

Transmission network development plan

2021-2026 period

EXECUTIVE SUMMARY



GOBIERNO
DE ESPAÑA

VICEPRESIDENCIA
TERCERA DEL GOBIERNO

MINISTERIO
PARA LA TRANSICIÓN ECOLÓGICA
Y EL RETO DEMOGRÁFICO

• red eléctrica

1. Introduction

The planning of the transmission network is a fundamental tool for the materialisation of the Integrated National Energy and Climate Plan.

The General State Administration, through the Ministry for Ecological Transition and the Demographic Challenge (MITERD), is responsible for designing the Spanish energy policy. To this end, with the collaboration of the Regional Administrations and the cities of Ceuta and Melilla, it carries out energy planning which, among many other aspects, defines the objectives of what the electricity system should be like in the medium and long term as regards the integration of renewable energies, decarboni-

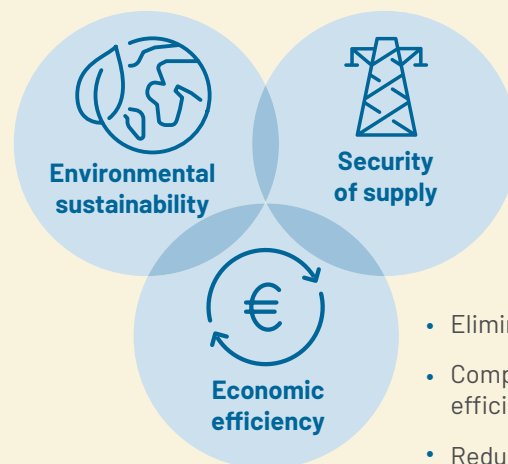
sation and security of supply at the minimum cost to the consumer. The energy planning includes binding and indicative planning. Binding planning refers to the development of the transmission network in accordance with the guiding principles set out in Order TEC/212/2019, while indicative planning covers the target scenario for electricity generation and supply. The indicative planning is fully described in the Integrated National Energy and Climate Plan (Spanish NECP).

The design of the future transmission network aims to allow the massive integration of new renewable energy sources, eliminating the structural limitations of the network, covering the needs of international interconnection and connection of non-mainland territories, while maintaining and improving the security of supply of the Spanish electricity system.

Figure 1. Guiding principles of the Network Development Plan 2021-2026

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

- Maximisation of RES production.
- Location of RES based on resources.
- Compatibility with environmental restrictions.
- Maximisation of the use of the existing network.



Guarantee of security of supply from the transmission network.

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

This transmission Network Development Plan maintains and reinforces approaches already present in current planning, such as the consideration of an adjusted starting network, the cost-benefit assessment of investments with a multi-criteria approach and the identification of investments considered necessary beyond the 2026 planning horizon. On the other hand, new aspects derived from the new context of energy transition and the search for greater transparency and objectivity are incorporated:

- Methodology for the location of new renewable energy sources established in the Spanish NECP so that the design of the development of the transmission network focuses on enabling the integration of renewable energy sources that can be located in areas with a greater

amount of resources and that have a lower environmental impact.

- 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 conventional deterministic analyses.
- The incorporation of 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.



2. Phases of the planning process

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

The planning process 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, also allowing the participation of any entity or individual who wishes to do so. The complete process consists of the following phases:

- **Proposal phase** (3 months). From the time of publication in the BOE of the start of the planning process, which took place on 2 March 2019, the Regional Administrations and parties with an interest in the sector submitted their proposals for development.

In the proposal phase of the Network Development Plan 2021-2026, a total of 1,335 proposals were received from 177 subjects.

- **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), in its role as System Operator, carries out the relevant technical studies and prepares the proposal, in accordance with the criteria established by MITERD.
- The National Markets and Competition Commission (CNMC), as National Regulatory Authority, prepared a report containing its recommendations on the economic

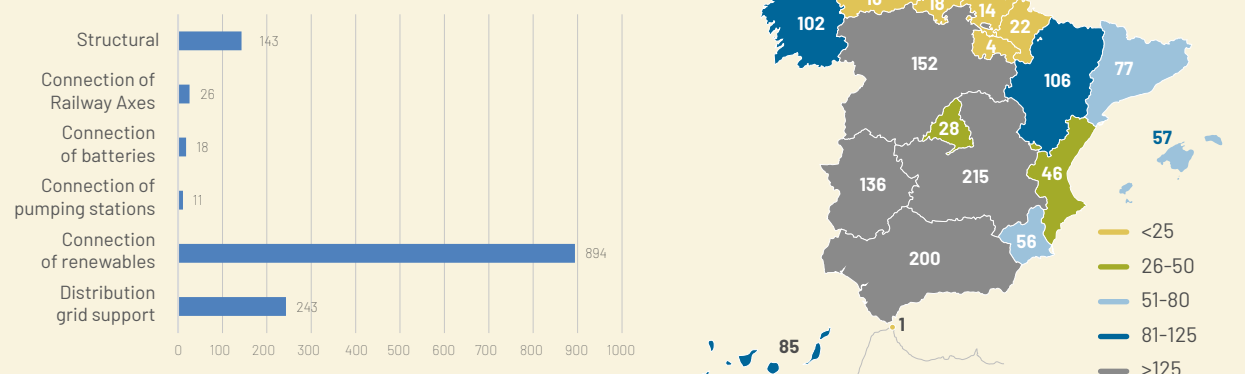
implications of the planned investments and their impact on the economic-financial sustainability of the electricity system, published on 2 July 2020.

- **Consultation phase**. Between 15 February and 12 April 2021, the consultation phase of the Proposal for the Transmission Network Development Plan 2021-2026 took place. This 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.
- **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 consultation phase, and the System Operator prepares the

proposal for the Transmission Network Development Plan for 23 June 2021 on this basis.

- **Consolidation phase**. Once the consultation phase and recommendations were analysed and incorporated into both the proposal for the Transmission Network Development Plan and its Strategic Environmental Study, and having obtained the Strategic Declaration issued by the Directorate General for Environmental Quality and Assessment of the MITERD on 9 December 2021, the proposal was consolidated in the Transmission Network Development Plan and sent back to the CNMC for its final assessment.
- **Approval phase**. Finally, the Transmission Network Development Plan 2021-2026 was submitted to the Council of Ministers for referral to the Congress of Deputies prior to its approval by the Government.

Figure 2. Proposals made by stakeholders in the 2021-2026 planning process



3. Hypothesis

The demand and generation forecast scenario is established by the indicative planning described in the Spanish NECP 2021-2030.

The Transmission Network Development Plan study scenario for the period 2021-2026 is established in the macroeconomic context and in the 2025 and 2030 Objective scenarios of the Spanish NECP, which determine the evo-

lution of electricity demand, installed generation capacity and fuel and emissions costs as the most significant variables. From these two scenarios, the Network Development Plan 2026 scenario has been derived by linear interpolation for most of the variables.

The scenario covers the Northern interconnection projects with Portugal and the HVDC Biscay Gulf link that will strengthen the interconnection with France, both considered in the Spanish NECP and classified as Projects of Common Interest by the European Commission.

Similarly, the reinforcement of the interconnection with Morocco has also been included to comply with the agreements with the Kingdom of Morocco¹.

The increase in demand for 2026 is very modest, with an annual growth rate of less than 0.5 % on the Spanish Mainland.

To define the installed generation capacity by type of technology, the data set in the Spanish NECP in the 2025 and 2030 Objective scenarios have been considered,

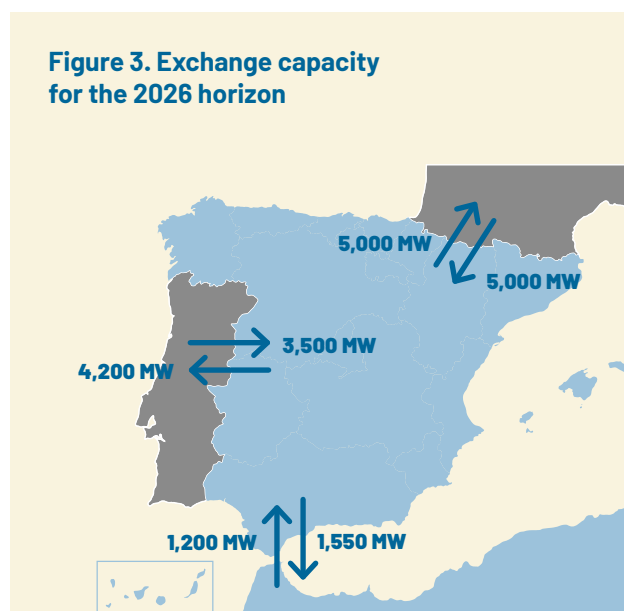
1. Agreement with the Kingdom of Morocco for the development of a third electricity interconnection and a strategy for collaboration in the field of energy by 2026, established in February 2019 (<https://www.lamoncloa.gob.es/serviciosdeprensa/notasprensa/ecologica/Paginas/2019/140219-ener-giamarruecos.aspx>).

applying a linear interpolation between both years to establish the value for 2026. The only exception to this is coal, for which the Spanish NECP estimates 2,165 MW in 2025 and 0 MW in 2030. In order to increase stress in the transmission network and detect potential needs caused by an early closure of coal-fired power plants, the withdrawal of all existing coal in 2026 has been considered.

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

Forecasts for the installation of renewable energy sources, both through applications for access and connection and proposals in the planning process, far exceed the renewable energy installation values of the objective scenario of the Spanish NECP for the 2026 study horizon and even for the 2030 horizon. It is therefore essential to estimate a deployment of these generation facilities consistent with the 2026 objective value of 39 GW of new renewable energy sources derived from the Spanish NECP. To this end, it has been necessary to identify the most likely locations for this renewable energy sources, taking into account both the availability of the resources and the environmental conditions for their deployment.

As a result, the following deployment zones of land-based renewable energy sources to be installed by 2026



is applied in line with the 2030 objective scenario of the Spanish NECP, which is the starting point for the analysis of the needs of the transmission network.

On the other hand, the locations with the highest probability of success for offshore wind in the study scenario are aligned with the priority use areas for offshore wind power established in the “Marine Spatial Plans” (Planes de Ordenación del Espacio Marítimo or POEM) draft.

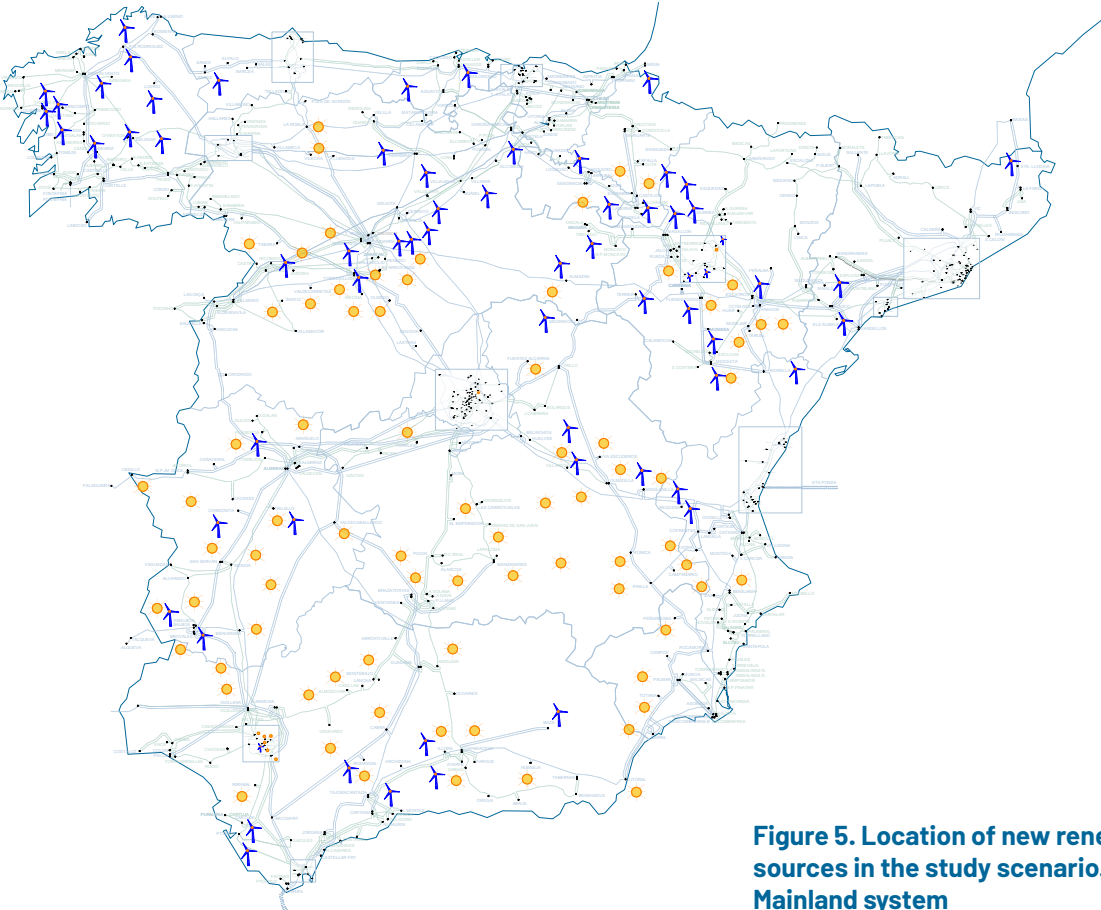
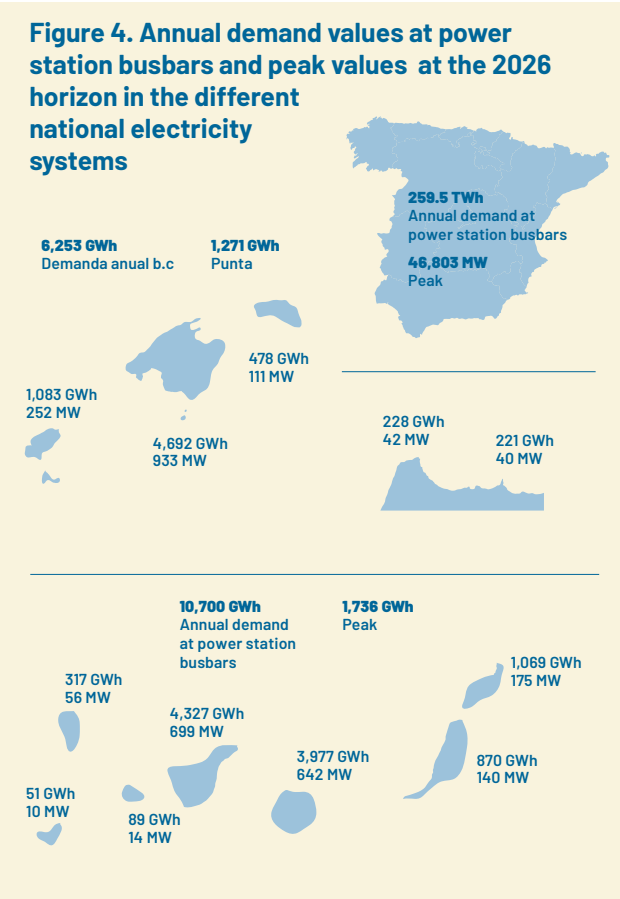


Figure 5. Location of new renewable energy sources in the study scenario. Spanish Mainland system

4. Methodology

Any investment for the development of the transmission network must respond to a need identified in the scenario envisaged for 2026 and must have a positive cost-benefit analysis for the system as a whole.

Taking the existing network on its own as the starting network for planning analyses is an excessively limited approach, as some facilities already planned are under construction or are at an advanced stage of processing. Therefore, the starting network includes developments already included in current planning with construction underway, with commissioning planned by the transmission operator prior to the planning period (2019 and 2020), facilities that have an Environmental Impact Statement (EIS) and facilities that do not require an EIS and whose planned commissioning date is prior to 2024, or which have already been undertaken, with permits granted.

The STARTINGS GRID for the study scenario goes beyond the network currently in service, as it includes facilities already planned that are expected, in all probability, to be in service by 2026, as they are either under construction or are at an advanced permitting stage.

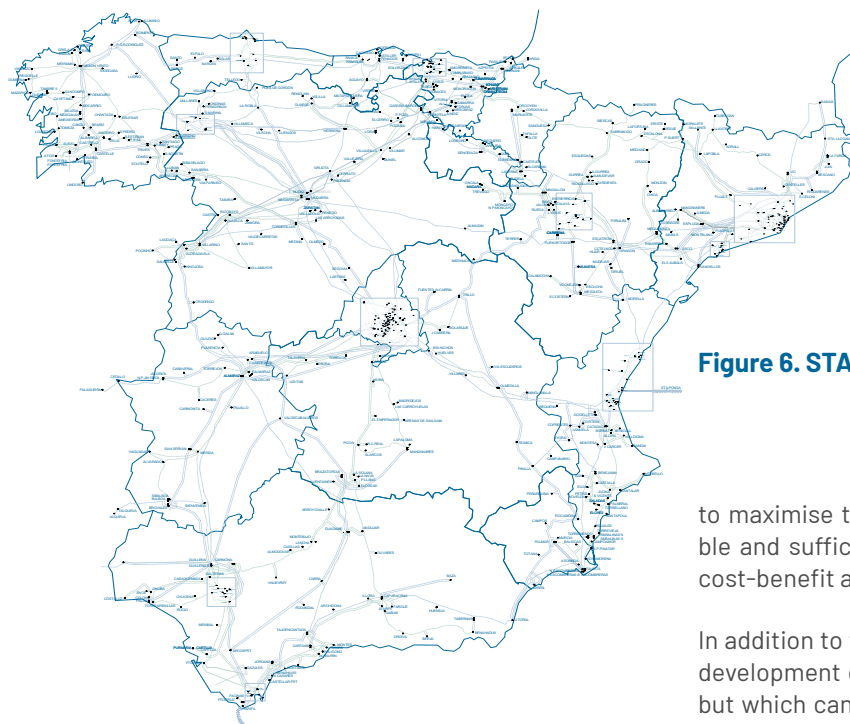


Figure 6. STARTINGS GRID

The production and demand scenario derived from the Spanish NECP is applied to this STARTINGS GRID, and the problems and needs of the transmission network are identified by means of simulation software with hourly detail.

Once the needs have been detected, mainly network overloads, curtailment of renewable energy sources and energy not supplied, possible solutions have been systematically assessed 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, and with a positive cost-benefit analysis for the system.

In addition to these needs, there are others to which the development of the transmission network must respond but which cannot be detected in the aforementioned simulations. Some of these are established as objectives in the Spanish NECP, such as the electrification of rail transport, others derive from compliance with European regulations and requirements established by the Electricity System Operation Procedures, and others involve needs associated with the distribution networks or the renovation of facilities. For these, objective criteria have been established for their incorporation into the Network Development Planning.

As established in the guiding principles, this process prioritises the use of the existing network as far as possible, as well as a greater use of new technologies.

5. Results

The transmission network planned for 2026 is essential to succeed in the decarbonisation pathway of the Spanish NECP.

If only the STARTINGS GRID were available, which would imply an investment volume of €1,154 million by 2026, renewable energy sources curtailment would be about 15% of its total potential production, and the integration of renewables would be 62 % of the total value of electricity generation, 6 percentage points below the 68% that should be obtained in a Spanish NECP compliance path. With an unconstrained network, the targets set in the Spanish NECP would be met and the curtailment would be reduced to 2.4 %, however, this network would have a high social and environmental impact and a high investment cost. With the planned developments, the network will be able to accommodate the estimated new flows in the transmission network. It constitutes a middle-ground between the STARTINGS GRID and the aforementioned unconstrained network, in order to strike a balance between energy policy objectives, security of supply, sustainability and environmental commitment. The planned transmission network allows capturing 80-90 % of the benefits that would be obtained with an unconstrained network to be achieved, but at a limited cost.

Indeed, the planned transmission network allows for a 68 % integration of renewables in the Spanish mainland electricity system, complying with the established objectives, while limiting curtailment to 4%, which is in

Planned network H2026

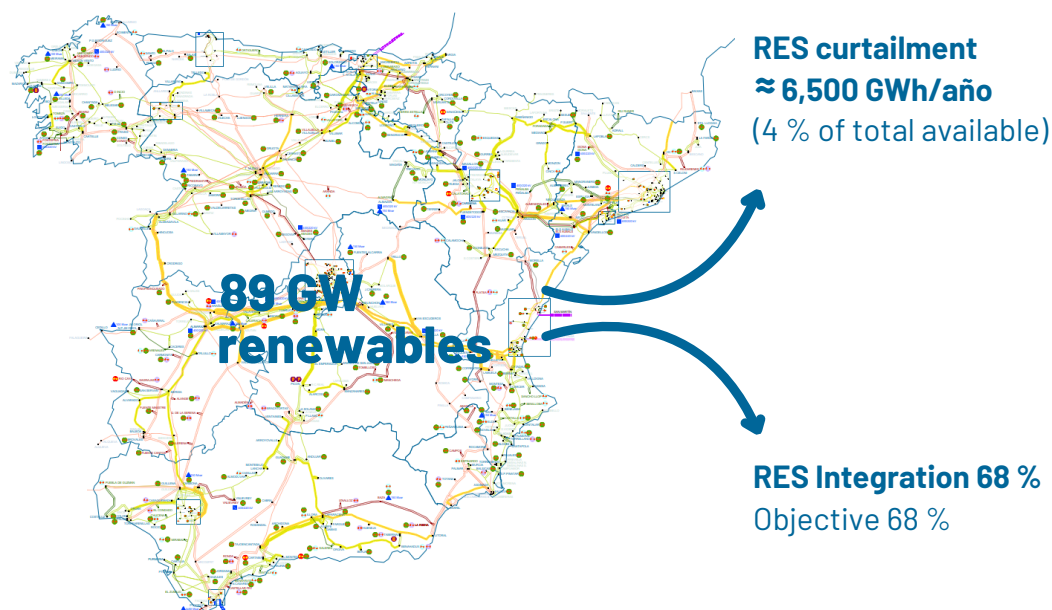


Figure 7. Integration of renewable energy sources and curtailment in the scenario with the planned transmission network

line with European recommendations. As for the Balearic electricity system, the proposed links mean that 65% of the Balearic supply will be sourced from the Spanish mainland, leading to a substantial reduction in the costs and emissions associated with supplying the archipelago.

Finally, in the electricity systems of the Canary Islands, the planned transmission network allows a substantial improvement in the security of supply and, through the greater integration of renewables, cooperates in reducing variable generation costs, which are 30 % lower with respect

to 2019. However, the analyses carried out demonstrate that compliance with the renewables integration objective included in the Spanish NECP for the Canary Islands will only be possible through the combination of the planned network and the installation of storage systems.

The overall benefits for the system associated with the planned transmission network (without considering interconnections) amount to €1,440 M/year, resulting in a clearly positive cost-benefit analysis for the system, in accordance with the methodologies approved by the European Commission.

The greatest investment effort is earmarked for the RES integration and the resolution of technical congestions.

The estimated investment cost of the set of initiatives included in the Transmission Network Development Plan 2021-2026 is €6,964 M, of which €1,260 M correspond to investments to strengthen international interconnections with France (Biscay Gulf), Portugal (Northern interconnection), Morocco (third interconnection) and Andorra, and €5,704 M to investments to reinforce the transmission network that makes up the national electricity system, both included in the STARTINGS GRID and in the planned network.

As shown in the attached figure, of the investment effort, €5,704 M in internal network reinforcement actions, the largest item corresponds to the RES integration and the resolution of technical congestions, and the second largest to the development of links between systems, as corresponds to planning focused on adapting the transmission network to facilitate the decarbonisation process and the massive implementation of renewables in the system.

Figure 8. Total investment cost of the Transmission Network Development Plan 2021-2026 by motivation (€M)

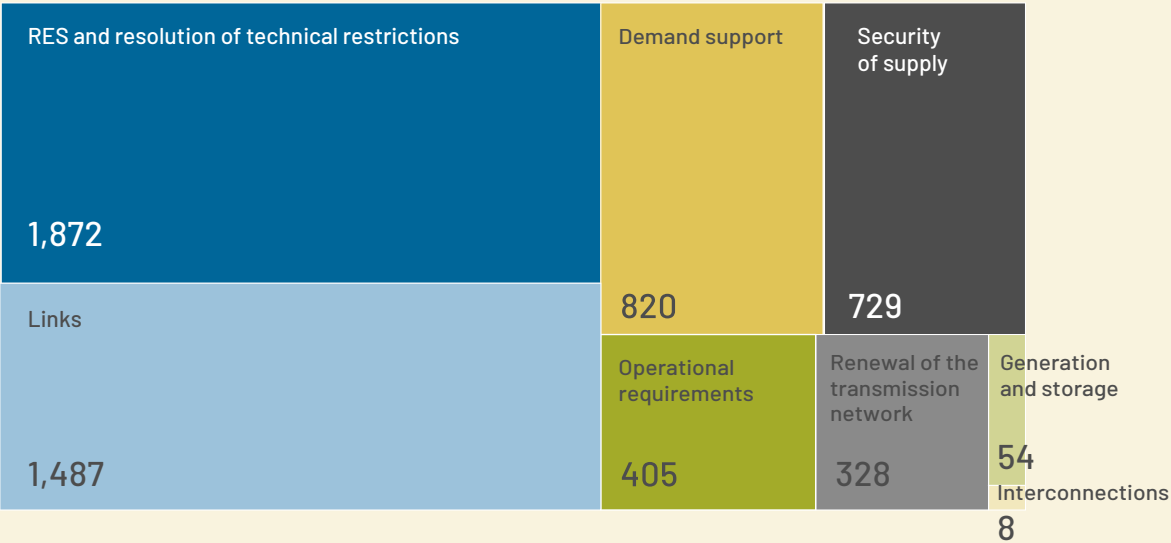
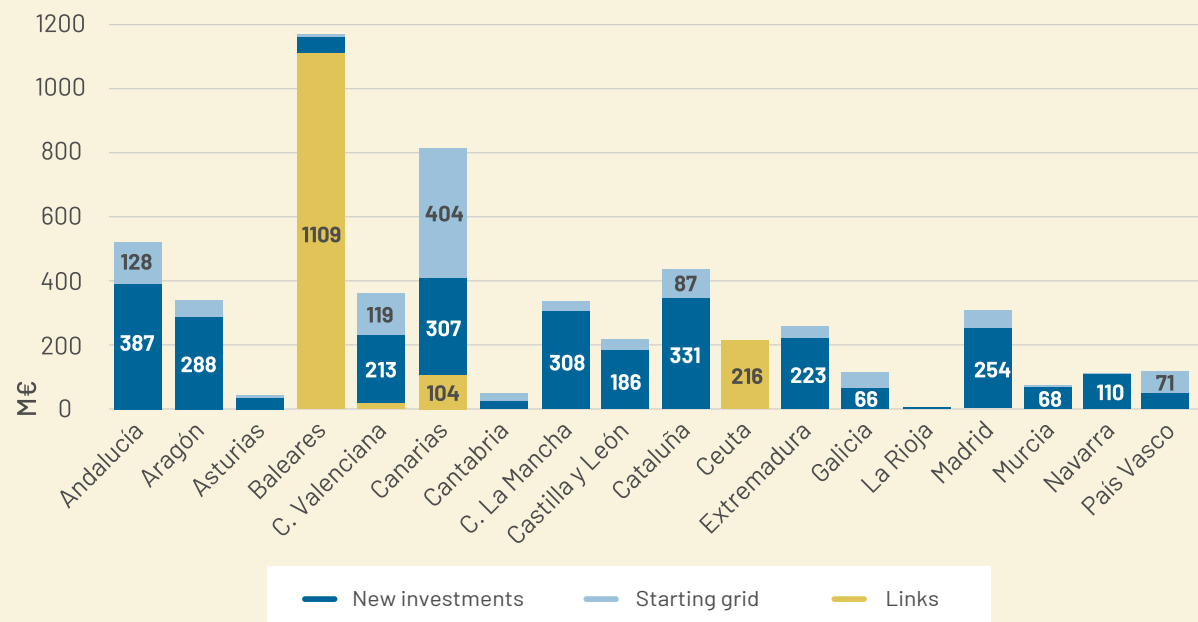


Figure 9. Distribution of costs 2021-2026 by Regional Administration: STARTINGS GRID and new planned investments



The Transmission Network Development Plan encourages the use and improvement of the existing network while minimising the environmental impact of the plan.

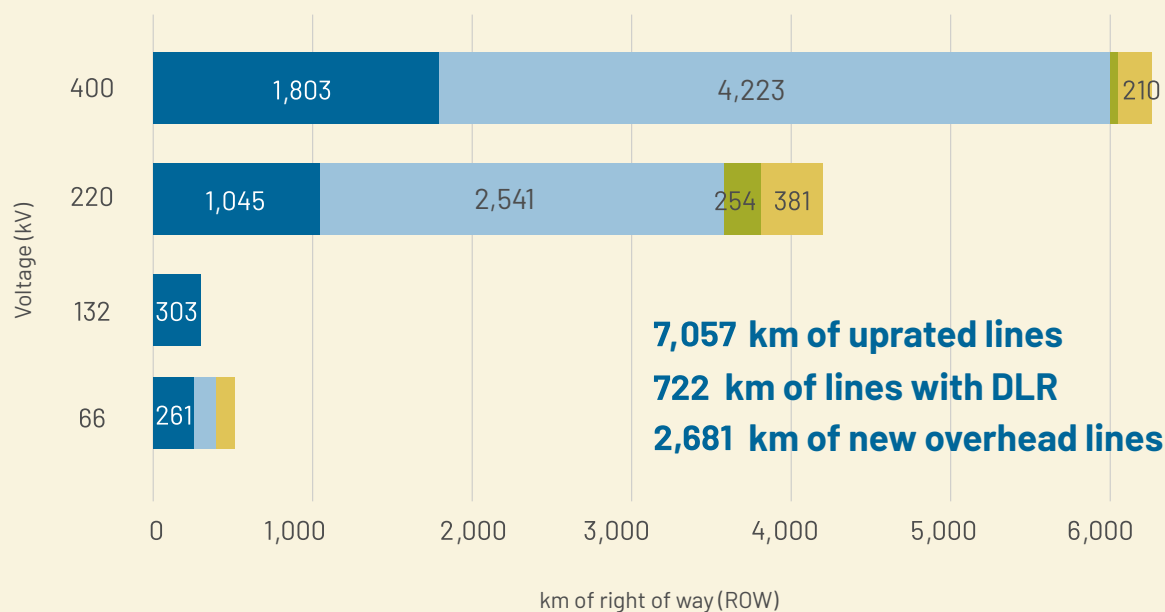
In line with the guiding principle for planning of maximising the use of the existing network, the Network Development Plan contains, excluding interconnections, 7,057 km of upgrading, the replacement of conductors on 300 km of existing lines and the provision of dynamic line rating (DLR) systems on 722 km of existing lines. The planning of new lines is substantially smaller, amounting to 2,681 km of new lines and 733 km of underwater cable routes.

In addition, 53 % of the connection of new renewable energy sources is made to existing or previously planned transmission facilities, while only 25 % require newly planned investments. 21 % is considered to be connected to the distribution network via the existing transmission-distribution interface or via newly planned reinforcements. Although the aim is to maximise the integration of renewable sources with a higher probability of successful connection to the transmission network, the actual deployment will be the result of the decision of the promoters to carry out the projects once the access permits have been processed and obtained.

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

In addition to the infrastructures planned 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 2026 planning horizon, are not feasible within that horizon due to construction or economic reasons. This is the case, among others, for some of the second or third phases of the major collecting routes for renewables, additional links between islands, such as between Majorca and Menorca or Gran Canaria and Fuerteventura, as well as two new interconnections with France through the central Pyrenees.

Figure 10. Planned investments on lines by type: installation of DLRs, uprating of existing lines or new lines (without interconnections)



6. Modification of specific items

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

- a) In accordance with the planning criteria established, an unexpected scenario has occurred which could significantly affect guarantee and security of supply.
- b) New supplies emerge which, for technical reasons, can only be powered by the transmission grid and this cannot be achieved with the existing transmission grid.
- c) There are considerations related to the system's economic efficiency.
- d) The construction of certain installations in the transmission grid that are critical for the energy transition and electrification of the economy, and this is not provided for in the existing planning document.

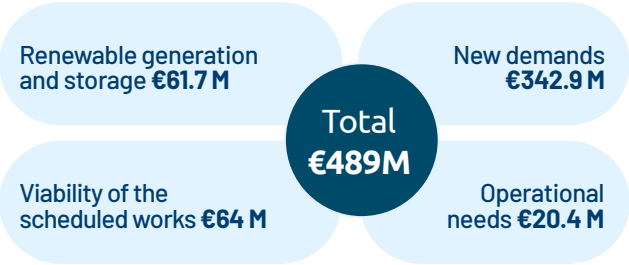
In accordance with the above, on **16 April 2024, a Modification of Specific Items** as part of the Development Plan for the Electricity Transmission Grid 2021-2026 was approved, which in the current Development Plan includes a set of actions to meet the needs of the electricity system that have emerged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

- They allow the system's emergency needs associated with security of supply to be addressed.
- They allow new supplies that have emerged following the approval of the current plan to be addressed. For technical reasons, the supplies can only be provided by the transmission grid.
- They substantially reduce costs due to technical restrictions that are currently in place, promoting the system's economic efficiency.
- They allow for the construction of certain installations in the transmission grid that are critical for the energy transition and electrification of the economy, and this was not provided for in the existing planning document.
- They make the future developments required to achieve the objectives set in relation to exchange capacity with neighbouring systems viable.
- They make certain installations in the transmission grid that are critical for the energy transition and electrification of the economy viable, which are provided for in the current planning document.

Due to the above, there is a set of modifications which have been grouped into the following categories:

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

The group of modifications of specific items represents a variation in the investment cost of 489 million euros associated with the existing plan, allocated to the group of works indicated in said plan.



On 8 July 2025, a second amendment to the 2021-2026 Transmission Grid Development Plan was approved.

This modification introduced measures to reinforce the stability of the electricity system, focusing on voltage control, reactive power compensation, and service restoration. The initiatives are structured around four main pillars:

- **Modernisation of reactive power compensation systems:** The plan includes complementing existing binary reactances with dynamic control technologies (e.g., synchronous compensators), enabling more precise voltage regulation.

Specifically, 10 new reactances (833 Mvar) will be installed for stepwise voltage reduction, along with the upgrade of 5 existing units.

Additionally, to handle dynamic voltage variations, 11 synchronous compensators with a total capacity of 2,135 Mvar will be installed 8 on the mainland system, 1 in Mallorca (previously planned for beyond 2026), and 2 in Islas Canarias.

- **Installation of stabilisation systems:** The plan advances the commissioning of the Pierola 400 kV series FACTS device—previously scheduled beyond 2026—to mitigate inter-area oscillations.
- **Deployment of controlled switching relays:** A total of 66 devices (60 on the mainland and 6 in Islas Canarias) will be installed to reduce service restoration times following incidents. These devices allow the circuit breakers on large power transformers to close at optimal moments during switching operations. This precise timing prevents sudden inrush currents from the transformer, which in turn avoids abrupt voltage drops during energisation.
- **Preparation of additional bays** for emergency generation in the Islas Canarias electricity system:

This involves a total investment of €750 million, which could be recovered in under three years.

