European Commission

INVESTORS DIALOGUE ON ENERGY

Financial instruments and models for transmission and distribution

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Acronyms

Acronyms	
CEF	Connecting Europe Facility
CF	Cohesion Fund
CfD	Contract for Difference
DFI	Development Financial Institution
DG	Directorate General
DSO	Distribution System Operator
EaaS	Energy-as-a-Service
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EE	Energy efficiency
EIB	European Investment Bank
EIC	European Innovation Council
EIF	European Investment Fund
ERDF	European Regional Development Fund
ESCO	Energy Service Company
ETS	Emission Trading System
EU	European Union
FiP	Feed-in Premium
FiT	Feed-in Tariff
GBER	General Block Exemption Regulation
GDP	Gross Domestic Product
GHG	Greenhouse gas
HHI	Herfindahl-Hirschman Index
HVDC	High-voltage direct current
ID-E	Investors Dialogue on Energy
IEA	International Energy Agency
LCOE	Levelised Cost of Energy
MF	Modernisation Fund
NECP	National Energy and Climate Plan
NRA	National regulatory Agency
NRRP	National Recovery and Resilience Plan
NZIA	Net-Zero Industry Act
P2P	Peer-to-Peer
PPA	Power Purchase Agreement
PV	Photovoltaic
RDI	Research, Development, and Innovation
RES	Renewable Energy Source
RRF	Recovery and Resilience Facility
SME	Small and medium-sized enterprise
T&D	Transmission and Distribution
TRL	Technology Readiness Level
TSO	Transmission System Operator
UK	United Kingdom
UoP	Use of Proceeds
US	United States
WACC	Weighted Average Cost of Capital

Executive summary

A significant increase in financing in energy transmission and distribution (T&D) infrastructures and systems will be needed to meet the objectives of REPowerEU and Fit for 55. Further to this, rising interest rates in the inflationary context and the global competition in clean tech pose additional challenges to the energy sector. T&D assets are key to enable energy transition and integration of net-zero energy technologies.

The mechanics through which T&D projects get financed are conditioned in large part by the asset remuneration regime in which they operate. Regulated regimes determine operators' remuneration capability, risk appetite, can incentivise cost reduction, and can transfer efficiency gains to final users.

Investments in T&D are affected by barriers of different nature, some stemming from market failures, others - from technical aspects.

Financial instruments can address some of the barriers to investment that are slowing down the decarbonisation of the EU energy sector. Through a range of instruments available at EU and Member State level, policy makers and investors can overcome some of the obstacles making clean energy projects, particularly innovative ones, too risky for the private sector alone. The presence of non-financial barriers affecting T&D investments requires additional measures beyond financial instruments to create a truly enabling environment for energy investments.

A mapping of financial instruments at Member State level resulted in the identification of 280 instruments available for financing T&D in the EU27. Several trends in offering of instruments at national level can be identified:

- Loans and grants are the most used type of financial schemes for T&D;
- Only 21 schemes target exclusively T&D, whereas all others target at least one more energy segment (energy production, T&D, energy storage, heating and cooling, services and prosumers), and 176 scheme target all segments of the energy value chain;
- Most of the mapped instruments target mature and market-ready projects ("roll-out stage"), and only to a lesser extent - less mature technologies;
- SMEs and larger companies are the most supported recipients by financial instruments in most EU Member States.

Four characteristics were identified as key for a financial support scheme to be effective in the T&D sector: financing tailored to TSOs and DSOs' needs and characteristics, the provision of different types of financing, long-term stability and visibility of the scheme, and the accessibility of the financial instruments.

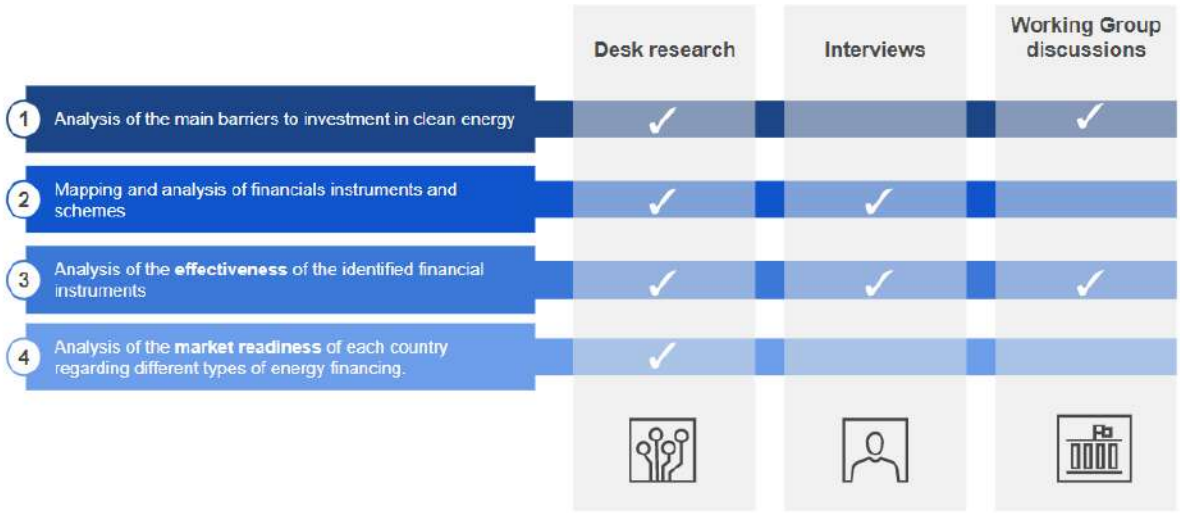
The availability of a comprehensive set of financial instruments for T&D is particularly important in countries with low market maturity and high investment needs to achieve their 2030 targets. In general, in most countries the current offering of financial instruments could be improved going forward in terms of the diversity of instruments offered and the calibration of instruments towards relevant target beneficiaries.

1. Introduction

This Study presents the results of the "Study on current energy sector investment instruments and schemes" in the transmission and distribution sector in the EU. The Study has been carried out as part of the Investors Dialogue on Energy – an initiative launched by the European Commission, DG Energy in 2022 as a multi-stakeholder platform bringing together experts from energy and finance sectors in all EU countries to assess and upgrade financing schemes to mobilise financing in the context of the European Green Deal.

This Study focuses on the transmission and distribution sector and is part of a series covering also energy generation, energy storage, heating and cooling, and services and prosumers. The Study has been prepared on the basis of research carried out in 2022 and 2023, and incorporates data collected via desk research and interviews, as well as feedback from the stakeholders participating in the discussion of Working Group 2 of the Investors Dialogue for Energy that focuses on transmission and distribution networks.

Figure 1: Overview of main topics and data sources



This Study will set the basis further work under the Investors Dialogue on Energy on the identification of possible new or upgraded solutions for financing transmission and distribution networks in order to support the achievement of the EU's 2030 climate and energy targets and pave the way towards long term carbon neutrality.

2. The investment context for transmission and distribution

2.1. The new macroeconomic conditions for energy investment

Over the last couple of years, Europe has experienced a period of profound macroeconomic and geopolitical change, characterised by often unpredictable events that have made it necessary to accelerate the energy transition process and to adapt funding flows to the evolving needs. The following four macroeconomic trends have been identified which will make the coming years, and the next MFF budgeting period, fundamentally different than the past decade.

Tackling the climate crisis

At the end of 2019, the European Union published the European Green Deal[1], which outlined its aim to become the first climate-neutral, resource efficient, and sustainable economy by 2050. As an intermediate step towards climate neutrality, the EU strengthened its commitments to climate and energy, pledging to reduce 55% of net GHG emissions by 2030, while ensuring Europe's security of energy supply. In order to align current laws with the 2030 and 2050 ambitions, the Commission tabled the Fit for 55 package[2] of legislative measures which, among other targets, proposed to increase the share of renewable energy sources in the overall energy mix from 32% to 40% to speed up the decarbonization of the energy system. These new and updated targets represent a major challenge and will require and acceleration of green investments. The impact of these policy shifts is already being felt strongly in the European financial sector. Example of notable shifts include:

- The adoption of the European Taxonomy for sustainable finance, which provide companies, investors and policymakers with appropriate definitions for which economic activities can be considered environmentally sustainable, thus helping the EU to scale up sustainable investment and implement the European Green Deal.
- The transformation of the EIB into the EU Climate Bank, and the ensuing commitment to gradually increasing its share of finance dedicated to green investment to over 50% by 2025 and beyond.

The urgency of the climate crisis is increasingly reshaping the investment environment for energy projects, including transmission and distribution ones, with an ever-stronger focus on low carbon technologies.

Ending the EU's dependence on Russian fossil fuels

The energy crisis, intensified by Russia's unprovoked aggression in Ukraine in February 2022, has had a significant impact on the EU's energy system and the European financial sector. Turbulence in energy markets, the all-time high energy prices and the risk of supply shortages across the EU have further exposed the EU's over-reliance on Russian fossil fuels, highlighting the need to accelerate the green transition under the European Green Deal and to ensure a more secure, affordable, resilient, and independent energy system[3]. To respond to these hardships, in May 2022 the European Commission presented updated energy targets

[1] The European Green Deal, *European Commission*, December 2019.

[2] 'Fit for 55': delivering the EU's 2030 Climate Target on the way to climate neutrality, *European Commission,* 2021.

[3] Progress on competitiveness of clean energy technologies, *EU Commission,* November 2022.

in the REPowerEU plan[4] and the emergency electricity market design interventions. The REPowerEU plan, which aims to cut the EU's energy dependency on Russian gas well before 2030, confirms the EU's commitment to achieving the European Green Deal's long-term goal of climate neutrality by 2050 and fully implementing the Fit for 55 package, proposing to increase the headline 2030 target for renewables from 40% to 45%[5].

Broadly speaking, the European Green Deal as an EU growth strategy, the war and the REPowerEU are expected to reshape the direction of financial flows. In particular, investments in gas-related projects are focused mainly on projects, which serve the objectives of the energy transition, Security of Supply and diversification of gas/energy supply. Examples of such projects may include directional changes to pipeline flows (e.g., establishing north-south pipeline connections), or the repurposing of gas infrastructure for transportation and storage of hydrogen or other low-carbon gases.

Rising interest rates in an inflationary context

The global economy is confronted with a challenging situation not witnessed for decades, with inflation persistently high amidst increased economic and geopolitical uncertainties, as well as disruptions in energy and commodity markets and supply chains bottlenecks caused by the COVID-19 pandemic and Russia's ongoing invasion of Ukraine. In past years, in the aftermath of the global financial crisis, central banks maintained low interest rates for extended periods of time, leading to a low-volatility environment and easy financial conditions that investors grew accustomed to. In the coming decade, rising interest rates mean that capital is more expensive, and harder to get to, which could prove especially daunting for nascent clean tech industries attempting to establish themselves on the market. This adverse impact of rising interest rates is likely to be compounded by the related phenomena of inflation and supply chain bottlenecks. This is why it is important to create a favourable financing environment that prevents the energy transition and the development of clean technologies from slowing down.

Rising global clean tech competition

Europe's partners are increasingly introducing policies and stimulus programs to seize the net-zero industrial opportunities. The prime example of rising competition for global clean tech dominance is the US Inflation Reduction Act (US IRA), which will mobilize over USD 360 billion by 2033. Japan, India, China, the UK and Canada have also put forward their own national programs to stimulate their own clean tech leadership. While competition is beneficial to the overall global climate race to net zero, the EU is also increasingly looking to cement its own positioning in the clean tech space and prevent the outflow of its own industrial champions overseas. Therefore, to facilitate the reaching of its climate objectives and enable the necessary greening and competitiveness of the EU industry, in January 2023 the Commission put forward the Green Deal Industrial Plan[6]. This plan will enable the EU to access key technologies, products, and solutions needed for a successful transition to net-zero, which will in turn boost economic growth and generate quality jobs. The Green Deal Industrial Plan will thus attract investments in the net-zero industrial base, with a focus on innovative technologies, helping them to overcome the so-called 'valley of death' before commercialisation[7]. In line with the Green Deal Industrial Plan the European Commission has adopted a new Temporary Crisis and Transition Framework which, together with the

[4] REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition, *European Commission*, May 2022.

[5] As provisionally agreed between the Council and the European Parliament, RES target is to raise in the EU's final energy consumption to 42.5% by 2030. The member states are urged to strive for a 45% share [status June 2023].

[6] A Green Deal Industrial Plan for the Net-Zero Age, *European Commission,* February 2023.

[7] Questions and Answers: Green Deal Industrial Plan for the Net-Zero Age, *European Commission,* 2023.

amended General Block Exemption Regulation (GBER) will help to accelerate investment and financing for clean tech production within the European Union and allow Member States more flexibility to design and implement support measures in sectors that are key for the transition to climate neutrality[8]. In addition, a proposal for a Net Zero Industry Act (NZIA)[9] has been submitted with the aim of establishing a framework of measures directed at strengthening Europe's net-zero technology products manufacturing ecosystem and overcoming barriers to scaling up the manufacturing capacity in Europe. The Regulation encompasses products, components and equipment used in manufacturing net-zero technologies and it distinguishes between net-zero technologies and strategic net-zero technologies, whereby the latter is regarded as making a significant contribution to decarbonisation by 2030.

Meeting the objectives of the European Green Deal and REPowerEU will entail, among other things, an increase in the share of renewable energy in the energy mix, electrification of end-use sectors, shift to hydrogen and other type of low-carbon gas in the hard-to-abate sectors, growth in the share of grid-connected distributed energy, and an ever-larger customer engagement including via demand response. Transmission and distribution networks play an enabling role for all of these developments.

2.2 The T&D investments needed to reach European Green Deal objectives

A net-zero greenhouse gas emissions economy will be achieved only with an adequate and smart energy infrastructure ensuring interconnection and sectoral integration across Europe. As the backbone of the energy system, **transmission and distribution networks need to undergo significant expansion, upgrading and automation** (notably through smart meters and other ICT) to support the major developments framing the energy landscape of tomorrow, for which grids will be required to:

- Ensure effective **grid integration of an increasing share of renewable energy and distributed energy resources**.
- **Maintain system adequacy, high reliability and quality of supply** by balancing energy loads and ensuring continuity of service of high-quality standards.
- Ensure **security of supply** and diversification of gas supplies.
- Increase and ensure **cross border energy flows** to guarantee cost-efficiency and security of supply.
- Allow **sector integration**, linking the various energy carriers - electricity, gas, solid and liquid fuels - with each other and with end-use sectors, such as buildings, transport or industry[10].

Power sector

Electricity transmission and distribution networks are key enablers for decarbonization, market integration, security of supply and competition. When it comes to interconnection targets, each Member State is expected to have electricity networks that allow to transport to

[8] Temporary Crisis and Transition Framework, *European Commission,* March 2023.

[9] Available at the following link.

[10] A Clean Planet for all A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy, *European Commission*, Brussels 2018.

neighbouring countries at least 15% of the electricity produced on its territory,[11] as a way to increase security of supply, lower the risk of faults and blackouts, reduce the need to build new power plants and better manage variable renewable power sources, adding flexibility to the whole system. For example, surplus renewable energy produced in one Member State could be used in another Member State at a time when demand for electricity is high[12].

Most Member States have included interconnectivity targets or projections of interconnectivity level by 2030 in their National Energy and Climate Plans. Table 1 below shows an overview of the 2030 interconnectivity pledges made by Member States in National Energy and Climate Plans (NECPs) submitted to the European Commission in 2019. In 2021, 16 countries reported being on track to reach that target by 2030, or have already reached the target, but more interconnections are needed in some regions.

Table 1: Member States' 2030 electricity interconnectivity targets

Country	Interconnectivity latest available data	2030 interconnectivity targets
Austria	15.3%	15%
Belgium	24%	33%
Bulgaria	7.1%	15%
Croatia	30%	15%
Cyprus	Not interconnected	200%
Czech Republic	26.6%	44.1%
Denmark	51%	N/A
Estonia	63%	>60%
Finland	29%	above 15%
France	N/A	16.5%
Germany	11.4%	N/A
Greece	10%	21%
Hungary	50%	60%
Ireland	7.4%	N/A
Italy	8.8%	10%
Latvia	50%	60%
Lithuania	62%	111%
Luxembourg	N/A	400%
Malta	24%	24%
Netherlands	>15%	37%
Poland	4%	8.7%
Portugal	8%	15%
Romania	9.3%	15.4%
Slovakia	43%	52%

[11] Based the Regulation on the Governance of the Energy Union (2018/1999)

[12] Electricity interconnection targets, *European Commission*.

Country	Interconnectivity latest available data	2030 interconnectivity targets
Slovenia	83.6%	N/A
Spain	6.5%	15%
Sweden	26%	27%

Source: Member States' National Energy and Climate Plans
Note: Targets in red fall below the 15% target set by the Regulation on the Governance of the Energy Union (2018/1999)

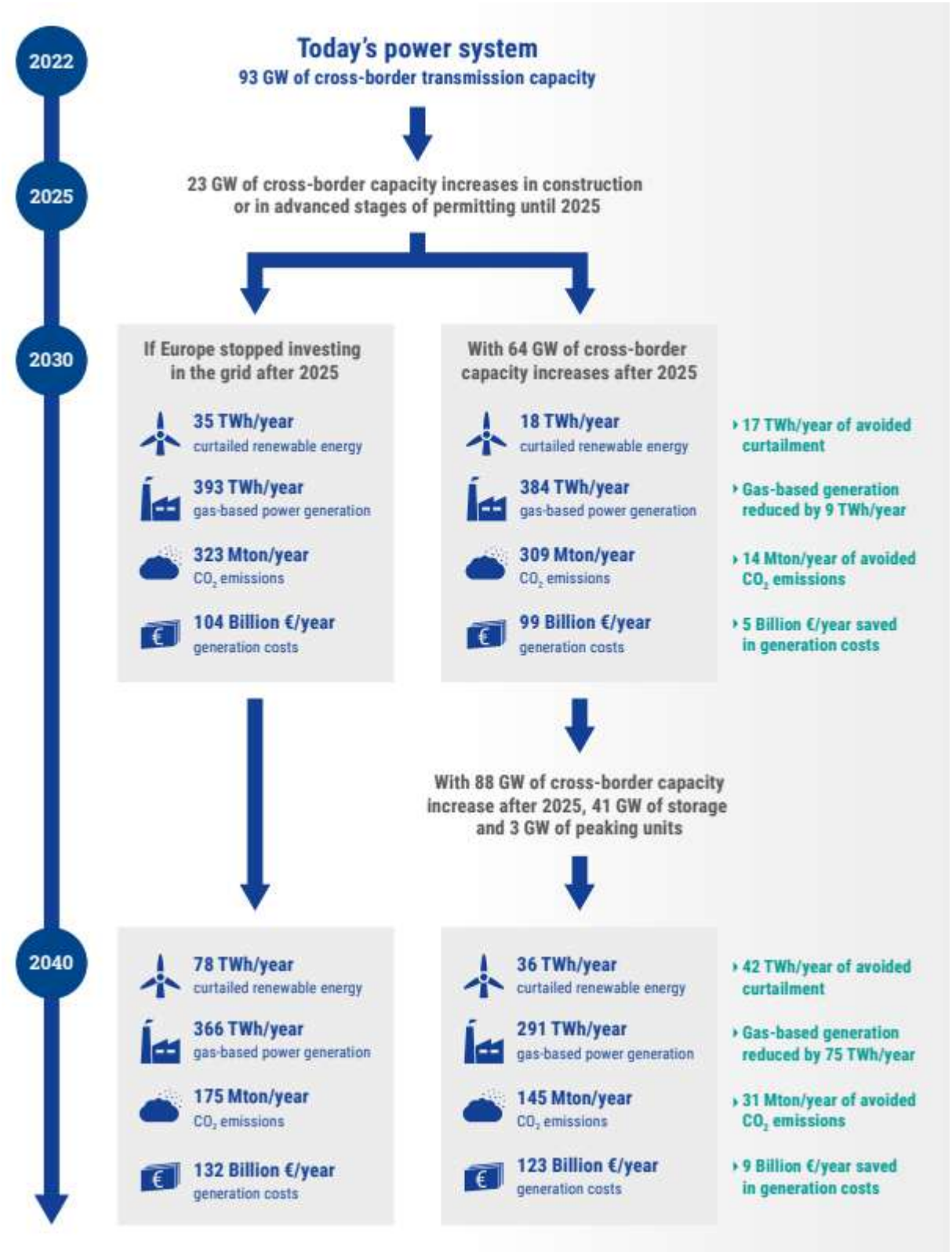
To support the expansion and upgrade of power transmission and distribution grids, substantial investments will be needed both at national and EU level.

In October 2022 the European Commission published a comprehensive action plan aimed at digitalising the energy system in Europe. In addition, the plan outlines emergency measures to address the current high energy prices and aid energy companies facing financial challenges. It also highlights the need for electricity grid investments of €584 billion by 2030 to support the increasing adoption of electric vehicles, renewable energy, heat pumps, and the shift from fossil fuels. About €400 billion of this investment will target the distribution grid, with €170 billion allocated for digitalization and the implementation of smart grids that respond quickly to fluctuations in supply and demand, reducing energy waste and taking advantage of cheaper energy periods[13].

According to ENTSO-E's 2022 Ten-Year Network Development Plan (TYNDP), cross-border transmission of electricity requires an additional 64 GW of capacity by 2030, beyond the 23 GW already in progress, to support Europe's power system. This would amount to an investment of around €2 billion per year, resulting in a yearly socio-economic welfare increase of €5 billion. By 2040, an additional 88 GW of cross-border capacity, 41 GW of storage, and 3 GW of CO2-free peaking units will be needed to transition Europe towards a carbon-free power system and ensure affordable access to electricity. Addressing these needs will require an investment of €6 billion per year between 2025 and 2040, with €3.5 billion allocated for cross-border capacity increases, €2 billion for storage, and €0.1 billion for peaking units. This investment will result in a socio-economic welfare increase of €9 billion per year until 2040[14].

[13] Digitalising the energy system – EU action plan, *European Commission,* October 2022.
[14] Ten-Year Network Development Plan 2022*, ENTSO-E*, January 2023.

Figure 2: Power System Needs in 2030 and 2040 (ENTSO-E)



Source: ENTSO-E, January 2023. Ten-Year Network Development Plan 2022

Gas sector

Meeting European Green Deal and REPowerEU goals will require investments also in gas T&D infrastructure, both for the needs of methane as a transition fuel as well as for decarbonized gases (e.g., biomethane as well as hydrogen). More specifically, the European Commission proposes in its REPowerEU plan to increase the resilience of the EU-wide energy system based on two pillars:

- **Diversifying gas supplies**, via higher Liquefied Natural Gas (LNG) and pipeline imports from non-Russian suppliers[15];
- **Increasing** volumes of biomethane and renewable hydrogen production and imports[16].

In this regard, as reported by the ENTSOG TYDNP 2022 draft project list[17], 41% of investments submitted to TYNDP 2022 qualify under one of the following three categories: (1) construction of new infrastructures to carry hydrogen or blends; (2) repurposing of existing gas infrastructures to carry hydrogen or blends; (3) project to enable the production and/or the injection of biomethane into the gas grid[18]. In order to decrease dependency from Russian gas and protect Europeans from possible supply shocks, the European Union set a mandatory minimum level of gas in storage facilities at 80% by 1 November 2022 and a storage level rising to 90% for the following years[19]. Subsequently, many Member States are now counting on rising LNG imports from the US and Qatar to fill the gap and substitute gas flows from Russia, but increasing imports also requires investment in new LNG infrastructure[20]. To address long-term sustainability issues and avoid stranded assets, the European Commission and the gas industry are considering repurposing LNG infrastructure for hydrogen. In the REPowerEU plan adopted in May 2022, the European Commission called for accelerated efforts to deploy hydrogen infrastructure. Estimates from the European Commission affirm that under the REPowerEU, an additional €27 billion are required for key hydrogen infrastructure (including distribution) as well as €37 billion to increase biomethane production by 2030 and €10 billion for new LNG infrastructure and pipeline corridors. Additionally, the European Hydrogen Backbone (EHB) Initiative estimates that an investment of €80-143 billion is necessary to set up 53.000 km of the hydrogen transportation infrastructure by 2040 considered necessary for the EU's decarbonisation.

An evolution of the energy infrastructure is necessary to allow significant import and production capacities of renewable and decarbonised gas, and to provide for the demand for new gases like hydrogen and biomethane. Today, hydrogen is mainly used as a feedstock for the industry. However, the demand for clean gaseous energy increases to meet the COP 21 and EU climate and energy targets for carbon neutrality by 2050. In a net-zero future, hydrogen and biomethane play a key role as confirmed by the respective ambitious targets defined by the REPowerEU Plan. The future gas infrastructure evolutions must allow for this

[15] The TYNDP 2022 hilights the importance of several projects in improving gas security of supply, increasing diversification and at the same time reducing dependence on Russian gas. Among the different categories of projects identified by the TYNDP, those with the highest potential benefits concern gas transmission pipelines (TRA), underground storage facilities (LNG), and projects defined as UGS which refer to reception, storage and regasification or decompression facilities for liquefied natural gas (LNG) or compressed natural gas (CNG). In addition, these projects can also contribute to improve sustainability by substituting more pollutant fuels in the energy mix

[16] In particular, by boosting biomethane production to 35 bcm by 2030 and by accelerating hydrogen penetration by 2030 with 10 mt of hydrogen production and 10 mt of hydrogen imported from diverse sources.

[17] Available at the following link.

[18] The disclosed value of all the projects included in the TYNDP 2022 amounts to €33 billion of CAPEX and € 654 million of OPEX.

[19] Parliament approves plans to restock gas reserves before winter, *European Parliament press room*, June 2022.

[20] Europe urged to invest in LNG infrastructure as winter gas crisis looms, *Euractiv.com,* July 2022.

uptake while also reducing Russian gas supply dependence, ensuring wider energy sources diversification.

Investment needs for T&D in the power and gas sector

This section provides an overview of the investments needed to expand, upgrade and automate transmission and distribution grids in the 2021-2030 period, and the investment gap that needs to be bridged with additional resources. Considering that data on the investment gap at national level is not consistently available across NECPs[21] and Resilience and Recovery Plans (RRPs), the estimations presented in this paragraph are aggregated at EU level, based on estimates by the Commission to reach the REPowerEU and Fit-for-55 objectives.

More in details, from an analysis carried out by the European Commission it emerged that to reach the **REPowerEU objectives in terms of energy savings, clean energy production and diversification of energy supply**, the electricity grid investments in the period from 2020 to 2030 should amount to **€583.8 billion, including a €210 billion** of cumulative investments between 2022 and 2027[22]**.** Whereby, the investment needed within the same decade to support the reduction of EU emission by at least 55% by 2030 in line with the **Fit-for-55** amounts **to €554.4 billion** for electricity grid. Moreover, in view of reaching the 2030 objectives of the **Clean Energy Package and the envisaged energy system integration**, the European Commission estimated that the energy infrastructure (transmission and distribution networks, heating and cooling, transport, and energy storage) investment needs stand at the level of **€59 billion per year**[23]. Regarding **hydrogen**, the European Commission estimated that, by 2030, between **€24-42 billion** of total investments will be needed for electrolysers **plus €220-340 billion to scale up and directly connect 80-120 GW of solar and wind energy production capacity**, and about **€65 billion** for **hydrogen transport, distribution and storage**.

Lastly, in the **Net Zero Industry Act**, the Commission estimated that, to meet the Fit-for-55 objectives, around **€487 billion** would need to be invested each year in the energy system until 2030, which include supply side (€55 billion and €93 billion for power grids and power plants respectively) and demand side (€339 bn) investments.[24]

Figure 3: Investment needs under the Clean Energy Package, Fit for 55, and the REPowerEU Plan

[21] Member States are expected to submit an updated versions of their NECPs by mid 2023. These versions sould perform better in terms of data estimates and quantifications, and are expected to be approved by mid-2024.

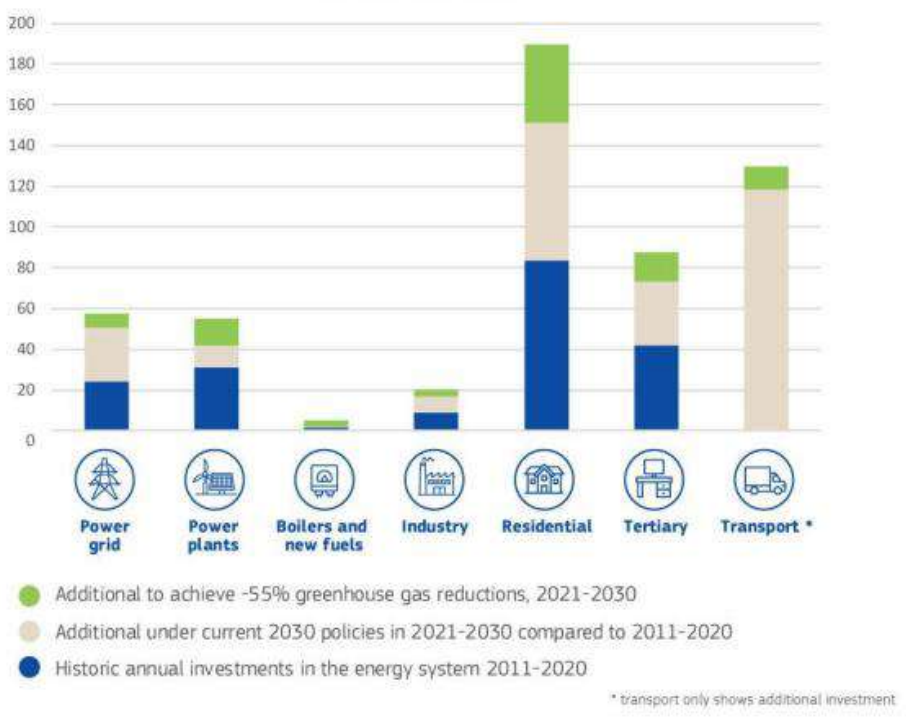
[22] Commission Staff Working Document (2022). IMPLEMENTING THE REPOWER EU ACTION PLAN: INVESTMENT NEEDS, HYDROGEN ACCELERATOR AND ACHIEVING THE BIO-METHANE TARGETS Accompanying the document COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS - REPowerEU Plan. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022SC0230&from=EN

[23] A Clean Planet for all A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy, *European Commission*, Brussels 2018.

[24] SWD (2023) 68 final.

The analysis of the investment needs at national level will be complemented based on the updated NECPs plans which are currently under review by the European Commission. Such an analysis will include a refinement of the estimation of investment needed to reach the EU emission reduction objectives, considering that the existing NECPs (2019) envisage the need of additional investments, as shown in the Figure below.

Figure 4: Average annual investments 2011-2020 and additional investments 2021-30 under existing policies and to achieve -55% GHG emission reductions (in €bn 2015)



Source: European Commission assessment of National Energy and Climate Plans. Brussels 2020

2.3. Economics of Transmission and Distribution

The mechanics by which projects in the T&D segment get financed and ultimately find their way to the market are conditioned in large part by the regulated asset remuneration regime. Because transmission and distribution infrastructure constitute natural monopolies, Transmission System Operators (TSOs) and Distribution System Operators (DSOs) operate in a regulated monopoly market regime where revenues are mostly based on tariffs applied on the bills paid by final consumers and which are regulated by National Regulatory Agencies (NRAs). As the ENTSO-E explains, the goal of the regulation is to mimic market conditions as much as possible to allow TSOs/DSOs to recover their costs and thus to ensure effective and efficient operation of networks[25].

The section that follows focuses on the impact of regulated remuneration to provide a high-level, hands-on understanding on the economics of T&D. Because TSOs and DSOs both operate in the same market regime and revenues for both derive mostly from regulatory measures, we consider them as equivalent for the purpose of the analysis of economics. We

[25] Fostering Electricity transmission investments to achieve Europe's energy goals: Towards a future-looking regulation, *ENTSO-E*, 2014.

will therefore refer to the projects implemented by TSOs/DSOs as energy infrastructure projects.

Regulated revenues

Regulatory regimes are broadly constructed considering 4 key economic principles[26]:

1. **The capability to remunerate the TSO/DSO's investments and to ensure their bankability**

   Investments performed by TSO/DSOs are capital intensive and capital needs to be raised when the investment is realised, while remuneration is only received progressively during the lifetime of the assets. Therefore, TSO/DSOs need to receive adequate remuneration in order to engage in large and long-lived investments which should take into consideration the cost borne by network developers (related to incurred risks) on one side and, on the other side, the ability of network developers to raise sufficient capital over time to realise and finance their required investments.

2. **The capability to reduce the risks borne by the TSOs/DSOs**

   Different types of risks exist that can affect TSOs/DSOs and can be mitigated or accentuated by the design of regulatory regimes: exogenous risks deriving from shocks on input costs or user demands, internal risks related to management and own company efficiency hazards and regulatory risks originating from the regulatory design itself.

3. **The capability to incentivise TSOs/DSOs to cost reduction**

   Cost reduction allows the energy systems to maximise T&D infrastructure investments while minimising the pressure of these investments on final consumers. Incentives for cost reduction achieve this through minimisation of investment realisation costs and the optimal trade-off between investments (CAPEX) and operational expenditures (OPEX) with the additional goal of preventing situations of over-investment (gold plating) where the amount of CAPEX is disproportionate to the OPEX.

4. **The capability to transfer efficiency gains and redistribution to final users**

Related to the previous principle, this criterion relates to the capability of the regulatory regimes to transfer efficiency gains realised by the TSOs/DSOs to final users and to avoid excessive monopoly rents, thus ensuring lower tariffs for final consumers, at least in the short term. This can be achieved by defining efficiency targets which are higher than those normally achievable or by defining a low allowed cost of capital.

National Regulatory Agencies (NRAs) must balance existing tensions between these 4 principles, and the way they achieve this is at the origin of the different designs of regulatory regimes. In Figure 5, proposed in the study by Glachant et al. (2013), these principles are represented in a two-dimensional figure highlighting two levels of tension:

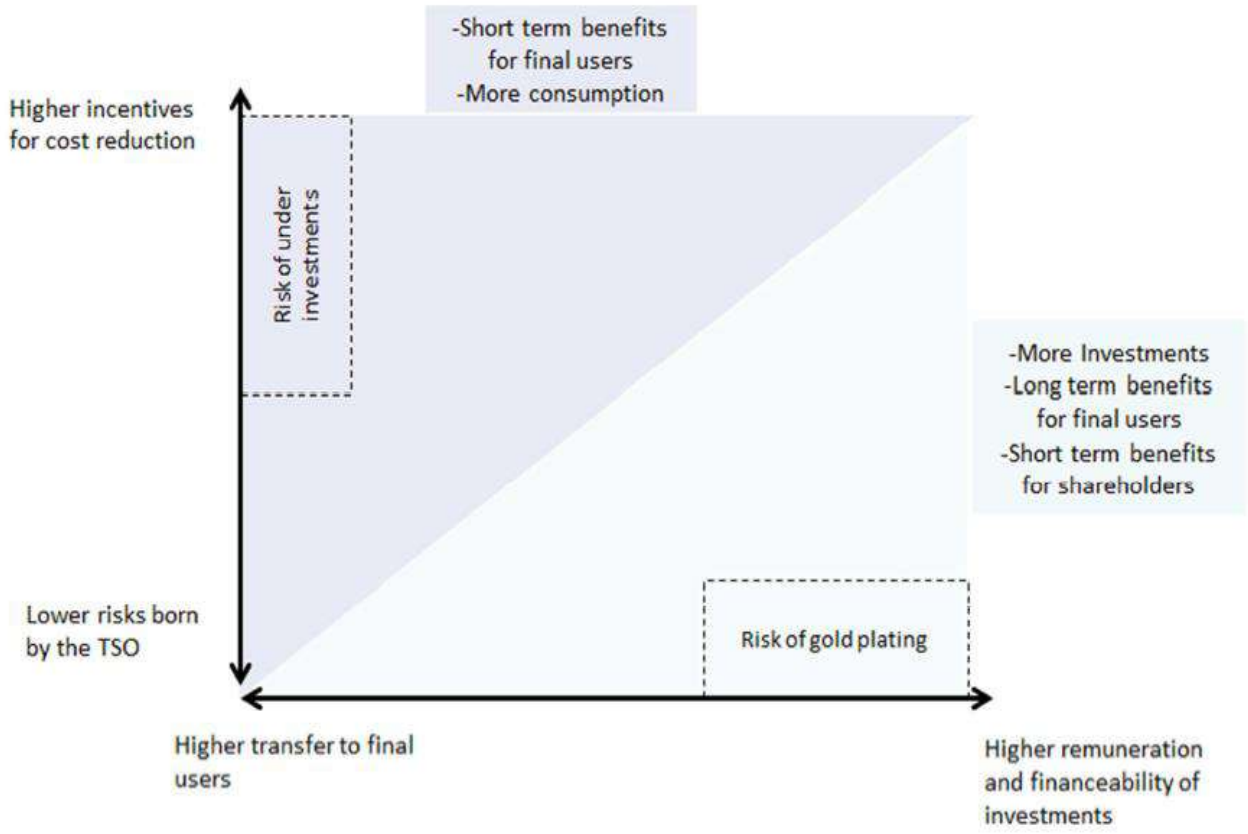
- One first level of tension arises where excessively stringent incentives for cost reduction designed by the regulatory regime give rise to more risks borne by the TSOs/DSOs. This tension is generated by the combination of the second criterion (minimising the risks born by the TSOs/DOSs) with the third one (incentives for cost reduction) on the vertical axis;
- A second level of tension arises where increasing efficiency gains transferred to the final users and for increasing redistribution, TSOs/DSOs will find it more difficult to

[26] Glachant, J., Saguan, M., Rious, V., Douguet, S., Incentives for investments: Comparing EU electricity TSO regulatory regimes, *Florence School of Regulation*, December 2013.

finance their investments. This tension is generated by the combination of the first criterion (ensuring remuneration and bankability) with the fourth (higher transfer of efficiency gains and redistribution to final users) on the horizontal axis.

How regulatory regimes are designed determines in which of the two areas illustrated in Figure 5 they fall into. Regulatory regimes positioned in the upper left-corner area are characterised by high incentives for cost reduction which in turn generate high risks borne by the TSO. These regimes are also characterised by low remuneration and bankability and high transfer and redistribution to final users. Such regimes result in lower tariffs (in the short term) and likely more consumption, but they also deliver weak incentives for investments, favouring under-investment in the present and generating bankability issues with potential higher costs in the future.

Figure 5: Trade-off between the 4 main economical properties of regulated regimes



Source: Glachant, J., Saguan, M., Rious, V., Douguet, S., Incentives for investments: Comparing EU electricity TSO regulatory regimes, Florence School of Regulation, December 2013

By contrast, the lower-right corner area corresponds to regimes characterised by high remuneration and bankability, with lower transfer and redistribution to final users. Risks for the TSO are lower because the incentives for cost reduction are lower. Such regulatory designs encourage a high level of investments in the short term and potential lower costs in the future. However, this translates into higher tariffs in the short term and the likelihood of over-investment ("gold plating").

Despite theoretical evidence pointing to the existence of five main regulatory designs[27], none of them are applied in their pure theoretical form in the EU since regulatory design is strictly

[27] Glachant et al (2013) list the following designs: Cost-plus, Forever price/revenue cap, Performance-based or sliding-scale regulation, Menu of contracts, Yardstick competition.

influenced by the national contexts of Member States. Of this, the state of development of T&D networks is the most important factor determining whether regulatory regimes focus on investments to expand the grid, or on efficiency to contain tariffs. One design has emerged as prominent among EU NRAs for T&D both for gas and electricity[28], although in forms and versions that differ among Member States through the integration of elements from the other regulatory designs: the **periodic revenue cap** design.

The periodic revenue cap design is based on the establishment of a maximum revenue that TSOs/DSOs are allowed to receive. In its pure theoretical form, this mechanism is aimed at remunerating TSOs/DSOs based on the observation of their past costs. This design favours cost efficiency by network developers since they can increase profits by reducing costs through efficiency, but it also increases their exposure to risks, limits investments and limits the sharing of efficiency gains with final consumers. To compensate for these downsides, the **periodic revenue cap** has been adopted by most EU NRAs by integrating, to different extents, elements from the other regulatory frameworks. Despite its variety, this design is based on 5 characteristics that fundamentally shape investment behaviours of TSOs/DSOs that abide by this regulatory regime (Glachant et al., 2013):

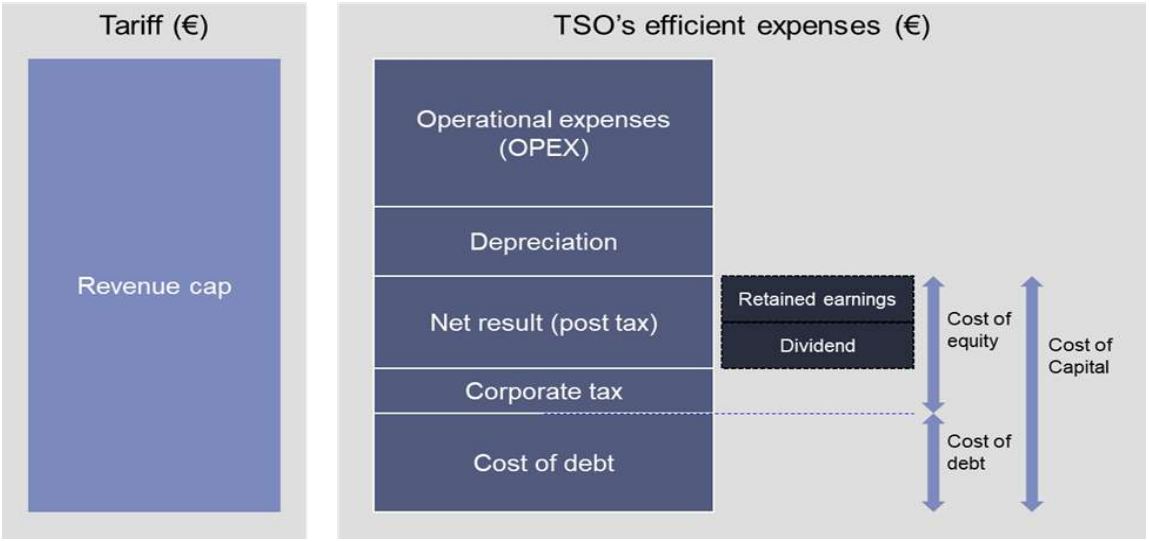
1. **The length of the regulatory period**

Regulatory periods ensure the updating and enhancement of the regime by updating the revenue cap considering the decrease of costs that TSOs/DSOs experience by achieving efficiency targets in previous regulatory periods. This enables sharing of efficiency gains between the network operator and final users. Short regulatory periods minimise incentives for cost reduction, maximise transfer of efficiency gains to final consumers and minimise risks on the network developers (exogenous risks and regulatory risks). The opposite is true for long regulatory periods.

2. **The scope of the revenue cap**

The scope of the revenue cap defines which costs are in the mechanism and which are treated separately by other measures or are not remunerated at all. Figure 6 offers a simplified representation of the range of costs that the revenue cap can potentially cover.

Figure 6: TSO/DSO simplified Profit/Loss



Source: Fostering Electricity transmission investments to achieve Europe´s energy goals: Towards a future-looking regulation, ENTSO-E, 2014

[28] Report on Regulatory Frameworks for European Energy Networks 2021, *CEER*, 2022.

The scope of the revenue cap can vary from two extremes: the **"TOTEX" approach** on one side, which is illustrated also in Figure *6*, where the revenue cap adopts the widest scope including all the costs/tasks of the TSO (e.g. OPEX, capital expenses, system operation costs, etc.) in the revenue cap, and the **"building blocks" approach** on the other, where the revenue cap adopts a small scope, including only one part of operating expenditure (e.g. controllable OPEX) in the revenue cap, as the other cost elements are remunerated through other mechanisms[29].

Between these two extremes, a large range of possible cases exists, in the function of which costs are included in the revenue cap and which other efficiency incentives whose related costs are excluded from the cap. The definition of the scope of the revenue cap balances two of the previously identified economic properties: the incentives for cost reduction and the risks imposed on the TSOs/DSOs. TOTEX performs better concerning the first principle but is ill suited when it comes to considering exogenous cost factors, in which case the building blocks method is better suited[30].

3. The tools to define allowances and efficiency targets

In order to maximise efficiency gains for final users, the definition of the allowed initial level of revenues and of the cost reduction trajectory (X-factor) to be applied to this initial level (i.e., how the allowed revenue varies during the regulatory period) are required. This is to ensure that the revenue allowance is as close as possible to the efficient level of cost thus ensuring that network developers do not have the possibility to create monopoly rent. If the efficiency targets are too ambitious, they will produce a redistribution of normal rent. If the efficiency targets are too light, they will leave too much monopoly rent to the network operator (Glachant et al., 2013).

4. The practical setting of the capital remuneration

A significant share of the allowed remuneration is represented by capital costs since investments performed by network operators are capital intensive. Several economic factors come into play in function of how remuneration is designed:

- RAB (Regulated Asset Base): reflects the net value of the investments undertaken by the company and it is adjusted yearly to take into consideration new investments as well as depreciation (Glachant et al., 2013). In general, the RAB provides for remuneration of both historic and new investment. It can comprise several components such as fixed assets, working capital or construction in progress, while other elements, such as capital contributions of customers, government (e.g., subsidies) and third parties are usually excluded. Also, the structure of individual components included in the RAB and their valuation can differ significantly among countries (CEER, 2022).
- Assets included in the RAB can be expressed either in terms of historical costs (or indexed historical costs in order to account for inflation), or in terms of re-evaluated values. The second method might prove more useful to accurately describe the true value of the capital goods a business owns and to avoid that NRAs deal with the significant increases of RAB due to market circumstances. However, none of the two methods is used unanimously among EU Member States, with differences even among the countries that use the re-evaluation method as re-evaluation can either be done once or on a frequent basis (CEER, 2022). One third option is to use a mix of historical and re-evaluated assets applied by some Member States like Germany, Hungary and Luxembourg (CEER, 2022).

[29] These mechanisms might derive from the other regulatory designs (e.g., cost-plus).

[30] As stated by Glachant et al. (2013) a common "rule of thumb" principle applied in regulatory designs is that only controllable costs should be covered by the revenue cap incentive scheme.

- While in the gas sector there is no difference among ECRB[31] countries between the two methods concerning the value of the RAB, for the electricity sector, one third of ECRB countries had a difference with percentages that varied greatly, from 65% to 152% (CEER, 2022).
- Allowed rate of return (RoR): it is multiplied by the RAB in order to determine the total allowed remuneration of network developers. It can either be expressed as a regulated WACC (Weighted Average Cost of Capital), or as two separate measures, Return on Equity (RoE) applied on equity capital and Cost of Debt (CoD) applied on debt capital. In addition, the method used to evaluate the RAB has an influence on the choice of the WACC since a RAB based on indexed historical costs would require the use of a "real" instead of a "nominal" WACC.
- Bankability: refers to the ability of network developers of securing finance from capital markets in order to meet their investment programs. Credit rating influences bankability as it determines the cost of debt capital. In a period of massive investments (like the one that Europe is expected to experience in the coming 30 years to reach decarbonisation targets), the allowed revenue of network companies must be set to maintain a high credit rating of companies in order to minimise the costs of finance. If this is not achieved, network developers might need to massively recur to debt capital, thus increasing their exposure and their risk which, in turn, decreases their rating and results in higher financing costs that are ultimately passed down in the energy bills, increasing tariffs paid by final consumers. Despite a theoretical ability by TSOs/DOSs to resort to equity financing to contain the total cost of capital, such an option is limited by the public ownership nature of most EU TSOs/DSOs in the gas and electricity sectors. As argued by the ENTSO-E (2014), Member States are reluctant both to infusing internal equity into their companies due to budget constraints, as well as to diluting their ownership share of this essential public good[32] by accepting external equity[33].
- TSOs/DSOs also need to operate within gearing constraints (debt/equity ratio) set by NRAs to limit the share of debt on total financed capital (leverage effect)[34] and thus keep a high credit rating with the additional goal of containing capital costs and tariff levels. This compulsory debt/equity ratio poses an obstacle to debt financing as state-owned TSOs/DSOs cannot recur to debt to finance projects over a predefined gearing limit and their ownership prevents them from increasing equity in view of increasing this limit. Thus, the level of the allowed revenue cap represents the main driver towards achieving the necessary investments to keep up T&D with the decarbonisation pace.

5. The adjustment mechanisms

The introduction of a revenue cap is based on a number of ex-ante estimates aimed at determining the revenue/tariff trajectory during the regulatory period. As such, adjustment mechanisms are necessary to manage the differences between the estimated ex ante and ex post values that are observed. Electricity demand uncertainty is an important factor to adjust as, in revenue cap schemes, the transformation from allowed revenues to the network

[31] Energy Community Regulatory Board (ECRB) is the independent regional body of energy regulators in the Energy Community and beyond.

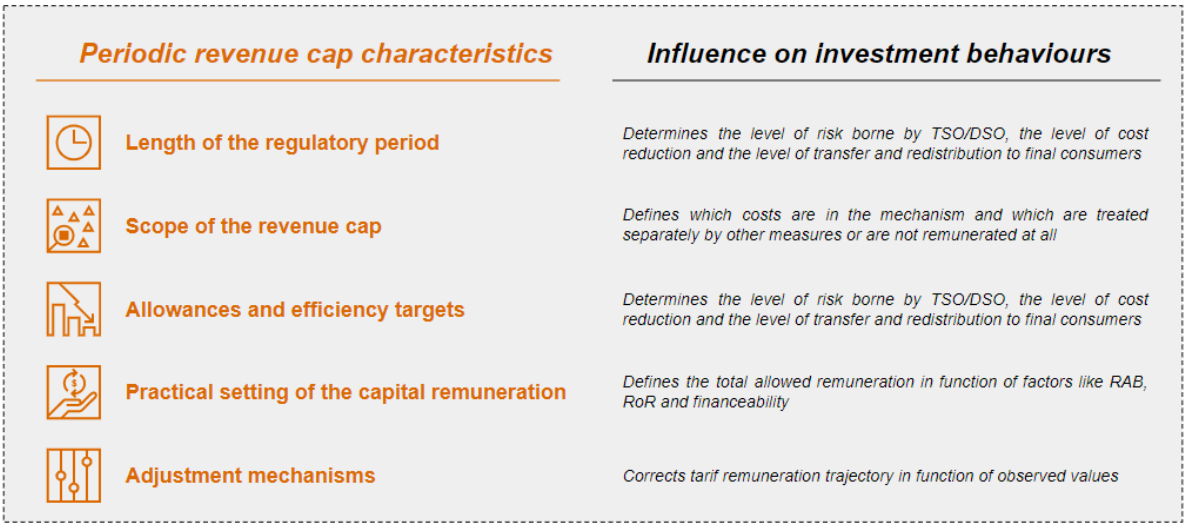
[32] Intermediate report: Financing framework for meshed offshore grid investments, *PROMOTioN – Progress on Meshed HVDC Offshore Transmission Networks*, 2017.

[33] TSOs are mostly state-owned across the continent concerning electricity, while for gas TSOs are mostly privately owned in Western Europe and mostly state-owned in the east (Roland Berger, 2011), while Electric DSOs are also mostly publicly owned across the continent (Eurelectric, 2020). On the positive side, state ownership provides strong sovereign guarantees which help TSOs to acquire debt more easily as opposed to privately owned TSOs, which may experience more difficulties.

[34] NRAs try to impose a limit of 60 to 70% (ENTSO-E, 2014).

tariffs requires an ex-ante estimation of electricity demand. If observed demand is different from the ex-ante estimation, tariffs need to be adjusted in order to ensure a proper remuneration for network developers (Glachant et al. 2013). Non controllable costs, which are determined by exogenous factors, and controllable costs whose levels depend to some degree on exogenous factors (e.g., cost of ancillary services that depend on the price of energy, or the needed investments that depend on the level of RES integration) can also be subject to adjustments.

Figure 7: The characteristics of the periodic revenue cap



The EU regulatory panorama concerning T&D has seen a gradual shift from cost-based regulatory frameworks in the past, which guaranteed certain predefined return on their costs but ensured high levels of investments, to the more incentive-based approaches of the present that induce network companies to achieve desired goals in terms of cost efficiency to keep network tariffs stable, also with the aim of preventing over-investment (CEER, 2022). This reflects also the change in the needs of the T&D networks, as regulatory regimes which favoured investments were required to develop and expand the network, while regimes that favour cost efficiency are required once the network is sufficiently developed. As the ENTSO-E points out (2014), this approach works well in a system where investments are stable over time but is affected by issues in case investments are required to increase.

The needs for investment in the T&D segment, necessary to keep up the pace of decarbonisation and meet the European Green Deal goals, converge around two main pillars:

1. **Grid digitalisation** represents the first pillar, referring to the need to increase the application of data-driven technologies[35] in the T&D sector with the scope of expanding the market for energy services, facilitating the integration of intermittent energy generation sources, and increasing the flexibility of the energy system overall. More specifically, digitalisation will allow the integration of distributed energy generation and storage sources as well as the participation of demand to the balancing requirements of the grid by reducing investment needs in physical T&D assets, thus allowing for increased levels of cost efficiency. To encourage such investments, the creation of a favourable regulatory environment for the classification and treatment of data both at the EU and national levels is essential, as stated in a joint declaration from the main

[35] Such as the Internet-of-Things (IoT), cloud services, and Artificial Intelligence (AI).

associations of the European electric sector[36] which also suggest the elaboration of targeted incentives to promote the uptake of data-sharing solutions across the energy system.

2. **Investments in physical assets** in T&D represent the second pillar alongside digitalization. On one hand, old assets need to be replaced as they reach the end of their operational life, while on the other, the change in the energy generation mix requires greater grid capacity and flexibility to accommodate a higher share of intermittent generation. For example, enhanced interconnection networks can contribute to the creation of an EU-wide flexibility market by balancing the load across wider geographic areas and by pooling sources of flexibility from across those areas, reducing the amount of ramping that needs to be provided by generating plants. Also, long-distance high-voltage direct current (HVDC) east-west transmission lines are particularly valuable for providing PV generated power at early morning or late afternoon, while north-south transmission lines offer potential for seasonal balancing[37]. Flexible high-voltage grid technologies, allowing better control of HVDC lines and the development of meshed HVDC grids, are currently at middle Technology Readiness Levels of maturity (TRLs 4-8)[38] which means that consistent investments will be needed to bring these technologies to commercially viable TRLs and implement them into the electric system. The same applies for the gas transmission infrastructure where policy discussions revolve around the question of how the existing grid can be retrofitted to host transportation of decarbonised gases like renewable hydrogen. The European Hydrogen Backbone (EHB) initiative estimates that the Backbone Infrastructure project could be developed across 5 corridors (e.g. North Sea corridor; Nordic & Baltic corridor; South-West corridor; South-eastern European corridor; North Africa Italy corridor) with a length of almost 53,000 km by 2040, of which 60% would be based on the repurposing of existing natural gas grids. The EHB estimates a total investment of €80-143 billion which includes subsea pipelines and interconnectors linking countries to offshore energy hubs and potential export regions. In order to carry out such investments, cohesion efforts will be necessary from all the gas TSOs of the Union. Initiatives such as the EU Hydrogen Strategy[39], and the European Clean Hydrogen Alliance[40], the IPCEI (Important Projects of Common European Interest) on Hydrogen[41] have fostered such cooperation amongst the industry actors.

The bulk of these investments will need to be carried on over a very short period of time (e.g., less than a decade to achieve the 2030 energy targets), something which may not be compatible with how TSOs/DSOs are currently regulated. Constraints on equity financing, the need to contain debt financing, and incentives to decrease OPEX through efficiency objectives may slow down and even prevent the necessary investments from being carried out. In other words, the level of investments is dependent on the level of grid tariffs set by regulators to remunerate TSOs/DSOs, and thus on the level of allowed revenue.

What type of financing is needed

Financing methods

[36] Joint declaration on aspects related to the upcoming EU Action Plan on digitalizing the energy sector, *Eurelectric, E.DSO, EHPA, WindEurope and SolarPower Europe*, July 2022.

[37] Energy Technology Perspectives 2020, *International Energy Agency*, 2020.

[38] The Energy Technology Perspectives — Clean Energy Technology Guide, *International Energy Agency*, 2020.

[39] Available at this link.

[40] Available at this link.

[41] Available at the following link.

Following the unbundling and partial privatisation of transmission and distribution operators, operators need to attract much more private capital than in the past, and under market conditions. In light of this, energy infrastructure projects can be financed via three sources:

- **Equity**: financing can be provided via internal equity originating from the TSO/DSO cashflows, and via external equity originating from investors as internal equity alone is not sufficient to cover investments[42]. Internal equity represents the basic form of financing for energy infrastructure projects and is suitable for low and stable investments where non-significant new infrastructure needs to be built. External equity originates from stock capital markets, for those TSOs/DSOs that are quoted, and comes in handy when specific leverage levels need to be maintained for credit rating reasons or as a prerequisite for additional debt funding[43].
- **Debt** financing can take several forms, including corporate bonds. For the T&D segment, access to debt can vary depending on the asset type (e.g., the Taxonomy will likely make gas T&D financing less attractive for investors as it is not considered "green" by the legislators, thus negatively impacting their sustainable lending volumes[44]) as well as on the country (sovereign risk levels tend to impact the cost of finance for national TSOs/DSOs). Notwithstanding these variations, access to debt in the T&D segment is relatively high as the low-risk nature of the regulated T&D model makes debt financing of T&D assets broadly attractive for a large range of risk-adverse investors.
- **EU financing in the form of grants, debt, de-risking instruments and equity**, is another important source of capital for the T&D segment. While EU financing may be small in terms of financed volumes, it remains an important mechanism for crowding in private financing by reducing risks as well as the "signalling effect". The Connecting Europe Facility is a notable example of a financing instrument dedicated to energy interconnection projects (Projects of Common Interest, PCIs) linking two or more Member States.

Financing business models

In a study by Roland Berger[45], three main business models regarding the financing of energy infrastructure projects are identified.

- **Fully regulated models**

This is the most frequent model applied by the vast majority of TSOs and DSOs for all domestic projects and the majority of interconnection projects. Investments are carried out according to grid development plans which are submitted by TSOs/DSOs to NRAs in order to allow the latter to verify the prudence of new investments. The investment costs are then included in the regulatory asset base (RAB) of TSOs/DSOs. Investment expenses for these projects are recovered through regulated revenues with final consumers that pay via a share

[42] As it is illustrated in the following section on barriers, external equity financing from investors can prove to be complex as it is influenced by the ownership of network developers. TSOs and DSOs which are predominantly state-owned may experience difficulties in attracting/accepting external equity due to the reluctance by their public shareholders to dilute their ownership share of what is considered an essential public good of strategic national interest. Despite this, some TSOs, like the Italian Terna, experience high levels of private participation - approximately 70% of Terna's share being privately owned (https://www.terna.it/en/investors/main-shareholders).

[43] A topic of interest that may gain significance in the future is the role of external equity in financing the repurposing of gas grids to accommodate the transportation of hydrogen (H2) and other green gasses. External equity can serve not only to channel capital, but also to enrich the TSOs/DSOs base of technical capabilities concerning H2 and opening new business lines.

[44] It is worth noting that despite the Taxonomy being a voluntary categorisation system, it is a powerful tool for channelling resources into sustainable activities that are aligned with a net zero trajectory by 2050.

[45] The structuring and financing of energy infrastructure projects, financing gaps and recommendations regarding the new TEN E financial instrument, *Roland Berger Strategy Consultants*, July 2011.

of the energy prices. Thus, project costs are directly "socialised" and risks are very low as a return on the approved investment is guaranteed. The main objective pursued by such model is to improve reliability and adequacy of the energy systems.

- **Merchant model**

This model is frequently used for large interconnection projects for electricity and gas that run on a commercial basis outside the regulatory scheme[46] . A variation of this model, the Offshore Transmission Owner (OFTO) model[47], is widely used in the UK where third parties compete for the ownership and operation of offshore transmission assets[48]. As such, revenues are determined by the market for both the merchant and the OFTO models. Investors are private entities and TSOs can participate as shareholders in these projects (e.g., Estlink 1 electricity interconnector between Estonia and Finland), but it is not mandatory as some merchant interconnectors have no TSO shareholder (e.g., Eleclink interconnector between France and the UK, Baltic cable between Germany and Sweden).

Concerning T&D for gaseous fuels, the merchant model is more common among long-haul transmission infrastructures, especially for projects aimed at importing gas from exporting countries. These projects are also characterized by long term supply contracts in order to provide certainty of returns to investors. On the contrary, the regulated model is likely to be preferred for investments increasing transmission capacity within the European borders as they increase security of supply and tackle market segmentation[49].

Under the merchant model, investment costs can be recovered either through the congestion rents or the sale of financial (or physical) transmission rights (FTRs)[50] which are usually allocated in a market-based mechanism (for example auction). Thus, the payers in this model are represented by market players who buy transmission rights. Risks are mainly transferred to investors.

- **Mixed merchant model with regulated elements**

Given by the merger of the first two models, this model includes both market and regulated elements and is applied for some interconnection projects (e.g., BritNed between the UK and the Netherlands, Nemo in Belgium). For these projects, revenues are determined by market regulation within a defined bandwidth (e.g., regulated cap and collar). BritNed and Nemo, for example, operate under a regulated cap and collar, including both a market-based auction mechanism and a regulated maximum revenue.

Financing structures

Below are presented the two main project financing structures:

- **Corporate Finance**: is applied mostly to projects that are part of grid development plans submitted to and approved by the NRAs for both TSOs and DSOs, thus all projects that are managed under the regulated model. In this context, projects are financed through debt incurred by TSOs/DSOs, which is repaid through network tariffs

[46] Thus, DSOs are excluded from such models as they operate in domestic contexts.

[47] The model is based on a competitive tender process through which offshore transmission assets are sold and licences are granted. The assets and licences are for the transmission of electricity generated by an offshore windfarm to bring it onto the onshore grid. A competitive process ensures that generators are partnered with transmission owners that are the most efficient and competitive players in the market. This should result in lower costs and higher standards of service for generators and, ultimately, consumers. https://www.ofgem.gov.uk/energy-policy-and-regulation/policy-and-regulatory-programmes/offshore-electricity-transmission-ofto.

[48] Schittekatte, T., UK vs DE: two different songs for transporting energy to shore, *Florence School of Regulation, European University Institute*, September 2016.

[49] Investments on transport infrastructures for natural gas and electricity: Towards a conceptual framework to assess their impact on social welfare, *CERRE (Centre on Regulation in Europe),* Brussels, April 2011.

[50] FTRs entitle the holder to the price difference between two nodes.

supported by final consumers. Corporate finance tends to be the option preferred by network developers operating in the mixed merchant model with regulated elements.

- **Project Finance**: is applied mostly to projects that take shape outside the perimeter defined by grid development plans and that are generally based on the merchant model for the generation of revenues as they are not included in the RAB. Interconnection projects are an example where project finance is sometimes adopted, although they might also come to form hybrid examples where project finance meets corporate finance if the project involves works that fall within the perimeter of the grid development plans.

In both corporate and project finance, the main sources of capital are debt and equity.

2.4. Barriers to investment

This chapter provides an overview of barriers affecting energy transmission and distribution for electricity and gas. Considering that T&D for electricity and gas is regulated in a similar manner, the same T&D barriers have been considered for both electricity and gas[51]. The barriers have been identified following a two-step process:

- **Literature review** to identify a long list of barriers for investments in T&D from authoritative sources (e.g., EIB, European Commissions, International Energy Agency - IEA, etc.). The identified barriers were grouped into four categories, namely:
  - **Political and regulatory**, associated with risks and barriers concerning compliance with the regulatory and policy frameworks, the permitting framework, as well as social acceptance of these projects on behalf of the general population
  - **Financial**, associated with risks and barriers deriving from financial factors like access to capital, costs of capital and credit ratings
  - **Technical**, associated with risks arising from technical features of projects like technology and the risk of stranded assets
  - **Energy market development**, barriers emerging from the immature nature of the market for emerging technologies

- **Deliberations of the Working Group (WG)** to identify the barriers considered most acute. Working Group participants were asked, firstly during the WG meeting and subsequently via a follow-up survey, the following questions:
  - Select 5 barriers out of those identified in step 1 which you consider most relevant.
  - Provide examples of the barriers you found most pertinent in the market(s) where you operate and / or in specific Member States.

Table 2 provides a view of the barriers identified as most acute, or most relevant. In the sections that follow, we provide more detailed information about participant's views of the barriers, as well as several examples of the effect of barriers on investments in T&D[52].

[51] Later in this chapter we do, however, highlight case studies and examples of differences in the impact of barriers on transmission and distribution, which emerged in part from Working Group discussions.

[52] Opinions expressed by some participants are reported. These opinions do not necessarily reflect the views of all WG members.

Table 2: List of barriers to investments in energy transmission and distribution

Risk Group	Barrier	Scoring
Political & Regulatory	Regulatory & policy risk	77%
	Administrative requirements (permitting)	54%
	Social acceptance & citizen engagement	46%
	Inadequate network development planning	46%
	Insufficient remuneration	23%
Financial	Availability of finance & access to finance	31%
Technical	Stranded assets risk	38%
	Technology risk	31%
	Advance capacity risk	23%
Energy market development	Inadequate or underdeveloped supply chain and industrialization	54%
	Availability of skilled labour	31%

Source: PwC's own elaboration based on the results of the online survey circulated amongst WG members

Political & Regulatory Barriers

Regulation & policy related issues were identified by several TSOs and investors as the main barrier to investments in energy infrastructure projects[53]. This category concerns issues that arise from how transmission and distribution are regulated by NRAs. Key issues relating to this barrier are the following:

- **Stability of regulation**: changing regulation over a short period of time creates uncertainties for both equity and debt providers, especially for institutions that provide long-term financing. Equity providers consider regulation stability a key concern for investments, even more than return on equity. The commitment and track record of regulators in ensuring stable returns over long timeframes are subject of most of the concerns expressed by TSOs/DSOs regarding stability of regulation.
- **Regulatory and legislative uncertainty** due to ambiguous or absent rules represents, a major risk, especially with regards to new energy carriers, in particular hydrogen. It refers not just to the market rules, but also to all other policies affecting the sector. Considering the hydrogen (H2) market, the lack of regulation in an area where regulation is expected, and the lack of certainty of what/how that area will be regulated strongly impacts the financing of assets in this market. When it comes to T&D, this effect goes beyond the uncertainty on the market model and on the broader regulations affecting the supply and demand for H2. This causes investments to stagnate, even if there is appetite for investment, in the wait of a certain regulatory framework.
- **Legal access to network operators' capital**: concerning constraints imposed by Member States on the access to state-owned TSOs/DSOs equity.

[53] Study on comparative review of investment conditions for electricity and gas Transmission System Operators (TSOs) in the EU, *Publications Office of the European Union*, 2015, Luxembourg.

- **Harmonization**: this issue is related to interconnection projects as they face the need to operate between regulatory regimes that can be very different. Thus, NRAs involved in such projects need to agree on a common regulatory framework and also on the allocation of costs and benefits.

The WG discussions and survey results suggest that regulation and policy are seen as the most acute barrier to investments in T&D with consensus from 77% of participants covering a vast range of stakeholders, namely investors, developers, research bodies, regulation authorities and associations. More specifically, there is slightly more concern expressed from investors representing the supply side of financing in comparison with developers representing the demand side. WG participants expressed the need to have stability in the regulatory framework stressing the fact that investments in T&D have long time frames, so any change in regulation poses an issue. They pointed out that stability is essential to accurately predict the return on investment. Uncertainty of regulatory treatment of financing R&D activities for operators based on arrangements approved by market regulator can also hamper the development of more innovative solutions. Participants also identified the lack of human and administrative capacity on the regulator and legislator side as a factor that slows down the implementation of EU policy regulations, also posing obstacles for their enforcement. Furthermore, participants reported that governments are often reluctant to implement new regulation during their term, highlighting the existence of a “not in my term” approach that can delay the implementation of reforms necessary to bring T&D up to the pace needed for reaching decarbonisation targets. Concerns were also expressed regarding the REPowerEU target of 35 bcm of biomethane and of 20 mt of hydrogen, as some of the participants consider neither the regulatory context nor the existing gas grids as ready to accommodate such a target.

In the second WG meeting, participants drew attention to regulatory barriers that can slow down digitalization processes for DSOs. These barriers relate to:

- Uncertainties concerning the cooperation between TSOs and DSOs, which is necessary to provide flexibility services in a cost-efficient manner for both TSOs and DSOs.
- Uncertainties deriving from regulation concerning data protection and sharing as DSOs will need to make increasing use of data to provide flexibility.

During the second WG meeting, participants also identified regulatory weaknesses for hydrogen pipeline transportation stating that regulation is still under development in this sector and does not clearly identify the actors responsible for the implementation of repurposing projects and their financing. Participants also reported that this shortcoming may lead to hesitation on behalf of investors and developers in providing capital for gas grid repurposing, leading them to prefer flexible economic models based on subsidies and grants.

Administrative requirements, mostly in the form of **permitting issues**, are considered major obstacles that affect both the generation and the transmission and distribution segments of the energy value chain. Permitting procedures can cause long delays and large administrative costs (including stranded asset costs). Cross border projects are particularly exposed to this issue due to their complexity and to the different national legal frameworks they need to interact with. Issues related to permitting procedures can occur before funding for a project is obtained, as funding is typically provided only after the successful completion of the permitting process, thereby generating delays at the start of the project and a rise in costs bared by TSOs/DSOs which have the potential to be reflected on the tariffs paid by final consumers. Also, permitting issues postpone the generation of revenues used to pay interests, repay loans and remunerate equity investors for their expenses. Additional costs generated by permitting delays might also require additional funding.

As pointed out by ENTSO-E, permitting issues can lead to opportunity costs as they increase perceptions of risk and either decrease the attractiveness of financing infrastructure investment or increase the return required by investors[54]. The EU has designed the PCI framework to accelerate the permitting process in accordance with the importance of projects, but these projects represent a minor part of EU-wide energy infrastructure projects. Some WG participants also considered the process of listing projects as PCI (e.g., selecting criteria such as cross-border relevance) and receiving CEF Energy funding as excessively burdensome in administrative terms.

With 54% of votes, administrative requirements were seen by stakeholders as the second most influential barrier for investments in T&D, on equal merit with underdeveloped supply chain. Concern was expressed equally between the demand and the supply side of financing as both developers and investors are concerned by the delays and the rising costs caused by burdensome permitting rules. Participants reported that administrative requirements cause difficulties in the access of funds, particularly in lower income countries (e.g., Romania). WG discussions also point out how permitting issues may originate from the lack of human capacities in public administration. Lawsuits of affected citizens are also listed by participants among the reasons behind delays in T&D investments. Alongside developers and investors, relevant concern is expressed also by regulatory bodies and by industry associations. This indicates how this barrier is recognised by the vast majority of stakeholders as relevant and capable of blocking the necessary investments to achieve the goals of decarbonisation. Finally, participants have expressed some concerns regarding the possibility that permitting issues, if not fixed, might delay even those investments and measures envisaged by REPowerEU.

In the WG meetings, participants also reported that the processes of applying for and securing some forms of EU funding instruments can often be excessively burdensome and bureaucratic. For nationally administered funding programs such as the RRF, participants reported bureaucratic burdens that are difficult to meet, hindering the effectiveness of the program[55]. Thus, participants expressed the need to ease access to EU funds and loosen the criteria required to receive support[56].

In order to ease access to EU funds, **three factors were identified by WG participants as useful**:

1. Easier rules to combine national and EU funds on the same project, as sometimes project promoters have to choose between one or the other financing opportunity due to incompatible rules.
2. Eligibility rules and conditions that reflect the national/local context and legal framework. Some participants reported that it is easier for them to use instruments provided by national authorities, rather than EU funds, as they are perceived as closer to the specific needs of local TSOs and DSOs.

[54] Creating conditions to allow TSOs to finance Europe's transmission investment challenge, *ENTSO-E*, March 2011.

[55] An example was local content requirements introduced in some MS RRF programmes, i.e., the requirement to only use equipment that has been manufactured only in the EU. For some components like batteries, meeting such requirements is extremely difficult or costly.

[56] One participant cited the CEF AFIF call as a best practice, as even before submitting the application for the grant, the implementing body can liaise with the Commission to address questions and potential project-to-project specificities ahead of the submission deadline. This helps with reducing bureaucracy, renders the application process less cumbersome, and ultimately increases the chances that a project will correctly meet the criteria and thus be selected for financing.
The objective of the Alternative Fuels Infrastructure Facility (AFIF) call for proposal is to support the deployment of alternative fuel supply infrastructure, contributing to decarbonising transport along the TEN-T network. With a total budget of €1.57 billion, the AFIF will fund actions by the combination of CEF grants with financial support from financial institutions to achieve a higher impact of the investment. It will be implemented through a rolling call for proposals launched on 16 September 2021, with five cut-off dates for the submission of proposals until the end of 2023.

3. A one-stop-shop at EU or national level able to provide an overview of all financing opportunities and eligibility conditions for potential project promoters.

Burdens concerning EU financing and funding instruments for DSOs

A study from Eurelectric of 2021[57] uncovered several administrative barriers that DSOs face when accessing EU financing and funding instruments. Three main categories of issues are identified:

- **Eligibility criteria**

Stringent eligibility criteria of some EU funding instruments lead to the exclusion from the participation to such instruments of investments promoted by DSOs from small to low-GDP Member States. Such is the case of HORIZON2020 where some companies reported high innovation requirements to access the program that can prove prohibitive for smaller countries or lower income countries which have not attained sufficient innovation levels of the distribution grids. Therefore, the report highlights a lack of adaptation of eligibility criteria to the specificities of each national context[58], recommending a more tailor-made approach in the design of funding solutions that can encourage the energy transition in every Member State of the European Union.

- **Burdensome application and evaluation process**

The application and evaluation processes for some financing programs have been reported as too long and resource-intensive, thereby discouraging the participation of companies. One such example is the CEF Energy instrument where companies must first apply to obtain the status of Project of Common Interest (PCI) for a project, before undergoing the application process for the CEF instrument. Such a process entails long duration and bureaucratic complexities which also combine with stringent eligibility criteria imposed by the CEF instrument. The report recommends implementing streamlined processes with two-stage procedures[59], in order to allow developers to test their ideas without investing excessive resources, and it identifies the revision of the TEN-E as an opportunity to promote such changes.

- **Access to information**

The report highlighted how scarcity of information concerning opportunities offered by EU funding programs can represent a barrier for their optimal use by DSOs. One example concerns loans offered by the EIB, as very few companies reported accessing such resources. The main reason reported by companies was lack of information on the opportunities offered by the EIB. In fact, small companies might lack internal resources to search for complete information about EU financing opportunities. Difficulties in finalizing negotiations with the Bank due to its high risk aversity is also reported as a discouraging factor, together with restrictive eligibility criteria imposed by the Bank. The report recommends increasing transparency of interest rates as well as eligibility procedures and criteria for the Bank, and in general increasing transparency on the EU financing instruments that have been accessed by DSO projects[60].

[57] Guide on EU Financing and Funding Instruments for DSO projects, *Eurelectric*, 2021.

[58] As illustrated in the the *Distribution Grids in Europe: Facts and Figures 2020* report from Eurelectric, the DSO landscape in Europe is bard-varied with uneven levels of development and modernisation.

[59] One for project promoters to submit their ideas and a second one dedicated to full project applications for selected ideas.

[60] The report suggests the creation of tools and platforms dedicated to sharing information. The report indicates the Funding & Tenders Portal as a first step towards a unified and easily accessible information bank.

Permitting: one of the main reasons for delays concerning energy PCI projects

In a recent report[61], ACER published data on the progress of PCI projects for the energy and gas sectors.

Concerning the implementation status of energy PCI projects, ACER observes that almost 70% of projects are in permitting, under construction, or commissioned, while slightly more than 30% of them are planned, but not yet in permitting or still under consideration[62]. The report provides analyses indicating which and how many projects have experienced delays or rescheduling[63] and for what reason. More specifically:

- **Electricity sector**

Permitting is seen as the most relevant cause for delays in electricity PCIs (30% of reported delays). Technological reasons (e.g., re-routing and/or siting or re-siting of facility initiated by the promoter) are the second most frequent cause for delays (about 20%) followed by tendering (about 15%) or financing issues (about 15%). Additionally, project promoter(s) reported delays in the procurement process and delays due to lawsuits and court proceedings. Four electricity PCIs appear to be stuck at the permitting phase since 2015[64].

More than a third of the project promoters reported difficulties encountered by their projects, many of which concerned the permit granting process, and require additional actions by the Competent Authorities (for about 15% of the electricity PCIs). Other reported difficulties were mainly related to the environmental impact assessment, arising from public opposition or due to appeals/court proceedings (about 10% each).

The average (actual or expected) duration of the permit granting process for transmission PCIs which applied for the first permit after 16 November 2013[65] is 3.3 years. For 21 transmission PCIs, the permitting duration exceeds the 3.5 years permit granting time limit set by the TEN-E Regulation (3.5 years), in 15 instances by more than 9 months. The overall duration of the permit granting process for 2 interconnection PCIs lasts more than 9 years. For smart grid projects, the average implementation duration is about 5.5 years (variation between 4 years and 7 years) and the permit granting duration is around 5.8 years (variation between 4.2 years and 7.6 years).

- **Gas sector**

For the gas sector, permitting is part of a diversified range of challenges which have led to delays, but it does not represent the main reason. Other reasons concerned also

[61] Consolidated report on the progress of electricity and gas Projects of Common Interest, *ACER*, June 2022.

[62] ACER considers that the status of the least developed element of a given PCI is representative for the overall status of the project. The information about the status of the projects is therefore rather conservative, as some of the investment items included in a given PCI may be at a more advanced implementation stage than other investment items belonging to the same project.

[63] ACER defines the two concepts in the following way:

- A **delayed** investment is still needed at the expected date, but cannot be delivered on time due to various external factors like permitting, environmental, legislative reasons, etc.
- A **rescheduled** investment is one that is voluntarily postponed by a promoter due to changes of its external driver (e.g. lower demand, less urgent need for the investment due to updated planning data, or assigning priority to other solutions). Rescheduling is generally caused by overoptimistic project milestones planning by the project promoter.

[64] PCIs 2.14, 2.18, 3.11.1, 3.11.4 available for consultation in the current list of PCI projects (Fifth PCI list) at the following link. The actual number of PCIs "in permitting" status since 2015 is in total 8, but the other projects reported to have started or even completed construction works for at least some sections or elements of the project.

[65] According to Regulation (EU) No 347/2013, for these projects Chapter III of the Regulation (Articles 7-10) regarding permit granting and public participation applies and provides a legally binding 3.5 years upper limit with a potential extension of maximum 9 months for the permit granting process.

financing, tendering, process delays, construction works, national law changes affecting permitting interdependency with other delayed infrastructure investments, environmental problems and lack of market interest. Project promoters reported that they have faced various difficulties in the permit granting process of their PCIs: several gas PCIs, it was reported that they encountered difficulties due to environmental impact assessments, and also due to difficulties related to appeals and/or court proceedings.

For PCIs in the gas sector, the estimated overall duration of the permitting process is about 3.6 years, and approximately 35% of the projects exceed the permitting duration foreseen in the TEN-E Regulation (3.5 years).

Social acceptance & citizen engagement is driven by the impact that new energy infrastructure has on the environment and the landscape as well as on local activities (farming, real estate, etc). Overhead electricity transmission and distribution lines, but also gas infrastructure, can encounter strong public opposition especially if they are situated near populated areas or near natural habitats. Cross-border projects are also affected by such issues as they as are often perceived as "transit lines" without local benefits[66]. This barrier can cause further delays in the permitting process.

This barrier is considered as relevant by 46% of participants on par with inadequate network development planning, with opinions from representatives of the supply and demand side of financing broadly converging. Besides developers and investors, such a concern is expressed evenly across the entire range of stakeholders by regulatory authorities, research bodies and industry associations alike. WG participants expressed concern over the combined effect this barrier can have together with permitting and administrative requirements rather than on its own, as the vast majority of participants have identified them as interlinked. One **high-level solution** suggested by participants is to improve communication on the benefits generated by the T&D sector, in particular with a focus on the importance of a modern grid to stakeholders and the general public.

Feedback from participants has also drawn attention to a possibly positive effect that repurposing of gas T&D might have in terms of social acceptance. On one hand, as reported by ACER in its overview of existing studies and reflections on the conditions for repurposing of 2021, natural gas pipeline networks are already available and thereby socially accepted since there is no need to construct additional network. On the other hand, repurposing fossil infrastructure into a green infrastructure can generate a positive social acceptance effect.

Public opposition in electricity and gas infrastructures

According to a paper published by the European Network of Transmission System Operators, a significant number of electric grid infrastructure projects in the Ten-Year Network Development Plan (TYNDP) 2018 have been delayed, with public opposition identified as the main hindrance[67]. The ENTSO-E suggests that, in order to avoid this problem and gain acceptance among the public, local citizens need to be engaged to "address people's concerns / needs and to jointly develop approaches to protect nature."

[66] Intermediate report: Financing framework for meshed offshore grid investments, PROMOTioN – Progress on Meshed HVDC Offshore Transmission Networks, 2017.

[67] European super-grid suffers delays, says ENTSO-E, *pvmagaznie.com*, May 2019.

Concerning gas, one example of fierce public resistance is provided by the TAP (Trans Adriatic Pipeline) project in Italy. Part of the Southern Gas Corridor and linking the Trans Anatolian Natural Gas Pipeline Project (TANAP) and the South Caucasus Pipeline (SCP) gas interconnectors to Italy, the project is aimed at diversifying the

EU's gas supplies. In 2011, the "No TAP" protest movement made its first appearance in Melendugno, Puglia, at the designated end point of the pipeline where the project encountered fierce public opposition. The movement involving the mayors of many towns in the Salento area organised a firm opposition to the project. They tagged the pipeline as "not useful" given Europe's declining gas demand, dangerous for the environment and "not safe"[68]. Increasing opposition led to the Puglia region joining municipalities against Italy's central government.

The beginning of construction in 2016 led to fiercer opposition with protests that turned violent. Construction trucks were obstructed, stones were thrown at workers and the site had to be shut many times, bringing fresh uncertainty surrounding the project's timeline. Two legal proceedings were also opened against the developer, TAP AG. Eventually the TAP project did manage to stay on track only to be delayed by the Covid Pandemic.

Inadequate network development planning is related to the requirement of TSOs/DSOs of designing network development plans. Unforeseeable circumstances may cause changes in TSOs/DSOs objectives and priorities, generating the need to update national development plans (NDPs). In relation to this, an excessively conservative regulatory regime focused more on cost efficiency than on investments might lead network developers to produce inadequate network development plans in relation to network investment needs. Under this circumstance some plans might result inadequate if not updated, especially concerning emerging technologies like hydrogen production where planning might be outdated and be perceived by stakeholders as unclear or ambiguous.

This barrier was considered as relevant for the T&D sector by 46% of WG participants. Concern was expressed more on the supply side of financing rather than on the demand side, with investors having difficulties to predict returns in a context of unclear network development. Network development planning is essential, especially in contexts of high investments as it provides long-term signals to investors. Unclear development plans might provide unreliable signals. In relation to this, participants were concerned over the lack of clear development plans for the transportation of hydrogen[69]. In addition, frequent changes in these plans might reflect a certain degree of regulatory instability which might prove detrimental for investors' confidence in the regulatory regime. Concern was expressed also by industry associations, which estimate development trajectories on the basis of data published by TSOs/DOSs in their plans, and, to a lesser extent, by regulation authorities. One **solution** proposed by participants is to enable integrated planning also at national level to create more certainty on the possible location of needed infrastructures. Another **solution** proposed by some respondents to the survey is to promote sector coupling for both electricity and gas.

Insufficient remuneration rate might hamper TSO/DSOs' capacity of implementing the necessary investments to adapt networks to the needs of decarbonisation. Integrated grid

[68] Favasuli, S., Hornby, G., Turning on TAP: a shift in the European gas landscape, *S&P Global*, September 2020.

[69] A research institution reported in the WG survey that in the North Sea region, significant investments in electricity and hydrogen networks will be needed. However, the pathway for the development of these sectors is unclear. There is uncertainty regarding how the upstream activities will evolve and the demand side on the downstream side. Network planning and investment in this environment depends on these elements and requires more clarity and regulatory direction. This uncertain operating environment needs incentives for the right capital investments as well as innovation and technologies.

solutions (e.g., offshore generation connection and cross-border project) are also exposed to such problems. Inadequate allowed regulatory returns may also discourage equity investments, as they might lead to an insufficient RoE.

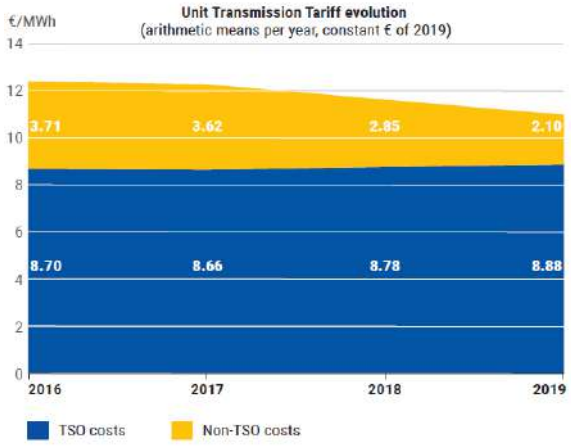
This remuneration rate issue gathered a relatively low degree of concern from stakeholders (23% of participants consider it a relevant barrier). Concern was expressed mainly by actors both on the supply and demand sides of financing, with investors expressing slightly more concern that developers. This is due to the fact that remuneration schemes represent long-term signals to investors which allow them to estimate returns on investments in T&D. The view of some of the WG participants highlighted that a reduction of tariffs over time has raised the risk of underinvesting in some regulatory contexts and pointed out that low tariffs are ideal when T&D structures need to be retrofitted but not when there is a need to build new transmission capacity, as is the case of the decarbonisation process. As such, participants, although converging on the idea that remuneration rate must increase to sustain the necessary investments, were sceptic about the possibility of grid tariffs being increased in the future. This is due to the growing costs of the current crisis which adds up to the resistance against further increases in consumers' bills, which have already been hugely impacted in the past months. In a following WG meeting, participants analysed the problem from a different perspective stating that, despite proving attractive to investors, increasing investments in regulated assets leads to increases in the RABs of network developers which in turn puts pressure on NRAs to increase grid tariffs paid by consumers in order to remunerate such investments. In details, one participant warned that increasing grid tariffs excessively might incentivize consumers to go off-grid to avoid increased costs of transmission, thus creating an ever-smaller base of consumers contributing to an ever-larger cost of grid financing. Other participants argued that albeit high, the cost of investing in grids to enable the decarbonization requirements of other segments of the energy value chain are nevertheless lower than the costs of inaction, in a scenario where NRAs' refusal to increase tariffs was to result in a long-term constraint on financing.

Evolution of network transmission tariffs for the power segment

There are a number of different solutions in setting network tariffs among EU Member States, and there is no "one-fits-all" solution as

each solution fits its own national context. However, all tariff-setting regulation at the EU level both for transmission and for

Figure 8: Evolution of UTT (2016 – 2019)



Source: Overview of Transmission Tariffs in Europe: Synthesis 2019, ENTSO-E, November 2020.

distribution must follow the principle of cost-reflectiveness[70].

Because of the vast heterogeneity in tariff-setting methods across the EU, it is difficult to compare tariffs individually between countries. The ENTSO-E however provides an overview on the evolution of network tariffs between 2016 and 2019 using a pre-defined base case measure for each Member States defined as the UTT (Unit Transmission Tariff) and expressed in €/MWh[71].

The overview distinguishes between tariffs related to costs borne directly by TSOs (infrastructure, system services and losses) and non-TSO mostly related to renewable energy support schemes. What emerges from Figure 8 is that TSO costs have remained fairly stable over the considered period. Although the overview does not explain how much of this trend is to be attributed to investments in infrastructure alone, it offers evidence of the choice pursued by NRAs of keeping network tariffs stable.

Some of the participants also reported that insufficient remuneration risk is higher for DSOs, which implies that remuneration schemes need to provide better certainty and security of returns for these companies. Finally, participants have expressed their view on the methodologies used for the setting of the scope of remuneration, with the vast majority agreeing that a TOTEX approach[72] is preferable as it allows to have a broader focus on costs on behalf of TSOs/DSOs, rather than considering a specific category of costs only. Regulation bodies have expressed their intention to study ways of encouraging the use of TOTEX.

Inadequate remuneration seen as limiting TSO investments

A study prepared by Roland Berger for DG ENER gathered the opinions of several TSOs regarding the adequacy of the remuneration schemes they participated to, in light of implementing new investments. Some TSOs stated that this remuneration was not sufficient to allow for an increase in investments. For example, the permitted ROE in the Czech Republic for natural gas transmission investments was 8%, considered insufficient to give the TSO an incentive to further expand the network. A decrease in ROA (Return on Assets) from 10.5% to 5-6% in Hungary also caused the Hungarian gas TSO to keep expectations low on the level of investments in new infrastructure. Similar statements were made by TSOs in in Lithuania, in the UK and in Germany. They said that expansion of investments does not yield adequate ROE in the current regulatory framework due to the low ROE allowances, further depressed by regulatory shortcomings such as a compulsory

[70] According to Eurelectric: “Network tariffs are cost-reflective if the costs of increased demand for network services (such as guaranteed capacity availability, energy delivery, metering, or billing) are adequately reflected in the prices of billable services.” - Powering the Energy Transition Through Efficient Network Tariffs, *Eurelectric.*

[71] In the overview, the ENTSO-E’s aim is not to compare individual transmission tariffs directly. Moreover, this overview does not take into account differences between countries in areas such as quality of service, market arrangements, technical characteristics, environmental aspects, or the location and density of generation/load, despite these factors having an influence on the absolute level of tariffs.

[72] As explained in a consultation document (link) published by the Italian Energy Regulator (ARERA), the TOTEX approach increasingly integrates tariff regulation, regulation of continuity and quality of service and support for innovation with output- based logic. It has the following features:

- focus on total expenditure, going beyond the separate consideration of operating costs and investments;
- forward-looking orientation which requires regulators to gain an increased ability to critically evaluate the expenditure forecasts of the various companies;
- application of regulatory menus to address the issue of information asymmetry.

debt ratio, delayed consideration of capital costs and regulatory uncertainty about the acceptance of costs.

Financial Barriers

Availability of finance & access to finance are crucial especially considering the relevant investments in energy infrastructure needed to reach the EU's decarbonisation goals. As illustrated in Section 2.3 in the paragraph concerning regulated revenues, in a situation where investments are required to increase, the high upfront costs of energy infrastructures cannot be financed with remuneration alone, thus equity and debt financing is needed:

- **Availability of equity** constitutes an issue especially for state-owned TSOs/DSOs where public authority shareholders (State or municipalities) are reluctant to either increase their share through own equity infusion or decrease their share to external equity infusion. Also, if regulated RoEs are kept on low levels, this increases the challenge in finding investors willing to provide equity.

In those cases where there is flexibility for equity financing, issues arise from the time gap between when equity is required (construction phase) and when revenues are generated. This time gap deters many investors, like infrastructure funds and typically all pension funds, from investing right from the construction phase, when equity is most needed since they can only invest in existing and operational assets[73].

- **Availability of debt**, especially concerning long-term investments, is being impacted by the Basel IV regulation[74] whereby long-term bank loans may become more costly as banks may have less appetite for long-term financing. This adds to the barrier of mismatching between the average economic lifetime of energy infrastructure projects (20-50 years) and the maturities of commercial loans (5-10 years) and corporate bonds (10 years for the most common, but some can reach also 30 years or more), as the reduced availability of long-term loans can lead to increased risks related to refinancing of projects.

This barrier was considered as relevant by 31% of respondents with concerns converging from both the supply and demand sides of financing as well as from regulation authorities. WG discussions have highlighted some level of concern among investors and developers alike, regarding the limits posed by the new EU regulation on taxonomy for sustainable investments. Despite gas projects being labelled as admissible in the taxonomy, investors expressed some degree of hesitation concerning gas investments as the reputational risk associated with financing of transitional projects might be high. Regulatory bodies have pointed out that access to finance is not an issue in the present, but it may become one in the future, and this may coincide with the increasing application of taxonomy rules and with rising interest rates

Industry associations stated that issues concerning access to finance are increasing, especially access to equity. The reasons for such concerns may be attributed to the state ownership of many TSOs/DSOs which poses constraints in the access to equity financing, as explained in Section "Financing tailored to TSOs and DSOs". In addition, reluctance on behalf of TSOs in accepting external equity has been reported by investors also concerning

[73] The structuring and financing of energy infrastructure projects, financing gaps and recommendations regarding the new TEN E financial instrument. *Roland Berger Strategy Consultants*, July 2011, Brussels.

[74] Basel IV is the final component of the Basel III reform and aims at strengthening the resilience of the EU banking system against future crises. Basel IV introduces changes that limit the reduction in capital that can result from banks' use of internal models under the Internal Ratings-Based approach. This also means that banks will have to carry significantly more capital to meet the requirements, resulting in higher interest rates and, more generally, more costly debt financing.

investments in grid repurposing for H2 transport, possibly indicating unwillingness to dilute their share of this strategic public good. Concern has been expressed by developers on the ability for DSOs to access EU funds, as some key financing programmes (e.g. Innovation Fund) do not have a dedicated financing category for DSOs, forcing them to compete for financing with entirely different projects. Some TSOs do not seem to consider access to finance as an acute issue when it comes to the availability of private investments as they state that investors are “knocking on the door” to invest in T&D. In this regard, also during the WG meetings, project developers highlighted that projects operating according to the regulated model have fewer difficulties in accessing finance compared to those operating in the merchant model. Similarly, from a financial perspective, participants expressed their preference for investments in regulated assets given that they are characterized by stability and predictability of revenues ensured by the tariff-based remuneration of assets.

In addition, some WG participants noted that in the case of large and riskier projects, a direct equity stake from public financial entities might be needed to crowd-in private investors. Specifically, the long development phases of most T&D projects make them more suited for blended finance or equity financing combined with grants and other de-risking schemes. Conversely, digitalisation projects, based on the innovative technologies introduced in the energy T&D sector by SMEs and innovative start-ups, make them more suited for sources of equity such as venture capital, angel investors and IPOs.

WG discussions highlighted that financing needs and available financing instruments vary between TSOs and DSOs. TSOs tend to be partially state-owned, which enables them to take higher risks and benefit from higher ratings (related to sovereign risk rating). TSO projects also tend to be large, structured under classic project finance logic. On the other hand, DSO projects tend to be more complex and sometimes of very small size (even up to € 100K). DSOs often also don't have the human and administrative capacities to prepare projects. This is especially true for small, local DSOs (e.g., municipal DSOs in France). Therefore, they may need project preparation and other forms of technical assistance.

During the WG meetings, participants identified EU financing (i.e. grants, concessional loans, or risk guarantees) as an option to draw investments into grid development without putting pressure on grid tariffs, as assets financed via grants are not included in the RAB and therefore their cost is not reflected in grid tariffs. Concessional loans backed by the EU funding can also reduce the cost of capital for the TSOs, and therefore additionally alleviate the pressure on grid tariffs. Hence, WG participants agreed that EU financing can reduce credit risk and make financing more affordable. However, participants highlighted a possible down-side of EU financing, particularly of grants, as some TSOs may face a disincentive for using EU grants due to their impact on the RAB, especially those that have a private predominance in their ownership. While grid assets financed with grants are not included in the RAB, they carry a cost of OPEX, and potentially also replacement costs, which are not covered by remuneration. This concern is however dependent on the approach used for the determination of the revenue cap, with some participants supporting the adoption of the TOTEX approach in view of covering such expenses through tariff remuneration.

Attention was given also to the role that EU financing can play in the development of the hydrogen transportation networks, particularly concerning projects for the repurposing of gas infrastructure. Participating DSOs stated that the hydrogen market is complex and it is highly exposed to market failure risks. As such, participants argued in favour of grants and subsidies as the only viable solution to support the market at its early stages, regarding other forms of financing as not feasible because they would generate additional pressure on grid tariffs.

Additionally, while equity investments may be a way to finance gas pipeline retrofits, there appears to be some degree of reluctance by TSOs towards this form of financing.

Finally, participants expressed relevant concerns related to inflation, stating that it affects projects both by increasing the cost of overall financing through rising interest rates[75], and by increasing prices of materials and technologies. In view of growing interest rates, slow economic growth, and energy crisis, WG participants emphasized the essential role of EU financing, pointing out that having a less leveraged structure may be more efficient as it would avoid incurring additional costs on debt financing. Inflation is seen as the "most important challenge" in the short term alongside rising costs of construction materials and taxonomy rules concerning particularly investments in gas. Conversely, participants representing long-term investors expressed a preference for projects whose business plans include inflation in the presentation of cash flows.

Technical Barriers

Stranded assets risk is particularly relevant for gas transmission and distribution infrastructures. The EU climate neutrality goal implies that gas consumption will necessarily decline, thereby putting at risk many recent investments in gas T&D infrastructures as not all of them can be repurposed to other uses (e.g., hydrogen transportation).

This barrier was identified by 38% of respondents as relevant for investments in T&D. Concern was expressed mostly by the supply side of financing and mostly for projects in the gas sector as some participants identify this as the most relevant risk for gas infrastructure assets. As mentioned, the EU Taxonomy rules have generated uncertainties concerning the ability of new investments in gas infrastructure of remunerating investments properly and in a timely manner. The labelling of gas and nuclear energy as "transitional technologies" could imply that investments in these technologies may be less remunerative with the acceleration of the decarbonization process and this holds also for investments in gas infrastructure. Despite this, some participants believe that, with the REPowerEU plan, investments in gas infrastructure might increase[76], although the risk of stranding the new assets remains relevant as the EU has also increased ambition on its decarbonisation targets within the same REPowerEU plan. In view of this, some participants considered that stranding of assets is unavoidable, and they see this as a necessary cost to ensure energy security and a stable transition towards decarbonisation given the current difficult geopolitical and diplomatic contexts. At the same time, stakeholders encouraged the adoption of regulatory schemes that can protect them against this risk in order to allow the T&D segment to ensure the continuation of fossil fuels supply as a means to build renewable capacity on one hand and adapt to the currently unstable geopolitical situation generated by the war in Ukraine on the other, with the ultimate goal of ensuring a steady and lean transition from fossil to renewable energy. One **solution** identified by WG participants for avoiding this risk is the provision of co-financing for network retrofit as well as the "green" gases production and injection into the gas network.

[75] The Governing Council of the ECB (European Central Bank) has decided to raise interest rates by 75 basis points as a measure to combat soaring inflation generated by the difficult geopolitical context. The interest rate on the main refinancing operations and the interest rates on the marginal lending facility and the deposit facility have been increased to 1.25%, 1.50% and 0.75% respectively, with effect from 14 September 2022. This increase was the biggest in the ECB's history and more increases are likely in the coming months as stated by the ECB: https://www.ecb.europa.eu/ecb/educational/explainers/tell-me-more/html/interest_rates.en.html.

[76] In relation the gas infrastructure, some believe that the current conjuncture linked to the Russian-Ukrainian conflict could lead to an over-estimation of the need for new infrastructures, leaving a legacy of an excessive 'burden' that could disrupt the transition process to 'net-zero'. In this context, special attention should be paid to the 'proportionality' of interventions.

The energy transition and the risk of stranded assets concerning gas infrastructure

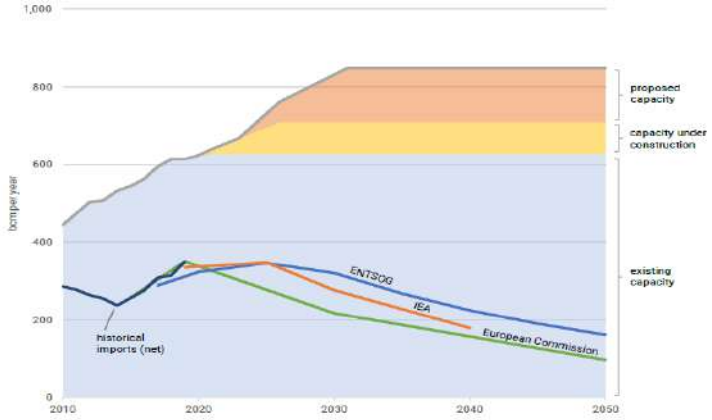
As reported in a survey from the Global Energy Monitor[77], currently Europe is building or planning to build €87 billion worth of fossil gas infrastructure in a continued expansion of pipelines and LNG terminals, despite the need to halve emissions by 2030 and to achieve net-zero GHG emissions by 2050. The countries that will see the biggest increases in gas infrastructure are Romania, Italy, Poland, Greece and Spain.

Because gas infrastructure projects have a typical lifespan of 50 years[78], this implies that these investments are set to become stranded assets as the rush to Net-zero by 2050 accelerates and gas consumption falls.

The study puts this expansion into perspective by illustrating in Figure 9 the downward trends estimated for future gas consumption in view of the EU's decarbonisation strategy, thus arguing that gas transmission infrastructure is seriously exposed to the risk of stranded assets.

Although some of the existing infrastructure will be repurposed to other uses, the most import of all being hydrogen transportation, stranding of gas assets may be unavoidable as it emerged from an online debate. Pipeline transportation of hydrogen might not always be efficient and hydrogen demand levels are marked by a high degree of uncertainty, thus clouding the investment case for repurposing[79].

Figure 9: EU fossil gas net import capacity and net imports



Source: Inman, M., Aitken, G., Zimmerman, S., Europe Gas Tracker Report, Global Energy Monitor, 2021

Technology risk is relevant in a scenario of a high required level of investments. Meeting the EU Green Deal goals will require investments in digitalising the grid and new technologies; for example, the ENTSO-E 2050 working group is actively considering scenarios involving higher voltage, long distance onshore lines (termed overlay grids) and interconnected subsea cabling. To achieve this, investments will need to focus on bringing to the market technologies which are currently at Demonstration / First of a kind TRL levels (TRLs 4-8)[80] implying that besides high levels of investments, TSOs/DSOs will need to bear an increasing level of risk carried by innovative solutions. Such risks will need to be adequately remunerated in order to guarantee sufficient return to investors.

[77] Inman, M., Aitken, G., Zimmerman, S., Europe Gas Tracker Report, *Global Energy Monitor*, 2021.
[78] Taylor, K., Europe risks €87 billion in stranded fossil gas assets, report reveals, *Euractiv.com*, April 2021.
[79] Stranded gas assets: the dilemma of the energy transition costs, *Florence School of Regulation*, May 2021.
[80] Considering the TRL scale elaborated by the IEA in its Clean Energy Technology Guide of 2020.

Technology risk was considered as relevant by 31% of respondents, with opinions converging between demand and supply of financing. Participants expressed concern over the fact the TSOs/DSOs need to invest significant time in implementing new technologies, thus leading to slower roll-up/ramp-up times than expected. They report, furthermore, that start-ups face challenges in deploying technologies in the DSO sector probably because these technologies require large amounts of capital to reach commercially viable TRLs which DSOs have difficulties in providing[81]. Furthermore, investors affirm that investments in new hardware (assts) are riskier than those in software, thus suggesting that there is a preference for investments in the digitalization of the grid over investments in the installation of new assets. This is backed up also by the view of an important international financing institution which states that T&D requires investments in digitalization. In relation to this, some stakeholders bring the attention to increasing risks (in term of cybersecurity and data management) that the uptake of digital technologies might bring in the T&D segment which can only be mitigated by a defined and stable regulation.

Discussions held during the WG meetings uncovered further evidence which supports participants' preference for investments in digitalisation rather than in hardware. Several participants, investors, and developers alike, agreed that investments in digitalization of the grid, smart grids, and flexibility services (e.g., demand response) can bring similar benefits of investing in hardware and physical assets, at a lower cost. As such, participants argued that investments should incentivize TSOs and DSOs to run energy models / marketplaces for flexibility. This would partially reduce the need to finance reinforcements (i.e., physical assets) as they allow to explore additional potential of existing and requalified T&D assets.

Digitalisation of power distribution grids

The historical core business of DSOs focused on minimizing the risk of power outages and restoring power as quickly as possible, which required relatively little innovation and strategic thinking. In the current context, power DSOs will need to assume a more dynamic and flexible role ensuring resilience of the system in view of massive integration of RES generation and increasing participation of demand and distributed generation to the provision and development of flexibility services. To achieve this, Eurelectric and E-DSO[82] estimate that €375-425 billion of investments are required for the power distribution segment in 2020-2030 in EU27+UK. Figure 10 shows that nearly 40% of these investments, amounting to €145-170 billion, need to be directed towards modernizing and increasing digitalization of grids by the means of technological solutions such as:

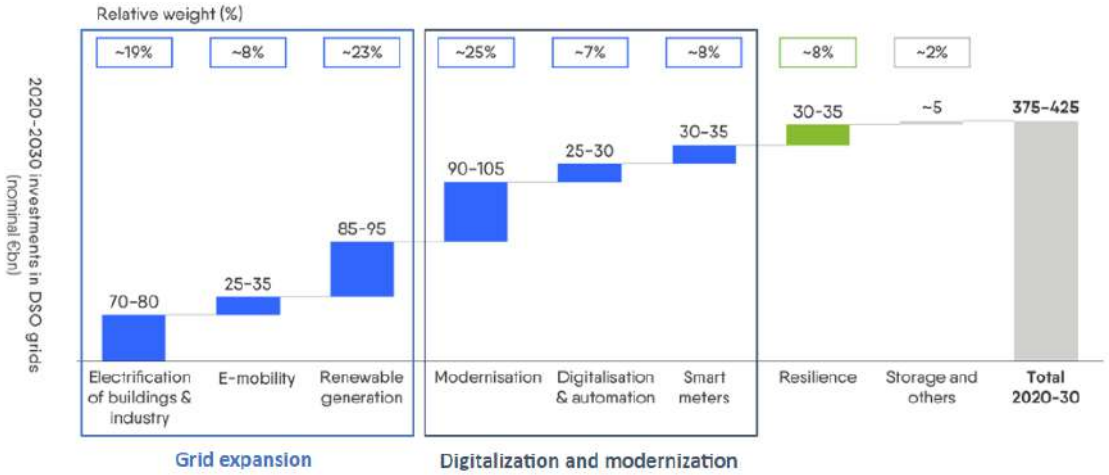
- **Replacement** of old grid assets (e.g., lines and transformation centres) with new ones to guarantee a high level of robustness;
- **Automation** of substations at distribution level, including remote control of substations;
- **Grid monitoring** to improve efficiency and security of supply and **data management systems** (storage, processing, cybersecurity, etc.);

[81] A developer has stated in the follow-up survey that an increase in low voltage supply of energy leads to technological problems in how to handle and control the energy flow from where it is generated to where it is used in the network. This problem increases the load on the neutral conductor and the star point of the transformers which are not designed to act as the supply side transformers and conductors. Two-way energy flows impose higher equipment costs on the low voltage side, more transformers, more current breakers albeit at a lower voltage. The control of energy flow requires also costly electronic equipment which the utilities are not ready to invest in since there is not value proposition for them per se in the endeavour.

[82] Connecting the dots: Distribution grid investment to power the energy transition, *Eurelectric, EDSO, Monitor Deloitte*, January 2021.

- **Installation** of smart meters (1st and 2nd generation) to enable customers' monitoring and increase observability of LV grid.

Figure 10: EU27+UK DSO investments in power distribution grids breakdown per relevant investment drivers



Source: Connecting the dots: Distribution grid investment to power the energy transition, Eurelectric, EDSO, Monitor Deloitte, January 2021

Modernization and digitalization will increase grid observability and enable smarter and more cost-effective power grids (e.g., due to big data exploitation for grid planning and operation) thus allowing to access additional potential of grid assets and limiting investments in grid expansion. As Figure 9 shows, the latter will still be required and will consist in 60% of the prospected investments for 2020-2030, but investments in grid digitalization will allow to reach the necessary objectives for the power distribution segment without recurring to more investments in grid expansion than necessary.

Although investments in distribution grids may result in a marginal increase of electricity prices in the short term, they will entail a decrease in the cost of energy in the longer term due to:

- Reduced incremental investments needs and tariff impact in the long term, also considering the efficiency effect from grid modernization and digitalization.
- Renewable deployment and electrification that will ultimately reduce total energy bill, (i.e., through lower marginal cost of renewable generation, cost savings via heat pumps, e-vehicles);
- Proliferation of flexibility measures that increase cost-effectiveness.

Advance capacity risk arises where the viability of a T&D investment is dependent on a complementary investment or additional future supply or throughput[83]. If there is a time lag between the completion of the energy generating source and the completion of the energy transmission infrastructure, one of the two might become a temporary stranded asset until the complementary investment is completed. Permitting issues affecting generation assets

[83] The structuring and financing of energy infrastructure projects, financing gaps and recommendations regarding the new TEN E financial instrument. *Roland Berger Strategy Consultants*, July 2011, Brussels.

can cause such problems to new infrastructure assets as they take less time to be constructed than generation assets.

Advance capacity risk in power transmission

In their study from 2011, Roland Berger used the Kriegers Flak wind farm and COBRA cable projects as an example of this risk in the area of electric power transmission. The lack of a wind farm investor on the Danish side of the Kriegers Flak offshore wind farm project has delayed investment in the combined grid solution, which involved upgrading the connection to the wind farm to an interconnector between Germany and Denmark, on both the Danish and German side.

The study also reasons that uncertainty regarding future capacities can also lead to underinvestment in current infrastructure projects. Using as example the same COBRA cable interconnector between Denmark and the Netherlands, the study reasons that, although transmission capacity can be increased along the interconnector thereby reducing the requirement for additional cable projects to connect future wind farms, this change would imply significant advance capacity and a stranded investment risk if the wind farm investments did not materialise. Thus, the advance capacity challenge prevents an increase in capacity that will most likely be required in the future.

This risk is considered somewhat relevant by different stakeholders among developers, investors and research bodies, gathering 23% of the votes.

Energy market development

Inadequate or underdeveloped supply chain and industrialisation can hinder investments in energy infrastructures due to disruptions in the:

- Supply of components, particularly IT components like microchips necessary for the digitalisation and the improvement of network services.
- Supply of raw materials, particularly rare earth and minerals (e.g., copper) necessary for the construction of transmission and distribution infrastructures.

In all these cases, disruptions in the supply of raw materials and components cause delays and a rise of costs in projects slowing down the energy transition process.

Nearly all types of stakeholders, from demand side of financing to supply side of financing, including stakeholders representing industry associations and research bodies, have converged on identifying this as one of the most important risks for investments in T&D with 54% of votes. Concern is manly tied to the disruptions in raw materials and technologies caused by the war in Ukraine, with the lack of cables and transformers being reported by some respondents, as well as the lack of steel which is causing concerns with regards gas grid repurposing projects. Concerns related to disruptions caused by the war in Ukraine shall prevail mainly in the short term, while in the longer term, EU dependency on few countries (mostly Asian) for critical grid components is also an issue. Furthermore, respondents also raised concerns over the perceived decrease in the quality of purchased material generated by the need to replace suppliers.

Shortage of raw materials and of IT components in the energy industry

With the decision to break free from Russian fossil fuels supply by 2030, the EU Commission is providing further impetus to the development of renewable energy. But one of the consequences of the war in Ukraine includes a shortage in the supply of raw materials and components that are essential for the power transmission and distribution. For example, copper, aluminium, and steel are the primary conductor materials used in electrical power systems[84] and according to research commissioned by Eurometaux, Europe's plans for producing clean energy technologies will require 5 million tonnes of copper (increase of 35% of today's use) and 5 million tonnes of aluminium (an increase of 33% on top of today's use) by 2050[85]. Sourcing these materials may be a challenge, considering that Europe relies heavily on Russia for the provision of these resources[86].

Availability of skilled labour is a risk driven in large part by the increasing digitalisation process of the grids which will require major upskilling and reskilling of the existing workforce as well as new workforce. This risk was considered relevant by 31% of the WG respondents, with developers being slightly more concerned than investors. In fact, some TSO representatives expressed their concern regarding the disruption in the supply of labour, besides that of materials, that the war in Ukraine is causing. Concerns also derive from the downward demographic trends which lower the potential available workforce as well as from brain drain effects, whereby some MSs may face a shortage of labour at a more systemic level.

During the WG meetings, participants have drawn further attention to the difficulties that small, local DSOs might experience in making use of EU financing instruments due to lack of personnel with expertise in such domain, thus emphasizing the need of providing technical assistance to these subjects concerning the design of projects and their preparation, as well as making projects bankable.

[84] Blume, S., W., Electric Power System Basics for the nonelectrical professional, *IEEE Press, Wiley*, 2017.
[85] Metals for Clean Energy: Pathways to solving Europe's raw materials challenge, *KU Leuven*, April 2022.
[86] No green and digital transition without raw materials, EU warns, *Euractiv.com*, April 2022.

3. Mapping and benchmarking of transmission and distribution schemes and investment products

This chapter presents the financial schemes and programmes available for transmission and distribution networks projects in the EU. The first part focuses on funding programmes at EU level, both under centralised and decentralised management that can be used to support T&D projects. The second part presents the instruments and schemes identified at Member State level that are available for T&D based on the findings from a mapping carried out across all EU Member States in 2022.

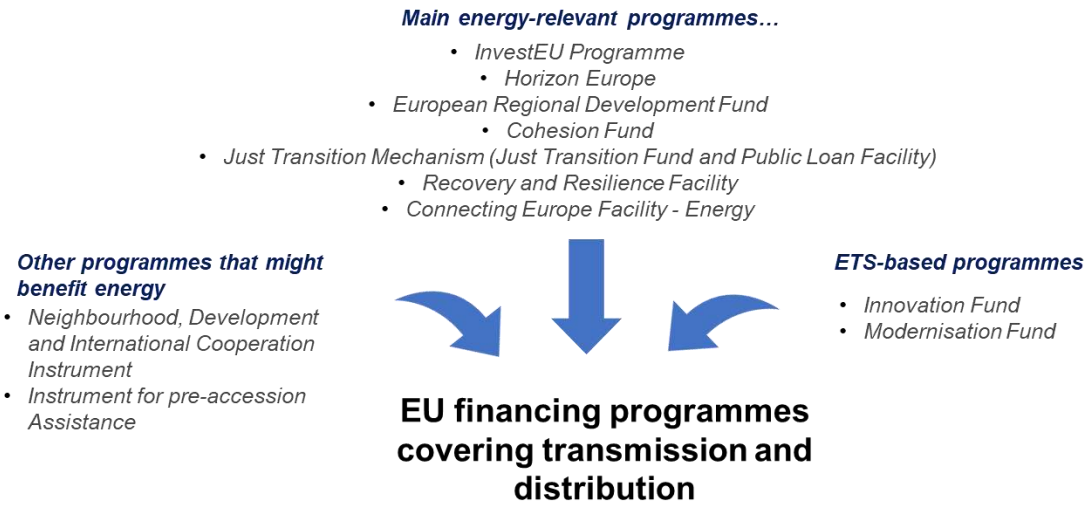
3.1. EU financing programmes for Transmission and Distribution

EU targets of climate neutrality and independence from Russian gas require an unprecedented level of investment. The European Commission has reported an overall investment need of €210 billion (until 2027) to reach REPowerEU targets.

To support the region's green transition, the EU has made it a priority to support the enhancement of development, construction, and operationalisation of transmission and distribution projects through several funds and programmes. Such programmes are either managed directly by the European Commission or by other EU bodies via *ad hoc* agreements. Starting from the 2014-2020 multiannual financial framework, the Commission has also adopted the **Climate Mainstreaming** approach, which requires all programs – regardless of their policy area – to take climate issues into account. For the 2021-2027 period, the EU budget is expected to deploy €557 billion (31% of the overall budget) for climate investments across different sectors and programmes.

The purpose of this section is to provide an overview of the financing instruments at EU level (Figure 11) which target the transmission and distribution sector by providing financing for energy infrastructure, pipelines, grids and networks.

Figure 11: Overview of the EU financing programmes covering for Transmission and Distribution



All the programmes funded by the EU budget fall under one of three types of implementation modes depending on the nature of the funding concerned:

- **Direct management**: EU funding is managed directly by the European Commission

- **Indirect management**: funding is managed by partner organisations or other authorities inside or outside the EU
- **Shared management**: the European Commission and national authorities jointly manage the funding.

In addition to these three management modes, this Study analyses programmes that are not financed from the EU budget but through the **EU Emission Trading System** (ETS)[87].

Direct management

In direct management, the European Commission is directly responsible for all steps in a programme's implementation. These tasks are carried out by the Commission's departments, at its headquarters, in the EU delegations or through EU executive agencies; there are no third parties. Programmes implemented in direct management account for around 20% of the EU budget 2021-2027[88].

NextGenerationEU: the Recovery and Resilience Facility

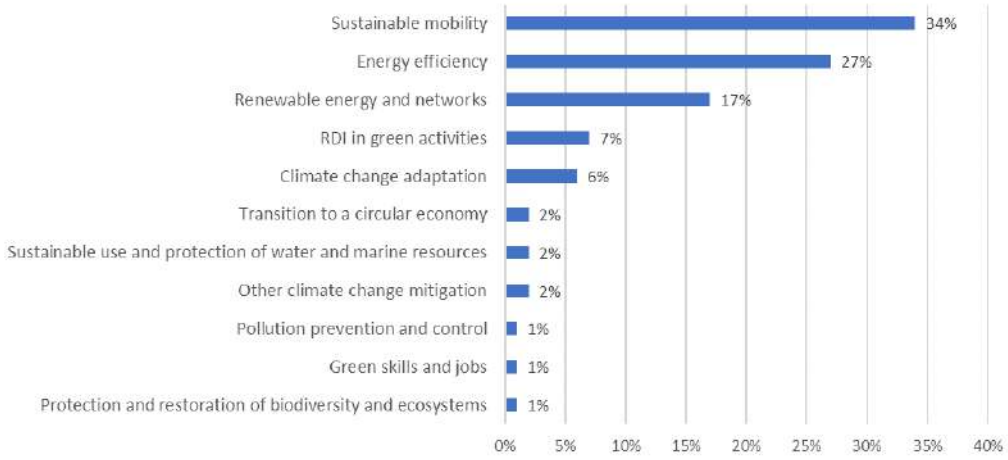
The **NextGenerationEU**, is a temporary recovery instrument with a budget of more than €800 billion aiming to support Member States in repairing the economic and social damage brought on by the Covid-19 Pandemic and build greater resilience to face incoming challenges. At its centre is the **Recovery and Resilience Facility (RRF)**, a programme providing financing to enable Member States to increase resilience and prepare for their digital and green transitions. It has a total budget of €723.8 billion, out of which €385.8 billion take the form of loans and €338 billion of grants. To access these funds, Member States prepared tailored **National Recovery and Resilience Plans** (NRRPs) reflecting the allocation of the funds in each country and detailing the investment and reforms they plan on undertaking with the RRF resources to make their economies more sustainable, resilient, and digital by end of 2026. All 27 Plans have been officially adopted.

The Facility is structured around **six pillars: green transition; digital transformation; social and territorial cohesion; health, economic, social and institutional resilience;** and **policies for the next generation**. Green transition is the pillar with the largest share of allocated RRF funds, amounting to 38.85% of the funds. Within the green transition pillar, sustainable mobility is the area with the largest share of allocated funds by the NRRPs, followed by energy efficiency, and renewable energy and networks
(see Figure 12).

[87] European Commission. EU Emission Trading System. https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en

[88] European Commission. Funding by management type. https://commission.europa.eu/funding-tenders/find-funding/funding-management-mode_en

Figure 12: Breakdown of expenditure towards climate objectives per policy area (Pillar 1)



Source: RRF Scoreboard – Green Transition

When it comes to distribution and transmission, the most relevant indicators are the "**Additional operational capacity installed**" and the "**Alternative fuels infrastructure**". More specifically, NRRPs aim at installing additional capacity of **1,067 MW from renewable energy** and **1,106 MW from green hydrogen**, as well as **731,714 alternative fuels infrastructures**. To date[89], already 795.4 MW from renewables and 553 MW from hydrogen, and 477,200 electricity recharging points have been installed.

For the Green Transition Pillar, €10.33 billion in grants and €5.09 billion in loans have already been disbursed[90], out of a total of €96.97 billion in grants and €47.11 billion in loans disbursed[91]. According to an analysis of NRRPs conducted by Eurelectric[92], €5.1 billion will be used to modernise and expand electricity grids, €4.2 billion for recharging points, and €5.2 billion for other energy infrastructures, including, for instance, smart meters.

Box 1: Country focus: The RRF in France

France was allocated €39.4 billion worth of RRF grants, which account for 1.57% of its GDP. Among the different pillar of allocation, the Green Transition and Smart, sustainable and inclusive growth pillars are the two biggest posts of expense as developed in the French NRRP.

In France's breakdown of expenditure towards Green Transition objectives, Energy efficiency comes in first position (40%), as the primary objective of the country, followed by sustainable mobility (>28%) in second position. As of 2022 (S1), France had installed additional 775 electricity recharging points, which appear under the Green Transition pillar's "total alternative fuels infrastructure" indicator and illustrate France's evolving commitment to energy transmission and distribution. This evolution is to put in perspective with France's Environmental Code's recent modification (Article L. 224-10 à L.224-11-1 du code de l'environnement), according to which since January 2022, 10% of yearly renewed vehicles should be electric vehicles. This share will increase to 20% in 2024, and to 70%

[89] Based on information available on the RRF Scoreboard as of 20/03/2023.

[90] These amounts refer to the while Green Transition pillar and not to the "Renewable energy and networks" area only.

[91] Based on information available on the RRF Scoreboard as of 16/02/2023.

[92] https://cdn.eurelectric.org/media/5651/revised_funding_guide-2021-030-0615-01-e-h-F2FE101C.pdf

starting in 2030. In other words, the allocation of part of the RRF budget to improved and additional alternative fuels infrastructure will be key in this transition.

Connecting Europe Facility

The **Connecting Europe Facility** (CEF) is one of the main EU funding instruments for infrastructure with grants to develop trans-European networks in the fields of transport, energy and digitalisation. In 2018, the CEF was renewed for 2021-2027 with a budget of €42.3 billion, 60% of is meant to contribute to climate objectives.

In the energy sector specifically, CEF-Energy aims at funding infrastructure projects that support the interoperability of the EU transmission infrastructure, boost the internal market and competition, enhance the security of supply in the EU, and foster the integration of renewables and smart grids. Around €5.84 billion are dedicated to support investments in EU infrastructure networks for energy.

CEF also includes the **Cross-Border Renewable Energy** programme, which aims to enable the cost-effective deployment of renewable energy. Any project meeting the criteria[93] may obtain the status of cross-border renewable energy project (CB RES status) and therefore enter a list of projects eligible for CEF funding (CB RES list). Having the official CB RES status is a requirement to be eligible for financial support under the CEF Programme, and it could provide further benefits such as higher visibility, increased investor certainty, and stronger support from Member States. All projects with the CB RES status are on a list of eligible projects (the CB RES list) and may therefore apply for dedicated calls for CEF grants for technical studies and works.

The first CEF Energy PCI call for proposal for the period 2021-2027 was launched in September 2021, making €785 million available to finance clean energy infrastructure projects. A second call worth €800 million was opened in May 2022 for works and studies in electricity, gas, smart grids and CO_2 networks. A third call for €750 million in the same field was launched in April 2023[94].

Box 2: Connecting Europe Facility and funded projects

CEF Energy has been financing national and cross borders energy-related projects through grants, blending instruments, and guarantees. For example, since the beginning of the 2021-2027 cycle, it has funded:

- The Aurora Line, an interconnection project between northern Finland and Sweden to build a new 400kV overheard line to increase the cross-border transmission capacity (€127 million EU contribution).
- The EuroAsia Interconnector, between Cyprus and Crete via submarine and land cables with a capacity of 1000MV (€656 million EU contribution).

[93] Criteria laid out in Part IV of the CEF Regulation.

[94] European Commission. Funding & tender opportunities. https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-search;callCode=CEF-E-2023-PCI;freeTextSearchKeyword=;matchWholeText=true;typeCodes=0,1,2,8;statusCodes=31094501,31094502,31094503;programmePeriod=2021%20-%202027;programCcm2Id=43251567;programDivisionCode=null;focusAreaCode=null;destinationGroup=null;missionGroup=null;geographicalZonesCode=null;programmeDivisionProspect=null;startDateLte=null;startDateGte=null;crossCuttingPriorityCode=null;cpvCode=null;performanceOfDelivery=null;sortQuery=sortStatus;orderBy=asc;onlyTenders=false;topicListKey=topicSearchTablePageState

- A study on the potential and feasibility of a Südostbayern-Oberösterreich cross-border heating system (between Germany and Austria) which would be supplied by waste energy from local industry, geothermal and bioenergy plants (€199.9 million EU contribution).
- A conceptual engineering study on the potential of cross-border off-shore wind farms between Estonia and Latvia (€0.099 million EU contribution).

These funding are dedicated to projects which lack commercial viability, but which bring positive externalities to the European energy strategy, as defined by the TEN-E regulation.

The InvestEU Programme

The **InvestEU Programme** combines thirteen centrally managed EU financial instruments[95] and the European Fund for Strategic Investments (EFSI) into a single instrument. The program is structured around three blocks, of which only two, however, are under direct management:

- *InvestEU Fund* (indirect management) which, through an EU budget guarantee of €26.2 billion, aims at raising more than €372 billion of public and private investments. The guarantee is deployed to back investments from selected implementing partners, with the EIB Group being the main one with 75% of the whole instrument. The guarantee supports investments in four policy windows: sustainable infrastructure, research, innovation, and digitalisation, SMEs, and Social investments and skills.
- *InvestEU Advisory Hub* (direct management) providing support and technical assistance;
- *InvestEU Portal* (direct management), brings together investors and project promoters on a single EU-wide platform, by providing an accessible and user-friendly database of investment opportunities.

Horizon Europe

Horizon Europe has an overall budget of €95.5 billion for the 2021-2027 period and aims to support research and innovation in the EU. Its resources are divided into four pillars and fifteen components. The two components *Climate, energy and mobility* and *Food, Bioeconomy, Natural Resources, Agriculture and Environment* will receive, respectively, around €15 and around €9 billion each.

Horizon Europe succeeded Horizon 2020 for the 2021-2027 cycle. While data on Horizon Europe is not yet available, Horizon 2020 provided €539 million (1.1% of its total budget) to energy networks projects. Most of these, 61%, were for electricity distribution, followed by electricity transmission (35%) and gas networks, including hydrogen (5%).

Indirect management

Some funding programmes are partly or fully implemented with the support of entities, e.g., national authorities or international organisations. The majority of the EU budget allocated to humanitarian aid and international development, for instance, is implemented under indirect

[95] *CEF Debt Instrument, CEF Equity Instrument, Loan Guarantee Facility under COSME, Equity facility for Growth under COSME, Innovfin Equity, Innovfin SME guarantee, Innovfin Loan Services for R&I Facility, Private Finance for Energy Efficiency Instrument, Natural Capital Financing Facility, EaSI Capacity Building Investments, EaSI Microfinance and Social Enterprise Guarantees, Student Loan Guarantee Facility, Cultural and creative sectors Guarantee facility*

management. Under this management mode, the Commission delegates budget execution tasks to different types of implementing partners.

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- *InvestEU Advisory Hub* (direct management) providing support and technical assistance;
- *InvestEU Portal* (direct management) brings together investors and project promoters on a single EU-wide platform, by providing an accessible and user-friendly database of investment opportunities.

Shared programmes

In shared management, both the European Commission and national authorities in Member States, such as ministries and public institutions, are in charge of running a particular programme. Around 70% of EU programmes are run this way. For what concerns the energy production sector, the European Regional Development Fund is the main relevant shared-management programme.

European Regional Development Fund

The **European Regional Development Fund (ERDF)** aims to strengthen economic, social, and territorial cohesion in the EU and to enable investments in greener and smarter practices. It functions through financing programmes in shared responsibility between the European Commission and national or regional authorities of Member States. Member States receive support for investments aligned with one or more of the ERDF's five policy objectives aimed at making the EU:

1. More competitive and smarter
2. Greener, low carbon and resilient
3. More connected
4. More social
5. Closer to citizens

The total budget of the ERDF is around €215 billion, to which around €97 billion of national co-financing by Member States should be added, for a total of around €308.8 billion[97]. A particularity of the fund is that less-developed regions will benefit from co-

[96] *CEF Debt Instrument, CEF Equity Instrument, Loan Guarantee Facility under COSME, Equity facility for Growth under COSME, Innovfin Equity, Innovfin SME guarantee, Innovfin Loan Services for R&I Facility, Private Finance for Energy Efficiency Instrument, Natural Capital Financing Facility, EaSI Capacity Building Investments, EaSI Microfinance and Social Enterprise Guarantees, Student Loan Guarantee Facility, Cultural and creative sectors Guarantee facility*

[97] European Commission. Cohesion Open Data Platform. https://cohesiondata.ec.europa.eu/funds/erdf/21-27

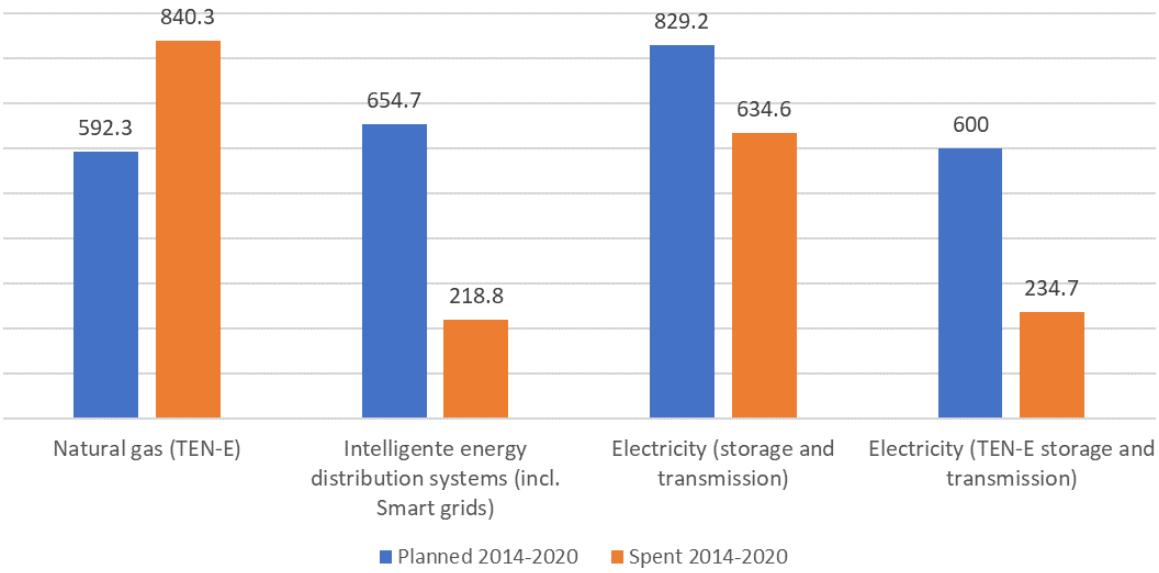
financing rates of up to 85% of the cost of the projects, while rates for transition regions and for more-developed regions will be up to 60% and 0% respectively.

Greener Europe is the Policy Objective with the second highest share of ERDF resources, around €73 billion, second only to Smarter Europe with €73.8 billion[98]. Through these resources, a significant number of national programmes have been financed in different Member States. Some of these programmes have been financed in full with ERDF resources, others have combined ERDF with other public resources. The Table below presents some of these schemes and shows that the instrument is being used and thus is relevant for Member States' ability to finance their transition.

Types of T&D covered[99]

When looking at EU cohesion data for the 2014-2020 financing period, electricity storage and transmission received the most planned financing commitments with approximately €1.4 billion, while planned expenditures on natural gas distribution were estimated at €592 million.

Figure 13: ERDF Planned and actual spending in electricity and natural gas T&D
(only ERDF contribution, national co-investments not included, programming period 2014-2020, in € M)[100]



Source: PwC analysis of cohesiondata.ec.europa data

For the **programming period 2021-2027**, the ERDF significantly steps up its contribution to the **Smart energy systems** objective, amounting now to €4.95 billion, plus other €426.6 million from the Cohesion Fund.

However, investment categories relevant for T&D span across multiple objectives (e.g., smart energy systems, renewable energy, energy efficiency, sustainable urban mobility, etc.). The "Smart energy systems (including smart grids and ICT systems) and related storage" category has a total allocation of €4.23 billion. The "Alternative fuels infrastructure" category gathers €730 million, and "Distribution and transportation of natural gas substituting coal" has allocated €700 million.

[98] Ibidem.

[99] The amounts reported on this section are based on the data from European Commission's Cohesion Data platform as from 20/02/2023.

[100] There is no earmarking of funds for electricity storage and electricity transmission.

In addition to ERDF funding, also the Cohesion Fund provided funding to electricity T&D and energy distribution systems, as detailed below.

Types of financing provided

ERDF resources are disbursed by Member States through different programmes and schemes, and thus through different types of financing. Based on the available data on disbursement modalities for the €4.95 billion of ERDF resources allocated to the objective "Smart energy systems" in the current financing period, **grants are the close to only used type of financing** (around 99.28%). Around €4.9 billion will be disbursed through grants, including grant components of financial instruments. Around €3.3 million (0.07%) are planned to be used for **guarantee schemes** in Italy, the only Member State with plans to use guarantees to deploy ERDF funding for smart energy systems, and €350,000 (0.01%) will be disbursed through **equity and quasi-equity** instruments in the Netherlands. **Loans** represent a bigger share compared to guarantees and equity, but still very marginal (0.77%), amounting to €37.9 million, mostly in Italy and, to a lesser extent, the Netherlands and France.

Cohesion Fund

The **Cohesion Fund,** with a total budget of around €37 billion, supports Member States with lower gross national incomes in the field of environment and trans-European networks in the area of transport infrastructure. Around 37% of the overall budget is allocated to climate goals. For the 2021-2027 period, the Cohesion Fund concerns Bulgaria, Czechia, Estonia, Greece, Croatia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Portugal, Romania, Slovakia and Slovenia.

In the programming period 2014-2020, the Cohesion Fund allocated €105 million to electricity storage and transmission projects in Poland and €45 million for TEN-E electricity transmission and distribution projects, also in Poland. Other €155.4 million were planned for intelligent energy distribution systems in Poland, Lithuania, and Slovenia.

Just Transition Mechanism

The **Just Transition Mechanism** supports the fair transition to climate neutrality across the EU. For the 2021-2027 period it is expected to mobilise nearly €55 billion targeting industries and workers in most affected regions. The program is structured around three pillars:

- *Just Transition Fund,* which aims to raise €25.4 billion of investments starting from a budget of €19.2 billion in current prices. The Fund has clean energy among its goals but there is no direct earmarking of budget for the sector;
- *InvestEU "Just Transition" scheme*, providing – under InvestEU – a guarantee and an advisory hub with the objective of mobilising €10-15 billion, predominantly from private sector. This is going to cover energy but there is no specific allocation to it.
- *Public Sector Loan Facility,* managed by CINEA, which combines resources from the EU budget (€1.5 billion) with those provided by the EIB (€10 billion). It will also provide technical assistance under the InvestEU Advisory Hub. By blending these resources, the Facility aims to raise around €18.5 billion of public investments to be used by public sector entities.

ETS-based programmes

Innovation Fund

The **Innovation Fund** is expected to provide €38 billion[101] between 2020 and 2030 for the commercial demonstration of innovative low-carbon technologies. This scheme is funded by the EU Emissions Trading System, so the exact amount of resources will ultimately depend on the carbon price. The fund is managed by CINEA and resources are allocated through regular calls for proposals for both large and small-scale projects[102].

Modernisation Fund

The **Modernisation Fund** was set up by the European Commission to support the ten lower-income Member States[103] in their transition to climate neutrality and to increase energy security. The Fund supports investments in energy production, energy efficiency, energy storage, **modernisation of energy networks**, and just transition in carbon-dependent regions.

The Modernisation Fund is an ETS-based instrument and not an EU budgetary programme. **It is funded from revenues from the auctioning of 2% of the total CO_2 allowances** for 2021-2030. At the price of €75/tCO_2, the total budget of the MF amounts to around €48 billion from 2021 to 2030, but this amount can change depending on carbon prices. In addition to the MF budget, beneficiary Member States can transfer additional allowances from other programmes under the ETS system. This can further increase the financial resources available to Member States to finance energy transition. To date, five Member States (Croatia, Czech Republic, Lithuania, Romania, Slovakia) have opted to do so.

Poland, Czech Republic, and Romania are the three biggest beneficiaries of the MF, with shares of 43.4%, 15.6%, and 12% of the total allowances, respectively. To date, 29 investments relevant for the modernisation of energy networks (of which 23 exclusively for energy networks, and 6 together with other eligible categories) were approved. Romania is the country with the most approved investments (12, for €774.4 million). Czech Republic is the second country in terms of financing received (€400 million) with two investments, although both not exclusive to energy networks, followed by Poland with 5 investments (€321.7 million). These investments are represented in Figure 14 and Figure 15.

Figure 14: Amount of approved MF resources for investments in "Modernization of energy networks" by country (in € M)

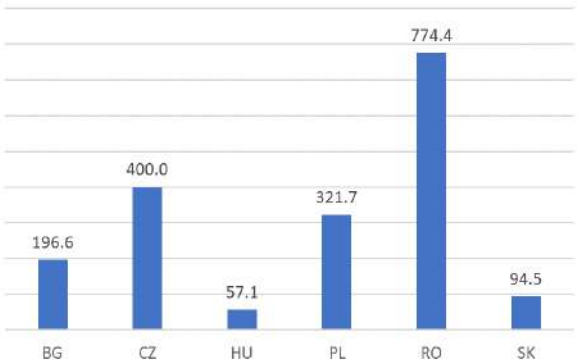
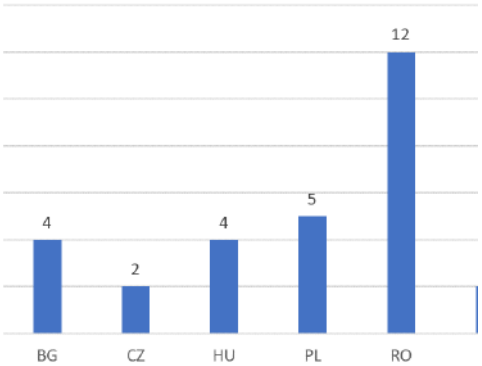


Figure 15: Number of confirmed investments in "Modernization of energy networks" by country



[101] Estimated assuming a carbon price of €75/tCO2

[102] For small-scale projects are intended all those with total capital costs under 7.5 million

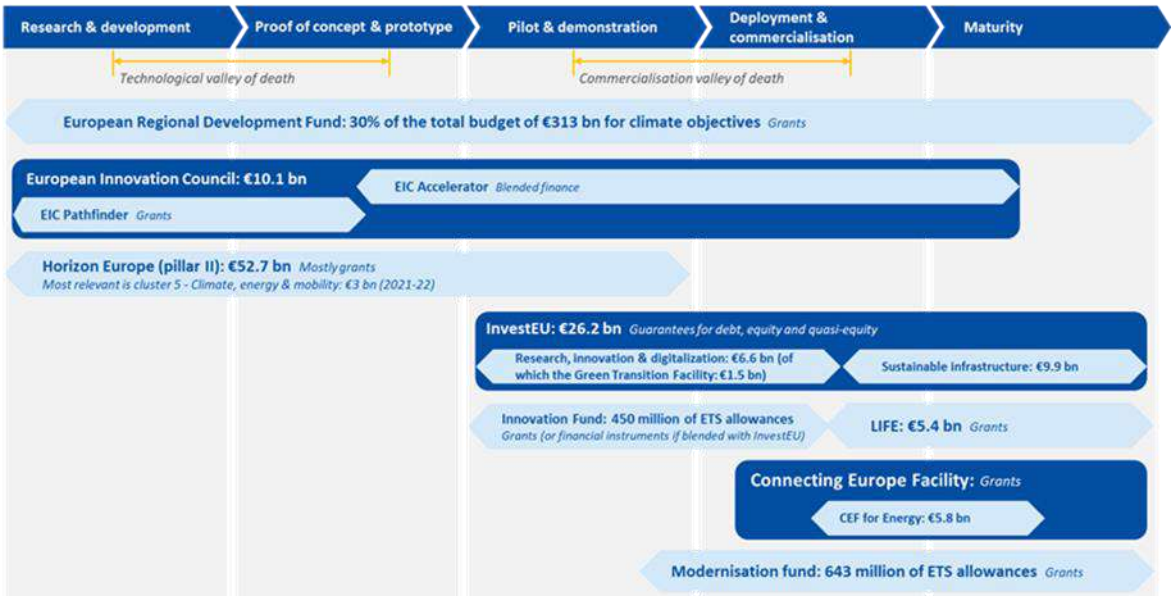
[103] Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia.

On May 2023, the revised EU ETS regulation was published in the Official journal of the EU[104]. The revised regulation strengthens the System and extends the ETS to new sectors of the economy, such as buildings, road transport and shipping, and to three additional Member States: Portugal, Greece and Slovenia. This will result in the Modernisation Fund to increase its size.

Maturity stages covered

The EU financing programmes target beneficiaries and projects at different levels of maturity and TRLs, aiming to address their specific barriers to investment. By focusing on different TRLs, programmes can better address the barriers to investment relevant for different companies in the sector. As can be seen from Figure 16 below, EU financing programmes provide complete coverage across different stages of maturity. The ERDF provides support across all maturity stages, based on how Member States decide to allocate such funding. For less mature technologies still in the research & development stage, Horizon Europe and the EIC Pathfinder provide support primarily in the form of grants, which tend to be the most suited type of financial support for technologies that are still far from commercial maturity. The EIC Accelerator, the Innovation Fund, and InvestEU's RDI investment window provide then support for more developed technologies, which are nonetheless still not fully mature. This support comes in the form of blended finance, grants and guarantees for debt and equity financing. Finally, InvestEU's Sustainable infrastructure window, CEF[105], and the Modernisation Fund provide financial support for mature technologies, in the form of grants and guarantees.

Figure 16: Overview of EU funding programmes and funds (also outside MFF) according to their targeted TRL levels for energy related projects under direct, shared and indirect management.



Transmission and distribution is characterised by projects covering both innovative solutions as well as the modernisation and upgrade of mature technologies and infrastructure. EU programmes are nonetheless able to support projects in transmission and distribution with different TRLs through a technology neutral approach. The Connecting Europe Facility - Energy, for instance, has supported numerous and different renewable

[104] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L:2023:130:TOC

[105] According to CEF Energy Work Programme, support is available also for innovative cross-border renewable energy solutions.

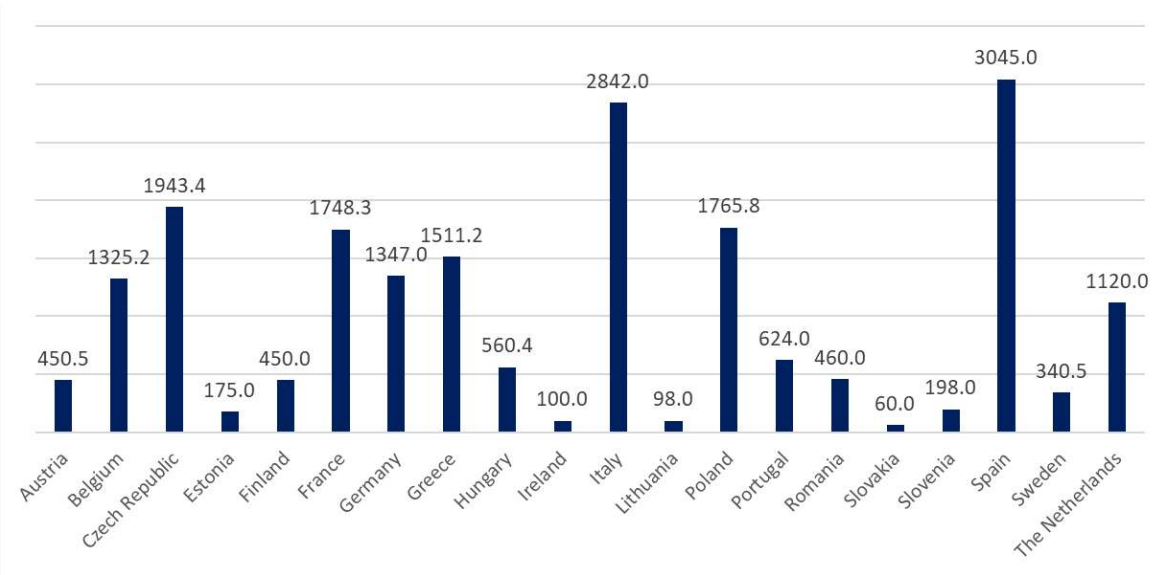
energy technologies such as offshore wind, solar energy, and also gaseous fuels, while focusing on efficient transmission of energy, particularly through cross-border interconnection infrastructure projects since the beginning of the 2021-2027 funding period.

The European Investment Bank Group

Although not an EU programme, the **European Investment Bank Group** (composed of European Investment Bank and European Investment Fund) also plays a central and key role in the energy financing landscape. While the EIBG does not have specific investment programmes or schemes for energy, in its **energy lending policy**[106], one of the key areas of intervention is the **decarbonisation of the energy supply**. This consists of supporting the deployment of renewables as well as investing in the construction and upgrade of electricity grids and pipelines.

When looking at data from the energy projects financed directly by the EIB through a combination of EU and own resources, Figure 17 shows the amounts of financing provided in the period Q1 2017- Q1 2023 for energy projects relevant for energy networks, energy transmission, energy distribution, and grids. Spain and Italy are the two countries that have received the most investments from the EIB for T&D projects. The amounts presented below do not include any national co-investment/contribution and include financing in the form of **loans, equity, and quasi-equity (venture debt)**.

Figure 17: EIB contribution to energy T&D projects in the 2017-2023 period (in € M)



Source: PwC analysis of eib.org data

The EIF also invests in the energy sector, although not directly but through other funds. Under the InvestEU equity product, EIF seeks to increase the availability of risk capital across all stages of company development, accelerating growth of European scale-ups accompanying and supporting them in accessing public markets, as well as other EU policy objectives. **Under the InvestEU Climate & Infrastructure Product, the EIF provides**

[106] EIB. Energy lending policy. https://www.eib.org/attachments/strategies/eib_energy_lending_policy_en.pdf

equity investments to, or alongside, climate & infrastructure funds investing in, among others, clean energy[107].

The Marguerite Fund is a pan-European initiative worth mentioning. Marguerite is an equity fund launched in 2010 and **backed by the EIB and the five National Promotional Banks** of Italy, Poland, Spain, Belgium, and Germany. It acts as a catalyst for key investments in energy (renewables, hydrogen, low-carbon gasses, T&D, storage) and transport. It is the first fund of its kind launched by Europe's leading public financial institutions following an initiative endorsed during the second half of 2008 by the Economic and Financial Affairs Council and the European Council as part of the European Economic Recovery Plan[108]. The first fund, the Marguerite I, gathered €710-million worth of commitments, and the Marguerite II reached €745 million.

[107] EIF. Climate & Infrastructure Funds. https://engage.eif.org/investeu/climate-infrastructure-funds

[108] EIB. Marguerite Fund. https://www.eib.org/en/products/equity/funds/marguerite-fund

3.2. Financial support schemes at Member State Level

To address the challenges faced by transmission and distribution projects and to enhance investments in energy transmission and distribution to achieve policy goals, the public sector can implement a series of financial support schemes. Financial instruments not only improve the financing conditions for a specific type of project (e.g., by de-risking it, increasing the financing available, improving the financing conditions, etc.), but also send a strong signal to market players about governments' and public authorities' commitment to that sector.

A mapping exercise was conducted to gather an overview on the existing financial support schemes available for energy projects, including transmission and distribution. The purpose of the mapping was to assess the current availability of instruments and schemes to support transmission and distribution projects, in order to assess to what extent they are effective in addressing barriers and mobilising additional finance. This will prove to be useful and functional for the development of future financial support schemes to support the energy transition in the EU, both new instruments or existing one being continued and improved.

Financial support schemes are not the solution for all barriers and bottleneck faced by energy projects. They are the most relevant to address barriers stemming from financial and market conditions, and less suitable for social and regulatory ones. This relevance is further explored in section 4.1 Relevance of instruments in addressing investment barriers: theory and evidence.

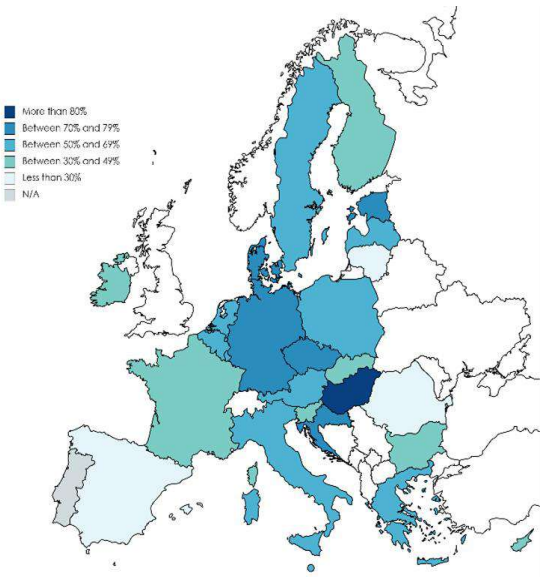
The mapping was conducted through a combination of desk research and interviews with selected stakeholders to obtain complementary information. Instruments were categorised by segments of the energy value chain they can support, eligible beneficiaries, targeted development phase, energy production sources, and type of financing provided (see Annex 1). Some instruments have been flagged as relevant for more than one single dimension. This is the case, for instance, of those instruments covering the installation of both PV panels and their connection to the grid (thus covering both energy production and T&D) or providing both loans and grants. These instruments were categorised under all the relevant categories, so as to reflect the scope of the instrument. This note should be kept in mind when reading the data presented below as, for instance, when it is stated that 100% of mapped instruments in Cyprus target energy production, it does not mean that all the mapped instruments target only energy production, but that they target also energy production and none of the mapped instruments do not target it.

Instruments targeting solely energy efficiency (e.g., for the renovation of buildings, for industries, etc.) – albeit particularly popular – have been excluded from the analysis, as already covered by the work on the Energy Efficiency Financial Institutions Group. Energy efficiency instruments were mapped only if they included also support for transmission and distribution. For the purpose of the analysis and to identify regional trends, EU Member States have also been aggregated in four geographical areas, following the classification from EuroVoc: Central and Eastern Europe, Northern Europe, Southern Europe, and Western Europe.

General overview: T&D schemes

The mapping has produced a database of 563 instruments providing support for energy projects in general across the 27 EU Member States. Among these, 280 instruments support Transmission and Distribution, about 50% of the total. However, out

Figure 18: Share of transmission and distribution instruments out of the total mapped



of these that have been identified as available for T&D**, only 21 are targeting only Transmission and distribution** (*for further information see* Box 3 *and* Box 4).

Additionally, 14 of them support Transmission and distribution and one more segment (Production 10 times, Storage 2 times, Energy Services and Prosumers 2 times). Finally, 176 instruments support all the five segments (i.e., energy production, transmission and distribution, energy storage, heating and cooling, energy services and prosumers).

All Countries but Portugal present at least 1 instrument dedicated to transmission and distribution. Hungary, Estonia, and Czech Republic are the only Member States which present a share of instruments supporting T&D which is higher than 75%. On the contrary, in both Lithuania and Spain such ratio is lower than 20%.

Instruments which only target Transmission and distribution have been found in 16 Member States. Hungary, Italy, Spain, and Sweden, with 2 instruments, are the Countries where the highest number has been mapped. Austria, Belgium, Cyprus, Croatia, Estonia, Finland, France, Germany, Greece, Latvia, the Netherlands, Poland, and Romania all have 1 mapped instrument focusing only on transmission and distribution. In both Sweden and Spain, the share of instruments supporting Transmission and distribution that only target this specific segment is 40%. While having few mapped instruments overall, Spanish and Swedish instruments present a high specificity. By leaving aside those countries for which no specific Transmission and distribution instruments was mapped, Germany – with around 4% - is the one that displays the lower value overall.

The mapping also looked for information about the **volumes of financing** provided. Information about the total budget of the instruments as well as the amount already deployed have been collected where available, to understand what the available magnitude of financing for different target groups is and how it is channelled through different funding instruments/financial schemes. However, the mapping was able to gather only partial information on volumes, as such data was publicly available for less than half of all instruments relevant for Transmission and distribution (133 instruments of the total 280 instruments) and information on deployment was missing in most of the cases.

Figure 19: Instruments mapped per country

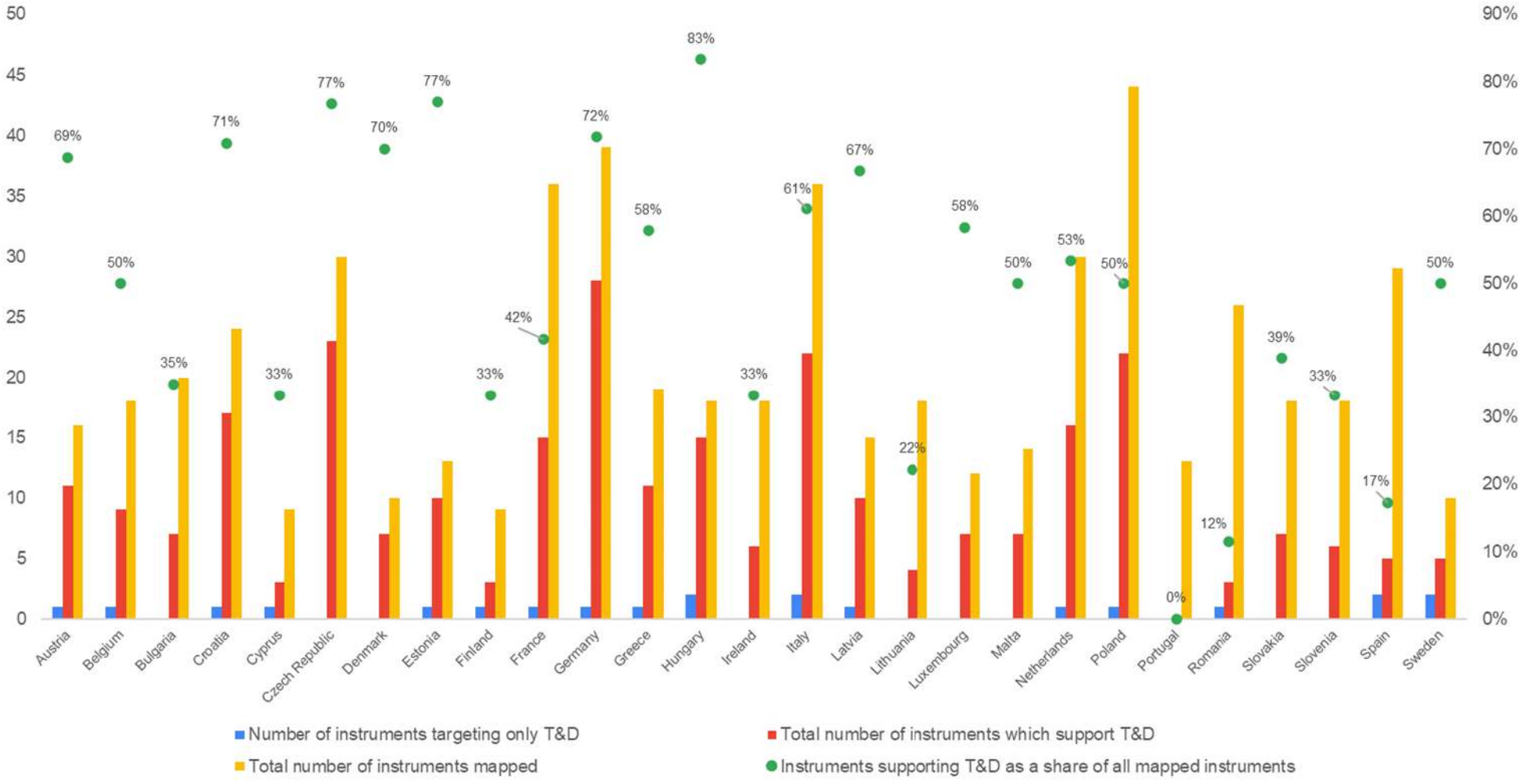
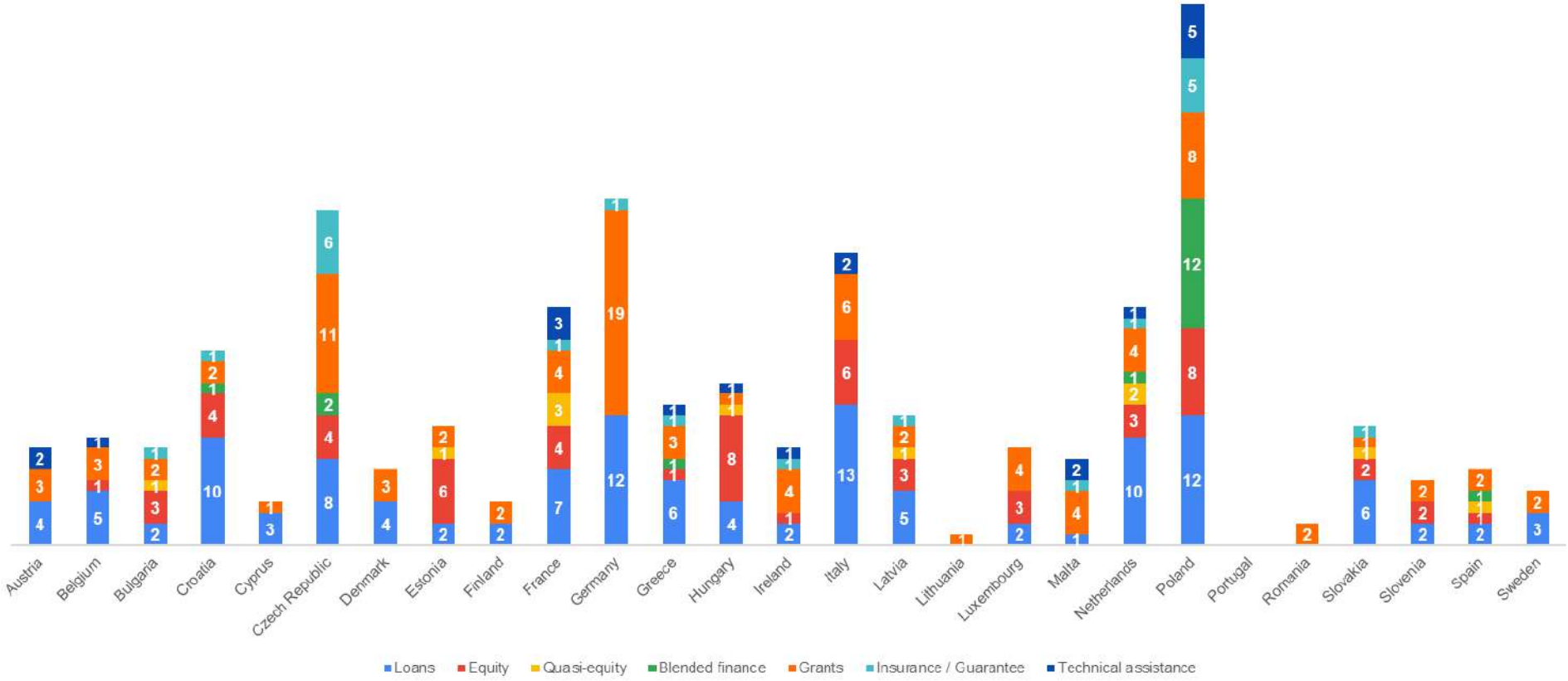
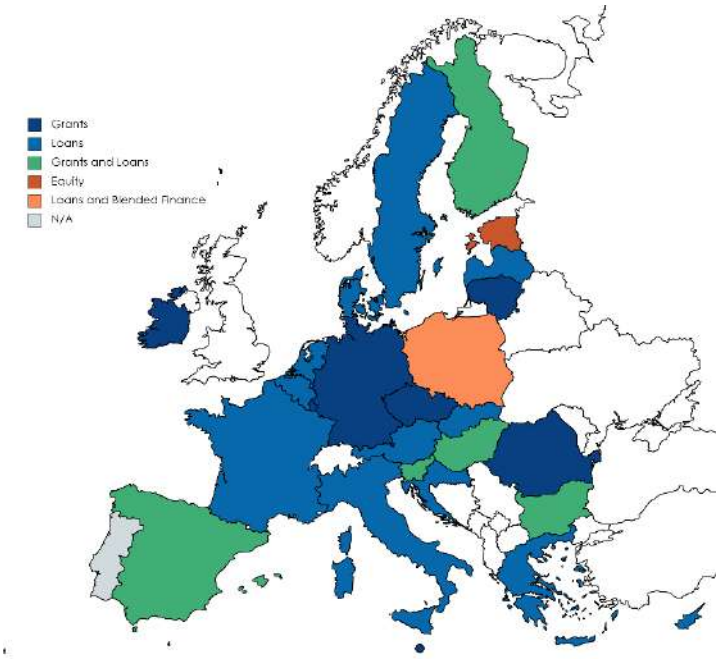


Figure 20: Number of financial instruments for transmission and distribution per country and per type of instrument



Financing instruments by type

Figure 21: Most mapped kind of instrument per MS

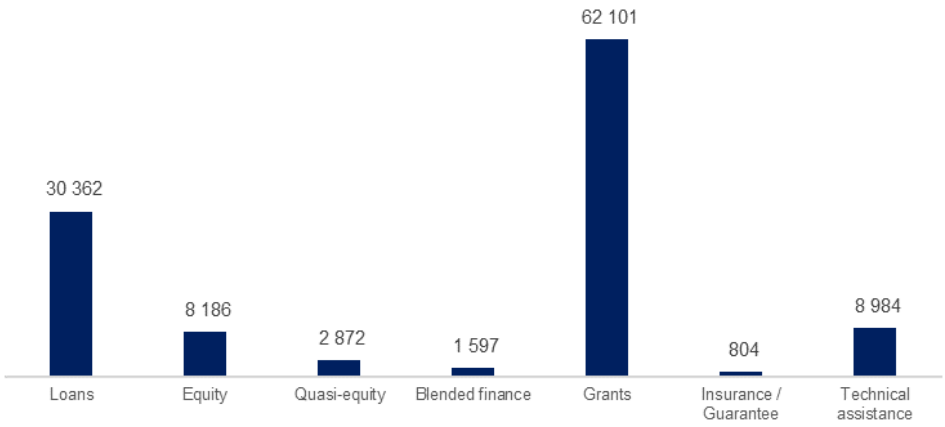


Loans and grants are the most widespread across the set of 280 instruments that the mapping identified as relevant for Transmission and distribution. Only in Estonia equity instruments are the most widely available.

A similar pattern was found also when considering only those instruments which specifically target only transmission and distribution. In this subsample indeed 50% of the instruments are grants and around 41% are loans.

On aggregate, **a total amount of around €114 billion has been estimated to be available inter alia for Transmission and distribution projects by taking into account the resources coming from the EU, national public authorities, and private institutions.** As displayed in Figure 22 below, overall, the amount allocated to grants, €62 billion, is around twice the size of that allocated to loans (€30 billion). For guarantees, the maximum leveraged investments due to the respective guarantee has been considered for the calculation, and not the amount of guarantees disbursed, which was not available. These estimates are based on information for 132 instruments. These volumes also include the total volume of instruments targeting also but not only Transmission and distribution, and for which there is no specific pre-allocation. This means that these volumes are not guaranteed to be spent in T&D only. **The fraction of these resources which is channelled through instruments targeting only T&D is about €8 billion.** This data is based on 20 instruments out of the 21 identified as relevant only for transmission and distribution.

Figure 22: Volume of financing per instrument (€ M)



The mapping identified a total of 98 grant-based schemes supporting transmission and distribution and **Germany is the country with the highest number of registered grant**

instruments (19). This data is explained by the fact that many of these schemes come from the investment arms of the Länder, reflecting the federal governance of the country. As emerged during the WG Discussions, **grants represent a crucial support instrument for financing T&D**, **since they help companies reducing risks while sustaining innovation and digitalization of the network**.

Box 3: Focus on: Grants for transmission and distribution only

Grants represent around the 38% of the 21 mapped instruments supporting only Transmission and distribution, for a total of 8 schemes. The mapping identified T&D-only grants in Croatia, Estonia, Finland, Hungary, Italy, Latvia, Romania, and Sweden so each of them is located in a different Member State.

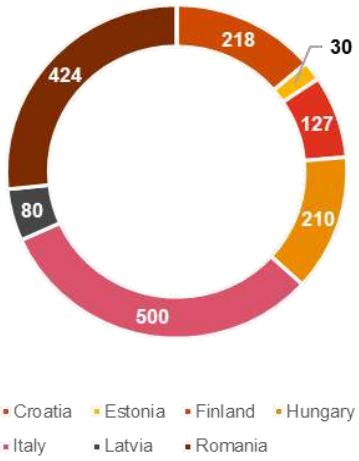
All these measures will provide resources for the modernisation or the expansion of the electric grid at the national level. There is no mapped instrument directly referring to individual scale projects or to gas pipelines. In some cases, namely in Sweden, Estonia and Hungary, one of the explicit goals of financed projects is to facilitate the connection of renewable powerplants to the system.

The absolute majority (7 out of 8) of T&D-only mapped grants are funded by EU programs. More specifically, 5 of them deployed resources coming from the **Recovery and Resilience Facility** (in Croatia, Estonia, Hungary Italy, and Latvia), while Finland used funds coming from CEF and investments in Romania have been financed thanks to the Modernisation Fund.

Table 3: Mapped T&D-only Grants

Member State	Topic	Funding source
Croatia	Investments and upgrades to power transmission grids	RRF
Estonia	Adding renewable capacity to the network	RRF
Finland	Construction of the Aurora Line	CEF
Hungary	Development of the distribution network	RRF
Italy	Network Climate Resilience	RRF
Latvia	Modernisation of electricity network infrastructure	RRF
Romania	Development of national grid infrastructure	Modernisation Fund
Sweden	Reduced connection costs for offshore wind power	National Funds

Figure 23: Volumes of mapped T&D-only grants per MS (EUR M)



Based on data for 7 grants out the 8 in total, around **€1.6 bn is being channelled specifically for Transmission and distribution projects** through such support schemes.

As in Figure 23, **the single largest instrument has been deployed in Italy with a total budget of €500 M**. Such intervention is part of the Italian RRP and provides resources for measures concerning network climate resilience. In particular, this intervention will regard preventive measures on 4000 km of infrastructure in order to increase the resilience of the electrical grid, thereby reducing the duration and extent of power outages during extreme climactic events.

The €424 M which Romania got from EU resources – accounting for the second largest mapped contribution - **will also be used to strengthen and develop the national network.** Such money, coming from the **Modernisation Fund** and with operations started in 2022, have been destined to *Transelectrica*, publicly traded transmission system operator whose share majority is owned by the Romanian Ministry of Economy and Commerce, for an overhaul of energy infrastructure. The nine selected projects will also involve the installation of some Smart Grid online monitoring systems and the digitalization of the electric transport network in the Country.

European resources are playing a key role also in the development of the project mapped in Finland. The **€127 M grant obtained under CEF** will indeed cover half of the costs of the **construction phase for the so-called Aurora Line electricity transmission link** which, by 2025, will run for 380km across the Finnish-Swedish border. The overall goal of this new infrastructure project is first to increase the transmission capacity between the two Countries, reducing the electricity price in Finland. Then, it will also allow further investments in the network, especially for renewables. Finally, this will strengthen security of supply in the Baltic regions.

Loans (127 in total) come mostly from market-oriented public institutions such as national promotional banks (NPBs) or the EIB Group and we found them across all member states. Some products coming from private banks and funds are also present. Loans are prevalent in all geographic areas and no specific differences or trend was identified. Italy (13), Germany (12) and Poland (12) are the countries with the highest number of instruments.

Box 4: Focus on: Loans for Transmission and distribution only

Loans represent around 52% of the 21 mapped instruments supporting only Transmission and distribution, for a total of 11 schemes. The mapping identified T&D-only loans in Austria, Belgium, France, Germany, Greece, Hungary, Italy, the Netherlands, Poland, Spain, and Sweden so each of them is located in a different Member State.

All the mapped loans, regardless of the Country in which they have been disbursed, **are set to finance infrastructural intervention on the electric grid**, without any specific mapped investment on the gas network.

The mapping identified information on volumes for all the T&D-only loans, for an **overall lent amount of €5.8 bn. All the 11 loans have been disbursed by the**

EIB so that, as in the case of grants (see Box 3 above), the mapping confirms the major role EU institutions play in the financing of transmission and distribution projects.

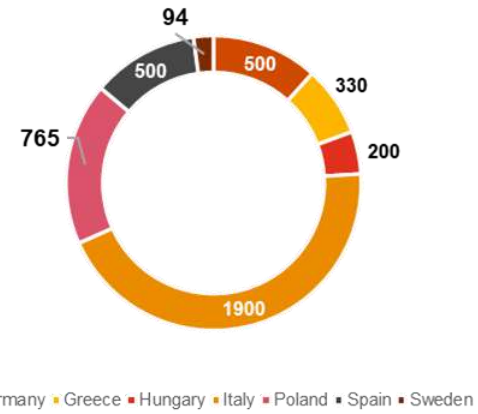
The size of mapped loans varies significantly, **going from the €94 m** multi-scheme investment project for electricity distribution grid infrastructure in the Greater Stockholm area in Sweden **up to the almost €2 bn** granted for the Tyrrhenian Link ensuring

electricity transmission between Italian mainland and the two islands of Sicily and Sardinia.

Table 4: Mapped T&D-only loans

Member State	Project	Funding source
Austria	ESTAG Network Investment and Green Loan	EIB
Belgium	Fluvius energy transition INFRA	EIB
France	Enedis Green Electricity Distribution Network	EIB
Germany	Neuconnect Interconnector	EIB
Greece	PPC Distribution VII	EIB
Hungary	MVM Transmission Network Upgrade	EIB
Italy	Thyrrenian Link	EIB
Netherlands	Tennet Eemshaven – Vierverlaten 380KV	EIB
Poland	Tauron Electricity Distribution III / Energa Electricity Distribution	EIB
Spain	Endesa Network Modernisation III	EIB
Sweden	Ellevio Distribution Network Investments II	EIB

Figure 24: Volumes of mapped T&D-only loans per MS (EUR M)



As we see in Figure 24, **Poland is the second MS for total amount conveyed by T&D only loans, with a total of € 765 m**. These money are being disbursed as part of two EIB-backed projects, presenting different regional scopes. One, for proposed EIB financing of € 150 m and a total cost of € 906 m, concerns investment schemes in the electricity distribution network of northern and central Poland over the period 2021-2023; the other focuses instead on the South and South-Western part of the Country over the period 2022 – 2026, with a proposed EIB finance of € 615 total cost of around € 880 m. In both cases the promoted interventions will enable the future integration of renewable generation, while also contributing to the electrification of the economy.

The **€ 330 m loan disbursed to Greece** through the Hellenic Electricity Distribution Network Operator SA, on the contrary to what happens for the other loans – always targeting large infrastructural investments –, **consists of a large number of medium- and low-voltage electricity distribution schemes** geographically dispersed throughout peninsular and insular Greece. In close connection with the specific territorial peculiarities of the Country, this program has the aim of enabling the connection of new system users and to improve reliability within the network.

The mapping found 60 equity instruments, across most of the EU countries, with very few countries missing, mostly the smallest ones. Poland is the country with the highest number of equity instruments identified (8). **Only 1 of all equity instruments is targeting exclusively Transmission and distribution[109].**

[109] This scheme refers to EIB's *Red Electrica Green Finance Framework* operation in Spain, which involves the purchase of Red Electrica's Green Bonds and/or Green Hybrid Bonds to finance newly built electricity transmission schemes. The scheme has been identified as a partial equity instrument, as the hybrid bonds will be partially considered as equity.

Quasi-equity, which is a more complex financial instrument, is less present and was found mainly in France and the Netherlands, for a total of 11 instruments. **Blended finance schemes have been identified in only six countries**[110] (18 instruments overall), with Poland accounting for the biggest shares by volume. **The provision of more sophisticated financial instruments such as (quasi)equity and blended finance require a high degree of cooperation between public and private providers of finance.** Most of the identified instrument are provided by or in cooperation with NPBIs and the EIB Group.

The ratio between the number of instruments targeting only transmission and distribution and the number of instruments which widely support this segment is considerably lower for equity than for loans or grants. As emerged during interviews with selected stakeholders that were run in the preparation of this study, in some countries the energy market is often not deep enough for funds and financial institutions to pursue a narrow investment strategy. In order to get a significant pool of projects and companies, it is indeed necessary to have a horizontal approach which looks at all the segments of the value chain. A more detailed analysis of market readiness is provided in Chapter 5 of this study.

Additionally, WG participants pointed out how, **from an investor's perspective, most T&D projects are not particularly suited for being financed by equity alone due to their long development phases.** This situation opens the door to a public direct intervention to crowd in private resources in a blended finance set-up and with the use of grants and/or guarantees. On the other hand, in the specific case of **energy interconnection projects** – which present stable and predictable returns – there is an opportunity for long-term investors such as private equity funds and infrastructure funds to deploy their resources.

One or more guarantee schemes for energy production are available in 12 EU Member States[111]**, for a total of 22.** The Czech Republic has six instruments, followed by Poland with 5, while the all the other countries only have 1. In the majority of the cases, guarantees are provided by the public sector, especially through facilities financed by the EIB Group or EU funds. **The mapping evidenced just one guarantee focused only on transmission and distribution, in Cyprus.** Such instrument is a state guarantee for the financing of the LNG terminal which covers the 100% of both loans from EIB and EBRD for the construction and operation of such infrastructural intervention. The guarantee has a duration of 20 years and is granted at zero premium.

According to the WG discussion, **guarantees may be redundant and not strictly needed for T&D projects operating according to the regulated model** since regulated revenues have, to some extent, the same attributes of guarantees in terms of risk limitation without the need to sustain additional fees, which can lead to increased grid tariffs. On the other hand, **for T&D projects operating according to the merchant model,** such as interconnectors, **guarantees are particularly helpful in reducing projects risks**, as revenues are not set by regulation, and are often difficult to forecast in the long term.

Finally, **19 instruments also including technical assistance (out of which 3 are inserted in programs targeting only transmission and distribution) have been mapped across 10 MS**[112]. Poland, France, and Italy are the countries in which Technical Assistance is provided the most. None of these instruments are offered on a standalone basis but rather combined with another instrument. In 10 occasions this instrument was paired with loans. 7 times it was offered together with a grant. In 3 occasions instruments were offered together, alongside technical

[110] Croatia, Czech Republic, Greece. the Netherlands, Poland, Slovakia

[111] Bulgaria, Croatia, Czech Republic, France, Germany, Greece, Ireland, Latvia, Malta, the Netherlands, Poland, and Slovakia

[112] Austria, Belgium, France, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Poland

assistance. Overall, as showcased in Figure 22 above, the volume of money channelled through programs, mostly loans and grants, that come with a technical assistance part is almost €9 billion.

Box 5: Focus on: Green Bonds

Green bonds are expected to become an increasingly important instrument for financing sustainable activities in the coming years. Over the last decade, both corporates and sovereigns in the EU have started tapping into the green bond market, in response to the increasing attention towards sustainable finance.

As emerged during WG discussions, **Green Bonds are a growing trend also in financing T&D projects.** Between 2010 and 2017 Transmission Line Project Bonds accounted indeed for approx. 16% of all Power-related Project Bond issuances by volume, and roughly 4% of the total Project Bond market[113].

While it is difficult to determine the exact allocation of funds to T&D projects, looking at issuances from TSOs and DSOs can provide insight into the amount of funds raised within this sector. However, it is worth mentioning that, particularly for larger companies that operate vertically along the energy value chain, green bond proceeds may not necessarily be earmarked for T&D projects. Additionally, it should be noted that for some EU companies that have operations outside the Union, some of the raised funds may have been directed towards projects in extra-EU countries.

Number of issuances and volumes

In the period between November 2013 and March 2023, 202 green bonds were issued by EU Companies operating in the aforementioned sectors across 14 Member States. Netherlands, with 46, is the country with the highest number of bonds issued during this period, followed by Italy (32), and France (30). Belgium and Lithuania are instead those with the lowest registered number (see Figure 25).

Figure 25: Number of GSS bonds issued by firms from 2013 to 2023 per Country

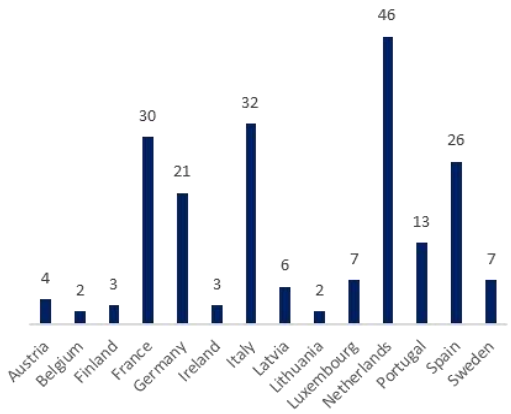
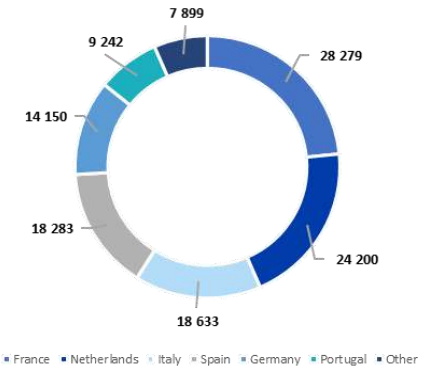


Figure 26: Aggregate volumes of GSS bonds issued by firms from 2013 to 2023 per Country (EUR M)



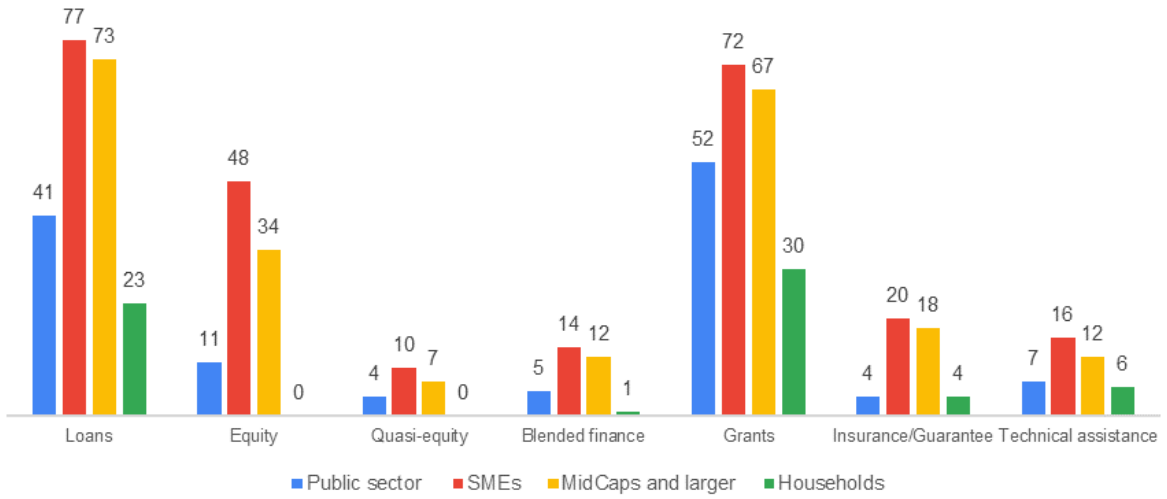
The total volume of issued bonds targeting renewable energy stood at around € 120 bn[114]. French issuers raised the highest total amount, at about € 28 bn. Dutch firms issued around € 24bn, while Italian and Spanish ones slightly more than € 10 both around EUR 18 bn (see Figure 26[115]). **The average volume of such emissions has been at around € 597 m.**

[113] Project Bonds: Power Transmission Lines, Crédit Agricole Securities (2017)

Financing instruments by beneficiary

SMEs and larger companies are the most supported recipients by financial instruments in most EU Member States[116]. They are the most supported type of beneficiary due to their higher investment needs in general, which lead to the need for greater support. In fact, "financing costs" was indicated by both SMEs and large companies as a relevant obstacle for their green transition activities in a recent Commission report on EU SMEs[117], showing an existing need for support in the field. Croatia and Poland are the two countries which have the highest number of loan instruments towards the private sector (10 and 9 respectively) while Germany and the Czech Republic have the highest number of grants (13 and 10). The vast majority of equity, quasi-equity and blended finance is directed towards SMEs and larger companies. Indeed, 80% of equity instruments target SMEs and 57% for Midcaps and larger companies. The share that is dedicated to public companies and households in negligible in all the EU countries. Similar results are found also for quasi-equity, where 91% of the instruments are directed towards SMEs and more than 64% to Midcaps and large companies.

Figure 27: Number of instruments by final recipient per type of instrument



Public-owned companies and public administrations ("public sector") are supported by about a third of the mapped instruments. The lower support for public sector entities could be linked to the extent such entities receive direct budget support from the state budget and their expenditures might not need to be financed through external instruments. Only 41 loans were found towards these recipients, mostly in Italy and Germany, while grant instruments for public sector are 56, mostly in Germany (14).

Households are the least supported group by the mapped instruments, with more than 10 instruments per country identified only in Germany. This can be explained by the fact that pure energy-efficiency instruments – the ones most suited for households - were excluded from the

[114] For bond issuances originally not in EUR the following exchange rates have been applied: EUR 1 = SEK 0.089, JPY 0.0069, USD 0.92, GBP 1.13, BRL 0.18

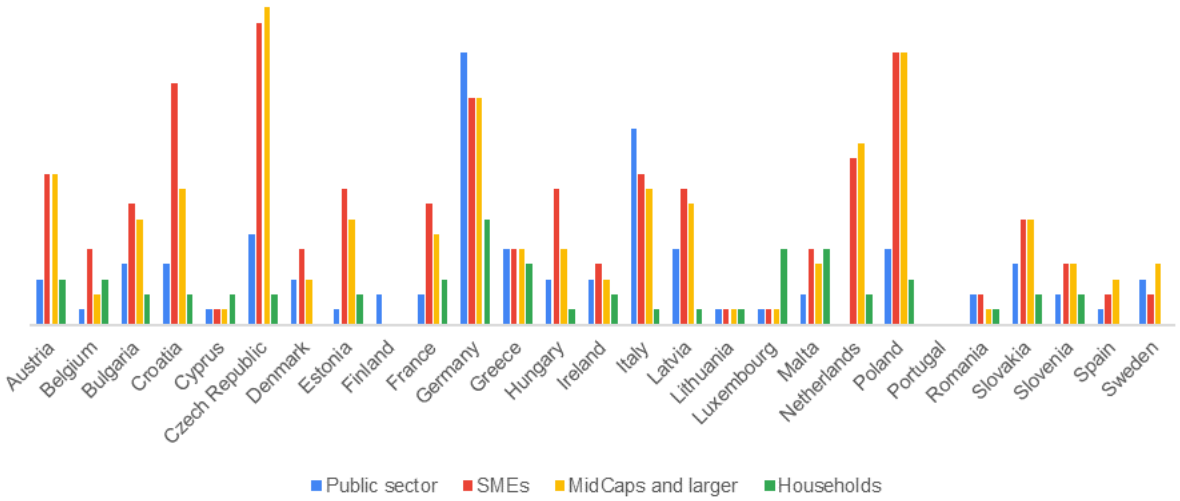
[115] The category "Others" in this figure is the sum of: Austria EUR 1.2 bn, Belgium EUR 1.1 m, Finland EUR 400 m, Ireland EUR 1.2 bn, Latvia EUR 350 m, Lithuania EUR 600 m, Luxembourg EUR 500 m, Spain EUR 1.8 bn, Sweden EUR 31 m

[116] As previously exposed, most of these schemes are generic and, therefore, while for each of them T&D is a targeted sector alongside other energy value chain segments. The fact that a certain category (i.e., households or public sector) is among the eligible categories of beneficiaries, it does not necessarily mean that such category is financed specifically in relation with T&D.

[117] European Commission (2021). Annual report on European SMEs 2021/2022. SMEs and environmental sustainability.

mapping. Grants are also the most used tool to support households, followed by loans (30 and 23 instruments, respectively).

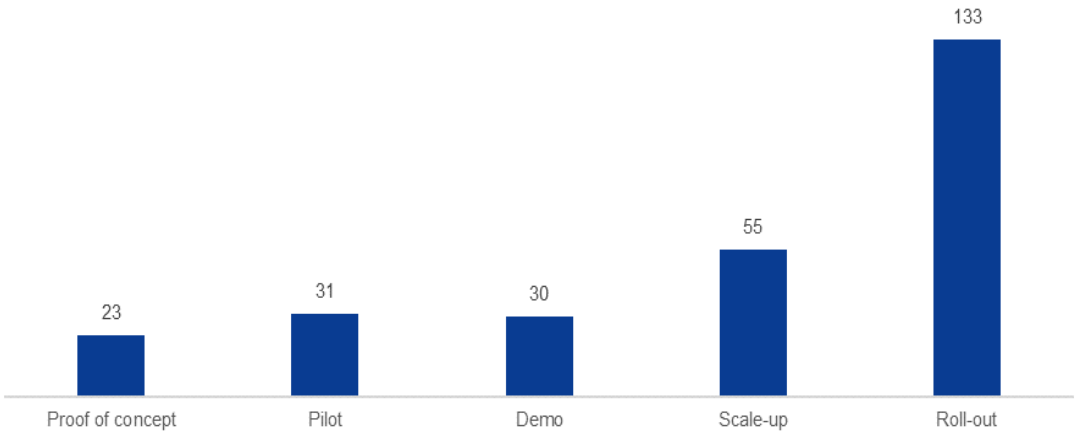
Figure 28: Number of mapped instruments per supported beneficiary by Country



Financing instruments by targeted TRL

Financial instruments in T&D target mainly projects that are mature and market-ready ("roll-out" stage). Most instruments target mature technologies and roll-out stage projects/activities and the availability of instruments decreases as the maturity stage decreases towards lower TRL and early-stage technologies. Indeed, about 48% of the identified instruments target roll-out stage and 20% are aimed at scale-up stages. This trend stays the same across the different types of instruments mapped.

Figure 29: Number of instruments per maturity stage

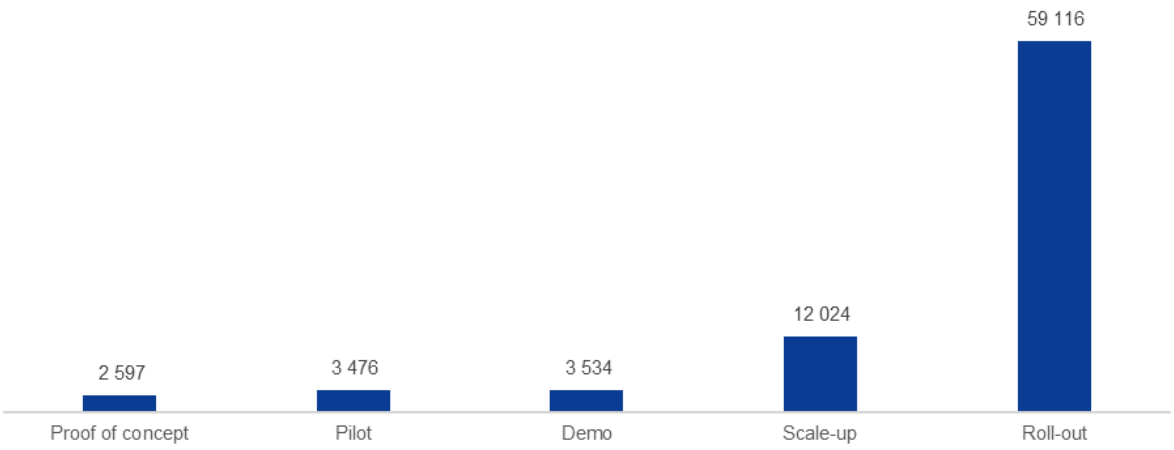


These results could indicate that there is a **shortage of instruments at Member State level that are able to specifically target less mature low-TRL technologies**. However, mature technologies have higher CAPEX costs for their roll-out, and low-TRL technologies, despite being less cost-efficient, still overall require less investments for their development than mature technologies require for their large-scale deployment. At EU level, as it has been showcased in the previous chapter, **programmes like Horizon Europe and the Innovation Fund have been put in place** to provide financing for innovative but less mature technologies that would otherwise

struggle to access financing opportunities in the market. Despite not being specific to T&D, these programmes can finance also such types of projects.

Nevertheless, based on the available data, about €2.5 billion are available by financial instruments targeting proof of concept stage and €3.5 billion for pilot and demo stage. The trend in terms of volumes of financing understandably replicates the one of absolute number of instruments. Significantly higher volumes of financing are available for scale-up and – above all – roll-out stage projects/activities. Indeed, the latest stage alone receives more than double the amount of all the other stages combined, reflecting the higher amounts of financing needed to deploy a mature technology at scale.

Figure 30: Volume of financing per maturity stage (€ M)



4. Assessing the relevance and effectiveness of instruments

As referred to in the section on Barriers to investment, T&D projects continue to face a series of barriers limiting the provision of financing and stemming from market failures, complex permitting frameworks and regulatory uncertainty.

This chapter focuses on the role **financial support schemes** can play in addressing investment barriers affecting T&D investments, and attempts to assess, based on the mapping of financial support schemes conducted, to what extent existing instruments are effective. **Contractual schemes** such as PPAs, while useful for crowding in private finance and for promoting private sector expertise in the development of complex infrastructure projects, are not analysed under this chapter as they are contractual arrangements/partnerships rather than financial products.

Section 4.1 provides more conceptual considerations and evidence from the mapping on the capacity of different types of instruments to address barriers. Indeed, not all barriers can be addressed through financial instruments and not all instruments address all barriers. Section 4.2 presents findings on instruments' effectiveness in addressing relevant barriers and reaching their objectives, drawing on evidence from the mapping and existing instrument evaluation studies.

4.1. Relevance of instruments in addressing investment barriers: theory and evidence

Theoretical considerations

This section focuses on the main types of instruments identified in the mapping and provides a conceptual analysis of their relevance for addressing different barriers to investment, based on the way they function and their effects on the project's bankability. This framework will then be used in sub-section 4.2 to analyse the findings from the mapping.

Loans

A loan is a debt type of product that can take different forms and function in different ways, depending on the way it is structured. While the mapping exercise did not distinguish among the different types of loans, mainly for a reason of feasibility[118], it is nonetheless useful to understand how different types/features of loans can help addressing investment barriers. This will also be key for the future development of new and improved financial instruments, which would benefit from a more tailored input and insight.

The following paragraphs provide a description of the most relevant features of loans for T&D projects and the types of financing needs they address.

Long-term loans are relevant for improving the financing conditions of T&D infrastructure investments by reducing refinancing risks and associated costs. As referred to in previous sections, energy infrastructure projects have an average economic lifetime of 20-50 years, compared to typical maturities of commercial loans of 5-10 years. A large mismatch between assets and liabilities gives rise to refinancing risks over the life of the assets, i.e., a risk that debt reaching its maturity will have to be refinanced at unusually high costs or that it will not be able to be refinanced at all. Such refinancing risks in turn can be caused by a number of factors, including high demand for corporate credit at the time of refinancing, which leads to higher

[118] Feasibility considerations included a) consistency of available information across loan instruments (most loan descriptions did not provide detailed information on underlying features); and b) consistency of available information across other instruments (most guarantee, equity and grant schemes did not provide detailed information as to their type).

interest rates, or severe market disruption events resulting in a sudden drop of liquidity in debt markets[119]. Long term loans such as the type of financing frequently offered by National Promotional Banks and Institutions, particularly if accompanied by fully amortizing repayment profiles, can therefore mitigate refinancing risks, and better distribute debt service costs across the project's economic life. Loans with long tenors are also efficient instruments for reducing the occurrence of incremental refinancing costs, such as arranging fees, legal fees and other costs that need to be paid for each new debt issuance and which can present significant expenses for the issuers concerned.

Loans with other advantageous terms such as reduced interest rates and flexible drawdown conditions are particularly relevant for TSOs/DSOs who face external constraints coming from their credit rating or existing loan covenants. Network operators that are externally rated face the challenge of raising enough debt for their investment projects while respecting limits and restrictions consistent with their target credit rating. Credit rating agencies in turn use leverage and interest coverage ratios[120] as critical indicators of regulated networks' financial flexibility and of their ability to adapt to changes in their economic or regulatory environments. Loans with advantageous pricing and other beneficial conditions permit T&D companies to contain their interest expenses and to manage their debt portfolio more flexibly, thus minimising the threat of new debt issuances to the companies' credit rating. Similarly, loans at favourable interest rates support TSOs' and DSOs' efforts to comply with any existing loan covenants imposing restrictions on additional indebtedness, by lowering the interest expense of such new additional debt.

Loans that facilitate the aggregation of investments are relevant for improving access to finance and financing conditions for smaller T&D projects. This is particularly relevant for DSO projects, which, in contrast to traditional large-scale TSO investments, show more variety in complexity and scale. Individual distribution network investments, if analysed in isolation, could face challenges in accessing commercial finance at attractive interest rates due to their smaller ticket sizes, which can disincentivise commercial banks and private investors from investing at commercially attractive terms. This is due to all the administrative and due diligence processes that must be performed before financing is provided, which in the case of smaller projects might not be worth the effort, as the revenues from the interest rates would be relatively small. Loan instruments facilitating the aggregation of investments can therefore enable smaller projects reach the necessary scale to attract bank financing at preferential rates and the involvement of specialized infrastructure financiers like EIB. Examples include multi-component loan schemes for different investments in both new and existing electricity distribution stations[121] or investment programmes covering schemes in both electricity and gas distribution networks[122].

Guarantees

Guarantees are relevant for improving access to finance and financing conditions for T&D investments involving high real or perceived risk. For projects of significant size such as those typically in the T&D sector, the optimal structure of guarantees depends on the specificities

[119] The example of Babcock and Brown and Allco Finance, two Australian infrastructure investment organisations that went into liquidation during the 2008 crisis due to an inability to refinance their short-term debt shows the threat that market disruption events can pose at the time of large refinancings. Even a successful refinancing but at higher interest rates can have a negative impact on the financial health of TSOs that typically manage large debt portfolios. New Zealand TSO Transpower recently highlighted that just a 50 basis point difference to its cost of debt would imply c. 17 USD M of additional annual debt service costs, given its >USD 3 billion debt portfolio (Transpower, 2016). Although these examples refer to non-EU entities, the challenges they highlight are also relevant for European operators dealing with high volumes of debt and long life of investment assets.

[120] Examples include the Adjusted Interest Coverage Ratio or the Funds from Operations Interest Coverage ratio (Moody's rating methodology for regulated electric and gas networks, April 2022)

[121] See example of recent EIB loan for various electricity distribution schemes (underground cables, new substations and works in existing substations) in the Greater Stockholm area.

[122] See example of recent EIB loan for an investment programme comprising a number of schemes in the electricity and gas distribution network of Styria (Austria).

of the T&D investments and the ownership of project promoters, while the ultimate conditions of a guarantee instrument will most likely be the result of direct negotiations between the involved parties.

Guarantees are particularly helpful in reducing project risks for T&D investments operating according to the merchant model. Merchant based T&D investments e.g., certain interconnector projects, are characterised by revenue profiles that are often difficult to forecast in the long term, as revenues are not set by regulation. This can deter risk-averse investors from investing with meaningful amounts or from offering beneficial financing conditions. As such, guarantees can be a necessary tool to enable merchant-based T&D investments to access long-term capital offered by patience investors like multilateral development banks and national promotional institutions. On the other hand, guarantees may not be particularly needed for T&D projects operating according to the regulated model, as regulated revenues have the same attributes of guarantees without the need to sustain additional fees.

Guarantees can also be tailored to support projects at different stages of maturity. As highlighted by WG members, guarantees covering the interruption of the project combined with grants can be particularly beneficial for projects in early stages, while guarantees covering a certain percentage of the loan can incentivise banks to offer long-term financing for more mature projects. The duration of guarantees can similarly be adjusted to support the fund-raising efforts of different T&D investments. Guarantees with a long duration and matching the duration of the debt they cover can be particularly helpful for transmission projects, improving their ability to access long-term financing. Guarantees with shorter durations may be sufficient for distribution projects which usually pertain to smaller scales, although this can also depend on the project.

For T&D investments in particular, the type of guarantees needed to secure funding is influenced by the ownership of project promoters. For promoters that are mostly publicly owned, such as many TSOs or gas infrastructure companies in Europe, sovereign guarantees can be a powerful tool to improve access to finance for projects considered to be in the public interest. This is despite the fact that the very public ownership of such entities might already amount to implicit guarantees. An additional explicit state guarantee may still be required for projects with high technology risks or in case of commercial banks that are negatively impacted by liquidity constraints coming from the latest regulations such as Basel IV. In addition, state guarantees can be particularly relevant in situations where the public nature of promoters' ownership limits their access to equity, making it even more important for such promoters to be able to access debt from the market easily and at low costs. On the other hand, project promoters that are mostly privately owned are likely to encounter obstacles in accessing sovereign guarantees. These promoters may make use of other types of guarantees, such as those issued by National Promotional Institutions, Development Finance institutions (DFIs) and commercial banks, in order to improve their access to debt and contain financing costs. Lastly, private corporates can also provide guarantees in certain cases. As mentioned by WG members, a private developer can provide a guarantee (e.g. to a Joint Venture established for the construction phase of an interconnector) in order to mitigate construction risks during the development phase of the project.

Equity

Equity instruments are relevant for financing the development of large-scale T&D infrastructure projects and for providing initial capital to new technologies and young companies offering innovative solutions to the T&D sector. Equity-type instruments expose investors to a higher degree of risk but also to potentially higher returns and can support both mature and less established investments/technologies in T&D.

Equity investments by infrastructure funds can be effective at catalysing mature and large-scale T&D investments. Infrastructure funds are specialised funds that only invest in infrastructure – traditional subsectors include among others power, transport, water or waste.

Although infrastructure investments can have different risk profiles, assets targeted by infrastructure funds typically share certain attributes that are meant to provide steady, reliable returns across a wide variety of economic conditions[123]. This makes infrastructure funds particularly relevant actors for supporting T&D investments, which, except in cases of projects operated on a fully merchant basis, provide cash-flow visibility due to full or partial regulated revenues.

WG members have highlighted in particular the relevance of infrastructure funds in financing **transmission interconnection** projects, which, due to their large size and typically sizeable financing needs, are well suited for long term equity investors[124]. Examples of European infrastructure funds active in T&D include Meridiam, which recently acted as lead investor in "NeuConnect"[125], a landmark interconnector project between the UK and Germany, or the Marguerite Fund, which focuses on pan-European greenfield and brownfield investments and counts on a strong public investor base[126] and private institutional funding. Infrastructure funds such as the examples referred to above also enable an efficient intermediation of diverse public and private sources of funding into T&D investments. By contributing with capital into specialised investment funds, public entities and institutional investors (e.g., pension funds, insurances, national and international financial institutions) can play a role in financing complex transmission and distribution projects without the need to develop tailored expertise and know-how in these types of investments.

Publicly backed equity schemes crowding in venture capital investors are particularly relevant for improving access to finance for young and innovative companies offering advanced technological solutions to the T&D sector. In recent years, an increasing number of innovative companies have entered the smart grid space. While the market potential of smart grids seems widely acknowledged by investors and the urgency to digitalize the grid is well understood by TSOs and DSOs, many investors remain hesitant to invest in this space[127]. Barriers to investment include traditionally high levels of risk-aversion from TSOs/DSOs when it comes to adopting new technologies into their grids, and varying standards and regulations across countries, which makes it more difficult for start-ups in this sector to scale up globally. Publicly supported equity schemes, such as CDP's Corporate Partners I Fund – Energy Tech[128], could therefore be necessary to crowd in private investors and mobilise equity financing for young companies offering innovative solutions to network operators.

Grants

Grants can be relevant in addressing a number of investment barriers, depending on the types of investments and beneficiaries targeted and cost components covered.

Grants for studies and construction works can provide a necessary financial incentive for the development of cross-border T&D Projects of Common Interest (PCIs). PCIs are key cross border infrastructure projects that link the energy systems of EU countries. As projects that benefit at least two EU countries, increase competitiveness, enhance the EU's energy security

[123] Mercer, Infrastructure investing – a primer, 2021

[124] On the other hand, WG members pointed out that infrastructure equity solutions are less relevant for landlocked TSOs whose projects may not reach the necessary scale to attract large private funds or in the case of fully state owned TSOs which, due to constraints imposed by regulation, may not be able to resort to external equity for financing their projects.

[125] Meridiam. First ever UK-German energy link moves ahead as £2.4bn/€2.8bn NeuConnect project reaches Financial Close. https://www.meridiam.com/news/first-ever-uk-german-energy-link-moves-ahead-as-2-4bn-e2-8bn-neuconnect-project-reaches-financial-close/

[126] Known public Marguerite investors include EIBG and five European national promotional banks and institutions, namely Italy's CDP, Spain's ICO, France's Caisse des Dépôts Germany's KfW, and Poland's BGK

[127] Apricum, 2022: *To invest or not to invest? The smart grid question*

[128] CDP Venture Capital. https://www.cdpventurecapital.it/cdp-venture-capital/en/dettaglio_comunicato.page?contentId=COM2455

and contribute to sustainability[129], PCIs are characterized by high socioeconomic value/positive externalities and by benefits that are spread across countries. As a result, the available remuneration offered solely through the regulatory framework(s) may not be enough to incentivize the development of such projects, resulting in a sub-optimal level of investment in strategic cross-border energy infrastructure. Grants, such as those from the CEF Energy programme specifically developed to support sustainable energy infrastructure projects, can improve the business case for network operators to invest in PCIs.

Investments grants can also be a necessary instrument to support new T&D segments and innovative young companies offering sustainable solutions to the sector. New T&D segments such as **hydrogen-related infrastructure** can face acute investment barriers stemming from an incomplete regulatory framework and significant technological risks. Given the strategic importance of ensuring a rapid development of such T&D infrastructure, public support can prove essential to incentivise companies to carry out risky investments. The "IPCEI Hy2Use" project[130], which will provide c. € 5 billion in public funding to 29 companies for carrying out projects in the hydrogen value-chain of Member States, exemplifies the need for public support to overcome market failures in energy and T&D sectors that are still in their infancy. Similarly, grants, in addition to equity schemes referred to above, can also be required in certain cases to support the growth of start-ups offering innovative solutions to TSOs/DSOs. For young companies still unable to access the debt market, grants can provide necessary support during the early phases of development, where market failures (e.g., imperfect information about the performance of new technologies) are likely to be most acute.

Grants encouraging citizen engagement in decentralised energy production could indirectly help to improve social acceptance for new T&D investments. Given their non-repayable nature, grants can incentivise households and companies to undertake relatively simple investments that support the energy transition, but which would not be considered a priority by individuals in the absence of sufficiently strong economic incentives. Examples include grants for domestic RES installations, electric vehicles or grants supporting the deployment of smart meters. Enhanced investments by individuals in these types of assets/activities requiring an enhanced use of power grids and supported by national or EU grants could indirectly help to improve social awareness and understanding about the need to expand power networks. This, in turn, could help to address the increase in local opposition seen recently in Europe in relation to construction projects for new power lines[131].

Indirectly, grants covering project preparation costs and technical assistance can also address insufficient planning and preparation capacity affecting smaller (e.g., municipal) DSOs who may lack the human capacities and technical expertise to develop complex network projects.

Bonds

Bond instruments are relevant for amplifying the sources of medium to long-term capital available to the T&D sector. Green bonds in particular are a common type of bond instrument used to raise capital for climate-friendly projects and can be issued by sovereigns, NPBIs, commercial banks or TSOs/DSOs[132] directly. By earmarking their proceeds towards sustainable projects, green bonds can serve as an important bridge between providers of capital, such as institutional investors, and necessary T&D investments to enable decarbonisation. This type of capital market instrument can support the development of T&D projects by improving their access

[129] European Commission. Projects of Common Interest. https://energy.ec.europa.eu/topics/infrastructure/projects-common-interest_en

[130] European Commission. State Aid: Commission approves up to €5.2 billion of public support by thirteen Member States for the second Important Project of Common European Interest in the hydrogen value chain. https://ec.europa.eu/commission/presscorner/detail/en/ip_22_5676

[131] *Going electric, but not in my backyard*; Politico, 2018

[132] See example of recent green bond issuances by TSOs TenneT (Germany/Netherlands) and AST (Latvia)

to medium to long-term and more diversified sources of capital, complementing traditional bank financing available to the sector.

Blended finance

Blended finance instruments are a versatile tool that can support different types of T&D projects with easier access to private finance. Although the mapping did not include a large number of blended finance instruments, such instruments can help mobilise commercial investment towards necessary T&D investments, whilst limiting the use of scarce public resources only to the extent needed to crowd-in enough private finance. Blended finance interventions benefit from the possibility to be tailored to particular sectors and barriers (e.g., equity co-investment facilities providing growth finance to energy start-ups), making them a versatile tool to mobilise commercial financing towards priority T&D investments and types of beneficiaries.

A blended finance instrument is typically developed by a public entity together with one or more private entities, where all entities involved pool their resources; the resources provided by the public entity are usually offered at below-market terms. Contrary to more standard financial instruments in which public resources crowd-in private ones after the launch of the instrument, in blended finance schemes private and public resources are combined since the creation of the instrument.

Common types of blended finance include below-market guarantees or concessional debt or equity. Blended finance is often also combined with technical assistance or investment grants, to provide capacity building and knowledge-sharing to the beneficiary, to support in the transaction preparation, or, in the case of investment grants, to strengthen a project's commercial viability.

The main investment barriers for private investors addressed by blended finance are (i) high perceived and real risk, and (ii) poor returns for the risk relative to comparable investments. Blended finance aims at creating investable opportunities in developing market sectors, as well as in sectors with under optimal returns to attract sufficient private investments.

Technical Assistance

Technical assistance is relevant for improving the planning and preparation capacity of smaller T&D project promoters and their ability to benefit from financial instruments. Technical assistance schemes identified through the mapping were primarily paired with loans or grants to SMEs, Midcaps or public sector entities and included support with environmental impact assessments, feasibility studies or on regulatory and policy matters.

TA can be particularly suitable for small DSOs lacking internal resources and specialised capabilities for project preparation and management. Dedicated assistance can help such promoters prepare a solid business plan that is ready to be submitted to investors, thus improving the investment readiness of local/regional distribution projects and their ability to access external financing. Combining technical assistance with instruments such as loans or equity schemes can therefore facilitate the implementation and uptake of such instruments to support well-defined and more mature project proposals.

Evidence from the mapping

The mapping collected available evidence on the relevance of financial instruments for addressing investment barriers currently affecting T&D projects[133]. For most instruments mapped, the instrument descriptions and guidelines would typically not refer to the investment

[133] The set of barriers considered are those identified by WG participants as most relevant and presented in Section 2.3

barriers targeted. Therefore, for each instrument, its relevance for addressing barriers to investment was established/assessed based on the following sources of information:

- **Instrument type**: The instrument's type (e.g., loan, equity, guarantee) and typical functioning mechanism were taken into account to identify the investment barriers that are most likely to be targeted. To reduce the risk of self-confirmation bias based on the theory of instruments' **relevance** in addressing barriers, inferences made from the instrument type were contrasted with other sources of information (see following points).
- **General description**: Most instruments in the mapping came with a general description summarizing the instrument's main features and eligibilities. Although usually limited in detail, some descriptions were able to provide insight on the investment barriers targeted by the respective schemes. This was mostly in the case of descriptions that explicitly referred to instruments' favourable financing terms, long tenors or flexible disbursement conditions, from which it was possible to infer the instrument's relevance for improving the financing conditions of underlying investments.
- **Instrument-specific characteristics**: In the case of instruments accompanied by more detailed guidelines, their relevance for addressing investment barriers was inferred from instrument-specific features that signalled relevance towards particular barriers. Some examples of such characteristics include:
    - **Targeted beneficiaries**: For instruments targeting young companies and start-ups who often struggle to attract sufficient investment during the product development stage, it was generally possible to infer the instrument was improving access to finance for target recipients.
    - **Targeted technology and innovation level:** For instruments targeting mainly newer technologies and innovative projects it was generally possible to infer instruments' relevance for addressing technology risks and restrictions in availability of finance, which typically affect less-established technologies.
    - **Eligible investments and project costs:** For instruments considering project and document preparation costs as eligible expenses covered by the instrument it was generally possible to infer instruments' relevance for supporting promoters' planning and preparation capacities.

However, some methodological caveats should be taken into consideration when reading the results presented below. The information presented in the graphs below should be interpreted as general trends rather than exact matches between instruments and specific barriers.

This is because of two main reasons: (i) **Most instruments do not only target T&D investments**, so the barriers identified as relevant may also be in relation to other segments of the energy value chain and particularly in relation to energy production, as c. 90% of instrument available to the T&D sector also finance energy production investments (ii) **Most barriers are correlated**, meaning that they are caused by intertwined conditions that might also lead to other barriers. For instance, a new, innovative, and not-yet-tested technology targeting the T&D sector might face heavy administrative requirements due to such technology not yet being regulated or covered by the standards of different countries. At the same time, it might also be subject to worse financing conditions compared to other more mature technologies due to its perceived technology risk, high degree of novelty, or uncertain adoption by TSOs/DSOs. Furthermore, the company developing the technology as well as TSOs/DSOs adopting it might struggle to hire enough workforce with the right qualifications to operate it. These three barriers all stem from the fact that the technology is based on innovative elements with a higher risk profile but are counted as different as they affect different aspects of the project. This of course poses challenges in the identification of barriers addressed by different instruments, as, from a theoretical perspective, addressing one barrier might also, indirectly and partially, address other barriers (e.g., reducing the technology risk exposure of an investor might increase the overall availability of financing, as the investor has to bear less risk and can thus invest more if willing to do so).

Financial instruments for T&D investments target mostly investment barriers related to the availability of finance and financing conditions of T&D projects. The results of the mapping confirmed the expected relevance of instruments for these barriers, across all types of instruments considered (see Figure 31 and Table 6 below). Around 85% of mapped instruments across the main instrument categories (loans, grants, equities and guarantees) address restrictions in the availability of finance and approximately 46% address restrictions in financing conditions.

Figure 31: Number of times investment barriers were identified as being "addressed" or "partially addressed" by the mapped financial instruments - by type of barrier

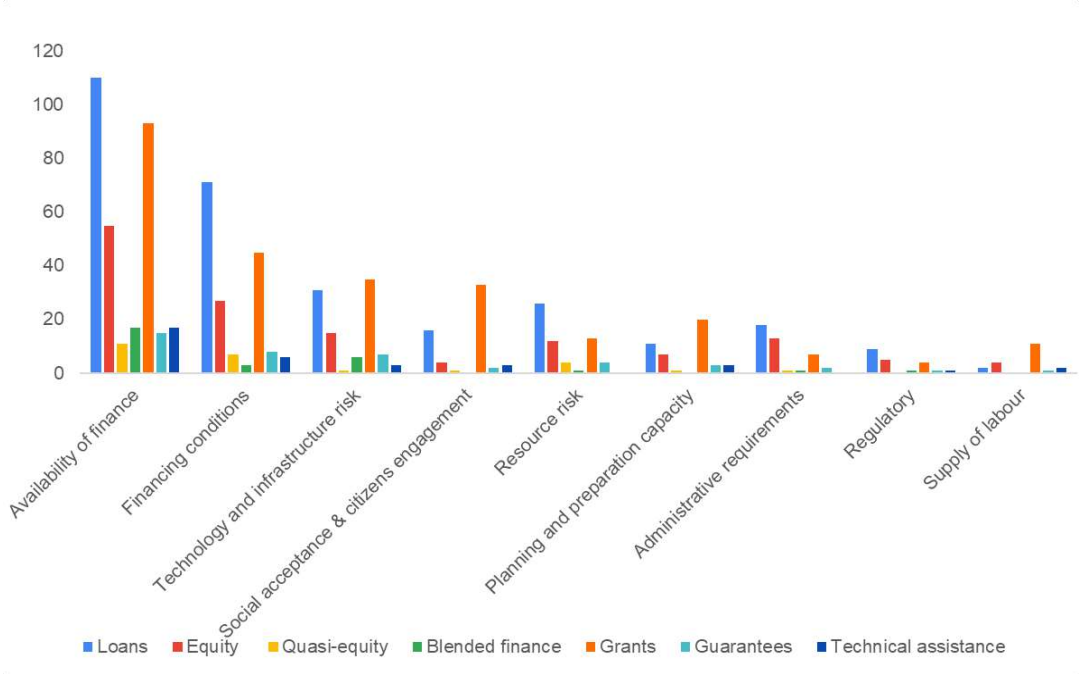


Table 5: Percentage of instruments mapped and identified as "addressing" or "partially addressing" particular barriers

	Availability of finance	Financing conditions	Technology and infrastructure risk	Social acceptance & citizen engagement	Resource risk	Planning and preparation capacity	Administrative requirements	Regulatory risk	Supply of labour
Loans	87%	56%	25%	13%	21%	9%	14%	7%	2%
Equity	92%	45%	25%	7%	20%	12%	22%	8%	7%
Quasi-equity	100%	64%	9%	9%	36%	9%	9%	0%	0%
Blended finance	94%	17%	33%	0%	6%	0%	6%	6%	0%
Grants	95%	46%	36%	34%	13%	20%	7%	4%	11%
Insurances & Guarantees	68%	36%	32%	9%	18%	14%	9%	5%	5%
Technical assistance	89%	32%	16%	16%	0%	16%	0%	5%	11%

Source: PwC mapping based on instruments' available descriptions

Technology and infrastructure risk is mostly being targeted by grants, blended schemes and guarantees, with an average of 34% of mapped instruments under these two categories

addressing this barrier. For grants and grant components, this finding is in line with theoretical predictions they can be necessary to support the deployment of new technologies in T&D– both in relation to large-scale investments such as hydrogen infrastructure[134] and in relation to smaller projects pursued by start-ups, where investors may be reluctant to finance the initial testing, validation and refinement stages of new technologies. Similarly, the findings support the theoretical prediction that guarantees and blended instruments can be helpful in de-risking T&D investments, where the introduction of new technologies or the risk of stranded assets can undermine the stability of revenues and discourage private investment. As most instruments targeting T&D also finance energy generation, the relevance of this barrier also likely captures synergies across energy production and T&D, where the timely development of the grid is relevant for reducing the technical risk of new energy projects not being able to connect to the network.

Social acceptance and citizen engagement is partially targeted through grants, but in general financial instruments are not the most relevant way of addressing this barrier in T&D projects. The identified examples were mainly related to schemes with broad eligibilities across the energy value chain and encouraging citizen participation in the energy transition, e.g., through RE renovations in buildings and residences. This finding is in line with theoretical predictions that grants can incentivize investments outside the household/company's usual business needs by improving the economic incentives for such energy investments. The relevance of this barrier for T&D likely captures the indirect effect that higher citizen involvement in local RE solutions can have on improved awareness and social acceptance for the expansion of T&D networks.

Resource risk also found some relevance in the mapping, particularly from loans[135] partially targeting this barrier. While loan funding can be necessary for T&D project promoters to pay suppliers and secure raw materials for the construction of new transmission lines, financial instruments are an insufficient tool to tackle this barrier effectively. Addressing shortages in key components and materials like microchips or copper needed for new T&D infrastructure will require a more holistic policy response at EU level, where better access to finance for strategic supply chain projects is likely to be one of several measures needed to build more resilient supply chains[136].

As expected, financial instruments were not found relevant for addressing regulatory barriers or those related to supply of labour. Subsidies or private sector investments would not do much to address the shortage of skilled and qualified labour required to operate more modern and digital grids. This barrier would be best addressed through a wider upskilling programme that includes relevant courses. Similarly, regulatory barriers cannot effectively or efficiently be addressed through new financial schemes, as they require regulatory and/or legislative changes to the framework governing that sector. Taking the example of the hydrogen market, the Florence School of Regulation[137] recently highlighted that the massive increase in investment which the EU aims to direct towards clean hydrogen in the next years renders it urgent to develop a robust regulatory framework for the sector that will ensure the maximum benefit from public investment.

A similar situation applies to barriers related to administrative requirements, which are caused by elements outside the financial market landscape, despite affecting it. Responding to the risk of long permitting procedures causing delays and adding to the financing costs of T&D

[134] The mapping included four instruments which were identified as targeting technology and infrastructure risks in hydrogen technologies and eligible to T&D investments as well as to other segments of the energy value chain e.g energy production or storage. All such four instruments were grants, which supports the relevance of this type of support scheme for promoting energy and T&D sectors that still display high levels of technological risks.

[135] Reference is made to loans rather than quasi-equity considering the four main instrument categories in the mapping (loans, guarantees, equity and grants).

[136] Critical Raw Materials Act – securing the new gas oil at the heart of our economy I Blog of Commissioner Thierry Breton.pdf

[137] https://fsr.eui.eu/hydrogen-regulation-under-time-pressure/

investments will require more targeted interventions at key bottlenecks of the permitting process, such as improving human capacities at public administrations or NRAs' coordination efforts for cross-border projects.

The findings indicate there is further room for instruments combining technical assistance support to T&D project promoters. The barrier related to **planning and preparation capacity** was identified as being only modestly addressed by the mapped instruments, suggesting there is further room for financial schemes combining technical assistance support. TA could be targeted to small DSOs who may lack internal capacities for project preparation or to TSOs dealing with complex investments, such as in the case of TSOs in the Western Balkans who recently received technical assistance to improve operational conditions in high-voltage electricity transmission networks in the region[138].

4.2. Evidence on the effectiveness of financial instruments – Findings from the mapping

Effectiveness of a financial support scheme can be defined as the instrument's capacity to achieve its objectives and targets, intended as addressing barriers and market failures, making a project bankable, mobilising additional financing, and contributing to the achievement of energy and climate objectives.

However, a complete effectiveness assessment can be done only once the scheme has been fully deployed and when the projects that have received financing are completed. Since the mapping exercise covered only ongoing and recently closed financial schemes, only in very few cases was there an available analysis on instruments' effectiveness so far. Quantitative and qualitative metrics on the deployment and impacts of the schemes are not yet available. Data on resources disbursed, financing crowded-in, km of new power lines built, and jobs created will likely be public only once mid-term and ex-post evaluations are conducted. This is not the case for the large majority of instruments mapped.

Given these limitations in data availability, the effectiveness analysis focuses on the factors that support a scheme's effectiveness - i.e., the characteristics and features that a financial support scheme can have that are required for its effectiveness. These factors were defined based on consultations with WG members during different WG meetings.

The main factors identified as key for the effectiveness of financial instruments and schemes for T&D are:

- Financing tailored to TSOs and DSOs,
- Availability of complementary types of financing,
- Long-term stability and visibility, and
- Easy application and low bureaucratic requirements.

Financing tailored to TSOs and DSOs

As explained in the section Economics of Transmission and Distribution, TSOs and DSOs usually function in heavily regulated sectors, meaning that the way they raise financing and invest in projects may significantly differ from how other companies in the energy sector work. This also translates in the fact that financial support schemes that are effective for companies in other segments of the energy value chain might not be effective for T&D operators.

[138] WBIF Technical Assistance for Improvement of Electricity Transmission Networks in the Western Balkans

Among equity schemes, infrastructure funds and equity investments made by NPBIs are most relevant for T&D projects. Many types of equity financing are often not an option for T&D projects, as the time gap between when equity is required (construction phase, upfront) and when revenues are generated (several years after) might make the investment less attractive for many investors. WG members noted that infrastructure funds are an example of equity financing tailored to TSOs and DSOs needs. These funds provide long-term equity financing for infrastructure projects and provide stable returns over the long term and low volatility in the portfolio as they generally have a stable cash flow. However, these funds do not invest in smaller projects and are thus less suited for many DSOs and TSOs in the EU. Similarly, WG members highlighted the role of NPBIs as long-term investors providing patient capital, making them a highly relevant type of investor for T&D operators requiring long-term, stable equity investments.

Debt schemes are subject to capital requirements, which may limit investors' ability to provide financing. Long-term investments are impacted by the Basel IV regulation[139], whereby long-term bank loans may become more costly as banks may have less appetite for long-term financing. Due to this, **explicit guarantees might be increasingly needed also for state-owned T&D entities**. This adds to the barrier of mismatching between the average economic lifetime of energy infrastructure projects (20-50 years) and the typical maturities of commercial loans (5-10 years), as the reduced availability of long-term loans by commercial financing institutions can lead to increased risks related to refinancing projects.

Similarly, **grant funding is not accounted for in the T&D operator's RAB[140] and this leads to an increase in operational costs but not in applicable tariffs**. Depending on the national regulatory framework, many DSOs are remunerated based on the actual capital they invested (i.e., their RAB), without having the possibility to get remuneration from investments made with public funding, for which they are nonetheless in charge of operating and maintaining. The issue is that assets that are not included in the RAB still do carry a cost of OPEX, and potentially also replacement costs, which are not covered by remuneration system, as it is often based on the RAB rather than the actual costs incurred. While this issue is not directly linked to financial support schemes themselves, but rather on the regulatory and remuneration framework, it still has an impact on the schemes' effectiveness. During WG discussions, the adoption of a **TOTEX approach**[141] was deemed a possible solution to enhance T&D schemes' effectiveness. A TOTEX approach could allow T&D operators to use grant financing to cover part of their costs, while still being able to adapt tariffs based on their actual expenses. However, further discussion and analyses are needed on this matter.

While the mapping did not capture whether identified schemes have features and characteristics suited for TSOs and DSOs, what is clear is that energy infrastructure operators often play in a different market context compared to other energy companies, and would thus benefit from dedicated schemes aligned with the regulatory framework in place.

Availability of complementary types of financing

Throughout the WG discussions, some of the WG members noted that, while grants represent a crucial support instrument for TSOs and DSOs, since they help them reducing risks while sustaining innovation and digitalization of the network, **the T&D sector could and should move towards repayable instruments and rely on a more diversified array of financial schemes.**

[139] Basel IV is the final component of the Basel III reform and aims at strengthening the resilience of the EU banking system against future crises. Basel IV introduces changes that limit the reduction in capital that can result from banks' use of internal models under the Internal Ratings-Based approach. This also means that banks will have to carry significantly more capital to meet the requirements, resulting in higher interest rates and, more generally, more costly debt financing.

[140] RAB stands for Regulatory Asset Base, the accumulation of the value of investments that a service provider has made in its network. It does not include investments that the operator did not sustain itself (e.g., grants from public money).

[141] TOTEX stands for Total Expenditures, i.e., all costs incurred by the operators, without distinction between CAPEX and OPEX.

This would also help it becoming more attractive for financial investors and even financing itself on market terms to gradually phase out reliance on subsidies.

As can be seen in Figure 32 below, data from the mapping on T&D-specific schemes shows that **loans and grants account for almost the entirety of financial schemes specific for T&D**.

Figure 32: Number of T&D schemes by type of financing

The low number of guarantees could be explained by the fact that **guarantees for T&D projects in the regulated model provide fewer benefits,** as the long-term stability and visibility of revenues is usually able to attract sufficient financing. However, projects operating in the merchant model would benefit from guarantees as revenues are not set by regulation, and are often difficult to forecast in the long term.

When it comes to the **lack of equity schemes**, as mentioned above, many TSOs and DSOs are public-owned entities and might be reluctant to accept external equity. In the T&D sector, **equity financing is mostly provided by infrastructure funds and NPBIs**. This is the case of the Marguerite Fund[142], which has invested in different grids and gas pipelines across the EU, as presented earlier in the Study in Section "Financing instruments by type", or Cassa Depositi e Prestiti's equity stakes in Terna[143], Italy's main electricity TSO, in Snam[144], Italy's gas TSO, and Italgas[145], the Italian largest gas DSO[146].

Overall, as mentioned previously in Section 2.4 Barriers to investment, WG members noted that **support schemes for T&D should provide different types of financing**, leverage the different characteristics and strengths of the different instruments and facilitate the combination of financing from different sources (e.g., European funds and national funds).

A country-level analysis of the different instruments available for T&D is presented in Section 5 "Diversity of instruments available for transmission and distribution".

Long-term stability and visibility

The stability of the instrument over long-term, intended as both the regular provision of financing, and the lack of unforeseen changes occurring during the instrument's lifetime helps creating trust among investors, thus incentivising them to invest. Sudden and unforeseen changes would negatively affect investors' trust and confidence, reducing their engagement with the instrument.

[142] Marguerite. https://www.marguerite.com/portfolio/

[143] Terna. Main shareholders. https://www.terna.it/en/investors/main-shareholders

[144] SNAM. Shareholders. https://www.snam.it/en/Investor_Relations/Shareholders/

[145] Italgas. Ownership structure. https://www.italgas.it/en/investors/market-title-shareholding/share-ownership/

[146] Terna, Snam and Italgas are listed companies and their equity stakes are also owned by fully private and retail investors, in parallel / complementarity to the stakes currently owned by CDP. These examples from Italy's T&D sector highlight that while NPBIs are important equity investors in the field, private investors can also be interested in having equity stakes in TSOs and DSOs.

Projects operating in the regulated model have fewer difficulties in accessing finance compared to those operating in the merchant model. This view was confirmed by some WG members representing the financing side, as they expressed their preference for investments in regulated assets given that they are characterised by stability and predictability of revenues ensured by the tariff-based remuneration of assets. Concerning this, WG members highlighted the importance of operating in clear and stable regulatory contexts, also expressing a preference for regulatory regimes that are characterised by longer regulatory periods as they give a clearer view on revenues in the long term. On this matter, for instance, WG members noted that the tenor of guarantee schemes should range between 20 to 30 years to match the duration of the debt financing and thus provide long-term certainty to the investor.

Furthermore, the process for ideating, developing and structing a project is long and complex, and requires **TSOs and DSOs to have visibility on the long-term conditions on which the project will be implemented**, so as to adequately plan their business and financial models. Even smaller changes in application requirements, eligibility criteria, or instrument functioning can derail the project preparation.

A third factor in the long-term visibility is the **alignment of schemes with policy objectives**. Financial support schemes should be suitable to and aligned with policy targets that arise from, for instance, the European Green Deal and REPowerEU. Risks for T&D operators due to the energy transition, new grid technologies, energy mix, and flexibility are rising and currently difficult to assess but they still need to be treated within capital remuneration[147]. Schemes could be used to support operators to face these new challenges and support the energy transition.

Long-term stability and visibility can however only be assessed in the long-term. Since the mapping covered ongoing and new instrument, it was not able to capture this aspect. Nonetheless, this feature should be taken into consideration for the development of future new financial support schemes, as pointed out in discussions in the Working Group on T&D.

Easy, periodic, and rapid application process (Accessibility)

A key element of an instrument's effectiveness is the ability of a potential project promoter to apply for it, understood as an **instrument's accessibility**. This was confirmed by multiple discussions with WG members. Regardless of the scope, financing conditions, and type of financing provided, the instrument will not be able to achieve its objectives and contribute to the decarbonisation of the energy sector if potential project promoters are not interested in applying to it, or do not qualify for financing because they submitted an incomplete or wrong application.

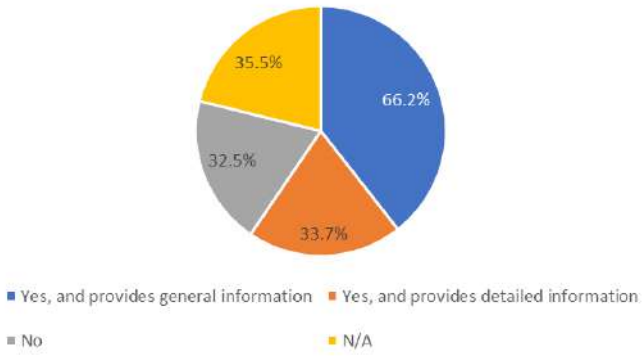
A potential project promoter would apply to get financing from a financial instrument only if the effort required to submit such an application is acceptable in relation to the amount of financing to be received, and the likelihood of success. For each individual project promoter and project there is going to be a "breakeven" point from which the amount and/or type of financing to be received is not worth the effort necessary to comply with the application requirements. Indeed, application processes with too many requirements or instruments with burdensome monitoring and reporting requirements will likely be perceived as less interesting from potential project promoters. This phenomenon is even more relevant for small local/regional operators (e.g., many of the DSOs in the EU), as they can often rely on a smaller pool of personnel, often without dedicated figures to take care of different administrative requirements and commitments compared to larger operators. For this reason, an instrument's effectiveness is also affected by its accessibility to all types of project promoters.

[147] ENTSO-E. European Electricity Transmission Grids and the Energy Transition.

In this context, an instrument's accessibility is assessed against four criteria: the availability of an application manual, the application periodicity, the length of the application in terms of number of pages that needs to be submitted in the application, and the possibility to contact the implementing authority to ask questions and clarifications.

Out of the 280 financial support schemes mapped as available for T&D[148], 166 of them have an application manual available to potential applicants. Most of the instruments with an application manual are either loans (74) or grants (63), followed by equity (41), guarantees (17), blended finance (16), and quasi-equity (7)[149]. Of these 166, 56 (33.7%) had an application manual with detailed information on the application process and requirements, and 110 (66.2%) had an application manual with more general information on the process, but without going into details on the different steps, leaving to the applicants to understand the requirements. Finally, for 54 of them (32.5%) do not have an application manual, and for the remaining ones (59, 35.5%), it was not possible to assess whether an application manual was available or not.

Figure 33: Share of schemes by availability of application manual



An instrument for which an application manual is available is likely to be more effective in achieving its purposes, from an accessibility point of view. While the availability of an application manual is not a guarantee of effectiveness, it does nonetheless contribute to reducing errors in applications and helps make the instrument application process **well-explained and easy to follow,** which are characteristics that WG members have highlighted as important for instruments to be effective. The application manual may also include aspects of investor strategy, which help potential beneficiaries to understand the ambition and investment rationale and thereby establish, whether they are a fit to the investments targeted. As mentioned above, the manual does not affect the effectiveness of the instrument per se, but it rather reduces the possibilities that projects do not receive financing because of administrative or bureaucratic mistakes committed during the application process.

The second factor analysed when it comes to accessibility is the **periodicity of the application window**. The assumption made in this case is that an instrument for which promoters can apply at any given moment in time (i.e., on a rolling basis) is more accessible compared to one that has limited cut-off windows. This is because projects might follow timelines that are not aligned with an application's timeframes. Because of this, project promoters might not be eligible for it or might not decide to apply for it, thus negatively affecting the absorption of that instrument and, consequently, its effectiveness. Out of all the instruments relevant for T&D, for 170 of them it was possible to identify the application period. Out of these 170, for the majority of them, 124, applications are possible anytime during the year. This gives greater flexibility to applicants, as they are less restricted in terms of when they can apply. For 36 instruments there are several application windows per year, but it is not possible to apply anytime, and for 10 instruments there is only one application window per year[150]. This latter figure includes instruments for which only one application period was/is envisaged.

[148] Including the schemes not specific to T&D but for which T&D is eligible.

[149] Double counting possible.

[150] It should be noted that application windows might differ significantly in terms of duration. This difference is not reflected in the mapping and, consequently, in this analysis.

A large majority of the mapped instruments can receive applications throughout the whole year. This should be interpreted as a positive fact in terms of accessibility, as project promoters can prepare their applications without specific concerns and restrictions in terms of timing. Furthermore, as remarked by some WG members during the third batch of meetings, the possibility to apply throughout the whole year makes it easier to plan and implement a company's business and technology roadmap.

The third element analysed in terms of accessibility is the **length of applications**, measured in number of pages of documentation, in paper or digital format, that an applicant has to submit in order to comply with the instrument's requirements. Like for the previous two elements analysed in this section, the length of an application is not a synonym of the effectiveness of an instrument. However, **shorter applications can be generally linked to fewer administrative and bureaucratic requirements**, as less documents, extracts, certificates, and so on are required to be submitted. This would thus make the application process easier and faster for the applicants, reducing the chances that the applicant gives up on applying due to the excessive administrative requirements. Furthermore, a faster preparation of the application could also decrease the time-to-market[151], and thus increase the investment return.

During the mapping exercise, it was possible to gather information on the average length of an application for only 51 instruments available for T&D. This does not come as a surprise, as applications are usually not made available to the public and is thus difficult to obtain information on this. Out of the 51 instruments, the large majority of them (39) usually require applications up to 30 page-long. Following, 12 instruments generally require between 30 and 100 pages of application. For none of the mapped instruments applications longer than 100 pages were identified.

Interestingly, while the results from the mapping seem to indicate that most schemes for T&D are accessible in terms of administrative requirements, **the feedback from WG members differ**. WG members reported that the processes of applying for and securing some forms of public funding instruments can often be excessively burdensome and bureaucratic. For nationally administered EU funding programs such as the RRF, participants reported bureaucratic burdens that are difficult to meet and hinder the effectiveness of the program[152]. Another example was the **Connecting Europe Facility Energy (CEF-E**), which is an important program with targeted support for transmission with cross-border impacts. However, **overall access to EU funding is hindered by complex bureaucracy.** The introduction of the EU Taxonomy may bring an additional layer of complexity in this regard.

The **CEF Alternative Fuels Infrastructure Facility** (AFIF)[153] call was mentioned by some WG members as a best practice when it comes to reducing administrative burdens. While this facility does not directly fund transmission and distribution networks, it represents a very effective EU support scheme to deploy energy technologies. Part of AFIF resources is allocated to projects supported by a financial contribution (no less than 10% of the overall project costs) of implementing partners, thus generating an important leverage effect between EU and national resources. Even before submitting the application for the grant, the implementing partners of the AFIF can liaise with the Commission to address questions and potential project-to-project

[151] The time-to-market is influenced by numerous other factors other than the time necessary to prepare the application.

[152] An example was local content requirements introduced in some MS RRF programs, i.e., the requirement to only use equipment that has been manufactured only in the EU. For some components like batteries, meeting such requirements is extremely difficult or costly.

[153] The objective of the Alternative Fuels Infrastructure Facility (AFIF) call for proposal is to support the deployment of alternative fuel supply infrastructure, contributing to decarbonising transport along the TEN-T network. With a total budget of €1.57 billion, the AFIF funds actions by combining CEF grants with financial support from financial institutions to achieve a higher impact of the investment. It is implemented through a rolling call for proposals launched on 16 September 2021, with five cut-off dates for the submission of proposals until the end of 2023.

specificities ahead of the submission deadline. This helps with reducing bureaucracy, renders the application process less cumbersome, and ultimately increases the chances that a project will correctly meet the criteria and contribute to achieving AFIF objectives.

Finally, the last element considered under the accessibility analysis is the **possibility to contact the implementing entity** to ask questions and clarifications. Ideally, there should be the possibility to interact with the investor before submitting an application. This would serve especially the beneficiaries which could confirm fit to investment strategy before engaging in the potentially effort-heavy application process. This was considered important as different project promoters might face very different situations and have very different questions and conditions, which might not all be clearly addressed in the instrument's website or application manual. For this reason, having the possibility to reach out to the implementing entity to ask for clarifications is important and particularly useful for potential applicants, but also for the investors, which thereby avoid screening of applications which do not match the investments targeted. Information on whether or not it is possible to contact the implementing entity with questions on the instrument was found for 60 instruments at Member State level available for T&D projects. For 58 of these it is possible, and only for 2 of them it is not. However, it should be noted that for the large majority of the mapped schemes it was not possible to clearly determine whether contact channels were established.

It was possible to identify only one instrument having all the "ideal" characteristics for an instrument effectiveness from the accessibility point of view[154], by doing a cross analysis of all the financial support schemes available for T&D. This instrument comes with a detailed application manual, offer the possibility to contact the implementing authority with questions and inquiries, have on average applications below 30 pages, and it is possible to apply to them anytime during the year. It is a loan instrument financed with RRF funds and implemented by HBOR[155], the Croatian Bank for Reconstruction and Development, and is for SMEs. The scheme is not specific to energy, but green investments, including on energy and T&D, are eligible.

All the other instruments mapped are characterised by different combinations of these features (e.g., short applications but only one cut-off per year, etc.). While this does not mean that those instruments are less effective than the one mentioned above, from a beneficiary/applicant perspective they represent a bigger effort to apply to. Ideally, according to consulted WG members, instruments should keep bureaucratic and administrative requirements at a minimum necessary, so as to avoid burdening beneficiaries, particularly start-ups and SMEs. This should also result in faster and easier application processes that smaller companies and households can complete without having to rely on external support and help. One-stop-shops were also indicated as good practices to increase visibility of existing financing opportunities and streamline the application process.

4.3.Examples of effectiveness

Effectiveness in addressing barriers: evidence from the mapping and case studies

The mapping identified a number of financial support schemes with evidence of their effectiveness in addressing barriers, summarized in the table below. As the mapping concentrated on ongoing instruments for which there are no formal evaluations yet, evidence was primarily collected from available news and press releases reporting on instruments' results and

[154] This does not mean that these are the only instruments having these characteristics, but rather that these are the only instruments for which it was possible to map these characteristics.

[155] HBOR. Special SME segments investment under the NRRP. https://www.hbor.hr/en/kreditni_program/special-sme-segments-investment-under-the-national-recovery-and-resilience-plan-nrrp/

impacts achieved so far, as well as feedback from stakeholders consulted in the process of data collection and the views of WG members shared in the context of the Investors Dialogue on Energy.

Grant schemes found to be effective attracted a high number of applications and/or are supporting the execution of T&D investments of national significance. For grant schemes that accept applications from different promoters, the interest shown by target beneficiaries in the scheme (evidenced by the applications submitted to the programme) is an indicator of the scheme's perceived relevance and usefulness for target promoters. A good application outcome was observed in the case of a recent **CEF Energy** call for cross-border energy infrastructure projects, which attracted 24 proposals amounting to c. €3 bn funding request[156], suggesting the relevance of the scheme for improving access to finance for PCIs. **Grants provided to specific TSOs and considered to be effective are expected to enable the execution of important national energy infrastructure projects.** Examples include recent grants to Romania's TSO Transelectrica, Finland's TSO Fingrid or Croatia's TSO HOPS. Transelectrica's recent signing of € 424m grants under the Modernisation Fund will finance several schemes including the construction of c. 480km of new overhead lines in what is considered a project of particular importance for the development of the national energy infrastructure[157]. Similarly, the € 127m of EU funding for the construction of the Aurora Line, a new electricity transmission link between Finland and Sweden, will support what is considered to be the most important investment in Finland's main grid this decade[158]. RRF grants of € 218m to Croatia's HOPS are expected to cover the vast majority of 11 investments under Croatia's NRRP and increase the renewables integration capacity of the country's transmission networks. These examples show the complementary role that grants can play in supporting the development of **strategic infrastructure projects** where TSOs may lack the financial flexibility to undertake the projects purely with equity or debt financing.

Loan instruments from the mapping with evidence of effectively supporting the implementation of T&D investments include recent examples of EIB loans to TSOs/DSOs in EU Member States. Select examples include EIB's € 1.9bn financing to Terna (Italian TSO) for the construction of a 970 km double submarine cable connecting Sicily with Sardinia and the Italian peninsula[159], EIB's recent € 500m loan to Spain's ENDESA to boost the modernisation of its distribution networks[160] and the Bank's recent € 200m loan to Hungary's TSO MVM for the extension and reinforcement of Hungary's electricity transmission network[161]. In all cases, the commitment from EIB is expected to generate high additionality and impact for the projects and borrowers concerned, by contributing to the acceleration of the projects' implementation and by sending a strong signal about the long-term soundness of the project and the creditworthiness of the promoters. In addition, the loans were offered at more **favourable financing conditions** than those available in the market. EIB's loan to MVM, for example, provided a substantial tenor extension while also offering flexible drawdown terms, a long availability period and disbursements in both € and the local currency, thus granting **additional flexibility** to MVM in optimising its use of the facility. Similarly, EIB's loan to ENDESA featured **sustainability-related pricing incentives,** an innovative element linking the financial conditions of the loan to the company's corporate direct emissions reduction target. These examples show the role of instruments that are **well-tailored to utilities' business models and financing needs** can play in supporting the development of large-scale and **price-sensitive infrastructure projects**, where the conditions of underlying

156 CEF Energy: about EUR 3 billion requested for energy infrastructure projects (europa.eu)
157 Romania plans record EU-funded investments in energy infrastructure – EURACTIV.com
158 EUR 127 million of EU grants for the Aurora Line electricity transmission link
159 TYRRHENIAN LINK (eib.org)
160 ENDESA NETWORK MODERNISATION III (eib.org)
161 MVM TRANSMISSION NETWORK UPGRADE (eib.org)

loans can play an important role in improving the financial soundness of the company and the project.

In relation to **equity instruments**, our desk research identified the Marguerite Fund as an example of a publicly supported equity initiative with evidence of targeting barriers across different infrastructure sectors. The discussion with WG members has further confirmed the relevance of this fund for supporting T&D investments in Europe. The Fund targets not only brownfield but also **greenfield investments** in the energy, transport, digital and waste & water sectors; in doing so, it acts as a **catalyst for infrastructure projects that are not yet fully developed** and which are likely to be perceived too risky for private funds. The Fund's activity in T&D includes an investment alongside Italgas, an important Italian DSO, to support the construction of natural gas distribution networks in Sardinia, and an equity participation in AS Conexus Baltic Grid, a unified natural gas transmission and storage operator in Latvia (now divested). Overall, the effectiveness of the Marguerite Fund can be seen through the Fund's successful investment of € 1.5bn since its establishment in 2010, with investments made in 15 different European countries. In terms of investment mobilised, the Marguerite Fund I alone is estimated to have helped unlock over € 10 billion of transformational investments[162]. Furthermore, the Fund has made important contributions in supporting **new markets** and financing models, such as project finance digital infrastructure deals in Europe, and considers that it will be able to support **hydrogen- related** opportunities in the years to come[163].

In relation to **guarantees,** the State guarantee issued by the Government of Cyprus in 2020 to support the financial close for an LNG terminal in Cyprus is a good example of an **individual guarantee** addressing a **funding gap** for a strategic energy infrastructure project. The project is considered a landmark for Cyprus as it will introduce natural gas to the country for the first time, thereby reducing the country's dependence on imported oil. The EIB and EBRD agreed to provide long-term financing to the project (20-year loans of € 150m and € 80m respectively) under the condition that such loans would be backed by a State guarantee covering 100% of the amounts borrowed, thus rendering a guarantee instrument **necessary for the project to access both loans**. Importantly, the guarantee issued had a duration of 20 years, corresponding to the maturity of the underlying loans. The instrument's importance for the realisation of the project was also recognised in the State aid assessment conducted by the European Commission[164], which highlighted that the project would not be carried out in the absence of the state guarantee as the LNG terminal would not be able to obtain a loan from the market.

Effective bond instruments identified through desk research include recent green bond issuances by TSOs AST (Latvia) and TenneT (Germany/Netherlands). In both cases, green bonds were effective in **improving the availability of diverse and medium to long-term capital sources** for T&D investments that facilitate the green energy transition. Examples of eligible projects under TenneT's recent € 3.85 bn green bond issuance, for example, include connections of large-scale offshore wind farms to the onshore electricity grid. The instruments' effectiveness can be seen through investors' **high demand for the bonds** (order book exceeding x2 times nominal bond value), as well as from the **varied thematic profile of interested investors** (AST's issuance has attracted pension funds, asset management funds, insurance companies, banks and IFIs).

[162] https://www.eib.org/en/press/all/2017-341-eib-and-europes-leading-national-promotional-banks-launch-marguerite-ii-a-successor-fund-to-the-2020-european-fund-for-energy-climate-change-and-infrastructure

[163] https://www.infrastructureinvestor.com/its-nearly-business-as-usual-as-marguerite-launches-third-fund/

[164] State aid SA.55388 (2020/N) – State aid to Cyprus LNG Terminal

Table 6: Mapped instruments [165]considered effective in addressing barriers

Instrument name	Instrument type	Instrument description	Country	Barriers addressed	Evidence of Effectiveness
CEF Energy	Grant	Grant scheme to support works and studies for cross-border energy infrastructure projects	EU level	Bridging financing gaps resulting from PCIs' high socioeconomic benefits vs. available remuneration through regulatory framework	Applications for funding as of September 2022 more than three times the size of the call budget
Grants to individual TSOs	Grant	RRF/CEF/Modernisation Fund grants to individual TSOs for the implementation of their grid development plans	Various; examples include Finland, Romania, Croatia	Availability of financing and establishment of sufficiently strong economic incentives for large-scale grid development projects	Size & strategic importance of investments supported by the grants
EIB loans to individual TSOs/DSOs	Loan	Direct loans by EIB to TSOs/DSOs for the financing of their investment programmes	Various; examples include Spain, Hungary, Italy	Availability of long-term finance at attractive interest rates & of dedicated sustainable finance products to T&D sector	High expected additionality and impact of the financing for the borrowers and projects concerned
Marguerite Fund	Equity	Pan-european infrastructure fund focused on energy, transport, waste & water and digital sectors	EU	Availability of equity financing for greenfield energy infrastructure investments	Fully invested status of Marguerite I and II Funds; pipeline for Marguerite III already under development; returns achieved so far in line with initial targets
State guarantee for the financing of the LNG terminal in Cyprus	Guarantee	Sovereign guarantee issued by the Government of Cyprus covering 100% of EIB and EBRD loans for the construction of LNG terminal	Cyprus	Lack of appropriate funding possibilities in the market to fund such a large project in Cyprus over the long-term	EC assessment confirming necessity of the guarantee for project to obtain loan financing
AST October 2021 green bond issuance	Bond	5.25-year green bond to refinance electricity transmission & interconnection projects	Latvia	Availability of medium/long-term financing for T&D projects	Size of the demand expressed by the market, diversification of investor base

[165] Bond instruments included in this table were identified through press releases issued by AST and TenneT and are not included in the mapping. Similarly, the Marguerite Fund (pan-European instrument) was identified through desk research and discussions with WG members and is not included in the mapping

Instrument name	Instrument type	Instrument description	Country	Barriers addressed	Evidence of Effectiveness
TenneT November 2022 green bond issuance	Bond	4.5-20year green bond (X4 tranches) to invest in green power transmission projects	Netherlands/ Germany	Availability of medium/long-term financing for T&D projects	Size of the demand expressed by the market, diversification of investor base

Further insight on the role financial support schemes can play in addressing investment barriers for T&D investments can be gained from two additional case studies identified through desk research and shown below. The first scheme concerns the Europe 2020 Project Bond Initiative, a financial instrument launched by the European Commission and the EIB in pilot phase in 2012 to support large EU infrastructure projects. The second case study looks at Nuventura, a Berlin-based startup offering innovative solutions to the T&D sector which began its funding journey with a Horizon 2020 grant and subsequently managed to raise significant amounts of equity form the market.

Case study 1: The Project Bond Initiative

Case study: The Europe 2020 Project Bond Initiative (PBI)

The Europe 2020 PBI is a financial instrument that was launched by the European Commission and the EIB in pilot phase in 2012 as an innovative response to the needs for investment in large EU infrastructure projects at that time. The aim of the initiative was to help finance priority projects in the EU and to **facilitate greater private sector involvement** in the long-term capital market financing of economically viable projects in the areas of Trans-European Transport networks (TEN-T), Trans-European Energy Networks (TEN-E), ICT and broadband.

Under the pilot phase, the EIB, supported by the EU budget contribution, provided a financing product ("**Project Bond Credit Enhancement**" or "**PBCE**") to project companies that issued **project bonds**. The PBCE could be provided under a funded or unfunded structure – the funded PBCE took the form of a subordinated loan, while unfunded PBCEs took the form of a guarantee/letter of credit. The mechanism foresaw a credit enhancement of the rating of the senior project bonds because of the **decrease in default risk and the improvement in recoveries of senior debt.** The maximum size of credit enhancement was limited to 20% of the project bonds from the outset.

As of July 2015, 7 transactions had been supported with a total PBCE amount of EUR 612 million, which enabled the issuance of over **EUR 3.7 billion in bonds**. The transactions supported included three projects in T&D - one project in Spain to provide a gas storage facility (later discontinued due to seismic activity) and two offshore transmission link projects in the UK. The Greater Gabbard offshore transmission link project was the first infrastructure project in the UK to attract finance from institutional investors using the PBCE. The EIB provided a GBP 45.8 million guarantee, representing 15% of the project bond issued, resulting in a **one-notch upgrade** in the project's rating provided by Moody's at the time.

Overall, the evaluation of the pilot phase concluded that the PBCE instrument contributed to raising the interest of institutional investors in the financing of EU infrastructure and encouraged them to reassess their business models. In addition, the evaluation found that the pilot phase proved to be **additional** to other sources of financing in the market and that it offered **distinctive advantages**, namely the capacity to **mitigate construction risks** inherent in greenfield infrastructure projects and to credit-enhance senior debt in a transparent manner for bond investors.

As a result, the evaluation concluded that the PBCE solution should continue to be deployed by the Commission and the EIB, as it had demonstrated to be able to provide long-term competitive solutions to finance crucial infrastructure in Europe.

The example from the Project Bond Initiative shows how good adaptation of an instrument to the specificities of large-scale infrastructure investments can support an instrument in bridging financing gaps in the sector. As noted by the instrument's pilot phase evaluation, the design features of the PBCE addressed particularly well the needs of bond investors for greenfield infrastructure projects. The protection offered by the instrument for pre-completion cash shortfalls served to mitigate construction risk, one of the main reasons institutional investors did not want to enter the infrastructure market. In addition, the 20% coverage rate offered by the instrument was deemed adequate and well-suited to project-finance transactions, the main type of transactions targeted by this instrument, and which typically already provide for high recovery rates. While it has not been possible to verify the projects supported by the initiative since 2015, PBCE solutions still appear to be offered by EIB for project finance operations[166]. In addition, some characteristics (e.g., maximum 20% coverage of the nominal senior bonds) remain the

[166] https://www.eib.org/en/products/guarantees/credit-enhancement/index.htm

same to date as per the pilot phase, suggesting they are still good design features of the instrument despite the time that has elapsed since its first launch.

The second case study is a good example of the role grants can play in supporting the early stages of development of new grid technologies before they can access commercial investment at market terms. Nuventura's access to Horizon 2020 grants facilitated the completion of a feasibility study, a key exercise for the company to validate the value proposition of its technology, but for which access to private finance is likely to have been limited given the still unclear rewards for private investors at that stage. The grants' positive contribution to the company's growth can be seen from Nuventura's subsequent successful development, where the company has built and tested their new technology and secured commercial equity for their scale-up and expansion to other potential markets.

Case Study 2: Nuventura

Case study: Nuventura – Greening the Grids

Founded in 2017, nuventura is a German startup that develops gas insulated switchgear (GIS) technologies that replace SF6 - the world's strongest greenhouse gas – with dry air in power grid infrastructure.

Much of the world's energy networks are connected by switchgear filled with SF6, a synthetic odourless GHG. When this switchgear ages or is disposed of in landfills the SF6 gas leaks, releasing the equivalent CO_2 emissions from 100 million cars annually. As countries around the world strive to decarbonise power generation, it is therefore important to do the same for T&D power grids upon which the system relies.

Nuventura's funding journey was supported in 2019 with a EUR 50,000 Horizon 2020 grant covering the costs of a **feasibility study**. This allowed the company to undertake **in-depth market research** and to better understand the use cases of its switchgear technology. In addition, the company was better able to assess the improvements that could be implemented during the technology's industrialisation phase which would lead to a reduction in production costs. This exercise was significant as it demonstrated a **feasible pathway** for the technology from the prototype stage to commercialisation.

Nuventura proceeded to successfully close a seed round in 2019, followed by an equity funding round of EUR 2.5 million in December 2020. Further financing was raised from the market in Q1 2021 to advance towards the product's industrialisation and prepare for expansion in other markets – the funding round attracted interest from new funds and well-known angel investors. By March 2021, Nuventura had raised more than EUR 8m and counted with an investor base that included E.ON, one of Europe's largest operators of energy networks, in addition to other venture capital firms and private investors. The company recently completed the first commercial installation of its technology in partnership with E.ON's regional subsidiary E.DIS in Germany. The pilot project will also test Nuventura's IoT solution, through which E.DIS will be able to remotely monitor the installed assets' conditions in real time and 24/7.

Source: European Commission, Private Equity Wire

Effectiveness in mobilising private finance

An important element of an instrument's effectiveness is its multiplier effect, that is the instrument's capacity to attract additional private financing compared to the instrument's initial public budget, and channel funds to the targeted projects. By crowding in and unlocking private

financing, financial instruments aim to increase the overall capital available to achieve EU policy goals more efficiently[167].

Because an instrument's multiplier is usually only calculated as part of evaluations conducted at the end of the instrument's life, **the mapping was not able to provide information on the achieved multiplier** effect or amount of additional investment crowded in of financial instruments for T&D projects. For what concerns the ***target* multiplier** of instruments dedicated to T&D investments, the mapping was able to provide information on the target multiplier of recent or ongoing EIB loans to entities in the sector, summarized in the table below[168]. In relation to equity or guarantee schemes, the mapping did not provide enough information on the target multiplier of schemes dedicated to T&D investments to enable a meaningful comparison with other instrument examples from the literature[169]. Feedback obtained during WG discussions suggests that the **target multiplier of publicly supported equity schemes** in the T&D sector should be in the range of **2x to 4x**, to ensure optimal use of public money and avoid crowding out the private sector.

Table 7: Target multiplier effect of recent EIB loans to European TSOs/DSOs

Project name	Country	First year of activity	Target multiplier
ESTAG NETWORK INVESTMENT AND GREEN LOAN	Austria	2019	1.1x
FLUVIUS ENERGY TRANSITION INFRA	Belgium	2022	1.5x
ENEDIS GREEN ELECTRICITY DISTRIBUTION NETWORK	France	2022	1.1x
NEUCONNECT INTERCONNECTOR	Germany	2022	3.8x
PPC DISTRIBUTION VIII	Greece	2021	0.8x
MVM TRANSMISSION NETWORK UPGRADE	Hungary	2021	0.5x
TYRRHENIAN LINK	Italy	2022	1.0x
TENNET EEMSHAVEN - VIERVERLATEN 380KV	Netherlands	2021	1.1x
PGE ELECTRICITY DISTRIBUTION	Poland	2022	1.0x
ENERGA ELECTRICITY DISTRIBUTION	Poland	2021	5.0x
TAURON ELECTRICITY DISTRIBUTION III	Poland	2021	0.4x
ENDESA NETWORK MODERNISATION III	Spain	2022	1.4x
ELLEVIO DISTRIBUTION NETWORK INVESTMENTS II	Sweden	2022	1.1x

[167] In addition to the multiplier effect, impact indicators (e.g. tons of CO_2 avoided, jobs created) are also important to assess the effectiveness of financial instruments. This section focuses exclusively on the multiplier effect as the mapping did not provide information on the impact generated by ongoing financial schemes. As such, this section should not be interpreted as a complete evaluation of the effectiveness of instruments in the mapping but rather as a presentation of findings related to their crowd-in potential. Crowding in of private funds in turn remains an important feature of financial instruments, as the initial public budget allocated to an instrument is typically not enough to cover all the investment costs and to ensure a timely deployment of the underlying target investment(s).

[168] Information on the target multiplier was also available for other instruments in the mapping with broad eligibilities across the energy value chain (including T&D). This section focuses on instruments explicitly dedicated to T&D to ensure the relevance of findings to the sector.

[169] As referred to in Section 3, the mapping identified only one guarantee instrument targeting exclusively T&D investments, for which there was no information available on the target multiplier. In relation to equity schemes dedicated to T&D, the mapping identified only one bond instrument with partial equity features, which has a target multiplier of 1x.

Target multiplier information on EIB's recent loans to T&D projects can be compared with the multiplier effect achieved by previous EIB loan instruments implemented at EU level[170]. It should be noted that this comparison does not focus on instruments being energy-specific but rather being of the same type, in this case loan instruments.

The average target multiplier of recent EIB T&D loan instruments included in the mapping (1.5x) is slightly lower than the multiplier of EIB's previous Covid-19 programme loan for MBILs (multiplier of 1.9x). This could be due to variations in multiplier calculation methodologies; whereas the mapping measured the target multiplier as the ratio of target *private* finance attracted based on the amount of public financing, recent EIB evaluations measured the multiplier effect as the share of *project investment cost*/approved financing, resulting in likely lower multiplier values in the mapping compared to EIB's recent Covid-19 schemes. EIB's Covid-19 ABS programme loan (multiplier of 6.8x) was a higher-leverage instrument through which capital released from intermediaries' securitised portfolios could be used to generate new lending. In addition, results from the mapping could also be influenced by the Bank's ability to finance up to 75% of project costs in certain energy projects under its recent Energy Lending Policy[171], which would lower the multiplier effect of such operations compared to other non-energy specific EIB loan instruments.

Results from the mapping can also be compared, although less directly, with the leverage effect achieved by previous ERDF/CF loan instruments implemented over the 2014-2020 programming period. As of 31 December 2020, ERDF and CF loan instruments (aggregated across 451 instruments implemented in EU Member States) had achieved a median leverage of 1.3x, slightly lower to the target multiplier of T&D loan instruments in the mapping. In addition to variations coming from multiplier vs. leverage calculation methodologies, this could signal an adequate potential for current active EIB loan schemes to mobilise private capital for T&D projects, particularly when compared to other non-EIB loan instruments in the market.

Summary findings on instrument relevance and effectiveness

- **Evidence from the mapping on the relevance of financial instruments for addressing investment barriers affecting T&D projects indicates that**:
  - **Financial instruments for transmission and distribution investments are primarily relevant for targeting barriers related to the availability of finance and financing conditions** of T&D investments.
  - **Financial instruments are not relevant for addressing regulatory barriers or those related to supply of labour**. A similar situation can be said to apply to the barriers related to **administrative requirements**, which are caused by elements outside the financial market landscape, despite affecting it.
  - **The mapping seems to suggest that there is further need for schemes combining the provision of finance with technical assistance support**. This should support in further tackling barriers related to the execution of complex network investments and in limitations in promoters' planning and preparation capacity.
- **Examples of mapped instruments found to be effective in addressing barriers include grants, long-term and low-interest EIB loans, a state guarantee, a pan-**

[170] An evaluation of the EIB L4SMEs intermediated lending product for the period 2005-2011 highlighted that loan products like L4SMEs generally provide for limited leverage potential and that leverage can be better achieved through higher risk products (such as equity fund investments), or guarantee/risk sharing products (with higher risk and capital consumption). More recent EIB loan instruments implemented as a response to the Covid-19 crisis achieved multipliers (at mid-2021) of 1.89x (EIB Covid 19 programme loan for MBILs) and 6.81x (EIB Covid 19 programme loan for asset backed securities).

[171] Examples include energy projects in Member States eligible to benefit from the Modernisation Fund, such as Poland or Hungary. This could contribute to explain the relatively lower multipliers observed in some of EIB's recent loans to TSOs/DSOs in these countries.

European equity scheme and green bonds[172] in a number of EU Member States. In general, evidence of the schemes' effectiveness could be seen from their **well-tailored features** for supporting T&D investments and from the direct interest **shown by target beneficiaries or investors** in the different schemes. More specifically, and considering the different types of instruments mapped:

- For grant schemes, such as CEF Energy or Modernisation Fund grants, evidence of their effectiveness in improving the availability of finance and the economic incentives for large-scale T&D investments could be seen through a **high number of applications[173]** for such schemes and/or through **strategic projects of national significance** supported by the grants.
- In the case of recent EIB loans to the sector, the high expected **additionality and impact** of the EIB financing was supported by the loans' more **favourable and flexible condition**s compared to market alternatives, such as long availability periods, flexible disbursements and substantially longer tenors which also respond to the **long-term financing needs** of T&D investments.
- In relation to the Marguerite Fund, evidence of its effectiveness in improving the availability of **equity financing for greenfield** infrastructure investments (including T&D) was seen through the fund's successful and diversified results achieved to date, with investments made by the fund covering 15 different European countries across all target sectors and helping to unlock over € 10 billion transformational investments.
- In the case of the State guarantee issued by the Government of Cyprus in 2020 for the financing of an LNG terminal, evidence of its effectiveness in **de-risking this investment** could be seen from the project's success at securing two loans from the EIB and EBRD, where the duration of the guarantee matched the maturity of the loans.
- In the case of green bond issuances by European TSOs, evidence of their effectiveness in amplifying medium/long-term finance for T&D projects was seen through **strong and diverse investor demand for the issued bonds.**

- **The mapping provided information on the target multiplier effect of recent or ongoing EIB loans to European TSOs/DSOs. EIB loan instruments from the mapping show on average a slightly lower target multiplier compared to previous EIB loan instruments** implemented at EU level and a slightly higher target multiplier compared to other (non-EIB) loan instrument examples from the literature. These results could be due to differences in multiplier/leverage calculation methodologies and could also signal an adequate potential for current active EIB loan schemes to mobilise private capital for T&D projects, particularly when compared to other non-EIB loan instruments in the market.

[172] As referred to in Section 4.2, bond instruments and the Marguerite equity fund were identified through separate desk research and through discussions with WG members and are not included in the mapping.
[173] While the number of applications alone is not sufficient to define the effectiveness of a grant, it is nonetheless essential to define its uptake, attractiveness and visibility in the market, which are key elements of effectiveness.

5. Market maturity

This section analyses the level of maturity of transmission- and distribution-specific finance markets across EU Member States. The aim is to assess to what extent each State has a financial setting that is fit to address investment gaps and to deliver the ambitious goals of the EU energy transition agenda. The section is organised as follows:

- Section 5.1 provides an overview of the chosen methodology to assess the level of maturity of transmission- and distribution-specific finance markets
- Section 5.2 shows the considered data and presents the results of the analysis

5.1. Approach to assessing market maturity

As explained in section 2.2., TSOs and DSOs operate in a regulated monopoly market regime where they derive most of their operational revenues from regulated tariffs. In addition, most of TSOs are partly or fully owned by national authorities. Moreover, in some cases, TSOs and DSOs are solely managers of the network, that is still directly owned by public authorities. In France, for instance, whereas the power transmission network is owned by the national TSO RTE, distribution networks are owned by local municipalities.[174] In this context, when it comes to new investments in energy infrastructure, TSOs and DSOs rely significantly on the adjustment of regulated tariffs or on public funding.

Within this specific setting, assessing the level of maturity of energy infrastructure finance markets, i.e., their ability to provide sufficient financing with respect to the identified investment needs (see section 2.2.) can be done by considering the market characteristics presented in the following table.

Market maturity characteristics	**Description** Why we have chosen this characteristic	**Key metric/indicators** How we will measure it
 **Sufficient supply of finance for investments in power & gas networks**	• Historical data on the level of investment in power and gas networks can serve as a reference to assess how much countries need to step up their financing efforts, potentially by channelling new sources of financing, in order to invest in the targeted levels of upgrade and digitalisaiton of T&D grids in the 2021-2030 period.	To evaluate the supply of finance, we will compare the investment gaps provided in section 2 with the following indicators: • Overall investment level for power (respectively gas) transmission networks • Overall investment level for power (respectively gas) distribution networks
 **Overall availability of finance**	• Best (2017)[175] finds that the availability of financial capital contributes to investments in more capital-intensive energy technologies in the energy transition. • When it comes to the expansion and upgrading of power and gas networks, despite the specific setting for the activities of TSOs and DSOs, an overall view of the availability of finance through different channels (banking debt, stock markets, bond issuance,	The overall availability of finance in each Member State is measured through: • Banking debt of corporates • Stock market capitalisation • Green bond market • Public finance

[174] Commission de Régulation de l'Energie, 2023, Présentation des réseaux d'électricité, URL: https://www.cre.fr/Electricite/Reseaux-d-electricite/presentation-des-reseaux-d-electricite#:~:text=En%20France%2C%20RTE%20est%20le,atteint%20100%20000%20kilom%C3%A8tres%20environ.

[175] Best R (2017) Switching towards coal or renewable energy? The effects of financial capital on energy transitions. Energy Econ 63:75–83. https://doi.org/10.1016/j.eneco.2017.01.019

Market maturity characteristics	Description Why we have chosen this characteristic	Key metric/indicators How we will measure it
	public finance) is relevant to refine the analysis.	
 **Low cost of capital - WACC**	• The weighted average cost of capital (WACC)[176] is one of the most important financial variables for low-carbon infrastructure, given their capital-intensive nature and high upfront costs (Dukan et al., 2019)[177]. • The WACC incorporates the level of interest rates and several country risks, such as regulatory, economic, political and legal. Furthermore, WACC can also reflect technological advancements and increased experience in the energy financing sector, signalling a high level of maturity. • For these reasons, low values of WACC signal mature energy finance markets and a low country risk.	To evaluate the cost of capital, the WACC for the closest sectors (Oil &Gas Distribution and the Power sectors) have been calculated for each Member State, mostly relying on Damodaran's website database.[178]
 **Presence of a diverse set of financial instruments, including the use of repayable finance**	• Finance markets that come with a broader and balanced diversity of financing instruments may be considered as more mature, especially when it integrates a significant number of repayable-finance instruments instead of being dominated by grants.	Comprehensive data on the instruments used for investments in T&D is not available. To evaluate the diversity and comprehensiveness of financial instruments available in each country, we will use the following indicators: • Diversity of financing instruments for power and gas networks, measured through a repurposed use of the Herfindahl-Hirschman Index (HHI) • Repayable-finance instruments, as a % of the total number of mapped financing instruments • Grant-instruments, as a % of the total number of mapped financing instruments

[176] The formula to calculate the WACC is presented below:

$$WACC = DD+E*Cd*1-t+ ED+E*Ce$$

- *D* is the market value of a firm's debt
- *E* is the market value of a firm's equity
- *Cd* is the cost of debt
- *t* is the corporate tax rate
- *Ce* is the cost of equity

[177] Dukan, M., Kitzing, L., Brückmann, R., Jimeno, M., Wigand, F., Kielichowska, I., Klessmann, C., & Breitschopf, B. (2019). *Effect of auctions on financing conditions for renewable energy* (Issue May).

[178] Available at: https://pages.stern.nyu.edu/~adamodar/

5.2. Analysis of market maturity

This section provides an assessment of the level of maturity of transmission- and distribution-specific finance markets across EU Member States, based on the four dimensions presented in the previous section.

Overall investment level in gas and power transmission and distributions networks

The following table presents the overall trends in the investment levels for power and gas infrastructure over the previous decade in the EU, distinguishing investment for transmission and that for distribution networks.

Table 8: Total investment in electricity and gas networks for the EU27 countries (as share of total investments in energy)[179]

	Sector / Sub-sector		2010	2014	2018
Total investment (billion €2018)	**Power**	**Transmission**	6.6	8.7 (+15%)	9.5 (+9%)
		Distribution	15.6	16.4 (+5%)	22.5 (+37%)
		Both	1.4	1.4 (+0%)	N/A N/A
		Total	23.6	26.5 (+12%)	32.0 (+21%)
	Gas	**Transmission**	3.8	3.4 (-11%)	4.1 (+21%)
		Distribution	2.7	3.7 (+37%)	5.4 (+46%)
		Both	2.6	1.0 (-62%)	0.4 (-60%)
		Total	9.1	8.1 (-11%)	9.9 (+22%)

These figures are to be put in perspective with the estimations of investment needs provided in section 2.1. Regarding power network infrastructure, for instance, ETIP Wind[180] estimates that overall annual investments need to reach a €80 bn yearly average,[181] which is more than the double of the investments in 2018.

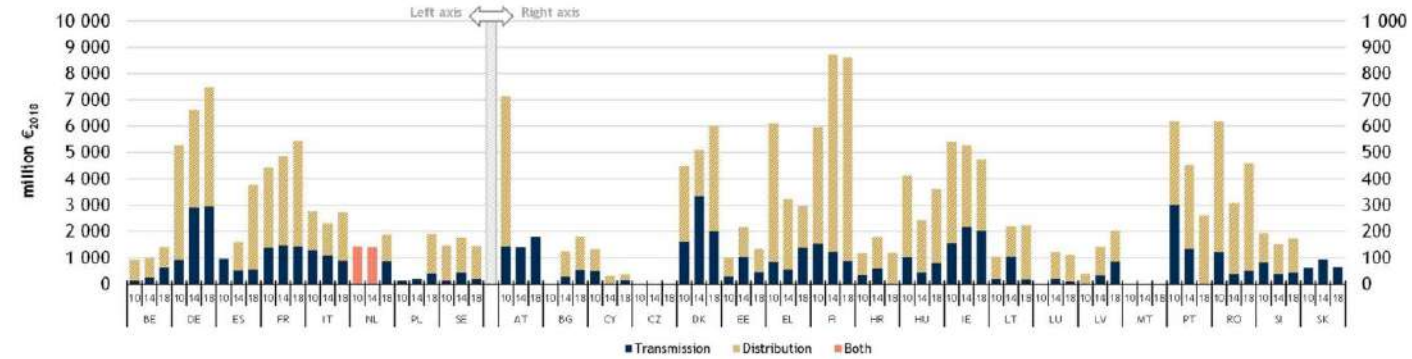
As the following bar charts show, the situation varies from one MS to another, partly due to network-scale differences, and through time, reflecting differences in infrastructure development strategies. It should be noted that the absence of data does not directly indicate a lack of investment.

[179] Trinomics, Final Report – Network Costs, October 2020. https://trinomics.eu/wp-content/uploads/2020/11/Final-Report-Network-Costs.pdf

[180] European Technology and Innovation Platform on Wind Energy.

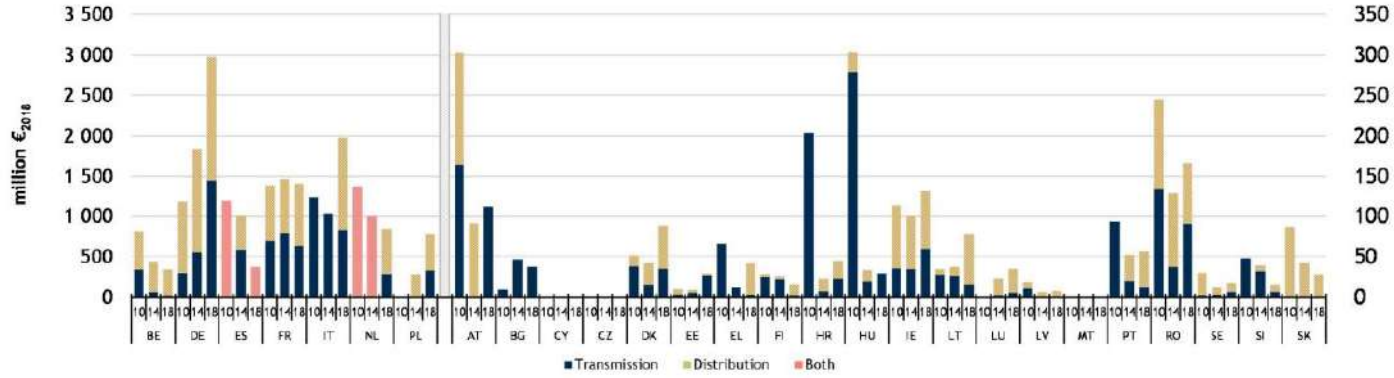
[181] Electricity Grids for a Climate-Neutral Europe, *ETIP Wind*, December 2021.

Figure 34: Investments in the power network in EU 27 MS for transmission and distribution (million €$_{2018}$)[182]



Not shown (confidential): AT (2014, 2018 D), CZ (2010-2018 T&D), HR (2018 T), LV (2010 T), PL (2010-2014 D), SK (2018 D)

Figure 35: Investments in the gas network in EU27 MS for transmission and distribution (million €2018)[183]



Not shown (confidential): AT (2014 T), CZ (2010-2018 T&D), PL (2010, 2014 T), SK (2014, 2018 T)

[182] European Commission (2020). Network Costs: Energy costs, taxes and the impact of government interventions on investments. Final report.
[183] Ibid.

At MS level, investment needs have been estimated in some of the NECPs. Most of these estimates cover the expansion and upgrading of both power and gas networks and can serve as a first proxy of the required investment over the 2020-2030 decade. Furthermore, some MS integrated energy networks as an investment stream under their RRPs. Nonetheless, it should be noted that **the investment needs detailed in current NECPs are likely to be a significant underestimation of the actual needs of the T&D sector**. The unprecedent challenges and goals that REPowerEU and Fit for 55 have brought come with an important mark up in the investment needs for grids, pipelines and power networks. Member States are expected to reflect these new needs in the updated version of their NECPs, which should be approved by mid-2024.

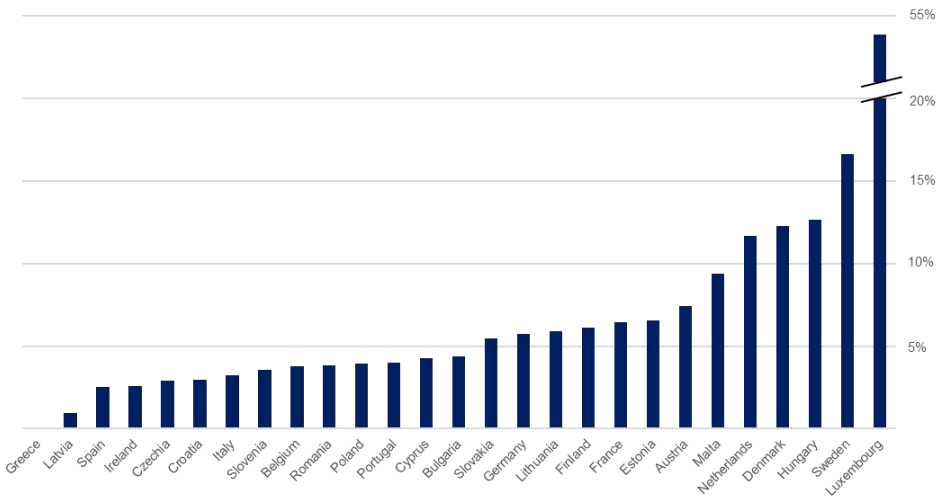
Overall availability of finance

An overall healthy financial system makes it easier to address investment gaps or to diversify financing sources for the expansion and upgrading of power and gas networks.

Bank financing

Bank financing is the main source of external finance for firms in general in the European Union. Data from EIBIS 2021 shows that, on average, bank loans represented 59% of external funding for companies in the EU. An adequately high, but sustainable, stock of debt to non-financial corporates can be an indicator of a well-functioning banking system. In countries where the banking system is in distress or constrained by high cost of financing or high ratios of non-performing loans, financial institutions will limit their lending to corporates and households, therefore increasing pressure on other sources of financing. The indicator “Debt securities and loans of the private non-financial sector as a ratio of GDP, 2021”, reported by the European Central Bank, can be used as an indicator of the amount of credit and debt financing that firms in general can access in each Member State. Although the setting for the activities of TSOs and DSOs is very specific, their access to financing can partly be extrapolated from this indicator, not only because it relates to one specific source of financing, but because in general, a distressed banking sector is likely to impact other sources of financing from which TSOs and DSOs usually benefit.

Figure 36: Debt securities and loans of the private non-financial sector as a ratio of GDP, 2021



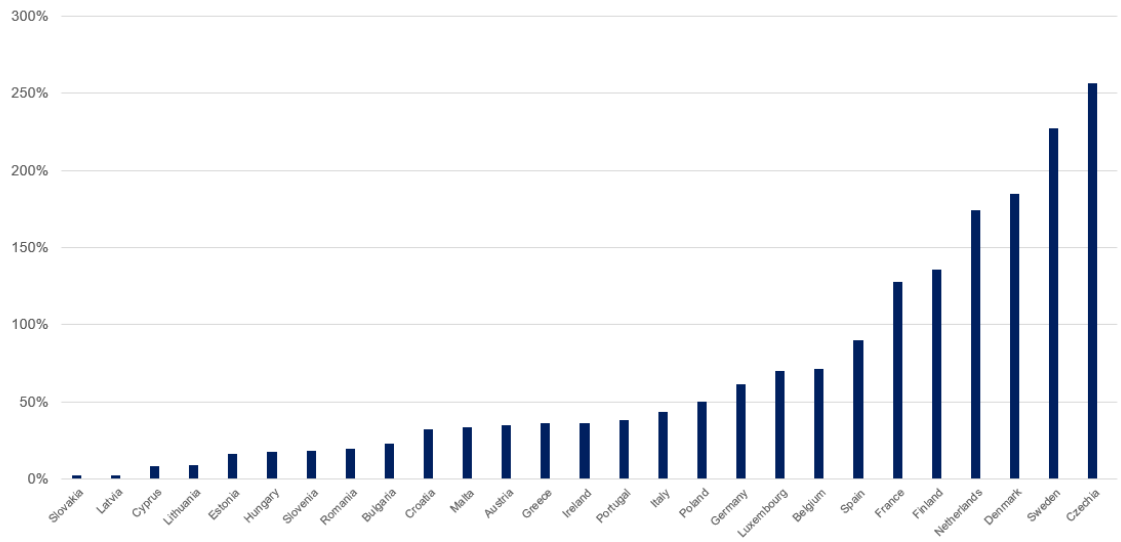
Source: European Central Bank[184]

[184] Available at: Link

Stock market

The stock market capitalisation of each Member State, divided by their GDP, is generally used as a measure of under – or – over-valuation of a country's stock market[185]. For the purpose of our analysis, it can be directly used as an indicator of access to equity capital markets, which is relevant for listed TSOs or TSOs that belong to listed groups, such as VERBUND (Austria), Terna, Snam and Italgas (Italy), Elia Group (Belgium), Redeia (Spain) or Rte (France). In addition, it provides an additional dimension of overall access to finance in each MS, similarly to the previous indicator.

Figure 37: Stock market capitalization as % of GDP (2021)



Source: CEIC[186]

Green bonds

The volume of green bonds issued is another element that can help assessing the access to capital markets for financing the energy transition, including energy transmission and distribution networks.

According to data from the Climate Bonds Initiative[187], energy represents on average 44% of the use of the proceeds of green bonds issued in Europe, between 2014 and the first half of 2022, equivalent to over USD 32 billion. Unfortunately, publicly available data does not enable to look into details and see which share of green bonds is actually used to finance the expansion and upgrading of energy network infrastructure.

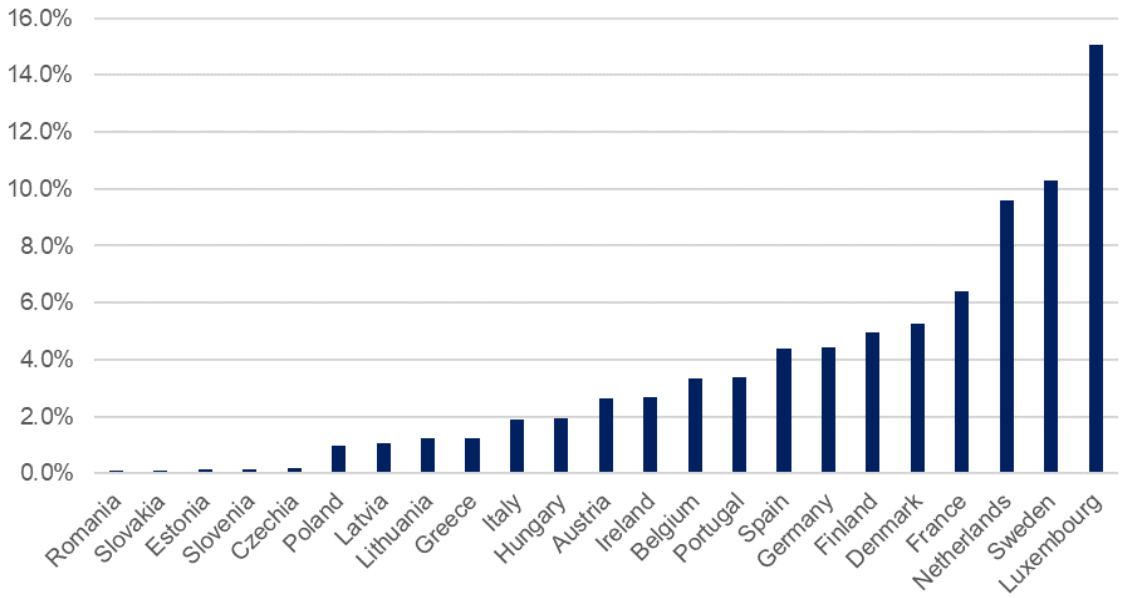
Nevertheless, it is still possible to investigate the specific situations of TSOs.[188] Out of the 31 power TSOs members of ENTSO, 11 have issued green bonds since 2018 (at firm or group level), amounting to a total of 49 bonds or € 25.6 billion. It can be observed that most of the power TSOs that have issued green bonds, directly or through the group they belong to, are listed on stock exchange markets, with the notable exception of TenneT. The Dutch wholly state-owned group has issued no less than 22 green bonds, amounting to € 15 billion. When it

[185] Stock Market Capitalization-to-GDP Ratio: Definition and Formula, available at: Link
[186] Available at: https://www.ceicdata.com/en/indicator/market-capitalization--nominal-gdp
[187] Available at: https://www.climatebonds.net/market/data/#use-of-proceeds-charts
[188] Environmental Finance, Green Bonds issued in the energy sector, retrieved on March the 10th 2023

comes to the 44 gas TSOs members of ENTSOG, 5 have issued green bonds since 2018, amounting to a total of 21 bonds or € 6.9 billion.

The chart below shows the stock of green bonds (in USD millions) in 23 EU countries[189] issued as of the first half of 2022 as share of their GDP[190]. This analysis allows to compare bond issuance to the relative size of a country's economy. Larger Member States have issued more Green bonds than smaller ones, but such larger issued amounts might represent a smaller share of that country's GDP. For instance, Germany and France are the two countries with the highest issued amounts, but rank 7th and 4th, respectively, if ranked by issuances as share of their GDP. Italy has the 6th highest issued total amount, but ranks only 14th if the issued amount is assessed proportionally to Italy's GDP. Luxembourg is the country with the highest Green bond issuance if assessed in relation to its GDP, despite being 11th in terms of absolute amounts.

Figure 38: Ratio between Green Bond market size (USD million, as of H12022) and GDP (USD, 2021)



Source: Climate Bonds Initiative[191], The World Bank[192]

Availability of public finance

As was previously mentioned, TSOs and DSOs rely significantly on the adjustment of regulated tariffs or on public funding when it comes to new investments in energy infrastructure. Interventions of the public sector and public financial institutions can be seen or intended as ways to address market failures and intervene in underserved markets, achieving additionality and providing financial resources where they are scarce and/or unaffordable.

[189] Green Bonds data have been extracted by the Climate Bonds Initiative database, which did not include all EU-27 countries. Available at: https://www.climatebonds.net/market/data/#use-of-proceeds-charts

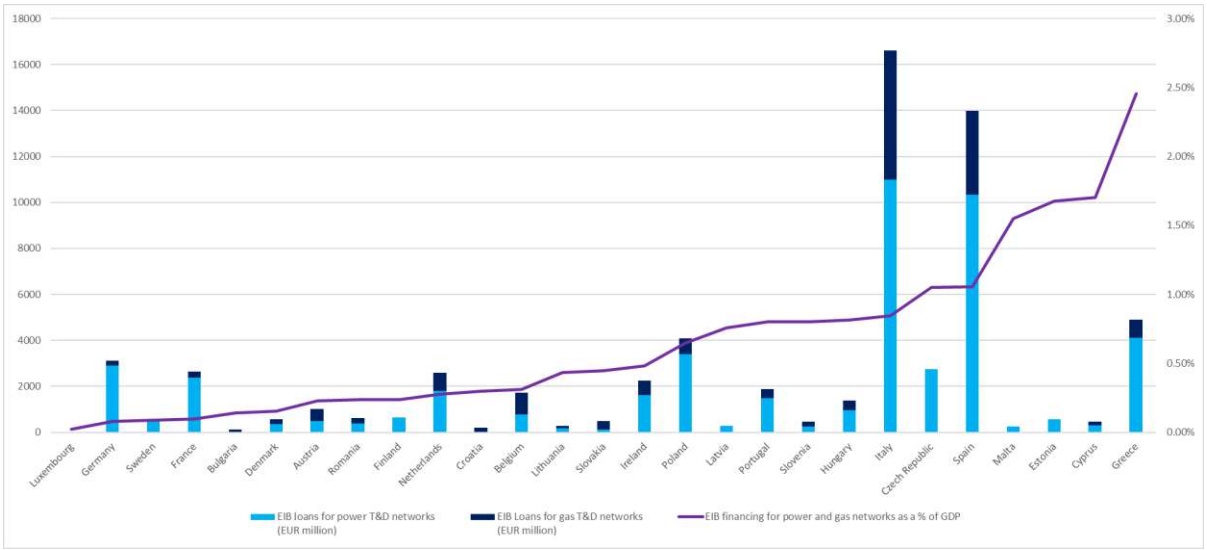
[190] World Bank data on GDP per capita data (USD current, 2021). Available at: Link

[191] Available at: https://www.climatebonds.net/market/data/#use-of-proceeds-charts

[192] Source of GDP per capita data (USD current, 2021): https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?end=2019&locations=EU&start=2019

Publicly available data on financed energy projects by the European Investment Bank (EIB)[193] in the EU over the 2000-2022 period can be investigated to derive the volumes of financing channelled for power and gas network infrastructure.[194] The analysis of this data should be interpreted with the limitation that it does not capture the full spectrum of public financing. Aggregated data for each of the 27 EU Member States, between 2000 and 2022, has been adjusted for the size of the economy of each Member State.

Figure 39: Amount of EIB loans for Power & Gas networks across the EU for the 2000-2022 period (€ M) and as a % of GDP (2021)



Source: EIB[195], The World Bank[196]

Venture Capital

Venture capital (VC) is a type of private equity focusing on funding small, early-stage, innovative emerging firms or start-ups that are deemed to have high growth potential. Innovative firms and start-ups need funding to develop their new technology and **can play a key role in the modernisation and upgrade of energy T&D systems**. At the same time, they have little initial income to report. Therefore, because they can struggle to provide the required levels of collateral, these companies may face difficulties accessing sufficient financing from banks. VC financing fills this financing gap because VC investors are willing to accept more risks than banks on account of the return opportunities or for strategic reasons.

Figure 40 below shows the total amount of recorded VC financing in EU-based companies active in the sectors of energy transportation and energy infrastructure, in the period from beginning of 2012 to end of 2022. As can be noticed, the trend in investments is quite irregular, with 2022 and 2013 being the two years with the highest invested amounts, and 2016 and 2018 the years with the lowest amount.

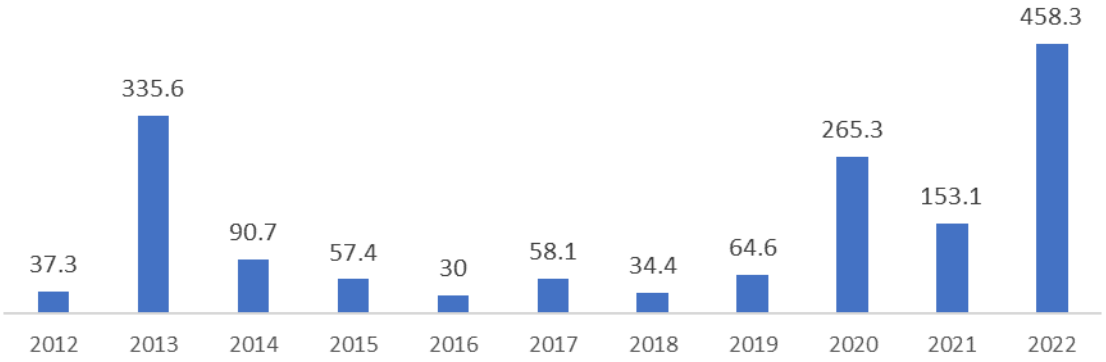
193 Available at: https://www.eib.org/en/projects/all/index.htm?q=&sortColumn=statusDate&sortDir=desc&pageNumber=0&itemPerPage=25&pageable=true&language=EN&defaultLanguage=EN&=&or=true&yearFrom=1959&yearTo=2023&orStatus=true&orRegions=true&orCountries=true&orSectors=true

194 Projects concerning transmission and distribution network for power and gas have been identified among a total of 1384 energy projects through a multiple keyword-search sorting process exploiting project descriptions

195 Ibid

196 Source of GDP per capita data (USD current, 2021): https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?end=2019&locations=EU&start=2019

Figure 40: Total amount of VC financing in EU-based companies active in "energy transportation" and "energy infrastructure"[197] (2012-2022, in USD M)

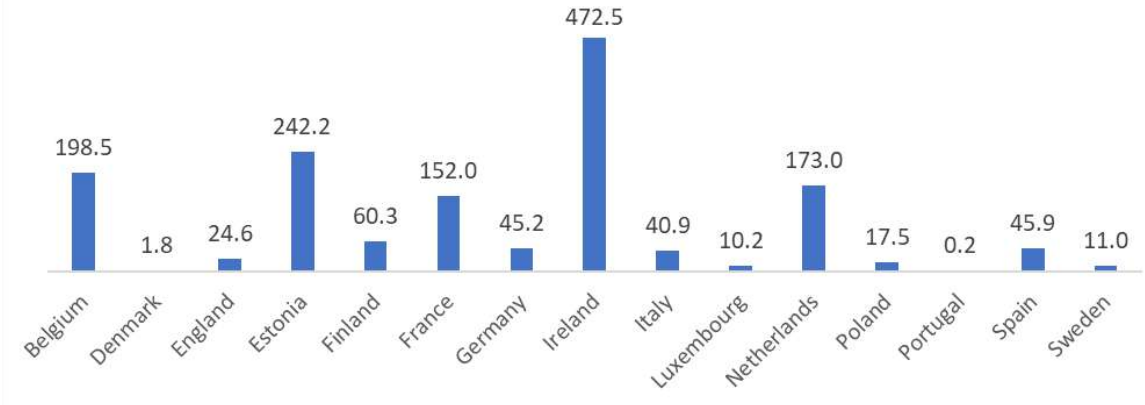


Source: PwC analysis of Pitchbook data

Below, Figure 41 shows the total amount of VC financing received between 2012 and 2022 by companies with headquarters in EU countries and active in energy transmission and energy infrastructure. T&D companies located in 15 EU countries raised VC capital in the period between 2012-2022. As can be noticed, Ireland is by far the country with the largest VC market for T&D, possibly due to the competitive investment environment that Ireland offers. Estonia, Belgium, and the Netherlands follow in terms of overall volume.

Nonetheless, these amounts should not be understood as solely used for T&D projects in the indicated countries, as companies can be active in multiple Member states despite having the headquarters in one. This caveat should be kept in consideration when looking at the data presented in the Figure below. For this reason also, VC financing is not taken into consideration in the broader assessment of market maturity for the scope of this Study, as it is not possible to correctly assess where the financing was used.

Figure 41: Total amount of VC financing in energy transmission and energy infrastructure by EU countries (2012-2022, in USD M)



Source: PwC analysis of Pitchbook data

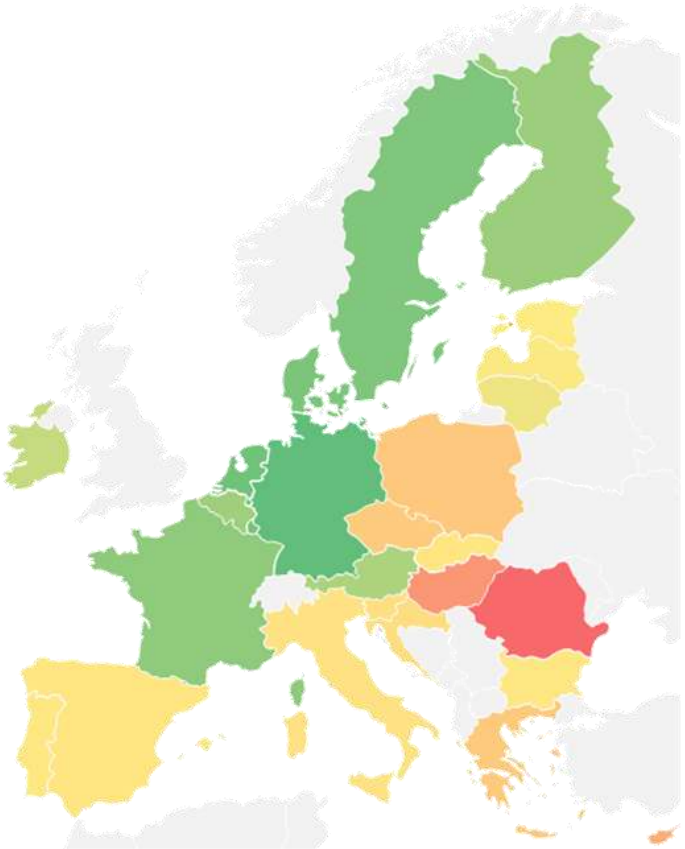
[197] Both categories cover both electricity and gasses transportation and infrastructures.

Cost of financing – Weighted Average Cost of Capital (WACC)

To evaluate the cost of capital, the WACC for the closest sectors (Oil &Gas Distribution and the Power sectors) have been calculated for each Member State, mostly relying on Damodaran's website database.[198]

Although the exact value of the WACC can be discussed as there was no available data for the transmission and distribution sector in particular, the relative ranking of MS for the sections above can still provide some insight. A relatively low WACC can be considered as an indicator of more available financing for projects. Indeed, it reflects abundance of capital at relatively low cost and a low country risk, thanks to an enabling regulatory and economic environment for investments. The Figures below show the WACC for the two considered sectors across EU MS, calculated by PwC for the purposes of this Study based on the latest data available. Details on the calculation and data sources are available in Annex: Methodology for WACC Calculation.

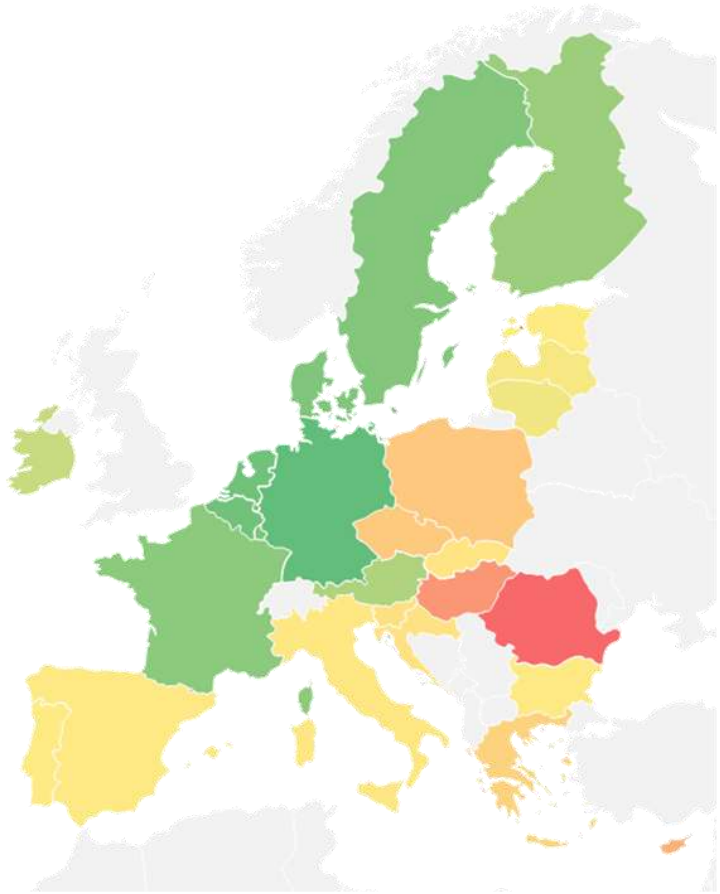
Figure 42: WACC for the Oil & Gas sector by MS



Country	WACC Oil &Gas 2023
Romania	11.98%
Hungary	10.07%
Cyprus	9.10%
Poland	7.99%
Greece	7.95%
Czechia	7.88%
Croatia	7.16%
Slovenia	7.06%
Italy	6.95%
Slovakia	6.81%
Spain	6.78%
Bulgaria	6.74%
Portugal	6.70%
Estonia	6.56%
Latvia	6.52%
Lithuania	6.38%
Malta	5.89%
Ireland	5.89%
Austria	5.60%
Belgium	5.43%
Finland	5.38%
France	5.24%
Sweden	5.06%
Denmark	5.03%
Luxembourg	4.96%
Netherlands	4.88%
Germany	4.70%

[198] Available at: https://pages.stern.nyu.edu/~adamodar/

Figure 43: WACC for the Power Sector across EU MS



Country	WACC Power 2023
Romania	10.93%
Hungary	9.14%
Cyprus	8.07%
Poland	7.18%
Czechia	7.11%
Greece	6.74%
Slovenia	6.22%
Croatia	6.13%
Slovakia	6.01%
Italy	5.95%
Bulgaria	5.88%
Spain	5.87%
Estonia	5.79%
Portugal	5.76%
Latvia	5.68%
Lithuania	5.61%
Ireland	5.16%
Malta	5.07%
Austria	4.88%
Belgium	4.69%
Finland	4.68%
France	4.51%
Sweden	4.42%
Denmark	4.38%
Luxembourg	4.32%
Netherlands	4.23%
Germany	4.05%

Source: Statista, Aswath Damodaran (Stern, New York University)

Diversity of instruments available for transmission and distribution

The mapping of energy financial instruments conducted as part of the present study can be used to identify the instruments available for energy networks. This sheds further light on the diversity of available financial instruments for the expansion and upgrading of energy networks at MS level.

It should be noted that there are few instruments specifically targeting energy transmission and distribution networks. A larger number includes energy networks among other eligible investment projects. For the following indicators, every instrument that potentially support energy network investment projects was considered.

Overall diversity of the available financing instruments

A first proxy of the diversity of mapped financing instruments available for each Member States can be obtained through a repurposed use of the Herfindahl-Hirschman Index (HHI). Usually, this indicator is employed to study market share concentration among active firms. In the present case, it is used to measure the concentration of identified financing instruments among different types of instruments.

For the scope of this Study, the calculation of the HHI is based on the share of each type of instrument over the total number of instruments mapped for a given country. The value of the HHI was obtained by squaring the share of each type of instrument and then summing the resulting numbers. It should be noted that some of the mapped financing schemes combine different kinds of instruments. In the mapping, those were consistently tagged in several

categories of financing instruments. Nevertheless, this does not change the interpretation that can be made for financing instruments: countries with a high HHI offer a limited number of financing instrument types, whereas countries with a lower HHI provide a diversity that can address relevant barriers to investment.

The obtained HHI values for each Member-State are available in the summary table at the end of this section.

Share of grants

In general, we consider mature those markets that have a balanced mix of financial instruments, including a fair share of repayable-finance instruments. On the other hand, markets that rely solely or mainly on grants can be considered less mature.

Recourse to repayable-finance instruments is not preferable to that of grants *per se*. However, the predominance of grants can indicate either missed financing opportunities or tenuous revenue streams associated to projects. The presence of repayable-finance instruments such as loans, equity and bonds can indicate a higher diversity of financing sources and the ability of the market to contribute to financing the expansion and upgrading of energy infrastructure networks. Nevertheless, when the overall diversity of instruments, as measured by the HHI, is low, the low percentage of grant-based instruments does not necessarily imply market maturity. It could also be that necessary state-intervention has not yet been implemented to address specific market failures.

The percentage of repayable-finance instruments and that of grants instruments are available for each MS in the summary table hereunder.

Table 9: HHI index and % of grants instruments by MS

Country	Concentration Index (HHI)	Grant instruments (%)
Austria	3580	27%
Belgium	3600	33%
Bulgaria	2346	29%
Croatia	3765	12%
Cyprus	6250	33%
Czech Republic	2508	48%
Denmark	5102	43%
Estonia	3719	20%
Finland	5000	67%
France	2066	27%
Germany	4941	68%
Greece	2899	27%
Hungary	3689	7%
Ireland	2840	67%
Italy	3361	27%
Latvia	2778	20%
Lithuania	10000	25%
Luxembourg	3580	57%
Malta	3438	57%
Netherlands	2727	25%
Poland	1864	36%
Portugal	N/A	N/A

Country	Concentration Index (HHI)	Grant instruments (%)
Romania	10000	67%
Slovakia	3554	14%
Slovenia	3333	33%
Spain	2245	40%
Sweden	5200	40%

Summary of findings on market maturity

The following table combines all the indicators presented in this section for each Member State. Except for the investment needs, Member States have been ranked from 1 to 27 for each indicator, where 1 is the highest and 27 is the lowest. For the WACC, the average of the two considered sectors was used for the ranking, which is why there is only one corresponding column in the table.

Table 10: Summary table – Market maturity

	Market maturity					Instruments diversity	
MS	**Debt and loans of corporates**	**Stock market capitalisation**	**Green Bond Market**	**Public finance (EIB loans)**	**WACC**	**Concentration Index (HHI)**	**Grant-based instruments share**
Austria	7	16	12	21	9	14	7
Belgium	19	8	10	16	8	15	9
Bulgaria	14	19	N/A	23	16	4	8
Croatia	22	18	N/A	17	21	18	2
Cyprus	15	25	N/A	2	25	23	9
Czechia	23	1	19	6	23	5	13
Denmark	4	3	5	22	4	21	12
Estonia	8	23	21	3	14	17	4
Finland	10	5	6	19	7	20	15
France	9	6	4	24	6	2	7
Germany	12	10	7	26	1	19	16
Greece	27	15	15	1	22	9	7
Hungary	3	22	13	8	26	16	1
Ireland	24	14	11	13	11	8	15
Italy	21	12	14	7	19	11	7
Latvia	26	26	17	11	13	7	5
Lithuania	11	24	16	15	12	24	6
Luxembourg	1	9	1	27	3	14	14
Malta	6	17	N/A	4	10	12	14
Netherlands	5	4	3	18	2	6	6
Poland	17	11	18	12	24	1	10
Portugal	16	13	9	10	15	N/A	N/A
Romania	18	20	23	20	27	25	15
Slovakia	13	27	22	14	18	13	3
Slovenia	20	21	20	9	20	10	9
Spain	25	7	8	5	17	3	11
Sweden	2	2	2	25	5	22	11

Interpretation of the results at Member State level

The complex picture of indicators collected in the summary table does not always present a clear-cut conclusion regarding the state of market maturity for the financing of transmission and distribution network infrastructures. However, it can lay the ground for some general findings at country level.

As can be seen from the following table, it is possible to group the EU Member States based on the degree to which they are likely to be able to undertake the needed investments to upgrade T&D infrastructures, their market maturity given the criteria considered above, and their instrument availability and diversity.

When it comes to the **investment needs**, as mentioned above, the values indicated in the NECPs do not reflect fully the current needs of the T&D sector as the NECPs assessed stem from 2019. Nonetheless, such values and past levels of investments can be used as a proxy to assess the extent to which a country is well positioned to undertake the investment needed in T&D to achieve the REPowerEU's objectives. For each of the MS, the average annual investment for power and gas networks for 2010, 2014 and 2018 (as an average derived from Figure 34 and Figure 35) was identified[199]. This value was compared with the annualised investment needs for T&D based on the 2019 NECPs. If the past investment values are higher than the annualised NECPs needs, then it is possible to assume that the country is better positioned to face the increased need for investments under REPowerEU, compared to those whose past investment levels are on par or below with the 2019 investment needs and would thus need to (significantly) step up their efforts in terms of T&D financing.

Table 11: Grouping of countries by market maturity and likeliness to being able to undertake the investment needed for T&D

	High market maturity	Medium market maturity	Low market maturity
Well positioned to undertake the needed investments	Finland, Sweden, France	Germany, Ireland, Italy, Spain	Slovenia, Poland
Might need additional efforts to undertake the needed investments	-	Austria, Belgium	Croatia, Latvia Slovakia, Greece
Significant additional effort needed to undertake the needed investments	-	-	Bulgaria, Romania
Unassessed needed effort	Denmark, Netherlands, Malta, Luxembourg	Czechia, Estonia, Hungary, Portugal	Cyprus, Lithuania

Note: Countries coloured in green are considered to have a relevant offering of financial instruments, whereas those in red have some room for improvement and those in black were found to not have any T&D instruments.

[199] The choice of an average value is intended to reduce the outlier effect of some data points: in MS with relatively small energy networks, investment may seem exceptionally high for a given year due to the commissioning of major projects.

Countries with high market maturity and:

- **Well positioned to undertake the needed investments –** With an overall high level of finance availability, combined with a high level of past investment, **Sweden** and **Finland** seem to have a rather favourable position for future expansion and upgrading of their energy networks. The available instruments do not present a high degree of diversity or sophistication and consist mostly of loans and grants from the public sector. This can be explained by a rather wide availability of private sources of capital, as well as low WACC values. **France** benefits from a similarly favourable availability of financing. However, the degree of intensification in investment efforts compared to past levels is higher than for Sweden, for instance. In terms of financing instruments, France benefits from a wide variety of available options, including both repayable-finance, grants, sophisticated instruments such as quasi-equity or blended finance, and technical assistance.
- **Unassessed needs –** For **Luxembourg**, **Denmark, Malta** and the **Netherlands** the relative difference between past investment levels and future required investments could not be assessed, and it is, therefore, not possible to assess the extent to which these countries are well positioned to undertake future investments in T&D. It can nevertheless be noted that all of these countries, in particular the Netherlands and Denmark, benefit from an overall favourable availability of finance. The Netherlands, similarly to France, exhibits a wide variety of available financing instruments, whereas Denmark and Malta are in a situation closer to that of Sweden and Finland, with mostly loans and grants from the public section. Luxembourg shows a close situation, with the significant difference of offering some equity-based instruments, in addition to loans and grants, therefore showcasing a diversity of instruments with a rather low degree of sophistication.

Countries with medium market maturity and:

- **Well positioned to undertake future investments –** With an intermediate overall availability of finance, **Germany**, **Ireland**, and **Italy** face high investment needs. As a result, even though their past track record in T&D investments provides a good basis for undertaking future ones, it would be important to reassess the investment gap based on the targets set in the updated NECPs. Whereas Italy already presents a diversified offering of financing instruments, Germany and Ireland could benefit from the development of new and more sophisticated instruments, as loans and grants still represent a substantial share of all instruments available. In **Spain**, the overall market maturity is similar to that of Germany and Italy, with important investments in T&D given the targets set by RePowerEU. Although Spain has somewhat fewer available financial instruments compared to other similar-size countries, the offering does include most types considered, apart from guarantees and technical assistance. Considering the remaining investment efforts ahead, Spain may benefit from the development of new targeted instruments, while strategically leveraging the existing diversity in finance offering.
- **Might need additional effort –** Both **Austria and Belgium** would likely need to make additional efforts to finance investment in a 2030-oriented network. The currently available financial instruments in both countries consist mostly of loans and grants, which highlights a potential need for diversification.
- **Unassessed efforts needed –** For the **Czech Republic, Estonia, Hungary,** and **Portugal** the relative difference between past investment levels and future required investments could not be assessed. These countries benefit from an overall intermediate market maturity. In terms of available financing instruments, Estonia and Hungary present a good variety, whereas Czech Republic relies mostly on grant-based instruments, complemented with some repayable ones. However, no technical

assistance schemes have been identified. No instruments for T&D were identified in Portugal, indicated a clear gap that should be address going forward.

Countries with <u>low market maturity</u> and:

- **Well positioned to undertake future investments – Poland** is characterised by high WACC and small green bond market. However, Slovakia shows a more balanced availability of financial instruments, as well as a lower share of grant-based instruments. Grants retain a high share in the current offering of financial instruments in Poland, so going forward it would be relevant to consider the possibility of enhancing the use of guarantees and equity instruments, as well as technical assistance schemes. **Slovenia** exhibits a relatively diversified offering of instruments, but no technical assistance schemes. Given that the country has a high WACC, going forward it would be important to ensure that the volumes of financing available through the offering of financial instruments is relevant for facilitating investment in the T&D projects needed to reach RePowerEU targets.
- **Might need additional efforts – Croatia, Latvia, Slovakia,** and **Greece** have recorded intermediate levels of past investments. The likely increased needs going forward could be supported by the rather diversified availability of financial instruments in Latvia and Croatia. Slovakia presents a rather diversified offering of instruments, although loans represent the most use type of financing. No technical assistance schemes were mapped in any of these countries. Greece, which has significantly benefitted from EIB investments, being first in terms of EIB loans as a % of the GDP over the last years. Its offering of financial instruments is mostly characterised by loans and grants, although cases of equity, guarantee, blended finance and technical assistance were identified.
- **Significant additional efforts needed – Romania** – the country with the highest WACC in the EU - was found to rely only on grants for T&D investments. This signifies a potential gap in relation to the offering of financial instruments that should be addressed going forward. **Bulgaria** presents a sufficiently varied offering of financial instruments, although the medium-to-high WACC and low public investments might represent a challenge for the country to mobilise sufficient volumes of investments.
- **Unassessed efforts needed –** For **Cyprus** and **Lithuania** the relative difference between past investment levels and future required investments could not be assessed. In any case, both countries face an intermediate-low availability of finance. Only one grant-based instrument was identified in Lithuania, and three loan-based instruments for Cyprus suggesting either the need to further develop the offering of instruments or the saturation of financing by the few existing instruments in these countries with relatively small energy networks.

6. Findings and recommendations

Summary view on effectiveness of instruments

The ambitious targets laid out in the Fit for 55 and REPowerEU targets come with significant investment needs in Transmission and Distribution assets and infrastructure to allow for increasing amount of clean energy to be integrated in Member States' energy systems.

Financial instruments can play a key role in mobilising the necessary public and private investments to expand and upgrade T&D assets in the EU. However, T&D operators act in highly regulated markets, which have a large degree of influence on how revenues and investments are made and managed. For instance, in a regulated model, grants to expand the infrastructure are not taken into account in the operator's RAB, with consequent challenges in terms of OPEX and possible revenues. Similarly, equity investments come with challenges in terms of shareholding, which might be a bottleneck for state-owned TSOs and DSOs.

A mapping of financial instruments at Member State level resulted in data on 280 schemes available for financing T&D in the 27 EU Member States. Among these, loans and grants are the most popular types of instruments across the EU, followed by equity. On aggregate, **a total amount of around €124 billion has been estimated to be available for T&D**, of which around half through loans. However, **the large majority of this financing comes from schemes that are not exclusively for T&D**, but rather can finance, among others, also T&D.

Availability of finance, financing conditions and technology risk were the investment barriers identified as being the most targeted by mapped instruments. On the contrary, supply of labour, regulatory, administrative and planning capacity risk were the least targeted barriers. These findings are in line with the broader theoretical analysis on the relevance and suitability of financial support schemes to address certain types of barriers over others, as well as in line with the findings from the Study on financial instruments for Energy Production[200]. Indeed, as mentioned above, some barriers to investments are caused by factors that, despite affecting financing conditions, are not possible to solve through financial schemes, and require legislative, regulatory, or social measures.

Four features emerged as key for financial instruments to be effective. First, provision of **financing that is tailored and suitable for TSOs and DSOs** needs, taking into consideration the regulatory environment in which they operate. Second, **provision of multiple types of financing**, that is not focusing only on grants and loans, but expand also to equity, guarantees and bonds. Third, **long-term stability and visibility** of both the financial schemes, meaning that they should change conditions over time, and of policies, to allow for long-term planning. Last, **accessibility**, understood as clear application requirements and processes and open dialogue with the implementing entities. These characteristics do not need to always be present in each financial support scheme for it to be effective but are those with the highest assessed impact according to WG members.

In terms of market maturity, the analysis has shown very diverse situation across EU Member States. Countries with a high degree of market maturity are likely to have at their disposal more options for addressing the investment needs for T&D compared to countries with lower market maturity. Nonetheless, in most countries the diversity of offering of instruments

[200] To consult all the available studies, visit the Investors Dialogue on Energy website.

could be improved, but this should come in parallel with a revision of the relevant regulatory frameworks, to ensure that they are fit for purpose for the energy transition.

Recommendations and next steps

Based on the analysis conducted, it was possible to broadly identify the direction in which the next generation of financial support schemes for T&D should go:

- Countries with low availability of diverse financial instruments and less mature financial markets would benefit from targeted efforts to develop and expand the offering of schemes for T&D, so as to cover a broader range of investment needs and progressively move away from grant-supported investments and more towards repayable instruments.
- Technical assistance facilities should also be deployed more broadly, particularly in countries with low market maturity, to foster capacity building and increase effectiveness and impact of instruments. These facilities should mainly target local authorities and smaller DSOs and TSOs, which might sometime lack the human resources and/or knowledge to conduct appropriate financial modelling and prepare applications for financing opportunities.
- In countries with more developed and mature financial markets, the use of guarantees, bonds, and equity should be prioritized to meet the investment needs of the T&D sector while limiting the impact on public finances.
- While the analysis did not cover regulatory environments in the EU27 and does not aim to do so, some countries might benefit from a revision of their regulatory frameworks to facilitate TSOs and DSOs investments. For instance, some WG members proposed the TOTEX model for remuneration mechanisms which, while not suitable for all contexts, could improve the financing environment for T&D operators.
- The mapping covered mainly instruments targeting mature technologies. Further input from stakeholders will be needed to assess whether lower-TRL solutions are in need for new financial instruments, or if EU-level instruments like the Innovation Fund and Horizon Europe are sufficient to address their financing needs. On this point specifically, the need to foster the EU Venture Capital ecosystem emerged several times throughout the WG meetings. VC financing plays a key role in supporting lower-TRL solutions and innovative companies in their path towards commercialisation. The New European Innovation Agenda[201] recognises this need through its flagship initiative Funding Scale-Ups[202], but further improvements are needed.
- The design of new financial instruments should take into account the features found to support effectiveness, such as tailoring to TSOs' and DSOs' needs and characteristics, accessibility, long-term stability, and variety in financing. However, some of these features might not be always needed. Furthermore, these new instruments should be designed to have application costs as low as possible, to do not disincentivise application from smaller promoters that might otherwise struggle to bear high costs. To facilitate access to finance, funding authorities should increase cooperation with implementing partners and in particular with NPBIs. This would not only support the absorption of instruments through a better identification of relevant projects, but also ensure that the funding application is in line with the purpose of the funding instrument.

[201] https://research-and-innovation.ec.europa.eu/strategy/support-policy-making/shaping-eu-research-and-innovation-policy/new-european-innovation-agenda_en

[202] https://research-and-innovation.ec.europa.eu/strategy/support-policy-making/shaping-eu-research-and-innovation-policy/new-european-innovation-agenda/new-european-innovation-agenda-roadmap/flagship-1-funding-deep-tech-scale-ups_en

- Overall, gas infrastructure was identified by some WG members as of at risk of stranded asset challenges, and investments in it should be mostly focused on modernisation and repurposing (e.g., for hydrogen), limiting investments in expansion and new assets only to proven needs. On the contrary, investments in electricity grids are needed on all aspects: expansion and modernisation of existing grids, but also construction of new ones.
- A guiding principle when developing new financial support schemes is to pay attention to the complementarities and coordination with other initiatives (e.g., CEF Energy, REPowerEU and RRF investments in hydrogen), and to facilitate the combination of different instruments and schemes. This is to avoid redundancies and overlapping, but also to streamline the provision of financing and of support. Indeed, consulted stakeholders often pointed out that too many instruments fail to be visible, and are thus underutilised and less effective. In this context, one-stop-shop at national and/or EU level could be set up to provide T&D operators with better visibility on the available opportunities. Blending facilities should be leveraged further, to combine different sources of public and private funding, and better address TSOs' and DSOs' investment needs through multiple types of financing (e.g., grant component for certain types of costs, guaranteed loan for others, plus technical assistance).

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8. Annexes

Annex 1: Methodology for WACC Calculation

We have calculated the Weighted Average Cost of Capital (WACC) for the Oil &Gas Distribution and Power sectors in Europe, using the following formula:

$$WACC = \frac{D}{D+E} * CoD * (1-t) + (\frac{E}{D+E} * CoE)$$

Where:

- *D* is the market value of a firm's debt
- *E* is the market value of a firm's equity
- *t* is the corporate tax rate
- *CoD* is the cost of debt after tax, calculated as follows: $CoD = (risk\ free\ rate + sector\ specific\ spread) * (1-t)$

We have applied a +2% assumption for lenders' margins to risk free rate and the sector specific spread, based on the literature on energy finance[203]. We have selected the country specific risk-free rate to reflect country risks[204].

- *CoE* is the cost of equity, calculated as follows: $CoE = risk\ free + \beta * ERP$, where ERP is the equity risk premium of every country and β is a measure of the volatility — or systematic risk — of a security or portfolio (or a specific sector/transaction) compared to the market as a whole. ERP is country-specific and β is specific to the renewable energy sector. Both data are extracted from Aswath Damodaran (Stern, New York University)[205].

One note on $\frac{D}{D+E}$ and $\frac{E}{D+E}$. They are sector-specific, reflecting the levels of debt and equity normally used for renewable energy projects. However, in absence of country-specific data, we have assumed that these variables are the same across the whole EU. This is of course an important caveat, as differences in $\frac{D}{D+E}$ and $\frac{E}{D+E}$ across countries might exist and they would significantly affect the WACC.

The tables below shows the calculation of the WACC for each sector and for each country (in dark blue are the columns for which the values change from the power sector to the gas & oil sector).

[203] Source: IRENA, RENEWABLE POWER GENERATION COSTS IN 2021, available at: https://www.irena.org/publications/2022/Jul/Renewable-Power-Generation-Costs-in-2021#:~:text=The%20global%20weighted%20average%20levelised,%25%20to%20USD%200.075%2FkWh.
[204] Source: Statista, available at: https://www.statista.com/statistics/885915/average-risk-free-rate-europe/
[205] Available at: https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datacurrent.html

Country	ERP - Total Equity Risk Premium	Country Risk Premium	Beta - Power	Risk free (Nov-2022)	CoE - Cost of Equity	Tax rate	E/(D+E)	D/(D+E)	CoD - After Tax Cost of Debt	WACC Power 2023
Austria	6.57%	0.56%	0.82	1.80%	7.19%	25%	54.38%	45.62%	2.85%	4.88%
Belgium	6.85%	0.84%	0.82	1.40%	7.02%	25%	54.38%	45.62%	2.55%	4.69%
Bulgaria	8.24%	2.23%	0.82	1.60%	8.36%	10%	54.38%	45.62%	3.24%	5.88%
Croatia	9.51%	3.50%	0.82	1.50%	9.30%	18%	54.38%	45.62%	2.87%	6.13%
Cyprus	9.51%	3.50%	0.82	3.50%	11.30%	13%	54.38%	45.62%	4.81%	8.07%
Czechia	6.85%	0.84%	0.82	4.10%	9.72%	19%	54.38%	45.62%	4.94%	7.11%
Denmark	6.01%	0.00%	0.82	1.40%	6.33%	22%	54.38%	45.62%	2.65%	4.38%
Estonia	7.00%	0.99%	0.82	2.50%	8.24%	20%	54.38%	45.62%	3.60%	5.79%
Finland	6.57%	0.56%	0.82	1.40%	6.79%	20%	54.38%	45.62%	2.72%	4.68%
France	6.70%	0.69%	0.82	1.30%	6.79%	27%	54.38%	45.62%	2.43%	4.51%
Germany	6.01%	0.00%	0.82	1.20%	6.13%	30%	54.38%	45.62%	2.24%	4.05%
Greece	11.04%	5.03%	0.82	1.60%	10.65%	24%	54.38%	45.62%	2.74%	6.74%
Hungary	8.67%	2.66%	0.82	4.90%	12.01%	9%	54.38%	45.62%	6.28%	9.14%
Ireland	7.00%	0.99%	0.82	1.50%	7.24%	13%	54.38%	45.62%	3.06%	5.16%
Italy	9.08%	3.07%	0.82	1.70%	9.15%	24%	54.38%	45.62%	2.81%	5.95%
Latvia	7.69%	1.68%	0.82	2.00%	8.30%	20%	54.38%	45.62%	3.20%	5.68%
Lithuania	7.19%	1.18%	0.82	2.00%	7.90%	15%	54.38%	45.62%	3.40%	5.61%
Luxembourg	6.01%	0.00%	0.82	1.40%	6.33%	25%	54.38%	45.62%	2.55%	4.32%
Malta	7.19%	1.18%	0.82	2.00%	7.90%	35%	54.38%	45.62%	2.60%	5.07%
Netherlands	6.01%	0.00%	0.82	1.30%	6.23%	25%	54.38%	45.62%	2.48%	4.23%
Poland	7.19%	1.18%	0.82	4.00%	9.90%	19%	54.38%	45.62%	4.86%	7.18%
Portugal	8.67%	2.66%	0.82	1.60%	8.71%	21%	54.38%	45.62%	2.84%	5.76%
Romania	9.08%	3.07%	0.82	7.20%	14.65%	16%	54.38%	45.62%	7.73%	10.93%
Slovakia	7.19%	1.18%	0.82	2.70%	8.60%	21%	54.38%	45.62%	3.71%	6.01%
Slovenia	7.69%	1.68%	0.82	2.60%	8.90%	19%	54.38%	45.62%	3.73%	6.22%

Spain	8.24%	2.23%	0.82	2.10%	8.86%	25%	54.38%	45.62%	3.08%	5.87%
Sweden	6.01%	0.00%	0.82	1.40%	6.33%	21%	54.38%	45.62%	2.70%	4.42%

Country	ERP - Total Equity Risk Premium	Country Risk Premium	Beta - Oil &Gas Distribution	Risk free (Nov-2022)	CoE - Cost of Equity	Tax rate	E/(D+E)	D/(D+E)	CoD - After Tax Cost of Debt	WACC Oil&Gas 2023
Austria	6.57%	0.56%	0.94	1.80%	8.00%	25%	59.07%	40.93%	2.85%	5.60%
Belgium	6.85%	0.84%	0.94	1.40%	7.87%	25%	59.07%	40.93%	2.55%	5.43%
Bulgaria	8.24%	2.23%	0.94	1.60%	9.39%	10%	59.07%	40.93%	3.24%	6.74%
Croatia	9.51%	3.50%	0.94	1.50%	10.48%	18%	59.07%	40.93%	2.87%	7.16%
Cyprus	9.51%	3.50%	0.94	3.50%	12.48%	13%	59.07%	40.93%	4.81%	9.10%
Czechia	6.85%	0.84%	0.94	4.10%	10.57%	19%	59.07%	40.93%	4.94%	7.88%
Denmark	6.01%	0.00%	0.94	1.40%	7.08%	22%	59.07%	40.93%	2.65%	5.03%
Estonia	7.00%	0.99%	0.94	2.50%	9.11%	20%	59.07%	40.93%	3.60%	6.56%
Finland	6.57%	0.56%	0.94	1.40%	7.60%	20%	59.07%	40.93%	2.72%	5.38%
France	6.70%	0.69%	0.94	1.30%	7.63%	27%	59.07%	40.93%	2.43%	5.24%
Germany	6.01%	0.00%	0.94	1.20%	6.88%	30%	59.07%	40.93%	2.24%	4.70%
Greece	11.04%	5.03%	0.94	1.60%	12.03%	24%	59.07%	40.93%	2.74%	7.95%
Hungary	8.67%	2.66%	0.94	4.90%	13.09%	9%	59.07%	40.93%	6.28%	10.07%
Ireland	7.00%	0.99%	0.94	1.50%	8.11%	13%	59.07%	40.93%	3.06%	5.89%
Italy	9.08%	3.07%	0.94	1.70%	10.28%	24%	59.07%	40.93%	2.81%	6.95%
Latvia	7.69%	1.68%	0.94	2.00%	9.26%	20%	59.07%	40.93%	3.20%	6.52%
Lithuania	7.19%	1.18%	0.94	2.00%	8.79%	15%	59.07%	40.93%	3.40%	6.38%
Luxembourg	6.01%	0.00%	0.94	1.40%	7.08%	25%	59.07%	40.93%	2.55%	4.96%
Malta	7.19%	1.18%	0.94	2.00%	8.79%	35%	59.07%	40.93%	2.60%	5.89%
Netherlands	6.01%	0.00%	0.94	1.30%	6.98%	25%	59.07%	40.93%	2.48%	4.88%
Poland	7.19%	1.18%	0.94	4.00%	10.79%	19%	59.07%	40.93%	4.86%	7.99%
Portugal	8.67%	2.66%	0.94	1.60%	9.79%	21%	59.07%	40.93%	2.84%	6.70%

Romania	9.08%	3.07%	0.94	7.20%	15.78%	16%	59.07%	40.93%	7.73%	11.98%
Slovakia	7.19%	1.18%	0.94	2.70%	9.49%	21%	59.07%	40.93%	3.71%	6.81%
Slovenia	7.69%	1.68%	0.94	2.60%	9.86%	19%	59.07%	40.93%	3.73%	7.06%
Spain	8.24%	2.23%	0.94	2.10%	9.89%	25%	59.07%	40.93%	3.08%	6.78%
Sweden	6.01%	0.00%	0.94	1.40%	7.08%	21%	59.07%	40.93%	2.70%	5.06%

Summary of the WACC values per country, respective ranking, and

Countries	WACC Oil&Gas	Ranking WACC Oil&Gas	WACC Power	Ranking WACC Power	avg WACC	Ranking avg WACC
Austria	5.60%	9	4.88%	9	**5.24%**	**9**
Belgium	5.43%	8	4.69%	8	**5.06%**	**8**
Bulgaria	6.74%	16	5.88%	17	**6.31%**	**16**
Croatia	7.16%	21	6.13%	20	**6.64%**	**21**
Cyprus	9.10%	25	8.07%	25	**8.58%**	**25**
Czechia	7.88%	22	7.11%	23	**7.49%**	**23**
Denmark	5.03%	4	4.38%	4	**4.71%**	**4**
Estonia	6.56%	14	5.79%	15	**6.18%**	**14**
Finland	5.38%	7	4.68%	7	**5.03%**	**7**
France	5.24%	6	4.51%	6	**4.87%**	**6**
Germany	4.70%	1	4.05%	1	**4.38%**	**1**
Greece	7.95%	23	6.74%	22	**7.35%**	**22**
Hungary	10.07%	26	9.14%	26	**9.60%**	**26**
Ireland	5.89%	10	5.16%	11	**5.52%**	**11**
Italy	6.95%	19	5.95%	18	**6.45%**	**19**
Latvia	6.52%	13	5.68%	13	**6.10%**	**13**
Lithuania	6.38%	12	5.61%	12	**6.00%**	**12**
Luxembourg	4.96%	3	4.32%	3	**4.64%**	**3**
Malta	5.89%	11	5.07%	10	**5.48%**	**10**

Netherlands	4.88%	2	4.23%	2	**4.56%**	**2**
Poland	7.99%	24	7.18%	24	**7.58%**	**24**
Portugal	6.70%	15	5.76%	14	**6.23%**	**15**
Romania	11.98%	27	10.93%	27	**11.45%**	**27**
Slovakia	6.81%	18	6.01%	19	**6.41%**	**18**
Slovenia	7.06%	20	6.22%	21	**6.64%**	**20**
Spain	6.78%	17	5.87%	16	**6.33%**	**17**
Sweden	5.06%	5	4.42%	5	**4.74%**	**5**

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