Future-Proofing Europe's Grid for Electric Heavy-Duty Vehicles

A Milence White Paper

Power to go further

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Introduction

Last November the Europe Commission published its Grid Action Plan. It noted that nearly €600 billion in grid infrastructure investment would be needed to meet the EU's 2030 climate targets. This substantial investment is necessitated by projections indicating a 60% surge in electricity consumption by 2030, coupled with the integration of massive amounts of new solar and wind power into the grid, and the imperative to double intra-EU cross-border transmission capacity.

Earlier this year the EU also adopted revised electricity market rules which, if implemented timely by the Member States, can trigger a new wave of investments into future grid buildout beyond the immediate requirements of generation and demand.

As the transportation sector undergoes a transformational shift towards sustainability, the electrification of Heavy-duty Vehicles (HDVs) emerges as a pivotal breakthrough. Supporting the transition to zero emissions in the heavy-duty road transport segment, Milence is at the forefront, pioneering the deployment of public charging hubs tailored specifically for electric HDVs across the European Union. However, amidst the ambitious drive towards the mass deployment of electric heavy-duty vehicles charging infrastructure, a critical bottleneck emerges – Europe's grid infrastructure.

The accelerated rollout of strategic public charging hubs along Europe's major road network relies on the buildout of a robust grid capable of supporting multimegawatt charging sites. These hubs must seamlessly accommodate the charging opportunities during resting times for truck drivers, during the day breaks and overnight. Sufficient capacity and timely connections are two issues that demand urgent political attention.

It requires prompt and resolute measures from both the EU and its Member States to strengthen Europe's electricity networks and streamline its connection procedures, ensuring they are prepared for the extensive electrification of mobility and transport solutions, particularly battery electric HDVs. The urgency for preparedness highlights the crucial roles that regulatory bodies and policymakers must undertake to facilitate this transition.

This White Paper shares first-mover findings by Milence and provides a set of experience-based policy recommendations on how to future-proof grids to propel the nascent market of electrified heavy-duty fleets.

Why is a robust grid buildout essential for the HDV charging infrastructure industry?

Before delving into Milence's policy recommendations, it is important to understand the set-up of a typical public charging hub. The section below provides some insights into the composition and functionality of these hubs and sheds light on the interconnection between grid capacity and the effective operation of HDV charging networks.

What are the core elements of a HDV charging hub?

The hardware – the heartbeat of the charging hub

Imagine a world where charging an electric truck is as seamless as any routine task in our daily lives. This is the reality Milence is crafting through its charging hubs. At the core of these hubs are the chargers themselves; sophisticated structures equipped to meet every driver's needs.

- **Accessible Solutions for all HDVs: Combined Charging Systems (CCS)**

At Milence's hubs you can find CCS chargers with the highest power outputs available today – up to 400 kW. These systems can be installed both split and stand-alone, and are known for their adaptability, equipped with cables and connectors that can be used on both sides of the vehicle, making them suitable for all electric HDVs.

- **A Leap into the Future: Megawatt Charging Standard (MCS)**

Milence's forward-thinking doesn't end with CCS chargers. The company is pioneering the integration of MCS chargers into its network, and preparing for the next wave of eHDVs. MCS holds the potential to deliver up to ~3.5 MW of power, drastically reducing the charging time for large battery packs. While a CCS charger might take a few hours to fully charge a truck from 0 to 100%, an MCS charger can accomplish the task in a fraction of that time. Shorter charging times mean trucks spend only the mandatory rest time at charging stations without any impact on current operational times. This translates to an easier transition for trucking companies.

The investment in this new future-proof technology underscores Milence's commitment to not just keeping pace with the industry but setting the benchmark for what is possible. Recognising that eHDVs require significantly more power, Milence wants to make the transition to MCS chargers as soon as possible as it believes its deployment will be essential to the swift decarbonisation of heavy-duty transport. To make this vision a reality, Milence's Technology team collaborates closely with various partners to ensure that the best charging solutions are available for its network.

Power supply & energy

Milence is building charging hubs with high capacity grid connections ranging from 6 to 30 MW. Connecting high demand charging hubs to congested and strained grids emphasizes the necessity for smart energy management. Milence therefore puts much effort into integrating energy storage and management systems which underscore the commitment to enhance the efficiency and reliability of our charging infrastructure. Eventually, uptime and reliability will be paramount for the success of rapid market adoption.

Beyond charging: control and management systems
Milence's charging hubs are designed to prioritise user experience by considering various aspects of the charging process. Some key features are:

- **Payment and billing systems:** Users can conveniently pay for charging services using card readers, mobile apps, or subscription services. These systems not only enhance user convenience but also assist operators in managing transactions efficiently.

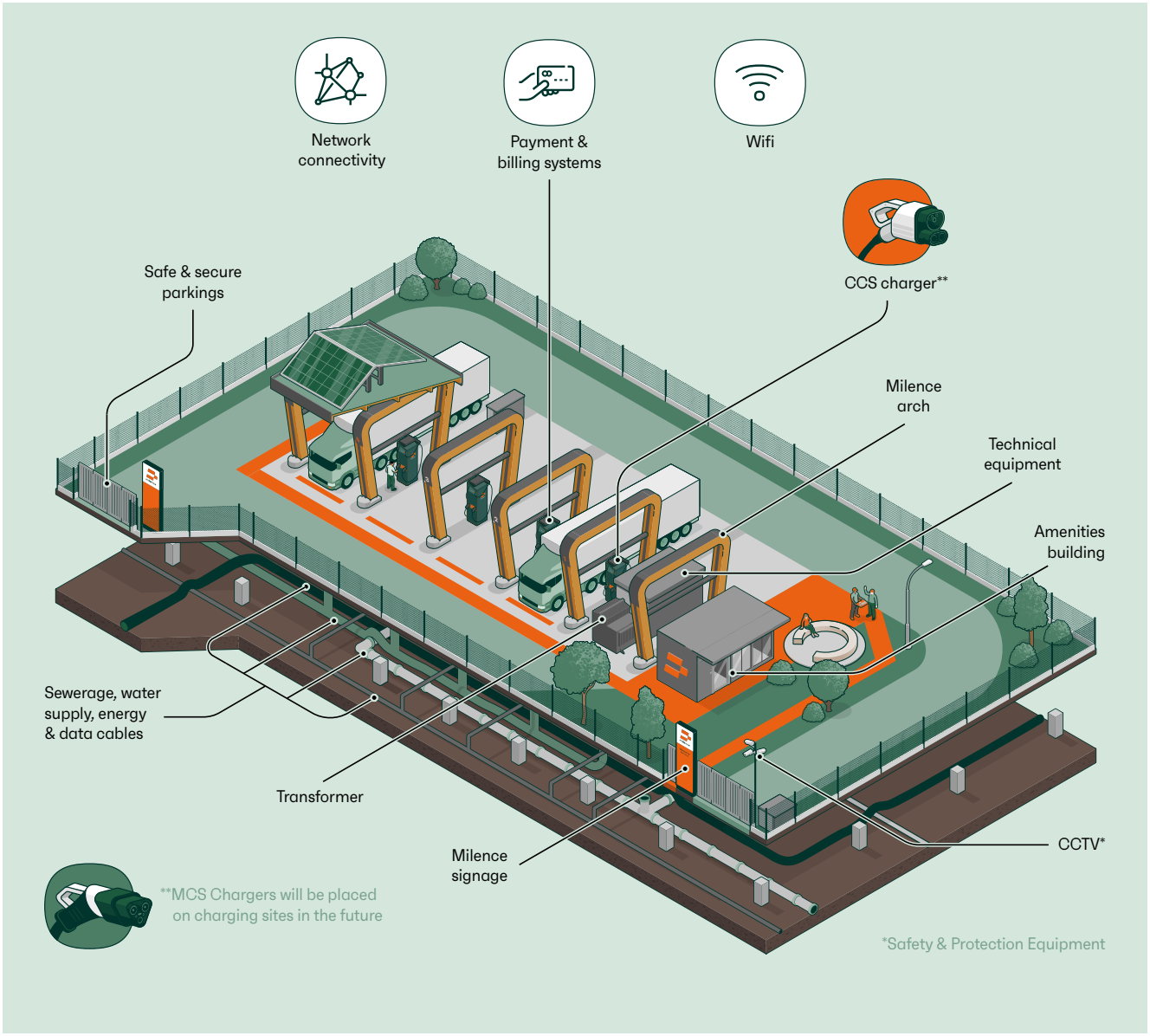
- **Network connectivity:** Milence charging hubs are equipped with wired internet connectivity that establishes and maintains a robust and secure connection with a central system. This connectivity allows for remote monitoring, effective management, and timely firmware updates, ensuring the stations operate optimally.

- **Network Operating Centre:** A critical component and the central hub of on-site operations, monitoring site activity and maintenance. This centre is able to remotely monitor, identify and address issues, including connectivity, and to offer emergency services to ensure drivers have a seamless charging experience.

Advanced Software Integration
Milence leverages cloud-based services to power, monitor, and optimise its charging ecosystem. This software integration allows for real-time management of charging operations, from individual charger status to overall hub performance. The integration of advanced data analytics not only streamlines the charging process, and minimises energy losses, but also bolsters the reliability of the charging network. This dual impact enhances the overall user experience, crucial in making a successful transition to fossil-free road transport.

Safety and Protection Equipment

The significance of safety and protection equipment at charging hubs is underscored by the complexity of these installations, encompassing over a thousand pieces of electrical equipment. Safety measures, including advanced protection systems against overcurrent and other electrical threats, play a crucial role in offering reliable charging infrastructure, and connected heavy-duty vehicles. Additionally, the design of the charging hub itself is of importance. A well-thought-out design – including proper placement of the equipment, fencing, surveillance, clear signage, and effective traffic flows – not only enhances the overall efficiency, but also contributes significantly to on-site safety.



Leveraging almost two years of hands-on experience collaborating with grid operators, local authorities and regulators, we have distilled invaluable insights into the challenges and opportunities inherent to integrating heavy-duty vehicle charging infrastructure to the European grid.

The recommendations outlined below transcend specific national boundaries and offer universal calls for action derived from our frontline engagement. While not prescriptive to any particular member state or region, the suggested policy actions are underpinned by exemplary practices from various countries where applicable.

Action 1:

Improve administrative process to get insights into grid capacity availability

Before locking in (buying/leasing) a plot of land to transform to a charging site for heavy-duty trucks, Milence assesses various factors including existing grid capacity, availability of additional power through existing connections, and the cost implications of securing additional grid capacity if required.

Today most EU countries lack an efficient process for Charge Point Operators (CPO) like Milence to verify the availability of grid capacity, posing initial obstacles to determining site eligibility, installation feasibility and scalability for future anticipated charging needs by electric HDVs. This is especially relevant as truck CPOs for public charging in particular have at least a certain degree of spatial flexibility, this in contrast to private chargers at fixed (depot) locations. Easily accessible information on available capacity and expansion planning across a region would support CPOs identifying best locations from both a transport power demand and grid connection perspective.

Recommendations:

1. Establish an online platform, either regionally or nationally, enabling **quick access to grid connection details by property location**. Such platform should include non-binding cost estimates for grid connection expansion for a requested amount of capacity and estimates of time constraints. The EU should provide guidelines to establish common frameworks for such platforms.
2. As long as 1. is not available across the board / is still under development, publish digital maps with **"go to areas" alongside major highways where grid connections with high or surplus capacity is or will become available** with minor efforts. A similar process is known, for example, when industrial settlements in certain areas are promoted.
3. Additionally, implement a **fast power supply request process with a set response time, allowing multiple applications in a single request**. This would expedite the process and reduce administrative burdens on both CPOs and grid operators sides.

The Milence experience

In Germany and the Netherlands, for instance, a formal application to the Distribution System Operator (DSO) must be submitted for each individual potential site, particularly for possible expansion of the grid connection. However, as the CPO can only decide to invest in a site after the grid information has been provided, many formal applications are submitted, although only a fraction of the sites are realized. This means unnecessary efforts on both sides - for both the grid operator and the CPO.

Although some DSOs offer digital mapping tools for indicating the distance to the nearest possible network connection point, these tools are not widely available or comprehensive. In Germany, a few DSOs offer this (e.g.: SNAP- Schnelle Netzanschlussprüfung MS MITNETZ STROM (mitnetz-strom.de)), but most of the grid operators do not yet have such tools or only have them for feeding into the grid and not for consumption.

Best practice

In France, Enedis, the main French DSO, updates a capacity map every six months to allow the evaluation of potential connections to the grid. In addition, in order to improve the connection request process, Enedis has introduced a mechanism of anticipated connection requests some years ago. The system allows customers whose connection power is greater than 36 kVA to launch a connection request before they have been able to obtain all the details of the project. Following this early connection request, customers receive a proposal for connection before completion of the submission, including estimated connection times and tariffs. When it leads to the acceptance of a technical and financial proposal, the amount billed for the request is deducted from the price of the final connection.

The mechanism is best practice and Milence recommends to expand it, providing customers with estimated connection times and tariffs before completion of the submission.

Action 2:

Improve process to deliver the requested grid capacity

Upon getting informed that existing power capacity is insufficient, CPOs will seek to apply for a grid connection that is future proof and which necessitates reinforcement of the grid.

However, the current process for obtaining (information about) such connections is marred by delays and uncertainties, hindering the timely deployment of charging infrastructure for electric trucks.

Recommendations:

1. **Expedite application process:** To mitigate delays and uncertainties, the application process for grid connections requiring reinforcement should be accelerated. This entails providing applicants with a binding and predictable timeline from the initial (multi-MW) request to the realization of the connection, including necessary reinforcement measures. Carrying this out in a digital and standardized manner will further support accelerating the whole application process.
2. **Transparency and accountability:** National regulators should enforce DSOs to provide their best estimates and maintain transparent reporting on the status of new connection requests. This ensures clarity and accountability throughout the process, allowing CPOs to make informed decisions and plan effectively.
3. **Single point of contact:** Establishing a single point of contact on both sides, especially for medium and high-voltage connections with longer project durations, is crucial. This ensures improved and sustained communication flows between CPOs and DSOs, enhancing coordination and improving project timelines.
4. **Establish dedicated customer teams:** If resource capacity allows, DSOs should establish dedicated customer teams specifically focused on serving HDV fleets. These teams will offer streamlined support to CPOs and freight companies, minimizing procedural hurdles and accelerating grid connection processes. Moreover, this dedicated approach facilitates collaboration and enables DSOs to gain insights into overall eHDV operations, leading to improved grid reliability and performance.

The Milence experience

Today in the Netherlands most connection requesters are placed on a waiting or reserve list without knowing their position on that list. Even if a CPO obtains information from the grid operator that a particular substation will be reinforced by a certain date, the CPO has no assurance that the requested capacity will be allocated to them or to another applicant in line. In other cases, DSOs can pause or reset the set timeframe in which a request receives a response.

How does Milence look at alternative solutions offered to the market to deal with grid congestions?

The short answer is straightforward: HDVs stop for a fast charge and then go. The possibility of load balancing during day stops is very limited to non-existing. Alternative flexibility measures for grid congestion are thus not really suitable for a fast public recharging session.

The more elaborated arguments are:

- **Incompatibility with operational needs:** The operational model of heavy vehicle charging stations, where trucks need to stop and recharge quickly within a limited time frame, requires a consistent and high-capacity power supply, throughout at least 18 hours during the day. Alternative contracts involving shared resources or flexible arrangements do not align with the operational needs of these locations, which can lead to potential disruptions and inefficiencies.
- **Risk of increased TCO (Total Cost of Ownership):** Alternative contracts may introduce additional costs and complexities for CPOs and truck operators. For example, if trucks are required to charge at lower capacities or if there are restrictions on the availability of power during peak periods, this can result in longer charging times or the need for extra charging sessions, ultimately increasing the TCO for truck operators. Especially in this stage of the market where trust among large fleets in the electric transition needs to be built.
- **Lack of control and assurance:** CPOs require a high level of control and assurance over the availability and reliability of power supply to meet the demands of heavy vehicle charging stations. Alternative contracts may leave CPOs at the mercy of external factors and dependencies, such as the willingness of other companies in the industry to provide flexibility or the capacity limitations of energy hubs.

Action 3:

Proactive grid planning based on HDV electric fleet market input

In order to achieve the transition towards electrification in the most seamless way possible, all actors need to be proactive when it comes to identifying the investments to be made in the coming years.

Given the time constraints and the costs associated with the investments necessary for the grids, this proactivity is even more crucial for grid operators.

Defining the most reliable scenarios on the basis of currently available market information and technology assumptions is key. They will provide valuable insights for forward-looking grid upgrades and be the basis for the necessary investments. When defining scenarios, as per the EU Action Plan for Grids, stakeholders should consider political, industrial, and climate objectives, and clearly integrate heavy-duty transport transition plans which consider expected electric HDV activity growth.

Only by proactively planning and by considering various growth trajectories, grid operators and regulators can adequately plan for capacity requirements and avoid bottlenecks in the charging network. Planning should be updated regularly to take into account the increasing shift towards eHDVs.

Recommendations:

1. The input from the market (HDV CPOs, OEMs, fleet operators and stakeholders from other sectors) should serve as **mandatory inputs for long term regional and national grid planning and capacity expansion by DSOs and TSOs** This needs to be properly reflected in the national implementation of the newly agreed EU electricity market rules. Forecasts should encompass different trucking applications, including urban, regional, and long-distance operations across various sectors – private depot charging as well as public charging. These forecasts should not only be seen as information and as a theoretical construct, but should actually trigger investments in expansion by the grid operators at particular locations. Of course, the costs need to be recognized by the regulator based on the planning.

The Milence experience

French DSO Enedis and TSO RTE can be cited as examples to follow. Enedis has been leading a working group tasked with identifying and sizing up the needs for charging for electric trucks and the impact on the power grid and infrastructure. This allowed the operator to make some projections considering the entirety of the needs. RTE has been taking into consideration HDV BEV electrification in its 2023-2035 forecast, updating its previous previsions in order to focus on “enhancing the prospects for electrification of heavy-duty vehicles (buses and trucks) in line with new European requirements on emissions from this type of vehicle”. Heavy-duty vehicles (buses and trucks) with ‘HDVs.

From a system cost perspective, it is however important to go even more granular, i.e. to collect the detailed regional site developed plans of market players and take these as input to required grid buildout plans. Today CPOs are investing (purchasing or leasing) in lands where the size of the land is very often much bigger than the number of charging bays which can be powered by the available (short term) grid connection. This carries a clear business risk for any CPO, and stimulates the wrong market behaviour as it pushes the industry to building smaller plots. However, larger hubs are more cost efficient to build and to operate and only require one large grid connection, instead of multiple smaller ones (which require again more work by grid operators).

As a good practice in this regard is Germany where the 4 major TSOs recently launched a web application that allows all stakeholders with an expected demand of at least 10 MW to autonomously enter their projects with the corresponding geo-coordinates and parameters for the required energy and grid connection. Based on this data, the 4 TSOs can work out their long-term grid expansion strategy.

Action 4:

Revise national regulatory frameworks to stimulate anticipatory investments

As regulated entities, DSO's remuneration is determined by national regulation. However, the current regulatory frameworks often fall short in providing adequate incentives for anticipatory investment.

This stems from the concern that investments made without clear, tangible short term demand may be considered inefficient under current regulations. Such investments are often either rejected by National Regulatory Authorities or discouraged in efficiency benchmarks. Recognizing the potential for distribution system operators to make proactive investments is paramount. Grid operators should not face financial penalties for building grid capacity based on forecasts, especially if the capacity is underutilized, as this could be erroneously perceived as inefficiency.

Developing efficient, scalable multimegawatt charging hubs will necessitate grid operators to adopt a forward-thinking approach, given the anticipated exponential growth in the market uptake of eHDVs.

It is also key to review the regulatory and functional procedures imposed on DSOs to answer applications for connection in the short term. These applications often require major improvements, including the creation of source substations and adaptation of the high-voltage network. As things stand at present, the timescales for carrying out this work infringe on the DSO's capabilities to meet operators' demands in time. Without a review of these procedures, network operators can be obligated to repeat roadwork and cable-laying at the staging areas several times over, increasing costs.

Furthermore, national regulations often discourage the use of public funding from national and EU budgets, despite the crucial role such funding can play. Investments supported by public funds are frequently excluded from the regulatory asset base in many EU countries, thereby falling outside the scope of regulated revenues.

Recommendations:

1. The EU electricity market reform provisions incentivise anticipatory investments and planning. The national regulatory frameworks should thus now **be revised to stimulate system operators at distribution and transmission level to make timely and adequate investments in grid connection capacity**, particularly at strategic parking and anticipated charging hub locations along and close to Trans-European Transport Network (TEN-T) core and comprehensive corridors.
2. Regulatory frameworks should allow DSOs to be more equipped in their efforts to improve the network to meet operators' future demands in time.
3. EU and national public funding should be made available as a complementary source tool to trigger investments in grid projects, recognized in the regulatory asset base, and used to alleviate potential increase of tariffs.

The Milence experience

In the UK, regulator Ofgem strongly encourages DSOs to anticipate expected EV charging demand from within their grid area and prepare their grids, even ahead of a connection request.

Action 5:

Connecting truck charging and renewable generation locally

It goes without saying that battery electric trucks have the largest decarbonisation impact when charged with renewable energy sources.

In addition to green Power Purchase Agreements (PPAs), the procurement of green energy by CPOs through on- or near-site generation via wind or solar power plants can ensure the carbon-free operation of charging hubs. This approach not only aligns with sustainability goals but also presents an opportunity to mitigate local energy flow peaks, thereby alleviating strain on the grid.

However, it is crucial to underscore that charging hubs, potentially coupled with stationary battery buffers, must always have the capacity to meet the charging demands of logistic companies. Particularly when nearby photovoltaic (PV) or wind turbines with a two-way (feed-in and consumption) grid connection are already established, there is an opportunity to accelerate the commissioning of new charging hubs by directly connecting them with the nearby renewable site.

Regrettably, grid operators often mandate separate grid connections for charging hubs and nearby renewable generation, even when situated on adjacent properties. This practice can introduce inefficiencies and increase costs unnecessarily. Ultimately, the decision should be made on a case-by-case basis, considering local circumstances.

Recommendations:

1. **Support direct connections to nearby RES sites:** In the context of the implementation of the revised Renewable Energy Directive, national regulators should encourage DSOs to facilitate the direct connection of charging hubs to nearby renewable generation sources where feasible, remove legal barriers for market parties to do so, reducing the need for additional grid infrastructure and promoting efficient energy utilization.
2. **Flexibility in grid connection requirements:** grid operators should be encouraged to adopt a flexible approach in grid connection requirements, allowing for the integration of charging hubs with nearby renewable generation while considering the unique characteristics of each location. Strict mandates regarding combined grid connections should be avoided to maintain flexibility and optimize cost-effectiveness. The regulator should acknowledge that the flexibility provided by such direct charge hub-renewables connections provides value to the wider energy system.

Action 6:

Adequate network charges for high peak charging hubs

Especially for larger consumers like truck charging hubs, grid fees are often structured based on the annual peak demand capacity in kilowatts (kW), which significantly influences the overall cost compared to additional volumetric fees based on kilowatt-hours (kWh).

While historically this fee structure has made sense, encouraging peak shaving and efficient grid use, it poses challenges for truck charging hubs dedicated to facilitating the shift towards carbon-free heavy-duty transport.

Considering the driving and resting regulations of truck drivers, which mandate a 45-minute break after 4.5 hours of driving, significant peaks in demand, reaching up to 1 MW per charging point during breaktime charging, are anticipated. The charging behaviour of trucks is expected to take place evenly throughout the day with less usage during the traditional grid peak times, i.e. the morning and evening peak times.

However, the current grid fee structure, incentivizing capacity-based charges, is counterproductive for truck charging CPOs striving to accommodate such demand patterns. Flexible grid fees could be a solution to stimulate the charging away from peak hours if the fee is more attractive.

Furthermore, during the early market phase, charging hubs may experience lower overall utilization but still encounter periodic peaks throughout the year. This imbalance between high capacity and kWh-based pricing, dominated by fixed fees, can jeopardize the viability of the business case. The uncertainty surrounding yearly capacity peaks, coupled with the challenge of invoicing multiple customers based on individual charging sessions and kWh, exacerbates the complexity of calculating stable and reliable pricing, crucial for logistic companies.

Looking ahead, grid fees should ideally incentivize specific consumption patterns throughout the day. This necessitates a shift towards predominantly time-varying volumetric-based grid tariffs to effectively communicate price signals to individual customers and charging sessions, allowing DSOs to charge more at time of congestion.

Recommendations:

1. **Shift to more time-varying volumetric-based fees:** National regulators should transition away from capacity-based grid fees towards time-varying volumetric-based fees to better support the operation and investment in truck charging points, certainly at this market stage, aligning with the specific demands of high-power charging, particularly for heavy-duty vehicles.

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