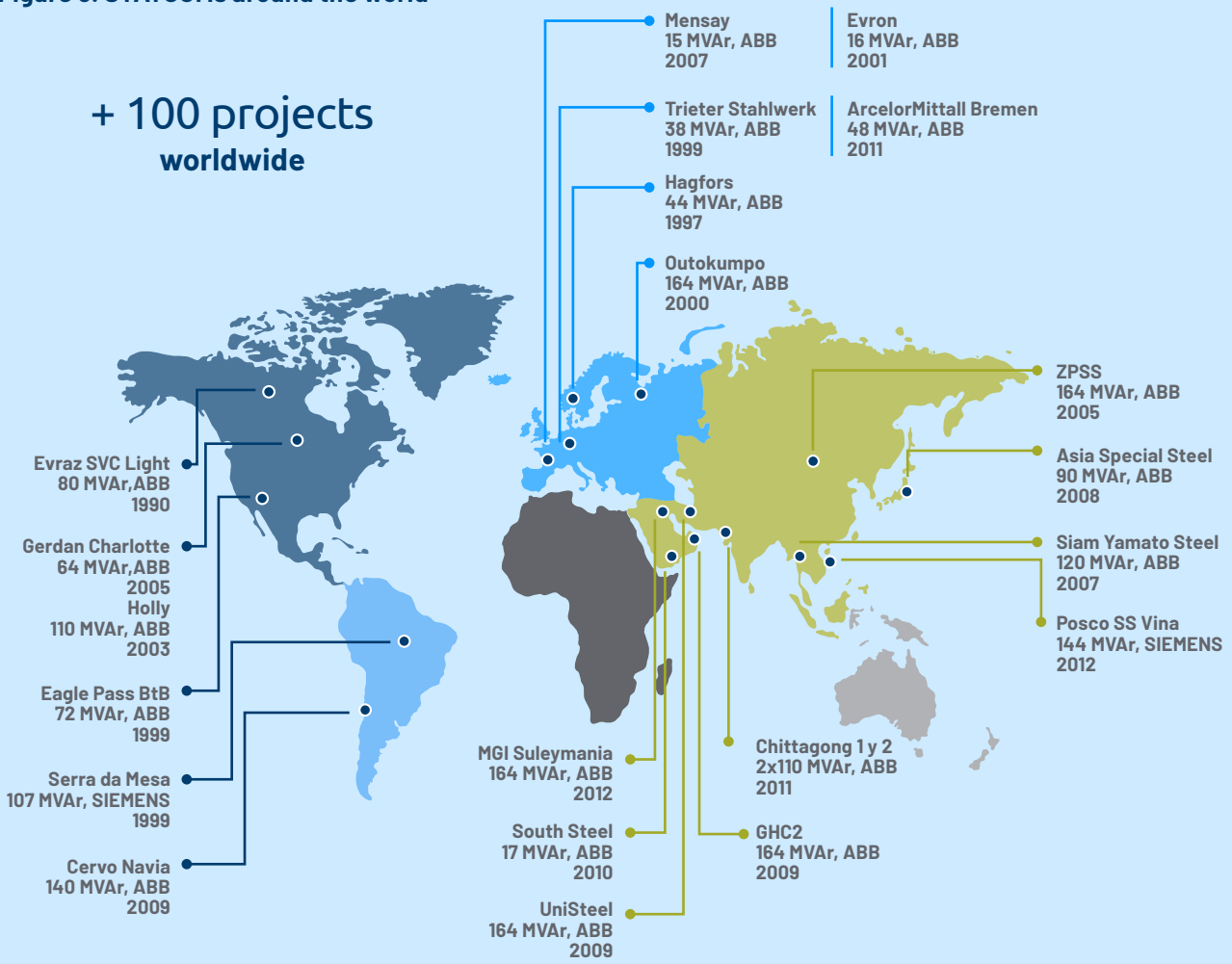
I: Staritng grid

II: New reinforcements

**III: Technical annexes**

Due to the reasons stated above, the inherent capacity of STATCOMs and TCSCs or UPFC[3] for inter-area oscillation damping together with an affordable cost and additional and interesting features for the power system (voltage control and transient stability, respectively), these are the FACTS devices that will be evaluated in this document for the improvement of the small signal stability of the system. This will be done considering that the mentioned devices are already deployed around the world with satisfactory results. Figure 6 shows a sample of STATCOM devices installed around the world, with more than 100 of these projects implemented in transmission networks.

**Figure 6. STATCOMs around the world**




3 SSSC and UPFC would be equivalent solutions to TCSC.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

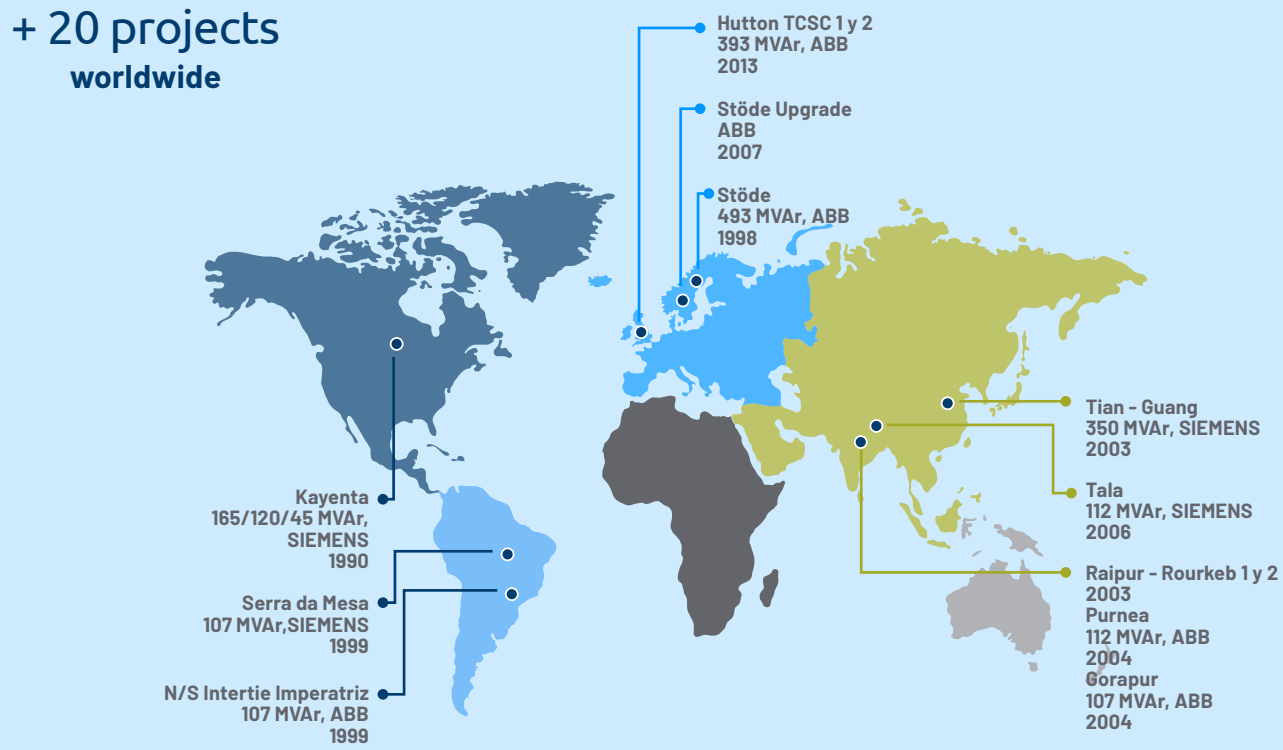
I: Staritng grid

II: New reinforcements

**III: Technical annexes**

As for TCSC, although its use is not as extensive, there are more than 20 projects around the world. The first TCSC was installed in 1980.

**Figure 7. TCSCs around the world**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 2.2.2. Most effective location for FACTS devices

Not only is the type of FACTS device chosen critical, but much of the success of improving damping in the power system lies in their correct location.

## MOST FAVOURABLE LOCATIONS FOR TCSC/UPFC[4] DEVICES

The TCSC or UPFC series FACTS devices need to be in the path of the oscillation, i.e., the inter-area oscillation must flow through the line to which they are connected to be effective, so the greater the percentage of oscillation flowing through the line to which the TCSC/UPFC is connected and the greater the power flowing through the equipment, the greater its effectiveness in damping that oscillation. In this way, and given that the problem of low damping is a problem of the European synchronous system, with international interconnections being the main means of propagation of oscillation between countries, the contribution of these devices will be better the closer their location is to the international interconnections. Also, the greater the length of the connection line, the greater the impedance. Therefore, the search for the most favourable location will focus on the highest impedance lines of the French-Spanish interconnection.

The increase in damping is a function, among other things, of the difference between the maximum and minimum impedance of the electrical axis interconnecting the systems caused by the TCSC/UPFC. When we have the parallel of a 400 kV line with a 220 kV line, the modification of the same physical impedance (same ohms) in the 400 kV line leads to a much higher variation in the equivalent impedance of the whole than the same variation in the 220 kV impedance. It should not be forgotten that the base impedance of a 220 kV system is 484 Ω and that of a 400 kV system is 1,600 Ω. Furthermore, it is preferable that the capacitive impedance does not exceed the impedance of the line on which it is located, to prevent the complete set (line + TCSC) from having a capacitive impedance. Therefore, there is a limit on the maximum impedance of the equipment to be installed. Considering all the above and trying to reduce the number of devices to be installed, these should only be installed on 400 kV lines. Table 1

**Table 1. Impedance values of the circuits under study**

| | East zone circuits | Interconnection | Length (km) | X (pu) |
|---|---|---|---|---|
| East zone | L-400 kV Baixas-Vic | Yes | 107.2 | 0.02068 |
| | L-400 kV Piérola-Vic | No | 84.78 | 0.01570 |
| | L-400 kV Bescanó-Sentmenat | No | 75.30 | 0.01311 |
| | L-400 kV Bescanó-Vic | No | 39.48 | 0.00690 |
| West zone | L-400 kV Argia-Hernani | Yes | 50.97 | 0.01022 |
| | L-400 kV Hernani-Ichaso | No | 35.90 | 0.00722 |
| | L-400 kV Azpeitia-Hernani | No | 27.18 | 0.00548 |

4 SSSC and UPFC would be equivalent solutions to TCSC.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

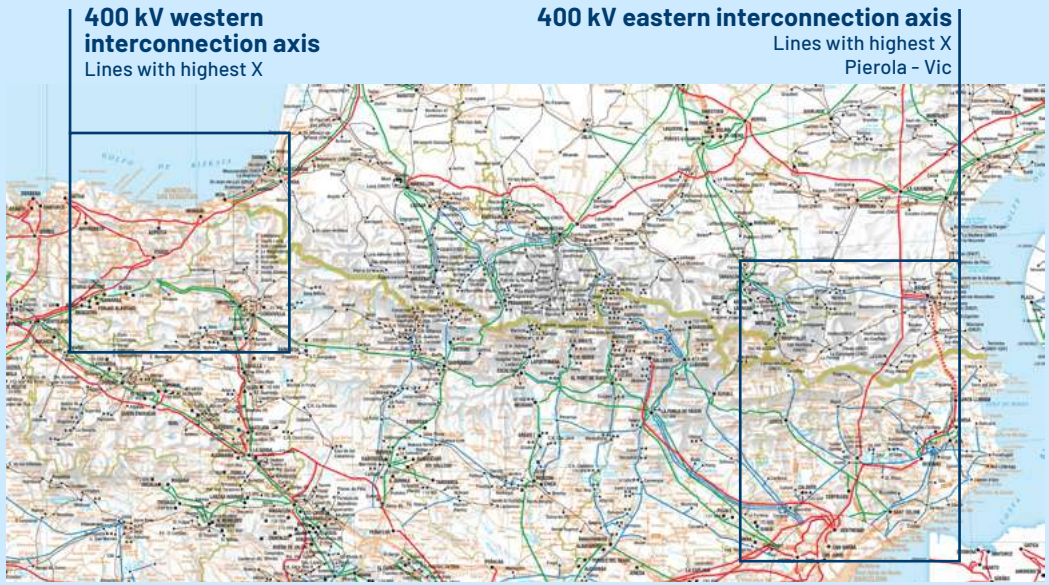
**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

**Figure 8. lines of the two main interconnection axes with France**




and Figure 8 show the impedance values of the 400 kV lines of the interconnection with France.

Taking into account the impedance values of the lines, the 400 kV western interconnection axis would be discarded in favour of the eastern interconnection axis, since the lines of the latter have the highest impedance values. As for the lines forming part of the 400 kV eastern interconnection, the three lines with the highest impedance are Baixas-Vic, Pierola-Vic and Bescanó-Sentmenat. However, although in principle the Baixas-Vic L-400 kV has all the necessary and optimal conditions to be able to successfully connect TCSC or UPFC equipment, it is also discarded mainly because it forms part of the AC-DC corridor in parallel with the HVDC Baixas-Santa Llogaia HVDC link. The main reason is that this link is operated with an autonomous active power control that adapts to the network conditions (known as Angle Difference Control –ADC–) with a very high influence on changes in the active power of the L-400 kV Baixas-Vic, so that if one of the lines increases the active power, the other parallel line will decrease a proportional amount of its own and vice versa. This dependence in the corridor means that any effect that the FACTS device may have on the power of the L-400 kV Baixas-Vic to improve small signal oscillations would be counteracted by the HVDC link, considerably reducing, and even cancelling out, any contribution that the FACTS device may make. The installation of a TCSC or UPFC on the Vic-Baixas line would mean a major modification in the HVDC control, which would require numerous tests to be carried out on the HVDC to ensure its stability. This would take a long time and increase the risk of HVDC failure, which leads to this solution being discarded.

For all the above reasons, the preferred line for the installation of a TCSC or UPFC is the L-400 kV Pierola-Vic line. To corroborate that this choice of location for theoretical reasons is the most appropriate for improving the damping of inter-area oscillations, studies have been carried out in the small signal domain both in the time domain and in the frequency domain and, considering a dynamic impedance of 20 Ω for the TCSC or UPFC, the obtained results are favourable, as shown in Figure 9.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

**Figure 9. Effectiveness of TCSC or UPFC for damping of inter-area oscillations**

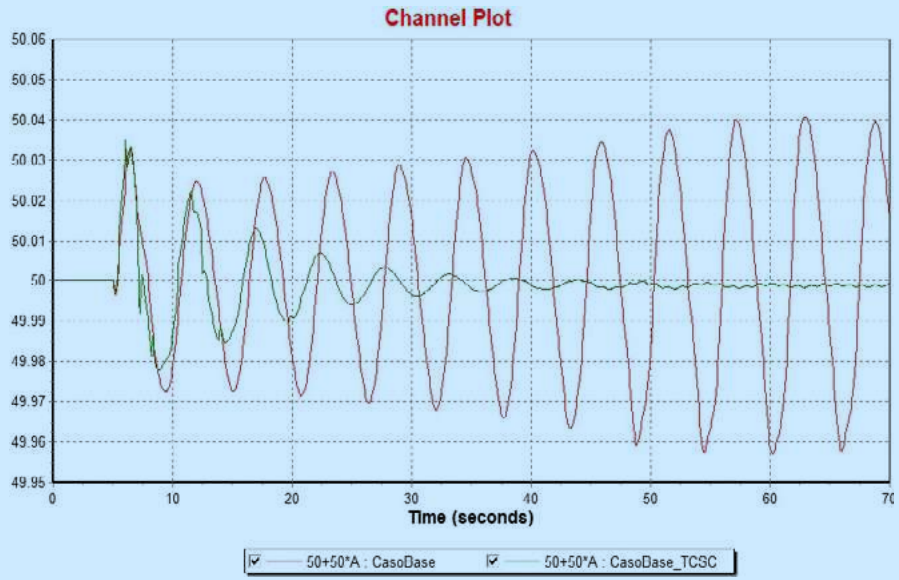
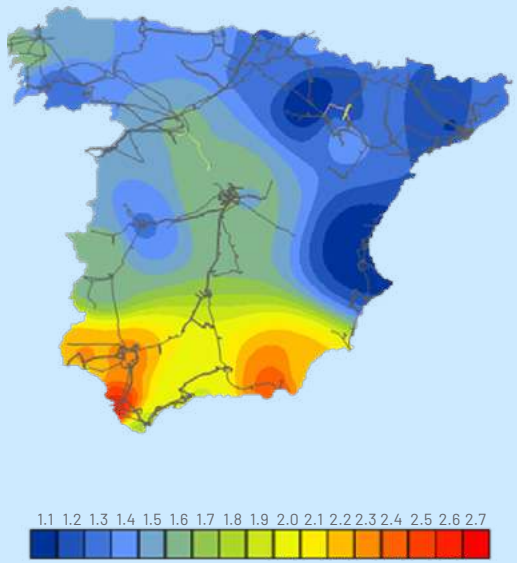



**Figure 10. Statcom damping improvement map with POD-Q**




## MOST FAVOURABLE LOCATIONS FOR STATCOM DEVICES WITH POD-Q FUNCTION

In order to determine the most effective locations from the point of view of damping inter-area oscillations for the installation of STATCOM-type parallel FACTS devices with POD-Q control, several small signal frequency-domain stability studies have been performed considering linear modelling and, assuming a typical size of ±150 Mvar, the effectiveness map obtained is shown in Figure 10.

The results show that the effectiveness in damping oscillations for a ±150 Mvar STATCOM with POD-Q ranges between 1% and 2.5%, depending on the location. In general, it can be stated that the effectiveness is determined by the distance of the device from the centre of the oscillation, i.e., greater effectiveness for STATCOMs installed in Andalucía and Galicia and, on the other hand, those that are close to large centres of demand, such as the central area of Madrid.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

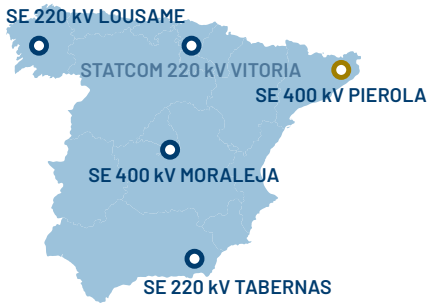
**III: Technical annexes**

# 2.3. Structural needs of the system to dampen inter-area oscillations

Considering the results obtained in this document, the structural solution for the transmission network that guarantees the needs of the system from the point of view of the stability of the small signal, complying with the provisions of PO 13. 1 (damping >5%) is 1 TCSC or UPFC unit (20 Ω dynamic reactance) in series with the 400 kV Pierola-Vic line and 4 STATCOM units with POD-Q function (±150 Mvar). Since the current transmission network development plan already includes the installation of a STATCOM in SE 220 kV Vitoria in the starting grid, it would only be necessary to plan for three new STATCOM units in the 2021-2026 timeframe.

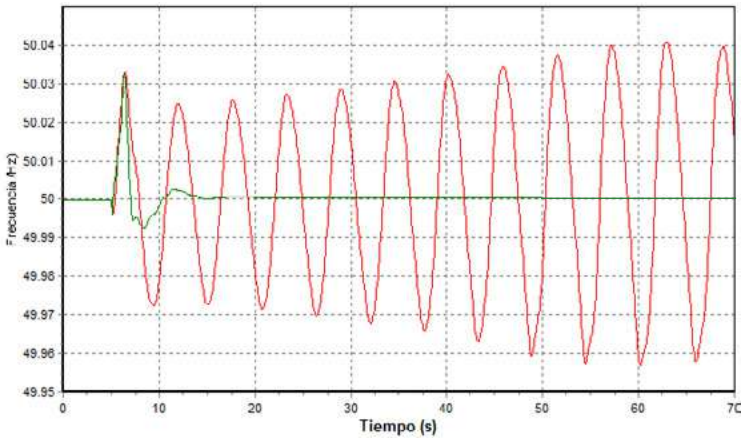
The simulation from the small signal time domain point of view showing the dynamic response of the system supporting the planned solution and the different damping figures obtained as a function of the number of devices considered on the reference scenario, is displayed in Figure 12.

**Figure 11. Structural needs of the system to dampen inter-area oscillations**




| Device | Location |
|---|---|
| FACTs | L-400 kV Pierola-Vic |
| STATCOM | SE 220 kV Vitoria |
| | SE 220 kV Tabernas |
| | SE 220 kV Moraleja |
| | SE 220 kV Lousame |

**Figure 12. Dynamic response of the system taking into account the structural requirements of the system for damping of inter-area oscillations**




| TCSC/UPFC No. | STATCOM No. | ξ (%) |
|---|---|---|
| 1 | 1 | (*) |
| 1 | 2 | 2.5 |
| 1 | 3 | 4.5 |
| 1 | 4 | 6.5 |
| 1 | 5 | 7.0 |

(*) The simulation is not terminated by loss of synchronism, so it is not possible to evaluate the damping value.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 2.4. References

[1] "Analysis and Control of Power System Oscillations. Task force 07 of Advisory Group 01 of Study Committee 38. Final Report.," December 1996.

[2] P.O. 13.1 Criterios de desarrollo de la red de transporte (OP 13.1 Transmission network development criteria)

[3] ENTSO-E, "https://docstore.entsoe.eu/Documents/SOC%20documents/Regional_Groups_Continental_Europe/2017/CE_inter-area_oscillations_Dec_1st_2016_PUBLIC_V7.pdf".

[4] "Grupo de Trabajo de Amortiguamiento Oscilaciones Inter-área mediante PSS en Centrales Nucleares" (Working Group on Damping Inter-area Oscillations using PSS in Nuclear Power Plants).

[5] "Propuesta normativa para la implementación de los códigos de red europeos de conexión y del artículo 40.5 de la directriz sobre la gestión de la red de transporte de electricidad" (Regulatory proposal for the implementation of the European network codes for connection and article 40.5 of the electricity transmission network management guidelines).

[6] "Análisis de la estabilidad de pequeña señal del sistema interconectado europeo y sus soluciones. Hito1 Actuaciones en RdT en escenarios presentes. Red Eléctrica de España. Septiembre 2017".1 (Analysis of the small signal stability of the European interconnected system and solutions. Milestone1 Reinforcements in TN in current scenarios. Red Eléctrica de España. September 2017).

[7] "Análisis de la estabilidad de pequeña señal del sistema interconectado europeo y sus soluciones. Hito3 Impacto de los desarrollos de red asociados a las interconexiones. Red Eléctrica de España. Noviembre 2017" (Analysis of the small signal stability of the European interconnected system and solutions. Milestone3 Impact of network developments associated with interconnections. Red Eléctrica de España. November 2017).



Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 3. Annex - synchronous condensers in the Islas Baleares electricity system: technical justification

## 3.1. Introduction

The Balearic electricity system (SEB) is relatively small, not very meshed and has little inertia, which complicates the resolution of generation-demand imbalances and RES integration. With reinforcements such as the commissioning of the HVDC LCC ("*Line Commutated Converter*") link connecting the Spanish mainland to the island of Mallorca and the commissioning of the Mallorca-Ibiza submarine links connecting the Mallorca-Menorca and Ibiza-Formentera subsystems, the Balearic electricity system was integrated into the mainland electricity market. The reliability of the electricity supply on all SEB islands was improved while significantly reducing their generation costs by using emission-free energy.

However, the decarbonisation of the SEB (*zero synchronous generators*) represents a significant challenge due to the particularities of the SEB and the technical characteristics of the HVDC LCC link. The existing HVDC link has operating limitations derived from the need for three-phase short-circuit power (Scc) at its connection point, which requires a minimum number of synchronous generators connected to the SEB. Such synchronous generators, in addition to increasing the short-circuit power, contribute to voltage control (especially in off-peak periods) and frequency control in static and transient regimes (inertia) to guarantee security and continuity of supply.

It is therefore essential to resolve the challenges that arise when operating with zero synchronous generators in the SEB and to prepare the system to be operated with absolute safety guarantees under these conditions.



Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 3.2. Operational issues associated to a 100% decarbonised SEB

The three problems identified as a result of the need to operate the SEB without coupled synchronous generation are described below:

- **Voltage control**: the voltages at the nodes must remain within acceptable limits both in normal operation and in the event of a transient contingency. For this purpose, static voltage control elements (reactances/capacitors) are not sufficient, but dynamic and continuous voltage control capability is required.

  In the SEB, this situation is critical during off-peak periods, as high operating voltages are typically recorded as a result of the intrinsic characteristics of the existing transmission network, the low demand, the low reactive power absorption profile of the generation fleet and the existing HVDC LCC interconnection. In normal operation, the HVDC LCC link presents levels of absorbed reactive power which must be compensated by connecting and disconnecting a series of filters which have a capacitive characteristic at nominal frequency. However, to maintain the necessary power quality, the filters must eliminate the harmonics generated by the link itself, which means that, on occasions, they must be connected even if they cause overvoltage in the system. This situation, already unfavourable, is aggravated by the disconnection of synchronous generators, since they are capable of controlling the voltage through their excitation system, thus improving the stability of the system.

- **Frequency control in static and transient regimes (inertia)**: frequency is a fundamental parameter in interconnected alternating current systems, as the generators and motor loads rotate at speeds proportional to it. Inertia, on the other hand, is the quality of the system that defines its capacity to withstand and overcome possible generation-demand imbalances that occur in it. If an electricity system has little inertia, as is the case of the SEB, and a disturbance occurs, a significant drop in frequency can occur in a short time. This can cause load shedding or a complete blackout if the frequency drop is so rapid that the load shedding systems are not capable of counteracting the generation-demand imbalance. So far, the SEB is operated with the minimum necessary number of synchronous generators, which provide the necessary inertia in the system through the kinetic energy stored in their rolling masses.

- **Necessary level of Scc at the SEB nodes**: an adequate level of Scc is necessary to guarantee, among other things, the correct operation of the protection systems of the islands and, specifically, in the SE 220 kV Santa Ponça to allow the HVDC LCC link to operate reliably[5] and in full operational conditions.

  The level of Scc at SE 220 kV Santa Ponça is strongly linked to:

  - **Network meshing**: which characterises and determines the equivalent impedance between the current coupled synchronous generation of the system and the Santa Ponça substation. This substation is a 220 kV antenna, connected solely via the 220 kV Valldurgent-Santa Ponça double circuit to the existing transmission network. It is also connected to Ibiza via the two 132 kV alternating current links. It is therefore a substation with structural weaknesses and it is critical to guarantee the necessary Scc thresholds.
  - **Connected synchronous generation**: which until now has been responsible for providing the system with sufficient inertia and Scc to meet the normal operating requirements of the HVDC LCC link and the system as a whole.

5 HVDC LCC technology inherently requires a minimum level of Scc to switch the converter station valves from the conduction state to the blocking state but needs a higher value of Scc to remain stable.

Introduction
Indicative Planning (NECP): study scenario
Analysis methodology
Results
Modification of specific items
Maps
**Annexes**
I: Staritng grid
II: New reinforcements
**III: Technical annexes**

As mentioned above, the level of Scc at SE 220 kV Santa Ponça is critical, as operating the HVDC LCC link with inadequate Scc values could lead to voltage instability, which could, in turn, result in oscillations in the power transmitted by the link, in a trip or blockage of the link itself, which would trigger transient overvoltages, or even magnification of harmonics in the electricity system to which it is connected.

The severity of each of these effects and the Scc values at which they occur, among other things, depends on the characteristics of the link and its operating point and the characteristics of the network.

A minimum value of Scc required is a simplification, since what is really important for the correct operation of an HVDC LCC link is the maintenance of the voltage at the converter terminals, which depends on the Thévenin impedance of the electricity system. Thus, with low Scc values, the electricity system is unable to maintain the voltage at the converter station terminals and the first problems that arise are voltage instability and overvoltage in the event of tripping or blocking.



In order to avoid these anomalous operations in low Scc situations, a stability function has been implemented in HVDC converters that limits their active power according to the following restrictions:

- **Scc≥1300 MVA:** normal operation with maximum power exchange capacity of 400 MW (unrestricted).
- **500 ≤Scc<1300 MVA:** operation with maximum power exchange capacity of 40% of nominal (160 MW) and with single-pole operation.
- **Scc<500 MVA:** necessarily implies link tripping.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 3.3. Technological solutions available

Given the imminent need to make the SEB independent of conventional generation based on fossil fuels and to reduce or eliminate the requirement to use this minimum number of synchronous generators once the Spanish mainland-Islas Baleares reinforcement included in this network development plan with a 2026 horizon, it is essential to explore technological solutions that contribute to the above-mentioned factors on the islands. Without being exhaustive, some possible technological solutions are as follows:

- **Parallel capacitors and reactances**: these are a simple means of injecting or consuming reactive power at the node where they are connected, however, they do not provide inertia, Scc or dynamic voltage control.
- **Reinforcements in the HVDC LCC link to reduce its dependence on the Scc at its connection node**: possible technological evolutions in the current converter stations at the end of SE 220 kV Santa Ponça to reduce its dependence on the Scc at the connection node. This reduces the need for synchronous generation in the system but does not completely eliminate it.
- **Installation of synchronous condensers**: synchronous machine whose axis is not connected to any turbine and which can control voltage, provide Scc and inertia continuously.
- **Installation of FACTS devices**: by means of an electronic converter or other technological solutions, these devices contribute to maintaining the voltage of a node by dynamically generating/consuming reactive power.

Among the different solutions, synchronous condensers are postulated as the best option for achieving a 100% decarbonised SEB (Figure 15), as they would ensure the minimum Scc required by the HVDC LCC link, and would help to solve voltage instability problems, mitigating possible overvoltage in the event of tripping or blockage of the link. In addition, they would provide the converter station at the Santa Ponça end with blackstart capacity.

**Figure 13. Issues to which the various technological solutions contribute to mitigate**

| | Inertia | Voltage control | Scc | Maturity of technological development |
|---|---|---|---|---|
| Capacitors and reactances | – | + | – | ++ |
| Reinforcements in the HVDC LCC | – | + | + | – |
| Synchronous condensers | + | ++ | ++ | ++ |
| FACTS | – | ++ | + | ++ |

– low/null; + limited; ++ high

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 3.4. Studies justifying the need for synchronous condensers

With this premise, the studies carried out focused on determining the minimum number of synchronous condensers necessary to achieve a fully decarbonised SEB.

To this end, two different study scenarios have been considered, both based on the same base scenario. The first is a similar scenario to the current one in which synchronous generators are replaced by synchronous condensers. The second scenario considers the existence of 2 links of 200 MW, each between the 400 kV El Fadrell substation on the mainland (substation included in the transmission network development plan 2021-2026) and the 220 kV San Martín substation in Mallorca.

The base scenario represents a period of demand valley, as it is the most unfavourable situation in terms of voltages and Scc, and without any synchronous generator coupled to the system. In Mallorca, only the waste-to-power generators of Tirme are considered coupled to their technical minimum and the HVDC LCC link.

Based on these network scenarios, the number and power associated with the synchronous condensers necessary in Mallorca to achieve a Scc equal to or greater than 1,300 MVA in SE 220 kV Santa Ponça has been evaluated, and which would therefore allow normal operation of the HVDC LCC link without operating restrictions in various situations.



**Figure 14. Need for synchronous condensers in the SEB**

| Number of synchronous condensers required in Mallorca | Scc in Santa Ponça 220 kV (MVA) |
|---|---|
| 200 MVA in Santa Ponça 220 kV | 980 MVA |
| 200 MVA in Santa Ponça 220 kV + 100 MVA in Llubí 220 kV | 1,285 MVA |
| 200 MVA in Santa Ponça 220 kV + 200 MVA in Llubí 220 kV | 1,537 MVA |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

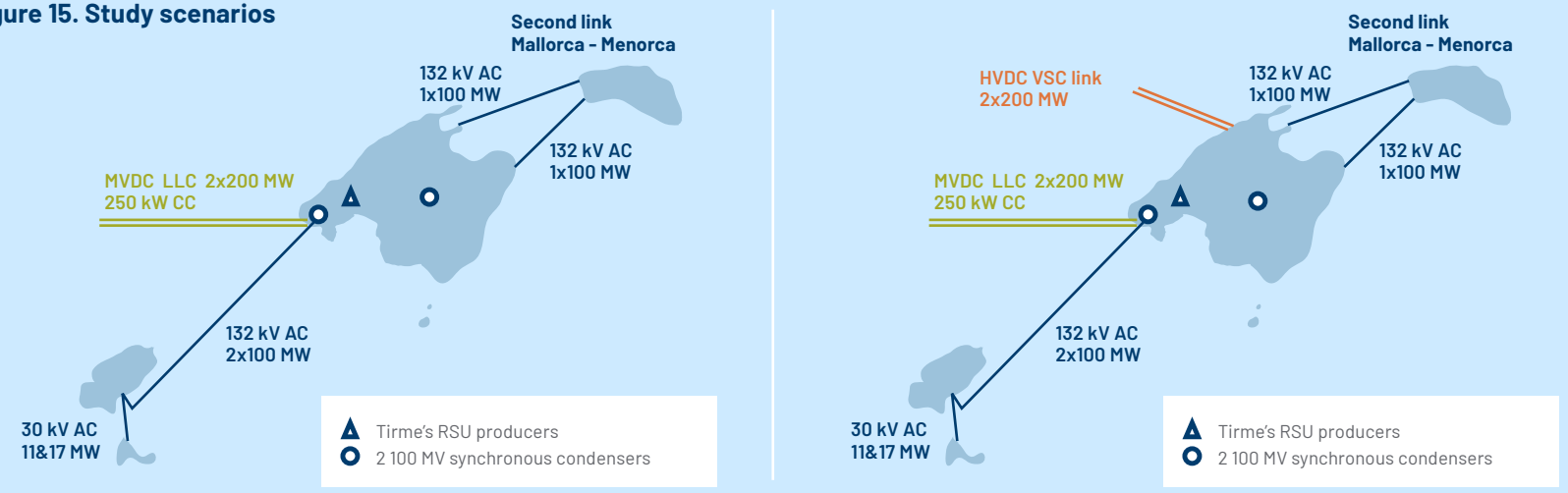
**III: Technical annexes**

Based on the results of Figure 19 and considering only the requirements of Scc in SE 220 kV Santa Ponça to ensure unrestricted operation in the HVDC LCC link, in a scenario without synchronous generators, synchronous condensers equivalent to 200 MVA in Santa Ponça and 200 MVA in Llubí 220 kV would be necessary.

The most appropriate configuration would be two 100 MVA synchronous condensers at SE 220 kV Santa Ponça and another two 100 MVA synchronous condensers at SE 220 kV LLubí. However, in order to comply with the safety requirements (N-1) for the operation of the system established in the O.P.1, it would be essential to consider an additional 100 MVA synchronous condenser, preferably in a substation close to SE 220 kV Valldurgent.

In addition, several contingencies have been postulated for these two scenarios in order to analyse the evolution of the system from the point of view of transient stability, which have allowed the planned solution to be validated.

**Figure 15. Study scenarios**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 3.5. Conclusions

In view of the above, the following conclusion can be drawn:

- It is essential to prepare the system to be able to operate it with guarantees without the presence of synchronous generation.
- The main needs of the system in the absence of coupled synchronous generation are inertia, Scc and dynamic voltage control.
- Synchronous condensers are currently the most appropriate alternative, as they can provide these three properties to the system with sufficient technological maturity.
- The preliminary studies carried out indicate the need for at least 500 MVA of synchronous compensation, 200 MVA of them connected to the 220 kV Santa Ponça substation.
- With the installation of 500 MVA of synchronous compensation in Mallorca, progress would be made towards a 100% decarbonised Balearic Electricity System, although to achieve this in its entirety, additional reinforcements would be necessary, such as a second HVDC VSC link with the mainland.

Although these are the reinforcements identified as necessary in the study horizon, based on the reinforcements limit value of the plan and the priorities established in accordance with the cost-benefit analyses using the sequential PINT methodology of the different elements that make up the reinforcements to reinforce the interconnection between the mainland and Mallorca, four of these units will be incorporated after 2026. Until the commissioning of these four synchronous condensers, it will be necessary to maintain synchronous generation in the Islas Baleares system to ensure that the inertia, Scc and dynamic voltage control needs of the system are satisfied.



Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 4. Annex - Synchronous condensers in the Islas Canarias electricity system: technical justification

Given their isolated nature, the electricity systems in the Islas Canarias are particularly vulnerable. Meeting the NECP decarbonisation objectives for these systems is a technological challenge in itself. The system must be operated at all times with a minimum of synchronous generators, or equipment that provides synchronous properties to the system such as inertia, short-circuit current injection, dynamic voltage control, etc. This is to ensure the dynamic stability of the system and to reliably integrate non-synchronous generators (such as wind and photovoltaic), which require a minimum strength of the network for stable operation.

## 4.1. MPE integration in weak networks

The current Power Park Module (PPM) technology, consisting of generators with a power electronics interface, is based on grid-following converters, which have a behaviour similar to that of a current source. They require a sufficiently strong network so that the active and reactive power controls, dependent on the phase-locked loop (PLL), can work correctly. In weak systems, where the system state variables are more changeable in the event of disturbances or even under normal conditions, this type of control can operate unsteadily, given that the delays associated with phase tracking and current injection can prevent the PPM from behaving coherently with the real state and evolution of the system.

This circumstance motivated CNMC Circular 1/2021 of 20 January, which establishes the methodology and conditions for access and connection to the transmission and distribution networks of electricity production facilities, to define a specific technical criterion for determining the capacity for access to the network of PPMs. This criterion being linked to short-circuit power. This criterion assesses the strength of the network to be able to accommodate PPMs without the risk of malfunction, interactions between their controls or with the system itself, which could jeopardise the reliability and security of supply. To this end, the Circular defines the Weighted Short Circuit Ratio (WSCR), through which the access capacity of PPMs is assessed, as the weighted ratio between the Scc and the maximum access capacities of PPMs in nodes of the same Zone of Electrical Influence (ZEI), according to the following expression:

$$WSCR = \frac{\sum_i^N Scc_i \cdot PMPE_i}{(\sum_i^N PMPE_i)^2}$$

Being:

$Scc_i$: Effective three-phase short-circuit power in MVA of node i belonging to the ZEI.

N: Number of nodes that make up the ZEI.

$PMPE_i$: Maximum capacity in MW of PPM connected or with an access permit granted and available at node i belonging to the ZEI.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

The CNMC Resolution of 20 May 2021, which establishes the detailed specifications for determining generation access capacity to the transmission network and distribution networks, defines ZEIs as the set of nodes in which the voltage variation at one node causes a significant voltage variation on the rest of the nodes of the set, for which the Multi Infeed Interaction Factor (MIIF) will be used:

$$MIIF_{ij} = \frac{\Delta V_j}{\Delta V_i}$$

Being:

$\Delta V_i$: Voltage variation (kV or p.u.) at node

$\Delta V_j$: Voltage variation (kV or p.u.) induced at node j as a result of voltage variation at node i

Two nodes (node i and node j) of the transmission network are considered to belong to the same ZEI if either of the MIIFij or MIIFji indices, evaluated by means of permanent regime load flows, is greater than or equal to 0.98.

The larger the size of the ZEIs, the weaker the system, i.e. the lower the dynamic voltage control capabilities, in modulus and angle, of the synchronous generators, since in that case, voltage variations at one node may affect more electrically distant nodes.



Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

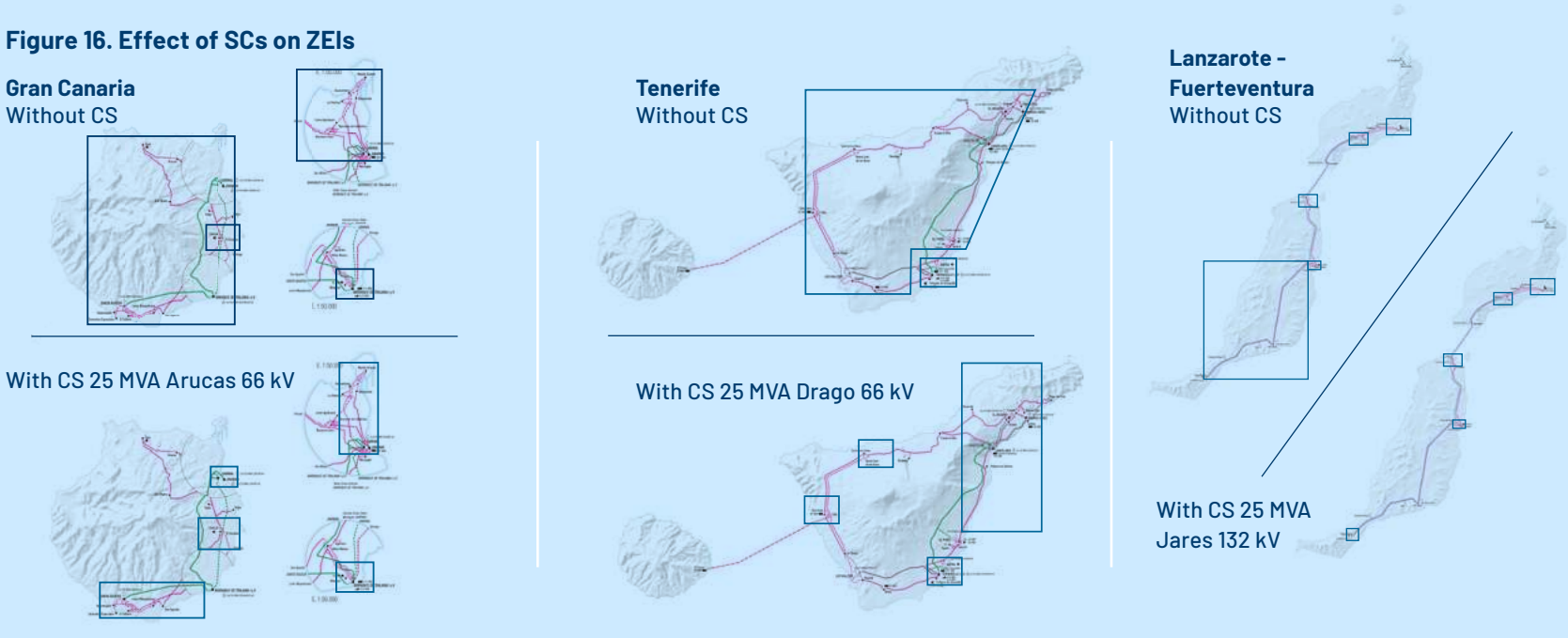
# 4.2. Influence of synchronous condensers on ZEI size

The incorporation of synchronous condensers in the electricity subsystems of the Islas Canarias allows the system to benefit from all the synchronous technical capacities that this equipment provides "naturally" and, therefore, to improve by itself, the operation and dynamic stability of the system.

Synchronous generation in the electricity subsystems of the Islas Canarias is concentrated in very few nodes, sometimes even in a single node per island. This represents a weakness and an intrinsic risk to security of supply, as these substations become critical points for the operation of the system. The incorporation of synchronous condensers at other nodes partly mitigates this risk because, although synchronous condensers do not provide active power, they do provide other capacities (such as short-circuit power, dynamic voltage control and inertia) which make system operation more reliable when distributed geographically across the island.

An illustrative example of this benefit can be observed by analysing the impact of incorporating synchronous condensers on the size of the ZEIs for the purpose of assessing the access capacity of PPMs. Synchronous condensers provide a new dynamic voltage control point and this improves the voltage stability of the island, and therefore divides the ZEIs that would virtually encompass the entire island in the absence of synchronous condensers. This effect can be seen visually below, considering the 25 Mvar SCs proposed in Gran Canaria, Tenerife and Fuerteventura.

**Figure 16. Effect of SCs on ZEIs**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

In practice, reducing the size of the ZEIs involves:

Reducing the risk of interactions between PPM controls in service or with access granted and thus making the granted accesses feasible. Provided that the criterion with which access permits have been granted until now[6] was based on the nodes (it did not take into account the effect of the ZEIs) with the new criteria of Circular 1/2021 (and in particular taking into account the WSCR criterion), a significant part of the production of generation with permits granted in the Islas Canarias could be limited for this reason. Synchronous condensers significantly reduce such potential constraint.

The aim is to improve the integration of generation that has already been granted access capacity under the criteria in force prior to CNMC Circular 1/2021, due to the effect of reducing the size of the ZEIs and the short-circuit power provided by the SCs. The increase in the limit values per WSCR will allow greater integration of available renewable energy sources, significantly reducing the need to impose limitations on generation for this reason and facilitating the achievement of a greater proportion of renewable energy sources in the electricity demand of these systems.

# 4.3. Conclusions



The isolated nature of electricity systems in the Islas Canarias makes them more vulnerable to the challenges posed by the high penetration of renewables foreseen in the NECP. The robustness of the network, which can be measured in terms of short-circuit power, is a fundamental characteristic to guarantee the correct operation of the Power Park Modules (PPM), in particular wind and photovoltaic generators.

The studies carried out demonstrate the need to incorporate elements, such as synchronous condensers (SC), that provide the Gran Canaria, Tenerife and Lanzarote-Fuerteventura subsystems with new dynamic voltage control points and short-circuit and inertia current injection points. This is to strengthen the system and thus reduce the risk of potential interactions between the power electronics controls.

In the absence of the proposed SCs, the Zones of Electrical Influence (ZEI) in these systems would encompass most of the nodes of each of these islands. The inclusion of 25 Mvar SC in Gran Canaria, Tenerife and the south of Fuerteventura makes it possible to split these ZEIs and thus improve the integration of renewable energy sources from PPMs by the criterion linked to short-circuit power (WSCR criterion) in these subsystems and reduce the risk of interactions for generation that already has access permits granted.

6 Criterion: 5% of Scc defined in Annex XV of RD 413/2014.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 5. Annex - Dynamic transmission capacity

## 5.1. Dynamic line rating (DLR) as an alternative to the development of the transmission network

Taking into account the provisions of Order TEC/212/2019, of February 25, which initiates the procedure for making proposals for the development of the transmission network (TN) of electricity with a 2026 horizon, and in particular the guiding principle "h) Maximising the use of the existing network, renewing, expanding capacity, using new technologies and reusing the existing facilities", the system operator, following the analyses carried out within the scope of the 2021-2026 plan, proposes, among other reinforcements, the installation of real-time monitoring systems on a set of overhead or mixed lines. This is to determine their transmission capacity using Dynamic Line Rating (DLR) techniques, also known as Real-Time Thermal Rating (RTTR).

These monitoring systems installed on the transmission network lines allow the implementation of DLR. DLR basically consists of estimating in real time the values of the transmission capacity of the lines of the electricity network according to different measurable variables that allow for its calculation: climatic conditions, conductor temperature measurements in real time, span deflection, conductor inclination, measurement of conductor vibration, etc... Consequently, DLR consists of calculating the maximum current that a line can carry considering the instantaneous environmental conditions or the state of the conductor respecting at all times its thermal limits and guaranteeing the safety distances established in the electrotechnical regulations. Degradation or premature ageing in the facility is prevented, as the operating conditions are always consistent with the technical (thermal) limits.

In contrast, at present, the transmission capacity of the lines that compose the electricity network is generally calculated taking into account the thermal model of the lines but using seasonal weather conditions based on historical statistical data. At present, for overhead circuits, and in accordance with the provisions of operating procedure 1.2. and 1 SENP, four values of transmission capacity are defined (except in the Islas Canarias, where only one value is considered) corresponding to the four seasons of the year. With DLR, "instantaneous" transmission capacity values calculated in real time will be used, considering the real conditions



Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

to which the facility is subjected.

Migrating from a seasonal transmission capacity model to real monitoring with DLR means optimising the use of the transmission network assets, as it is often possible to transmit more power with the same infrastructure. However, this requires:

- adequate monitoring of the line, in order to know the real thermal conditions of the facility along its entire route;
- the development of communications systems that allow reliable and secure transmission of the information captured in the field;
- a meticulous processing of the information to correctly determine the maximum admissible intensity in the conductor in real time;
- the establishment of forecasting models to predict the estimated values of transmission capacity for the coming hours; and
- modifications to control systems and applications to allow new transmission capacity values and their forecasts to be included in system operation processes.

In any case, the potential benefits to be obtained by applying DLR is highly dependent on the particular asset to which it is applied, given that the environmental conditions to which the line is subjected along its route and the safety margins in distances used in its design will determine them in each case. The length of the line, the orography of the terrain it crosses, the climatic conditions of its surroundings, etc. are factors that have an impact on the DLR, both in terms of the results that can be obtained, and the level of monitoring required.

Currently, there are various technologies with different degrees of maturity and reliability for applying DLR to a circuit. These are technologies based on discrete or distributed monitoring methodologies, which measure or monitor only environmental variables and/or measure physical variables of the facility itself. The concrete characteristics of each facility, its critical spans, as well as the degree of technological development that DLR will undergo in the coming years, will ultimately determine the best solution for its application to transmission network circuits.

Likewise, the cost of the different technologies is also different, depending on the degree of monitoring required, and on whether the solution is using technology and systems developed by REE, or whether they are complete commercial solutions. Within the scope of the 2021-2026 plan studies, the minimum cost for which a solution for implementing DLR is known to exist today has been considered. In any case, the final technological solution for implementing DLR, and the degree of monitoring of the facilities (number of sensors to be installed), will ultimately depend on the characteristics of each facility, the progress of technological development and the experience gained by REE during the implementation of DLR.




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 5.2. Criteria for identifying DLR as a solution for the network development plan 2021-2026. Benefits for the system

Within the scope of the 2021-2026 plan studies, around 200 lines of the transmission network have been assessed to determine the potential benefit of a DLR solution. The benefit of DLR, i.e. the potential increase of the transmission capacity of the line, has been determined on the basis of the best available historical meteorological information, in particular historical hourly records of the environmental temperature, solar irradiation, wind speed and wind direction variables obtained from the weather stations of the World Meteorological Organisation.

This available historical information generally corresponds to points located far from the network lines. After several analyses of the correlation between measurements from different weather stations, it has been concluded that, for the estimation of the potential benefit of DLR to be reasonable, not all variables recorded at remote weather stations can be directly considered. In detail, the results showed that environmental temperature and solar irradiation do correlate between local (weather stations installed on the line itself) and remote weather stations, while wind speed and wind direction are hardly correlated, being also the most influential variables in cooling, and therefore in determining the transmission capacity of a line. It has therefore been decided to assume relatively conservative environmental conditions in order to determine the DLR potential in planning studies:

- For environmental temperature, historical hourly records from remote weather stations located in airports or provinces are considered, with data freely available through the World Meteorological Organisation.
- For solar irradiation, an analytically calculated value is considered for a conservative assumption of clear skies, so that the scattering shown in the results is eliminated.
- For the wind speed on the line, a discontinuous function is taken as a function of the wind value measured at the remote weather station, and its direction is always considered to be perpendicular:

$$v_W = \begin{cases} 0.6\ \text{m/s} & L90^\circ,\ \text{wind}_{\text{measuredRemote}} < 10\text{m/s} \\ 2\ \text{m/s} & L90^\circ,\ \text{wind}_{\text{measuredRemote}} \geq 10\text{m/s} \end{cases}$$

For the suitability analysis of the application of DLR on the lines of the transmission network in the scope of the 2021-2026 Plan, on the one hand, the results have been analysed from the point of view of the gain in transmission capacity obtained with DLR with respect to the seasonal transmission capacity and, on the other hand, from the point of view of the resolution of the overloads identified in the analyses.

- From the point of view of the transmission capacity gain with DLR compared to the seasonal capacity, the following indicators are defined:
  - Cutoff with the capacity duration curve. The cutoff value with the capacity duration curve is obtained by arranging the results of hourly transmission capacity with DLR for each station from highest to lowest (i.e. representing the monotonous duration curve), and comparing it with the seasonal capacity value, which provides an indication of what percentage of time the DLR would be allowing for a greater transmission capacity than the calculation of the seasonal ratio. The higher this cutoff value with the capacity duration curve, the greater the number of hours that the

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

DLR has provided greater transmission capacity, and therefore, in some way, it can be considered that the probability that the DLR will provide greater capacities in the future is higher. Figure 17 presents these values for each season of the year for the example of the L/ Llucmajor - Son Orlandis 66 kV.

Given that the wind variable used in the DLR calculation equation is a considered conservatively (it does not reflect the real wind speed at the facility), the cut-off point of these capacity duration values with the seasonal transmission capacity should not be interpreted directly as the risk associated with the calculation of the seasonal transmission capacity (this risk being understood as the probability that the seasonal transmission capacity reflects values higher than the real thermal capacities of the facility).

- Maximum capacity obtained with DLR. This is the maximum hourly transmission capacity obtained with DLR, expressed as a percentage of the transmission capacity ratio. Such value delimits the greatest expected gain in terms of the transmission capacity of the line. The following figure graphically represents the indicator for winter on the L/ Llucmajor - Son Orlandis 66 kV.

**Figure 17. Graphical representation of the "cutoff with capacity duration curve" indicator**

**Representation of seasonal CdT vs hourly CdT with DLR (monotonous) L/66kV Llucmajor - Son Orlandis**

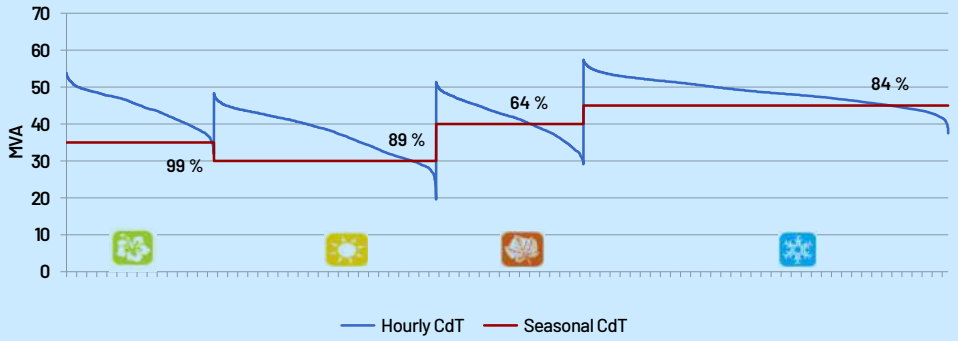
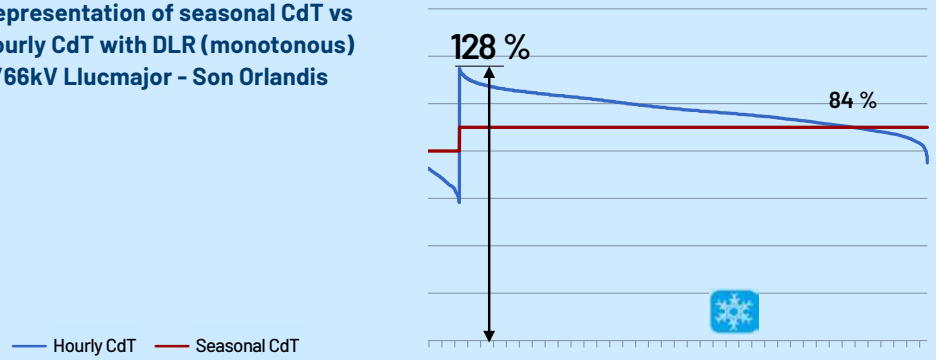



**Figure 18. Graphical representation of the maximum transmission capacity obtained with DLR**

**Representation of seasonal CdT vs hourly CdT with DLR (monotonous) L/66kV Llucmajor - Son Orlandis**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

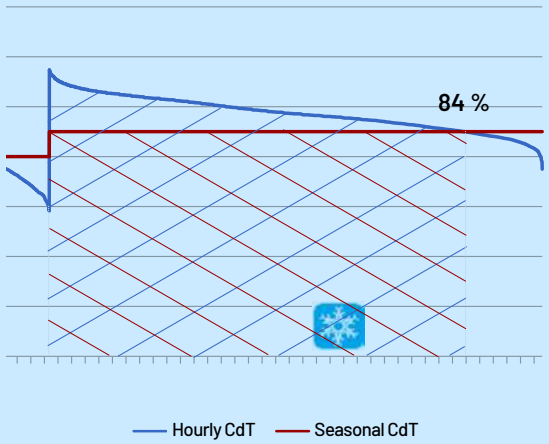
**III: Technical annexes**

- Gain factor. This is the ratio between the transmission capacity of the DLR and the seasonal capacity, calculated in aggregate for all the hours of a station in which the transmission capacity implementing DLR is greater than the seasonal capacity. The higher the ratio, the greater the capacity increase achieved when DLR is implemented.

  In the following figure, a graphical representation of the values that make up the ratio (blue striped area/orange striped area) is shown for the winter season on the L/ Llucmajor - Son Orlandis 66 kV:

**Figure 19. Graphical representation of the "gain factor" indicator**

**Representation of seasonal CdT vs hourly CdT with DLR (monotonous) L/66kV Llucmajor - Son Orlandis**




- From the point of view of resolving overloads, it should be borne in mind that DLR, unlike other structural solutions such as uprating, does not represent a permanent and stable increase in transmission capacity on the line. Therefore, its suitability as a planning solution not only depends on the aforementioned indicators, but also on the fact that the times when the line can be operated with greater capacity coincide with the times when the system needs it. This has been evaluated in detail in the studies carried out for the 2021-2026 Plan by comparing, for the 8,760 hourly cases of the scenario at the 2026 horizon, the overloads in the network compared with the hourly transmission capacity values (DLR) expected for the lines. The result of these analyses and the application of the cost-benefit analysis (CBA) methodology is the set of reinforcements for the application of the DLR included in this plan.

  In general, the DLR has a positive correlation for resolving congestion linked to the evacuation of wind generation. In the above cases, wind represents the dominant factor in causing congestion, but it is also the dominant factor in solving it, as it is the factor with the most positive impact on increasing transmission capacity, as shown in the following figure.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

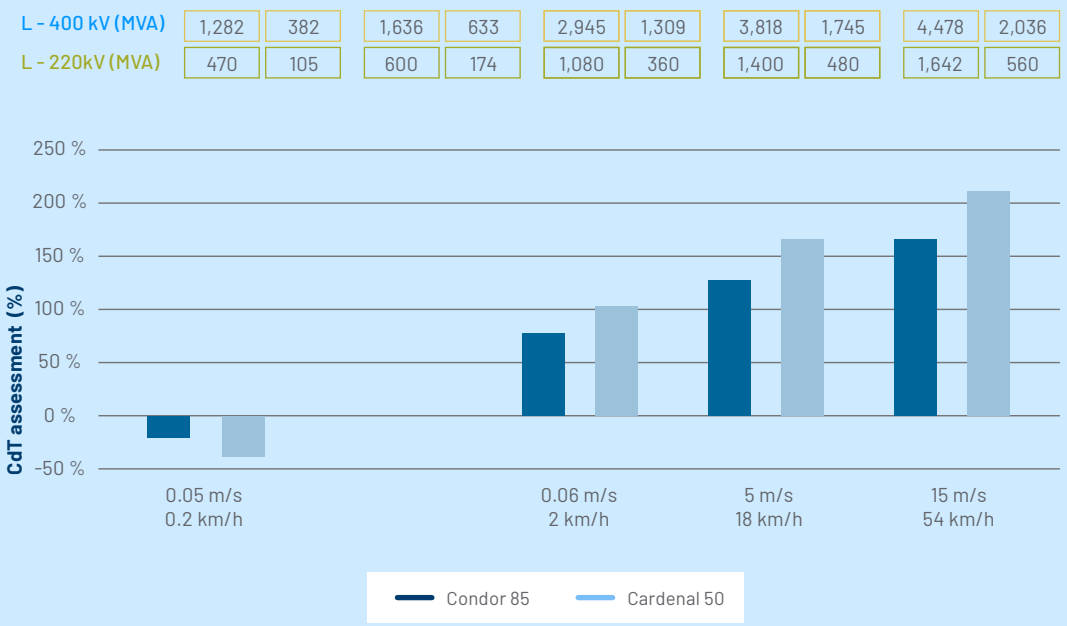
**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

**Figure 20. Influence of wind on the transmission capacity of lines**




DLR can also be combined with traditional uprating solutions. In these cases, the benefit of DLR can be twofold. On the one hand, its foreseeable faster deployment than the structural solution will allow additional (but not sufficient) benefits to a simple uprating-only solution; for this reason, while the uprating is being implemented, the system will be able to benefit from additional capacity gains from the DLR. Lastly, once the uprating has been implemented, higher than nominal line capacities can be obtained from the uprating, if needed. If such additional increases are not necessary, the versatility and modularity of the DLR provides the additional benefit of flexibility, since the sensorisation could be used for other lines in the network and transfer its benefit to other installations in which greater capacities than the seasonal nominal ones are required.

In addition to all of the above, the DLR solution should be identified as a tool for moving towards a smarter and more digitised network. DLR is currently an innovative technology, and as such, it is considered appropriate to deploy it throughout the territory (mainland and island) in order to be able to truly assess the benefit provided according to the characteristics of the different electricity systems and territorial conditions through specific implemented solutions. For this reason, in the DLR reinforcements planned, it has also been considered as a criterion to have a representation of these solutions in different geographical areas of the Spanish electricity system. In this way, the practical implementation of the DLR itself is intended to serve as a knowledge acquisition and consolidation repository for the technological solution, for potential greater deployment in the future.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 5.3. DLR applicability

As described in the previous section, within the scope of the studies for the transmission network development plan 2021-2026, the suitability of the DLR has been evaluated on around 200 circuits of the transmission network. Based on the obtained results and considering the innovative nature of the solution (and consequently its intrinsic risk as it is a solution that has not been fully tested and validated), the use of this solution has been restricted to a limited set of lines, although it allows a solid approximation to this solution.

The development plan includes monitoring with DLR for a total of 722 km distributed over 23 lines of the transmission network in Spain, 14 of which are in the mainland electricity system, 3 lines in the Islas Baleares electricity system and 6 lines in the Islas Canarias electricity system.

The following table shows the DLR implementation reinforcements included in the plan:

**Table 2. Lines included in the plan for the implementation of DLR in the 2021-2026 horizon**

| Lines on which DLR is to be installed | Region | L [km] |
|---|---|---|
| L/ Aragón – Mequinenza 400 kV | Aragón | 54 |
| L/ Vandellós - La Plana 400 kV | Cataluña | 156 |
| L/ Pazos de Borbén - Tomeza 220 kV | Galicia | 20 |
| L/ Tibo - Tomeza 220 kV | Galicia | 27 |
| L / Logroño - El Sequero 220 kV | La Rioja | 27 |
| L/ Palencia - Renedo 220 kV | Castilla y León | 65 |
| L/ La Selva - Tarragona 220 kV | Cataluña | 16 |
| L/ María - Fuendetodos 1 220 kV | Aragón | 30 |
| L/ María - Fuendetodos 2 220 kV | Aragón | 30 |
| L/ Pont de Suert - La Pobla 220 kV | Cataluña | 29 |
| L/ La Pobla - T de Sesue 220 kV | Cataluña | 55 |
| L/ Riera de Caldes - Sentmenat 220 kV | Cataluña | 10 |
| L / Llucmajor - Son Orlandis 1 66 kV | Islas Baleares | 18 |
| L / Llucmajor - Son Orlandis 2 66 kV | Islas Baleares | 18 |
| L/ Ibiza - San Antonio 66 kV | Islas Baleares | 10 |
| L/ Escucha - Híjar 220 kV | Aragón | 57 |
| L/ Escatrón - Híjar 220 kV | Aragón | 16 |
| L/ Aldea Blanca - Agüimes 66 kV | Islas Canarias | 6 |
| L/ Agüimes - Escobar 66 kV | Islas Canarias | 14 |
| L/ Candelaria – Geneto 1 66 kV | Islas Canarias | 10 |
| L/ Candelaria - Geneto 2 66 kV | Islas Canarias | 10 |
| L/ Arico II - Polígono de Güimar 66 kV | Islas Canarias | 22 |
| L/El Poris-Candelaria 66kV | Islas Canarias | 22 |

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 6. Annex - Quality of service and relation with transmission network characteristics

## 6.1. Historical situation of the quality of service of the transmission network in the mainland, balearic islands and canary islands systems

Historically (considering the last decade), the quality of service in the transmission network of the Spanish electricity system (SEE), in terms of continuity and quality of supply, has generally been adequate.

The global indicators of continuity of supply of the transmission network are Energy Not Supplied (ENS) and Average Interruption Time (TIM). The most relevant reference value is that associated with the TIM, which the regulations set at 15 minutes.

In the mainland (SEPE) and Balearic (SEB) electricity systems, the overall indicators of continuity of supply have been stable within the reference values established in current legislation, reflecting an adequate level of overall quality, which is tending to improve, particularly in the SEPE. However, in the Islas Canarias electricity systems (SEC) a lower level of quality has been observed, with occasional but significant breaches of the reference indicators for continuity of supply over the last 10 years.



The quality of service of the transmission network generally presents values that comply with regulatory references, although there is some room for improvement in the Islas Canarias electricity system, where occasionally there have been larger deviations with respect to these references.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

**Figure 21. Historic TIM SEPE and SEB**

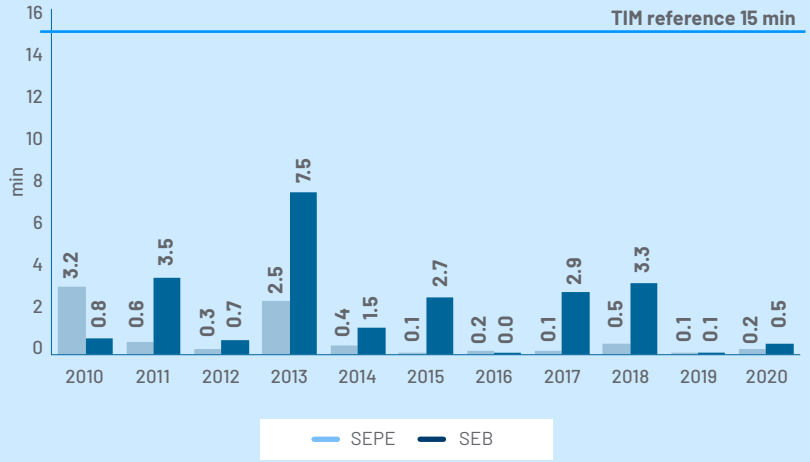
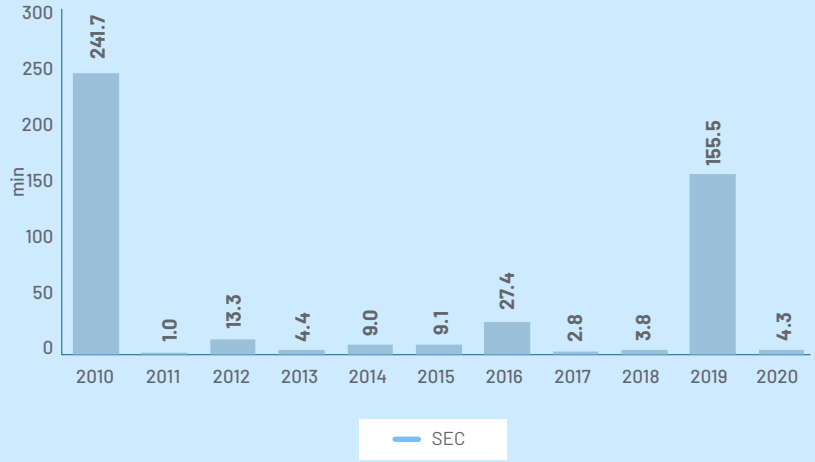



**Figure 22. Historic TIM SEC**






Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

**Figure 23. Historical evolution of Energy Not Supplied (ENS) in SEPE, SEB and SEC**

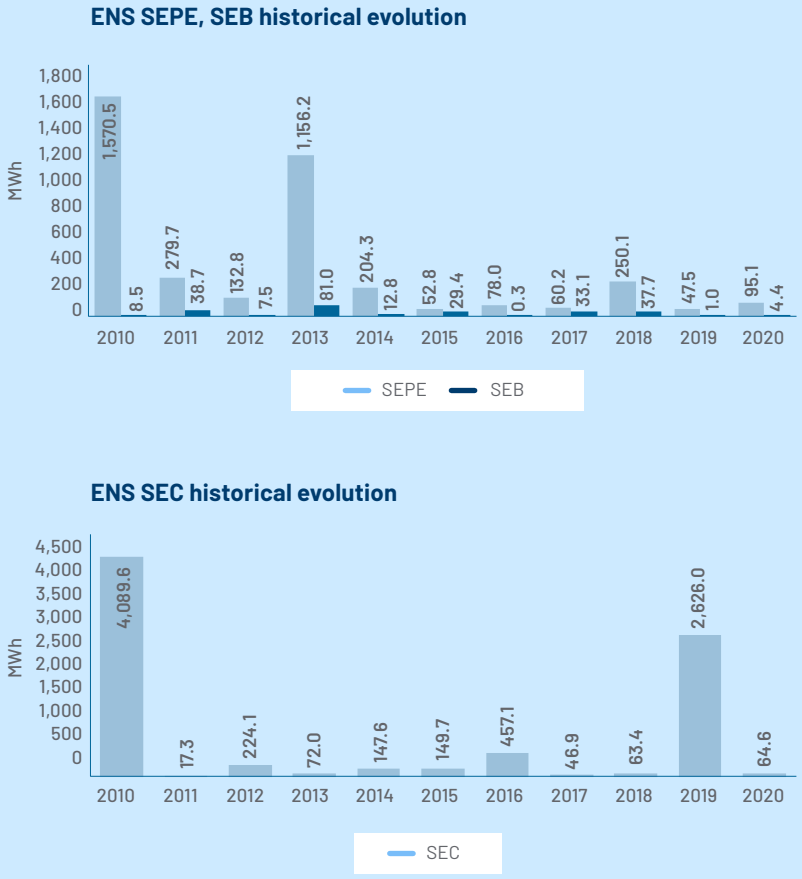
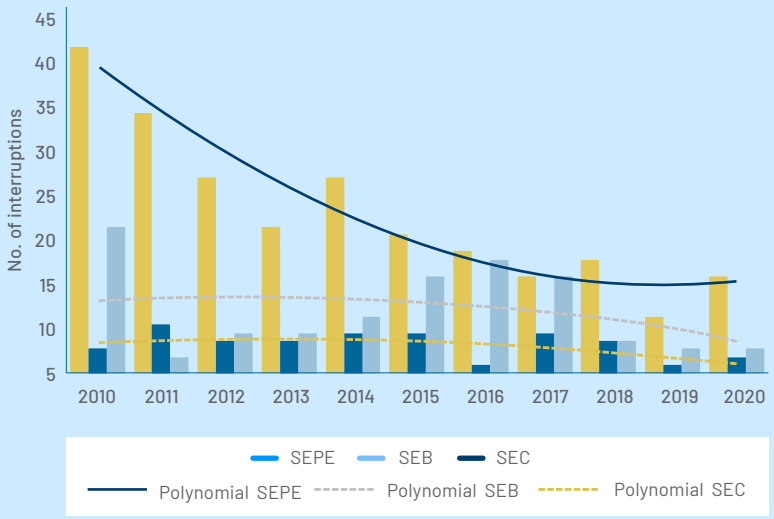



**Figure 24. Historical evolution of the number of interruptions on the transmission network**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

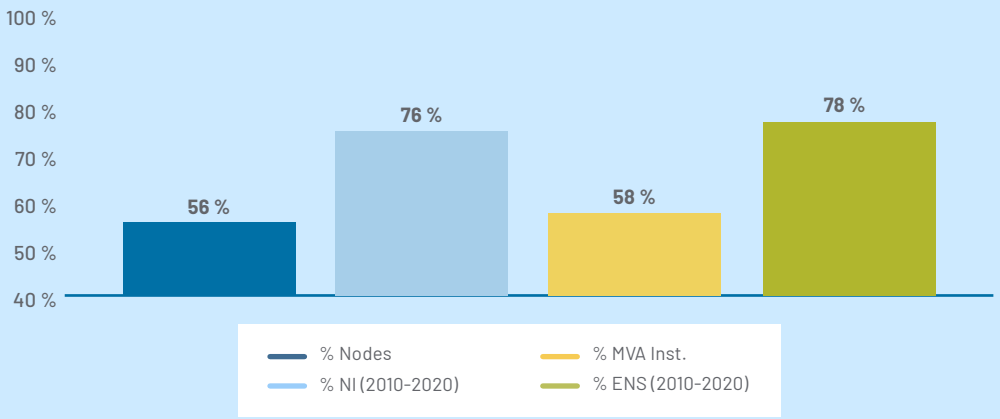
**III: Technical annexes**

# 6.2. Analysis of the influence of the topology and meshing of the transmission network on quality of service

The following is an analysis for the different electricity systems in which topological and meshing characteristics of the transmission network are related to the effects in terms of energy not supplied, interruption time or number of interruptions associated with them. The objective of this study is to provide relevant information to identify possible development needs of the transmission network linked to the quality of service and continuity of supply.

The topology of the transmission network and the influence of the network underlying the transmission network have been identified as the most relevant general factors influencing the continuity of supply (interruptions recorded in the study period 2010-2020).

**Figure 25. Single busbar effect % Nodes and MVA vs ENS and NI in SEC**




The topology of the transmission network has been analysed in the light of the influence on the quality of service of the local topology of the nodes where the interruptions have been recorded, and particularly in relation to substations with single busbar configuration (as the most relevant chapter of the non-preferred configuration facilities according to Operational Procedureo PO13.3).

Substations with a single busbar configuration account for 76% of the number of interruptions recorded in the Islas Canarias Electricity System between 2010-2020, with an ENS of 78% of the total, despite representing 56% of the number of nodes and 58% of the installed transmission-distribution transformation power.

The frequency of occurrence of interruptions in relative terms is higher in insufficiently meshed nodes. This effect is more pronounced in non-peninsular systems.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

**Figure 26. Topology and number of outages by topology in the electricity system**

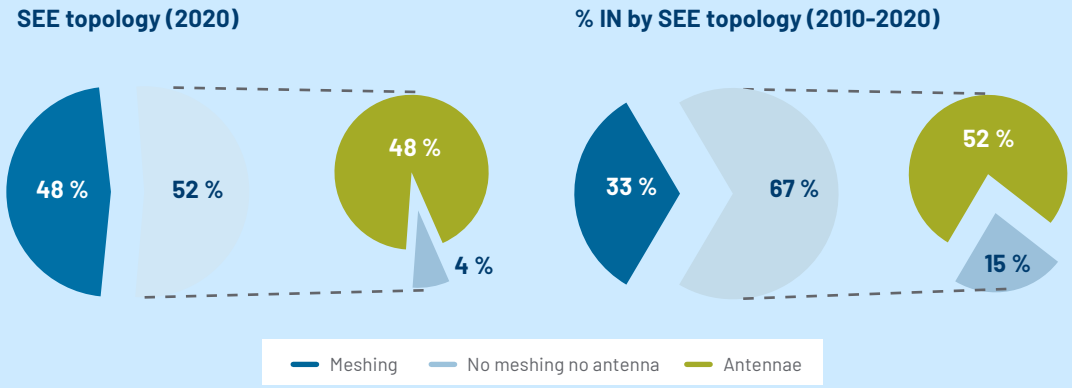
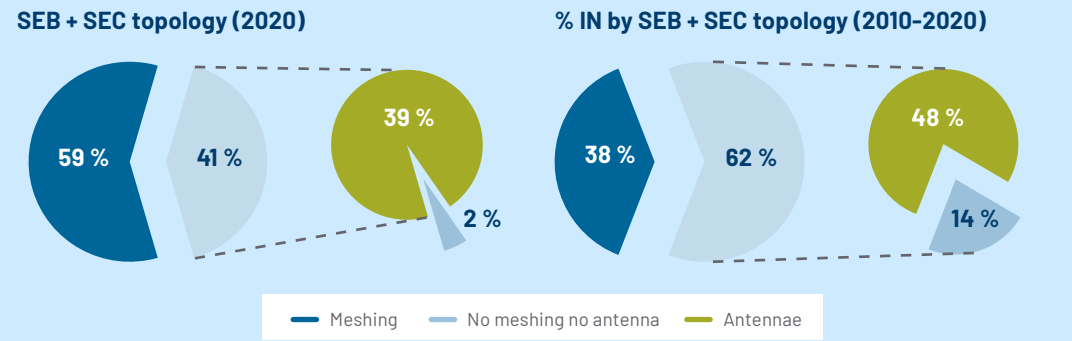



**Figure 27. Topology and number of outages by topology in the Balearic islands and Islas Canarias electricity systems**




The meshing of substations is a very significant factor, as most of the interruptions (approximately 67% of the total number of interruptions -NI- between 2010 and 2020) have occurred in "insufficiently meshed" nodes[7], which account for 52% of the total number of nodes in the transmission network.

This proportion is significantly higher in the case of non-peninsular systems, where 62% of outages occurred, compared to 41% at insufficiently meshed nodes.

As regards the influence on the underlying network in situations of unavailability in the transmission network, the effect, which is particularly significant for the non-peninsular electricity systems, of the distribution network having insufficient support of its own is identified.

7 400 kV nodes are considered insufficiently meshed if they are connected to other nodes of the transmission network by no more than two 400 kV lines and with less than two 400/220 kV transformers. In the case of 220 kV, nodes are considered insufficiently meshed if they are connected to other nodes of the transmission network by no more than two 220 kV lines and no 400/220 kV transformers.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

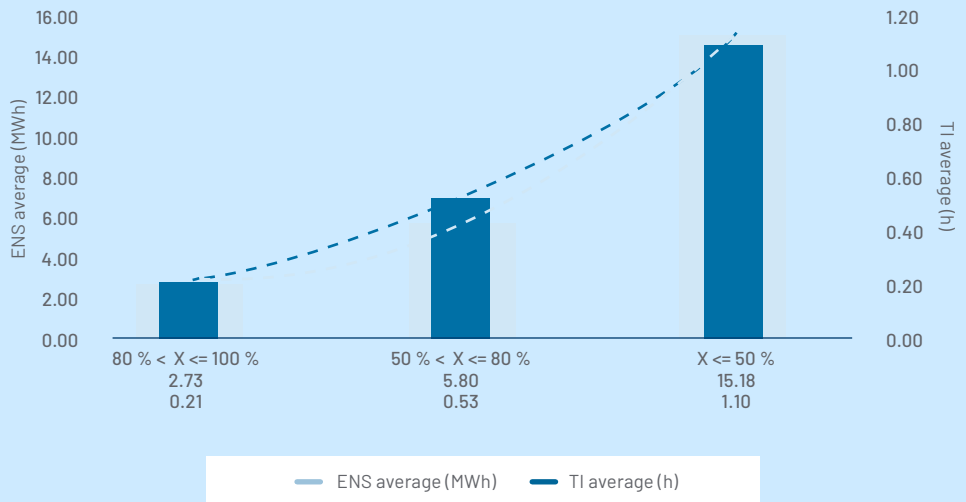
I: Staritng grid

II: New reinforcements

**III: Technical annexes**

The simple busbar configuration in substations, particularly in those with demand connected directly or via the distribution network, entails a greater risk of being affected in terms of energy not supplied in the event of a supply interruption, which is aggravated in systems with a lower degree of meshing.

**Figure 28. Affection of the degree of own support of the RdD in the event of unavailability of TN vs ENS and TI**




The degree of support that the distribution network itself can provide in the event of supply interruptions at border points of the transmission network minimises the impact of these disturbances on the end consumer who generally connects to the distribution network. In this sense, there are clear positive effects of the degree of support of the loads underlying a specific substation from the rest of the distribution network on the average ENS and average TIM at border points. The values indicated for these indicators are shown below for the supply interruptions recorded in the period 2010-2020 depending on different values of the degree of support from the distribution network itself.

The influence in terms of security of supply of insufficiently meshed transmission network nodes is a particularly relevant factor in non-peninsular systems.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

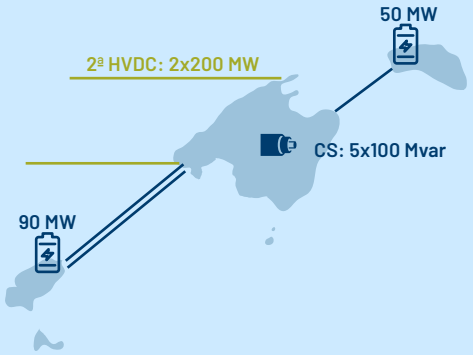
# 7. Annex - CBA analysis with sequential PINT in the project for the reinforcement of the electricity connection between the mainland and the Islas Baleares

## 7.1. Introduction

The reinforcement of the electricity interconnection between the mainland and the Islas Baleares comprises a set of reinforcements with an impact on net transfer capacities both with the mainland and between islands. Specifically, this reinforcement consists of the following reinforcements:

- New direct current (HVDC) submarine link with VSC technology, between El Fadrell (Castellón) and San Martín (Mallorca), consisting of a bipole with a 2x200 MW capacity metallic return.
- Installation of storage systems: 90 MW of batteries and 67.5 MWh capacity on the island of Ibiza and 50 MW of batteries and 37.5 MWh capacity on the island of Menorca.
- Synchronous condensers on the island of Mallorca with a total capacity of 500 Mvar located in three different substations: San Ponsa 220 kV, Llubí 220 kV and Valldurgent 220 kV.

**Figure 29. Reinforcements to reinforce the electricity interconnection between the Spanish mainland and the Islas Baleares**




The reinforcement of the interconnection between the mainland and the Islas Baleares comprises a set of reinforcements whose CBA analysis is positive. However, each of these reinforcements will be commissioned in different chronological periods. It is therefore relevant to know the CBA analysis for each of them separately.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

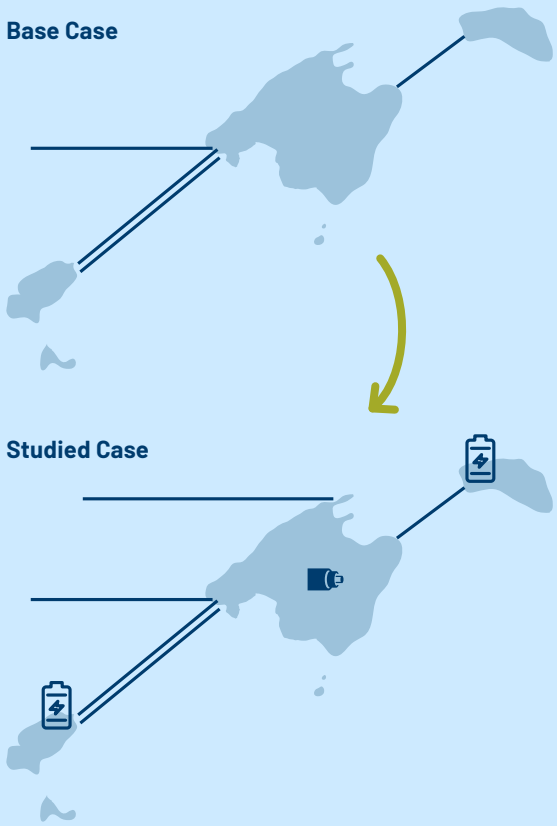
II: New reinforcements

**III: Technical annexes**

This appendix presents the cost-benefit analysis of all the reinforcements that make up the reinforcement of the interconnection between the Spanish mainland and the Islas Baleares. The results of this analysis show higher benefits than costs and, therefore, a positive CBA for all the reinforcements as a whole compared to a situation in which these reinforcements are not considered, i.e. with the PINT methodology.

However, due to the different technical complexity of each of the reinforcements that make up the reinforcement, it is likely that their commissioning will take place in different chronological periods. Therefore, it is advisable to know the CBA analysis of each of the reinforcements separately, which is called sequential PINT analysis, in order to determine whether any of them might not present a positive CBA analysis on its own and to obtain information on the sequence of commissioning of the different reinforcements that maximises the benefit for the system.

**Figure 30. CBA analysis of all the reinforcements to reinforce the interconnection between the mainland and the Islas Baleares**




**PROFITS**

Reduction of $CO_2$ emissions
**905 kt/year**

RES integration
**236 GWh/year**

Total reinforcements
**1,154 M€**

Annual profit
**148 M€/year**

NPV
**1,157 M€**

Annual profit/reinforcements year1
**1.2**

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 7.2. Sequential PINT analysis of the reinforcements to reinforce the interconnection between the mainland and the Islas Baleares

The following sections present the sequential PINT analysis for each of the reinforcements that are part of the reinforcement of the interconnection between the mainland and the Islas Baleares:



## 7.2.1. CBA analysis of the battery storage systems

In the Balearic system, the installation of two storage systems with a total capacity of 140 MW is proposed: one of 90 MW / 67.5 MWh on the island of Ibiza and another of 50 MW / 37.5 MWh on the island of Menorca. These batteries are proposed as fully integrated network components in the transmission network[8] whose function is no other than to increase the exchange between the mainland and the Islas Baleares and between the islands of the archipelago themselves under safe conditions, achieving a higher degree of utilisation of the submarine links.

The proposed storage system makes it possible to increase the net transfer capacity available on a link or axis of the transmission network as it reduces the impact of the "N-1" criterion in determining the net exchange capacity available under safe conditions: in the event of the loss of a circuit of the link or axis considered –"N-1"– the energy stored in the battery will be deployed to supply the flow that was transported by the affected circuit for the time necessary, until the unavailable element is recovered or until alternative operating measures are adopted, in particular, the start-up of generation units.

Therefore, the proposed storage system will always be on load and standby, i.e. it will not inject any energy into the system under normal conditions and will only act upon the failure of a transmission network element. Given the low probability of these situations, the number of operating cycles is very low and, therefore, their useful life is extended.

The CBA analysis of the batteries is presented below, taking into account two different hypotheses: first, assuming that they are commissioned before the second HVDC link between the mainland and the Islas Baleares and the synchronous condensers and, second, assuming that they come into operation after the commissioning of the HVDC link between the mainland and the Islas Baleares and the synchronous condensers.

8 Royal Decree Law 29/2021 of 22 December introduces fully integrated network components, including storage facilities, into Art 34.1 of the Electricity Sector Law as those used to guarantee the secure operation of the transmission network and not for balancing or congestion management purposes.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

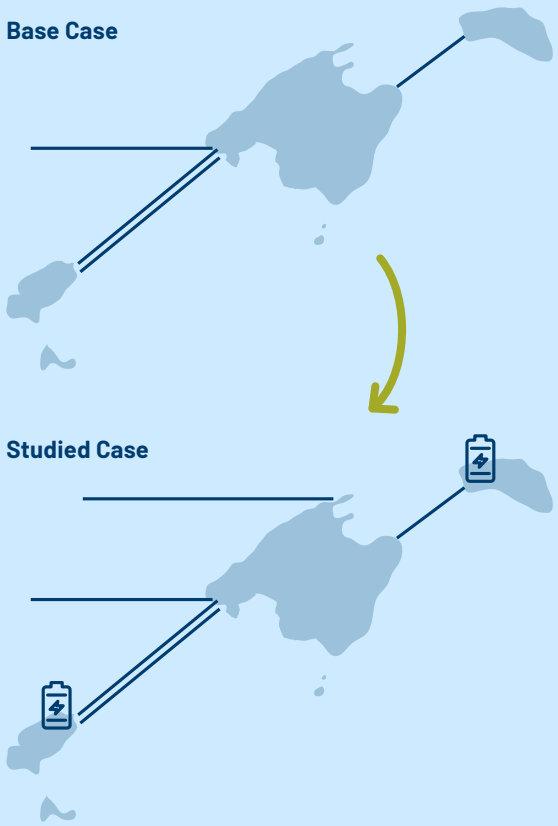
II: New reinforcements

**III: Technical annexes**

Such increase in flow allows a greater proportion of system demand to be supplied from the mainland or from Mallorca, reducing the variable generation costs of the whole, greater integration of renewable energy sources located on the mainland by being able to supply additional demand in the Balearic system and, as a result, a reduction in $CO_2$ emissions.

- **CBA analysis of batteries without a second HVDC link and without synchronous condensers**: with this hypothesis, the base case is the same as that considered in the analysis of the reinforcement of the interconnection between the Islas Baleares as a whole, and the case study considers only the storage systems in Ibiza and Menorca:

**Figure 31. CBA analysis of the batteries without second HVDC and without CS**




PROFITS

Reduction of $CO_2$ emissions
**203 kt/year**

RES integration
**92 GWh/year**

Total reinforcements
**135 M€**

Annual profit
**41 M€/year**

NPV
**657 M€**

Annual profit/reinforcements year1
**2.4**

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

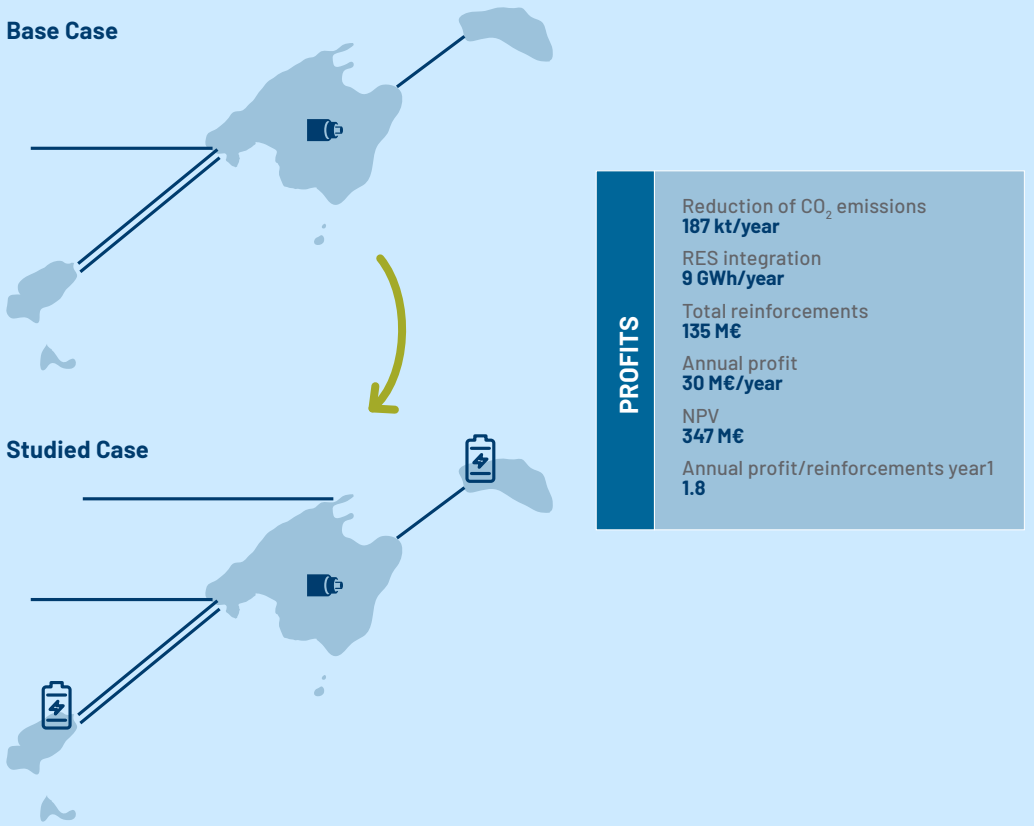
II: New reinforcements

**III: Technical annexes**

- **CBA analysis of batteries with second HVDC link and with synchronous condensers**: with this hypothesis the base case considers the second HVDC and the synchronous condensers in service and the case study considers the reinforcements of the base case to which the batteries in Ibiza and Menorca are added:

In both hypotheses, the increase in flow through the links allowed by the batteries enables a greater part of the Balearic system demand to be supplied from the mainland and reduces the operation of the generators located in the Islas Baleares, which have a higher cost. In this way, the variable generation costs of the system as a whole are reduced, with greater integration of renewable energy sources located on the mainland and a reduction in $CO_2$ emissions. Therefore, a positive CBA analysis is obtained for the battery storage reinforcements in both hypotheses.

**Figure 32. CBA analysis of batteries with second HVDC and with CS**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

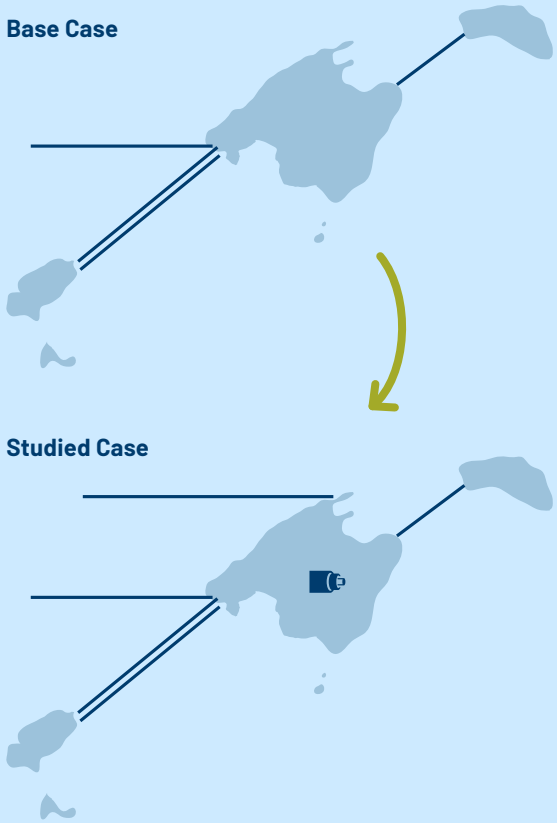
# 7.2.2. CBA analysis of synchronous condensers

In addition to the storage systems, the reinforcements under analysis also proposes the installation of a series of synchronous condensers in different locations on the island of Mallorca, specifically, 5 synchronous condensers of 100 MVA each. These synchronous condensers will ensure the short-circuit power levels required by the current HVDC link with LCC technology between the mainland and the Islas Baleares and increase the inertia of the system. In addition, they make a significant contribution to voltage control in the static regime and frequency control in the transient regime to guarantee the security and continuity of supply of the Islas Baleares system.

The CBA analysis of the synchronous condensers is presented below, taking into account two different hypotheses: first, assuming that the synchronous condensers are commissioned with the second HVDC link already in service, but without the battery storage system, and second, assuming that they are commissioned with the second HVDC link and the batteries already in operation.

- **CBA analysis of synchronous condensers with second HVDC link and without batteries**: with this hypothesis the base case considers the second HVDC link in service and the case study adds the synchronous condensers in Mallorca:

**Figure 33. CBA analysis of CS with second HVDC and without batteries**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

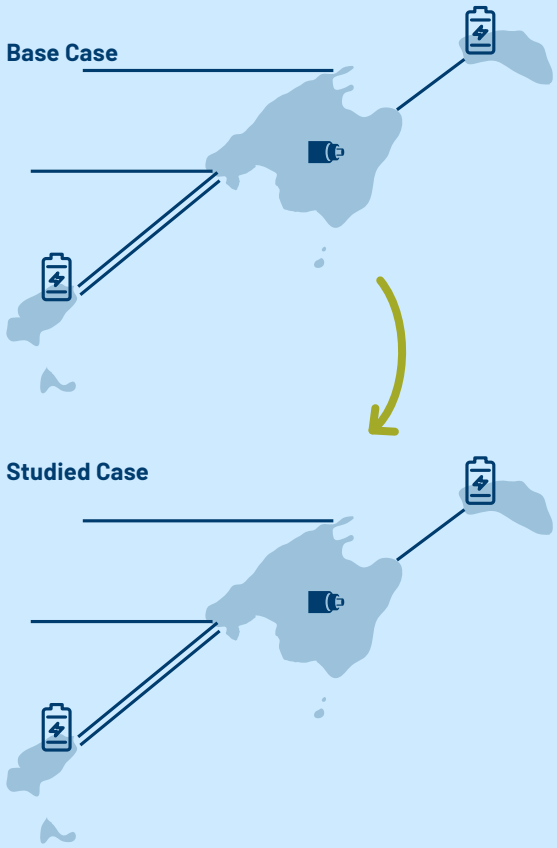
**III: Technical annexes**

- **CBA analysis of synchronous condensers with second HVDC link and with batteries**: with this hypothesis the base case considers the second HVDC link and the batteries in service and the case study adds the synchronous condensers in Mallorca:

From the results presented, it can be observed that synchronous condensers provide a benefit to the system when they are put into service after the HVDC link between the mainland and the Islas Baleares. The benefit is higher when batteries are also considered in service.

In addition to the CBA analyses presented here, the benefits of synchronous condensers have also been evaluated when they are commissioned before the second HVDC link (with and without batteries). In these cases, the results show a negative CBA as the benefits are not significant enough to offset the cost. However, it is important to point out that another of the functions proposed to be included in the Islas Baleares is to improve the stability and voltage control of the Islas Baleares system as a whole. The additional benefits that can be obtained with these additional functions have not been taken into account in the economic evaluation, due to the complexity of monetising them.

**Figure 34. CBA analysis of CS with second HVDC and with batteries**




**PROFITS**

Reduction of $CO_2$ emissions
**300 kt/year**

RES integration
**67 GWh/year**

Total reinforcements
**175 M€**

Annual profit
**59 M€/year**

NPV
**861 M€**

Annual profit/reinforcements year1
**3.0**

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

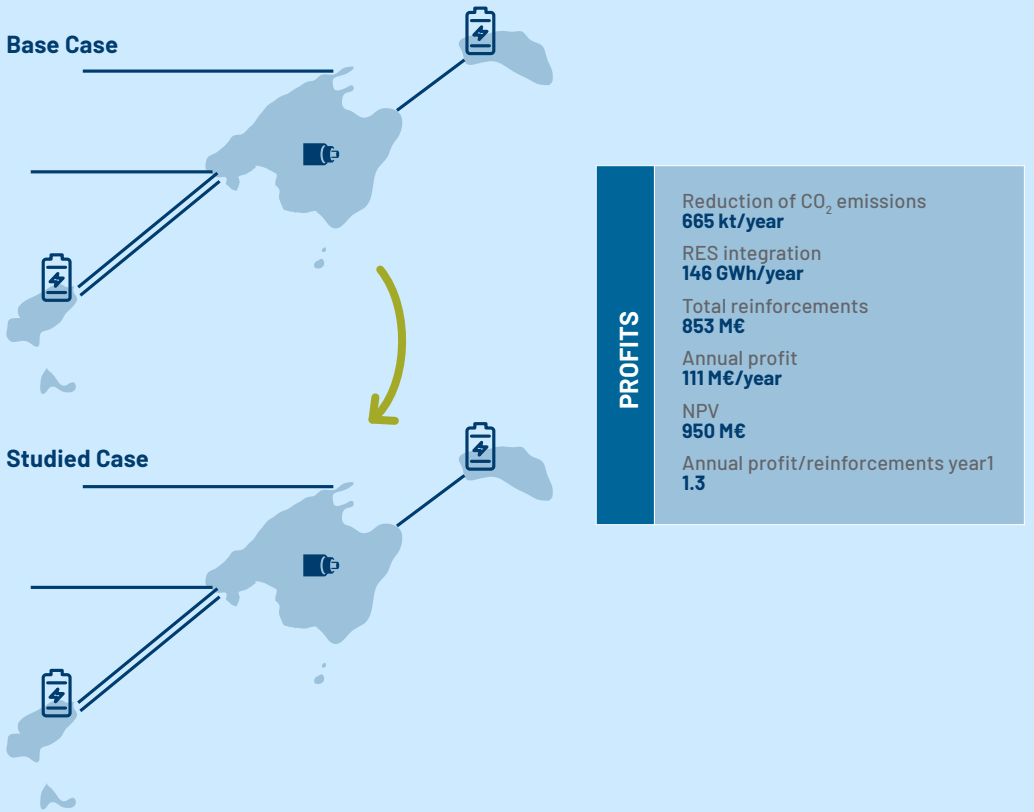
**III: Technical annexes**

# 7.2.3. CBA analysis of the second HVDC link between the Spanish mainland and the Islas Baleares

In order to progress in the integration of the Balearic system into the mainland system, and to facilitate the transition to a decarbonised economy, reduce the vulnerability of this territory and replace part of the higher cost thermal generation mix with a cheaper one and with a greater presence of renewables, a second direct current interconnection between the mainland and the Islas Baleares is proposed. The new direct current submarine link, using VSC technology, will connect the El Fadrell (Castellón) and San Martín (Mallorca) substations. The configuration of the link will be two-pole with metallic return and its capacity will be 2x200 MW.

The result of the CBA when considering the synchronous condensers and batteries in service is displayed below:

**Figure 35. CBA analysis of the second HVDC link with synchronous condensers and batteries**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

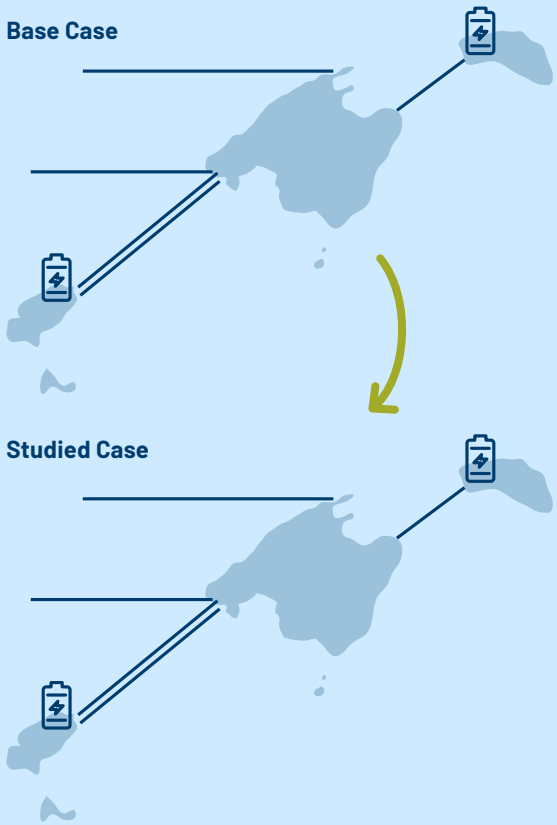
I: Staritng grid

II: New reinforcements

**III: Technical annexes**

Finally, the following is the result of the CBA in which the batteries are considered to be in service but not the synchronous condensers:

**Figure 36. CBA analysis of the second HVDC link with the batteries but without the synchronous condensers**




PROFITS

Reduction of $CO_2$ emissions
**285 kt/year**

RES integration
**125 GWh/year**

Total reinforcements
**853 M€**

Annual profit
**89 M€/year**

NPV
**508 M€**

Annual profit/reinforcements year1
**1.1**

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# 7.2.4. Conclusions

The group of reinforcements that make up the reinforcement of the electricity connection between the mainland and the Islas Baleares provides a positive benefit to the system both by using the PINT methodology jointly and by applying sequential PINTs.

The batteries on Ibiza and Menorca bring positive benefits to the system whether they are commissioned before the second HVDC link between the mainland and the Islas Baleares (including the synchronous condensers) or after the second HVDC link between the mainland and the Islas Baleares. However, the benefit is somewhat higher if they are brought into service before the second HVDC link.

All five proposed synchronous condensers bring positive benefits to the system when commissioned with the second HVDC link (with and without batteries). Bringing forward one condenser to provide short-term stability and voltage control for the Balearic system as a whole would be very beneficial from a security of supply point of view.

The second HVDC link between the mainland and the Islas Baleares brings a positive benefit to the system both when assuming that it is commissioned after the batteries and synchronous condensers and when assuming that it is commissioned after the batteries, but before the synchronous condensers.



Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

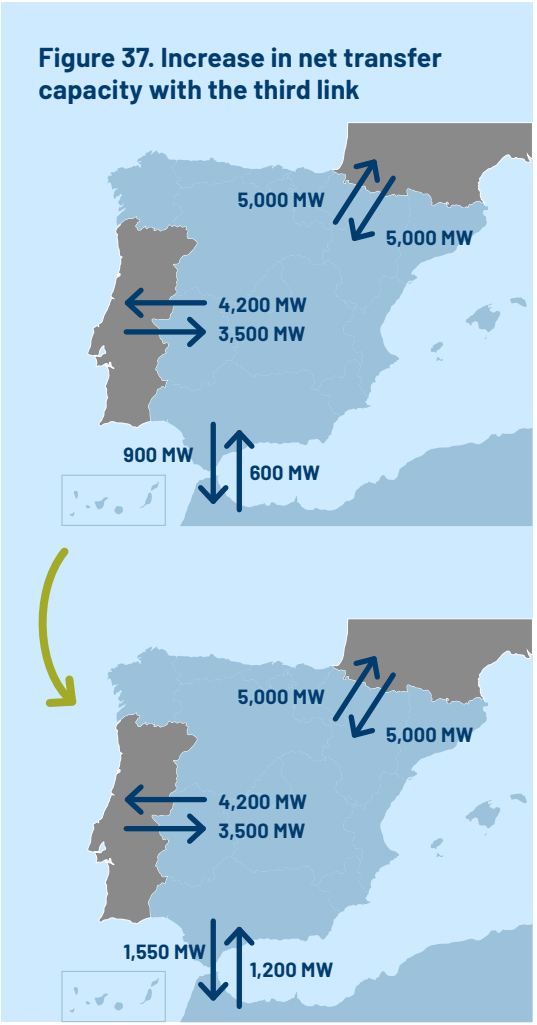
# 8. Annex - Analysis of the reinforcement of the interconnection between Spain and Morocco

The 2021-2026 plan includes a reinforcement of the interconnection with Morocco in order to fulfil the agreement with the Kingdom of Morocco for the development of a third electricity interconnection and a strategy for collaboration in the field of energy by 2026, established in February 2019[9]. This reinforcement consists of building a third 400 kV link:

- New underground-submarine link between Puerto de la Cruz 400 kV and Beni Harchane 400 kV (Morocco). This new circuit is planned with technical characteristics similar to those of the two present circuits, which have a thermal transmission capacity of 700 MVA.
- 2 reactances of 150 Mvar at Puerto de la Cruz 400 kV

The following figure illustrates the variation in net transfer capacity at the border, which allows this reinforcement to be carried out while maintaining the safety conditions of the system.

**Figure 37. Increase in net transfer capacity with the third link**




The cost-benefit analysis of the Spain-Morocco interconnection, included in the INT_ESP_MAR file, has been carried out in accordance with the methodology established by ENTSO-E and approved by the European Commission for international connection studies, which means that:

- The study is carried out considering all the electricity systems that are affected, in this case, all the interconnected European electricity systems, including the Spanish system, as well as the Moroccan system.
- The benefits obtained with this methodology are, therefore, those obtained for the set of systems considered.

It should be noted that, as this is a project incorporated late in the planning analysis process, the benefits of this last interconnection have been calculated assuming that all the other reinforcements planned for 2026 have been developed (sequential PINT methodology).

Lastly, it should be noted that the assessment has adopted as a hypothesis a cost of $CO_2$ emissions in Morocco equivalent to that of the rest of Europe, a factor that still requires regulatory developments aimed at harmonising the market environment.

9 https://www.lamoncloa.gob.es/serviciosdeprensa/notasprensa/ecologica/Paginas/2019/140219-energiamarruecos.aspx.

Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

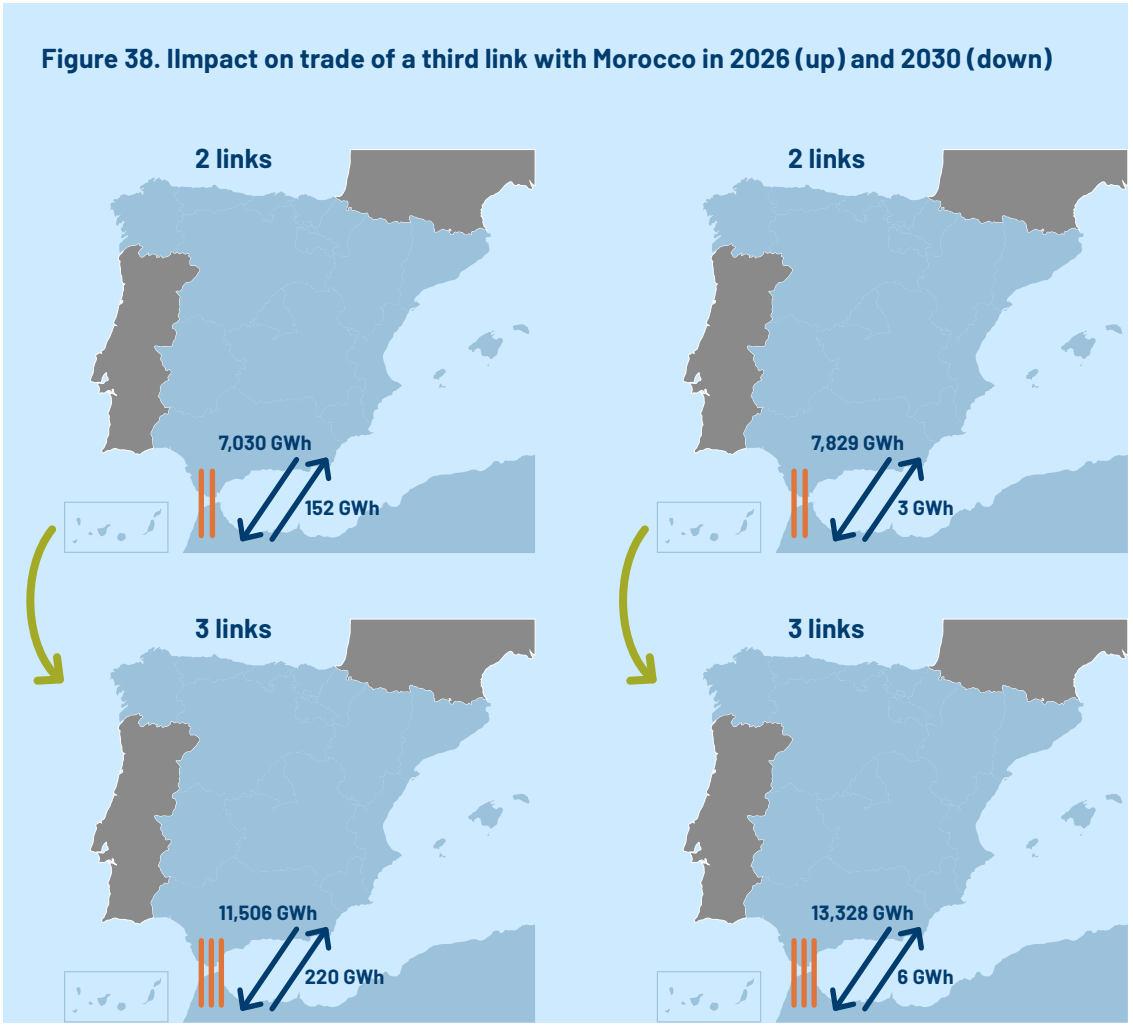
II: New reinforcements

**III: Technical annexes**

As a complement to the joint results set out in the project sheet, the following provides details of the effects on the European system (including the Spanish system), on the mainland system separately and on the Moroccan system. The 2026 planning horizon has been analysed, along with a consideration for the 2030 horizon. For the Moroccan model, the MedTSO models for 2030 were used, which are consistent with the ENTSO-E National Trends scenario, and for the 2026 horizon, the model was estimated taking into account not only the 2030 model, but also the current demand and generation data, and the forecasts published by ONEE on its website. The conclusions of the analysis are as follows:

- The commissioning of a third Spain-Morocco line would allow a significant increase in exports to Morocco.
- The net balance of trade is clearly exporting from Spain to Morocco. In fact, imports are very limited in the medium to long term and have little effect on the new link.

**Figure 38. IImpact on trade of a third link with Morocco in 2026 (up) and 2030 (down)**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

- The increase in flows at the border makes it possible to support the supply of Morocco and replace part of the Moroccan thermal generation with renewables and more efficient thermal generation coming from Europe, especially in 2030.
- In Europe, renewable integration is increasing, mainly in Spain, which allows for the delivery of an important part of the renewable energy from the south of the Spanish mainland, which would otherwise be curtailed.
- The RES integration in European systems, which replaces the thermal generation with the highest cost for the system, which happens to be in Morocco, although the higher demand also requires the production of a certain volume of thermal generation in Europe, which is higher in 2026 than in 2030.
- Due to the higher thermal production, there is an increase in variable costs and $CO_2$ emissions in Europe, higher in 2026 than in 2030 and which, in both cases, has little repercussion in Spain.

**Figure 39. System impact of a third link with Morocco in 2026 (up) and 2030 (down)**




Introduction

Indicative Planning (NECP): study scenario

Analysis methodology

Results

Modification of specific items

Maps

**Annexes**

I: Staritng grid

II: New reinforcements

**III: Technical annexes**

# Transmission network development plan

## 2021-2026 period

GOBIERNO DE ESPAÑA
VICEPRESIDENCIA TERCERA DEL GOBIERNO
MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO

red eléctrica
Una empresa de Redeia