DSOs Fit for 55

Challenges, practices and lessons learnt on connecting renewables to the grid

DSO ENTITY
DSOs FOR EUROPE

Acknowledgements

DSO Entity would like to express its thanks to the work of the Editorial team whose commitment and expertise were instrumental in making this paper possible.

- Susete Albuquerque (E-REDES, PT)
- Héctor Cuenca García (Iberdrola, ES)
- Egle Drungiene (ESO, LT)
- Samira Rotteveel (Alliander, NL)
- Richard Vidlička (CEZ Group, CZ)

DSO Entity is grateful to the other contributors for taking an active part in the editing of the paper by sharing practices from their respective countries.

- Fabrizio Callari (E-Distribuzione / Enel Group, IT)
- Luc Decoster (Fluvius, BE)
- Henrik Fiil-Nielsen (Netselskabet N1, DK)
- Tony Hearne (ESB Networks, IE)
- Patrick Leithner and Ewald Traxler (NetzOÖ, AT)
- Rodolfo Martinez Campillo (Iberdrola, ES)
- Han Slootweg (Enexis, NL)

We also share our appreciations towards the Country Expert Group's members for their support in the development of the paper by participating in DSO Entity's internal survey on the deployment of solar PV and grid-related aspects in the EU-27.

This paper was designed to share practices from European DSOs to address the challenges posed by connecting the surge of new renewable generation capacities into the grids. Experts from DSO Entity's members contributed to the paper by providing examples of initiatives implemented in their country.

For any complementary information or requests regarding the practices displayed in this paper, please get in touch with:

Elisa Schenner *Teamlead Strategy, Legal and Regulatory Affairs, DSO Entity*
Email - elisa.schenner@eudsoentity.eu

Claire Vandewalle *Advisor, Strategy, Legal and Regulatory Affairs, DSO Entity*
Email - claire.vandewalle@eudsoentity.eu

List of abbreviations

ACER	European Union Agency for the Cooperation of Energy Regulators
AI	Artificial Intelligence
AFIR	Alternative Fuels Infrastructure Regulation
CEER	Council of European Energy Regulators
DC	Direct Current
DCC Regulation	Network Code on Demand Connection
DER	Decentralised Energy Resources
DNO	Distribution Network Operator
DSO	Distribution System Operator
EC	European Commission
EED	Energy Efficiency Directive
EPBD	Energy Performance of Buildings Directive
EU	European Union
EV	Electric vehicle
FF55	Fit for 55 package
FiT	Feed-in Tariff
GFC	Grid Forming Capability
GHG	Greenhouse Gas
HVDC Regulation	Network Code on Requirements for High Voltage Direct Current Systems
ICT	Information and Communications Technology
NC	Network Code
NCDR	Network Code on Demand Response
PV	Photovoltaic
RED	Renewable Energy Directive
RfG Regulation	Network code on Requirements for Generators
RES	Renewable Energy Source
STEM	Science, Technology, Engineering and Mathematics
SO	System Operator
TEN-T	Trans-European Transport Network
TSO	Transmission Systems Operator

Contents

Executive summary

DECENTRALISATION AS A MAIN FEATURE OF THE ENERGY TRANSITION PUTS DSOS AND CUSTOMERS CENTRE STAGE

This paper shows the role and relevance of DSOs in achieving the European climate and energy objectives. Recent legislative actions in the form of the Fit for 55 package and REPowerEU drastically increased the ambitions and accelerated the process to decarbonise Europe. Time pressure for the delivery is high, especially on the distribution grid, which is responsible for connecting most of the new renewable energy resources, facilitating the electrification of transport (EVs) and heating/cooling (heat pumps), and thereby empowering customers. However, physically enforcing and digitally smartening the power infrastructure cannot be delivered in the blink of an eye. **DSOs remain heavy infrastructure actors and regulated entities that are dependent on the right framework conditions to deliver**. The current situation of increased uncertainties such as disrupted supply chains, staffing shortages and long permitting procedures, additionally aggravates the conditions.

PROACTIVE DSO ENGAGEMENT ALONE CANNOT MEET ALL CHALLENGES

This paper outlines seven - non-exhaustive - challenges DSOs are currently facing when facilitating the energy transition by connecting decentralised energy resources, especially solar PV. The description of the challenges shows that DSOs are often confronted with obstacles on different levels and ill-fitting framework conditions. The paper also illustrates how DSOs attempt to overcome some of the obstacles by launching proactive initiatives and/or fostering close cooperations with relevant actors to make it work. **Nevertheless, some challenges remain and cannot be solved by proactive DSO action alone. More fundamental changes in the current framework are necessary to empower DSOs and ultimately customers.** Only then, can DSOs remain enablers of this energy transition and not develop into bottlenecks. Without upgraded, smartened and well-equipped power grids this historic transition towards a renewable energy system will not materialize.

LESSONS LEARNT FROM SHARED PRACTICES

In the paper seven core challenges are described and practices presented to overcome the following challenges: high demand in short time, capacity constraints, investment and financing needs, permitting, regulatory framework, network tariff regime and staff and skills shortage. With this paper DSO Entity works toward fulfilling its mandate of " identifying best practices " on several aspects of the energy system as provided in Art. 55(2c) of the Electricity Market Regulation 2019/943/EU. Some general conclusions can be drawn from the displayed practices, but it should be kept in mind that **with more than 2,500 DSOs in the whole of Europe differing in sizes and capabilities, no one-size-fits-all solution can be proposed**.

In brief, the following lessons can be learnt from the practices displayed.

A transformed energy system requires an adapted - forward looking - regulatory (investment) framework to thrive: Since the transition of the energy system primarily takes place in the distribution grid, unprecedented investments within a short timeframe are required. DSOs as regulated entities are dependent on suitable regulatory frameworks that apply a more forward-looking investment approach. Furthermore, in situations of increasing uncertainties, adaptable regulatory frameworks that support DSOs in coping with more unstable conditions are key. These are conclusions drawn from several of the practices that show the positive effects of a proactive investment climate, the introduction of capacity tariffs for instance as a form of tariff network reform or developments towards flexible connection agreements.

Transparency between DSOs and RES developers/ investors leads to better results: Some of the displayed practices showed the benefits of more exchange and transparency between developers/investors and DSOs. While it is important that renewable developers involve DSOs early in their projects, DSOs can also provide support with information about the available capacity in their grid. Faster grid connection agreements and less additional investment in extra capacity are the obvious benefits. Already now, most DSOs offer either capacity maps or display the numbers of available capacity at transformer level or have clear commitments to react within a short time to specific requests.

Early involvement and cooperation with DSOs are key for a smooth (connection) process: Practices such as the bundling of permitting in the Netherlands show how several obstacles can be overcome by, for instance, synchronizing permitting procedures for assets like wind farms and the grid-infrastructure. The early and close involvement of DSOs and TSOs in the spatial planning on regional/provincial level can lead to faster and better results. A precondition is the acknowledgement of the key role of DSOs in the whole process of connecting RES.

Incentives for a grid-supportive behaviour of customers and investors can accelerate a cost-efficient and faster deployment of RES: Practices such as the geo-dependent standard connection fee in Denmark and/ or the capacity tariff in Belgium/Flanders show how capacity constraints can be better managed through innovative concepts, closer cooperation and more transparency. Again here, positive adaptations in the regulatory environment of DSOs are key to guarantee an optimal outcome.

The benefits of smartening the grid are displayed in practice, evoking further innovations: Not only the physical expansion of the grid but also its digitalisation and smartening are key. Investments that go into the smartening of the grid can lead to innovative solutions that help meet several challenges. This could be seen in two of the practices in which smart metering functionalities were used in an innovative way that enabled the DSO to use the grid to its full potential, thereby, connecting more renewable users in less time and with fewer staff. Again here, a close link to the right regulatory framework is seen.

Managing external factors, such staffing shortages, must be a collective effort with sufficient support from the national and EU-level: The practices displayed showed that a proactive approach of DSOs to manage the drastic staff shortages is always organised in close cooperation with partners, public bodies and governmental organisations. Close cooperations with universities and schools show the need for a holistic cooperation between all actors, including the educational system. Initiatives at the EU level can provide additional support and should include DSOs as an important net-zero industry sector.

It can be concluded that DSOs try their best to stay on track to be "*Fit for 55*" and remain a promotor of this energy transition. However, as regulated entities, they are dependent on the right framework conditions and adequate support to be able to live up to their role as key partner of renewables, facilitator of customers' needs and an enabler of the energy transition.

Introduction

There is no green future for Europe without an upgraded power grid

" **It is time to shift our attention from targets and rules to what is needed to make things happen. This means placing the issue of grids at the heart of the debate** " stated Energy Commissioner Kadri Simson[1] addressing the key-role of grids in the energy transition. Without a power network fit for purpose and ready to integrate the surge of renewable energies, the EU will neither achieve its energy climate targets by 2030 nor reach its REPowerEU goals. Distribution grids are the technical enablers behind most of the EU requirements set in the Fit for 55 package and the REPowerEU by connecting millions of customers to the growing number of solar rooftops, PVs and other new generation capacities. To deliver this mission, DSOs are facing several challenges but are also proactively preparing for addressing them through different initiatives in Member States.

This paper aims to show the **key role of DSOs in achieving the EU's net zero targets and presents a state of play of solar PV grid connection in the EU. The paper is structured in three main chapters**, of which Chapters 1 and 2 provide the most comprehensive picture of DSOs' initiatives to connect solar energy installations.

- **Chapter 1** provides an overview of the obligations set out in the Fit for 55 package and REPowerEU for DSOs.
- **Chapter 2** sheds light on the challenges faced by DSOs when connecting the increase of decentralised renewables, especially solar PVs, to the grid while sharing practices actively put in place to overcome them.
- **Chapter 3** summarises the conclusions and lessons learnt in the paper, highlighting the proactive and undergoing endeavors of DSOs to be fit for 2030.

This paper is part of DSO Entity's Knowledge Sharing Strategy for 2023 designed to **share practices among DSOs and with European institutions, partners and stakeholders** in accordance with the association's mandate provided by the Electricity Market Regulation 2019/943/EU in Article 55(2c).

[1] " Energy Commissioner Kadri Simson (September 2023) " There is no green future for Europe without an upgraded power grid " Financial Times. Available at https://www.ft.com/content/4c843612-1890-49bb-83eb-ddbe4495d6c9

DSOs fit for 55 : Role and requirements for DSOs

1. DSOs fit for 55: Role of and requirements for DSOs

1.1. Overview of new requirements for DSOs in the Fit for 55 package and REPowerEU

FIT FOR 55: REQUIREMENTS FOR DSOS

The European Green Deal and the so-called " Fit for 55 package " marked a turning point in the European energy and climate policies. Raising to the challenge of achieving climate neutrality by mid-century, the European Union passed its first European Climate Law (2020)[2] which also included an intermediate ambitious commitment to cut the continent's GHG emissions by 55% by 2030. With the Fit for 55[3], a mammoth package of 13 legislative proposals, the European Commission intended to **set the right conditions to accelerate the transition towards a more renewable and decentralised energy system and increased the EU's energy targets, thereby, especially affecting DSOs**.

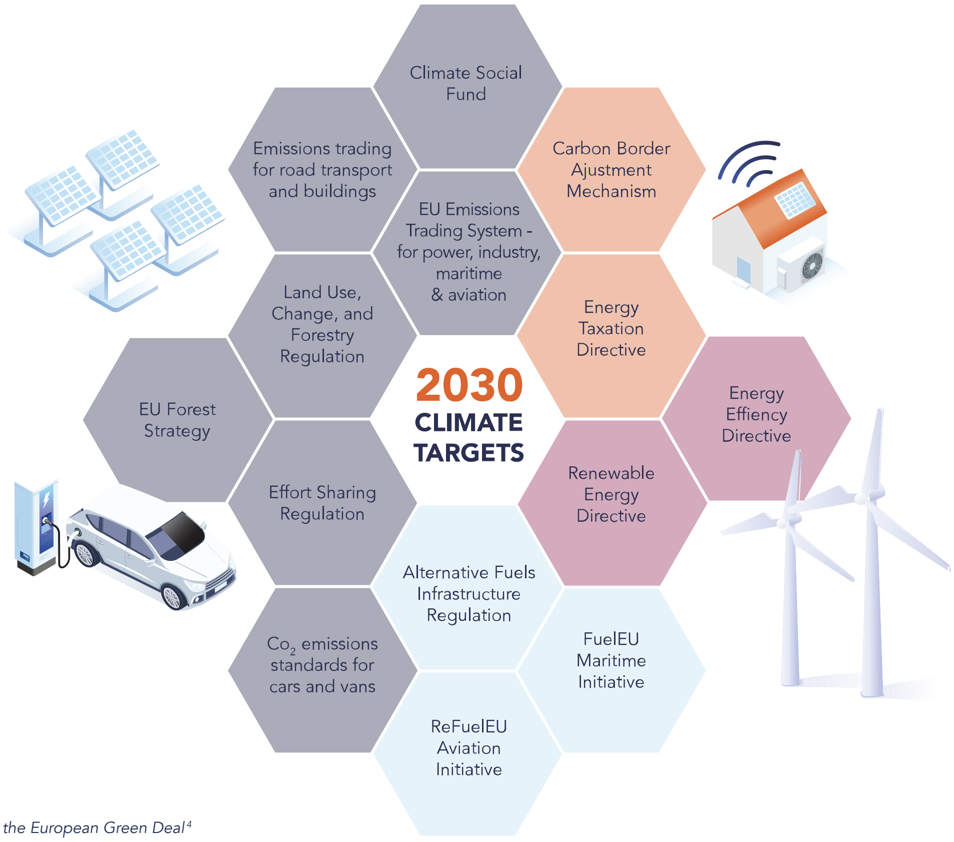


Figure 1: Legal documents on delivering the European Green Deal[4]

[2] Regulation of the European Parliament and of the Council (EU) 2021/1119 of 30 June 2021 on establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 [2021] L243/1

[3] The Fit for 55 package was proposed in two stages with a part I in July 2021 and a part II in December 2021.

[4] European Commission (July 2021) Communication from the Commission to the European parliament, the Council, the European economic and social committee and the Committee of the regions: " Fit for 55 ": delivering the EU's 2030 Climate Target on the way to climate neutrality (COM/2021/550), p.14 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0550&from=EN

The Fit for 55 package has both direct and indirect repercussions on DSOs. Some of the provisions directly address DSOs in the context of the energy system integration, improved TSO-DSO cooperation, a common network planning for electricity and gas, and new requirements for data sharing. However, the greatest effects will be indirect: DSOs will be the technical enablers of the higher targets set to:

- Speed up the deployment of renewables;
- Accelerate the roll-out of electric vehicles;
- Increase energy savings by enabling flexibility solutions;
- Implement requirements for data access and interoperability;
- Manage the grid reliably with additional complexity.

The impact of the Fit for 55 package will soon be felt in national capitals since most of the regulations will be concluded at the European level by the end of 2023 at the latest. Then, the EU's legislative objectives will need to be transposed into national law and transferred into concrete measures on the ground and implemented at the local level. This is where DSOs will play a crucial enabling role.

REPOWEREU: REQUIREMENTS FOR DSOS

As of February 2022, the war in Ukraine and related concerns about security of supply in the light of high energy dependence on Russian gas further sped up Europe's efforts to increase energy-saving measures and **boost electrification as well as the deployment of domestic renewable energy sources**. As a result, the war gave additional impetus to achieving the objectives of 55% GHG reduction by 2030 and carbon neutrality by 2050.

The European Commission acted accordingly and proposed its **REPowerEU Strategy**[5] in March and May 2022, in which it foresaw more ambitious targets and obligations for the deployment of decentralised renewables and an accelerated electrification of the heating and mobility sectors. These provisions have a **direct impact on DSOs by accelerating the integration of a growing number of renewables, heat pumps and EVs into the distribution grids**. Several proposals strengthen or set new requirements which will be implemented by DSOs:

- **Reinforcement of the EU's 2030 targets** set in the Fit for 55 package for renewables and energy efficiency;

- **Temporary framework to advance permitting procedures for renewables**, including grid infrastructure extension and **partly grid connection permits**, adopted in December 2022[6];

- **EU Solar Strategy** adopted in May 2022 aiming to further boost decentralised renewable production and to remove remaining barriers to the deployment of solar technologies (refer to Figure 3).

[5]European Commission (May 2022), "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", (COM/2022/230). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A230%3AFIN

[6]European Commission (May 2022), "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", (COM/2022/230). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A230%3AFIN

Additionally, major and persistent disturbances of the European energy markets and the negative effects of high gas prices on electricity markets have led the European Commission to also propose a **reform of the Electricity Market Design** in March 2023[7]. The proposal of a targeted reform contains highly relevant proposals for DSOs addressing demand response, flexibility and metering with a close connection to the future Network Code on Demand Response.

All these developments highlight the **increasingly important role of DSOs** in deploying decentralised renewables, empowering customers, smartening the grid and facilitating distributed flexibility to reach a carbon-neutral Europe by 2050.

DSOs as (technical) enablers to accelerate the achievement of the EU's climate objectives

Figure 2 shows how the successful implementation of the European objectives is closely interlinked with the daily (technical) work of DSOs and why the latter are vital for their achievement. High-level political objectives will only be reached if the technical preconditions in the system and market are right. As a result, technical bodies are pivotal for enabling and facilitating the transition.

Figure 2: Impact of EU objectives on the distribution grid

[7] European Commission (14 March 2023), " Proposal for Regulation of the European Parliament and of the Council amending Regulations (EU) 2019/943 and (EU) 2019/942 as well as Directives (EU) 2018/2001 and (EU) 2019/944 to improve the Union's electricity market design " (COM/2023/148 final), https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023PC0148&qid=1679410882233

[8] Regulation (EU) 2023 :1804 of 13 September 2023 on the deployment of alternative fuels infrastructure, and repealing Directive (EU) 2014/94.

[9] Directive of the European Parliament and of the Council of the European Union (EU) 2023/2413 of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652. [2023] OJ L2023/2413.

[10] Directive (EU) 2023/1791 of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023:955 (recast)

[11] Proposal of the European Commission to revise Directive (EU) 2010/31 on the energy performance of buildings (currently (10/2023) under trialogue negotiations). Since the file was still under negotiation when the report was finalised, the outcome can deviate from the provisions described in the table.

[12] Eurelectric (2022). Power sector accelerating e-mobility: Can utilities turn EVs into a grid asset?, p.27. URL: https://www.eurelectric.org/media/5704/power_sector_accelerating_e-mobility-2022_eyeurelectric_report-2022-030-0059-01-e.pdf

[13] Eurelectric (2021). Connecting the dots: Distribution grid investment to power the energy transition., URL: https://www.eurelectric.org/connecting-the-dots/

[14] Directive (EU) 2023/1791 of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023:955 (recast)

[15] Eurelectric (2022). Power sector accelerating e-mobility: Can utilities turn EVs into a grid asset?, p.27. URL: https://www.eurelectric.org/media/5704/power_sector_accelerating_e-mobility-2022_eyeurelectric_report-2022-030-0059-01-e.pdf

[16] Communication (EC) 2022/221 final of 18 May 2022 on EU solar energy strategy

	DSO-specific tasks	New generation capacities integration (RES, electromobility)	Data requirements
Alternative Fuels Infrastructure Regulation (AFIR)[8] **Entered into force on** 12 October 2023 **Directly applicable as of** 13 April 2024	Art. 14 & 15 Assessment of the potential contribution of recharging-point deployment and operation to the flexibility of the energy system in the network development plans	Art. 5 Publicly accessible recharging points capable of smart charging and digitally-connected Art. 3, 4, 6 and 7 Deployment of publicly accessible recharging points along the TEN-T network for light-duty vehicles, heavy-duty vehicles by 2030	**85% of charging will be done at home** and 6% in the workplace by 2035[12]
Renewable Energy Directive (REDII/REDIII)[9] **To be transposed into national laws** in the 2 years following its entry into force	Art. 16, 16a-e (RePowerEU) Simplified permit-granting and grid-connection-granting processes for RES and heat pumps in and outside renewables go-to areas. Defined minimum durations do not include time needed to ensure grid stability, reliability, safety and grid reinforcements Art. 16 (f) (RePowerEU) Planning and building of the grid for RES deployment as " overriding public interest "	Art. 15 (e) Member States may adopt plans to designate dedicated infrastructure areas for the development of grid and storage projects that are necessary to integrate RES. Grid operators should be consulted during planning. Art. 20.a(4) Non-publicly accessible recharging points must support smart charging functionalities and, where appropriate, the interface with smart metering systems and bi-directional recharging functionalities.	Art. 20.a(1) If (technical) obtainable, obligation to make digitally available: • Data on the share of RES and GHG-emission content in the grid • Anonymised and aggregated data on demand response potential and RES injected to the grid by self-consumers Around **70% of the installed renewable capacity** by 2030[13]
Energy Efficiency Directive (EED)[10] **Entered into force on** 10 October 2023 **To be transposed into national laws** by 11 October 2025	Art. 3 Application of the energy efficiency first principle Art. 9 DSOs as potential obligated parties of the energy efficiency obligation schemes (depending on the Member State) Art. 25 Monitoring and quantification of network losses by improving network efficiency and optimising networks (where feasible)		Active contribution to the 11.7% energy consumption reduction target by 2030[14]
Energy Performance of Buildings Directive (EPBD)[11] **To be transposed into national laws** in the 2 years following its entry into force		Art. 9a (REPowerEU) Solar rooftop obligation Art. 12 Installation of charging point in residential and non-residential buildings Installation of pre-cabling for new or under major renovation buildings and buildings owned or occupied by public authorities by 2033 Smart-charging (if feasible, bidirectional) capability for all charging points	**65M chargers** needed to accommodate **130M** EVs expected on the EU roads by 2035[15]
REPowerEU Strategy (non-binding		REPowerEU Communication Doubling the deployment rate of individual heat pumps resulting in a cumulative 10 million units over the next 5 years European Solar Rooftops Initiative Setup of at least one renewable-based energy community in every municipality with more than 10 000 inhabitants by 2025	EUR 29B additional investments needed in the power grid by 2030 to meet the REPowerEU objectives[16]

Table 1: DSOs in the spotlight of the Fit for 55 and REPowerEU

ZOOM IN ON THE DEPLOYMENT OF SOLAR ENERGY IN EUROPE

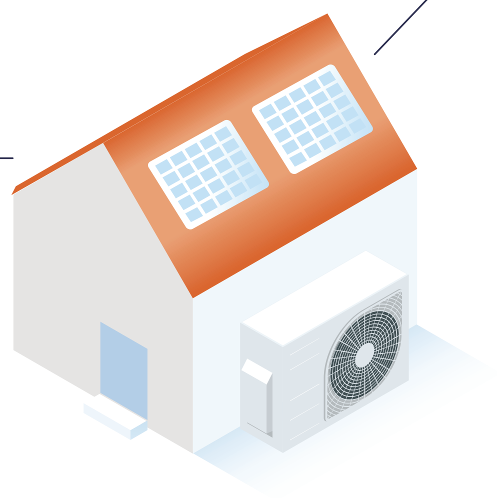
As part of the REPowerEU Strategy, the **EU Solar Strategy**[17] sets new targets and obligations to speed up the deployment of solar energy in Europe and empower customers to be part of the energy transition. The strategy strives to tackle the outstanding barriers to the roll-out of solar technologies through different initiatives proposed by the European Commission. The **European Solar Rooftops Initiative**[18] sets new solar obligations in different types of buildings by 2030 through a phased approach to make good use of the full potential of European rooftops.

The **new solar targets directly affect DSOs** which are responsible for connecting solar rooftops to the distribution network. The integration of decentralised solar installations will **require adaptations of the distribution grids and thereby significant investments** to expand and smarten the network. According to the EC, the REPowerEU objectives will require €29 billion of **additional investment** in the power grid to make it fit for increased use and production of electricity[19]. In the framework of collective self-consumption, DSOs will also need to ensure cost-reflective tariffs and avoid any discriminatory cost-socialisation of grid-related costs between customers.

All new buildings should be "solar ready"

Binding **EU solar rooftop obligation** for :

2026	All new public and commercial buildings with useful floor area larger than 250 m^2
2027	All existing public and commercial buildings with useful floor area larger than 250 m^2
2029	All new residential buildings



TARGETS

Over **320 GW of solar photovoltaic newly installed by 2025** (twice the current level)

Almost **600 GW by 2030**

Figure 3: Deployment of solar energy in Europe: Targets and obligations[20]

[17] Ibid

[18] Ibid, European Solar Rooftops Initiative, p.3

[19] European Commission (COM/2022/230), op cite. p.14.

[20] Proposal of the European Commission to revise Directive (EU) 2010/31 on the energy performance of buildings (under trilogue negotiations), Article 9a.

1.2. DSOs as invisible enablers of the energy transition

FROM PASSIVE ACTORS TO ACTIVE MANAGERS

The mission of an electricity distribution system has historically been to passively supply energy from power plants and transmission network to final customers. Traditional regulatory and distribution business frameworks have only consisted of ensuring an efficient network growth to accommodate new consumption connections and an optimal quality and continuity of supply by investing and maintaining the network. However, new European regulations and policies, ambitious climate targets, the digitalisation of the network and new market businesses models have led to a paradigm shift in which electricity distributors play a key role.

This new context has required that the traditional passive Distribution Network Operator (DNO) moves toward an active Distribution System Operator (DSO). It has enabled the participation of new market agents and contributes to achieving the EU ambitious energy transition towards carbon neutrality by increasing the penetration of energy renewable installations.

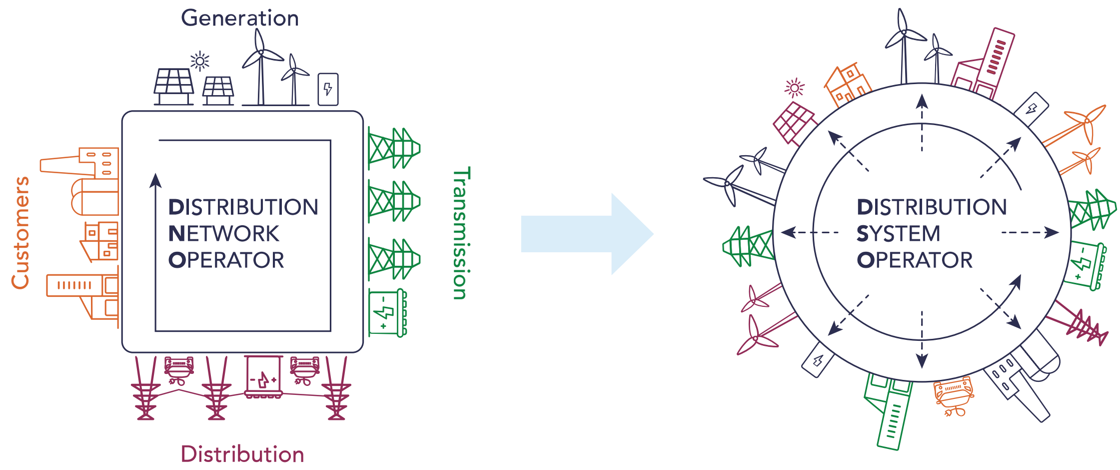


Figure 4: From Network Operator to System Operator: The transformation of the role of the DSO[21]

This paradigm shift has led DSOs around Europe to face similar challenges in terms of facilitating new DER connections in the distribution network to contribute to reaching the high energy and climate targets. These challenges not only cover the generation side, but also final customers, as the EU Electricity Market Directive 2019/244 empowers end-users as active actors of the EU electricity market enabling them to participate in, by offering different services to the system, such as demand response and energy surplus from self-consumption PV installations. All these factors require that DSOs develop an active organisation of services for solving local network constraints, coordinate with TSOs and set new planning methodologies such as flexible grid connections.

This combination of high DER penetration, end-user participation and new energy market agents (i.e., energy communities, aggregators, etc.) makes DSOs key actors as active, neutral and impartial facilitators of the energy transition.

Particularly, the highly ambitious EU renewable energy penetration targets led DSOs to face a wide range of challenges, such as investment in digitalisation and network development, capacity constraints, permitting, etc. To address these challenges, an adaptation and evolution in regulation is necessary to allow DSOs to provide a proper response to this new environment and, in consequence contribute to delivering the energy transition and EU energy targets.

[21] Iberdrola (2023), " DSO — how to convert grid management towards a smarter system? ", available at https://www.iberdrola.com/innovation/distribution-system-operation

FACILITATORS OF THE ENERGY TRANSITION

DSOs play a vital role in the energy eco-system towards the energy transition as a natural trusted enabler, neutral market facilitator as demonstrated in selected examples.

The urgent need towards decarbonisation, new targets promoting the replacement of fossil fuel-based generation by non-dispatchable renewable sources of generation such as wind and solar require electrical energy grid operation entities, like DSOs, to appropriately adapt to ensure customers have a reliable power supply within this complex new energy system. They need to simultaneously assure and foster maximum RES, DER, EVs and heat pumps incorporation in the distribution grid, in a cost-effective way, while guaranteeing the security of present and future energy demand to all stakeholders. Basically, assuring to keeping " the lights on ".

By 2030 approximately 70% of the installed renewable capacity will be connected into the DSOs grid[22], which can be translated into **510 GW** of non-dispatchable renewable generation to be managed by DSOs, alongside EV and heat pump loads.

The high percentage of intermittent RES and DERs already poses challenges associated with fast increase and, particularly, decrease of generation (e.g., solar energy production during the daily cycle.)

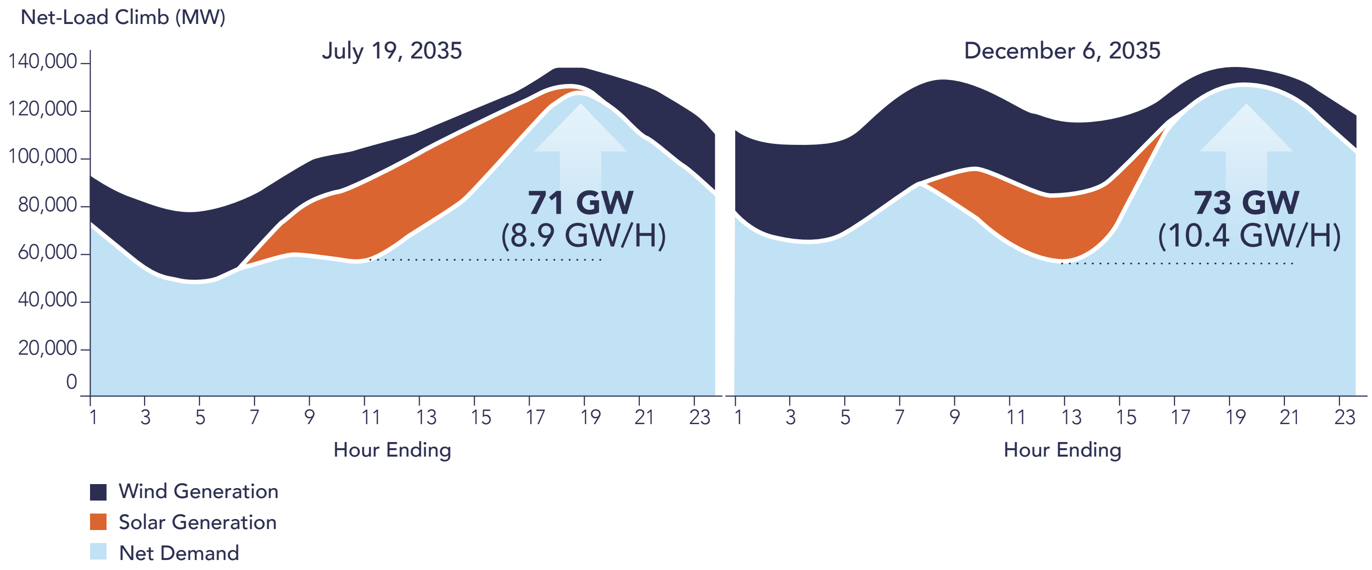


Figure 5: Total power increase from beginning to end of the ramping period for selected summer and winter days for PJM[23]

Figure 5 illustrates part of the challenges associated with the decarbonisation of electrical energy production, with a higher RES share of production. Solar energy production occurs within well-defined periods of the day and of the year. Solar energy wanes by late afternoon, when most people will be on their way home, leading to an increase in residential energy consumption, which often represents peak consumption in the electrical energy system. This demand can no longer be met by solar production, requiring the ramp-up of other resources to meet that demand.

[22] Eurelectric (2022), op cite.

[23] PJM (2022), " Energy Transition in PJM: Emerging Characteristics of a Decarbonizing Grid, available at https://www.pjm.com/-/media/library/reports-notices/special-reports/2022/20220517-energy-transition-in-pjm-emerging-characteristics-of-a-decarbonizing-grid-white-paper-final.ashx

The emerging complexity of new unpredictable situations related to, but not dependent on customer empowerment pushed DSOs to speed up and increase the implementation of new or more advanced technical solutions like digitalisation of almost all its processes, ensuring simultaneously privacy, security and safety by design and default. The incorporation of more advanced and accurate probabilistic models that allows better responses to low probability situations and demands is also a path that DSOs use alongside the adaptation of new responses to solve constraints (e.g., flexibility).

DSOs serve as technical enablers of the energy transition by facilitating the integration of renewable energy sources, deploying smart grid technologies, supporting decentralised energy systems, and ensuring grid resilience. They play a crucial role in managing the challenges of renewable energy intermittency, enabling efficient energy distribution, accommodating energy storage, promoting EV adoption, using data analytics and AI, advocating for supportive policies, and enhancing grid adaptability to climate change. Through these actions, DSOs contribute to a sustainable, reliable, and efficient energy landscape during the transition away from fossil fuels (see illustration).

INFO BOX

E-REDES

DSOs and consumers: an ever-closer relationship

DSOs are constantly deepening and improving their relationship with their customers. One way of doing so is by providing easy access to information and services via digital tools as the example of E-REDES's " Digital one stop shop " in Portugal shows.

EXAMPLE: Portuguese DSO E-REDES Balcão Digital one free stop shop Digital Customer Contact

In this one free stop shop several services can be accessed and provided through requests by the customer, like the following examples:

- **Grid connection request:** With E-Connection service, a new grid connection request is just a click away.
- **Load profile consumption, production and contract power**: This functionality allows to evaluate their historical load profile and compare with their generation load curve.
- **Follow E-REDES service Team (Siga a Equipa):** This functionality enables customers individually to follow in real time E-REDES Teams to their home.

In addition to this, E-REDES is also providing to all stakeholders an **open data portal** with the aim of enabling customer participation, improvement of energy literacy promoting new business developments and research developments among all (e.g., customers, solar promotors, energy communities, municipalities, universities and startups).

Some available data sets among others: information regarding total number of Production Units for Self-Consumption (UPAC), hourly/monthly consumption by zip code dashboard, number of new connections to the grid associated with electromobility, geographic location of low- and medium- voltage secondary substations from distribution network with installed power and use percentage information, number of active power outages.

Connecting renewables in Europe with a focus on solar PV

2. Connecting renewables in Europe with a focus on solar PV

2.1. Facts and Figures: Solar PV deployment and grid initiatives in the EU-27

HIGHLIGHTS FROM DSO ENTITY'S MEMBERS

+20 Member States have capacity maps or similar tools informing about the available grid capacity

+537% Increase of Lithuania's 2030 solar target

€5B Annual investments needed in the distribution grid to adapt to the energy transition in France by 2032

INCREASE IN APPLICATION REQUESTS FOR CONNECTING SOLAR PV

All European DSOs have experienced a significant increase of their application requests from double to triple

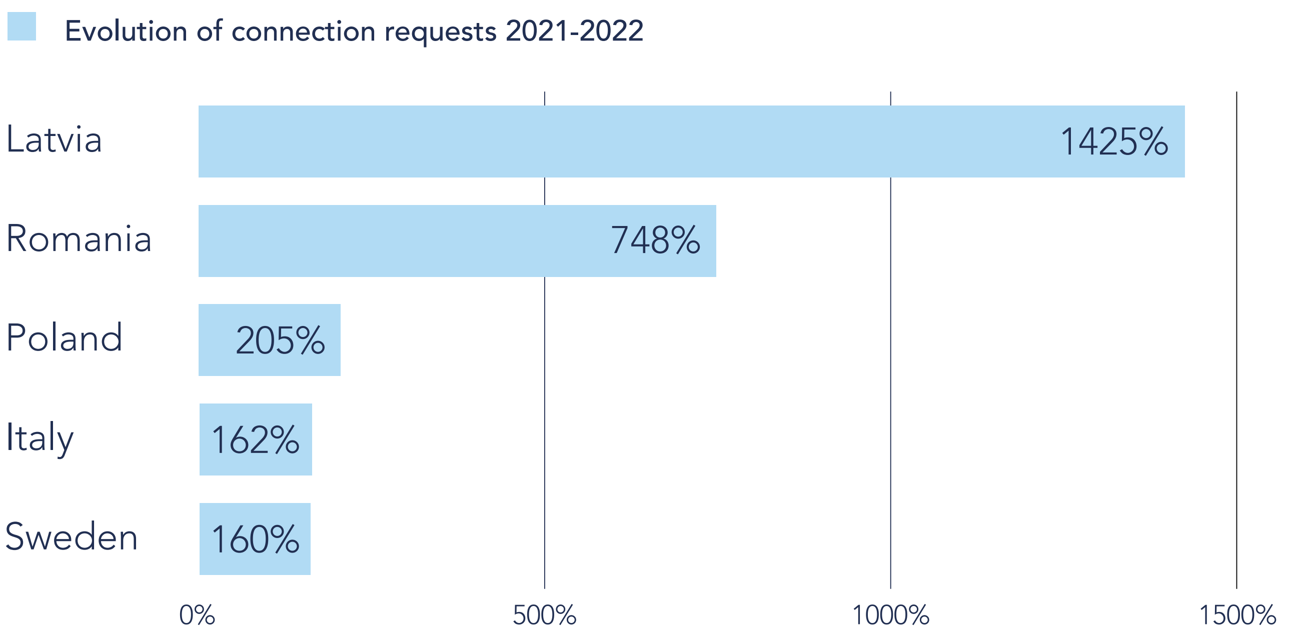


Figure 6: Increase in application requests reported by DSO Entity's members

DEPLOYMENT OF SOLAR PVS IN THE EU-27

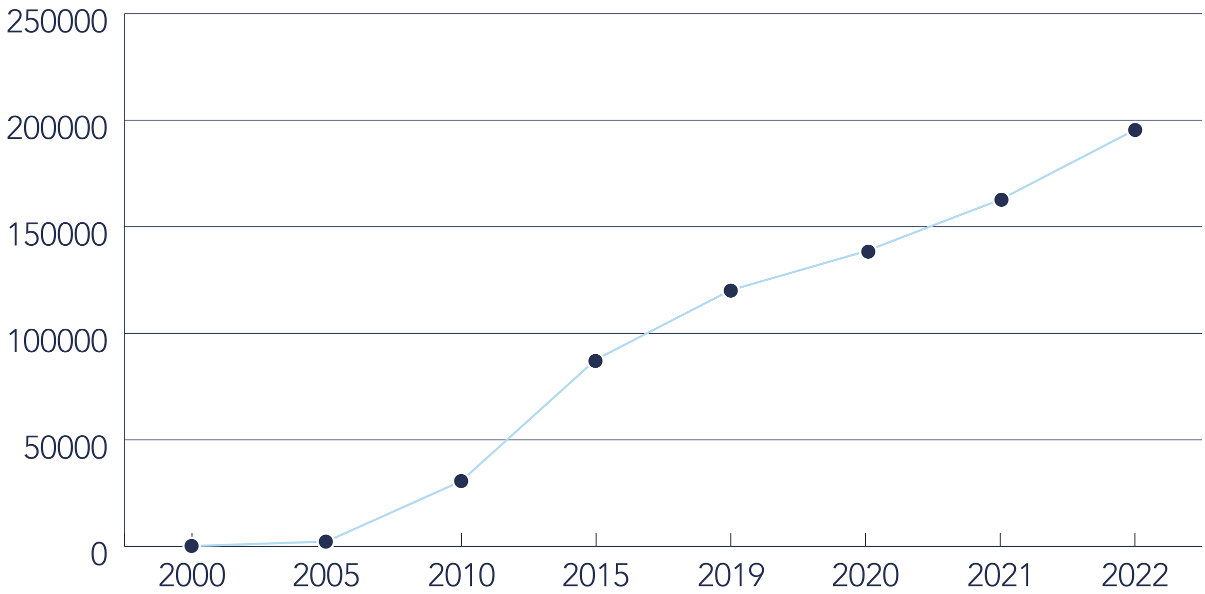


Figure 7 : Installed and cumulated solar photovoltaic capacity In the EU-27
Figure based on data from Eurobserv'er, Photovoltaic Barometer 2023, and Eurostat

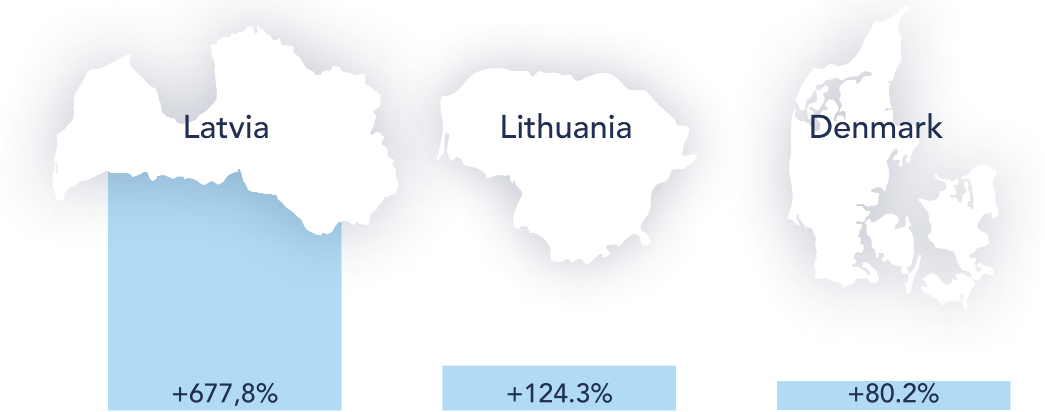


Figure 8 : Top 3 Member States with the highest increase of installed solar PV capacity (2021-2022)

INFO BOX

Subsidies supporting RES deployment

ALMOST ALL OF THE MEMBER STATES IMPLEMENT SUBSIDY SCHEMES

GREECE EXAMPLE

In 2023, the Greek solar PV subsidy program for households ranges from 45% to 75% of the total cost depending on their income, while for farmers from 40% to 60%. The program covers overall EUR 10,000 to EUR 16,000 for a rooftop solar PV combined with a battery.

STATE OF PLAY OF IMPLEMENTATION OF LEGAL PROVISIONS ON RENEWABLE AND CITIZEN ENERGY

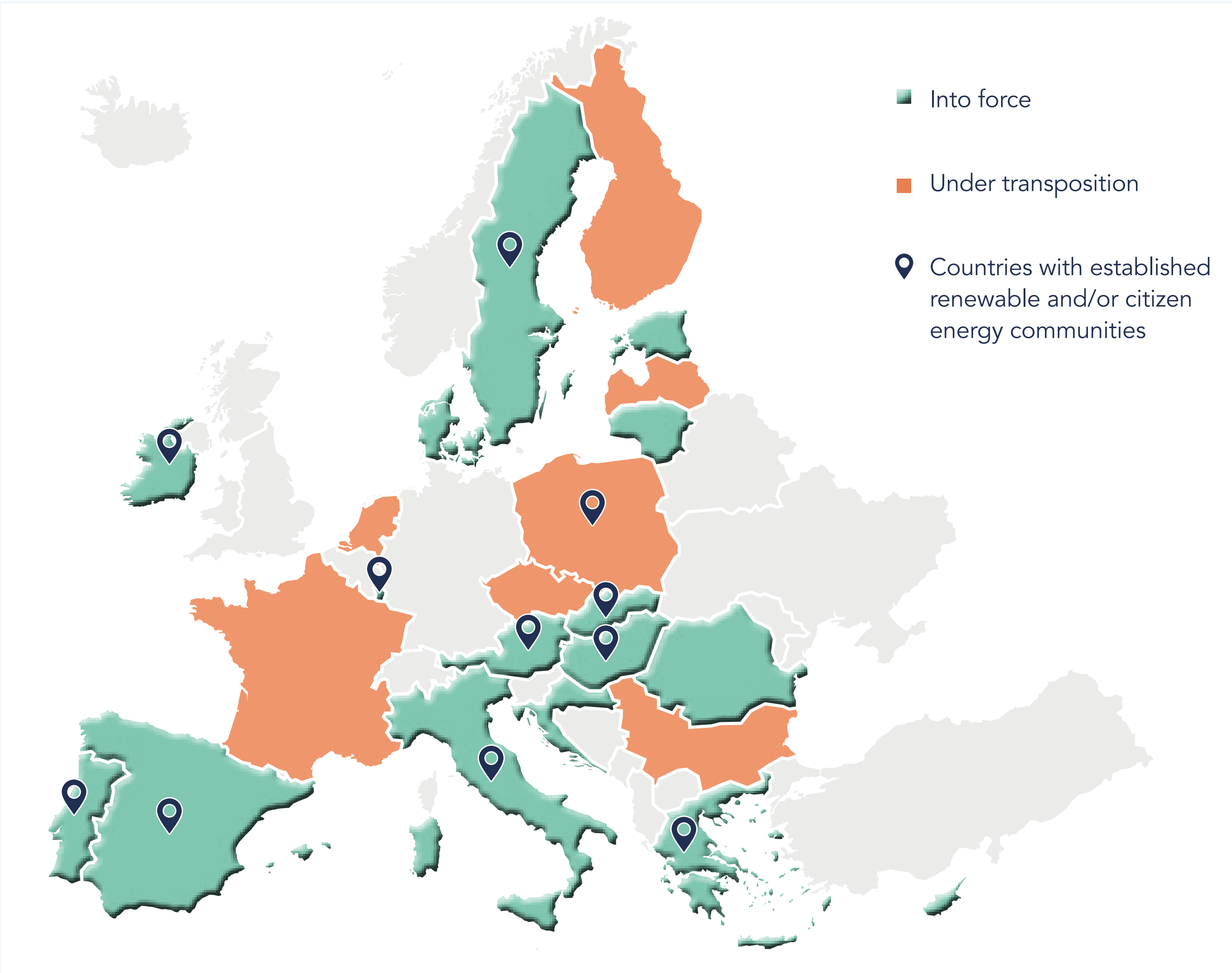
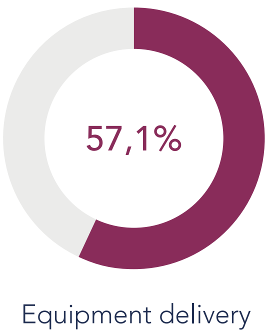


Figure 9: State of play of implementation of legal provisions on renewable and citizen energy communities in Europe

Based on data from a DSO Entity's survey collected in 2023 in Austria, Bulgaria, Cyprus, Czechia, Denmark, Estonia, Germany, Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Netherlands, Poland, Portugal, Romania, Sweden and Slovakiafrom double to triple

PROBLEMS ENCOUNTERED WITHIN MEMBER STATES WHEN CONNECTING SOLAR PV TO THE GRID



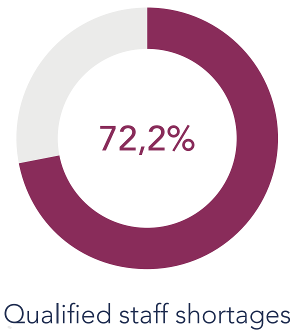


Figure 10: Problems of equipment delivery
Figure 11: Qualified staff shortages

Based on data from a DSO Entity's survey collected in Austria, Bulgaria, Cyprus, Czechia, Denmark, Estonia, Germany Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Netherlands, Poland, Portugal, Romania, Sweden and Slovakia

EMPOWERING CONSUMERS

Proactive initiatives implemented by European DSOs to raise awareness among consumers and encourage their engagement in the electricity market.*

Public Information

France Ireland Slovakia	Direct customer service and experts advice regarding the process of connecting solar PV to the grid
Croatia Lithuania	Organisation of workshops and seminars to inform about the potential of renewable energies and the interactions with the grid
Austria Cyprus Greece Spain Finland Hungary Latvia Sweden	Easily accessible information regarding PV installations benefits and connection processes

Digital tools

Online capacity maps	Croatia Hungary Ireland Netherlands
Live consumer information: production units for self-consumption, number of new connections to the grid associated with electric mobility, number of active power outages by ZIP code ...	Portugal

Sectoral engagement

Denmark	Dialogue with solar development companies to plan and limit connection time

*The county examples provided are based on the results of a DSO Entity's survey conducted in 2023 and are non-exhaustive.

DSO CAPACITY MAPS IN MEMBER STATES

- National capacity mapping
- Individual DSOs initiatives
- One DSO reporting
- Third Party Reporting (e.g. TSOs)
- Comparable information tool

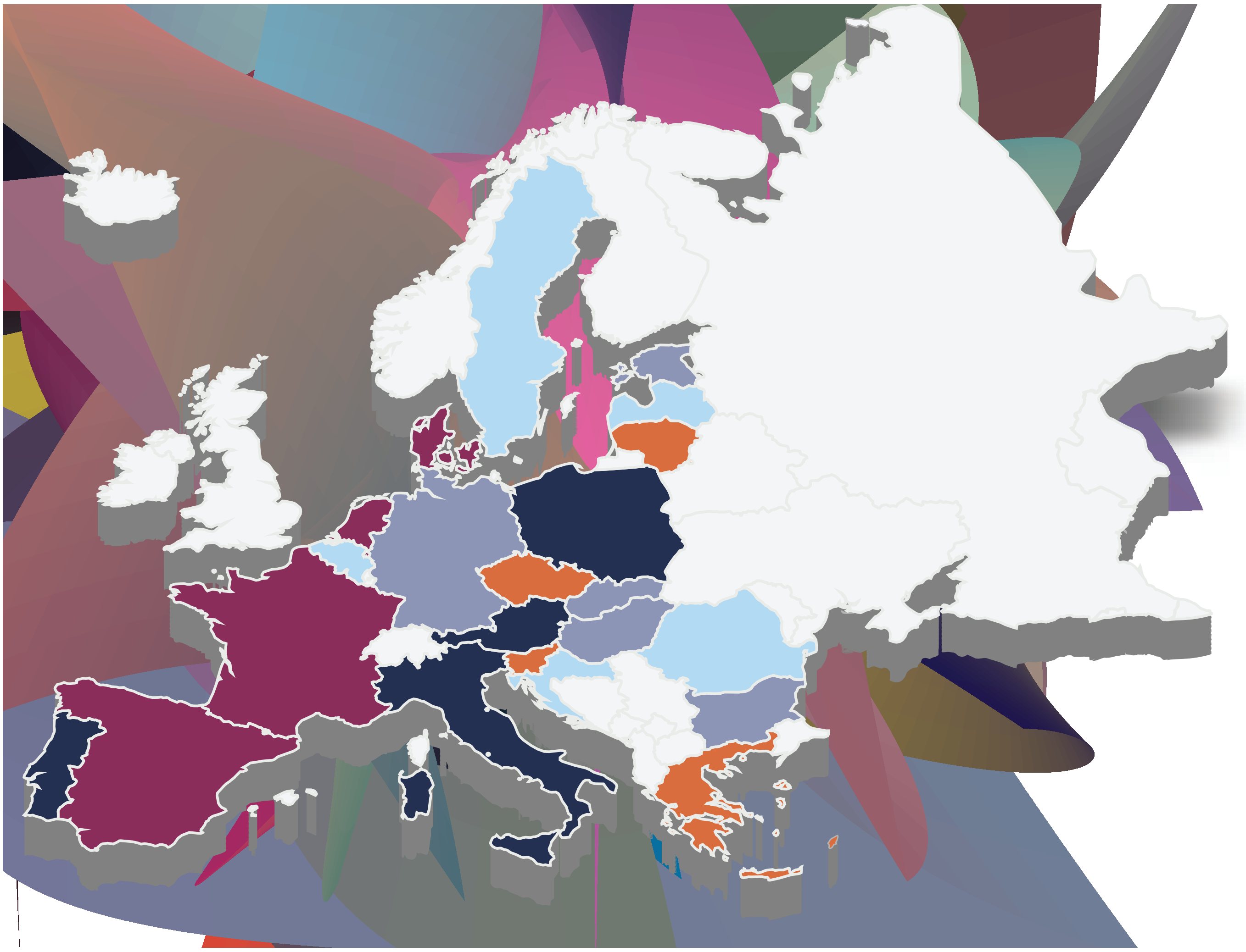


Figure 12: DSO capacity maps in Member States

Based on data from a DSO Entity's survey collected in Austria, Bulgaria, Cyprus, Czechia, Denmark, Estonia, Germany,Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Netherlands, Poland,Portugal, Romania, Sweden and Slovakia

2.2. Grid Connection of renewables : Challenges and practices

This paper outlines seven (non-exhaustive) challenges currently faced by DSOs when facilitating the energy transition by connecting decentralised energy resources, especially solar PV : high demand in short time, capacity constraints, investment and financing needs, permitting, regulatory framework, network tariff regime and staffing shortages.

The description of the challenges shows that DSOs are often confronted with obstacles on different levels and ill-fitting framework conditions. The paper also illustrates how DSOs attempt to overcome some of the obstacles by launching proactive initiatives and/or fostering close cooperations with relevant actors.

ADDRESSING THE CHALLENGES

High demand in short time

1. Austria (Netz Oberösterreich)
2. Italy (E-Distribuzione)

Capacity constraints

1. Denmark (Netselskabet N1)
2. Netherlands (Alliander)

Permitting

1. Netherlands (Enexis)
2. Portugal (E-Redes)

Investement and funding

1. Czech Republic (CEZ Group)

Regulatory framework and technical rules for grid connection

1. Lithuania (ESO)
2. Italy (E-Distribuzione)
3. Republic of Ireland (ESB Networks)

Staff and skills shortage

1. France (Enedis)
2. Czech Republic (CEZ Group)
3. Spain (Iberdrola)

Network tariff regimes

1. Belgium/Flanders (Fluvius)

1 Challenge: High demand for the RES connection to the grid in short time

Challenge: The significant cost reductions of solar PVs, European targets, high energy prices and support schemes for the deployment of renewables have resulted in a boom of decentralised renewable energy installations. DSOs are confronted with a spike of connection request, especially for solar PVs. Almost all DSOs experienced a surge in applications for connecting solar PVs to the distribution gird from one year to another such as Latvia with 1400% or Romania with 750% (see Chapter 2.1). The scale and speed of the current development represents a significant challenge for DSOs who need to deliver in a relatively short timeframe while struggling with limited capacities in the existing grid infrastructure and having to guarantee the stability of the system. from distribution network with installed power and use percentage information, number of active power outages.

The significant cost reduction of solar PVs has strongly contributed to speeding up the deployment of RES in the last years. The renewable energy technologies have never been so competitive in terms of prices than in 2022, despite cost inflation of raw and equipment materials. Alongside the competitiveness of DERs, various incentive schemes which are offered to customers, businesses, and communities to invest in PV panels and other renewable energy technologies, played a role in accelerating the deployment of RES. Almost all Member States have RES support schemes implemented. They can take various forms from general taxation and subsidies (such as feed-in tariffs) to non-tax levies as well more indirect operational incentives (i.e., tax reliefs or tax exemptions, dedicated financing programmes). They all play a vital part in accelerating the installation of new RES capacities in Member States, thus contributing to increasing the overall grid demand and takes on distribution network. In 2021 solar PV still had the highest average support level with around 136 €/MWh.[24]

As a result, DSOs must account for the increased capacity needed to seamlessly integrate and manage the growing number of PV panel installations while facing a relatively short timeframe to achieve these RES targets. **The rapid growth of PV panel installations requires expedited planning, coordination, and implementation of grid upgrades** to accommodate the influx of renewable energy.

When addressing both the scale and speed of the RES integration into the grid, DSOs also encounter a series of **interconnected challenges** such as for instance:

Financial barriers: Securing the necessary funding for grid upgrades and expansions poses a substantial obstacle. DSOs must explore innovative financing models and government support to overcome budget constraints.

Resource constraints: Limited manpower hampers managing the rapid growth of solar PV installations. DSOs must carefully prioritize grid enhancements and manage human and financial resources effectively.

Regulatory complexity: Navigating the intricate regulatory landscape to gain approval for grid reinforcements can be time-consuming and bureaucratic. Streamlining regulatory processes is crucial to expedite necessary changes.

[24] CEER (September 2023). 'Status Review of Renewable Support Schemes in Europe for 2020 and 2021' (C22-RES-80-04), p.27. Available at https://www.ceer.eu/documents/104400/-/-/6c2376e9-7072-a1c1-0b8e-7b7954e17264

FACILITATION OF PROCEDURE FOR THE ASSESSMENT OF FEED-IN REQUESTS

High energy costs and various funding mechanisms in Austria led to a massive increase in feed-in requests for PV power plants, especially in lower voltage levels. For the DSOs the very high simultaneous feed-in power could lead to an increased expansion of the public grid infrastructure. Especially in rural areas, the feed-in power exceeds the electrical infrastructure provided for power consumption, therefore presenting a challenge for DSOs.

Figure 13 shows the development of feed-in requests for decentralised power plants (> 90 % PV power plants) from 2013 to 2022 in the grid area of Netz Oberösterreich GmbH. In 2022, a total of 35,298 feed-in requests for decentralised power plants were conducted, representing an increase of 350 % compared to 2021. This development shows the challenges in dealing with a high number of feed-in requests for DSOs from a grid-capacity, but also human-resources perspective.

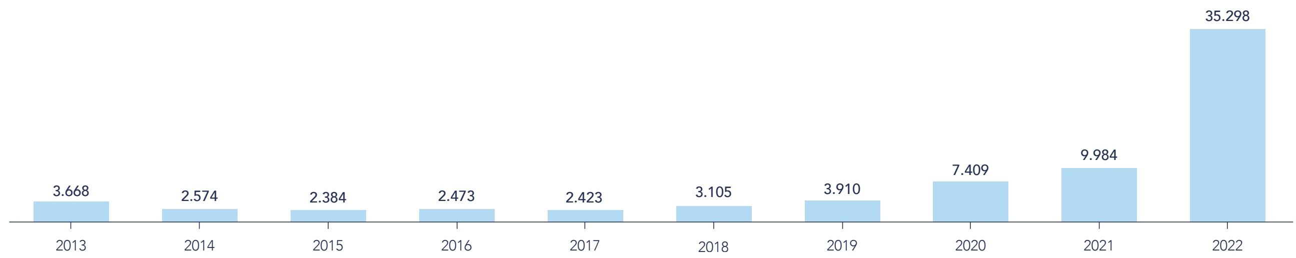


Figure 13: Development of feed-in requests for decentralised power plants from 2013-2022

Thanks to the roll-out of smart meters in the whole network area Netz OÖ and a fully digitalised data base in which Netz OÖ invested during the last years, the application and notification process for decentralised power plants is **fully digitalised and carried out via an online portal**. This guarantees an utmost fast and comfortable application process for the customer. In a first step, a licensed electrician submits the feed-in requests. In the application, the most important technical parameters of the decentralised power plants are collected and transferred to the feed-in database of Netz´OÖ. The grid confirmation for low-power distributed power plants (≤ 21 kVA) in the low-voltage grid is done automatically, thus, immediately approved.

According to existing technical rules there is a limit for the voltage level variation of max. 3%. Therefore, the resulting voltage rise caused by the potentially newly added decentralised power plant at each individual interconnection point is determined under consideration of all decentralised power plants in the low-voltage grid. If the voltage rise is below the limit of 3%, an automated grid confirmation is granted. In the past, in cases where the voltage rise exceeded the limit for decentralised power plants in the low voltage grid, no confirmation to connect the decentralised installation could be granted. However, thanks to additional data provided by the smart meter, a more detailed manual analysis is carried out in a further step that then determines if the installation can be placed without reinforcing the grid or other measures. This manual analysis uses geographical information together with historical voltage values (in form of histograms) in the investigated low-voltage grid. By using historical real measured voltage values in the low-voltage grid a higher use of existing grid capacities can be achieved, and additionally leads to a faster approval of feed-in requests for the customer.

The Netz OÖ case shows how investments in the digitalisation of the distribution grid and a proactive DSO engagement can positively affect the roll-out of more solar PVs. Without the digital platform it would have been impossible to cope with the 350 % increase in requests with the existing workforce in such a short time. Time and money (less network reinforcements and human resources) could be saved, and more renewable energy fed into the grid at a time when energy prices were extremely high.

e-distribuzione

www.e-distribuzione.it

Italy

SIMPLIFICATION AND DIGITALISATION OF CUSTOMER CONNECTION

Distributed generation capacities, such as small-scale installations located behind the consumer meters, solar PVs, energy storage and EVs, are increasing significantly and are fundamentally transforming the Italian energy system.

Last year, E-Distribuzione, the major Italian DSO, achieved a record of nearly 204,000 of new producers and prosumers connected to its grid and almost 2,2 GW of new additional renewable energy capacity. This led to over 1,3 million distributed generation plants connected to low- and medium-voltage network.

This pace of increase and the growing customers' connection requests to the network have led E-Distribuzione to further digitalise and automate the entire grid connection process, in order to simplify the fulfilment of both customers' and internal employees' tasks required by the National Regulation Authority (ARERA).

The interaction channels, such as the producers' website, have been further enhanced, ensuring the integration with other relevant stakeholders' systems/database (i.e., Terna, GSE), in order to better integrate information flows, limiting the resort to manual activities.

The main new digital features introduced to facilitate the management of connection requests are:

- **Quotation simulator**: available for low-voltage prosumers, it aims to verify the presence/absence of work on the network and to assess the related connection costs. The simulator allows customers to autonomously obtain useful information on the complexity of their connection request, thus providing greater awareness of the time required for connection.
- **AI algorithms**: templates with QR codes have been set up in the website to automate the document validation with AI algorithms, reducing processing and waiting times for customers.
- **Requests tracking** for real-time and totally transparent progress consultation of requests.
- **Smart Quotation**; automation of the calculation of technical and commercial quotation and consequently automatic dispatch to the customer.

All these functionalities aim to digitalise, simplify and improve the connection experience of prosumers/producers.

2 Challenge: Capacity constraints

Challenge: The rapid and accelerated expansion of PV capacity, driven by the EU's renewable targets and the intention to quickly reduce the EU's dependance from Russian gas, has led to a boom in electricity demand that severely challenges the distribution grid's original design and capacity. In some countries, it has led to significant capacity constraints, and thus, to a higher demand for grid upgrades.

Large-scale solar PV installations require significant grid capacity to manage their high-electricity output and thus entail substantial investments in upgrading infrastructure, such as in transformers and substations. As a result, the roll-out of PV-generated electricity could be hampered by the limited space available to seamlessly integrate new PV installations into the grid.

The reduction in available grid capacity due to high connection requests exacerbates the **issue of grid congestion**. Grid congestion occurs when the electricity generated surpasses the network's ability to handle and distribute the power effectively, potentially leading to overload problems. DSOs are faced with **growing pressure to ensure sufficient capacity to cope with the surge of intermittent power generation and to keep the electricity demand and supply in balance at all times**. As the number of PV installations continues to rise, electricity flows into the grid concentrate, straining the existing infrastructure, thus, compromising the stability and reliability of the grid.

Several Member States are dealing with grid congestion issues and some European regions are experiencing more difficulties than others due to a lower starting grid capacity leading to potential local bottlenecks. To identify the strategic areas where grid constraints occur, some countries established, in cooperation with DSOs, capacity or connectivity maps providing an overview of the grid availability (see Chapter 2.1.).

Addressing the lack of available grid capacity constitutes a challenge for DSOs in Europe. This scenario makes it necessary to prioritise requests and proceed with phased integration, given that attempting to accommodate all demands simultaneously would strain the existing infrastructure. Collaborative efforts with regulatory bodies, policymakers, and other stakeholders are essential to streamline processes, secure necessary funding, and implement grid enhancements efficiently while ensuring grid stability and resilience. Increased cooperation between DSOs and stakeholders can lead to faster upgrade of the grids, smarter use of grid capacity and incentives for flexible consumption.

GEO-DEPENDENT STANDARD CONNECTION FEE

The Danish Climate Act sets a target to reduce Denmark's emissions by 70 percent in 2030 compared to 1990 and climate neutrality by 2050. The Danish government has taken a commitment to quadruple the production of renewable energy from solar and onshore wind by 2030. The total electricity production from solar and onshore wind was 12 TWh in 2021 and is expected to be around 50 TWh in 2030. To ensure cost-efficient and expedient integration of the new renewable energy production to the Danish distribution grid, the Danish DSOs have introduced a geographically dependent standard connection fee.

Geographically differentiated fee for RES grid connection

The standard connection fee covers the costs related to connecting the new renewable energy production to the grid. The fee is geographically differentiated based on whether the connection is made in an area with a production surplus or consumption surplus. If there is a production surplus the payment will be higher, and if there is a consumption surplus it will be correspondingly lower.

To provide an easy overview of the geographical differentiation, the Danish DSOs have developed a publicly available map that divides Denmark into zones and specifies whether it is a production surplus area (green), an area that is evenly balanced between production and consumption (yellow) or a consumption dominated area (red). The interactive map (see Figure 14) is updated on an annual basis to ensure that it reflects the ongoing developments in consumption and production patterns across Denmark.

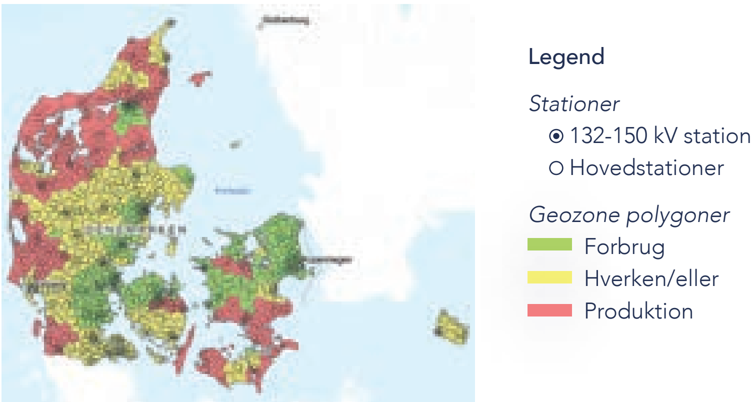


Figure 14: Denmark's interactive map of production and consumption developments for 2023.

The dots in the map show the substations in Denmark's distribution grid. Each of them covers different sections of the grid. The colors show whether the area covered is a production surplus area (green), balanced (yellow) or consumption dominated area (red).

Benefits of the geo-dependent connection fee:

- Ensuring that RE producers pay a fee that corresponds to their actual impact on the relevant section of the grid, which ensures cost-efficiency.
- Providing clarity to the RE producers about the cost associated with selecting different locations for a project, which plays into the assessment of potential locations and related business cases.
- Helping alleviate potential congestion issues by dampening the incentive to place new RE production in areas with a significant production surplus.
- Giving incentive to place new RE production in consumption dominated areas, which reduces the need for reinforcement of the grid, and hence allows for a faster integration of RE production.

Netherlands

www.alliander.com/nl

FLEXIBLE CONNECTION AGREEMENTS

In the Netherlands, grid congestion has become a notable concern. Historically reliant on natural gas, the country's electricity grid was designed for centralised energy production and thus struggles to handle decentralised renewable sources. The surge in solar PV, partly driven by Dutch net metering incentives, strained this legacy infrastructure and has led to grid congestion across the country.

To proactively address grid congestion while integrating RES, Dutch DSOs are making significant investments in grid reinforcement and undertaking various strategies to alleviate congestion issues, enhance the capacity, and improve the flexibility of the electricity grid.

Multi-year program for infrastructure, energy, and climate (miek)

In the Netherlands, the MIEK program identifies energy infrastructure expansion projects of high societal importance. The MIEK list outlines the projects for expanding energy infrastructure which are most needed in each province. The projects are integrated into the investment plans of SOs and the spatial policies of provinces and municipalities. Such a program ensures that provinces, municipalities, and SOs collaborate to align the energy system with spatial developments.

In its early stages, the MIEK initiative already fosters effective cooperation among SOs, government bodies, and other stakeholders, promoting coordinated efforts to combat grid congestion and capacity issues. Identifying energy infrastructure projects of high societal importance and coordinating government's and SO's plans are crucial to ensure efficient resource allocation and mitigate network congestion.

Alliander's Pilot flexible connection agreement

In early 2023, a Dutch factory sought to install a high-power e-boiler in the Dutch province of Noord-Holland but encountered grid capacity limitations. To address this issue, Alliander, offered a (pilot) flexible connection agreement. With this agreement, Alliander was able to offer capacity outside of peak hour, allowing the e-boiler to be connected and circumventing capacity issues during peak hours. The factory adjusted its e-boiler operations, accordingly, enabling the e-boilers to be successfully connected to the grid without the need for a 3 to 7-year wait for the grid connection.

Flexible connection agreements enable DSOs to connect more customers to the grid without having to expand the grid capacity as it is used in a more efficient manner. Customers are provided with the right to use the network so far as there is grid capacity available, during non-peak times for example.

The pilot program for non-firm connection agreements optimises grid capacity use, enabling increased RES integration despite capacity constraints and congestion issues.

While flexible connection agreements are not yet common under Dutch legislations, the early outcomes of implemented pilot initiatives show positive results. Dutch DSOs and NRAs are under ongoing discussions to consider whether and how to increase the use of the practice in the country and turn

3 Challenge: Investment and financing

Challenge: The accelerated transition towards a decarbonised and decentralised energy system and the increase in electricity demand require significant investments in the expansion and smartening of the grid. The European Commission estimates that EUR 584 billion investment will be needed by 2030, with large parts geared towards the distribution grids[25]. With 70% of the renewable capacity connected to the distribution grid, they are at the forefront of the development and will need to invest massively in the renewal, expansion, and smartening (flexibility) of the grid.

Delivering a share of 42.5% renewables in the EU's final energy consumption by 2030 translates roughly into 70% of renewables in the electricity sector. With more than two third of the (mostly volatile) renewables connected to DSOs, investments in the expansion, reinforcement and smartening of the grid need to accelerate. DSOs will have to connect millions of customers and facilitate energy communities while ensuring a certain balance to keep costs efficient for customers. Higher investment needs are also driven by the necessity to increase the resilience of the energy system and to empower customers at local level. A study conducted before REPowerEU and RED III estimated EUR 400 billion from 2020-2030 in the distribution grid which is an increase of 50-70% in comparison with the decade before[26]. According to the EC the REPowerEU objectives alone will require EUR 29 billion of additional investment in the power grid to make it fit for increased use and production of electricity[27].

Some of the obstacles faced by DSOs are summarised below:

- **High level of uncertainty**: Increased uncertainties due to the fast transition of the energy system, the war in Europe and its repercussions (supply chains, raw materials) as well as regulatory challenges (permitting, fast changing legislation) and others (staffing) put DSOs under pressure. A high level of uncertainty entails that more projects are considered high-risk projects, which increases investors' risks, i.e., cost of capital for DSOs.

- **Regulatory framework incl. anticipatory investments**: Higher than average (cost, timing and output) uncertainty needs to be reflected in the regulatory framework, i.e., ensuring that it includes uncertainty management mechanisms to avoid unnecessary increases in the cost of capital. Also, a more forward-looking investment framework (dynamic efficiency) enabled by the regulator would be beneficial. However, DSOs are still confronted with rigid, inflexible regulatory frameworks that hamper (anticipatory) investments.

- **External (EU) funding**: The high investment needs and competition for low-cost financing in the whole energy sector and the lack of DSO-earmarked funds means that DSOs compete with a wide range of "non-grid" projects for EU funds which might appear more attractive. The complex and large-scale focus of EU funding is especially challenging for smaller- and medium-sized DSOs.

- **Barriers in regulatory regimes that inhibit DSOs to get public funding**: Several DSOs face the challenge that regulators often cut the regulated revenues and/or deduct acquired surplus after a DSO acquires public funding through loan or subsidy.

[25] European Commission (March 2023): Staff Working Document: Reform of EMD. SWD 2023/58 final. https://energy.ec.europa.eu/system/files/2023-03/SWD_2023_58_1_EN_autre_document_travail_service_part1_v6.pdf

[26] Eurelectric (2022), op cite.

[27] European Commission (COM/2022/230), op cite. p.14

CEZ GROUP

www.cez.cz/en/home

INFORMATION SUPPORT TO INVESTORS IN RENEWABLE ENERGY

While the Czech Republic is facing the same challenges as all Member States when it comes to investment, in recent years, the country has benefited from a balanced and favourable environment for investments in energy grids in terms of regulatory conditions, support for political representation and readiness of DSOs to effectively invest in network development and integration of RES. Czech DSOs have implemented several initiatives which have proven to deliver positive results for investment.

Information support is provided by DSOs to investors in renewable energy sources through web portals and dedicated applications in Czech Republic.

- The investor receives guidance in the process of connecting RES, with most of the steps taking place fully electronically. Low-voltage plant and micro-source connection guide are accessible online with all connection conditions and regulatory requirements publicly available on CEZ Group's website thus facilitating the process for potential investors.
- In addition, selected data on the state of the network in the given location are available online, in essence all open data. CEZ Group's connectivity map provide information and guidance to investors on the possibilities of connecting a decentralised power plant in their location.

It facilitates the orientation of the interested parties and investors in connecting solar PV sources in procedural and technical issues. These applications ensure automated confirmation of the existence and nature of electrical networks in the given location. Thanks to the connectivity map, investors can make informed choices on the installation location of their decentralised power plants and are incentivised to target areas where grid capacity is available. By doing so, investments in grid infrastructure can be saved ensuring a most efficient use of the network.

4 Challenge : Permitting

Challenge : The rapidly growing need to expand renewables requires fast and smooth processes to connect these sources to the distribution network. Permitting is one of the components in the whole process of connecting renewables that often causes delays and setbacks on both sides : for the renewable installations but also for the grid infrastructure. The connection of new (renewable) installations to the distribution grid often entails grid infrastructure expansion or reinforcement. To facilitate the connection to the new installation, DSOs need to apply for infrastructure permits which are often lengthy and protracted processes which can delay the deployment of renewables.

Connection agreements between generators and DSOs and infrastructure permits for DSOs go hand in hand. Hence, if the permit for the DSO infrastructure takes too long, negative consequences for the application of the connection agreements might follow. While the need for faster procedures for connection agreements is frequently discussed, the necessity to speed up infrastructure permitting for DSOs and the early involvement of DSOs in new generation projects remains untouched. A recently conducted internal survey by DSO Entity showed that DSOs are facing severe problems with costly, complex, and protracted infrastructure permitting processes and administrative hurdles (i.e., lack of resources and flexibility from authorities). Most DSOs struggle with long procedures, but also with expropriation issues (e.g., with landowners, local community), environmental requirements and a high complexity (e.g., specific rules for public roads, railways for which further permissions are needed or too detailed and complex requirements to connect certain technologies).

Furthermore, long permitting processes for renewable installations are problematic; not only for RES developers, but also DSOs, who must keep the reserved network capacity for delayed projects or start searching for new capacity if the issued capacity expires during the authorisation process. If the installation of renewable facilities is delayed due to protracted permitting processes, the plant cannot connect to the grid on time. In the meantime, the power plant connection costs may significantly change, and the project may become economically unprofitable. As a result, some projects may be completely cancelled, and DSOs must unnecessarily hold reserved network capacity for long periods of time without allowing other available technologies to be connected in a fast and efficient way without additional investment to the expansion of the grid capacity.

The long process of issuing permits especially when it is caused by to detailed requirements and procedures poses the risk that the regulation may be changed during the time, and new requirements may be imposed which may cause the situation when renewable energy projects that have been started no longer meet the new requirements and may be terminated.

The **challenges for the DSOs** can be summarised as follows :

- **DSOs are often not involved early enough in the planning of renewable generation projects** : Cooperative planning and the early involvement of DSOs are key to identify technically feasible connection points to prevent problems at a later stage, especially for larger generation projects.
- **No acknowledgement of the fact** that infrastructure permitting, and connection agreements go hand in hand and that DSOs need the right conditions to be able to connect renewables.
- **A lack of streamlined permitting processes (such as one-stop-shops)**.

Netherlands

ENEXIS NETBEHEER
www.enexis.nl

SIMULTANOUS PERMIT- AND GRID-CONNECTION-GRANTING PROCESSES FOR WIND FARM INSTALLATION

In general, the permit-granting process for the installation of new generation capacities proceed without any consultation with the DSOs regarding the grid capacity at the chosen location. As a result, another procedure to grant a permit for grid connection is needed as an additional step, thus leading to increased procedural delays to connect new renewables to the power network.

Recently in the Netherlands, TSOs and DSOs have been working together to ensure a better and upstream integration of the considerations of transmission and distribution grids on the state of the grid capacity into the permitting procedures for the installations of new wind farms or solar parks.

In most cases, for windfarm projects, the location is chosen and receives authorisation before the start of the permit-granting process for the connection to the grid and/or to substations. Therefore, it is only after the permitting procedure of the windfarm is completed that the procedure to accommodate (and permit) the potential expansion of the grid starts.

Dutch DSOs and TSOs cooperate and are involved in the spatial planning at regional level in the Dutch provinces. Thanks to their close cooperation and an early planning of network development, **a more integrated approach of permitting processes** is achieved. It is particularly important in the case of the installation of new wind farms or solar parks as most of them require an expansion of grid capacity of both the distribution and the transmission networks.

Therefore, DSOs and TSOs strive to:

- Be specifically included in the permitting procedures by providing information on when and how grid-related investments are needed to connect new wind farms.
- Establish a synchronisation between the permit-granting process of new installations and the permit-granting process for its connection to network infrastructure to ensure that the permits are granted in parallel to the asset construction.
- Cooperate with the municipalities to allow for one-step permit-granting processes instead of a two-step (often disconnected) approach creating delays for the installation of wind farms.

Thanks to a more integrated approach and strong cooperation with partners at different levels (between TSOs and DSOs, and between DSOs, TSOs and local and regional authorities), DSOs contribute to accelerating the permitting procedures and therefore reducing delays to connect new renewable generation capacities to the grid.

DIGITALISATION OF PERMITTING PROCESSES

In Portugal, the licensing of energy production facilities and the licensing of connection infrastructures to the public service network are different processes that, however, converge towards the same purpose: guaranteeing permission to operate the facilities and the flow of the energy produced to the network.

Licensing is supported by complex and long processes that involve at least the promoter of the production unit, the DSO or TSO and, depending on the case, the licensor (national level authority for the licensing of electrical installations), municipalities and owners of the land used. If there are other impacts, namely classified or protected areas, watercourses, highways, railways or other existing infrastructure, licensing becomes more complex as it requires the acceptance of all entities responsible for the affected resources. Due to the sequential process of project approvals by several different entities in combination with a lack of warnings or penalties to avoid delays, several permitting licenses accumulate delays, out of control of the DSO, andw not compatible with investment needs.

How to address the challenge?

To simplify, speed and continue monitoring this complex process, E-REDES is currently involved with national responsible authorities to develop and operationalise an **online portal** that will allow the submission of the requests, upload the necessary information and project, approve necessities by competent entities and monitor systematically the whole process.

Licensing guide for onshore renewable energy projects

The initiative of a licensing guide for onshore renewable energy projects was launched in July 2023 by the Portuguese Renewable Energy Association, Portuguese Environmental Agency and Directorate -General Energy and Geology. It aims to guide promoters on the procedures to adopt for licensing energy production facilities. The initiative involves various agents, from promoters to DSOs and TSOs. E-REDES was invited to participate in forums of discussion and clarification of the process and to comment and contribute to improving the final version of the guide.

Digital platform for licensing connection infrastructure to the public service network

The big challenge in streamlining licensing procedures is digitalising the permitting process. E-REDES has joint efforts with the national authority to develop and implement a single digital platform that allows the **total dematerialisation of the complex permitting process** (" zero paper " needed). After the release of the first module of this development at the end of August 2023, the platform will get by the end of December, expectedly, all the necessary tools to guarantee interaction and control of response deadlines for all interested entities, with the possibility of the responsible authoring to grant permitting being able to impose a response deadline or a tacit approval.

5 Challenge: Network tariff regime

Challenge: For DSOs as regulated entities, suitable network tariff regimes are key to finance the needed investments. If tariffs are not well designed, this could lead to a remuneration deficit and, therefore, the system agents may not receive the necessary compensation for the services provided. Current evolutions in the electricity system such as the high increase of solar PV in the distribution grid or flexible connection agreements require that the tariff regime keeps pace with these new developments and avoids imbalances in the system.

Electricity network tariffs have traditionally evolved in parallel with the organisation and regulation of electricity systems: so, from integral tariffs based on bundled services and costs under the paradigm of vertically integrated utilities, regulated as monopolies, to deregulation and markets, with a separation between energy as a commodity and regulated tariffs to allocate transmission and distribution costs from monopolistic activities and other regulated costs[28]. Nowadays, electricity systems are facing new evolutions, and electricity tariffs should evolve accordingly.

On the one hand, the high increase of DER and self-consumption installations in electricity network highlight the need of revisiting electricity tariffs. These new technologies are available directly at the premises of end users for changing the way they consume, self-produce, or store their energy requirements, which enables customers to respond to electricity prices and regulated tariffs. If these economic signals are cost-reflective, this will create savings for the customers and for the whole system. A tariff redesign should, thus, consider the new opportunities for (grid) efficient customer behavior.

However, it is important that network tariffs are applied to renewable generation installations in line with their use of the network. Otherwise, this could lead to a distortion of fair competition and/or underfinancing of the grid. For instance, in some countries, such as Spain, regulators have exempted all the generation connected to the national electricity system from access tariffs payments. The objective is to avoid market prices that internalise the network tariffs and to provide an incentive for renewable installations deployment. However, this practice may negatively affect the economic system equilibrium in the long term and require public subsidies to avoid losses, which could affect DSOs remuneration. The future regulatory framework must find a solution that uses the massive deployment of DER and its reaction capacity to its advantage without over-incentivising its use, when it is not efficient for the system.

The application of the following principles is key:

- non-discrimination, i.e., no special tariff or treatment for certain technologies or applications, such as EV charging for instance, and
- cost-reflectiveness, i.e., incentives to trigger optimal behavior and allocation of costs to the actor who is at the origin of it, are key. Various options could foster cost-reflectiveness in a future energy system, but will require considerable caution in practice, examples are time of use tariffs, tariffs for generators (feed-in tariffs) or capacity-based tariffs.

On the other hand, there are new innovative types of access and connections permits, such as flexible connection possibilities, that require investments by DSOs in technology and active management, such as control system technology and software, to actively manage the installations under these circumstances. These DSO expenditures need to be financed as an additional CAPEX/OPEX component for both the investment and management. If this is not the case, DSOs income will be negatively affected as these flexible connections are drastically increasing due to capacity constraints. These issues have led to an essential discussion regarding the network tariff regime that should be applied to these installations to keep the economic system in balance, but also to provide an economic incentive for promoting a higher penetration of renewable energy when needed. For DSOs as regulated entities, suitable network tariff regimes are key. If tariffs are not well designed, this could lead to a remuneration deficit and, therefore, the system agents may not receive the necessary compensation for the services provided.

[28] Pérez-Arriaga, I.J. et al. (2013) " Electricity tariffs ". In Regulation of the Power Sector; Power Systems; Springer: London, pp.397-441

fluvius.

www.fluvius.be

INTRODUCTION OF A CAPACITY TARIFFS

Like other countries/regions described in the paper, Flanders expects a strong increase of the electrical consumption due to the electrification of the heating and transportation sector and an expansion of the renewable decentralised installed capacity. More electrification together with the specific simultaneous behaviour of these newly introduced technologies (e.g. heat pumps, EVs) and the intermittent and less predictable behaviour of renewable energy sources (RES) will introduce balancing risks and might lead to peak demand and congestion risk in the distribution grid.

Considering these future challenges for the grid, the Flemish government included the introduction of a capacity tariff (a tariff that reflects the capacity a customer reserves) in its government program (policy paper) for the new legislative term 2014-2019. The idea was that a capacity tariff should implicitly and proactively influence customers' individual behaviour and secure the optimal use of the grid by reducing the capacity system peak. After more than three years of intense deliberations between the sector, the DSOs, civil society and the regulator the capacity tariff for all grid users was introduced in Flanders as of January 2023. The wide consultation process should ensure that the tariff mechanism meets several criteria, such as cost-reflectiveness, social compatibility, transparency, non-discrimination and general comprehensibility to name but a few.

Reasoning: Making usage of implicit flexibility

The general reasoning behind the introduction of the capacity mechanism was that only investing in a robust and reliable infrastructure ready to support operational security in various grid conditions would be very costly and would not solve the problem of balancing risk. To tackle especially the challenge of congestion, the short-term and locally available (implicit) flexibility was addressed. Implicit flexibility is basically a price incentive that influences the behaviour of the customer, for example, by shifting part of the consumption to another time frame, to optimise the use of the grid and thereby reducing the simultaneous system peak. After all, grids need to be designed for this peak value. By spreading the consumption (and reducing their individual peak) customers can optimise their individual energy bills.

Simply spoken, such a price signal should prevent users from plugging in all electrical devices at the same time which strains the grid, especially if all households do the same simultaneously. By introducing a capacity component (kW) as a cost driver in the grid-fee instead of only a volume component (kWh), customers are not solely incentivised to reduce their energy consumption but also encouraged to use the energy at the right moment.

Concrete implementation in Flanders

Two different tariff structures were implemented in Flanders as from January 2023:

- one low-voltage tariff (small customers, households), and
- one medium-voltage tariff (larger customers).

For the low-voltage tariff in addition to the volume-based price signal (€/kWh) also a peak tariff was introduced. These users pay now a part of their grid fee based on the grid capacity (€/kW) they use, i.e., their peak consumption. Customers with a digital meter pay most of the grid costs based on the monthly maximum of the measured capacity and a smaller portion for the consumption. The basis for the capacity part of the tariff is the mean value of the monthly maximum peak (measured 1/4-hour value) of the past 12 months. For those without a digital meter a capacity value of 2.5 kW is assumed and billed. The remaining consumption-based tariff (€/kWh) is higher for customers without a digital meter compared to the tariff in €/kWh for customers with a digital meter.

Larger customers are billed monthly. Previously, they were already billed based on their maximum measured 15' peak. As from January 2023 they are additionally charged on the capacity they reserve from the grid, by a nomination in advance.

The current grid fee tariffs are the same throughout the year, they do not vary in time (e.g., season, time of the day). Analyses are ongoing to investigate the cost reflectiveness and added value to integrate time of use elements in the grid fee tariff.

Although the capacity tariff in Flanders was only introduced a year ago, the first positive trends are already visible. Especially among users of new flexible appliances, such as EVs or heat pumps, a change of behavior pattern is observed. They are reacting to the new tariff by avoiding a too intensive usage of the grid at the same time. This is beneficial for the grid, since less costly grid enforcements are needed and also better for the customer. S/he can make the energy transition towards more electrical consumption (i.e., EV, heat pump, …) and keep her/his energy bills under control.

6 Challenge: Regulatory framework and technical rules for grid connection

Challenge: Provisions for the implementation and support of renewable technologies are mostly geared towards the needs of market participants, but rarely consider the (technical) needs of the grid to connect new resources. This leads to a situation in which the implementation of new regulations and renewable support schemes do not always keep pace with rapidly changing technologies. In such situations, national regulations can impede a swift and efficient connection of renewables to the grid, either due to a lack of clear rules and guidelines or overregulation.

Lack of clear rules: The last few years saw an unprecedented increase in decentralised energy resources (DER) such as small, modular resources, hybrid electricity generation and storage technologies which need to be connected to the distribution grid. Existing regulation can often not keep pace with this rapid appearance of new technologies resulting in a lack of timely implemented rules and requirements for connecting them. Consequently, DSOs face problems when being confronted with the requests of market participants to efficiently implement new technologies such as certain batteries, since it is still not clear how such processes should be carried out from the operator's side. In such cases DSOs face issues with not being able to connect new more efficient technologies but must invest in the expansion of the grids to connect more of long existing technologies to ensure the same needs of the electricity market.

Overregulation: Another problem that DSOs face when ensuring the connection of renewables to the grid is too much segmentation of different users' groups, such as private customers, producers, or renewable energy communities. This creates many variables that lead to the need for distribution network operators to apply many different RES connections to the grid processes. Even though the process of connecting the power plant and accounting of the produced electricity is carried out in the same way for different groups, separate requirements for certain groups due to their status in the market or expected activities create an excessive burden by applying very similar but slightly different processes for connecting power plants to the distribution network.

The relevance of Grid Connection Network Codes for connecting renewables

The description of the challenge showed that in some Members States clear technical rules and requirements for connecting new technologies to the grid are often missing. This can lead to delays and inefficiencies. The fast uptake of DER in recent years poses a special challenge, however, is now being tackled at the European level with the amendment of two of the existing Grid Connection Network Codes.

In general, the topic of (technical) grid or network connection is one of the areas regulated by the specific network codes. Currently, there are three NC on Grid Connection:

- NC RfG Regulation establishes common standards that generators must respect to connect to the grid.
- DCC Regulationsets up harmonised requirements that demand facilities must respect to connect to the grid.
- VDC Regulation covers the definition of harmonised standards for direct current (DC) connections.[29]

These requirements should establish a harmonised electricity grid connection regime that ensures efficient and secure operations. Given the magnitude of new DER connected to the distribution grid, European rules are more needed than ever.

Currently, two of the three Grid Connection Network Codes are in the process of being amended: the NCs on RfG and the DCC. The objective of the amendment is to update the existing codes and develop clear technical requirements for e-mobility (mobile storage / EVs, electrical charging points), storage, mixed customer sites, active customers and energy communities.

[29] https://www.acer.europa.eu/electricity/connection-codes

eso
www.eso.lt/en/home.html

QUOTAS FOR DIFFERENT TYPE OF RENEWABLE ENERGY SOURCES AND PRIORITY GROUPS FOR ACCESS TO THE GRID

Lithuania, as many other countries, is confronted with the need to connect new renewables while ensuring an effective usage of grids and responding to the needs of different users and social groups. Decisions have been made so that technologies or user groups requiring longer RES connection processes are not overshadowed by other faster developing projects.

Excessive regulations for RES deployment

In Lithuania quotas for different types of renewable energy sources and priority groups for access to the grid were established by law. Thereby available TSOs grid capacity was allocated to different technologies (solar and wind) as well as to many different user groups, such as renewable energy communities, private prosumers, legal entity prosumers or producers. The allocation of the capacity was assigned to the DSO grid. So, the DSO is responsible for determining and coordinating network capacity proportions with the regulator, verifying remaining capacity and offering possible alternatives if the capacity is no longer available for a particular user.

The intention of the regulation was to ensure that the slower uptake of certain technologies and user groups with less capability to develop new renewable projects would still have the opportunity to connect to the grid. Among the prioritised user groups were for instance (municipally owned) renewable energy communities. The effect of the measure is twofold: On the one hand, this measure guaranteed that not only commercial producers take all the capacity but also community projects. On the one hand this regulation entailed that some of the user groups have no grid capacity left to connect new RES power plants whilst others have grid capacity, but do not (yet) have the knowledge or financial resources to implement PVs or wind power plants. This leads to a situation in which the DSO grid is not utilised efficiently and frequently blamed by unsatisfied user groups although they are not allowed to make decisions on how to distribute available power.

This practise shows that attempts to provide a fair and just energy transition that includes everyone, can be difficult to achieve and learnings are still ongoing. One early learning is for instance that the large amount of different user groups should be reduced from eleven to three what will reduce complexity, also, for the DSO.

REGULATORY REFORM ON SIMPLIFYING AND HARMONISING THE CONNECTION REQUESTS

To accelerate the energy transition and to consider the new evolutionary needs of the electricity system - such as high increase of connection requests, mostly from small production plants in self-consumption, large offshore plants, storage, charging infrastructures for EVs - the Italian regulatory regime is going through a profound process of reform regarding the grid connection rules for generation plants.

The reform was launched with a consultation document of the Italian Regulatory Authority (ARERA) and a first preliminary deliberation as the result of simplifications introduced by European directives. The overall reform should have two effects: on the one hand, it will impact in the short-term directly the technical methods, economic and procedural aspects for connecting production plants and on the other hand, it should unify and harmonise in the long-term the procedures and methods of access to the electricity networks - both in relation to electricity production plants and in relation to customers.

- The innovative changes proposed by ARERA aim to accelerate the connection of small production plants, for example, by extending the application of the simplified documentation, the so-called " Modello Unico ", to several types of production plants to manage efficiently their connection.
- Further, this " Modello Unico " introduces an important simplification of the documentation and management of the necessary data to register the production plant, thereby, reducing the possibility of mistakes and easing the conditions for the producer.
- Another important foreseen change is the possibility to rapidly connect production plants to the network, i.e., within five days, if the connection of the plant does not require heavy and relevant grid reinforcement works.

NETWORKS

www.esb.ie/home

Ireland

GROUP PROCESSING OF GENERATORS APPLICATIONS

Introduction and background

In 2004, applications to connect windfarms to both the DSO and TSO, which had been very rare, began to ramp up significantly. Prior to this point, applications were processed by both SOs, sequentially and in isolation. In addition, they were well geographically dispersed and hence did not really interact with each other.

This sudden rise was a concern to the TSO –(EirGrid), given that it is an Island System, and they convinced the regulator [CRU], to impose a moratorium on the processing of such connections, until certain technical provisions were put in place. This was done and indeed, many of the new requirements identified at that time, were fore runners to what ultimately became the RfG Network Code.

However, all this took about a year to put in place. In the meantime, the rate of application increased still further and by the time the moratorium was lifted, both SOs, were left with a huge - and still growing - stack of applications which became known as " the queue ".

What to do?

It was clear to both SO's and the regulator, that resuming the previous sequential processing was not appropriate and a new approach was required. Many options were considered.

- **Treat the entire queue as one batch**: This was looked at but the available resource from both SO's could not possibly do it in a reasonable timeframe.
- **Take batches from the stack sized such that they could be processed by the SO's**. But then – how to select them?
    - Pure date order? Arguably the fairest approach but would lead to sub-optimal network planning as other connections that were in the immediate vicinity would be ignored.
    - Network optimisation? The most efficient approach from an SO perspective but could potentially disadvantage those ahead in date order.

Ultimately, each of these and combinations of them were used in successive batches, which initially came to be known as " Gates ". For each Gate, the regulator hosted discussions with TSO/DSO and the wind industry on the criterion before issuing Directions to the SOs accordingly.

Did it work?

It is not claimed here that the Group approach was perfect by any means. No matter what approach was taken, there was always going to be parties who felt that they lost out on not getting a timely connection. That said, the process was somewhat dynamic, and improvements/efficiencies evolved over time. Many new aspects necessarily had to be created along the way such as,

- Joint parallel processing of both distribution network design and transmission implications.
- Capture of related transmission reinforcements and associated charges in the DSO Connection Agreements.
- A system of allocating costs to the connecting parties for shared assets to be built.
- Re-distribution of costs from new connecting parties to those who had already paid for new shallow and deep assets.
- Varying degrees of optimisation of network planning for interacting applications.
- A transparent system of charging for reinforcements.

The queue unfortunately, is still with us and variations of this approach continue to be operated, more recently called " Enduring Connection Policy " (ECP). At the time of writing, discussions on a successor to ECP are ongoing.

Technical repercussions of more RES in the grid: uncertainty on the technical impacts of Grid Forming Capability (GFC) on the operation of Distribution Networks

The energy transition includes the very significant displacement of traditional transmission-connected fossil-fuelled generation, to be replaced with large volumes of distribution-connected renewable generation. The former has natural characteristics which provide necessary overall system stability; the latter does not naturally provide such characteristics.

To ensure the overall system remains manageable, TSOs are investigating the technical requirements for renewable generation to be able to provide the necessary future stabilising characteristics. Among these are what is commonly referred to as " grid forming ", as distinct from the existing renewable technologies, which are termed " grid following " in contrast.

The question of how grid forming shall be considered in the revision of the European Network Code on RfG is currently debated. Since the technology is new, with only experimental experience in DSO grids. Since it has not been deployed at scale in distribution systems, DSOs have significant safety concerns about the propensity for grid forming technology to allow uncontrolled unintentional power islands to occur and persist. Nevertheless, the need to recognise grid forming technology in DSO's network to supplant the grid forming capabilities of transmission-connected generation, which is being displaced, is generally acknowledged.

The core question will be to find an acceptable roadmap to any mandatory deployment, in terms of scale and pace of introduction, that will be manageable by DSOs. The challenge for DSOs will be dependent on the detailed design of their networks and are thus very far from uniform. The RfG revision is still ongoing.

7 Challenge: Staff and skills shortage

Challenge: Across the EU, the labour market is not transforming fast enough to support the energy transition and many skill shortages are being reported. DSOs are especially challenged by labour shortages mainly caused by the increase of staff needed to facilitate the energy transition, (i.e., connecting increasing numbers of DERs), the transformation of jobs due to the continuous digitalisation of the sector (i.e., smart grid, cybersecurity), but also the high competition for workers in the energy sector in general. A skilled workforce that can facilitate the renewable and digital transformation (re-, up-skilling, education) is a precondition for DSOs to deliver their part in the energy transition.

With the energy transition, jobs are being transformed and created, while the demand grows for pre-existing specialised jobs. According to the European Commission, the energy transition could lead to the creation of one million additional jobs by 2030, and two million by 2050 [30].While these previsions relay opportunities, labour shortages have been reported in all parts of the energy value chain. Between 40 and 42% of European companies say they experience skills gaps. The most affected labour shortages in 2022 were in the STEM (science, **technology, engineering**, and mathematics), and particularly **ICT sector** [31].This explains why DSOs, who are at the core of delivering the **green and digital twin-transition, are especially challenged by labour shortages**.

The causes of labour shortages reported by DSOs can be explained as follows:

- The high increase in the volume of jobs needed;
- The difficulty for companies to find adequate hiring (profile scarcity, high competition);
- The high degree of transformation of the jobs with very different skills and training needed.

These factors are connected to the fast increase of renewable energy sources deployed and the growing role of new active participants in the European energy market (e.g., energy communities, EV charging points operators, solar PV installation companies, etc.).

The European Commission estimates the investment needs for retraining, reskilling and upskilling in manufacturing of **strategic net-zero technologies** (including grid technologies) between EUR 1.7 billion and EUR 4.1 billion up to 2030. To delivering the transition on the ground, DSOs are in **need of direct and indirect jobs** to manage connection, maintenance and operation. Some specific skilled workforces will be needed in areas such as **renewables, cybersecurity** (i.e., security products, operating systems, etc.), **IT and digitalisation** (i.e., data analyst, technology watch, data architecture).

But also dedicated skilled workers to cope with the related increasing administrative tasks such as managing the growing demand for connecting decentralised generation capacity.

[30] European Commission (September 2020), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Stepping up Europe's 2030 climate ambition - investing in a climate-neutral future for the benefit of our people (COM 2020/562 Final). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0562

[31] European Commission (July 2023): Employment and Social Developments in Europe. Addressing labor shortages and skills gaps. https://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=8553&furtherPubs=yes#:~:text=Employment%20and%20Social%20Developments%20in%20Europe%202023&text=It%20highlights%20c-ertain%20labour%20market,workers%20born%20outside%20the%20EU.

ENEDIS
www.enedis.fr

France

GRIDS SCHOOLS FOR THE ENERGY TRANSITION

In France, 8,300 jobs need to be filled in the power sector every year. The number is only growing with 9,000 estimated, additional jobs necessary to deliver the energy transition and 35% of the jobs in the electricity industry in tension. With 39,000 employees, Enedis is engaged in French territories to retrain, reskill and upskill the network workforce and is involved in an unprecedented skills programme.

In March 2023, Enedis, together with partners from the power sector, launched "*Les Ecoles des réseaux pour la transition énergétique*", i.e., the Grids Schools for the energy transition programme. The programme was developed by Enedis together with the French Ministry of Education and partners, including French TSO RTE.

The **Grids Schools for the energy transition** aims to:

- Anticipate and support the electricity industry's massive recruitment needs taking into account the technical and technological changes of the sector;
- Raise the attractiveness of the sector for young people and people undergoing retraining;
- Provide appropriate training to support the electricity sector's needs for staffing.

Creation of electricity grid classes in vocational high schools

- 40 partner schools for the academic year 2023-2024
- Students from National Vocational Training (CAP in France) to Master degree level

Strong involvement of company partners

- Individual mentoring programmes with one employee from the power sector for one student
- 18 weeks of company internship during the school year

Training courses teachers and educational professionals

- Partnership with the French Ministry for Education
- Setup of training of teachers and education staff to train to the challenges of the energy sector and the jobs of the grid sector

Figure 16: In-brief: Grids Schools for the energy transition programme

Grids Schools of the energy transition started at the beginning of the academic year 2023-2024 with 2,000 students expected to be hosted in 40 vocational high schools for the first year of the programme.

The benefits expected are:

- Young talented professionals better skilled to the future jobs in the grid sector.
- An increase of the recruiting pool available to encourage student success.
- A programme supporting the attractiveness of the grid sector.

The program is expected to be extended to more technical educational trainings as of September 2024 for the second year of the program (to French BTS in electro-engineering).

MASTER'S DEGREE IN SMART GRIDS

In collaboration with the Scottish University of Strathclyde and the Spanish ICAI School of Engineering, the Spanish DSO Iberdrola provides a dedicated training for future grid engineers within the Master's Degree in Smart Grids. This Master of Science degree has for objective to meet the increasing need for engineers vital to smarten and digitalise the grid.

The program provides an in-depth understanding of the operation and planning of the grids (including courses on transmission and distribution grid operation and planning, data analytics and AI, telecommunications of smart grids, cybersecurity, etc.) and presents the business opportunities in the sector. Iberdrola contributes to the master program by complementing the academic knowledge of the universities with practical know-how and expertise on the grid. The one-year program is recognised by the European Credit Transfer System (ECTS) delivering 90 ETCS to the students following the cursus.

RECRUITMENT PROGRAM AND EDUCATION PARTNERSHIP

Czech DSOs have been experiencing a lack of permanent qualified staff since 2020 with a noticeable fall of qualified technicians [32]. Initiatives have been launched to reinforce the connection between the education programmes and the labour workforce needs. ČEZ Group has undertaken active initiatives to address the staffing challenge of the company.

Support of the recruitment in the power sector

ČEZ Group has developed a new recruitment policy in cooperation with communication departments (i.e., marketing communications, information centers, social networks, customer experience and research, diversity and inclusion). It emphasises the job opportunities in the sector by:

- Preparing a series of sector-oriented recruitment videos and a hiring support website.
- Conducting a survey targeting a group of potential job seekers to investigate the perception of the energy sector.

Partnership with the education system

ČEZ Group is also engaged in educational programmes from secondary school to university levels to raise the sector's attractiveness among young people and ensure that academic training are adapted to the power industry's needs. The DSO has been a partner of the Technology Literacy Educational Program and is currently negotiating partnerships with other university programs, such as Prague Czech Technical University. These include lectures by in-house experts, compulsory internships at secondary schools, and participation in summer schools.

[32] https://www.acer.europa.eu/electricity/connection-codes

Conclusion and lessons learnt

3. Conclusion and lessons learnt

UPGRADING THE POWER GRID WILL PLUG EUROPE INTO A SUSTAINABLE FUTURE!

European Commissioner for Energy, Kadri Simson[33]

This paper shows the role and relevance of DSOs in achieving the European climate and energy objectives. Recent legislative actions in the form of the Fit for 55 package and REPowerEU drastically increased the ambitions and accelerated the process to decarbonise Europe. Time pressure for the delivery is high, especially on the distribution grid, which is responsible for connecting most of the new renewable resources, facilitating the electrification of transport (EVs) and heating/cooling (heat pumps), and thereby empowering customers. However, physically enforcing and digitally smartening the power infrastructure cannot be delivered in the blink of an eye. **DSOs remain heavy infrastructure actors and regulated entities that are dependent on the right framework conditions to deliver**. The current situation of increased uncertainties such as disrupted supply chains, staffing shortages and long permitting procedures, additionally aggravates the conditions.

Proactive DSO engagement alone cannot meet all challenges

The paper outlines seven - non-exhaustive - challenges DSOs are currently facing when facilitating the energy transition by connecting decentralised energy resources, especially solar PV. The description of the challenges shows that DSOs are often confronted with obstacles on different levels and ill-fitting framework conditions. The paper also illustrates how DSOs attempt to overcome some of the obstacles by launching proactive initiatives and/or fostering close cooperations with relevant actors to make it work. **Nevertheless, some challenges remain and cannot be solved by proactive DSO action alone, but more fundamental changes in the current framework are necessary to empower DSOs and ultimately customers**. Only then, DSOs can remain enablers of this energy transition and not develop into a bottleneck. Without upgraded, smartened and well-equipped power grids this historic transition towards a renewable energy system will not materialise.

Lessons learnt from shared practices

In the paper seven core challenges are described and practices presented to overcome the following challenges: high demand in short time, capacity constraints, investment and financing needs, permitting, regulatory framework, network tariff regime and staffing shortages. With this paper DSO Entity works toward fulfilling its mandate of "identifying best practices" on several aspects of the energy system as provided in Art. 55(2c) of the Electricity Market Regulation 2019/943/EU. Some general conclusions can be drawn from the displayed practices, but it should be kept in mind that with **more than 2,500 DSOs in the whole of Europe differing in size and capabilities, no one size fits all solution can be proposed**.

[33] Energy Commissioner Kadri Simson (September 2023), op cite.

Lessons learnt from practices addressing the challenge of high demand for RES grid connection in a short time

Situation	During the last few years, DSOs have experienced a spike in application requests for connecting decentralised renewables to the distribution grid, especially solar PV. For instance, in Latvia the number of applications increased 1425% within one year. The significant cost reduction of solar PVs, ambitious European targets, high energy prices and support schemes for the deployment of renewables have caused this boom. So, in 2021 solar PV still had the highest average support level with around 136 €/MWh.
Practice highlights	The practices from Austria (Netz OÖ) regarding the simplification and digitalisation of the procedure for solar PV feed-in requests and Italy (E-Distribuzione) show how digital tools and their innovative application can help manage an increase in requests with a limited number of staff.
Learning	These practices illustrate that sufficient investments in the digitalisation and smartening of the grid are vital for enabling innovative solutions that can lead to efficiency gains and a faster deployment of renewables.

Lessons learnt from practices addressing the challenge of capacity constraints

Situation	The rapid and accelerated expansion of renewable capacity, driven by the EU's renewable targets and the intention to quickly reduce the EU's dependence from Russian gas, has led to a boom in electricity demand exceeding the distribution grid's original design and capacity. DSOs are facing growing pressure to ensure sufficient capacity to cope with the surge of decentralised and intermittent power generation and always keep the electricity demand and supply in balance.
Practice highlights	The practices from the Netherlands (Alliander) and Denmark (Netselskabet N1) show how capacity constraints can be better managed through innovative concepts, closer cooperation and more transparency. In the Netherlands pilot projects with flexible connection agreements are developed which enable DSOs to connect more customers to the grid without having to expand the grid capacity immediately. The geo-dependent standard connection fee in Denmark incentivizes renewable production in consumption dominated areas, which reduces the need for reinforcement of the grid, and hence, allows for a faster integration of renewable production. Furthermore, most countries or DSOs are publishing capacity or connectivity maps that help developers find spots with available capacities.
Learning	These practices show that incentives for a grid-supportive behaviour of customers and investors can accelerate a cost-efficient and faster deployment of RES. Here again, positive adaptations in the regulatory environment of DSOs are key to guarantee an optimal outcome.

Lessons learnt from practices addressing the challenge of investment and funding

Situation	Delivering a share of 42.5% renewables in the EU's final energy consumption by 2030 translates roughly into 70% of renewables in the electricity sector. With more than two thirds of the (mostly volatile) renewables connected to DSOs, investments in the expansion, reinforcement and smartening of the grid need to accelerate. A study conducted before REPowerEU and REDIII estimated EUR 400 billion of investments for 2020-2030 in the distribution grid which is an increase of 50-70% in comparison to the decade before . According to the EC, the REPowerEU objectives alone will require EUR 29 billion of additional investment in the power grid to make it fit for increased use and production of electricity .

Practice highlights	In the Czech Republic (CEZ Group) within the last few years, DSOs could benefit from a balanced and favourable environment for investments in terms of regulatory conditions and support of DSOs to effectively invest in network development and the integration of renewables.
Learning	The practice illustrates that a supportive, more forward-looking, regulatory framework that helps DSOs reduce uncertainties is key in tackling the investment challenge and enabling DSOs to facilitate the transition towards a more renewable and decentralised energy system.

Lessons learnt from practices addressing the challenge of permitting

Situation	The rapidly growing need to expand renewables requires fast and smooth processes to connect these sources to the distribution network. The connection of new (renewable) installations to the distribution grid often entails grid infrastructure expansion or reinforcement for which DSOs need to apply for infrastructure permits which are often lengthy and protracted processes which can delay the deployment of renewables.
Practice highlights	The example from the Netherlands (Enexis) shows how bundling of permitting can overcome several obstacles by, for instance, synchronising permitting procedures for assets like a wind farm and the grid infrastructure. Involving DSOs and TSOs in the spatial planning on regional/provincial level adds additional benefits. DSO and TSO cooperation when liaising with municipalities on grid-related permits both accelerates the procedure and improves the cooperation between DSOs-TSOs. Increased cooperation, but also the digitalisation of processes as displayed in the Portuguese example (E-Redes) are factors that can accelerate lengthy permitting processes.
Learning	The early involvement of DSOs in renewable project planning and a cooperative relationship between developers/investors, DSOs and TSO are key success factors for smooth (connection) processes as was shown by the practices.

Lessons learnt from practices addressing the challenge of network tariff regime

Situation	For DSOs as regulated entities, suitable network tariff regimes are key. If tariffs are not well designed, this can lead to a remuneration deficit and, therefore, the system agents may not receive the necessary compensation for the services provided. Current evolutions in the electricity system such as the high increase of solar PV in the distribution grid or flexible connection agreements require that the tariff regime keeps pace with these new developments and avoids imbalances in the system.
Practice highlights	The example of the introduction of a capacity tariff in the region of Flanders in Belgium (Fluvius) illustrates how changes in the systematics of grid fees can work to the benefit of the grid and the customer. By putting more emphasis on the capacity component of the electricity bill, customers are incentivised not to overuse the grid at the same time. Not even after a full year into force, customers are already reacting to the new tariff by avoiding a too intensive usage of the grid at the same time. This is beneficial for the grid, since less costly grid enforcements are needed and also better for the customer who can keep his energy bill under control.
Learning	The example highlighted that incentives for a grid-supportive behaviour of customers through price signals are efficient and supportive for both the grid and the consumer. Again here, positive adaptations in the regulatory environment of DSOs are key to guarantee an optimal outcome.

Lessons learnt from practices addressing the challenge of regulatory framework and technical rules for grid connection

Situation	The last few years saw an unprecedented increase in decentralised energy resources (DER) such as small, modular resources, hybrid electricity generation and storage technologies which need to be connected to the distribution grid. Existing regulation can often not keep pace with this rapid appearance of new technologies resulting in a lack of timely implemented rules and requirements for connecting them. In general, national regulations can impede a swift and efficient connection of renewables to the grid, either due to a lack of clear rules and guidelines or overregulation.
Practice highlights	The practices from Lithuania (ESO), Ireland (ESB Networks) and Italy (E-Distribuzione) show that cooperation between DSOs, TSOs and regulators in devising and implementing the right regulatory framework is important. Especially at times of growing uncertainties, reforming systems is often more a learning process which could require several attempts to arrive at the most suitable solution rather than a straightforward process.
Learning	A transformed, intertwined and integrated energy system cannot thrive if it is still operating within an outdated framework of rules and regulations. The practices showed that adapting the regulatory framework is key to manage new challenges and that dialogue and communication between all the involved actors are a prerequisite for an optimal outcome.

Lessons learnt from practices addressing the challenge of staff and skills shortage

Situation	DSOs are especially challenged by labour shortages mainly caused by the increase of staff needed to facilitate the energy transition, (i.e., connecting increasing numbers of DERs), the transformation of jobs due to the continuous digitalisation of the sector (i.e., smart grid, cybersecurity), but also the high competition for workers in the energy sector in general. The most affected labour shortages in 2022 were in the STEM (science, technology, engineering, and mathematics), and particularly ICT sector , which explains why DSOs, who are at the core of delivering the green and digital twin-transition, are especially challenged by labour shortages.
Practice highlights	The practices from France (Enedis), the Czech Republic (CEZ group) and Spain (Iberdrola) show how DSOs with the support of public organisations and/or in close cooperation with the educational system attempt to proactively tackle staff shortages.
Learning	The depicted practices highlighted that managing external factors, such staffing shortages, must be a collective effort with sufficient support from governmental organisations. Also, initiatives at the EU level, such as the European Net-Zero Academies, can support DSOs to address the challenge.

To sum-up, the paper highlighted the efforts undertaken by DSOs all over Europe to facilitate the requests of customers to connect renewables to the grid despite facing multiple challenges at the same time. It can be concluded that DSOs try their best to stay on track to be " Fit for 55 " and continue acting as promotor of this energy transition. However, as regulated entities, they are dependent on the right framework conditions and adequate support to be able to live up to their role as key-partner of renewables, facilitator of customers' needs and enabler of the energy transition.

DSO ENTITY
DSOs FOR EUROPE

Rue du Luxembourg 3 (Nordic House) | 1000 Brussels, Belgium
info@eudsoentity.eu | www.eudsoentity.eu
European Transparency Register Number: 479956248822-45

@eudsoentity
@DSOEntity_eu