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Bolstering the electricity grid: A priority to achieve Romania’s 2030 decarbonisation objectives

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About EPG:

Energy Policy Group (EPG) is a non-profit, independent think-tank specializing in energy and climate policy. EPG does evidence-based policy analysis on the decarbonization of the energy, industry, buildings and transport sectors. Its geographical focus is mostly the European Union and Southeast Europe, yet its analyses are informed by the global markets, technology, and geopolitical trends. EPG is based in Bucharest, Romania, where it was founded in 2014.

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Cover image:

A tall metal electricity transmission tower set against a backdrop of a blue sky with scattered white clouds. Photo by Jordan Cormack on Unsplash.

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Executive Summary

Electricity grids play a critical role in the European Union's efforts to reduce greenhouse gas emissions (GHG) and become climate neutral by 2050. They must accommodate an increasing demand of clean electricity in transports, buildings' heating and cooling, industry, production of green hydrogen, and data centres. Projections indicate a surge in electricity consumption of no less than 60% between 2023 and 2030 at EU and UK level.

According to the draft NECP, Romania's electricity consumption is expected to grow by approximately 38% until 2030, from 46.5 TWh in 2021 to 64 TWh. The increase will be driven by the electrification of several economic sectors. The adoption of heat pumps, along with a steady rise in the number of electric vehicles (EVs) will visibly add to higher electricity consumption.

The European Commission (EC) estimates needed investments of €584bn in the power grids to achieve the integration of vastly increased RES generation – 42.5% by 2030. The figure includes both the distribution and transmission networks, with about of €170bn required for digitalisation (EU Action Plan for Grids, 2023). As Romania charts its course toward a sustainable and decarbonised energy future, the importance of expanding and modernising the transmission and distribution grids cannot be overstated. Grid infrastructure forms the backbone of the energy transition, facilitating the integration of renewable energy sources (RES) and ensuring a reliable and efficient delivery of electricity to consumers, as well as their empowerment according to the new electricity market design.

The investment needs for Romania's electricity grids are substantial, with **€6.8bn earmarked for transmission and an estimated €9.2 - 11.5bn required for distribution**. Such investments are essential to accommodate the growing RES capacity and to meet the targets outlined in the draft NECP. Failure to adequately invest in the power grid risks bottlenecking the transition to clean energy and Romania's ability to achieve its climate and energy objectives.

Investing in the power grid development represents a critical opportunity for Romania to modernise its energy infrastructure, enhance grid resilience, and drive economic growth. Strategic investment in grid modernisation will improve energy efficiency, reduce transmission losses, and bolster reliability, ultimately benefitting consumers and businesses alike. To realise these benefits, the following recommendations should be considered:

- Stable and clear regulatory framework that supports investments
- Increased funding from EU mechanisms such as the Modernisation Fund (MF)
- Consistence between the national strategic documents
- Ensure adequate workforce for grid development
- Prepare for a back-up scenario in which not all investment needs are met by 2030.

Sumar executiv

Rețelele de energie electrică au un rol esențial în eforturile Uniunii Europene de a reduce emisiile de gaze cu efect de seră (GES) și de a atinge neutralitatea climatică în anul 2050. Acestea trebuie să răspundă unei cereri tot mai mari de energie electrică în sectoare precum transporturile, încălzirea și răcirea, industria, producția de hidrogen regenerabil și centrele de date. Consumul de energie electrică va crește cu cel puțin 60% în perioada 2023 - 2030 la nivelul UE și al Marii Britanii. Potrivit propunerii de revizuire a Planului Național Integrat în domeniul Energiei și Schimbărilor Climatice (PNIESC), consumul de energie electrică al României ar urma să crească cu aproximativ 38% în perioada 2021 - 2030, de la 46,5 TWh la 64,0 TWh.

Comisia Europeană (CE), prin Planul de Acțiune pentru rețele (EU Action Plan for Grids), estimează necesarul de investiții în rețelele de energie electrică la aproximativ 584 miliarde de euro pentru integrarea țintelor ambițioase de capacități din surse de energie regenerabilă (SRE) asumate până în anul 2030, respectiv obiectivul de 42,5% a ponderii energiei regenerabile în total consum de energie. Această sumă include atât investițiile necesare în rețelele de distribuție, cât și în cele de transport, din care 170 mld. euro sunt necesare pentru digitalizare. Astfel, importanța extinderii și modernizării rețelelor de energie electrică trebuie evidențiată în documentele strategice ale României. Infrastructura sistemului electroenergetic constituie coloana vertebrală a tranziției, întrucât facilitează integrarea SRE, asigură livrarea eficientă a energiei către consumatori și contribuie la îmbunătățirea indicatorilor de eficiență energetică prin responsabilizarea consumatorilor potrivit noului model de piață de energie electrică.

În România, nevoia de investiții în rețelele de electricitate este majoră, fiind estimată la **6,8 mld. euro pentru transport și aproximativ 9,2 - 11,5 mld. euro pentru distribuție până în anul 2030**. Aceste investiții sunt esențiale pentru preluarea producției de energie din surse regenerabile care va crește substanțial în perioada următoare și implicit atingerea obiectivelor din PNIESC. În lipsa acestor investiții în rețelele de energie electrică, România riscă neîndeplinirea obiectivelor climatice.

Investițiile în dezvoltarea rețelelor de electrice reprezintă o șansă importantă pentru România din perspectiva modernizării infrastructurii energetice, a sporirii rezilienței sistemului și a stimulării creșterii economice. În vederea realizării acestor investiții, facem următoarele recomandări:

- Un cadru de reglementare stabil și clar, favorabil investițiilor
- Creșterea finanțării prin mecanismele financiare UE, precum Fondul de Modernizare
- Asigurarea coerenței între documentele strategice naționale
- Asigurarea unei forțe de muncă calificate pentru dezvoltarea sistemului electroenergetic național
- Pregătirea pentru un scenariu de back-up, în care necesarul de investiții estimat nu va fi realizat până în anul 2030

Acronyms

ANRE	National Energy Regulatory Authority
bn	billion
CEE	Central and Eastern Europe
CFE	Connecting Europe Facility
DSO	Distribution System Operator
EC	European Commission
ENTSO-E	European Network of Transmission System Operators
EPG	Energy Policy Group
ESO	Electricity System Operator (Bulgarian TSO)
EV	Electric Vehicle
EU	European Union 27
FACTS	Flexible Alternating Current Transmission System
GW	Gigawatts
HV	High Voltage
HVDC	High Voltage Direct Current
IEA	International Energy Agency
kWh	kilowatt-hour
LV	Low Voltage
LTS	Long Term Strategy
MF	Modernisation Fund
mil	million

MV	Medium Voltage
NECP	National Energy and Climate Plan
OHL	Overhead Lines
PCI	Project of Common Interest
RES	Renewable Energy Sources
SEE	Southeast Europe
TSO	Transmission System Operator
TYNDP	Ten Year Network Development Plan

Introduction

The energy transition involves significant changes to the electricity systems, both on the demand and supply sides, greatly impacting the transmission and distribution grids. According to the International Energy Agency (IEA, Electricity Grids and Secure Energy Transitions , 2023), achieving the national energy and climate goals worldwide will require adding or refurbishing over 80 million km of network by 2040, equivalent to the entire current global grid. More than 3,000 GW of renewable power projects are awaiting connection, and the grid's flexibility requirements grow as the latter get increasing network access.

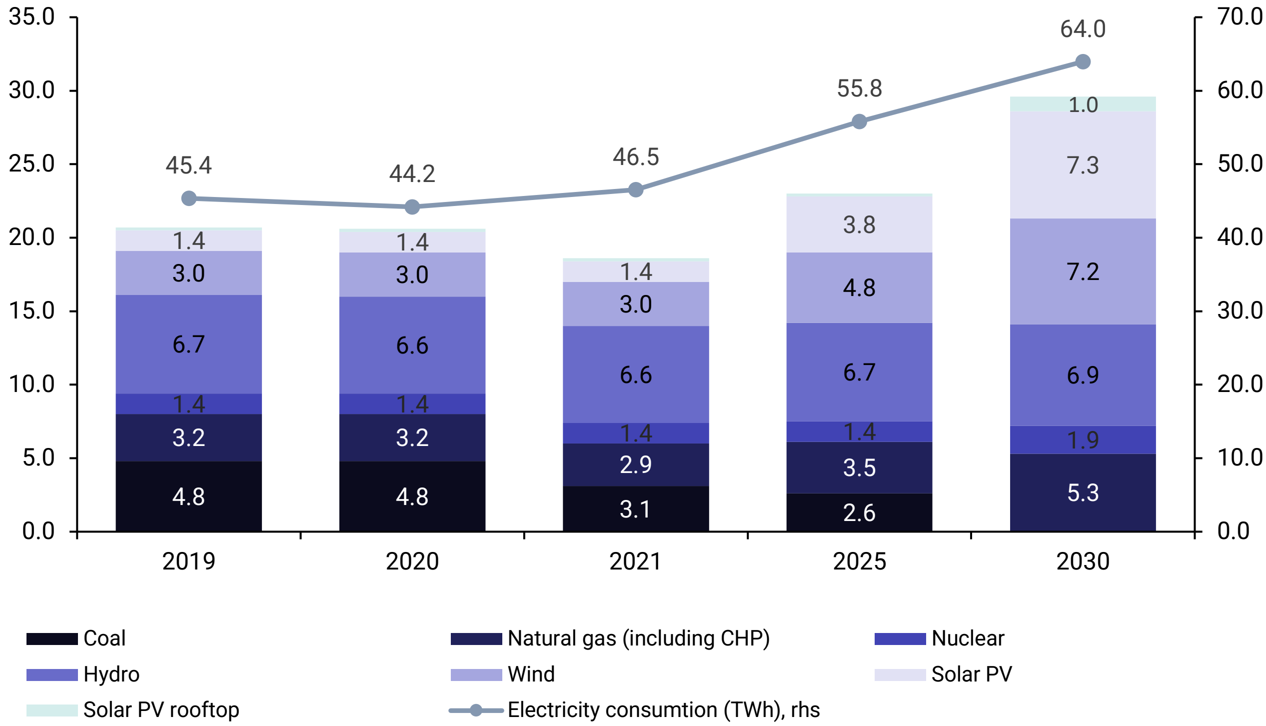
To address these challenges, planning across sectors needs updating and integration, and the regulatory frameworks for grid operators' remuneration require revision. Grids have become a bottleneck for energy transitions, but investment is on the rise, according to IEA. After being stagnant at around $300bn/year since 2015, spending is deemed to reach $400bn in 2024, driven by new policies in Europe, the United States, China, and parts of Latin America. Advanced economies and China account for 80% of global grid spending (IEA, World Energy Investments 2024, 2024).

In Europe, the power grids must accommodate an increasing demand of clean electricity in transports, buildings' heating and cooling, industry, production of green hydrogen, and data centres. Projections, according to the EU Action Plan for Grids (EC, European Comission, 2023) indicate a surge in electricity consumption of no less than 60% between 2023 and 2030 at EU and UK level. The RePowerEU Plan (EC, RePower EU Plan , 2022) envisages a significant expansion of wind and solar power generation, from 400 GW in 2022 to at least 1,000 GW by 2030, with offshore wind alone expected to reach 317 GW.

Romania's energy mix is also poised for a major transformation, with a growing focus on clean energy sources. By 2030, if all the investments outlined in the National Energy and Climate Plan (NECP, 2023) are realised, the total installed capacity will reach 30.4 GW, an increase of over 38% from the current 18.6 GW (Transelectrica, 2024). While hydropower's contribution will remain relatively stable, wind and solar power are expected to grow substantially from 4.4 GW in 2021 (4.6 GW in April 2024) to over 15.9 GW[1] in 2030 – see Figure 1. As a result, the share of renewable energy sources (RES) in the electricity mix is projected to rise from 42.5% to 55.8%, relying on modernisation and digitalisation of the grid to accommodate an increased supply of intermittent energy.

[1] Prosumers are not accounted. They reached 1.4GW in Q12024.

Figure 1. Installed capacities and electricity consumption by 2030 (GW lhs, TWh rhs)



Source: Draft NECP (EC, 2023)

According to the national Long-Term Strategy (LTS) for decarbonisation and the revised draft NECP, Romania's electricity consumption is projected to grow by approximately 38% until 2030, from 46.5 TWh in 2021 to 64 TWh in 2030. The increase will be driven by growing electrification in several economic sectors. The adoption of heat pumps, along with a steady rise in the number of electric vehicles (EVs) will significantly add to higher electricity consumption.

According to the Romanian Transport System Operator's (TSO) Ten-Year Development Plan (TYDP 2024-2033), by 2030 there will be more than 300,000 EVs on Romania's roads. While the NECP modelling does not advance a figure for the electric and hybrid-electric vehicles by 2030, it mandates the installation of at least 16,086 fast charging stations of at least 50 kW each, and at least 12,083 standard power charging stations.

1. The Electricity Transmission Grid

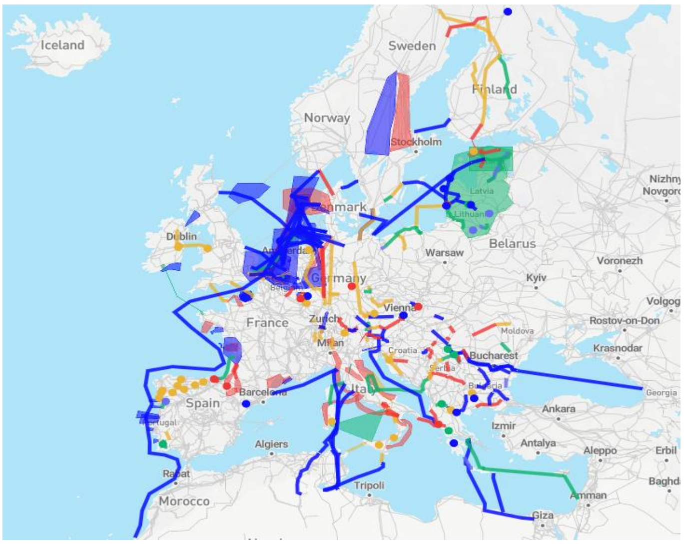
1.1 Context

To meet the EU's ambitious decarbonisation targets for 2030, there are, according to ENTSO-E, several milestones related to the power grid:

- 64 GW of interconnection capacity increase after 2025 on over 50 European borders.
- 17 TWh of curtailed energy saved each year.
- 9 TWh/ year decrease of dependence on gas for power generation.
- 14 Mt CO_2 emissions avoided yearly.
- €5bn/year decrease in power generation costs.
- 15 GW investment shortfall in the transmission power grids.

The most concerning is **the investment gap required** for transmission projects necessary to meet the needs of the European power system, and the Romanian power grid is no exception. Figure 2 shows the mapping of transmission and storage projects across Europe, at various stages of completion. These investments account for new renewable capacities, storage, and other technologies that increase the flexibility of power grids.

Figure 2. ENTSO-E TYNDP 2024 Projects Mapping



Source: ENTSO-E

Strengthening the national power transmission network ought to help the absorption of new RES capacities, among other benefits. Some types of investments could increase the power system's availability, depending on different technical factors such as grid area, number of electrical substations and power lines, voltage level, number of consumers and generation points, etc. There are several kinds of investment that bolster the power grid by unlocking new generation capacities:

A. Extensions of existing HV electrical substations or construction of new HV electrical substations, depending on the power level that needs to be connected to the electricity grid. Electrical substations are complex assets for the grid operators. It is where the energy generated by different power plants is evacuated and switched to higher voltage levels, for long-distance transmission. At the same time, they provide switching to lower voltage, adapted to the DSO needs. Depending on the technical characteristics of an electrical substation and the space available on the substation's land for subsequent extensions, as well as the capacity of lines that can be additionally connected, the choice will be based on a technical study for the best option – extending the existing substation or building a new one.

B. Upgrading/Reconductoring existing HV power lines or construction of new ones. Since the construction of new power lines is a long and complex process, because of the needed permits, expropriations, and other technical challenges, there are other options for increasing the capacity of existing power lines, such as **reconductoring**.

There are two basic types of reconductoring: if the voltage level is kept the same, only the electrical conductors will be replaced with new ones of superior technical parameters, able to ensure the flow of stronger current levels at lower power losses. If, on the other hand, the voltage level is lifted to a higher one, a new electrical substation for the higher voltage level should be built, the power transformers on the substations should be replaced, as well as both the electrical conductors and the transmission towers – on the same footprint as the previous towers, though they provide a much higher power capacity to the power line.

The alternative is constructing new power lines. Although these investments take more time, they enhance the power system's resilience and increase power availability to the grid. Depending on the length and purpose of the power line, a decision must be made between conventional HV and HVDC options. HVDC technology is typically used for long-distance terrestrial applications (more than 500 km) or submarine applications, such as evacuating offshore wind power, for lines longer than 50 km (Electrical Deck, n.d.).

C. FACTS Technology (Flexible AC Transmission Systems), which refers to power electronic-based systems and other static equipment that provide control of one or more AC transmission system parameters to enhance controllability and increase power transfer capability. FACTS is a generic term for a family of technologies that can dramatically increase the capacity of existing transmission power grids. While they cannot increase the rated capacity of a transmission line, they can modify the electrical parameters of the line to increase the quantity of power that is transferred.

The main types of FACTS technologies used by TSOs are STATCOM (Static Synchronous Compensator) and SVC (Static Var Compensator). Both STATCOM and SVC installations can be vital for a TSO in enhancing the stability, efficiency, and capacity of the transmission grid by providing fast voltage control, reactive power management, dynamic stability support, and power quality improvement. Although both STATCOMs and SVCs serve similar functions, the choice between them depends on specific grid requirements and cost considerations, with STATCOMs generally being more expensive due to their faster response time.

FACTS facilities can solve some of the main bottlenecks occurring in the development of RES capacities – such as voltage and power factor fluctuations resulting from the intermittent generation – by continuously and rapidly correcting this parameter using power electronic equipment. FACTS enable more power transfer and thus represent an important support to the dispatch centres of the TSOs. Undoubtedly, this technology is among the best solutions so far in terms of flexibility, stability and efficiency of the transmission power grids.

D. Digital Technologies. As digitalisation has become part of every industrial process, the power system has also seen in recent years a remarkable development in this direction, with new technologies developed to solve different operational challenges. A digital technology that has gained popularity with the power grid operators thanks to the advantages it brings in maximising the capacity on the power lines is **DLR** (Dynamic Line Rating). DLR uses a set of sensors that are installed on the power lines. Responding to the environmental conditions, the digital system provides information about how much more could the power line's load be increased before reaching its thermal limit. Thus, depending on the timeframe when large quantities of energy must be evacuated in the power system and on the weather conditions, the capacity of the power lines is increased to the maximum potential of conductors. From the static operation baseline of a power line, the DLR technology can increase capacity on the lines by 30-50%.

Such investments are already being implemented by TSOs all over Europe. For its part, Transelectrica has projects in different phases of implementation, including the mentioned new technologies of FACTS (in five electrical substations: Bradu, Sibiu Sud, Gutinaș, Roșiori, and Suceava) and DLR (on 23 OHL power lines, including 13 power lines for evacuating high energy generation in Dobrogea and 10 interconnection power lines) (Transelectrica, 2023).

Nonetheless, with the expected RES capacities that will be connected to the grid in different regions of the country, more challenges to the operation of the power grid will likely come up, so new investments should be prepared to maintain system resilience in the future. This responsibility should not rest on the TSO's shoulders alone, but ought to be shared with the government, the regulatory authority, and other relevant stakeholders.

The European Commission estimates needed investments of €584bn in the power grids to achieve the integration of vastly increased RES generation – 42.5% by 2030. This figure regards both the distribution and transmission power systems, with about of €170bn for grid digitalisation (EC, 2023).

Investment in the European transmission power grid is determined by the national TSOs, in line with the anticipated development of national power systems concerning generation capacities and consumers. The planned investments are outlined in the TYNDPs, which are approved by national regulatory authorities. These plans are crafted based on extensive analyses of power systems. The type of projects and the financial resources allocated to TSOs may vary from country to country, influenced by factors such as:

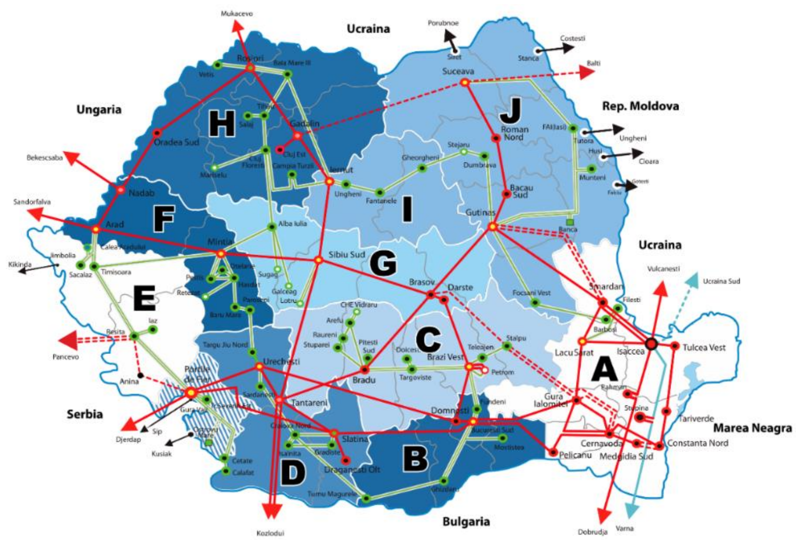
- Kilometres of operated power lines;
- Number of operated electrical power lines;
- Types of operated power lines (HV vs HVDC);
- Operated voltage levels;
- Power system profile (generation and consumption configuration);
- Location and weather conditions.

1.2 Estimated investment needs in the Romanian transmission grid

Taking a closer look at the Romanian transmission grid, several projects are highlighted in ENTSO-E's TYNDP, in Transelectrica's own TYNDP, and in the draft NECP, published for public consultation in December 2023 (Ministry of Energy, 2023). These projects, which are at different stages of development, aim to strengthen the national electricity transmission infrastructure and to consolidate the regional power grid.

The primary focus is on the development of new power lines. Most of the projects considered priorities at the EU level are depicted in Figure 3 (dotted lines).

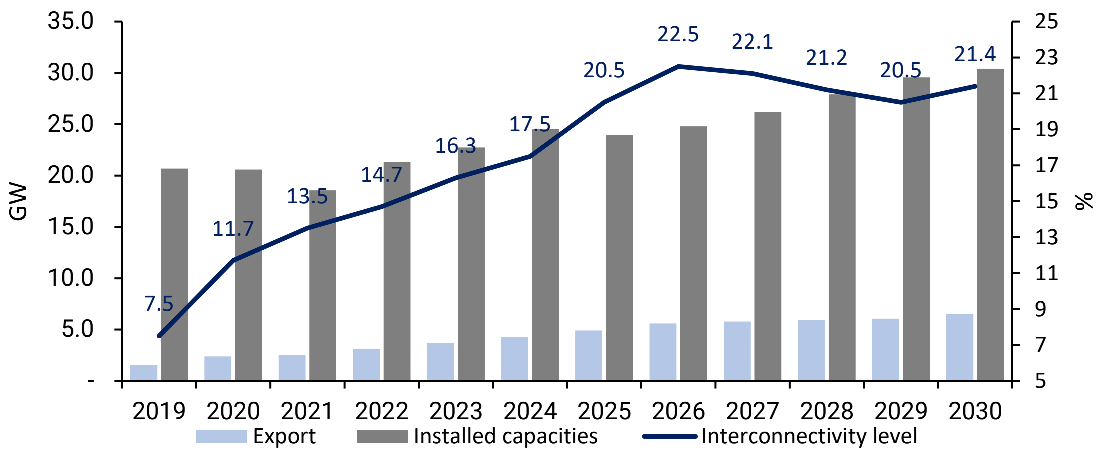
Figure 3. Transelectrica 2022, Mapping of TYNDP Projects



Source: Transelectrica TYNDP

Most of these new power line projects are part of priority regional financing clusters, categorised based on their location and contribution as presented in Table 5 – Annexes. The investment costs for these projects, which are part of various PCIs or cross-border initiatives, are detailed in Table 2, which includes the estimated years of commissioning and contribution to interconnectivity – expected to reach 21.4% in 2030 (draft NECP, 2023), exceeding the 15% target assumed at EU level. In 2022, Romania's interconnectivity level was 14.7%, as presented in Figure 4.

Figure 4. Trajectory of installed capacities and interconnection level (GW - lhs, % - rhs)



Source: Draft NECP (2023)

Table 1. Investment in the Romanian transmission power grid

<table>
<tr><th>Type of investment</th><th>CAPEX
(EUR mil)</th><th>Year of commissioning</th><th>Contribution to interconnection level</th></tr>
<tr><td>OHL 400 kV double circuit, Gutinaș-Smârdan</td><td>50.3</td><td>2024</td><td rowspan="2">-</td></tr>
<tr><td>Upgrade to 400 kV of existing 220kV Stâlpu substation</td><td>15.0</td><td>2024</td></tr>
<tr><td>OHL 400 kV single circuit, Porțile de Fier-Reșița</td><td>28.0</td><td>2024</td><td rowspan="2">+1,4pp</td></tr>
<tr><td>OHL 400 kV double circuit, Reșița-Pancevo</td><td>47.0</td><td>2025</td></tr>
<tr><td>OHL 220 kV Reșița-Timișoara-Săcălaz upgrade to 400 kV double circuit</td><td>46.9</td><td>2029</td><td rowspan="4">+2,4pp</td></tr>
<tr><td>Extension of 220/110 kV Reșița substation with new 400 kV substation</td><td>23.3</td><td>2025</td></tr>
<tr><td>Replacement of existing 220/110 kV Timișoara substation with new 400/220/110 kV substation</td><td>18.0</td><td>2028</td></tr>
<tr><td>OHL 220 kV Arad-Timișoara-Săcălaz upgrade to 400 kV double circuit</td><td>50.4</td><td>2029</td></tr>
<tr><td>OHL 400 kV single circuit Oradea-Józsa</td><td>110.0</td><td>2030</td><td rowspan="3">+2,7pp</td></tr>
<tr><td>400/220 kV power transformer Roșiori electrical substation</td><td>5.2</td><td>2027</td></tr>
<tr><td>Upgrade to 400 kV of existing OHL 220 kV Urechești-Tg. Jiu-Paroșeni-Baru Mare-Hășdat</td><td>9.2</td><td>2028</td></tr>
<tr><td>OHL 400 kV Porțile de Fier-Djerdap, second circuit</td><td>4.0</td><td>2029</td><td>+2,8pp</td></tr>
<tr><td>Other investments in the Romanian power transmission grid, such as power lines and substations modernisation and digitalisation.</td><td>1,022.6</td><td>2030</td><td>-</td></tr>
<tr><td>Total (based on TYNDP, € mil)</td><td colspan="3">1,430</td></tr>
<tr><td>Georgia-Romania Black Sea HVDC Interconnection Submarine Cable</td><td>2,118.9 (Energy Policy Group, 2023)[2]</td><td>2029 (Under Consideration)</td><td>-</td></tr>
</table>

[2] EPG estimations

HVDC Interconnector Project Romania-Hungary (Arad-Constanța Sud)[3]	*2,747.3*	*N/A (Under consideration)*	-
HVDC Interconnector Project Romania-Hungary (Albertirsa-Arad)	*393.9*	*2030 (Under Consideration)*	-
400kV OHL Suceava-Gădălin	*101.0*	*2030 (Under Consideration)*	-
400kV OHL Suceava-Bălți	*32.0*	*2027 (Under Consideration)*	-
Total (investments under consideration, € mil)	*5,393*		
TOTAL (€ mil)	**6,823**		

Source: ENTSO-E TYNDP and Transelectrica TYNDP

As listed in Table 1, there are two major power line projects, which are both in northern and northeastern Romania, and are expected to enhance the capacity of the Romanian transmission electricity grid and the level of interconnection:

- The 400 kV single circuit OHL Gădălin-Suceava will boost the grid's capacity and is one of the missing links due to complete Romania's 400 kV power Ring.
- The 400 kV single circuit OHL Suceava-Bălți will be the most significant interconnection with the Republic of Moldova.

Both power lines are scheduled for commissioning in 2030.

The projects assumed by the TSO, amounting to €1.43bn, are priorities of transmission infrastructure that will support the development of new RES and the clean energy transition. However, they alone will not be sufficient without additional reinforcement of the high-voltage (HV) power system to ensure it can handle an increased load and RES integration.

There are several planned power generation capacities expected by 2030 that urgently require power grid updates. These include a third nuclear reactor at the Cernavodă power plant (U3), as well as new RES projects, with offshore wind capacities that are expected to start delivering power as of 2032.

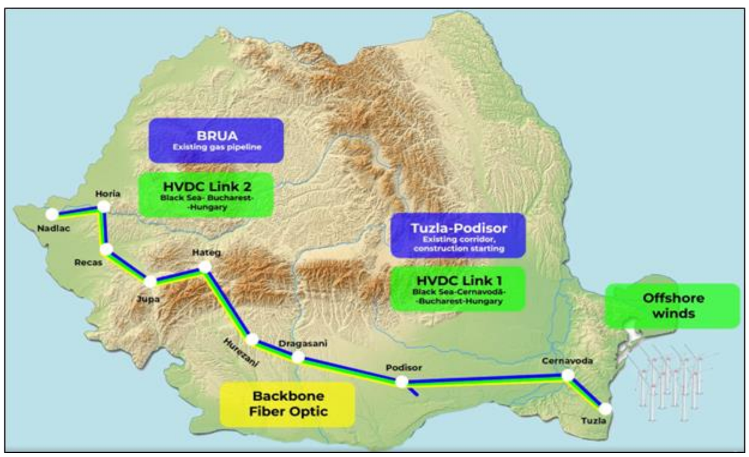
A large project currently promoted by the Romanian Ministry of Energy is a High-Voltage Direct Current (HVDC) 525 kV power line from the Black Sea coast to Nădlac (Arad County), at the Hungarian border. This initiative aims to enhance power transmission capabilities needed to accommodate offshore wind power production in the Black Sea, including the planned Georgia-Romania HVDC submarine cable. Additionally, it seeks to evacuate the excess power generated

[3] EPG estimations based on one cable (525 kV HVDC, 830 km, 2,500 MW).

in the Dobrogea region (SE Romania) to the country’s main consumption centres and to the CEE electricity markets.

The HVDC 525 kV power line is envisioned to consist of two separate 525 kV segments. HVDC Link 2 would run parallel to the existing BRUA gas pipeline for about 550 km, with a capacity of up to 2,500 MW. HVDC Link 1 would also have a capacity up to 2,500 MW and is planned to run alongside the Tuzla-Podișor gas pipeline for about 300 km. Works on the Tuzla-Podișor pipeline project officially started on 2023. Aligning the HVDC power line with the existing gas pipeline allows avoiding some of the most time-consuming challenges of infrastructure projects: land expropriations and permitting. The lead time for large-scale power line projects can exceed a decade from design to commissioning, largely due to the protracted processes of securing land rights for the installation of electrical towers and cables on privately owned properties. By using state-owned land already earmarked for gas pipelines, this approach can greatly expedite the project’s execution.

Figure 4. HVDC cable following the BRUA gas pipeline

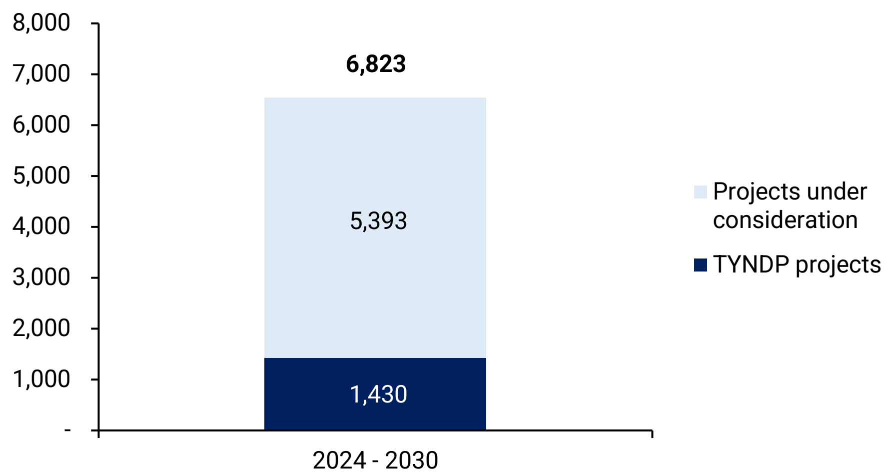


Source: Ministry of Energy Romania (Postelnicu, 2023)

Dobrogea stands out as a region with significant energy surplus compared to other areas of Romania, driven by RES development (both PV and wind power) and with plans for two new nuclear units at the Cernavodă power plant, as well as offshore wind projects. Clearly, the ongoing enhancements to the power grid will not suffice. The HVDC project would bring a sizable contribution to unlocking the region’s energy potential. There are no official financial estimates as yet for this HVDC project (Transelectrica a. , 2023). However, an EPG analysis (EPG, 2023) that has gauged the average cost per km for similar large-scale national connection and interconnectors developed in Europe in recent years estimated for the project an average cost of €3.31 million/km. Thus, the project’s total cost will amount to about €2.75bn.

Considering the projects in the latest approved TYNDP (2022-2031) and those under consideration, we estimate a need for €6.8bn of investment in the transmission electricity grid by 2030, as shown in Figure 5. This amount is nearly five times greater than the value assumed in the current TYNDP. These investments will be crucial to accommodate the additional RES proposed in the draft NECP, particularly considering the potential increase in the RES target, as recommended by the Commission (EC, 2023).

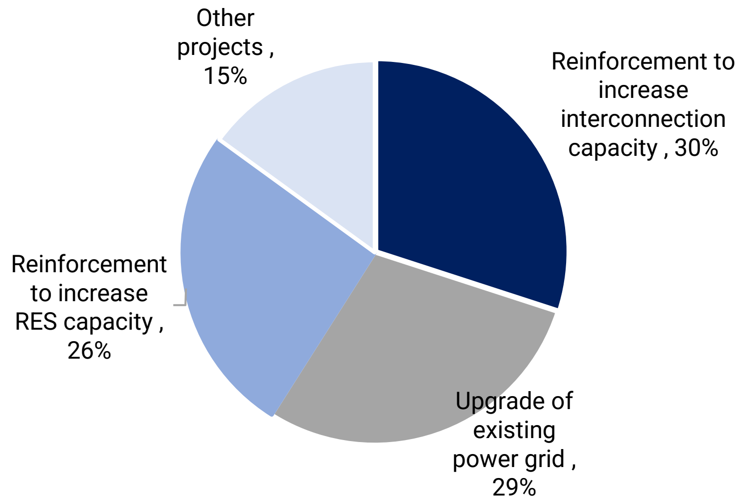
Figure 5. Estimated investment in the Romanian transmission power grid (EUR mil)



Source: ENTSO-E TYNDP, Transelectrica TYNDP, public statements, EPG estimations

Out of the assumed TYNDP value of €1.43bn, 29% will be used to upgrade the existing power lines and substations, 26% to increase the integration of new RES in the national power system, and 30% to increase the interconnection capacity with the neighbouring countries (Transelectrica, 2023) (AGERPRES, 2022), as presented in Figure 6.

Figure 6. Investments in the transmission power grid allocated according to the TYNDP



Source: TYNDP 2022/24-2031/33

Although Transelectrica's 2024-2033 TYNDP, launched for public consultation in April 2024, acknowledges the new capacities from the draft NECP, it does not adjust the investment needs to align with these targets. The investment value remains at €1.43bn, despite the reviewed RES and interconnection targets compared to the current approved plan (2022-2031).

1.3 Funding sources for Romania's electricity transmission grid

A critical factor in meeting Romania's decarbonisation targets through power grid development is securing adequate funding. Underwriting the required large-scale investments, as mentioned, through higher transmission tariffs could increase price pressure on the end consumers. On the other hand, the availability of public funds and the TSO's own financial resources are limited. Therefore, alternative funding mechanisms must also be tapped into.

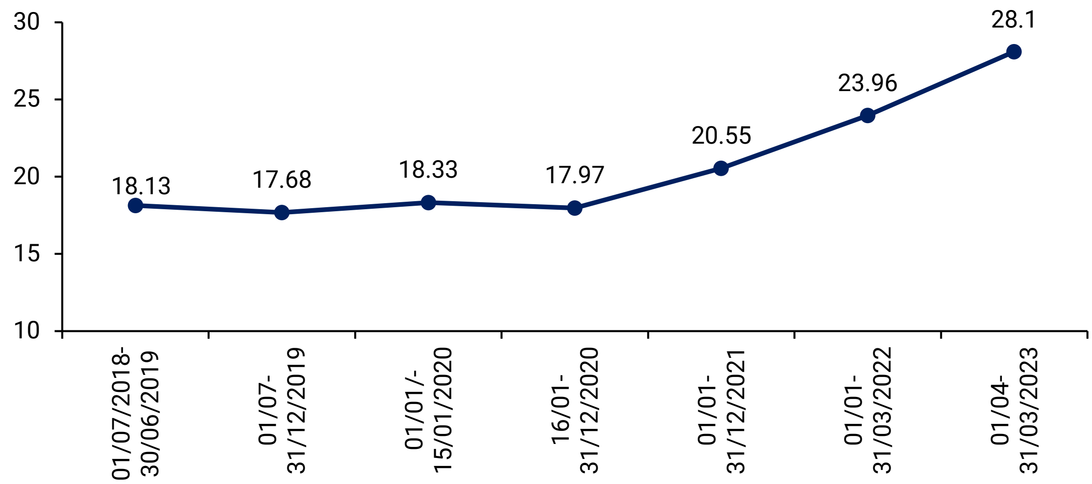
The main financing mechanisms available for power grid investments are as follows:

- **Transport tariff-based revenue.** The framework is governed by ANRE, which sets the rules and guidelines for the tariff structure (current ANRE Order No. 68/2023). The tariff covers the costs of transmission services, including operational costs, maintenance, and necessary investments for network expansion and modernisation and expenditures for acquiring energy to cover network losses[4] through revenue cap. It is collected from

[4] Own technological consumption as well as payments to distributors for providing transmission services on their 110 kV lines.

consumers via their electricity invoices. For example, the transport tariff typically makes up 5-7% of the total monthly invoice for a household consuming 100 kWh of electricity. This revenue serves as the primary source of investment for the TSO. Between 2019 and 2023, the average transport tariff increased by 55%, from RON 18 to RON 28, with minimal impact on the consumers' invoices. However, a substantial increase in investments, coupled with a higher number of prosumers, could have a notable impact on consumers.

Figure 7. Evolution of average transport tariff (RON)



Source: ANRE Report 2022

- **Modernisation Fund** (MF). The MF plays a vital role in supporting the transition to climate neutrality for 10 lower-income EU Member States, including Romania, by financing the modernisation of their energy systems. It stands as the second-largest financial source (after the tariff-based revenue) for the Romanian TSO in funding projects aimed at reinforcing and digitalising the power grid. Transelectrica has signed through the MF around €450 million worth of projects, out of which €400 million is non-refundable financing for nine major projects that include power substations refurbishments, construction of new power lines, integration of smart grid technologies, and the first two FACTS installations. All these projects are expected to be commissioned by 2030 (Ministry of Energy, 2023).
- **Projects of Common Interest (PCI).** PCIs are projects identified by the Commission as a priority to interconnect the energy infrastructure in the EU. They serve as an important funding mechanism for cross-border infrastructure projects, available for both TSOs and DSOs through the Connecting Europe Facility (CEF). Several PCIs are designed to increase the grid's capacity and interconnection level, as presented in Table 5 (Annex). In addition, Transelectrica is also part, together with MAVIR and Delgaz Grid, of the CARMEN PCI proposed project,

dedicated to the modernisation and digitalisation of the power grid through smart grid technologies such as FACTS, OHL reconductoring, SCADA upgrade, regional phasor data exchange (Carmen Smart Grid Project, n.d.). However, the process of obtaining a PCI status and associated financing is quite complex (PCI, n.d.).

2. The Electricity Distribution Grid

2.1 Context

The power distribution networks have a critical role in the energy transition. The intricate web of power lines, poles, transformers, and other components ensures the safe delivery of electricity to the final consumers. Until recently, however, the distribution grids, typically operated as natural monopolies, have rather been taken for granted, even though the 'green transition' is largely tantamount to increased electrification of the economy.

Because of the inherent variability of RES, of their limited or total lack of dispatchability, and of the exponentially growing number of prosumers, the technical limits of the power grid have become strained, and the traditional business model of utility companies is challenged. This has occurred on top of a redefinition of the entire energy system, from centralized and mainly baseload driven to a decentralised yet less predictable one, with new consumption patterns, empowerment of the end-consumers, and more volatile energy markets.

However, if timely dealt with by the decision-makers, such challenges are an opportunity to rethink, bolster and modernise the distribution grids. This requires a massive investment boost in network expansion and modernisation (including digitalisation and automatization), supported by an up-to-date regulatory framework, able to ensure resilience and flexibility (physical and digital), as well as the ability to operate in an increasingly data-driven, multi-stakeholder, service-based power system.

Grid digitalisation is critical in navigating the intricacies of the energy transition and unlocking efficiency gains that would otherwise be inaccessible. This, again, requires investment, with funding from various sources, both public and private. The overarching goal is to ensure the grid remains capable of consistently meeting the end-user power demands (i.e., grid *adequacy*). There is also a strong need to digitalise the activities of the grid operators, by means of Information Technology (Data Analytics, Customer Experience, Enterprise Resources Management, etc.) and for further integrating OT (Operational Technology) and IT with serious focus on cyber-security.

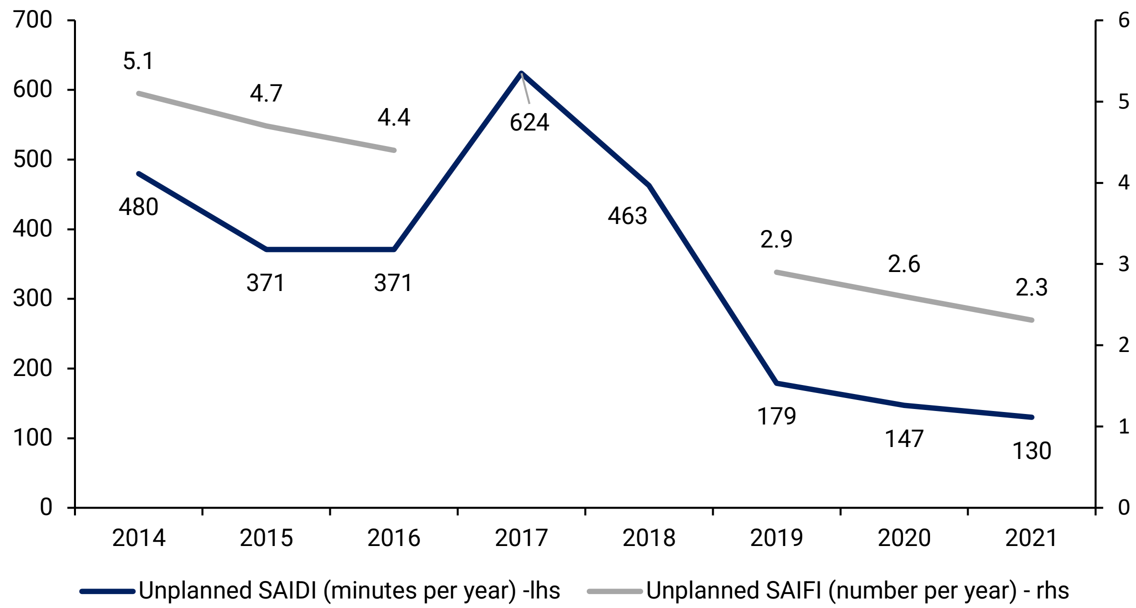
According to the EU Action Plan for Grids, **around €375 - 425bn of investment in distribution grids is necessary by 2030** for adaptation to a more decentralised, digital, and flexible system, with millions of rooftop PV panels and local energy communities collaborating in resource sharing.

2.2 The Romanian electricity distribution grids

A large share of Romania's electricity distribution grid was developed in the 1960s and '70s. Although some parts have undergone modernisation over the years, there are remaining areas that require extensive refurbishment.

The SAIDI and SAIFI indicators, as presented in Figure 8,[5] evince a positively evolving status of the distribution network. Both have decreased notably in the last couple of years – SAIDI from 480 minutes/year in 2014 to 130 minutes/year in 2021 (more than three times), and SAIFI from 5.1 unplanned interruptions per year in 2014 to 2.3 in 2021.

Figure 8. Unplanned SAIDI and SAIFI in Romania (2014-2021)



Source: CEER, National Energy Regulatory Authority (ANRE)

About 97% of Romanian households are connected to the electricity distribution system. However, there are still several isolated regions lacking grid connection.

The electricity distribution services are overseen by six[6] Distribution System Operators (DSOs), each operating as a natural monopoly within designated geographical regions. These DSOs

[5] SAIDI – System Average Interruption Duration Index; it designates the average duration of interruption per customer expressed as minutes per year. SAIFI – System Average Interruption Frequency Index; it designates the average interruptions per customer per year.

[6] After the consolidation process of DEER.

acquired ownership rights over the grid and concession rights on the public service of electricity distribution following the privatisation of previously state-owned power companies and function under a regulatory framework, with a yearly target revenue reached through distribution tariffs.

The tariffs are set by ANRE with the observance of the principles and rules from the *Methodology for establishing the tariffs for the distribution service (*currently ANRE Order No. 111/2023*)*. The regulation of distribution tariffs is based on 5-year periods (except for the first period, which only lasted three years) – see Table 2. The methodology covers the operating and maintenance costs (controllable and non-controllable) related to the power-distribution activity, costs of acquiring energy for covering network losses, depreciation of assets and a reasonable return of the invested capital (return on assets).

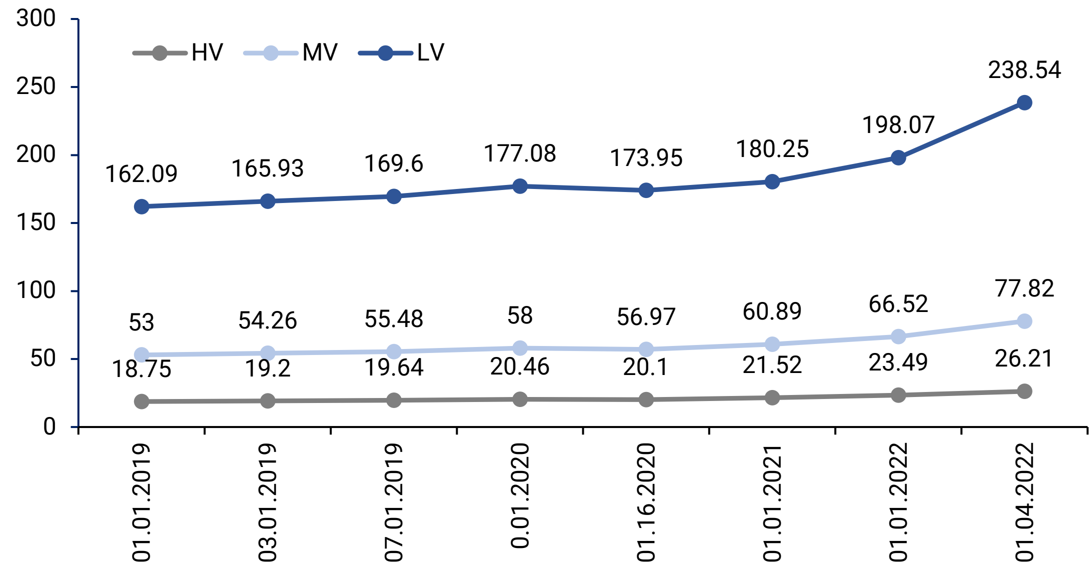
Table 2. Regulatory periods

Regulatory period	**Year of application**
I	2005-2007
II	2008-2012
Interim year	2013
III	2014-2018
IV	2019-2023
	2024 (transition year)
V	*2025 - 2028*

Source: National Energy Regulatory Authority (ANRE)

The tariff is collected from consumers via suppliers through electricity invoices. For instance, the distribution tariff makes up 30% of the total monthly invoice for a household consuming 100 kWh of electricity. This revenue serves as the primary source of investments for DSOs. Between 2019 and 2022 the average distribution tariff for low voltage increased by 47% from RON 162 to RON 239, albeit energy crisis context.

Figure 9. Evolution of average distribution tariff (RON)



Source: ANRE Report 2022

2.3 Estimated investment needs

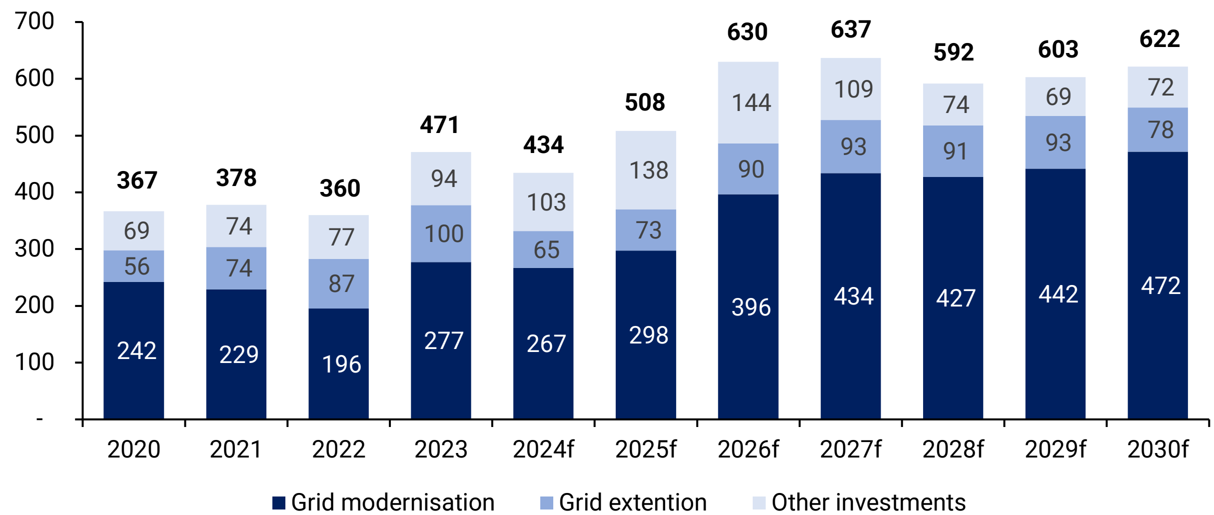
In an evolving landscape of high decarbonisation targets, with growing electricity demand on the mid-term and rising installation of RES, as outlined in the draft NECP, it is imperative to adjust the regulatory framework to incentivise grid investment, yet without imposing excessive additional burdens on consumers. For illustration, Romania's projected additional RES until 2030 amount to 11.5 GW, comprising 6.9 GW of PVs and 4.6 GW of wind power, in contrast to the 2021 figures of 1.4 GW for PVs and 3.0 GW for wind, as per the objectives outlined in the draft NECP. The acceleration of investment in the distribution grids rests on four pillars:

1. **Modernisation of aging infrastructure:** a significant investment share is to be directed to replacing outdated equipment and systems that are more than 40 years old, which currently makes up about 60% of Romania's grid infrastructure (NECP, 2022).
2. **Integration of RES:** investments are also aimed at facilitating grid integration of RES, such as solar and wind. This involves enhancing grid capacity and flexibility to handle the variability of RES production and prosumers.
3. **Digital transformation:** implementing smart grid technologies, such as advanced metering and grid automation, is another major focus. These upgrades are essential for improving energy efficiency, reducing losses, and providing better service to consumers.

4. **Support for electrification:** Enhancing the grid to support an increased demand for electric vehicles and other electrification initiatives is also a critical aspect of the investment plan.

The DSOs' own investment plans until 2030 envisage a significant investment rise aimed at enhancing the above four pillars. Spending is expected to increase significantly from €360 million in 2022 to €637 million by 2027, as illustrated in Figure 10, with the largest share going into grid modernisation and expansion (for more details on data collection, please see the Annexes).

Figure 10. DSOs allocated investments from tariff-based revenue (2020-2030, EUR mil), baseline scenario



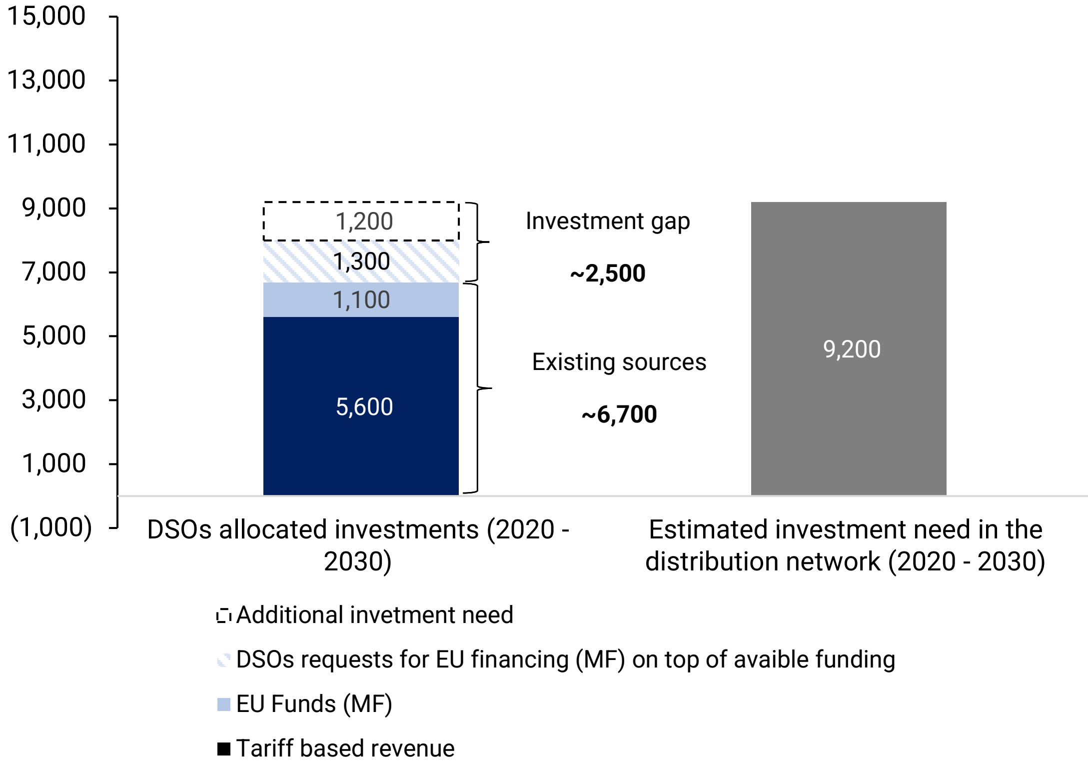
Source: EPG assessment based on ACUE and DSOs data

Such investments should be fostered by the methodology regulating tariffs and revenue. Nevertheless, they fall significantly short of the needed amount. **According to EPG calculations, the investment needs in the Romanian distribution system are estimated to be between €9.2 - 11.5bn between 2020 and 2030. This reveals a major gap of €2.5 - 4.8bn compared to the planned investments by DSOs from the tariff-based revenue and EU funding**, with the MF serving as the primary source of such funding – see Figure 11.

We have devised two methods to estimate the investment requirements for the distribution grid, with remarkably convergent results. First, we base our calculations on the new installed capacities, using the cost assumptions outlined in the draft NECP. Second, we use the cost assumptions for new installed capacities of the Energy Information Administration (EIA, US), with Poland's investment needs until 2030 serving as a benchmark.

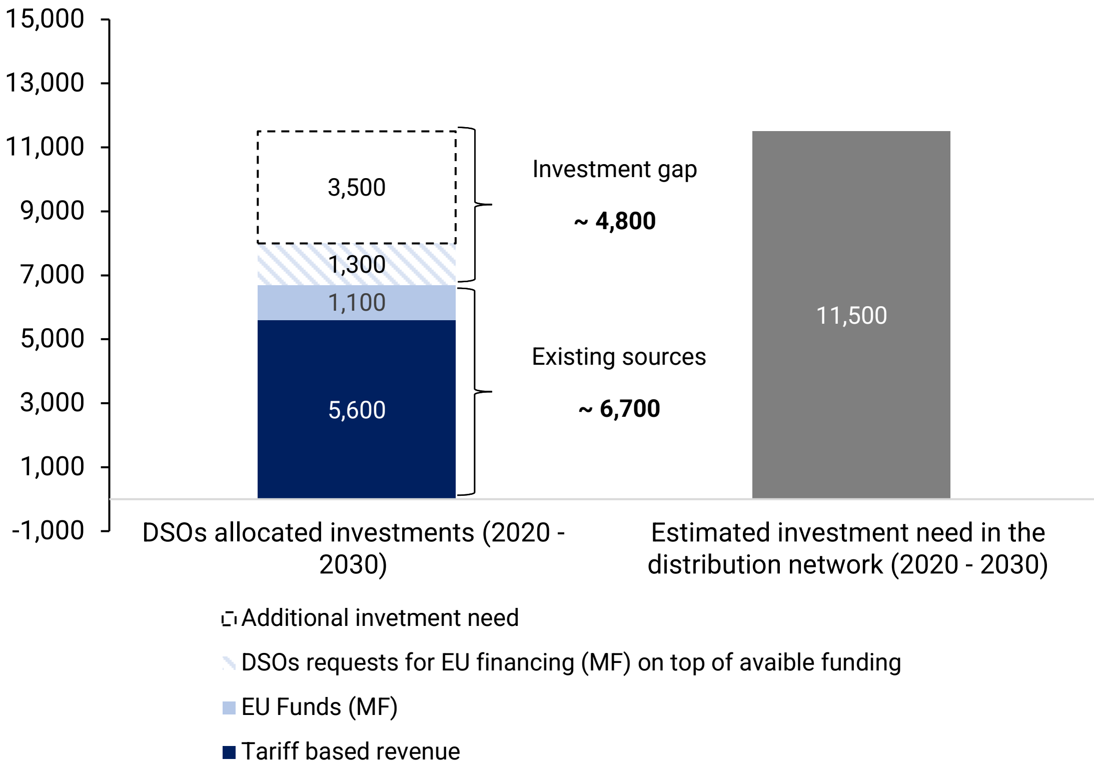
Figure 11. Investment needs in the Romanian distribution grid (2020-2030, EUR mil)[7]

Method 1. Estimated investment needs at €9.2bn by 2030, representing about €0.8bn/year (11 years) and an investment gap of €2.5bn



[7] According to DSOs estimations, the total investment needs in the distribution network is around €11.8bn to (i) modernise the aging infrastructure, (ii) integrate assumed RES targets, (iii) digitalise the grid and operations and (iv) support for electrification.

Method 2. Estimated investment needs at €11.5bn by 2030, representing about €1.05bn/year (11 years) and an investment gap of €4.8bn

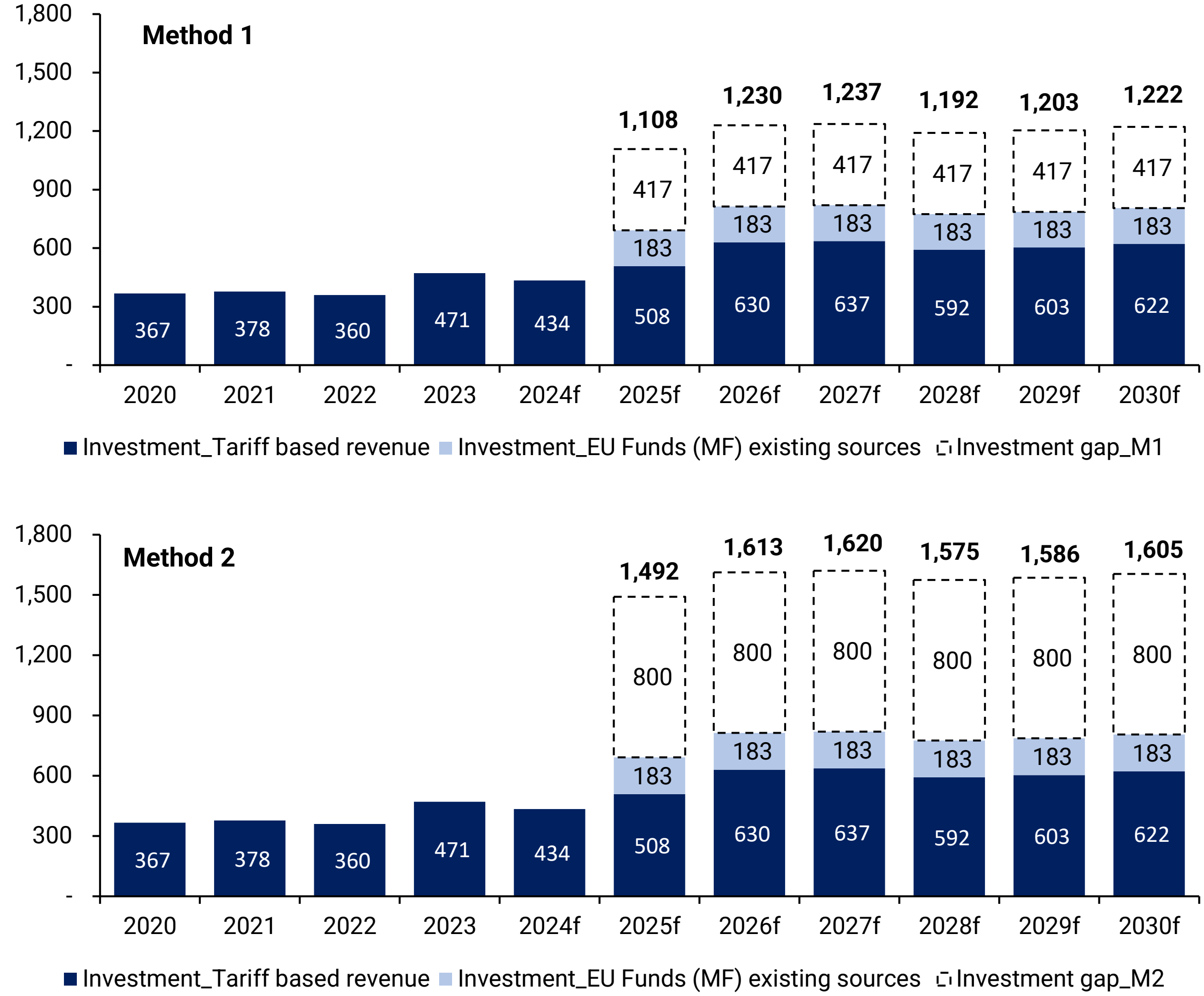


Source: EPG assessment

The assessment highlights that if DSOs continue investment under the current business model, they are expected to invest around **€4bn by 2030**. If ANRE approves increased investments in CAPEX programs for the following regulatory periods, although this would impact tariffs, DSOs could mobilise around **€6.7bn** (from tariff-based revenue model and existing EU funds, as shown in Figure 8). **However, the total investment required is €9.2bn - 11.5bn, leaving a funding gap of €2.5 - 4.8bn.**

Based on our assessment of annual investment needs, **Romania's distribution grid will require, on average, between €1.2bn and €1.6bn annually until 2030** to meet its climate objectives. This would be an increase by about three times the current investment levels. Between 2020 and 2024, investments amounted for **€0.4bn** compared to the actually needed **€0.8 - 1.05bn**.

Figure 12. Annual average investment gap – Methods 1 and 2 (EUR mil)



Source: EPG assessment Section 2.4 below details the two calculation methods just mentioned

2.4 Methodology for estimated investment needs in the distribution grid

2.4.1 Assumptions for investment in new installed capacities in Romania

According to Eurelectric (Power Barometer, 2023), "achieving the needed expansion and digitalisation of grids, investment is crucial, therefore we should be investing €0.67 in the grid for every €1 invested in generation capacity to close the exiting gap. In 2023, that figure is closer to €0.30." As one may infer from the Eurelectric statement that "new generation capacity" refers exclusively to RES, we have used the following values as a proxy for estimating the need for investments in Romania's distribution network:

- 67% of the investment value for the development of new wind and solar capacities (as suggested by Eurelectric) and
- 30% of the investment value for the development of new capacities on nuclear, natural gas and hydro

Tables 3 and 4 below present the investment needs for generation capacities corresponding to two sets of cost assumptions: (i) Table 3 focuses on cost assumptions from the draft NECP, while (ii) Table 4 considers the EIA cost assumptions, i.e. the minimum values for the US market.

Table 3. Investment in new capacities between 2020 and 2031 based on NECP cost assumptions

Type	Capacity to be developed [MW]	Cost per unit of capacity [$/kW]	Source of data	CAPEX ($ mil)	Share of investment [%]	Required investments in grids ($ mil)
Nuclear classic	700	6,522	NECP	4,565.4	30%	1,369.6
Nuclear SMR	462	8,349	US average	3,857.2	30%	1,157.2
Onshore wind	4,630	1,304	NECP	6,037.5	67%	4,045.1
PV	4,400	815	NECP	3,586.0	67%	2,402.6
Conventional hydro	304	1,850	NECP	562.4	30%	168.7
CCGT	3,500		EPG estimations	2,723.0	30%	816.9
Total ($ mil)				**21,332**	**46.7%**	**9,960.1**
Total (€ mil)				**19,625**		**9,163.3**

Source: EPG estimations based on draft NECP cost assumptions

Table 4. Total investment in new capacities 2020-2031 based on EIA lower range of cost assumptions)

Type	Capacity to be developed [MW]	Cost per unit of capacity [$/kW]	Source	CAPEX ($ mil)	Share of investment [%]	Required investments in grids ($ mil)
Nuclear classic	700	7,341	US (min)	5,138.7	30%	1,541.6
Nuclear SMR	462	7,779	US (min)	3,593.9	30%	1,078.2
Onshore wind	4,630	1,566	US (min)	7,250.6	67%	4,857.9
PV	4,400	1,392	US (min)	6,124.8	67%	4,103.6
Conventional hydro	304	1,612	US (min)	490	30%	147
CCGT	3,500		EPG estimation	2,723	30%	816.9
Total ($ mil)				**25,321**	**49.5%**	**12,545.2**
Total (€ mil)				**23,295.3**		**11,541.6**

Source: EPG estimations based on Energy Information Administration (EIA, 2023) lower range/minimum cost assumptions (link)

The above tables indicate, for every type of new power generation, the capacity to be developed (according to the Romanian NECP), the cost per unit of capacity type, the CAPEX of the respective capacities, the share of the investment required for the development of the distribution network (67% or 30%, respectively, as explained), and the actual required investment in the distribution networks. The total investment in the distribution grid is also expressed as an average share of the total investment for new capacities development.

In conclusion, for investment in new power generation capacities ranging between €19.6 – 23.3bn, **we have obtained a range for the grid investment needs of €9.2 – 11.5bn.**

2.4.2 The polish case Poland as a proxy

According to the EU Action Plan for Grids (2023), "the industry estimates around €375 - 425bn of necessary investments in the distribution grids by 2030". The document refers to data from Monitor Deloitte, E.DSO and Eurelectric, Jan 2021. The analysis does not include a deep dive for Romania; therefore, we used Poland as a benchmark.

The investment needs for Poland from 2020 to 2030 was estimated at €25bn, based on:

(i) 15 GW of RES capacity

(ii) 67% of new RES connected to the distribution grid

(iii) 1.5 million EVs (BEV and PHEV) by 2030

(iv) 91,000 non-residential charging points

(v) 0.9 million residential charging points

(vi) electrification in residential sector driven by a 17% expected growth in new customers by 2030.

The investment value from Poland was adjusted for Romania using:

- Average share of electricity consumption per capita (2017-2023)
- SAIDI and SAIFI (2014-2016 – publicly available data RO vs PL)
- Length of EHV and HV (extra high voltage and high voltage) circuits (2016 – publicly available data RO vs PL)
- RES (wind and solar) installed capacities (2023 – RO vs PL)
- Prosumers installed capacities (2023 – RO vs PL)

The calculated rate for Romania is 48% of the Polish estimated investment, i.e. €12.0bn.

Policy recommendations

Grids have emerged as a foundation for transitioning to a decarbonised economy, and the corresponding investment requirements are considerable. **Investments of €6.8bn are needed for the transmission part of the Romanian power grid, and €9.2 - 11.5bn are required for the distribution grid until 2030.**

To stimulate such investments, the following measures should be taken:

1. **Stable and clear regulatory framework that supports investment, while mitigating the impact on grid users**. The current regulatory framework requires various adjustments to meet the increased investment needs in grid infrastructure. Financing a large share of investments through tariff-based revenues will impose a cost burden on consumers. With approximately €400 million invested in distribution grids, the tariff currently accounts for around 30% of the total invoice for low-voltage consumers (€5 - 5.5) with an average consumption per month of 100kWh. **To meet the decarbonisation targets, investment should increase almost four times to around €1.2 - 1.6bn/year until 2030,** which could impact consumer prices. Therefore, the new (fifth) regulatory period for distribution activity, due to start in 2025, should enhance the incentives for DSOs to use EU funds for investments. Besides, ANRE should carefully analyse best practices from other EU countries on supporting grid investment and accelerating the digitalisation, while limiting the impact on consumers.
2. **Increased funding from EU financial mechanisms, such as the Modernisation Fund (MF).** Currently**,** the second most important financing source for grid investments in Romania is the MF. It includes two grid-related support schemes: (i) one dedicated to the TSO, with €400 million in non-reimbursable funding, and (ii) another for the DSOs, tender-based, accounting for €1.1bn in non-reimbursable funding. While these schemes are decisive for supporting grids investments, given the total requirements, the allocated amount is insufficient.

   For example, DSOs have submitted 105 projects worth €2.4bn, which is more than double the existing available funding, resulting in a gap of €1.3bn. This shortfall demonstrates the need for the scheme to be extended with additional funding as soon as possible, especially considering the 2030 deadline for MF allocations. The funding should not only cover the current project proposals, but also exceed them. Moreover, the scheme should be extended under the current call for projects, to prevent a potential 1.5 - 2-year bureaucratic delay coming with the launch a new call, that could hinder the planned investments, including an accelerated roll-out of smart meters.
3. **Consistence between the national strategic documents.** National strategic papers such as the draft NECP, the LTS, the TSO's TYNDP, the DSOs' ten-year development plans, the draft National Hydrogen Strategy, the National Industrial Strategy and the

regional/municipal investment plans ought to be mutually consistent and coherent to promote a clear vision of Romania's investment priorities, and available funding.

For example, the TSO's TYNDP for 2024 – 2033 mentions the new RES targets assumed in the draft NECP, but does not estimate the impact on investment needs, keeping the value from TYNDP 2022 – 2031 (€1.43bn), which merely accounts for the less ambitious decarbonisation targets from the initial NECP version. Then, according to the draft NECP and the LTS, all CCGT units are deemed to fully transition to renewable hydrogen as of 2036, yet without estimating the corresponding requirements for extra RES capacities to produce renewable hydrogen, or the needed hydrogen transport infrastructure. Although 2036 may seem remote, planning and development should start much earlier to ensure infrastructure readiness. In view of the critical role of grids and the substantial investment requirements for this sector, the country's Industrial Strategy should have considered the sector's contribution to the national value added and its multiplier effect on other economic sectors. This is particularly relevant given that many suppliers for the construction of grid infrastructure are sourced at national level.

All such planning documents should be harmonised and mutually consistent to facilitate the mapping of financial sources, including EU Structural Funds from the 2021 - 2027 financial framework and subsequent financial periods.

4. **Ensure adequate workforce for grid development.** To meet Romania's decarbonisation targets until 2030 and beyond, it is essential to attract skilled workforce, particularly engineers and technical specialists. The curriculum in technical high-schools and universities should be adapted to the new grid technologies, RES integration and digitalisation. Additionally, incentivising Science, Technology, Engineering and Mathematics (STEM) education through scholarships, internships with companies, and professional development will help attract and retain talent in the power sector. By fostering a pipeline of skilled workforce, Romania will be able to ensure a timely and effective implementation of its major grid projects.

   Currently, both the transmission and the distribution operators are experiencing workforce shortages, which are causing project delays. With an overall increased demand for skilled workforce in the energy sector, Romania should prioritise reforms aimed at incentivising and retaining skilled workers. The government should also capitalise on new job opportunities created through the energy transition, promoting careers in the energy sector through targeted education and training programs.

5. **Prepare for the scenario in which not all investment needs will be met by 2030**. The global landscape gets more and more complicated, with massive investment planned in data centres. The global output of transformers and, in general, the global value chain will be subject to enormous pressures, which will compound the shortage of cash and labour force in Romania.

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Annexes

Data collection for Chapter 2

Chapter 2 *The Electricity Distribution Grid* presents the estimated investment through tariff-based revenue, which is based on data collected from the Federation of Association of Energy Utility Companies (ACUE) members.

Data collection process involved a series of steps:

- **25th September, 2023**: Kick off meeting between EPG and ACUE members to present the proposal of the Report;
- **25th September, 2023 – 15th January, 2024**: Process of signing Non-Disclosure Agreements (NDAs) between EPG and DSOs;
- **1st February – 15th March, 2024**: Data collection;
- **15th March – 9th April, 2024**: Data analysis;
- **9th April, 2024**: Working group between EPG and ACUE to review main findings;

Data requested form DSOs for estimated commissioning projects (puneri în funcțiune – PIF):

(01) Power station/Stații

(02) Transformer/Posturi de transformare

(03) Power lines/Linii aeriene

(04) Underground power lines/Linii subterane

(05) Reinforcement of tension level/Imbunătățirea nivelului de tensiune

(06) GIS

(07) Network (grid) reinforcement/Intarire retea

(08) Photovoltaic panels/Panouri fotovoltaice

(09) Network (grid) extention/Extinderi retea

(10) Branch connector/Bransamente

(11) Smart meters

(12) IT Software

(13) IT Hardware

(14) Power station automatisation/Automatizare statii

(15) Other investments

Table 5. Priority regional financing clusters for transmission electricity grids

No.	Project name	Description
1	**Project 138** ***Black Sea Corridor***	The PCI promoted by Transelectrica and ESO will allow the transfer of power generated next to the Black Sea coast towards the consumption and storage centres in Central and South-Eastern Europe and will also increase the interconnection capacity between Romania and Bulgaria. The investments promoted through the Black Sea Corridor are (ENTSO-E, 2022): • 159 km Overhead Line (OHL) 400kV double circuit Cernavodă - Stâlpu. Construction completed in 2022. • 140 km OHL 400kV double circuit Gutinaș - Smârdan. Construction will be completed in late 2024. • Upgrade to 400kV voltage level of existing 220kV Stâlpu electrical substation. Upgrade will be completed in late 2024. • 86 km OHL 400kV single circuit Varna - Burgas. Construction completed in 2021.
2	**Project 144** ***Mid Continental East Corridor***	The PCI promoted by Transelectrica and EMS will enhance the transmission capacity along the East-West corridor in CE and SE Europe. It will provide access to the market for more than 1,000 MW installed new wind generation in the Banat region and will increase the interconnection capacity between Romania and Serbia. The investments promoted through the Mid Continental East Corridor are (Transelectrica, 2023): • 131 km OHL 400kV double circuit Reșița - Pancevo. Construction will be completed by the end of 2025. • 116 km OHL 400kV single circuit Porțile de Fier - Reșița. Construction will be completed by the end of 2024. • Upgrade of existing 220kV double circuit corridor Reșița - Timișoara - Săcălaz to 400kV double circuit. Upgrade will be completed by the end of 2026. • Extension of existing 220/110kV Reșița electrical substation with the construction of new 400/220/110 kV substation. Construction will be completed by the end of 2025. • Replacement of existing 220/110kV Timișoara electrical substation with the new 400/220/110kV substation. Construction will be completed by the end of 2026. • Upgrade of existing 220kV double circuit corridor Arad-Timișoara - Săcălaz to 400kV double circuit: Upgrade will be completed by the end of 2029 (Transelectrica, 2023).

3	**Project 259** ***Hungary-Romania***	Project promoted by Transelectrica and MAVIR (Hungarian TSO) – 120 km long 400kV interconnector between Hungary and Romania that will connect Oradea (RO) and Józsa (HU) electrical substations. There are few other internal investments associated with this project: a new 400/220kV power transformer in the Roșiori electrical substation and the upgrading to 400kV of OHL 220 kV Urechești - Tg. Jiu-Paroșeni - Baru Mare - Hășdat. According to the 2024 version of ENTSO-E TYNDP, a second circuit of the OHL 400kV Nădab (RO) - Bekescsaba (HU) existing power line was also added. These investments will strengthen the RO - HU interconnection and, at the same time, increase the power capacity available within the Romanian transmission system. The project is currently in the planning stage.
4	**Project 341** ***North CSE Corridor***	Project promoted by Transelectrica and EMS (Serbian TSO) and it consists in the construction of a second circuit to the existing OHL 400 kV Porțile de Fier - Djerdap, which is the interconnector between Romania and Serbia. Coupled with that, there are a few investments that will be needed in the Serbian power system: a 400/110 kV Belgrade 50 electrical substation and the construction of OHL 400 kV Belgrade 50-WPP Cibuk. In ENTSO-E 2024 TYNDP, the reconductoring of the OHL 220 kV double circuit Porțile de Fier (RO) - Reșița (RO) existing power line was added to this project. These investments will strengthen the East-to-West European energy corridor and enhance the market integration in the region, allowing the connection of large RES capacities. The project is currently in the planning stage.
5	**Project 1105** ***Georgia - Romania Black Sea (Submarine) Interconnection Cable Project***	One of the most important projects included by ENTSO-E in the 2022 TYNDP is the Georgian - Romanian submarine interconnection cable that should connect the South Caucasus region to the synchronous grid of Continental Europe to evacuate the renewable energy from Caucasus region towards Europe. The plan is for a 1,200 km, 1,000 MW, 500kV HVDC submarine cable that will link the Georgian shore in GSE's Anaklia electrical substation, with the Romanian shore in Transelectrica's Constanța Sud electrical substation (ENTSO-E). Azerbaijan, Georgia, Hungary, and Romania agreed on the construction of the cable, with the financial support from the EC, after signing a memorandum on 17 December 2022. The project is in feasibility study stage and construction is not expected to be completed before 2029.
6	**Project 1138** **400kV OHL Suceava (RO) - Bălți (MD)**	Project promoters are Transelectrica and Moldelectrica: • 142 km OHL 400kV single circuit Suceava (RO) - Bălți (MD). Construction estimated to be completed in 2027; • 259 km OHL 400kV single circuit Gădălin - Suceava in the Romanian power system. Construction estimated to be completed in 2030;

		• 400/330kV Bălți electrical substation in the Moldovan power system. The project will bring mutual benefits to both countries. It aims to increase Moldova's energy security by accelerating the country's integration with the European grid, ENTSO-E, and at the same time, it will strengthen the RO-MD interconnection. Additionally, through the OHL 400kV Gădălin - Suceava, the 400 kV ring within the Romanian power grid will be closed, increasing energy security within the power system.
7	**Project 1216** **High-Voltage Direct Current Interconnector Project Romania-Hungary**	Project promoters are Transelectrica and MAVIR; it refers to a long distance HVDC underground cable that should connect the S-E Romania, next to the Black Sea (Constanța) with Hungary (Albertirsa). The promoted investments are: • 238 km, 2500 MW, 525kV underground HVDC power line between Albertirsa (HU) - Arad (RO); • New 830 km, 2500 MW, 525kV underground HVDC power line between Arad (RO) - Constanța Sud (RO); • New 586 km, 2500MW, 525kV underground HVDC power line between Arad (RO) - București Sud (RO); • New 344 km, 2500MW, 525kV underground HVDC power line between București Sud (RO) - Constanța Sud (RO); • 4 new VSC conversion stations in Albertirsa, Arad, București Sud and Constanța Sud. Construction is estimated to be completed in 2030.

Source: ENTSO-E