

2025

Development Plan
Overview



*The **Development Plan** describes the objectives and criteria underpinning **the process of planning the national electricity transmission grid** within the national and European context. The document sets out the priority actions and the expected results following analyses of the relevant energy scenarios and with implementation of the plan itself.*

*The Plan contains all the interventions that Terna plans **to ensure the efficiency and resilience of the grid, security of supply and service, and the integration of production from renewable sources**, which represents one of the enabling factors for the **energy transition**.*



“ Terna is investing in Italy's development

We guarantee energy security and balance electricity supply and demand 24 hours a day, ensuring that the system is reliable, efficient and accessible to all.

We invest and innovate every day in the development of an electricity grid capable of integrating the energy produced from renewable sources, improving links between the different areas of the country and strengthening cross-border interconnections, applying a sustainable approach that takes into account the needs of the communities and people we work with. ”

MISSION

“ We are behind the energy you use every day

We are responsible for guaranteeing the continuity of power supply, essential in making sure that electricity reaches Italian homes and businesses at all times.

We provide everyone with equal access to electricity and are working to provide clean energy for future generations. ”

PURPOSE

“ We care about the future of energy

We are committed to building a future powered by clean energy, enabling new forms of consumption and production increasingly based on renewable sources. This will allow us to achieve the goal of delivering an energy transition that is fair and inclusive, whilst also lowering costs.

Thanks to our overall vision of the electricity system and new digital technologies, we are leading the country's drive to get to net zero by 2050, in line with European climate goals. ”

VISION



A sustainable and digital grid to meet the challenges of the transition

The **2025 National Development Plan** (2025 NDP) further consolidates Terna's role in delivering a sustainable, decarbonised future for Italy. The projects planned by the Transmission System Operator over the **ten-year time horizon from 2025 to 2034** is intended to ensure grid efficiency and resilience, service sustainability, security and quality, as well as the integration of production from renewable sources.

In terms of electricity transmission, the **grid is one of the enablers for achieving global decarbonisation goals**.

The 2025 Development Plan is of **fundamental importance in pursuing the goals of energy transition, energy independence and grid efficiency, through investment in strategic infrastructure** that will have a major impact on net transmission capacity in the national grid.



The 2025-2034 Development Plan is consistent with the National Energy and Climate Plan (NECP) and the updated Terna-Snam 2024 Scenario Description Document (24SDD), starting from the following basic premises:

- **Renewable Energy Sources (RES):** based on the European and national targets contained in the 2024 Scenarios Description Document (24SDD), renewable capacity is expected to increase by more than 65 GW by 2030 (compared with 2023). An additional 20 GW is expected to be added by 2034 based on the targets set for 2040. Based on zonal distribution, also broken down on the elements of the Ministerial Decree of 21 June 2024 (the “Eligible Areas Decree”), a share of around 43 GW is estimated to be connected directly into the high-voltage grid with infrastructure works included in this plan.
- **Storage:** the 24SSD highlights a considerable need for increased storage capacity over the next decade, as an indispensable tool for the effective market integration of renewables, with 71.5 GWh¹ expected to be directly connected to the NTG. This development will also be highly dependent on an innovative forward contracting system: the MACSE (the Electricity Storage Capacity Procurement Mechanism), due to be launched by Terna in 2025.
- **Data Centres and other non-RES connections:** connection requests for consumers have also increased over the last two years. Among others, Data Centres are particularly significant, with connection requests amounting to 30 GW in December 2024. Their operation requires high amounts of energy and, therefore, new grid infrastructure or upgrades of existing components will be needed to connect them to the NTG. Indeed, this aspect will be one of the drivers of increased electricity demand in the coming years.
- **Strategic capacity for efficient interzonal exchange:** development projects will make it possible to achieve the target capacities for 2030 and 2040, enabling the efficient exchange of capacity between market zones while continuing to ensure grid security. This will result in increases of 6.8 GW by 2030 and over 35 GW by 2040.

¹ Excluding existing pumped hydro storage



In view of the assumptions deriving from development scenarios and requirements, the 2025 NDP sets out a **series of actions designed to adequately meet grid requirements and efficiently integrate renewable and non-renewable** (RES and non-RES) energy based on the requests received.

In light of these needs, the steps to be taken in the ten-year period from 2025 to 2034 were identified and are confirmed in the 2025 NDP. The resulting integrated action plan will meet the following aims:

- the integration of RES and non-RES connections;
- interzonal interventions;
- cross-border interconnections;
- intrazonal interventions;
- grid restructuring and security enhancement measures.

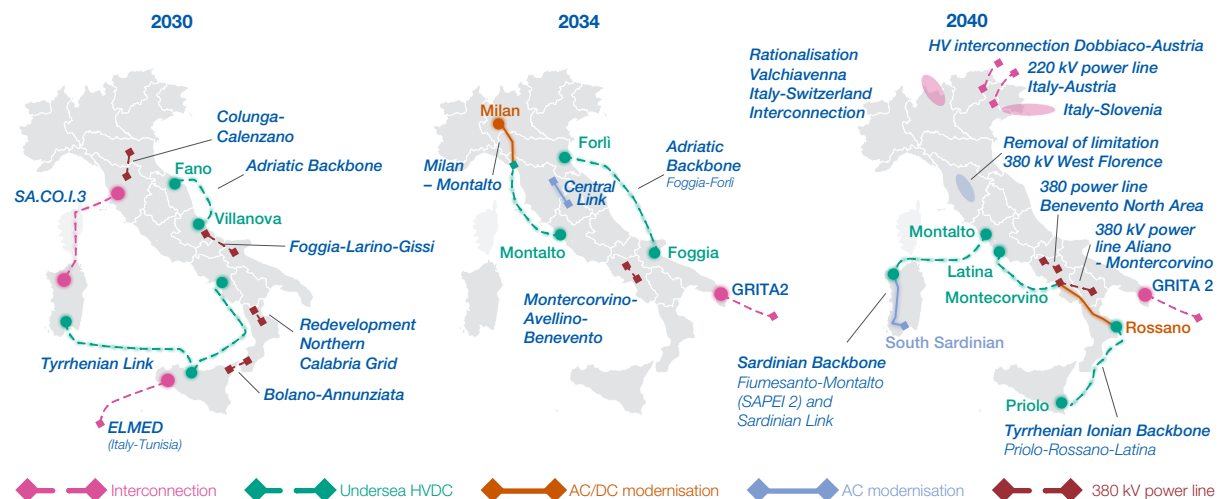
With regard to the main interzonal and intrazonal interventions, under the plan, **target capacities will be achieved in 3 steps** by 2030, 2034 and 2040.

By **2030**, strategic works already authorized to or close to receiving authorization have been planned, including the following main projects: the Tyrrhenian Link (between Campania, Sicily and Sardinia), the Adriatic Link (between Abruzzo and Marche), SA.CO.I. 3 (between Sardinia, Corsica and Tuscany), the ELMED interconnection (between Italy and Tunisia), Northern Calabria Grid redevelopment, the 380 kV Foggia - Gissi - Villanova power line, and the 380 kV Bolano-Paradiso power line.

By **2034**, further infrastructure improvements have been planned to guarantee achievement of the objectives defined in the reference scenario, including the Milan - Montalto HVDC backbone, the Foggia - Forlì HVDC backbone, the Central Link (between Umbria and Tuscany), the 380 kV Montecorvino - Benevento power line and the GRITA2 interconnection (first stage).

Finally, by **2040**, the grid architecture will be completed with the construction of the Priolo - Rossano - Montecorvino - Latina HVDC power line, the Sardinian backbone, the 380 kV Aliano-Montecorvino power line and the interconnections with Greek (GRITA2: complete project), Austria, Slovenia and Switzerland.

Figure 1 Evolution of grid architecture



With regard to the works to be completed by 2034 that have not yet received authorization, advanced studies for the **Hypergrid project** are continuing, in preparation for the design of the Milan-Montalto backbone, as well as confirmation of the Central Link corridor and the Adriatic Backbone (Foggia-Forlì), **works that will play a strategic role in achieving the targets set over the ten-year time horizon.**

The 2025 NDP calls for an investment programme of **over €23 billion** over the 2025-2034 ten-year horizon, with a total value beyond the **ten-year time horizon of up to approximately €40 billion.**

It is worth highlighting **two new elements of the Plan** which, although less significant from a financial perspective, are of major strategic value due to their impact on development of the grid:

- the **maximisation of existing assets** with new interventions and capital light technological and digital solutions, which will help to bring forward the expected benefits from commissioning of the individual development works, even during intermediate phases;
- **Efficient Territorial Planning (ETP)** which will allow for the integrated and efficient planning of RES Connections, Storage and Data Centres with grid development, with the aim of facilitating the connection process and the sharing of transparent information with the permitting bodies thanks to the new digital TE.R.R.A. Portal.

One of the **main expected benefits** that can be achieved through the Plan is the **doubling of transport capacity between market zones**: this will rise to over 35 GW from approximately 16 GW currently.

The cost-benefit analysis for the interventions, making the greatest contribution to the energy transition, resulted in solid system utility index, demonstrating that the investment is fully sustainable, albeit against the backdrop of rising costs. These projects are characterised by a significant increase in interzonal capacity (over 16 GW and twice current capacity) and other benefits for the National Transmission Grid.

By 2030, a total reduction in **CO₂ emissions** of up to nearly 2,000 kt/year is expected, with the long-term trend reduction (to 2040) amounting to almost 12,100 kt/year.

Contents

1	Context and energy scenarios	8
	1.1 Main aspects of planning the development of the electricity grid	10
	1.2 Energy transition targets at EU level and Italian energy scenario	12
	1.2.1 <i>Energy scenarios</i>	13
	1.3 Commodity price trends and impact on the price of electricity	16
	1.4 Security of energy supply and European and Italian dependence on primary energy sources	18
	1.5 Increased risk of extreme weather events	20
	1.6 Greater adequacy vulnerability of the European and Italian electricity system	22
2	Market trends and regulatory environment relating to the energy transition	24
	2.1 Infrastructure regulation	26
	2.2 Forward markets for RES	27
	2.3 Capacity market	28
	2.4 Electricity Storage Capacity Procurement Mechanism (MACSE)	30
	2.5 Flexibility needs: insight into evolving flexibility requirements	31

3	Objectives to be pursued, NTG development strategy and investment in the new Development Plan	34
	3.1 Integrating RES connections, storage, primary distribution stations and consumers	37
	3.2 Increasing transmission capacity between market zones and resolving congestion in the electricity system	38
	3.3 Developing cross-border interconnections	43
	3.4 Improving the levels of security, quality and resilience of the electricity system, and continuity of service	47
	3.5 Guaranteeing a robust grid and dampening low-frequency inter-area oscillations	47
4	Efficient Territorial Planning	48
	4.1 Reference scenario	50
	4.2 The solutions offered by Terna	51
5	Investment and expected benefits of the new Development Plan	54
	5.1 The main expected benefits	56
6	Structure of the 2025 Development Plan	58



1 Context and energy scenarios



1.1 Main aspects of planning the development of the electricity grid	10
1.2 Energy transition targets at EU level and Italian energy scenario	12
1.2.1 Energy scenarios	13
1.3 Commodity price trends and impact on the price of electricity	16
1.4 Security of energy supply and European and Italian dependence on primary energy sources	18
1.5 Increased risk of extreme weather events	20
1.6 Greater adequacy vulnerability of the European and Italian electricity system	22

Context and energy scenarios



Terna plays a central role in the energy transition process, both as the **enabler of a grid increasingly based on renewable sources** and as a strategic leader of this large-scale process. The electricity grid is the main enabler for reaching the global decarbonisation goal. In addition to this, there are also a number of fundamental issues, specifically linked to the complexity of the current context, which will be addressed in the following paragraphs.

1.1 Main aspects of planning the development of the electricity grid

EU energy transition targets and the Italian energy scenario

The European targets in the **Fit-for-55** package call for a **55% reduction in CO₂ emissions by 2030** compared with 1990 levels.

To meet the “Fit-for-55” objectives, the NECP and, therefore, also the **2024 Scenarios Description Document**, on which the 2025 NDP is based, show that approximately 107 GW in photovoltaic and wind capacity is needed by 2030, compared with the 43 GW installed in 2023. This will ensure that the share of RES energy in final consumption in the electricity sector is at least 63%.

These challenging objectives are only fully attainable via **coordinated and synergic development** of:

- Infrastructure
- Storage
- Renewable generation plants

Commodity costs and electricity prices

Over the last two years (2023-2024), **gas prices** have stabilised at lower values than the peaks recorded during 2022. However, both prices and their volatility remain at higher levels than pre-crisis values, indicating that the market is in a fragile equilibrium.

As a result, **electricity prices** remain at **higher levels than pre-crisis values**, as they are considerably impacted by gas price trends.

Following the 2022 energy crisis, gas prices have stabilised on average at below **€50/MWh** over the last two years. However, both prices and their volatility remain at higher levels than pre-crisis values (€10-15/MWh).

As a result, the PUN (National Single Price) value is also higher than in the pre-crisis period, averaging just over **€100/MWh** in the last two years compared with **€52/MWh** recorded in 2019.

The energy price for standard domestic consumers in the enhanced protection market for 2023 and 2024 is **€279/MWh** on average, more than double the figure for 2019.

Security of energy supply

The EU covers a large share of its **energy demand** with **imports from non-EU countries**. Italy, like Europe, is a net importer of energy for electricity as well.

In 2023, the EU covered 58% of its energy demand with imports from non-EU countries.

In the same year, Italy met 75% of its national energy demand with imports, while the remaining 25% was covered by domestic production, for the most part from renewables.

Around 37% of Italy's electricity demand in 2023 was covered by domestic resources (exclusively renewables), while the remainder was imported directly or indirectly (e.g. through power plants that convert imported gas into electricity).

In forecasts to 2030, RES will contribute 227 TWh² (63% of electricity demand) to energy independence.

Increase in risk of extreme weather events

The close link between **climate change and weather events**, which are increasingly severe in both intensity and frequency, is now undisputed. Furthermore, National Transmission Grid (NTG) infrastructure has been and will increasingly be exposed to the risk of damage and disruption if no targeted actions are put into place to prevent and mitigate the effects of climate change.

Increasing NTG resilience becomes one of the enabling factors to respond to the climate crisis, by adopting an innovative approach to support planning. This approach must be:

- forward-looking, to identify the evolution of weather events over the coming decades;
- focused on engineering, to estimate grid asset vulnerability;
- probabilistic, to assess faults and contingencies, as well as their impact on the electricity system.

Vulnerability of the European electricity system to adequacy risks

Over the last few years **the adequacy of the electricity system**, regarding its ability to meet demand for energy required at all times and in every area of the country, has been gradually deteriorating owing to the progressive reduction in thermoelectric plants, the increase in extreme weather events, such as high summer temperatures, and the greater variability of imports available at the northern border (particularly from France).

Between 2013 and 2021, a reduction of as much as 15 GW in the thermoelectric fleet was recorded. In the near future, decommissioning thermoelectric facilities could continue further, with direct consequences on system adequacy, which will also be negatively affected by market conditions for some of the remaining gas plants.

The climate change in progress, with an exacerbation of exceptionally high temperatures and rainfall, has negative and multiplicative effects on system adequacy because they impact at the same time both European electricity demand (following the gradual electrification of final uses, including air conditioning) and generation capacity (hydroelectric, solar, wind for obvious reasons but also conventional thermal owing to the effects of high temperatures on derating and on the limits for cooling the plants).

It is not certain that in future energy scenarios imports will always be available under critical conditions to guarantee adequacy: the gradual decommissioning of uneconomic **conventional capacity** is a phenomenon that affects all European countries, generating a need for market instruments to avoid a situation of an overall lack of programmable capacity, particular when this occurs in conjunction with contingent phenomena such as the gas crisis and the unavailability of French nuclear power.

² 2030 NECP Policy Scenario from the 2024 Scenarios Description Document.

1.2 Energy transition targets at EU level and Italian energy scenario

The **energy scenarios** make it possible to **map out the possible trajectories of development of the current energy system**, thus providing an essential basis for identifying and planning the investments and infrastructure developments necessary to enable the energy transition. Every two years, Terna together with Snam, the operator of the gas transport network³, prepares the **Scenarios Description Document (SDD)** in preparation for the network development plans for both sectors. The 2024 edition of the SDD considers a series of legislative and regulatory requirements.

In particular, the scenarios for Terna and Snam incorporate the Government's most recent indications, including the final text of the National Energy and Climate Plan (**NECP**), submitted to the European Commission by the Ministry of the Environment and Energy Security and the Ministry of Infrastructure on 1 October 2024. The NECP lays out the objectives in the European "Fit-for-55" legislative package at national level.

More specifically, the "Fit-for-55" legislative package⁴ sets a number of specific targets at European level, including a 55% reduction in CO₂ emissions by 2030 compared with 1990 levels. Also at European level, the Renewable Energy Directive stipulates that the share of energy from renewable sources in the European Union's gross final energy consumption must be at least 42.5% by 2030, while the Energy Efficiency Directive requires a reduction in energy consumption of 11.7% by 2030⁵.

In addition, the European Commission has allocated effort sharing quotas to EU Member States. For Italy, the emissions reduction target in the residential and transport sector (non-ETS) is 43.7% by 2030 compared with 2005. For ETS sectors (mainly industry and thermoelectricity), the target remains exclusively European, leaving the ETS market to decide in which country and to what extent to reduce emissions associated with these activities.

To meet the "Fit-for-55" objectives, the NECP and, therefore, also the 2024 Scenarios Description Document, on which the 2025 NDP is based, approximately 107 GW in photovoltaic and wind capacity will be needed by 2030, compared with the 43 GW installed in 2023.

³ Pursuant to resolutions 654/2017/R/eel and 689/2017/R/gas.

⁴ To date, the "Fit-for-55" package has been fully adopted by the European Council and the European Parliament, with the exception of the Energy Taxation Directive.

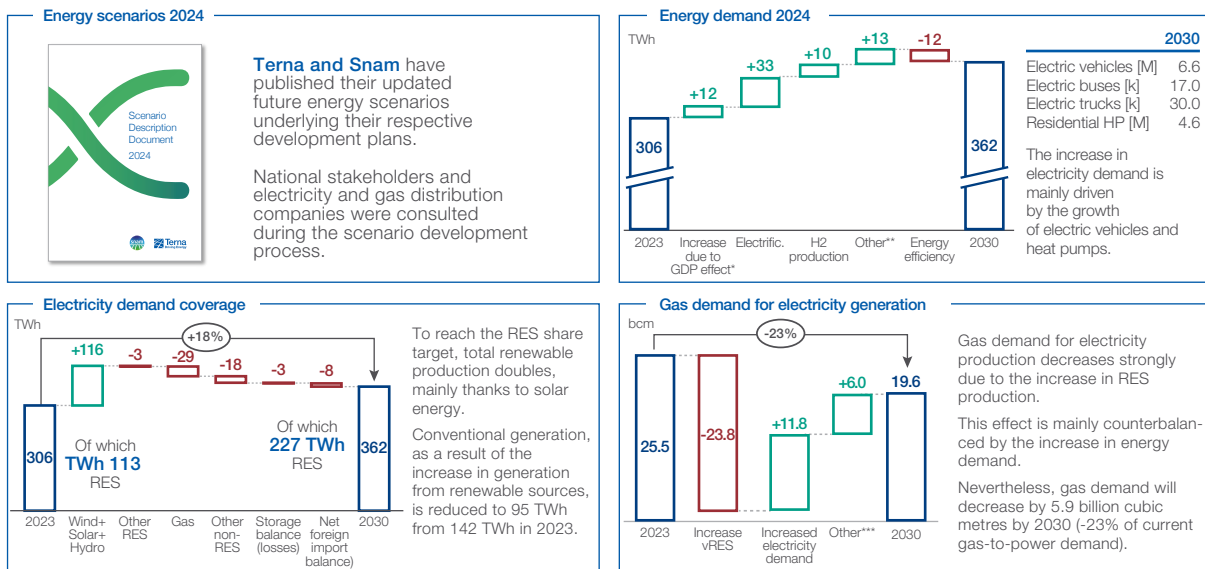
⁵ On the basis of article 1 of EU Directive 2023/1791, Member States shall collectively ensure a reduction in energy consumption of at least 11.7% by 2030 compared with the projections in the 2020 EU reference scenario, thus ensuring that the EU's final energy consumption does not exceed 763 Mtoe.

1.2.1 Energy scenarios

The relevant 2030 energy scenario in the 24SSD (2030 NECP Policy scenario) provides for an increase of 56 TWh in **total electricity demand** from roughly 306 TWh in 2023 to 362 TWh in 2030 (of which 10 TWh destined for the production of green hydrogen and 33 TWh attributable to the expected growth in electricity consumption, among which the contribution from electric mobility and data centres stands out).

The scenario also predicts that electricity production from renewable sources will double from 113 TWh in 2023 to 227 TWh in 2030 (Figure 2). This **increase in renewable energy production** will replace an equivalent amount of gas-powered thermoelectric production. All other conditions being equal, the reduction in gas generation would therefore entail savings on gas consumption of approximately 23.8 billion cubic metres. The gas reduction effect is mitigated by growth in demand and the phase-out of coal- and oil-powered plants. Considering all of the effects, demand for gas for thermoelectricity is likely to decrease by 23% compared with the 2023 figure.

Figure 2 Energy scenarios



(*) GDP-load correlation of 71%.

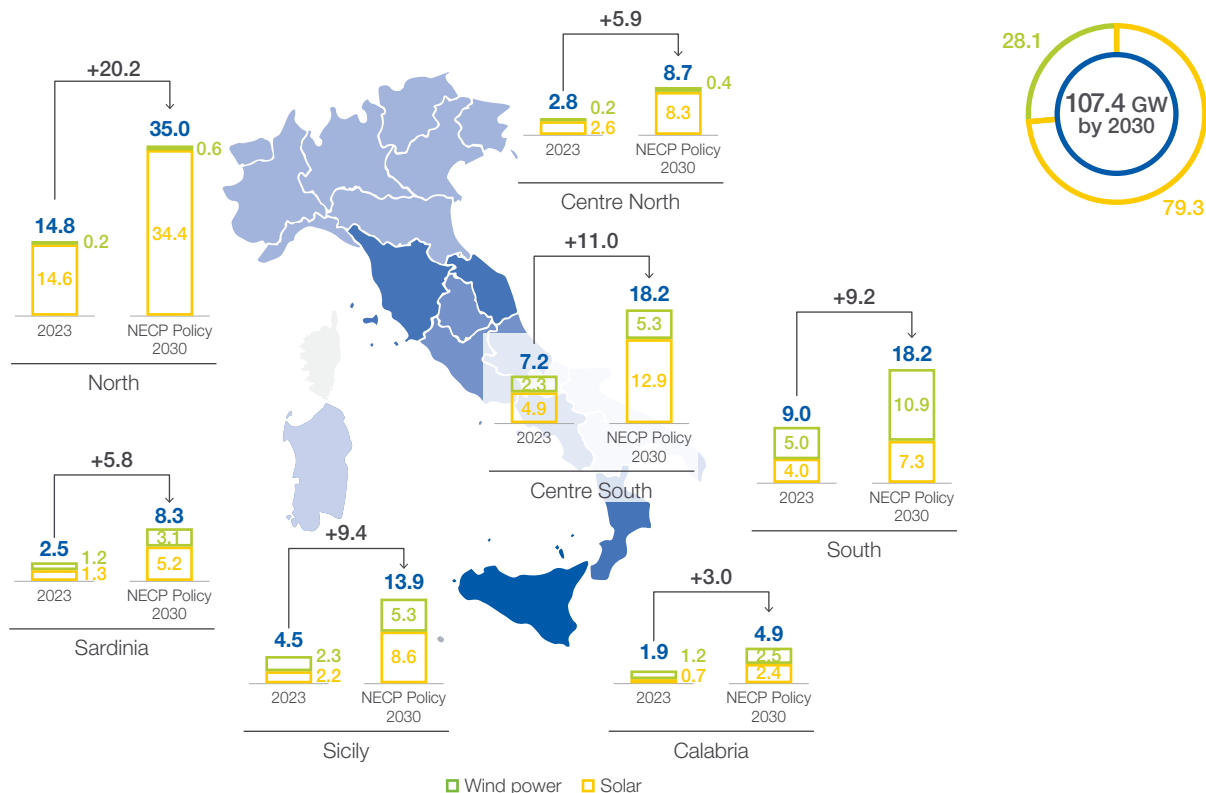
(**) Other include data centres, green steel production (DRI), increased losses and other energy uses.

(***) Other considers the phasing out of coal and oil, a reduction in imports and an increase in losses and storage.

Figure 3 shows the expected evolution of wind and solar capacity at zonal level needed to reach the decarbonisation targets in the 2030 NECP Policy scenario. In more detail, the reference scenario to 2030 considers 28.1 GW and 79.3 GW of wind and solar capacity up by 15.8 GW and 49 GW, respectively, compared with installed capacity at the end of 2023. The zonal distribution of RES in this scenario is consistent with what is set forth in the Ministerial Decree of 21 June 2024 (the “Eligible Areas Decree”), which establishes the criteria to be used by regional authorities in identifying the areas suitable for the installation of renewable plants, taking into account resource availability, the location of electricity demand and the characteristics of grid infrastructure, as well as its development potential.

The new energy scenario assumes the construction of a set of necessary and urgent works to increase grid transmission capacity. These works will be functional to the integration of renewable sources and to the current energy transition process, guaranteeing an acceptable level of overgeneration and the transmission of energy from the south of Italy to the northern regions where consumption is higher.

Figure 3 Geographical distribution of RES (Figures in GW)



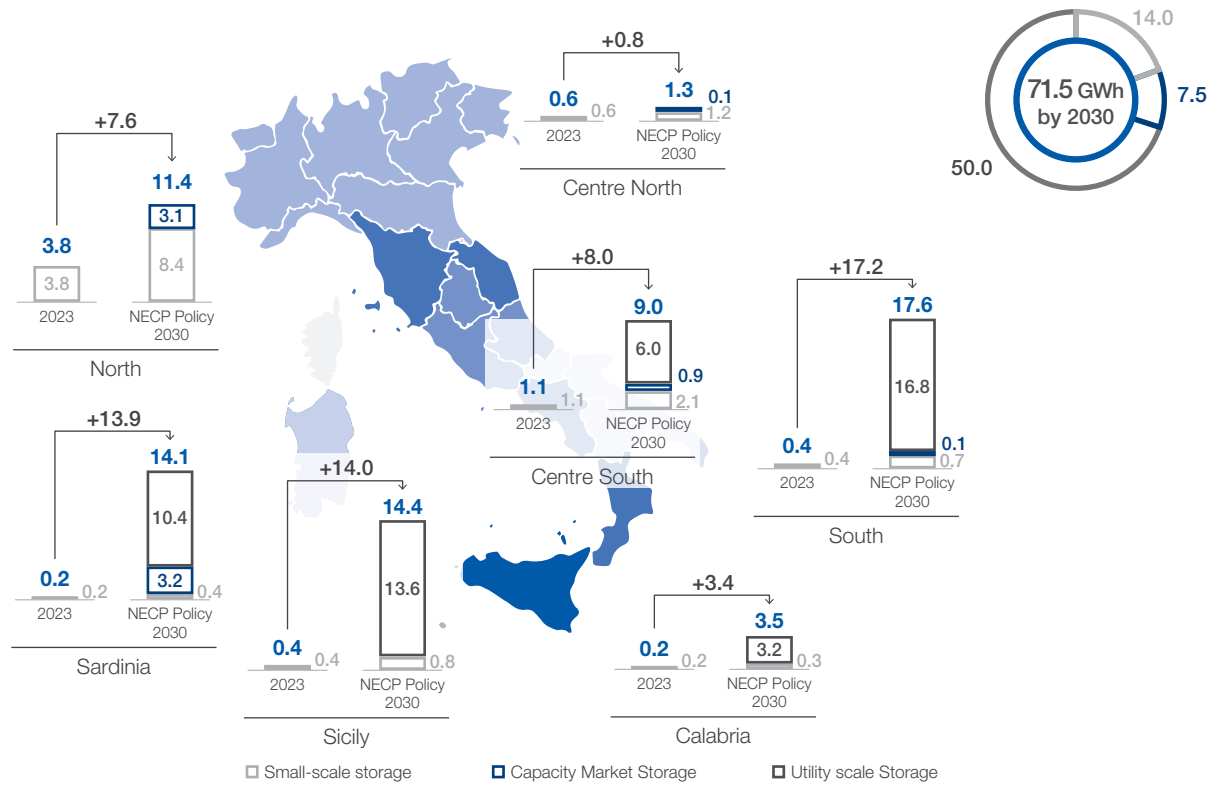
It will also be possible to integrate new RES by developing large volumes of storage capacity. In the 2030 NECP Policy scenario, around 122 GWh of storage capacity is expected, broken down as follows:

- 50 GWh of existing pumped storage;
- roughly 14 GWh from small-scale storage;
- around 8 GWh of storage already awarded under multi-year contracts in Capacity Market auctions;
- 50 GWh in utility scale plants that can be supplied through the MACSE⁶ and/or as a result of private initiatives.

⁶ The MACSE is the forward procurement mechanism for new electricity storage capacity, approved by the European Commission in December 2023 (State Aid SA.104106 (2023/N)).

It is important to emphasise that the development of new storage capacity (including that which will be contracted pursuant to the MACSE) is an element that further compensates for the development of the grid necessary for the integration of RES and will be closely dependent on the capacity and location of the RES created. The DDS scenarios expect new storage systems to be located mainly in southern Italy and on the islands (Figure 4), where new RES is expected to have a higher concentration. Nevertheless, with a view to operational planning, it will be appropriate to periodically update the localisation of the need for storage, with the objective of efficiently following the effective change in system resources that will occur in the coming years.

Figure 4 Storage location (net of existing pumped hydro storage) [GWh]



1.3 Commodity price trends and impact on the price of electricity

In 2022, there was a sharp increase in gas prices (*Figure 5*), with an average⁷ of €123/MWh and peaks of over €300/MWh in August 2022. Over the last two years, prices then stabilised at around €40-50/MWh. However, both prices and their volatility remain at higher levels than pre-crisis values (€10-15/MWh), indicating that the market is in a fragile equilibrium. The gas market remains highly influenced by geopolitical tensions, fears of possible supply risks and short-term climatic trends (winter temperatures, “Dunkelflaute” events).

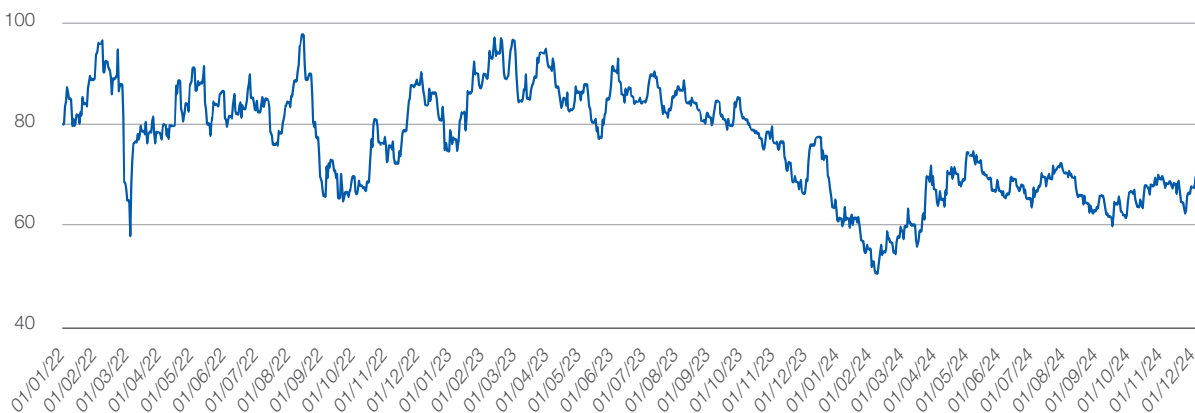
Today’s European gas market is characterised by an increasing volume imported via Liquefied Natural Gas (LNG) compared with those imported via gas pipeline. In this context, the low liquidity of the global LNG market entails a high risk of volatility in European gas prices. Indeed, minor changes in the market balance are capable of having large impacts on prices, because the LNG supply is relatively rigid and gas demand inflexible (especially for thermoelectric and heating).

The price of CO₂ (*Figure 6*), after peaking at almost €100 per tonne in August 2022, also stabilised at around €60-70 per tonne during 2024, which is still higher than in the pre-crisis period (€20-30 per ton).

Figure 5 Historical price trend of TTF gas (€/MWh)



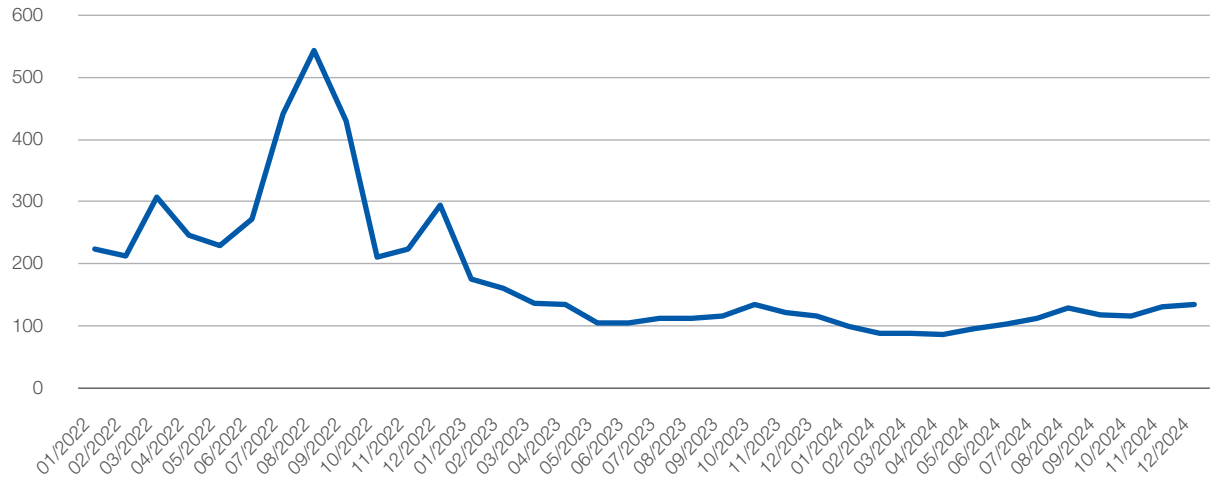
Figure 6 Historical price trend of CO₂ (€/t)



⁷ TTF - Title Transfer Facility Gas Prices.

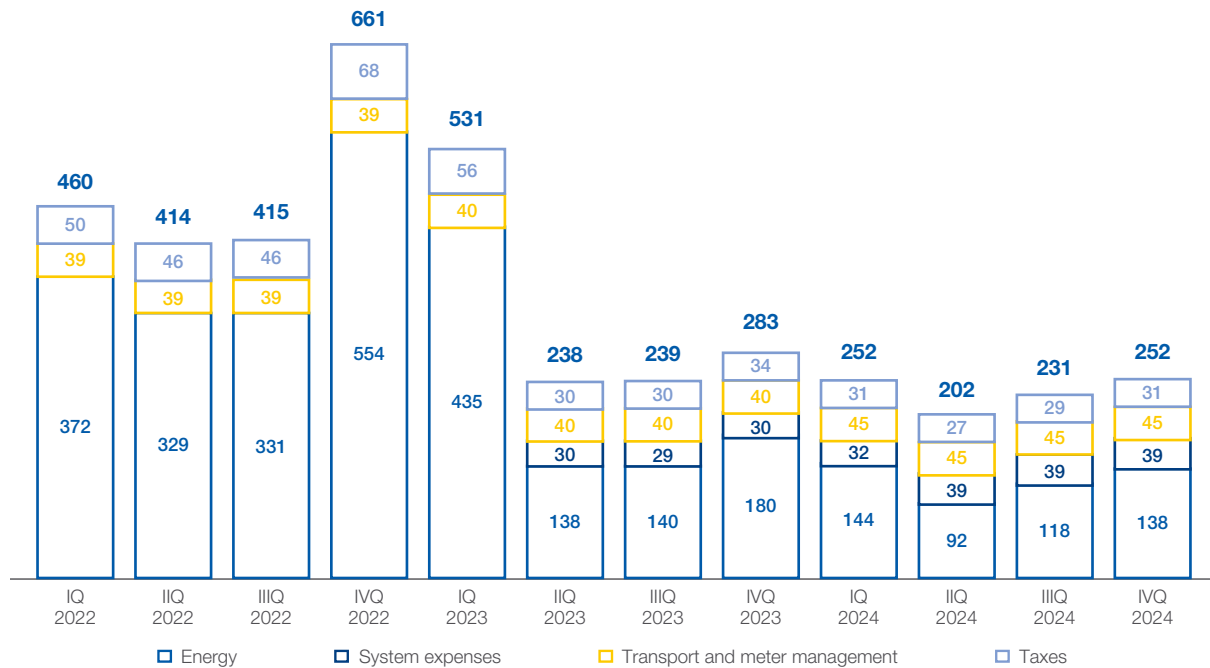
As a result of high CO₂ and, above all, gas prices, the PUN (Figure 7) is also higher than in the pre-crisis period. In 2023 and 2024, the average PUN was €127/MWh and €109/MWh, respectively, down from €304/MWh in 2022, but still well above the €52/MWh recorded in 2019.

Figure 7 Monthly trend of the PUN (€/MWh)



A high PUN has a negative impact on the costs incurred by end customers for electricity consumption. The energy price for the standard domestic consumer⁸ in the enhanced protection market (Figure 8) in 2023 and 2024 was €279/MWh on average, a level that is in any event lower than the peaks recorded during 2022 but more than double the level in 2019.

Figure 8 Price of electricity for standard consumer in the enhanced protection market (€/MWh)



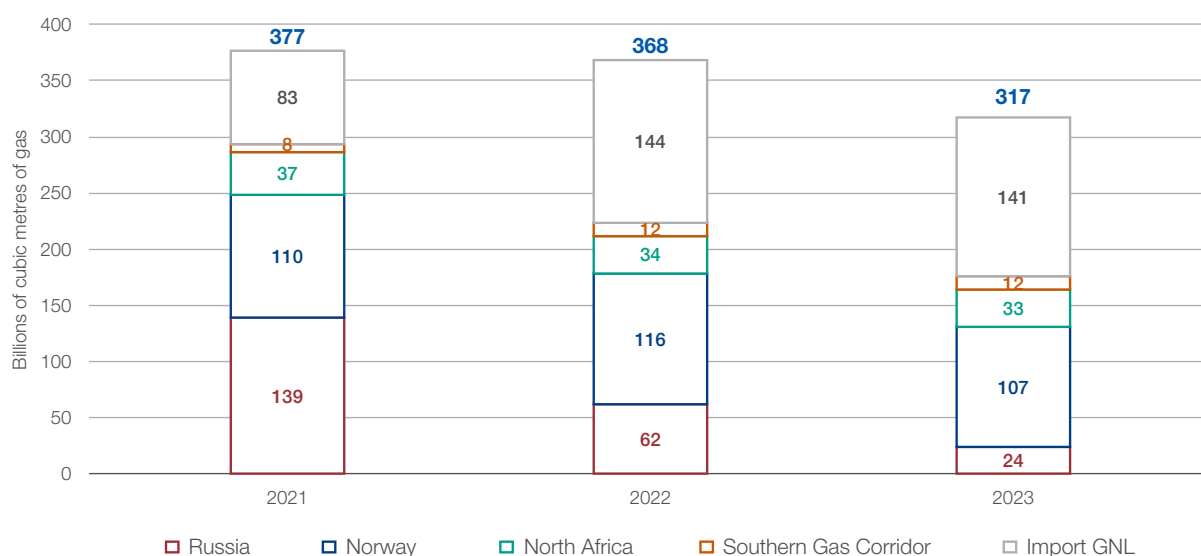
⁸ Users with 3 kW of committed power and 2,700 kWh of annual consumption.

One of the consequences of higher electricity prices is higher inflation, which in Italy stood at 8.7% in 2022. However, from 2023 onwards, in Italy as well as in the Eurozone as a whole, there will be a decrease in inflation due to the higher interest rates set by the EU central bank. In fact, in Italy inflation stood at 6% in 2023 and at 1.1% in 2024⁹.

1.4 Security of energy supply and European and Italian dependence on primary energy sources

The European Union is a net energy importer: in 2023, it covered roughly 58% of its energy demand with imports from non-EU countries¹⁰. Historically, Russia has been the main energy supplier. However, after the outbreak of the war in Ukraine in February 2022, Russian energy supplies began to dwindle and gradually be replaced by supplies from other countries. In March 2022, the European Commission launched the REPowerEU Plan, also with the aim of ending the EU's dependence on Russian fuel. This trend is particularly evident in the natural gas sector, where Russian gas imports via pipeline decreased by 83% in just two years, from 2021 to 2023. Indeed, *Figure 9* shows how the share of Russian gas via pipeline out of total European gas imports decreased from 37% in 2021 to 8% in 2023, mainly due to the progressive replacement of Russian gas with LNG.

Figure 9 Natural gas imports (pipelines and LNG) in Europe¹¹, source Bloomberg



Italy, like Europe, is a net energy importer: in 2023, 75%¹² of national energy demand (144 Mtoe) was met with imports, while the remaining 25% was covered by domestic production¹³, mostly renewable (*Figure 10*). Like for Europe, Russian gas has been drastically reduced for Italy as well, from 40% in 2021 to just 4% in 2023, when most of Italy's gas demand was met by Algerian gas (38%) and LNG (27%)¹⁴.

⁹ Inflation figures refer to the HICP (Harmonised Index of Consumer Prices). Source: EUROSTAT, January 2025.

¹⁰ Terna calculations based on Eurostat data.

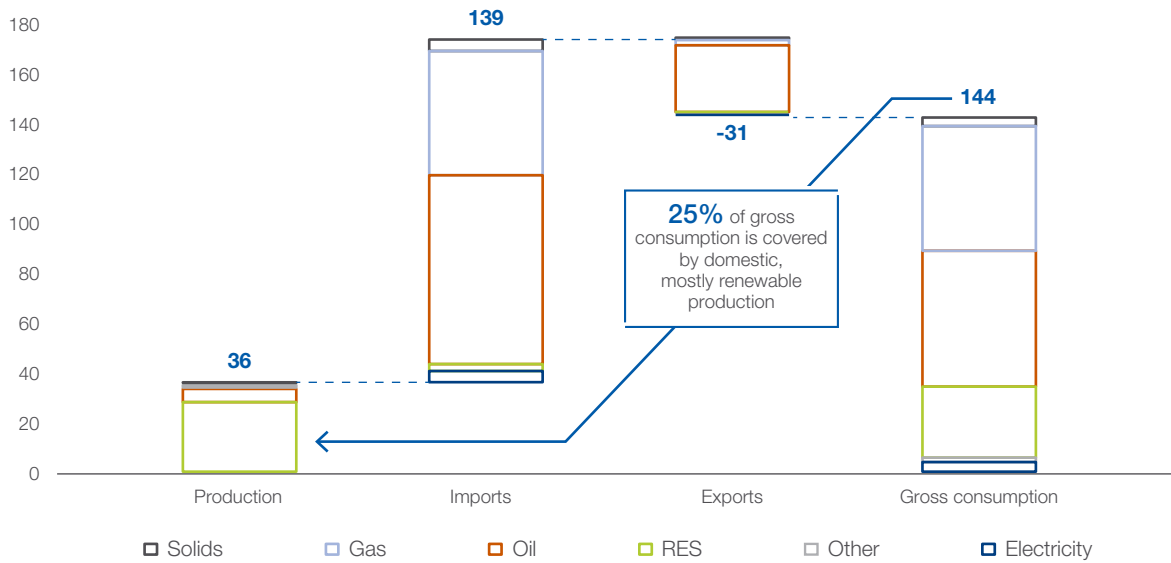
¹¹ Europe does not include Turkey, Ukraine, Moldova and Norway

¹² Source: Eurostat. Energy dependence is calculated as the ratio of net energy imports (i.e. the difference between imports and exports) to gross consumption (often referred to as "gross available energy").

¹³ Source: Eurostat. Production also includes recovered and recycled products and changes in stocks.

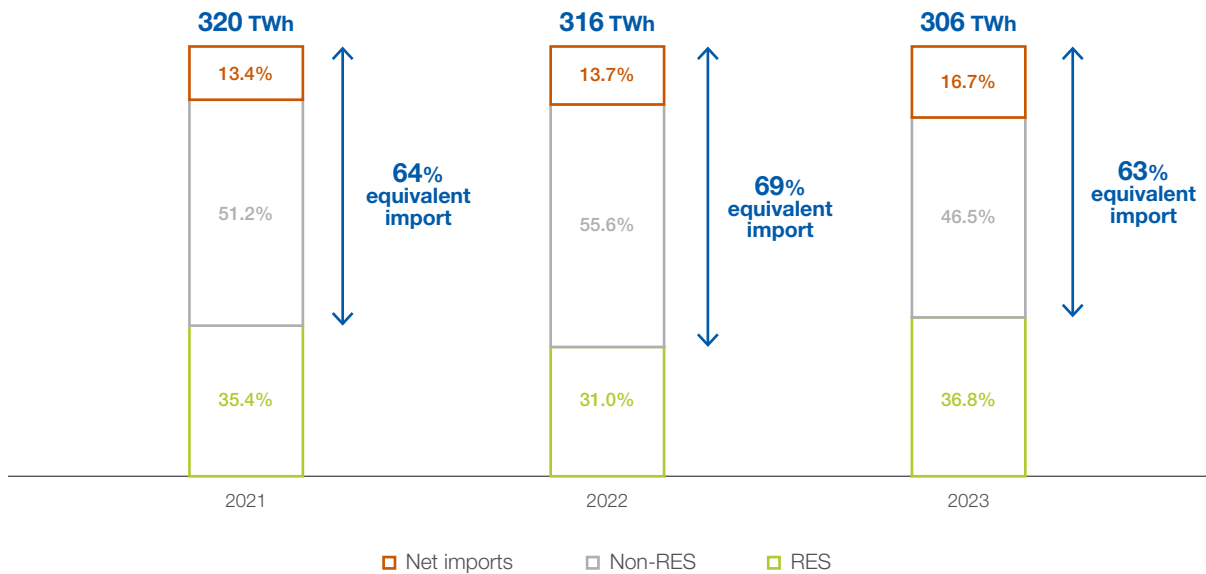
¹⁴ Ministry of the Environment and Energy Security and SNAM data.

Figure 10 Gross energy available in Italy by source, 2023 data (Mtoe¹⁵)



The balance sheet of primary energy used for electricity supplies also confirms this dependence if we consider that in 2023, approximately 37% of electricity demand¹⁶ of 306 TWh was covered by resources internal to the country, exclusively renewable energy sources (RES), while the remaining 63% was imported in direct form via power lines (16.7%) or indirectly from other sources (46.5%). Indeed, production from thermoelectric plants represents an indirect form of import, considering that the plants transform an imported energy source (mainly gas) into electricity (Figure 11).

Figure 11 Electricity procurement by source in Italy (%)



¹⁵ Source: Eurostat. Primary Production also includes changes in storage.

¹⁶ Source: Terna statistics.

1.5 Increased risk of extreme weather events

In a time of major global challenges, such as climate change, it is crucial to adopt effective, sustainable and innovative strategies for the future.

It is now clear that global warming is closely linked to the occurrence of severe weather events, which arrive one after another in a contrasting, variable and sudden manner with increasingly significant physical, economic and social impacts.

National Transmission Grid (NTG) infrastructure is also subject to the effects of climate change: indeed, the severe events recorded in recent years have led to the potential for negative impacts on electricity service continuity (Figure 12).

Figure 12 *Main impacts of extreme weather events on the NTG over the last 15 years*



Analyses of historical events show that the main causes of NTG disruptions are related to both snow accretion, which weighs down lines, causing them to fail, and strong wind, with its direct and indirect effects of plants falling on the lines.

Floods, mudslides and landslides also have major consequences for lines and stations, as does the accumulation of polluting materials, which cause electrical discharges on insulators.

In addition to these events, there are also fires triggered by high temperatures that can directly affect assets, causing failures or requiring them to be taken out of service to facilitate firefighting efforts.

Therefore, having a robust electricity grid resilient to the possible damage caused by the growing intensity and severity of extreme weather events becomes one of the enabling factors in responding to the climate crisis.

As part of its climate assessment, Terna has adopted a tool, the **Resilience Methodology**, whose ability to predict the evolution and impact of the climate over the next few decades, as well as the probabilistic nature needed to assess multiple failures and contingencies and the resulting risk of energy not being supplied to the grid following the occurrence of severe weather events, make it possible to implement effective and efficient planning to increase grid resilience.

This tool, which is applied in Terna's Resilience Plan, makes it possible to identify and expand infrastructure interventions which, thanks to technological diversification, boost grid mesh and reliability, alongside capital light actions to mitigate and/or reduce disruption caused by severe weather events.

The issue of resilience is also becoming increasingly digital with the identification of innovative and technological solutions for monitoring electricity assets and reducing the time needed to restore service after disruptions and/or disconnections caused by severe weather events. This aspect is supported by the new measure defined at European level with REPowerEU, through which €140 million in grants has been approved for the use of IoT techniques for the widespread collection of information on Terna's assets and which, together with complex calculation algorithms, ensure the optimal and resilient operation of the electricity system.



1.6 Greater adequacy vulnerability of the European and Italian electricity system

The **adequacy margin** is a deterministic parameter that identifies, for each geographical area and analysis period, the difference between:

- the sum of available generation capacity and the import of electricity from neighboring areas, including the contributions of storage and demand-side-response;
- the electricity demand increased by the necessary tertiary replacement reserve (understood as production capacity made available to the operator for balancing purposes).

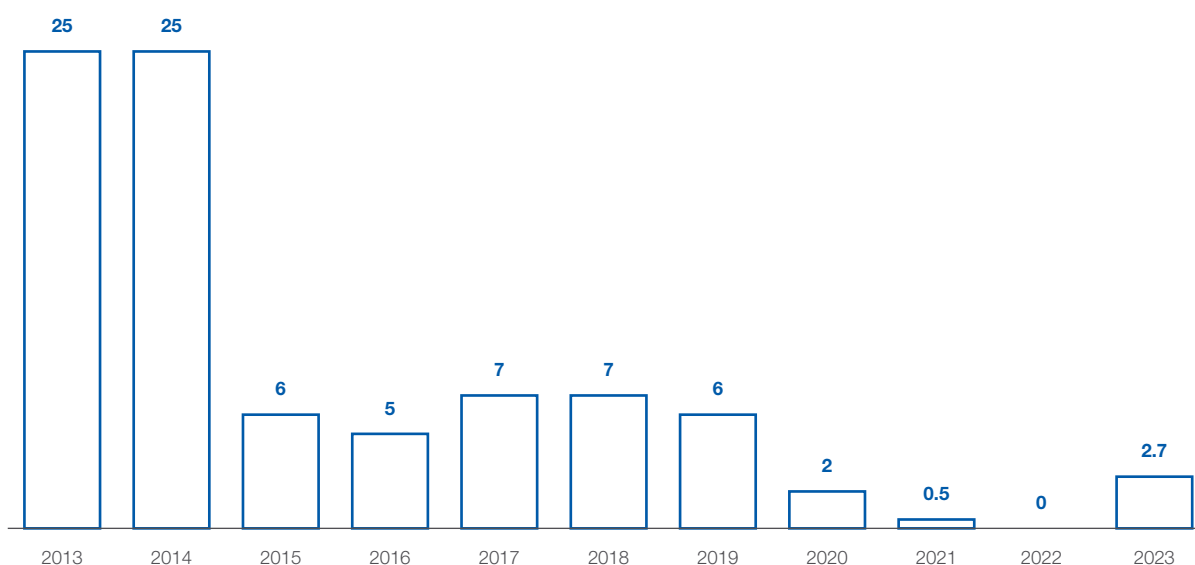
The gradual reduction in available production capacity and the contribution of imports from neighbouring European countries in recent years have had the initial consequence of reducing the system's adequacy margin. The first significant reduction in the adequacy margin occurred between 2014 and 2015 (-76%), remaining between 5 and 7 GW for the next four years (*Figure 13*).

In the following years, the margin reduced further until it was cancelled out in 2022, when the electricity grid was subject to several phenomena at the same time: a prolonged drought that caused a severe restriction on hydroelectric production and the shutdown of several thermoelectric plants that could no longer cool down during periods of high demand as a result of high temperatures, and a lack of available imports from neighbouring countries.

The system's water flow situation improved as the months passed, leading to positive margins in 2023, thanks also to the initial benefits of the **Capacity Market**, despite peak demand of 59 GW.

In fact, through the auctions held to date and relating to delivery years 2022, 2023, 2024, 2025 and 2026, more than 8 GW of new capacity available in probability has been procured, whose gradual entry into operation is contributing and will contribute to the stabilisation and growth of the minimum adequacy margin and, in parallel, completion of the decommissioning of the most polluting plants, both on the mainland and on the main islands. In this regard, in addition to the auctions held to date, Terna has planned to carry out a further two auctions relating to delivery years 2027 and 2028.

Figure 13 *Minimum adequacy margin (GW) 2013-2023*



Context and energy scenarios	Market trends and regulatory environment relating to the energy transition	Objectives to be pursued, NTG development strategy and investment in the new Development Plan	Efficient territorial Planning	Investment and expected benefits of the new Development Plan	Structure of the 2025 Development Plan
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The experience of the last few years shows how the transformations affecting European generation (decarbonisation, the distribution of generation, the penetration of intermittent generation) are making the electricity system more exposed to the variability of climate phenomena and conditions in neighbouring countries.

In addition to playing a key role in system adequacy by mitigating potentially critical situations, the Capacity Market has also made it possible to phase out coal, according to the timeline set by the NECP, which will see the complete phase out of coal-powered plants on the continent by the end of 2025.

Table 1 Decommissioning of coal-powered capacity on the mainland

MONTH/YEAR	CAPACITY ENABLED FOR DECOMMISSIONING (MW)	TECHNICAL CONSTRAINTS ON DECOMMISSIONING
By December 2024	605	Commissioning of generation capacity and storage capacity contractualised in CM auctions
By April 2025	1,210	
By January 2026	1,865	

Source: NECP.

In addition, thanks to the commissioning of new plants, the Capacity Market has made it possible to decommission older ones, making generation plants more efficient ([Table 1](#)).

It is important to highlight that the Capacity Market not only ensures electricity grid adequacy, but also protects suppliers and consumers from the risk of future electricity price volatility. At European level, the Capacity Market is already a reality not only in Italy, but also in France, Belgium, Ireland and Poland. Particularly in Italy, as well as in Ireland and Belgium¹⁷, the mechanism involves the application of a “payback clause” when the energy price exceeds a certain threshold, thus helping to limit price volatility. Germany, on the other hand, opted for a substantially opposite market design, relying almost exclusively on spot markets, without having developed final contracting mechanisms capable of protecting consumers from price volatility. During the hours of high renewable production, Germany enjoys a low price (increasingly even negative), while during hours of low wind, there may be extremely high prices, just as happened on 11 and 12 December 2024.

¹⁷ Source: Florence School of regulation, Capacity Mechanism, 30 July 2024.



2.1 Infrastructure regulation	26
2.2 Forward markets for RES	27
2.3 Capacity market	28
2.4 Electricity Storage Capacity Procurement Mechanism (MACSE)	30
2.5 Flexibility needs: insight into evolving flexibility requirements	31



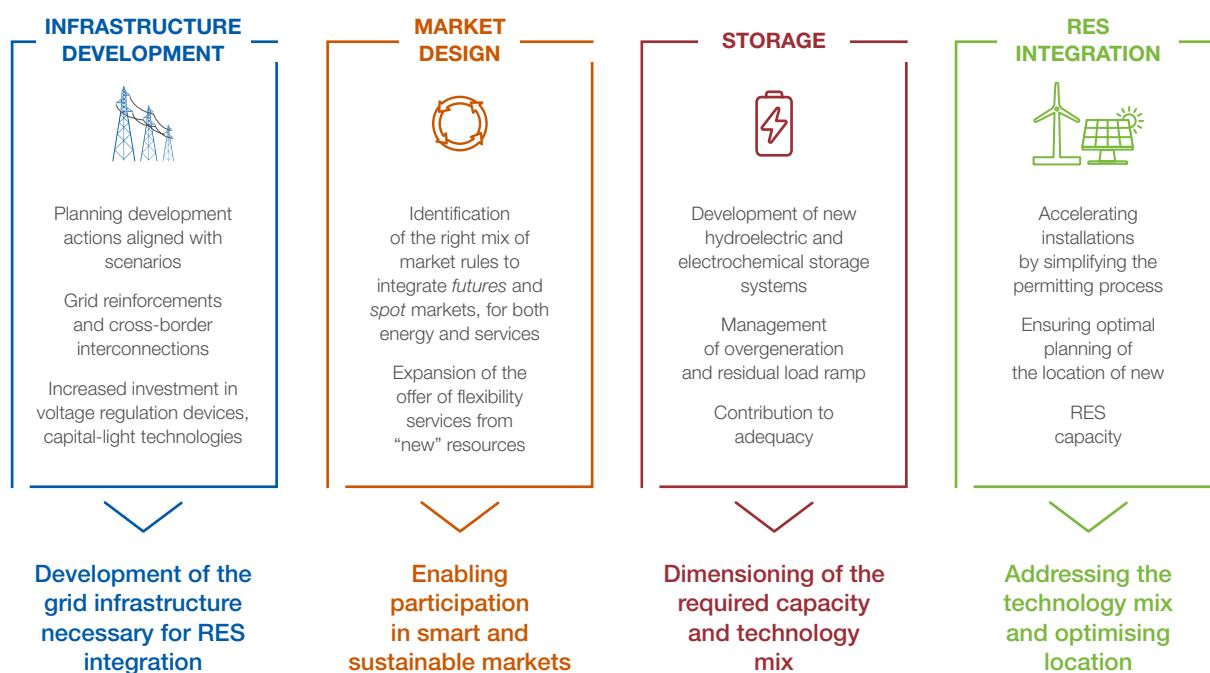
2 Market trends and regulatory environment relating to the energy transition

Market trends and regulatory environment relating to the energy transition

2.1 Infrastructure regulation

Delivery of the investment needed to achieve the energy policy objectives in the planned timeframe inevitably requires a **sharp acceleration in investment** in the energy sector and even more in the electricity sector.

Figure 14 **Enabling factors for the energy transition**



This investment must be channelled, to a great extent, into the **development of new RES capacity, storage and transmission and distribution grids**, to be achieved through a coordinated approach so as to minimise the cost for the system as a whole.

The organic reform of the electricity dispatching regulation envisaged by the **Consolidated Law on Electricity Dispatching (TIDE)** approved by ARERA Resolution 345/2023 and in force as of 1 January 2025, through a phased implementation process, fits within this context. The TIDE pursues the objectives of **meeting the challenges posed by electricity system transformation**, which is increasingly characterised by non-programmable renewable sources and, in parallel, **streamlining the regulatory aspects of dispatching**, taking into account the European legal and regulatory framework¹⁸. Indeed, several new aspects are introduced that will affect the functioning of the energy and services markets in Italy.

To help make the necessary investment quickly, the regulatory framework, in particular as regards tariffs, assumes a central role in providing the instruments and incentives necessary to ensure infrastructure development can keep pace with the evolution of the national energy system.

¹⁸ For example, see Regulation 943/2019 and Regulation 2195/2017.

Context and energy scenarios	Market trends and regulatory environment relating to the energy transition	Objectives to be pursued, NTG development strategy and investment in the new Development Plan	Efficient territorial Planning	Investment and expected benefits of the new Development Plan	Structure of the 2025 Development Plan
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On this point, we consider that the new **output-based regulation**, which will be fully applied with the definition of the related rules, will make it possible **to adjust the current criteria for recognising electricity transmission costs to meet the objectives supporting the energy transition**, while also guaranteeing the the ability to finance investment and ongoing alignment of the interests of regulated entities with those of the system and consumers.

In this regard, it is fundamental to have a set of **output-based** incentive tools to ensure full consistency between the system objectives to be achieved and guaranteeing greater selectivity and priority in investment based on its usefulness and the consequent actions of the regulated companies. Over the last few years, **output-based** regulation has in fact proved to be an effective instrument in orienting investment and Terna's actions involving those most useful for the electricity system, generating notable savings for final customers. Examples of this are the incentives to reduce the costs for procuring resources on the dispatching services market and the incentives for resolving congestion between market zones.

2.2 Forward markets for RES

Besides a major simplification of the permitting process, development of RES consistent with the scenarios included in the Fit-for-55 and REPowerEU European packages cannot overlook **forward contracting mechanisms** which guarantee their construction, reducing the related development costs. The spot energy markets tend to express prices in line with the variable cost of the marginal technology, represented — currently — by gas-powered plants in most of the hours in a year. However, in a market with a growing penetration of renewable plants which, as is known, are characterised by very low variable costs, the market prices of energy will tend to fall and, consequently, may not guarantee sufficient stimulation for the development of additional renewable plants. This will increase the related risk premium.

In the last two years and compared with the previous Plan, there have been **new elements** that will contribute to electricity system management, also in light of expected developments for the energy transition. The forward contracting system provided for in article 6 of Italian Legislative Decree 199 of 8 November 2021 and broken down in the draft of the decree subject to consultation between August and September 2023 will make it possible to:

1. guarantee that RES initiatives are fully financed even in an environment different from the current one, marked by falling energy prices;
2. reduce the risk premium of the initiatives, guaranteeing a certain flow of revenue to operators;
3. avoid that, in the presence of significant market tensions, such as those recorded in 2021 and 2022, the (new) RES will be remunerated on the energy markets at prices defined by technologies powered by fossil fuels.

In particular, the draft decree calls for:

- the conclusion of two-way contracts for difference (CfDs), with consideration being paid even in the case of a production cut;
- the definition of separate quotas by technology and the valuation under normal circumstances of the geographical location of plants in the selection stage.



2.3 Capacity market

The **capacity market** allows for the development of new capacity through **forward contracting mechanisms**, so as to guarantee the **adequacy of the electricity system** at a time when it is marked by an ongoing profound transformation in generation plants. The mechanism aims to accompany the **transition to renewables**, by allowing for the decommissioning of more inefficient and polluting plants through the planned entry or retention of more efficient and flexible capacity with lower pollution.

The capacity market is a mechanism whereby Terna procures capacity through annual contracts, in the case of existing capacity, or multi-year contracts, in the case of newly built capacity, awarded through competitive auctions.

Participation in **auctions** organised by Terna is open to operators with both programmable and non-programmable generation units. As concerns the production capacity contracted following the auction, they acquire:

- the obligation to offer capacity in the energy and services markets (if authorised);
- the right to receive an established fixed annual premium from Terna;
- the obligation to return to Terna any positive difference between the electricity price earned in the energy and services markets and the operating price defined by ARERA.

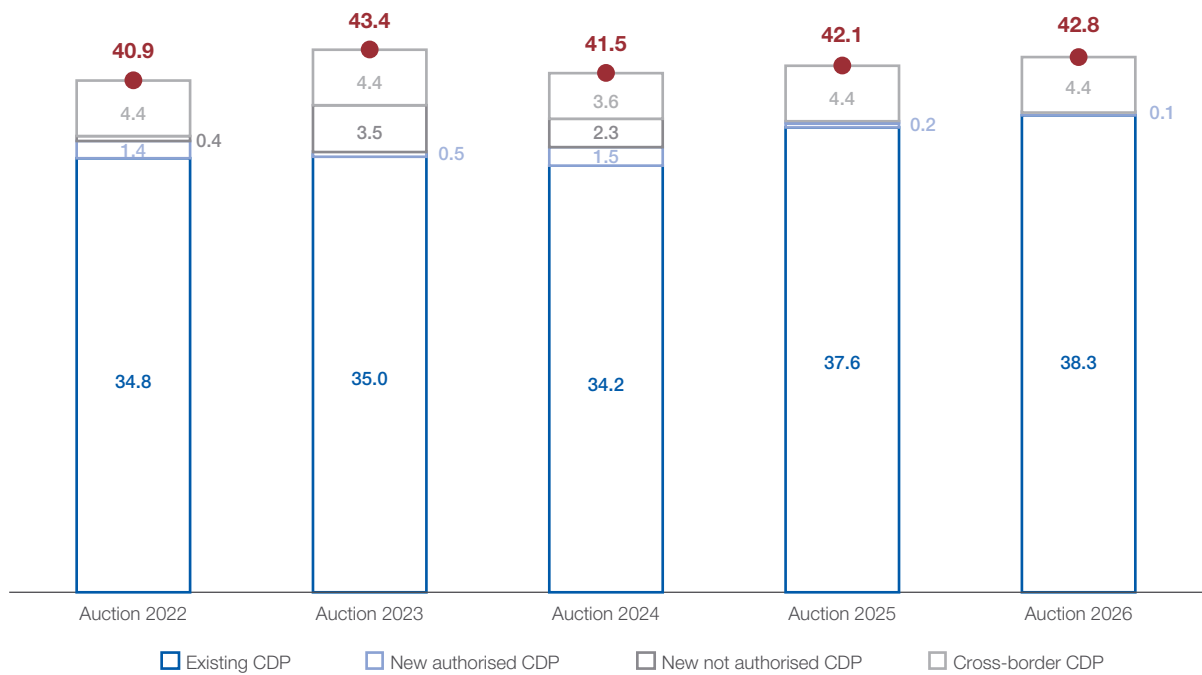
Capacity market units (demand-response) and cross-border resources may also participate in the auctions.

Through the auctions for delivery years 2022 to 2026, **more than 8 GW of new capacity available in probability (CDP) was procured**. This capacity has already supported and will continue to contribute to completion of the decommissioning of the most polluting plants, both on the mainland and on the major islands (*Figure 15*).



The amount of capacity allocated in the auctions held so far is shown below¹⁹, distinguishing between existing capacity, new (authorised and not authorised) capacity and cross-border capacity.

Figure 15 Capacity allocated in auctions (GW)



¹⁹ The results reported do not take into account new capacity contract terminations, amounting to about 1.5 GW.

2.4 Electricity Storage Capacity Procurement Mechanism (MACSE)

In parallel with the installation of new capacity from renewable sources, **it is indispensable to create new electricity storage capacity**. The target identified by Terna in the Scenarios Description Document (24SDD) provides for **50 GWh** of new large-scale plant capacity **by 2030**, located mostly in the south of Italy and on the major islands where it is expected that 20 GWh and 24 GWh, respectively, of new electricity storage plants will be created.

Electricity storage systems will allow energy generated from renewable sources to be stored during surplus hours and then returned to the grid when production from these sources is inadequate to meet demand.

To provide the national electricity grid with this storage capacity, Italian Legislative Decree 210 of 2021 introduced a **forward contracting mechanism** dedicated to these resources: the **MACSE** (acronym for Electricity Storage Capacity Procurement Mechanism). This mechanism calls for auctions organised by Terna to conclude long-term contracts for the development of new storage facilities.

In addition to allowing for the effective integration of renewable energy sources into the electricity system through the provision of the time-shifting service, these facilities will also make it possible to:

- make a contribution in terms of system adequacy;
- resolve grid congestion between and within zones;
- offer voltage regulation, inertia, short-circuit power, reserve and balancing services.

Competitive MACSE procedures **will initially focus especially on established technologies**, i.e. that have been recognised for their technological maturity, such as lithium-ion batteries and hydroelectric pumping plants. However, it is expected that **up to 10%** of the share put out to tender in each auction may be allocated to **emerging technologies**.

In return for the recognition of the auction premium, the assignees undertake to create and make available the agreed storage capacity, which will then be offered on the wholesale markets and the Dispatching Services Market (MSD), in specific ways. For further details on the MACSE and how auctions are conducted, more in-depth information is available in File “Efficient Territorial Planning and Connections”.

2.5 Flexibility needs: insight into evolving flexibility requirements

The evolution of flexibility needs

Electrical system flexibility is to be understood as the **system's ability to cope with the variability and uncertainty** that demand and generation from **non-programmable renewable sources** introduce into the system at different times, supplying all of the energy required by consumers, minimising system costs and keeping curtailment below a defined acceptability level. The energy transition involves a progressive, not necessarily linear, increase in the **complexity of system management**, which will be characterised by structural overgeneration as installed renewable capacity increases, a zero or negative residual load curve, significant positive and negative load ramps, sustained load peaks, as well as progressively more limited availability of programmable regulating technologies and, finally, incidents of potential dynamic instability. To manage these complexities, the system will require the use of **increasing flexibility contributions**.

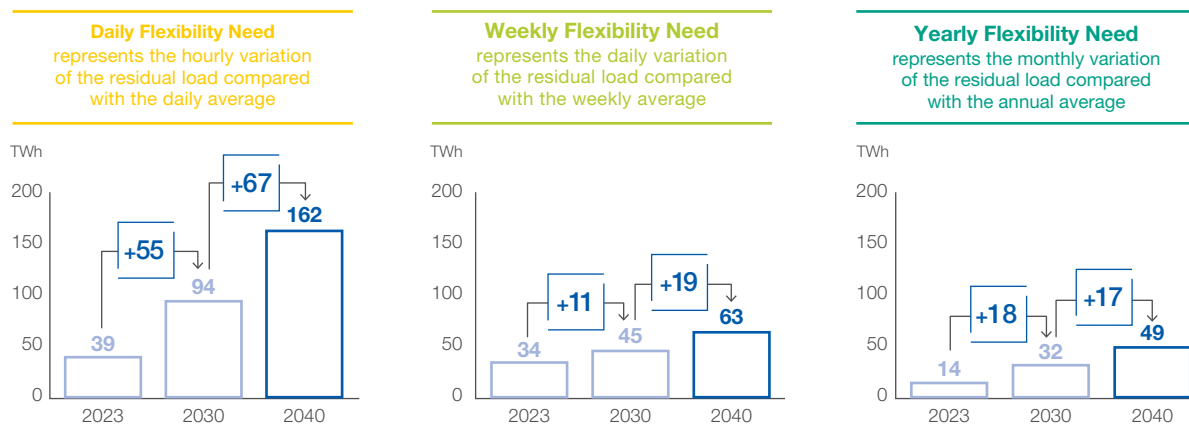
A quantitative, albeit simplified, representation of the implications of this progressive increase in complexity can be developed based on **indicators** that analyse the **residual load variability**. These indicators, which were introduced a few years ago and for which there are several publications (Artelys, JRC²⁰), are necessary for the quantification of "**Flexibility Needs**" at national level, required by the European Commission in the Electricity Market Reform. These studies are based on a methodology for analysing residual load variability shared at European level (ENTSO-E and EU DSO Entity) and underlying the **National Flexibility Assessment** that each Member State will be obliged to prepare.

Considering residual load variability as a **qualitative indicator of the system's flexibility needs**, it is possible to differentiate on different time scales according to the physical phenomena involved: daily, weekly, monthly. In view of future scenarios, the increase in installed renewable capacity will lead to an increased need for flexibility across all time scales. *Figure 16* compares in terms of flexibility needs the year 2023, the 2030 NECP Policy scenario and the 2040 DE-IT scenario described in 24SSD. Specifically, focusing on 2030, the following is observed:

- an increase in the indicator on a **daily scale of +41%** (from 39 TWh to 94 TWh) essentially as a result of the expected higher penetration of photovoltaic production;
- an increase in the indicator on a **weekly scale of +32%** (from 34 TWh to 45 TWh), which is mainly due to the expected growth in wind power production;
- an increase in the indicator on an **annual scale of +28%** (from 14 TWh to 32 TWh), influenced by seasonal fluctuations in sun and wind as well as the effects of the progressive electrification of heating.

Terna's assessments therefore show that the **major challenge in the coming years** will be represented by the **management of daily flexibility needs**, which will require resources capable of making available to the system a cyclical and systematic change in their input and/or withdrawal profile in order to accommodate renewable generation (essentially photovoltaic) in structural excess in the middle of the day.

²⁰ Artelys (METIS Studies), Design of flexibility portfolios at Member State level to facilitate a cost-efficient integration of high shares of renewable electricity, 2019.
Koolen, D., De Felice, M. and Busch, S., "Flexibility requirements and the role of storage in future European power systems, Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/384443, JRC130519.

Figure 16 Flexibility Needs in future scenarios


In essence, resources will be needed that systematically store the sun’s energy in the middle of the day and make it available during the rest of the day. This function will primarily be performed by physical storage (pumped storage and batteries) but, at least theoretically, could also be performed by “virtual” storage such as, for example, distributed energy resource aggregations. Aggregations of resources such as electric cars and heat pumps have an “embedded” storage capacity (batteries or building thermal inertia) and can change their grid exchange profile.

Enabling distributed resources

Aggregated distributed resources, which generally provide a demand response service, can contribute to the operation of the national electricity system both through the energy market in indirect form and through the ancillary services market in direct form. These resources, which can support the grid both by providing the load reduction needed to manage operational adequacy and by providing a consumption time shift (load shifting service), which can be associated with planning and balancing up to real time, will be a complementary tool to the storage available to the TSO to increase system flexibility. In particular, the load shifting service will be associated with technologies in the residential and commercial sectors, considering that the industrial flexibility segment is limited by process constraints.

However, small-scale distributed and aggregated flexibility is a segment that requires more analysis at both technological and commercial level. Indeed, there are currently a number of constraints that reduce the participation of these resources in the markets: for example, technological standards are absent and engagement and commercial management processes are burdensome.

Terna is strongly committed to enabling distributed flexibility with multiple highly synergic initiatives at varying degrees of maturity: research projects financed by the European Commission (e.g. OSMOSE, BeFlexible, FLOW), applied research projects and studies with Italian and international centres of excellence, pilot projects supporting the evolution of national regulation (e.g. UVAM pilot, TSO-DSO coordination pilot), equity interests, Energy System Innovation programmes (e.g. ESI E-mobility, ESI Heating & Cooling and ESI Aggregation).





3.1 Integrating RES connections, storage, Primary Distribution Stations and consumers	37
3.2 Increasing transmission capacity between market zones and resolving congestion in the electricity system	38
3.3 Developing cross-border interconnections	43
3.4 Improving the levels of security, quality and resilience of the electricity system, and continuity of service	47
3.5 Guaranteeing a robust grid and dampening low-frequency inter-area oscillations	47



3

**Objectives to be pursued,
NTG development strategy
and investment in the
new Development Plan**

Objectives to be pursued, NTG development strategy and investment in the new Development Plan

In the light of the challenges that characterise the electricity system, owing to the expected trends in the forecast energy scenarios and the climate change in progress, in the context of planning the development of the transmission grid it is necessary to achieve the following objectives for the electricity system:



**INTEGRATING
RES, PRIMARY
DISTRIBUTION
STATIONS,
STORAGE and
CONSUMERS**



**INCREASED
TRANSMISSION
CAPACITY
BETWEEN MARKET
ZONES AND
RESOLUTION OF
CONGESTIONS IN
THE ELECTRICITY
SYSTEM**



**DEVELOPMENT OF
CROSS-BORDER
INTERCONNECTIONS**



**IMPROVED LEVELS OF
SECURITY, QUALITY
AND RESILIENCE OF
THE ELECTRICITY
SYSTEM, IN ORDER TO
GUARANTEE CONSTANT
COVERAGE OF
ELECTRICITY DEMAND,
AND CONTINUITY OF
SERVICE**



**GUARANTEE A ROBUST
GRID AND DAMPENING
LOW-FREQUENCY
INTERAREA
OSCILLATIONS**

3.1 Integrating RES connections, storage, Primary Distribution Stations and consumers

The development of grid infrastructure must necessarily aim to guarantee the efficient integration of rapidly growing **renewable energy** and create optimal conditions for achieving the decarbonisation objectives, in line with the forecast scenario for renewables and new storage capacity.

In addition, to manage the sudden changes in generation due to the unpredictability of the primary energy source and to channel, direct and control the energy flows produced, **the infrastructure developments planned in the previous Development Plans are necessary, as they will make it possible to efficiently integrate new renewable generation**, increasing transit capacity between market zones. The main development projects enabling the integration of new renewable capacity include, for example, the Tyrrhenian Link, the Adriatic Link and the Hypergrid project.

In addition, infrastructure development also takes into account the need to connect **consumers**, also known as passive users, who draw energy directly from the NTG and include energy-intensive users, to the NTG. **Over the last two years** there has also been a **considerable increase** in these types of non-RES connections, driven, *inter alia*, by access to NRRP funding for parties proposing specific types of project (e.g. Cold Ironing, High Speed Rail), as well as technological innovations in the development of new Data Centres.

Among non-RES connection requests, there has also been an increase in active Primary Distribution Stations²¹ requests, mainly due to the **electrification of consumption** and growth in distributed generating plants, which are causing the various distributors (DSOs) to build large numbers of new primary distribution stations that need to be connected to the NTG or upgrade existing infrastructure. For some primary distribution stations, distributors have also had access to NRRP funding.

For all of these phenomena, the **Development Plan meets the need to plan the share of RES and non-RES connections to be integrated into the HV grid**, in terms of preparatory infrastructure works for their connection:

- for RES connection requests, the volume of **RES** to be integrated into the HV grid **over the 10-year time horizon**, estimated on the basis of the scenarios and equal to about **43 GW**, is considered. This estimate is based on the total increase in renewable capacity of more than 65 GW by 2030 and an additional 20 GW by 2034 (compared with 2023), net of the capacity that will be connected to the distributor's grid;

²¹ Electricity infrastructures owned by DSOs that interconnect the NTG with the medium- and low-voltage grids to increase service quality.

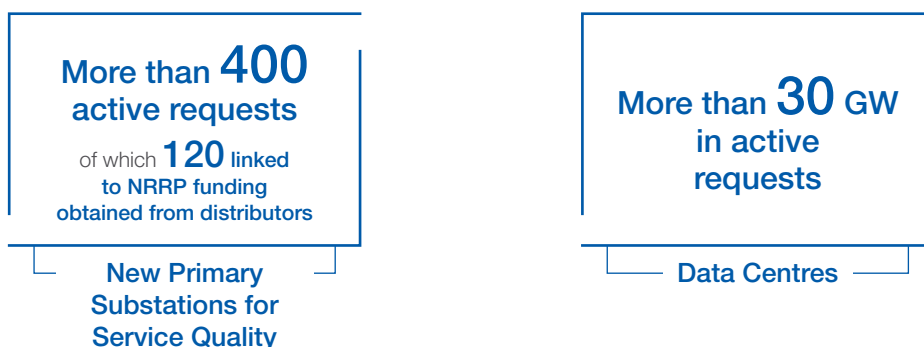
- for the integration of **new storage capacity**, **~50 GWh** of the utility scale type is expected. The estimate of exactly how much is to be connected to the HV grid will depend on the maturity and location of existing requests, as connection requests in the advanced stage are often close to production facilities/industrial sites with existing electricity infrastructure;
- for **non-RES connection requests** (Primary Distribution Stations and consumers), Terna is also in charge of authorising grid works for the connection, as well as carrying out preparatory grid works to make the connections. Their planning is based on an optimisation and efficiency approach, prioritising projects linked to NRRP funding and/or other urgent phenomena (e.g. Primary Distribution Stations for the 2026 Olympic Games).

The continuous monitoring of these requests and future estimates and forecasts lays the foundation for efficient and sustainable NTG infrastructure investment planning.

Figure 17 Connection of primary distribution stations and consumers (active requests as at 31 December 2024)



Figure 18 Connection of primary distribution stations and consumers (active requests as at 31 December 2024)



3.2 Increasing transmission capacity between market zones and resolving congestion in the electricity system

Following the analysis of the signs coming from the energy markets and the results of market simulations (see the File “Development requirements - New Projects”) Terna has provided for the performance of a series of **actions functional to guaranteeing that congestion between market zones is overcome, making production more efficient and increasing the availability of resources in the dispatching services market** (for more details, see the File “System benefits and assessment of grid robustness “).

To address existing critical grid issues, it is necessary **to identify further actions** in addition to those already included in the Development Plan (NDP), with a view to **optimising investment** in the national transmission grid (NTG), guaranteeing the **maximum benefits** that can be obtained for the system by increasing the exploitation of existing NTG infrastructure.

The main development projects that will contribute to increasing exchange capacity include, in addition to the projects

Context and energy scenarios	Market trends and regulatory environment relating to the energy transition	Objectives to be pursued, NTG development strategy and investment in the new Development Plan	Efficient territorial Planning	Investment and expected benefits of the new Development Plan	Structure of the 2025 Development Plan
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already mentioned enabling RES integration, the new Bolano-Annunziata, Foggia-Gissi, Colunga-Calenzano and Montecorvino-Benevento 380 kV connections and new initiatives to maximise the use of existing assets.

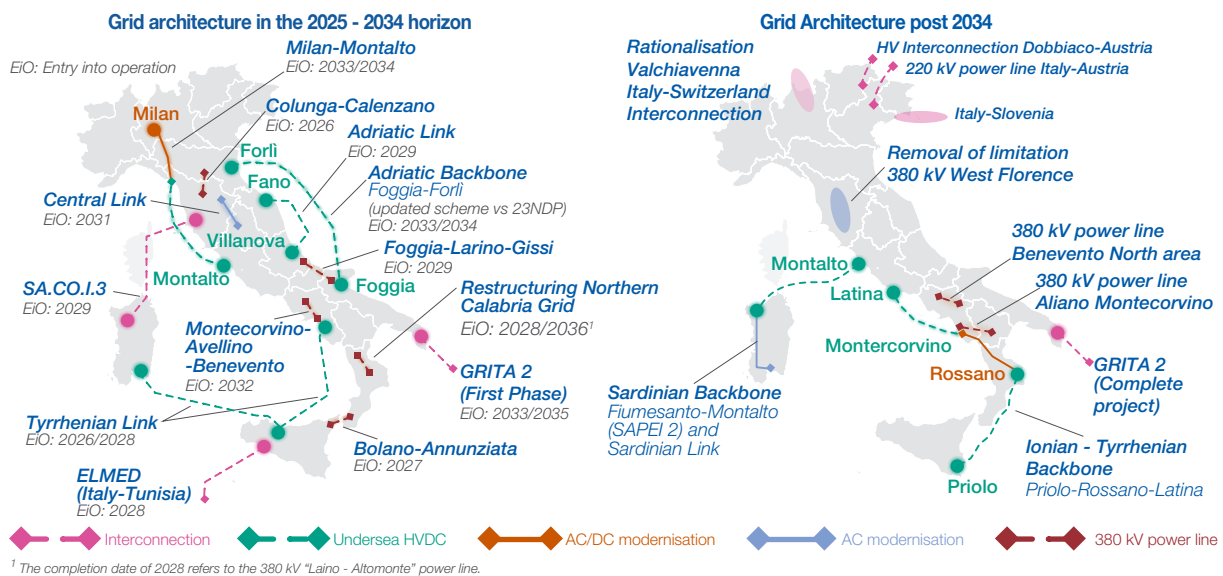
In accordance with a holistic vision of the national electricity system, the actions included in the 2025 Development Plan pursue the goal of generating synergies with development works already planned (in the 2023 and previous NDPs) as well as existing infrastructure in order to guarantee the utmost security and operating flexibility.

The **grid architecture to 2034 and 2040** takes into account synergies between the Hypergrid project and the EHV grid initiatives already planned, in order to:

1. optimally manage intrazonal energy exchanges;
2. guarantee the transfer of energy produced by renewable plants to high-consumption zones;
3. ensure the ability to fully control flows in all directions;
4. support mutual aid between the various market zones as required.

Figure 19 shows the main development initiatives planned through to 2034 and 2040.

Figure 19 Main initiatives planned in the 10-year Plan time horizon and post 2034



The planned grid architecture takes the following main projects into account:

1. **380 kV Bolano Annunziata power line** (code 555-P): a new 380 kV Bolano-Annunziata undersea power line between Sicily and Calabria authorised in September 2024, to facilitate the integration of new RES generation planned in Sicily and southern Italy.
2. **Tyrrhenian Link** (code 723-P): new direct current (HVDC) interconnection between Sardinia, Sicily and the Continent, divided into two sections, Sardinia - Sicily (West link authorised in September 2023) and Sicily - Continent (East link consented to in September 2022).
3. **Elmed** (code 601-I): new direct current connection (HVDC) between Italy and Tunisia. The project is considered to be of strategic importance for the electricity transmission system in the Mediterranean basin.
4. **Adriatic Link** (code 436-P): a new direct current (HVDC) link between the Villanova and Fano stations that will increase transmission capacity between South-Central and North-Central areas. Work on the project began in 2022 and authorisation was obtained in January 2024.

5. **SACOIII** (code 301-P): a new HVDC line connecting Tuscany and Sardinia between the Suvereto and Codrongianos stations. The project received authorisation in September 2023.
6. **Montecorvino-Benevento 380 kV power line** (code 506-P): a new 380 kV power line between the Montecorvino and Benevento stations, which will also pass through the 380 kV Avellino N ES.
7. **Milan - Montalto HVDC line** (code 355-P/HG-1): will connect Lazio to Lombardy via Liguria and will include an HVDC undersea connection and the re-use of existing AC backbones.
8. The **Central Link** (code 356-P/HG-2): reconstruction of the current 220 kV line between Villavalle (Umbria) and Santa Barbara (Tuscany), using innovative low electromagnetic impact supports called “5 Phases”.
9. **Sardinian Backbone** (code 732-P/HG-3), which includes:
 - the **Fiumesanto - Montalto HVDC line** (“Sapei 2”): a new undersea connection between the existing stations of Fiumesanto in Sardinia and Montalto in Lazio;
 - the **Sardinian Link**: consisting of the reconstruction of the 220 kV grid in the Sardinian hinterland by replacing existing pylons with innovative low electromagnetic impact supports called “5 Phases”.
10. The **Ionian - Tyrrhenian Backbone** (Priolo - Rossano - Latina HVDC line, code 563-P/HG-4) that will connect Sicily to Lazio with an intermediate station located in Calabria (Rossano). The Ionian-Tyrrhenian Backbone includes three HVDC sections:
 - **Undersea HVDC line** between the Latina converter station and an overhead-cable transition station located near Montecorvino;
 - **DC modernisation** by reconstruction on the same route or adjacent to them up to ± 525 kV DC of the existing Rossano-Laino (380 kV) and Laino-Tusciiano (220 kV) AC power lines. The new connection will be at the overhead-cable transition station near Montecorvino on the one hand and at a new converter station near Rossano on the other;
 - **Undersea HVDC line** between the Rossano converter station and a new converter station to be located near the Priolo site in Sicily.
11. The **Adriatic Backbone** (code 447-P/HG-5), which features a technological solution calling for a single HVDC connection between the extreme nodes of Foggia and Forlì with voltage of up to ± 525 kV DC, which will strengthen the Adriatic corridor for energy exchanges on this backbone.

In summary, the Hypergrid project, together with all of the planned actions on the EHV grid and the capital light actions included in the 2025 NDP, in continuity with the 2023 NDP, will make it possible to achieve EU decarbonisation targets, by encouraging the connection of the expected renewable plants.

Confirming the benefits of the actions contributing most to achieving decarbonisation targets and the energy transition, the cost-benefit analysis also demonstrated their full sustainability through robust system utility indexes (SUJ), despite a challenging backdrop of rising costs.

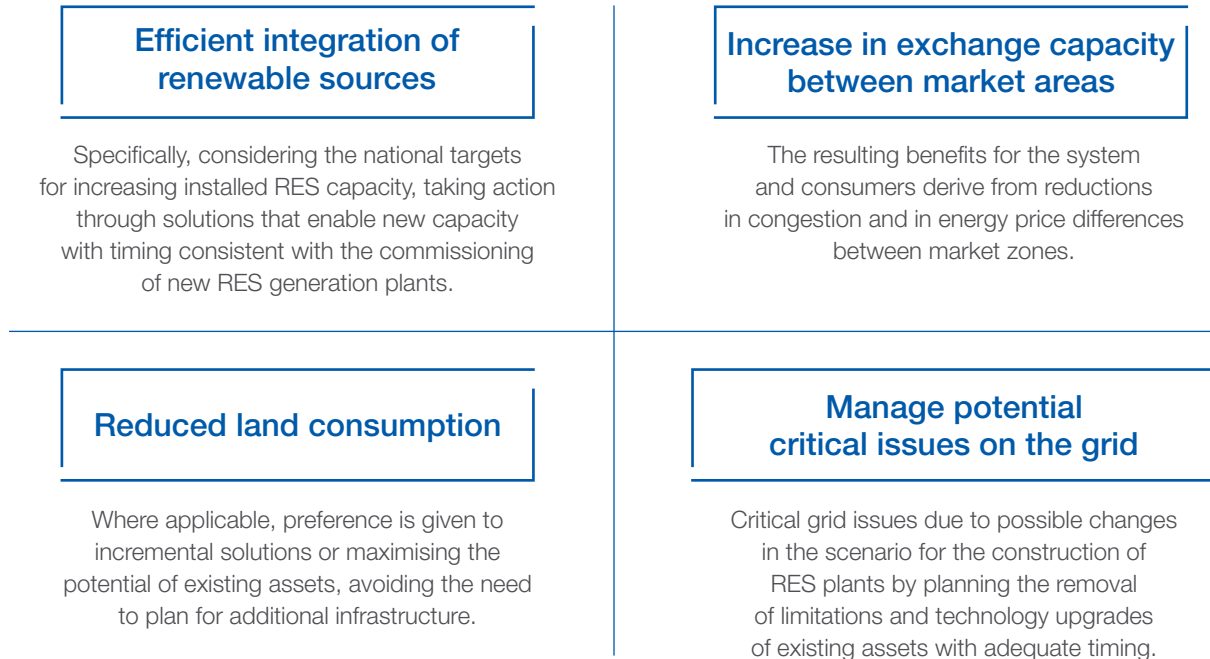
In the **2025 Development Plan** for the National Transmission Grid, Terna aims to extract **more value from existing assets** through capital light actions, which are based on **innovative, low capital intensity instruments and solutions** alongside traditional infrastructure interventions, making it possible to **obtain benefits** in terms of:

- increased transit limits between market zones;
- the mitigation of intrazonal congestion;
- maximisation of RES production and reductions in curtailment;
- maximisation and anticipation of expected benefits from the commissioning of the individual development projects, including during intermediate phases.

The removal of limitations and technological upgrades of NTG assets, described in the following paragraphs, are therefore aimed at maximising the performance of grid infrastructure and, depending on the critical issues they address, meeting the following main needs:

Context and energy scenarios	Market trends and regulatory environment relating to the energy transition	Objectives to be pursued, NTG development strategy and investment in the new Development Plan	Efficient territorial Planning	Investment and expected benefits of the new Development Plan	Structure of the 2025 Development Plan
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In particular, **initiatives that maximise assets** aim to increase capacity between market zones, **offering greater availability** during the year of **maximum exchange capacity**, guarantee a significant benefit under specific grid conditions, influenced by major injections of energy from non-programmable renewable sources (NPRS), the uneven distribution of flows, the availability of resources and safe and cost-effective operation even during scheduled works or maintenance. This results in actions that structurally boost capacity and others that are likely to increase capacity during the year.



The **main technologies** used for digitalisation and the maximisation of asset utilisation on existing grids are:

- **OMP - Tower Maneuvering Device:** replacement of existing manual or rigid maneuvering devices (where present) with new, gas-insulated and readily available equipment, in conjunction with a shelter for their command and control;
- **Reconductoring:** replacement of conventional conductors with other conductors offering improved performance in terms of deflection and operating temperature;
- **Dynamic Thermal Rating:** this is a method for managing power line conductors under high temperatures, aimed at verifying their actual operating limits as grid conditions and environmental parameters change, while respecting the safety constraints of all spans constituting each line;
- **removal of limitations on station and line elements:** work on removing limitations introduced by power components (the rationalisation of carrier frequency coils, replacement of current transformers or change in their transformation ratio, the replacement of station busbars, etc.);
- **innovative Defence System criteria:** changes to Terna's Defence System designed to protect the national electricity grid by countering accidental events through the extremely rapid implementation of appropriate corrective actions.

Assessments were therefore carried out on the portions of the grid most affected by actions that are particularly strategic for the electricity system, with the aim of identifying the necessary countermeasures (e.g. on the existing grid) to mitigate the impact on the NTG due to any slowdowns in the creation of interdependent development works.

In this regard, some cases of the application of technological solutions for grid optimisation (OMP, DTR, defence systems, etc.) described above are listed below, for the identification of the necessary actions and with timeframes consistent with the evolution of ongoing generation scenarios.

Table 2 Action areas for asset maximisation

ACTION AREA	POTENTIAL CRITICAL ISSUE	IDENTIFIED SOLUTION
Sicily Area	In the event of possible delays in the commissioning of the 380 kV Chiaramonte Gulfi-Ciminna power line, overloads could occur on the 150 kV and 220 kV grids. This could lead to potential limitations on the capacity of the Tyrrhenian Link.	Work to remove limitations and technology upgrades as well as the need to install DTR devices on both 150 and 220 kV lines, with the aim of improving the utilisation performance of the most critical power lines and reaping concrete short-term benefits, while waiting for the main development works.
Campania Area	In the case of Campania, a similar grid assessment was carried out in the absence of development action "506-P Montecorvino-Avellino N. Benevento III 380 kV power line" and in the presence of the East section of the Tyrrhenian Link. The assessment demonstrated the need to act on the adjustment of transformation capacity in the Montecorvino ES, and also highlighted a series of overloads on the 220 kV grid in the Naples area.	Work to remove limitations and technology upgrades on the 220 kV grid in the Naples area and adjustment of the 380/220 kV transformation capacity at the Montecorvino ES, to reduce congestion between market areas in the short term.
Central North and North Area	Between the North and Central North zones, the 380 kV line between the Bargi and Calenzano stations limited exchange more frequently. Through in-depth technical verifications, several limiting elements were identified.	Work to remove limitations and technology upgrades on the Bargi - Calenzano 380 kV line. Replacing these elements helped to increase exchange capacity in the North-Central North market zone.
Central South - Central North	The 220 kV Candia - Villanova and Santa Barbara - Villavalle lines and the 380/220 kV Candia and Villanova ATRs frequently limited exchange between the Central South and Central North zones. Extensive technical inspections were carried out on the 220 kV lines, after which specific measures were identified to improve their performance.	Replacement of the 380/220 kV ATRs located at the Candia and Villanova Power Stations. These actions helped to increase the exchange capacity of the Central South market zone and the Central North zone.
Sardinia Area (Ogliastra)	The need to resolve congestion on the HV grid can sometimes lead to production limitations being imposed on renewable source plants connected to the grid (lack of wind/solar power production). In Sardinia, especially in the Ogliastra area, MPE volumes were recorded due to congestion on the local 150 kV grid, linked to limited line transmission capacity.	In the course of 2023, a series of actions were carried out to increase the performance of the lines converging on the 150 kV Selegas ES. These capital light actions made it possible to maximise existing asset utilisation and reduce the limitations imposed on renewable plants in the area, amounting to about 2 GWh per year.
Benevento Area	For more than 10 years, the Benevento area in the Campania region has seen a wide spread of wind power plants, generally connected to the 150 kV grid. In order to manage the high power flows that would be created during the periods of expected high wind speeds and to avoid possible local grid congestion and manage the grid safely, it may be necessary to take action to limit production on connected plants in the area.	Actions for improving the performance of lines located between Benevento, Foiano and Montefalcone. It is estimated that these actions will lead to a reduction in MPE of about 60%.
North Area	The operation of the electricity grid in the North zone during the summer period was characterised by high transits both internally (from North-West to North-East) and to the south of Italy. Simulations were conducted to identify capital light initiatives in synergy with the development actions already planned in the area.	Action was taken to improve the performance of some specific 380 kV power lines in conjunction with the changes to the defence system, resulting in an increase in exchange capacity between the North-West and North- East areas of roughly 10%.

3.3 Developing cross-border interconnections

Interconnection Projects Planned by Terna

The **2025 Development Plan**, in line with the previous ones, confirms the importance of upgrading electricity interconnections (*Figure 20*) with neighbouring countries to ensure greater market integration and strengthen system security through mutual aid between connected grids.

Terna's main planned interconnection projects under construction or authorised to include:

- **NEW ITALY - TUNISIA INTERCONNECTION**

The new HVDC connection is not only important for the electricity transmission system in the Mediterranean basin, but also provides an additional tool to optimise the use of energy resources between Europe and North Africa.

- **SARDINIA - CORSICA - ITALY HVDC CONNECTION (SA.CO.I.3)**

The project consists of the modernisation and repowering of the existing Sardinia-Corsica-Continent (SA.CO.I.2) interconnection, which has now reached the end of its useful life.

- **ITALY - MONTENEGRO HVDC INTERCONNECTION (SECOND POLE)²²**

The project involves the construction of the second HVDC connection for interconnection between Italy and Montenegro.

In addition to the projects mentioned above, the following interconnections planned by Terna are currently at the permitting or consultation stage:

- **NEW ITALY-GREECE INTERCONNECTION (GRITA 2)**

The project calls for the upgrade of the existing interconnection with Greece by constructing a new HVDC connection between the Italian and Greek transmission grids.

- **NEW ITALY - SWITZERLAND INTERCONNECTION AND VALCHIAVENNA RATIONALISATION**

The project calls for an increase in transmission capacity between the Italian and Swiss transmission grids in preparation for the broader rationalisation project in the Valchiavenna area.

- **ITALY - AUSTRIA 220 kV INTERCONNECTION**

The project calls for reconstruction of the existing 220 kV Soverzene - Lienz power line and the adaptation of power flow regulation devices.

Interconnection projects under study

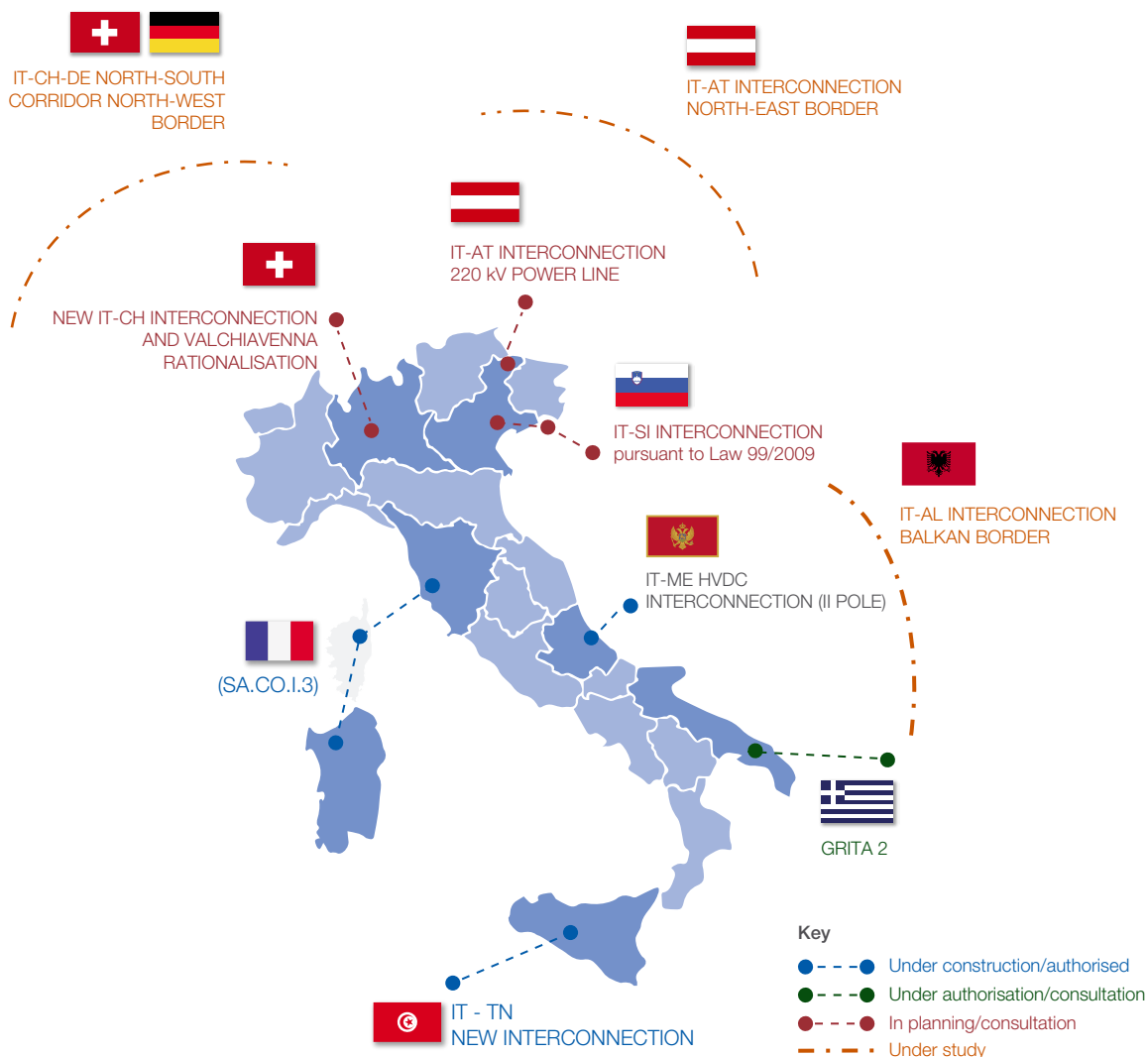
Notwithstanding the above, Terna is also studying further initiatives on the various Italian borders (*Figure 20*):

- **North-East Border:** in synergy with the rail transport infrastructure of the Brenner Base Tunnel, evaluations and studies are underway for the construction of a new interconnection between Italy and Austria;
- **North-West Border** (Italy-Switzerland-Germany North-South Corridor): to achieve further increases in transmission capacity on the northern border and support the integration of energy from renewable sources, it is necessary to promote the development of new infrastructure corridors in the south-north direction. Therefore, it is essential to further investigate upgrades on the Swiss border, also taking into account the necessary infrastructure synergies between Switzerland and Germany;

²² Development of the second Italy-Montenegro interconnection hub is conditional on the issue of an opinion by the regulator as well as the development of the Transbalkan corridor.

- Balkan Border:** as part of the completion of a ring involving Italy, Montenegro, Albania and Greece, aimed at increasing the reliability and operational continuity of energy exchange infrastructure between the two sides of the Adriatic Sea and optimising the use of existing and future grids, new solutions for the development of additional interconnections between the Italian peninsula and the Balkan area are currently being explored. In particular, the possibility of building a new electricity connection between Italy and Albania is being studied, with the aim of increasing the integration and efficiency of the regional energy system.

Figure 20 Interconnection projects planned by Terna and under consideration



Merchant Line and/or other promoters' interconnections

In addition to the above projects planned and at the study phase described above, it is of particular importance to provide as complete an overview as possible of the interconnection initiatives submitted by promoters other than transmission operators (known as “Merchant Lines”) in accordance with article 1-*quinquies*, paragraph 6 of Law Decree 239 of 29 August 2003, converted with amendments by Law 290 of 27 October 2003.

In view of the growing number of private projects and merchant lines, driven by recent changes in the geopolitical and energy context, the TSO (Terna) conducted an analysis to assess the impact of these initiatives on the national system in order to prepare this Plan. *Figure 21* and *Table 3* show and describe the Merchant Line initiatives for which the proposing party has made a request for connection to the National Transmission Grid at the consultation start date.

Figure 21 Merchant Lines and/or other promoters' projects that have already submitted a request for connection to the NTG on the public consultation start date

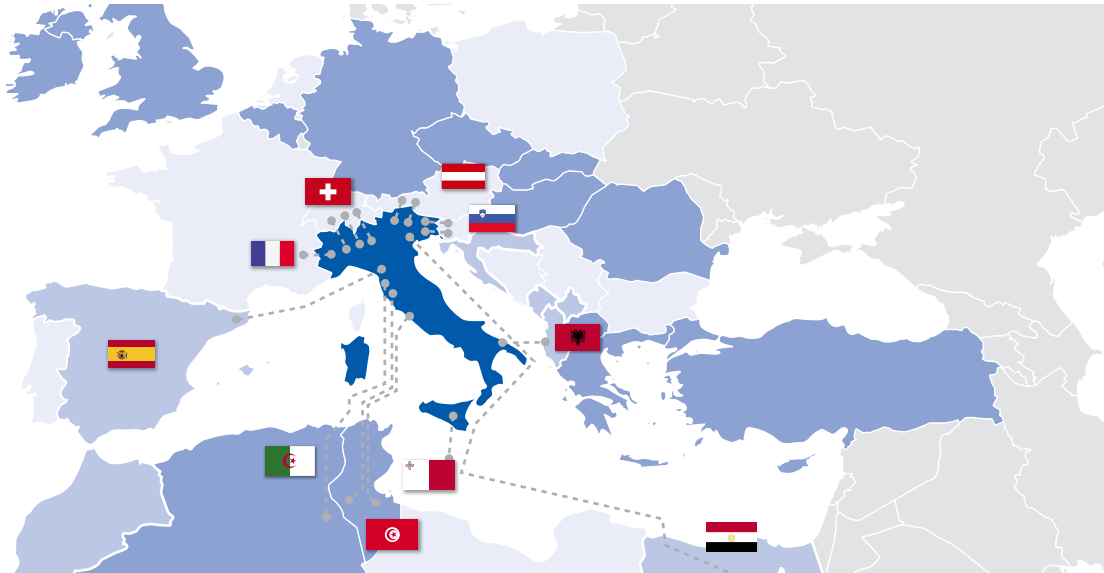


Table 3 Merchant Line Initiatives for which a request for connection to the NTG in the consultation start phase is available

PROMOTER	MERCHANT INITIATIVE	BORDER	NOMINAL CAPACITY STATED BY THE PROPOSING PARTY [MW]
ZHERO EUROPE B.V.	Medlink Algeria	Italy-Algeria	2,000
ALPE ADRIA ENERGIA S.R.L.	Somplago-Würmalch	Italy-Austria	300
K AND K GROUP	The Green Vein (Italy-Egypt)	Italy-Egypt	3,000
ENEL PRODUCTION S.P.A.	Cesana-Briançon	Italy-France	150
INTERCONNECT MALTA	Second Malta-Sicily Cable Link	Italy-Malta	225
ADRIA LINK S.R.L.	Redipuglia- Vrtojba	Italy-Slovenia	125
ADRIA LINK S.R.L.	Dekani-Zaule ²³	Italy-Slovenia	125
OMNIA	Apollo Link	Italy-Spain	2,000
MERA S.R.L.	Mese-Castasegna	Italy-Switzerland	200÷250
TUNUR POWER ITALIA S.R.L.	TUNUR	Italy-Tunisia	2,000
ZHERO EUROPE B.V.	Medlink Tunisia	Italy-Tunisia	2,000
MEMC SPA	Brenner-Steinach	Italy-Austria	100
GREENCONNECTOR S.R.L.	Greenconnector	Italy-Switzerland	1,000
ENEL PRODUCTION S.P.A.	Mese-Castasegna	Italy-Switzerland	100
Europa Link	Aquila Link	Italy-Albania	1,000

Based on the information collected for each merchant initiative with an available NTG connection request as of the consultation process start date in *Figure 22*, information is provided about the context of each initiative. The overview for each initiative is obtained in relation to the characteristics of each merchant line project on the basis of five summary indicators defined on a discrete scale between a minimum value of one and a maximum value of five (for further details, see File 5):

1. Economic sustainability
2. Technological level
3. Level of authorisation
4. Initiative maturity
5. Promoter classification

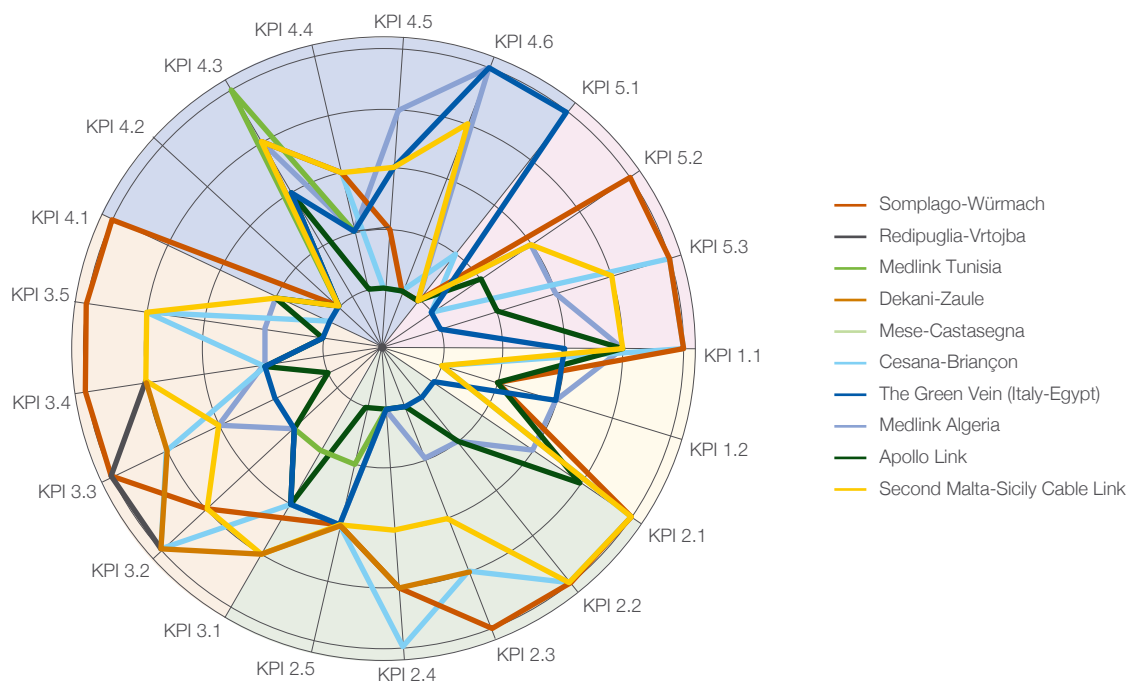
²³ Active connection request for the local distribution grid.

Table 4 shows the details of each KPI for the five indicators.

Table 4 KPIs used to define the placement of each Merchant Line and/or other promoter initiative

INDICATOR	KPI	
1 - Economic sustainability	Investment/Efficient net capacity available	1.1
	Market integration utility	1.2
2 - Technological level	Connection length	2.1
	Nominal capacity	2.2
	Technical operating complexity	2.3
	Technical implementation complexity	2.4
	Need for internal reinforcement	2.5
3 - Authorisation level	Permitting timing	3.1
	Station obstacles due to technology	3.2
	Territorial complexity	3.3
	Foreign complexity level	3.4
	Permitting process status	3.5
4 - Initiative maturity	Inclusion in ENTSOE TYNDP and/or EU PCI/PMI list	4.1
	Procurement status	4.2
	Date of entry into operation	4.3
	Practical project status	4.4
	Political endorsement	4.5
	Connection request ageing	4.6
5 - Promoter classification	Shareholders' equity/Share capital	5.1
	Previous experience	5.2
	Shareholders/Partners Profile	5.3

Figure 22 Analysis of Merchant Line and/or other promoters' initiatives



3.4 Improving the levels of security, quality and resilience of the electricity system, and continuity of service

One of the objectives of the planning activity is to improve the levels of security, quality and resilience of the electricity system, in order to guarantee constant coverage of electricity demand, and continuity of service.

For this reason, in the 2025 Development Plan the actions are characterised by activities linked to the expansion of the grid but also to the creation of new supply routes, in order to increase the reliability of the electricity system and reduce the risks of poor service in terms of energy not supplied.

Alongside the mainly infrastructure initiatives, the Development Plan provides for initiatives aimed at ensuring an adequate level of security also through:

- **the integration of the ex-RFI HV lines** with the 150 kV NTG power lines, increasing the quality and operating security standards, also reducing the impact of the infrastructure on the territory;
- the **removal of the operating restrictions** on the grid that do not guarantee, under certain load and production conditions or in the case of unavailability for maintenance, the security and continuity of the service;
- the **resolution of connection of power lines in rigid derivation**;
- the **installation of automated and motorised switching devices** that make it possible to reduce recovery times in the case of outages and motorised bypass switchers to increase the operating flexibility in favour of users supplied in antenna on plants that are not owned by Terna.

For the purpose of managing securely the operation of the grid, linked in particular to the control of voltages, the Development Plan provides for a series of **actions to install new capacitors and devices for the adjustment of reactive power** and, in synergy with the actions in the Development Plan, there are also those of the Defence Plan aimed at optimised management of voltage adjustment and the removal of grid constraints.

3.5 Guaranteeing a robust grid and dampening low-frequency inter-area oscillations

In the context of the energy transition, a gradual integration into the electricity system of renewable source plants interfaced with the grid with inverters is provided for; this will entail a sizeable reduction in conventional generation. The generation mix of the near future will bring ever-increasing attention to the phenomenon related to **System Robustness**, understood as the ability of the electricity system to maintain or control the voltage waveform at any node of the grid following a fault or disruption. In other words, System Robustness defines how rapidly the system manages to return the grid to normal operation following an issue that alters its operation. As the grid becomes more robust, there is an increase in the ability of the system to keep the voltage profile stable at the nodes when disruption occurs.

The grid of the future will have to handle the gradual reduction in robustness attributable to the rapid replacement of conventional generation facilities with distributed inverter-based generation through the efficient use of the services introduced by future grid developments (AC/DC converter substations).

The further actions necessary to deal with these transformations, as well as increasing the robustness of the system (e.g. CS, STATCOM, shunts), must enable a more effective directionality of the power flows to areas of high load, helping to maintain grid parameters within the quality standards provided for.

A different and increasingly “active” electricity grid is therefore necessary, with respect to the grid we had in the past, with a greater exchange capacity between internal market zones and interconnections, and with more efficient and stronger approaches to cope with electricity systems increasingly characterised by inverter-based resources, increased demand for electricity and greater complexity in a system that balances supply and demand in real time.



4.1 Reference scenario

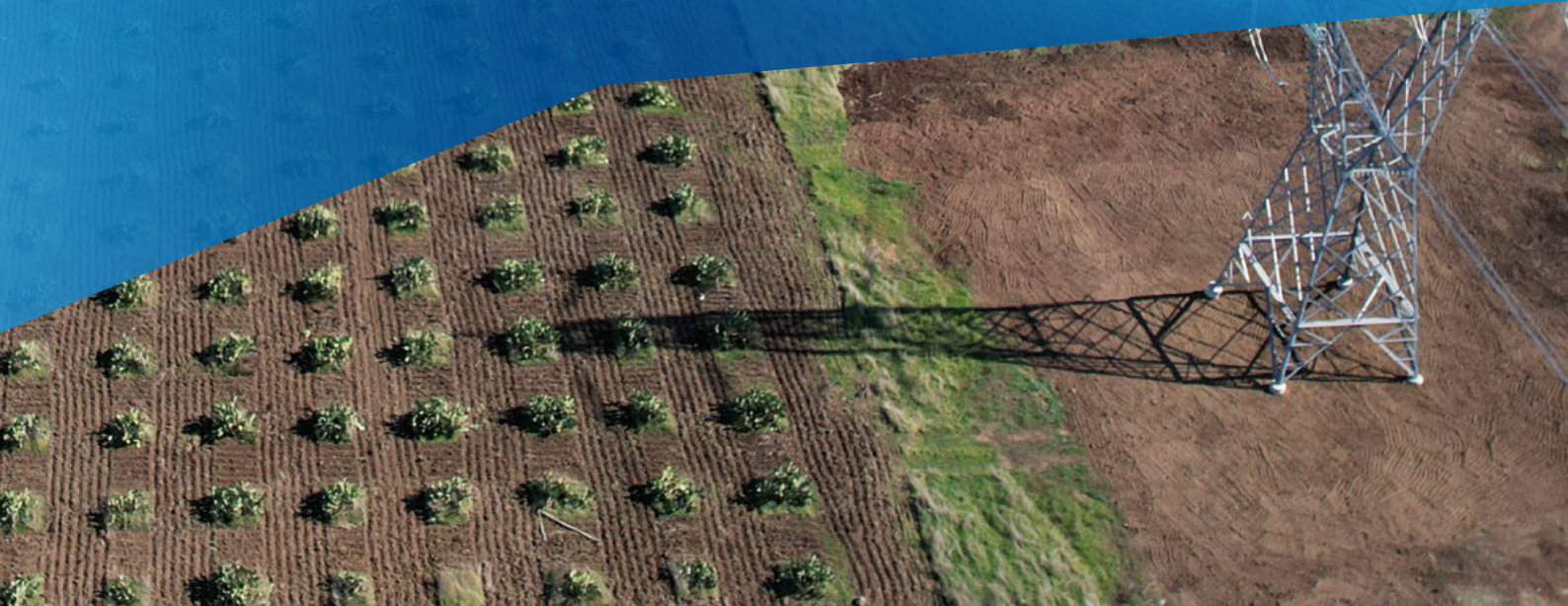
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4.2 The solutions offered by Terna

51



4 Efficient Territorial Planning



Efficient Territorial Planning

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4.1 Reference scenario

The management of connection requests submitted by proposing parties provides Terna with an overall view of how the energy system is evolving. On this basis, it is essential to conduct **an in-depth analysis of the evolution over time of all requests** to identify the critical points to be considered in the planning of the national transmission grid (NTG), the development of infrastructure and the identification of new tools, with the aim of ensuring the utmost efficiency in the implementation of work on the grid.

Particularly in recent years, there has been **constant growth in the number of requests to connect to the grid** received for all types of user. These are even higher when compared with the medium-term targets set by the NECP Policy scenario through to 2030.

The magnitude of the phenomenon requires the consideration of **new variables in grid management** in view of Terna's regulatory obligation to connect all requesting parties to the NTG. For example, it is necessary to manage:

- a lengthening of the permitting process, due to the large number of requests submitted to the permitting bodies, and the need to manage the complexity of the technical working groups set up to allow for the coordinated design of the NTG works needed to connect several parties submitting requests concerning the same portion of the NTG;
- the potential oversizing of planned grid reinforcements to enable connection to the NTG, considering that only part of the new initiatives for which connection is requested will actually be authorised to and/or carried out.

In addition, the market is partially capable of recognising signals regarding transmission grid saturation, i.e. detailed indications within individual market zones regarding the availability and/or capacity of the grid to accommodate new generation capacity.

In any case, Terna has been increasingly committed in recent years to **ensuring data transparency and accessibility**. One example of this is the **Econnexion** platform, created in February 2023 for the benefit of industry players, the first digital dashboard on RES connection requests. This is a **consultation tool** with which Terna shares information on **the regional and local distribution of renewable connection requests** broken down by source (photovoltaic or wind, onshore and offshore), in terms of the number of initiatives and the associated capacity.

Context and energy scenarios	Market trends and regulatory environment relating to the energy transition	Objectives to be pursued, NTG development strategy and investment in the new Development Plan	Efficient territorial Planning	Investment and expected benefits of the new Development Plan	Structure of the 2025 Development Plan
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4.2 The solutions offered by Terna

In light of the challenges posed by the energy transition and the increase in requests for connection to the NTG, Terna must make an increasingly functional contribution to the way local interconnection infrastructure is planned, adopting a new paradigm for more efficient and synergic energy planning between local areas, infrastructure and the management of connections.

To this end, Terna has defined a **new model** - called **Efficient Territorial Planning** - to ensure efficiency in the construction of grid works enabling the connection and integration of new resources, minimising costs for the system and the impact of infrastructure on local areas. The new model aims to mitigate the aspects described above, by:

- **defining and updating micro-zones**, portions of the NTG within market zones, in which it is possible to define and compare:
 - a “capacity offer”, defined as the additional RES capacity that can be integrated locally into the transmission grid in light of future grid developments;
 - demand, in terms of requests for the connection of new plants, characterised on the basis of various aspects (e.g. technology, progress in the grid connection process, local constraints).

The aim is to make information transparent to the market, proposing parties and all players involved, to enable informed decision-making, taking into account all constraints and aspects that affect and enable infrastructure developments;
- the definition of **“micro-zonal” connection solutions** in order to streamline the requirements for the construction of the new grid works necessary for the full integration of RES and storage. The expected benefits are greater speed in obtaining authorisation, thanks to a decrease in the time needed to complete the process and acceleration of the commissioning of new plants, as well as the potential simplification of technical working group procedures. This also results in lower overall system costs and a reduced local impact of grid works;
- **management of the connection process for authorised interventions** in accordance with final micro-zonal solutions, also reviewing the solutions already issued according to the principle of transparency.

The **innovative path** starting with the 2025 Development Plan already considers the introduction of two **key tools to promote the efficient planning** of NTG infrastructure:

1. The **portal called TE.R.R.A.** (Territorio, Reti, Rinnovabili, Accumuli - Territory, Grids, Renewables, Storage), the core of the sharing and transparency model, established in accordance with article 9 of Law Decree 181/2023 (the Energy Security Decree), which laid out several provisions to promote the efficient planning of NTG infrastructure, in coordination with the development of RES plants and storage systems. This is an integrated digital platform that includes:

- a. data and information on NTG development initiatives, requests for connection to the NTG of RES plants, storage and consumption plants;
- b. monitoring reports, prepared by Terna, on the progress of procedures for connection to the NTG with a view to achieving the 2030 and 2050 decarbonisation targets.

The platform can be accessed by the Ministry of the Environment and Energy Security, the Ministry of Culture, ARERA, regional authorities and the Autonomous Provinces of Trento and Bolzano, and, at a later stage, also by economic operators interested in the development of RES and non-RES plants, storage systems and consumption plants. Procedures for access to the portal's content by the parties listed above have been defined by ARERA.

2. The **definition of “micro-zones”**, sub-regional (and, therefore, sub-zonal) portions of the NTG that make it possible to model the main intrazonal constraints on energy transmission and define a coherent scope on which to study overall connection solutions and remaining capacity and quantify the additional RES capacity that can potentially be integrated into the NTG, also in view of expected grid developments. These will be published and updated periodically on Terna's website, after defining, in agreement with Ministry of the Environment and Energy Security and ARERA, the level of data and information disclosure.



FOCUS

TE.R.R.A.

The energy transition process requires a common commitment at national level to achieve the challenging decarbonisation goals outlined in Italy by the National Energy and Climate Plan: this is why the Energy Decree has assigned Terna the task of creating a new digital portal to enable and promote efficient territorial planning of the country's energy infrastructure.

TE.R.R.A. is the integrated digital platform, online as of June 2024, that Terna has made available to national and local administrators, legislators and proposing parties for consulting strategic and relevant information on Territory, Grids, Renewables and Storage. It is a cutting-edge institutional communication tool that aims to promote the utmost data and information transparency, promote rationalisation and optimisation in the planning of electricity infrastructure and support the stakeholders involved, including through continuous monitoring and progress reports on the electricity grid and system provided by Terna.

Confirming the constant work done on data quality and process and system digitalisation, the platform contains a huge wealth of information on connection request status - around 7,400 renewable plants, storage systems and consumers with connection solutions accepted by the proposing parties - and the geographical location of more than 41,000 plants in operation. Also by using navigable multilayer maps, it is possible to consult the necessary development work, planned development work and existing power lines, the registry of plants already in operation and progress made in new connection initiatives.

The TE.R.R.A. portal therefore provides the Ministry of the Environment and Energy Security, the Ministry of Culture, the Regulatory Authority for Energy, Networks and the Environment (ARERA) and regional authorities and the Autonomous Provinces of Trento and Bolzano with timely and detailed access to data and the content of monitoring reports on the progress of plant connection procedures, with a view to achieving national and European decarbonisation targets in the medium and long term (to 2030 and 2050).



5 Investments and expected benefits of the new Development Plan



5.1 The main expected benefits

56

Investments and expected benefits of the new Development Plan

5

5.1 The main expected benefits

With the 2025 Development Plan, Terna intends to enable the energy transition and achieve the environmental objectives outlined by EU regulations in both the medium and long term, by delivering an investment programme worth more than **€23 billion** over the 2025-2034 ten-year period.

The investment set forth in the 2025 Development Plan, enabling the achievement of **system benefits**, is grouped into the following main categories: **Non-RES Connections, RES Connections, Large HVDC and Hypergrid Projects, Interconnections, EHV Interventions**.

The projects planned, particularly those belonging to the HVDC - Hypergrid Layer, allow for a more integrated and robust electricity system capable of optimising energy transmission against the unpredictability of renewable production, with the aim of reducing overall system costs for end consumers.

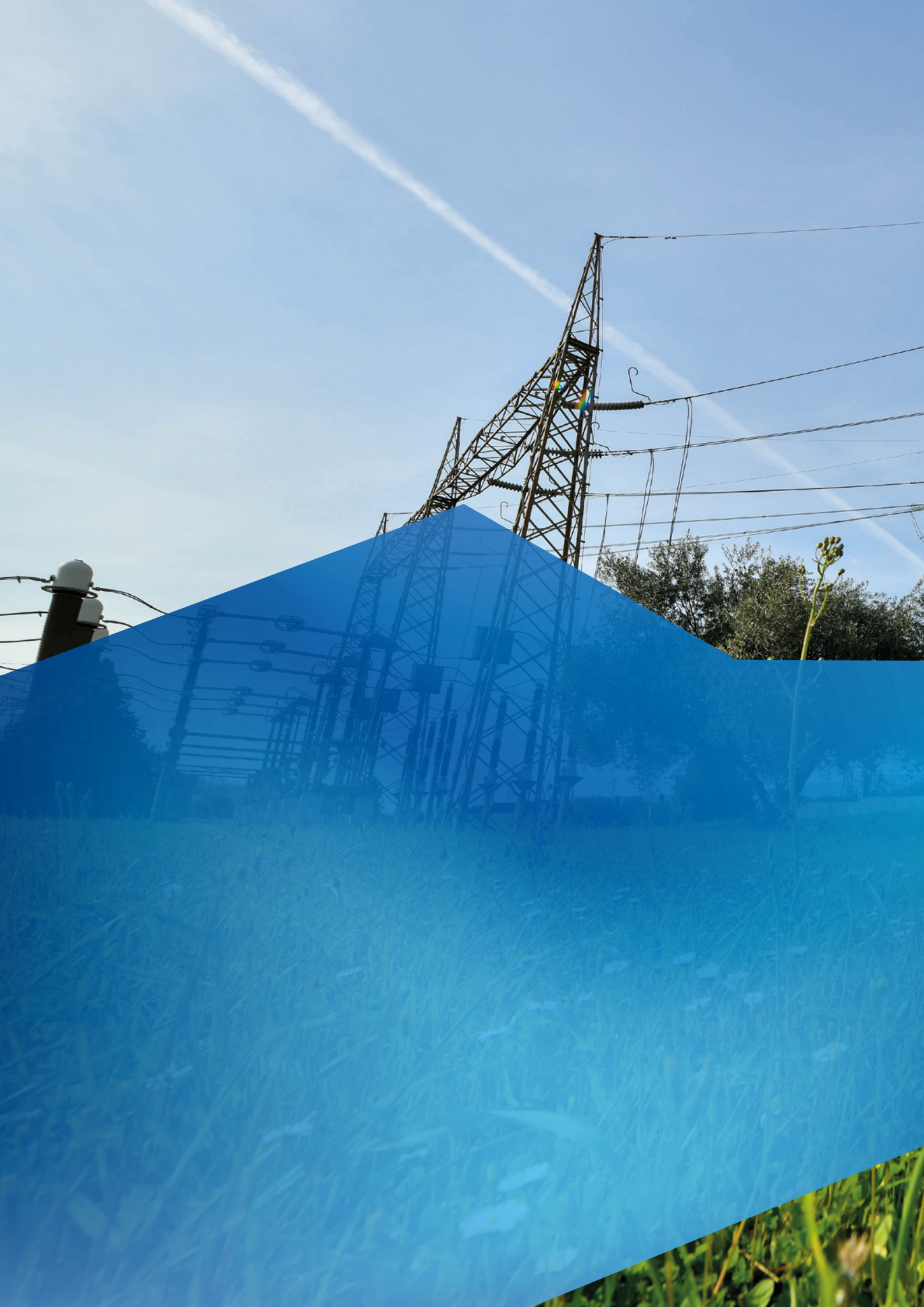
The **cost-benefit analyses** carried out also confirm the full sustainability of development interventions based on robust system utility indexes (SU).

The benefits brought to the system can be expressed as follows:

- an **increase in transmission capacity between market zones from the current 16 GW to over 35 GW**, enabling the transmission of renewable energy produced in the south to the large consumption centres in the north of the country, resulting in a more stable, secure, robust and adequate electricity system of the future. All development work is planned with a view to minimising environmental impact, upgrading and increasing the efficiency of portions of the grid for the benefit of the entire electricity system from a medium- to long-term perspective;
- an **increase in cross-border transmission capacity**: the planned interconnections are intended to increase system security and reliability, through the possibility of mutual aid between interconnected systems, to diversify the supply of the production mix and achieve greater resource availability in market balancing services. Overall, future interconnections (Switzerland, Austria, Slovenia, Greece and Tunisia) will make it possible to **increase cross-border exchange capacity by around 40% compared with current levels**;

Context and energy scenarios	Market trends and regulatory environment relating to the energy transition	Objectives to be pursued, NTG development strategy and investment in the new Development Plan	Efficient territorial Planning	Investments and expected benefits of the new Development Plan	Structure of the 2025 Development Plan
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- **reduced congestions:** without development initiatives, the horizon years 2030, 2035 and 2040 will see an increasing amount of congestion along the south-north axis, due to the increasing RES capacity installed in the south. Specifically, the Central South-South and South-Central North sections represent the most critical sections: by 2040 they are affected by 2,800 and 5,000 hours of congestion, respectively, and constitute a limit for the transit of renewable energy from south to north. Development will lead to a significant reduction in congestion hours throughout the sections mentioned, reaching 300 and 1,100 hours by 2040, respectively. In this context, the Milan-Montalto Hypergrid links and the Adriatic Backbone play an important mitigating role, by bypassing the most critical sections and conveying energy directly to load centres;
- **greater integration of RES:** on the basis of the objectives defined by the new 2024 NECP, the Italian electricity sector is facing its most ambitious challenge ever, namely to install at least 65 GW of new renewable capacity by 2030, of which around 49 GW from solar photovoltaics and 16 GW from wind power. Grid infrastructure development is a strategic element to facilitate the efficient integration of renewable generation. In particular, the implementation of the Hypergrid project, by enhancing energy transfer capacity between the different zones, will significantly **reduce overgeneration phenomena** by minimising the need to limit production from renewable sources. The benefits of the infrastructure upgrade and the resulting increase in transit limits not only ensure a more effective energy transfer from the south to the north, but also extend to **improved flexibility in reserve management** by optimising mutual support capabilities between the different system areas. Development works have an impact on exchange limits and allow for substantial renewable integration, **reducing total system overgeneration by about 70%**;
- **minimisation of losses:** the large-scale integration of renewable energy sources, together with the need to transmit larger amounts of energy on the grids, inevitably leads to an increase in losses. These can be even more significant in a grid that lacks advanced power flow control tools, a need that HVDC technology addresses. The choice of direct current transmission (HVDC) is in fact an optimal solution for the controlled transmission of energy over distances in the order of hundreds of kilometres. Indeed, compared with an equivalent AC system, it keeps overall losses (including converter station consumption) at lower levels;
- a **reduction in CO₂ emissions:** in addition to reducing losses at system level, the actions included in the Plan also contribute to reducing CO₂ emissions, reflecting Terna's significant commitment to combating climate change. By 2030, an overall reduction in emissions of up to about 2,000 kt/year is expected, with a further decline expected in the long term, i.e. by 2040 reaching nearly 12,100 kt/year.





6

Structure of the 2025 Development Plan



Structure of the 2025 Development Plan



The 2025 Development Plan is structured into 6 main files and 3 technical annexes, with its contents organised by subject area and technical details, also in line with regulatory and legislative provisions.

The **six files** enhance the content through a structure that focuses on the main themes and innovations in the 2025 Development Plan. In particular, the “Efficient Territorial Planning and Connection Requests” file represents a new element of this Plan and includes, *inter alia*, requests for connection to the NTG previously dealt with in a specific annex.

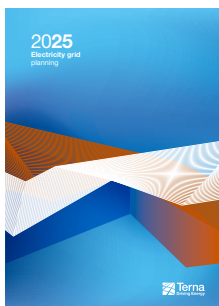
The files are structured as follows:

DEVELOPMENT PLAN - OVERVIEW



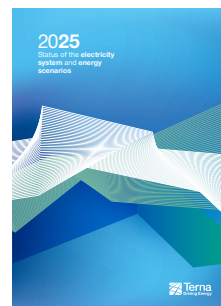
The current file describes the challenges and objectives in the current international, energy and legislative context, exploring energy scenarios and Terna's related strategy. It illustrates the main innovations and drivers underpinning the Plan.

ELECTRICITY GRID PLANNING



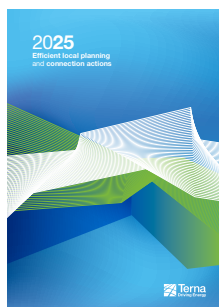
It describes the objectives, planning criteria and guidelines, Terna's role as TSO in the European and Mediterranean area, DSO coordination activities and the grid digitalisation strategy. It also describes the main national and European forms of subsidised financing and potential new asset acquisitions.

STATUS OF THE ELECTRICITY SYSTEM AND ENERGY SCENARIOS



It describes the makeup of the current grid and provides information about the electricity market and impacts of the energy transition on the electricity system, as well as the main critical issues. It presents a summary of the energy scenarios selected for the NDP, described in detail in the 2024 Scenarios Description Document (SDD).

EFFICIENT TERRITORIAL PLANNING (ETP) AND CONNECTION REQUESTS



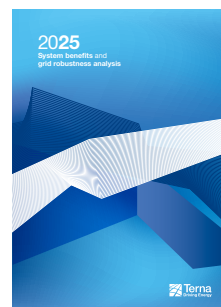
It describes the new grid development planning strategy, with a view to efficiency and greater local sustainability. It also describes NTG connection requests, with details of RES and non-RES production plants as well as capacity market units, incorporating what was contained in the annex “Renewable Evolution and Connection Requests” in the 2023 NDP.

DEVELOPMENT NEEDS: NEW PROJECTS



It provides an overview of the new developments planned, illustrating the investment plan and providing the progress status of the Hypergrid project. It describes the infrastructure works and the technological and digital solutions identified to maximise efficiency in the use of existing assets. It also provides an overview of work on cross-border interconnections.




SYSTEM BENEFITS AND GRID ROBUSTNESS ASSESSMENT



It describes the main system benefits brought about by development works and analyses the topic of grid robustness, or the future strength of the system.

The **technical annexes** to the 2025 Development Plan include further details regarding the legislation underlying the Plan, the criteria and methodologies used in the planning of the NTG and the detailed progress of the development activities already included in previous editions of the Plan.

The annexes are structured as follows:

<p>PROGRESS MADE ON PREVIOUS DEVELOPMENT PLANS</p>	<p>REGULATORY REFERENCES 2023-2024</p>	<p>METHODOLOGICAL DOCUMENT FOR THE APPLICATION OF THE COST-BENEFIT ANALYSIS APPLIED TO THE 2025 DEVELOPMENT PLAN</p>
		
<p>The three documents focusing on the progress of work on initiatives envisaged in previous Development Plans describe in detail the progress made on each development project, divided into the three geographical areas:</p> <ul style="list-style-type: none"> • Northwest • Northeast • Centre South 	<p>This provides details of the main legislative and regulatory measures issued during the 2023-2024 two-year period, as well as insight into those at European level.</p>	<p>This describes the criteria and methodology used by Terna to assess the NTG infrastructure development projects included in its ten-year Development Plan.</p>

All 2025 Development Plan documents can be consulted online at www.terna.it





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