Grid-Optimised Deployment of Charging Infrastructure for Light and Heavy-Duty Vehicles

Overcoming Capacity Constraints

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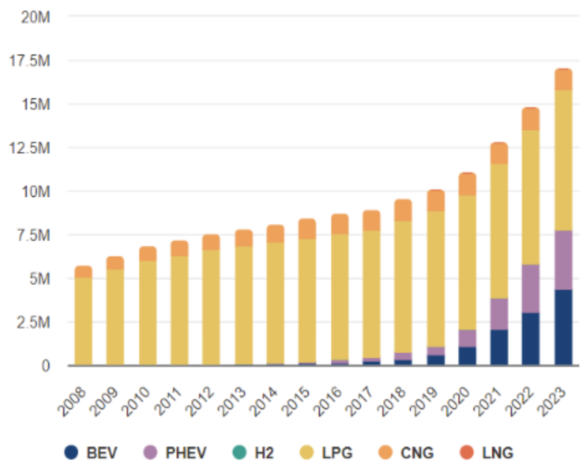
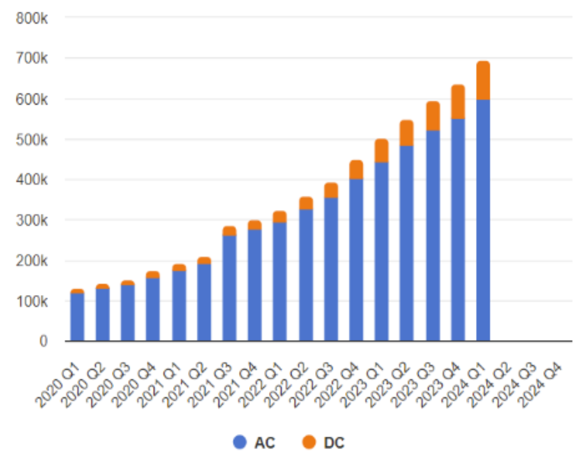
I. Introduction

The electrification of transport is pivotal in the European Union's (EU) strategy to achieve a more sustainable transport system. As part of the EU's objectives to reduce greenhouse gas (GHG) emissions, the Alternative Fuels Infrastructure Regulation (AFIR), seeks to bolster the infrastructure needed for the electrification of transport by encouraging the provision of charging stations and investment in power grids to accommodate an increasing number of electric vehicles (EVs) on European roads.

Although electric vehicles (EVs) provide numerous advantages, their rising electricity demand presents a challenge for distribution networks connected to charging points. Presently, network capacity is being allocated to electromobility at a faster rate than new infrastructure can be developed. Consequently, it is widely acknowledged that the integration of EVs could exacerbate the congestion on grids with limited capacity and may lead to power quality events or service interruptions.

However, the success of EVs depends on the ability of users to charge their vehicles and satisfy their transportation needs. Moreover, under EU regulation 2019/1242, new heavy-duty vehicles must reduce 15% to 30% CO_2 emissions by 2025 and 2030, respectively. Failure to meet targets could have both economic and reputational consequences for DSOs. As such, the need for a safe and resilient grid capable of coping with the electrification of transport is becoming urgent, since EV sales and the deployment EV recharging infrastructure will have an exponential growth trend as can be seen in *Figure 1*.





(a) (b)

Figure 1: Progress of (a) alternative fuel car sales in the EU for the last 15 years and (b) EV recharging infrastructure (Source: European Alternative Fuels Observatory)

In this context, distribution system operators (DSOs) are instrumental in ensuring that the increasing demand for EV charging is met with reliable and efficient electricity infrastructure. However, this new demand impacts **every aspect of the DSO's activity in the distribution grid**. As such, this paper will provide a set of considerations from technical, regulatory and policy perspective from the DSO standpoint that, should facilitate the transition into a decarbonised transport system while ensuring grid reliability and stability. As part of E.DSO efforts to convey the views of the leading electricity DSOs in Europe, the common challenges concerning the move towards an electrified transport sector will be considered and the potential solutions to overcome capacity constraints across the EU will be presented. This is based on existing initiatives implemented at a national level across the EU.

II. Key challenges and considerations

The move towards an electrified society combined with the grid's limited capacity are already impacting day to day activities across the EU. The delays on new supply and demand connections are impacting the competitiveness of EU businesses as well as the move to a sustainable transport system. A well-known example of the magnitude of this issue is found in the Netherlands, where the waiting list to connect new businesses, house and schools is increasingly long. However, the pressure on grids is expected to increase even more, as forecasts predict that electricity demand will double by 2050, exacerbating the issue.

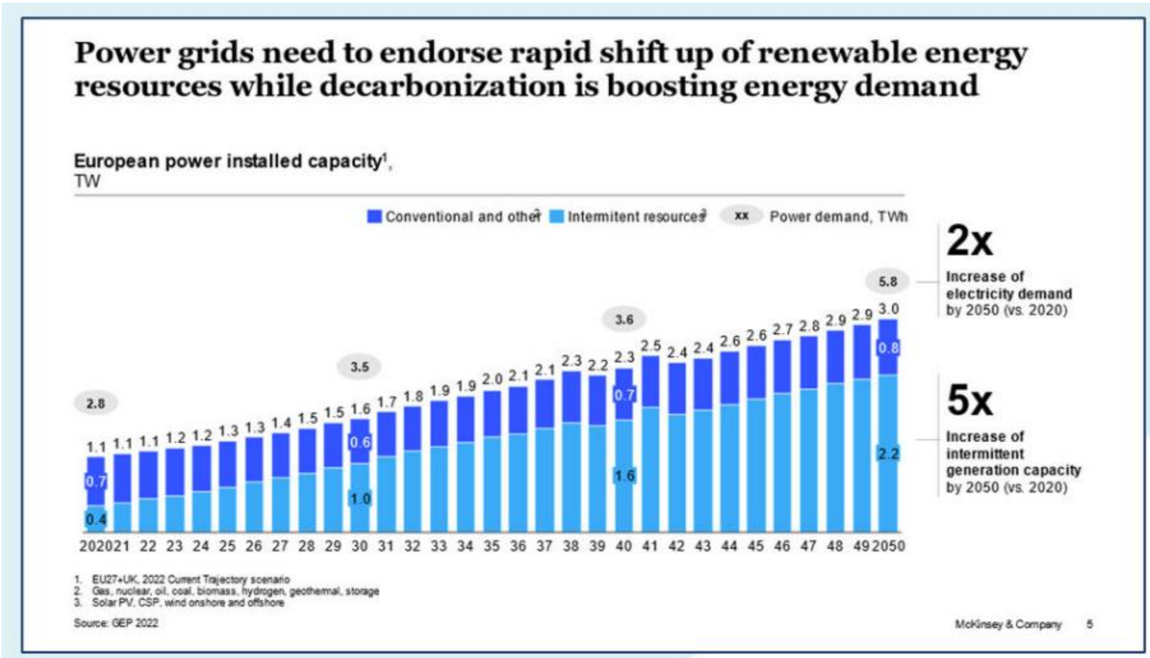


Figure 2: Forecasts of installed capacity of the European power grid until 2050

Connecting the recharging stations for both light-duty vehicles (LDVs) and heavy-duty vehicles (HDVs) to the distribution system come with a set of challenges **from the technical, regulatory and policy perspectives**. These include the following:

- **Time to connect and prioritisation – complexity and increasing volume**.
- **Capacity & congestion management in the distribution networks**.
- **Network planning and long-term development**.

At a policy and regulatory level, these challenges relate to the connection process to the electricity networks, planning policies for network development and the regulatory landscape around advanced investments in the distribution system. **Also, as part of their remit, DSOs must manage a high volume of demand for connections within a short period of time**, navigating permitting requirements, and capacity constraints. For this paper, E.DSO members have identified the aforementioned challenges related to electromobility within the context of grid connection and network operations. These challenges arise from the impact of this new demand on **DSO activities**, requiring new ways of planning, handling new connections and operating the system with different types of loads.

2.1. Time to connect and prioritisation

The transition towards a decarbonised energy system has led to a dramatic increase in connection requests from renewable energy projects and new technologies like EV charging stations. In countries like Spain and Italy, the backlog of grid connection applications has reached almost 200

GW, with similar issues in Eastern Europe where Poland and Romania each have over 50 GW waiting to connect[1].

Connection procedures are sometimes so lengthy that Charge Point Operators (CPOs) might lose interest in the business case, impacting Member States' commitments to the targets under AFIR. Moreover, DSOs must balance connection requests for E-mobility with the need to connect new renewables (which are essential for meeting climate targets), with the requirements of the existing grid infrastructure and with customer demand. This system often involves complex decision-making processes that consider grid capacity, the urgency of requests, the different policy priorities and regulatory mandates.

As regulated business, most EU DSOs operate a **first-come, first served** policy for new connection requests. The increasing volume and complexity of connection requests, driven by the transition to renewable energy, requires efficient queueing strategies to manage the grid connections effectively.

2.2. Capacity and congestion management

Electrification of transport increases the load on electricity distribution grids, leading to network congestion during specific periods of time of certain days. Congestion occurs when demand exceeds the network capacity to transfer the load. The network's limitation to handle a certain amount of load is determined by the grid component output limits and may lead to outages and failures on the grid. Congestion is already a problem across the EU.

The Netherlands is experiencing significant grid congestion, which is becoming a major bottleneck for renewable energy integration and overall electricity distribution[2]. Several factors contribute to this situation, including rapid renewable energy development, rapid development of the recharging infrastructure regulatory hurdles, and an aging infrastructure that cannot keep pace with modern energy demands.

The unpredictability of EV charging patterns can lead to peak load issues, especially during times of high residential electricity use. At the same time, the simultaneous charging of numerous EVs could cause the overload of electric system components such as cables or transformers and voltage deviations, with potential implication in quality of supply and grid security challenges. The challenge is exacerbated by the fact that a significant portion of Europe's distribution grid infrastructure is aging, with about one-third of the low-voltage (LV) grid over 40 years old, and this figure is expected to rise to 55% by 2030[3].

2.3. Network planning development

With the advent of electromobility, it became quickly apparent that the nature of this type of load is different to the traditional ones as they consume available network capacity faster than new capacity can be built. This has an impact on short and long-term planning.

[1] https://windeurope.org/newsroom/press-releases/eu-grid-action-plan-will-help-renewables-but-urgent-action-needed-on-excessive-connection-queues/
[2] https://www.iea.org/reports/italy-2023
[3] https://ember-climate.org/insights/research/european-electricity-review-2024/

In the short term, DSOs must ensure the network availability to meet current demand for an increasing number of imminent connections for EV recharging pools in a specific area of the distribution network while ensuring voltage stability, power quality and addressing technical issues associated with this new type of loads.

In the long term, DSOs must be able to resolve the following challenges:

- **Accurately estimate the load growth rate** over the next 5-15 years and adapt investment strategies in correlation with the EV outlook and other additional loads
- **Analyse the distributed impact of increased energy consumption due to EV penetration**: This includes energy consumption across different networks (rural, urban) with attention to the varying effects based on levels of urbanisation, wealth, and other socio-economic factors.
- **Compare flexibility solutions with traditional options**: Evaluate and compare flexibility solutions such as demand response and energy storage with traditional grid reinforcement and expansion methods to determine the most effective strategies. DSOs shall work with the wider industry and consultancy houses to calculate the cost and value of flexibility solutions to provide a clear understanding of their economic and operational benefits compared to conventional grid enhancements.
- **Analyse the impact of V2G solutions alongside V1G**: Evaluate how the adoption of V2G (Vehicle-to-Grid) solutions in addition to V1G (Smart Charging) can enhance grid support, with a comprehensive assessment of the added value of V2G to grid investment and operation.

For DSOs, network development plans describe a mandatory exercise to forecast the development of their network for the next five-to-ten years[4]. It is important to note that connecting the EV Recharging infrastructure is part of both short, and long-term planning process.

III. Key solutions to the challenges identified

Considering that there is no one-size-fits-all solution, this section aims to showcase success stories and successful practices that may enable EVs' integration into the grid. The goal is to provide a recap of best practices and recommendations on the way forward analysed from the perspective of the contributing DSOs to be considered in the future decision-making process.

3.1. Solutions for time to connect and prioritisation

The escalating challenges and urgent demands of the energy transition require DSOs to come up with solutions. The identified solutions, for the surge in connection requests are based on the current projects underway in some European DSOs and fully in line with the Electricity Directive, where there are certain requirements and obligations for EU DSOs.[5]

[4] Directive (EU) 2019/944, Article 32.3.
[5] Directive (EU) 2019/944, Article 31and Article 33.

3.1.1. Digitalisation and standardisation of requests

DSOs' connection procedures are slowing down the deployment of EV charging infrastructure. This highlights the need for a more streamlined and efficient approach to managing end-to-end processes. It is crucial to enable **digitalisation and standardisation** of dealing with connection requests, but it also showcases the need for an open **dialogue and cooperation between all stakeholders** involved in the electromobility space to ensure that the activities related authorisation, planning and installation of the charging points do not endanger business opportunities.

E-REDES (Portugal) has been implementing a set of initiatives in **three strategic pillars** – new organisation, proactive information, and digitalisation & automation. In 2022, the Sprint Verde project introduced a new Agile methodology: daily meetings with all parties started to be set and a single point of contact for customers started being established.

New IT tools have been created to provide proactive and valuable information to customers: digital functionalities [6] have been implemented to automate processes and allow customers to find information about their processes, and an open data portal [7] has been launched, including valuable information on available capacity in the distribution network.

3.1.2. Use it or lose it principle

DSOs are making substantial investments to expand, maintain, and strengthen their networks to integrate new capacity into the grid. However, it is equally crucial to optimise the usage of the existing network capacity. Innovative approaches for this optimisation include alternative transport rights and the 'use it or lose it' (UIOLI) principle. This principle ensures that available capacity is used efficiently, helping to balance the load and prevent congestion.

The UIOLI principle could further enhance grid efficiency. Under UIOLI, if contracted power is not used within a certain period of time, the unused capacity is reassigned to other users. This policy ensures that the requested power is actively used, promoting more effective utilisation of the grid and preventing wastage of valuable capacity. By implementing the UIOLI principle, DSOs can enhance the efficiency and reliability of the grid, ensuring it can meet the growing demands of the energy transition. These strategies not only maximise existing capacity but also encourage more sustainable and cost-effective grid use.

The UIOLI principle empowers grid operators to draw up flexible contracts that allow them to adjust the contracted power downward if a customer consistently underuse their allocated capacity. This approach frees up space on the existing power grid, enabling more users to access the electricity supply they need. By accessing the unused capacity, grid operators can provide new or reinforced connections more quickly to customers that request them.

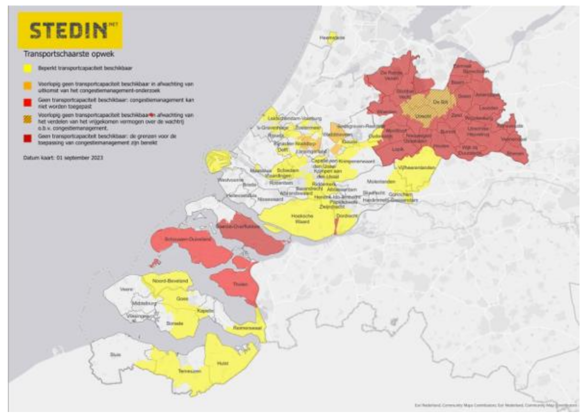
3.1.3 Sharing accurate information on available grid capacity

Many DSOs, such as those in Austria, Ireland and other EU countries, provide an online visualisation of their grid capacities at the substation level. This tool is currently utilised by potential contributors

[6] Balcão Digital E-REDES (https://balcaodigital.e-redes.pt/home)
[7] E-REDES open data portal (https://e-redes.opendatasoft.com/explore/dataset/postos-transformacao-distribuicao/mapa/)

from renewable energy generation, allowing for better planning and use of the existing grid infrastructure.

Cooperation between DSOs and end-users is essential to overcome long connection queues. In this sense, an example of this practice can be found in the Netherlands where the DSO Stedin provides data on the status of the grid in different cities and regions that are used to inform a city's decisions on new connections.



This practice can be maximised by sharing data with municipalities and urban areas to promote an **integrated planning of energy and urban development**.

A best practice in this regard is the E.ON EnergyPortal platform that combines **several energy solutions proposed to municipalities**. Based on the collection of data, the EnergyPortal offers multiple solutions:

- Data visualisation
- Energy monitoring
- Energy efficiency analysis
- Street lighting planner
- Problem reporting.

The portal counts now more than 2,000 municipalities and 2,300 users in Germany.

3.2. Solutions to capacity and congestion management

By investing in essential infrastructure and communication systems, DSOs can actively engage consumers and encourage them to shift their electricity usage during peak demand periods. This strategy helps balance the grid and alleviate capacity constraints, while also fostering the development of flexibility markets at the DSO level across Europe.

3.2.1 Combined Connections for EV Recharging pools (service area on motorways)

DSOs must be part of the discussion to help customers to reduce the network connection in the case where there are at the same area HDV and LDV infrastructure. A recent study conducted by Enedis and other relevant stakeholders gives some figures on the impact of the combination of uses for connections.[8]

At existing service areas, the emergence of new HDV charging infrastructure and the arrival of new operators will, if nothing changes, result in requests to increase power supply that will lead to over design and invest in these stopping areas leading to suboptimal connections.

To illustrate this point, independent requests for Heavy-Duty Vehicle (HDV) and Light-Duty Vehicle (LDV) connections would result in uncombined needs, thereby generating additional work. The study estimates that failing to optimize would necessitate the construction of 5 additional high voltage (HV) and medium voltage (MV) substations, as well as 7 additional HV/MV transformers in the high scenario, leading to approximately 90 million euros in extra costs (+14%)[9]. This amount is projected to become increasingly significant in the coming years, with the growth of these two fleets.

Considering this observation, it is crucial to establish effective measures for optimising stopping areas and to delineate responsibilities accordingly. This includes identifying the roles of the distribution network manager, road infrastructure manager, and other existing stakeholders, as well as potentially creating new stakeholder roles. Additionally, it is essential to define cost-sharing rules for future connections, covering both investment costs for each new connection and power increase, and the allocation of network usage tariffs. Consequently, the integrated connection of electric vehicle charging infrastructure (EVCI) for heavy-duty vehicles (HDVs) and light-duty vehicles (LDVs) serves as a pivotal strategy for optimising both the work and costs associated with the electricity network, benefiting the collective network and each future EVCI operator.

3.2.2 Enabling Smart Charging

As pointed out in a recent study conducted by Elaad NL[10], smart charging has the potential to unlock available capacity at low voltage grids, allowing more connections to be made to one transformer before the transformer capacity is reached. This helps the grid expansion, could buy additional time for deploying grid reinforcements and allows customers to be connected more quickly, reducing connection queues.. To enable an efficient and timely grid connection of e-mobility charging infrastructure, the following needs to be considered/implemented by the e-mobility market participants:

- Implementing smart charging technologies allows for the optimisation of charging processes based on grid conditions and user preferences. Smart charging systems can communicate with the grid and adjust charging rates or schedules to avoid overloading the grid during peak demand periods.

[8] Electrification of the long-distance heavy-duty vehicle fleet. On-highway charging needs and Challenges, March 2024, available at https://totalenergies.com/sites/g/files/nytnzq121/files/documents/2024-06/totalenergies_etude-mobilite-poids-lourds_en_pdf.pdf

[9] This is just for the road service areas in France included in the study.

[10] Unlocking EV smart charging to reduce grid congestion – lessons from the Netherlands, March 2024. Available here https://elaad.nl/en/pwc-report-seven-barriers-to-optimal-use-of-smart-charging-and-v2g/

- Load management techniques involve controlling and balancing the charging load across multiple charging stations. This can be achieved through load balancing algorithms that distribute the charging load evenly, preventing localised grid congestion.

- As a prerequisite, ensuring the full roll out of smart meters is essential for consumers to **access price signals**. Moreover, it is essential to make progress on the national implementation of article 19 of the 2019 EU Electricity Directive[11]. This article includes provisions to remove public intervention in the setting of electricity prices. The access of consumers to the price signals should encourage them to charge their EVs in a cost-effective and time-optimised way.

It is important to note that the specific measures required for grid connection of e-mobility charging infrastructure will vary depending on the **local grid characteristics**, regulatory requirements, and the scale of the charging infrastructure deployment. The DSOs are not responsible for these control levers but must encourage their implementation by allowing dialogue with those seeking connection solutions.

3.2.3 Enabling the provision of EVs' flexibility services

V2G technology enables bidirectional power flow between EVs and the grid. It allows EVs to not only charge from the grid but also discharge electricity back to the grid when needed. V2G can help balance grid demand and supply, provide grid services and support grid stability.

In this approach, the demand-side flexibility from EVs is seen as a product that can be traded between consumers and grid operators. This flexibility can be procured via bilateral contracts or in a market-based way. At a distribution level, it is possible to create flexibility markets where consumers compete to provide flexibility services to the DSO that is the single buyer. In particular, EVs can offer their congestion management services to the DSO by charging or not charging at the requested time and location.

To benefit from this, DSOs must be prepared for connecting the V2G-capable vehicles to the distribution electricity network. In particular, the DSO/Customer interfaces and the metering system must be ready to accept both use case. The deployment of V2G seems to be very close and DSOs must be able to technically respond to these industrial deployments, the deadlines or volumes of which DSOs have no control over. In close cooperation the car manufacturers and the energy industry (esp. DSOs) should jointly develop solutions beneficial for the customers but at the same time supporting local grid stability.

- The French manufacturer Renault just launched the R5, the first V2G bidirectional vehicle.

- Similarly, German manufacturer BMW announced a focus on V2G: The models of the New Class X coming onto the market in 2025 will be equipped with bidirectional charging technology. Thanks to its cooperation partner E.ON in Germany, the customers should benefit

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[11] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (recast)

from access to the external electricity market or provide grid-friendly feed-in of electricity to the grid at suitable times.

3.2.4 Enabling Flexible Connection Agreements

It is widely accepted that implementing smart charging and leveraging grid flexibility can reduce peak demand and congestion issues. However, these solutions have technical and regulatory barriers:

- The access to smart charging requires the roll-out of smart meters, but only 54% of households in the EU have one.
- The implementation of smart charging is further limited by preexisting regulations such as price interventions or price caps in national electricity markets, which prevent the access to prices signals across the EU.

When considering flexibility, DSOs face a similar scenario.

Flexible connection agreements as enshrined in the Electricity Market Design (EMD)[12] allow DSOs to access flexibility by setting up non-firm network access for network users. The idea is that the parties agree to a limited access to electricity when the network is congested. In practice, this means that the DSO can manage grid issues by curtailing demand peaks in exchange for a monetary compensation. Another solution is the procurement of flexibility though the provision of V2G – V2X services. This solution has a legal basis established under Article 32 of the Energy Directive. However, the implementation of these provisions into the Member States' national laws is encountering regulatory barriers.

The provisions for flexible connections agreements significantly benefit DSOs by addressing the challenges of limited grid capacity. These agreements allow for non-firm, flexible connections that can include energy storage or restricted power injection times, enhancing the adaptability of the grid. To optimise these processes, a new capacity distribution framework, along with an associated tariff system and new contract forms, is essential.

ESB Networks (Irish DSO) has recently launched an expression of interest for Flexible Demand Connections – ESB Networks Expression of Interest for Flexible Demand Connections. The use of demand flexibility offers a pragmatic approach to capacity management, allowing customers conditional early access to the network and potentially reducing the need for network reinforcement in the short term. This has tangible benefits in electromobility as it allows large demand loads such as bus depots, HDV charging pools and fleet depots to charge their fleets at times when there is capacity in the distribution network. Timed Connections offer an interim solution for customers designed to fit their unique demand profiles and will enable them to make efficient use of existing energy infrastructure.

[12] Directive (EU) 2024/1711 of the European Parliament and of the Council of 13 June 2024 amending Directives (EU) 2018/2001 and (EU) 2019/944 as regards improving the Union's electricity market design and Regulation (EU) 2024/1747 of the European Parliament and of the Council of 13 June 2024 amending Regulations (EU) 2019/942 and (EU) 2019/943 as regards improving the Union's electricity market design

3.3. Solutions to network planning and long-term development

Regarding long-term planning, designing electricity networks based on the occasional peak in transport demand, peaks of generation, and peaks of demand is no longer optimal. The use of this principle will most likely lead to overdesign, substantial costs for grid reinforcement and significant overcapacity that will be used very little.

3.3.1 Anticipatory investments

Anticipatory investments are vital for DSOs as they navigate the challenges of managing modern grid. These proactive investments enable DSOs to strengthen their infrastructure in advance, preparing for future demands as outlined in strategic planning and master plans.

Frontier Economics has calculated the economic costs of underinvestment into the power distribution networks in Germany to 2050[13]. Savings from underinvestment will not compensate for costs resulting from inadequately developed networks. The cost risk arising from too strict regulation – and consequently under investments into the networks – considerably exceeds the risk of having slightly too many network investments, and it increases disproportionately over time.

Demand at service areas to connect EV charging infrastructure have, so far, come from successive increases to contracted power and each operator making connection requests.

The average completion time varies between 12 and 24 months. However, the growth in the number of EVs on the road will quickly generate network constraints for the stopping areas most frequented by LDVs.

This will require major work to be carried out, which could go as far as constructing HV/MV substations and adapting the HV network. As things stand, the time required to complete such work will not allow the operators' requirements to be met and hence nor will the needs of the electric HDV fleet.

To avoid this happening, the two following actions need to occur:

- A collective anticipation of the investment required to supply the necessary power for HDVs and LDVs at each stopping area and at various points in the schedule. This provides a framework for financing the work required on the network.
- A review of the regulatory and operating procedures for managing short-term connection requests. In most cases, the work conducted to meet this demand is insufficient to fulfil medium- and long-term needs.

3.3.2 Strategic charging infrastructure master plans

National Master Plans, grounded in the planned **Trans-European Transport Network** (TEN-T Network), are key in guiding the future of grid planning for e-mobility charging infrastructure. These plans offer a strategic framework for developing charging stations, setting clear goals, targets, and

[13] The economic value of power distribution networks https://www.frontier-economics.com/uk/en/news-and-insights/case-studies/case-study-i8185-energy-the-economic-value-of-power-distribution-networks/

timelines for regional and national deployment. This systematic approach ensures coordinated grid expansion and upgrades to meet the rising demand for EVs.

According to the **European Commission's "Clean Energy for All Europeans"** package, distribution grids will need substantial investments to integrate new loads from EVs and renewables.

National Master Plans provide a framework for developing EV charging infrastructure, setting clear goals and timelines that ensure a coordinated approach to grid expansion and upgrades. This strategic approach helps distribution grids manage the integration of EVs more efficiently, reducing the risk of overloading and improving reliability. Identifying optimal locations for charging stations, considering factors like population density and transport corridors, ensures efficient use of the distribution grid. This helps prevent localised congestion and maximises the use of existing grid infrastructure.

Effective grid planning requires collaboration among **government agencies, grid operators, charging infrastructure providers, car manufacturers, and customers**. This ensures that the planning and implementation of EV infrastructure align with the needs and interests of all stakeholders, fostering a more inclusive and effective transition.

National Master Plans also help stakeholders, such as road operators and charging point operators (CPOs), Develop coherent investment strategies and financial process. The cost of recharging cannot be very different depending on the territory (country, axes, etc.).

If DSOs make anticipatory investments, it means that network connections will be faster and possibly cheaper. Then, all stakeholders can be engaged to develop more recharging infrastructure.

To unlock the necessary anticipatory process, DSOs are ready to work with the regulator. This work must address the risk of stranded costs and adapt the network connection process to allow customers to make requests well before the need is established. Indeed, some network adaptation can represent several years of work.

In France, there are actual discussions with the stakeholders to define a process, regulated by law, which should make it possible to carry out work for a final need, by making connections in stages to support the deployment of electromobility.

3.3.3 Accurate and reliable data

Accurate and reliable data are essential for **effective long-term grid planning**. Data on peak power and energy consumption patterns, population growth, technological advancements, and infrastructure development are important for making informed decisions about future network requirements.

With access to reliable data forecasts, DSOs can better estimate the impact of future loads and proactively plan interventions to ensure the network's capacity meets future demands. Advanced grid planning also requires regulatory approval for anticipatory investments, emphasising the importance of accurate data in securing support for future network development initiatives.

A prime example is the "**Build Once for 2040**" concept introduced by the Irish DSO in their latest strategy. Investments in new technologies focused on data analytics and forecasting tools enable DSOs to analyse **historical data, predict future load patterns, and identify potential grid challenges**. By leveraging these insights, DSOs can make informed investment decisions, optimise grid operations, and effectively manage capacity constraints.

DSOs have identified examples of software tools that would bring important assistance for long-term grid planning:

- Tools to model the impact on LV networks associated with the electrification of energy consumption and increased self-consumption.
- Tools that model the impact of different flexibility solutions in increasing hosting capacity across networks with varying characteristics.
- Tools that compare the impact of flexibility solutions with traditional grid reinforcement and expansion methods.
- Tools to model storage as an ancillary service provision.

These tools would be instrumental in enabling DSOs to plan for a future that includes increased electrification, ensuring that the grid remains reliable and capable of meeting growing demands.

VI. Recommendations

Based on the experience of DSOs' representatives in the WG, the following recommendations have been suggested for overcoming the challenges listed in chapter 2:

- Implementation of online self-serving tools for faster connections and network capacity maps – when this become widely available, the CPOs will be able to make more informed decisions regarding the location of charging pools based on the available capacity on the grid.
- Review the rules of the long-term network planning process.
- Anticipatory investments in network development for better long-term planning.
- Introduction of the 'use it or lose it' approach for better capacity management as the unused capacity may be used/allocated to other customers – this will have a positive impact on capacity and congestion management.
- Implementation of flexible/timed connections – this can resolve capacity and congestion management at peak times while allowing more electromobility loads to be connected to the distribution system.
- Collaboration with stakeholders – planning requires collaboration among government agencies, grid operators, charging infrastructure providers, vehicle manufacturers, and customers. This will enable better long-term grid planning and development while reducing the uncertainties regarding electromobility requirements