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 DE ESPAÑA




Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

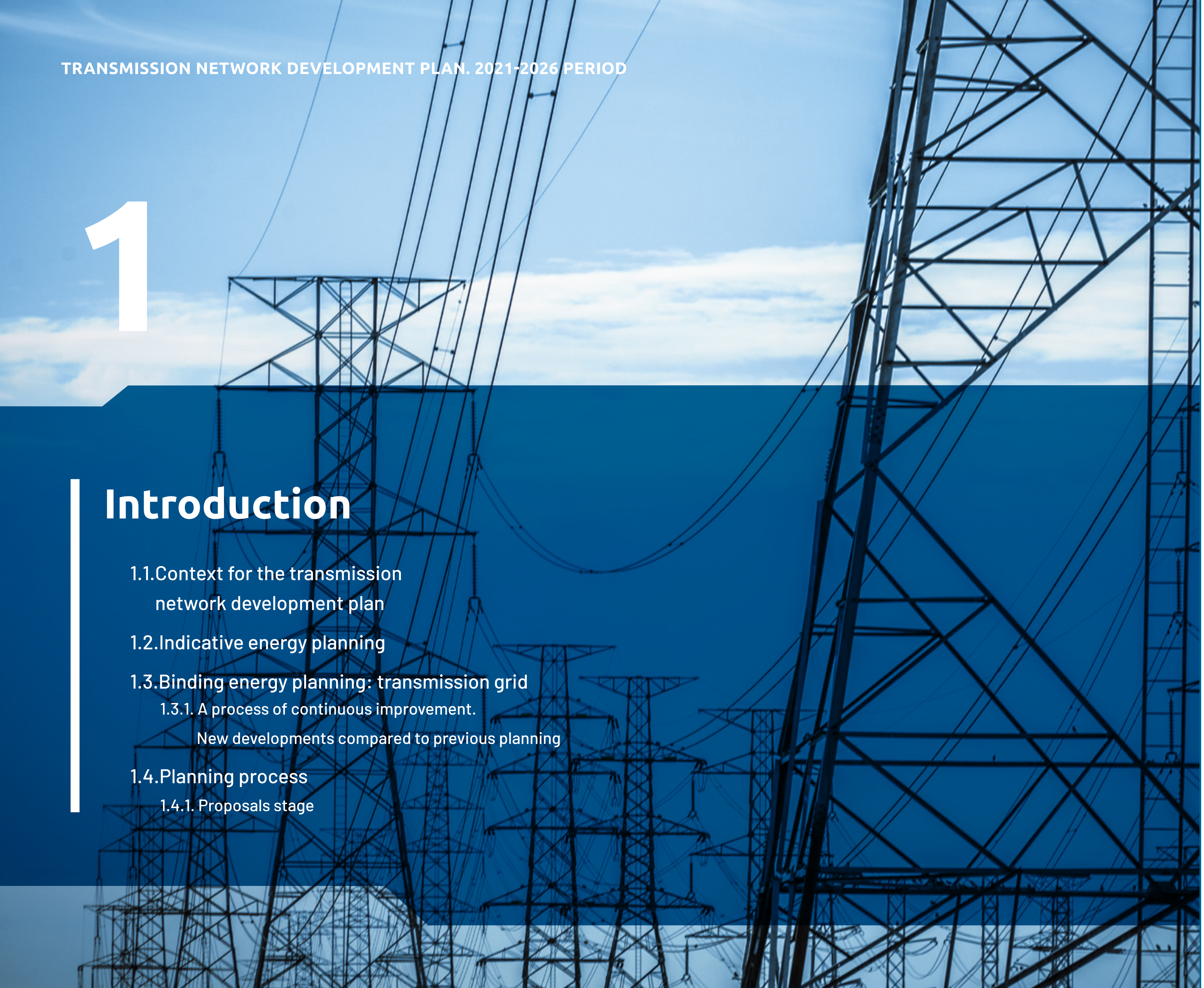
Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes



1

Introduction

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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
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 (PNIEC)".

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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
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 PNIEC). The PNIEC 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.

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.

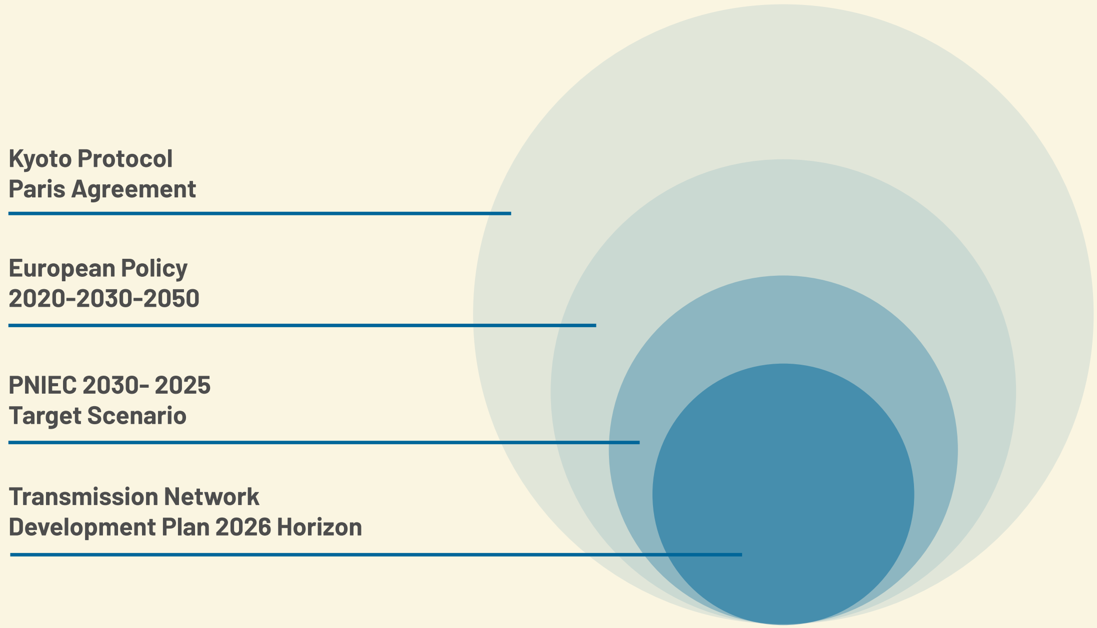
In order to ensure that the electricity supply is reliable and efficient for consumers in a new energy transition scenario, it is essential to have a correctly designed electricity system and, in particular, an electricity transmission network designed for this purpose.

The PNIEC 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 PNIEC. 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 PNIEC itself, the transmission network development plan for the 2021-2026 horizon must be based on the target scenario of the PNIEC, 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 PNIEC, 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



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 PNIEC 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.

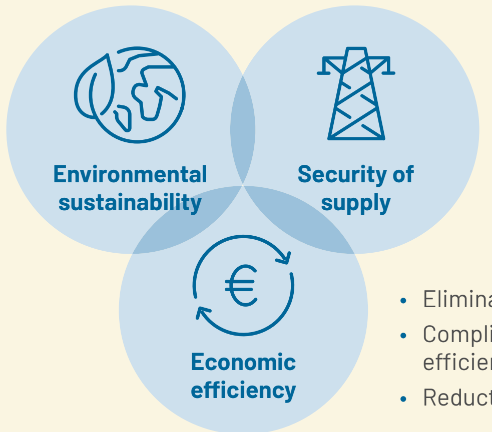
h) Maximisation of the utilisation of the existing network by renovating, uprating, using new technologies and reusing existing facilities.

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 PNIEC 2021-2030 (decarbonisation, efficiency and interconnections)

- Maximisation of RES production
- Evacuation of RES based on resources
- Environmental compatibility
- Maximisation of the use of the existing network



Guarantee of security of supply from the transmission network

- Elimination of technical constraints
- Compliance with the principles of efficiency and economic sustainability
- Reduction of losses

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.

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

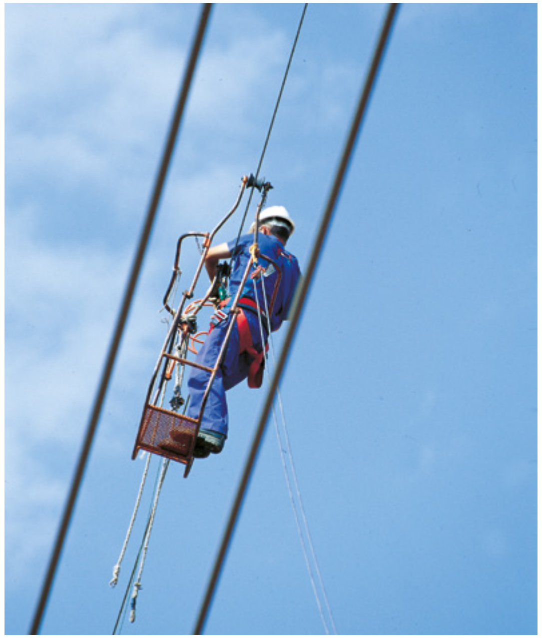
The 2015-2020 plan introduced some new approaches, which the 2021-2026 planning maintains and reinforces:

- 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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes
10

- 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

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

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.

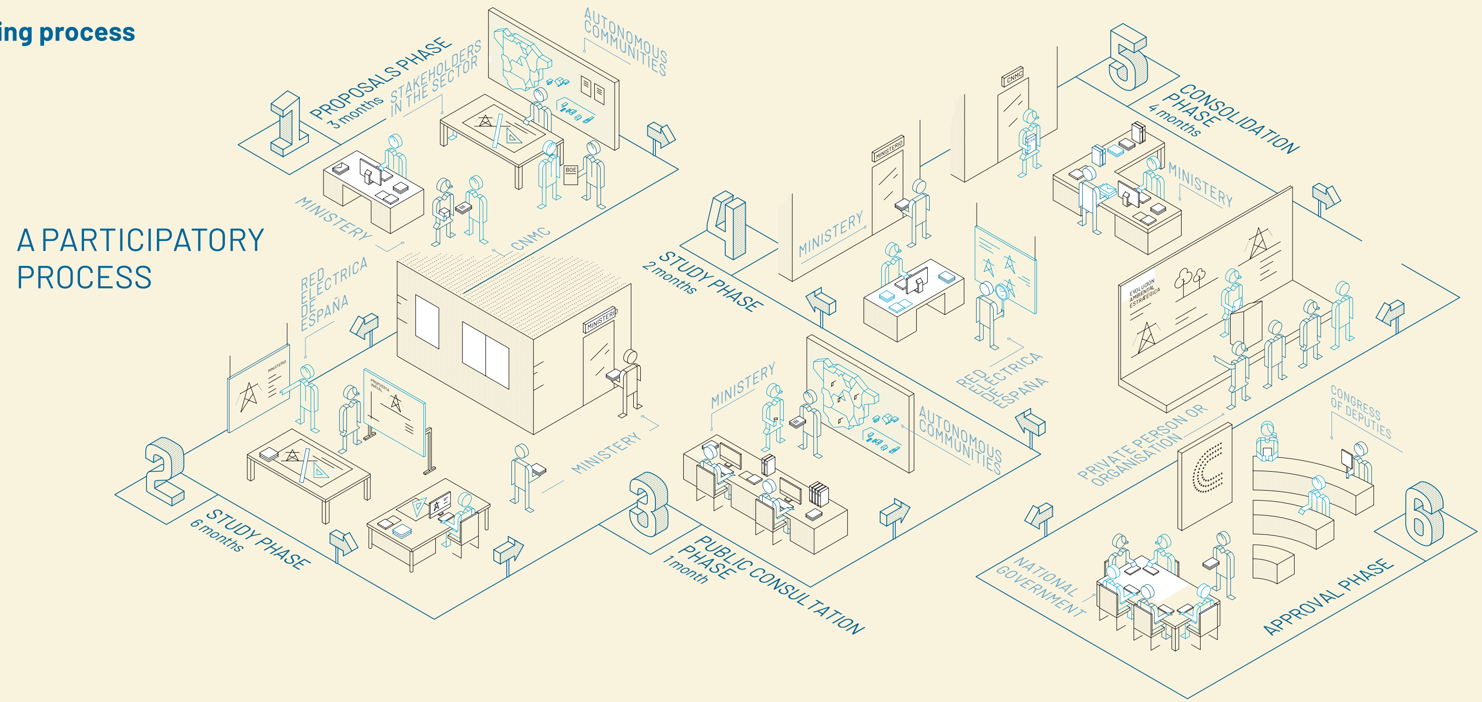
The Strategic Environmental Assessment (SEA) is a parallel process regulated by Law 21/2013 of 9 December on environmental assessment. The process started in August 2020 with the request to initiate and submit the strategic document and the draft plan.

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



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

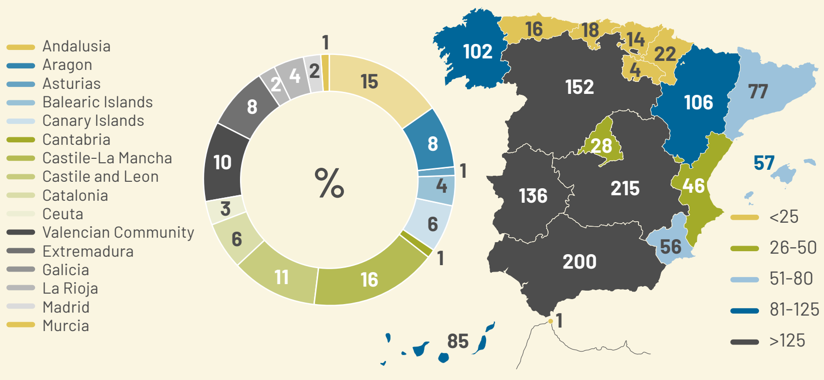
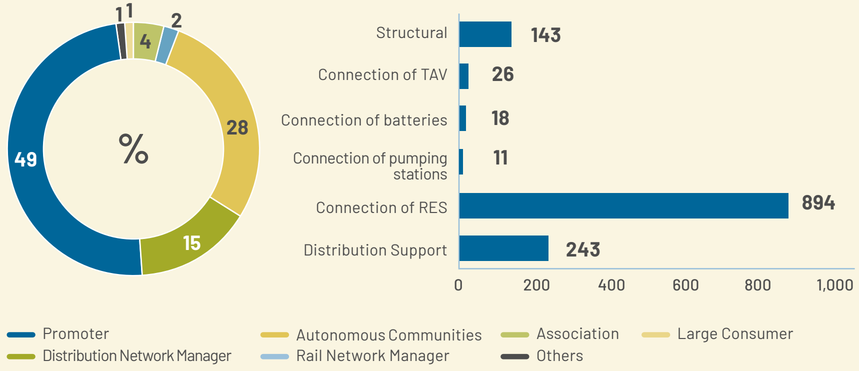
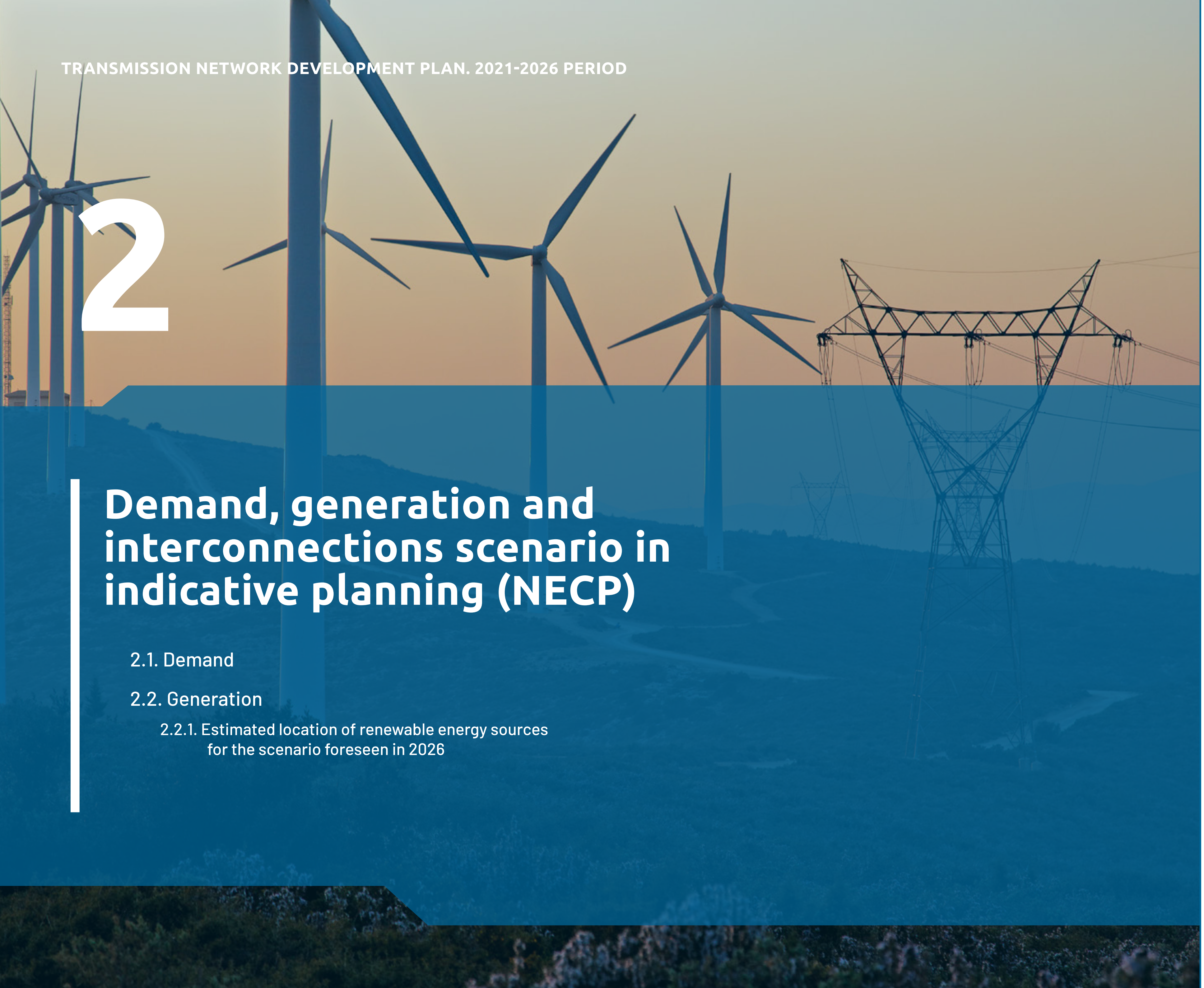


Figure 5. Distribution of the proposals received by type of agent and motivation





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Demand, generation and interconnections scenario in indicative planning (NECP)

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:

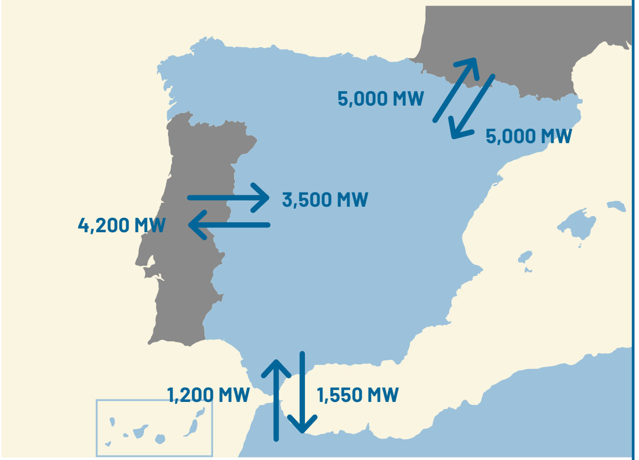
The study scenario is established by the indicative plan contained in the NECP (PNIEC) 2021-2030.

- 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.

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.

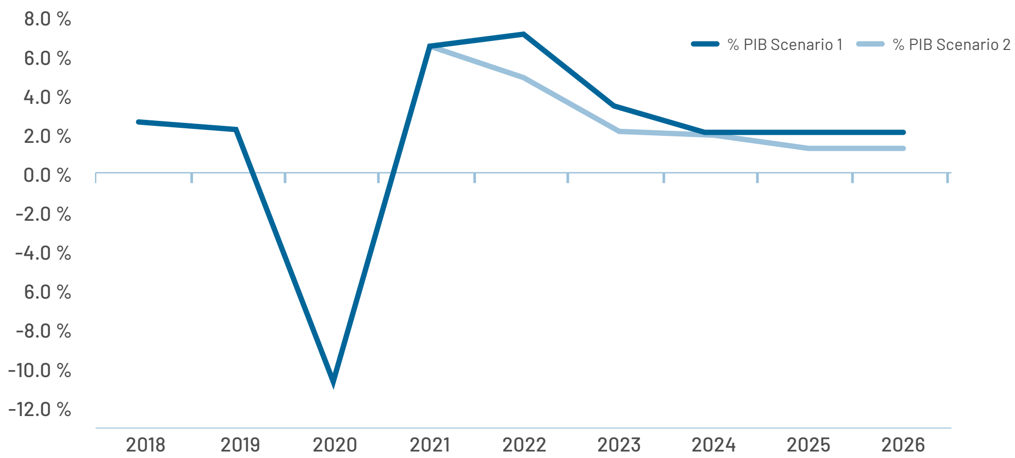
The figure above depicts two possible scenarios for long-term GDP developments: Scenario 1 assumes a significant fall in GDP in 2020 with a moderate recovery from 2021 onwards. Scenario 2 is based on the GDP developments projected in the "Stability programme update 2021" of April 2021. In this respect,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



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)

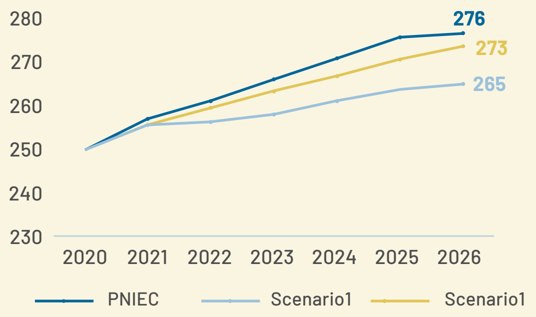
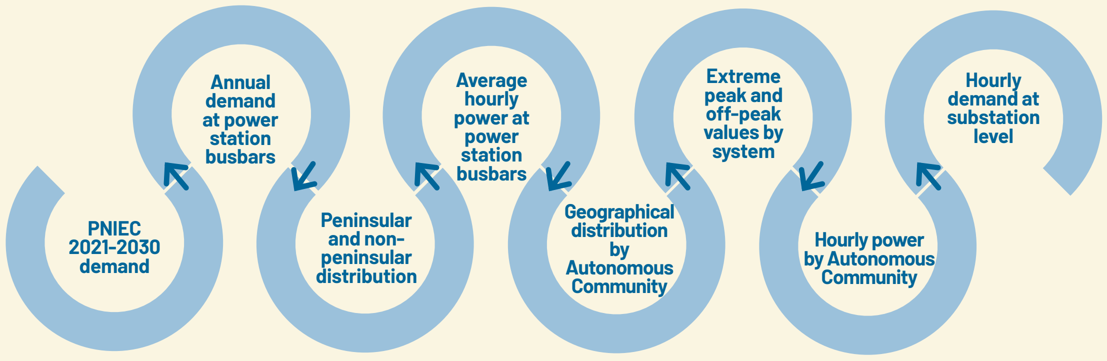


Figure 9.Process for obtaining hourly demand at substation level



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.

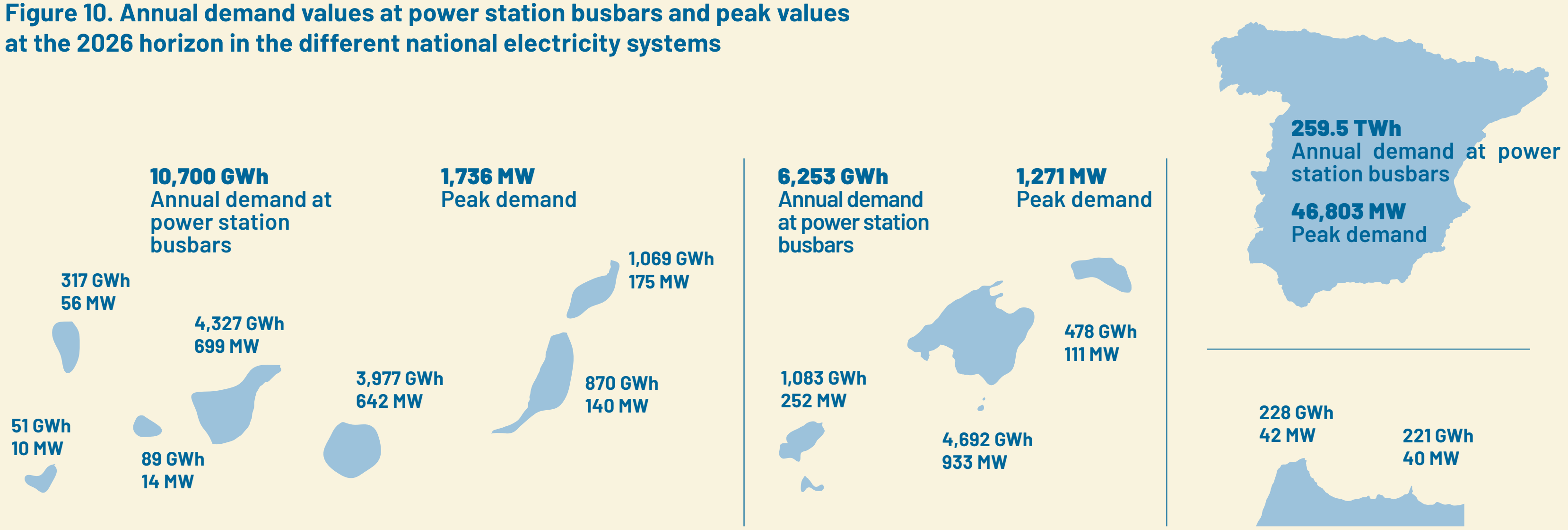
Then, based on the forecast load curve, the extreme values (peak and off-peak) are determined for the analysis period for each electricity system.

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



2.2. Generation

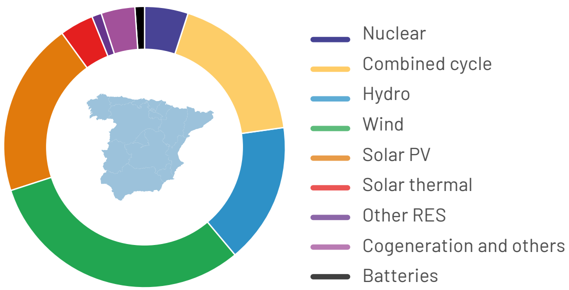
In order to establish the value of installed generation capacity by type of technology in the 2026 scenario, in general, the data set in the NECP in the 2025 and 2030 target scenarios have

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

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

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 %**



generation study scenario includes the capacity currently in service.

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)

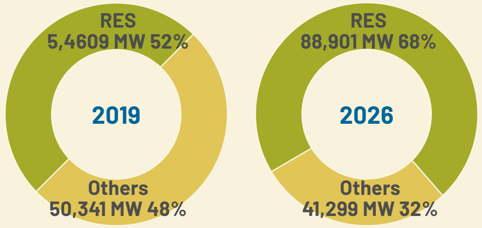
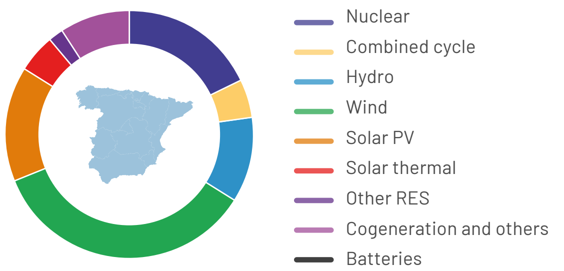


Figure 13. Generation ratio by technology in the 2026 study scenario. Spanish mainland

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-Balearic Islands	4,060	
Balance Spanish Mainland-Ceuta	228	
Spanish Mainland demand at power station busbars	**259,549**	**GWh**



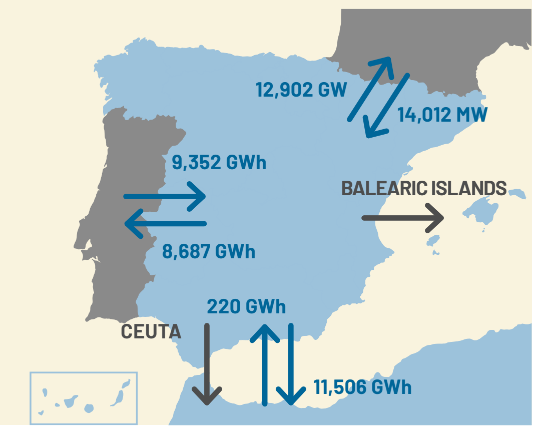
Note: in order to determine the needs for internal reinforcements, the study scenario for the Spanish mainland system considers the exchange balances resulting from the reinforcements included in the development plan of the interconnections. As a result, Spain will be a net exporter by 2026, with a net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

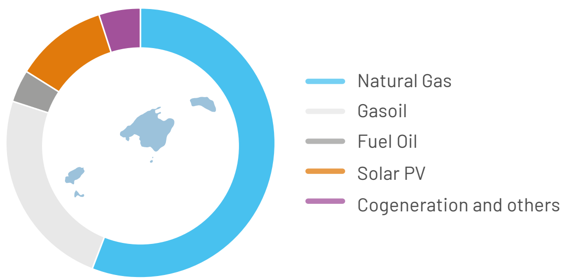
Figure 14. International exchanges and exchanges with non-peninsular systems



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. Balearic Islands

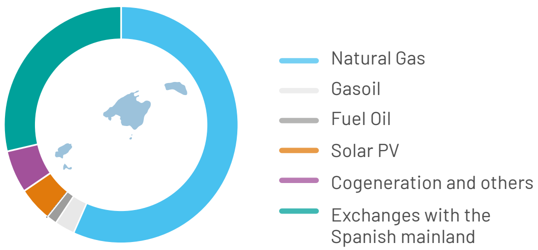
Technology type	MW	%
Natural Gas	977	56 %
Gas oil	417	24 %
Fuel Oil	70	4 %
Wind	3	0 %
Solar photovoltaic	201	11 %
Cogeneration and others	80	5 %
Total	**1,748**	**100%**



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Figure 16. Generation ratio by technology in the 2026 study scenario. Balearic Islands

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 Canary Islands, 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 Canary Islands, 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. Canary Islands

Technology type	MW Tenerife -La Gomera	MW Gran Canaria	MW Fuerteventura -Lanzarote	MW La Palma	MW Canary Islands	%
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%

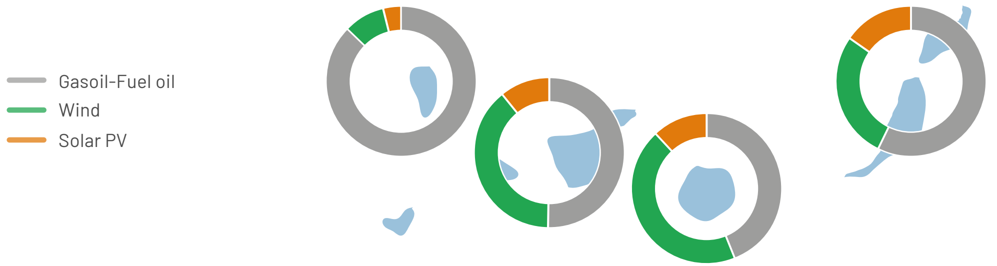
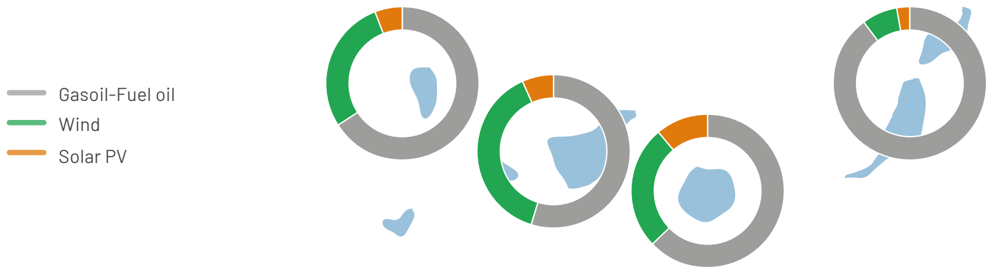


Figure 18. Generation ratio by technology in the 2026 study scenario. Canary Islands

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 Canary Islands 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.

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/.

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.

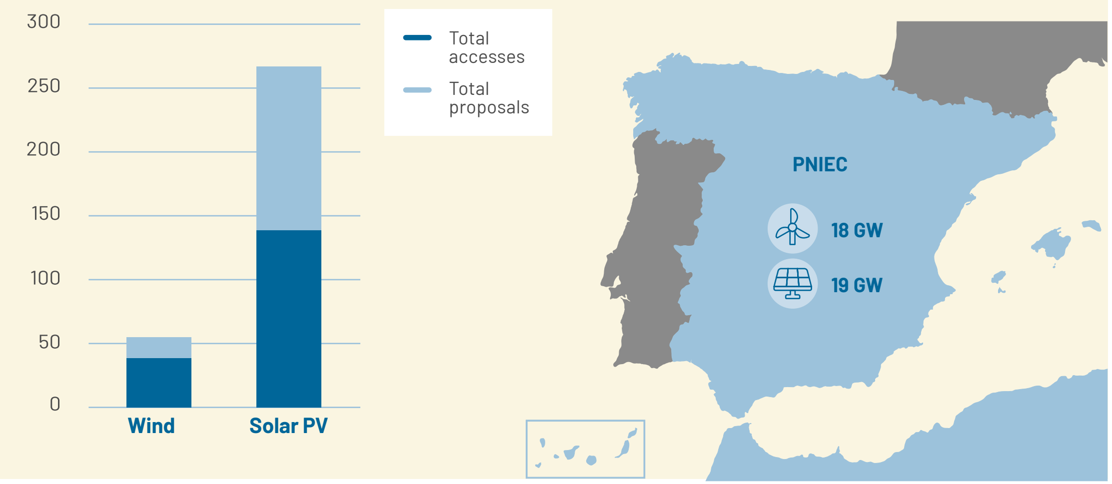
In the current planning process, unlike previous ones, the change in the generation fleet necessary for the energy transition is occurring very quickly and requests for network access, particularly for wind and photovoltaic generation, greatly exceed the values corresponding to the 2026 horizon consistent 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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes
24

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.

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.

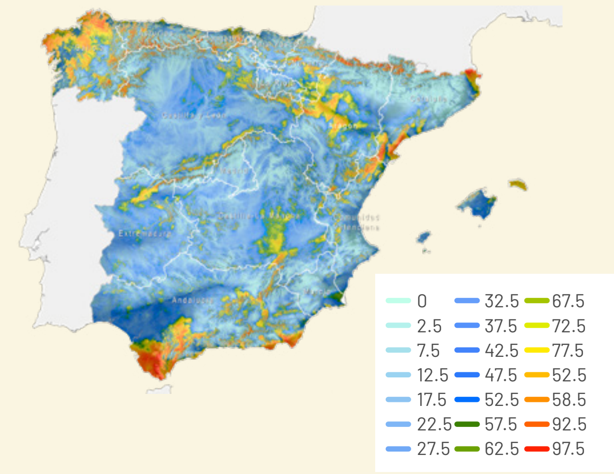
For photovoltaic generation, the historical series of real production of the photovoltaic generators currently in service, which are available to the System Operator, have been used as a reliable and joint measure of the resource (sunlight together with the effect on production efficiency of other local 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.

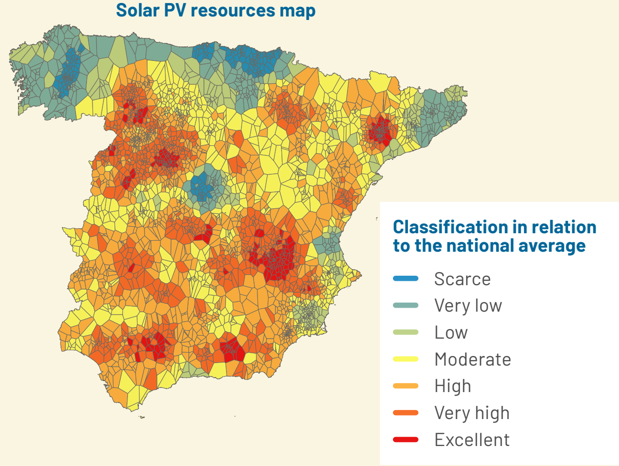
On the other hand, the wind resource is concentrated in certain production areas and is not distributed throughout the territory. In this case, the analysis was based on IDAE data (Wind Resource Study and preparation of the Spanish Wind Atlas) for identifying wind resources in Spain and a methodology 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

Wind resources map



Solar PV resources map



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
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.

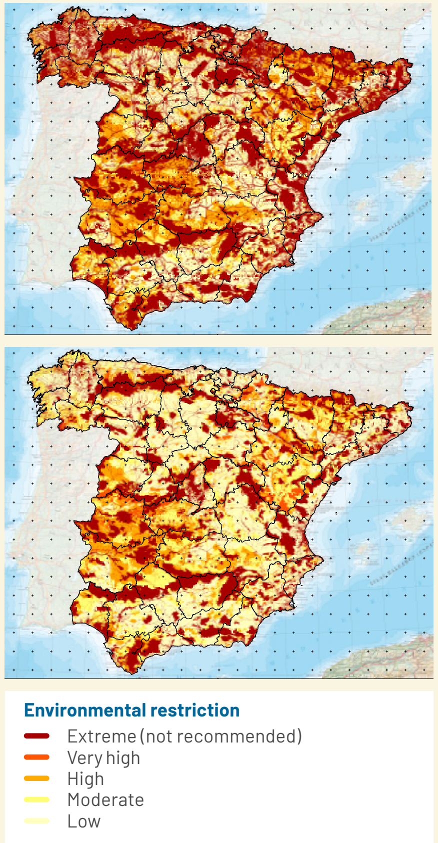
Using a multi-criteria assessment approach, all foreseeable environmental impacts, conditioning factors, and restrictions that developers of new photovoltaic and wind energy sources may face have been considered together, and environmental zoning has been established for the deployment of renewable energy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

IDENTIFICATION OF AREAS WITH THE HIGHEST PROBABILITY OF DEPLOYMENT SUCCESS

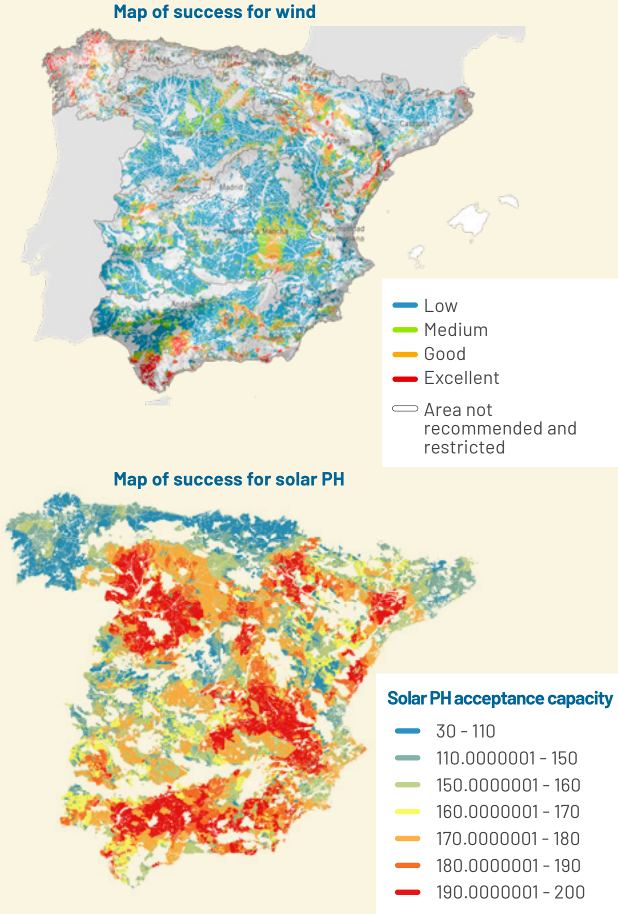
In order to identify the areas in which future wind and photovoltaic plants are most likely to be installed for planning studies, a synthetic indicator has been developed by combining the previous indicators of production capacity (resource and efficiency) and ease of environmental permitting (acceptance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



DEVELOPMENT OF THE BASELINE SCENARIO HORIZON 2026 AND TRANSFER TO NODES

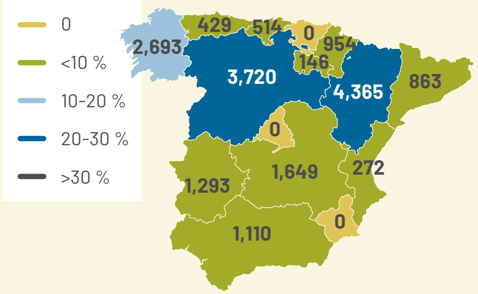
The allocation of capacity to create the most likely scenario for 2026 has been approached in two steps, first by autonomous community and then at substation level.

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%).

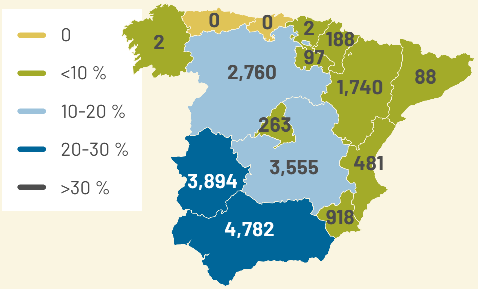
Although considering only the access requests could achieve the renewable generation value established for the 2026 scenario, these requests are subject to the existing or planned network in the 2015-2020 horizon. Therefore, considering only the access requests would not comply with the guiding principles 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

Wind MW by Autonomous Community
Percentage of new MW installed by Autonomous Community with respect to the Peninsular total



Solar PH MW by Autonomous Community
Percentage of new MW installed by Autonomous Community with respect to the Peninsular total



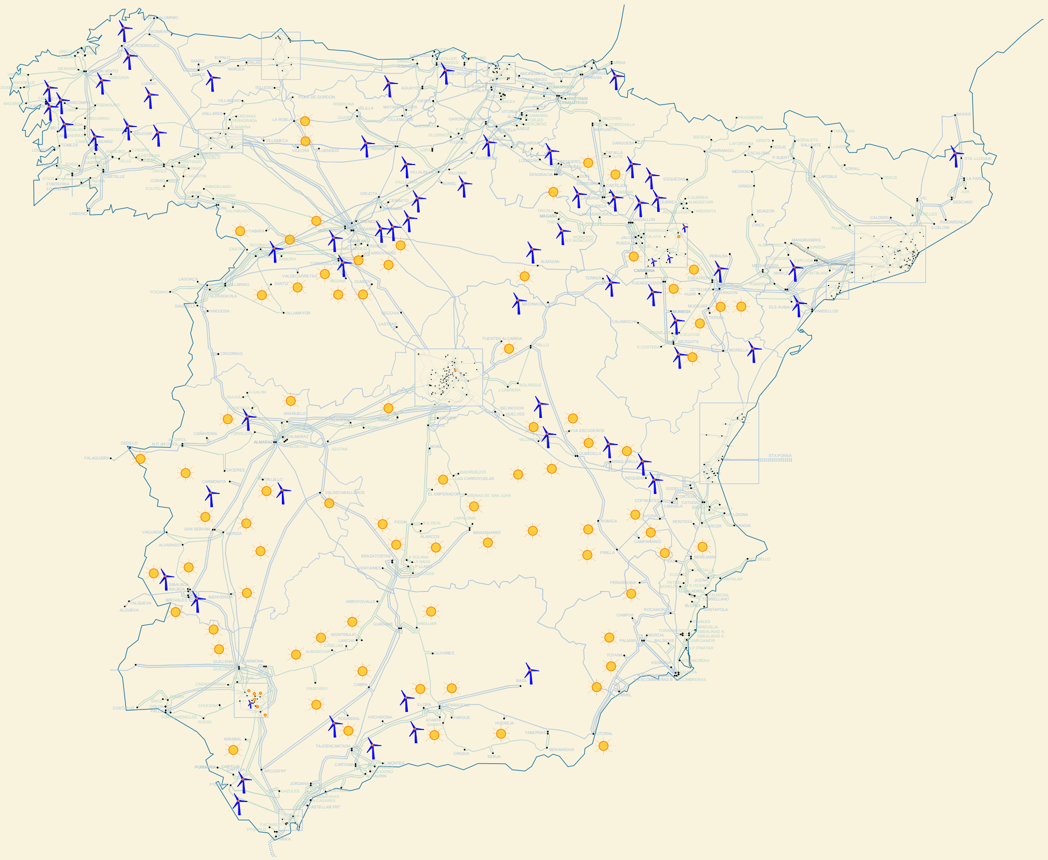
In addition, the maximum probability of success is given to those projects corresponding to the 2017 auctions (RD359/2017 and RD650/2017) that will contribute to achieving the 2020 renewables target, and therefore present a much lower degree of uncertainty in their installation.

> 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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
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.

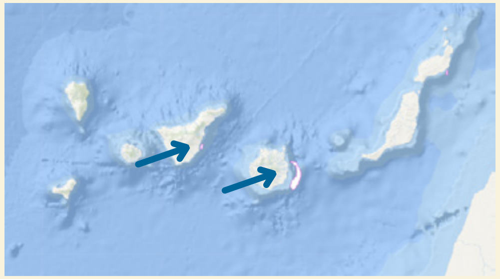
The future deployment of generation will be defined by the developers, who will continue to be able to connect to the grid by requesting the necessary permits.

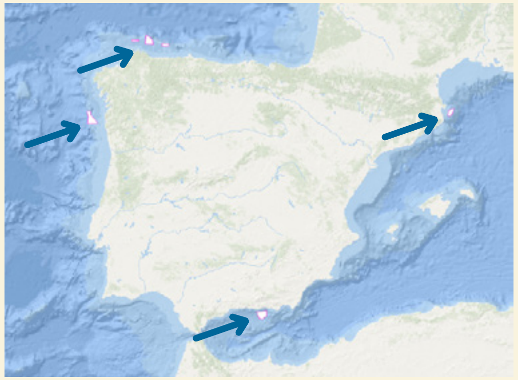
ESTIMATION OF THE LOCATION OF OFFSHORE WIND POWER

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.

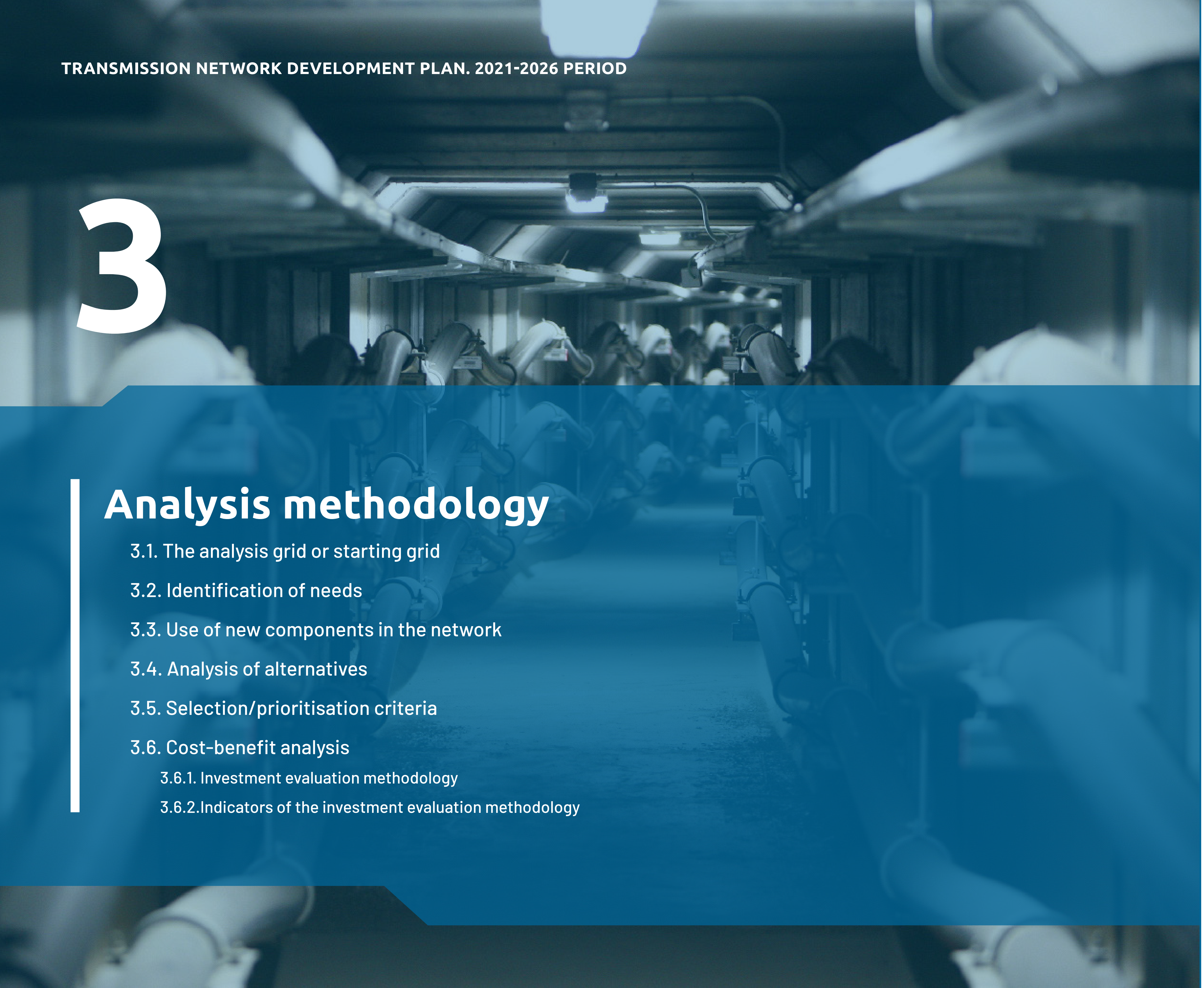
Figure 25. Priority use areas for offshore wind energy (Source: POEM - MITERD)





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.



3

Analysis 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.

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.

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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
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.

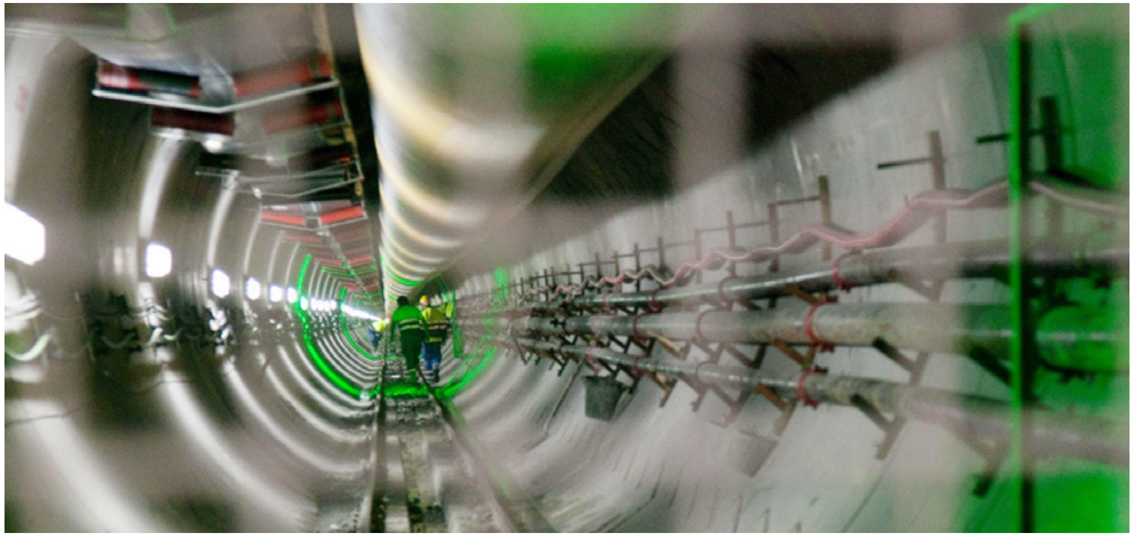
As a complement to these studies over a yearly period, static and dynamic simulations of different system situations have been carried out to determine the needs for voltage control and minimum generation connected to the system to guarantee its stability.

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.



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.

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 Balearic Islands, 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 Balearic Islands, 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 Balearic Islands 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.

In the electricity systems of the Canary Islands, 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 Canary Islands 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

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

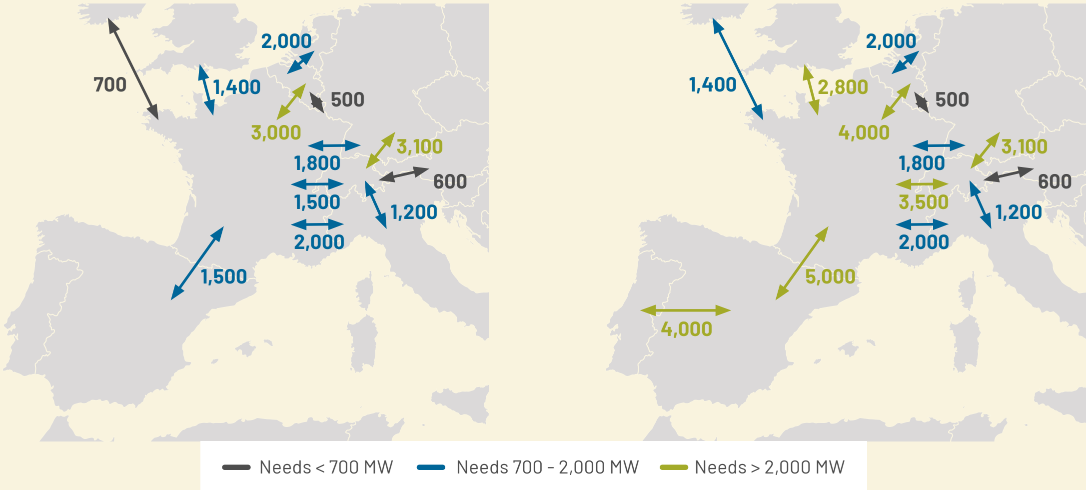
61-78 % in 2018-2020

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.

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

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.

SYNCHRONOUS CONDENSERS

Canary Islands:

The isolated nature of electricity systems in the Canary Islands 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].

Balearic Islands:

In order to achieve a significant increase in the exchange from the mainland to the Balearic Islands, in addition to the installation of a new link, it is necessary to reduce the operation of thermal generation in the Balearic Islands. This requires covering the needs of the Balearic Islands 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 Canary Islands 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).

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.

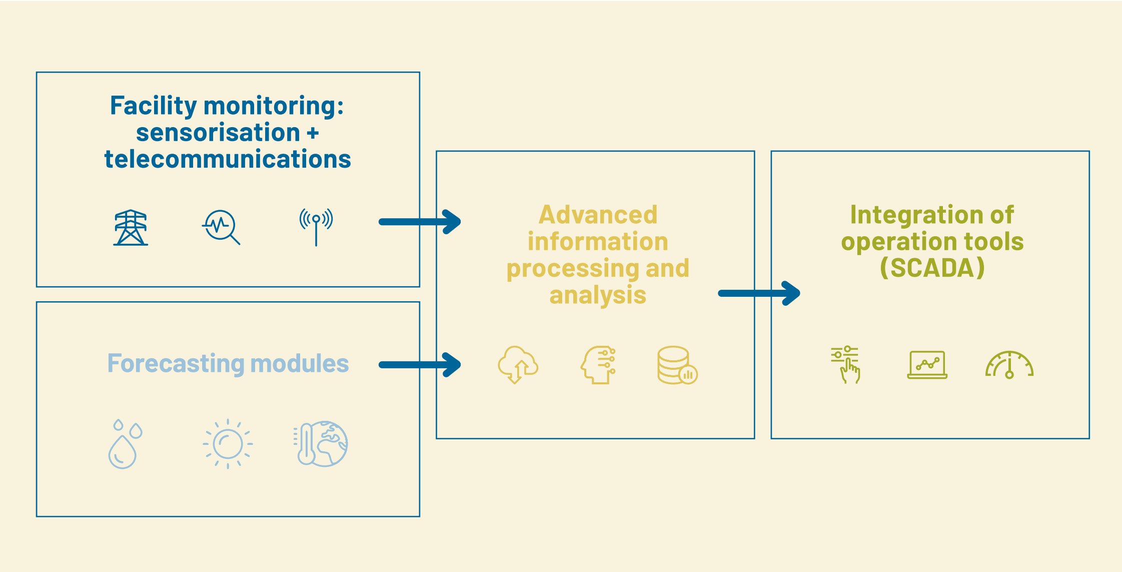
DLR (Dynamic Line Rating), also known as RTTR (Real-Time Thermal Rating), is based on technologies that estimate in real time the transmission capacity values of power lines according to different measurable variables that allow their calculation. These variables include weather conditions in the vicinity 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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
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.

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.

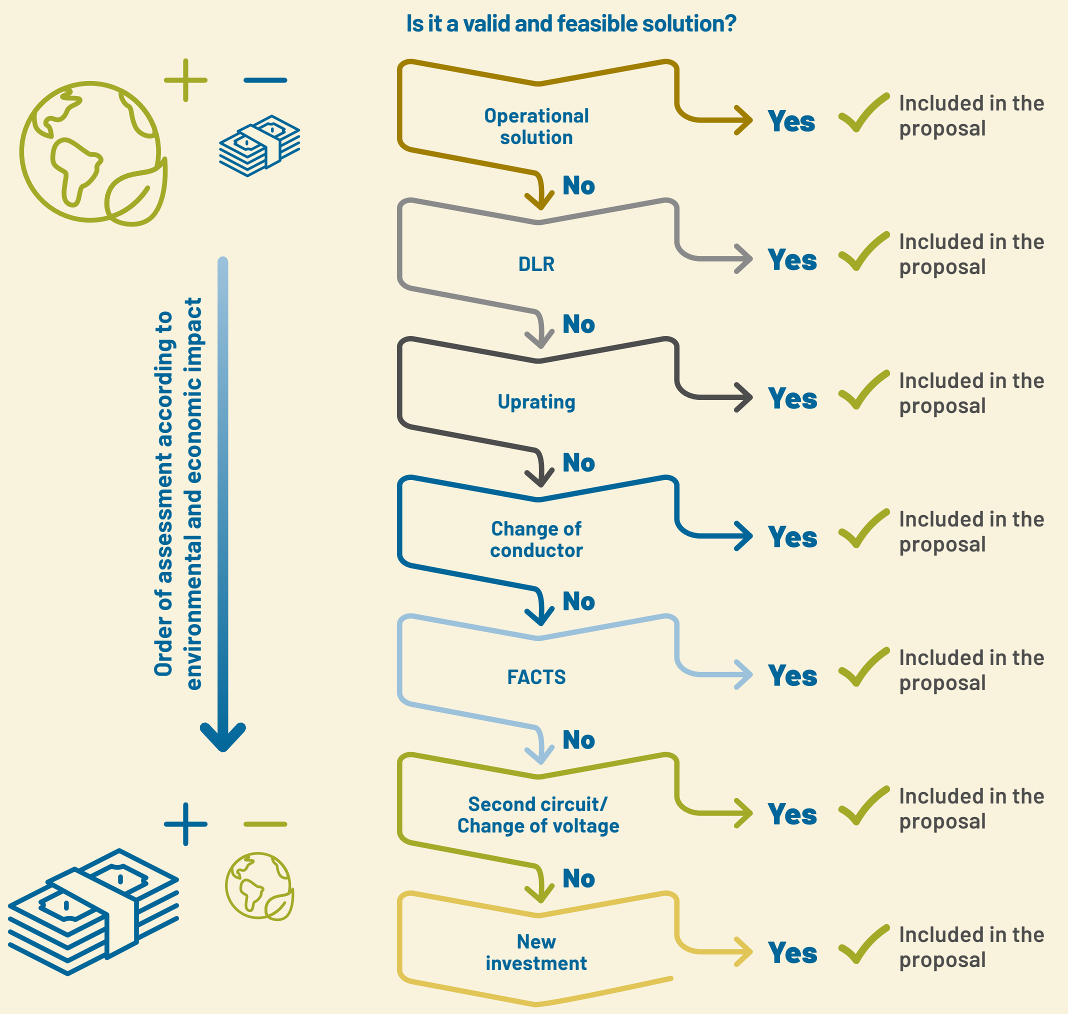
In order to resolve the identified needs, alternatives have been considered, from the lowest to the highest environmental and economic impact, until a valid and sufficient one is found.

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



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.

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.

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.

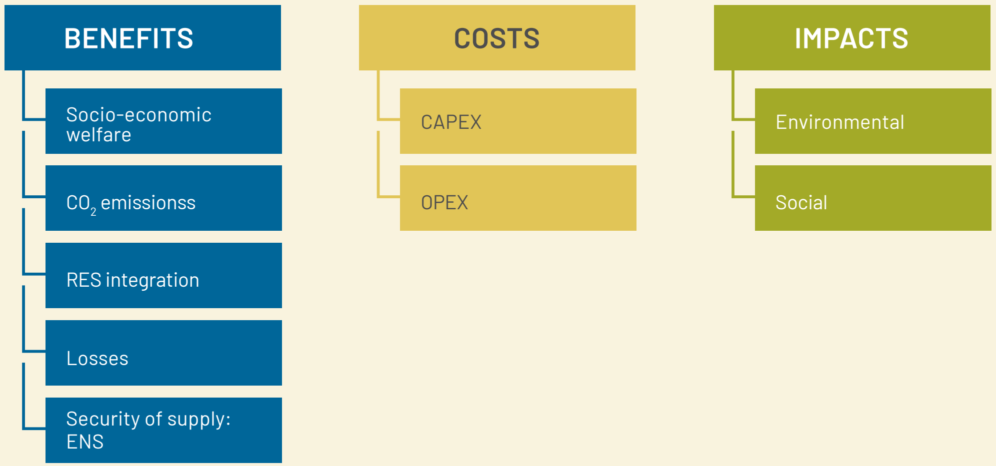
The evaluation is based on a PINT (Put IN one at the Time) methodology commonly used in ENTSOE in which the contribution of each investment is evaluated by comparing the main benefit indicators in two scenarios, a reference scenario in which the reference network is modelled and another in which the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

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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
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	Balearic Islands system	Canary Islands 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.

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.

SUPPLY SECURITY: 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].

SUPPLY SECURITY: 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.

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.

4

Results

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

SPANISH MAINLAND ELECTRICITY SYSTEM

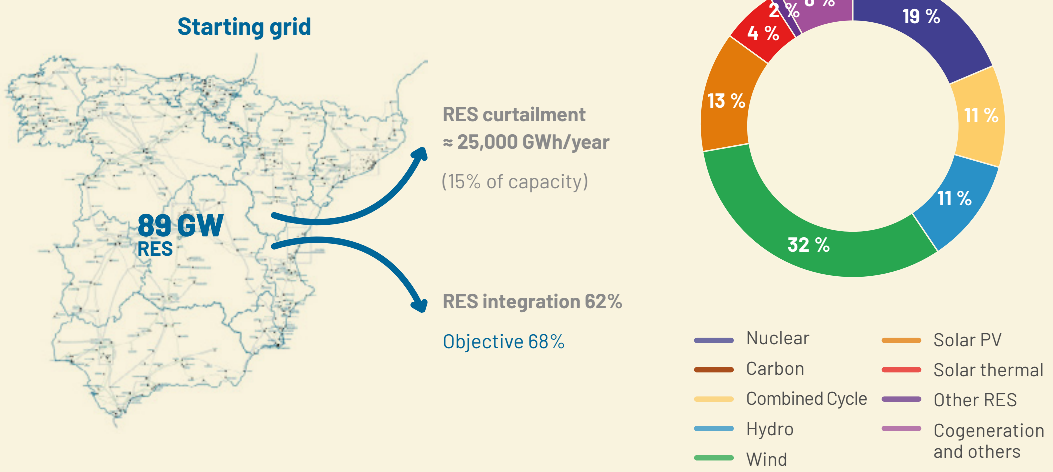
From the analysis of the results obtained considering the study scenario (demand and generation of the indicative planning) without additional transmission network developments beyond the starting grid, it can be seen that the possibilities of the electricity system achieving the energy policy objectives 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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

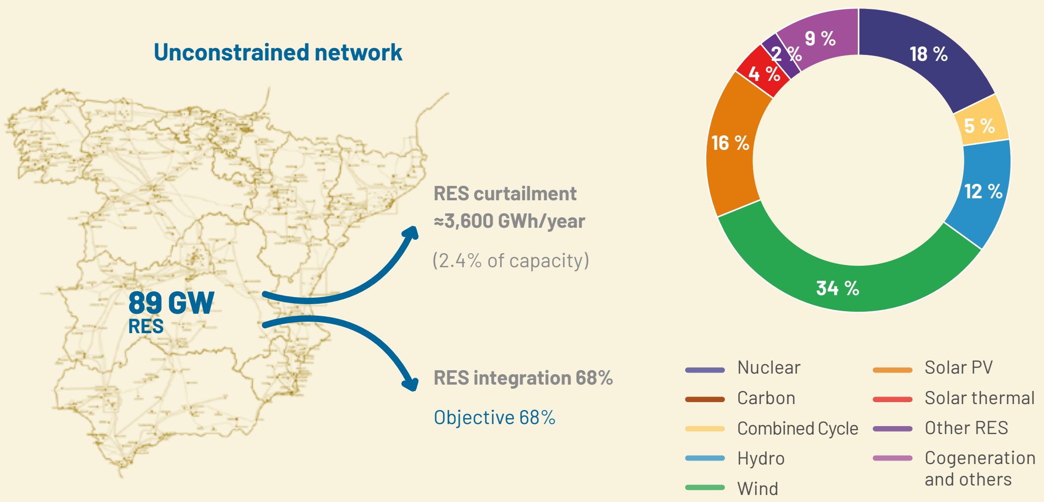
4.2. What would happen with an unconstrained transmission network?

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



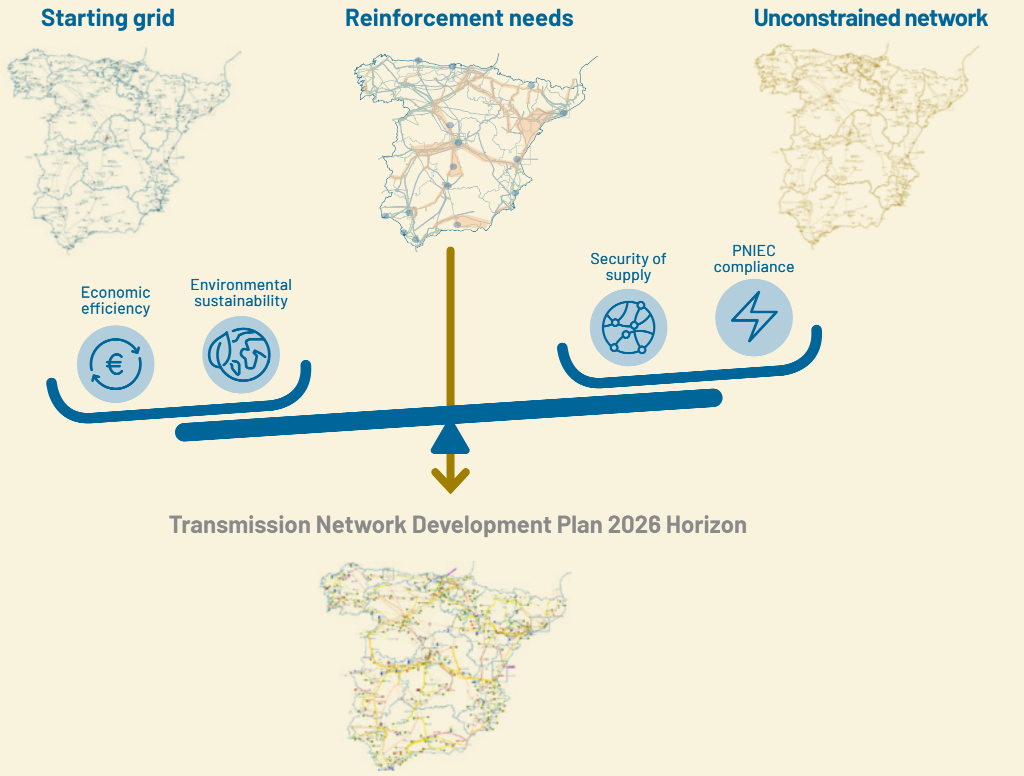
A network without limitations would allow energy policy objectives to be met, although its development would have a high social and environmental impact and the investment costs would exceed the established limits.

Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
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.

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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

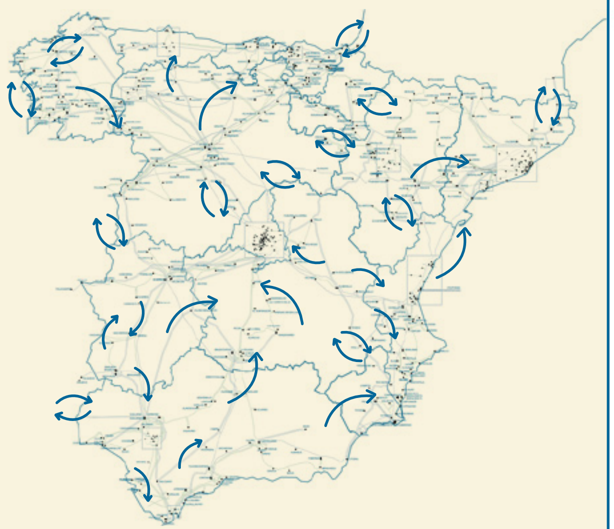
In the 2026 study scenario, the overall effect of the new renewable energy sources on the main system flows translates into an increase in the number of hours in which the up to now usual North-South and West-East flows are inverted by South-North and East-West flows. Thus, there are areas of the grid whose generation-demand balance is significantly modified, becoming more importing (less exporting), such as Asturias, the Basque Country and Catalonia, while others are becoming clearly exporting areas, such as Andalusia, Aragon, Castile-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 Catalonia. The aforementioned production is replaced by renewable energy sources that must be transported from more distant areas: on some occasions from Eastern Andalusia and Levante, and on others from Aragon, Castile-La Mancha or Navarre.

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, Castile-La Mancha and Andalusia, 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



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 Balearic Islands 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 Balearic Islands, 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 Balearic Islands, 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 Canary Islands, 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 Balearic Islands, 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 Canary Islands, 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.

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 Balearic Islands

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 Andalusia

22 APD-ARA: Distribution network support in Aragon

23 APD-AST: Distribution network support in Asturias

24 APD-CAN: Distribution network support in Cantabria

25 APD-CAT: Distribution network support in Catalonia

26 APD-CLM: Distribution network support in Castile-La Mancha

27 APD-CVA: Distribution network support in Valencian Community

28 APD-CYL: Distribution network support in Castile and Leon

29 APD-EXT: Distribution network support in Extremadura

30 APD-GAL: Distribution network support in Galicia

31 APD-IBA: Distribution network support in Balearic Islands

32 APD-ICA: Distribution network support in Canary Islands

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 Navarre

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

37 APD-PVA: Distribution network support in Basque Country

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 Navarre and Landes

44 INT_ESP-FRA_5: Spain-France via the Aragon 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 Balearic Islands

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 Andalusia - Extremadura - Madrid Corridor

55 ESTE_1: New Aragon-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

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

60 N_ESTE_1: Aragon-Navarre Reinforcement

61 N_ESTE_2: Aragon - Southern Catalonia Reinforcement

62 N_ESTE_3: Aragon - Central Catalonia 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 Navarre - Basque Country axis

74 SUR_1: New corridors in Andalusia

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 Circuit 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

90 OWNERSHIP: Changes of ownership

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

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

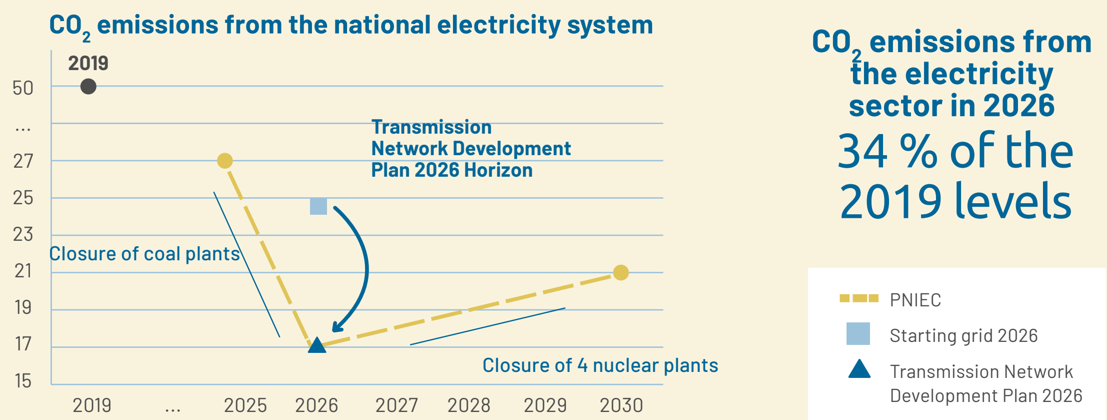
4.6. Impact of the development of the Transmission Network

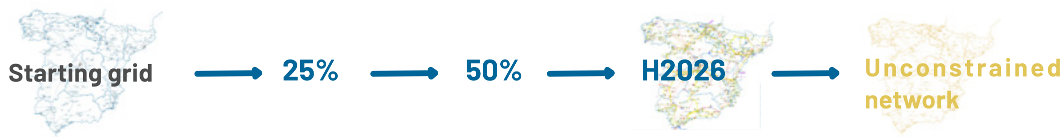
The analysis of a final scenario including both the starting grid and the set of new planned investments leads to the conclusion that the development plan presented is necessary to meet the energy policy objectives set out in the NECP in terms of CO_2 emissions and the integration of renewable energy 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.

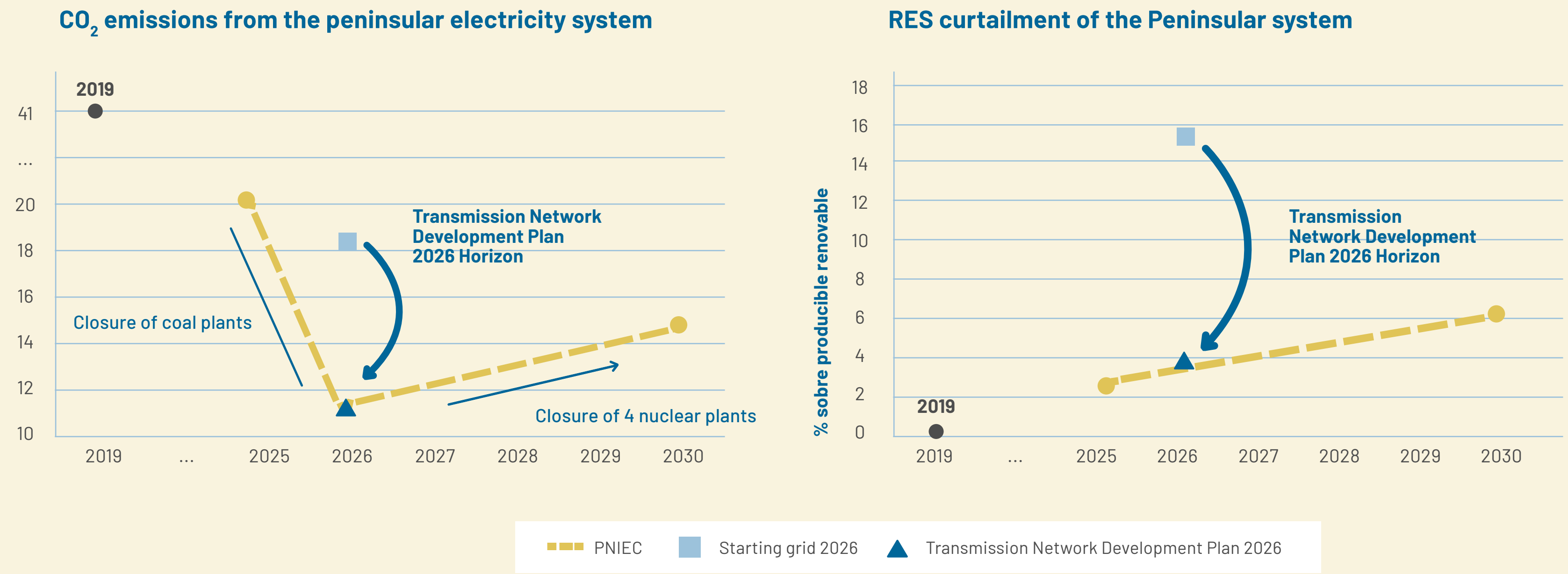
SPANISH MAINLAND SYSTEM

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.

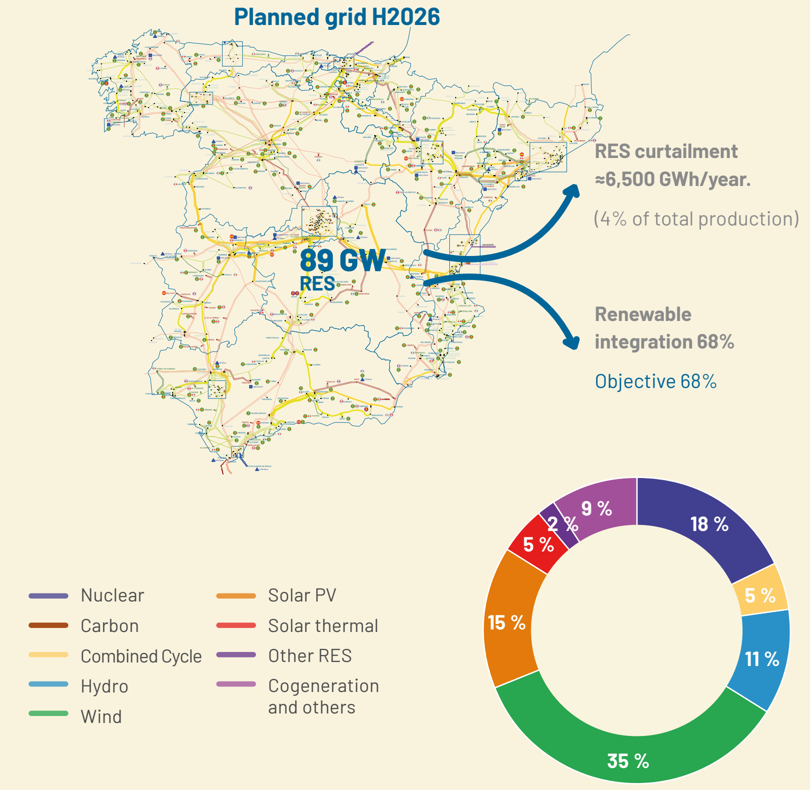
Figure 37. Estimated evolution path of CO_2 emissions and RES curtailment of the Spanish mainland electricity system: planned grid for H2026 vs starting grid



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
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.

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



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.

Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

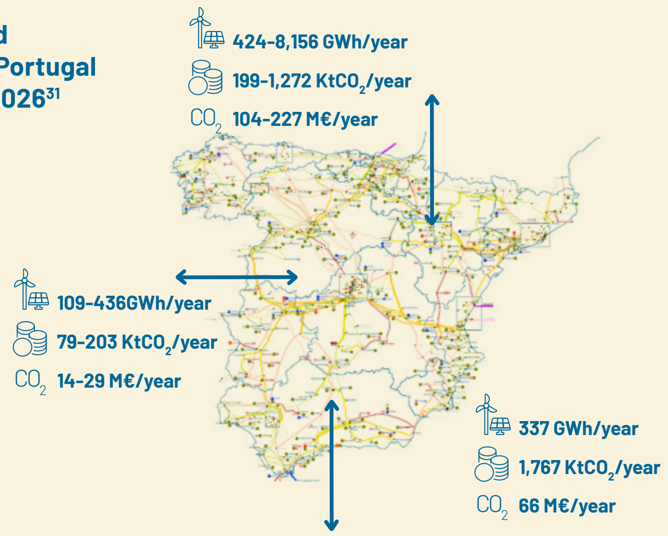
INTERNATIONAL INTERCONNECTIONS

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.

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 Balearic Islands, the set of new investments planned, in particular the second mainland-Balearic Islands link, will maximise the integration of the Balearic Islands system into the mainland system, as stipulated by the NECP. The contribution of the mainland system to covering demand in the Balearic Islands 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.

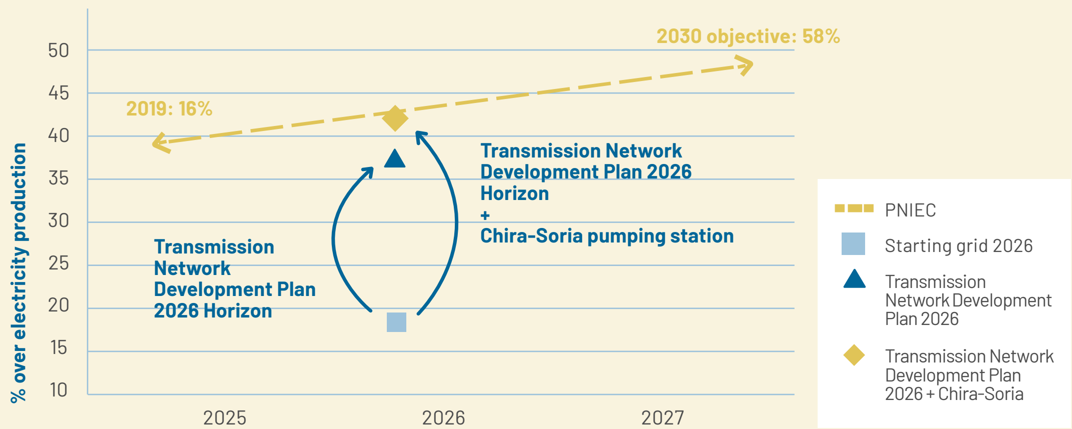
At the level of the electricity systems in the Canary Islands, the set of new planned investments will substantially increase security of supply and reduce the variable cost associated with conventional generation in the Canary Islands by 7% compared to the starting grid, a reduction of more than 30% 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 Canary Islands, 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 Canary Islands electricity system as a whole: planned grid for H2026 vs. starting grid. Impact of Salto de Chira



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

Balearic Islands 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

Canary Islands 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

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€)

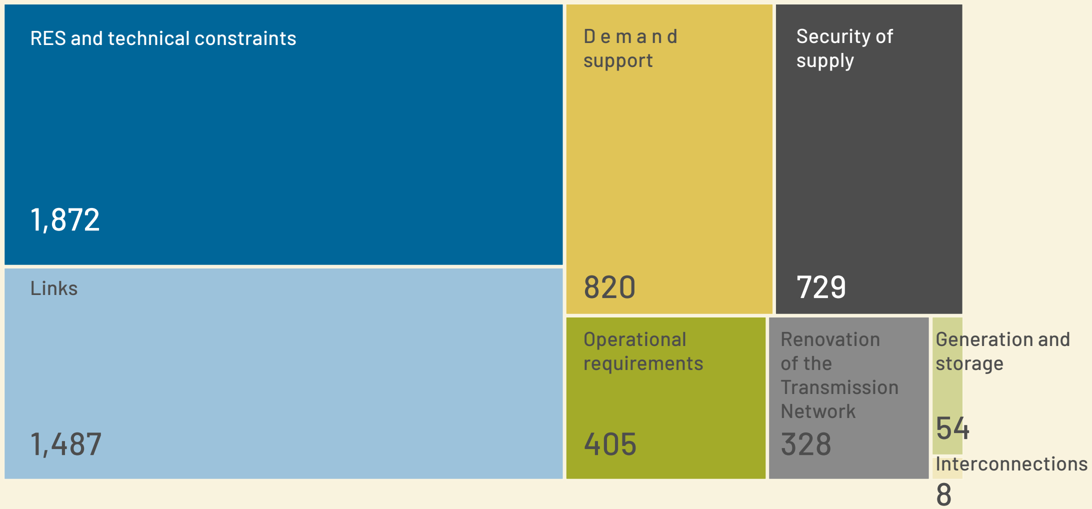
34 This includes the investments in international interconnections that do not count towards the investment limit value, part of which are in the starting grid.

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€).

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 Andalusia, Extremadura and Castile-La Mancha to Madrid, as well as the flows of renewable energy evacuation from Aragon and Navarre 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)

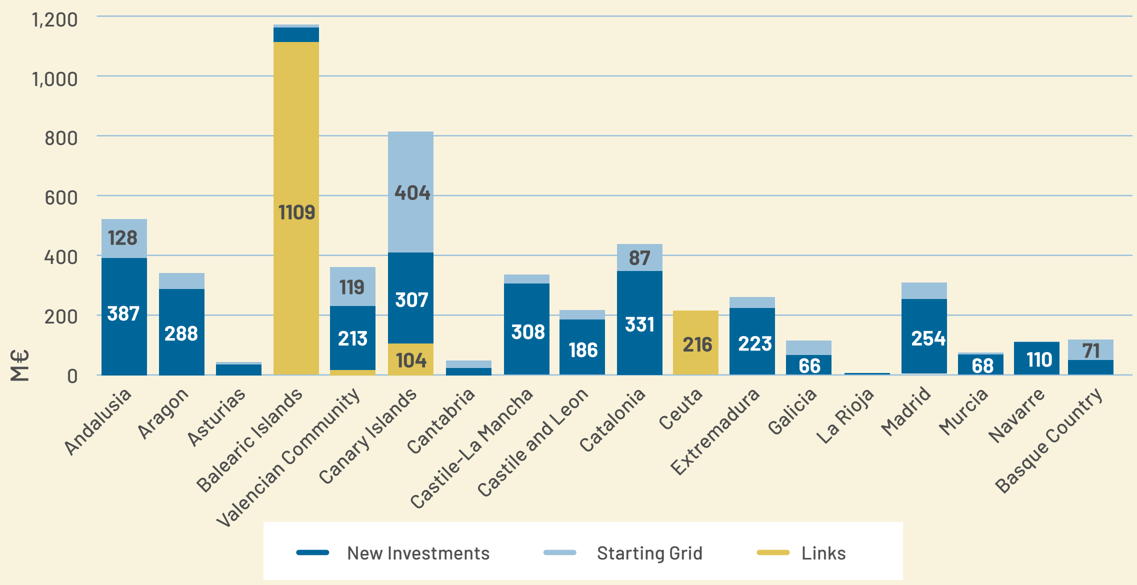


Figure 46. Distribution of costs by Autonomous Community or Autonomous City associated with the plan for the development of links between Spanish electricity systems

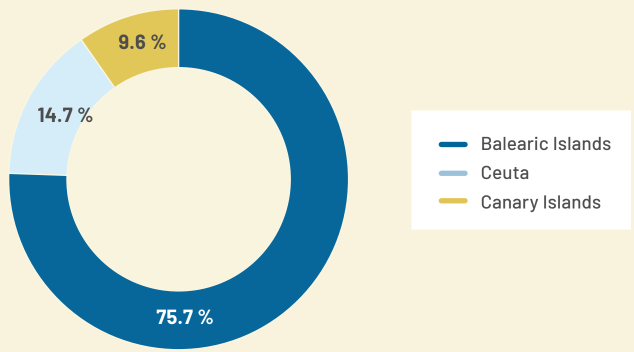
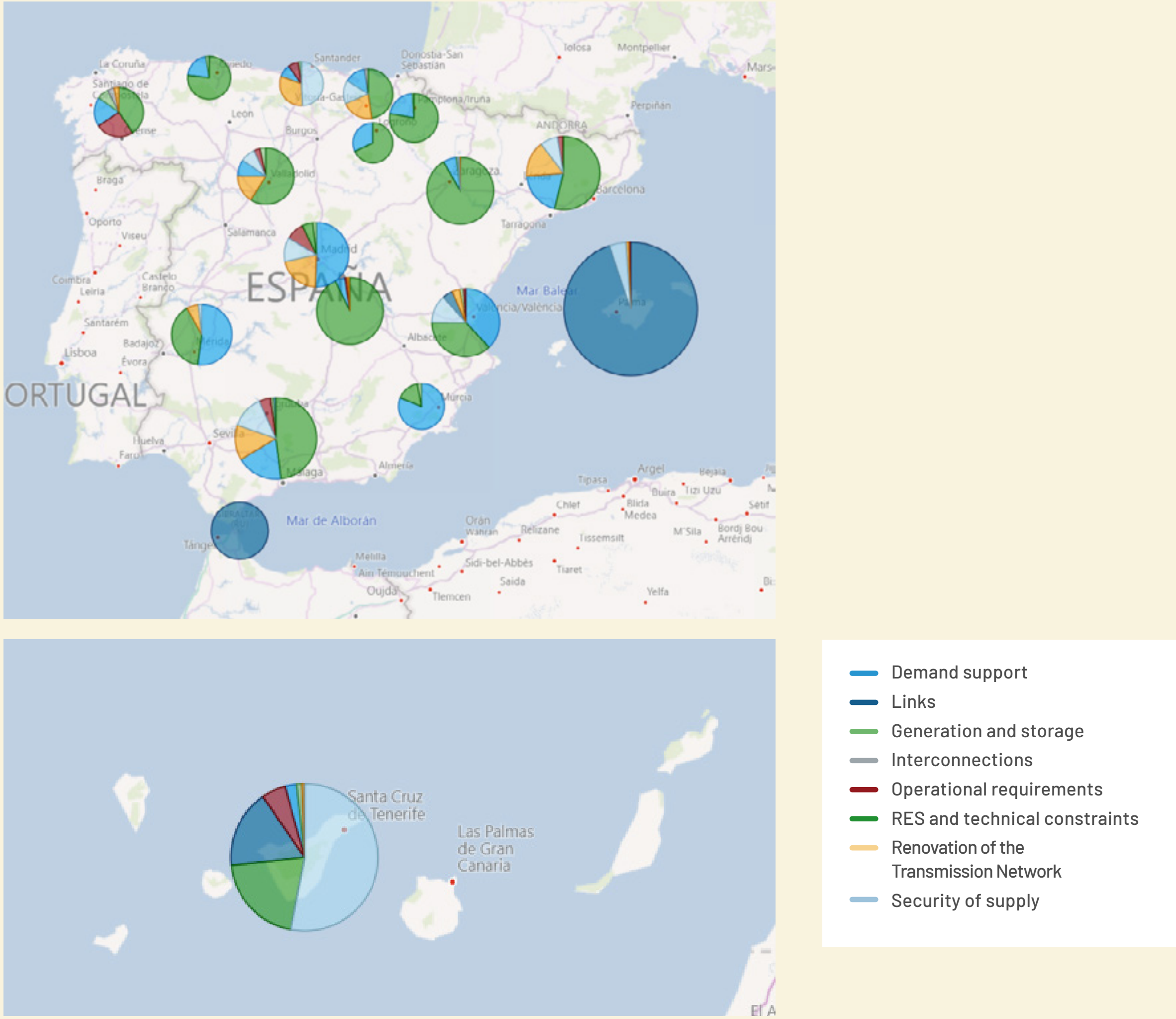


Figure 47. Distribution of the total investment cost of the 2021-2026 plan by Autonomous Community or Autonomous City and by driver

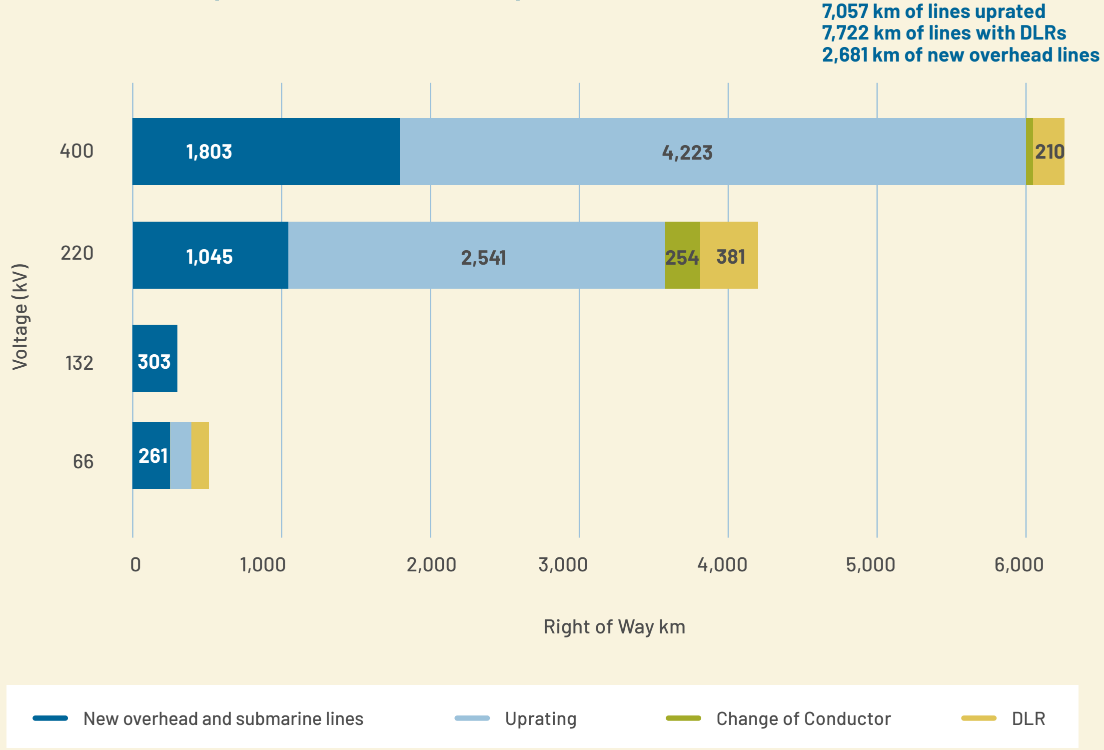


LEVERAGING THE EXISTING TRANSMISSION NETWORK

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.

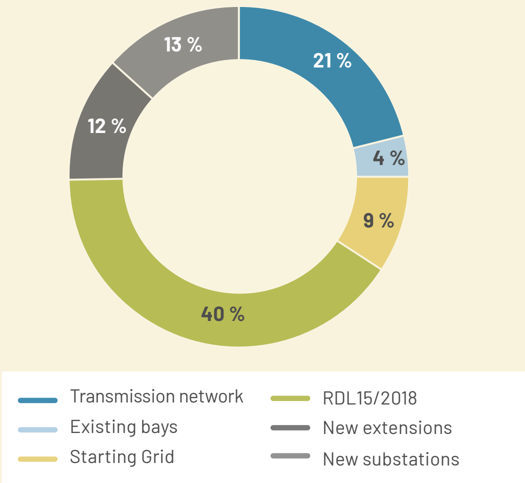
Figure 48. Planned investments in lines by type: installation of DLRs, uprating of existing lines or new lines[37] (without interconnections)



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.

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.

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 Navarre and Aragon, 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.

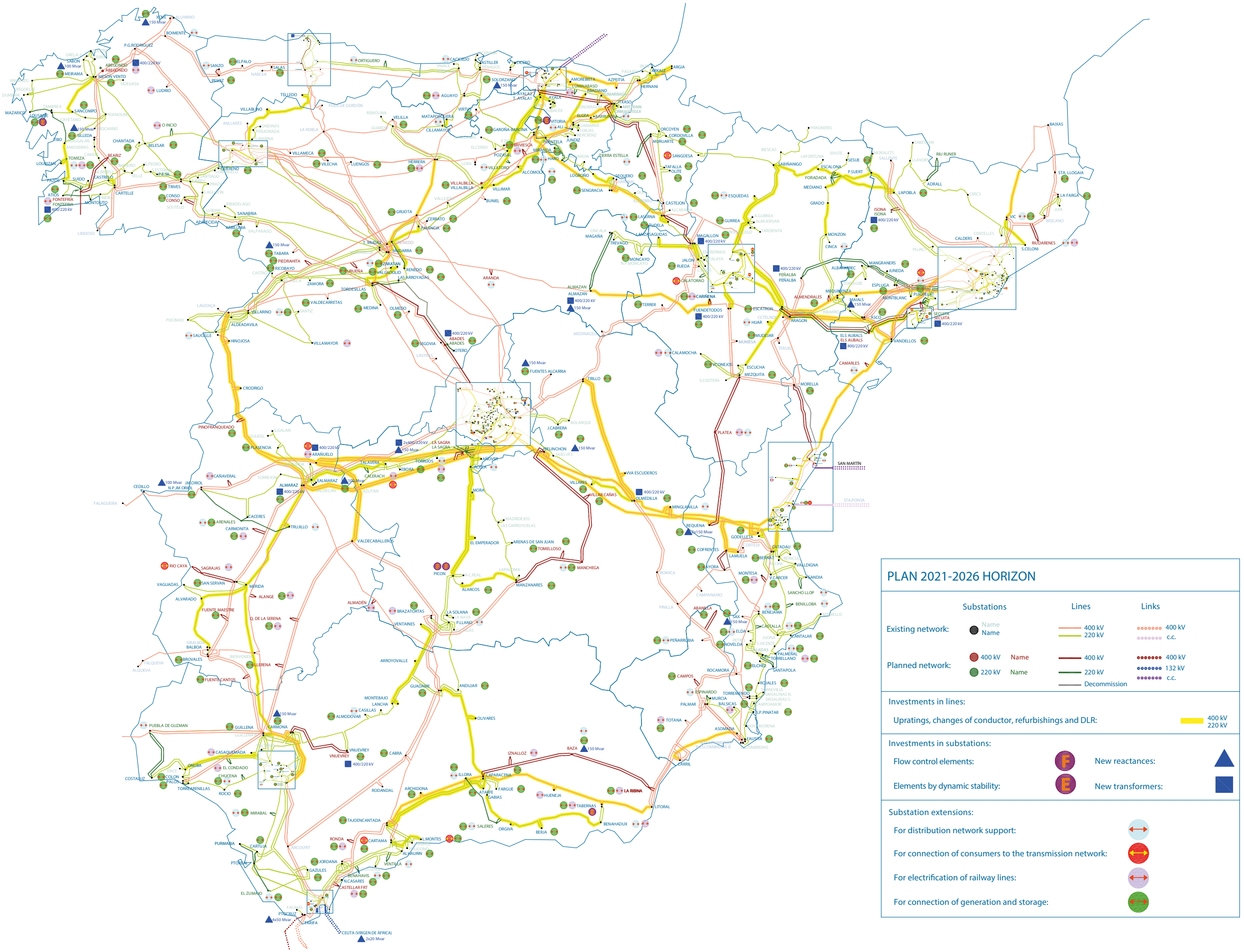
A list of these investments, which are proposed for indicative purposes, with a commissioning date after 2026, is included in the Annex Investments beyond the 2026 Horizon.

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.

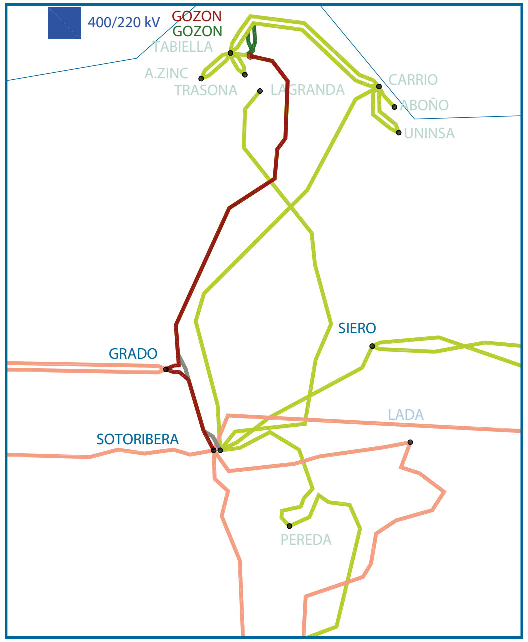
4.9. Maps

4.9.1. Spanish mainland

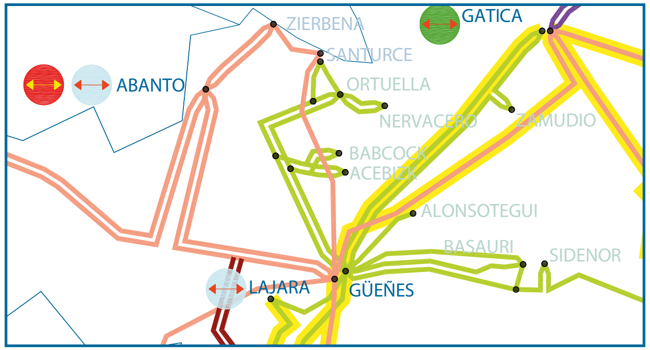


4.9.2. Spanish mainland detail

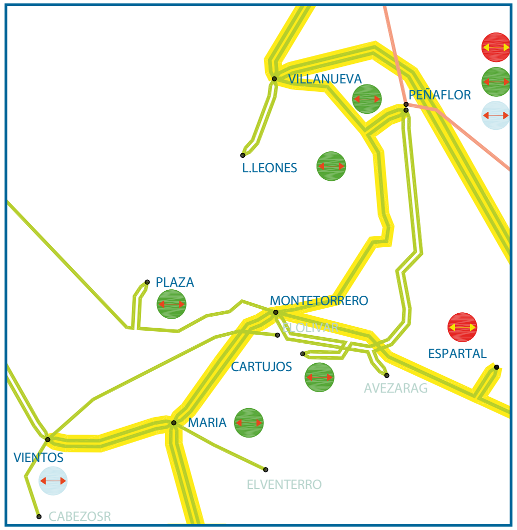
Asturias detail



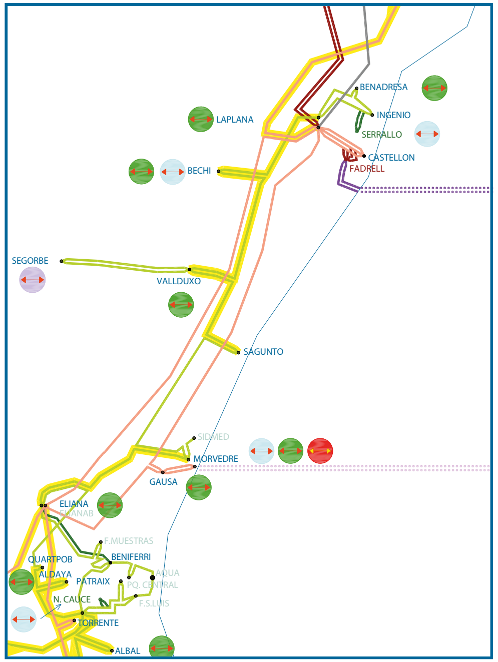
Aragon detail



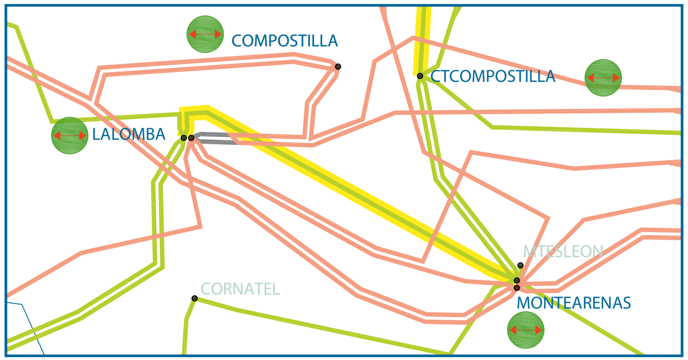
Basque Country detail

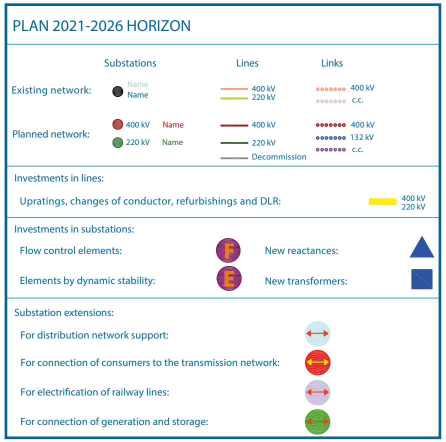


Valencian Community detail

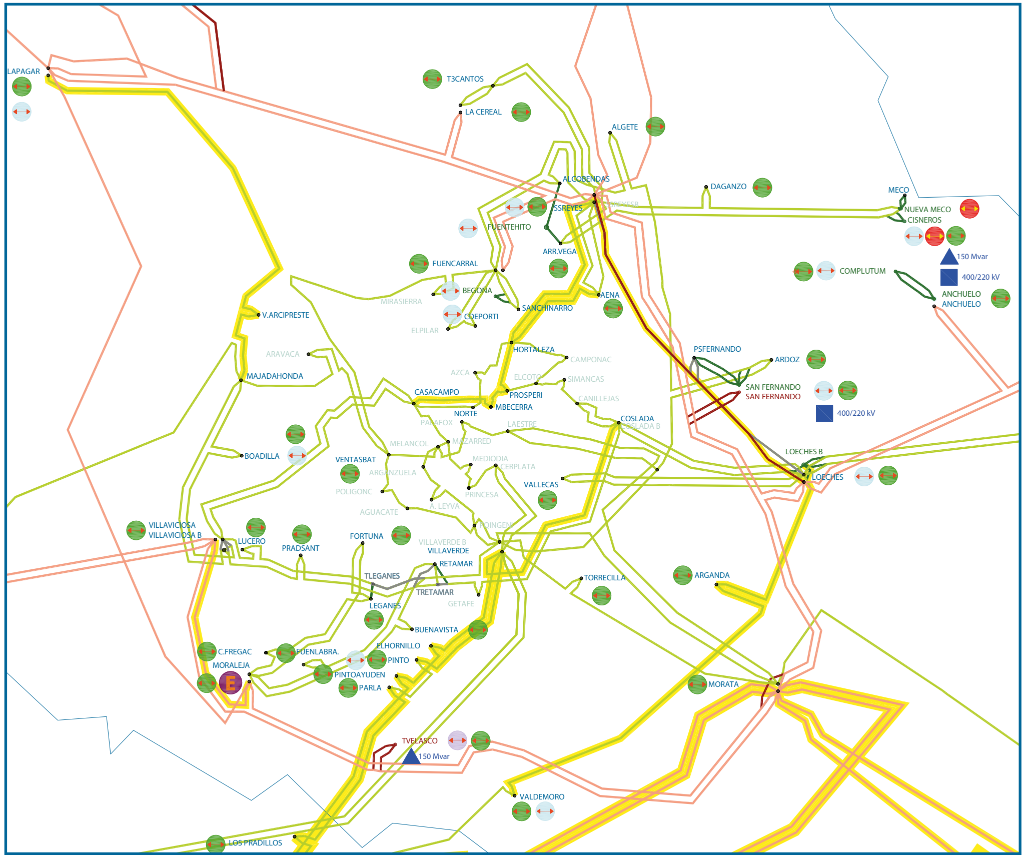


Castile and Leon detail

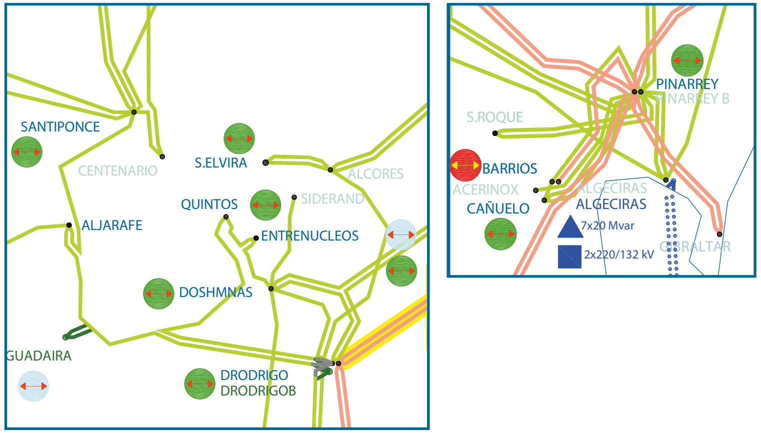


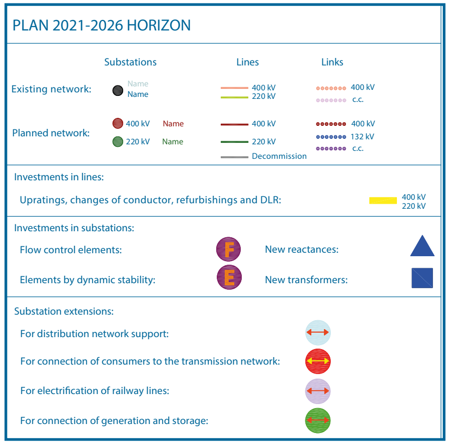


Community of Madrid detail



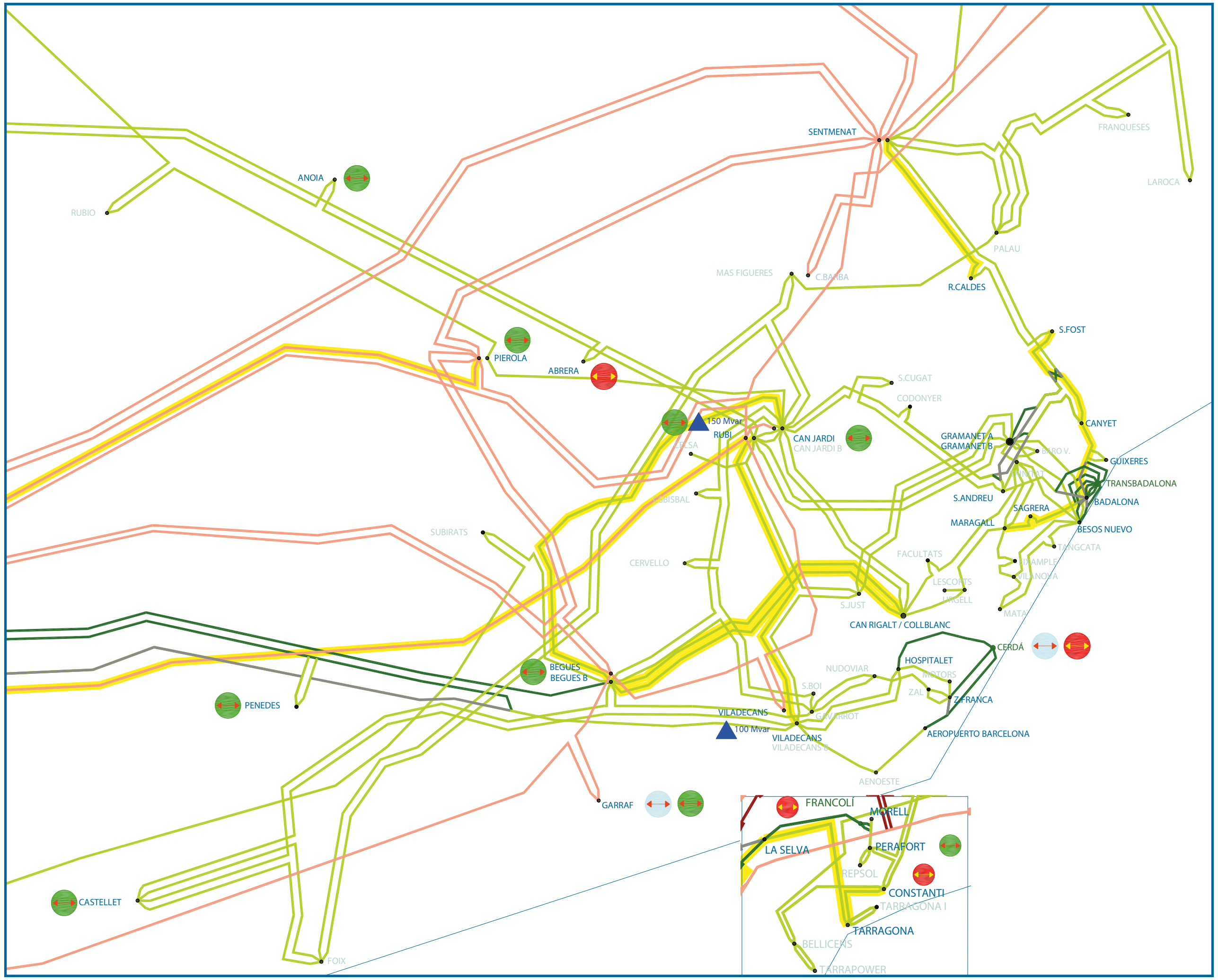
Andalusia detail

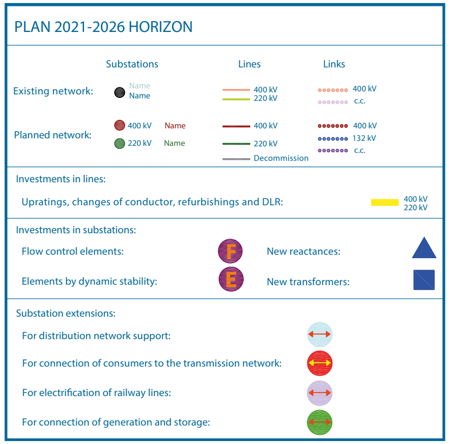




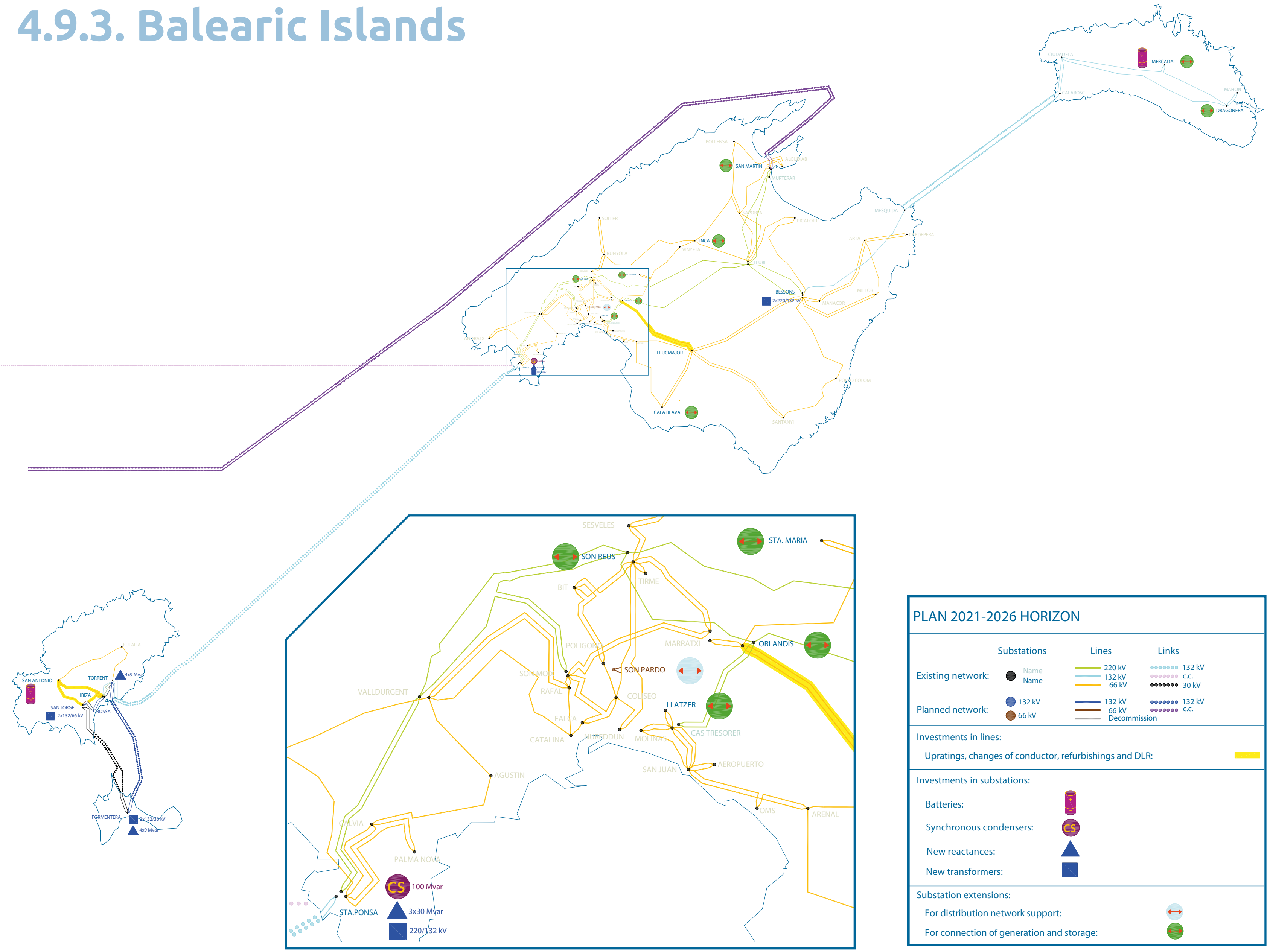
Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes
80

Catalonia detail



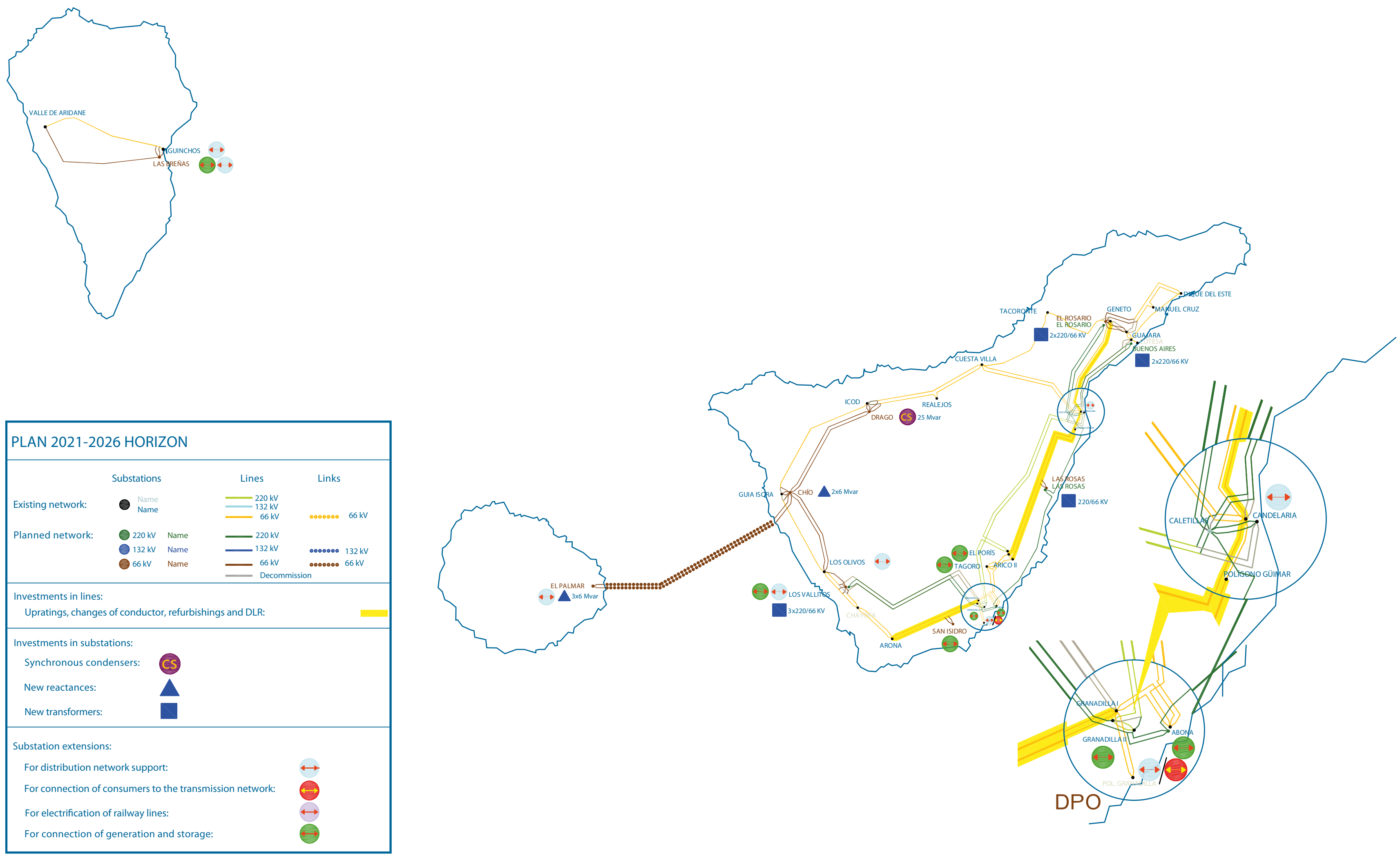


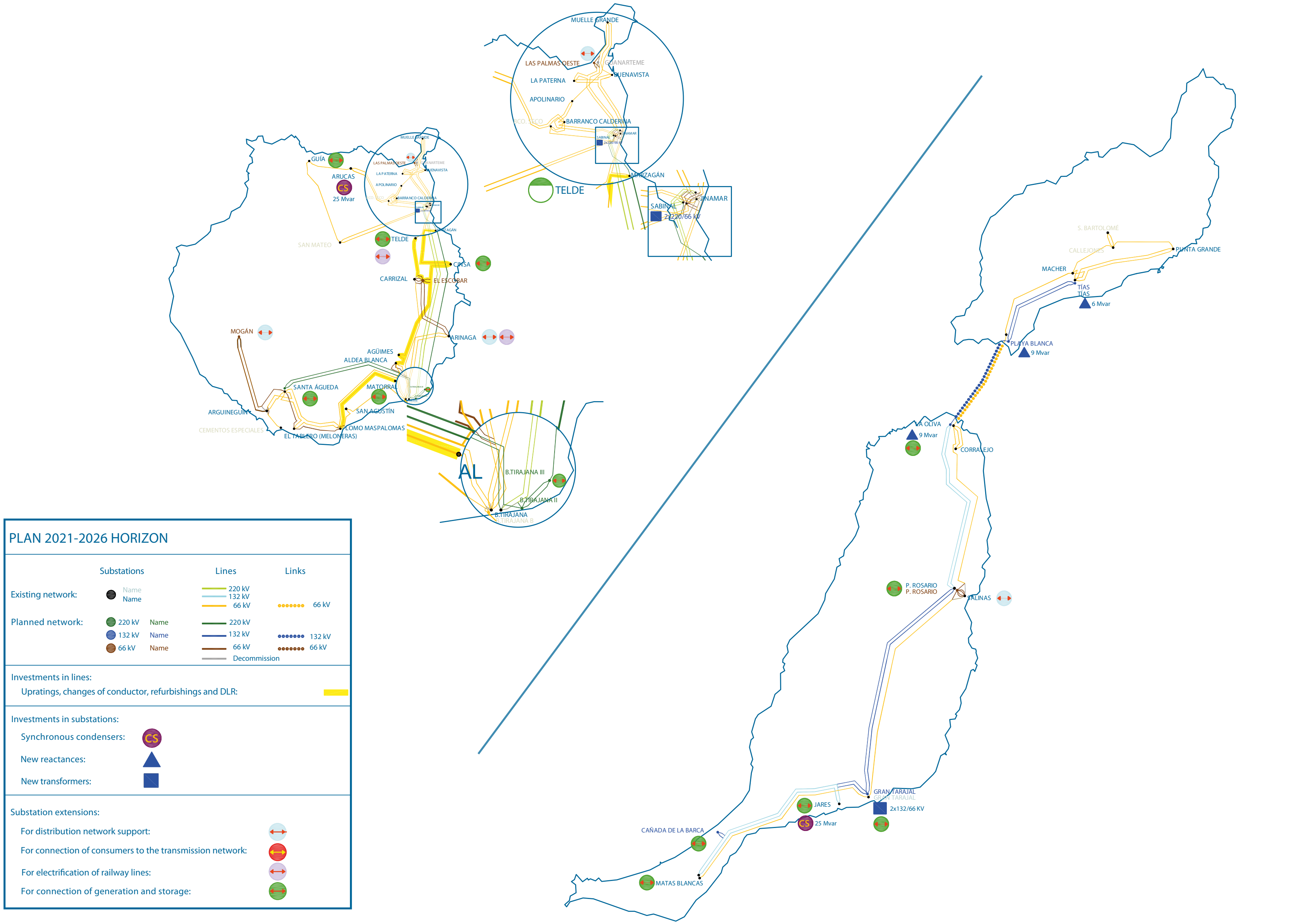
4.9.3. Balearic Islands



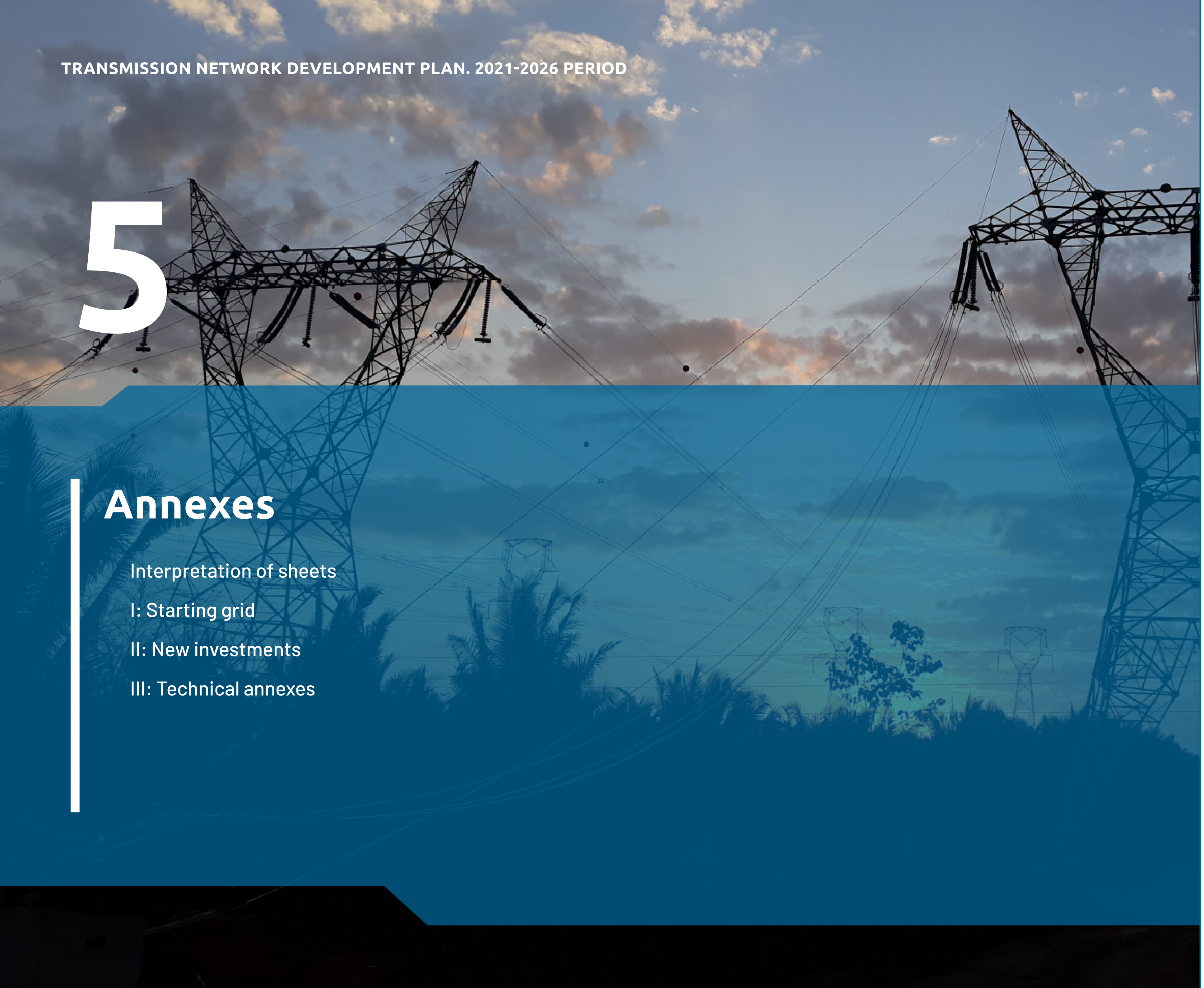
Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

4.9.4. Canary Islands





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes



5

Annexes

Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

INTERPRETATION OF SHEETS

Investment Code

Project type **Specific name of the project under analysis**

General description: General description of the project.

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.

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

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.

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

Investment 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.

Benefits: No calculation of benefits is made for the investments 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

Costs:

CAPEX	OPEX
- M€	- M€/year

The investment 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.

Profitability: No calculation of profitability is made for the investments included in the starting grid.

Socio-environmental impact:

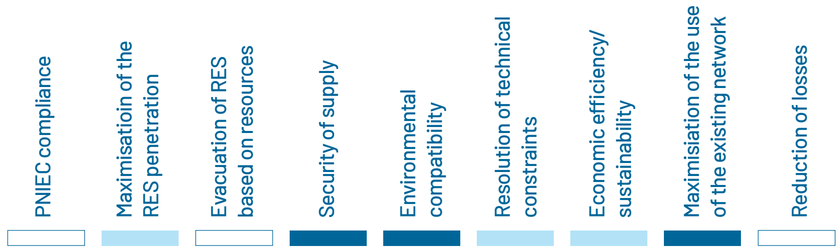
Impact degree: + / -

Environmental impact	Social 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).

Contribution to guiding principles:

Contribution degree: + / -



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).

Investment Code
Project type **Specific name of the project under analysis**

Table of physical units:

A summary of all the physical units of the investments 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 investments 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 investments 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.

Detailed list of investments:

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

Detailed list of investments (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 1995/2000.

Investment Code
Project type **Specific name of the project under analysis**

Detailed list of investments (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.

Dirvers (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.

Annexes

I: STARTING GRID

TABLE OF CONTENTS

DEFINITION OF THE STARTING GRID

Once the forecast scenario for generation, demand 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 investments 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 investments of the current 2015-2020 plan that meet the following criteria by 30 September 2019[1]:

- Investments with construction underway.
- Investments with commissioning planned by the carrier prior to the start of the study period 2021-2026 (in 2019 and 2020).
- Investments that have an Environmental Impact Statement (EIS). For those investments that consist of a set of works 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 investment 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 investment is included in the starting grid.
- 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.
- 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.

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 investments 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 investments included in the 2015-2020 plan.

I Investment RDP_ANDALUCIA
Starting grid **Andalusia**

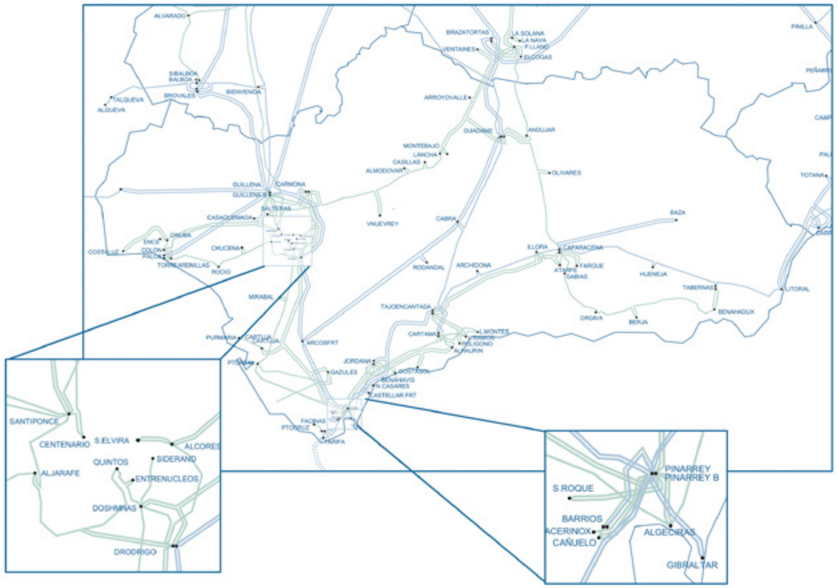
I General description: This sheet includes all the planned investments in Andalusia that are included in the starting grid according to the established criteria.

I Drivers / Objectives: To ensure that the investments included in the 2015-2020 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: The investments in the starting grid and possible alternatives were evaluated in the process of drawing up the 2015-2020 Transmission Network Development Plan.

I European dimension: No

I Map:



PLAN H2021-2026

	Substations	Lines	Links
Starting Grid:	Name	400 kV	400 kV
		220 kV	132 kV
		132 kV	30 kV
		66 kV	
		30 kV	

Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment RDP_ANDALUCIA
Starting grid **Andalusia**

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
131.2 M€	1.91 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	12.5	12.3	12.1	12.0	11.8	11.6	11.4	11.2	11.0

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

Profitability:

Profitability: NPV
- M€

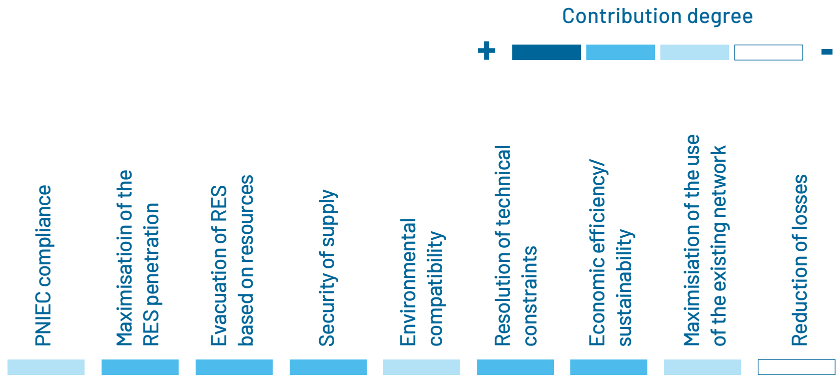
Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:



Investment RDP_ANDALUCIA
Starting grid **Andalusia**

Table of physical units:

	220 kV	400 kV
Bays (units)	19	19
Overhead line (km)	13	246
Cables (km)	4	
Uprating (km)	267	

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

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.

Detailed list of investments (continued):

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

I Investment RDP_ANDALUCIA
Starting grid **Andalusia**

I Detailed list of investments (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	516	516	0.7	Cable	SuD	2022
I/O in Benahavis, of Costasol - Jordana 220 kV, circuit 1	420	370	3	Line	SuD	2022
I/O in Castellar de La Frontera, of Jordana - Pinar del Rey 400 kV, circuit 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

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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment RDP_NORESTE
Starting grid **Aragon and Catalonia**

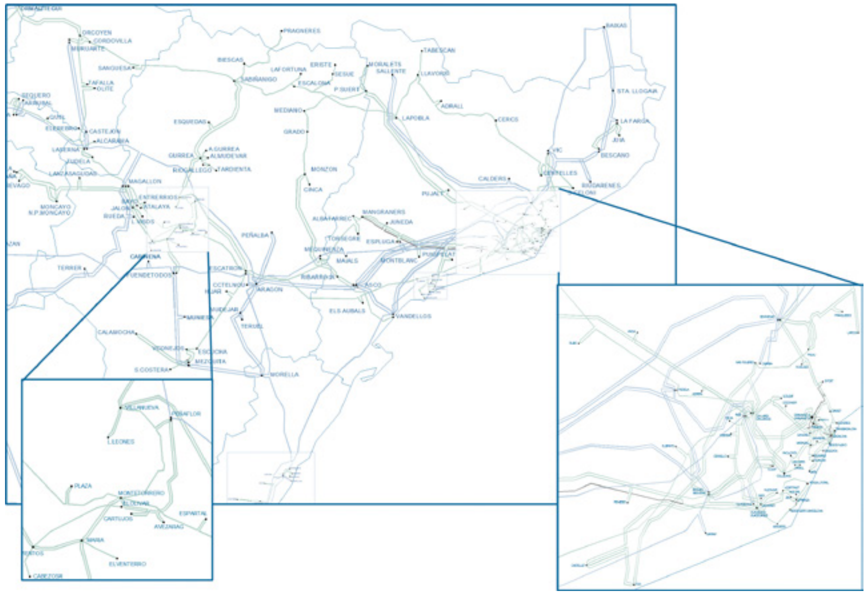
General description: This sheet includes all the planned investments in Aragon and Catalonia that are included in the starting grid according to the established criteria.

Drivers / Objectives: To ensure that the investments included in the 2015-2020 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.

Alternatives: The investments in the starting grid and possible alternatives were evaluated in the process of drawing up the 2015-2020 Transmission Network Development Plan.

European dimension: No

Map:



PLAN H2021-2026

	Substations	Lines	Links
Starting Grid:	Name	400 kV	400 kV
		220 kV	132 kV
		132 kV	30 kV
		66 kV	
		30 kV	

Investment RDP_NORESTE
Starting grid **Aragon and Catalonia**

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
153.7 M€	1.81 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	14.2	14.0	13.8	13.6	13.4	13.2	12.9	12.7	12.5

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

Profitability:

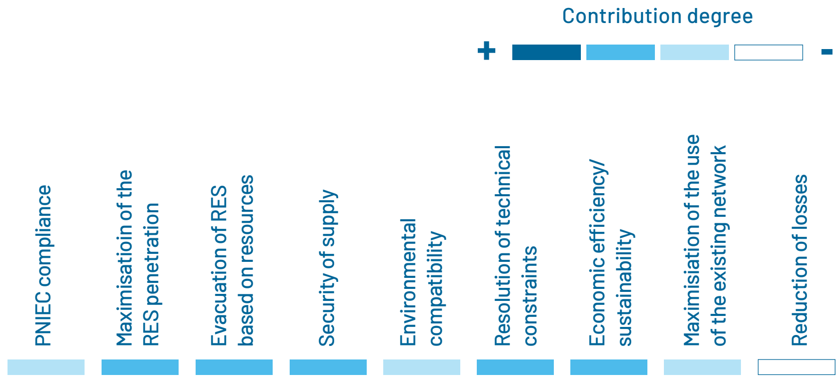
Profitability: NPV
- M€

Socio-environmental impact:

Impact degree + -

Environmental impact	Social impact

Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment RDP_NORESTE
Starting grid **Aragon and Catalonia**

Table of physical units:

	220 kV	400 kV
Bays (units)	30	16
Overhead line (km)	48	35
Cables (km)	31	
Uprating (km)	27	

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Cariñena 400 kV	Outdoor	2021
Cerdá 220 kV	Building	2022
Riudarenes 400 kV	Outdoor	2024
Transbadalona 220 kV	Building	2023

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Cariñena 400 kV	5	Conv.	TN	2021
Cariñena 400 kV	2	Conv.	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	2023
Gurrea de Gallego 220 kV	1	Conv.	Gen./Sto.	2022
Hospitalet 220 kV	1	Conv.	TN	2022
Mas Figueres 220 kV	2	Conv.	TN	2018
Mezquita 220 kV	2	Conv.	TN	2018
Mudejar 400 kV	1	Conv.	Gen./Sto.	2022
Mudejar 400 kV	1	Conv.	TN	2022
Palau 220 kV	1	Conv.	TN	2018
Riudarenes 400 kV	2	Conv.	Rail.	2024
Riudarenes 400 kV	5	Conv.	TN	2024
Tarragona 220 kV	1	Conv.	TN	2019
Transbadalona 220 kV	11	GIS	TN	2023
Valdeconejos 220 kV	3	Conv.	TN	2022
Villanueva de Gallego 220 kV	2	Conv.	TN	2021

I Investment RDP_NORESTE
Starting grid **Aragon and Catalonia**

I Detailed list of investments (continued):

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Aeropuerto Barcelona - 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
DC Escucha - Valdeconejos 220 kV [5]	360	300	4	Line	RES	2019
DC Escucha - Valdeconejos 220 kV [6]	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	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
I/O in Riudarenes, of Vic - Bescanó 400 kV, circuit 1	2,380	2,030	17	Line	Rail.	2024
Guixeres - Sant Andreu 220 kV, circuit 1 [7]	450	450	0.4	Cable	RES	2023
Guixeres - Transbadalona 220 kV, circuit 1 [8]	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 [9]	415	415	0.6	Cable	SoS	2023
Mas Figueres - Palau 220 kV, circuit 1	360	260	0.8	Line	RES	2022

New lines/cables (continued)	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
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 [10]	414	414	0.9	Cable	SoS	2023
Sentmenat - Gramanet 220 kV, circuit 1 [11]	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	1	Cable	SuD	2023

Notes:
1. AEBarcelona is not part of ZonaFranca, and connects with Cerdá
2. Besos Nuevo is disconnected from Badalona and connected with Transbadalona 1
3. Besos Nuevo is disconnected from Badalona and connected with Transbadalona 1
4. Crossing in DC: Codonyers-Canyet and S. Fost-S. Andreu 220 kV disappear. Andreu 220 kV and Canyet-GramanetB, Sentmenat-GramanetA, S.Fost-Canyet and Codonyers-Sant Andreu 220 kV are created.
5. Double circuit with overhead lines of the first circuit
6. Double circuit with overhead lines of the first circuit
7. Operable bypass
8. Guixeres is disconnected from Badalona and connected with Transbadalona 1
9. Sagrera is disconnected from Badalona and connected with Transbadalona 1
10. Sant Andreu is disconnected from Badalona and connected with Transbadalona 1
11. Crossing in DC: Codonyers-Canyet and S. Fost-S. Andreu 220 kV disappear. Andreu 220 kV and Canyet-GramanetB, Sentmenat-GramanetA, S.Fost-Canyet and Codonyers-Sant Andreu 220 kV are created.

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

I Investment RDP_NOROESTE
Starting grid **Asturias, Cantabria, Castile and Leon**

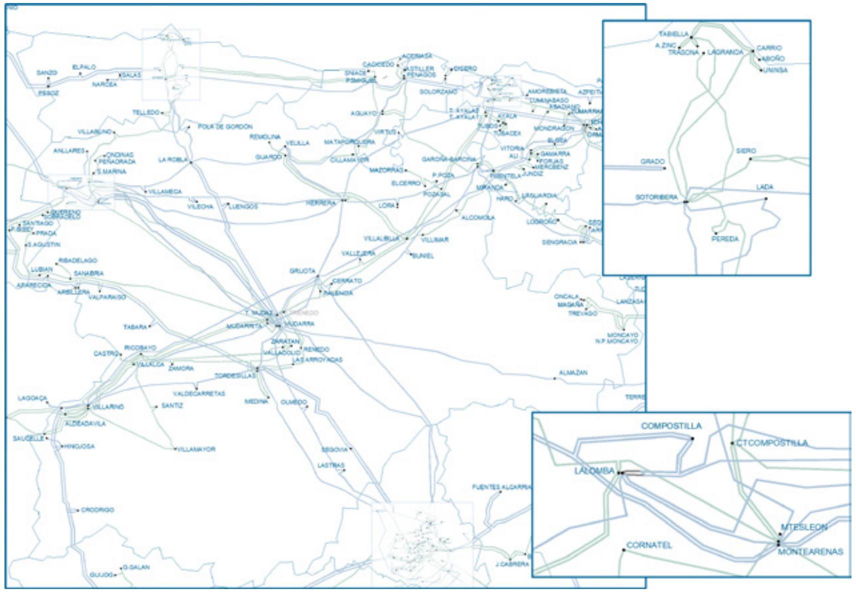
I General description: This sheet includes all the planned investments in Asturias, Cantabria and Castile and Leon that are included in the starting grid according to the established criteria.

I Drivers / Objectives: To ensure that the investments included in the 2015-2020 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: The investments in the starting grid and possible alternatives were evaluated in the process of drawing up the 2015-2020 Transmission Network Development Plan.

I European dimension: No

I Map:



PLAN H2021-2026

	Substations	Lines	Links
Starting Grid:	● Name	400 kV	400 kV
		220 kV	132 kV
		132 kV	30 kV
		66 kV	
		30 kV	

Investment RDP_NOROESTE
Starting grid **Asturias, Cantabria, Castile and Leon**

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
52 M€	0.58 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	4.8	4.7	4.6	4.6	4.5	4.4	4.4	4.3	4.2

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

Profitability:

Profitability: NPV

- M€

Socio-environmental impact:

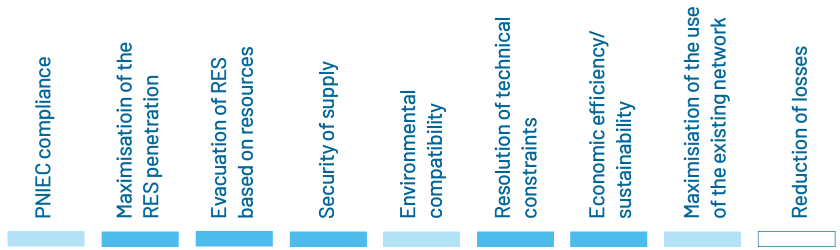
Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -



Investment RDP_NOROESTE
Starting grid **Asturias, Cantabria, Castile and Leon**

Table of physical units:

	220 kV	400 kV
Bays (units)	10	3
Overhead line (km)	32	6
Cables (km)	9	
Uprating (km)	49	405

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

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

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

Detailed list of investments (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, circuit 1			0.2	Cable	SuD	2022
Renedo - T de Mudarrita 220 kV, circuit 1 [1]	773	667	32	Line	RES	2021
Soto de Ribera - La Robla 400 kV [2]	1,768	1,635	2	Line	RES	2020
Soto de Ribera - Narcea 400 kV, circuit 1 [2]	1,768	1,635	1	Line	RES	2020
Soto de Ribera - Carrió 220 kV, circuit 1 [2]	972	899	0.3	Cable	RES	2021
Soto de Ribera - Tabiella 220 kV, circuit 1 [2]	972	899	0.7	Line	RES	2020

Notes:
1. Elimination of T Renedo 220 kV, leaving T Mudarra-Renedo 220 kV and Palencia-Renedo 220 kV lines.
2. Compacting of 400 kV Robla and Narcea and 220 kV Carrió and Tabiella lines at the entrance to the Soto de Ribera substation.

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

I Investment RDP_BALEARES
Starting grid **Balearic Islands**

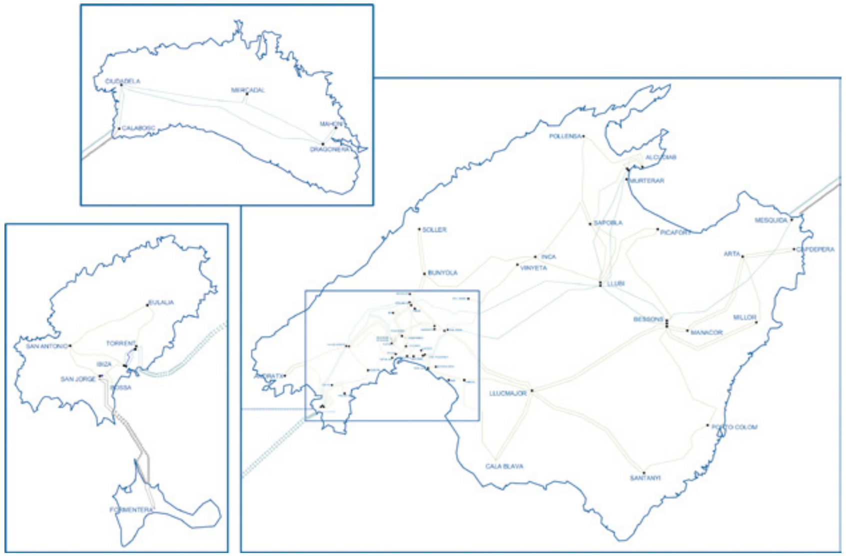
I General description: This sheet includes all the planned investments in the Balearic Islands that are included in the starting grid according to the established criteria.

I Drivers / Objectives: To ensure that the investments included in the 2015-2020 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: The investments in the starting grid and possible alternatives were evaluated in the process of drawing up the 2015-2020 Transmission Network Development Plan.

I European dimension: No

I Map:



PLAN H2021-2026

	Substations	Lines	Links
Starting Grid:	Name	400 kV	400 kV
		220 kV	132 kV
		132 kV	30 kV
		66 kV	
		30 kV	

I Investment RDP_BALEARES
Starting grid **Balearic Islands**

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
12.1 M€	0.24 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	1.1	1.1	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 investments that may be scheduled beyond 2026.

I Profitability:

Profitability: NPV

- M€

I Socio-environmental impact:

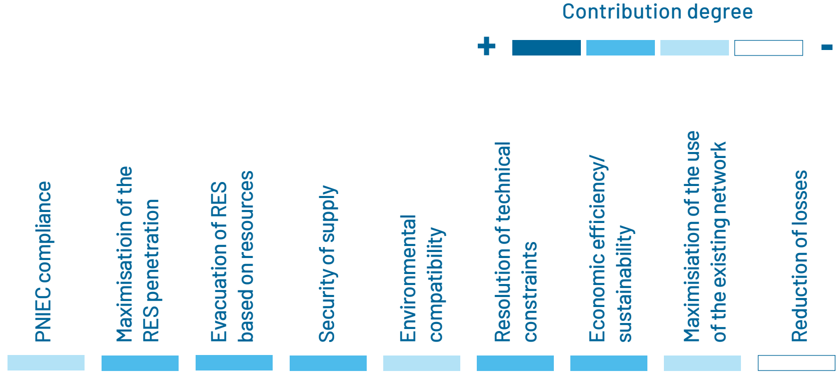
Impact degree

+ -

Environmental impact

Social impact

I Contribution to guiding principles:



I Investment RDP_BALEARES
Starting grid **Balearic Islands**

Table of physical units:

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

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

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	Conv.	Gen./Sto.	2021
Es Bessons 132 kV [1 2]	2	Conv.	TN	2023
San Martín Balearic Islands 66 kV	1	GIS	Gen./Sto.	2021
Son Pardo 66 kV	3	GIS	TN	2023

Notes:
1. Coupling switch for adaptation to P.O.
2. Output switch to the Mesquida 132 kV line for adaptation to P.O.

Detailed list of investments (continued):

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Coliseo - Son Moix 66 kV, circuit 1	80	80	0	Cable	SoS	2023
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, circuit 1[1]			0.2	Cable	SoS	2023

Notes:
1. Connection line for the output switch to the Mesquida 132 kV line for adaptation to P.O.

Total renewal of transformers	MVA	Type	Driv.	Year
Es Bessons 220/132 kV, TF1	320	Triph. B.	SoS	2023

I Investment RDP_CANARIAS
Starting grid **Canary Islands**

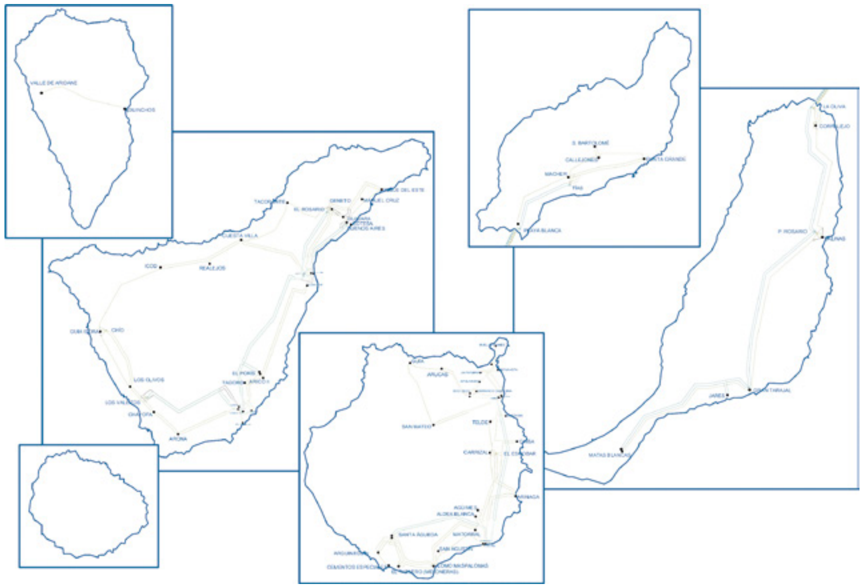
I General description: This sheet includes all the planned investments in the Canary Islands that are included in the starting grid according to the established criteria.

I Drivers / Objectives: To ensure that the investments included in the 2015-2020 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: The investments for the starting grid are not re-evaluated in this reporting period in accordance with the principles of this Planning and therefore no alternatives are evaluated.

I European dimension: No

I Map:



PLAN H2021-2026

	Substations	Lines	Links
Starting Grid:	● Name	400 kV 220 kV 132 kV 66 kV 30 kV	400 kV 132 kV 30 kV

Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment RDP_CANARIAS
Starting grid **Canary Islands**

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
444.3 M€	4.91 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	40.8	40.2	39.6	39.0	38.3	37.7	37.1	36.5	35.9

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

Profitability:

Profitability: NPV
- M€

Socio-environmental impact:

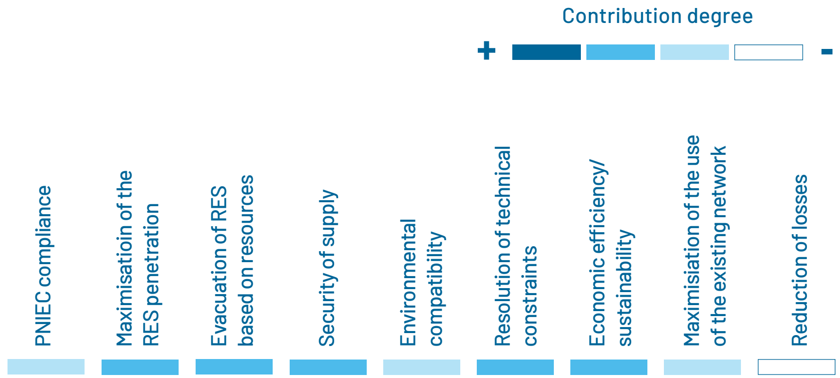
Impact degree

+ -

Environmental impact

Social impact

Contribution to guiding principles:



I Investment RDP_CANARIAS
Starting grid **Canary Islands**

Table of physical units:

	66 kV	132 kV	220 kV
Bays (units)	100	27	37
Overhead line (km)	52	118	16
Cables (km)	62	9	17
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

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

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
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	2	GIS	TN	2022
Barranco de Tirajana 66 kV	1	Conv.	TN	2020
Barranco de Tirajana 66 kV	2	Conv.	TN	2021
Barranco de Tirajana II 220 kV	2	GIS	TN	2022
Buenos Aires 220 kV	6	GIS	TN	2022

I Investment RDP_CANARIAS
Starting grid Canary Islands

I Detailed list of investments (continued):

Substation extension (continued)	units	Type	Driv.	Year
Buenos Aires 66 kV	2	Conv.	TN	2021
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	Conv.	Gen./Sto.	2023
El Matorral 66 kV	1	GIS	Gen./Sto.	2021
El Porís 66 kV	1	GIS	TN	2018
El Porís 66 kV	1	GIS	Gen./Sto.	2021
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	Conv.	Gen./Sto.	2023
Jares 132 kV	1	GIS	Gen./Sto.	2022
La Oliva 132 kV	2	GIS	TN	2017
La Oliva 66 kV	3	GIS	TN	2019

Substation extension (continued)	units	Type	Driv.	Year
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 [2]	2	Conv./GIS	TN	2023
Los Olivos 66 kV	4	GIS	TN	2023
Matas Blancas 132 kV	1	GIS	TN	2017
Matas Blancas 66 kV	1	Conv.	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	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	Conv.	Rail.	2023
Telde 66 kV	1	Conv.	Gen./Sto.	2021
Tías 132 kV	2	GIS	TN	2020
Vallitos 220 kV	6	GIS	TN	2023
Vallitos 66 kV	9	GIS	TN	2023

Notes:
1. Commissioning of DC Granadilla I-Buenos Aires/ Granadilla II-Caletillas 220 kV and decommissioning of DC Granadilla I/ Granadilla I-Candelaria.
2. Reconfiguration of Guinchos for adaptation to P.O.: typology of bays pending final feasibility of the project.

I Investment RDP_CANARIAS
Starting grid **Canary Islands**

Detailed list of investments (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
DC Arguineguín - Santa Águeda 66 kV [1]	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 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	1	Cable	SoS	2023
DC Chío - Los Olivos 66 kV [2]	76	76	12	Line	SoS	2023
DC Chío - Los Olivos 66 kV [3]	83	80	2	Cable	SoS	2023
DC El Rosario - Guajara 66 kV	69	69	8	Cable	SoS	2022
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 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 Salinas - Puerto del Rosario 66 kV	80	80	4	Cable	SoS	2022

New lines/cables (continued)	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
DC Puerto del Rosario - Gran Tarajal 132 kV [4]	160	160	44	Line	SoS	2023
DC Puerto del Rosario - Gran Tarajal 132 kV	160	160	0.3	Cable	SoS	2023
DC Santa Águeda - Barranco de Tirajana II 220 kV	323	323	1	Cable	SoS	2022
DC Tías - Playa Blanca 132 kV	160	160	14	Line	SoS	2023
DC Tías - Playa Blanca 132 kV	190	190	3	Cable	SoS	2023
DC Vallitos - Granadilla 220 kV	200	200	0.1	Line	SoS	2023
DC Vallitos - Granadilla 220 kV	200	200	4	Cable	SoS	2023
I/O in Abona, of Granadilla II - Vallitos 220 kV, circuit 1	393	360	1	Cable	RES	2023
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

Notes:
1. Double circuit with overhead lines of the first circuit. Part of the current circuits arriving at Arguineguín must be decommissioned.
2. The Icod line de Los Vinos-Guía de Isora 66 kV must be decommissioned.
3. The Icod line de Los Vinos-Guía de Isora 66 kV must be decommissioned.
4. Macher-Playa Blanca 66 kV and Corralejo-Salinas-Gran Tarajal-Matas Blancas 66 kV will be decommissioned subject to the commissioning of the entire 132 kV axis between Tías-Playa Blanca and La Oliva-Matas Blancas.

I Investment RDP_CANARIAS
Starting grid Canary Islands

Detailed list of investments (continued):

New lines/cables (continued)	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Puerto del Rosario, of Corralejo - Las Salinas 66 kV, circuit 1	80	80	0.8	Line	SoS	2022
I/O in Puerto del Rosario, of Corralejo - Las Salinas 66 kV, circuit 1	80	80	0.2	Cable	SoS	2022
I/O in Puerto del Rosario, of Gran Tarajal - Las Salinas 66 kV, circuit 1	80	80	0.1	Cable	SoS	2022
I/O in Puerto del Rosario, of Gran Tarajal - Las Salinas 66 kV, circuit 1	80	80	1	Line	SoS	2022
I/O in Vallitos, of Chayofa - Los Olivos 66 kV, circuit 1	62	62	4	Line	SoS	2023
I/O in Vallitos, of Chayofa - Los Olivos 66 kV, circuit 1	62	62	1	Cable	SoS	2023
El Tablero - Lomo Maspalomas 66 kV, circuit 2	80	80	0.3	Cable	SoS	2022
El Tablero - Lomo Maspalomas 66 kV, circuit 2	76	76	6	Line	SoS	2022
El Tablero - Santa Águeda 66 kV, circuit 2	90	90	3	Cable	SoS	2022
La Oliva - Playa Blanca 132 kV, circuit 1	120	120	17	Subm.	Link	2022

Voltage changes	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
DC Buenos Aires - Las Caletillas 220 kV	400	400	6	Cable	SoS	2022
DC Buenos Aires - Las Caletillas 220 kV	400	400	14	Line	SoS	2022

Topology changes	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Barranco de Calderina - Sabinal 66 kV, circuit 1 [1]	76	76	0.3	Cable	SoS	2023
Buenavista GC - 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 - Los Olivos 66 kV, circuit 1 [4]	52	48	0.5	Cable	SoS	2023
DC Barranco of Calderina - Sabinal 66 kV	76	76	0.2	Cable	SoS	2023
DC Buenavista GC - Sabinal 66 kV	60	60	0.1	Cable	SoS	2023
DC El Rosario - Dique del Este 66 kV [5]	66	66	6	Cable	SoS	2022
DC El Rosario - Tacoronte 66 kV [6]	66	66	0.4	Cable	SoS	2022
DC Guanarteme - Sabinal 66 kV	58	58	0.1	Cable	SoS	2023
DC Las Caletillas - Granadilla 220 kV [7]	290	290	0.5	Line	SoS	2022
DC Santa Águeda - Cementos Especiales 66 kV [8]	40	40	0.5	Line	SoS	2022
Guanarteme - Sabinal 66 kV, circuit 1 [9]	58	58	0.2	Cable	SoS	2023
La Oliva - Playa Blanca 66 kV, circuit 1 [10]	60	60	0.5	Cable	Link	2022

I Investment RDP_CANARIAS
Starting grid **Canary Islands**

Detailed list of investments (continued):

Topology changes (continued)	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
La Oliva - Puerto del Rosario 66 kV, circuit 1 [11]	60	60	0.5	Cable	Link	2022
La Paterna - Sabinal 66 kV, circuit 2	60	60	0.8	Cable	SoS	2023
San Agustín (Gran Canaria) - El Tablero 66 kV, circuit 1 [12]	66	66	0.5	Cable	SoS	2022

Notes:
1. Topology change with decommissioning of the Jinamar-Bco Seco and Jinamar- Bco of Calderina 66kV lines and commissioning of the Sabinal-Bco Seco and Sabinal-Bco of Calderina 66kV lines.
2. Topology change 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. Topology change with commissioning of Chío-Icod 66 kV and decommissioning of Guía Isora-Icod 66 kV.
4. Topology change with commissioning of Chío-Los Olivos 66 kV and decommissioning of Guía Isora-Los Olivos 66 kV.
5. Topology change of DC Dique del Este/Manuel Cruz-Geneto to DC Dique del Este/Manuel Cruz-El Rosario 66 kV.
6. Topology change of Tacoronte-Geneto to Tacoronte-El Rosario 66 kV.
7. Former Granadilla-Candelaria line cto. 1 220 kV.
8. Topology change with decommissioning of the Sta Águeda-Arguineguín 1 and Arguineguín Cementos Especiales lines and commissioning of the Sta Águeda-C Especiales 1 66 kV lines.
9. Topology change 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.
10. Commissioning of La Oliva-Playa Blanca 66 kV and La Oliva-Puerto del Rosario 66 kV due to topology change of the current Corralejo-Playa Blanca 66 kV link and the Corralejo-Puerto del Rosario 66 kV line-cable.
11. Commissioning of La Oliva-Playa Blanca 66 kV and La Oliva-Puerto del Rosario 66 kV due to topology change of the current Corralejo-Playa Blanca 66 kV link and the Corralejo-Puerto del Rosario 66 kV line-cable.
12. Bypass not operable at 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	76	76	7	Line	SoS	2023
Sabinal - Barranco Seco 66 kV, circuit 1	76	76	4	Line	SoS	2023

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	2023
Vallitos 220/66 kV, TF2	125	Triph. B.	SoS	2023

New reactances	MVAr	Type	Driv.	Year
La Oliva 132 kV, REA1	9	-	Link	2017
Playa Blanca 132 kV, REA1	9	-	Link	2019

I Investment RDP_CENTRO
Starting grid **Castile-La Mancha and Madrid**

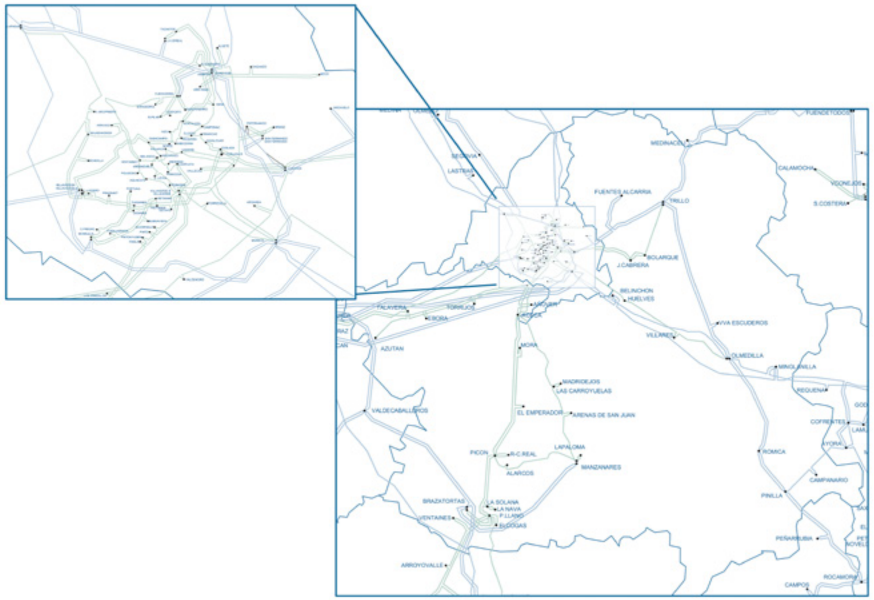
I General description: This sheet includes all the planned investments in Castile-La Mancha and Madrid that are included in the starting grid according to the established criteria.

I Drivers / Objectives: To ensure that the investments included in the 2015-2020 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: The investments in the starting grid and possible alternatives were evaluated in the process of drawing up the 2015-2020 Transmission Network Development Plan.

I European dimension: No

I Map:



PLAN H2021-2026

	Substations	Lines	Links
Starting Grid:	● Name	400 kV 220 kV 132 kV 66 kV 30 kV	400 kV 132 kV 30 kV

Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment RDP_CENTRO
Starting grid **Castile-La Mancha and Madrid**

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
99.5 M€	1.48 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	9.5	9.4	9.2	9.1	9.0	8.8	8.7	8.5	8.4

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

Profitability:

Profitability: NPV

- M€

Socio-environmental impact:

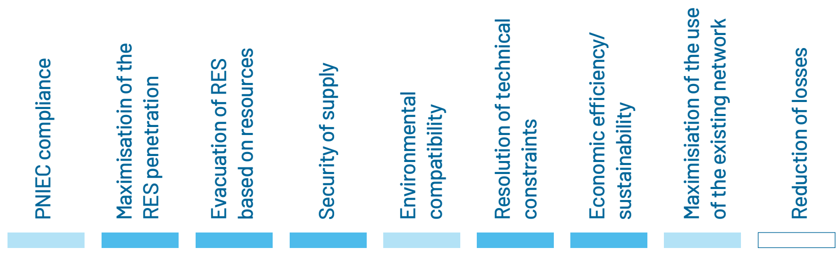
Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment RDP_CENTRO
Starting grid **Castile-La Mancha and Madrid**

Table of physical units:

	220 kV	400 kV
Bays (units)	18	17
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 investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Olmedilla 220 kV	Outdoor	2022
San Fernando 220 kV	Building	2022
San Fernando 400 kV	Building	2023

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Brazatortas 400 kV	1	Conv.	Gen./Sto.	2023
Brazatortas 400 kV	1	Conv.	TN	2023
Coslada 220 kV [1]	5	Conv.	TN	2020
José Cabrera 220 kV	1	Conv.	Gen./Sto.	2023
Loeches 400 kV [2]	2	Conv.	TN	2022
Minglanilla 400 kV	1	Conv.	Gen./Sto.	2020
Olmedilla 220 kV	3	Conv.	TN	2022
Olmedilla 400 kV	3	Conv.	TN	2022
Olmedilla 400 kV	1	Conv.	Gen./Sto.	2022
San Fernando 220 kV	3	GIS	TN	2022
San Fernando 220 kV	3	GIS	TN	2023
San Fernando 400 kV	1	Conv.	Gen./Sto.	2023
San Fernando 400 kV	6	GIS	TN	2023
San Sebastián de los Reyes 400 kV [3]	1	Conv.	TN	2022
Villares del Saz 220 kV	1	Conv.	Gen./Sto.	2021

Notes:
1. Coslada B 220 kV with connection to Coslada 220 kV circuits 1 and 2 (Longitudinal busbar coupling. AIS technology) and connection of the Getafe and Loeches bays previously connected to Coslada. Extension of the Coslada B 220 kV substation for transverse coupling.
2. Change of voltage and topology of the Loeches-Puente San Fernando 220 kV and Puente San Fernando- San Sebastián de los Reyes 220 kV lines, with commissioning of the Loeches-San Sebastián de los Reyes 2 400 kV line.
3. Change of voltage and topology of the Loeches-Puente San Fernando 220 kV and Puente San Fernando- San Sebastián de los Reyes 220 kV lines, with commissioning of the Loeches-San Sebastián de los Reyes 2 400 kV line.

I Investment RDP_CENTRO
Starting grid **Castile-La Mancha and Madrid**

Detailed list of investments (continued):

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
DC San Fernando - Puente San Fernando 220 kV	440	440	1	Cable	SuD	2022
I/O in Ébora, of Torrijos - Almaraz ET 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 ET - 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]			0.8	Cable	RES	2022

Notes:
1. Voltage and topology change: the 400 kV Loeches-San Sebastián de los Reyes line route is extended by 2 km.
2. For connection of the transformer, which is connected to the 220 kV network by 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 Ines 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

I Investment RDP_EXTREM
Starting grid **Extremadura**

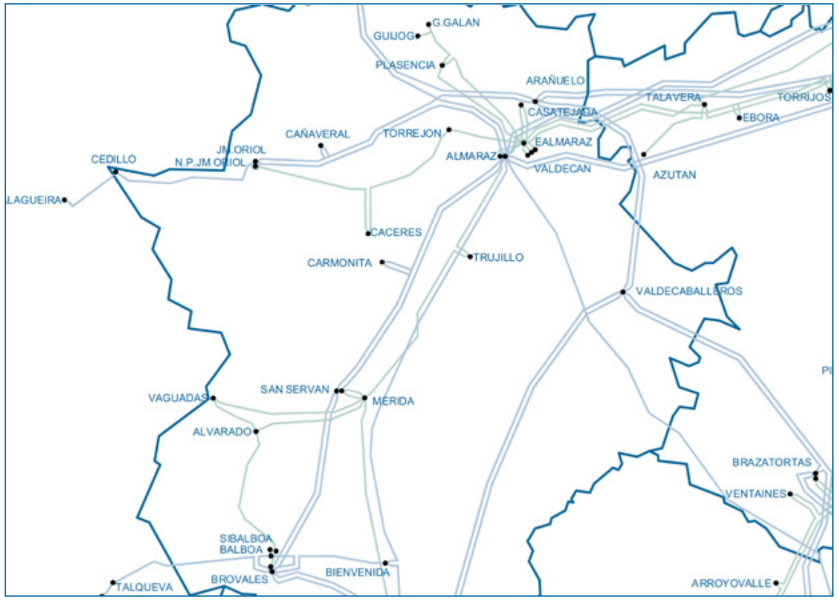
I General description: This sheet includes all the planned investments in Extremadura that are included in the starting grid according to the established criteria.

I Drivers / Objectives: To ensure that the investments included in the 2015-2020 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: The investments in the starting grid and possible alternatives were evaluated in the process of drawing up the 2015-2020 Transmission Network Development Plan.

I European dimension: No

I Map:



PLAN H2021-2026

	Substations	Lines	Links
Starting Grid:	● Name	400 kV 220 kV 132 kV 66 kV 30 kV	400 kV 132 kV 30 kV

I Investment RDP_EXTREM
Starting grid **Extremadura**

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
36.9 M€	0.79 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	3.8	3.7	3.7	3.6	3.6	3.5	3.5	3.4	3.4

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

Profitability:

Profitability: NPV
- M€

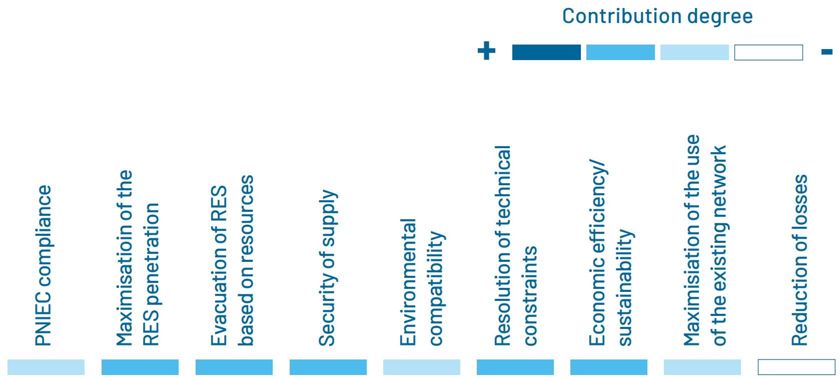
Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:



Investment 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 investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Carmonita 400 kV	Outdoor	2021
Jose María de Oriol NP 220 kV	Outdoor	2021

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Almaraz ET 220 kV	1	Conv.	TN	2022
Carmonita 400 kV	2	Conv.	Rail.	2021
Carmonita 400 kV	5	Conv.	TN	2021
Carmonita 400 kV	1	Conv.	Gen./Sto.	2021
Jose María de Oriol NP 220 kV [1]	4	Conv.	TN	2021
Río Caya 66 kV	2	Conv.	INT	2021
San Servan 400 kV	1	Conv.	Gen./Sto.	2023

Notes:
1. Relocation of the Cáceres bay 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 NP 220 kV [1]	430	350	0.6	Line	RES	2021
DC Jose María de Oriol - Jose María de Oriol NP 220 kV	860	730	0.2	Line	RES	2021
I/O in Carmonita, of Almaraz CN - San Servan 400 kV, circuit 1	2,343	1,942	1	Line	Rail.	2021
Río Caya - Portuguese border 66 kV, circuit 1 [2]			0.1	Line	INT	2021

Notes:
1. Relocation of the Cáceres bay from J.M. Oriol to J.M. Oriol NP 220 kV.
2. Topology change from Badajoz - Portuguese Border to Río Caya - Portuguese Border.

Investment RDP_EXTREM
Starting grid **Extremadura**

Detailed list of investments (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 at 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

I Investment RDP_GALICIA
Starting grid **Galicia**

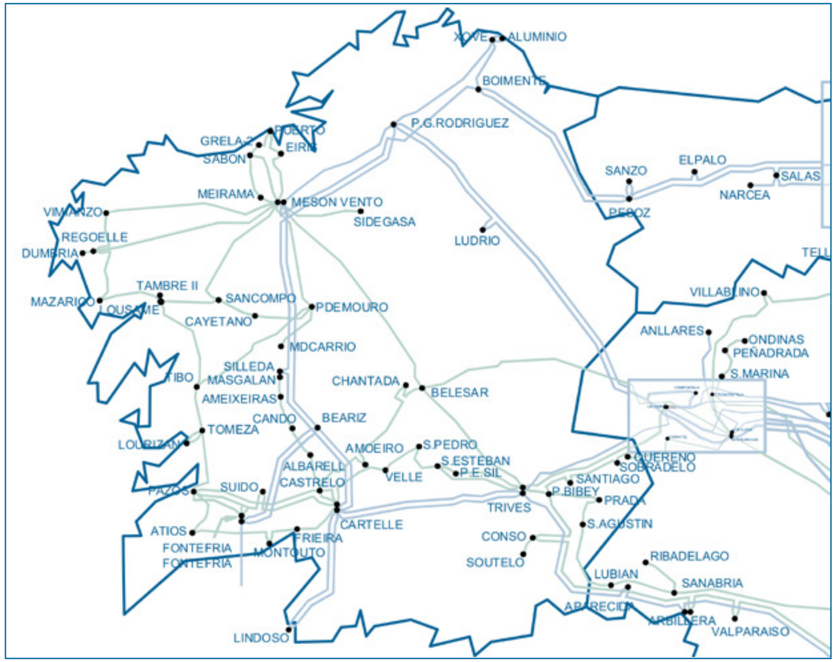
I General description: This sheet includes all the planned investments in Galicia that are included in the starting grid according to the established criteria.

I Drivers / Objectives: To ensure that the investments included in the 2015-2020 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: The investments in the starting grid and possible alternatives were evaluated in the process of drawing up the 2015-2020 Transmission Network Development Plan.

I European dimension: No

I Map:



PLAN H2021-2026

	Substations	Lines	Links
Starting Grid:	Name	400 kV	400 kV
		220 kV	132 kV
		132 kV	30 kV
		66 kV	
		30 kV	

Investment RDP_GALICIA
Starting grid **Galicia**

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
63.8 M€	0.82 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	5.3

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

Profitability:

Profitability: NPV
- M€

Socio-environmental impact:

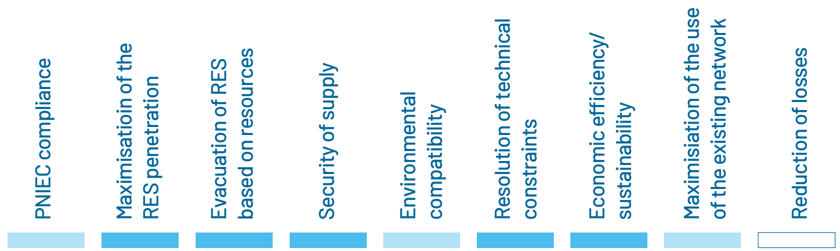
Impact degree
+ -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree
+ -



I Investment RDP_GALICIA
Starting grid **Galicia**

Table of physical units:

	220 kV
Bays (units)	23
Overhead line (km)	104
Cables (km)	0.4
Uprating (km)	49

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Tomeza 220 kV	Outdoor	2021

Substation extension	units	Type	Driv.	Year
Atios 220 kV	1	Conv.	TN	2010
Chantada 220 kV	1	GIS	Gen./Sto.	2021
Fontefría 220 kV	1	Conv.	Gen./Sto.	2024
Fontefría 220 kV	3	Conv.	TN	2024
Lousame 220 kV	2	Conv.	TN	2019
Mazaricos 220 kV	1	Conv.	TN	2019
Montouto 220 kV	1	Conv.	TN	2010
Pazos de Borbén 220 kV	1	Conv.	TN	2024
Regoelle 220 kV	2	GIS	TN	2016
Santiago de Compostela 220 kV	1	Conv.	Gen./Sto.	2023
Tibo 220 kV	1	Conv.	Gen./Sto.	2022
Tibo 220 kV	1	Conv.	TN	2011
Tomeza 220 kV	2	GIS	Rail.	2021
Tomeza 220 kV	5	GIS	TN	2021

Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

I Investment RDP_GALICIA
Starting grid **Galicia**

Detailed list of investments (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 [2]	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	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 overhead lines of the first circuit.
2. Double circuit with overhead lines of the first circuit.
3. The new line utilises part of the existing circuit.

Investment RDP_NORTE
Starting grid **Navarre, Basque Country and La Rioja**

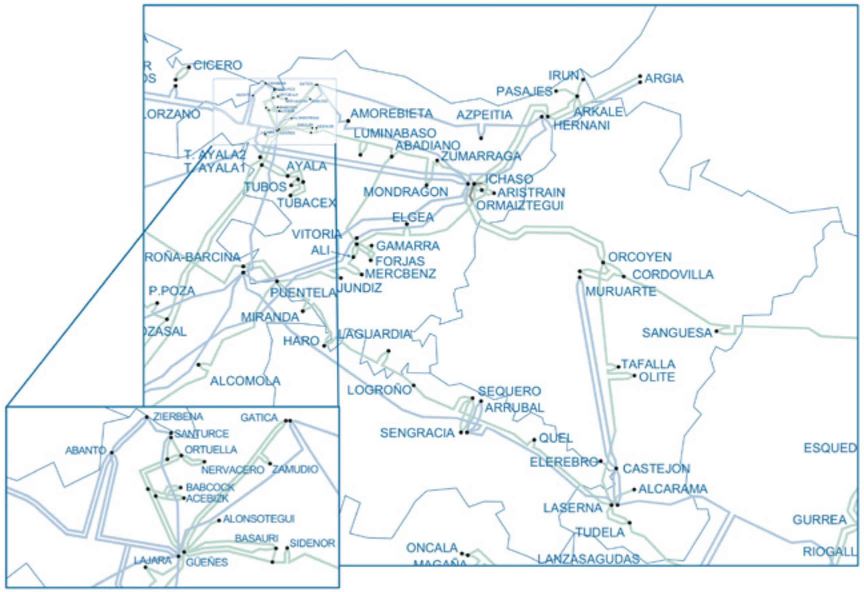
General description: This sheet includes all the planned investments in Navarre, Basque Country and La Rioja that are included in the starting grid according to the established criteria.

Drivers / Objectives: To ensure that the investments included in the 2015-2020 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.

Alternatives: The investments in the starting grid and possible alternatives were evaluated in the process of drawing up the 2015-2020 Transmission Network Development Plan.

European dimension: No

Map:



PLAN H2021-2026

	Substations	Lines	Links
Starting Grid:	Name	400 kV	400 kV
		220 kV	132 kV
		132 kV	30 kV
		66 kV	
		30 kV	

Investment RDP_NORTE
Starting grid **Navarre, Basque Country and La Rioja**

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
72.2 M€	1.03 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	6.9	6.8	6.7	6.6	6.5	6.4	6.3	6.2	6.1

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

Profitability:

Profitability: NPV
- M€

Socio-environmental impact:

Impact degree

\+ -

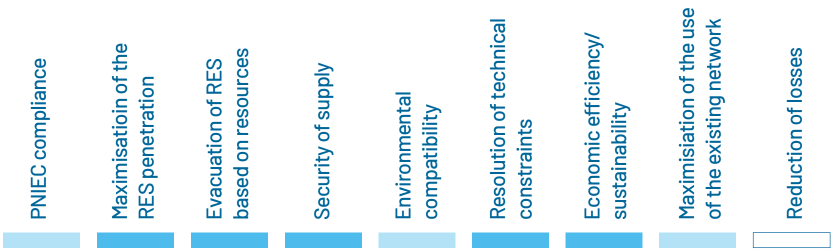
Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree

\+ -



Investment RDP_NORTE
Starting grid **Navarre, Basque Country and La Rioja**

Table of physical units:

	220 kV	400 kV
Bays (units)	7	3
Overhead line (km)	1	147
Uprating (km)	50	
STATCOM (units)*	150	

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Luminabaso 220 kV	Outdoor	2023

Substation extension	units	Type	Driv.	Year
Itxaso 400 kV	3	Conv.	TN	2021
La Serna 220 kV	1	Conv.	SuD	2023
Luminabaso 220 kV	2	Conv.	Rail.	2023
Luminabaso 220 kV	3	Conv.	TN	2023
Olite 220 kV	1	Conv.	Gen./Sto.	2023

Detailed list of investments (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

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

Nuevos STATCOM	units	Type	Driv.	Year
Vitoria 220 kV	150	-	SoS	2022

Investment RDP_ESTE

Starting grid **Valencian Community and Murcia**

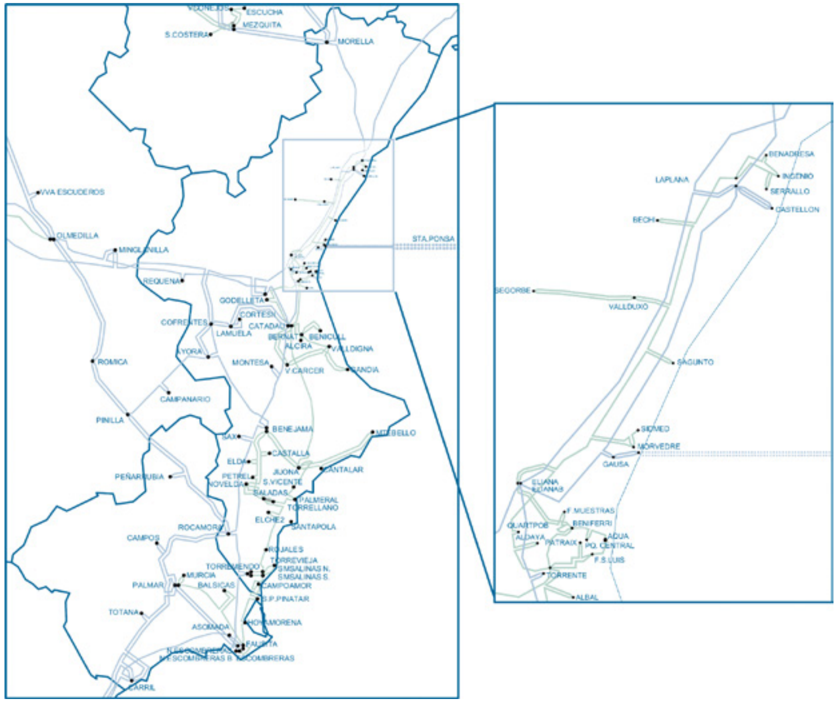
General description: This sheet includes all the planned investments in the Valencian Community and Murcia that are included in the starting grid according to the established criteria.

Drivers / Objectives: To ensure that the investments included in the 2015-2020 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.

Alternatives: The investments for the starting grid are not re-evaluated in this reporting period in accordance with the principles of this Planning and therefore no alternatives are evaluated.

European dimension: No

Map:



PLAN H2021-2026

	Substations	Lines	Links
Starting Grid:	● Name	400 kV	400 kV
		220 kV	132 kV
		132 kV	30 kV
		66 kV	
		30 kV	

Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment RDP_ESTE
Starting grid **Valencian Community and Murcia**

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
127.9 M€	1.38 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	11.7	11.5	11.4	11.2	11.0	10.8	10.6	10.5	10.3

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

Profitability:

Profitability: NPV

- M€

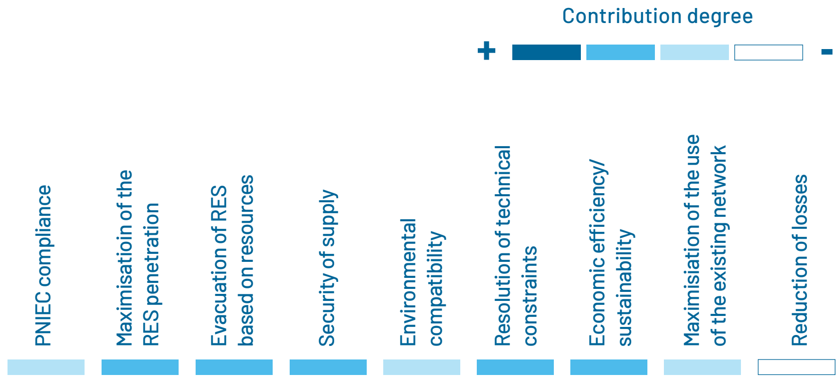
Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:



Investment RDP_ESTE
Starting grid **Valencian Community and Murcia**

Table of physical units:

	220 kV	400 kV
Bays (units)	17	17
Overhead line (km)	4	42
Cables (km)	31	
Uprating (km)		63

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

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

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Ayora 400 kV	2	Conv.	TN	2023
Beniferri 220 kV	1	GIS	TN	2019
Campos 400 kV	1	Conv.	Gen./Sto.	2023
Campos 400 kV	4	Conv.	TN	2023
Castalla 220 kV	1	Conv.	SuD	2022
Castalla 220 kV	3	Conv.	TN	2022
Cofrentes 400 kV	1	Conv.	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	Conv.	Rail.	2021
Montesa 400 kV	4	Conv.	TN	2021
Morella 400 kV	1	Conv.	Gen./Sto.	2023
Totana 400 kV	1	Conv.	Gen./Sto.	2023
Totana 400 kV	1	Conv.	TN	2023

Investment RDP_ESTE
Starting grid **Valencian Community and Murcia**

Detailed list of investments (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	1,745	1,470	0.3	Line	RES	2023
I/O in Castalla, of Novelda - Benejama 220 kV, circuit 1	460	300	2	Line	SuD	2022
I/O in El Serrallo, of El Ingenio - La Plana 220 kV, circuit 1	460	310	2	Cable	SuD	2022
I/O in Elda, of Benejama - El Petrel 220 kV, circuit 1	460	380	5	Cable	SuD	2022
I/O in Montesa, of Catadau - Benejama 400 kV, circuit 1	1,670	1,490	0.6	Line	Rail.	2021

Notes:
1. Decommissioning of the current Ayora-Cofrentes 400kV is required.

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

Investment INT_ESP-POR

International interconnections **Northern Spain-Portugal**

General description:

The project consists of a new 400 kV interconnection between Spain and Portugal together with the associated internal reinforcements in Spain for integration into the existing network:

- New input-output at the new Beariz 400 kV substation on the Cartelle-Mesón do Vento 2 400 kV line.
- New Fontefría 400/220 kV substation with new 600 MVA transformer 1 Fontefría 400/220 kV.
- New double circuit Beariz- Fontefría 400 kV.
- New Fontefría 400 kV-Portuguese border line.

Drivers / Objectives:

- To increase the exchange capacity with Portugal available to the Iberian electricity market (MIBEL).
- To contribute to the integration of existing and future renewable energy in the Spanish Mainland, avoiding spillage.
- To improve the level of interconnection in Spain with a view to meeting the targets set by the EU.
- To comply with the intergovernmental agreements of the Madrid Declaration.

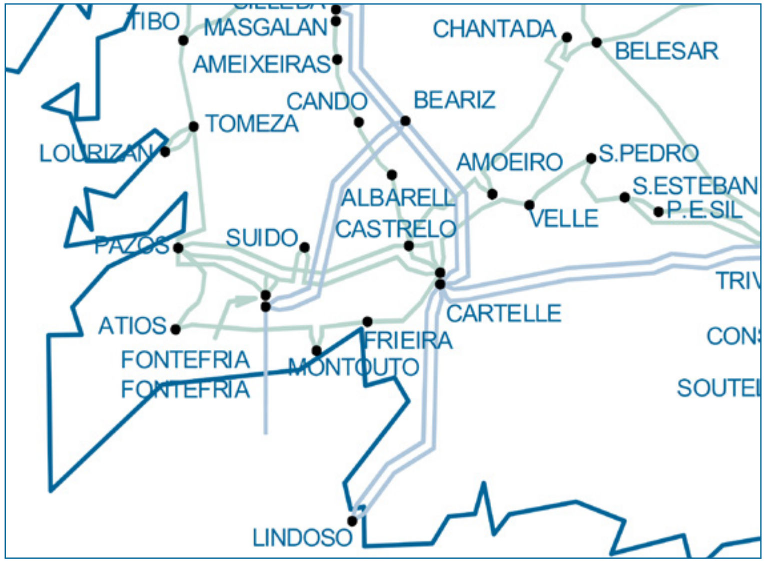
Alternatives:

This investment is presented as the most appropriate reinforcement for an adequate distribution of flows in the Spain-Portugal interconnection. The alternative parallel solutions studied in the Douro area do not allow the expected gains in net transfer capacity. Alternative routes closer to the coast are unfeasible due to a higher social and environmental impact, and underwater routes present a much higher investment cost.

European dimension:

Yes / TYNDP 2020 Project 4 and PIC Project 2.17 in 2019 list.

Map:



PLAN H2021-2026

	Substations	Lines	Links
Starting Grid:	● Name	400 kV 220 kV 132 kV 66 kV 30 kV	400 kV 132 kV 30 kV

Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment INT_ESP-POR

International interconnections **Northern Spain-Portugal**

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
51.2 M€	0.82 M€/year

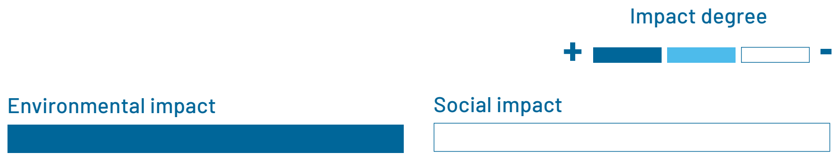
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	5.0	4.9	4.8	4.7	4.7	4.6	4.5	4.5	4.4

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

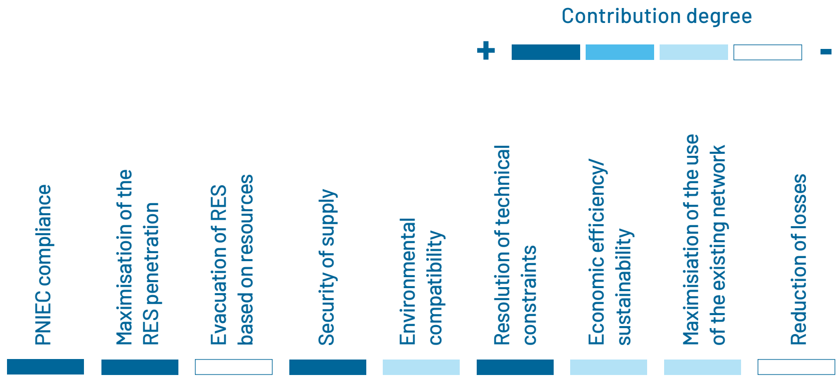
Profitability:

Profitability: NPV
365 M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment INT_ESP-POR
International interconnections **Northern Spain-Portugal**

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 investment 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 right of way kilometres.

Detailed list of investments:

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	Conv.	TN	2024
Fontefría 220 kV	2	Conv.	TN	2024
Fontefría 400 kV	6	Conv.	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 - Portuguese border 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 overhead lines of the first circuit.

New transformers	MVA	Type	Driv.	Year
Fontefría 400/220 kV, TF1	600	Triph. B.	INT	2024

I Investment RDL

RES integration and resolution of technical constraints **Connection of renewables**

General description: The investment includes all the extensions planned when granting access in accordance with the fourth additional provision of RDL15/2018 (until 31 May 2020).

Drivers / Objectives: Generation or storage connections in existing substations or substations already planned in the 2015-2020 Planning.

Alternatives: The investments in the starting grid and possible alternatives were evaluated in the process of drawing up the 2015-2020 Transmission Network Development Plan or have been planned through the provisions of the fourth additional provision of RDL 15/2018.

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
43 M€	11.2 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	14.7	14.6	14.6	14.5	14.4	14.4	14.3	14.3	14.2

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

Investment RDL

RES integration and resolution of technical constraints **Connection of renewables**

Cost-Benefit Multi-Criteria Analysis

Profitability:

Profitability: NPV

- M€

Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -

PNIEC compliance

Maximisatioin of the RES penetration

Evacuation of RES based on resources

Security of supply

Environmental compatibility

Resolution of technical constraints

Economic efficiency/ sustainability

Maximisation of the use of the existing network

Reduction of losses

Table of physical units:

	66 kV	132 kV	220 kV	400 kV
Bays (units)	9	6	160	118

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	Units	Type.	Driv.	Year
Abades 400 kV	1	Conv.	TN	2024
Abades 400 kV	1	Conv.	Gen./Sto.	2024
Abegondo 220 kV	1	Conv.	Gen./Sto.	2024
Abona 220 kV	1	GIS	TN	2023
Abona 220 kV	1	GIS	Gen./Sto.	2023
Aceca 220 kV	1	Conv.	SuD	2023
Aena (Madrid) 220 kV	1	GIS	Gen./Sto.	2023
Aguayo 400 kV	1	Conv.	Gen./Sto.	2023
Alarcos 220 kV	1	Conv.	Gen./Sto.	2023
Albatarrec 220 kV	1	GIS	Gen./Sto.	2022
Alcocero de Mola 220 kV	1	Conv.	Gen./Sto.	2023
Aldaia 220 kV	1	GIS	Gen./Sto.	2023
Algete 220 kV	1	GIS	Gen./Sto.	2023
Alhaurín 220 kV	1	Conv.	Gen./Sto.	2023

I Investment RDL

RES integration and resolution of technical constraints **Connection of renewables**

Detailed list of investments (continued):

Substation extension (continued)	Units	Type.	Driv.	Year
Almaraz CN 400 kV	1	Conv.	Gen./Sto.	2021
Almaraz ET 220 kV	1	Conv.	Gen./Sto.	2023
Almendrales 400 kV	1	Conv.	Gen./Sto.	2023
Anchuelo 220 kV	1	Conv.	Gen./Sto.	2022
Anchuelo 400 kV	1	Conv.	Gen./Sto.	2022
Andújar 220 kV	1	Conv.	Gen./Sto.	2023
Anoia 220 kV	1	GIS	Gen./Sto.	2023
Arbillera 220 kV	1	Conv.	Gen./Sto.	2023
Arbillera 400 kV	1	Conv.	TN	2023
Arbillera 400 kV	1	Conv.	Gen./Sto.	2023
Archidona 400 kV	1	Conv.	TN	2023
Archidona 400 kV	1	Conv.	Gen./Sto.	2023
Ardoz 220 kV	1	GIS	Gen./Sto.	2023
Arenas de San Juan 220 kV	1	Conv.	Gen./Sto.	2021
Arganda 220 kV	1	GIS	Gen./Sto.	2023
Arroyo de la Vega 220 kV	1	Conv.	Gen./Sto.	2023
Ascó 400 kV	1	Conv.	Gen./Sto.	2023
Atarfe 220 kV	1	Conv.	Gen./Sto.	2023
Ayora 400 kV	1	Conv.	TN	2023
Ayora 400 kV	1	Conv.	Gen./Sto.	2023
Balsicas 220 kV	1	GIS	Gen./Sto.	2023

Substation extension (continued)	Units	Type.	Driv.	Year
Barcina 400 kV	1	Conv.	Gen./Sto.	2023
Beariz 400 kV	1	Conv.	TN	2022
Beariz 400 kV	1	Conv.	Gen./Sto.	2022
Bechi 220 kV	1	GIS	Gen./Sto.	2023
Begues 400 kV	1	Conv.	Gen./Sto.	2023
Belesar 220 kV	1	Conv.	Gen./Sto.	2023
Belinchón 400 kV	1	Conv.	Gen./Sto.	2022
Benadresa 220 kV	1	GIS	Gen./Sto.	2023
Benahavis 220 kV	1	GIS	Gen./Sto.	2023
Benejama 220 kV	1	Conv.	Gen./Sto.	2023
Berja 220 kV	1	Conv.	Gen./Sto.	2023
Bernat 220 kV	1	Conv.	Gen./Sto.	2023
Boadilla 220 kV	1	GIS	Gen./Sto.	2023
Brazatortas 220 kV	1	Conv.	Gen./Sto.	2023
Brovales 400 kV	1	Conv.	Gen./Sto.	2021
Buenavista 220 kV	1	GIS	Gen./Sto.	2023
Cabra 400 kV	1	Conv.	Gen./Sto.	2023
Camino de Fregacedos 220 kV	1	GIS	Gen./Sto.	2023
Can Jardi 220 kV	1	Conv.	Gen./Sto.	2023
Caparacena 400 kV	1	Conv.	Gen./Sto.	2023
Cariñena 400 kV	1	Conv.	Gen./Sto.	2022

Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

I Investment RDL

RES integration and resolution of technical constraints **Connection of renewables**

I Detailed list of investments (continued):

Substation extension (continued)	Units	Type.	Driv.	Year
Carmona 220 kV	1	GIS	Gen./Sto.	2025
Cártama 220 kV	1	GIS	Gen./Sto.	2023
Cártama 400 kV	1	Conv.	Gen./Sto.	2023
Cartujos 220 kV	1	Conv.	Gen./Sto.	2023
Casares NP 220 kV	1	GIS	Gen./Sto.	2023
Castalla 220 kV	1	Conv.	Gen./Sto.	2022
Castejón 400 kV	1	Conv.	Gen./Sto.	2023
Castellar de La Frontera 400 kV	1	Conv.	Gen./Sto.	2022
Castellet 220 kV	1	Conv.	Gen./Sto.	2023
Catadau 400 kV	1	Conv.	Gen./Sto.	2023
Chucena 220 kV	1	Conv.	Gen./Sto.	2022
Cisneros 220 kV	1	GIS	Gen./Sto.	2024
Cofrentes 400 kV	1	Conv.	Gen./Sto.	2023
Cofrentes 400 kV	1	Conv.	TN	2023
Complutum 220 kV	1	GIS	Gen./Sto.	2023
Compostilla 220 kV	1	Conv.	Gen./Sto.	2023
Compostilla 400 kV	1	GIS	TN	2023
Compostilla 400 kV	1	GIS	Gen./Sto.	2023
Constanti 220 kV	1	Conv.	Gen./Sto.	2023
Cordovilla 220 kV	1	Conv.	Gen./Sto.	2023
Cristóbal Colon 220 kV	1	GIS	Gen./Sto.	2023

Substation extension (continued)	Units	Type.	Driv.	Year
Daganzo 220 kV	1	GIS	Gen./Sto.	2023
Dos Hermanas 220 kV	1	Conv.	Gen./Sto.	2023
Dragonera 132 kV	1	Conv.	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	Conv.	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	Conv.	Gen./Sto.	2023
Elche 220 kV	1	GIS	Gen./Sto.	2023
Elda 220 kV	1	GIS	Gen./Sto.	2023
Entrenúcleos 220 kV	1	Conv.	Gen./Sto.	2023
Escatrón 220 kV	1	Conv.	Gen./Sto.	2023
Escatrón 400 kV	1	Conv.	Gen./Sto.	2023
Esquedas 220 kV	1	Conv.	Gen./Sto.	2023
Fargue 220 kV	1	GIS	Gen./Sto.	2023
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	Conv.	TN	2023
Fuencarral 400 kV	1	Conv.	Gen./Sto.	2023

I Investment RDL
RES integration and resolution of technical constraints **Connection of renewables**

I Detailed list of investments (continued):

Substation extension (continued)	Units	Type.	Driv.	Year
Fuendetodos 400 kV	1	GIS	Gen./Sto.	2023
Fuenlabrada 220 kV	1	GIS	Gen./Sto.	2023
Fuentes de La Alcarria 400 kV	1	Conv.	Gen./Sto.	2023
Galapagar 220 kV	1	Conv.	Gen./Sto.	2023
Garoña 220 kV	1	Conv.	Gen./Sto.	2023
Garraf 400 kV	1	Conv.	Gen./Sto.	2023
Gatica 220 kV	1	Conv.	Gen./Sto.	2023
Gatica 400 kV	1	Conv.	Gen./Sto.	2023
Gaussa 400 kV	1	GIS	Gen./Sto.	2023
Gazules 220 kV	1	GIS	Gen./Sto.	2023
Godelleta 220 kV	1	Conv.	Gen./Sto.	2023
Godelleta 400 kV	1	Conv.	Gen./Sto.	2023
Granadilla 220 kV	1	GIS	Gen./Sto.	2023
Granadilla 220 kV	1	GIS	TN	2023
Grijota 400 kV	1	Conv.	Gen./Sto.	2023
Guadame 220 kV	1	Conv.	Gen./Sto.	2022
Guadame 400 kV	1	Conv.	TN	2023
Guadame 400 kV	1	Conv.	Gen./Sto.	2023
Guillena 220 kV	1	Conv.	Gen./Sto.	2023
Guillena 400 kV	1	Conv.	Gen./Sto.	2023
Guillena 400 kV	1	Conv.	TN	2023

Substation extension (continued)	Units	Type.	Driv.	Year
Haro 220 kV	1	GIS	Gen./Sto.	2023
Herrera 400 kV	1	Conv.	Gen./Sto.	2023
Herrera 400 kV	1	Conv.	TN	2023
Inca 66 kV	1	Conv.	Gen./Sto.	2023
Isona 220 kV	1	Conv.	Gen./Sto.	2025
Isona 400 kV	1	Conv.	Gen./Sto.	2025
Jordana 220 kV	1	GIS	Gen./Sto.	2022
Jordana 400 kV	1	GIS	Gen./Sto.	2023
Jose María de Oriol NP 220 kV	1	Conv.	Gen./Sto.	2021
La Cereal 400 kV	1	Conv.	Gen./Sto.	2023
La Eliana 400 kV	1	Conv.	Gen./Sto.	2023
La Espluga 220 kV	1	Conv.	Gen./Sto.	2023
La Farga 220 kV	1	GIS	Gen./Sto.	2023
La Fortuna 220 kV	1	Conv.	Gen./Sto.	2023
La Lomba 220 kV	1	Conv.	Gen./Sto.	2023
La Oliva 132 kV	1	GIS	TN	2023
La Oliva 132 kV	1	GIS	Gen./Sto.	2023
La Plana 400 kV	1	Conv.	TN	2023
La Plana 400 kV	1	Conv.	Gen./Sto.	2023
La Pobla 220 kV	1	Conv.	Gen./Sto.	2023
La Serna 400 kV	1	Conv.	Gen./Sto.	2023

I Investment RDL
RES integration and resolution of technical constraints **Connection of renewables**

I Detailed list of investments (continued):

Substation extension (continued)	Units	Type.	Driv.	Year
La Solana 220 kV	1	GIS	Gen./Sto.	2023
La Torrecilla 220 kV	1	Conv.	Gen./Sto.	2023
Las Breñas 66 kV	1	GIS	Gen./Sto.	2025
Las Breñas 66 kV	1	GIS	TN	2025
Leganés 220 kV	1	Conv.	Gen./Sto.	2023
Loeches 400 kV	1	Conv.	Gen./Sto.	2023
Los Arenales 220 kV	1	Conv.	Gen./Sto.	2022
Los Leones 220 kV	1	GIS	Gen./Sto.	2023
Los Montes 220 kV	1	Conv.	Gen./Sto.	2023
Los Montes 220 kV	1	Conv.	TN	2023
Los Pradillos 220 kV	1	GIS	Gen./Sto.	2022
Lousame 220 kV	1	Conv.	Gen./Sto.	2023
Lucero 220 kV	1	GIS	Gen./Sto.	2023
Luengos 400 kV	1	Conv.	Gen./Sto.	2023
Magallón 400 kV	1	Conv.	Gen./Sto.	2023
Mangraners 220 kV	1	Conv.	Gen./Sto.	2023
Manzanares 400 kV	1	Conv.	Gen./Sto.	2023
Manzanares 400 kV	1	Conv.	TN	2023
María 220 kV	1	Conv.	Gen./Sto.	2023
Matas Blancas 132 kV	1	GIS	TN	2023
Matas Blancas 132 kV	1	GIS	Gen./Sto.	2023

Substation extension (continued)	Units	Type.	Driv.	Year
Medina del Campo 220 kV	1	Conv.	Gen./Sto.	2023
Meirama 220 kV	1	Conv.	Gen./Sto.	2023
Mercadal 132 kV	1	Conv.	Gen./Sto.	2023
Mesón do Vento 400 kV	1	Conv.	Gen./Sto.	2023
Mezquita 400 kV	1	Conv.	Gen./Sto.	2023
Mirabal 220 kV	1	Conv.	Gen./Sto.	2023
Miranda de Ebro 220 kV	1	Conv.	Gen./Sto.	2023
Moncayo 220 kV	1	Conv.	Gen./Sto.	2023
Montearenas 400 kV	1	Conv.	Gen./Sto.	2023
Montesa 400 kV	1	Conv.	Gen./Sto.	2021
Montesa 400 kV	1	Conv.	TN	2021
Moraleja 220 kV	1	Conv.	Gen./Sto.	2023
Moraleja 400 kV	1	Conv.	Gen./Sto.	2023
Morata 220 kV	1	Conv.	Gen./Sto.	2023
Morata 400 kV	1	Conv.	Gen./Sto.	2023
Morata 400 kV	1	Conv.	TN	2023
Morvedre 220 kV	1	Conv.	Gen./Sto.	2023
Mudarra 400 kV	1	Conv.	Gen./Sto.	2023
Muruarte 220 kV	1	Conv.	Gen./Sto.	2023
Muruarte 400 kV	1	Conv.	TN	2023
Muruarte 400 kV	1	Conv.	Gen./Sto.	2023

I Investment RDL

RES integration and resolution of technical constraints **Connection of renewables**

Detailed list of investments (continued):

Substation extension (continued)	Units	Type.	Driv.	Year
Novelda 220 kV	1	GIS	Gen./Sto.	2023
Olmedilla 220 kV	1	Conv.	Gen./Sto.	2023
Olmedo 400 kV	1	Conv.	Gen./Sto.	2023
Olmedo 400 kV	1	Conv.	TN	2023
Orcoyen 220 kV	1	Conv.	Gen./Sto.	2023
Palencia 220 kV	1	Conv.	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	Conv.	Gen./Sto.	2023
Penedés 220 kV	1	GIS	Gen./Sto.	2023
Peñaflor 220 kV	1	Conv.	Gen./Sto.	2023
Peñaflor 400 kV	1	Conv.	Gen./Sto.	2022
Peñaflor 400 kV	1	Conv.	TN	2022
Peñarrubia 400 kV	1	Conv.	Gen./Sto.	2023
Peñarrubia 400 kV	1	Conv.	TN	2023
Perafort 220 kV	1	Conv.	Gen./Sto.	2023
Pierola 220 kV	1	Conv.	Gen./Sto.	2023
Pierola 400 kV	1	Conv.	Gen./Sto.	2023
Pinar del Rey 220 kV	1	Conv.	Gen./Sto.	2023
Pinar del Rey 400 kV	1	Conv.	Gen./Sto.	2023

Substation extension (continued)	Units	Type.	Driv.	Year
Pinto 220 kV	1	Conv.	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	Conv.	Gen./Sto.	2023
Quintos 220 kV	1	Conv.	Gen./Sto.	2023
Quintos 220 kV	1	Conv.	TN	2023
Renedo 220 kV	1	Conv.	Gen./Sto.	2023
Requena 400 kV	1	Conv.	Gen./Sto.	2023
Ricobayo 220 kV	1	Conv.	Gen./Sto.	2023
Rocío 220 kV	1	GIS	Gen./Sto.	2023
Rojales 220 kV	1	Conv.	Gen./Sto.	2023
Ronda 400 kV	1	Conv.	Gen./Sto.	2023
Rubí 220 kV	1	Conv.	Gen./Sto.	2023
Rubí 400 kV	1	Conv.	Gen./Alm	2023
Rueda de Jalón 400 kV	1	Conv.	Gen./Sto.	2022
Salas 400 kV	1	Conv.	TN	2023
Salas 400 kV	1	Conv.	Gen./Sto.	2023
Saleres 220 kV	1	Conv.	Gen./Sto.	2024
San Pedro del Pinatar 220 kV	1	GIS	Gen./Sto.	2023

I Investment RDL

RES integration and resolution of technical constraints **Connection of renewables**

I Detailed list of investments (continued):

Substation extension (continued)	Units	Type.	Driv.	Year
San Sebastián de los Reyes 220 kV	1	Conv.	Gen./Sto.	2023
San Sebastián de los Reyes 400 kV	1	Conv.	TN	2023
San Sebastián de los Reyes 400 kV	1	Conv.	Gen./Sto.	2023
San Servan 220 kV	1	Conv.	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	Conv.	Gen./Sto.	2023
Santa Engracia 400 kV	1	Conv.	Gen./Sto.	2023
Santa Llogaia 400 kV	1	Conv.	Gen./Sto.	2023
Santa Llogaia 400 kV	1	Conv.	TN	2023
Santa Maria 66 kV	1	GIS	Gen./Sto.	2023
Santiponce 220 kV	1	Conv.	Gen./Sto.	2023
Sax 400 kV	1	Conv.	Gen./Sto.	2023
Sax 400 kV	1	Conv.	TN	2023
Segovia 400 kV	1	Conv.	Gen./Sto.	2023
Silleda 400 kV	1	Conv.	Gen./Sto.	2022
Solorzano 220 kV	1	GIS	Gen./Sto.	2023
Son Orlandis 66 kV	1	Conv.	Gen./Sto.	2023
Son Reus 66 kV	2	Conv.	Gen./Sto.	2023
Tábara 400 kV	1	Conv.	Gen./Sto.	2023

Substation extension (continued)	Units	Type.	Driv.	Year
Tabernas 400 kV	1	Conv.	TN	2023
Tabernas 400 kV	1	Conv.	Gen./Sto.	2023
Tafalla 220 kV	1	Conv.	Gen./Sto.	2023
Tajo de La Encantada 400 kV	1	Conv.	Gen./Sto.	2023
Terrer 400 kV	1	Conv.	Gen./Sto.	2023
Tomeza 220 kV	1	GIS	Gen./Sto.	2022
Tordesillas 400 kV	1	Conv.	Gen./Sto.	2023
Torrejón de Velasco 400 kV	2	Conv.	Gen./Sto.	2025
Torrejón de Velasco 400 kV	1	Conv.	TN	2025
Torrellano 220 kV	1	GIS	Gen./Sto.	2023
Torremendo 400 kV	1	Conv.	Gen./Sto.	2023
Torremendo 400 kV	1	Conv.	TN	2023
Torrijos 220 kV	1	Conv.	Gen./Sto.	2022
Tres Cantos GIS 220 kV	1	GIS	Gen./Sto.	2023
Trevago 220 kV	1	Conv.	Gen./Sto.	2023
Trillo 400 kV	1	Conv.	Gen./Sto.	2022
Trives 220 kV	1	Conv.	Gen./Sto.	2023
Tudela 220 kV	1	Conv.	Gen./Sto.	2023
Valdecarretas 400 kV	1	Conv.	Gen./Sto.	2021
Valdemoro 220 kV	1	Conv.	Gen./Sto.	2023
Vall D'Uxo 220 kV	1	Conv.	Gen./Sto.	2022

I Investment RDL

RES integration and resolution of technical constraints **Connection of renewables**

I Detailed list of investments (continued):

Substation extension (continued)	Units	Type.	Driv.	Year
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	Conv.	Gen./Sto.	2023
Velilla 400 kV	1	Conv.	Gen./Sto.	2023
Venta del Batán 220 kV	1	GIS	Gen./Sto.	2023
Vic 220 kV	1	Conv.	Gen./Sto.	2023
Vilecha 400 kV	1	Conv.	Gen./Sto.	2023
Villalbilla 220 kV	1	Conv.	Gen./Sto.	2023
Villameca 400 kV	1	Conv.	Gen./Sto.	2023
Villanueva de Gallego 220 kV	1	Conv.	Gen./Sto.	2023

Substation extension (continued)	Units	Type.	Driv.	Year
Villarino 220 kV	1	Conv.	Gen./Sto.	2023
Villarino de Conso 220 kV	1	Conv.	Gen./Sto.	2026
Villaviciosa 220 kV	1	Conv.	Gen./Sto.	2023
Villaviciosa 400 kV	1	Conv.	Gen./Sto.	2023
Villaviciosa 400 kV	1	Conv.	TN	2023
Virtus 400 kV	1	Conv.	Gen./Sto.	2023
Vitoria 220 kV	1	Conv.	Gen./Sto.	2023
Vitoria 400 kV	1	Conv.	Gen./Sto.	2023
Xove 400 kV	1	Conv.	Gen./Sto.	2023
Xove 400 kV	1	Conv.	TN	2023
Zamora 220 kV	1	Conv.	Gen./Sto.	2022
Zaratán 220 kV	1	Conv.	Gen./Sto.	2022

I Investment OWNERSHIP
Changes of ownership

General description: The investment includes a series of changes in the ownership of bays in the transmission network in favour of Red Eléctrica de España, as sole transmission manager, specifically in the substations of 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.

Drivers / Objectives:

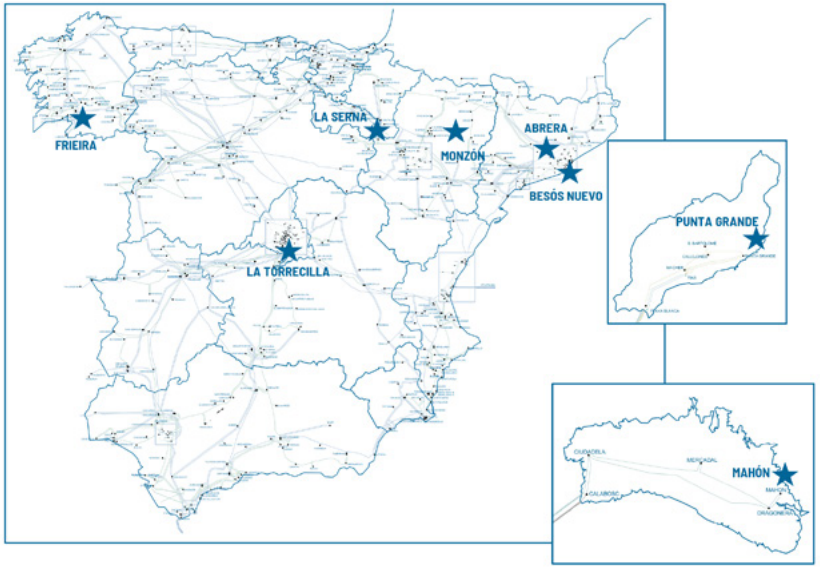
- This investment makes it possible to increase the reliability of transmission network assets and security of supply. The main objective of the changes of ownership is to achieve high availability rates of the transmission network elements thanks to a unified set of criteria for maintenance and equipment renewal, as well as to facilitate decommissioning and other types of interventions.
- The proposed changes of ownership aim to achieve a single complete park in the affected substations, which allows higher availability rates to be achieved by facilitating both unloading and interventions and a single set of criteria for maintenance and renewal of equipment.

Alternatives: The possible alternative is to maintain the current ownership of these bays, which leads to higher rates of unavailability and to a reduction in the security of supply.

As in the case of demand-side supply investments, for consumers directly connected to the transmission network or for reinforcing the transmission network for security of supply, the CBA methodology is difficult to apply when it comes to monetising the benefits of this investment.

European dimension: No

Map:



PLAN H2021-2026

	Substations	Lines	Links
Starting Grid:	Name	400 kV	400 kV
		220 kV	132 kV
		132 kV	30 kV
		66 kV	
		30 kV	

Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment OWNERSHIP
Changes of ownership

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
- M€	0.3 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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV

- M€

Socio-environmental impact:

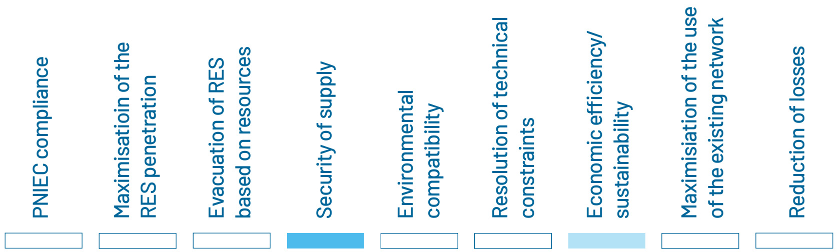
Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -



I Investment OWNERSHIP
Changes of ownership

Table of physical units:

	66 kV	132 kV	220 kV
Bays (units)	1	2	7

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Changes in the ownership of bays	Uds	Type.	Driv.	Year
Abrera 220 kV	1	GIS	TN	2022
Besos Nuevo 220 kV	1	GIS	TN	2021
Frieira 220 kV	1	Conv.	TN	2022
La Serna 220 kV	1	Conv.	TN	2021
La Torrecilla 220 kV	1	GIS	TN	2022
Mahón 132 kV	2	GIS	TN	2021
Monzón 220 kV	2	Conv.	TN	2021
Punta Grande 66 kV	1	Conv.	TN	2021

Annexes

II: NEW INVESTMENTS

TABLE OF CONTENTS

INVESTMENTS FOR THE 2021-2026 TIMEFRAME

Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

151

Investment RdT_RENOVE
Transmission Assets Renewal

General description: Following the analysis of the proposals to renew the transmission network assets submitted by both Red Eléctrica de España and Unión Fenosa, the proposals included in the Network Development Plan are those that have been prioritised in terms of their environmental impact, as well as in terms of their impact on the reliability of supply in the 2026 study scenario. The plan includes both complete renewals with commissioning and decommissioning of transmission network components (cables, substation bays, transformers and reactances) as well as component renewals of lines and substation bays.

Drivers / Objectives:

- To improve the security of supply by increasing the reliability of the components of the transmission network.
- To mitigate the possible environmental impact as a consequence of possible incidents in the network components.

Alternatives: The alternative of delaying the renewal of the components proposed by the transmission companies until later development plans has been assessed, prioritising those renewals for which the delay would have greater environmental impact and on the security of supply of the 2026 study scenario.

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
346.5 M€	1.4 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	29.4	28.9	28.4	27.9	27.5	27.0	26.5	26.0	25.5

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

Investment RdT_RENOVE
Transmission Assets Renewal

Profitability:

Profitability: NPV

- M€

Table of physical units:

	66 kV	220 kV	400 kV
Total renewal of bays (units)	6	13	12
Partial renewal of bays (units)	9	82	47
Partial renewal of overhead lines (km)		462	201
Total renewal of lines/cables (km)	21	30	
Total renewal of 220 kV transformers (MVA)			4,200
Total renewal of reactances (MVAr)			150

Note: The table covers all assets included in the investment 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 right of way kilometres.

Socio-environmental impact:

Impact degree

+ -

Environmental impact

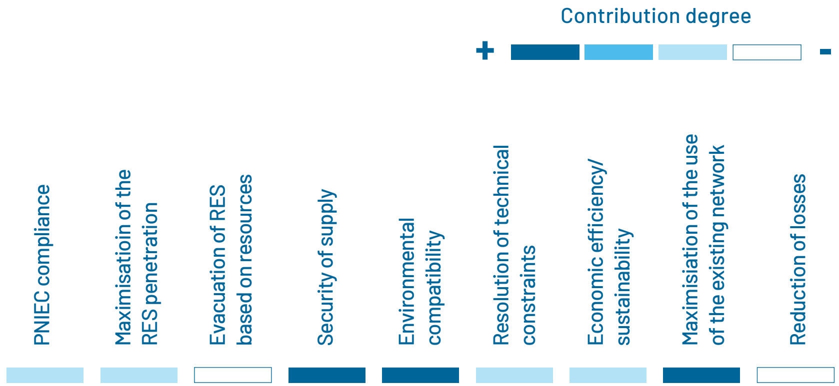
Social impact

Detailed list of investments:

Total renewal of bays	units	Type	Driv.	Year
Chayofa 66 kV [1]	6	Mobile	RenovTN	2025
Litoral 400 kV	12	GIS	RenovTN	2024
Mataporquera 220 kV [2]	6	GIS	RenovTN	2024
Norte 220 kV	7	GIS	RenovTN	2023

Notes:
1. Renewal changed to double-bar GIS configuration.
2. Renewal changed to double-bar GIS configuration.

Contribution to guiding principles:



Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment RdT_RENOVE
Transmission Assets Renewal

Detailed list of investments (continued):

Partial renewal of bays	units	Type	Driv.	Year
Almaraz CN 220 kV	3	Conv.	RenovTN	2022
Almaraz CN 220 kV	4	Conv.	RenovTN	2023
Almaraz CN 400 kV	1	Conv.	RenovTN	2022
Almaraz CN 400 kV	3	Conv.	RenovTN	2023
Ayala 220 kV	1	Conv.	RenovTN	2023
Catadau 400 kV	3	Conv.	RenovTN	2023
Cofrentes 400 kV	6	Conv.	RenovTN	2023
Gatica 220 kV	4	Conv.	RenovTN	2022
Gatica 220 kV	1	Conv.	RenovTN	2023
Gatica 400 kV	6	Conv.	RenovTN	2022
Gatica 400 kV	1	Conv.	RenovTN	2023
Grado 220 kV	1	Conv.	RenovTN	2023
Grijota 400 kV	3	Conv.	RenovTN	2023
Guadame 220 kV	5	Conv.	RenovTN	2022
Guadame 220 kV	3	Conv.	RenovTN	2023
Guadame 400 kV	5	Conv.	RenovTN	2022
Guillena 220 kV	2	Conv.	RenovTN	2022
Guillena 400 kV	6	Conv.	RenovTN	2022
Itxaso 220 kV	5	Conv.	RenovTN	2022
Itxaso 220 kV	7	Conv.	RenovTN	2023
Marratxí 66 kV	3	Conv.	RenovTN	2022

Partial renewal of bays (continued)	units	Type	Driv.	Year
Marratxí 66 kV	6	Conv.	RenovTN	2023
Mediano 220 kV	1	Conv.	RenovTN	2023
Mérida 220 kV	1	Conv.	RenovTN	2022
Mesón do Vento 220 kV	9	Conv.	RenovTN	2022
Mesón do Vento 220 kV	1	Conv.	RenovTN	2023
Moraleja 220 kV	2	Conv.	RenovTN	2022
Pinar del Rey 220 kV	7	Conv.	RenovTN	2023
Pinar del Rey 220 kV	7	Conv.	RenovTN	2022
San Sebastián de los Reyes 220 kV	6	Conv.	RenovTN	2022
Santiponce 220 kV	6	Conv.	RenovTN	2022
Santiponce 220 kV	3	Conv.	RenovTN	2023
Sentmenat 220 kV	1	Conv.	RenovTN	2023
Tajo de la Encantada 400 kV	2	Conv.	RenovTN	2023
Trillo 400 kV	6	Conv.	RenovTN	2023
Vic 400 kV	4	Conv.	RenovTN	2022
Vic 400 kV	1	Conv.	RenovTN	2023
Villaviciosa 220 kV	2	Conv.	RenovTN	2022

Investment RdT_RENOVE
Transmission Assets Renewal

Detailed list of investments (continued):

Total renewal of lines/cables	km (±10%)	Type	Driv.	Year
Aena (Madrid) - Hortaleza 220 kV, circuit 1	1	Cable	RenovTN	2023
Badalona - Canyet 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
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. Conductor installed at 85º.

Partial renewal of lines/cables	km (±10%)	Type	Driv.	Year
Albal - Catadau 220 kV, circuit 1	16	Line	RenovTN	2026
Albal - Torrente 220 kV, circuit 1	3	Line	RenovTN	2023
Alcocero de Mola - Puentelarra 220 kV, circuit 1	40	Line	RenovTN	2025
Alcocero de Mola - Villimar 220 kV, circuit 1	28	Line	RenovTN	2025
Aldaia - Quart de Poblet 220 kV, circuit 1[1]	3	Line	RenovTN	2023
Aldaia - Torrente 220 kV, circuit 1[2]	9	Line	RenovTN	2026

Partial renewal of lines/cables (continued)	km (±10%)	Type	Driv.	Year
Arkale - French border 220 kV, circuit 1	9	Line	RenovTN	2023
Bechi - La Plana 220 kV, circuit 1	8	Line	RenovTN	2026
Bechi - Vall D'Uxo 220 kV, circuit 1	13	Line	RenovTN	2025
Elgea - Itxaso 220 kV, circuit 1	47	Line	RenovTN	2025
Godelleta - Torrente 220 kV, circuit 1	1	Line	RenovTN	2024
Güeñes - T de Güeñes 220 kV, circuit 1	11	Line	RenovTN	2025
Guillena - Mérida 220 kV, circuit 1	149	Line	RenovTN	2026
La Eliana - Morvedre B 220 kV, circuit 1[3]	18	Line	RenovTN	2026
Maials - Mequinenza 400 kV, circuit 1	20	Line	RenovTN	2026
Maials - Rubí 400 kV, circuit 1	132	Line	RenovTN	2026
Rubí - Viladecans 220 kV, circuit 1	18	Line	RenovTN	2026
Sagunto - Vall D'Uxo 220 kV, circuit 1[4]	16	Line	RenovTN	2026
Valladolid Nuevo - Zaratán 220 kV, circuit 1[5]	5	Line	RenovTN	2023
Vic - French border 400 kV, circuit 1	49	Line	RenovTN	2026
Villalbilla - T de Ayala 220 kV, circuit 1	47	Line	RenovTN	2025
Villalbilla - Villimar 220 kV, circuit 1	23	Line	RenovTN	2025

Notes:
1. Underground section included.
2. Underground section included.
3. Underground section included.
4. Underground section included.
5. Underground section included.

Investment RdT_RENOVE
Transmission Assets Renewal

Detailed list of investments (continued):

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 Reactance	MVAr	Type	Driv.	Year
Herrera 400 kV, REA2	150	-	RenovTN	2024

Investment AUT24

Operational requirements

Service replenishment plan: 24 hour autonomy requirement

General description: The proposed investment will provide 100-200 kVA generator sets with 24-hour autonomy in:

- substations deemed essential for service restoration without a generator,
- voice communication systems between the system operator and the agents involved in the emergency and restoration plans, owned by the system operator, and
- critical tools of the system operator involved in emergency and restoration plans.

Drivers / Objectives: Adaptation of the transmission network to comply with the European network code, “Network Code Emergency and Restoration”, which regulates emergency and restoration scenarios in the electricity system, enforced on 18 December 2017 and mandatory by 18 December 2022.

Alternatives: The use of batteries has been considered as an alternative. 48 Volt batteries have been discarded due to incompatibility with existing installations. 125 Volt batteries and 125 Volt/48 Volt converters have likewise been discarded due to their higher cost and the need to change complete equipment and systems in 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 investments that may be scheduled beyond 2026.

Investment AUT24
Operational requirements
Service replenishment plan: 24 hour autonomy requirement

Profitability:

Profitability: NPV

- M€

Table of physical units:

	220 kV	400 kV
24 hour autonomy equipment (units)	172	448

Note: The table covers all assets included in the investment 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 right of way kilometres.

Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Detailed list of investments:

24 hour autonomy equipment	units	Driv.	Year
Spanish Mainland 220 kV	172	N_SO	2022
Spanish Mainland 400 kV	448	N_SO	2022

Contribution to guiding principles:

Contribution degree + -

PNIEC compliance
Maximisatioin of the RES penetration
Evacuation of RES based on resources
Security of supply
Environmental compatibility
Resolution of technical constraints
Economic efficiency/ sustainability
Maximisiation of the use of the existing network
Reduction of losses

Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes
158

Investment COMP_ICA

Operational requirements

Support to renewable integration with synchronous condensers

General description: The investment involves the installation of three 25 MVAr synchronous condensers as fully integrated components in the transmission network, in accordance with the provisions set forth in RDL 29/2021, in the Canary Islands systems at the substations Drago 66 kV (Tenerife), Arucas 66 kV (Gran Canaria) and Jares 132 kV (Fuerteventura).

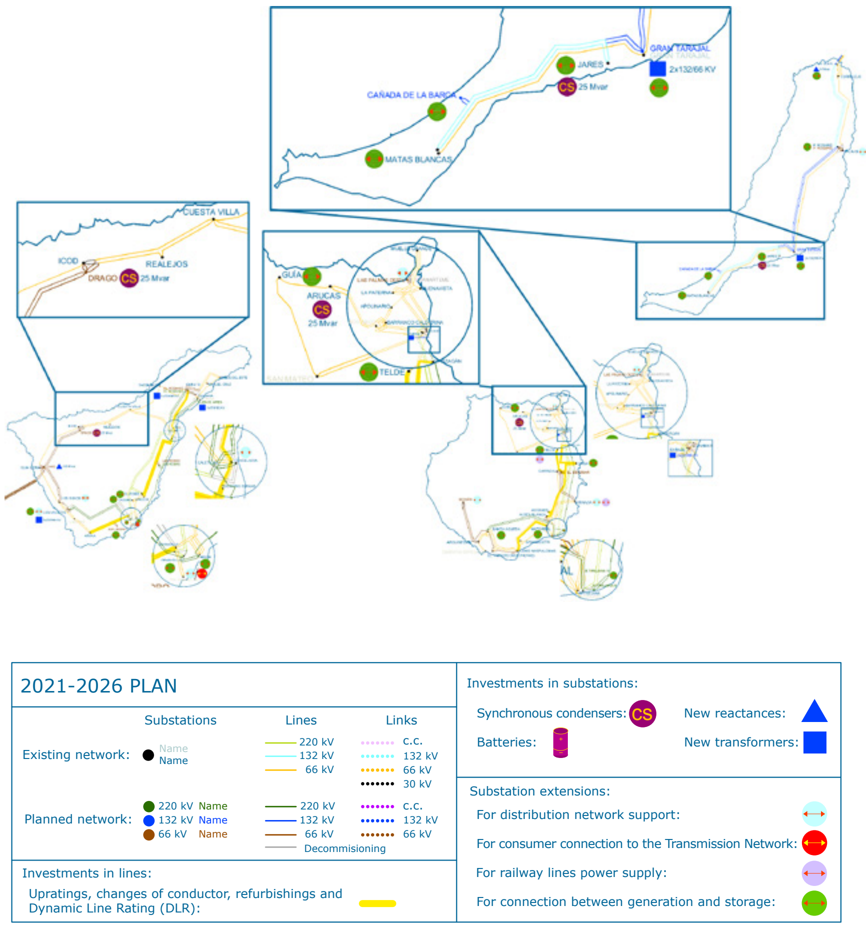
Drivers / Objectives:

- To provide short-circuit capacity to the systems by incorporating short-circuit current supply at additional nodes to those where synchronous energy sources are located.
- To allow greater access capacity to power plant modules by separating the areas of electrical influence by short-circuit capacity.
- To reduce the interaction between the power electronics of the renewable energy sources in the area.

Alternatives: The alternative of not installing these synchronous condensers would imply a limitation of renewable energy sources in virtually all of the islands in which they are connected to ensure security of supply due to the risk of interaction between the power electronics systems of the renewable energy sources.

European dimension: No

Map:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment COMP_ICA
Operational requirements
Support to renewable integration with synchronous condensers

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
43.1 M€	0.97 M€/year

Remuneration costs

Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	4.5	4.4	4.3	4.3	4.2	4.2	4.1	4.0	4.0

Note: For the Tenerife-La Gomera system, a sequential cost-benefit analysis methodology has been implemented. First, the benefit of incorporating synchronous condensers is analysed and then the benefit of the rest of the planned investment is assessed, except for the TF-LG link, the benefit of which is analysed in a final stage, based on the rest of the investment commissioned.

Profitability:

Profitability: NPV
5,034 M€

Socio-environmental impact:

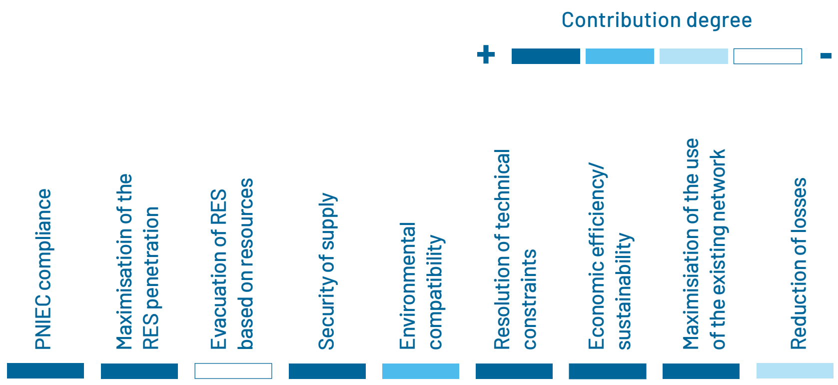
Impact degree

+ -

Environmental impact

Social impact

Contribution to guiding principles:



Investment COMP_ICA

Operational requirements

Support to renewable integration with synchronous condensers

Table of physical units:

	66 kV	132 kV
Bays (units)	2	1
Synchronous condensers (MVAr)	50	25

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Arucas 66 kV	1	Conv.	TN	2024
Drago 66 kV	1	GIS	TN	2024
Jares 132 kV	1	GIS	TN	2024

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

Investment DESP_TELE

Operational requirements **Tele-control systems and control centres**

General description: The proposed investment involves the installation of tele-control systems and control centres, and their telecommunications needs. The purpose of these investments is to guarantee the operational capacity of the installations and of the entire transmission system, ensuring the supply reliability. They include Tele-control of new bays, telecommunications systems, tele-control and security systems and protection systems.

Drivers / Objectives:

- To remotely control the transmission network installations by integrating them into the centralised dispatching system to enable the management, communication, and control of these assets.
- Digitalisation of transmission networks to enable more efficient and secure technologies.
- Updating protection systems with analogue technology, thus avoiding shortages in the supply of spare parts, as well as insufficient technical support from manufacturers.

Alternatives: The new planned bays should be managed from the control centres, with an alternative of local control, which implies higher costs and security of supply risks. In the case of the rest of the protection and telecommunications systems, failure to update and digitize these systems would result in their progressive deterioration and isolation problems in case of network failures.

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 investments that may be scheduled beyond 2026.

Investment DESP_TELE

Operational requirements **Tele-control systems and control centres**

Profitability:

Profitability: NPV

- M€

Socio-environmental impact:

Impact degree

+ -

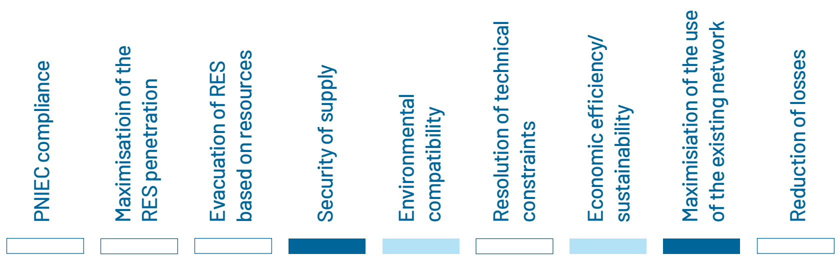
Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree

+ -



Detailed list of investments:

Tele-control and systems control centres	(M€)	Driv.	Year
Tele-control systems and control centres	33.6	N_SO	2021
Tele-control systems and control centres	45.6	N_SO	2022
Tele-control systems and control centres	44.1	N_SO	2023
Tele-control systems and control centres	36.6	N_SO	2024
Tele-control systems and control centres	36.5	N_SO	2025
Tele-control systems and control centres	35.5	N_SO	2026

Investment FACTS

Operational requirements **Transmission network support with FACTS**

General description: The proposed investment involves incorporating equipment based on power electronics to improve the system damping in case of inter-area oscillations. Specifically, it involves the installation of:

- a FACTS equipment at Pierola 400 kV (>2026),
- a 150 MVAr STATCOM at Tabernas 220 kV,
- a 150 MVAr STATCOM at Moraleja 400 kV and
- a 150 MVAr STATCOM at Lousame 220 kV.

Drivers / Objectives:

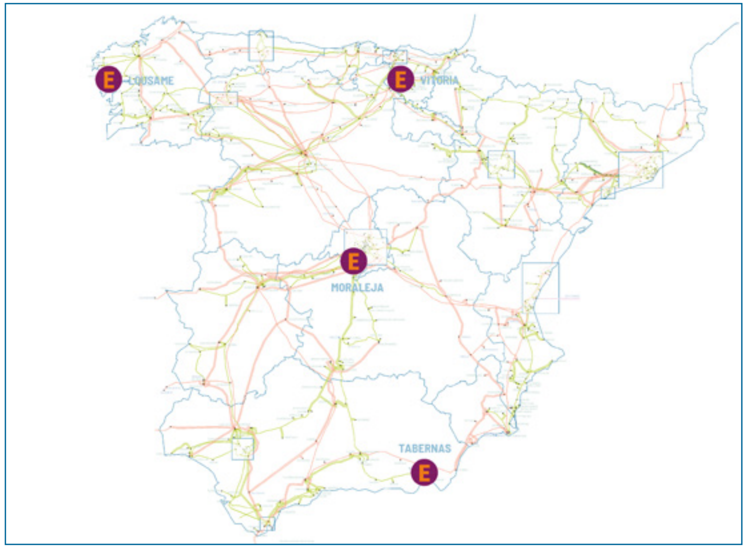
- This equipment improves the damping of inter-area oscillations, which results in increased security of supply for the entire Spanish Mainland system.
- To increase the continuous voltage control capabilities of the system, also increasing security of supply.

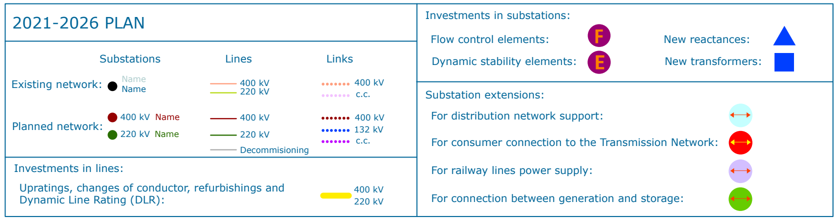
Alternatives: The following alternatives have been evaluated to mitigate inter-area oscillations:

- the implementation of operational measures is insufficient to meet the estimated oscillation needs.
- the installation of power stabilisation equipment in nuclear power plants (generally referred to as PSS) has been evaluated in working groups of the system operator with the nuclear plant managers and finally considered unfeasible.

European dimension: No

Map:





Investment FACTS

Operational requirements **Transmission network support with FACTS**

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
102.2 M€	2.11 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	10.4	10.2	10.1	9.9	9.8	9.7	9.5	9.4	9.2

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

Profitability:

Profitability: NPV

- M€

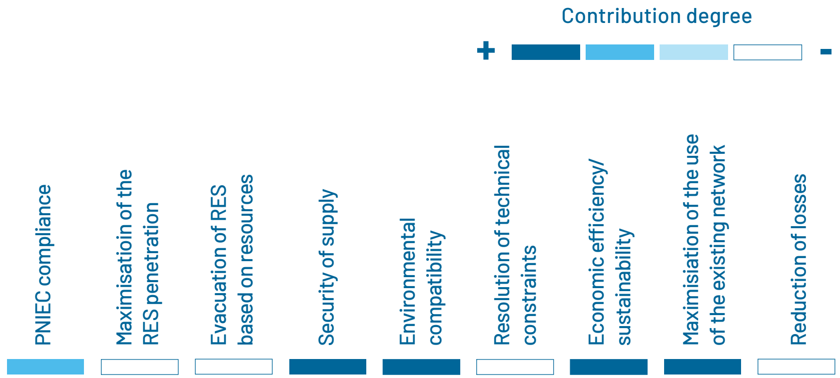
Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:



Investment FACTS
Operational requirements **Transmission network support with FACTS**

Table of physical units:

	220 kV	400 kV
Bays (units)	2	3
STATCOM (units)	2	1
FACTS (units)		1

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Lousame 220 kV	1	Conv.	TN	2026
Moraleja 400 kV	1	Conv.	TN	2025
Pierola 400 kV	2	Conv.	TN	> 2026
Tabernas 220 kV	1	GIS	TN	2024

New FACTs	units	Type	Driv.	Year
Pierola 400 kV[1]	1	-	N_SO	>2026

Notes:
1. Installed above the exit to Vic

New STATCOM	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

Investment PEN_REAS

Operational requirements **Reactances for voltage control in SEPE**

General description: The investment involves the installation of 14 new reactances in the Spanish Mainland system. Specifically, 12 150 MVAr reactances in Silleda, Xove, Solórzano, Almazán, Tábara, Maials, Rubí, Torrejón de Velasco, Fuentes de la Alcarria, Requena, Anchuelo and Carmona 400 kV and two 100 MVAr reactances in Sabón and Viladecans 220 kV.

Drivers / Objectives:

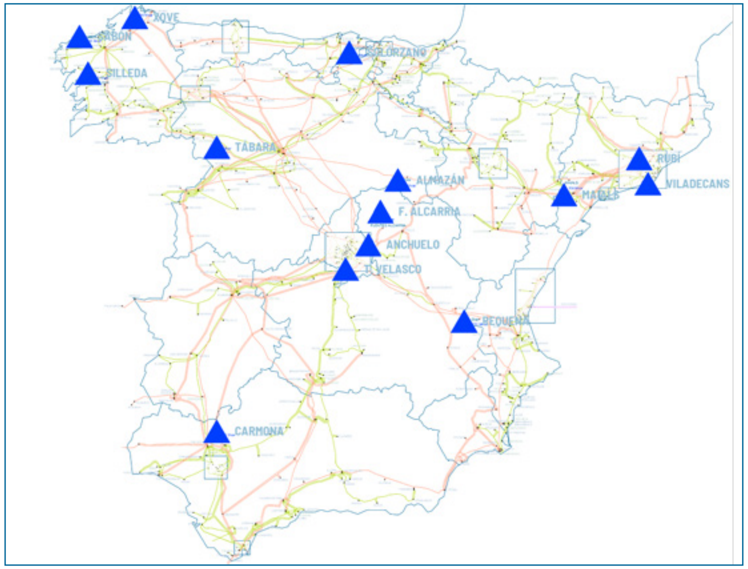
- To improve security of supply through better voltage control, avoiding the occurrence of overvoltage in the transmission network.
- To reduce the additional cost of technical constraints on the daily market due to voltage control. In 2019, the additional cost of technical constraints to the daily market due to voltage control amounted to €96 million and, had this series of reactances been commissioned, the cost would have been reduced to €18 million. The energy re-dispatched for voltage control in the process of technical constraints to the daily market amounted to 2791 GWh and would have been reduced to 606 GWh.
- To allow the integration of a higher quota of renewable energy sources in hours with curtailment.

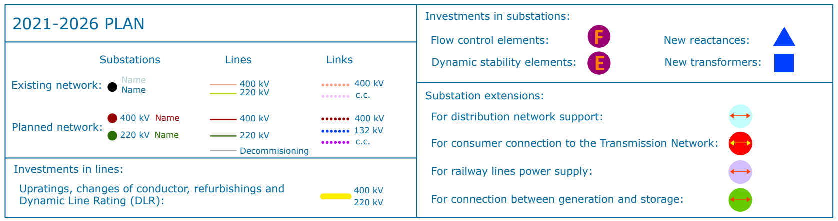
Alternatives:

- A higher number of line openings due to voltage control to maintain adequate voltage levels may result in a reduction in the meshing of the transmission network to unacceptable levels.
- Coupling thermal groups in the area due to technical constraints caused by voltage control is a much more expensive solution and there is not enough geographical distribution for optimal voltage control.

European dimension: No

Map:





Investment PEN_REAS

Operational requirements **Reactances for voltage control in SEPE**

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
52.3 M€	0.7 M€/year

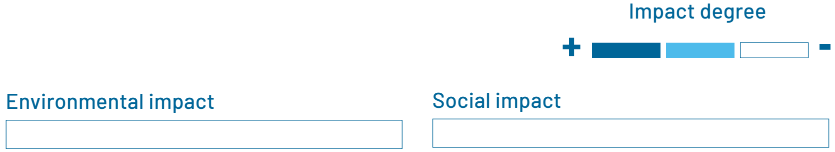
					Remuneration costs					
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	4.9	4.9	4.8	4.7	4.6	4.6	4.5	4.4	4.3

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

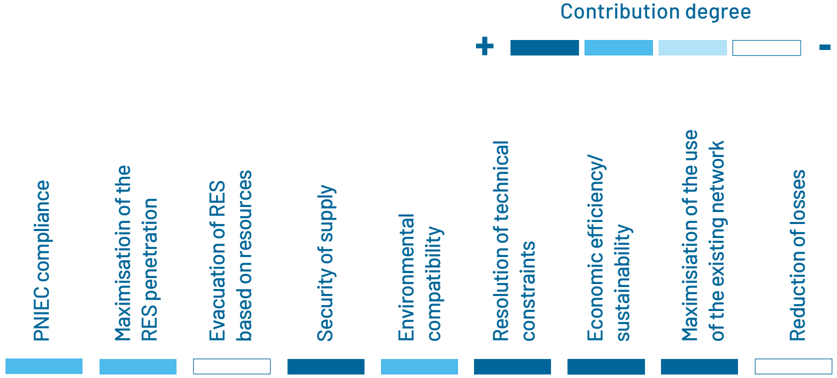
Profitability:

Profitability: NPV
1,486 M€

Socio-environmental impact:



Contribution to guiding principles:



Investment PEN_REAS

Operational requirements **Reactances for voltage control in SEPE**

Table of physical units:

	220 kV	400 kV
Bays (units)	2	13
Reactance (Mvar)	200	1,950

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Almazán 400 kV	1	Conv.	TN	2023
Anchuelo 400 kV	1	Conv.	TN	2023
Carmona 400 kV	1	Conv.	TN	2025
Fuentes de La Alcarria 400 kV	1	Conv.	TN	2023
Maials 400 kV	1	Conv.	TN	2023
Requena 400 kV	1	Conv.	TN	2023
Rubí 400 kV	1	Conv.	TN	2024
Sabón 220 kV	1	GIS	TN	2024
Silleda 400 kV	1	Conv.	TN	2023
Solorzano 400 kV	1	Conv.	TN	2023
Tábara 400 kV	1	Conv.	TN	2024
Torrejón de Velasco 400 kV	1	Conv.	TN	2025

Detailed list of investments (continued):

Substation extension (continued)	units	Type	Driv.	Year
Torrejón de Velasco 400 kV	1	Conv.	TN	> 2026
Viladecans 220 kV	1	Conv.	TN	2023
Xove 400 kV	1	Conv.	TN	2024

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, REA1	100	-	N_SO	2023
Xove 400 kV, REA1	150	-	N_SO	2024

Investment TNP_REAS

Operational requirements **Reactance for voltage control in the Balearic Islands**

General description:

The investment involves changing reactances location to optimise their use as reactive power compensation components in the Balearic Islands' electricity system. Specifically, it involves changing the location of reactances 1 and 2 of 30 MVAr of Cala Mesquida 132 kV and reactance 1 of 30 MVAr of Ciudadela 132 kV to Sta. Ponsa 132 kV.

Drivers / Objectives:

To maintain adequate voltage levels in the Balearic Islands system.

Alternatives:

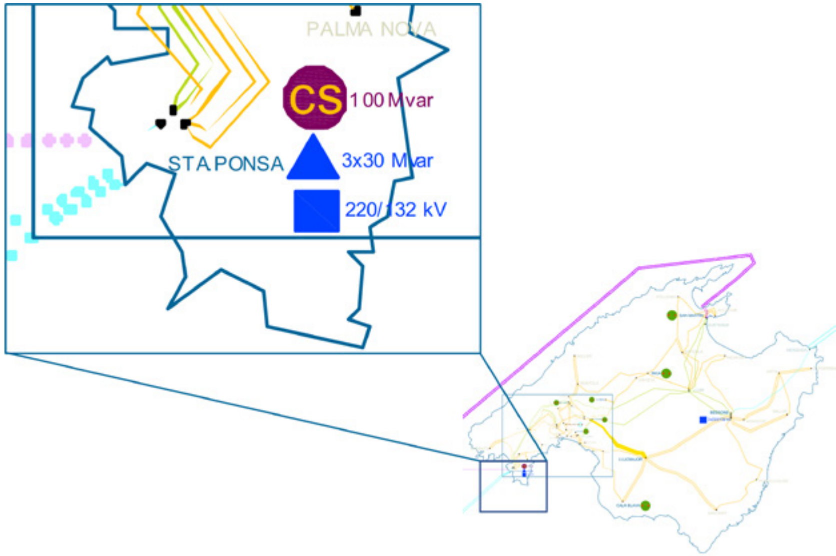
The alternative involving the coupling of additional thermal groups in the area is a more costly solution due to technical constraints caused by voltage control.

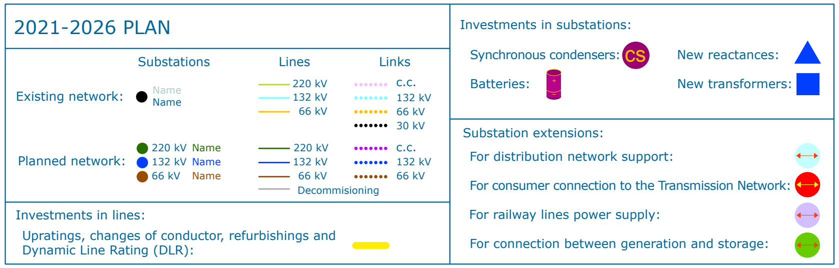
By simulating the weekly scheduling in the Balearic Islands system with and without reactances, i.e., considering these energy sources restrictions, an extra cost of €168,000 per week is estimated to be required in the system, at least 30 weeks per year. Therefore, the annual savings from the reactance transfer would be 5.04 M€/year, which would be achieved in 2024, 2025 and 2026 since, from 2026, the synchronous condenser at Sta. Ponsa 220 kV replaces this functionality.

European dimension:

No

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment TNP_REAS

Operational requirements **Reactance for voltage control in the Balearic Islands**

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
4.6 M€	0.07 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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
94 M€

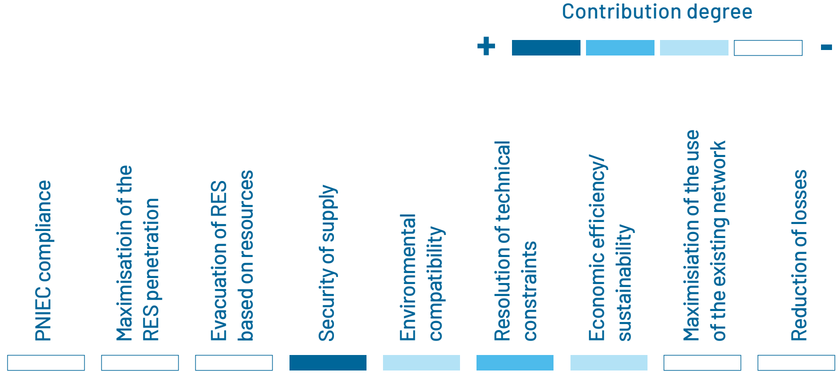
Socio-environmental impact:

Impact degree

+ -

Environmental impact	Social impact

Contribution to guiding principles:



Investment TNP_REAS
Operational requirements **Reactance for voltage control in the Balearic Islands**

Table of physical units:

	132 kV
Bays (units)	3
Cables (km)	0.5
Reactance (Mvar)	90

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Santa Ponsa 132 kV	2	GIS	TN	2022
Santa Ponsa 132 kV	1	GIS	TN	2023

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Santa Ponsa - Santa Ponsa 132 kV, circuit 1			0.3	Cable	N_SO	2022
Santa Ponsa - Santa Ponsa 132 kV, circuit 1			0.2	Cable	N_SO	2023

New reactances	MVAr.	Type	Driv.	Year
Santa Ponsa 132 kV, REA1 [1]	30	-	N_SO	2022
Santa Ponsa 132 kV, REA2 [2]	30	-	N_SO	2022
Santa Ponsa 132 kV, REA3 [3]	30	-	N_SO	2023

Notes:
1. Transfer of REA1 reactance of Mesquida 132 kV a Santa Ponsa 132kV.
2. Transfer of REA2 reactance of Mesquida 132 kV to Santa Ponsa 132kV.
3. Transfer of REA1 reactance of Ciudadela 132 kV to Santa Ponsa 132kV.

Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment AF-01

Railway axis power supply **Bobadilla-Algeciras**

General description:

The investment 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.

Drivers / Objectives:

This investment allows transport electrification, contributing to achieving the objectives set out in the PNIEC.

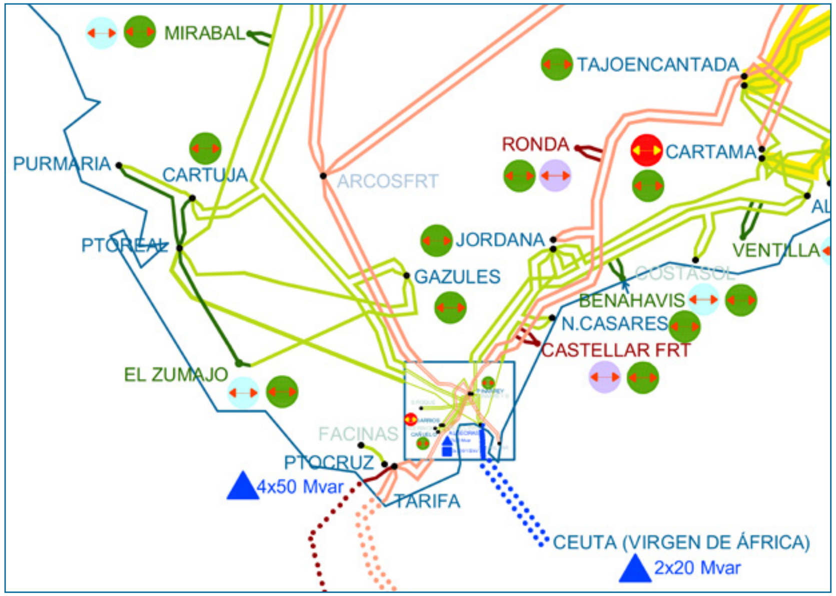
Alternatives:

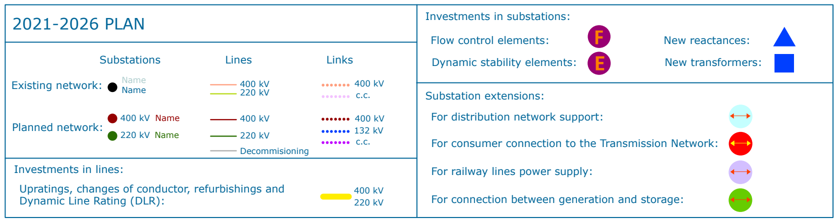
The power supply points to the railway axis have been defined in coordination with ADIF, minimising to the extent possible the distance of the traction substations from existing transmission network infrastructures.

European dimension:

No

Map:





Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment AF-01

Railway axis power supply **Bobadilla-Algeciras**

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
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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV

- M€

Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -

PNIEC compliance

Maximisatioin of the RES penetration

Evacuation of RES based on resources

Security of supply

Environmental compatibility

Resolution of technical constraints

Economic efficiency/ sustainability

Maximisiation of the use of the existing network

Reduction of losses

Investment AF-01
Railway axis 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 investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Ronda 400 kV	Outdoor	2023

Substation extension	units	Type	Driv.	Year
Ronda 400 kV	5	Conv.	TN	2023
Ronda 400 kV	2	Conv.	Rail.	2023

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	1,730	1,420	4	Line	Rail.	2023

Investment AF_02
Railway axis power supply **Burgos-Vitoria**

General description: The investment involves the necessary components for the power supply from the transmission network to the traction substations of the Burgos-Vitoria railway line:

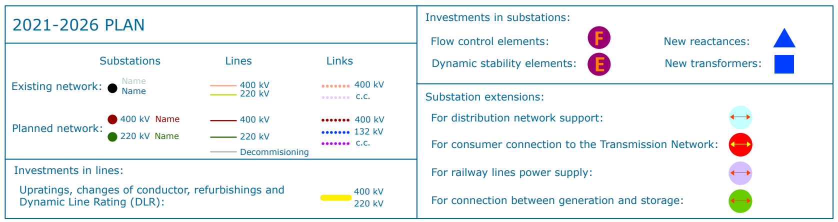
- Briviesca 400 kV substation extension.

Drivers / Objectives: This investment allows transport electrification, contributing to achieving the objectives set out in the PNIEC.

Alternatives: The power supply points for the railway axis have been defined in coordination with ADIF, minimising to the extent possible the distance of the traction substations from existing transmission network infrastructures.

European dimension: No

Map:



Investment AF_02
Railway axis power supply **Burgos-Vitoria**

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
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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
- M€

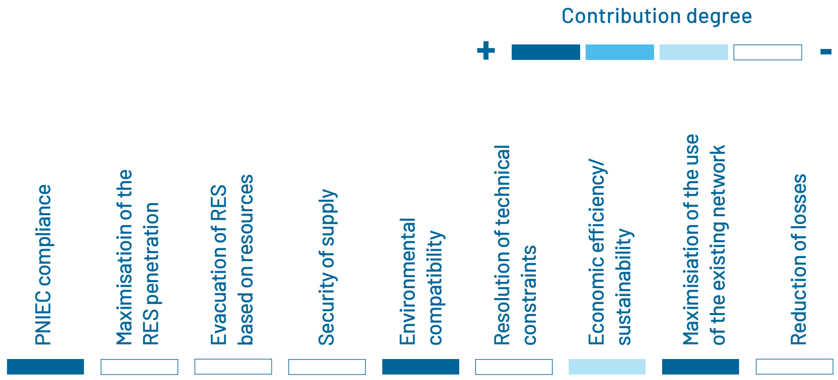
Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:



Investment AF_02

Railway axis power supply **Burgos-Vitoria**

Table of physical units:

	400 kV
Bays (units)	3

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Briviesca 400 kV	1	Conv.	TN	2025
Briviesca 400 kV	2	Conv.	Rail.	2025

I Investment AF_04
Railway axis power supply **Granada-Almería**

I General description:

The investment involves the necessary components for the power supply from the transmission grid to the traction substations of the Granada-Almería railway line:

- New Iznalloz 400 kV substation.
- New input-output at the Iznalloz 400 kV substation on the Caparacena-Baza 400 kV line
- Extension of the Hueneja 400 kV substation
- Extension of the Benahadux 220 kV substation.

I Drivers / Objectives:

This investment enables the transport electrification, contributing to the fulfilment of the objectives set out in the PNIEC.

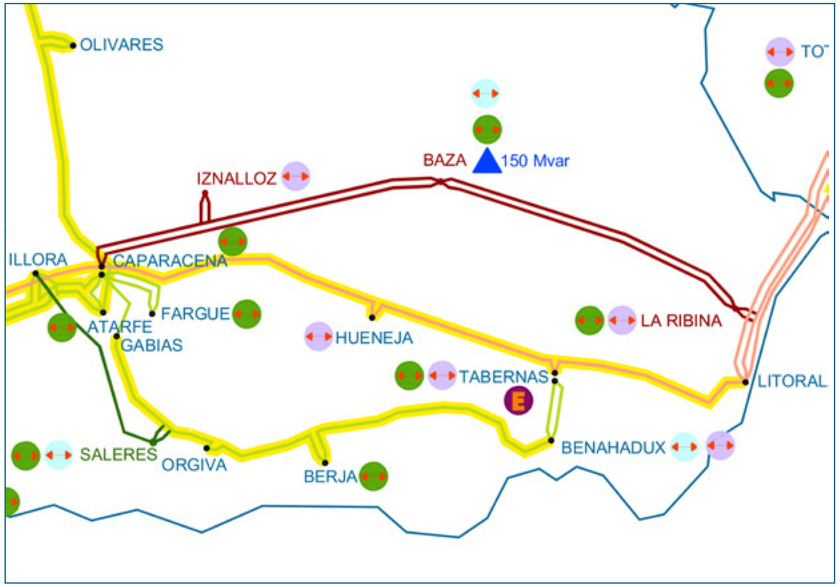
I Alternatives:

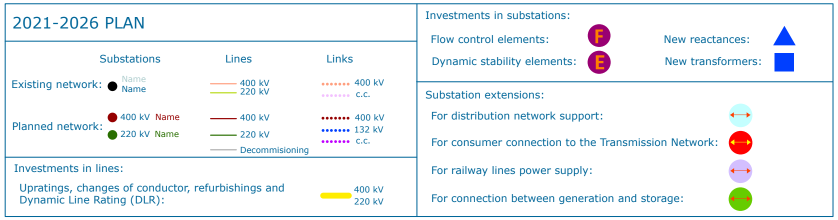
The power supply points to the railway axis have been defined in coordination with ADIF, minimising to the extent possible the distance from the traction substations to existing transmission network infrastructures.

I European dimension:

No

I Map:





Investment AF_04
Railway axis power supply **Granada-Almería**

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
10 M€	0.53 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	1.3	1.3	1.2	1.2

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

Profitability:

Profitability: NPV
- M€

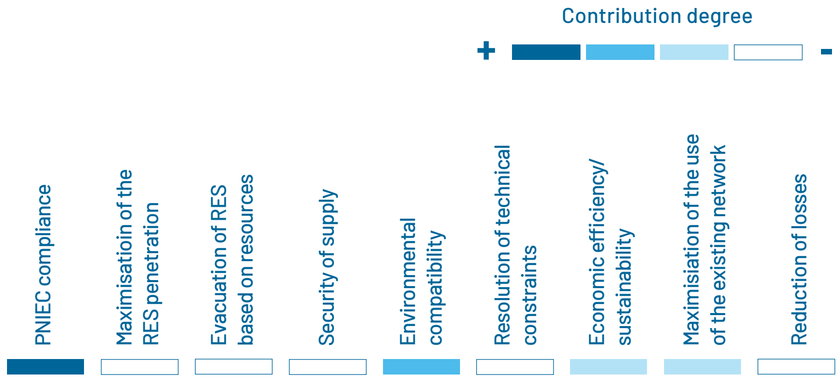
Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:



Investment AF_04
Railway axis power supply **Granada-Almería**

Table of physical units:

	220 kV	400 kV
Bays (units)	2	10
Overhead line (km)		8

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

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	Conv.	Rail.	2024
Hueneja 400 kV	1	Conv.	TN	2024
Iznalloz 400 kV	2	Conv.	Rail.	2024
Iznalloz 400 kV	5	Conv.	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 1	2,370	1,910	4	Line	Rail.	2024

Investment AF_05
Railway axis power supply **Madrid-Albacete-Alicante-Valencia**

General description: The investment involves the necessary components for the power supply from the transmission network to the traction substations of the Madrid-Albacete-Alicante-Valencia railway line:

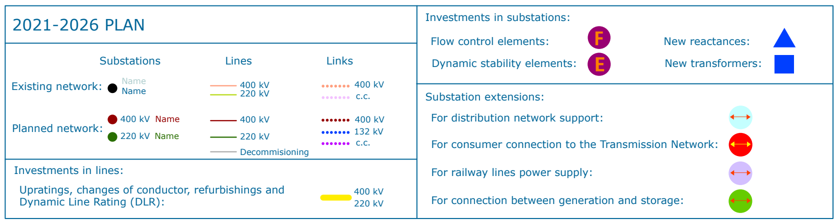
- New Torrejón de Velasco 400 kV substation.
- New input-output at the Torrejón de Velasco 400 kV substation on the Morata-Villaviciosa 400 kV line.

Drivers / Objectives: This investment enables the transport electrification, contributing to the fulfilment of the objectives set out in the PNIEC.

Alternatives: The power supply points to the railway axis have been defined in coordination with ADIF, minimising to the extent possible the distance from the traction substations to existing transmission network infrastructures.

European dimension: No

Map:



Investment AF_05
Railway axis power supply **Madrid-Albacete-Alicante-Valencia**

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
7.9 M€	0.34 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9

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

Profitability:

Profitability: NPV

- M€

Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -

PNIEC compliance

Maximisatioin of the RES penetration

Evacuation of RES based on resources

Security of supply

Environmental compatibility

Resolution of technical constraints

Economic efficiency/ sustainability

Maximisiation of the use of the existing network

Reduction of losses

Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment AF_05
Railway axis power supply **Madrid-Albacete-Alicante-Valencia**

Table of physical units:

	400 kV
Bays (units)	7
Overhead line (km)	4

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Torrejón de Velasco 400 kV	Outdoor	2025

Substation extension	units	Type	Driv.	Year
Torrejón de Velasco 400 kV	2	Conv.	Rail.	2025
Torrejón de Velasco 400 kV	5	Conv.	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	1,810	1,480	2	Line	Rail.	2025

Investment AF_06
Railway axis power supply **Murcia-Almería**

General description: The investment involves the necessary components for the power supply from the transmission grid to the traction substations of the Murcia-Almería railway line:

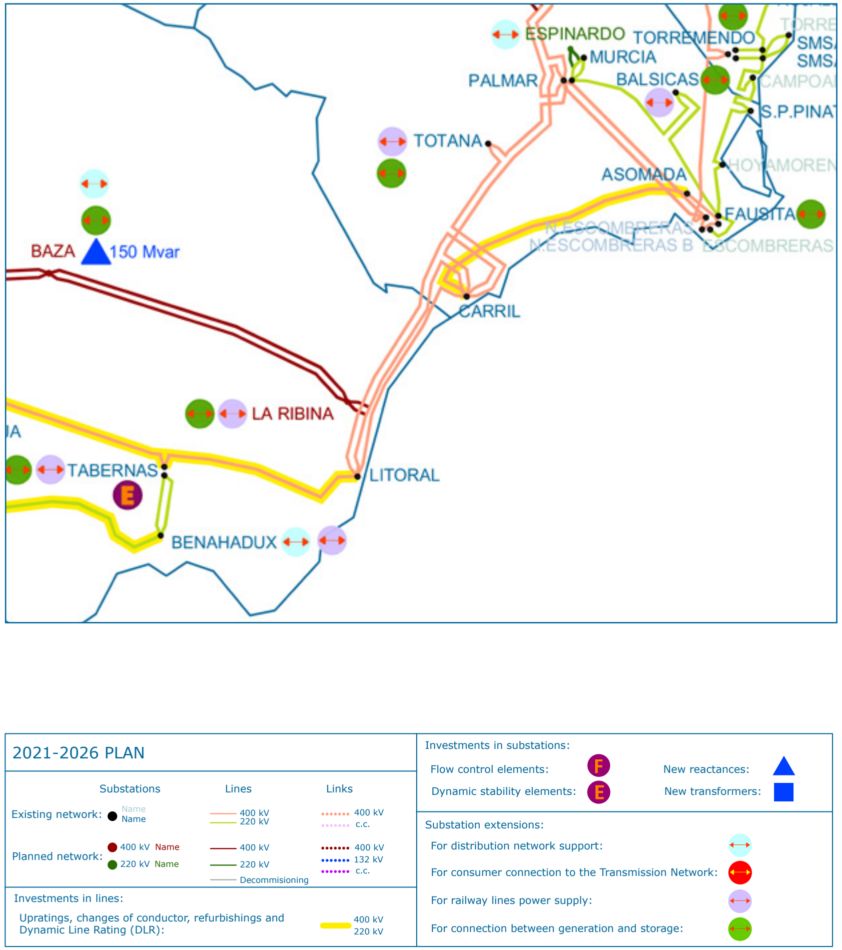
- Totana 400 kV substation extension
- Tabernas 400 kV substation extension
- La Ribina 400 kV substation extension.

Drivers / Objectives: This investment enables the transport electrification, contributing to the fulfilment of the objectives set out in the PNIEC.

Alternatives: The power supply points to the railway axis have been defined in coordination with ADIF, minimising to the extent possible the distance from the traction substations to existing transmission network infrastructures.

European dimension: No

Map:



Investment AF_06
Railway axis power supply **Murcia-Almería**

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
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 investments that may be scheduled beyond 2026.

Profitability:

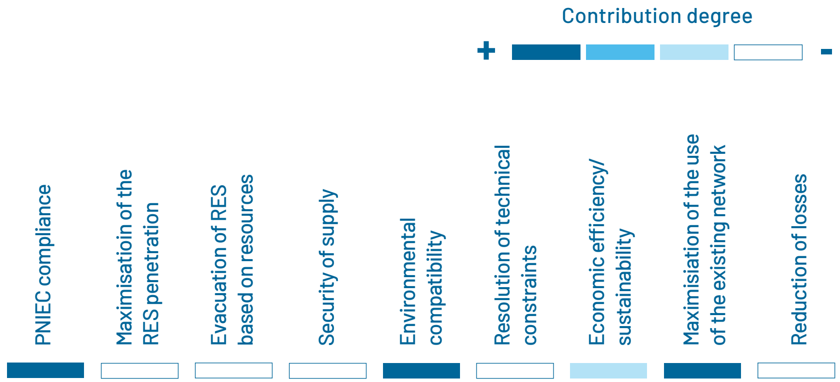
Profitability: NPV
- M€

Socio-environmental impact:

Impact degree + −

Environmental impact	Social impact

Contribution to guiding principles:



Investment AF_06
Railway axis power supply **Murcia-Almería**

Table of physical units:

	400 kV
Bays (units)	9

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
La Ribina 400 kV	2	Conv.	Rail.	2024
La Ribina 400 kV	1	Conv.	TN	2024
Tabernas 400 kV	2	Conv.	Rail.	2023
Tabernas 400 kV	1	Conv.	TN	2023
Totana 400 kV	2	Conv.	Rail.	2020
Totana 400 kV	1	Conv.	TN	2020

Investment AF_07
Railway axis power supply **Murcia-Cartagena**

General description: The investment involves the necessary components for the power supply from the transmission network to the traction substations of the Murcia-Cartagena railway line:

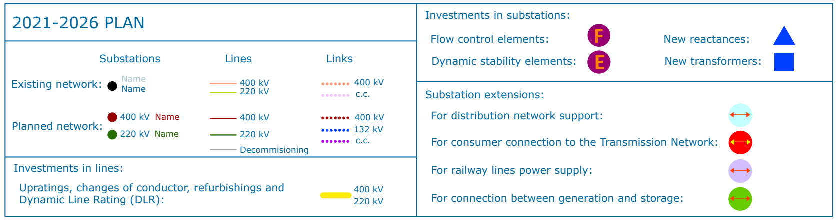
- Extension of Balsicas 220 kV substation.

Drivers / Objectives: This investment enables the transport electrification, contributing to the fulfilment of the objectives set out in the PNIEC.

Alternatives: The power supply points to the railway axis have been defined in coordination with ADIF, minimising to the extent possible the distance from the traction substations to existing transmission network infrastructures.

European dimension: No

Map:



Investment AF_07
Railway axis power supply **Murcia-Cartagena**

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
- 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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
- M€

Socio-environmental impact:

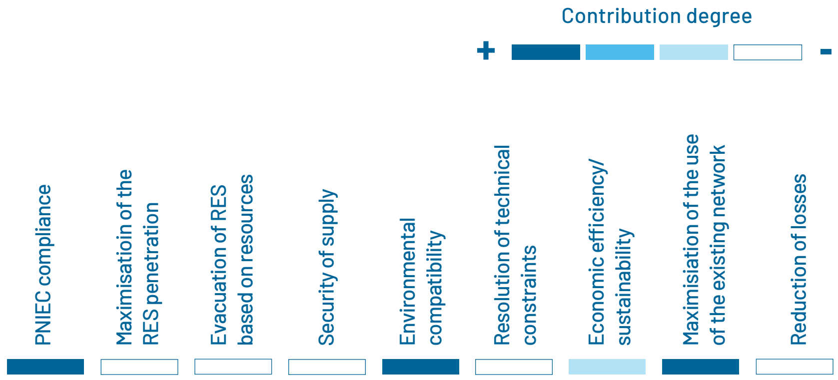
Impact degree

\+ -

Environmental impact

Social impact

Contribution to guiding principles:



Investment AF_07

Railway axis power supply **Murcia-Cartagena**

Table of physical units:

	220 kV
Bays (units)	2

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Balsicas 220 kV	2	GIS	Rail.	2020

Investment AF_08
Railway axis power supply **Palencia-Santander**

General description: The investment involves the necessary components for the power supply from the transmission network to the traction substations of the Palencia-Santander railway line:

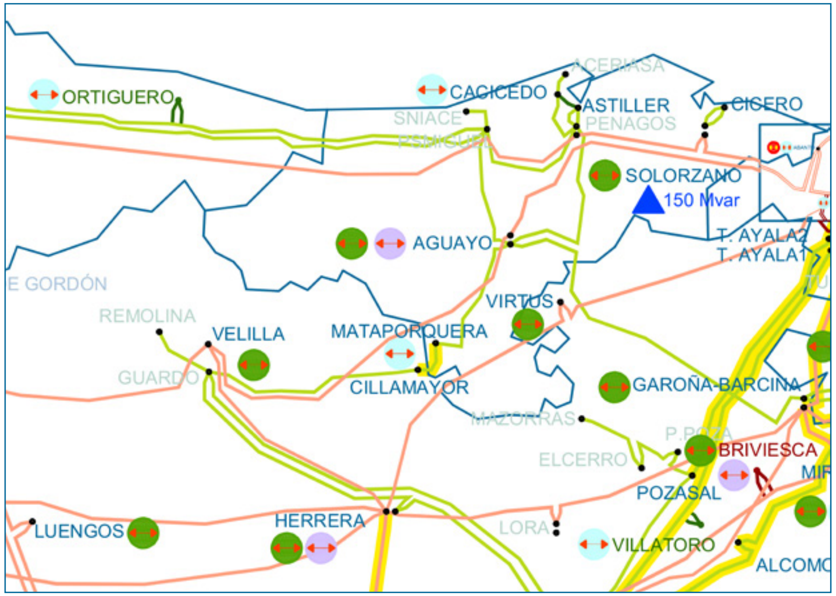
- Extension of Herrera 400 kV substation.
- Extension of the Aguayo 400 kV substation.

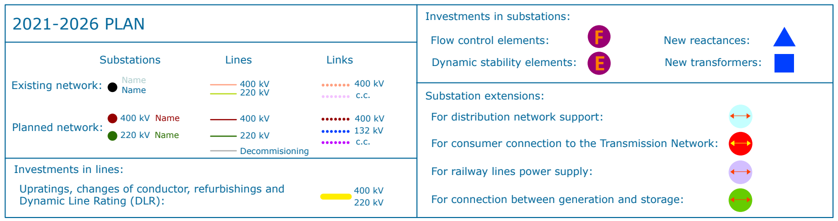
Drivers / Objectives: This investment enables the transport electrification, contributing to the fulfilment of the objectives set out in the PNIEC.

Alternatives: The power supply points to the railway axis have been defined in coordination with ADIF, minimising to the extent possible the distance from the traction substations to existing transmission network infrastructures.

European dimension: No

Map:





Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment AF_08
Railway axis power supply **Palencia-Santander**

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
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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV

- M€

Socio-environmental impact:

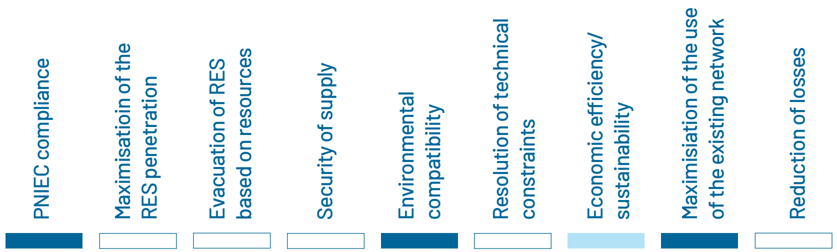
Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -



Investment AF_08
Railway axis power supply **Palencia-Santander**

Table of physical units:

	400 kV
Bays (units)	6

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Aguayo 400 kV	1	Conv.	TN	2024
Aguayo 400 kV	2	Conv.	Rail.	2024
Herrera 400 kV	2	Conv.	Rail.	2024
Herrera 400 kV	1	Conv.	TN	2024

Investment AF_09
Railway axis power supply **Puertollano-Mérida**

General description:

The Investment involves the necessary components for the power supply from the transmission network to the traction substations of the Puertollano- Mérida railway line:

- New input-output at the new Almadén 400 kV substation on the Almaraz-Guadame 400 kV line.
- New input-output at the new La Serena 400 kV substation on the Valdecaballeros-Carmona 400 kV line.
- New input-output at the new Alange 400 kV substation on the Almaraz-Bienvenida 400 kV line.
- Substation extensions at Brazatortas 220 kV, Almadén 400 kV, La Serena 400 kV and Alange 400 kV.

Drivers / Objectives:

This investment enables the transport electrification, contributing to the fulfilment of the objectives set out in the PNIEC.

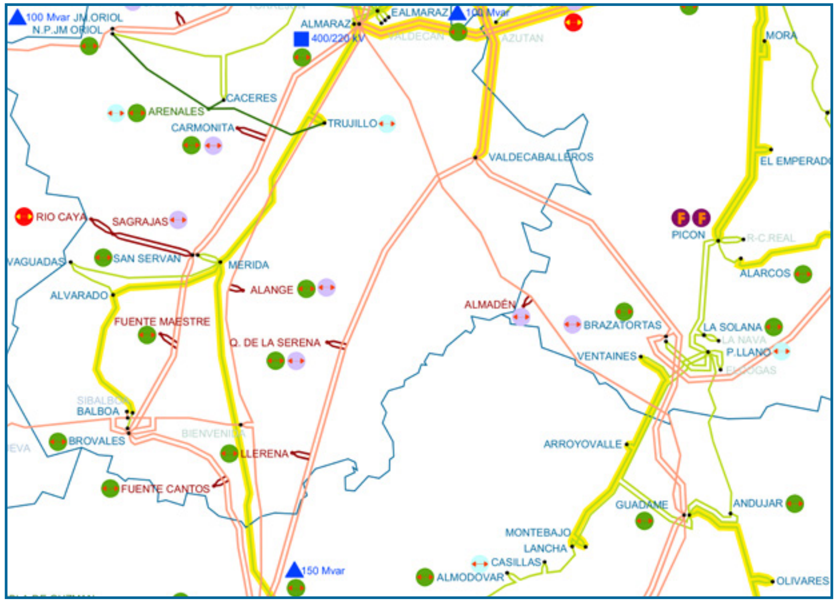
Alternatives:

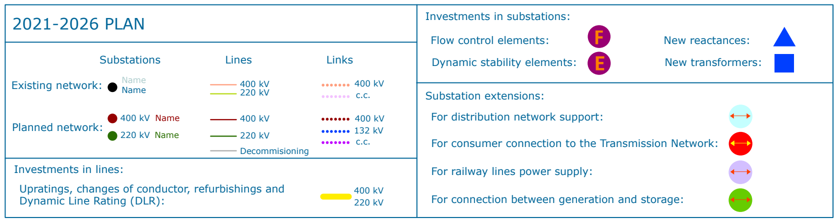
The power supply points to the railway axis have been defined in coordination with ADIF, minimising to the extent possible the distance from the traction substations to existing transmission network infrastructures.

European dimension:

No

Map:





Investment AF_09

Railway axis power supply **Puertollano-Mérida**

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
23.8 M€	1.1 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	3.0	3.0	3.0	2.9	2.9	2.9	2.8	2.8	2.8

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

Profitability:

Profitability: NPV

- M€

Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -

- PNIEC compliance
- Maximisatioin of the RES penetration
- Evacuation of RES based on resources
- Security of supply
- Environmental compatibility
- Resolution of technical constraints
- Economic efficiency/ sustainability
- Maximisiation of the use of the existing network
- Reduction of losses

Investment AF_09
Railway axis power supply **Puertollano-Mérida**

Table of physical units:

	220 kV	400 kV
Bays (units)	2	21
Overhead line (km)		18

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Alange 400 kV	Outdoor	2024
Almadén 400 kV	Outdoor	2024
La Serena 400 kV	Outdoor	2024

Substation extension	units	Type	Driv.	Year
Alange 400 kV	2	Conv.	Rail.	2024
Alange 400 kV	5	Conv.	TN	2024
Almadén 400 kV	5	Conv.	TN	2024
Almadén 400 kV	2	Conv.	Rail.	2024
Brazatortas 220 kV	2	Conv.	Rail.	2024
La Serena 400 kV	2	Conv.	Rail.	2024
La Serena 400 kV	5	Conv.	TN	2024

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Alange, of Bienvenida - Almaraz CN 400 kV, circuit 1	1,750	1,410	1	Line	Rail.	2024
I/O in Almadén, of Guadame - Almaraz CN 400 kV, circuit 1	1,280	720	2	Line	Rail.	2024
I/O in La Serena, of Valdecaballeros - Carmona 400 kV, circuit 1	1,760	1,420	6	Line	Rail.	2024

Investment AF_10

Railway axis power supply **Sevilla-Huelva**

General description:

The investment 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
- Extensions of the Casaquemada 220 kV and Palma del Condado 220 kV substations.

Drivers / Objectives:

This investment enables the transport electrification, contributing to the fulfilment of the objectives set out in the PNIEC.

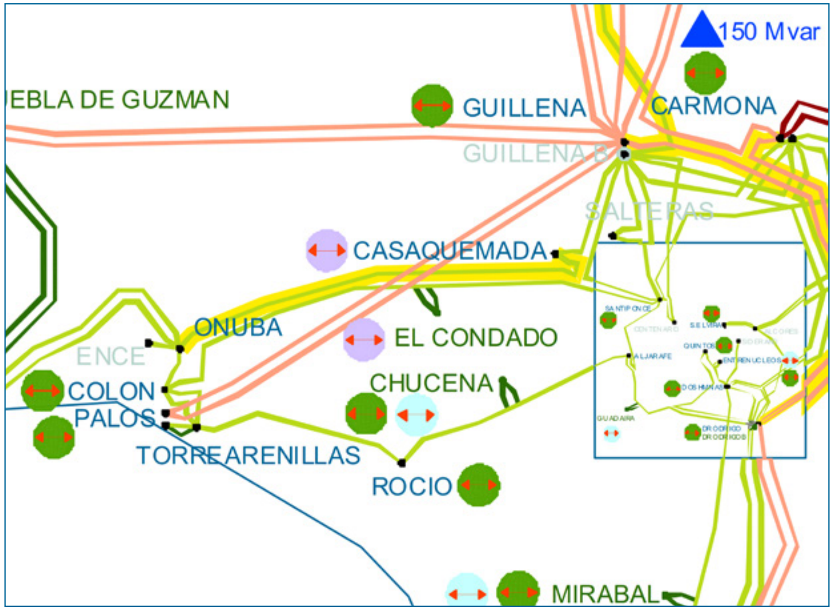
Alternatives:

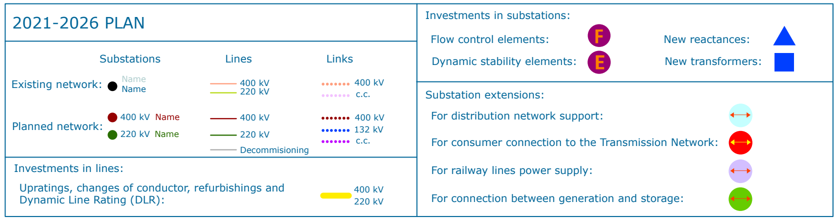
The power supply points to the railway axis have been defined in coordination with ADIF, minimising to the extent possible the distance from the traction substations to existing transmission network infrastructures.

European dimension:

No

Map:





Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment AF_10
Railway axis power supply **Sevilla-Huelva**

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
3.3 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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
- M€

Socio-environmental impact:

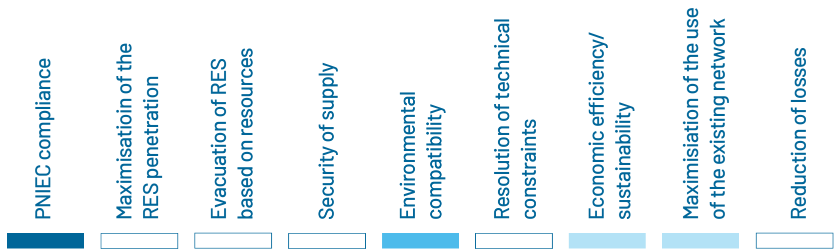
Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -



Investment AF_10
Railway axis 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 investment 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 right of way kilometres.

Detailed list of investments:

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	Conv.	TN	2024
El Condado 220 kV	2	Conv.	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	420	350	1	Line	Rail.	2024

Investment AF_11
Railway axis power supply **Toledo-Navalmoral-Cáceres-Badajoz**

General description:

The investment involves the necessary components for the power supply from the transmission network to the traction substations of theToledo-Navalmoral-Cáceres-Badajoz railway line:

- Extension of the Torrijos 220 kV substation.
- New input-output at the new Calera y Chozas 220 kV substation on the Almaraz-Talavera 220 kV line and extension of the Calera y Chozas substation.
- Extension of Arañuelo 400 kV substation.
- Extension of Sagrajas 400 kV substation.

Drivers / Objectives:

This investment enables the transport electrification, contributing to the fulfilment of the objectives set out in the PNIEC.

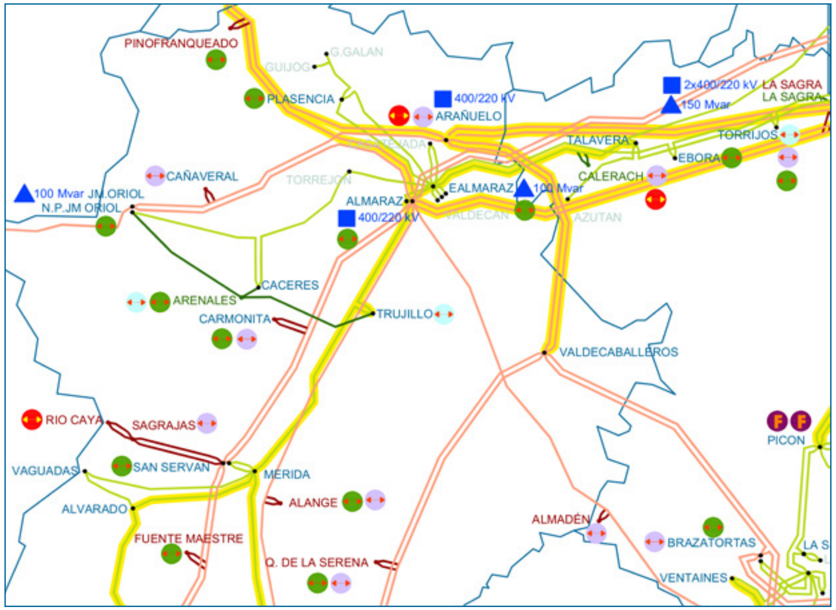
Alternatives:

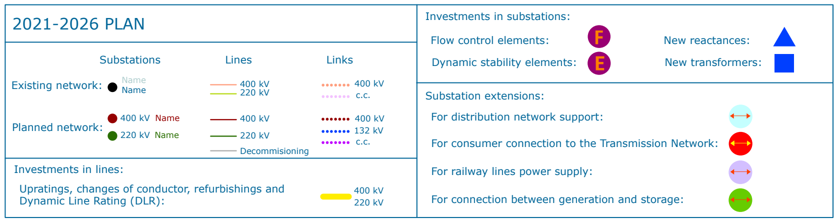
The power supply points to the railway axis have been defined in coordination with ADIF, minimising to the extent possible the distance from the traction substations to existing transmission network infrastructures.

European dimension:

No

Map:





Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment AF_11
Railway axis power supply **Toledo-Navalmoral-Cáceres-Badajoz**

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
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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV

- M€

Socio-environmental impact:

Impact degree
+ -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree
+ -

PNIEC compliance

Maximisatioin of the RES penetration

Evacuation of RES based on resources

Security of supply

Environmental compatibility

Resolution of technical constraints

Economic efficiency/ sustainability

Maximisiation of the use of the existing network

Reduction of losses

Investment AF_11
Railway axis 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 investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Calera y Chozas 220 kV	Outdoor	2024

Substation extension	units	Type	Driv.	Year
Arañuelo 400 kV	2	Conv.	Rail.	2023
Arañuelo 400 kV	1	Conv.	TN	2023
Calera y Chozas 220 kV	2	Conv.	Rail.	2024
Calera y Chozas 220 kV	3	Conv.	TN	2024
Sagrajas 400 kV	2	Conv.	Rail.	2024
Sagrajas 400 kV	1	Conv.	TN	2024
Torrijos 220 kV	2	Conv.	Rail.	2024

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	Rail.	2024

Investment AF_12
Railway axis power supply **Vigo-Orense-Lugo-A Coruña**

General description:

The Investment 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:

- Extension of Fontefría 220 kV substation.
- New input-output at the new O Incio 220 kV substation on La Lomba-Belesar 220 kV line. Extension of O Incio 220 kV substation.
- Extension of Ludrio 400 kV substation.
- New input-output at the new Abegondo 400 kV substation on the P. G. Rodriguez-Meson do Vento 400 kV line. Extension of Abegondo 400 kV substation.

Drivers / Objectives:

This investment enables the transport electrification, contributing to the fulfilment of the objectives set out in the PNIEC.

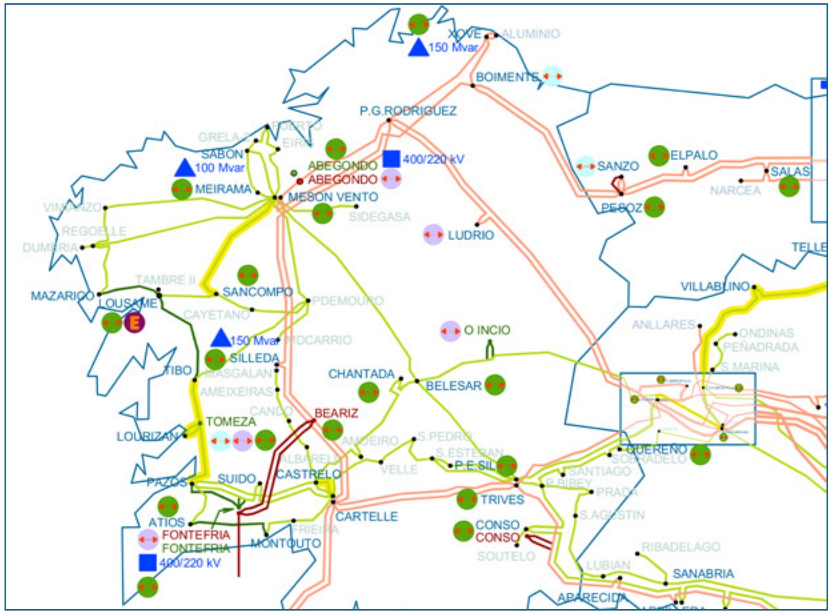
Alternatives:

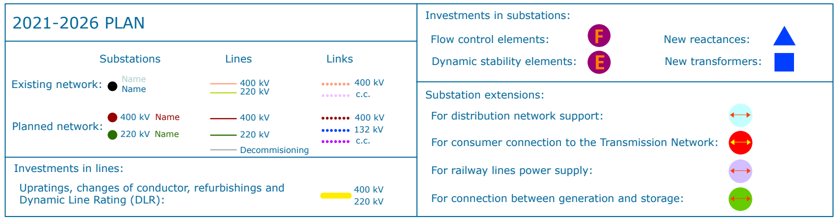
The power supply points to the railway axis have been defined in coordination with ADIF, minimising to the extent possible the distance from the traction substations to existing transmission network infrastructures.

European dimension:

No

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment AF_12

Railway axis power supply **Vigo-Orense-Lugo-A Coruña**

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
10.9 M€	0.75 M€/year

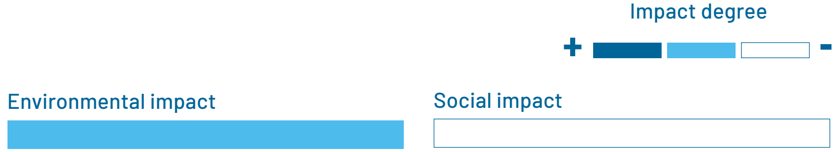
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.5	1.5

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

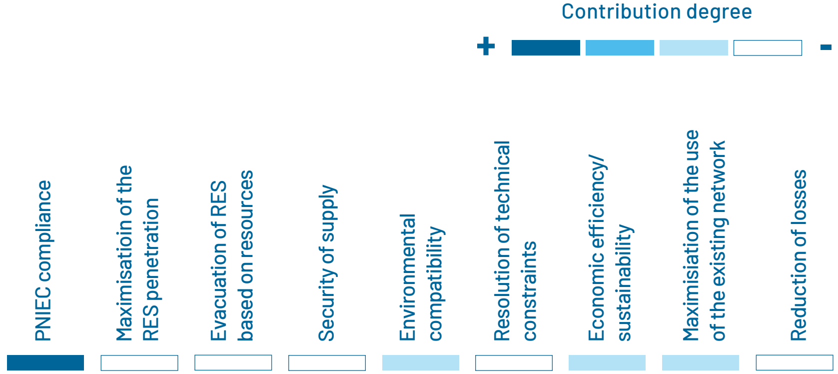
Profitability:

Profitability: NPV
- M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment AF_12
Railway axis power supply **Vigo-Orense-Lugo-A Coruña**

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 investment 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 right of way kilometres.

Detailed list of investments:

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	Conv.	TN	2024
Abegondo 400 kV	2	Conv.	Rail.	2024
Fontefría 220 kV	2	Conv.	Rail.	2022
Ludrio 400 kV	2	Conv.	Rail.	2022
Ludrio 400 kV	1	Conv.	TN	2022
O Incio 220 kV	2	Conv.	Rail.	2023
O Incio 220 kV	3	Conv.	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	1,805	1,612	0.7	Line	Rail.	2024
I/O in O Incio, of Belesar - La Lomba 220 kV, circuit 1	440	390	0.5	Line	Rail.	2023

Investment AF_13

Railway axis power supply **Zaragoza-Teruel-Sagunto**

General description:

The Investment involves the necessary components for the power supply from the transmission network to the traction substations of the Zaragoza-Teruel-Sagunto railway line:

- Extension of Calamocha 220 kV substation.
- Extension of Platea 400 kV substation.
- Extension of Segorbe 220 kV substation.

Drivers / Objectives:

This investment enables the transport electrification, contributing to the fulfilment of the objectives set out in the PNIEC.

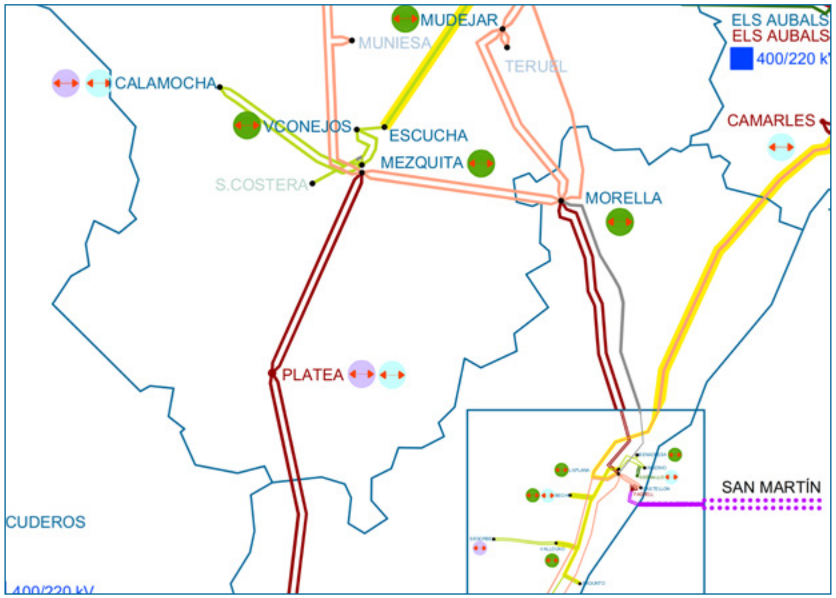
Alternatives:

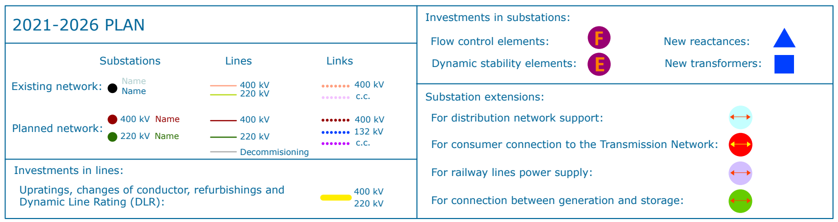
The power supply points to the railway axis have been defined in coordination with ADIF, minimising to the extent possible the distance from the traction substations to existing transmission network infrastructures.

European dimension:

No

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes
206

Investment AF_13
Railway axis power supply **Zaragoza-Teruel-Sagunto**

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
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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
- M€

Socio-environmental impact:

Impact degree
+ -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree
+ -

PNIEC compliance

Maximisatioin of the RES penetration

Evacuation of RES based on resources

Security of supply

Environmental compatibility

Resolution of technical constraints

Economic efficiency/ sustainability

Maximisiation of the use of the existing network

Reduction of losses

Investment AF_13
Railway axis 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 investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Calamocha 220 kV	2	Conv.	Rail.	2024
Platea 400 kV	2	Conv.	Rail.	2024
Platea 400 kV	1	Conv.	TN	2024
Segorbe 220 kV	2	Conv.	Rail.	2023

Investment AF_14
Railway axis power supply **Alicante-Crevillente**

General description: The Investment involves supply from the transmission network to the traction substations of the Alicante-Crevillente railway axis:

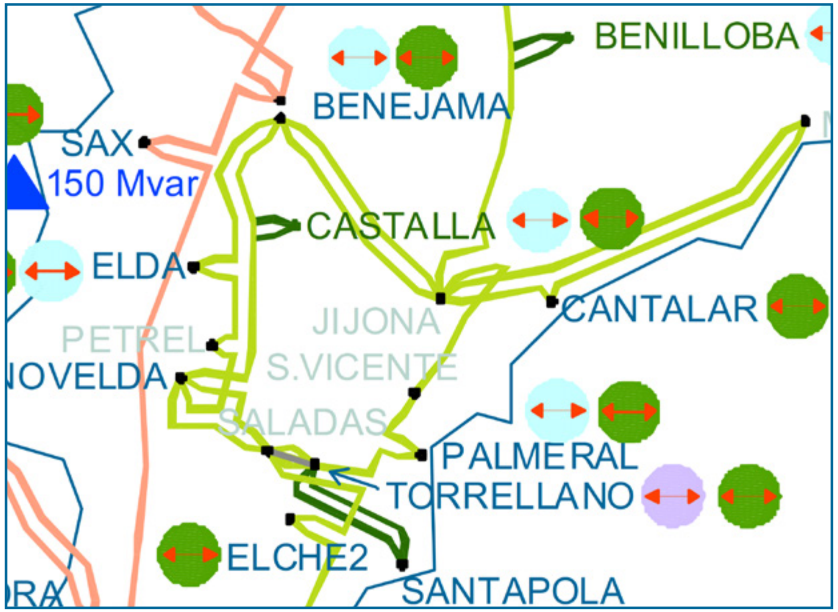
- Extension of Torrellano 220 kV substation.

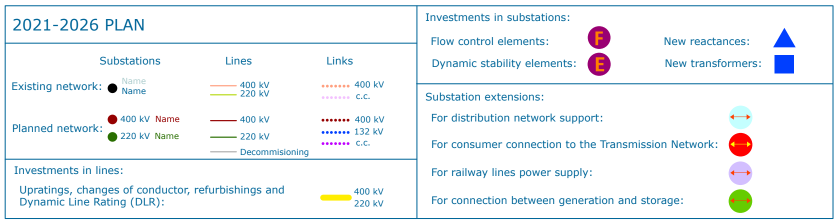
Drivers / Objectives: This investment enables the transport electrification, contributing to the fulfilment of the objectives set out in the PNIEC.

Alternatives: The power supply points to the railway axis have been defined in coordination with ADIF, minimising to the extent possible the distance from the traction substations to existing transmission network infrastructures.

European dimension: No

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes
209

Investment AF_14
Railway axis power supply **Alicante-Crevillente**

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
- 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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
- M€

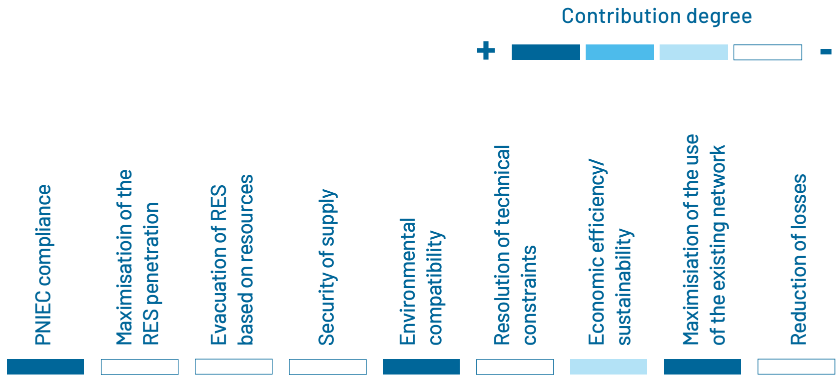
Socio-environmental impact:

Impact degree
\+ -

Environmental impact

Social impact

Contribution to guiding principles:



Investment AF_14
Railway axis power supply **Alicante-Crevillente**

Table of physical units:

	220 kV
Bays (units)	2

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Torrellano 220 kV	2	GIS	Rail.	2024

Investment APD-AND
Distribution network support **Andalusia**

General description:

The investment included allows improving the transmission-distribution interface in Andalusia. The following actions are included:

- Extensions at the Baza 400 kV and Casillas, Íllora, Guadaira(2), El Zumajo, Saleres(2), Ventilla, Puebla de Guzmán, Entrenúcleos, Benahadux and Chucena 220 kV substations.
- New input-output at the new Guadaira 220 kV substation on the Aljarafe-Don Rodrigo 220 kV. New input-output at the new Ventilla 220 kV on the Alhaurín-Jordana 220 kV 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.

Drivers / Objectives:

- To improve the security of supply of demand in the Saleres and Íllora area.
- To support future demand in the Chucena, Entrenúcleos, Santa Elvira, 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.

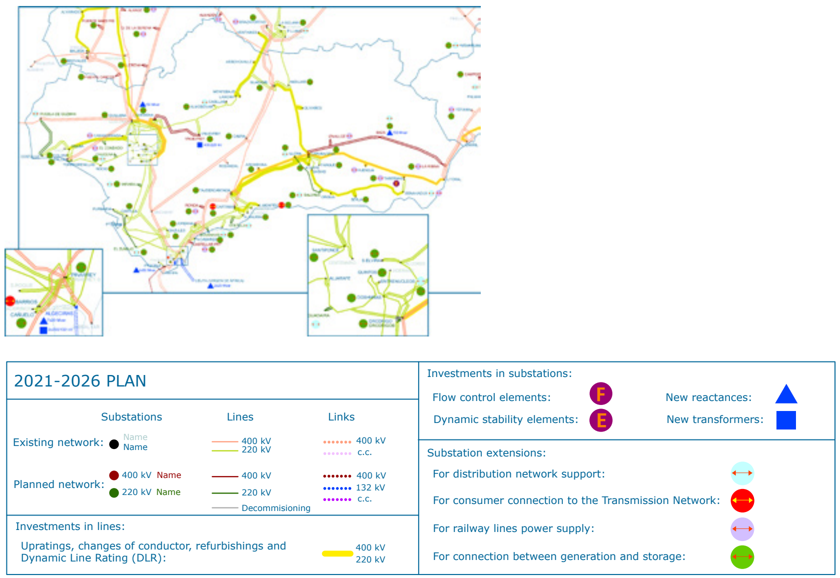
Alternatives:

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.

European dimension:

No

Map:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment APD-AND

Distribution network support **Andalusia**

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
51.4 M€	1.07 M€/year

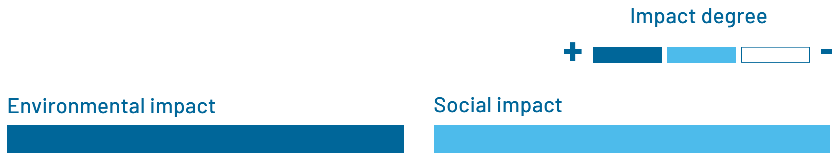
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	5.2	5.2	5.1	5.0	4.9	4.9	4.8	4.7	4.7

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

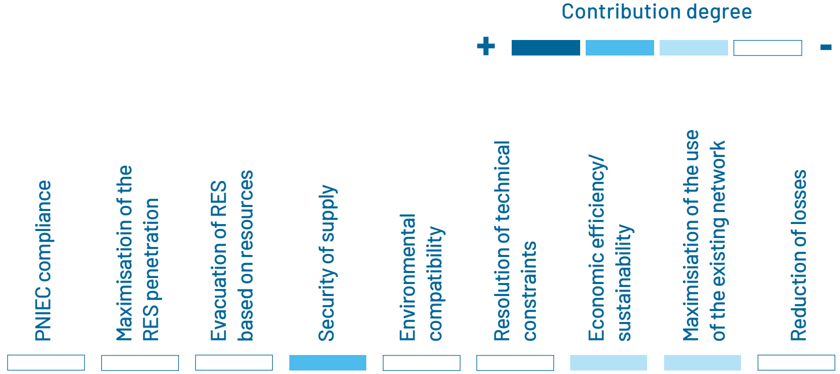
Profitability:

Profitability: NPV
- M€

Socio-environmental impact:



Contribution to guiding principles:



Investment APD-AND
Distribution network support **Andalusia**

Table of physical units:

	220 kV	400 kV
Bays (units)	25	1
Overhead line (km)	80	
Uprating (km)	1	

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
El Zumajo 220 kV	Outdoor	2022
Guadaira 220 kV	Outdoor	2023
Ventilla 220 kV	Building	2023

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Baza REE 400 kV	1	Conv.	SuD	2022
Benahadux 220 kV	1	GIS	SuD	2022
Casillas 220 kV	1	Conv.	TN	2022
Casillas 220 kV	1	Conv.	SuD	2022
Chucena 220 kV	1	Conv.	SuD	2022
El Zumajo 220 kV	1	Conv.	SuD	2022
El Zumajo 220 kV [1]	1	Conv.	Gen./Sto.	2022
El Zumajo 220 kV	3	Conv.	TN	2022
Entrenúcleos 220 kV	1	Conv.	SuD	2022
Guadaira 220 kV	2	Conv.	SuD	2023
Guadaira 220 kV	3	Conv.	TN	2023
Íllora 220 kV	1	Conv.	SuD	2022
Puebla de Guzmán 220 kV	1	Conv.	SuD	2022
Puerto Real 220 kV	2	Conv.	TN	2022
Saleres 220 kV	2	Conv.	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.

Investment APD-AND
Distribution network support **Andalusia**

Detailed list of investments (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	SuD	2022
Casillas - Lancha 220 kV, circuit 1[2]	440	340	0.1	Cable	SuD	2022
DC El Zumajo - Gazules 220 kV[3]	396	290	0.2	Line	SuD	2022
DC Puerto Real - Puerto Real 220 kV[4,5]			3	Line	SuD	2022
I/O in Guadaira, of Aljarafe - Don Rodrigo 220 kV, circuit 1	420	340	4	Line	SuD	2023
I/O in Ventilla, of Alhaurín - Jordana 220 kV, circuit 1	420	360	13	Line	SuD	2023
I/O in Ventilla, of Alhaurín - Jordana 220 kV, circuit 1	420	360	0.5	Cable	SuD	2023
El Zumajo - Puerto Real 220 kV, circuit 1[6]	600	600	38	Line	SuD	2022
Puerto Real - Puerto Real 220 kV, circuit 1[7]			1	Line	SuD	2022

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. Lines rearrangement and compacting in the area surrounding SE Puerto Real 220 kV required.
7. 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.

Investment APD-ARA
Distribution network support **Aragon**

General description:

The investments included enable the improvement of the transmission-distribution interface in Aragon:

- Extension of Peñaflor 220 kV substation.
- Extension of Hijar 220 kV substation.
- Extension of Cinca 220 kV substation.
- Extension of Esquedas 220 kV substation.
- Extension of Calamocha 220 kV substation.
- Extension of Los Vientos 220 kV substation.
- Extension of Platea 400 kV substation.

Drivers / Objectives:

- To support demand in Cinca in case of failures in the existing transmission-distribution transformers.
- To support a singular demand in the distribution network in the Esquedas area.
- To support demand in the area of Peñaflor, Hijar, Calamocha, Los Vientos and Platea and to facilitate the evacuation of renewables in the distribution network.

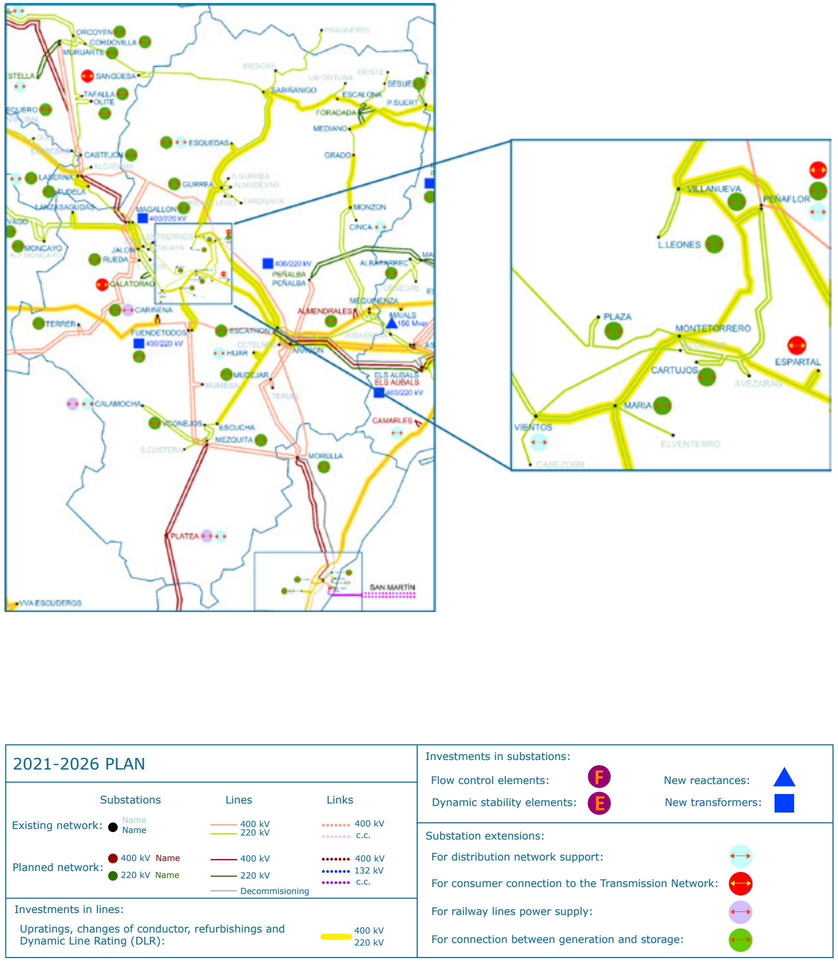
Alternatives:

No feasible alternatives have been identified in the distribution network by the distribution network manager in any of the cases.

European dimension:

No

Map:



Investment APD-ARA
Distribution network support **Aragon**

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
5.6 M€	0.28 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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
- M€

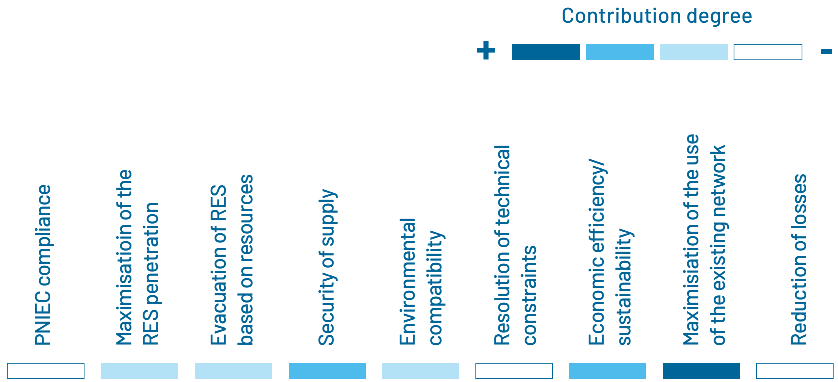
Socio-environmental impact:

Impact degree
\+ -

Environmental impact

Social impact

Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment APD-ARA
Distribution network support **Aragon**

Table of physical units:

	220 kV	400 kV
Bays (units)	6	1

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Calamocha 220 kV	1	Conv.	SuD	2022
Cinca 220 kV	1	Conv.	SuD	2022
Esquedas 220 kV	1	Conv.	SuD	2022
Hijar 220 kV	1	Conv.	SuD	2022
Los Vientos 220 kV	1	Conv.	SuD	2022
Peñaflor 220 kV	1	Conv.	SuD	2022
Platea 400 kV	1	Conv.	SuD	2024

Investment APD-AST
Distribution network support **Asturias**

General description:

The investment included enables the improvement of the transmission-distribution interface in Asturias:

- Extension of Pesoz 400 kV substation, new transformer 3 Sanzo 400/132 kV and new Pesoz-Sanzo 400 kV line.
- New input-output at the new Ortiguero 220 kV substation on the Siero-Puente San Miguel 220 kV line.
- Extension of the Ortiguero 220 kV substation.

Drivers / Objectives:

To improve the security of supply of demand in the eastern part of Asturias, as well as to facilitate the evacuation of renewables in the distribution network in the western part of Asturias.

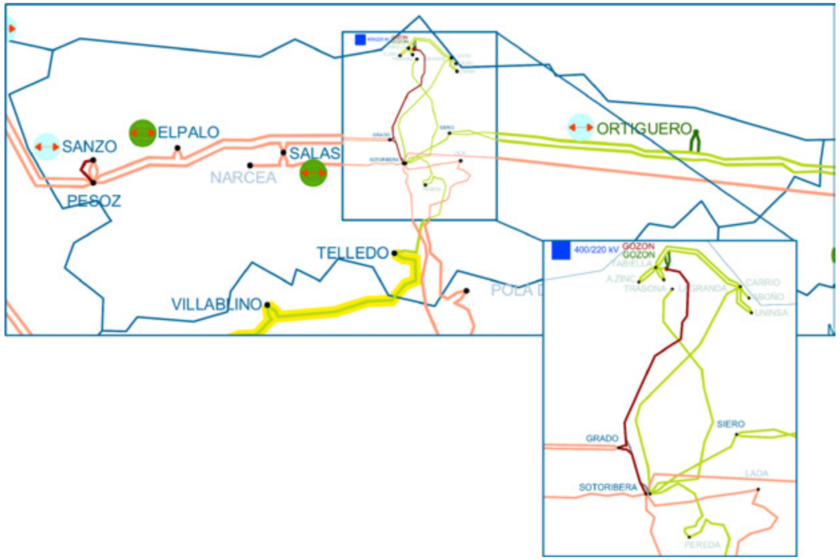
Alternatives:

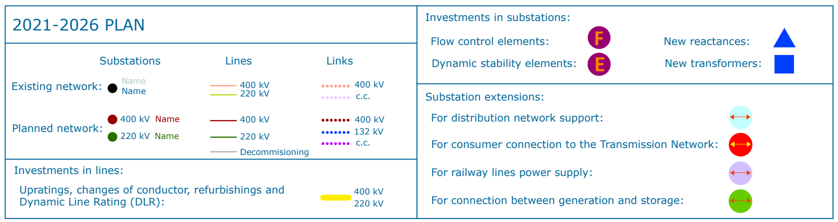
Alternatives in the distribution network have been assessed by the distribution network managers at a higher cost than the alternatives proposed in the transmission network.

European dimension:

No

Map:





Investment APD-AST
Distribution network support **Asturias**

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
8.6 M€	0.16 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

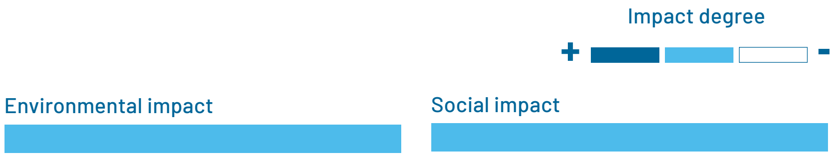
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including investments that may be scheduled beyond 2026.

Profitability:

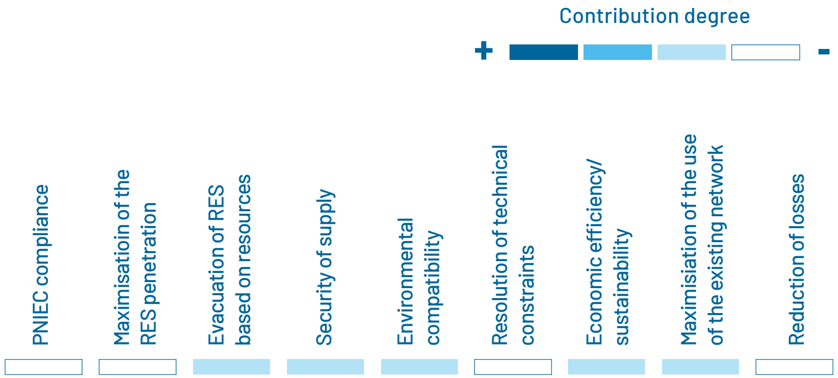
Profitability: NPV

- M€

Socio-environmental impact:



Contribution to guiding principles:



Investment APD-AST
Distribution network support **Asturias**

Table of physical units:

	220 kV	400 kV
Bays (units)	4	1
Overhead line (km)	4	2

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

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	Conv.	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	970	890	2	Line	SuD	2023
Pesoz - Sanzo 400 kV, circuit 3	2,430	2,230	2	Line	SuD	2023

Investment APD-CAN
Distribution network support **Cantabria**

General description:

The investment included enables the improvement of the transmission-distribution interface in Cantabria area:

- Extension of the Cacicedo 220 kV substation.
- Extension of the Mataporquera 220 kV substation.

Drivers / Objectives:

- To improve the security of supply for the demand of the city of Santander and to support the vegetative growth of demand in case of failures in the existing transmission-distribution transformers.
- To facilitate the evacuation of renewables in the distribution network in the Mataporquera area.

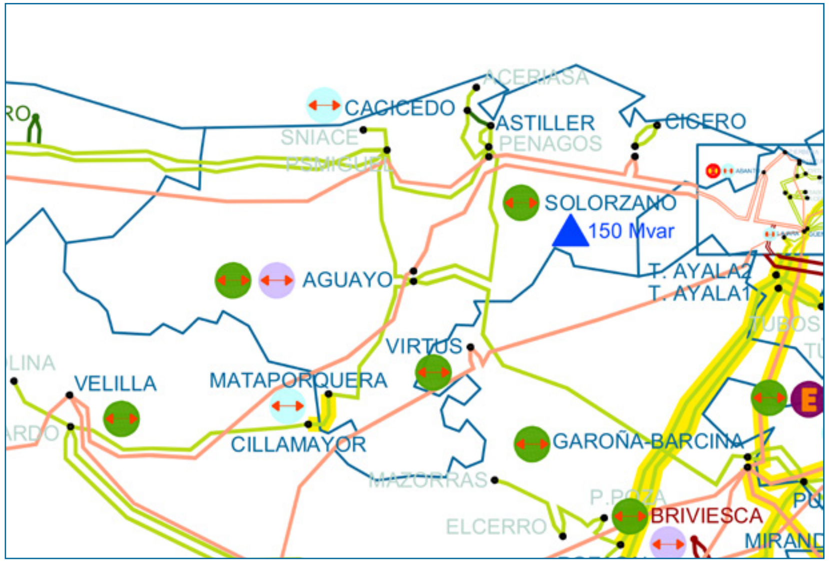
Alternatives:

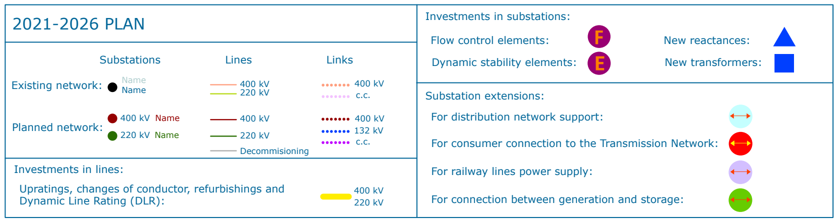
Alternatives in the distribution network have been assessed by the distribution network managers at a higher cost than the Alternatives proposed in the transmission network.

European dimension:

No

Map:





Investment APD-CAN
Distribution network support **Cantabria**

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
3.5 M€	0.07 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	0.4	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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
- M€

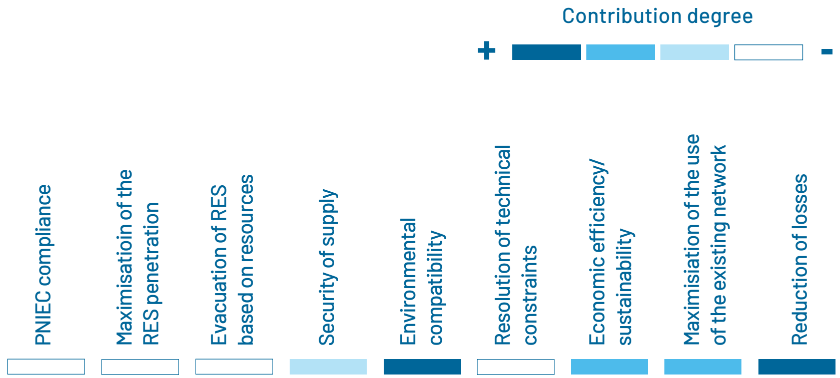
Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:



Investment APD-CAN
Distribution network support **Cantabria**

Table of physical units:

	220 kV
Bays (units)	3
Cables (km)	0.1

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Cacicedo 220 kV	1	GIS	SuD	2022
Cacicedo 220 kV	1	GIS	TN	2022
Mataporquera 220 kV	1	GIS	SuD	2022

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Cacicedo - Cacicedo 220 kV, circuit 1			0	Cable	SuD	2022

Investment APD-CAT
Distribution network support **Catalonia**

General description:

The investment included enables the improvement of the transmission-distribution interface in Catalonia:

- Extension of the Puigpelat, Vic and Cerdá 220 kV substations.
- New input-output at the new Camarles 400 kV substation on the Vandellós-La Plana 400 kV line.
- New input-output at the new Valdonzella 220 kV substation on the Vilanova-Mata 220 kV line and extension of Valdonzella 220 kV substation (>2026).
- Extension of Riudarenes, Garraf and Camarles 400 kV substation.
- Transfer of SE Collblanc 220 kV to Can Rigalt 220 kV subject to the interested party in the transfer covering the full investment costs in accordance with section 3 of Art. 154 of R. Decree 1955/2000, of 1 December.

Drivers / Objectives:

- To support existing and future demand, including singular consumption, in Riudarenes (La Selva and Costa Brava area), Puigpelat, Camarles and Garraf in order to reinforce and enable their adequate supply.
- To provide support to ensure the vegetative growth of demand in the Cerdá and Valdonzella area.
- To reinforce the transmission-distribution interface to cover new demand in the Vic area.

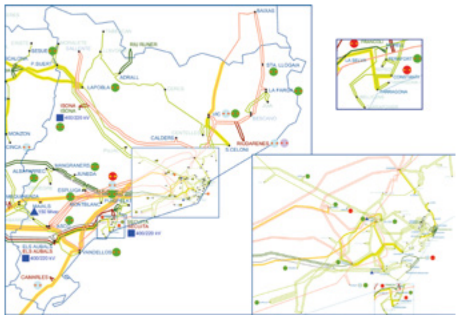
Alternatives:

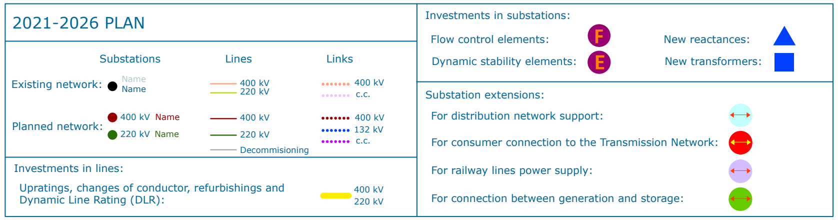
The distribution network manager has assessed alternatives in the distribution network in Riudarenes, Camarles and Valdonzella at a higher cost than the alternatives proposed in the transmission network.
In the case of Camarles, the alternative selected is the best after a collaborative study with the distribution network manager. In the rest of the investment, the distribution network manager did not identify any feasible alternatives in the distribution network.

European dimension:

No

Map:





Investment APD-CAT
Distribution network support **Catalonia**

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
29.3 M€	0.85 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	2.9	2.9

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

Profitability:

Profitability: NPV

- M€

Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -

PNIEC compliance

Maximisatioin of the RES penetration

Evacuation of RES based on resources

Security of supply

Environmental compatibility

Resolution of technical constraints

Economic efficiency/ sustainability

Maximisation of the use of the existing network

Reduction of losses

Investment APD-CAT
Distribution network support **Catalonia**

Table of physical units:

	220 kV	400 kV
Bays (units)	18	8
Overhead line (km)		5
Cables (km)	6	

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Camarles 400 kV	Outdoor	2022
Can Rigalt 220 kV [1]	Building	2026
Valldonzella 220 kV	Building	> 2026

Notes:
1. Subject to the interested party in the transfer covering the full investment costs in accordance with the provisions of Article 154(3) of Royal Decree 1955/2000 of 1 December 2000. Requiring deregistration of SE Collblanc 220 kV.

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Camarles 400 kV	4	Conv.	TN	2022
Camarles 400 kV	1	Conv.	SuD	2022
Can Rigalt 220 kV [1]	5	GIS	SuD	2026
Can Rigalt 220 kV [2]	5	GIS	TN	2026
Cerdá 220 kV	1	GIS	SuD	2022
Garraf 400 kV	2	Conv.	SuD	2022
Puigpelat 220 kV	1	GIS	SuD	2021
Riudarenes 400 kV	1	Conv.	SuD	2024
Valldonzella 220 kV	2	GIS	SuD	> 2026
Valldonzella 220 kV	3	GIS	TN	> 2026
Vic 220 kV	1	Conv.	SuD	2019

Notes:
1. Expansion of substations due to the transfer of Collblanc 220 kV to Can Rigalt 220 kV.
2. Bays required due to topological changes

Investment APD-CAT
Distribution network support **Catalonia**

Detailed list of investments (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 [3]	500	500	0.5	Cable	TN	2026
I/O in Camarles, of Vandellós - La Plana 400 kV, circuit 1 [4]			2	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 [5]	500	500	0.5	Cable	TN	2026
Urgell - Can Rigalt 220 kV, circuit [6]	500	500	0.5	Cable	TN	2026

Notes:
1. Change of topology incorporating Begues-Can Rigalt 1 220 kV and decommissioning Begues-Collblanc 1 220 kV
2. Change of topology incorporating Begues-Can Rigalt 2 220 kV and decommissioning Begues-Collblanc 2 220 kV
3. Change of topology incorporating Can Jardi-Can Rigalt 220 kV and decommissioning Can Jardí-Collblanc 220 kV
4. No CoT indicated due to a dynamic monitoring system.
5. Change of topology incorporating Facultat-Can Rigalt 220 kV and decommissioning Facultat-Collblanc 220 kV.
6. Change of topology incorporating Urgell-Can Rigalt 220 kV and decommissioning Urgell-Collblanc 220 kV.

Investment APD-CLM
Distribution network support **Castile-La Mancha**

General description:

The investment included enables the improvement of the transmission-distribution interface in Castile-La Mancha:

- Extension of Manchega and Minglanilla 400kV substation.
- Extension of the Torrijos and Puertollano 220kV substation.
- Extension of the Huelves and Talavera 220kV substation (>2026).

Drivers / Objectives:

- To improve the security of supply of demand in Torrijos, Puertollano, Huelves and Talavera.
- To support demand in the Manchega and Minglanilla area and to facilitate the evacuation of renewables in the distribution network.

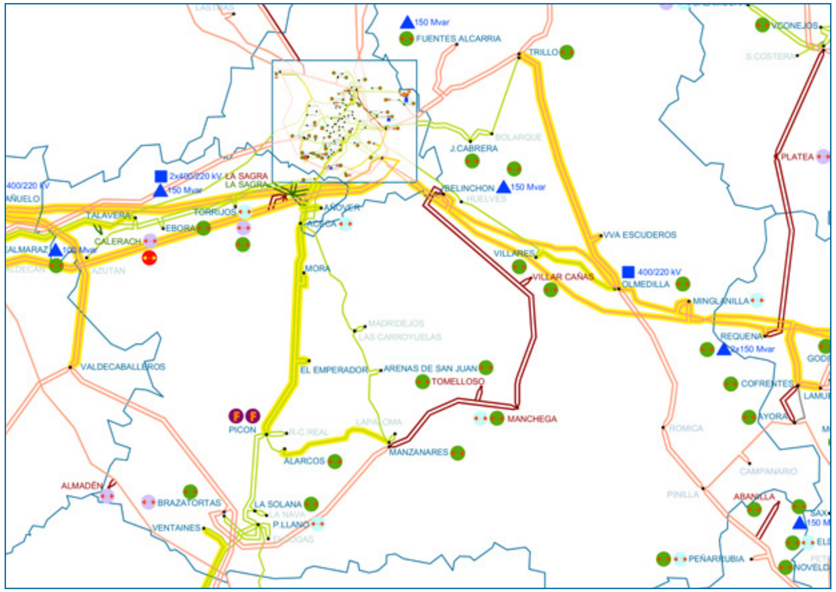
Alternatives:

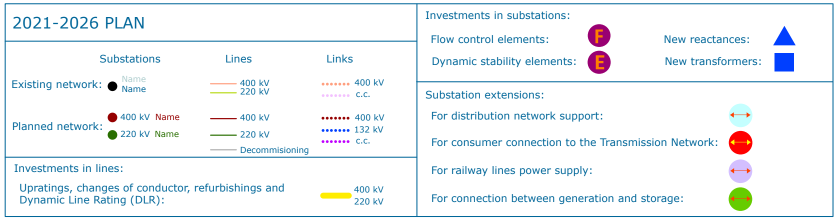
Alternatives in the distribution network have been assessed by the distribution system operator which either represent a higher cost than the alternatives proposed in the transmission network or no feasible alternatives have been identified.

European dimension:

No

Map:





Investment APD-CLM
Distribution network support **Castile-La Mancha**

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
6.4 M€	0.3 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	0.7	0.7

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

Profitability:

Profitability: NPV
- M€

Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -

Investment APD-CLM
Distribution network support **Castile-La Mancha**

Table of physical units:

	220 kV	400 kV
Bays (units)	4	3

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Huelves 220 kV	1	Conv.	SuD	> 2026
Manchega 400 kV	1	Conv.	SuD	2025
Minglanilla 400 kV	1	Conv.	SuD	2022
Minglanilla 400 kV	1	Conv.	TN	2022
Puertollano 220 kV	1	Conv.	SuD	2022
Talavera 220 kV	1	Conv.	SuD	> 2026
Torrijos 220 kV	1	Conv.	SuD	2022

Investment APD-CVA

Distribution network support **Valencian Community**

General description: The investment included enables the improvement of the transmission-distribution interface in the Valencian Community:

- Extension of Sagunto GIS, Morvedre and Bechí (2) 220 kV, El Palmeral and Benejama 400 kV substations.
- New input-output at the new Sancho Llop 220 kV substation on the Gandía-Valldigna 220 kV cable, Benilloba 220kV on the Jijona-Catadau 220 kV line and Nuevo Cauce 220 kV on the Torrente-Patraix 220 kV cable.
- New input-output at the new Assegador 220 kV substation on the La Plana-Bechí 220 kV line and new La Plana-Assegador 2 line (>2026).
- New double circuit Santa Pola-Torrellano 220 kV line.
- Extension of Aldaia 220 kV substation (>2026).

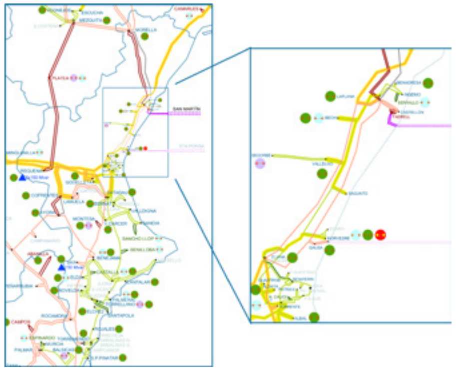
Drivers / Objectives:

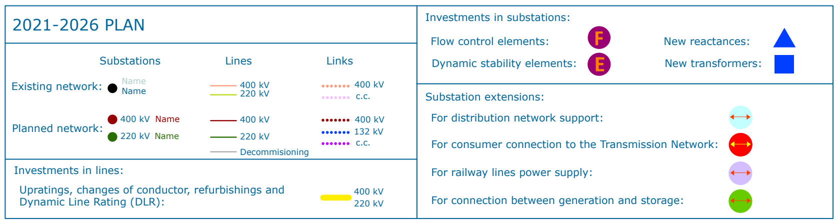
- To improve the security of supply of demand in the Valencia region,
- to support the vegetative growth of demand in case of failures in the existing transmission-distribution transformers,
- to supply new singular demands in the Morvedre area,
- and to facilitate the evacuation of renewables in the distribution network.

Alternatives: There are coordinated studies between the system operator and the distribution network manager which indicate that the alternatives included are optimal in Sagunto, Nuevo Cauce and Benilloba. In terms of other investment, no feasible alternatives have been identified in the distribution network by the distribution network manager.

European dimension: No

Map:





Investment APD-CVA
Distribution network support **Valencian Community**

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
101.9 M€	0.94 M€/year

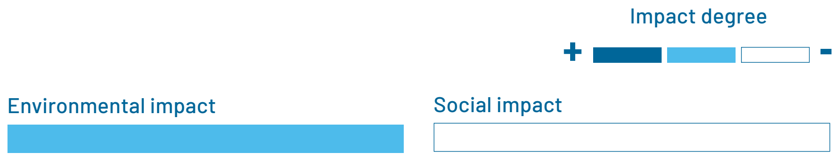
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	9.2	9.0	8.9	8.7	8.6	8.5	8.3	8.2	8.0

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

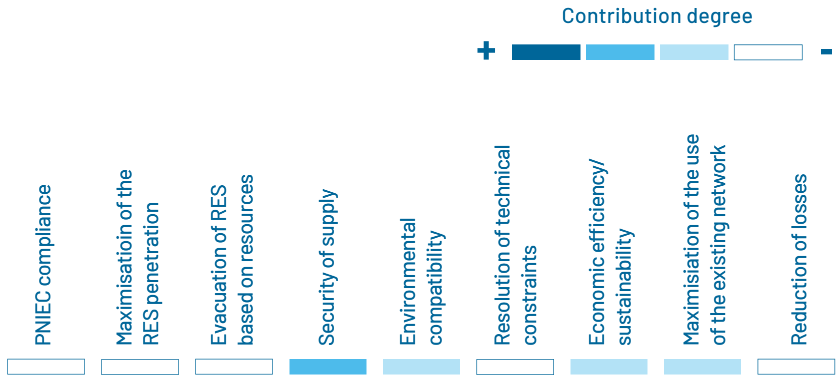
Profitability:

Profitability: NPV
- M€

Socio-environmental impact:



Contribution to guiding principles:



Investment APD-CVA
Distribution network support **Valencian Community**

Table of physical units:

	220 kV	400 kV
Bays (units)	29	2
Overhead line (km)	33	
Cables (km)	25	

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Assegador 220 kV	Building	> 2026
Benilloba 220 kV	Outdoor	2023
Nuevo Cauce 220 kV	Building	2023
Sancho Llop 220 kV	Building	2022

Detailed list of investments (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	2022
Benejama 400 kV	1	Conv.	TN	2022
Benejama 400 kV	1	Conv.	SuD	2022
Benilloba 220 kV	1	Conv.	SuD	2023
Benilloba 220 kV	3	Conv.	TN	2023
El Palmeral 220 kV	1	GIS	SuD	2022
La Plana 220 kV	1	Conv.	TN	> 2026
Morvedre 220 kV	1	GIS	SuD	2022
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

Investment APD-CVA
Distribution network support **Valencian Community**

Detailed list of investments (continued):

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Aldaia - Aldaia 220 kV, circuit 1			0.1	Cable	SuD	> 2026
DC Santa Pola - Torrellano 220 kV	450	450	9	Line	SuD	2023
DC Santa Pola - Torrellano 220 kV	450	450	5	Cable	SuD	2023
I/O in Assegador, of La Plana - Bechi 220 kV, circuit 1	460	320	1	Cable	SuD	> 2026
I/O in Benilloba, 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	540	540	3	Cable	SuD	2023
I/O in Sancho Llop, of Gandía - Valldigna 220 kV, circuit 1	460	300	3	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
Sagunto GIS - Sagunto 220 kV, circuit 1			0.3	Cable	SuD	2022

Investment APD-CYL
Distribution network support **Castile and Leon**

General description:

The actions included enable the improvement of the transmission-distribution interface in Castile and Leon:

- Extension of Villarino 220 kV, Alcocero de Mola 220 kV, Zaratán 220 kV, Vilecha 400 kV (>2026) and Saucelle 220 kV substations.
- New input-output at the new Aranda 400 kV substation on the La Mudarra-Almazán 400 kV line.
- Extension of Aranda 400 kV substation.
- New input-output at the new Villatoro 220 kV substation on the Villalbilla-T Ayala 220 kV line.

Drivers / Objectives:

To improve the reliability and security of supply of demand in the Villarino, Alcocero de Mola, Vilecha, Villatoro and Aranda areas, as well as to facilitate the evacuation of renewables in the distribution network.

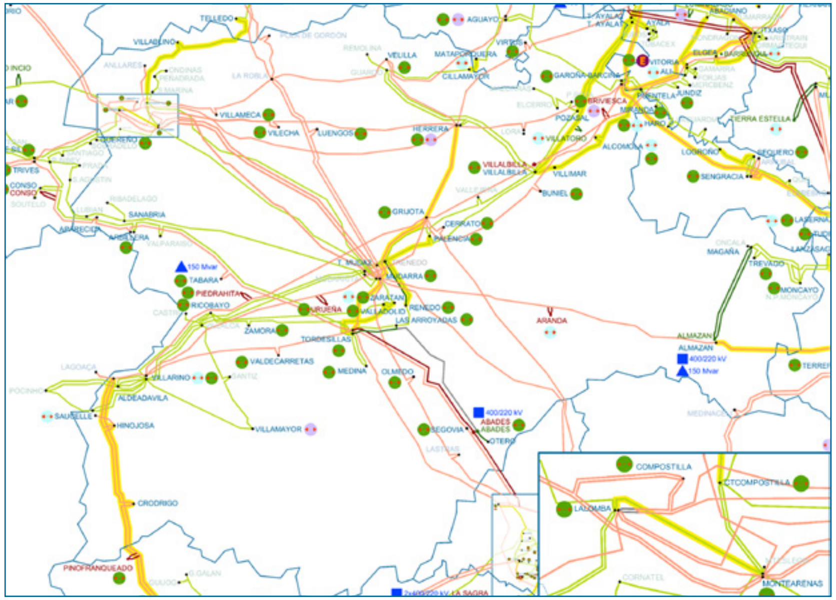
Alternatives:

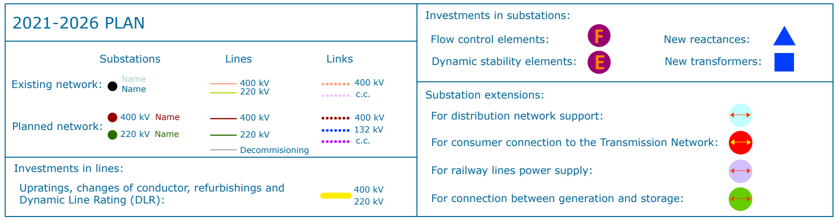
Alternatives to reinforce the distribution network have been assessed by the distribution network managers at a higher cost than the alternatives being considered of support from the transmission network.

European dimension:

No

Map:





Investment APD-CYL
Distribution network support **Castile and Leon**

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
18.5 M€	0.55 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	2.0	2.0	2.0	2.0	1.9	1.9	1.9	1.9	1.8

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

Profitability:

Profitability: NPV
- M€

Socio-environmental impact:

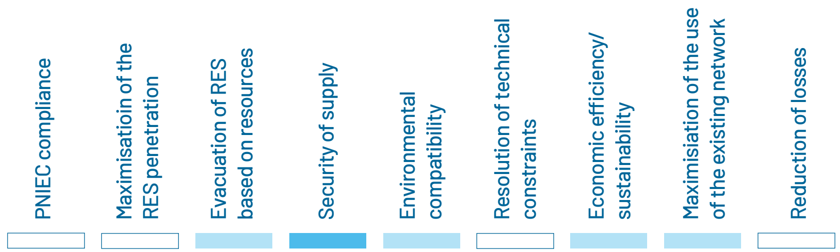
Impact degree
+ -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree
+ -



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment APD-CYL
Distribution network support **Castile and Leon**

Table of physical units:

	220 kV	400 kV
Bays (units)	8	6
Overhead line (km)	6	4

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Aranda de Duero 400 kV	Outdoor	2023
Villatoro 220 kV	Building	2023

Substation extension	units	Type	Driv.	Year
Alcocero de Mola 220 kV	1	Conv.	SuD	2022
Aranda de Duero 400 kV	4	Conv.	TN	2023
Aranda de Duero 400 kV	1	Conv.	SuD	2023
Saucelle 220 kV	1	Conv.	SuD	2022
Vilecha 400 kV	1	Conv.	SuD	> 2026
Villarino 220 kV	1	Conv.	SuD	2022
Villatoro 220 kV	1	GIS	SuD	2023
Villatoro 220 kV	3	GIS	TN	2023
Zaratán 220 kV	1	Conv.	SuD	2022

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Aranda de Duero, of Almazán - Mudarra 400 kV, circuit 1	1,830	1,540	2	Line	SuD	2023
I/O in Villatoro, of Villalbilla - T de Ayala 220 kV, circuit 1	500	420	3	Line	SuD	2023

Investment APD-EXT

Distribution network support **Extremadura**

General description:

The investment included enables the improvement of the transmission-distribution interface in Extremadura:

- New Los Arenales 220 kV substation and new line-cable Cáceres-Los Arenales 220 kV and Los Arenales-Trujillo 220 kV.
- New Los Arenales-José María Oriol NP 220 kV line.
- Extension of Los Arenales 220 kV substation.
- Extension of Trujillo 220 kV substation.
- Extension of La Serena 400 kV substation (>2026).

Drivers / Objectives:

- To support demand in the Cáceres area which cannot be supplied by the distribution network as a result of the use of the route of the Cáceres-Trujillo 132 kV line for the new Los Arenales-Trujillo 220 kV line.
- To support the transmission-distribution interface to supply new demands in the Quintana de la Serena area, as well as to allow the integration of existing and future renewables in the area.

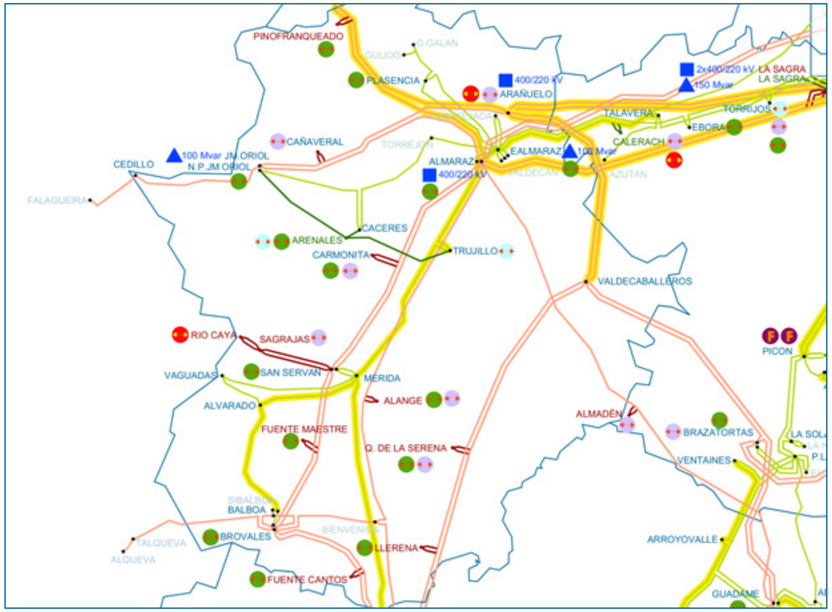
Alternatives:

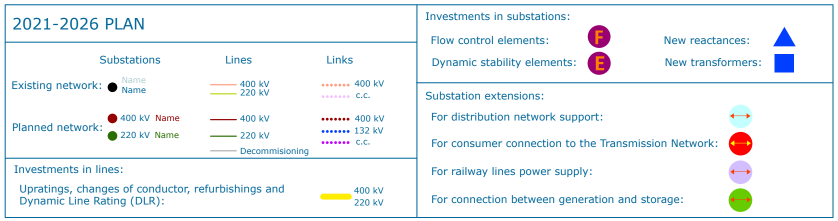
Alternatives in the distribution network have been assessed by the distribution network manager with a higher cost than the alternatives proposed for the transmission network.

European dimension:

No

Map:





Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment APD-EXT
Distribution network support **Extremadura**

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
67 M€	0.49 M€/year

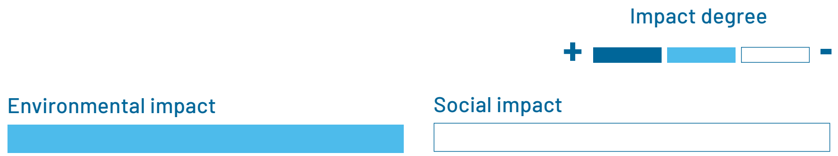
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	5.9	5.8	5.7	5.6	5.5	5.4	5.3	5.3	5.2

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

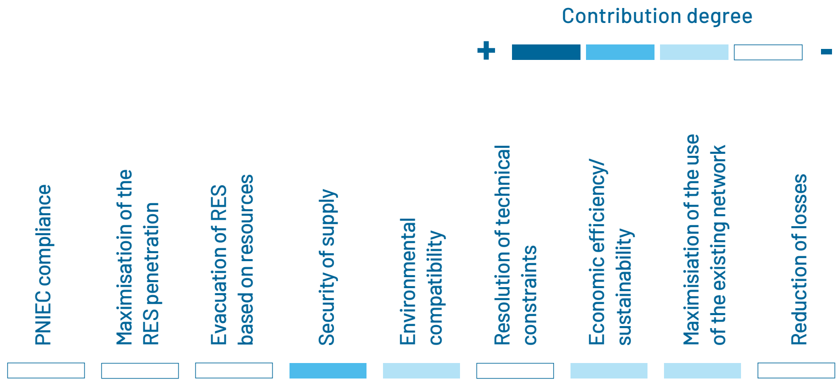
Profitability:

Profitability: NPV
- M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes
240

Investment APD-EXT
Distribution network support **Extremadura**

Table of physical units:

	220 kV	400 kV
Bays (units)	9	1
Overhead line (km)	102	
Cables (km)	8	

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Los Arenales 220 kV	Outdoor	2021

Substation extension	units	Type	Driv.	Year
Cáceres 220 kV	1	Conv.	TN	2022
Jose María de Oriol NP 220 kV	1	Conv.	TN	2021
La Serena 400 kV	1	Conv.	SuD	> 2026
Los Arenales 220 kV	1	Conv.	SuD	2022
Los Arenales 220 kV	2	Conv.	TN	2022
Los Arenales 220 kV	2	Conv.	TN	2021
Trujillo 220 kV	1	GIS	TN	2022
Trujillo 220 kV	1	GIS	SuD	2022

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Cáceres - Los Arenales 220 kV, circuit 1	374	374	4	Cable	SuD	2022
Cáceres - Los Arenales 220 kV, circuit 1	374	374	5	Line	SuD	2022
DC Jose María de Oriol NP - Los Arenales 220 kV [1]	863	714	50	Line	SuD	2021
Trujillo - Los Arenales 220 kV, circuit 1	450	450	4	Cable	SuD	2022
Trujillo - Los Arenales 220 kV, circuit 1	450	450	47	Line	SuD	2022

Notes:
1. Double circuit with connection of the first circuit.

Investment APD-GAL

Distribution network support **Galicia**

General description:

The investment included enables the improvement of the transmission-distribution interface in Galicia:

- Extension of Tomeza 220 kV substation.
- Extension of Boimente 400 kV substation.

Drivers / Objectives:

To enable improved suplly security of demand in the Tomeza area, as well as to facilitate the evacuation of renewables in the distribution network in the Boimente area.

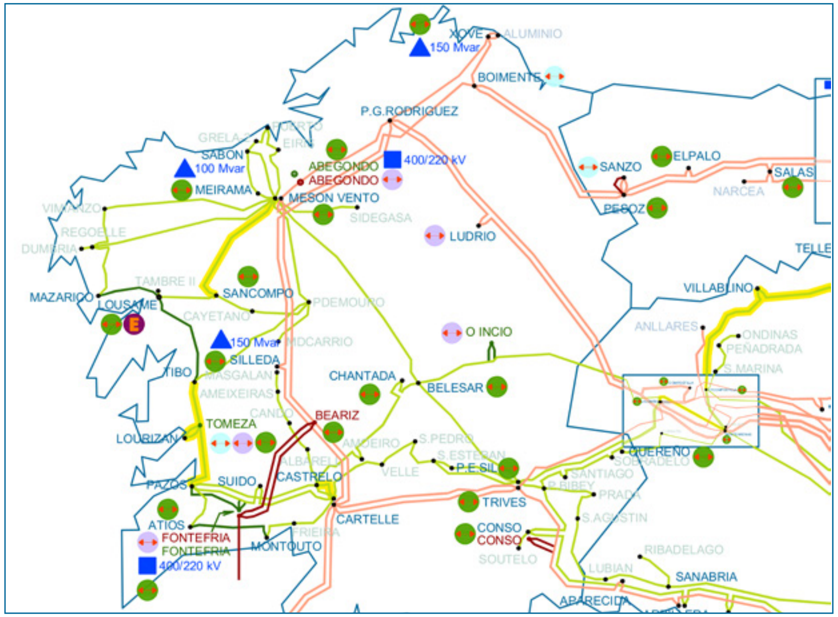
Alternatives:

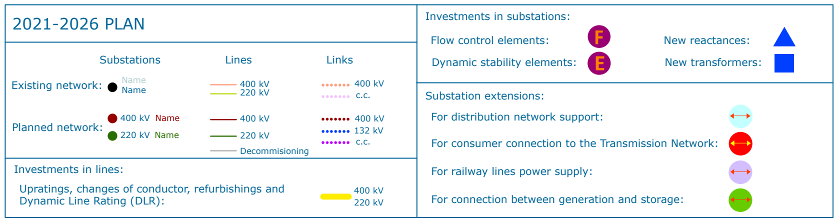
Alternatives have been assessed in the distribution network by the distribution network managers at a higher cost than the alternatives proposed for the transmission network.

European dimension:

No

Map:





Investment APD-GAL
Distribution network support **Galicia**

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
2.2 M€	0.07 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	0.3	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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV

- M€

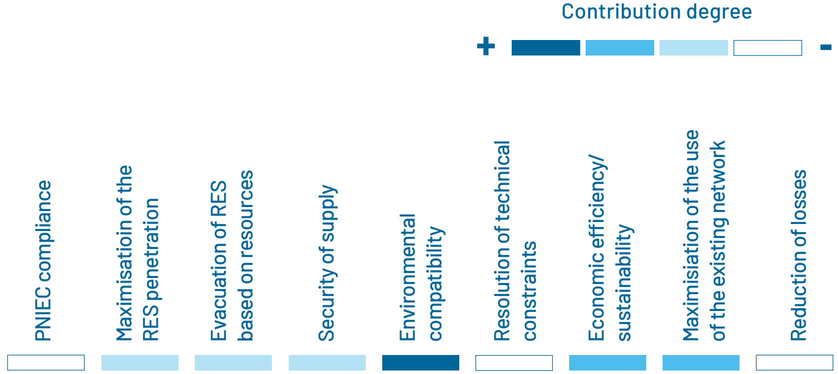
Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment APD-GAL

Distribution network support **Galicia**

Table of physical units:

	220 kV	400 kV
Bays (units)	1	1

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Boimente 400 kV	1	Conv.	SuD	2022
Tomeza 220 kV	1	GIS	SuD	2022

Investment APD-IBA
Distribution network support **Balearic Islands**

General description:

The investment included enables the improvement of the transmission-distribution interface in the Balearic Islands:

- Extension of the Son Pardo 66 kV substation.
- New input-output at the new Son Noguera 66 kV substation on the Arenal-Lluçmajor line (>2026).

Drivers / Objectives:

To support existing demand and vegetative growth in the affected areas.

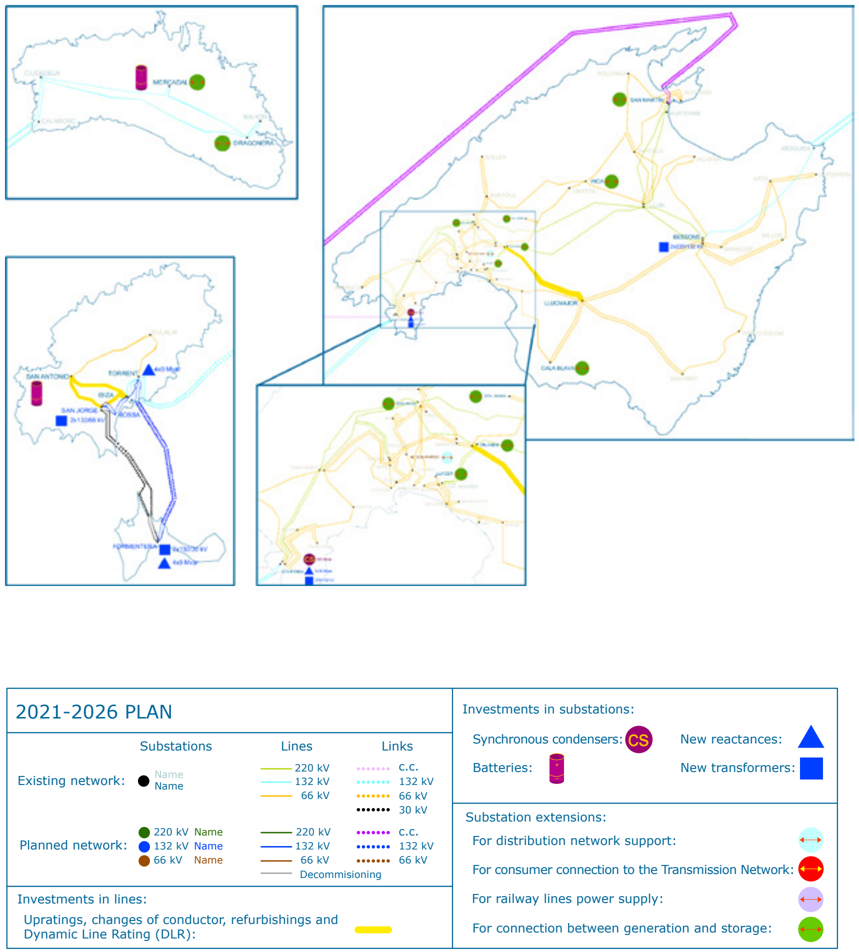
Alternatives:

In the case of Son Pardo and Son Noguera, the distribution network managers have evaluated alternatives to reinforce the distribution network at a higher cost than the alternatives of support from the transmission network.

European dimension:

No

Map:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment APD-IBA
Distribution network support **Balearic Islands**

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
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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV

- M€

Socio-environmental impact:

Impact degree
+ -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree
+ -

PNIEC compliance

Maximisatioin of the RES penetration

Evacuation of RES based on resources

Security of supply

Environmental compatibility

Resolution of technical constraints

Economic efficiency/ sustainability

Maximisiation of the use of the existing network

Reduction of losses

Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment APD-IBA
Distribution network support **Balearic Islands**

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 investment 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 right of way kilometres.

Detailed list of investments:

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 [2]	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.
2. 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 [2]	82	55	1	Cable	SuD	> 2026

Notes:
1. Prepared with 132 kV insulation although initially operating at 66 kV.
2. Prepared with 132 kV insulation although initially operating at 66 kV.

Investment APD-ICA
Distribution network support **Canary Islands**

General description: The investments included enable the improvement of the transmission-distribution interface in the Canary Islands:

- Extension of 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 comment in tables).
- New Mogán 66 kV substation, new double circuit Mogán-Arguineguín 66 kV and second circuit of DC Sta Águeda-Arguineguín 66 kV (H>2026).
- New Las Palmas Oeste 66 kV due to the transfer of the Guanarteme 66 kV substation.

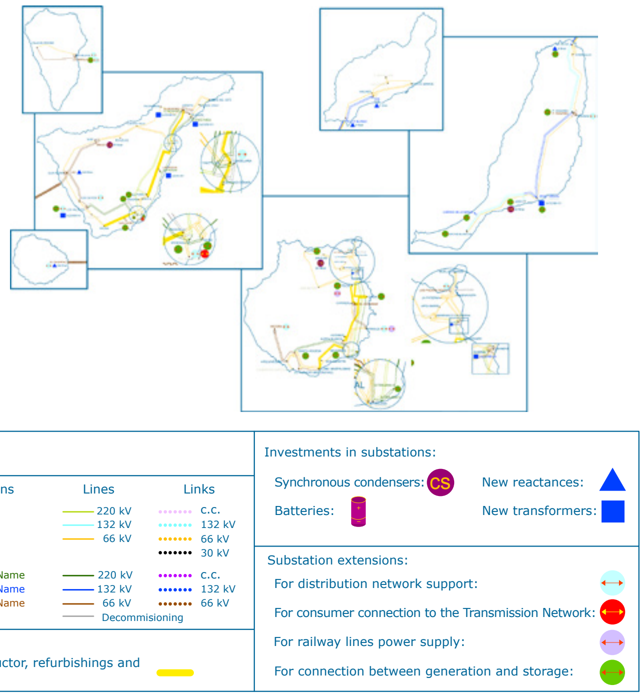
Drivers / Objectives:

- To improve support for existing demand in the Salinas, Candelaria and Las Palmas Oeste áreas in case of failures in the existing transmission-distribution transformers.
- To support the vegetative growth of demand in the western area of Tenerife (Los Vallitos and Los Olivos) and the eastern area of Gran Canaria (Arinaga).
- To create new transmission-distribution support in areas with future demand growth prospects: western Gran Canaria (Mogán), La Gomera (El Palmar), northern Lanzarote (Haría) and Tenerife (Abona).
- To enable adequate connection and evacuation of future renewable energy sources in the north of Lanzarote.

Alternatives: Alternatives to develop the distribution network have been assessed by the distribution network manager at a higher cost than the investment included in the transmission network. In the cases of El Palmar and Guanarteme, no feasible alternatives have been identified to develop the distribution network.

European dimension: No

Map:



Investment APD-ICA
Distribution network support **Canary Islands**

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
25 M€	0.42 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	2.3	2.2	2.2	2.2

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

Profitability:

Profitability: NPV

- M€

Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -

PNIEC compliance

Maximisatioin of the RES penetration

Evacuation of RES based on resources

Security of supply

Environmental compatibility

Resolution of technical constraints

Economic efficiency/ sustainability

Maximisiation of the use of the existing network

Reduction of losses

Investment APD-ICA
Distribution network support **Canary Islands**

Table of physical units:

	66 kV
Bays (units)	21
Overhead line (km)	33
Cables (km)	4

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Las Palmas Oeste 66 kV [1]	Building	2024
Mogán 66 kV	Building	2024

Notes:
1. New substation due to transfer of SE Guanarteme 66 kV.

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 66 kV	2	GIS	SuD	2026
El Palmar de La Gomera 66 kV	1	GIS	TN	2026
Haria 66 kV	1	GIS	SuD	> 2026
Las Palmas Oeste 66 kV	3	GIS	SuD	2024
Las Palmas Oeste 66 kV [2]	1	GIS	TN	2024
Las Salinas 66 kV	1	GIS	SuD	2022
Los Olivos 66 kV	2	GIS	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	2023

Notes:
1. Power supply to port area. Pending allocation.
2. New substation due to transfer of SE Guanarteme 66 kV.

Investment APD-ICA
Distribution network support **Canary Islands**

Detailed list of investments (continued):

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
DC Arguineguín - Mogán 66 kV	80	80	1	Cable	SuD	2024
DC Arguineguín - Mogán 66 kV	67	67	13	Line	SuD	2024
DC Santa Águeda - Arguineguín 66 kV [1]	74	74	6	Line	SuD	> 2026
La Paterna - Las Palmas Oeste 66 kV, circuit 1 [2]	58	58	0.5	Cable	SuD	2024
Muelle Grande - Las Palmas Oeste 66 kV, circuit 1 [3]	62	62	0.5	Cable	SuD	2024
Sabinal - Las Palmas Oeste 66 kV, circuit 1 [4]	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 [5]	67	67	1	Line	SuD	2024

Notes:
1. Double circuit with connection of the second circuit
2. Change of topology incorporating La Paterna-Las Palmas Oeste 66 kV and decommissioning La Paterna-Guanarteme 66 kV.
3. Change of topology incorporating Muelle Grande-Las Palmas Oeste 66 kV and decommissioning Muelle Grande-Guanarteme 66 kV
4. Change of topology incorporating Sabinal-Las Palmas Oeste 66 kV and decommissioning Sabinal-Guanarteme 66 kV.
5. Change of topology incorporating Sta Águeda-Mogán 66 kV and decommissioning Sta Águeda-Arguineguín 4 66 kV and Arguineguín-Mogán 2 66 kV.

Investment APD-MAD_1
Distribution network support **Madrid**

General description: The investments included enable the transmission-distribution interface in the Madrid area to be improved:

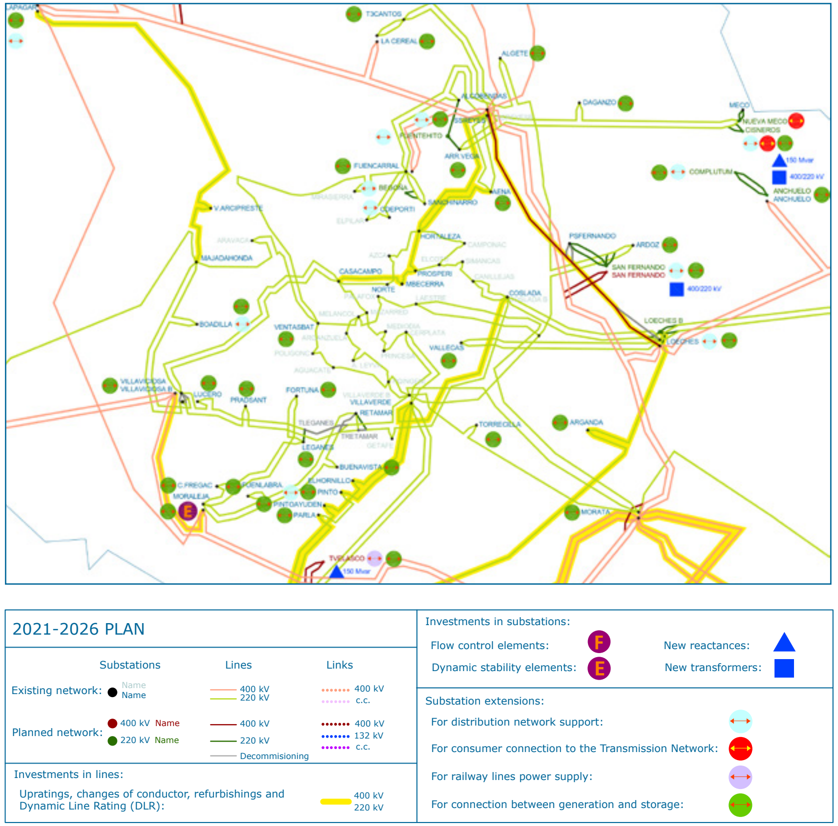
- New Fuente Hito 220 kV substation. New input-output at the new Begoña 220 kV substation on the Fuencarral-Sanchinarro 220 kV cable and Cristo de Rivas 220 kV substation on the Loeches-Vallecas 220 kV line (>2026).
- New Alcobendas-Fuente Hito cable and Fuente Hito-Arroyo de la Vega cable line.
- Extension of Fuente Hito (2), Begoña, Ciudad Deportiva, Boadilla, Loeches, Valdemoro, Galapagar (2), Pinto and Morata 220 kV substations (>2026)
- New Begoña- Fuente Hito 220 kV cable (>2026)
- Change of configuration of Valdemoro 220 kV substation.

Drivers / Objectives: To improve the security of supply of demand, as well as supplying new specific demands in the Madrid area.

Alternatives: Alternatives to reinforce the distribution network have been assessed by the distribution network manager at a higher cost than the support from the transmission network included. Likewise, in some cases, there are studies coordinated between the system operator and the distribution network manager indicating that the optimal solution is the proposed alternative.

European dimension: No

Map:



Investment APD-MAD_1
Distribution network support **Madrid**

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
109.4 M€	0.77 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	9.6	9.5	9.3	9.1	9.0	8.8	8.7	8.5	8.4

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

Profitability:

Profitability: NPV

- M€

Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -

PNIEC compliance

Maximisatioin of the RES penetration

Evacuation of RES based on resources

Security of supply

Environmental compatibility

Resolution of technical constraints

Economic efficiency/ sustainability

Maximisiation of the use of the existing network

Reduction of losses

Investment APD-MAD_1
Distribution network support **Madrid**

Table of physical units:

	220 kV
Bays (units)	25
Partial renewal of bays (units)	0.1
Cables (km)	34

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

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 investments (continued):

Substation extension	units	Type	Driv.	Year
Alcobendas 220 kV	1	GIS	TN	2025
Arroyo de La Vega 220 kV	1	Conv.	TN	2025
Begoña 220 kV	1	GIS	SuD	2024
Begoña 220 kV	3	GIS	TN	2024
Begoña 220 kV	1	GIS	TN	> 2026
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	Conv.	SuD	2022
Loeches 220 kV [1]	1	Conv.	SuD	2022
Morata 220 kV	1	Conv.	SuD	> 2026
Pinto 220 kV	1	Conv.	SuD	2022
Valdemoro 220 kV	1	Conv.	SuD	2024

Notes:
1. In Double Bus A.

Investment APD-MAD_1
Distribution network support **Madrid**

Detailed list of investments (continued):

Partial renewal of bays	units	Type	Driv.	Year
Valdemoro 220 kV	0	Conv.	TN	2022

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
Begoña - Fuente Hito 220 kV, circuit 1	470	470	16	Cable	SuD	> 2026
I/O in Begoña, of Fuencarral - Sanchinarro 220 kV, circuit 1	450	450	2	Cable	SuD	2024
I/O in Cristo de Rivas, of Loeches - Vallecas 220 kV, circuit 1	310	310	2	Cable	SuD	> 2026

Investment APD-MAD_2

Distribution network support **East Madrid. Henares corridor**

General description: The investments included will improve the transmission-distribution interface in the Henares corridor area of Madrid:

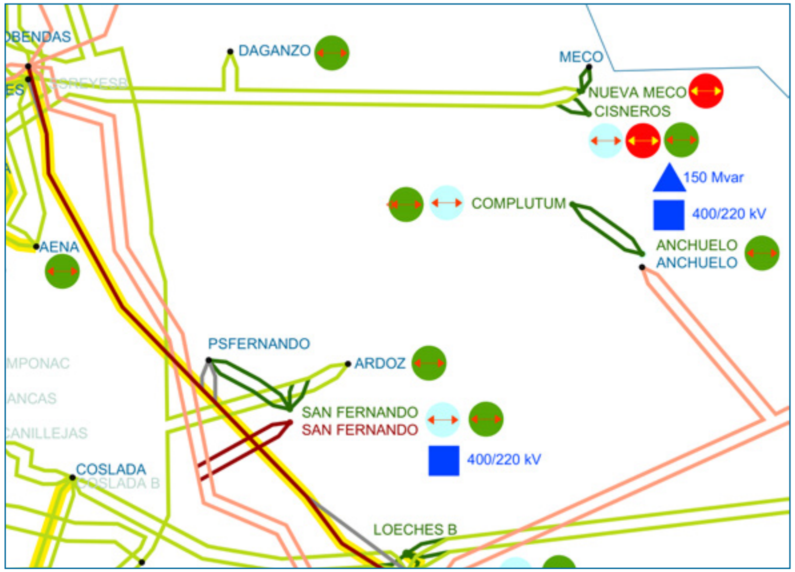
- New Complutum 220 kV substation and new Anchuelo-Complutum 220 kV double circuit.
- New Anchuelo 220 kV substation and new transformer 1 at Anchuelo 400/220.
- New input-output at the new Cisneros 220 kV substation on the Arroyo de la Vega-Meco line.
- Extension of Complutum, San Fernando and Cisneros (2) 220 kV substations
- New double circuit Complutum-Cisneros 220 kV (>2026).

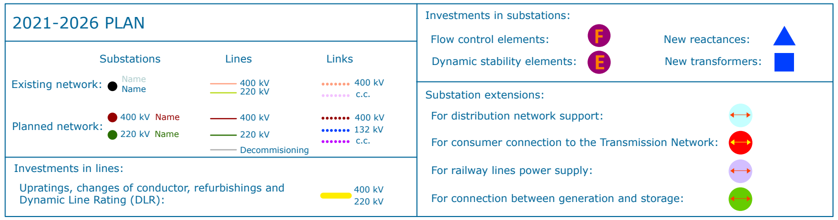
Drivers / Objectives: To improve the security of supply of demand, as well as to supply new singular demands in the area of the Henares corridor in Madrid.

Alternatives: The distribution network manager has assessed alternatives to reinforce the distribution network at a higher cost than the alternatives for support from the transmission network. Likewise, in some cases, there are coordinated studies between the system operator and the distribution network manager indicating that the alternatives included are the best ones to meet the needs identified in the distribution network.

European dimension: No

Map:





Investment APD-MAD_2

Distribution network support **East Madrid. Henares corridor**

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
72.4 M€	0.66 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	5.8	5.7

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

Profitability:

Profitability: NPV
- M€

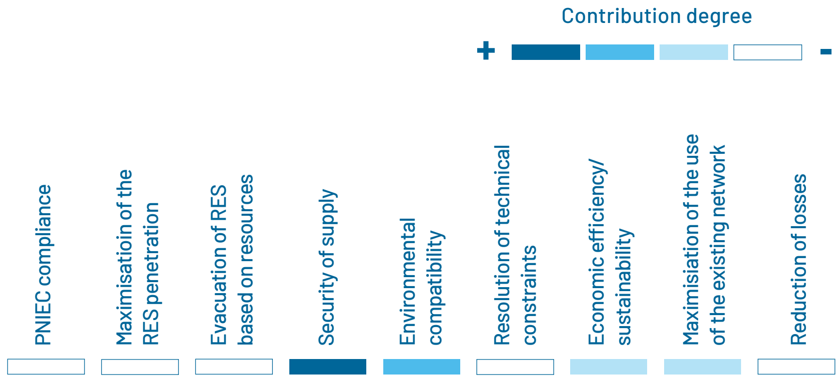
Socio-environmental impact:

Impact degree
+ -

Environmental impact

Social impact

Contribution to guiding principles:



Investment APD-MAD_2
Distribution network support **East Madrid. Henares corridor**

Table of physical units:

	220 kV	400 kV
Bays (units)	18	1
Overhead line (km)	23	
Cables (km)	16	
Transformed to 220 kV (MVA)		600

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

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	Conv.	TN	2023
Anchuelo 220 kV	2	Conv.	TN	2022
Anchuelo 400 kV	1	Conv.	TN	2022
Cisneros 220 kV	2	GIS	SuD	2024

Detailed list of investments (continued):

Substation extension (continued)	units	Type	Driv.	Year
Cisneros 220 kV	2	GIS	TN	> 2026
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
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 - Meco 220 kV, circuit 1	470	320	2	Line	SuD	2024
I/O in Cisneros, of Arroyo de La Vega - Meco 220 kV, circuit 1	470	320	2	Cable	SuD	2024

New transformers	MVA	Type	Driv.	Year
Anchuelo 400/220 kV, TF1	600	Triph. B.	SuD	2022

Investment APD-MUR
Distribution network support **Murcia**

General description:

The investments included allow the transmission-distribution interface in the Region of Murcia to be improved:

- New input-output at the new Espinardo 220 kV substation on the El Palmar-Murcia 220 kV line.
- Extension of Espinardo 220 kV.
- Extension of Peñarrubia 400 kV.

Drivers / Objectives:

To improve the security of supply of the demand of the city of Murcia, to support the vegetative growth of demand in case of failures in the existing transmission-distribution transformers, as well as to facilitate the evacuation of renewables in the distribution network.

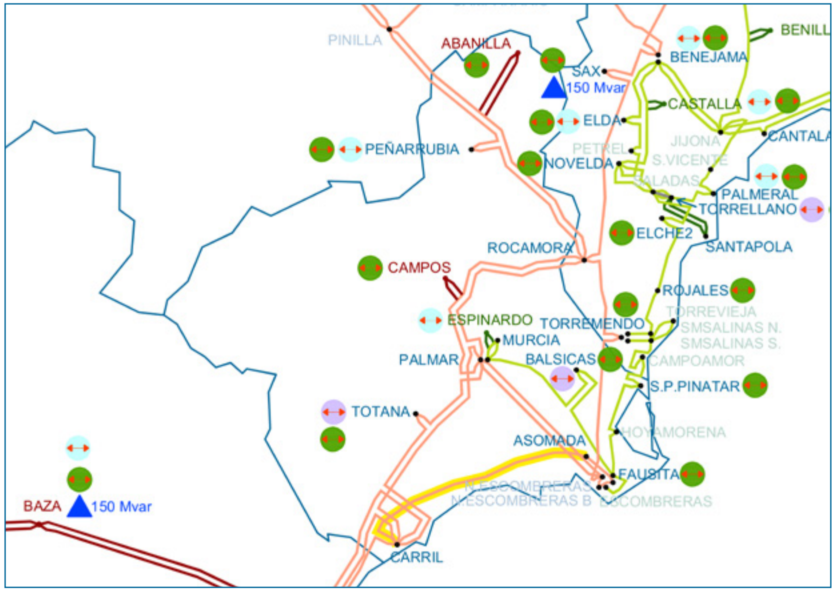
Alternatives:

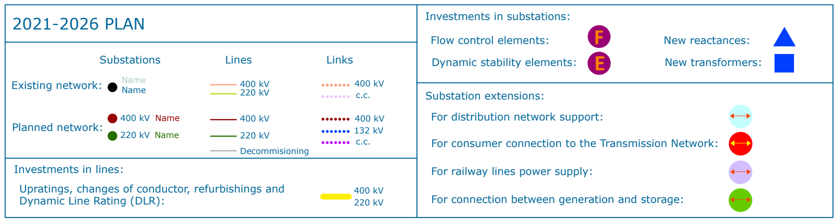
The distribution network manager has not found any feasible alternatives to reinforce the distribution network to meet the needs identified.

European dimension:

No

Map:





Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment APD-MUR
Distribution network support **Murcia**

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
61.6 M€	0.21 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	5.2	5.1	5.0	4.9	4.8	4.8	4.7	4.6	4.5

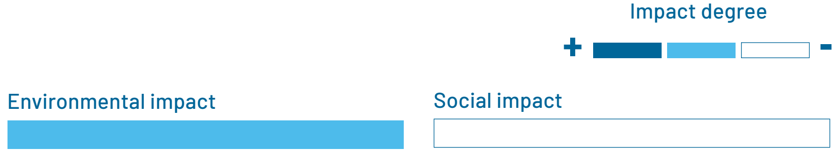
Note: the CAPEX covered in the cost-benefit analysis includes the costs of the complete project under study, including investments that may be scheduled beyond 2026.

Profitability:

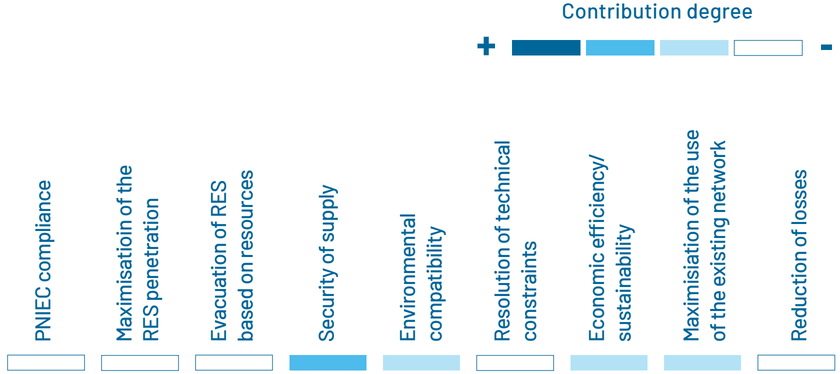
Profitability: NPV

- M€

Socio-environmental impact:



Contribution to guiding principles:



Investment APD-MUR
Distribution network support **Murcia**

Table of physical units:

	220 kV	400 kV
Bays (units)	4	2
Cables (km)	24	

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

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	Conv.	TN	2023
Peñarrubia 400 kV	1	Conv.	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	12	Cable	SuD	2023

I Investment APD-NAV
Distribution network support **Navarre**

I General description:

The investments included allow the transmission-distribution interface in Navarre to be improved:

- New Tierra Estella 220 kV substation and new double circuit Muruarte-Tierra Estella 220 kV.
- Extensions (2) of the Tierra Estella 220 kV substation.

I Drivers / Objectives:

To improve the security of supply of demand in the Tierra Estella area.

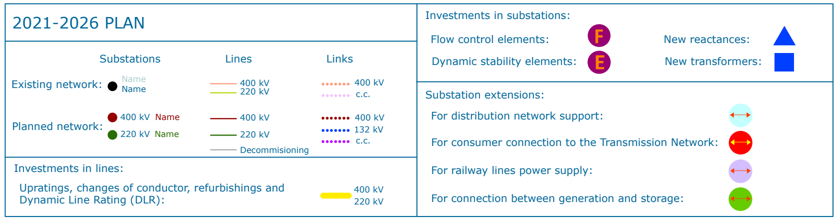
I Alternatives:

Alternatives to reinforce the distribution network by the distribution network manager have been assessed at a higher cost than the alternatives of support from the transmission network. In addition, the investment will allow greater RES integration in the area into the distribution grid.

I European dimension:

No

I Map:



Investment APD-NAV
Distribution network support **Navarre**

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
23.7 M€	0.34 M€/year

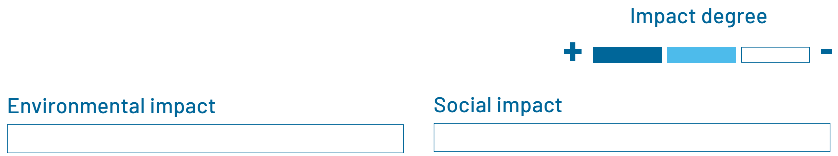
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	2.3	2.2	2.2	2.2	2.1	2.1	2.1	2.0	2.0

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

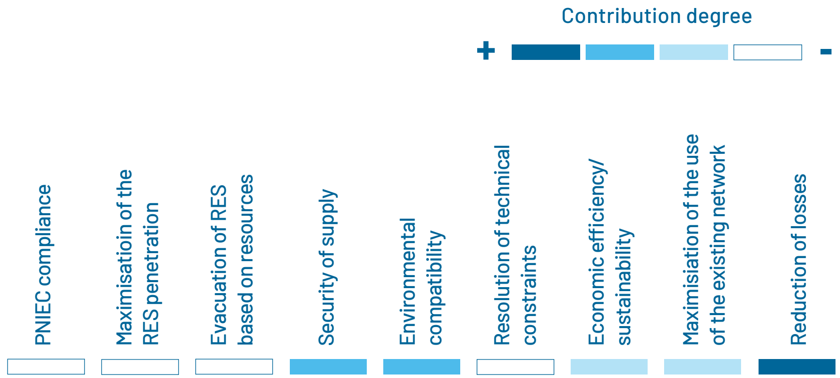
Profitability:

Profitability: NPV
- M€

Socio-environmental impact:



Contribution to guiding principles:



Investment APD-NAV
Distribution network support **Navarre**

Table of physical units:

	220 kV
Bays (units)	7
Overhead line (km)	70

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Tierra Estella 220 kV	Outdoor	2023

Substation extension	units	Type	Driv.	Year
Muruarte 220 kV	2	Conv.	TN	2023
Tierra Estella 220 kV	1	Conv.	SuD	2023
Tierra Estella 220 kV [1]	1	Conv.	SuD	> 2026
Tierra Estella 220 kV	3	Conv.	TN	2023

Notes:
1. The 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

Investment APD-PVA
Distribution network support **Basque Country**

General description:

The investments included enable the transmission-distribution interface in the Basque Country area to be improved:

- New Barrundia 220 kV substation and connection with Elgea 220 kV.
- Extension of the Ali and Barrundia 220 kV substations.
- Extension of the Abanto 400 kV substation.
- Extension of the Jundiz 220 kV substation (>2026)
- Extension of La Jara 220 kV substation to finish equipping the distribution support bays (H>2026).

Drivers / Objectives:

- To ensure supply to meet the vegetative growth in demand in Vitoria with the reinforcement of Ali, Barrundia and Jundiz.
- To improve security of supply with investment in the Abanto and La Jara substations.

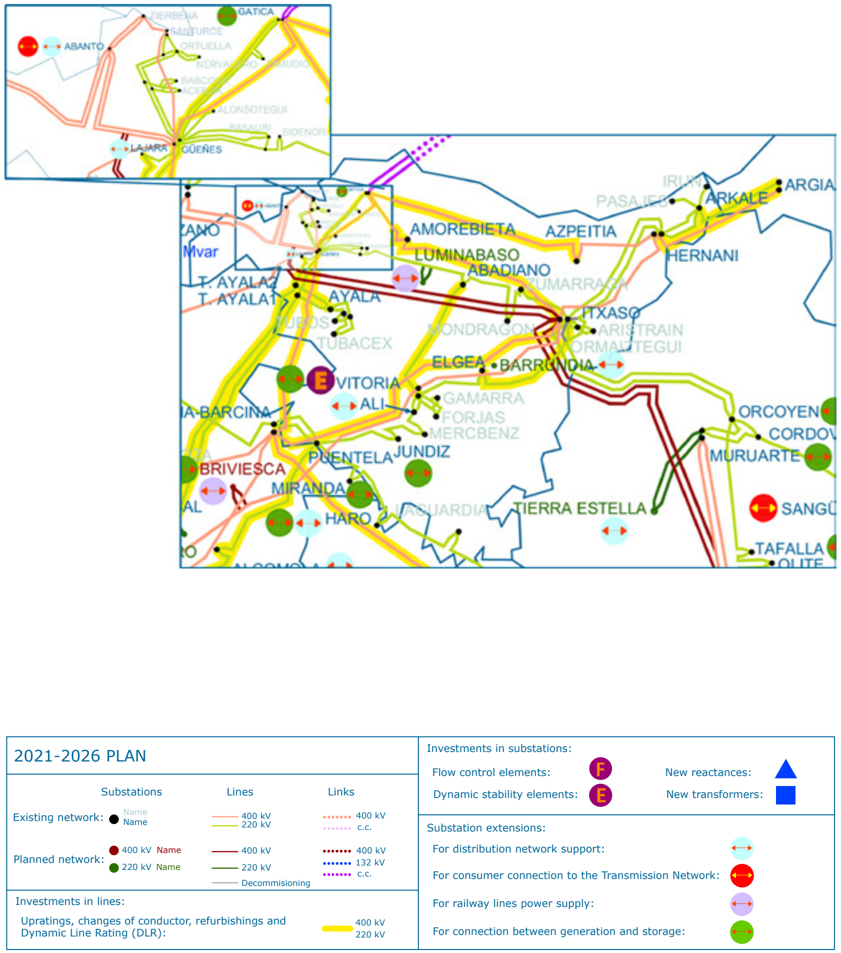
Alternatives:

Alternatives to reinforce the distribution network have been assessed by the distribution network manager at a higher cost than the support from the transmission network.

European dimension:

No

Map:



Investment APD-PVA
Distribution network support **Basque Country**

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
14.4 M€	0.45 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5

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

Profitability:

Profitability: NPV
- M€

Socio-environmental impact:

Impact degree

\+ -

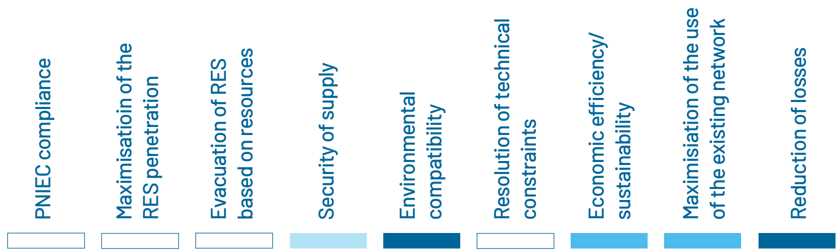
Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree

\+ -



Investment APD-PVA
Distribution network support **Basque Country**

Table of physical units:

	220 kV	400 kV
Bays (units)	11	1
Overhead line (km)	2	
Cables (km)	1	

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Barrundia 220 kV	Outdoor	2023

Substation extension	units	Type	Driv.	Year
Abanto 400 kV [1]	1	Conv.	SuD	2022
Ali 220 kV	1	Conv.	SuD	2023
Barrundia 220 kV	2	Conv.	SuD	2023
Barrundia 220 kV	1	Conv.	Gen./Sto.	2023
Barrundia 220 kV	3	Conv.	TN	2023
Jundiz 220 kV	1	GIS	SuD	> 2026
La Jara 220 kV	1	GIS	TN	2023
La Jara 220 kV [2 3]	2	Conv.	SuD	2023

Notes:
1. Transformer 400/132 kV
2. Transformer switch
3. Transformer switch

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Ali - Ali 220 kV, circuit 1			1	Cable	SuD	2023
DC Elgea - Barrundia 220 kV			1	Line	TN	2023

Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment APD-RIO
Distribution network support **La Rioja**

General description: The investments included will improve the transmission-distribution interface in La Rioja area:

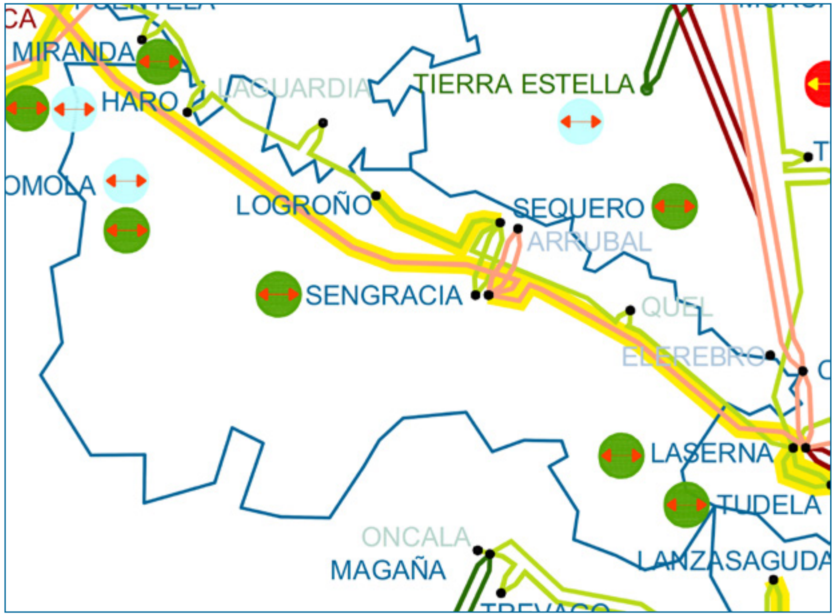
- Extension of the Haro 220 kV substation.

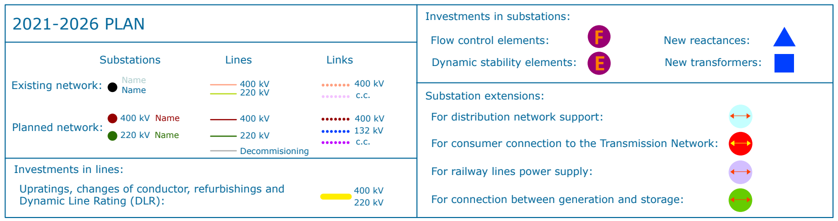
Drivers / Objectives: To improve the security of supply of demand in the Haro area in case of failures in the existing transmission-distribution transformers.

Alternatives: No feasible alternatives have been detected to reinforce the distribution network by the distribution network manager.

European dimension: No

Map:





Investment APD-RIO
Distribution network support **La Rioja**

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
1.1 M€	0.02 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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
- M€

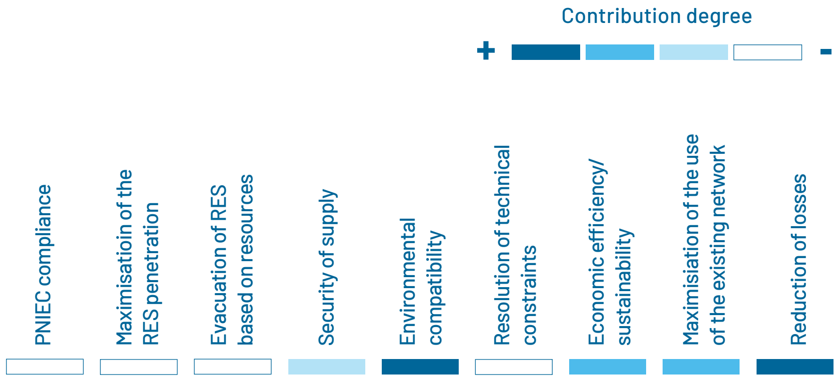
Socio-environmental impact:

Impact degree
\+ –

Environmental impact

Social impact

Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment APD-RIO
Distribution network support **La Rioja**

Table of physical units:

	220 kV
Bays (units)	1

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Haro 220 kV	1	GIS	SuD	2022

I Investment CONSUM
Consumers connected to the transmission network

General description: The following investment is included to supply consumers connected to the transmission network:

- New input-output at the new Francolí 220 kV substation on the Perafort-Morell 220 kV line.
- New Sagrajas and Rio Caya 400 kV substations and new San Serván-Sagrajas and Sagrajas-Rio Caya 400 kV DCs.
- New input-output at the new Calatorao 220 kV substation on the Jalon-Los Vientos 1 220 kV line.
- New Nueva Meco 220 kV substation with connection to Meco, Arroyo de la Vega and Daganzo 220 kV.
- Extension and change of configuration of Abrera 220 kV and El Espartal 220 kV substation.
- Extension of the 220 kV substations at Los Barrios, Sangüesa, Cártama, Constantí, Los Montes, Cisneros, Cerdá, Francolí, Puigpelat and Calera y Chozas; of the 400 kV substations at Abanto, Arañuelo, Morvedre and Peñaflor and the 66 kV substation at Abona.

Drivers / Objectives: To supply large consumers directly connected to the transmission network.

Alternatives: Several connection alternatives have been assessed at other substations. Specifically:

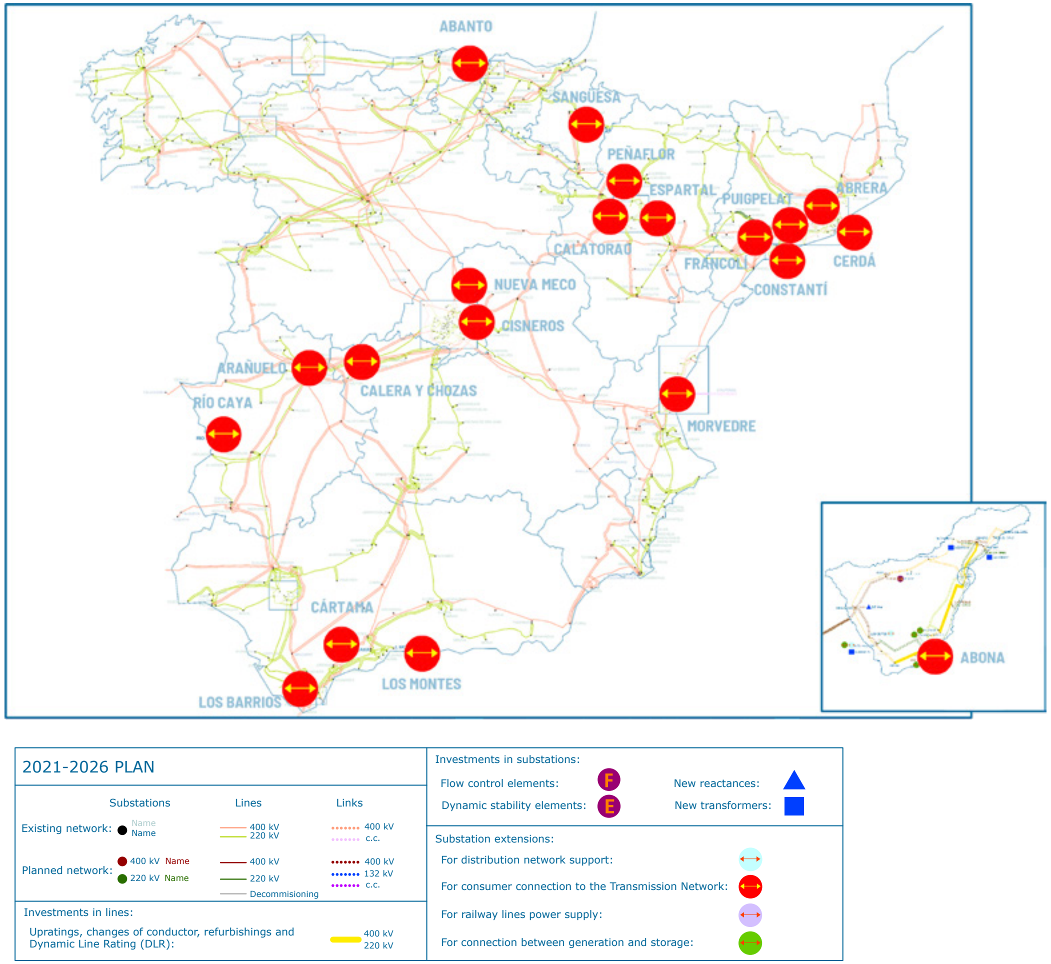
- The connection alternatives at Morell 220 kV are not feasible.
- The connection alternatives at Esquedas and Abrera 220 kV without renewing the substation are not feasible.
- The connection alternatives at Ave Zaragoza 220 kV do not meet the stated requirements.
- The connection alternatives at Nerja as an input-output at Los Montes-Saleres 220 kV are not feasible due to the environmental and social complications involved in the implementation of this line.

European dimension: No

I Investment CONSUM

Consumers connected to the transmission network

I Map:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment CONSUM

Consumers connected to the transmission network

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
79.5 M€	2.56 M€/year

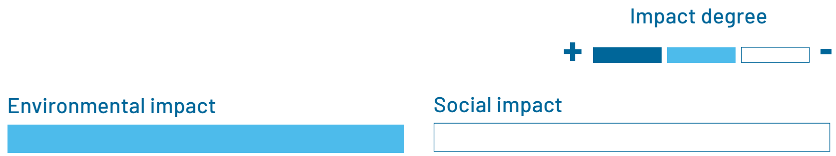
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	9.0	8.9	8.8	8.6	8.5	8.4	8.3	8.2	8.1

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

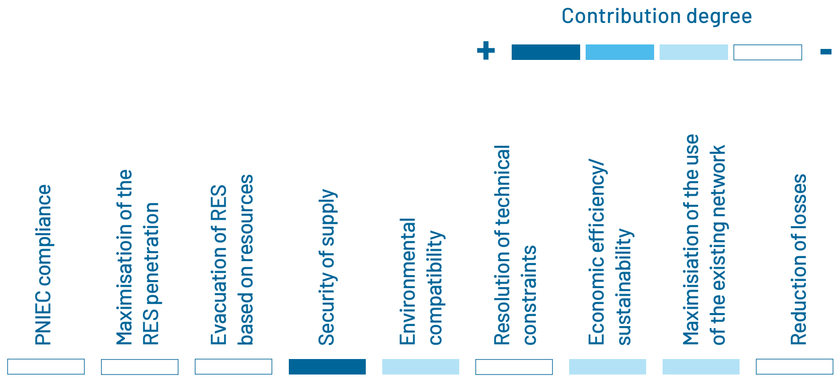
Profitability:

Profitability: NPV
- M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment CONSUM
Consumers connected to the transmission network

Table of physical units:

	220 kV	400 kV
Bays (units)	48	21
Overhead line (km)	18	107
Cables (km)	1	

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Calatorao 220 kV	Outdoor	2025
Francolí 220 kV [1]	Outdoor	2024
Nueva Meco 220 kV	Outdoor	2024
Río Caya 400 kV	Outdoor	2024
Sagrajas 400 kV	Outdoor	2024

Notes:
1. Likewise called Nueva Morell

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Abanto 400 kV	1	Conv.	Consum.	2023
Abrera 220 kV	6	GIS	TN	2024
Abrera 220 kV	2	GIS	Consum.	2024
Arañuelo 400 kV	2	Conv.	Consum.	2024
Calatorao 220 kV	4	Conv.	Consum.	2025
Calatorao 220 kV	3	Conv.	TN	2025
Calera y Chozas 220 kV	4	Conv.	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	Conv.	Consum.	2023
Espartal 220 kV	3	Conv.	TN	2024
Espartal 220 kV	2	Conv.	Consum.	2024
Francolí 220 kV	2	Conv.	Consum.	2024
Francolí 220 kV	1	Conv.	Consum.	2023
Francolí 220 kV	4	Conv.	TN	2024
La Selva 220 kV	1	GIS	TN	2024
Los Barrios 220 kV	1	Conv.	Consum.	2023
Los Montes 220 kV	1	Conv.	Consum.	2023
Morvedre 400 kV	2	Conv.	Consum.	2024
Nueva Meco 220 kV	2	Conv.	Consum.	2024

I Investment CONSUM
Consumers connected to the transmission network

I Detailed list of investments (continued):

Substation extension (continued)	units	Type	Driv.	Year
Nueva Meco 220 kV	5	Conv.	TN	2024
Peñaflor 400 kV	2	Conv.	Consum.	2024
Puigpelat 220 kV	1	GIS	Consum.	2024
Río Caya 400 kV	1	Conv.	Consum.	2024
Río Caya 400 kV	4	Conv.	TN	2024
Sagrajas 400 kV	6	Conv.	TN	2024
San Servan 400 kV	3	Conv.	TN	2024
Sangüesa 220 kV	1	Conv.	Consum.	2023

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Abrera - Abrera 220 kV, circuit 1 [1]			0.2	Cable	Consum.	2024
Abrera - Abrera 220 kV, circuit 2 [2]			0.2	Cable	Consum.	2024
Abrera - Abrera 220 kV, circuit 3 [3]			0.2	Cable	Consum.	2024
Abrera - Abrera 220 kV, circuit 4 [4]			0.2	Cable	Consum.	2024
Abrera - Abrera 220 kV, circuit 5			0.2	Cable	Consum.	2024
DC Espartal - Espartal 220 kV			0.3	Line	Consum.	2024
DC Meco - Nueva Meco 220 kV			0.2	Line	TN	2024
DC Nueva Meco-Arroyo de La Vega / Daganzo 220kV [5]			0.2	Line	TN	2024
DC Sagrajas - Río Caya 400 kV	1,960	1,790	24	Line	Consum.	2024
DC San Servan - Sagrajas 400 kV	1,960	1,790	30	Line	Consum.	2024
I/O in Abrera, of Pujalt - Rubí 220 kV, circuit 1 [6]	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, of Perafort - Morell 220 kV, circuit 1	190	170	0.5	Line	Consum.	2024
Francolí - La Selva 220 kV, circuit 1	880	760	8	Line	Consum.	2024

Notes:
1. Connection of the bay to the distribution transformer.
2. Connection of the bay to the distribution transformer.
3. Connection of the bay to the distribution transformer.
4. Connection of the bay to the distribution transformer.
5. Change of topology incorporating Nueva Meco-A. Vega/ Daganzo 220 kV and decommissioning Meco-A.Vega/ Daganzo 220 kV.
6. New section of line required at the I/O at Abrera 220 kV from Pujalt-Rubí 220 kV.

I Investment INT_ESP-FRA_1

International interconnections **Spain-France via the Bay of Biscay**

I General description:

The project involves a new direct current submarine interconnection between Spain and France, using VSC technology and consisting of two symmetrical 400 kV monopoles of 1000 MW each. This interconnection will connect to the existing Gatica 400 kV substation through a double circuit of 400 kV.

I Drivers / Objectives:

- Integration of the peninsular electricity system into the single European market, contributing to reducing the price gap between countries.
- To contribute to integrating existing and future renewable energy throughout Europe, and especially in Spain and the Iberian Peninsula.
- To reduce the electrical isolation of Spain and the Iberian Peninsula, and to improve their level of interconnection in order to meet the targets set by the EU.
- To comply with the intergovernmental agreements of the Madrid Declaration.

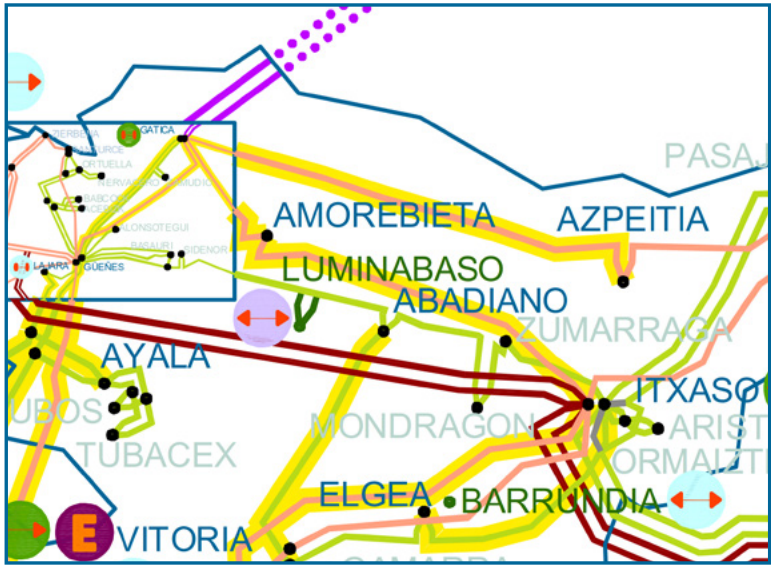
I Alternatives:

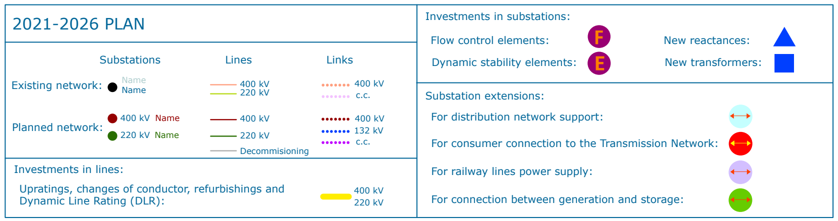
After the commissioning of the eastern interconnection in 2015, the optimal reinforcement for an adequate flow distribution should be located in the western part of the Spain-France border. Other overhead or underground land-based solutions are unfeasible due to their physical implementation and have a much higher social impact and environmental impact.

I European dimension:

Yes / TYNDP 2020 Project 16 and PIC Project 2.7 in 2019 list.

I Map:





I Investment 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 Costs:

CAPEX	OPEX
934.3 M€	9.14 M€/year

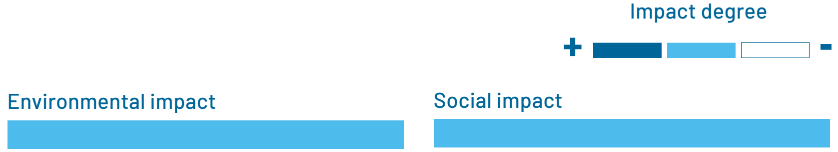
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	84.6	83.3	82.0	80.7	79.4	78.1	76.8	75.5	74.2

Note: The CAPEX indicated represents the part of the investment 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.

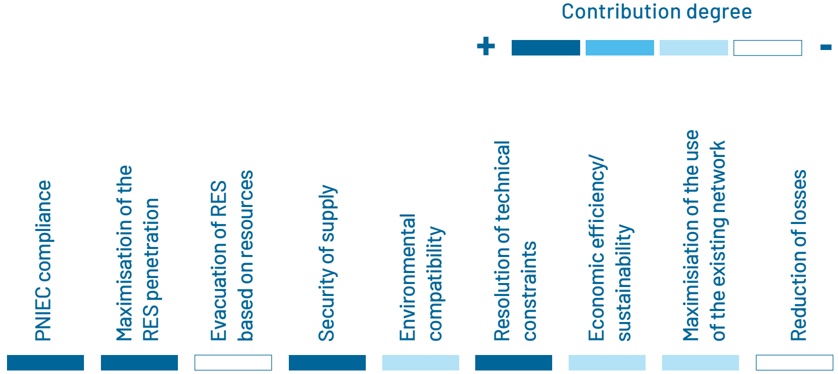
I Profitability:

Profitability: NPV
2,490 M€

I Socio-environmental impact:



I Contribution to guiding principles:



Investment INT_ESP-FRA_1
International interconnections **Spain-France via the Bay of Biscay**

Table of physical units:

	400 kV
Bays (units)	3
Overhead line (km)	2
Submarine Link (km)	390

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Gatica 400 kV	3	Conv.	TN	2026

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
DC Gatica - Gatica EC 400 kV			1	Line	INT	2026
Gatica - Cubnezais 400 kV, circuit 1 [1]	2,000	2,000	390	Subm.	INT	2026

Notes:
1. Submarine Link HVDC with 2 symmetrical monopoles.

Investment INT_ESP-FRA_2

International interconnections

Reinforcement of the Spain - France interconnection (Gatica)

General description:

The project involves the internal reinforcements associated with the future submarine interconnection between Spain and France via the Bay of Biscay:

- Uprating of the Gatica-Gueñes 400kV, Gatica-Azpeitia 400kV, Gatica - Amorebieta and Amorebieta-Itxaso 400kV lines.
- New transformer at Gatica 400/220 kV (>2026).

Drivers / Objectives:

- To meet the flows from/to France, to be increased due to the increase in the Net Transfer Capacity as a result of the future Bay of Biscay link.
- To enable the increased Net Transfer Capacity.
- To reduce the need to apply technical constraints to reach the objective of 70% of the available capacity in these elements for commercial Net Transfer Capacity according to Art. 16(8) of Regulation 2019/943 of the internal energy market.

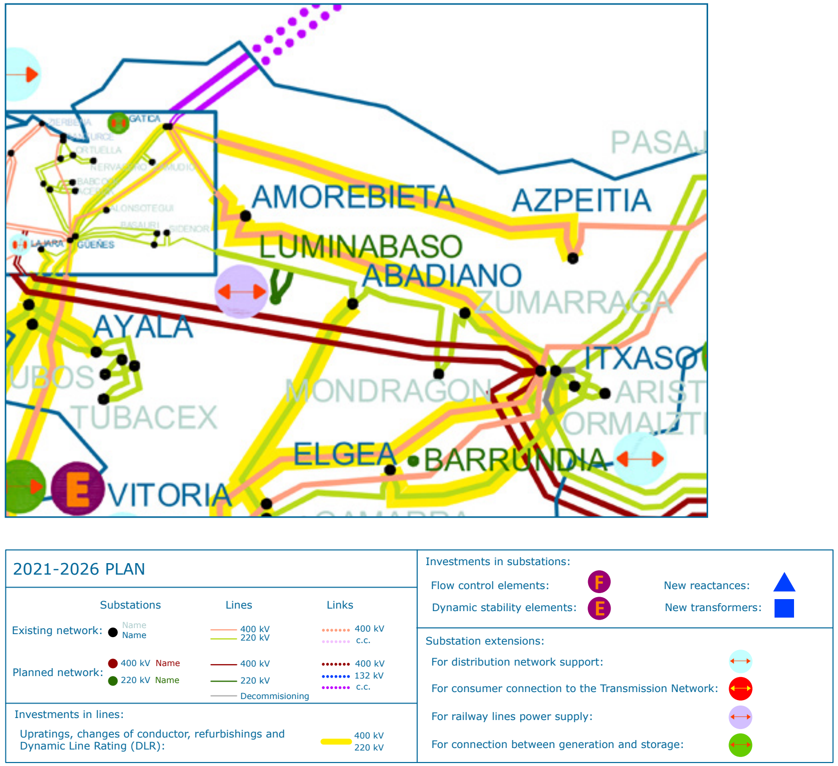
Alternatives:

Operating solutions or DLRs are not solutions that can replace this investment due to the lack of sufficient capacity to ensure that these elements do not become constraining elements of the net transfer capacity with France. The renewal of the current 400/220 kV transformer at Gatica by a larger machine (600 MVA) allows the installation of a new transformer at Gatica to be postponed to a timeframe beyond 2026.

European dimension:

Yes / Projects 378 and 379 of the TYNDP 2020.

Map:



Investment INT_ESP-FRA_2
International interconnections
Reinforcement of the Spain - France interconnection (Gatica)

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
12.2 M€	0.21 M€/year

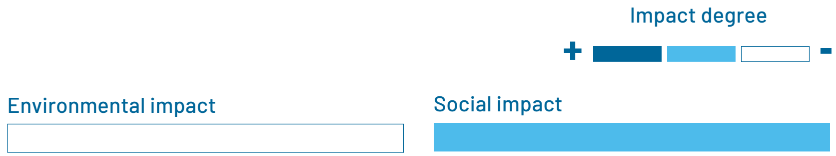
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1

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

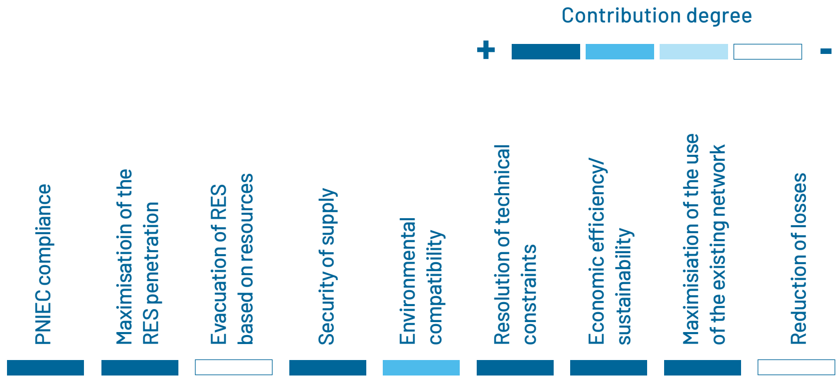
Profitability:

Profitability: NPV
- M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment INT_ESP-FRA_2
International interconnections
Reinforcement of the Spain - France interconnection (Gatica)

Table of physical units:

	200 kV	400 kV
Bays (units)	1	2
Transformed to 220 kV (MVA)		600
Uprating (km)		164

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Gatica 220 kV	1	Conv.	TN	> 2026
Gatica 400 kV	2	Conv.	TN	> 2026

Detailed list of investments (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

Investment INT_ESP-FRA_3

International interconnections

Reinforcement of the Spain-France (Hernani-Argia)

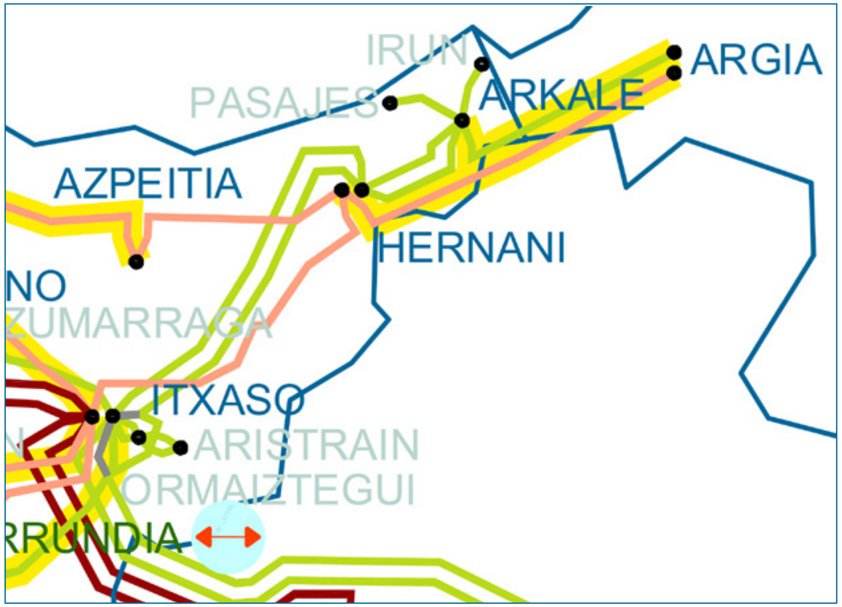
General description: The project involves the renewal with conductor replacement of the current Hernani - French Border 400 kV section of the Hernani - Argia line.

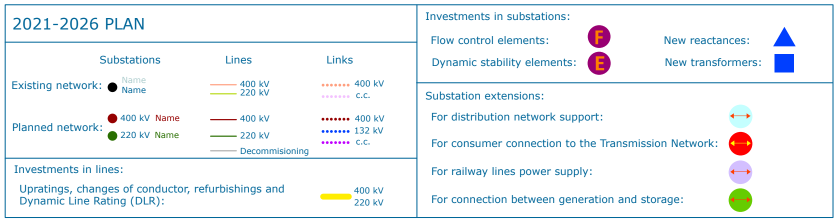
Drivers / Objectives: To meet the flows from/to France, enabling an increased net transfer capacity.

Alternatives: The use of standard uprating fails to meet the required capacity values to allow an increased net transfer capacity with France. The application of DLR fails to achieve a significant increased capacity when this section is constraining.

European dimension: No

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment INT_ESP-FRA_3
International interconnections
Reinforcement of the Spain-France (Hernani-Argia)

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
6.6 M€	- M€/year

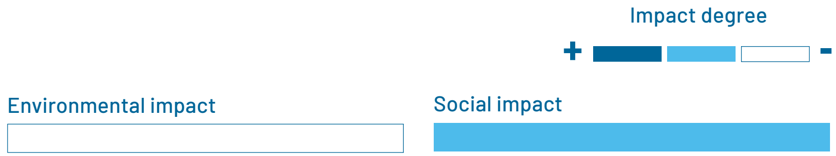
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

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

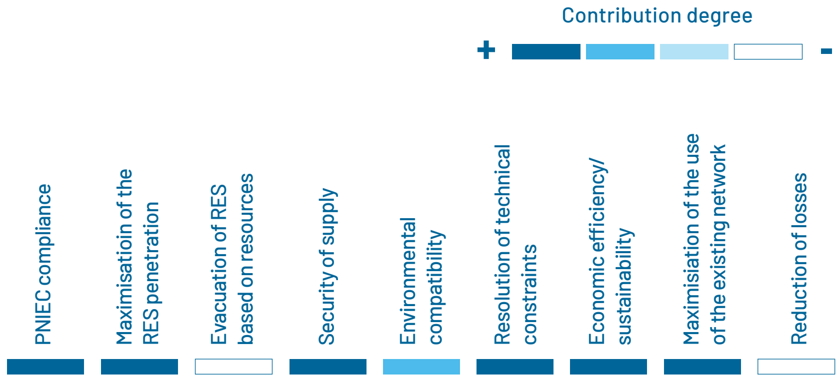
Profitability:

Profitability: NPV
- M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment INT_ESP-FRA_3
International interconnections
Reinforcement of the Spain-France (Hernani-Argia)

Table of physical units:

	400 kV
Change of conductor (km)	24

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Change 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

Investment INT_ESP-MAR

International interconnections **Interconnection with Morocco**

General description: This investment involves the construction of a third 400 kV axis between Spain and Morocco with a new underground-submarine link between Puerto de la Cruz 400 kV and Beni Harchane 400 kV (Morocco) and four 50 MVAr reactances at Puerto de la Cruz 400 kV.

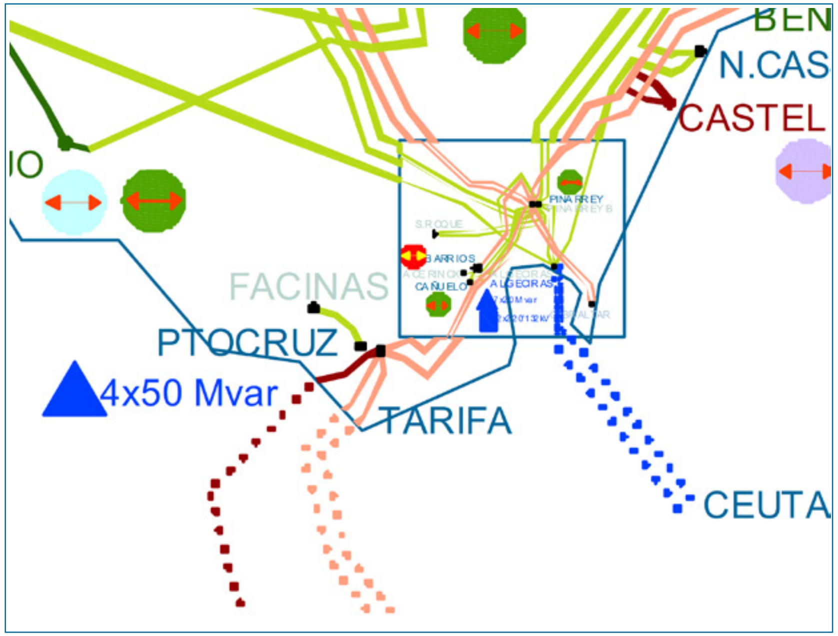
Drivers / Objectives:

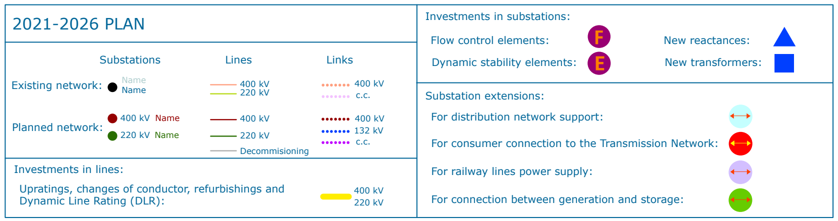
- To increase the net transfer capacity between the Spanish and Moroccan electricity systems.
- A technical annex is included with a detailed CBA analysis of this investment.

Alternatives: The alternative of a direct current link has been assessed, a solution which does not provide an equal contribution to the security of the Moroccan system and has a higher investment cost.

European dimension: No

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment INT_ESP-MAR

International interconnections **Interconnection with Morocco**

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
234.7 M€	4.29 M€/year

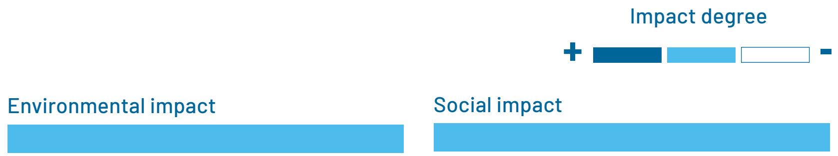
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	23.3	22.9	22.6	22.3	21.9	21.6	21.3	21.0	20.6

Note: The above CAPEX reflects the investment for the entire interconnection project, notwithstanding the agreement reached on cost-allocation between the parties. The cost-benefit 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 investments in the Spanish Mainland network are commissioned.

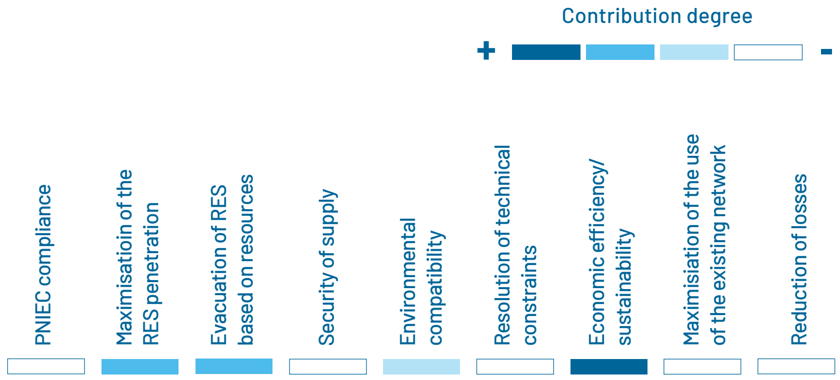
Profitability:

Profitability: NPV
966 M€

Socio-environmental impact:



Contribution to guiding principles:



Investment INT_ESP-MAR

International interconnections **Interconnection with Morocco**

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 investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Puerto de La Cruz 400 kV	6	Conv.	TN	2026

Detailed list of investments (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 reached on the cost allocation 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 [2]	50	-	INT	2026
Puerto de La Cruz 400 kV, REA6 [3]	50	-	INT	2026
Puerto de La Cruz 400 kV, REA7 [4]	50	-	INT	2026

Notes:
1. Cable-supported reactance
2. Cable-supported reactance
3. Cable-supported reactance
4. Cable-supported reactance

Investment INT_ESP-AND

International interconnections **Interconnection with Andorra**

General description:

This investment involves the construction of a new interconnection between Spain and Andorra including the following elements:

- New 220 kV double circuit from Adrall to the Andorran border.
- Extension and adaptation of the Adrall 220 kV substation.
- Modifications to the Adrall access to the Adrall-Llavorsí 220 kV and Adrall-Cercs 220 kV lines.

Drivers / Objectives:

To increase the net transfer capacity with the Andorran system in order to feed the expected demands in this system from the Spanish system.

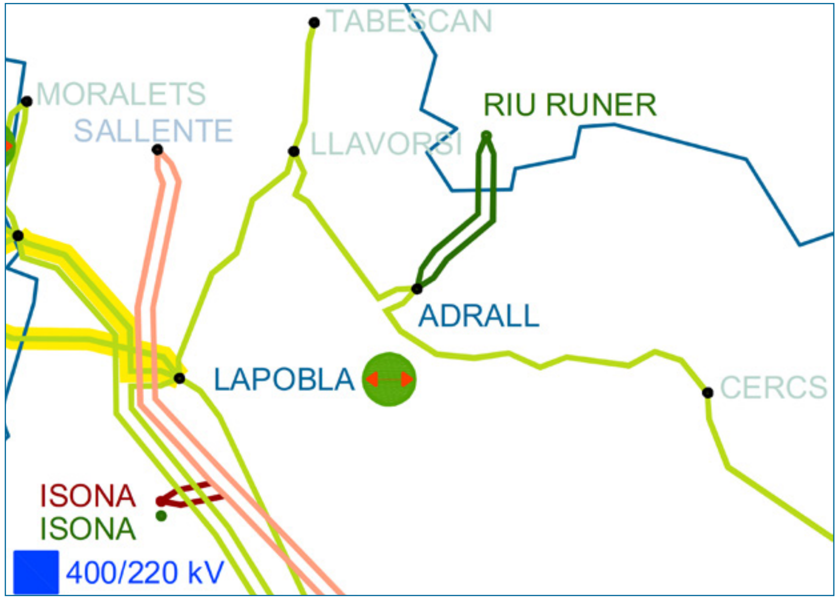
Alternatives:

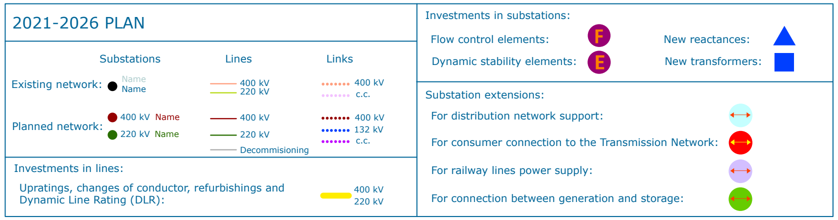
Uprating the current 110 kV axis fails to achieve sufficient capacity.

European dimension:

No

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment INT_ESP-AND

International interconnections **Interconnection with Andorra**

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
14.5 M€	0.23 M€/year

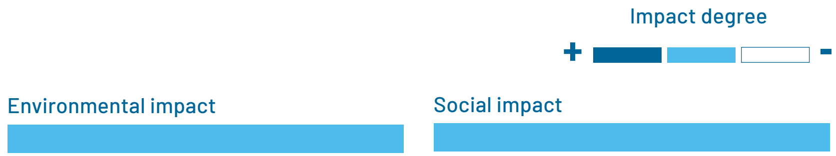
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2

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

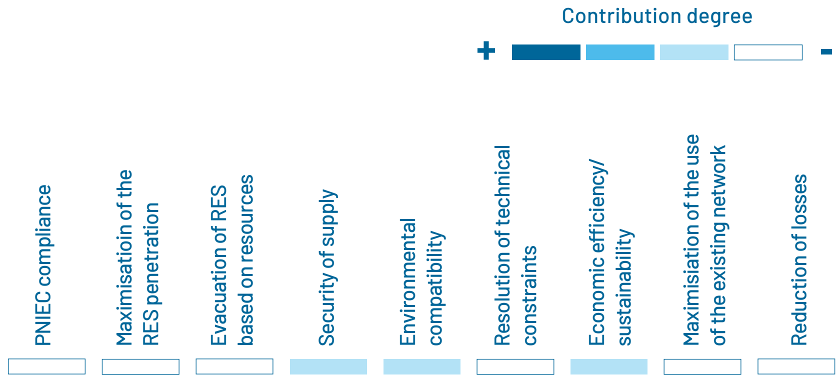
Profitability:

Profitability: NPV
- M€

Socio-environmental impact:



Contribution to guiding principles:



Investment INT_ESP-AND

International interconnections **Interconnection with Andorra**

Table of physical units:

	220 kV
Bays (units)	5
Overhead line (km)	33
Cables (km)	0.3

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Adrall 220 kV	5	Conv.	TN	2024

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Adrall - Cercs 220 kV, circuit 1 [1]	380	240	0.3	Cable	INT	2024
DC Adrall - Andorra border 220 kV [2]	437	381	16	Line	INT	2024
DC Adrall - Llavorsi 220 kV [3]	380	250	0.7	Line	INT	2024

Notes:
1. Modification at Adrall-Cercs
2. The current Adrall-Margineda 1 and 2 lines should be decommissioned.
3. Modification at Adrall-Llavorsi/Cercs

Investment ENL_PEN-IBA

Interconnections between systems **Reinforcement of interconnection between the Spanish Mainland and the Balearic Islands**

General description: The investment involves reinforcing the connection between the Spanish Mainland and the Balearic Islands with a second 2x200MW direct current link, combined with storage systems and synchronous condensers as fully integrated elements of the network in accordance with RDL 29/2021. This investment will enable a significant increased percentage of electricity demand in the Balearic Islands covered by more efficient energy sources with lower emissions from the Spanish Mainland.

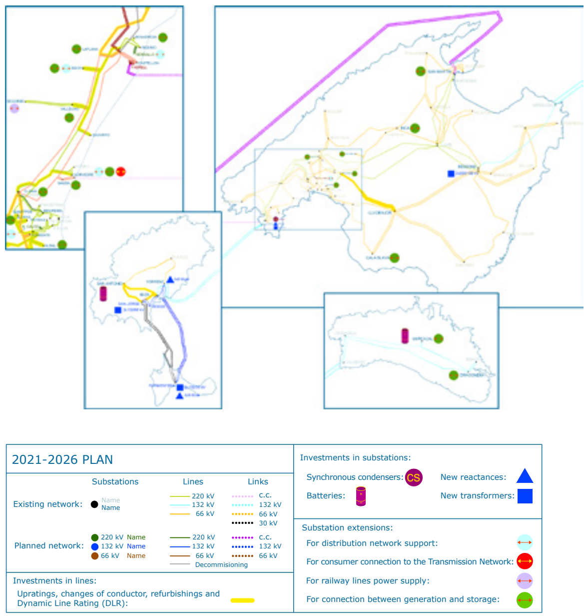
Drivers / Objectives:

- To make progress in electricity connections between the non-peninsular territories and to integrate the Balearic Islands system into the internal energy market, taking into account the European Commission's authorisation of the compensation scheme SA.42270 (2016/NN).
- To increase security of supply in the Balearic Islands' electricity system.
- To replace part of the higher-cost thermal generation in the Balearic Islands system with cheaper generation and more renewable energy from the Spanish Mainland.
- To reduce the demand for internal reinforcements on the island of Majorca.
- To ensure safe operation and to meet the requirements of voltage control in Majorca.

Alternatives: Three different alternatives have been analysed depending on the link capacity (2 x 500 MW, 2 x 200 MW and 1 x 200 MW). Since all three alternatives are feasible in technical terms, the alternative with the greatest value for the system in terms of NPV compared to the investment cost of the Investment has been selected.

European dimension: No

Map:



Investment ENL_PEN-IBA

Interconnections between systems **Reinforcement of interconnection between the Spanish Mainland and the Balearic Islands**

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
1,163.9 M€	20.29 M€/year

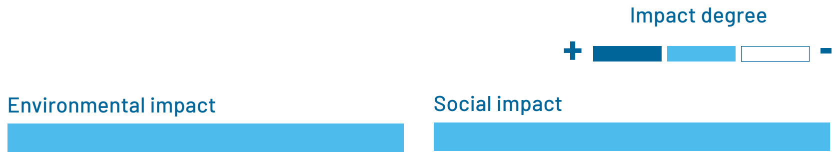
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	114.3	112.7	111.1	109.5	107.8	106.2	104.6	103.0	101.3

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

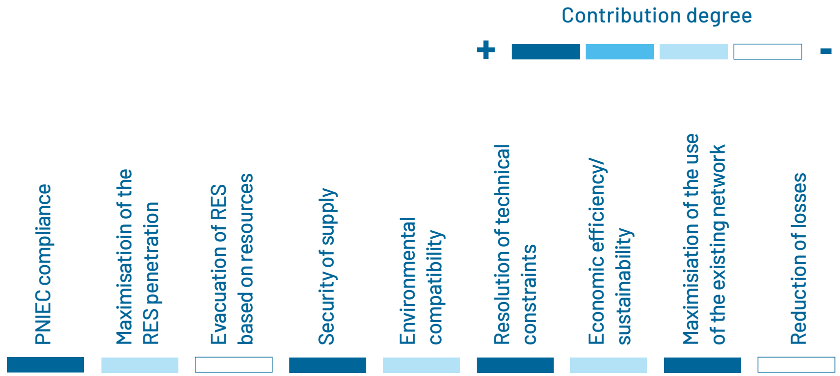
Profitability:

Profitability: NPV
1,157 M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment ENL_PEN-IBA

Interconnections between systems **Reinforcement of interconnection between the Spanish Mainland and the Balearic Islands**

Table of physical units:

	66 kV	132 kV	220 kV	400 kV
Bays (units)	2	4	13	10
Overhead line (km)				12
Cables (km)	1	1	8	
Transformed to 132 kV (MVA)			160	
Submarine Link (km)			420	
Battery (MW)	90	50		
Synchronous condensers (MVAr)			500	

Detailed list of investments:

New substations	Type	Year
Fadrell 400 kV	Outdoor	2026

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Fadrell 400 kV	10	Conv.	TN	2026
Llubi 220 kV	4	GIS	TN	> 2026
Mercadal 132 kV	2	Conv.	TN	2024
San Antonio 66 kV	2	Conv.	TN	2024
San Martín Baleares 220 kV	2	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
Valldurgent 220 kV	2	Conv.	TN	> 2026

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Fadrell, of La Plana - Castellón CT 400 kV, circuit 1	1,280	850	3	Line	Link	2026
I/O in Fadrell, of La Plana - Castellón CT 400 kV, circuit 2	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
Fadrell EC - San Martín Baleares EC [1]	400	400	420	Subm.	Link	2026
Llubi - Llubi 220 kV, circuit 1			0.5	Cable	Link	> 2026
Llubi - Llubi 220 kV, circuit 2			0.5	Cable	Link	> 2026

Investment ENL_PEN-IBA
Interconnections between systems **Reinforcement of interconnection between the Spanish mainland and the Balearic Islands**

Detailed list of investments (continued):

New lines/cables (continued)	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Mercadal - Mercadal 132 kV, circuit 1			1	Cable	Link	2024
San Antonio - San Antonio 66 kV, circuit 1			1	Cable	Link	2024
San Martín Baleares - San Martín Baleares EC 220 kV, circuit 1			2	Cable	Link	2026
San Martín Baleares - San Martín Baleares EC 220 kV, circuit 2			2	Cable	Link	2026
Santa Ponsa - Santa Ponsa 220 kV, circuit 1			1	Cable	Link	2026
Santa Ponsa - Santa Ponsa 220 kV, circuit 1			1	Cable	Link	> 2026
Valldurgent - Valldurgent 220 kV, circuit 1			1	Cable	Link	> 2026

Note:
1. Submarine Link HVDC-VSC 2 x 200 MW

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, CS1	100	-	Link	> 2026
Valldurgent 220 kV, CS1	100	-	Link	> 2026

New batteries	MVA	Type	Driv.	Year
Mercadal 132 kV, BAT1	50	-	Link	2024
San Antonio 66 kV, BAT1	90	-	Link	2024

Investment ENL_IBA: IB-FO

Interconnections between systems **Ibiza-Formentera 132 kV links**

General description: The investment consists of reinforcing the connection between the islands of Ibiza and Formentera through the commissioning of two new 132 kV alternating current links between Torrent and Formentera.

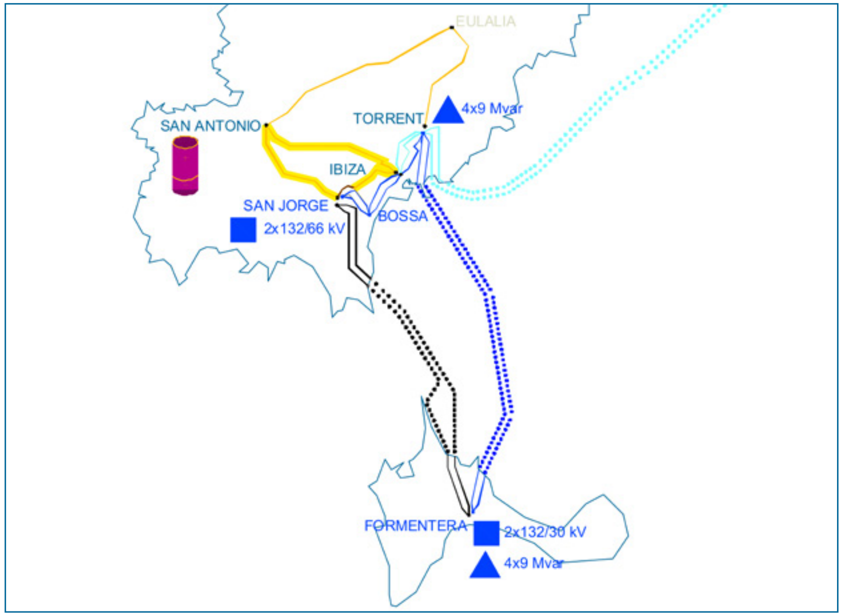
Drivers / Objectives:

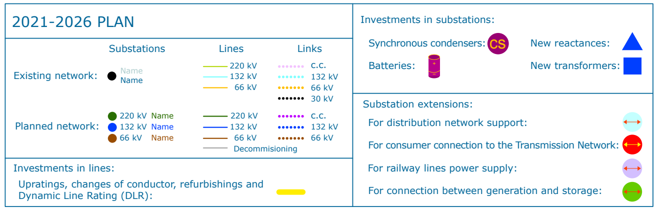
- To advance with the electricity connections between non-peninsular territories to facilitate the transition to a decarbonised economy.
- To reduce the need for generation in Formentera for the peaks of demand of this island.
- To improve the quality of supply and security of the subsystem of Formentera.

Alternatives: As an alternative to the proposed links, the installation of the thermal generator mix on Formentera could be extended. However, this alternative significantly increases generation costs and CO_2 emissions.

European dimension: No

Map:





Investment ENL_IBA: IB-FO

Interconnections between systems **Ibiza-Formentera 132 kV links**

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
104.2 M€	1.42 M€/year

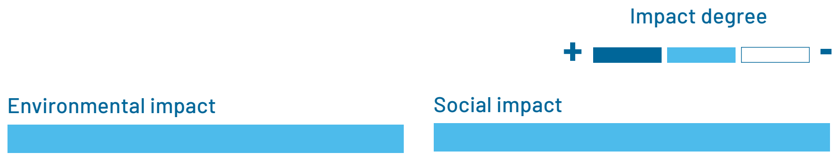
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	9.8	9.7	9.6	9.4	9.3	9.1	9.0	8.8	8.7

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

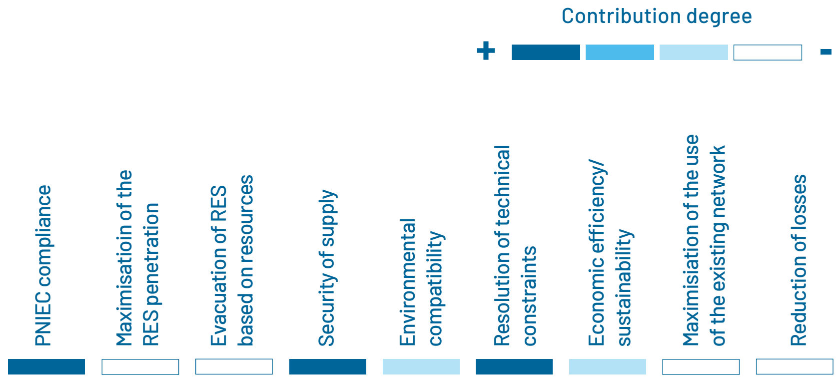
Profitability:

Profitability: NPV
206 M€

Socio-environmental impact:



Contribution to guiding principles:



Investment ENL_IBA: IB-FO
Interconnections between systems **Ibiza-Formentera 132 kV links**

Table of physical units:

	30 kV	132 kV
Bays (units)	2	20
Transformed to 30 kV (MVA)		60
Reactance (Mvar)		72
Submarine Link (km)		75

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

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	8	GIS	TN	2023

Detailed list of investments (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

New transformers	MVAr	Type	Driv.	Year
Formentera 132/30 kV, TF	60	Triph. B.	Link	2023

New reactances	MVAr	Type	Driv.	Year
Formentera 132 kV, REA1	36	-	Link	2023
Torrent 132 kV, REA1	36	-	Link	2023

ENL_ICA: TE-LG

Interconnections between systems **Tenerife-La Gomera links**

General description: The proposed investment consists of a submarine link between the electricity systems of Tenerife and La Gomera. This requires the following developments:

- New El Palmar 66 kV substation in La Gomera.
- New El Palmar-Chío 66 kV alternating current double-circuit submarine-cable link, with 50 MVA capacity per circuit.
- Extension of the Chío 66 kV substation on Tenerife.
- 5 reactances at 66 kV of 6 MVAr.

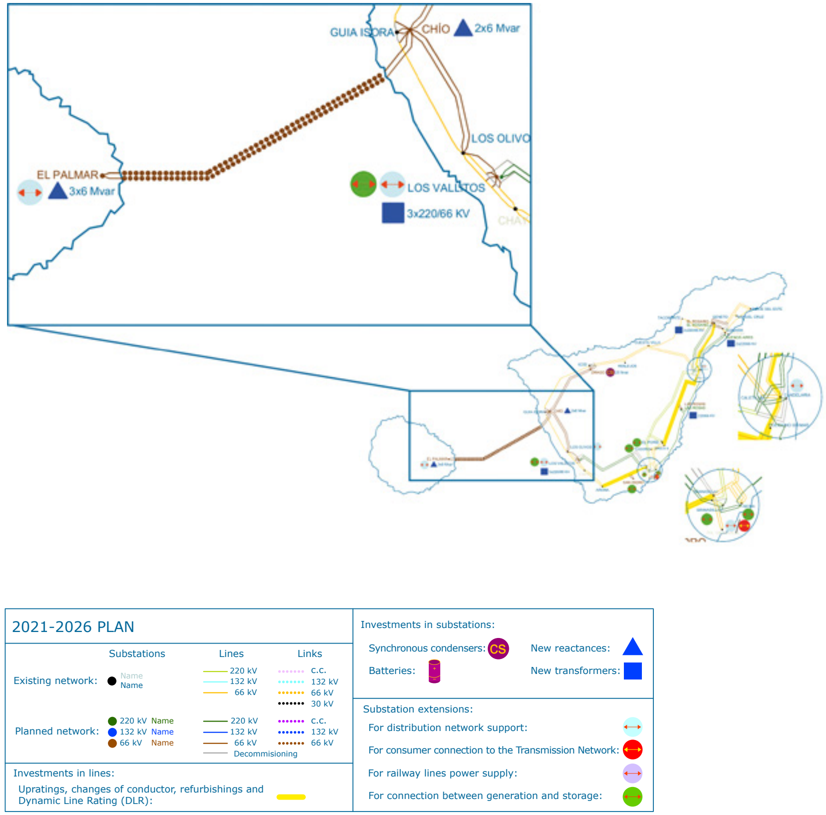
Drivers / Objectives:

- To integrate the currently independent electricity systems of La Gomera and Tenerife, increasing the quality and security of supply.
- To reduce the overall production costs of the new joint system by improving generation efficiency.
- To enable greater RES integration, especially in La Gomera, and to reduce CO_2 emissions.
- To reduce installed generation power requirements in the joint system.

Alternatives: As an alternative, maintaining isolated systems has been analysed, with the consequent increase in generation costs and emissions.

European dimension: No

Map:



ENL_ICA: TE-LG
Interconnections between systems **Tenerife-La Gomera links**

Cost-Benefit Multi-Criteria Analysis

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*	Reduction of needed installed generation capacity: 14 MW

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

Costs:

CAPEX	OPEX
103.8 M€	2.01 M€/year

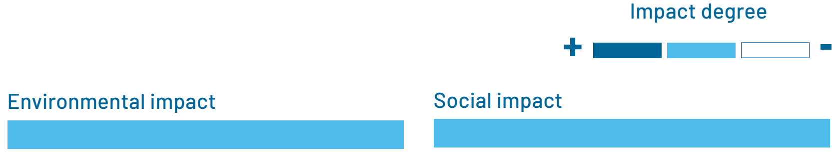
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	10.4	10.3	10.1	10.0	9.8	9.7	9.5	9.4	9.2

Note: The evaluation of the net present value (NPV) for this action has been carried out using the sequential PINT methodology, i.e. the benefits that the link would bring are evaluated on a reference scenario with all the other planned actions in the Tenerife-La Gomera system already in service.

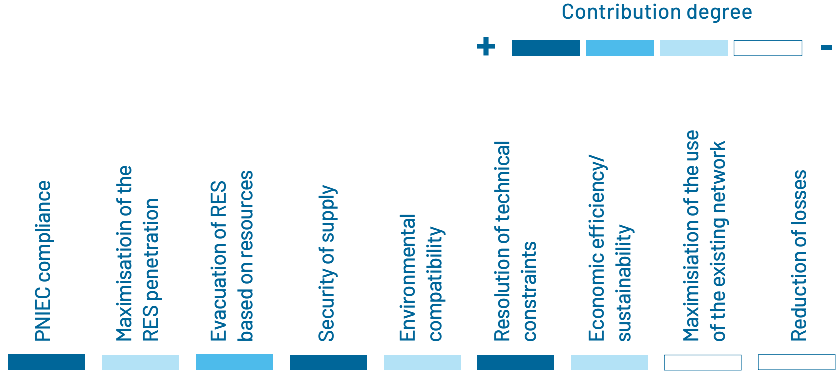
Profitability:

Profitability: NPV
84 M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

ENL_ICA: TE-LG

Interconnections between systems **Tenerife-La Gomera links**

Table of physical units:

	66 kV
Bays (units)	14
Reactance (Mvar)	30
Submarine Link (km)	84

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
El Palmar de La Gomera 66 kV	Building	2025

Substation extension	units	Type	Driv.	Year
Chío 66 kV	4	GIS	TN	2025
Chío 66 kV	2	Conv.	TN	2025
El Palmar de La Gomera 66 kV	5	GIS	TN	2025
El Palmar de La Gomera 66 kV	3	Conv.	TN	2025

Detailed list of investments (continued):

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Chío - El Palmar de La Gomera 66 kV, circuit 1	50	50	42	Subm.	Link	2025
Chío - El Palmar de La Gomera 66 kV, circuit 2	50	50	42	Subm.	Link	2025

New reactances	MVAr	Type	Driv.	Year
Chío 66 kV, REA1 [1]	6	-	Link	2025
Chío 66 kV, REA2 [2]	6	-	Link	2025
El Palmar de La Gomera 66 kV, REA1 [3]	6	-	Link	2025
El Palmar de La Gomera 66 kV, REA2 [4]	6	-	Link	2025
El Palmar de La Gomera 66 kV, REA3 [5]	6	-	Link	2025

Notes:
1. Reactance associated with the link.
2. Reactance associated with the link.
3. Reactance associated with the link.
4. Reactance associated with the link.
5. Busbar reactance.

I ENL_PEN-CEU

Interconnections between systems **Spanish Mainland-Ceuta links**

I General description:

The proposed investment consists of a submarine link between the Mainland electricity system and the electricity system of Ceuta. The following developments are required for this purpose:

- New Virgen de África 132 kV substation in Ceuta.
- New submarine link with two circuits Algeciras-Virgen de África 132 kV in alternating current.
- Extension of the Algeciras substation 220 kV.
- New Algeciras 132 kV substation with two 220/132 kV transformers.
- Reactances of 20 MVAr each: 7 in Algeciras 132 kV and 2 in Virgen de África 132 kV.

I Drivers / Objectives:

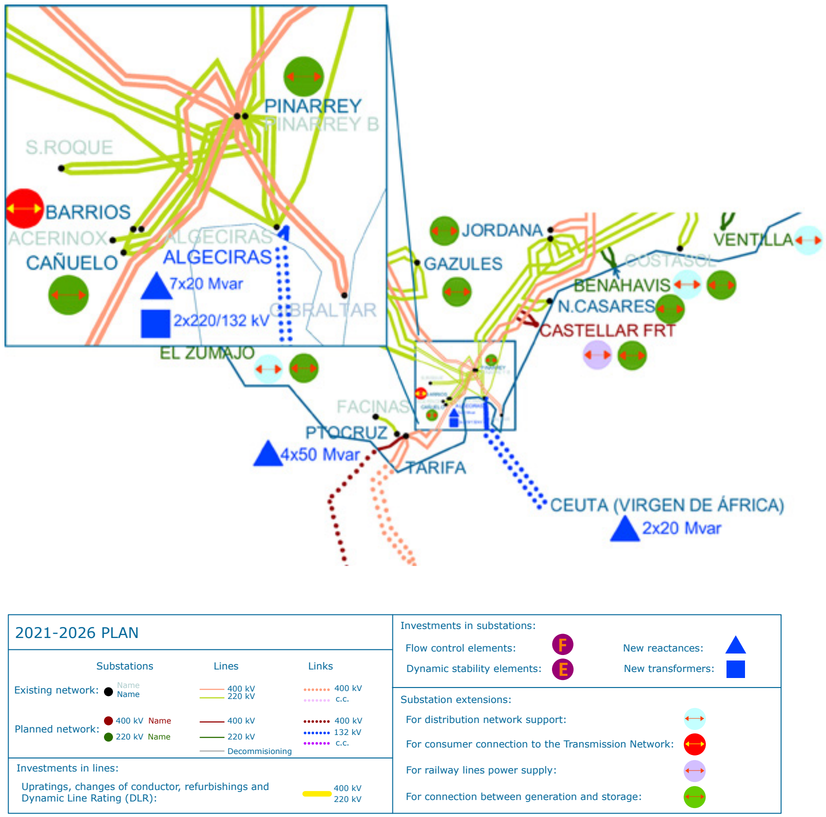
- To integrate Ceuta's electricity system into the peninsular system in order to substantially increase the security and quality of the electricity supply of Ceuta.
- To reduce installed generation needs in Ceuta.
- To reduce overall generation costs and increase the RES integration.

I Alternatives:

As an alternative, maintaining Ceuta's supply under the current conditions has been evaluated, which implies the need to use less efficient generation with higher emissions than that of the Spanish Mainland, as well as lower levels of guarantee of supply in the Ceuta system. The alternative of connecting the link on the peninsula to a new substation instead of an existing substation has also been assessed, but strong social opposition to the possible locations has been encountered.

I European dimension: No

I Map:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

ENL_PEN-CEU
Interconnections between systems **Spanish Mainland-Ceuta links**

Cost-Benefit Multi-Criteria Analysis

Benefits:

Socio-economic welfare: 29.7 M€/year	Reduction of CO_2 emissions: 299 kt/year*
Additional RES integration: 473 MWh/year	Reduction of system losses: - MWh/year*
Reduction of ENS: 51 MWh/year*	Reduction of needed installed generation capacity: 10 MW

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

Costs:

CAPEX	OPEX
220.9 M€	3.43 M€/year

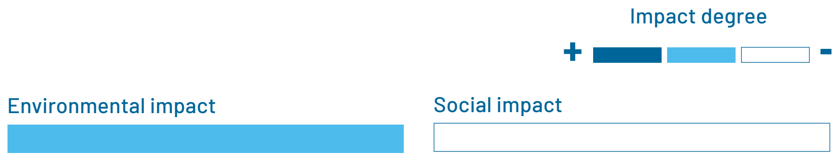
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	21.3	21.0	20.7	20.3	20.0	19.7	19.4	19.1	18.8

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

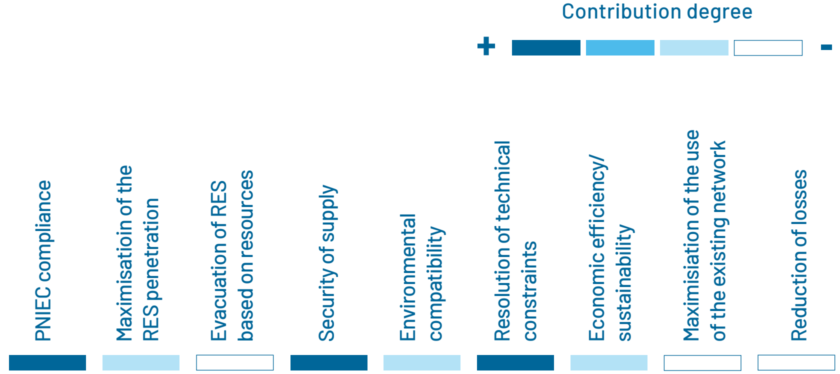
Profitability:

Profitability: NPV
303 M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

ENL_PEN-CEU

Interconnections between systems **Spanish Mainland-Ceuta links**

Table of physical units:

	132 kV	220 kV
Bays (units)	21	2
Total renewal of bays (units)		1
Cables (km)	3	1
Transformed to 132 kV (MVA)		250
Reactance (Mvar)	180	
Submarine Link (km)	138	

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Algeciras 132 kV [1]	Building	2025
Virgen de África 132 kV [2]	Building	2025

Notes:
1. Non-standard cost included in total cost of project.
2. Non-standard cost included in total cost of project.

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Algeciras 132 kV [1]	6	GIS	Link	2025
Algeciras 132 kV [2]	7	Conv.	Link	2025
Algeciras 220 kV	2	GIS	Link	2025
Virgen de África 132 kV [3]	2	GIS	SuD	2025
Virgen de África 132 kV [4]	4	GIS	Link	2025
Virgen de África 132 kV [5]	2	Conv.	Link	2025

Notes:
1. Non-standard cost included in the link cost.
2. Non-standard cost included in the link cost.
3. Non-standard cost included in the link cost.
4. Non-standard cost included in the link cost.
5. Non-standard cost included in the link cost.

Total renewal of bays	units	Type	Driv.	Year
Algeciras 220 kV	1	GIS	Link	2025

Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

I ENL_PEN-CEU
Interconnections between systems **Spanish Mainland-Ceuta links**

I Detailed list of investments (continued):

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Algeciras - Algeciras 132 kV, circuit [1]			0.2	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 [3]			2	Cable	Link	2025

Notes:
1. Cost of connection of non-standard transformers and reactances included in the cost of the link.
2. Submarine - underground link. The cost includes all non-standard installations associated with the link.
3. Transformer connection cables to distribution and non-standard reactances 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 [2]	125	Triph. B.	Link	2025

Notes:
1. Non-standard cost included in total cost of project.
2. Non-standard cost included in total cost of project.

New reactances	MVAr	Type	Driv.	Year
Algeciras 132 kV, REA1 [1]	20	-	Link	2025
Algeciras 132 kV, REA2 [2]	20	-	Link	2025
Algeciras 132 kV, REA3 [3]	20	-	Link	2025
Algeciras 132 kV, REA4 [4]	20	-	Link	2025
Algeciras 132 kV, REA5 [5]	20	-	Link	2025
Algeciras 132 kV, REA6 [6]	20	-	Link	2025
Algeciras 132 kV, REA7 [7]	20	-	Link	2025
Virgen de África 132 kV, REA1 [8]	20	-	Link	2025
Virgen de África 132 kV, REA2 [9]	20	-	Link	2025

Notes:
1. Fixed reactance in stages. Non-standard cost included in the project cost.
2. Fixed reactance in stages. Non-standard cost included in the project cost.
3. Fixed reactance in stages. Non-standard cost included in the project cost.
4. Fixed reactance in stages. Non-standard cost included in the project cost.
5. Fixed reactance in stages. Non-standard cost included in the project cost.
6. Fixed reactance in stages. Non-standard cost included in the project cost.
7. Fixed reactance in stages. Non-standard cost included in the project cost.
8. Fixed reactance in stages. Non-standard cost included in the project cost.
9. Fixed reactance in stages. Non-standard cost included in the project cost.

Investment PEN_USO_RdT

RES integration and resolution of technical constraints **Increased use of the Transmission Network**

General description:

This investment includes increasing the use of the existing network by installing thermal capacity monitoring equipment (Dynamic Line Rating - DLR), uprating and increasing capacity by changing the conductor on 400 kV and 220 kV lines.

The kms of line on which these investments are being conducted amount to 435 km with DLR equipment, nearly 1,700 km of uprating and 137 km of capacity increase using high temperature conductors.

A quota of such investments is also included in the zonal projects in conjunction with new developments for the period 2021-2026.

Drivers / Objectives:

Maximise the use of the existing network in order to:

- Reduce the need for technical constraints due to overloads through the curtailment of existing and future renewable energy sources, which leads to an improvement in the integration of renewable energy sources.
- Improve the security of supply.

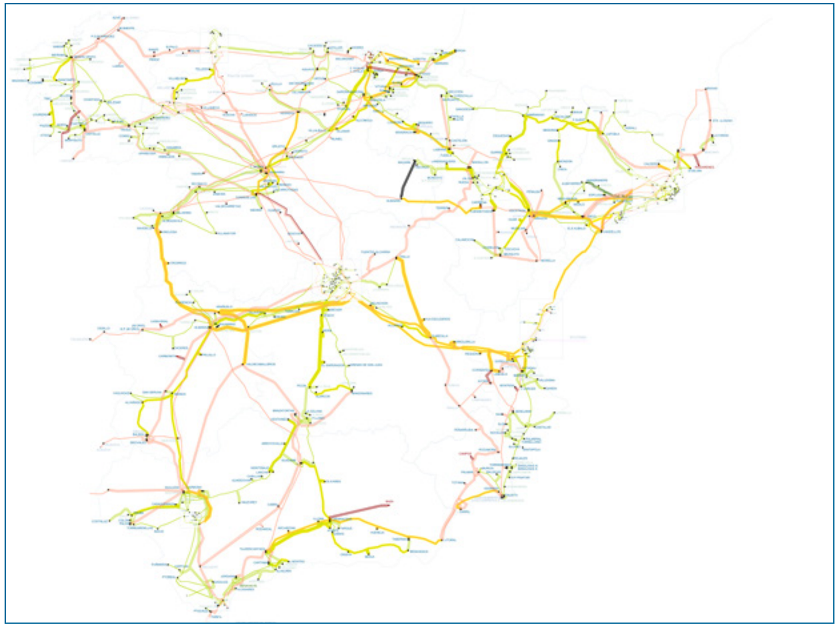
Alternatives:

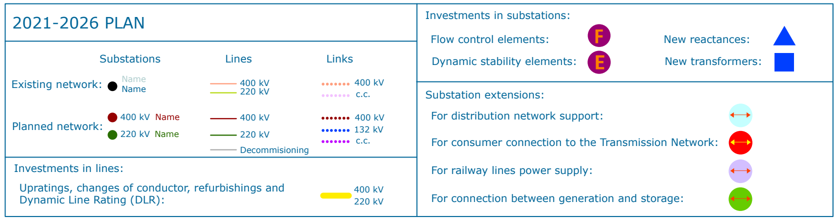
The alternative to these investments is the construction of new axes with a considerably higher social and environmental impact and investment cost.

European dimension:

No

Map:





Investment PEN_USO_RdT

RES integration and resolution of technical constraints **Increased use of the Transmission Network**

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
86.7 M€	0.13 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	6.5	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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
443 M€

Socio-environmental impact:

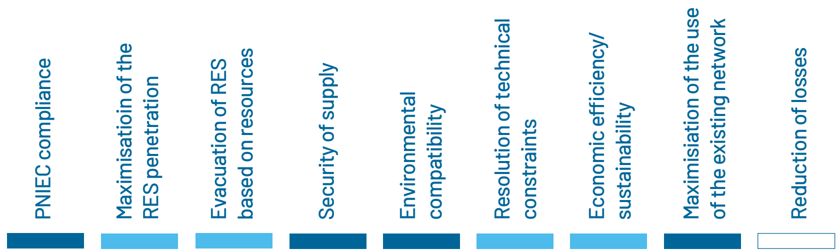
Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment PEN_USO_RdT

RES integration and resolution of technical constraints **Increased use of the Transmission Network**

Table of physical units:

	220 kV	400 kV
Uprating (km)	1,020	671
DLR (km)	381	54
Change of conductor (km)	103	34

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Change of conductor	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Cartelle - Castrelo 220 kV, circuit 2 [1]	566	480	7	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 [4]	650	620	17	Line	RES	2023
La Lomba - Montearenas 220 kV, circuit 1 [5]	802	680	9	Line	RES	2026
Mudarra - Tordesillas 400 kV, circuit 1 [6]	2,502	2,120	34	Line	RES	2024
Peñaflor - Villanueva de Gallego 220 kV, circuit 1 [7]	650	620	11	Line	RES	2026

Notes:
1. Requires change to high temperature conductor.
2. The ratio and cost are estimates. These will be determined after a more detailed study of the project.
3. Requires change to high temperature conductor.
4. Requires change to high temperature conductor.
5. Requires change to high temperature conductor.
6. Requires change to high temperature conductor.
7. Requires change to high temperature conductor Includes a 3 km variant of a 220-132 kV double-circuit line section.

Detailed list of investments (continued):

Line uprating	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Abadiano - Vitoria 220 kV, circuit 1	488	440	34	Line	RES	2022
Alcocero de Mola - Puentelarra 220 kV, circuit 1	800	680	40	Line	RES	2026
Alcocero de Mola - Villimar 220 kV, circuit 1	800	680	28	Line	RES	2026
Almazán - Cariñena 400 kV, circuit 1	1,790	1,500	116	Line	RES	2022
Ayala - T de Ayala 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
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 2	482	409	33	Line	RES	2022

Investment PEN_USO_RdT

RES integration and resolution of technical constraints **Increased use of the Transmission Network**

Detailed list of investments (continued):

Line uprating	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Grado - Monzón 220 kV, circuit 1	483	409	26	Line	RES	2022
Grijota - Herrera 400 kV, circuit 1	1,990	1,700	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
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 220 kV, circuit 2	488	440	10	Line	RES	2022
La Serna - Tudela 220 kV, circuit 1	437	378	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
Maials - Rubí 400 kV, circuit 1	1,850	1,530	132	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	850	710	49	Line	RES	2022
Mequinenza - Maials 400 kV, circuit 1	1,830	1,530	20	Line	RES	2022
Mesón do Vento - Santiago de Compostela 220 kV, circuit 1	441	394	48	Line	RES	2022

Line uprating	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Montetorrero - Peñaflor 220 kV, circuit 1	426	363	21	Line	RES	2022
Palencia - T de Mudarrita 220 kV, circuit 1	773	667	57	Line	RES	2022
Poza de La Sal - T de Ayala 220 kV, circuit 2	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
Villalbilla - Villimar 220 kV, circuit 1	800	680	23	Line	RES	2026

Investment PEN_USO_RdT

RES integration and resolution of technical constraints **Increased use of the Transmission Network**

Detailed list of investments (continued):

Dynamic Line Rating	km (±10%)	Type	Driv.	Year
Aragon - 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 - 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 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

Investment CENTRO_1

RES integration and resolution of technical constraints **La Mancha-Madrid Corridor**

General description: This corridor consists of a set of investments that allow the integration of renewable energy in Castile-La Mancha by means of 400 kV axes that facilitate its flow towards Madrid.

Finally, using existing 400 kV and 220 kV axes and by means of various inputs / outputs, it is connected to the transmission network of the metropolitan area of Madrid.

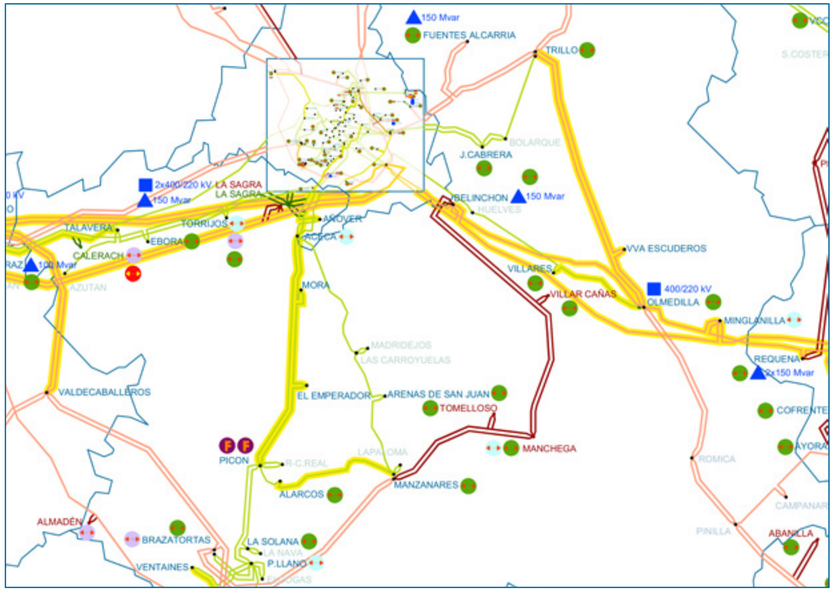
Drivers / Objectives:

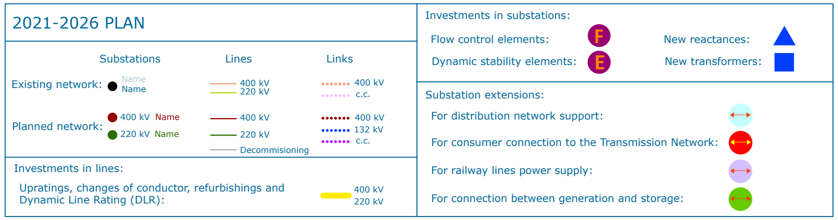
- Connect and integrate renewable energy sources, both solar and wind, in the important resource areas of Castile-La Mancha.
- Facilitate the integration of renewable energy sources and its transmission to an area of high electricity demand such as Madrid.

Alternatives: Solutions based on the reinforcement of existing axes, even with operational measures, dynamic line rating (DLR) or uprating of 400 kV and 220 kV axes, do not resolve the needs detected. Other solutions using additional 400 kV axes that would have a similar effect have a higher economic and environmental cost.

European dimension: No

Map:





Investment CENTRO_1

RES integration and resolution of technical constraints **La Mancha-Madrid Corridor**

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
453 M€	5.13 M€/year

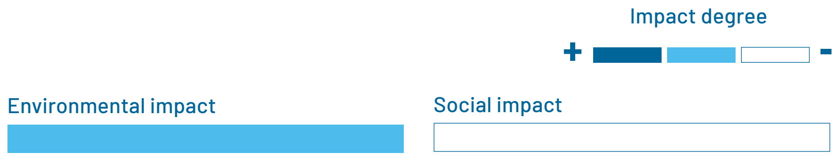
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	41.7	41.1	40.5	39.8	39.2	38.6	37.9	37.3	36.7

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

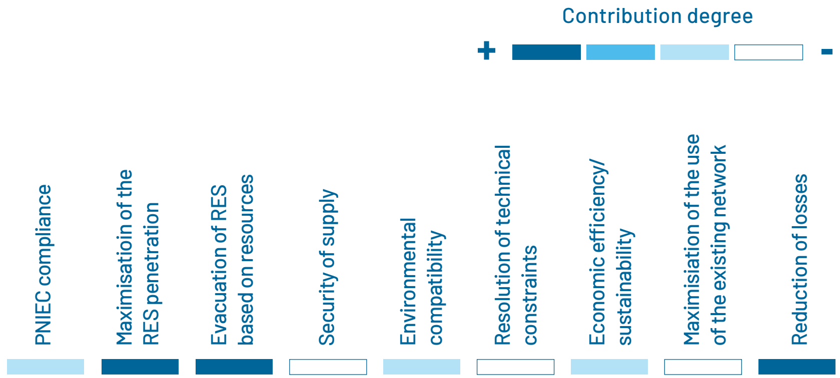
Profitability:

Profitability: NPV
340 M€

Socio-environmental impact:



Contribution to guiding principles:



Investment CENTRO_1

RES integration and resolution of technical constraints **La Mancha-Madrid Corridor**

Table of physical units:

	220 kV	400 kV
Bays (units)	15	57
Overhead line (km)	120	942
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 investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
La Sagra 220 kV [1]	Outdoor	2025
La Sagra 400 kV	Outdoor	2025
Manchega 400 kV	Outdoor	2025
Picón 400 kV	Outdoor	> 2026
Tomelloso 400 kV	Outdoor	2026
Villar de Cañas 400 kV	Outdoor	2026

Notes:
1. La Sagra 220 kV is created as a double bus: In double bus A the bays of Aceca, Añover, Pinto Ayuden, Villaverde, Trafo 2 and in double bus B the bays of Pradillos, Talavera, Torrijos, Villaverde, Trafo 1.

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Belinchón 400 kV	3	Conv.	TN	> 2026
Belinchón 400 kV	3	Conv.	TN	2026
Belinchón 400 kV	1	Conv.	TN	2025
La Sagra 220 kV	14	Conv.	TN	2025
La Sagra 400 kV	10	Conv.	TN	2025
Manchega 400 kV	1	Conv.	Gen./Sto.	2025
Manchega 400 kV	4	Conv.	TN	2025
Manchega 400 kV	3	Conv.	TN	2026
Manchega 400 kV	4	Conv.	TN	> 2026
Manzanares 400 kV	3	Conv.	TN	2025
Manzanares 400 kV	4	Conv.	TN	> 2026
Morata 400 kV	3	Conv.	TN	> 2026
Picón 220 kV	1	Conv.	TN	> 2026
Picón 400 kV	5	Conv.	TN	> 2026
Romica 400 kV	3	Conv.	TN	> 2026
Tomelloso 400 kV	1	Conv.	Gen./Sto.	2026
Tomelloso 400 kV	4	Conv.	TN	2026
Villar de Cañas 400 kV	4	Conv.	TN	2026
Villar de Cañas 400 kV	1	Conv.	Gen./Sto.	2026

I Investment CENTRO_1

RES integration and resolution of technical constraints **La Mancha-Madrid Corridor**

I Detailed list of investments (continued):

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
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	91	Line	RES	2025
DC Picón - Manzanares 400 kV	2,440	1,970	80	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 1	1,760	1,430	4	Line	RES	2025
I/O in La Sagra, of Morata - Almaraz CN 400 kV, circuit 2	1,760	1,430	4	Line	RES	2025
I/O in La Sagra, of Talavera - Villaverde 220 kV, circuit 1	780	630	10	Line	RES	2025
I/O in La Sagra, of Torrijos - Villaverde Bajo 220 kV, circuit 1	780	630	10	Line	RES	2025
I/O in Tomelloso, of Manchega - Manzanares 400 kV, circuit 1	2,440	1,970	1	Line	RES	2026
I/O in Villar de Cañas, of Manchega - Belinchón 400 kV, circuit 2	2,440	1,970	25	Line	RES	2026

Line uprating	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Aceca - Los Pradillos 220 kV, circuit 1 [1]	758	620	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 [2]	780	640	9	Line	RES	2024
Los Pradillos - Parla 220 kV, circuit 1 [3]	757	619	15	Line	RES	2024
Pinto - Villaverde Bajo 220 kV, circuit 1 [4]	780	640	13	Line	RES	2024

Notes:
1. Uprating of the overhead section to 85º.
2. Uprating of the overhead section to 85º.
3. Uprating of the overhead section to 85º.
4. Uprating of the overhead section to 85º.

Investment CENTRO_1

RES integration and resolution of technical constraints **La Mancha-Madrid Corridor**

Detailed list of investments (continued):

New transformers	MVA	Type	Driv.	Year
La Sagra 400/220 kV, TF1	600	Triph. B.	RES	2025
La Sagra 400/220 kV, TF2	600	Triph. B.	RES	2025
Picón 400/220 kV, TF1	600	Triph. B.	RES	> 2026

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

Nuevos limitadores of flujo	units	Type	Driv.	Year
Picón 220 kV [1 2]	2	-	RES	2024

Notes:
1. One restrictor at Picón-Aceca 220 kV and the other at Picón-El Emperador.
2. One restrictor at Picón-Aceca 220 kV and the other at Picón-El Emperador.

Investment CENTRO_2

RES integration and resolution of technical constraints

Reinforcement Andalusia - Extremadura - Madrid Corridor

General description: The investment consists of reinforcing the existing network to enable the integration of renewable production in the area and the inclusion of new substations and the extension of existing ones for the connection of new renewable energy sources or storage. Numerous uprating and capacity increases of the Lines in the area are included.

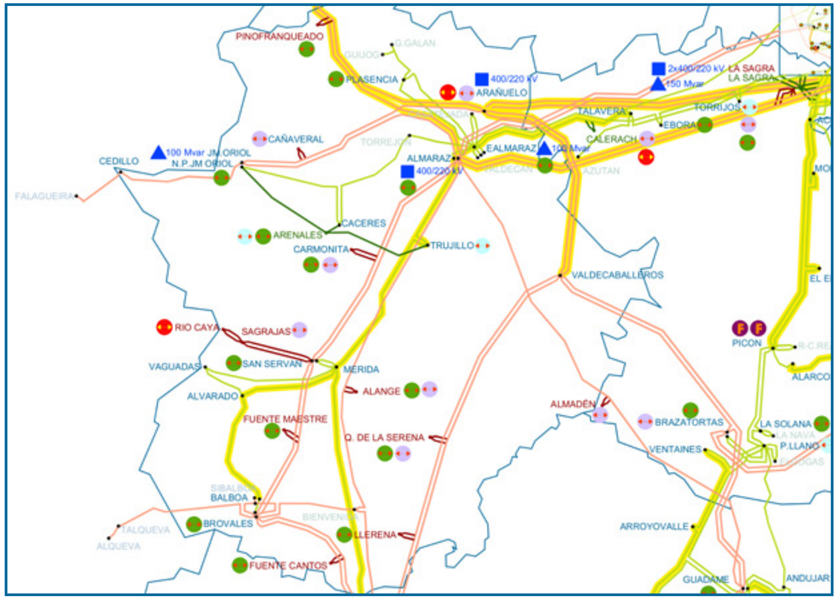
Drivers / Objectives:

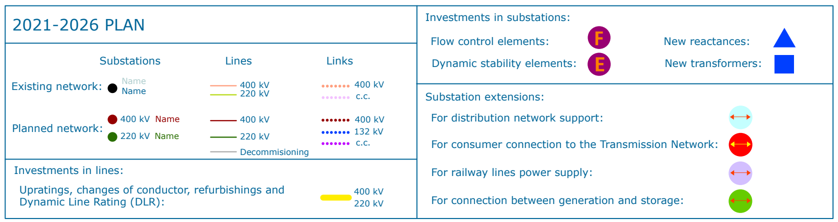
- Reduce technical constraints that would lead to curtailments of renewable energy sources in the area by reinforcing the 400 kV and 220 kV axes between Andalusia, Extremadura and Madrid.
- Enable the connection of future renewable energies in areas with a high probability of successful deployment.

Alternatives: As an alternative, the construction of new 400 kV connection axes to increase transmission capacity has been studied, however, this investment would entail environmental impacts and higher costs.

European dimension: No

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment CENTRO_2

RES integration and resolution of technical constraints

Reinforcement Andalusia - 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.

Costs:

CAPEX	OPEX
106.9 M€	1.28 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	9.9	9.8	9.6	9.5	9.3	9.2	9.0	8.9	8.7

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

Profitability:

Profitability: NPV
3,120 M€

Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -

PNIEC compliance

Maximisatioin of the RES penetration

Evacuation of RES based on resources

Security of supply

Environmental compatibility

Resolution of technical constraints

Economic efficiency/ sustainability

Maximisation of the use of the existing network

Reduction of losses

Investment CENTRO_2

RES integration and resolution of technical constraints

Reinforcement Andalusia - Extremadura - Madrid Corridor

Table of physical units:

	220 kV	400 kV
Bays (units)		25
Overhead line (km)		70
Cables (km)	0.6	
Uprating (km)	139	929
Change of conductor (km)	166	

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Fuente de Cantos 400 kV	Outdoor	2025
Fuente del Maestre 400 kV	Outdoor	2025
Llerena 400 kV	Outdoor	2025
Pinofranqueado 400 kV	Outdoor	2024

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Alange 400 kV	1	Conv.	Gen./Sto.	2024
Fuente de Cantos 400 kV	4	Conv.	TN	2025
Fuente de Cantos 400 kV	1	Conv.	Gen./Sto.	2025
Fuente del Maestre 400 kV	1	Conv.	Gen./Sto.	2025
Fuente del Maestre 400 kV	4	Conv.	TN	2025
La Serena 400 kV	1	Conv.	Gen./Sto.	2024
Llerena 400 kV	4	Conv.	TN	2025
Llerena 400 kV	1	Conv.	Gen./Sto.	2025
Pinofranqueado 400 kV	1	Conv.	Gen./Sto.	2024
Pinofranqueado 400 kV	4	Conv.	TN	2024
Valdecaballeros 400 kV	3	Conv.	TN	> 2026

I Investment CENTRO_2
RES integration and resolution of technical constraints
Reinforcement Andalusia - Extremadura - Madrid Corridor

I Detailed list of investments (continued):

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Almaraz CN - Trujillo 220 kV, circuit 1	555	470	0.3	Cable	RES	2023
I/O in Fuente de Cantos, of Brovales - Guillena 400 kV, circuit 1	2,330	1,890	13	Line	RES	2025
I/O in Fuente del Maestre, of San Servan - Brovales 400 kV, circuit 1	2,330	1,890	1	Line	RES	2025
I/O in Llerena, of Valdecaballeros - Guillena 400 kV, circuit 1	1,760	1,420	1	Line	RES	2025
I/O in Pinofranqueado, of Aldeadávila - Arañuelo 400 kV, circuit 1	1,760	1,420	2	Line	RES	2024
I/O in Valdecaballeros, of Almaraz CN - Guadame 400 kV, circuit 1	1,760	1,420	18	Line	RES	> 2026
Mérida - Trujillo 220 kV, circuit 1	543	460	0.3	Cable	RES	2023

Change of conductor	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Almaraz CN - Trujillo 220 kV, circuit 1 [1]	555	470	47	Line	RES	2023
Alvarado - Mérida 220 kV, circuit 1 [2]	684	580	44	Line	RES	2023
Mérida - Trujillo 220 kV, circuit 1 [3]	543	460	76	Line	RES	2024

Notes:
1. Requires change to high temperature conductor.
2. Requires change to high temperature conductor.
3. 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
Arañuelo - Valdecaballeros 400 kV, circuit 1	1,760	1,420	53	Line	RES	2023
Arañuelo - Valdecaballeros 400 kV, circuit 2	1,760	1,420	53	Line	RES	2023

Investment ESTE_1

RES integration and resolution of technical constraints

New Aragon-Levante Corridor

General description: The investment consists of creating new 400 kV axes between Valencia and Aragon and reinforcing 400 kV axes between Valencia and Castile-La Mancha.

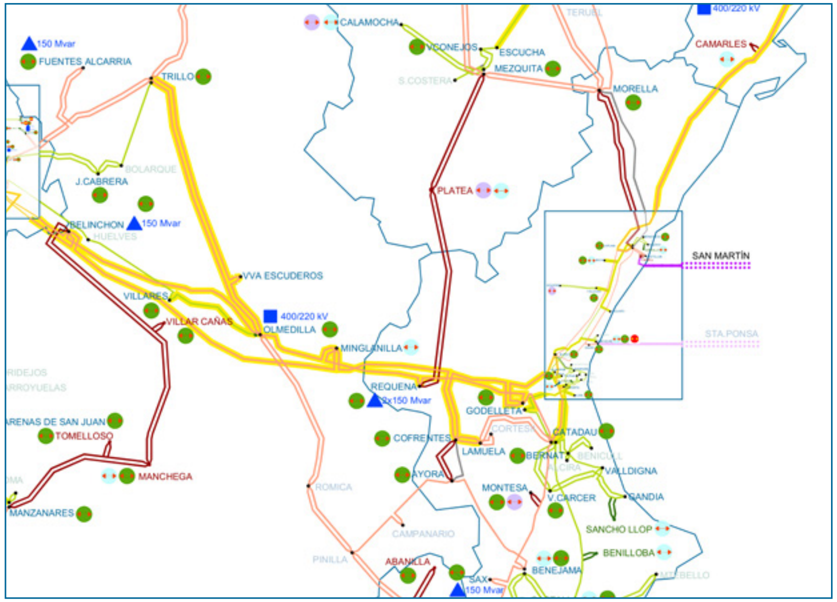
Drivers / Objectives:

- Reduce technical constraints due to overloads in the area by reinforcing the 400 kV network.
- Integrate existing and future renewable energy sources in the area by reducing curtailments derived by the application of the above-mentioned technical constraints.

Alternatives: Only with operational solutions, dynamic line rating (DLR), uprating of existing Lines or increases in their capacity, the needs identified in the area cannot be sufficiently met.

European dimension: No

Map:



2021-2026 PLAN

	Substations	Lines	Links
Existing network:	Name	400 kV / 220 kV	400 kV / c.c.
Planned network:	400 kV Name / 220 kV Name	400 kV / 220 kV / Decommissioning	400 kV / 132 kV / c.c.

Investments in lines:
Upratings, changes of conductor, refurbishings and Dynamic Line Rating (DLR): 400 kV / 220 kV

Investments in substations:
Flow control elements: F
Dynamic stability elements: E
New reactances:
New transformers:

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

Investment ESTE_1
RES integration and resolution of technical constraints
New Aragon-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.

Costs:

CAPEX	OPEX
247.1 M€	2.11 M€/year

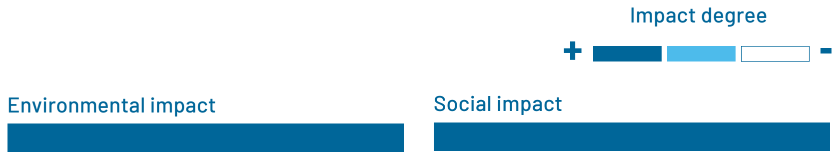
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	22.1	21.7	21.4	21.0	20.7	20.4	20.0	19.7	19.3

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

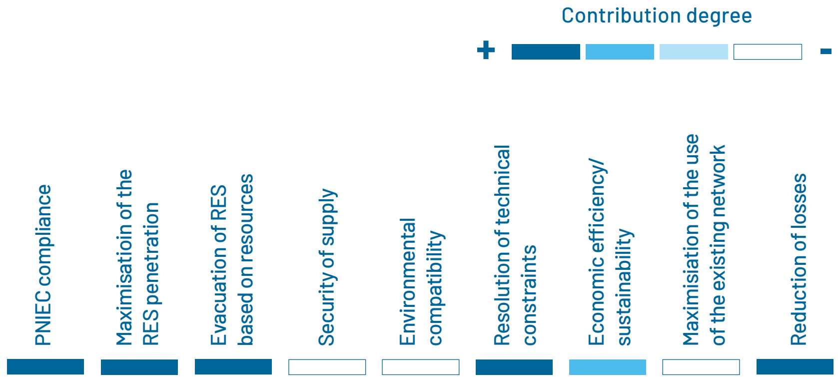
Profitability:

Profitability: NPV
1,297 M€

Socio-environmental impact:



Contribution to guiding principles:



Investment ESTE_1

RES integration and resolution of technical constraints

New Aragon-Levante Corridor

Table of physical units:

	220 kV	400 kV
Bays (units)	1	24
Overhead line (km)		572
Cables (km)	0.5	
Transformed to 220 kV (MVA)		600
Uprating (km)		436
Reactance (Mvar)		450
DLR (km)		156
Phase shifters (units)		1

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Platea 400 kV	Outdoor	2024

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Castellón CT 400 kV	1	Conv.	TN	> 2026
El Serrallo 220 kV	1	GIS	TN	> 2026
Godelleta 400 kV	4	Conv.	TN	2023
La Plana 400 kV	2	Conv.	TN	> 2026
Mezquita 400 kV	3	Conv.	TN	2024
Morella 400 kV	2	Conv.	TN	2023
Platea 400 kV	3	Conv.	TN	2024
Platea 400 kV	3	Conv.	TN	2025
Platea 400 kV	1	Conv.	TN	> 2026
Requena 400 kV	3	Conv.	TN	2025
Requena 400 kV	1	Conv.	TN	2023
Sax 400 kV	1	Conv.	TN	2023

Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment ESTE_1
RES integration and resolution of technical constraints
New Aragon-Levante Corridor

Detailed list of investments (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
El Serrallo - El Serrallo 220 kV, circuit 1			0.5	Cable	RES	> 2026
Godelleta - Godelleta 400 kV, circuit 1			0.2	Line	RES	> 2026

Notes:
1. The current Morella-La Plana 400kV line must be decommissioned.

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	2,315	2,013	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 investments (continued):

Dynamic Line Rating	km (±10%)	Type	Driv.	Year
Vandellós - La Plana 400 kV, circuit 1	156	Line	RES	2022

New transformers	MVA	Type	Driv.	Year
Castellón CT 400/220 kV, TF1	600	Triph. B.	RES	> 2026

New phase shifters	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

Investment ESTE_2

RES integration and resolution of technical constraints **Connection at Abanilla**

General description: The following investments enable the connection and integration of renewable energy sources in the Region of Murcia:

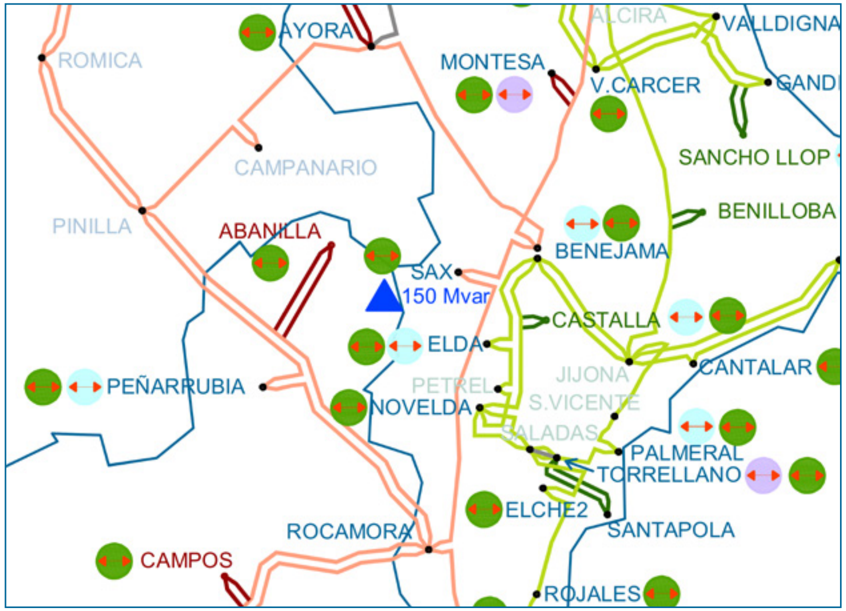
- New input-output at the new Abanilla 400 kV substation on the Pinilla-Rocamora line.
- Extension of Abanilla 400 kV for the connection of generation or storage.

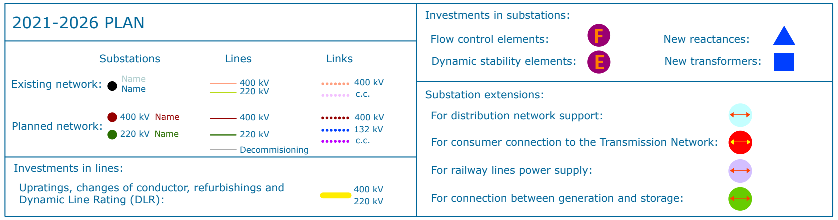
Drivers / Objectives: Connection and integration of existing and future renewable energy sources in the Abanilla and Yecla area.

Alternatives: Maintaining the starting grid would only allow the connection of the high quotas of renewable energy sources located in areas with high probability of success to the distribution network.

European dimension: No

Map:





Investment ESTE_2

RES integration and resolution of technical constraints **Connection at Abanilla**

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
6.3 M€	0.24 M€/year

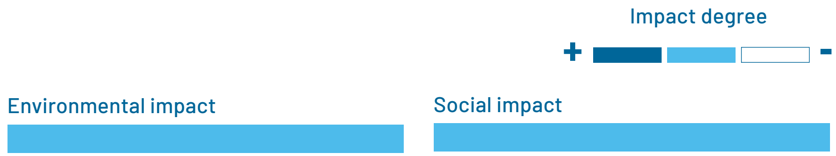
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7

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

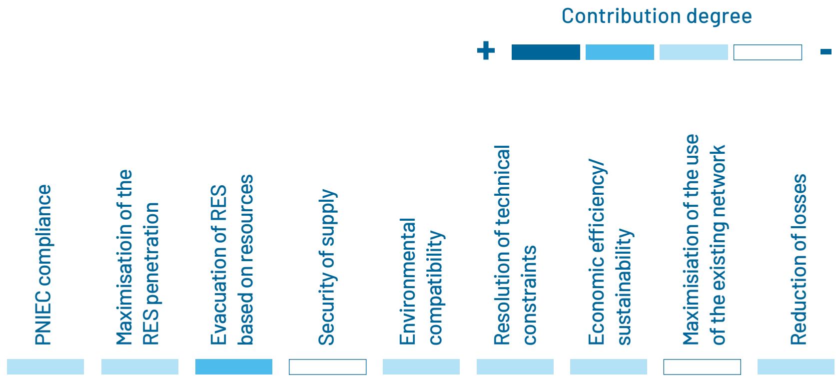
Profitability:

Profitability: NPV
22 M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment ESTE_2

RES integration and resolution of technical constraints **Connection at Abanilla**

Table of physical units:

	400 kV
Bays (units)	5
Overhead line (km)	2

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Abanilla 400 kV	Outdoor	2025

Substation extension	units	Type	Driv.	Year
Abanilla 400 kV	1	Conv.	Gen./Sto.	2025
Abanilla 400 kV	4	Conv.	TN	2025

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Abanilla, of Rocamora - La Pinilla 400 kV, circuit 1	1,730	1,440	1	Line	RES	2025

Investment ICA_1

RES integration and resolution of technical constraints

Reinforcement of the north-south axis of Gran Canaria

General description:

The proposal consists of reinforcing the current north-south axis between Barranco de Tirajana and Sabinal by the following investments:

- 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.
- New input-output at the Aldea Blanca 66 kV substation on 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:

- Enable the proper integration of connected renewables to the north-south axis (both existing and future renewables, including possible offshore wind generation).
- 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 southeast.

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.

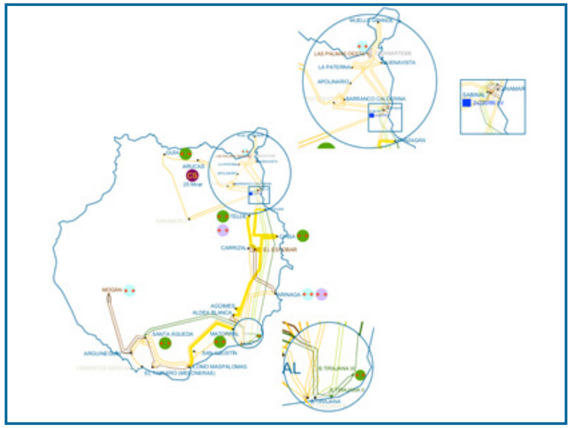
Alternatives (continued):

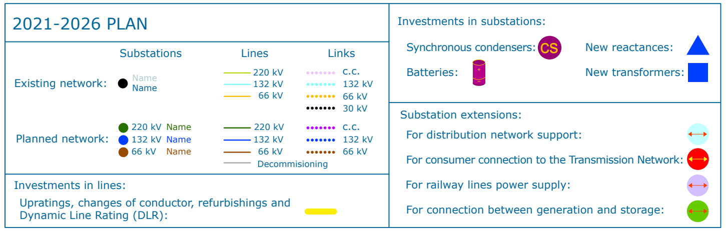
However, these measures are insufficient, so the reinforcement of the 220 kV line is also proposed. As an alternative to the latter, the possible closure of the meshed system in the western area (Mogán-La Aldea-Agaete 66 kV) has been analysed, but this solution has been discarded due to its high implementation risk and lower effectiveness for security of supply.

European dimension:

No

Map:





Investment 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.

Costs:

CAPEX	OPEX
65.3 M€	0.38 M€/year

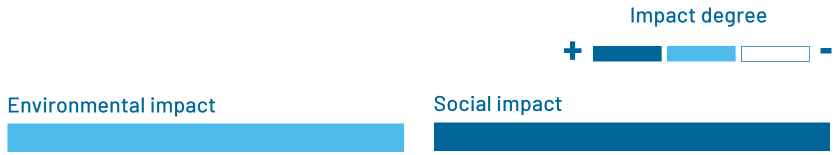
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	5.7	5.6	5.5	5.4	5.3	5.2	5.1	5.0	4.9

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

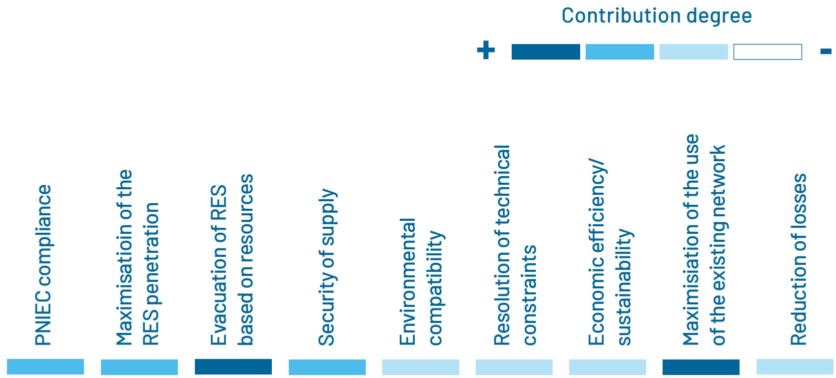
Profitability:

Profitability: NPV
247 M€

Socio-environmental impact:



Contribution to guiding principles:



Investment 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)	3	10
Overhead line (km)		35
Cables (km)	10	7
Uprating (km)	56	
DLR (km)	20	

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Barranco de Tirajana III 220 kV	Building	2024

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
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

Investment ICA_1
RES integration and resolution of technical constraints
Reinforcement of the north-south axis of Gran Canaria

Detailed list of investments (continued):

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Barranco de Tirajana III - Sabinal 220 kV, circuit 1	323	323	5	Cable	RES	2025
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]	323	323	35	Line	RES	2025
I/O in Aldea Blanca, of Barranco de Tirajana - Escobar 66 kV, circuit 1	80	80	0.5	Cable	RES	2024
El Matorral - Lomo Maspalomas 66 kV, circuit 1	77	77	7	Cable	RES	2024
Escobar - Cinsa 66 kV, circuit 1	77	77	0.3	Cable	RES	2024
Marzagán - Sabinal 66 kV, circuit 1 [2]	80	80	0.7	Cable	RES	2024
Telde - Sabinal 66 kV, circuit 1 [3]	80	80	0.7	Cable	RES	2024

Notes:
1. Double circuit with first circuit laid.
2. Change of topology with disconnection of the Jinamar-Marzagán 66kV line and connection of the Sabinal-Marzagán 66kV line.
3. Disconnection of the Jinámar-Telde 66 kV line.

Detailed list of investments (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	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

Dynamic Line Rating	km (±10%)	Type	Driv.	Year
Agüimes - Escobar 66 kV, circuit 1	14	Line	RES	2023
Aldea Blanca - Agüimes 66 kV, circuit 1	6	Line	RES	2023

Investment ICA_2

RES integration and resolution of technical constraints

Reinforcement of the north-south axis in the east of Tenerife

General description:

The proposed investment allows the evacuation of existing and future renewable energy sources in the southeast of Tenerife under adequate secure conditions while minimising the 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.

Drivers / Objectives:

- To allow for the adequate evacuation and transmission to the north of the island of the renewable energy sources installed and planned in the southeast of the island, as well as the foreseeable renewable energy sources - including off-shore wind power - in the Las Rosas area. Currently, there are already curtailments of renewable energy sources due to a lack of evacuation capacity in the area.
- To reduce the risk of a demand curtailment, including the risk of complete loss of supply to Tenerife in the event of a contingency on the existing 220 kV north-south axis. This risk will increase as the island's generation becomes more concentrated in the southeast of the island.

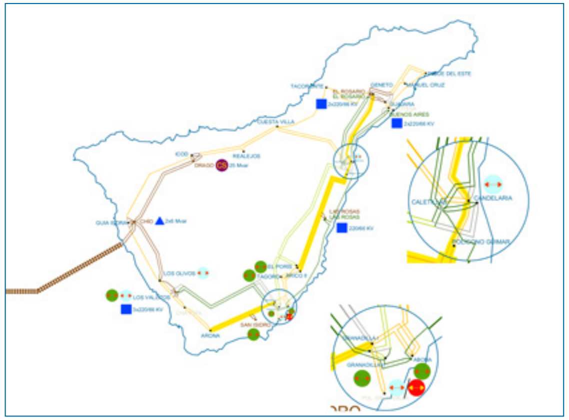
Alternatives:

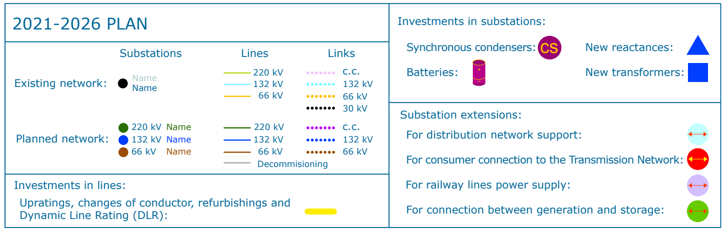
The possibility of uprating the existing 66 kV north-south axis has been assessed, however, this is insufficient to securely evacuate the renewable quota foreseen for the 2026 horizon. This solution would also not resolve the risks of loss of supply in the event of a contingency on the existing 220 kV north-south line.

European dimension:

No

Map:





Investment 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
96.6 M€	1.16 M€/year

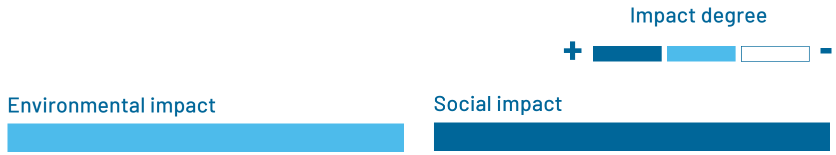
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	9.0	8.8	8.7	8.6	8.4	8.3	8.2	8.0	7.9

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 investments planned except for the TF-LG link, the benefit of which is analysed in a final stage considering the rest of the investments in service.

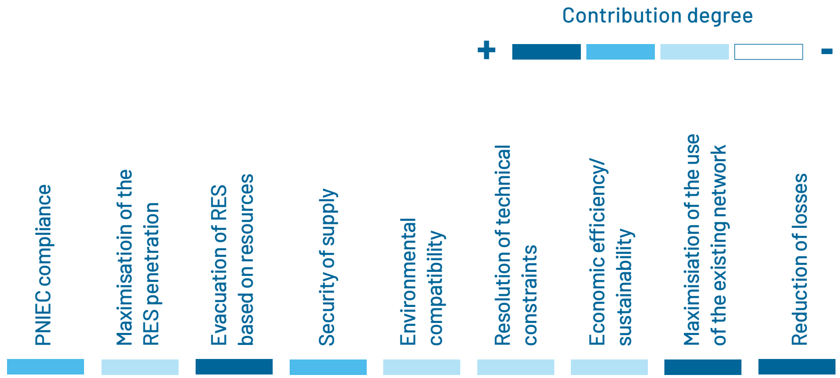
Profitability:

Profitability: NPV
52 M€

Socio-environmental impact:



Contribution to guiding principles:



Investment 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	23
Overhead line (km)	6	28
Cables (km)		21
Transformed to 66 kV (MVA)		375
DLR (km)	64	

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Las Rosas 220 kV	Building	2025
Las Rosas 66 kV	Building	2025

Detailed list of investments (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	Gen/Alm.	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	2024

Investment ICA_2

RES integration and resolution of technical constraints

Reinforcement of the north-south axis in the east of Tenerife

Detailed list of investments (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, from Arico 2 - Polígono Güímar 66 kV, circuit 2	65	65	2	Line	RES	2025
I/O in Las Rosas, from Buenos Aires - El Poris 220 kV, circuit 1	290	290	0.5	Line	RES	> 2026
I/O in Las Rosas, from Candelaria - El Porís 66 kV, circuit 1	65	65	2	Line	RES	> 2026
I/O in Las Rosas, from 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

Detailed list of investments (continued):

Dynamic Line Rating	km (±10%)	Type	Driv.	Year
Arico 2 - Polígono Güímar 66 kV, circuit 1	22	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

I Investment ICA_3

RES integration and resolution of technical constraints

Reinforcement of the southern axis Tenerife and new San Isidro

I General description:

The investment consists of reinforcing the 66 kV axis in the south of Tenerife between Granadilla and Arona, which is already overloaded in certain situations, as well as the creation of a new renewable injection point in the area. Specifically, it includes:

- Uprating of the Granadilla-Arona 66 kV double circuit
- New input-output at the new San Isidro 66 kV substation on the Granadilla-Arona 1 66 kV line.
- Extension of the San Isidro 66 kV substation for generation or storage connection.

I Drivers / Objectives:

- Enable the integration of renewable energies in the south-eastern part of the island by reducing loads in the axis.
- Eliminate the need, which already exists, to connect the Arona gas turbine due to technical constraints, in order to avoid overloads on this axis.
- Summarizing, it will reduce the costs of technical constraints and improve the security of supply of the island of Tenerife.

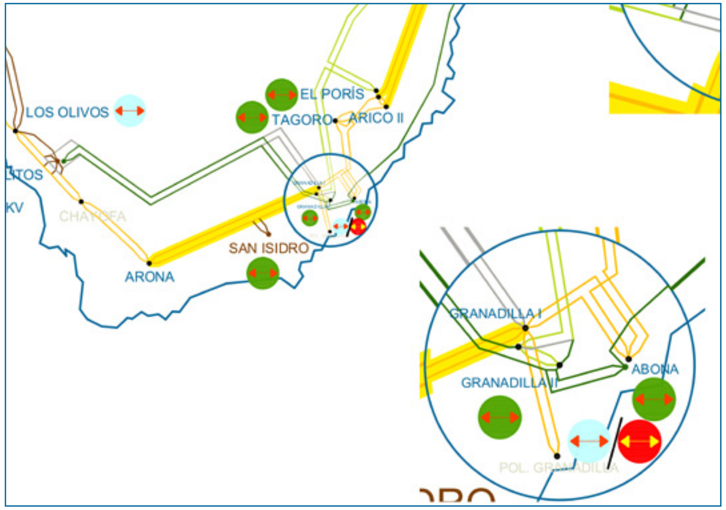
I Alternatives:

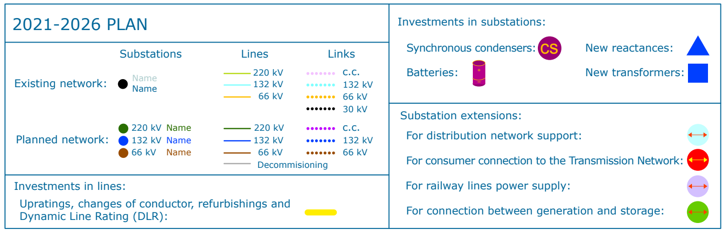
The dynamic line rating solution is not sufficient to solve the above constraints.

Alternative solutions of creating new parallel axes have also been evaluated, but have been discarded due to their higher cost and social and environmental impact.

I European dimension: No

I Map:





Investment ICA_3

RES integration and resolution of technical constraints

Reinforcement of the southern axis Tenerife and new San Isidro

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
7.4 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	0.6	0.6	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 investments planned except for the TF-LG link, the benefit of which is analysed in a final stage considering the rest of the investments in service.

Profitability:

Profitability: NPV
4 M€

Socio-environmental impact:

Impact degree

\+ -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree

\+ -

Investment ICA_3

RES integration and resolution of technical constraints

Reinforcement of the southern axis Tenerife and new San Isidro

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 investment 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 right of way kilometres.

Detailed list of investments:

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 investments (continued):

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
DC Granadilla - Arona 66 kV	77	77	0.3	Cable	RES	2024
I/O in San isidro, from Granadilla - Arona 66 kV, circuit 1	77	77	0.2	Cable	RES	2026
I/O in San isidro, from Granadilla - Arona 66 kV, circuit 1	77	77	0.2	Line	RES	2026

Line uprating	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
DC Granadilla - Arona 66 kV	77	77	36	Line	RES	2024

Investment N_ESTE_1

RES integration and resolution of technical constraints **Aragon - Navarre Reinforcement**

General description:

This investment consists of creating a new 400 kV axis between Navarre and Aragon and the uprating of 220 kV lines near Magallón:

- New 400 kV double-circuit between La Serna and Magallón
- Uprating of the Jalón-Magallón 1 and 2 220 kV, Lanzas Agudas-Magallón 220 kV, Tudela-Magallón 220 kV and Magallón-Moncayo 220 kV lines.

Drivers / Objectives:

- Reduce technical constraints due to overloads on the lines in the area consisting of the application of curtailments to renewable energy sources in the area.
- Improve the integration of existing and future renewable energies in the area.

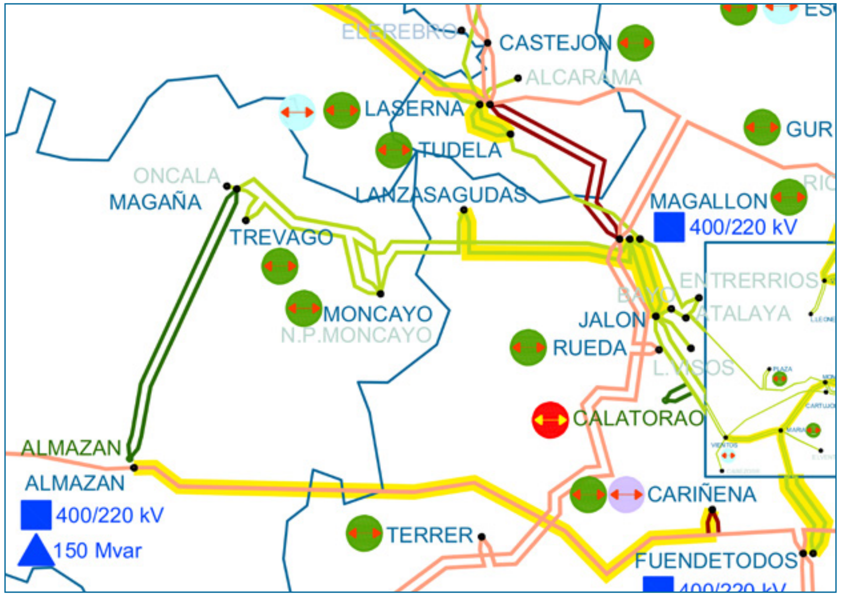
Alternatives:

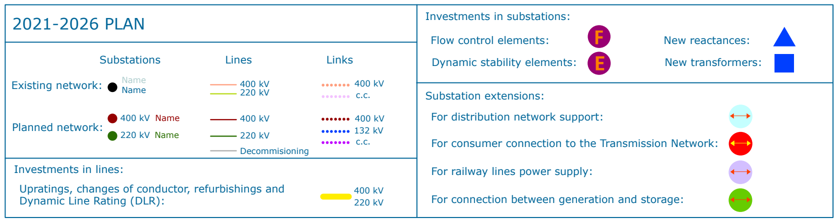
The duplication of the existing line between La Serna and the junction between La Serna-Magallón 400 kV and Magallón-Peñaflor 400 kV has also been analysed. However, from this analysis it is concluded that this would be an investment with an elevated risk of non-feasibility. The application of DLR is not sufficient to address the needs identified in the area.

European dimension:

No

Map:





Investment N_ESTE_1

RES integration and resolution of technical constraints **Aragon - Navarre Reinforcement**

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
40.7 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	3.6	3.5	3.5	3.4	3.4	3.3	3.2

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

Profitability:

Profitability: NPV
630 M€

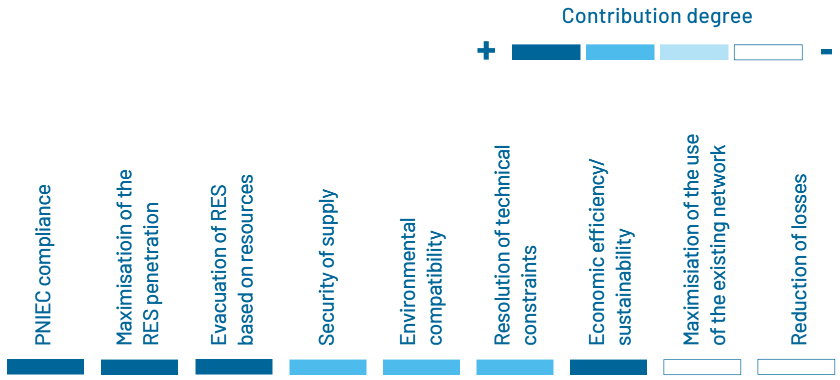
Socio-environmental impact:

Impact degree
\+ -

Environmental impact

Social impact

Contribution to guiding principles:



Investment N_ESTE_1

RES integration and resolution of technical constraints **Aragon - Navarre 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 investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
La Serna 400 kV	3	Conv.	TN	2025
Magallón 400 kV	3	Conv.	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 investments (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

Investment N_ESTE_2

RES integration and resolution of technical constraints

Aragon - Southern Catalonia Reinforcement

General description: This investment consists of creating a new double-circuit axis from Aragon to Catalonia isolated at 400 kV in which one circuit is operated at 400 kV connecting the Escatrón, Els Aubals and La Secuita substations, with another circuit operating at 220 kV connecting the Escatrón, Els Aubals and La Selva substations. The investment includes the uprating of the DC Aragon-Ascó 400 kV, DC Vandellós-Ascó 400 kV, Constantí-Tarragona 220 kV and Aragon-Mequinenza 400 kV lines and the change of conductor on the Escatrón-Aragon 400 kV line

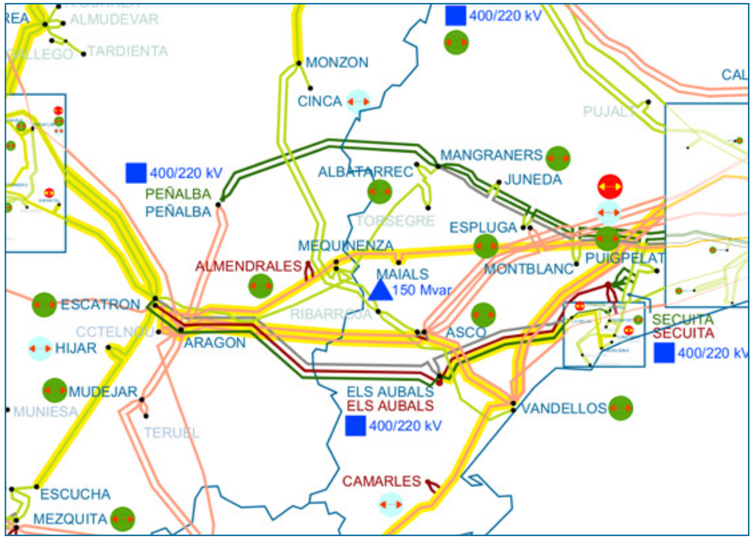
Drivers / Objectives:

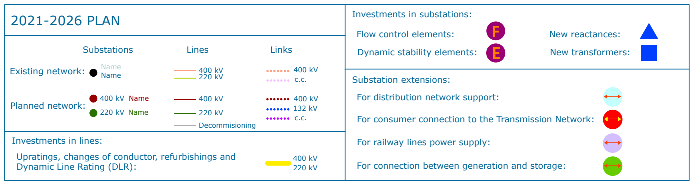
- Reduce the technical constraints due to overloads that cause the curtailment of renewable energy sources in the area by strengthening the connection between Aragon and Catalonia.
- Increase the security and quality of the electricity supply in the area.
- Improve the integration of existing and future renewable energies in the area.

Alternatives: The uprating of the 220 kV line between Escatrón, Els Aubals and La Selva has been analysed, but it does not satisfactorily resolve the needs detected. On the other hand, the construction of a 400 kV axis between Peñalba and Isona, an alternative investment to this one, has been met with strong social opposition.

European dimension: No

Map:





Investment N_ESTE_2
RES integration and resolution of technical constraints
Aragon - Southern Catalonia 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
168.4 M€	1.75 M€/year

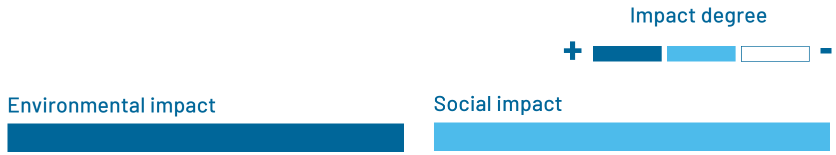
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	15.4	15.1	14.9	14.7	14.4	14.2	13.9	13.7	13.5

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

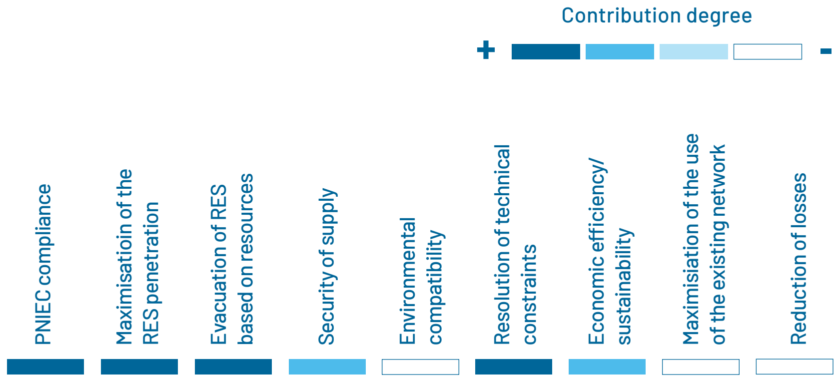
Profitability:

Profitability: NPV
894 M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment N_ESTE_2

RES integration and resolution of technical constraints

Aragon - Southern Catalonia Reinforcement

Table of physical units:

	220 kV	400 kV
Bays (units)	9	16
Overhead line (km)	12	314
Cables (km)	0.6	
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 investment 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 right of way kilometres.

Detailed list of investments:

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	2	GIS	TN	2024
Els Aubals 400 kV	5	Conv.	TN	2024
Els Aubals 400 kV	1	Conv.	TN	> 2026
Escatrón 400 kV	1	Conv.	TN	2024
Fuendetodos 220 kV	1	Conv.	TN	2023
Fuendetodos 400 kV	2	GIS	TN	2023
La Secuita 220 kV	6	Conv.	TN	2024
La Secuita 400 kV	6	Conv.	TN	2024
La Secuita 400 kV	1	Conv.	TN	> 2026

Investment N_ESTE_2
RES integration and resolution of technical constraints
Aragon - Southern Catalonia Reinforcement

Detailed list of investments (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 [2]	2,380	2,000	95	Line	RES	2024
I/O in La Secuita, of Garraf - Vandellós 400 kV, circuit 1	1,360	980	2	Line	RES	2024
I/O in La Secuita, of Juneda - Perafort 220 kV, circuit 1	430	280	3	Line	RES	2024
I/O in La Secuita, of Puigpelat - Constanti 220 kV, circuit 1	430	430	3	Line	RES	2024
Els Aubals - Els Aubals 220 kV, circuit 1 [3]			0.1	Cable	RES	2024
Els Aubals - La Selva 220 kV, circuit 1 [4]	605	605	0.5	Cable	RES	2024

Notes:
1. One of the two circuits operates at 220 kV, Escatrón-Aubals-La Selva 220 kV. The disconnection of Escatrón-Aubals-La Selva 220 kV is required.
2. One of the two circuits operates at 220 kV, Escatrón-Aubals-La Selva 220 kV. The disconnection of Escatrón-Aubals-La Selva 220 kV is required.
3. Cable to connect the transformer.
4. Section of cable to connect to La Selva.

Change of conductor	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Escatrón - Aragon 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
Aragon - Ascó 400 kV, circuit 1	1,760	1,511	73	Line	RES	2022
Aragon - Ascó 400 kV, circuit 2	1,760	1,511	73	Line	RES	2022
Aragon - 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

Investment N_ESTE_3

RES integration and resolution of technical constraints

Aragon - Central Catalonia Reinforcement

General description:

This investment consists of creating a new 220 kV line from Aragon to Catalonia, between the Peñalba and Mangraners substations. It includes the transformation of the current 220 kV single circuit between Lérida and Tarragona into a double circuit from Mangraners to Begues/Viladecans.

Drivers / Objectives:

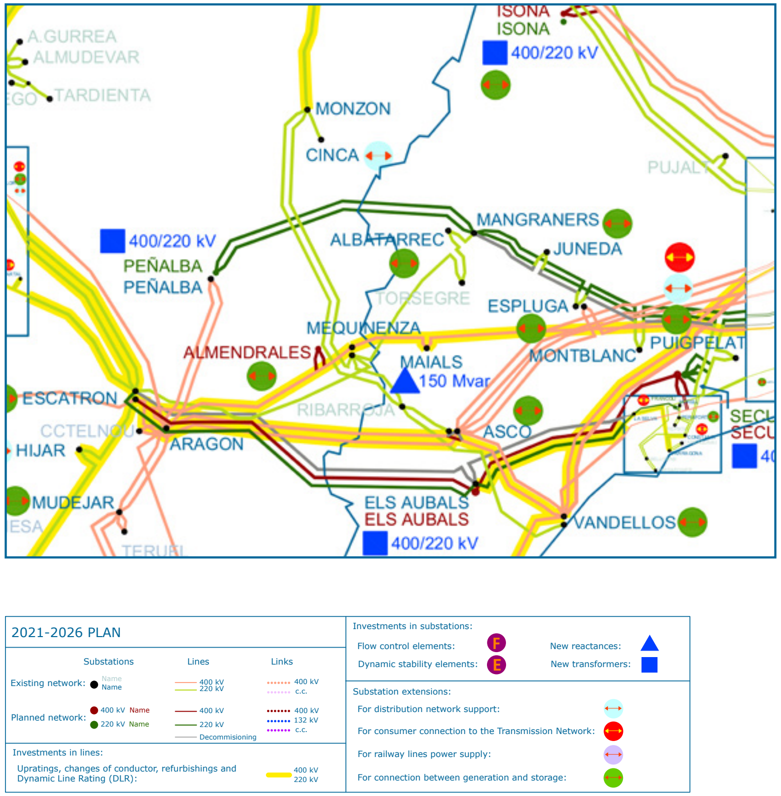
- Reduce the technical constraints due to overloads that cause the curtailment of renewable energy sources in the area by strengthening the connection between Aragon and Catalonia.
- Resolve the following critical network elements of the ES-FR interconnection detected in ENTSOE bidding zone configuration technical report - 2018: Torres del Segre-Albatarrec 220 kV and Mequinenza-Torres del Segre 220 kV.
- Decrease the need for technical constraints to reach the target of 70% of the available capacity in these elements for trading capacity according to Art. 16(8) of the Internal Energy Market Regulation 2019/943.

Alternatives:

The uprating of the 220 kV line between Escatrón, Mequinenza, Torres de Segre, Albatarrec and Mangraners has been analysed, but this investment is not feasible. On the other hand, the alternative investment consisting of the construction of a 400 kV axis between Peñalba and Isona is very much opposed by the local population. For the connection between Mangraners and Begues/Viladecans, the possibility of new developments further north has been analysed, but they also present a substantial risk of unfeasibility.

European dimension: No

Map:



Investment N_ESTE_3

RES integration and resolution of technical constraints

Aragon - Central Catalonia 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
125.3 M€	0.84 M€/year

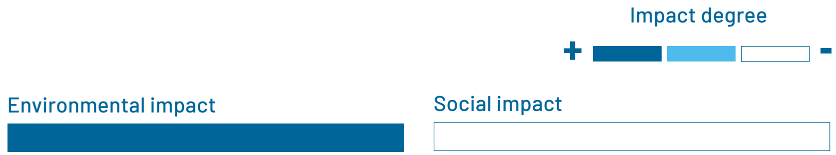
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	11.0	10.8	10.6	10.4	10.3	10.1	9.9	9.7	9.6

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

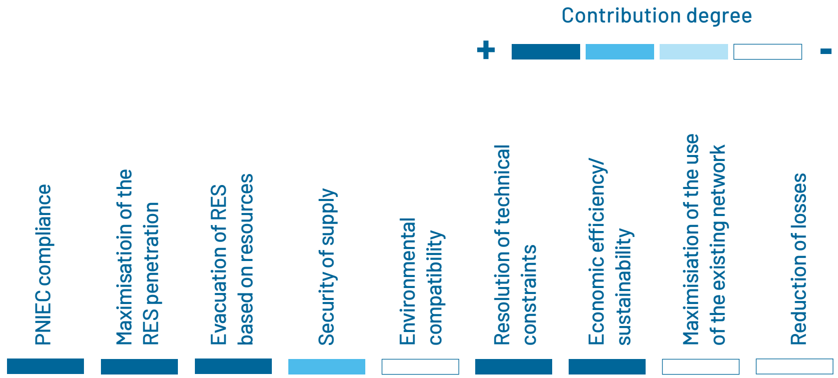
Profitability:

Profitability: NPV
1,242 M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment N_ESTE_3
RES integration and resolution of technical constraints
Aragon - Central Catalonia Reinforcement

Table of physical units:

	220 kV	400 kV
Bays (units)	8	2
Overhead line (km)	376	
Cables (km)	4	
Transformed to 220 kV (MVA)		600

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Peñalba 220 kV	Outdoor	2025

Substation extension	units	Type	Driv.	Year
Begues 220 kV	1	Conv.	TN	2025
Mangraners 220 kV [1]	3	Conv.	TN	2025
Peñalba 220 kV	4	Conv.	TN	2025
Peñalba 400 kV	2	Conv.	TN	2025

Notes:
1. For the whole investment, only one additional bay is needed in Mangraners and Begues. The current bays of Mangraners, Juneda, La Espluga, Perafort, Puigpelat Penedes and ViladecansB are reused.

Detailed list of investments (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

Notes:
1. On one circuit we can find the I/Os of Juneda, Perafort/Puigpelat and Penedes and the arrival at Viladecans, and on the other circuit the I/Os of Espluga and Montblanc. In both cases, part of the existing I/Os is used. The construction of the DC makes use of the route of the current simple circuit and the arrival at Viladecans, requiring the disconnection of part of the current lines.
2. DC section on which only one circuit is installed.
3. A section of cable is needed on arrival at Mangraners.

New transformers	MVA	Type	Driv.	Year
Peñalba 400/220 kV, TF1	600	Triph. B.	RES	2025

Investment N_ESTE_4

RES integration and resolution of technical constraints

Connection at Almendrales 400 kV

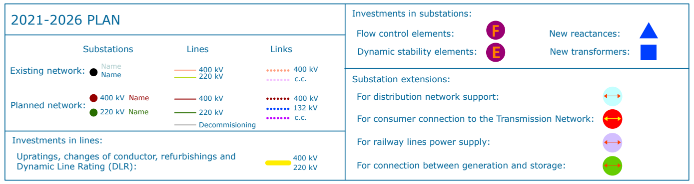
General description: The investment consists of the new input-output at the new Almendrales 400 kV substation on the Aragon-Mequinenza 400 kV line.

Drivers / Objectives: Enable the connection of new renewable energy sources with granted access permits.

Alternatives: The accesses already granted at this substation do not allow the replacement of this substation by an alternative.

European dimension: No

Map:



Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment 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.

Costs:

CAPEX	OPEX
7.1 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	0.7

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

Profitability:

Profitability: NPV
- M€

Socio-environmental impact:

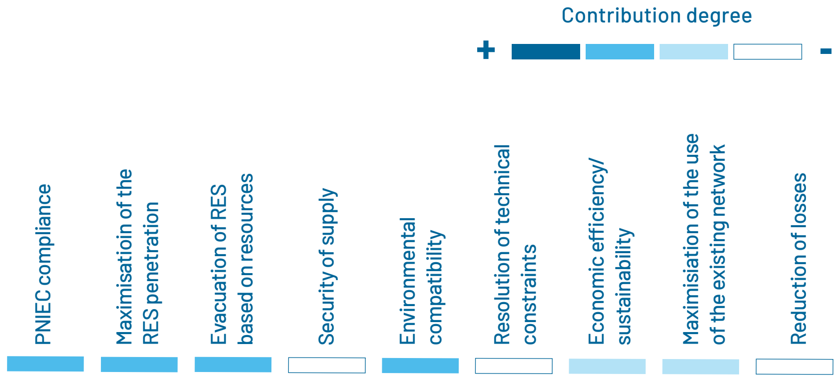
Impact degree

\+ -

Environmental impact

Social impact

Contribution to guiding principles:



Investment 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)	10

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Almendrales 400 kV	Outdoor	2023

Substation extension	units	Type	Driv.	Year
Almendrales 400 kV	2	Conv.	Gen./Sto.	2023
Almendrales 400 kV	3	Conv.	TN	2023

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Almendrales, of Aragon - Mequinenza 400 kV, circuit 1			5	Line	RES	2023

Investment N_ESTE_5

RES integration and resolution of technical constraints

Topological modification of the Pyrenean network

General description: This investment consists of creating a new substation in the Aragonese Pyrenees area that will enable the 220 kV network that runs parallel to the Pyrenees and connects Aragon and Catalonia to be operated uncoupled.

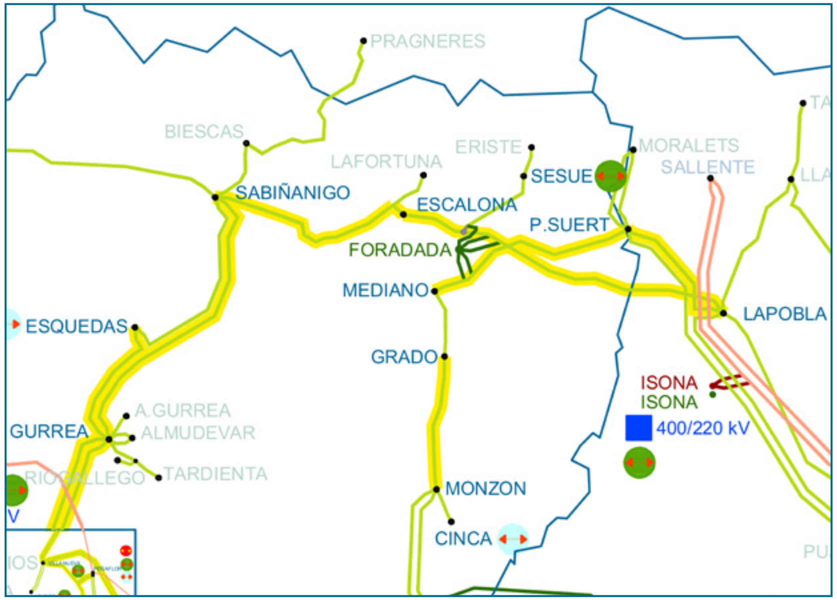
Drivers / Objectives:

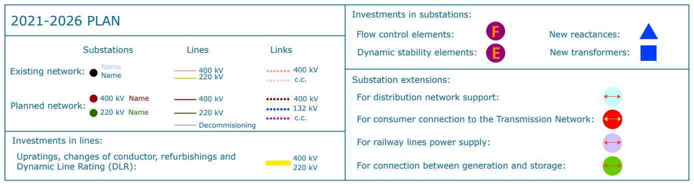
- Reduce the technical constraints due to overloads that cause the curtailmentof renewable energy sources in the area by strengthening the connection between Aragon and Catalonia.
- Improve the security of supply by eliminating the T Sesué 220 kV.
- Resolve the following critical network elements of the Spain-France interconnection identified in ENTSOE bidding zone configuration technical report 2018: Pont de Suert-La Pobla 220 kV.
- Decrease the need for the application of technical constraints to reach the target of 70% of the available capacity in these elements for commercial exchange capacity according to Art. 16(8) of the Internal Energy Market Regulation 2019/943.

Alternatives: The possibility of uprating the 220 kV network running parallel to the Pyrenees between Aragon and Catalonia has been analysed, but the necessary capacity values have not been reached. The duplication of these axes is not feasible.

European dimension: No

Map:





Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment 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.

Costs:

CAPEX	OPEX
11.6 M€	0.15 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	1.1	1.1	1.1	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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
93 M€

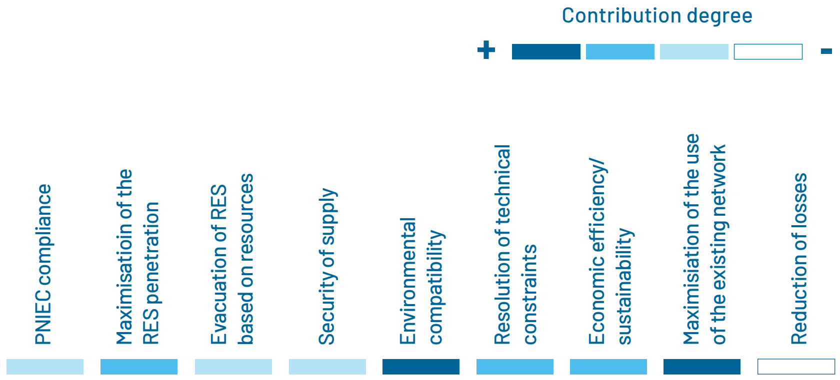
Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:



Investment 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 investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Foradada 220 kV [1]	Building	2024

Notes:
1. This investment requires the disconnection of T Sesue 220 kV.

Substation extension	units	Type	Driv.	Year
Foradada 220 kV	6	GIS	TN	2024

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Foradada, from Mediano - Pont de Suert 220 kV, circuit 1	490	410	2	Line	RES	2024
I/O in Foradada, from Mediano - Pont de Suert 220 kV, circuit 1 [1]	490	410	0.1	Cable	RES	2024
I/O in Foradada, from Sesué - Escalona 220 kV, circuit 1	390	330	0.5	Line	RES	2024
I/O in Foradada, from Sesué - Escalona 220 kV, circuit 1 [2]	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 [4]			0.1	Cable	RES	2024

Notes:
1. Cable to connect with Foradada 220 kV.
2. Cable to connect with Foradada 220 kV.
3. No transfer capacity is identified as it has a dynamic monitoring system.
4. Cable to connect with Foradada 220 kV.

Investment N_ESTE_6
RES integration and resolution of technical constraints
New Isona 400/220 kV substation

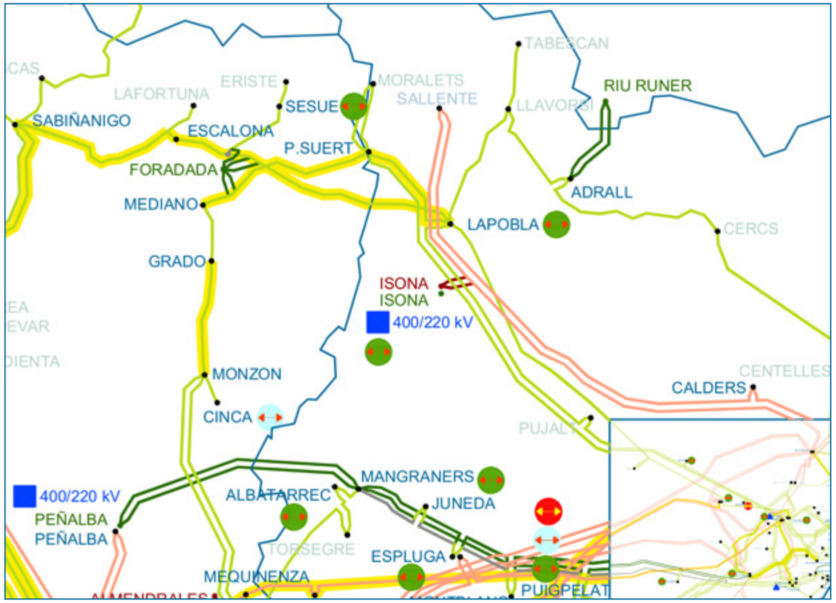
General description: The investment consists of the new Isona 400/220 kV substation, with input/output on the Sallente-Sentmenat 400 kV line.

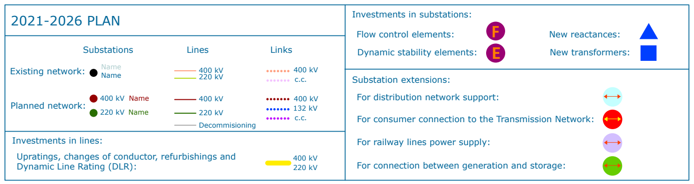
Drivers / Objectives: Enable the connection of new renewable energy sources with granted access permits.

Alternatives: The accesses already granted at this substation do not allow the replacement of this substation by an alternative.

European dimension: No

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment 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.

Costs:

CAPEX	OPEX
16.5 M€	0.48 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.7	1.6

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

Profitability:

Profitability: NPV
- M€

Socio-environmental impact:

Impact degree

+ -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree

+ -

PNIEC compliance

Maximisatioin of the RES penetration

Evacuation of RES based on resources

Security of supply

Environmental compatibility

Resolution of technical constraints

Economic efficiency/ sustainability

Maximisation of the use of the existing network

Reduction of losses

Investment 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 investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Isona 220 kV	Outdoor	2025
Isona 400 kV	Outdoor	2025

Substation extension	units	Type	Driv.	Year
Isona 220 kV	1	Conv.	Gen./Sto.	2025
Isona 220 kV	2	Conv.	TN	2025
Isona 400 kV	1	Conv.	Gen./Sto.	2025
Isona 400 kV	5	Conv.	TN	2025

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Isona, from 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

Investment N_OESTE_1

RES integration and resolution of technical constraints

Asturias 400 kV Reinforcement

General description: The investment consists of a new 400 kV line to guarantee supply, reduce the need for technical constraints in the area and improve the integration of renewable energy sources in Asturias:

- New Gozón 400 kV substation and new Gozón-Grado-Soto de Ribera 400 kV line.
- New input-output at the new Gozón 220 kV substation on the Tabiella-Carrió 220 kV line.
- New Tabiella-Gozón 220 kV line.
- New transformer 1 Gozón 400/220 kV.

Drivers / Objectives:

- Reduce generation constraints in the area that are currently solved by coal-fired generation scheduling by reinforcing the Asturias grid with a new 400 kV axis.
- Improve the security and quality of electricity supply in the Asturias area.
- Improve the integration of existing and future renewable energy sources in the area.

Alternatives:

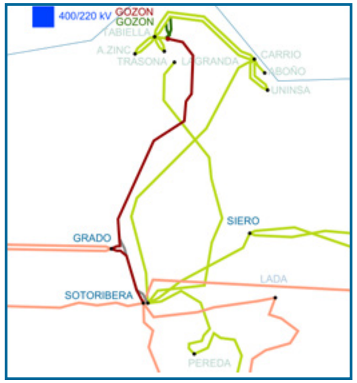
- Operating solutions, DLR, uprating of the existing 220 kV line or increasing its capacity do not solve the problems in the area.
- Solutions involving support from 400 kV to 220 kV from Tabiella present implementation difficulties and prevent possible future developments.

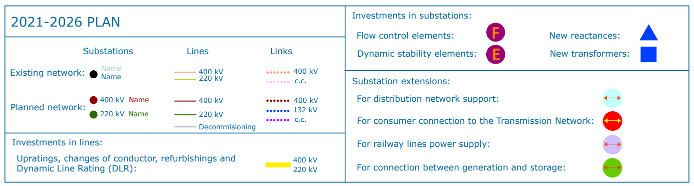
Alternatives (continued):

- Maintaining the operation of Aboño and its programming by technical constraints implies high-cost overruns for technical constraints and a considerable increase in emissions.

European dimension: No

Map:





Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment N_OESTE_1
RES integration and resolution of technical constraints
Asturias 400 kV Reinforcement

Cost-Benefit Multi-Criteria Analysis

Benefits:

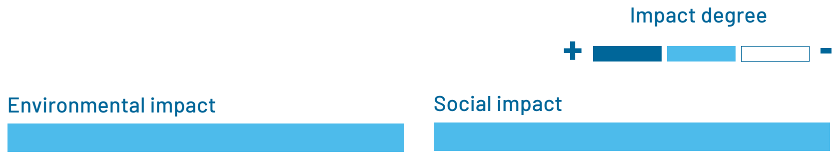
Socio-economic welfare: 2.8 M€/year	Reduction of CO_2 emissions: 12 kt/year*
Additional RES integration: 101,779 MWh/year	Reduction of system losses: 54,756 MWh/year*
Reduction of ENS: - MWh/year*	Reduction of needed installed generation capacity: - MW

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

Profitability:

Profitability: NPV
13 M€

Socio-environmental impact:



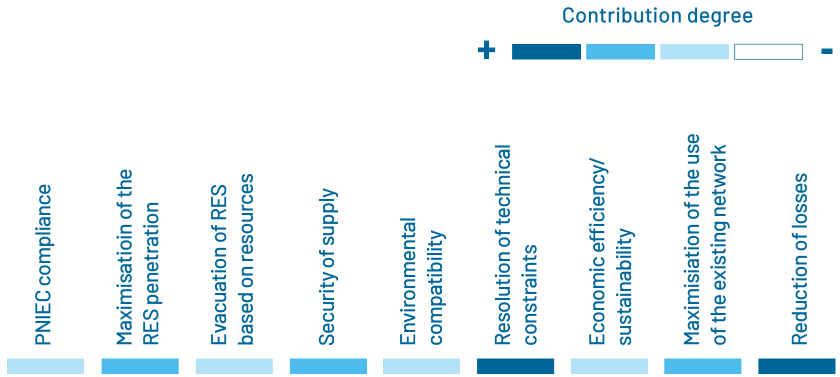
Costs:

CAPEX	OPEX
29.9 M€	0.47 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 investments that may be scheduled beyond 2026.

Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment N_OESTE_1

RES integration and resolution of technical constraints

Asturias 400 kV Reinforcement

Table of physical units:

	220 kV	400 kV
Bays (units)	5	4
Overhead line (km)	4	2
Transformed to 220 kV (MVA)		600
Voltage change (km)		30

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Gozón 220 kV	Outdoor	2024
Gozón 400 kV	Outdoor	2024

Substation extension	units	Type	Driv.	Year
Gozón 220 kV	5	Conv.	TN	2024
Gozón 400 kV	3	Conv.	TN	2024
Soto de Ribera 400 kV	1	Conv.	TN	2024

Detailed list of investments (continued):

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Gozón, of Carrió - Tabiella 220 kV, circuit 1	896	828	2	Line	RES	2024
Gozón - Tabiella 220 kV, circuit 1[1]	991	916	0.5	Line	RES	2024
Santa Maria de Grado - Gozón 400 kV, circuit 1	1,780	1,690	1	Line	RES	2024
Soto de Ribera - Santa Maria de Grado 400 kV, circuit 1	1,340	880	1	Line	RES	2024

Notes:
1. The disconnection of a section of the Tabiella-Soto 220 kV line is required.

Voltage changes	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Santa Maria de Grado - Gozón 400 kV, circuit 1	1,780	1,690	25	Line	RES	2024
Soto de Ribera - Santa Maria de Grado 400 kV, circuit 1	1,340	880	5	Line	RES	2024

New transformers	MVA	Type	Driv.	Year
Gozón 400/220 kV, TF1	600	Triph. B.	RES	2024

Investment N_OESTE_2
RES integration and resolution of technical constraints
Connection at Briviesca

General description: The investment consists of a new substation for the integration of renewable energy sources in the Briviesca area:

- New input-output at the new Briviesca 400 kV substation on the Grijota-Vitoria 400 kV line.

Drivers / Objectives:

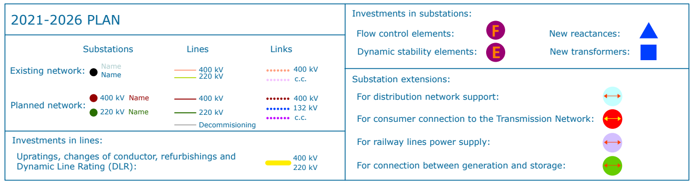
- Connect existing and future renewable energy sources in the area, with a high probability of successful deployment.
- Supply from the transmission network to the transmission substations of the Burgos-Vitoria railway line.

Alternatives: Operating solutions, DLR, uprating of the existing 220 kV axis or increasing its capacity are not solutions that solve the problem of increasing the evacuation capacity of the area.

The alternative connection to the Alcocero de Mola 220 kV substation presents integration difficulties due to overloads on the 220 kV lines in the area.

European dimension: No

Map:



Investment N_OESTE_2
RES integration and resolution of technical constraints
Connection at Briviesca

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.

Costs:

CAPEX	OPEX
7 M€	0.24 M€/year

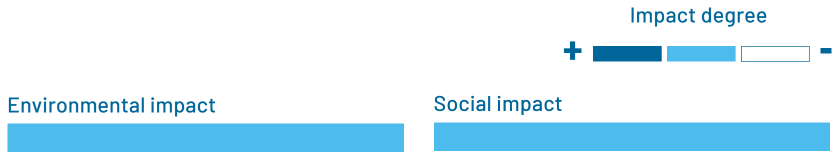
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7

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

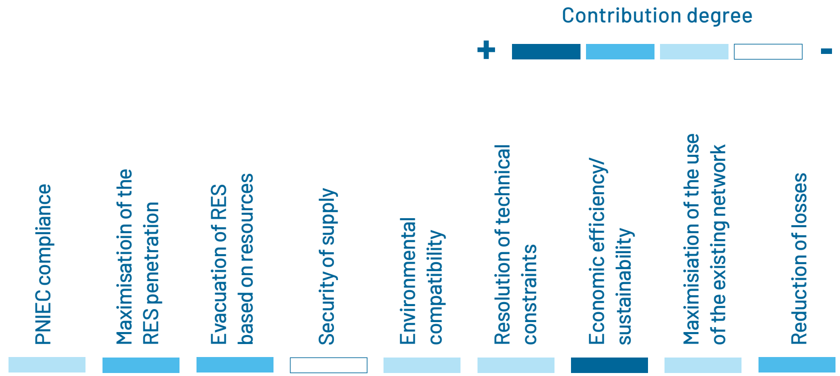
Profitability:

Profitability: NPV
107 M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment N_OESTE_2

RES integration and resolution of technical constraints

Connection at Briviesca

Table of physical units:

	400 kV
Bays (units)	5
Overhead line (km)	5

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Briviesca 400 kV	Outdoor	2025

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Briviesca 400 kV	4	Conv.	TN	2025
Briviesca 400 kV	1	Conv.	Gen./Sto.	2025

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Briviesca, of Grijota - Vitoria 400 kV, circuit 1	1,830	1,540	2	Line	RES	2025

I Investment N_OESTE_3

RES integration and resolution of technical constraints

Connection at Villalbilla

I General description:

The investment consists of a new 400 kV substation to support the 220 kV grid in the Burgos area and increase the integration of renewable energy sources:

- New input-output at the new Villalbilla 400 kV substation on the Grijota-Vitoria 400 kV line.
- New transformer 1 at Villalbilla 400/220 kV (>2026).

I Drivers / Objectives:

- Connect existing and future renewable energy sources in the area, with a high probability of successful deployment.
- Reduce technical constraints due to overloads that cause the curtailment of renewable energy sources in the area by supporting from the 220 kV axis between Burgos and the Basque Country from the 400 kV network.

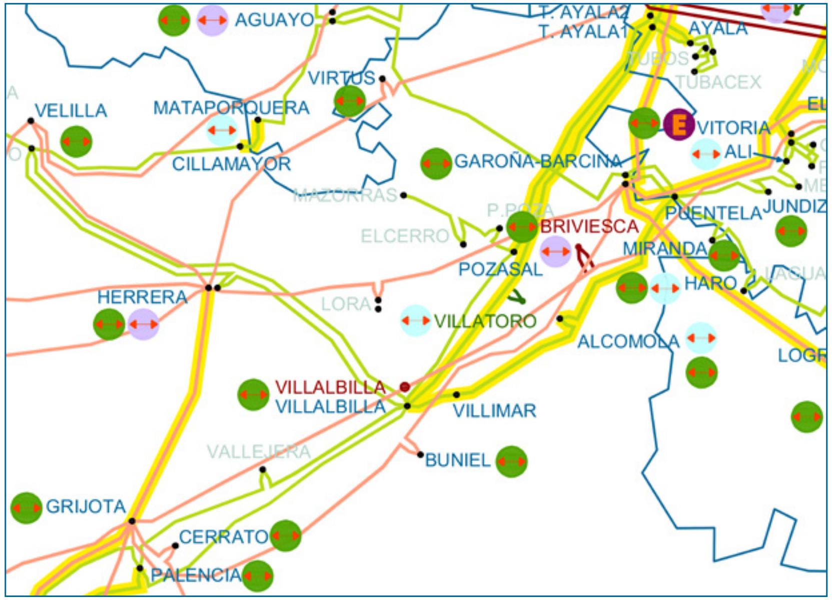
I Alternatives:

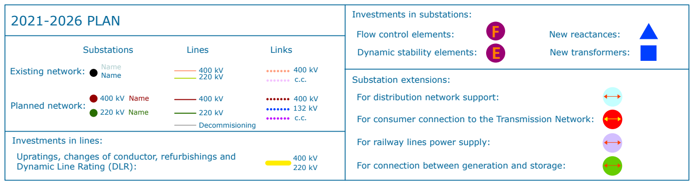
Operating solutions, DLR, uprating of the existing 220 kV line or increasing its capacity are not solutions that satisfactorily resolve the needs detected in the area.

I European dimension:

No

I Map:





Investment N_OESTE_3

RES integration and resolution of technical constraints

Connection at Villalbilla

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
15.5 M€	0.45 M€/year

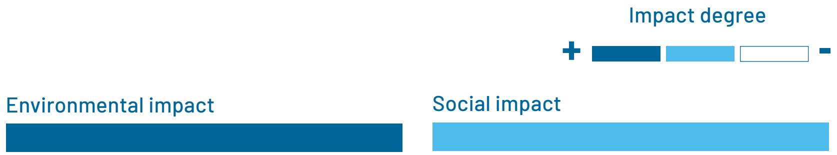
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6	1.5

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

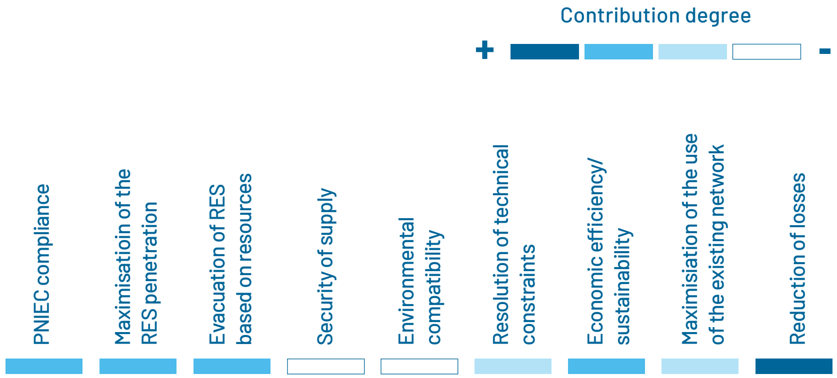
Profitability:

Profitability: NPV
129 M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment N_OESTE_3
RES integration and resolution of technical constraints
Connection at Villalbilla

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 investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Villalbilla 400 kV	Outdoor	2025

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Villalbilla 220 kV	1	Conv.	TN	> 2026
Villalbilla 400 kV	4	Conv.	TN	2025
Villalbilla 400 kV	2	Conv.	TN	> 2026
Villalbilla 400 kV	1	Conv.	Gen./Sto.	2025

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Villalbilla, of Grijota - Vitoria 400 kV, circuit 1	1,830	1,540	2	Line	RES	2025

New transformers	MVA	Type	Driv.	Year
Villalbilla 400/220 kV, TF1	600	Triph. B.	RES	> 2026

Investment N_OESTE_4

RES integration and resolution of technical constraints

Connection at Urueña

General description:

The investment consists of a new substation for the integration of renewable energy sources in the Tordesillas area:

- New input-output at the new Urueña 400 kV substation on the Villarino-Grijota 400 kV line.

Drivers / Objectives:

- Connect existing and future renewable energy sources in the area, with a high probability of successful deployment.

Alternatives:

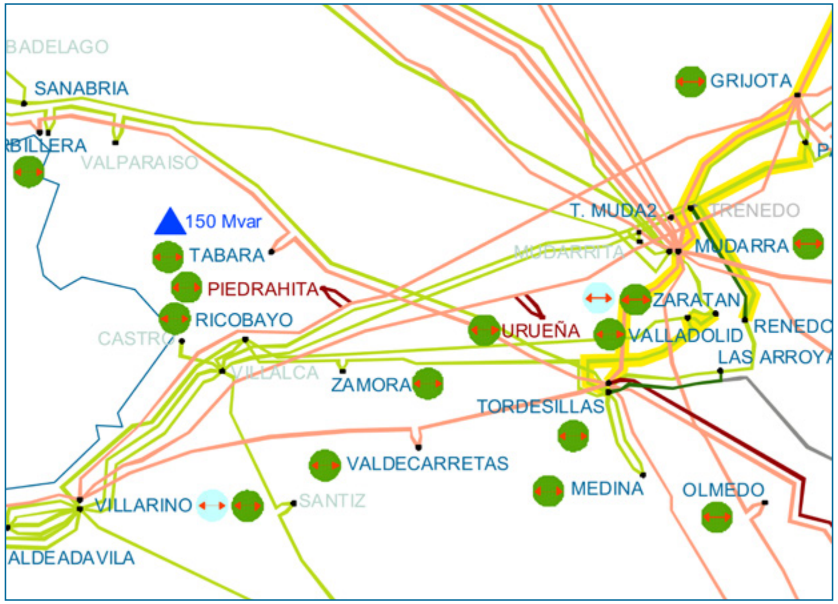
Operating solutions, DLR, uprating the existing 220 kV line or increasing its capacity are not solutions that solve the problems in the area.

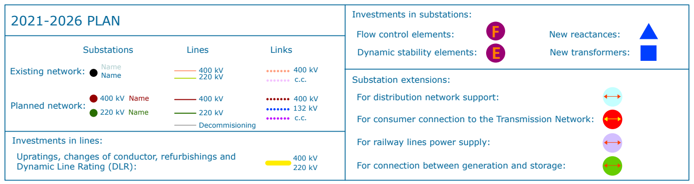
Solutions involving the extension of 220 kV substations in the Tordesillas and Medina area do not allow the integration of the high renewable resource in the area with a high probability of successful implementation.

European dimension:

No

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment N_OESTE_4
RES integration and resolution of technical constraints
Connection at Urueña

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.

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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
95 M€

Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -

PNIEC compliance
Maximisatioin of the RES penetration
Evacuation of RES based on resources
Security of supply
Environmental compatibility
Resolution of technical constraints
Economic efficiency/ sustainability
Maximisation of the use of the existing network
Reduction of losses

Investment N_OESTE_4

RES integration and resolution of technical constraints

Connection at Urueña

Table of physical units:

	400 kV
Bays (units)	5
Overhead line (km)	6

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Urueña 400 kV	Outdoor	2025

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Urueña 400 kV	4	Conv.	TN	2025
Urueña 400 kV	1	Conv.	Gen./Sto.	2025

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Urueña, of Grijota - Villarino 400 kV, circuit 1	2,400	2,000	3	Line	RES	2025

Investment N_OESTE_5

RES integration and resolution of technical constraints

Connection at Piedrahita

General description: The investment consists of a new substation for the integration of renewable energy sources in the area of Tábara (Zamora):

- New input-output at the new Piedrahita 400 kV substation on the Grijota-Villarino 400 kV line.

Drivers / Objectives:

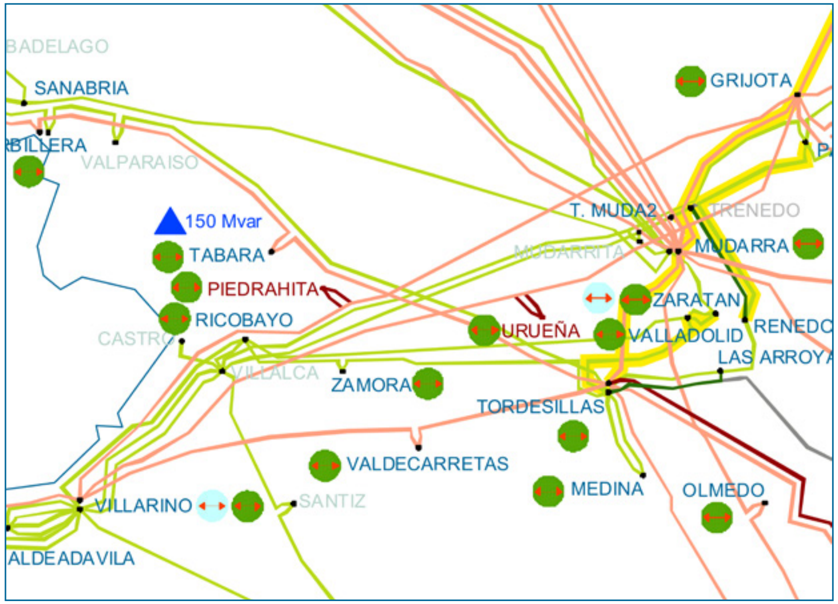
- Connect existing and future renewable energy sources in the area, with a high probability of successful deployment.

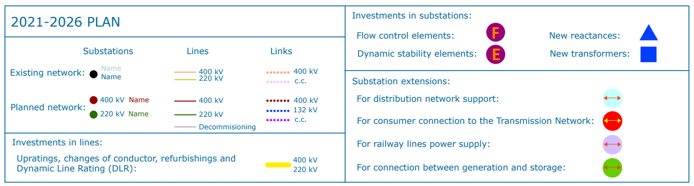
Alternatives: Operating solutions, DLR, uprating the existing 220 kV line or increasing its capacity are not solutions that solve the problems in the area.

Solutions involving the extension of 400 kV substations in the Tábara area do not allow the integration of the high renewable resource in the area with a high probability of successful implementation.

European dimension: No

Map:





Investment N_OESTE_5
RES integration and resolution of technical constraints
Connection at Piedrahita

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.

Costs:

CAPEX	OPEX
6.8 M€	0.24 M€/year

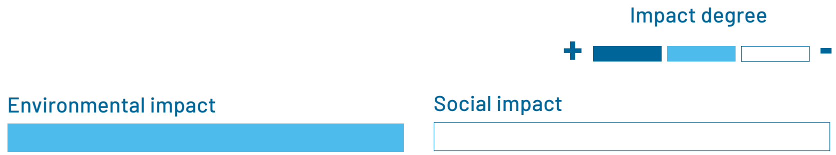
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7

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

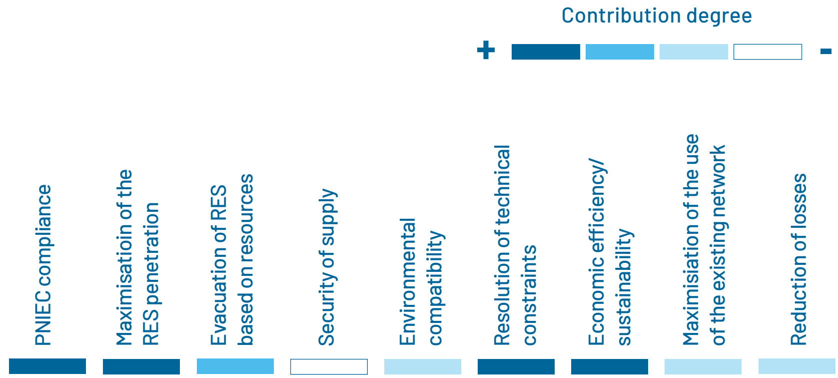
Profitability:

Profitability: NPV
833 M€

Socio-environmental impact:



Contribution to guiding principles:



Investment N_OESTE_5

RES integration and resolution of technical constraints

Connection at Piedrahita

Table of physical units:

	400 kV
Bays (units)	5
Overhead line (km)	4

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Piedrahíta de Castro 400 kV	Outdoor	2025

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Piedrahíta de Castro 400 kV	4	Conv.	TN	2025
Piedrahíta de Castro 400 kV	1	Conv.	Gen./Sto.	2025

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Piedrahíta de Castro, of Grijota - Villarino 400 kV, circuit 2	2,420	2,030	2	Line	RES	2025

Investment N_OESTE_6

RES integration and resolution of technical constraints

Connection at Abegondo 220 kV

General description:

The investment consists of a new substation for the connection of renewable energy sources in the north of A Coruña:

- New Abegondo 220 kV substation.
- New transformer 1 Abegondo 400/220 kV.

Drivers / Objectives:

- Enable connection of new renewable energy sources with granted access permits.

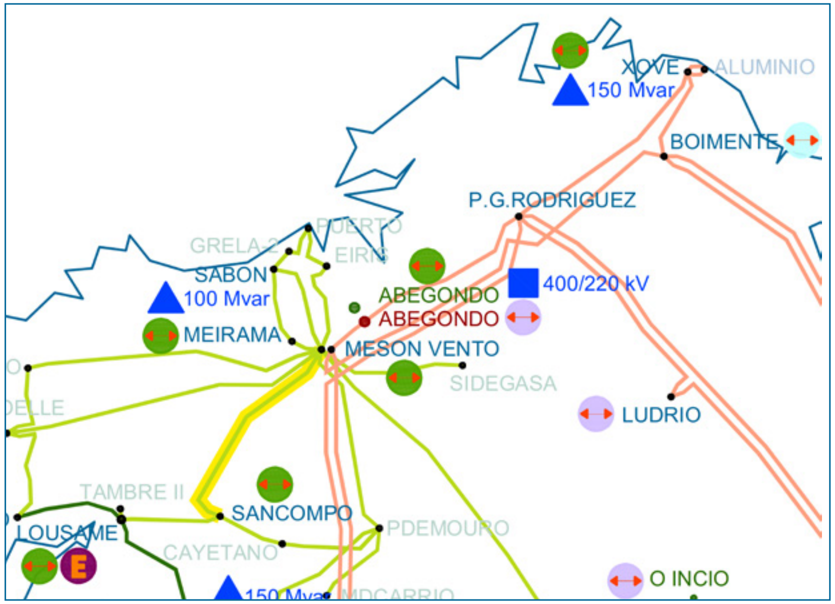
Alternatives:

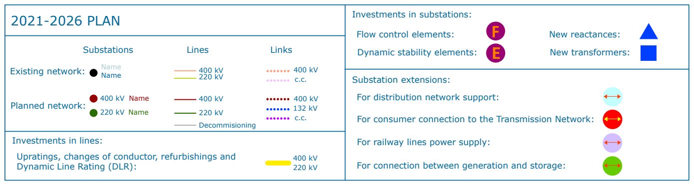
The accesses already granted at this substation do not allow the replacement of this substation by an alternative.

European dimension:

No

Map:





Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment 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.

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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
- M€

Socio-environmental impact:

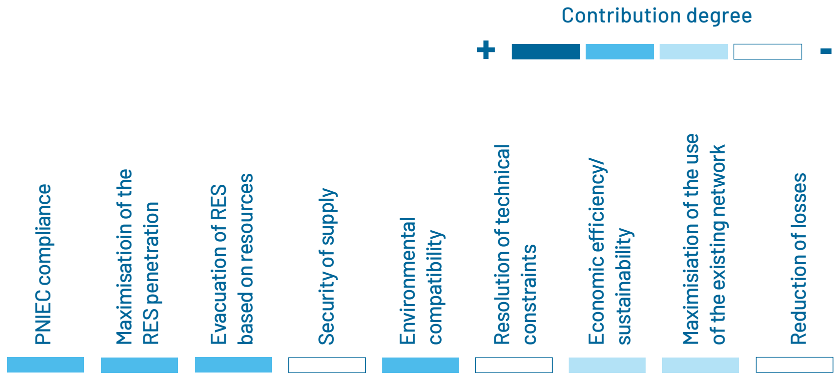
Impact degree

\+ -

Environmental impact

Social impact

Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment 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 investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Abegondo 220 kV	Outdoor	2024

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Abegondo 220 kV	2	Conv.	TN	2024
Abegondo 400 kV	1	Conv.	TN	2024

New transformers	MVA	Type	Driv.	Year
Abegondo 400/220 kV, TF1	600	Triph. B.	RES	2024

Investment N_OESTE_7

RES integration and resolution of technical constraints

Reinforcement of the Soria network

General description:

The investment consists of the electrical connection of the existing Magaña substation (Soria) and the 400 kV Mudarra-Aranda-Almazán- Cariñena-Fuendetodos axis:

- New substation Almazán 220 kV with double circuit Magaña-Almazán 220 kV.
- New transformer 400/220 kV Almazán.

Drivers / Objectives:

- Increase the meshing in the 220 kV grid in the Magaña area (Soria) to reduce the need to apply technical constraints to solve overloads through the curtailments of renewable energy sources in the area, mainly wind energy.

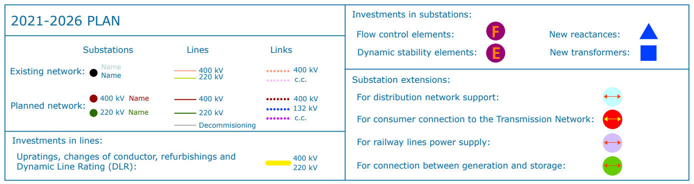
Alternatives:

Although uprating has already been conducted and others are planned on the 220 kV axes in the area, the high wind power potential in the Soria and Aragon area requires the construction of new infrastructure to ensure that it is fully exploited.

European dimension:

No

Map:



Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment 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.

Costs:

CAPEX	OPEX
48.5 M€	0.53 M€/year

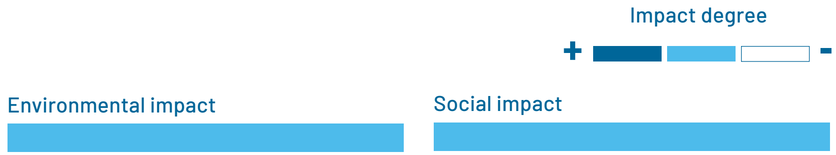
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	4.4	4.4	4.3	4.2	4.2	4.1	4.0	4.0	3.9

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

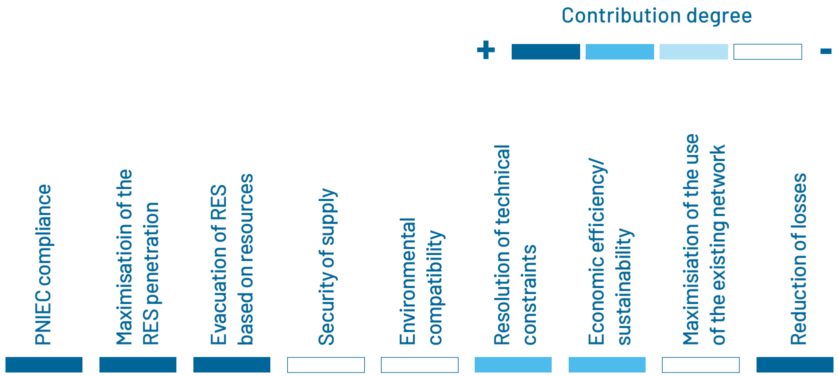
Profitability:

Profitability: NPV
214 M€

Socio-environmental impact:



Contribution to guiding principles:



Investment 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 investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Almazán 220 kV	Outdoor	2026

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Almazán 220 kV	4	Conv.	TN	2026
Almazán 400 kV	2	Conv.	TN	2026
Magaña 220 kV	2	Conv.	TN	2026

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Almazán - Almazán 400 kV, circuit 1			1	Line	RES	2026
DC Almazán - Magaña 220 kV	890	760	65	Line	RES	2026

New transformers	MVA	Type	Driv.	Year
Almazán 400/220 kV, TF1	600	Triph. B.	RES	2026

Investment NORTE_1

RES integration and resolution of technical constraints

New Navarre - Basque Country axis

General description:

The investment consists of reinforcing the connection between the Itxaso substation (Basque Country) and the Muruarte - Castejón axis (Navarre):

- New double circuit Itxaso - Muruarte 400kV and Itxaso - Castejón 400 kV.

Drivers / Objectives:

- The current connection between Navarre and the Basque Country is via two 220 kV lines of limited capacity, which causes grid overloads that require the application of technical constraints to renewable energy sources in the area, increasing generation costs and causing curtailments.
- Decrease the need for the application of technical constraints to reach the target of 70% of the available capacity in these elements for commercial exchange capacity according to Art. 16(8) of the Internal Energy Market Regulation 2019/943.

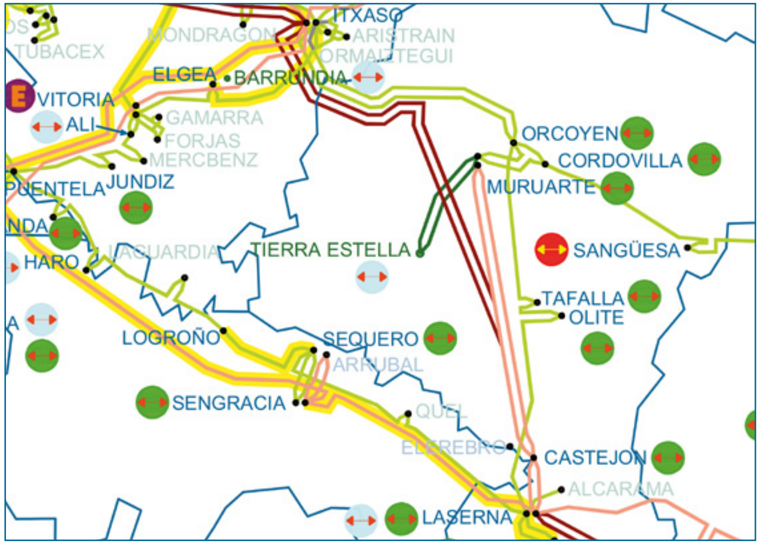
Alternatives:

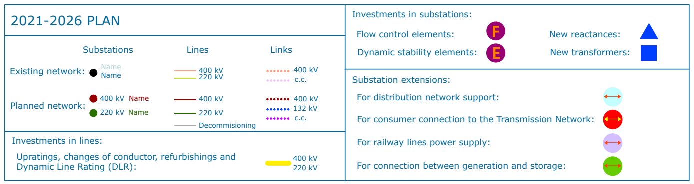
Other operational solutions, DLR, uprating of existing lines or increases in their capacity do not adequately solve the problems in the area.

The investment involves the disconnection of the existing Itxaso - Orcoyen 220 kV 1 and 2 circuits, which contributes to reducing their environmental impact.

European dimension: No

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment NORTE_1
RES integration and resolution of technical constraints
New Navarre - Basque Country 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.

Costs:

CAPEX	OPEX
65.2 M€	0.43 M€/year

Remuneration costs

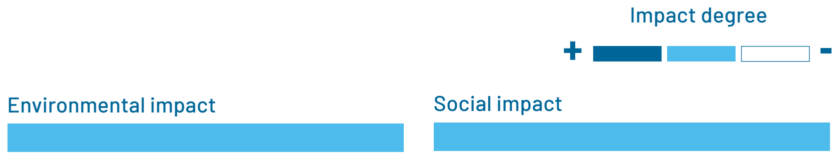
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	5.7	5.6	5.5	5.4	5.3	5.2	5.2	5.1	5.0

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

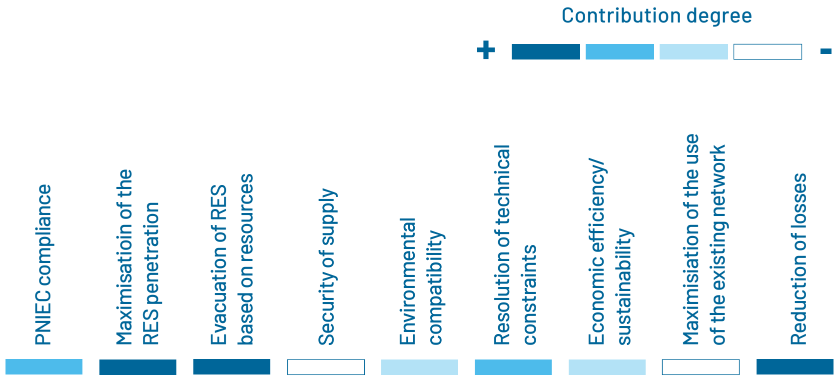
Profitability:

Profitability: NPV
246 M€

Socio-environmental impact:



Contribution to guiding principles:



Investment NORTE_1

RES integration and resolution of technical constraints

New Navarre - Basque Country axis

Table of physical units:

	400 kV
Bays (units)	3
Overhead line (km)	200

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Itxaso 400 kV	3	Conv.	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. Itxaso-Orcoyen 220kV 1 and 2 are required to be disconnected.

Investment SUR_1

RES integration and resolution of technical constraints

New corridors in Andalusia

General description:

Reinforcement of the Andalusian transmission network by means of new 400 kV axes (Baza-La Ribina, Seville-Cordoba and Andalusia-Castile-La Mancha).

In addition, it includes uprating of the existing network to maximise the benefits of these meshes, the reactances associated with the new network and a support for the 220 kV network.

Drivers / Objectives:

- To reduce the technical constraints due to overloads that cause the curtailment of renewable energy sources in the area by strengthening the connection between Andalusia and Castile-La Mancha and between Almeria and the rest of Andalusia.
- Increase the security and quality of the electricity supply in the area.
- Improve the integration of existing and future renewable energies in the area.

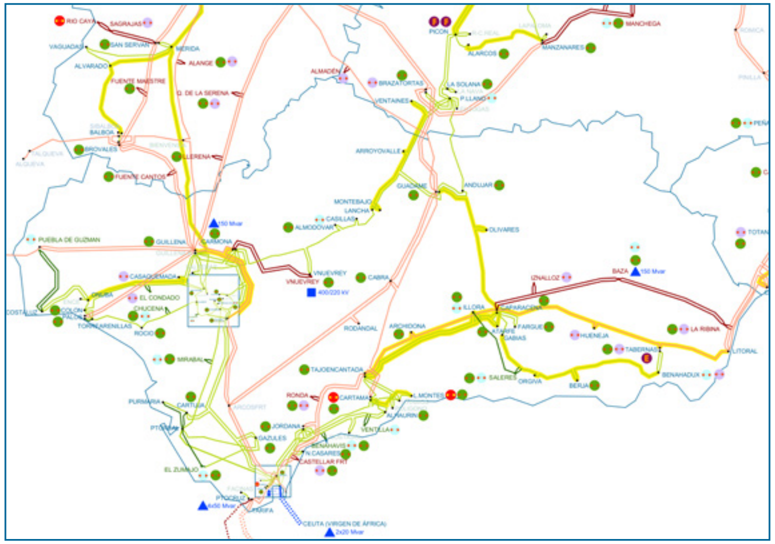
Alternatives:

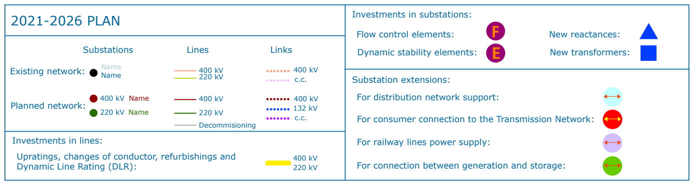
Alternative connections to Castile-La Mancha or Extremadura from Puebla de Guzmán and Hornachuelos have been considered, but have a greater environmental impact.

The alternative to the Carmona-Guadame axis consisting of the Carmona-Cabra axis has been evaluated, although it presents less benefits for the system as a whole.

European dimension: No

Map:





Investment SUR_1

RES integration and resolution of technical constraints

New corridors in Andalusia

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
361.6 M€	3.12 M€/year

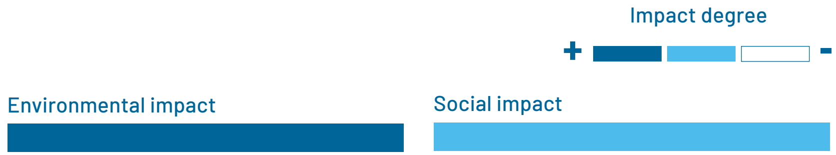
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	32.3	31.8	31.3	30.8	30.3	29.8	29.3	28.8	28.3

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

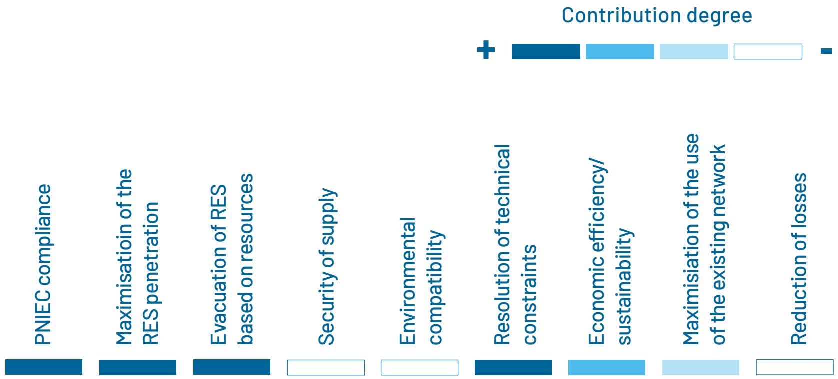
Profitability:

Profitability: NPV
1,740 M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment SUR_1

RES integration and resolution of technical constraints

New corridors in Andalusia

Table of physical units:

	220 kV	400 kV
Bays (units)	2	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 investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
La Ribina 400 kV	Outdoor	2024
Villanueva del Rey 400 kV	Outdoor	2025

Substation extension	units	Type	Driv.	Year
Baza REE 400 kV	3	Conv.	TN	2024
Baza REE 400 kV	1	Conv.	TN	2022
Carmona 400 kV	3	Conv.	TN	2025
Guadame 400 kV	6	Conv.	TN	> 2026

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
La Ribina 400 kV	7	Conv.	TN	2024
La Ribina 400 kV	1	Conv.	Gen./Sto.	2024
Manzanares 400 kV	2	Conv.	TN	> 2026
Villanueva del Rey 220 kV	1	Conv.	TN	2025
Villanueva del Rey 220 kV	1	Conv.	TN	> 2026
Villanueva del Rey 400 kV	1	Conv.	Gen./Sto.	2025
Villanueva del Rey 400 kV	6	Conv.	TN	2025
Villanueva del Rey 400 kV	3	Conv.	TN	> 2026

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
DC Baza REE - La Ribina 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 La Ribina, of Carril - Litoral 400 kV, circuit 1	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.

Investment SUR_1
RES integration and resolution of technical constraints
New corridors in Andalusia

Detailed list of investments (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 Ines 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	1,477	1,432	72	Line	RES	2023
Guadame - Olivares 220 kV, circuit 1	430	350	54	Line	RES	2023

Detailed list of investments (continued):

Line uprating	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Hueneja - Tabernas 400 kV, circuit 1	1,732	1,427	59	Line	RES	2024
Lancha - Montecillo Bajo 220 kV, circuit 1	416	339	3	Line	RES	2022
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

Investment GEN_ALM

RES integration and resolution of technical constraints

Connection of renewables and storage

General description: This includes additional substation bays associated with the connection of new storage facilities as well as extensions for the possible connection of offshore wind generation in areas included as priorities in the draft Marine Spatial Plan (POEM, for its acronym in Spanish):

- New input-output at the new Villarino de Conso 400 kV substation on the Trives-Aparecida line.
- New input-output at the new Abres 400 kV substation on the Pesoz-Boimente 400 kV line (> 2026).
- Extension for generation and storage at the Aguayo, Montearenas, Conso, Almendrales, Xove and Santa Llogaia 400 kV and Atios and Plaza 220 kV substations.

Drivers / Objectives: Enable the connection and integration of the generation of the study scenario marked by the National Energy and Climate Plan (PNIEC).

Alternatives: Connection via existing or planned substation bays has been assessed as 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
16.9 M€	0.89 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	2.2	2.1	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 investments that may be scheduled beyond 2026.

Investment GEN_ALM

RES integration and resolution of technical constraints

Connection of renewables and storage

Profitability:

Profitability: NPV

- M€

Socio-environmental impact:

Impact degree

\+ -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree

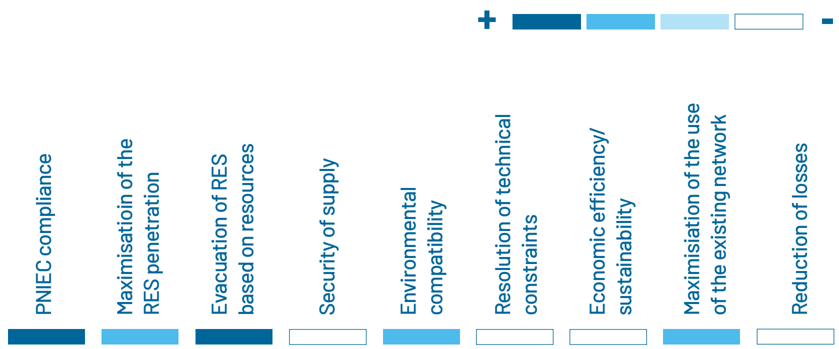


Table of physical units:

	220 kV	400 kV
Bays (units)	2	17
Overhead line (km)		8

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Abres 400 kV	Outdoor	> 2026
Villarino de Conso 400 kV	Outdoor	2026

Investment GEN_ALM
RES integration and resolution of technical constraints
Connection of renewables and storage

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Abres 400 kV	1	Conv.	Gen./Sto.	> 2026
Abres 400 kV	4	Conv.	TN	> 2026
Aguayo 400 kV	1	Conv.	Gen./Sto.	2023
Aguayo 400 kV	1	Conv.	TN	2023
Almendrales 400 kV	1	Conv.	TN	2026
Atios 220 kV	1	Conv.	Gen./Sto.	2026
Montearenas 400 kV	1	Conv.	Gen./Sto.	2025
Plaza 220 kV	1	Conv.	Gen./Sto.	2026
Santa Llogaia 400 kV	1	Conv.	Gen./Sto.	2026
Villarino de Conso 400 kV	2	Conv.	Gen./Sto.	2026
Villarino de Conso 400 kV	4	Conv.	TN	2026
Xove 400 kV	1	Conv.	Gen./Sto.	2026

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Abres, of Pesoz - Boimente 400 kV, circuit 1	2,430	2,240	2	Line	Gen./Sto.	> 2026
I/O in Villarino de Conso, of Trives - Aparecida 400 kV, circuit 1	2,410	2,060	2	Line	Gen./Sto.	2026

Investment SoS_CENTRO

Security of Supply **Reliability of supply Madrid**

General description:

The following investments are included for the security of supply of the transmission network in the Madrid area:

- Elimination of T Leganés 220 kV and T Retamar 220 kV and corresponding topological changes.
- Uprating with a change of Right of Way of the Moraleja-Villaviciosa 400 kV line, replacement of the Arganda-Loeches 220 kV and Arganda-Valdemoro 220 kV cables and capacity increase with a change of conductor on the Galapagar-Valle del Arcipreste-Majadahonda 220 kV axis. Uprating of Loeches-San Sebastian de los Reyes, 2 400 kV.

Drivers / Objectives:

- Improve reliability and security of supply of demand in the metropolitan area of Madrid.
- Decrease the need for technical constraints in the area to guarantee supply to the demand in the area.

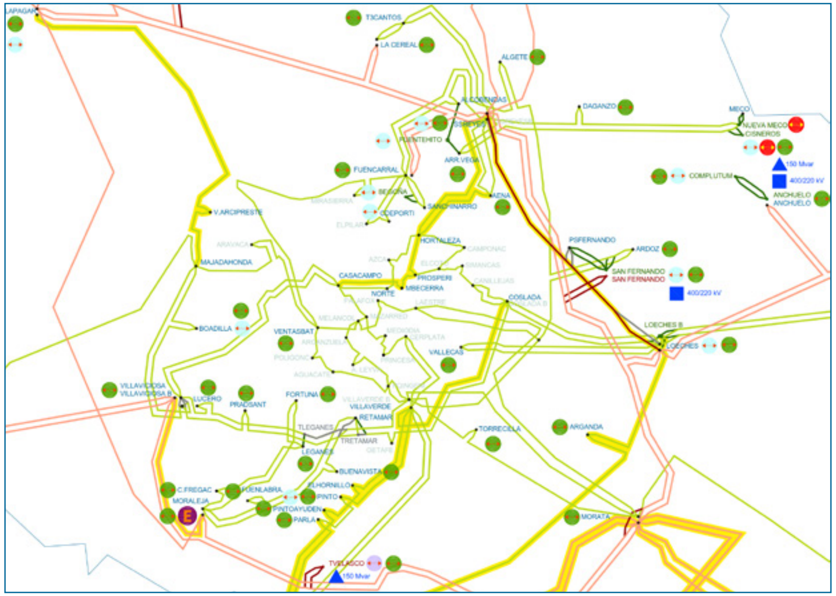
Alternatives:

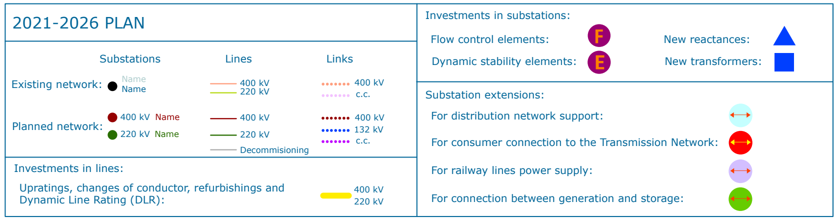
The possible alternatives would involve the development of a new network, which would have a more complex feasibility and require a higher volume of investment.

European dimension:

No

Map:





Investment SoS_CENTRO

Security of Supply **Reliability of supply Madrid**

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
31.6 M€	0.11 M€/year

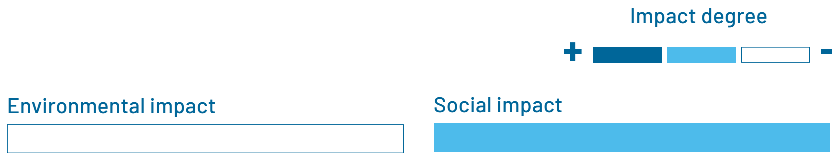
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	2.7	2.6	2.6	2.5	2.5	2.4	2.4	2.4	2.3

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

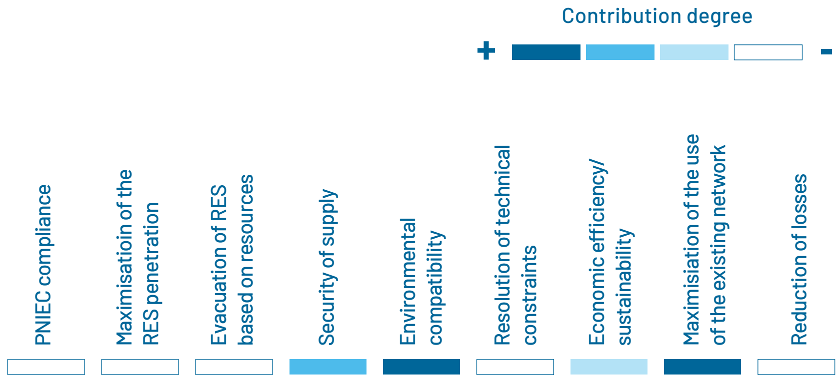
Profitability:

Profitability: NPV
- M€

Socio-environmental impact:



Contribution to guiding principles:



Investment SoS_CENTRO
Security of Supply **Reliability of supply Madrid**

Table of physical units:

	220 kV	400 kV
Bays (units)	2	
Overhead line (km)	20	24
Cables (km)	4	
Uprating (km)	60	29

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Parque Ingenieros 220 kV [1]	2	GIS	TN	> 2026

Notes:
1. Extension for operable bypass of the lines Aguacate-Parque Ingenieros 220 kV circuit 1 and Parque Ingenieros-Villaverde Bajo B 220 kV circuit 2

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Arganda - Loeches 220 kV, circuit 1	600	600	2	Cable	SoS	2024
Arganda - Valdemoro 220 kV, circuit 1	600	600	2	Cable	SoS	2024
Galapagar - Valle del Arcipreste 220 kV	466	466	8	Line	SoS	2024
DC Moraleja - Villaviciosa 400 kV [1]	1,770	1,450	12	Line	SoS	2024

Detailed list of investments (continued):

New lines/cables (continued)	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Getafe - Retamar 220 kV, circuit 1 [2]	320	190	0.4	Line	SoS	2024
Leganés - Lucero 220 kV, circuit 1 [3]	439	361	0.7	Line	SoS	2024
Majadahonda - Valle del Arcipreste 220 kV, circuit 1	466	466	2	Line	SoS	2024

Notes:
1. It shares pylons with the Morata-Villaviciosa 400 kV line.
2. The lines linking the eliminated T Retamar 220 kV with Retamar 220 kV, Getafe 220 kV and Prado de Santo Domingo 220 kV are disconnected due to a topological change. It involves, due to topological changes, the disconnection of the Buenavista-Retamar 220 kV line and the additions of the Leganés-Lucero 220 kV, Buenavista-Villaverde Bajo 220 kV, Getafe-Retamar 220 kV and Retamar-Prado de Santo Domingo 220 kV lines.
3. The lines linking the eliminated T Leganés 220 kV with Leganés 220 kV, Lucero 220 kV and Villaverde Bajo 220 kV are disconnected due to a topological change. It involves, due to topological changes, the disconnection of the Buenavista-Retamar 220 kV line and the additions of the Leganés-Lucero 220 kV, Buenavista-Villaverde Bajo 220 kV, Getafe-Retamar 220 kV and the 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	600	600	10	Line	SoS	2024
Arganda - Valdemoro 220 kV, circuit 1	600	600	22	Line	SoS	2022
Galapagar - Valle del Arcipreste 220 kV, circuit 1	490	400	24	Line	SoS	2024
Loeches - San Sebastián de los Reyes 400 kV, circuit 2 [1]	2,079	1,709	26	Line	SoS	2022
Majadahonda - Valle del Arcipreste 220 kV, circuit 1	430	360	3	Line	SoS	2024
Moraleja - Villaviciosa 400 kV, circuit 1	1,755	1,441	3	Line	SoS	2022

Notes:
1. Uprating of the overhead section to 85º.

Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment SoS_CENTRO_Pcc

Security of Supply **Reliability of supply Madrid (Short Circuit Current)**

General description: The investments included allow the reliability and security of supply of the transmission network in the Madrid area to be increased by reducing the short-circuit power in the area:

- Double bus operable at Loeches 220 kV
- Operable bypass at Morata 400 kV of the SS Reyes-S. Fernando-Morata 400 kV and Morata-Moraleja 400 kV axes forming one SSReyes-S.Fernando-Moraleja 400 kV axis
- Operable bypass at Parque de Ingenieros 220 kV of the Parque Ingenieros-Villaverde Bajo,2 220 kV and Parque Ingenieros-Aguacate lines forming a provisional Aguacate-Villaverde Bajo 220 kV line (>2026).

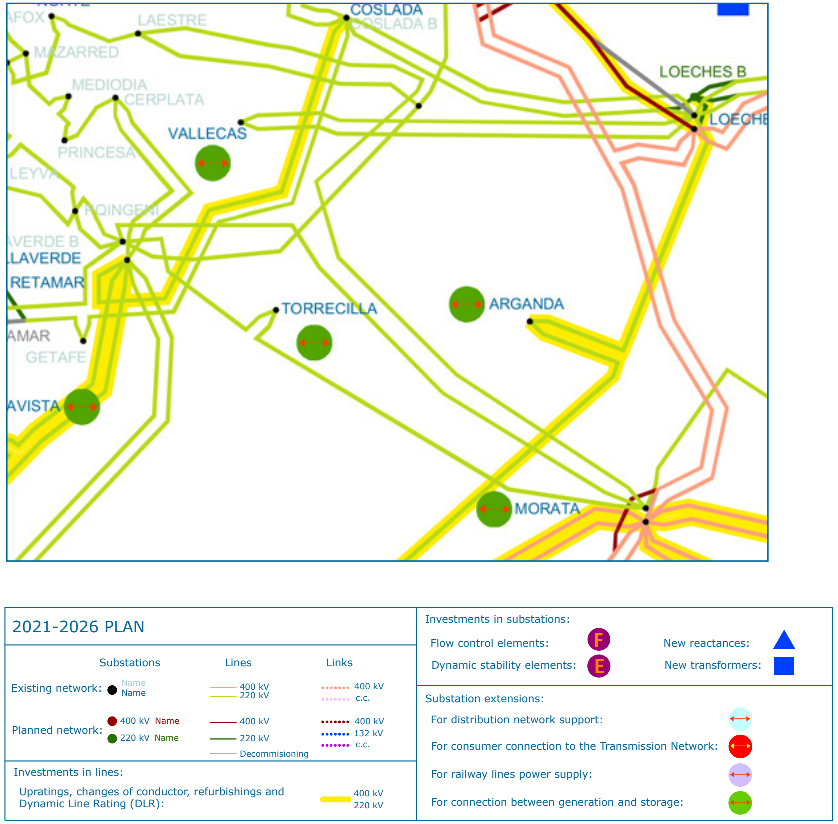
Drivers / Objectives:

- These investments make it possible to combine the development of the transmission network in urban areas where the connection between the different substations increases, with the control of short-circuit power and the reduction of flows on lines with possible overloads.
- Reduce the need for technical constraints to be applied in the area to maintain security of supply.

Alternatives: The possible alternatives would involve upgrading the switchgear of numerous substations in the area to withstand the short-circuit power values expected in the Plan horizon. On the other hand, developments consisting of new investments in the network have been assessed in order to prevent possible occasional overloads.

European dimension: No

Map:



Investment SoS_CENTRO_Pcc

Security of Supply **Reliability of supply Madrid (Short Circuit Current)**

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
7.6 M€	0.14 M€/year

Remuneration costs

Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	0.8	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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV

- M€

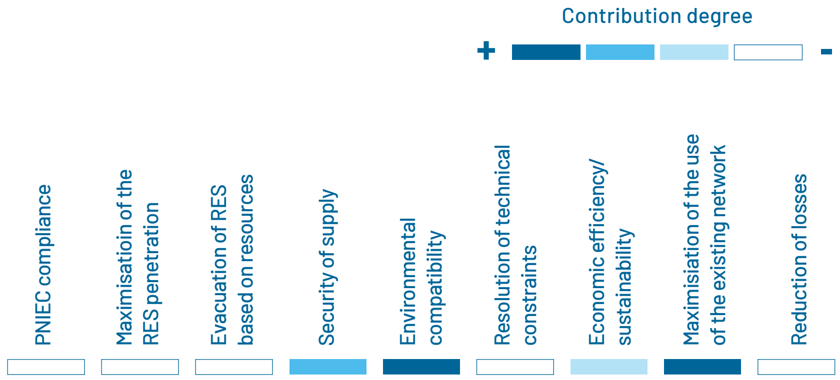
Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:



Investment SoS_CENTRO_Pcc
Security of Supply **Reliability of supply Madrid (Short Circuit Current)**

Table of physical units:

	220 kV	400 kV
Bays (units)	3	1
Overhead line (km)	0.5	1

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Loeches 220 kV	2	GIS	TN	2024
Loeches 220 kV	1	Conv.	TN	2024
Morata 400 kV [1]	1	Conv.	TN	2024

Notes:
1. Extension for operable bypass at Morata 400 kV of the lines San Fernando-Morata 400 kV circuit 1 and Morata-Moraleja 400 kV circuit 1.

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Loeches - Arganda 220 kV, circuit 1 [1]	600	600	0.2	Line	SoS	2024
Loeches - Coslada 220 kV, circuit 1	315	315	0.2	Line	SoS	2024
Loeches - José Cabrera 220 kV, circuit 2	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. Extension to make the double bus in Loeches 220 kV operable, which requires investments in some of the lines.
2. To make the bypass operable, investments are needed on some lines.

Investment SoS_IBA_1

Security of Supply **Reinforcement of the southern network of the island of Ibiza**

General description:

In order to improve the security of supply of the island of Ibiza, a change of voltage to 132 kV is proposed for the part of the southern network of the island of Ibiza currently operated at 66 kV, obtaining new 132 kV Torrent-Ibiza-Bossa-San Jorge axes. This also includes the uprating of the 66 kV Ibiza-San Antonio, Ibiza-Bossa and San Jorge-San Antonio lines.

Drivers / Objectives:

Increase the security and quality of the electricity supply on the island of Ibiza.

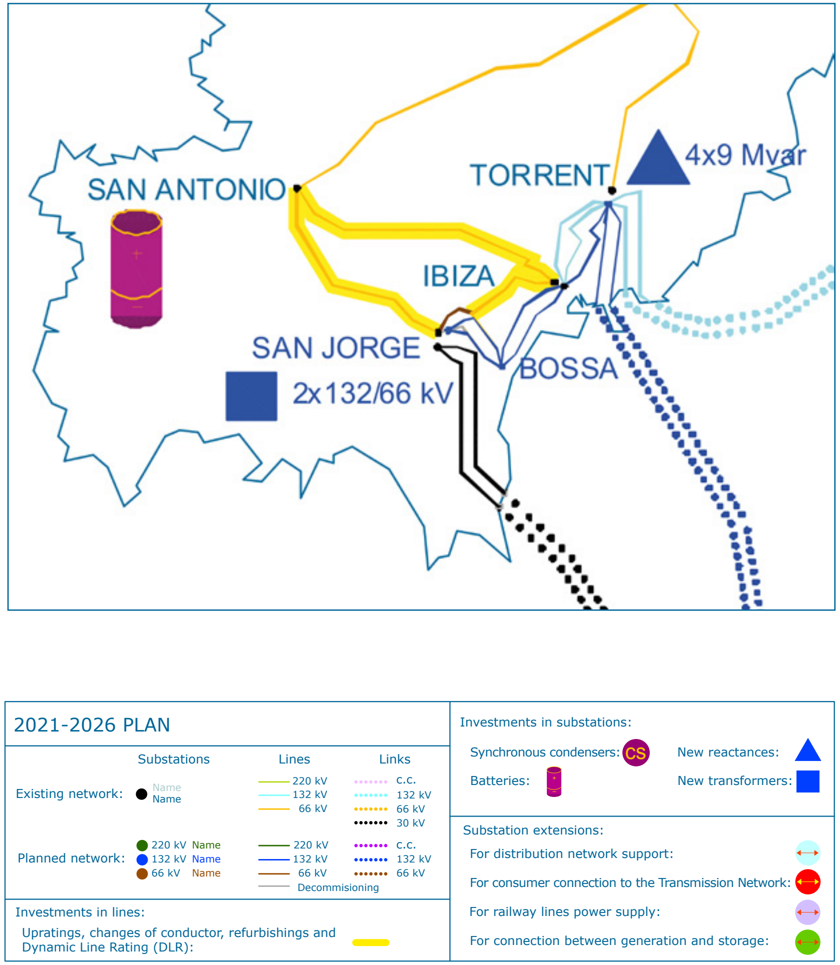
Alternatives:

To solve the current supply problem in the western part of the island of Ibiza, various alternatives have been studied to reinforce the southern network of Ibiza and raise the voltage to 132 kV in San Antonio, such as the construction of a new double circuit San Antonio-Torrent 132 kV by means of a new route and using the route of the current San Antonio-Ibiza 66 kV. Both alternatives are not viable because of strong social opposition and environmental problems.

European dimension:

No

Map:



Investment SoS_IBA_1

Security of Supply **Reinforcement of the southern network of the island of Ibiza**

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
33 M€	0.44 M€/year

Remuneration costs

Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	3.1	3.1	3.0	3.0	2.9	2.9	2.8	2.8	2.7

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

Profitability:

Profitability: NPV
146 M€

Socio-environmental impact:

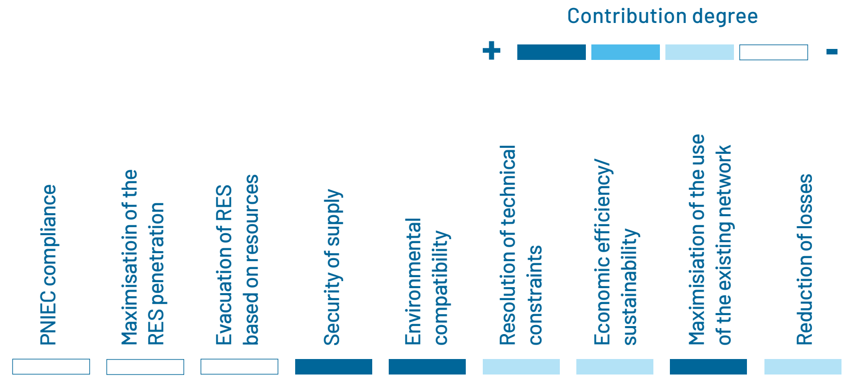
Impact degree

+ -

Environmental impact

Social impact

Contribution to guiding principles:



Investment SoS_IBA_1

Security of Supply **Reinforcement of the southern network of the island of Ibiza**

Table of physical units:

	66 kV	132 kV
Bays (units)	2	16
Overhead line (km)	0	
Cables (km)		11
Transformed to 66 kV (MVA)		160
Uprating (km)	24	
DLR (km)	10	

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

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	5	GIS	SoS	2024
San Jorge 132 kV	7	GIS	SoS	2024
San Jorge 66 kV	2	Conv.	SoS	2024
Torrent 132 kV	2	GIS	SoS	2024

Detailed list of investments (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	Line	SoS	2024

Notes:
1. Change voltage input/output at Bossa de Ibiza-San Jorge ready for 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	2022

Dynamic Line Rating	km (±10%)	Type	Driv.	Year
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

Investment SoS_IBA_2

Security of supply **Dynamic Line Rating at Llucmajor-Orlandis 66 kV**

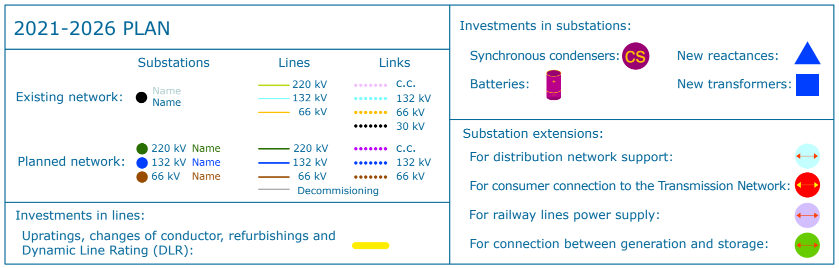
General description: The investment consists of the installation of a Dynamic-Line-Rating (DLR) capacity monitoring system on the Llucmajor-Orlandis 66 kV double circuit.

Drivers / Objectives: Increase the security and quality of electricity supply in the eastern part of Mallorca

Alternatives: Solutions involving the uprating of the existing line or its replacement by a 220 kV line have a higher economic cost and environmental impact.

European dimension: No

Map:



Investment SoS_IBA_2

Security of supply **Dynamic Line Rating at Llucmajor-Orlandis 66 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.

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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
- M€

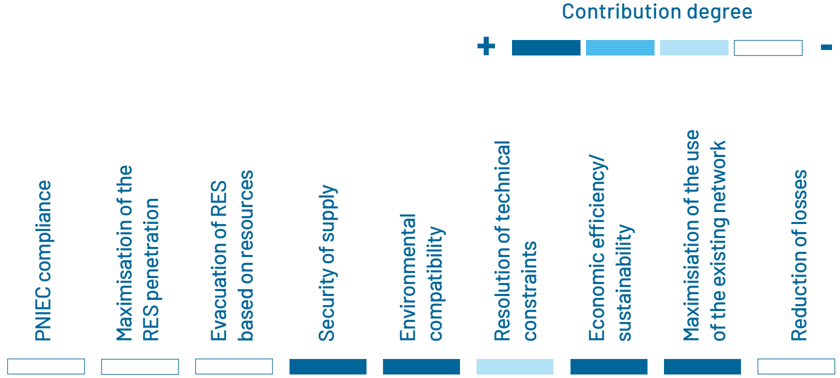
Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:



Investment SoS_IBA_2

Security of supply **Dynamic Line Rating at Llucmajor-Orlandis 66 kV**

Table of physical units:

	66 kV
DLR (km)	36

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Dynamic Line Rating	km (±10%)	Type	Driv.	Year
Llucmajor - Son Orlandis 66 kV, circuit 1	18	Line	SoS	2023
Llucmajor - Son Orlandis 66 kV, circuit 2	18	Line	SoS	2023

Investment SoS_ICA_1

Security of Supply **Reinforcement of Tenerife West Ring**

General description: The proposed investment enables the reinforcement of the 66 kV ring in the western part of the island to supply a high consumption area, with future growth prospects and which is already overloaded at present. The complete investment includes the following developments:

- New Drago 66 kV substation.
- New double-circuit cable-line Chío-Drago 66 kV.
- New input-output at the new Drago 66 kV substation on the Icod de los Vinos-Realejos/ Icod de los Vinos-Cuesta de la villa 66 kV double circuit.
- Third circuit Los Olivos-Los Vallitos 66 kV.

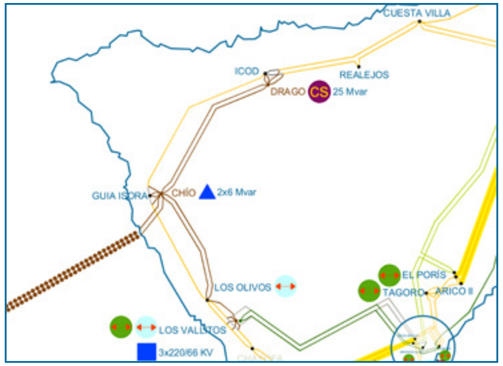
Drivers / Objectives:

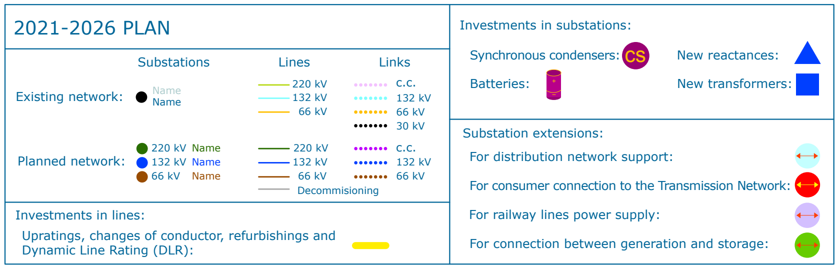
- Eliminate the need for the connection of the Guía de Isora 66 kV groups by technical constraints to avoid overloads in the area, at present.
- Enable adequate supply to La Gomera through the proposed Tenerife-La Gomera link.
- Improve security of supply on the island of Tenerife, supporting supply in the north of the island in the event of contingencies on the north-south axis between Granadilla and Caletillas/Candelaria.
- The values of the cost-benefit analysis indicators shown do not consider the Tenerife-La Gomera link to be in service.

Alternatives: Currently, the alternative is the connection by technical constraints of the gas turbines of Guía de Isora. As network development alternatives, the reinforcement of the 220 kV network to the north as far as Cuesta Villa has been evaluated, with a higher cost and a greater social and environmental impact.

European dimension: No

Map:





Investment SoS_ICA_1

Security of Supply **Reinforcement of Tenerife West Ring**

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
61 M€	0.31 M€/year

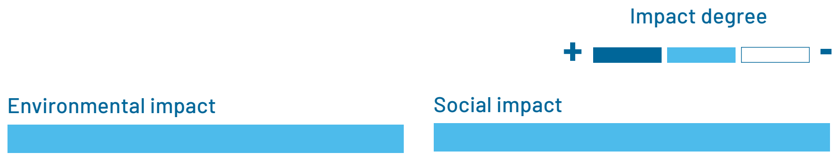
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	5.2	5.2	5.1	5.0	4.9	4.8	4.7	4.6	4.6

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

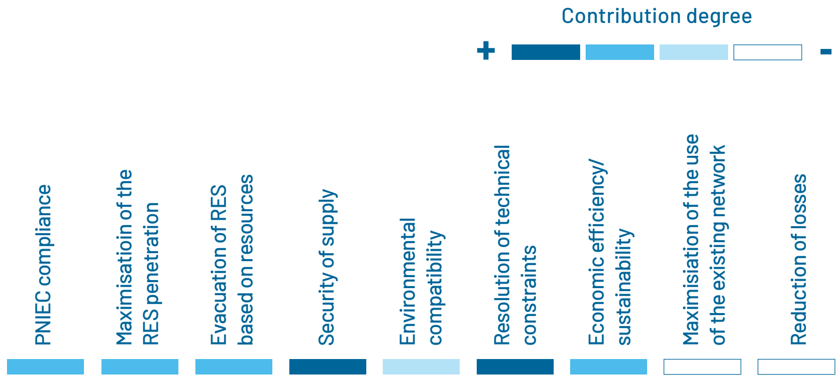
Profitability:

Profitability: NPV
521 M€

Socio-environmental impact:



Contribution to guiding principles:



Investment SoS_ICA_1
Security of Supply **Reinforcement of Tenerife West Ring**

Table of physical units:

	66 kV
Bays (units)	13
Overhead line (km)	48
Cables (km)	39

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Drago 66 kV [1]	Building	2023

Notes:
1.Formerly known as 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	Mobile	TN	2025
Vallitos 66 kV	2	GIS	TN	2025

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	5	Cable	SoS	2023
I/O in Drago, from Icod de Los Vinos - Cuesta de La Villa 66 kV, circuit 1	70	70	5	Cable	SoS	2023
I/O in Drago, from Icod de Los Vinos - Los Realejos 66 kV, circuit 1	70	70	5	Cable	SoS	2023
Vallitos - Los Olivos 66 kV, circuit 3	66	66	4	Line	SoS	2025
Vallitos - Los Olivos 66 kV, circuit 3	66	66	9	Cable	SoS	2025

Notes:
1. Associated disconnection of the Guía de Isora-Icod de los Vinos 66kV line.

I Investment SoS_ICA_2
Security of Supply **Reinforcement of La Palma network**

I General description:

The proposed investment will strengthen the transmission network of La Palma, which currently consists of a single circuit, in order to improve the quality and security of supply. Specifically, the complete investment includes the following developments:

- New input-output at the new Las Breñas 66 kV substation on the Valle de Aridane-Los Guinchos 66 kV line.
- New line Las Breñas-Los Guinchos 2 66 kV.
- New line Las Breñas-Valle de Aridane 2 66 kV.
- New input-output at the new Fuencaliente 66 kV substation on the Las Breñas-Valle de Aridane 66 kV line (>2026).

I Drivers / Objectives:

To improve the security and quality of the electricity supply on the island of La Palma. In the future, this investment will allow the connection of renewable energy sources in the southern part of the island.

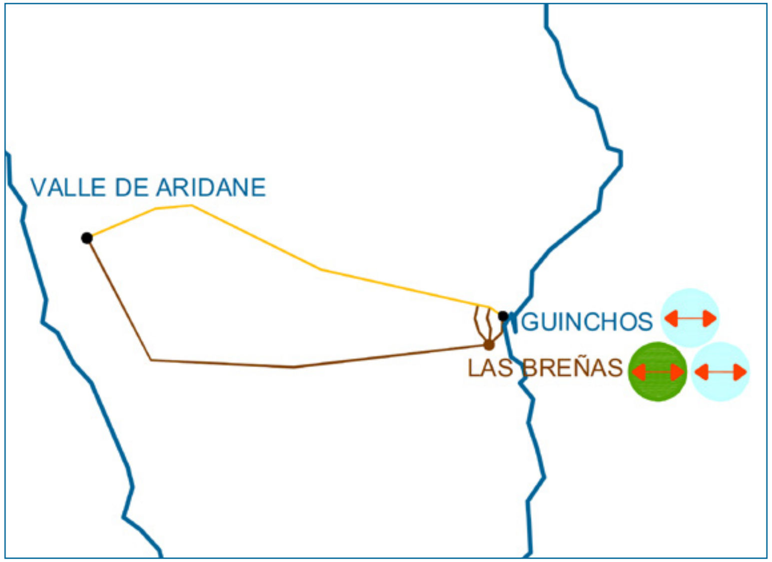
I Alternatives:

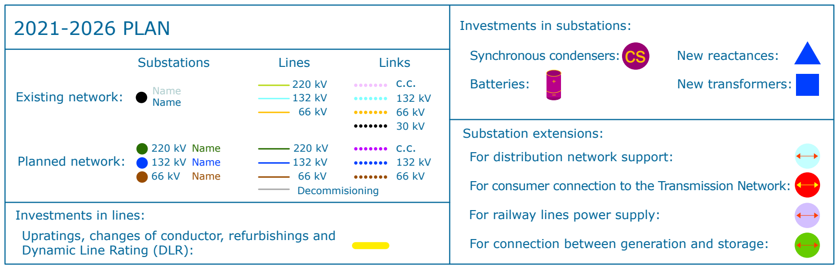
As there is only one point with connected generation on the island, additional power supply from the western part of the island is required to avoid supply cuts in the event of failure or maintenance works of the existing line.

I European dimension:

No

I Map:





Investment SoS_ICA_2
Security of Supply **Reinforcement of La Palma network**

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
32.6 M€	0.31 M€/year

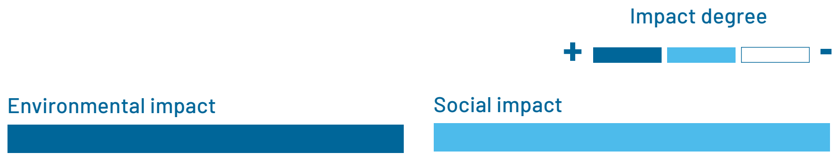
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	2.9	2.9	2.9	2.8	2.8	2.7	2.7	2.6	2.6

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

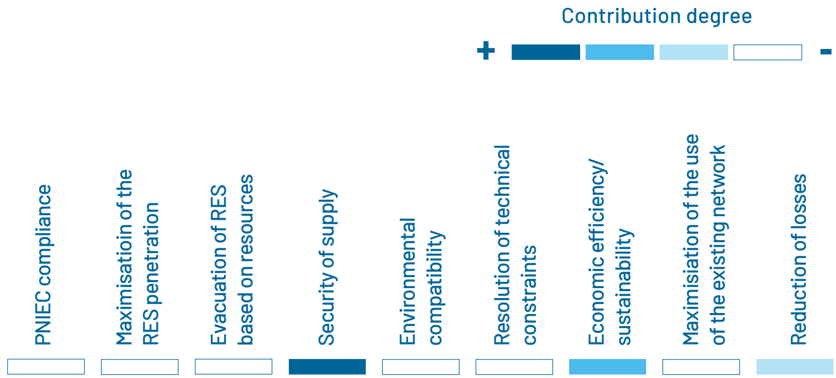
Profitability:

Profitability: NPV
80 M€

Socio-environmental impact:



Contribution to guiding principles:



Investment SoS_ICA_2

Security of Supply **Reinforcement of La Palma network**

Table of physical units:

	66 kV
Bays (units)	11
Overhead line (km)	15
Cables (km)	12

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

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	Conv.	TN	2025
Valle de Aridane 66 kV	1	Conv.	TN	2025

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Las Breñas, from Valle de Aridane - Los Guinchos 66 kV, circuit 1	80	80	0.5	Cable	SoS	2025
Las Breñas - Los Guinchos 66 kV, circuit 2	80	80	0.5	Cable	SoS	2025
Las Breñas - Valle de Aridane 66 kV, circuit 2	80	80	11	Cable	SoS	2025
Las Breñas - Valle de Aridane 66 kV, circuit 2	80	80	15	Line	SoS	2025

Investment SoS_ISLAS

Security of Supply **Increased security of supply in non-peninsular systems**

General description:

In order to increase security of supply in the Balearic and Canary Islands systems, the inclusion of a new reactance at Tías 66 kV is proposed, as well as configuration changes with busbar partitioning and new coupling switches in the following 66 kV substations with single busbar configuration:

- Fuerteventura: Corralejo, Gran Tarajal and Matas Blancas.
- Lanzarote: Macher.
- Gran Canaria: Telde and San Agustín.
- Mallorca: Cala Millor and Bunyola.

Drivers / Objectives:

Increase the reliability of supply in the Balearic and Canary Islands systems.

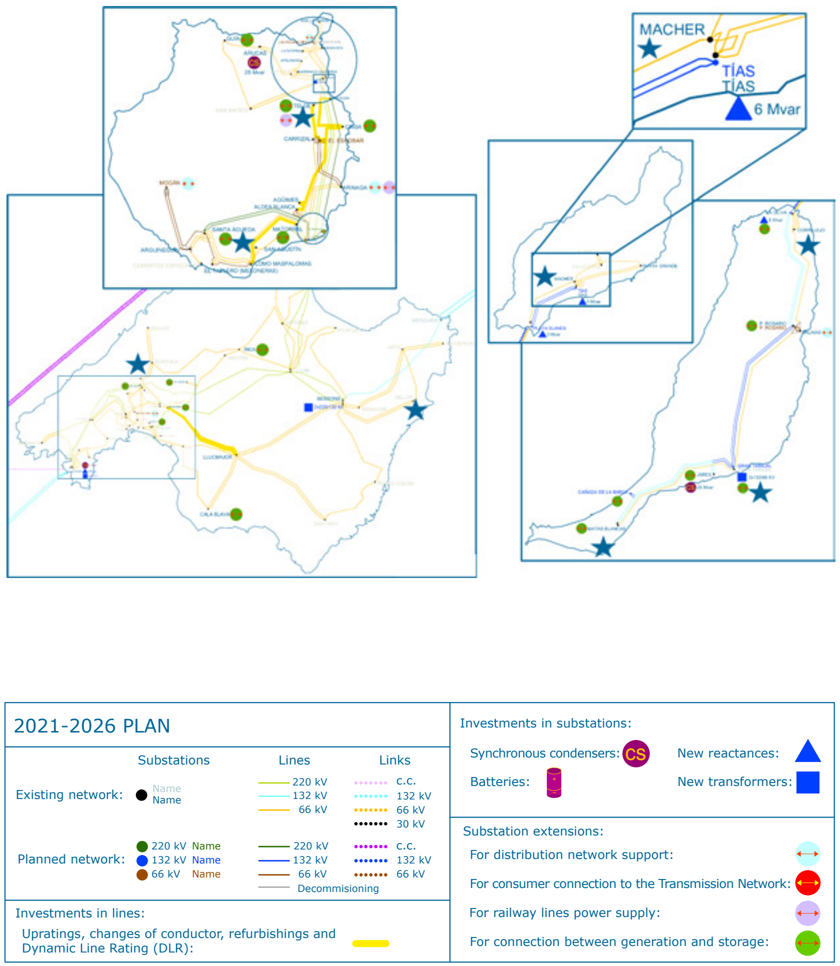
Alternatives:

The alternative to the proposed investments is to plan new substations with double busbar configuration with busbar coupling, which entails higher environmental impacts and investment volumes.

European dimension:

No

Map:



Investment SoS_ISLAS

Security of Supply **Increased security of supply in non-peninsular systems**

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
6.1 M€	0.26 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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
- M€

Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -

Investment SoS_ISLAS
Security of Supply **Increased security of supply in non-peninsular systems**

Table of physical units:

	66 kV
Bays (units)	9
Reactance (Mvar)	6

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Bunyola 66 kV [1]	1	Conv.	TN	2022
Cala Millor 66 kV	1	Conv.	TN	2025
Corralejo 66 kV [2]	1	Conv.	TN	2022
Gran Tarajal 66 kV [3]	1	Conv.	TN	2024
Macher 66 kV [4]	1	Conv.	TN	2023
Matas Blancas 66 kV [5]	1	Conv.	TN	2022
San Agustín (Gran Canaria) 66 kV [6]	1	Conv.	TN	2023
Telde 66 kV [7]	1	Conv.	TN	2023
Tías 66 kV	1	GIS	TN	2023

Notes:
1. The busbar is required to be split and include a longitudinal coupling.
2. The busbar is required to be split and include a longitudinal coupling (associated with the connection of the double circuit Corralejo-Los Olivos 66 kV).
3. The busbar is required to be split and include a longitudinal coupling (associated with the connection of the new 132/66kV transformers).
4. The busbar is required to be split and include a longitudinal coupling.
5. The busbar is required to be split and include a longitudinal coupling.
6. The busbar is required to be split and include a longitudinal coupling.
7. The busbar is required to be split and include a longitudinal coupling.

New reactances	MVAr	Type	Driv.	Year
Tías 66 kV, REA4	6	-	SoS	2023

I Investment SoS_N_ESTE

Security of Supply **Refurbishment of Cinca 220 kV**

I General description:

This investment consists of adapting the configuration of the Cinca 220 kV substation to Operation Procedures and creating a second supply to this substation.

- Change of Cinca 220 kV configuration to double busbar.
- New input-output at the Cinca 220 kV substation on the Monzón-Mequinenza 1 220 kV line (>2026).

I Drivers / Objectives:

Increase the security of supply of the area by changing the configuration, installing the 2nd 220/132 kV unit to support the distribution network and meshing of the substation.

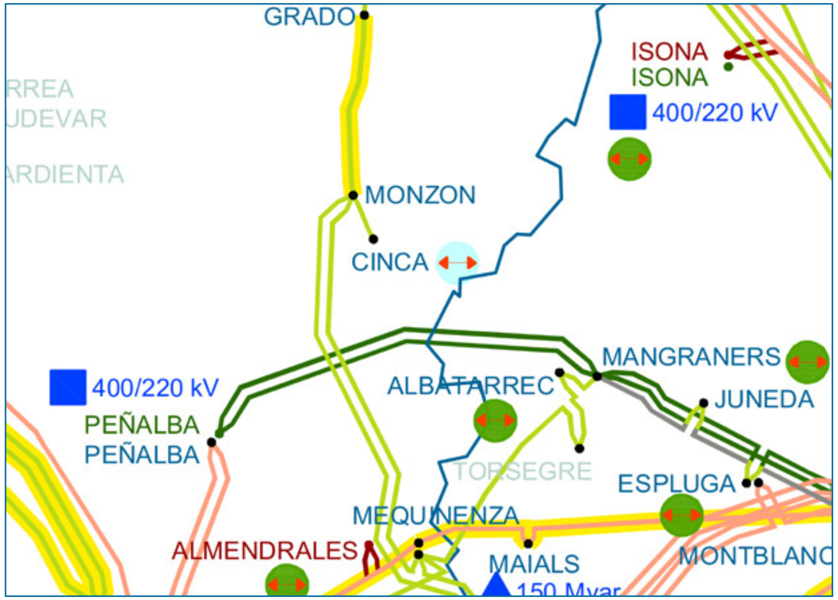
I Alternatives:

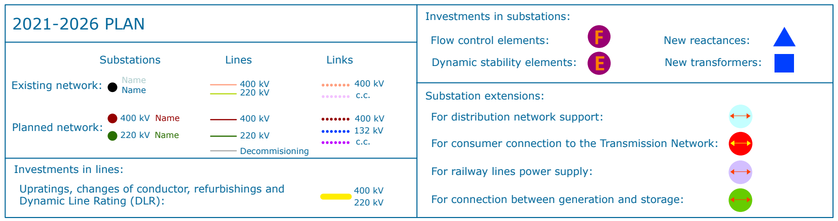
The alternative to this investment would be the construction of a new procedure-compliant substation in a nearby area, but this would involve a higher investment value. The alternative analysed for the second Cinca 220 kV supply consists of building the second supply from the Monzón 220 kV substation, but the extension required at Monzón is highly unfeasible.

I European dimension:

No

I Map:





Investment SoS_N_ESTE

Security of Supply **Refurbishment of Cinca 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.

Costs:

CAPEX	OPEX
8.6 M€	0.21 M€/year

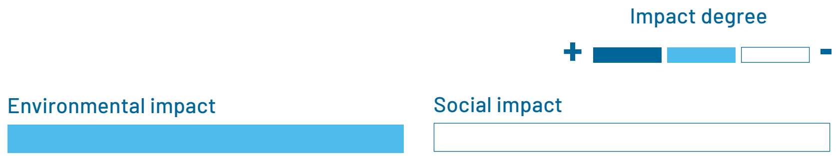
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8

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

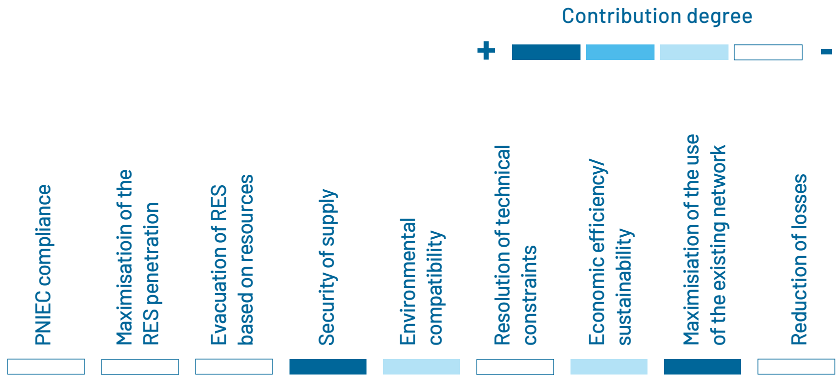
Profitability:

Profitability: NPV
- M€

Socio-environmental impact:



Contribution to guiding principles:



Investment SoS_N_ESTE
Security of Supply **Refurbishment of Cinca 220 kV**

Table of physical units:

	220 kV
Bays (units)	5
Overhead line (km)	18

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Cinca 220 kV	3	Conv.	TN	2024
Cinca 220 kV	2	Conv.	TN	> 2026

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
I/O in Cinca, from Monzón - Mequinenza 220 kV, circuit 1	870	720	9	Line	SoS	> 2026

Investment SoS_N_ESTE_Pcc

Security of Supply **Topological modification in Gramanet (Short Circuit Current)**

General description:

This investment consists of changing the connection of the double circuit between Rubi - Gramanet B 220 kV within the Gramanet double bus to connect it to the Gramanet A busbars and the uprating of Collblanc-Begues B 1 and 2 220 kV.

Drivers / Objectives:

- Increase quality and security of supply in the area.
- Reduce the need for the application of technical constraints in the area.

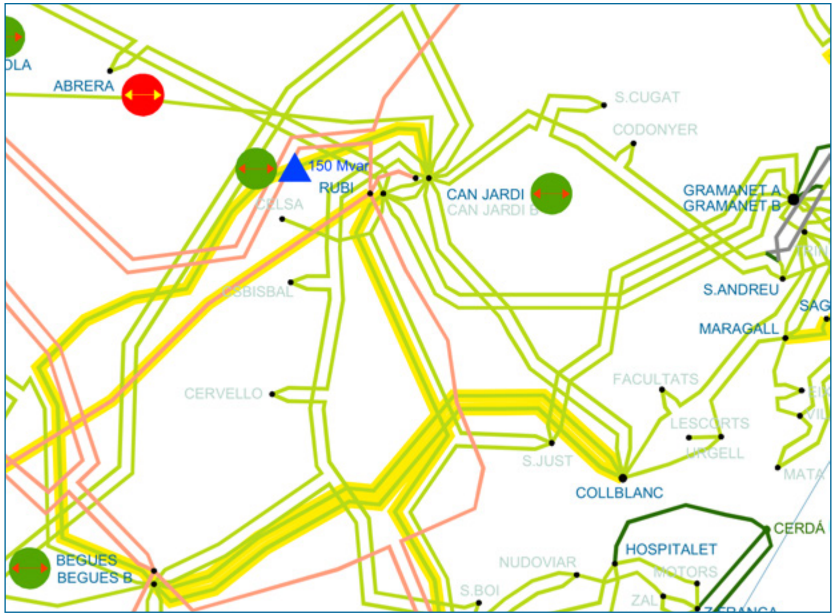
Alternatives:

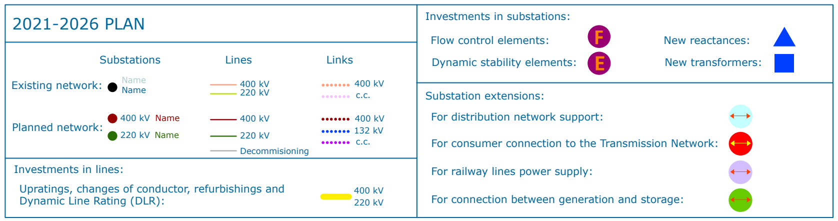
The alternative to this investment is the construction of the new Gramanet 400 kV substation, which would have a greater social and environmental impact and a higher investment value.

European dimension:

No

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment SoS_N_ESTE_Pcc

Security of Supply **Topological modification in Gramanet (Short Circuit Current)**

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
7.3 M€	0.03 M€/year

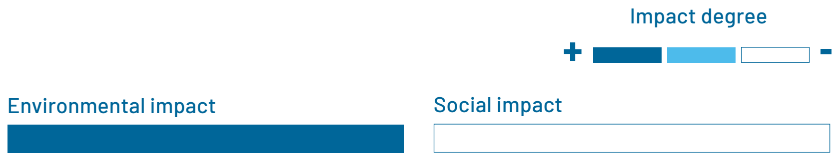
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5

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

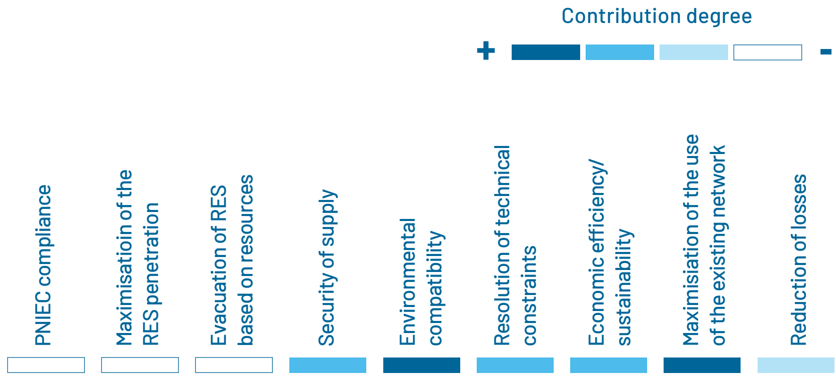
Profitability:

Profitability: NPV
90 M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment SoS_N_ESTE_Pcc

Security of Supply **Topological modification in Gramanet (Short Circuit Current)**

Table of physical units:

	220 kV
Bays (units)	1
Cables (km)	0.8
Uprating (km)	42

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Gramanet 220 kV [1]	1	GIS	TN	2022

Notes:
1. Transfer from 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

Notes:
1. Transfer from DC Rubí-Gramanet B to Gramanet A.

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 2 [2]	630	550	21	Line	SoS	2022

Notes:
1. Uprating of the overhead section to 85º.
2. Uprating of the overhead section to 85º.

Investment SoS_N_OESTE

Security of Supply **New Substation Abades 400 kV (Formerly Herreros)**

General description:

The investment consists of the 400 kV link between Tordesillas and Madrid, including the following investments:

- New input-output at the new Abades 400 kV substation on the Tordesillas-La Cereal 400 kV line.
- New Abades 220 kV substation.
- New transformer 1 Abades 400/220 kV.
- New line Abades-Otero 220 kV.
- New line Tordesillas-Las Arroyadas 220 kV line.

Drivers / Objectives:

- Improve the security and quality of electricity supply in the Madrid area.
- Improve the integration of existing and future renewable energy sources in the area.
- Facilitate the supply of the train at Otero de Herreros 220 kV.

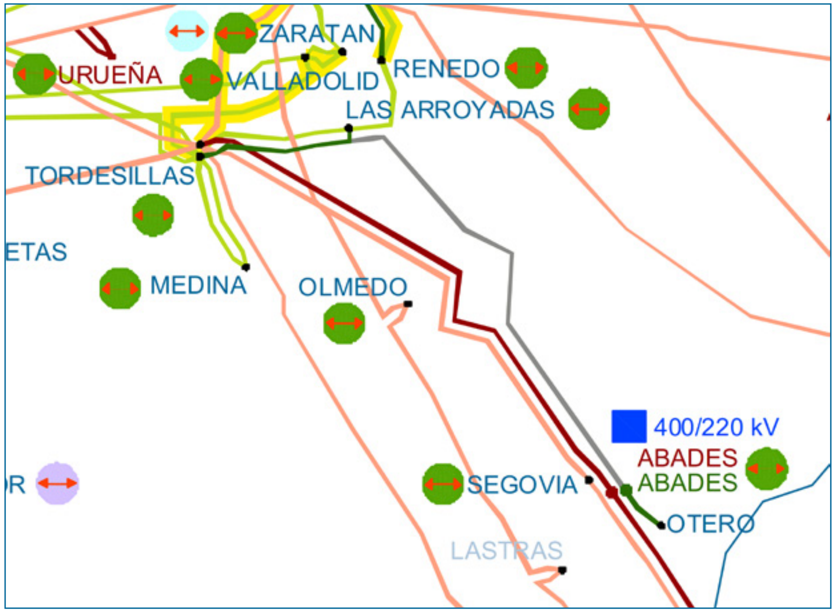
Alternatives:

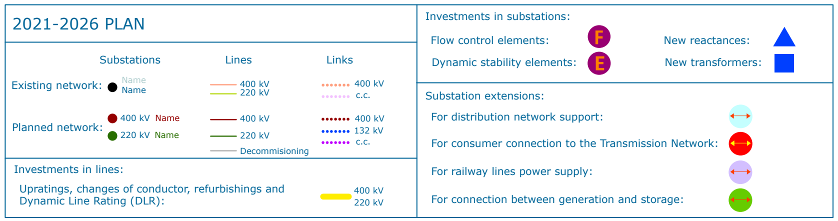
Solutions involving new transmission substations in the Otero area present an elevated risk of environmental unfeasibility.

European dimension:

No

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment SoS_N_OESTE

Security of Supply **New Substation Abades 400 kV (Formerly Herreros)**

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
17.5 M€	0.43 M€/year

Remuneration costs

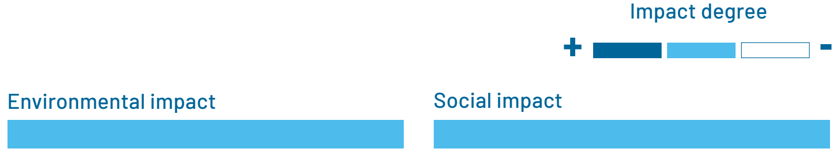
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	1.8	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.7

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

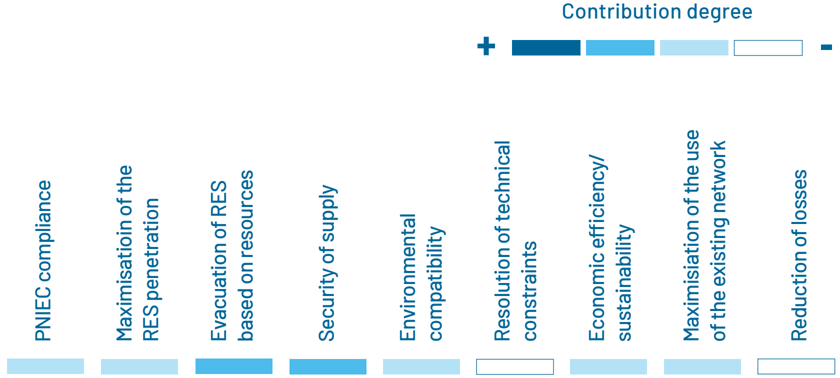
Profitability:

Profitability: NPV
- M€

Socio-environmental impact:



Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment SoS_N_OESTE
Security of Supply **New Substation Abades 400 kV (Formerly Herreros)**

Table of physical units:

	220 kV	400 kV
Bays (units)	4	5
Overhead line (km)	13	2
Transformed to 220 kV (MVA)		200

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

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	Conv.	TN	2024
Abades 400 kV	5	Conv.	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, from 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	363	239	13	Line	SoS	2024

New transformers	MVA	Type	Driv.	Year
Abades 400/220 kV, TF1	200	Triph. B.	SoS	2024

Investment SoS_SUR_1

Security of Supply **Supply reinforcement in Huelva (Costa de la Luz)**

General description: This investment reinforces the supply of demand from the pyritic belt in Huelva:

- New double circuit Puebla de Guzmán-Costa de la Luz 220 kV.

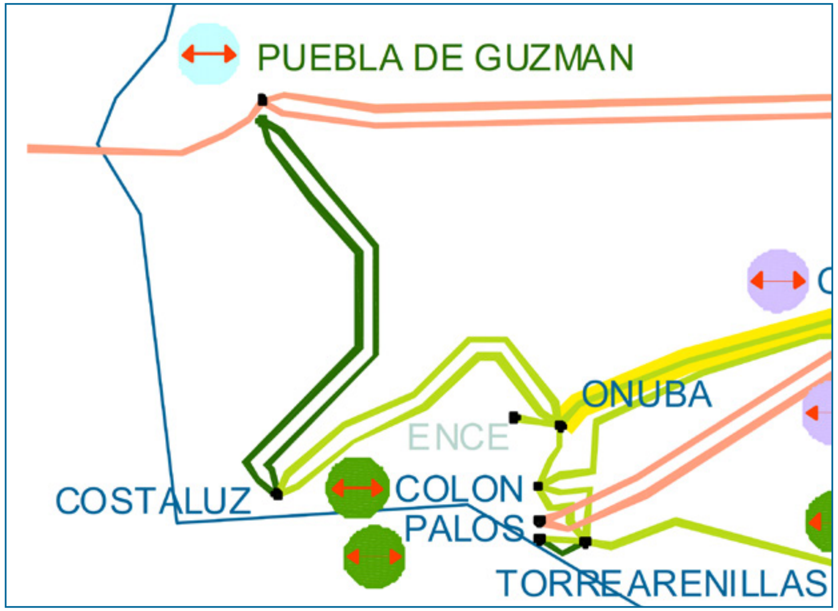
Drivers / Objectives:

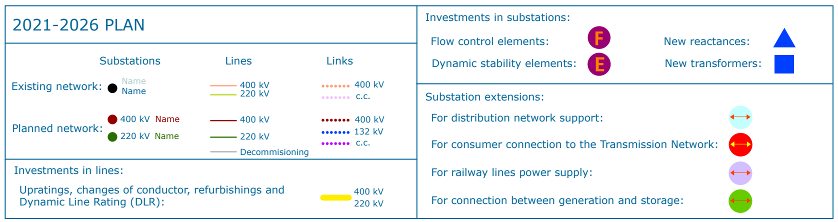
- Increase the security and quality of the electricity supply in the Huelva area.
- Comply with the operational procedures regarding the necessary meshing at Puebla de Guzmán 220 kV.

Alternatives: Operating solutions, DLR, uprating the existing 220 kV line or increasing its capacity are not solutions that solve the problems in the area, since new connections are needed at the 220 kV Costa de la Luz and Puebla de Guzmán substations, in the case of the former to guarantee security of supply in the area and in the case of the latter to be able to feed the distribution network through the meshing of the substation.

European dimension: No

Map:





Investment SoS_SUR_1
Security of Supply **Supply reinforcement in Huelva (Costa de la Luz)**

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
23.4 M€	0.19 M€/year

Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	2.1	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8

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

Profitability:

Profitability: NPV
- M€

Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree + -

PNIEC compliance

Maximisatioin of the RES penetration

Evacuation of RES based on resources

Security of supply

Environmental compatibility

Resolution of technical constraints

Economic efficiency/ sustainability

Maximisiation of the use of the existing network

Reduction of losses

Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

Investment SoS_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)	66
Cables (km)	0.4

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Costa de La Luz 220 kV	2	GIS	TN	2025
Puebla de Guzmán 220 kV	2	Conv.	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	33	Line	SoS	2025

Investment SoS_SUR_2

Security of Supply **Puerto de Santa María 220 kV**

General description:

Reinforcement of the electricity supply to the Puerto de Santa María 220 kV substation:

- New 220 kV circuits Puerto Real-Cartuja and Puerto Real-Puerto de Santa María

Drivers / Objectives:

- Increase the security and quality of the electricity supply to the area of Puerto de Santa María currently connected to the system by a single 220 kV circuit.
- Comply with the operational procedures regarding the necessary meshing at Puerto de Santa María 220 kV.

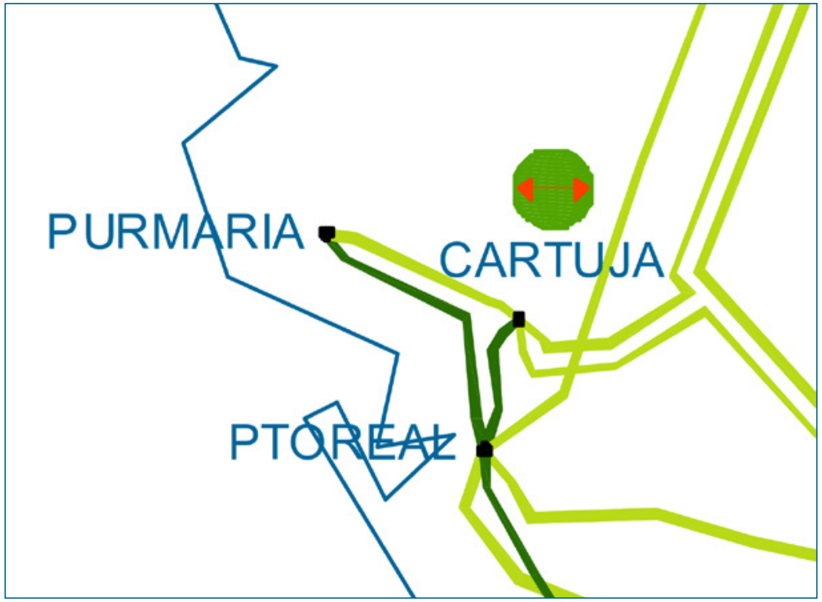
Alternatives:

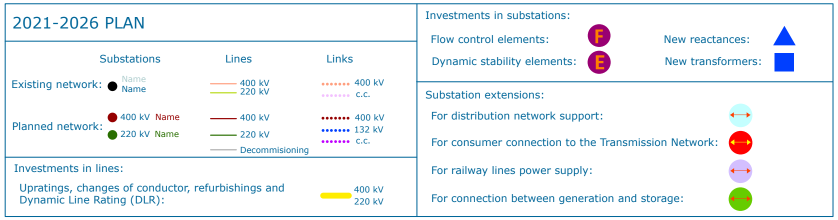
The need for meshing can only be met through the construction of new investments.

European dimension:

No

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment SoS_SUR_2
Security of Supply **Puerto de Santa María 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.

Costs:

CAPEX	OPEX
13.1 M€	0.23 M€/year

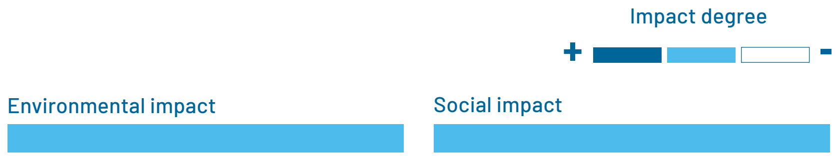
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.1

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

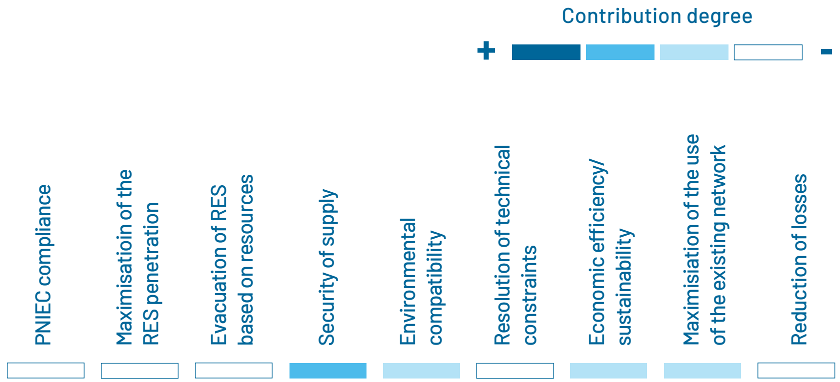
Profitability:

Profitability: NPV
- M€

Socio-environmental impact:



Contribution to guiding principles:



Investment SoS_SUR_2
Security of Supply **Puerto de Santa María 220 kV**

Table of physical units:

	220 kV
Bays (units)	5
Overhead line (km)	36

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Cartuja 220 kV	1	Conv.	TN	2024
Puerto de Santa María 220 kV	1	Conv.	TN	2024
Puerto Real 220 kV	3	Conv.	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

Investment SoS_SUR_3

Security of Supply **Reliability of supply in Saleres**

General description: The investment consists of doubling the existing 220 kV line between the city of Granada and Órgiva:

- New input-output at the new Saleres 220 kV substation on the Gabias-Órgiva 220 kV line.
- New Illora-Saleres 220 kV line (prepared for double circuit).

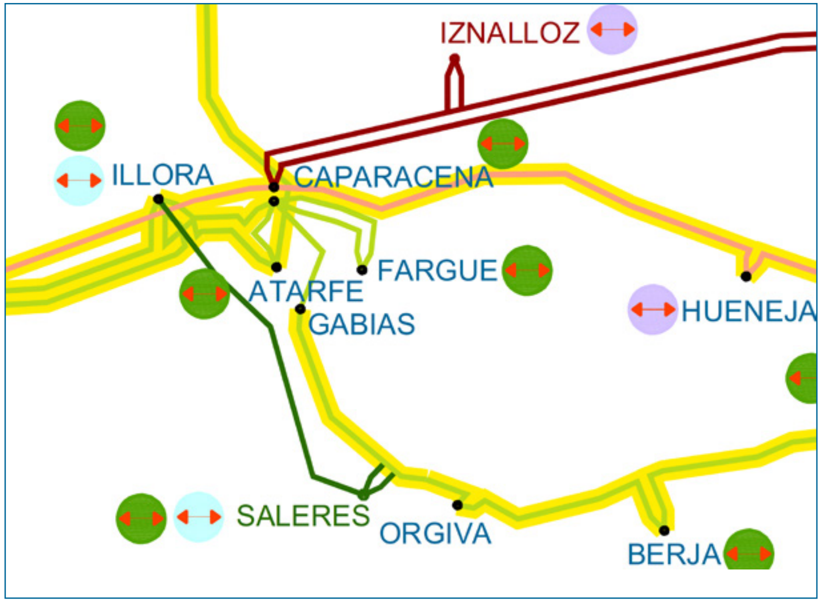
Drivers / Objectives:

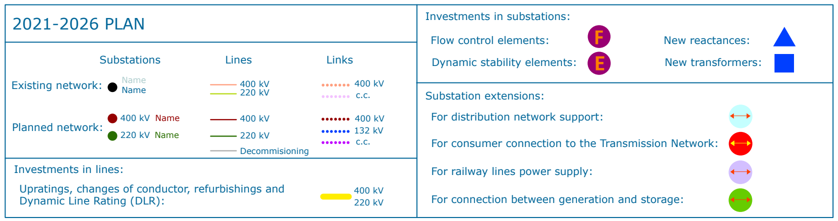
- Increase the security and quality of the electricity supply in the substations dependent on the 220 kV axis between Caparacena and Tabernas.
- Provide the area with a meshed connection point to support the distribution network.
- Enable connection of new renewable energy sources with granted access permits.

Alternatives: This investment in itself constitutes an alternative to the development of the transmission network included in the planning horizon 2015-2020, and makes it possible to adapt the transmission network to the needs detected in the area in the new planning horizon by means of a solution with a lower social and environmental impact.

European dimension: No

Map:





Investment SoS_SUR_3

Security of Supply **Reliability of supply in Saleres**

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
26.4 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	2.1	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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV
- M€

Socio-environmental impact:

Impact degree

\+ -

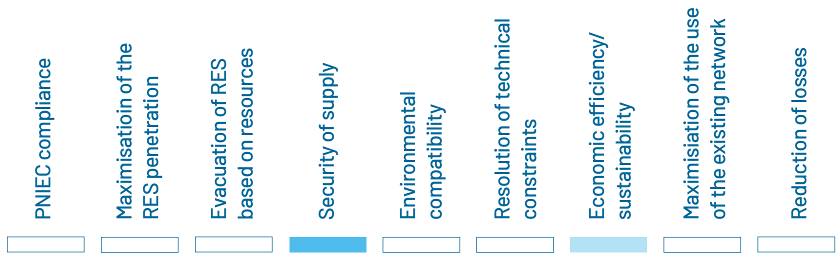
Environmental impact

Social impact

Contribution to guiding principles:

Contribution degree

\+ -



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment SoS_SUR_3

Security of Supply **Reliability of supply in Saleres**

Table of physical units:

	220 kV
Bays (units)	5
Overhead line (km)	56

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Saleres 220 kV	Outdoor	2024

Substation extension	units	Type	Driv.	Year
Íllora 220 kV	1	Conv.	TN	2025
Saleres 220 kV	3	Conv.	TN	2024
Saleres 220 kV	1	Conv.	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	430	350	4	Line	SoS	2024

Notes:
1. Double circuit with first circuit laid.

Investment SoS_SUR_Pcc
Security of Supply **Double bus in Don Rodrigo**

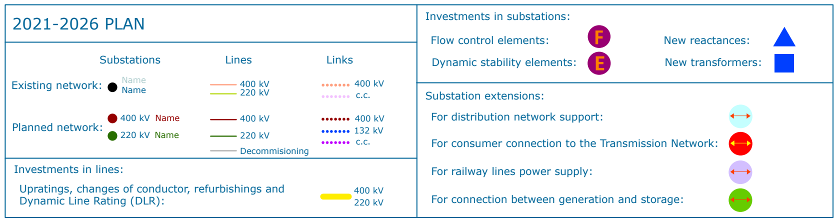
General description: New double bus in the Don Rodrigo 220 kV substation with two longitudinal couplings.

Drivers / Objectives: The existing and expected future generation in the area around Seville makes this double bus necessary to reduce the short-circuit power in the area and thus increase the reliability of the transmission network.

Alternatives: The alternative would be to replace the switchgear with one that allows higher short-circuit currents in many substations in the area, for which the investment cost would be much higher.

European dimension: No

Map:



Investment SoS_SUR_Pcc
Security of Supply **Double bus in Don Rodrigo**

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
2.2 M€	0.05 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 investments that may be scheduled beyond 2026.

Profitability:

Profitability: NPV

- M€

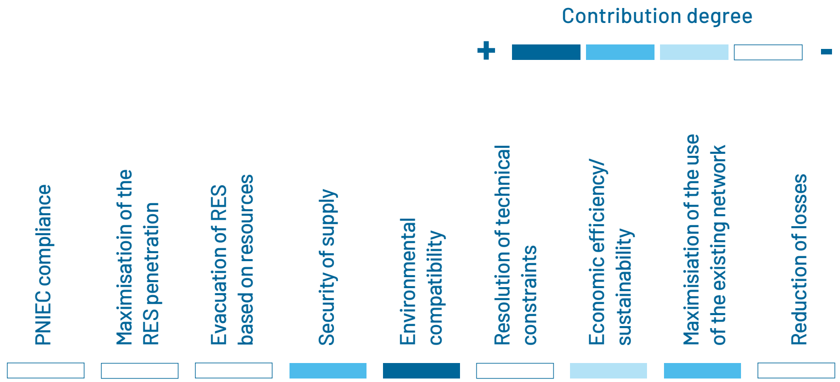
Socio-environmental impact:

Impact degree + -

Environmental impact

Social impact

Contribution to guiding principles:



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment SoS_SUR_Pcc

Security of Supply **Double bus in Don Rodrigo**

Table of physical units:

	220 kV
Bays (units)	2

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

Substation extension	units	Type	Driv.	Year
Don Rodrigo 220 kV	2	GIS	TN	2024

Investments beyond the 2026 horizon

INTRODUCTION

Below is a list of the investments 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 investment 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 investments include information on their drivers and observations. The drivers include:

- RES integration and resolution of technical constraints. These investments reduce system costs. This group includes, among others, investments for the integration of renewable energies and the resolution of overloads or voltage problems.
- Security of supply. These investments prevent local or zonal outages and ensure the security of the system as a whole. This group would include investments for the reduction of short-circuit current or the elimination of "T" configurations, among others.
- Support to the distribution network.
- Railway axis power supply.
- Storage. Investments needed for access to new energy storage facilities.
- International interconnections. These investments are necessary for international connections.
- Links between systems. These are connections between Mainland and non-peninsular systems or interconnections between island systems.

Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

III: Technical annexes

LIST OF INVESTMENTS WITH COMMISSIONING BEYOND 2026

Andalusia

ID	Investments with commissioning beyond 2026 in Andalusia	Information	
		Drivers	Observations
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	

Aragon

ID	Investments with commissioning beyond 2026 in Aragon	Information	
		Drivers	Observations
POS5	Interconnection Spain-France HVDC Aragon-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	
POS7	New input-output in Cinca on the Monzón- Mequinenza 220 kV line	Security of Supply	
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	

LIST OF INVESTMENTS WITH COMMISSIONING BEYOND 2026

Asturias

ID	Investments 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	

Balearic Islands

ID	Investments with commissioning beyond 2026 in Balearic Islands	Information	
		Drivers	Observations
POS14	Mallorca-Menorca 132 kV interconnection between San Martín and Oeste, and associated reactors. 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	
POS17	A 100 MVA synchronous condenser at Valldurgent 220 kV	Links between systems	
POS18	Two 100 MVA synchronous condensers at Llubí 220 kV	Links between systems	

LIST OF INVESTMENTS WITH COMMISSIONING BEYOND 2026

Canary Islands

ID	Investments with commissioning beyond 2026 in Canary Islands	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	
POS24	New input-output at the Fuencaliente 66 kV substation on Valle de Aridane-Las Breñas 66 kV circuit 2	RES integration and resolution of technical constraints	
POS25	Haría 66 kV substation and DC Callejones-Haría 66 kV	RES integration and resolution of technical constraints/ Distribution network support	

Cantabria

ID	Investments with commissioning beyond 2026 in Cantabria	Information	
		Drivers	Observations
POS26	Cacicedo-Puente de San Miguel 220 kV line/cable	Security of Supply	

Castile-La Mancha

ID	Investments with commissioning beyond 2026 in Castile-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	

LIST OF INVESTMENTS WITH COMMISSIONING BEYOND 2026

Castile and Leon

ID	Investments with commissioning beyond 2026 in Castile and Leon	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	

Catalonia

ID	Investments with commissioning beyond 2026 in Catalonia	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	
POS39	FACTS at Pierola 400 kV	Security of Supply	

Valencian Community

ID	Investments with commissioning beyond 2026 in Valencian Community	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	
POS42	New transformer in Castellón 400/220 kV 600 MVA	Security of Supply	Included in the Plan 2015-2020, as El Serrallo
POS43	New phase-shifter in Godelleta 400 kV substation	Security of Supply	
POS44	New double bus in Torrente 220 kV substation	Security of Supply	

LIST OF INVESTMENTS WITH COMMISSIONING BEYOND 2026

Extremadura

ID	Investments 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	Investments 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 investments.

Community of Madrid

ID	Investments with commissioning beyond 2026 in Community of Madrid	Information	
		Drivers	Observations
POS51	Double circuit Cisneros-Complutum 220 kV	Security of Supply	Requires 2,500 mm² 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 mm² 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	
POS58	Reactance 2 Torrejón de Velasco 400 kV of 150 Mvar	RES integration and resolution of technical constraints	

LIST OF INVESTMENTS WITH COMMISSIONING BEYOND 2026

Murcia

There are no investments.

Navarre

ID	Investments with commissioning beyond 2026 in Navarre	Information	
		Drivers	Observations
POS59	Spain-France HVDC interconnection Navarre-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 axis power supply	Alternative to Irañeta 220kV I/O in the Ichaso-Orcoyen 220kV lines.
POS61	Extension of the Tafalla 220 kV substation	Railway axis 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	

Basque Country

ID	Investments with commissioning beyond 2026 in Basque Country	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

Investment INT_ESP-FRA_4

International interconnections

Spain-France interconnection between Navarre and Landes

General description: The project consists of a new interconnection between Spain and France through the western Pyrenees between the Olza region in Spain and Cantegrit in France. This new interconnection will be a direct current interconnection, with VSC technology, consisting of two symmetrical monopoles of 1,000 MW each.

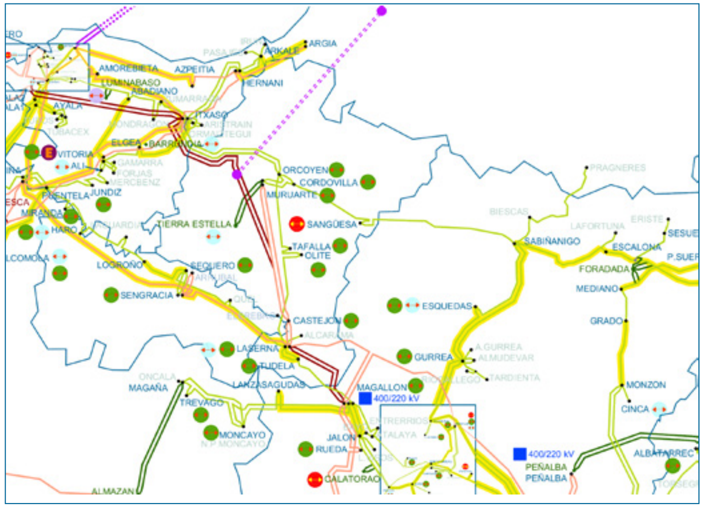
Drivers / Objectives:

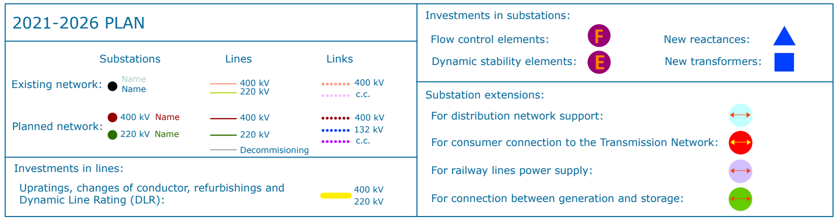
- Integration of Spain and the Spanish Mainland into the European single market, helping to reduce the price differential between countries.
- Contribute to the integration of existing and future renewable energy throughout Europe, and especially in Spain and the Spanish Mainland.
- Reduce the electrical isolation of Spain and the Spanish Mainland and improve the level of interconnection in order to meet EU targets.
- Comply with the intergovernmental agreements of the Madrid Declaration and the exchange values of the Spanish NECP 2030 target scenario.

Alternatives: In order to maintain a balanced distribution of flows between Spain and France after the commissioning of the submarine interconnection in the Biscay Gulf and to reach the target interconnection level of 8,000 MW, two new projects crossing the Pyrenees are envisaged. To increase the acceptance of the project by the local populations and to maximise the respect for the environment in the Pyrenean area, the interconnection will be buried and direct current.

European dimension: Yes / Project 276 of TYNDP 2020 and PCI 2.27.2 Project in the 2019 list.

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment INT_ESP-FRA_4

International interconnections

Spain-France interconnection between Navarre and Landes

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
1,470 M€	9.5 M€/year

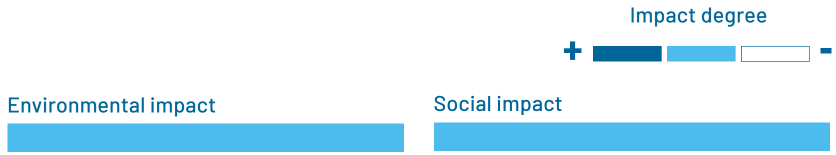
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	111.1	109.2	107.4	105.6	103.8	102.0	100.2	98.3	96.5

Note: The indicated CAPEX corresponds to the investment 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.

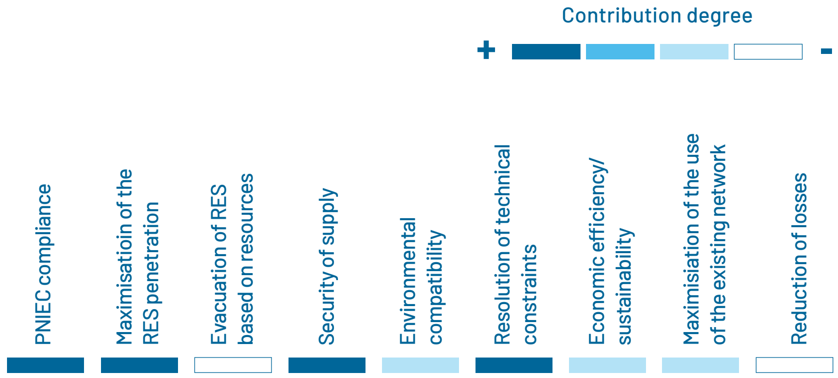
Profitability:

Profitability: NPV
228 M€

Socio-environmental impact:



Contribution to guiding principles:



Investment INT_ESP-FRA_4
International interconnections
Spain-France interconnection between Navarre and Landes

Table of physical units:

	400 kV
Bays (units)	9
Enlace HVDC (km)	225

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Olza 400 kV	Outdoor	> 2026

Substation extension	units	Type	Driv.	Year
Olza 400 kV	9	Conv.	TN	> 2026

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Olza - Cantegrit 400 kV, circuit 1[1]	2,000	2,000	225	HVDC	INT	> 2026

Notes:
1. Link HVDC with 2 symmetrical monopoles.

Investment INT_ESP-FRA_5

International interconnections

Spain-France via the Aragon Pyrenees - Atlantic Pyrenees

General description: The project consists of a new interconnection between Spain and France through the central Pyrenees between the region of Aragon in Spain and Marsillon in France. This interconnection will be a direct current interconnection, using VSC technology and consisting of two symmetrical monopoles of 1,000 MW each.

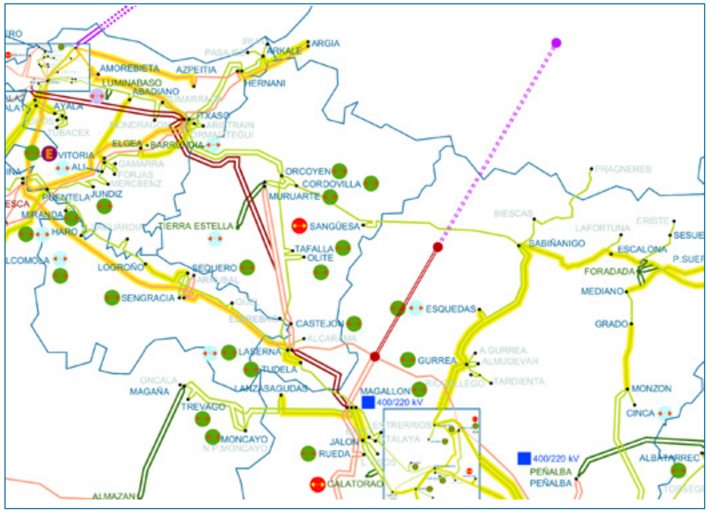
Drivers / Objectives:

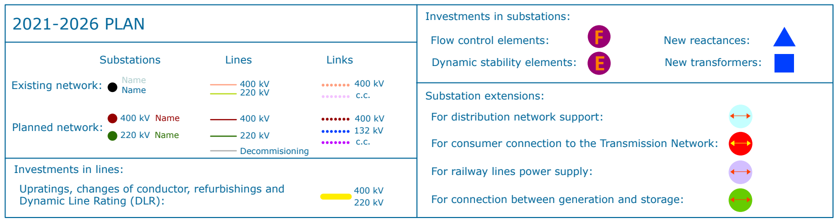
- Integration of Spain and the Spanish Mainland into the European single market helping to reduce the price differential between countries.
- Contribute to the integration of existing and future renewable energy across Europe, and especially in Spain and the Spanish Mainland.
- Reducing the electricity isolation of Spain and the Spanish Mainland and improving their level of interconnection with a view to meeting the targets set by the EU.
- Comply with the intergovernmental agreements of the Madrid Declaration and the exchange values of the PNIEC 2030 target scenario.

Alternatives: In order to maintain a balanced distribution of flows between Spain and France after the commissioning of the submarine interconnection in Biscay Gulf and to reach the target interconnection level of 8,000 MW, two new projects crossing the Pyrenees are envisaged. To increase the acceptance of the project by the local populations and to maximise the respect for the environment in the Pyrenean area, the interconnection will be buried and direct current.

European dimension: Yes / Project 270 of TYNDP 2020 and PCI 2.27.1 Project in the 2019 list.

Map:





Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Investment INT_ESP-FRA_5
International interconnections
Spain-France via the Aragon Pyrenees - Atlantic Pyrenees

Cost-Benefit Multi-Criteria Analysis

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.

Costs:

CAPEX	OPEX
1,170 M€	6.03 M€/year

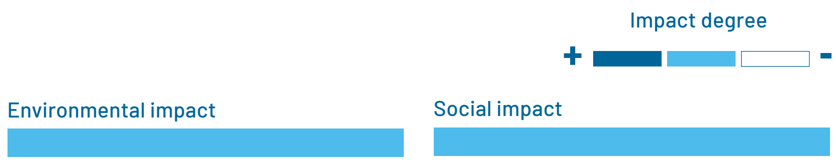
Remuneration costs										
Year	1	2	3	4	5	6	7	8	9	10
M€	0.0	103.4	101.6	99.9	98.1	96.3	94.5	92.8	91.0	89.2

Note: The indicated CAPEX corresponds to the investment 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.

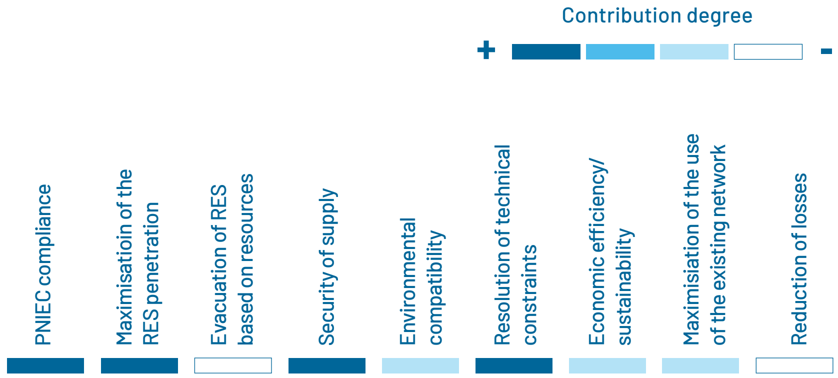
Profitability:

Profitability: NPV
469 M€

Socio-environmental impact:



Contribution to guiding principles:



Investment INT_ESP-FRA_5
International interconnections
Spain-France via the Aragon Pyrenees - Atlantic Pyrenees

Table of physical units:

	400 kV
Bays (units)	15
Overhead line (km)	220
Link HVDC (km)	230

Note: The table covers all assets included in the investment 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 right of way kilometres.

Detailed list of investments:

New substations	Type	Year
Aragon Region 400 kV	Outdoor	> 2026
Ejea de los Caballeros 400 kV	Outdoor	> 2026

Detailed list of investments (continued):

Substation extension	units	Type	Driv.	Year
Aragon Region 400 kV	6	Conv.	TN	> 2026
Ejea de los Caballeros 400 kV	9	Conv.	TN	> 2026

New lines/cables	MVA [win.]	MVA [sum.]	km (±10%)	Type	Driv.	Year
Aragon Region - Marsillon EC 400 kV, circuit 1 [1]	2,000	2,000	230	HVDC	INT	> 2026
DC Ejea de los Caballeros - Aragon Region 400 kV			110	Line	INT	> 2026

Notes:
1. Link HVDC with 2 symmetrical monopoles.

Annexes

III: TECHNICAL ANNEXES

TABLE OF CONTENTS

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.

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

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.

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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
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

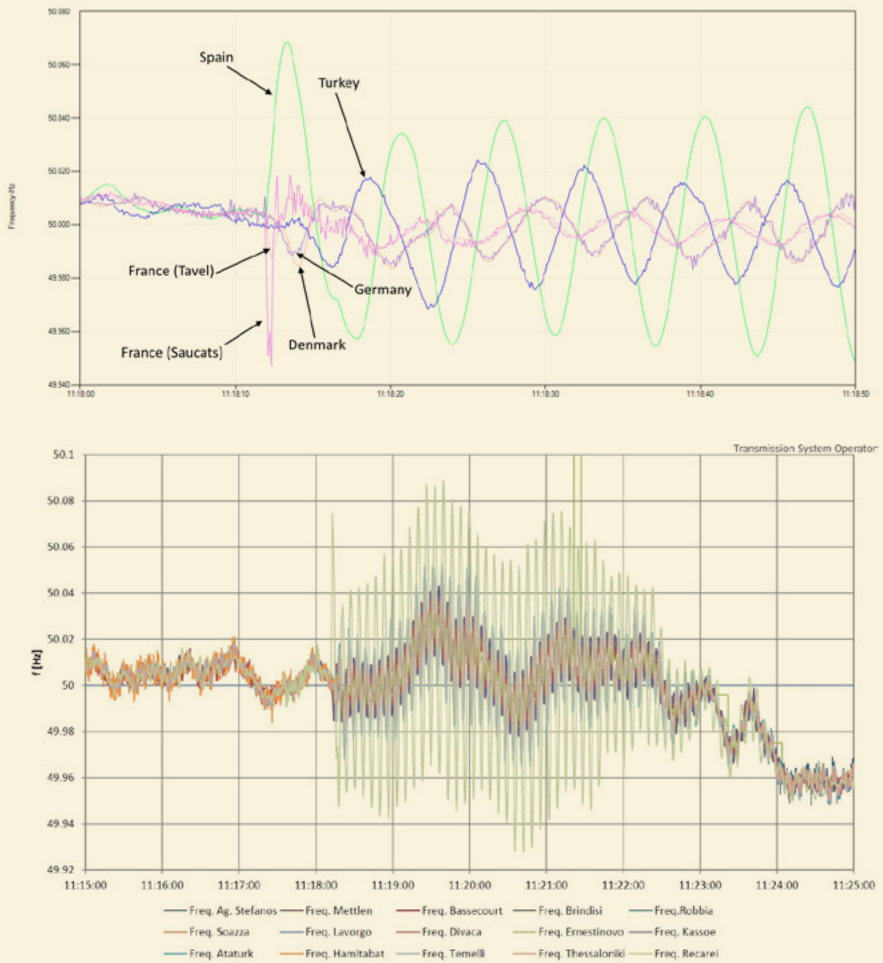
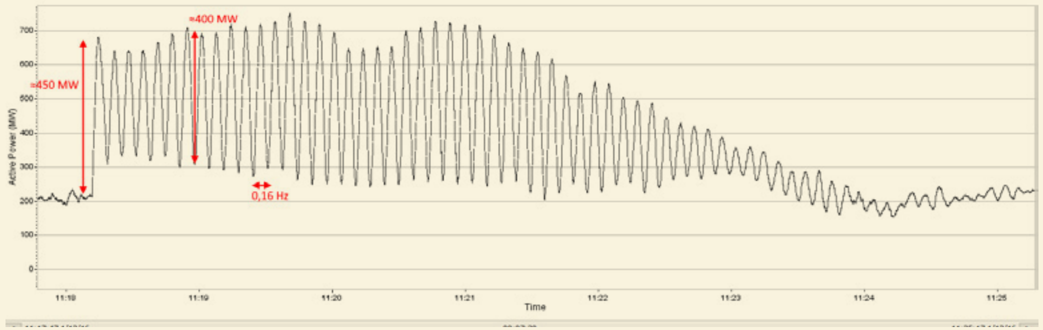


Figure 2 below shows the detail of the active power of the 400 kV Baixas-Vic line, the interconnection line between the mainland system and the rest of the European synchronous system, during the aforementioned oscillatory event.

Figure 2. Active power record on the Baixas-Vic 400 kV line. Incident on 1 December 2016



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 investments 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.
  - 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

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

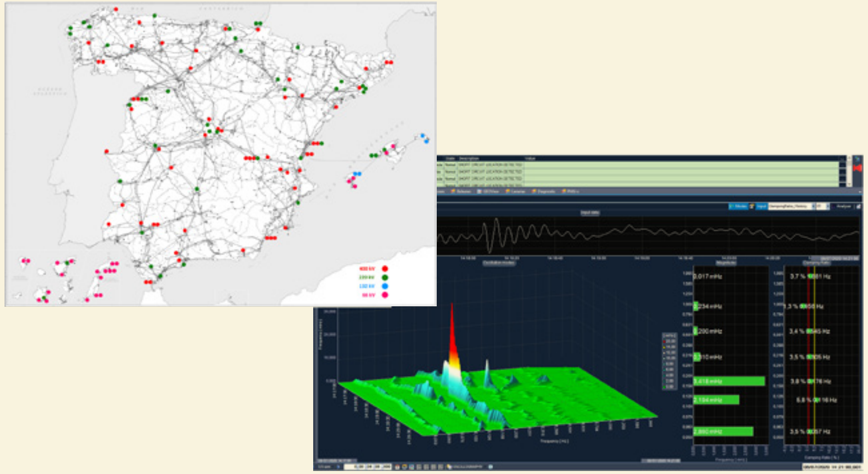
Annexes

I: Starting grid

II: New investments

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

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

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 reactors) and SCSR

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	High impact	Very low or null impact	Medium impact	Medium impact
Parallel	MCSR-based systems	High impact	Very low or null impact	Medium impact	Very low or null impact
Series	TCSC (and its variants); SSSC; SSSC with storage system	low impact	Medium impact	High impact	High impact
Series/Parallel	PST	Medium impact	Medium impact	Very low or null impact	Very low or null impact
Series/Parallel	UPFC	High impact	High impact	High impact	High impact
Series/Parallel	HVDC back-to-back	High impact	High impact	High impact	High impact
Series/Parallel	Combination of CLRs (current limiting reactors) and SCSR	High impact	High impact	High impact	Very low or null impact

✓ (blue) 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.

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

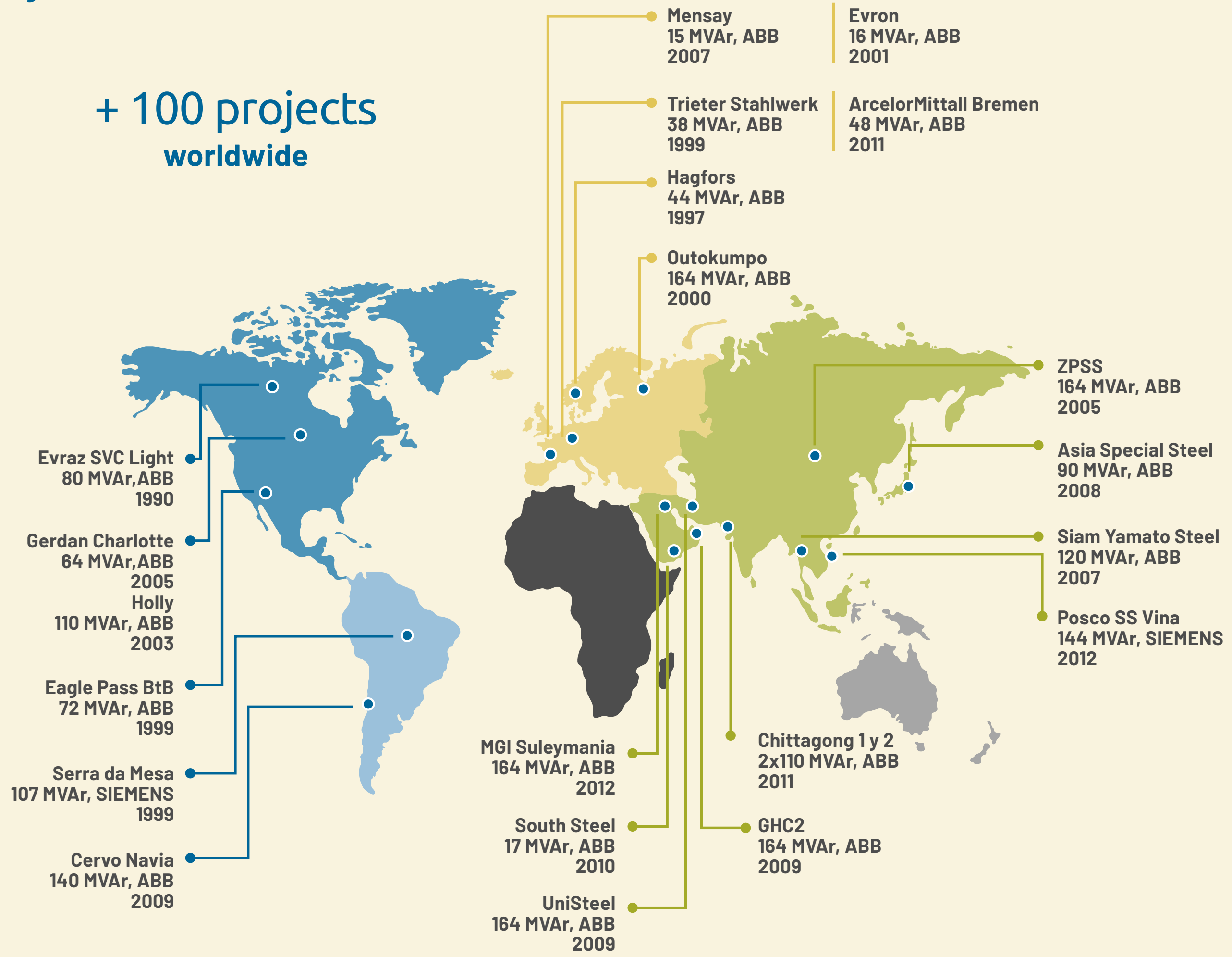
The most common devices are the PST (*Phase Shifting Transformer*), the UPFC (*Unified Power Flow Controller*) and the HVDC back-to-back. The PST does not use power electronics and therefore its main application is the control of active power flows in continuous operation. UPFCs can control both active 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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes
453

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.

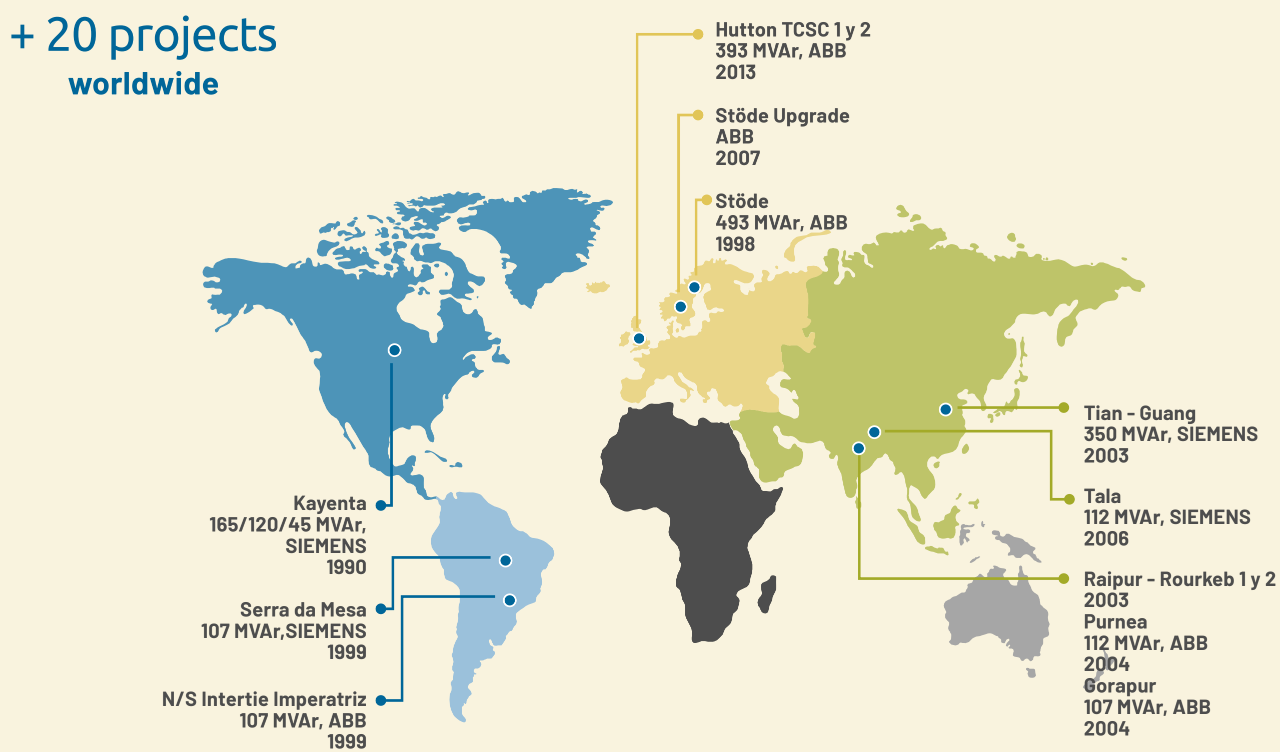
Figure 6. STATCOMs around the world



3 SSSC and UPFC would be equivalent solutions to TCSC.

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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
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.

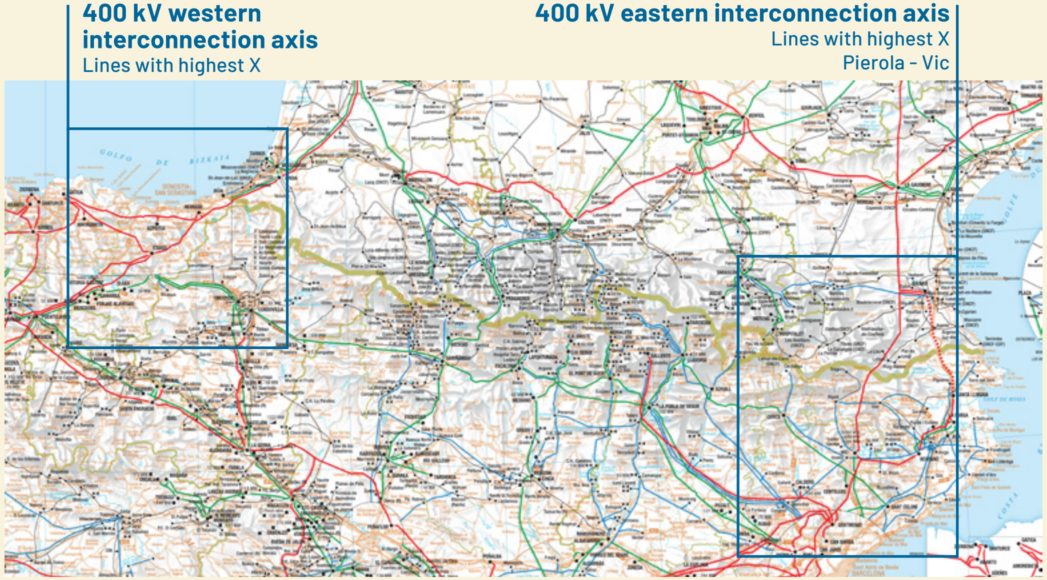
The increase in damping is a function, among other things, of the difference between the maximum and minimum impedance of the electrical axis interconnecting the systems caused by the TCSC/UPFC. When we have the parallel of a 400 kV line with a 220 kV line, the modification of the same physical impedance (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.

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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

Figure 9. Effectiveness of TCSC or UPFC for damping of inter-area oscillations

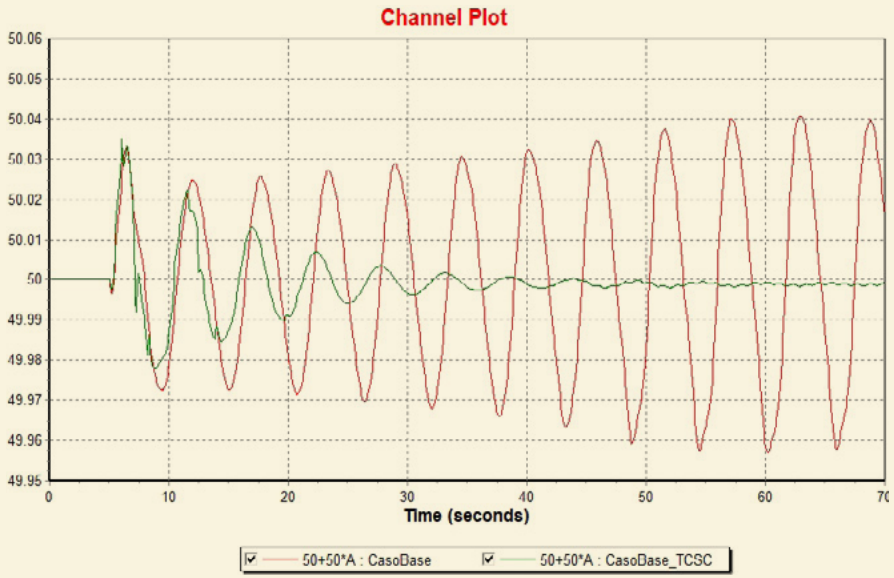
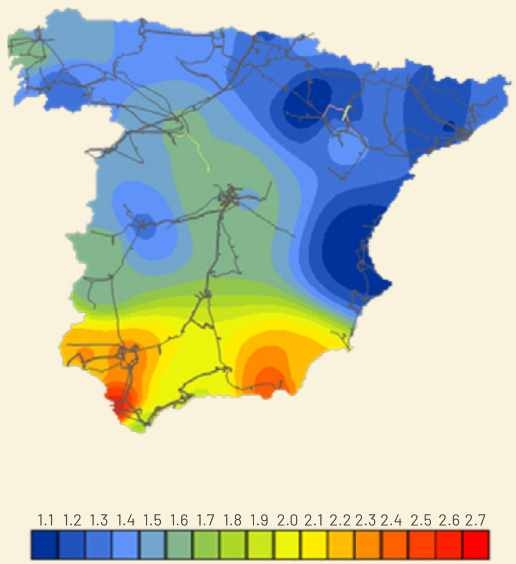


Figure 10. Statcom damping improvement map with POD-Q



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.

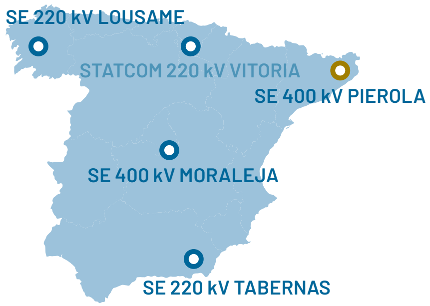
The results show that the effectiveness in damping oscillations for a ±150 Mvar STATCOM with POD-Q ranges between 1% and 2.5%, depending on the location. In general, it can be stated that the effectiveness is determined by the distance of the device from the centre of the oscillation, i.e., greater effectiveness for STATCOMs installed in Andalusia and Galicia and, on the other hand, those that are close to large centres of demand, such as the central area of Madrid.

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.

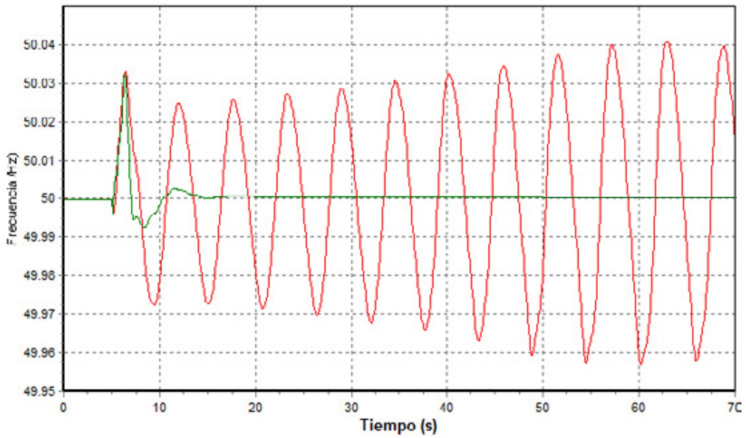
The simulation from the small signal time domain point of view showing the dynamic response of the system supporting the planned solution and the different damping figures obtained as a function of the number of devices considered on the reference scenario, is displayed in Figure 12.

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.

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%20 documents/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 Investments 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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes
460

3. Annex - synchronous condensers in the Balearic Islands 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 investments 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.

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 (reactors/ 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
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
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.

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-Balearic Islands 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.
- **Investments 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	–	+	–	++
Investments in the HVDC LCC	–	+	+	–
Synchronous condensers	+	++	++	++
FACTS	–	++	+	++

– low/null; + limited; ++ high

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

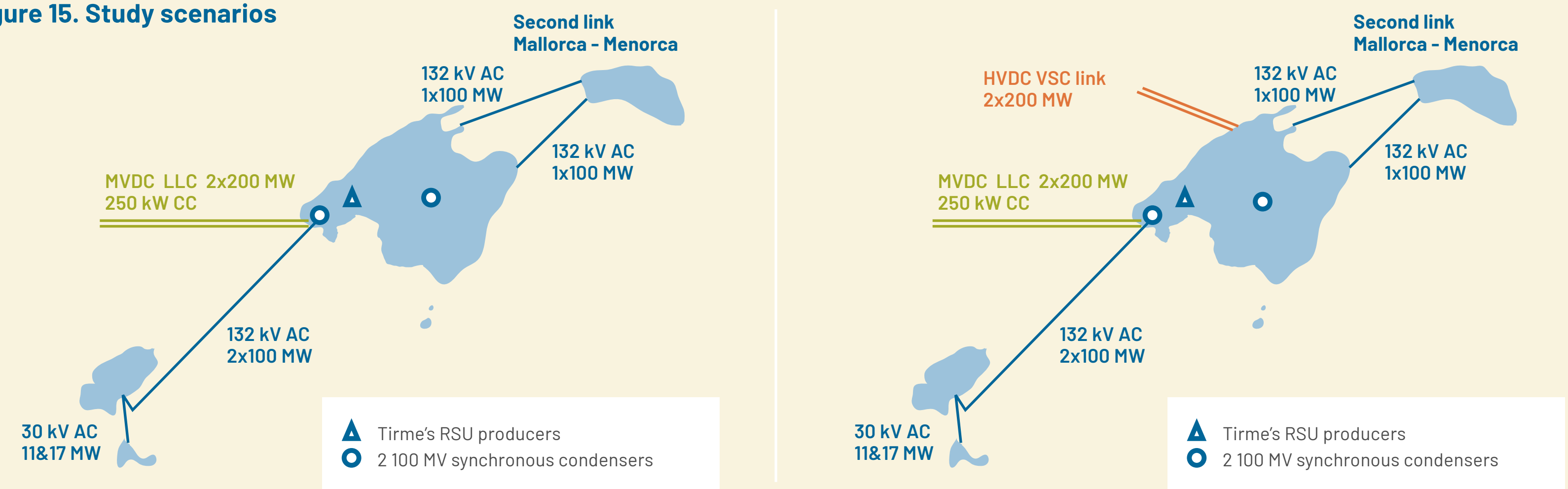
Number of synchronous condensers required in Mallorca	Scc in Santa Ponça 220 kV (MVA)
200 MVA in Santa Ponça 220 kV	980 MVA
200 MVA in Santa Ponça 220 kV + 100 MVA in Llubí 220 kV	1,285 MVA
200 MVA in Santa Ponça 220 kV + 200 MVA in Llubí 220 kV	1,537 MVA

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 Santa Ponça, as for example in 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



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 investments would be necessary, such as a second HVDC VSC link with the mainland.

Although these are the investments identified as necessary in the study horizon, based on the investment 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 investment 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 Balearic Islands system to ensure that the inertia, Scc and dynamic voltage control needs of the system are satisfied.

4. Annex - Synchronous condensers in the Canary Islands electricity system: technical justification

Given their isolated nature, the electricity systems in the Canary Islands 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.

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:

ΔV_i: Voltage variation (kV or p.u.) at node

ΔV_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.

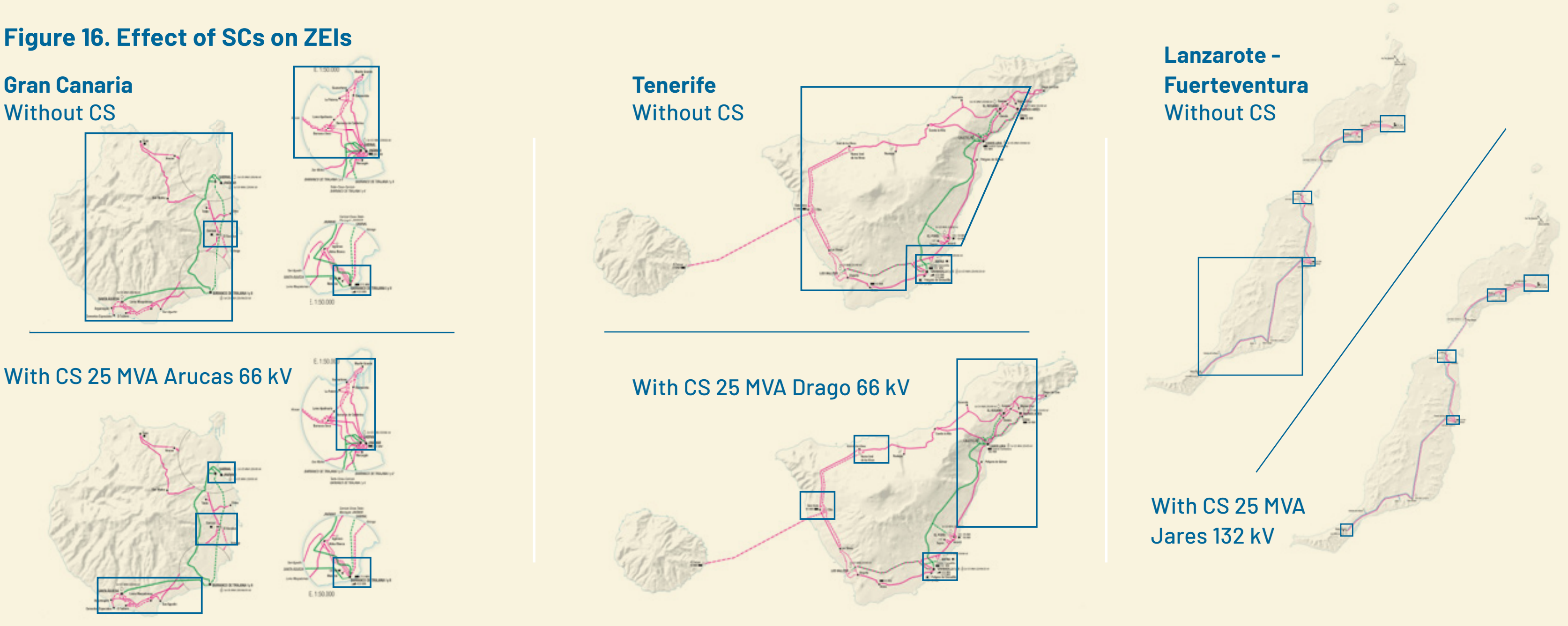
4.2. Influence of synchronous condensers on ZEI size

The incorporation of synchronous condensers in the electricity subsystems of the Canary Islands 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 Canary Islands 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



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 Canary Islands 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 Canary Islands 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.

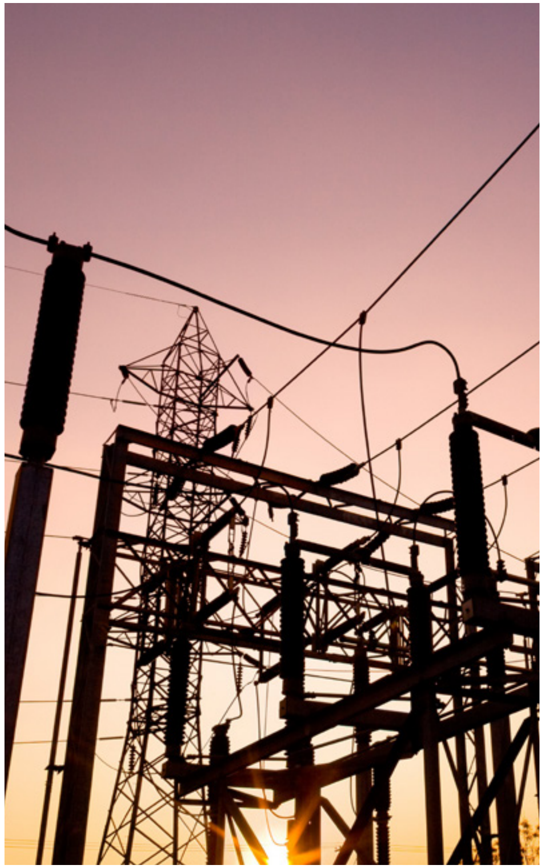
5. Annex - Dynamic transmission capacity

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 investments, 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 Canary Islands, 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 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.

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:

$$v_{w}=\begin{cases} 0.6\ m/s\ \ L90^{\circ}, & wind_{measuredRemote} < 10 m/s \\ 2\ m/s\ \ L90^{\circ}, & wind_{measuredRemote} \geq 10 m/s \end{cases}$$

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

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

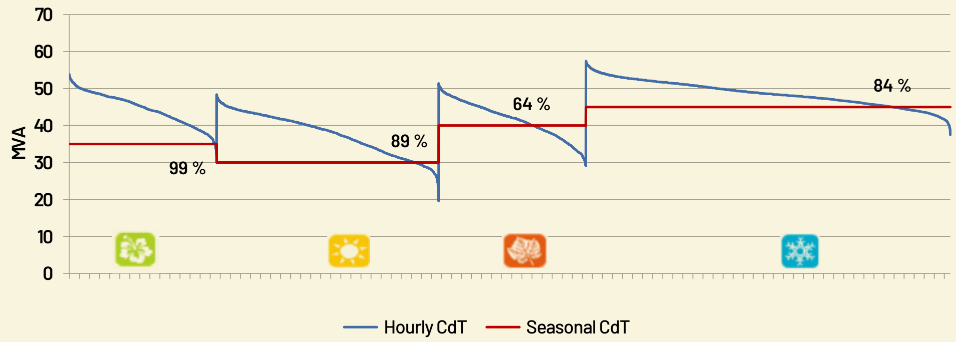
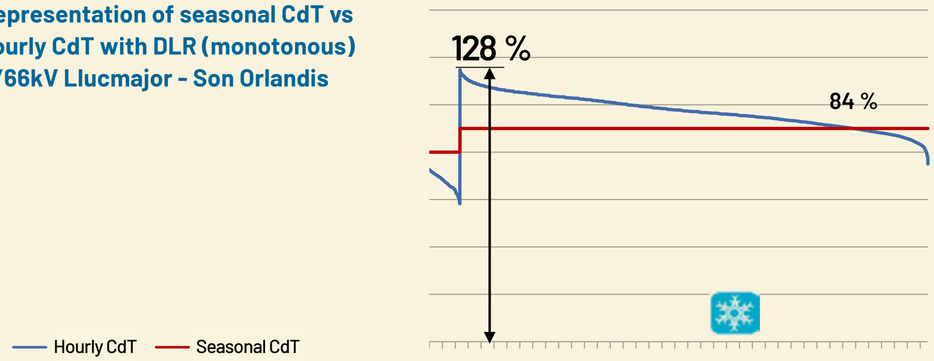


Figure 18. Graphical representation of the maximum transmission capacity obtained with DLR

Representation of seasonal CdT vs hourly CdT with DLR (monotonous) L/66kV Llucmajor - Son Orlandis



Introduction

Demand, generation and interconnections scenario in indicative planning (NECP)

Analysis methodology

Results

Annexes

I: Starting grid

II: New investments

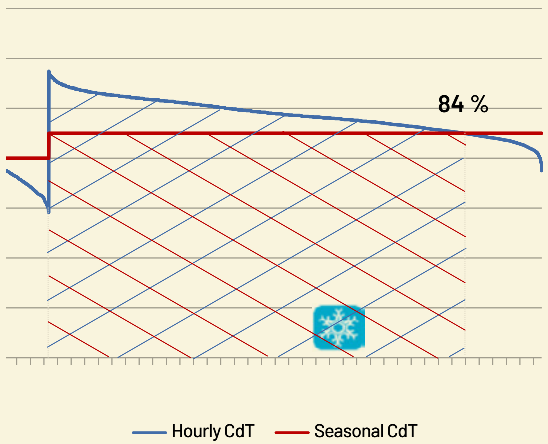
III: Technical annexes

- 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

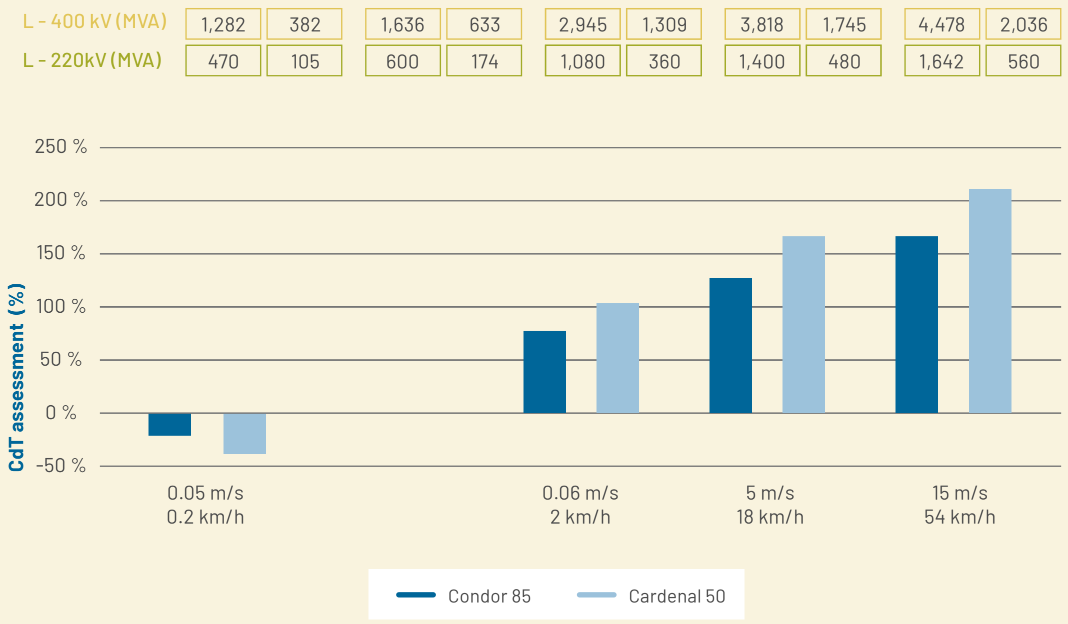
Representation of seasonal CdT vs hourly CdT with DLR (monotonous) L/66kV Llucmajor - Son Orlandis



- 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 investments 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.

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 investments 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.

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 Balearic Islands electricity system and 6 lines in the Canary Islands electricity system.

The following table shows the DLR implementation investments 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/ Aragon – Mequinenza 400 kV	Aragon	54
L/ Vandellós - La Plana 400 kV	Catalonia	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	Castile and Leon	65
L/ La Selva - Tarragona 220 kV	Catalonia	16
L/ María - Fuendetodos 1 220 kV	Aragon	30
L/ María - Fuendetodos 2 220 kV	Aragon	30
L/ Pont de Suert - La Pobla 220 kV	Catalonia	29
L/ La Pobla - T de Sesue 220 kV	Catalonia	55
L/ Riera de Caldes - Sentmenat 220 kV	Catalonia	10
L / Llucmajor - Son Orlandis 1 66 kV	Balearic Islands	18
L / Llucmajor - Son Orlandis 2 66 kV	Balearic Islands	18
L/ Ibiza - San Antonio 66 kV	Balearic Islands	10
L/ Escucha - Híjar 220 kV	Aragon	57
L/ Escatrón - Híjar 220 kV	Aragon	16
L/ Aldea Blanca - Agüimes 66 kV	Canary Islands	6
L/ Agüimes - Escobar 66 kV	Canary Islands	14
L/ Candelaria – Geneto 1 66 kV	Canary Islands	10
L/ Candelaria – Geneto 2 66 kV	Canary Islands	10
L/ Arico II - Polígono de Güimar 66 kV	Canary Islands	22
L/El Poris-Candelaria 66kV	Canary Islands	22

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 Canary Islands 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 Canary Islands electricity system, where occasionally there have been larger deviations with respect to these references.

Figure 21. Historic TIM SEPE and SEB

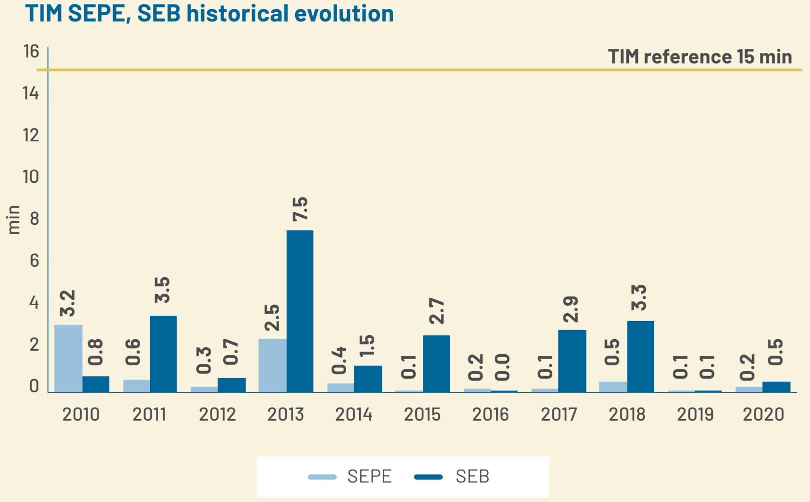


Figure 22. Historic TIM SEC

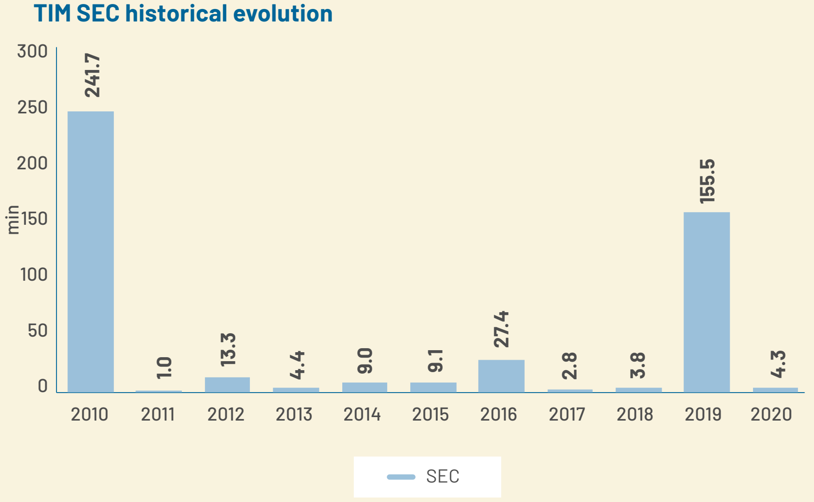


Figure 23. Historical evolution of Energy Not Supplied (ENS) in SEPE, SEB and SEC

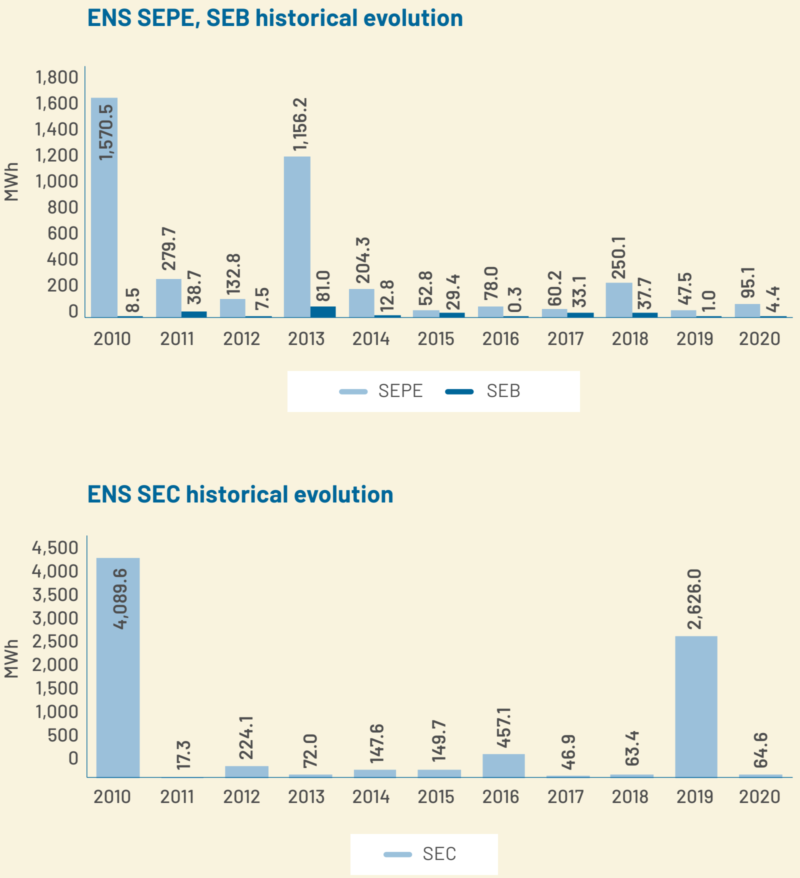
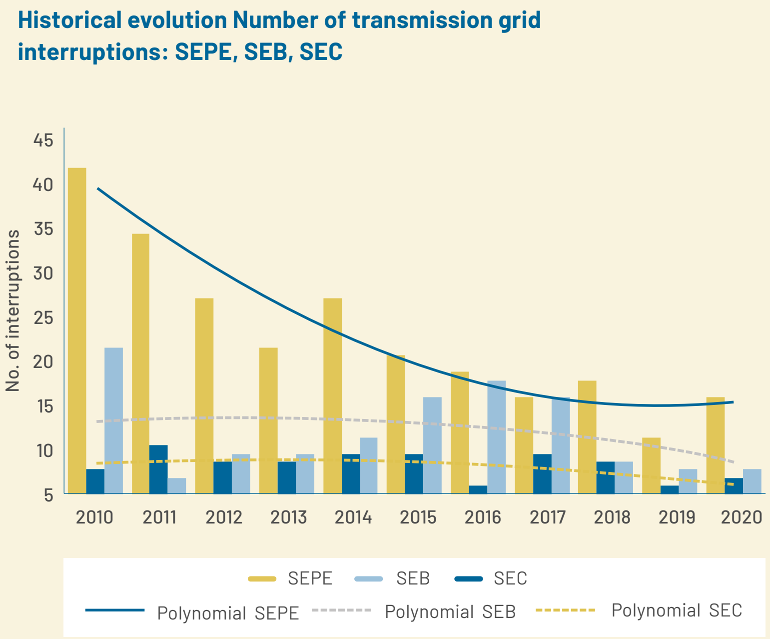


Figure 24. Historical evolution of the number of interruptions on the transmission network

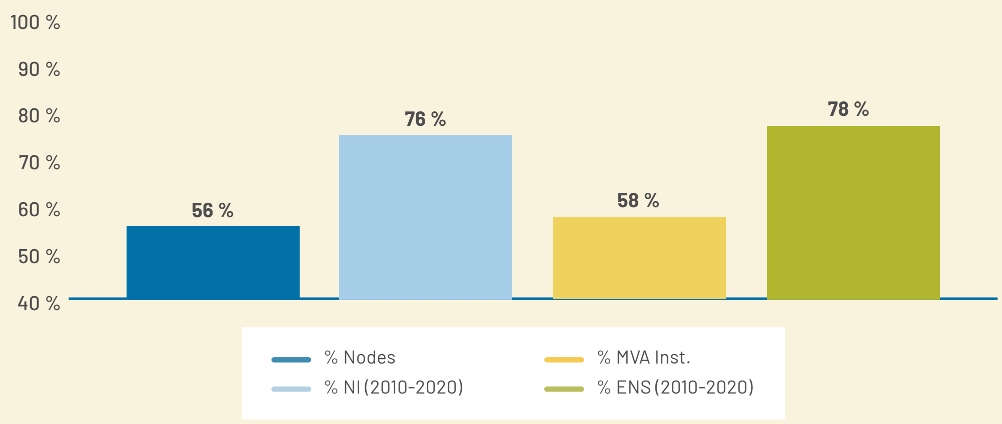


6.2. Analysis of the influence of the topology and meshing of the transmission network on quality of service

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 P013.3).

Substations with a single busbar configuration account for 76% of the number of interruptions recorded in the Canary Islands 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.

Figure 26. Topology and number of outages by topology in the electricity system

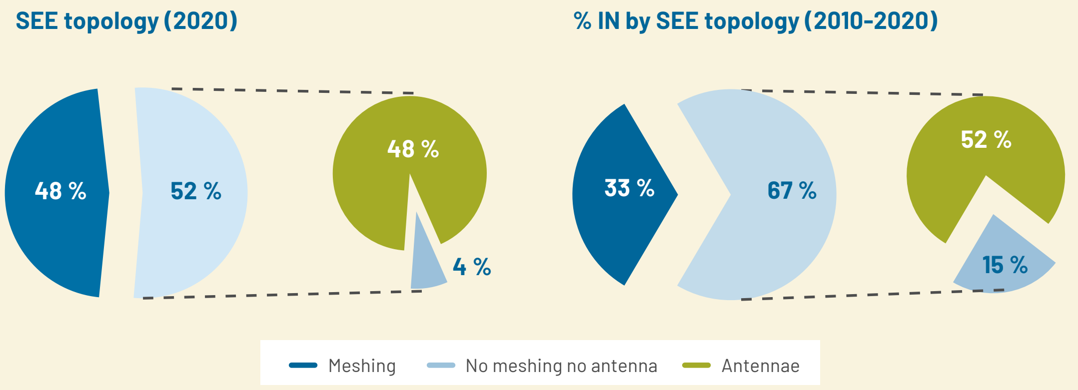
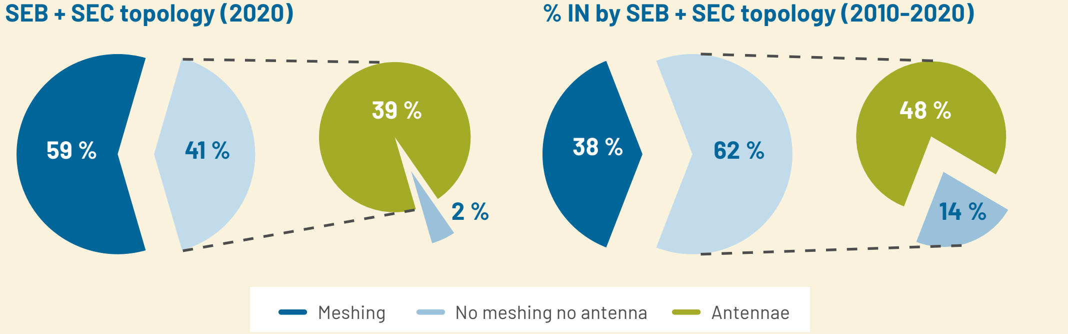


Figure 27. Topology and number of outages by topology in the Balearic islands and Canary Islands electricity systems



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.

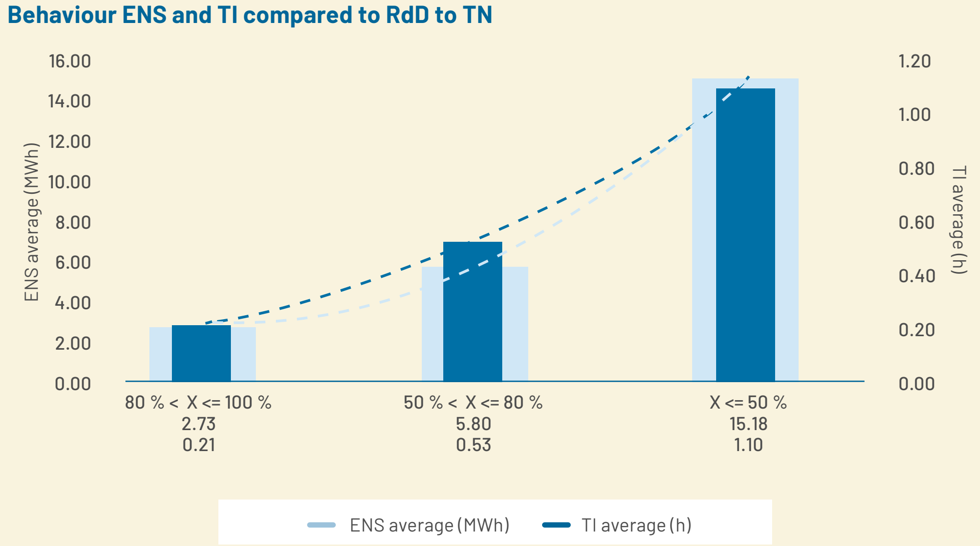
This proportion is significantly higher in the case of non-peninsular systems, where 62% of outages occurred, compared to 41% at insufficiently meshed nodes.

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.

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.

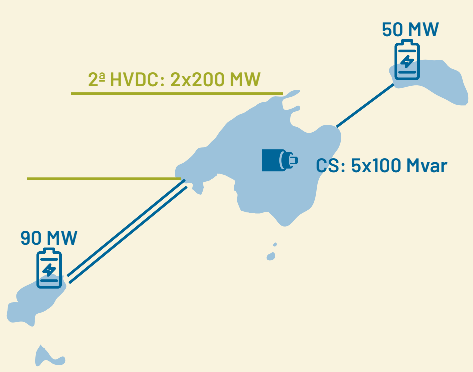
7. Annex - CBA analysis with sequential PINT in the project for the reinforcement of the electricity connection between the mainland and the Balearic Islands

7.1. Introduction

The reinforcement of the electricity interconnection between the mainland and the Balearic Islands comprises a set of investments with an impact on net transfer capacities both with the mainland and between islands. Specifically, this reinforcement consists of the following investments:

- 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. Investments to reinforce the electricity interconnection between the Spanish mainland and the Balearic Islands

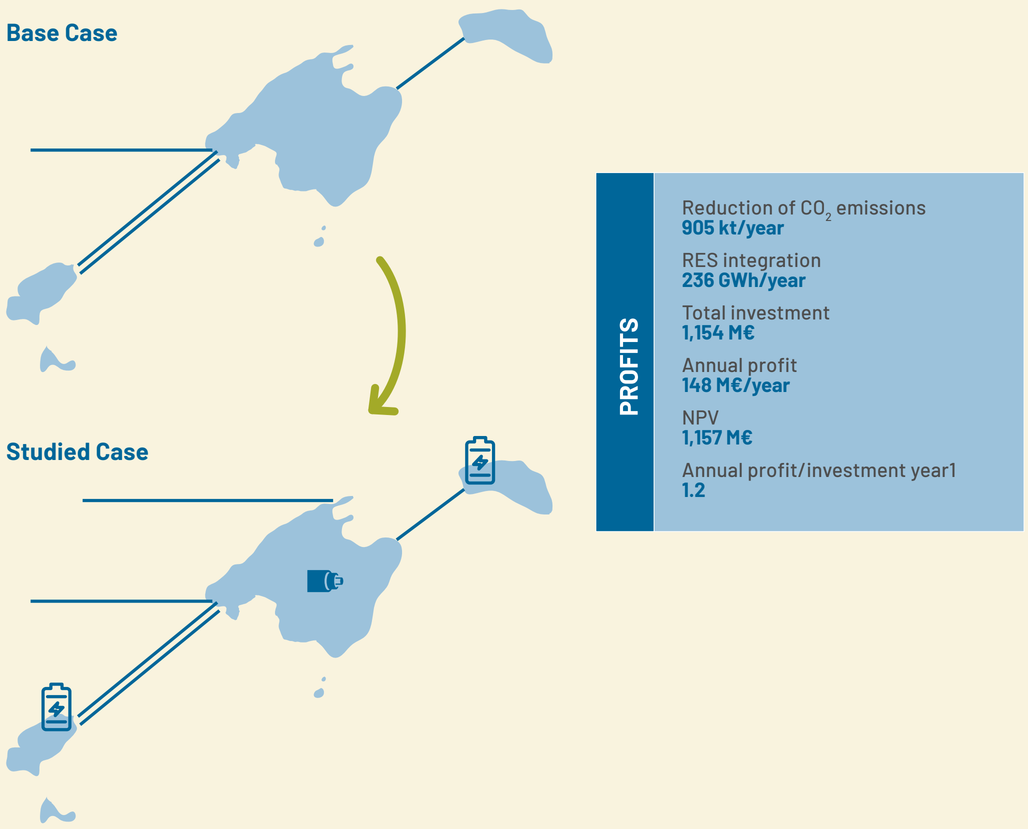


The reinforcement of the interconnection between the mainland and the Balearic Islands comprises a set of investments whose CBA analysis is positive. However, each of these investments will be commissioned in different chronological periods. It is therefore relevant to know the CBA analysis for each of them separately.

This appendix presents the cost-benefit analysis of all the investments that make up the reinforcement of the interconnection between the Spanish mainland and the Balearic Islands. The results of this analysis show higher benefits than costs and, therefore, a positive CBA for all the investments as a whole compared to a situation in which these investments are not considered, i.e. with the PINT methodology.

However, due to the different technical complexity of each of the investments 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 investments 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 investments that maximises the benefit for the system.

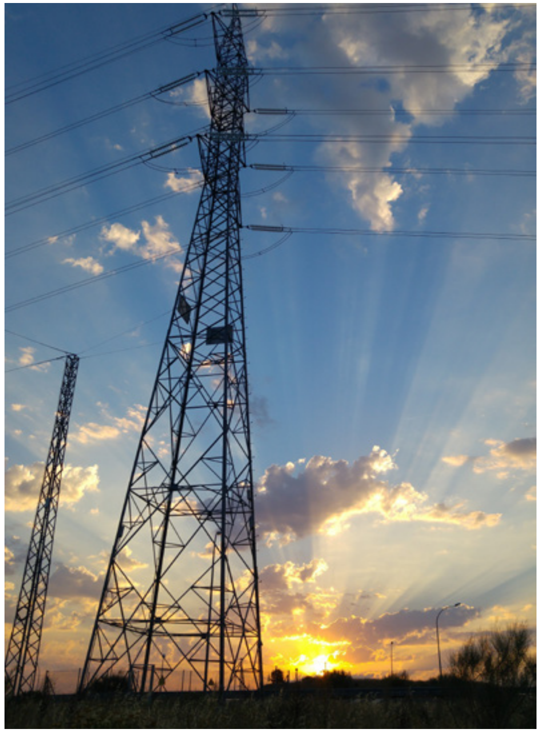
Figure 30. CBA analysis of all the investments to reinforce the interconnection between the mainland and the Balearic Islands



Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

7.2. Sequential PINT analysis of the investments to reinforce the interconnection between the mainland and the Balearic Islands

The following sections present the sequential PINT analysis for each of the investments that are part of the reinforcement of the interconnection between the mainland and the Balearic Islands:



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 Balearic Islands 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.

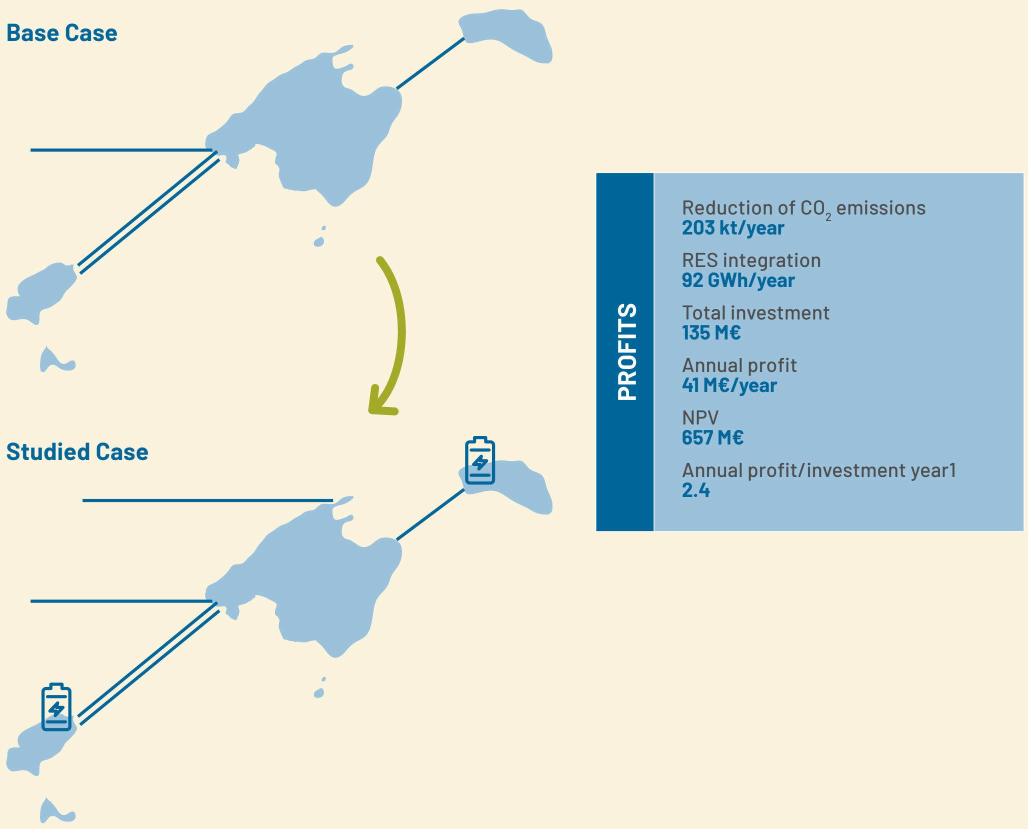
The CBA analysis of the batteries is presented below, taking into account two different hypotheses: first, assuming that they are commissioned before the second HVDC link between the mainland and the Balearic Islands and the synchronous condensers and, second, assuming that they come into operation after the commissioning of the HVDC link between the mainland and the Balearic Islands 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.

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 Balearic Islands 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

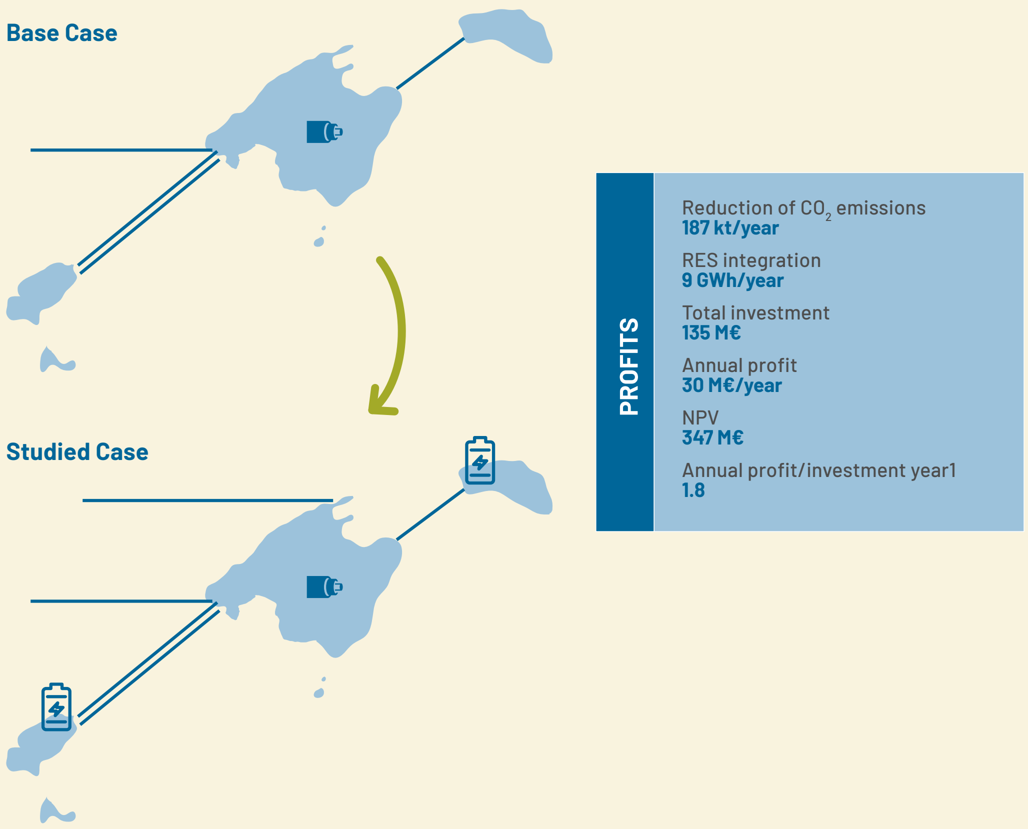


Introduction
Demand, generation and interconnections scenario in indicative planning (NECP)
Analysis methodology
Results
Annexes
I: Starting grid
II: New investments
III: Technical annexes

- **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 investments 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 Balearic Islands, 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 investments in both hypotheses.

Figure 32. CBA analysis of batteries with second HVDC and with CS



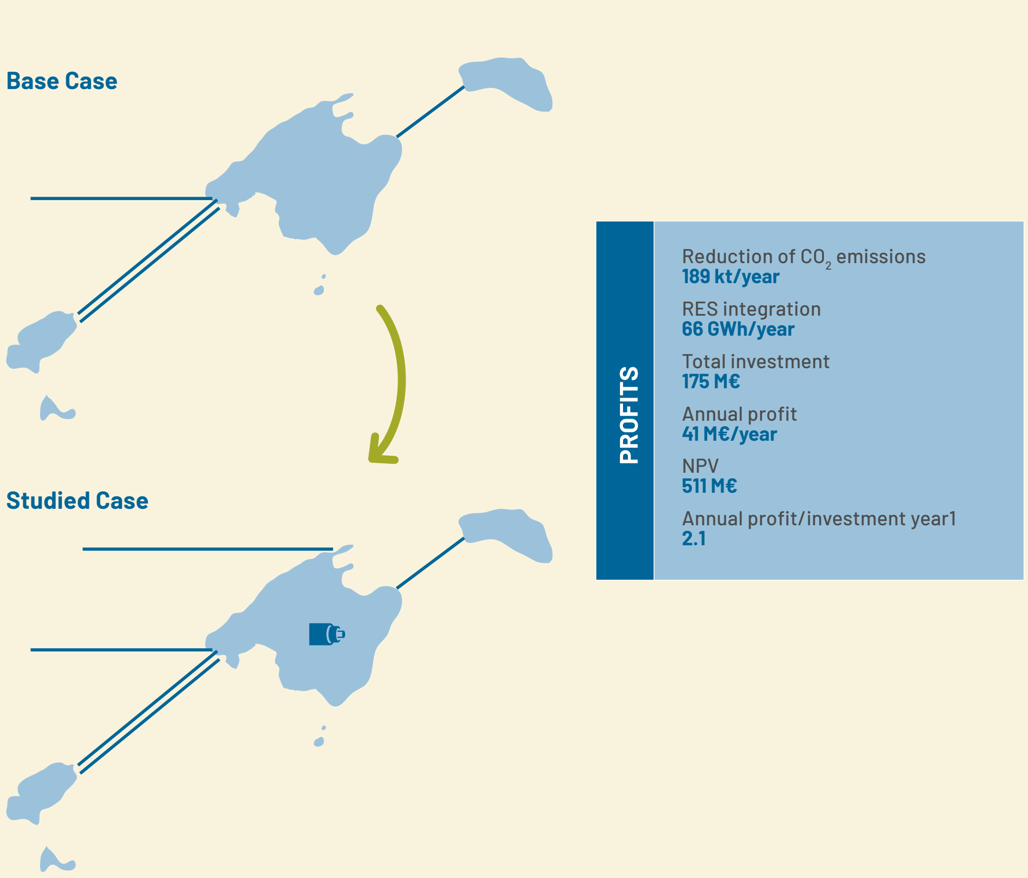
7.2.2. CBA analysis of synchronous condensers

In addition to the storage systems, the investment 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 Balearic Islands 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 Balearic Islands 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

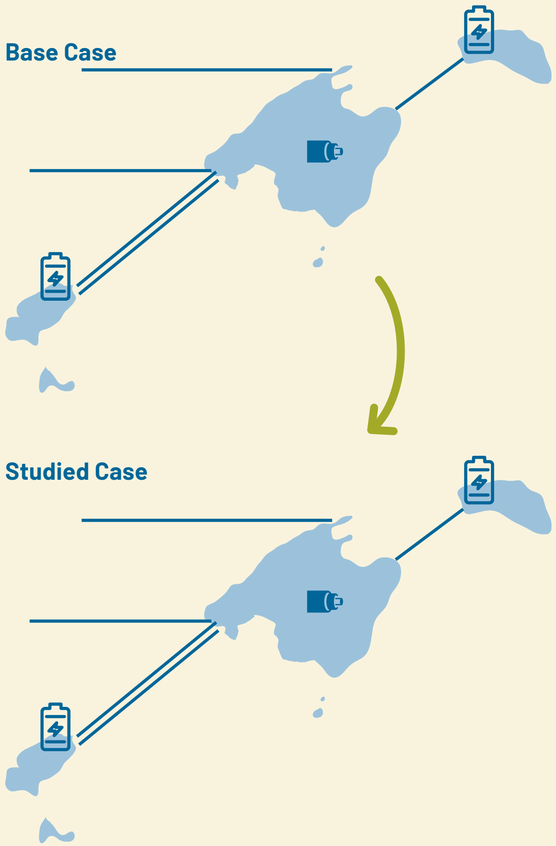


- **CBA analysis of synchronous condensers with second HVDC link and with batteries**: with this hypothesis the base case considers the second HVDC link and the batteries in service and the case study adds the synchronous condensers in Mallorca:

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 Balearic Islands. 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 Balearic Islands is to improve the stability and voltage control of the Balearic Islands 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 investment
175 M€

Annual profit
59 M€/year

NPV
861 M€

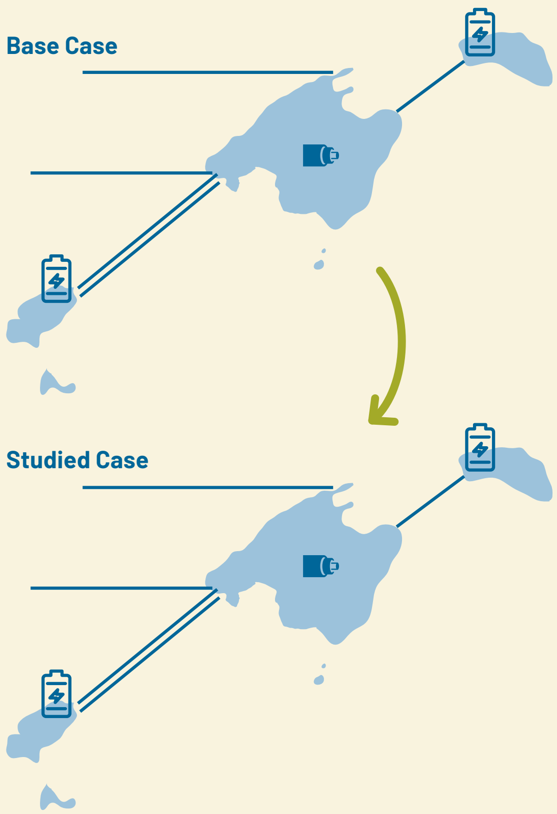
Annual profit/investment year1
3.0

7.2.3. CBA analysis of the second HVDC link between the Spanish mainland and the Balearic Islands

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 Balearic Islands 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



PROFITS

Reduction of CO_2 emissions
665 kt/year

RES integration
146 GWh/year

Total investment
853 M€

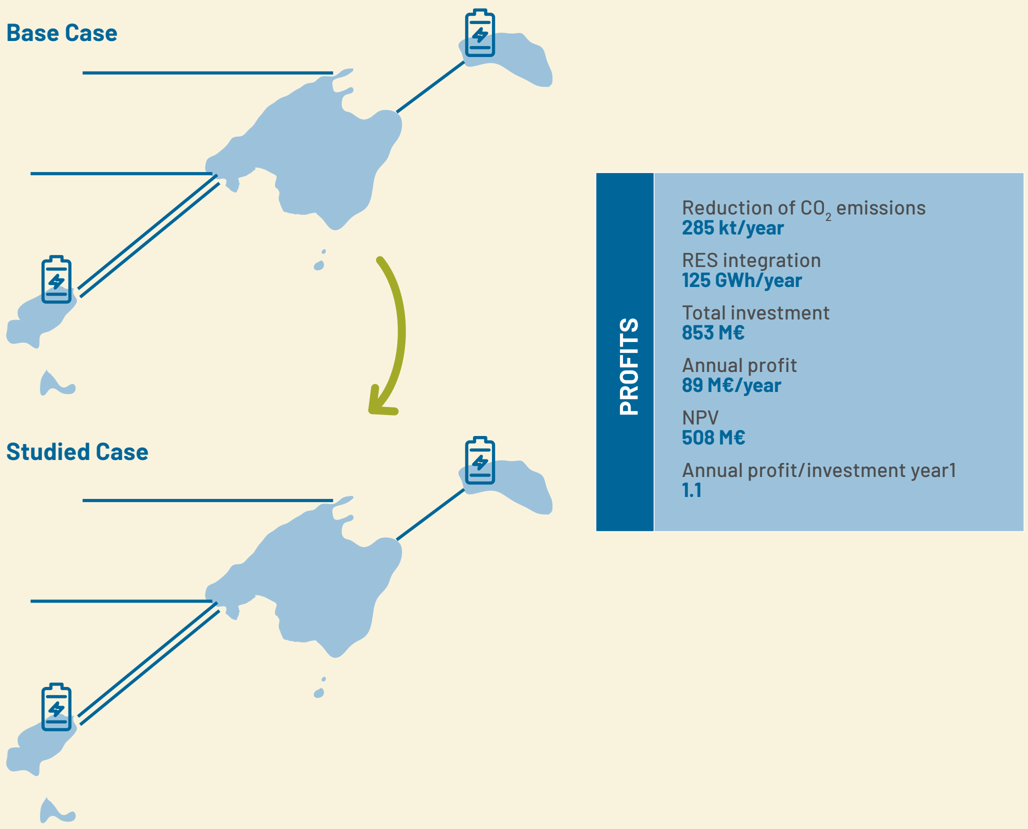
Annual profit
111 M€/year

NPV
950 M€

Annual profit/investment year1
1.3

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



7.2.4. Conclusions

The group of investments that make up the reinforcement of the electricity connection between the mainland and the Balearic Islands 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 Balearic Islands (including the synchronous condensers) or after the second HVDC link between the mainland and the Balearic Islands. 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 Balearic Islands 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.

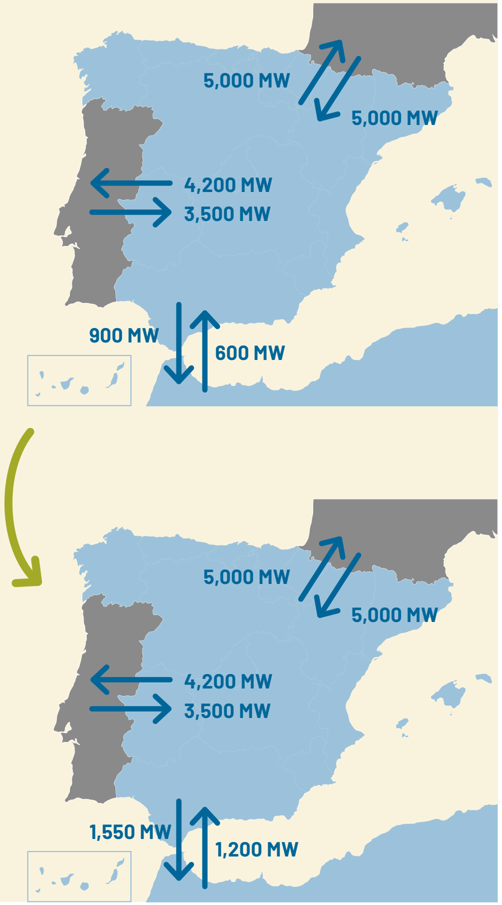
8. Annex - Analysis of the reinforcement of the interconnection between Spain and Morocco

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 investments planned for 2026 have been developed (sequential PINT methodology).

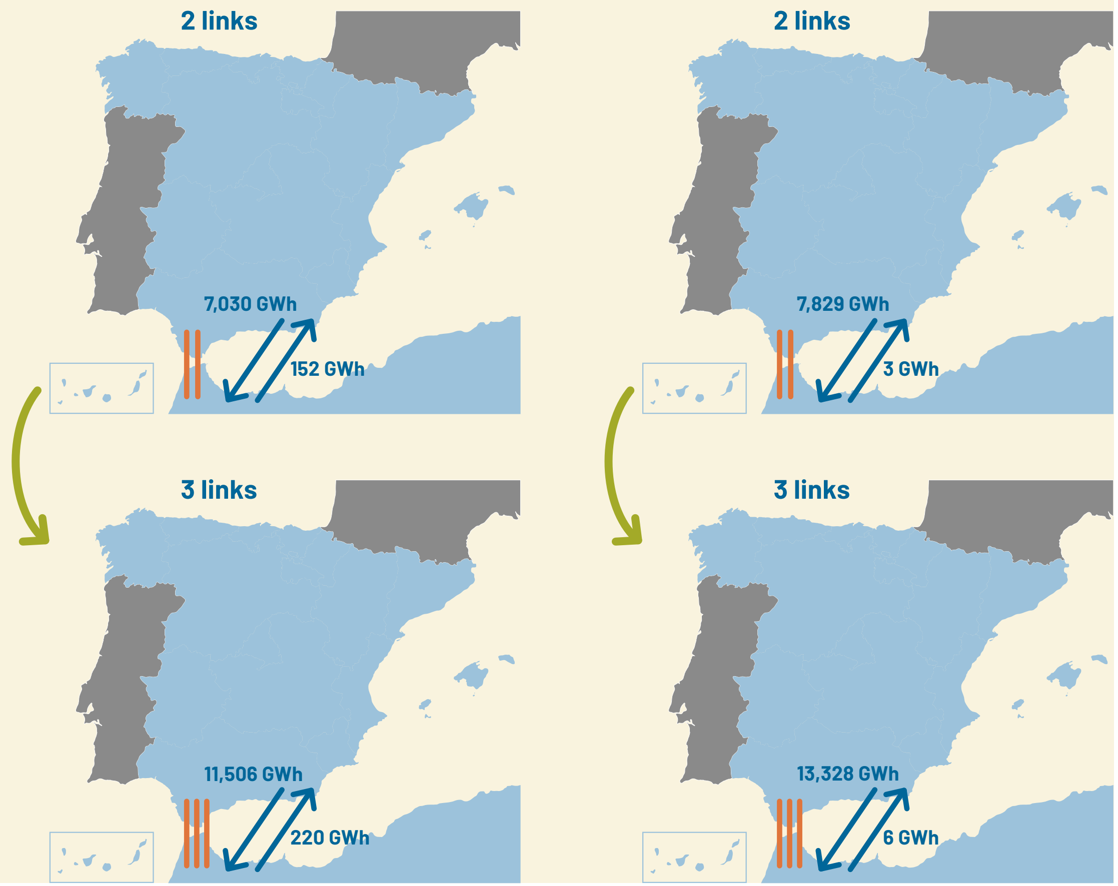
Lastly, it should be noted that the assessment has adopted as a hypothesis a cost of CO_2 emissions in Morocco equivalent to that of the rest of Europe, a factor that still requires regulatory developments aimed at harmonising the market environment.

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

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. Ilmpact on trade of a third link with Morocco in 2026 (up) and 2030 (down)



- 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)

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 DE ESPAÑA