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Solar Connection

Key Outcomes

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A set of roundtables between DSOs and the Solar PV industry

Solar energy is leading and overtaking fossil fuels across Europe. The European Commission has targeted 600 GW of total installed PV capacity by 2030 to offset the loss of Russian imports. This growth represents a revolution in the distribution grids, which must adapt to the increasing solar PV capacity. Congestion issues are likely to emerge across Europe as a result.

The Solar Connection project was designed to address this challenge through a collaborative approach. Experts from the solar and distribution system operation (DSO) industries across Europe, came together to discuss grid integration optimisation, identify best practices, and develop joint solutions. To that purpose, Eurelectric and SolarPower Europe organised a series of three roundtables:

1. The first focused on bottlenecks in individual grid connection procedures at the project level.
2. The second examined network development plan practices and investments at the system level.
3. Finally, the third roundtable took a cross-cutting perspective, assessing bottlenecks in deploying flexibility resources within the distribution grid.

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D/2023/12.105/39

Key Messages

- **Forward-looking approach:** secure the necessary grid investment based on political objectives and 2050 perspective. Security of supply, smooth integration of RES. **Political support** is crucial to secure the necessary infrastructure deployment, notably through **anticipatory planning and investments.**

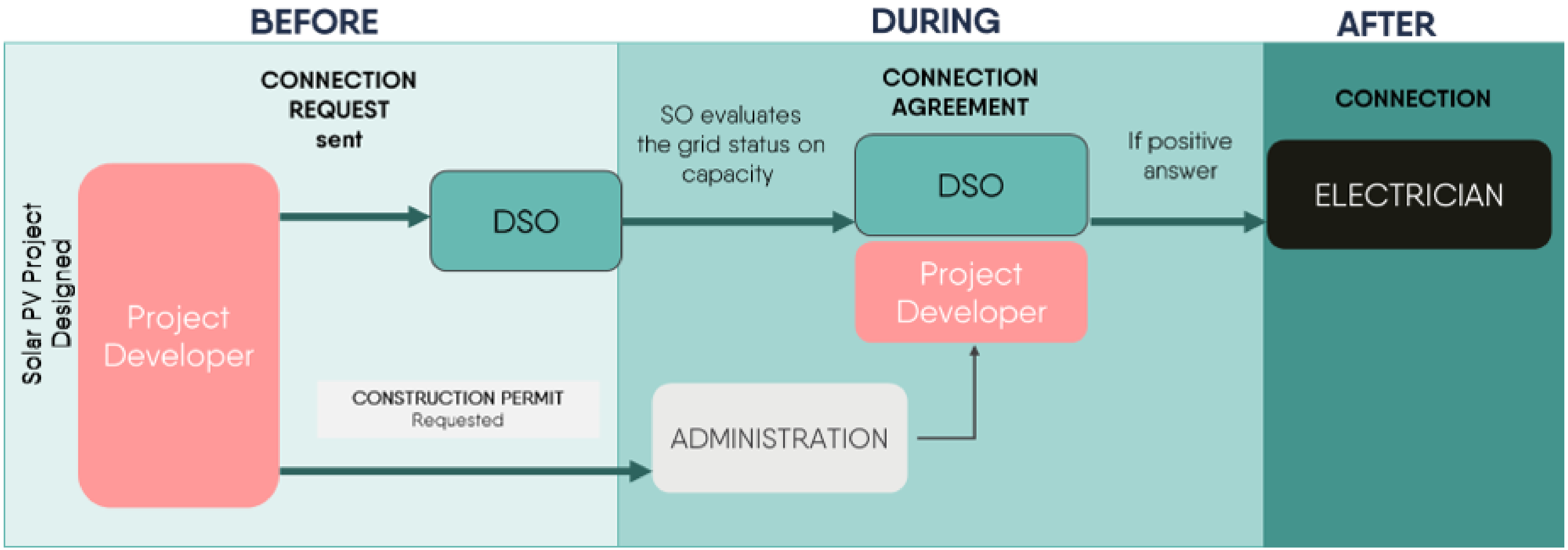
- **Make the EU governance structure up to the challenge** of grid modernisation, expansion, and digitalisation. The EU should propose new grid governance instruments beyond the existing TYNDP, that will include the distribution level, to ensure the implementation of the clean energy package, monitor the performance of grid infrastructure and facilitate the exchange of best practices.

- **Standardise and digitalise connection procedures:** grid connection procedures must be streamlined, standardised, and digitalised to bring clarity and efficiency to the procedure while ensuring full transparency for **market stakeholders**. The implementation of deadlines can be incorporated for the most efficient achievement of this goal.

- **Incorporate flexibility:** decarbonising the EU means integrating DERs in the distribution grid. This requires an **assessment and mapping of flexibility needs and solutions** to efficiently manage grid capacity and optimise the use of all generated power.

- **Encourage innovation to develop efficient grid and capacity management solutions:** to facilitate energy transition, **innovation** in deployed technologies and operational practices is required. Policymakers and regulators must foster innovation through the **regulatory framework** and **incentives**.

Grid Connection



Grid connection procedure phases (simplified)

Grid connection procedures impact the economics of a solar project, while speculation on grid connection can amplify the grid queue. Europe and the USA have around 1,000 GW of solar projects in the queue to be connected. Optimising all steps of the grid connection procedure is paramount to achieve an efficient and faster integration of assets, for small to large-scale solar photovoltaic (PV) projects. This relies on improving transparency, communication, digitalisation, and standardisation.

Grid Connection

Firstly, it is essential to establish harmonised, national rulebooks, which describe grid connection processes, timelines, and the respective roles of stakeholders, something which is currently not available. The rulebook must be comprehensible to everyone: dedicated training programmes should be implemented to enhance awareness among all supply chain actors about the process and their respective roles in it. This holds particular significance in countries with numerous DSOs, such as Germany with 800 DSOs.

In addition, the EU connection network codes, such as the Requirements for Generators (RfG) code, must better address solar integration challenges to optimise the grid connection process. In particular, the current network code should ensure:

- Consistent grid connection rules and certification processes for small PV power plants: while the grid connection rules are well harmonised in the EU at a high-voltage level, they differ widely at a lower voltage, creating burdens for EU manufacturers in the rooftop PV market. Standardising achievable inverter requirements through an “EU passport” system would enhance clarity and consistency, benefiting international inverter manufacturers.

- A definition of a simplified notification grid connection procedure: DSOs should establish clear criteria and conditions specifying when a single notification suffices for grid connection, accomplished by defining thresholds for 'small PV' and 'prosumer PV' installations. Examples of this can be seen in Spain and Italy where simplified procedures already exist.

- Improved hybridisation at the connection point: hybrid systems (solar + storage or a combination of renewable energy sources like wind + solar) should be actively included in the capacity mapping and flexibility provision. Portugal and Spain serve as notable examples of hybridisation.

Secondly, it is crucial for project developers to have clear visibility of the existing available network capacity when planning their projects. This can be achieved through a system where DSOs communicate data and adhere to transparent guidelines, following an EU-wide nomenclature. Such transparency would enable PV developers to make better-informed decisions about their project size and location, as done by some DSOs who spontaneously designed capacity maps. However, these capacity maps must be an obligation for all Member States to implement, where regularly updated information for all grid users at all voltages, on available network capacity, is mapped and published with EU-wide nomenclature and granularity guidelines.

Once the connection request is submitted, the developer must have access to the progress of the process, with estimated time, responsible body, and indications for upcoming steps. This could be achieved via a ticketing system, a software that allows clear tracking of individual requests. One-stop shops could be established to streamline the application procedure between developers, DSOs, and public authorities, thus enhancing communication and coordination between all relevant parties. Grid connection procedures should be bound by clear timelines that grid operators can reasonably meet, subject also to the release of grid works permitting by authorities where necessary. These recommendations align with the revised Renewable Energy Directive's (RED) timescales and proposals for accelerated grid permitting, qualified as overriding public interest, and they should be enforced until climate neutrality is achieved.

This implies the need for streamlining grid development permitting. Policymakers must take decisive action to expedite permitting procedures for grid infrastructure while adhering to environmental imperatives. Administrative delays should be minimised by recognising the crucial role of grid development, thereby avoiding any hindrance to RES projects, which are themselves boosted by the RED directive.

Network Planning

The traditional approach to network planning needs to adapt to the challenges of the evolving energy system in the EU. Non-anticipatory regulations have solidified practices in an outdated model that fails to consider the emerging paradigms.

So where do we start?

To get started, a shift in distribution network planning should be initiated towards a forward-looking approach. This involves anticipating the implications of the solar energy industry's expansion. This planning should extend over a longer horizon, spanning 5 to 10 years, and align with national energy planning exercises (NECPs), incorporating a perspective that extends to 2050. It is imperative to maintain close coordination with industry stakeholders and regional political authorities throughout this process.

Also, following the 45 % EU RES best-case scenario, Member States should ensure that the grid plans are in line with climate neutrality, by adding corresponding renewable scenarios, to test and better understand the grid needs in scenarios with high renewable shares.

In addition to the necessary evaluation of grid extension, network developments should also consider non-grid reinforcement solutions, including infrastructure digitalisation and flexibility deployment. Therefore, network development plans should include an analysis of investment needs in smart grid deployment and management, as well as an assessment of flexibility needs, as essential components of efficient network planning. Based on this assessment, action plans for implementing the required technologies should be formulated.

Secondly, the EU's current infrastructure planning primarily targets high voltage and interconnection levels, making it ill-equipped for the local scale. Network planning must be developed at low voltage levels where most of the grid connection of solar PV is happening with an adapted approach, distinct from TYNDP as the distribution grids have their own specificities, The efficient national implementation of network development plans for DSOs, as outlined in Articles 32(3) and (4) of the Electricity Directive is crucial. The Clean Energy Package establishes clear requirements for modern network planning, but there is a significant implementation gap and a lack of monitoring at the EU level. It is crucial to start the modernisation journey of network development plans now. The Commission together with the EU DSO entity can play a pivotal role in incentivising, monitoring, and facilitating the exchange of best practices.

Another challenge in the network planning for grid operators is to model active consumers and prosumers, which are growing in number. In 2022, 138 GW of solar was installed on Europe’s rooftops, which should double by 2026, making it part of the relevant stakeholders to include in the planning process. Regulatory sandboxes for prosumers' planning can support system operators in integrating these “new” players into the grid planning while finding an adequate legal and technical framework.

Network Investment

Regarding investments in the grid, there are three main categories to consider. To start with, there is the extension of grid capacity meaning the grid hardware infrastructure (cables and substations). Then, there are the technologies required to transform grids into dynamic and smarter systems (digitalisation, monitoring and communication tools). Lastly, human expertise and resources which play a central role in complementing these categories.

Currently, two significant issues exist in grid investments. Firstly, there is a predominant focus on CapEx while OpEx costs are increasing significantly. Secondly, many regulatory frameworks tend to lag behind the demand, as DSOs lack the incentives and authorisation to anticipate and innovate. To address these challenges, there is a need for a regulation that stimulates both CapEx and OpEx, and makes it possible to transition to output-based remuneration[1] mechanisms to foster efficiency and encourage anticipatory investments. This output-based remuneration mechanism must be combined with anticipatory investments, following forward-looking planning. Simultaneously, as digital systems are being implemented, the investment framework must be aligned accordingly. Investments in digitalisation should be acknowledged as costs covered by the distribution tariff, as per Article 18 of the Electricity Regulation.

[1] Output-based remuneration is a compensation system where DSOs are rewarded based on the actual results and performance they achieve in managing and improving the grid. Instead of solely receiving fixed payments, DSOs are motivated to achieve specific outcomes, such as ensuring grid reliability, minimising energy losses, and enhancing the integration of renewable energy sources. This approach enables compensation that can encompass both CapEx and OpEx, plus the provision of financial incentives that align with the evolving requirements of the network.

Solar Flexibility Models

Flexibility refers to the ability provided to the grid to respond and adapt to fluctuations in energy supply and demand. As the share of renewable energy sources such as solar and wind increases in the energy mix, the variability of their output poses challenges to maintaining grid stability and reliability. Consequently, it is crucial to map flexibility needs and capacity, with the involvement of all stakeholders, and incentivise flexibility both at the time of connection and operation. The ongoing work on the *Network Code on Demand Response* will support a European regulatory framework for demand-side flexibility, as set in Article 59 of the Electricity Regulation. The implementation in the field must be practicable and include generation as well as demand-side solutions.

Flexibility assessment is the first step to unveiling the grid's capacity to integrate more renewables at the current stage. DSOs are responsible for identifying and publicly disclosing their flexibility requirements. Based on this assessment, they should formulate a framework or plan for flexibility price signals. A complementary national economic assessment methodology should be developed to challenge the best flexibility solutions from a cost-efficiency point of view. Such initiative will allow the sharing of best practices at the EU level, and the setting of national flexibility targets with cross-border flexibility applications. These targets would be included into DSOs' grid planning, enabling the inclusion of flexibility costs in anticipatory investments.

This flexibility price signals framework could encompass tools such as flexibility services, flexible grid connection agreements, and system hybridisation. Grid users, such as project developers and prosumers, would then be able to choose the optimal price signal from a technical and economic point of view.

Flexibility and expeditious connections of solar and other DERs at all voltage levels can be incentivised through "flexible connection agreements"[2], i.e. a grid connection agreement that limits the import and export of electricity to the grid. Such agreement should be available to grid users on a voluntary basis and with pre-defined rules and requirements agreed by the two parties. To support such connections, a power control system, supported by EU standards, which electronically limits or controls the power at a reference point to a programmable level should be installed. These agreements should not compete with other flexibility solutions nor slow down grid reinforcement work. At connection time, hybridisation of solar PV, i.e. the co-location of another energy asset like storage, should be facilitated by system operators to optimise the use of solar PV with energy storage and other RES.

Unlocking flexibility also requires clear price signals during operation to support congestion management. Such price signals can be provided by local flexibility markets, which can be operated by grid operators, by private market parties, or other

[2] Different names are used. The term used in the CEER's report is Alternative connection agreements. Unfirm or non-firm connection agreements are other terms used.

designated entities (e.g. designated by the NRA or other competent authorities). Nevertheless, the potential of alternative, non-market, flexibility solutions to provide price signals to grid users should also be highlighted, such as Time of Use (ToU) tariffs or dedicated tariffs (lump-sum) to incentivise self-consumption. Such solutions can unlock implicit flexibility. This is valid in the context of grid tariffs retaining a significant share of the calculation based on consumed energy. Such solutions must be smartly designed in order not to penalise the consumers, with periodic assessments by ACER and the national energy regulators.

More broadly, regulators should embrace a pro-flexibility stance, promoting the experimentation of innovative technologies and economic models through pilot projects and the use of regulatory sandboxes. Regulators can add incentive measures such as financial bonuses attached to key performance indicators (KPIs) to foster proactive flexibility and capacity creation. Also, a continuous dialogue should be organised at the EU level with the energy trade associations, generators, EU DSO entity, ENTSO-E, ACER, and the Commission, for the efficient evolution of regulation.