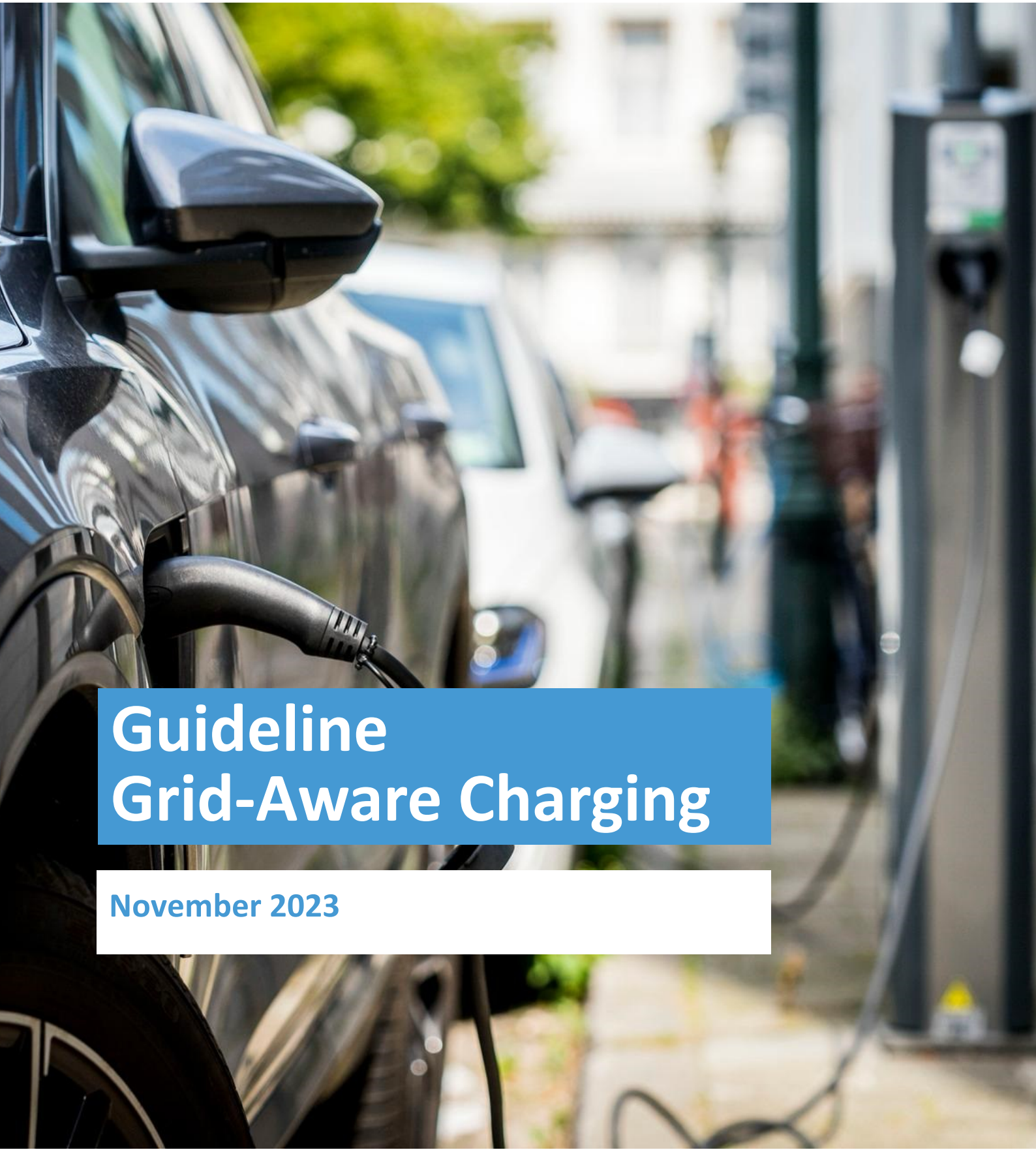
Nationale Agenda Laadinfrastructuur



Guideline Grid-Aware Charging

November 2023

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1. Introduction

This document outlines how municipalities and regions can translate Grid-Aware Charging into requirements for public charging infrastructure concession contracts. Using this guideline, Grid-Aware Charging can be broadly applied to public charging infrastructure in the coming years. Although the guideline focuses on concession contract requirements, it can also apply to charging stations on public land operating in the open market model.

Implementation and Rollout of Public Charging Infrastructure in the Netherlands

Regional governments play a key role in the rollout of public charging infrastructure. In the Netherlands, three implementation models are used for charging infrastructure, each involving a different role for the regional government: the open market model, the concession model, and the assignment model.

Open Market Model

In this model, charging infrastructure operates within a free market, where private companies, with limited government intervention, install and operate charging stations. The market self-regulates, meaning providers select locations, negotiate agreements with municipalities, and then offer their services.

Concession Model

In the concession model, the government, often through municipalities or regions, grants concessions to a limited number of market players to install and operate charging stations within a set period. The concession holder is given the right to place and/or manage charging stations within a defined area.

Assignment Model

In the assignment model, the government remains the owner of the charging infrastructure and hires a private party to operate and maintain it on its behalf. The government determines the location, tariffs, and other terms, while the operator is responsible for the day-to-day management. This model is the most regulated and ensures maximum government control over the rollout.

Grid-Aware Charging is one of the actions from the national action plan, *Smart Charging for Everyone (SLVI)*, which promotes large-scale application of smart charging across private and public charging points. Ten actions are detailed in execution plans, with enabling Grid-Aware Charging being a critical element. Grid-Aware Charging optimizes the utilization of the electricity network, ensuring the energy and mobility transition can continue even under potential capacity constraints.

The primary focus of Grid-Aware Charging is on capacity issues within the medium/low voltage distribution network. For bottlenecks at higher network levels, charging stations can be aggregated for congestion management. However, this latter form of smart charging is beyond the scope of this guideline.

Implementing Grid-Aware Charging via concession contracts represents an initial step in a growth path that involves both technical and regulatory development (see Figure 1).

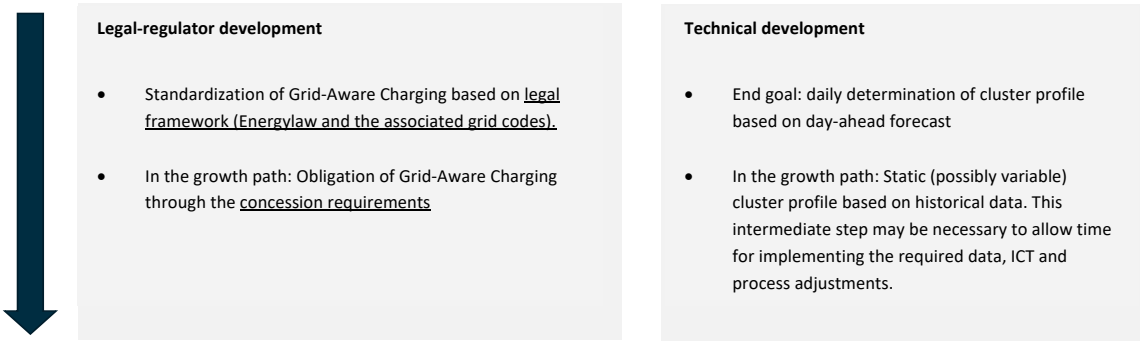

Figure 1: Growth path Grid-Aware Charging

Reading Guide

Chapter two describes what Grid-Aware Charging is and why it is important to implement. Chapter three discusses the functionality and principles of Grid-Aware Charging, which are translated in chapter four into requirements that can be included in concession contracts for public charging stations.

Open Market Model for Charging Stations and Existing Contracts

The requirements in chapter 4 can be applied by municipalities and regions in new concession contracts. The requirements can also be used for contracts based on the open market model. Where the requirements refer to Concession Holder and Concession Grantor, these terms should be adjusted accordingly.

Incorporating the requirements into existing contracts requires renegotiation and agreement from both parties, relying on the goodwill of the contractor. Since this does not constitute a substantial modification, the change can be formalized through a contractual addendum.

2. Grid-Aware Charging

Electric transportation and charging infrastructure—alongside heating demand solutions such as heat pumps, the increase in solar energy, and electric cooking—are rapidly increasing pressure on medium (MV) and low-voltage (LV) networks. This situation increases the risk of grid congestion, especially during peak evening hours, potentially accelerating congestion within low-voltage networks and beyond. Although electricity grids are being upgraded to accommodate mobility needs, this takes time. To support both the mobility and energy transition, it is essential to maximize the use of the existing grid and increase users' flexible capacity, such as through Grid-Aware Charging.

Charging Within Capacity Limits

Grid-Aware Charging means charging within the capacity limits of the local medium/low voltage transformer station (MV/LV-transformer). This allows optimal utilization of the locally available grid capacity, benefiting all electricity users in an area and reducing the risk of local grid overload.

By shifting flexible loads, such as EV charging at public stations, away from peak hours and/or reducing charging power, the network can handle demand without exceeding its capacity. An activation threshold of 80% or higher of the total available capacity of the MV/LV transformer in the neighborhood has been set for Grid-Aware Charging. Minimizing impact and ensuring charging reliability for EV drivers are central principles in the development of this guideline.

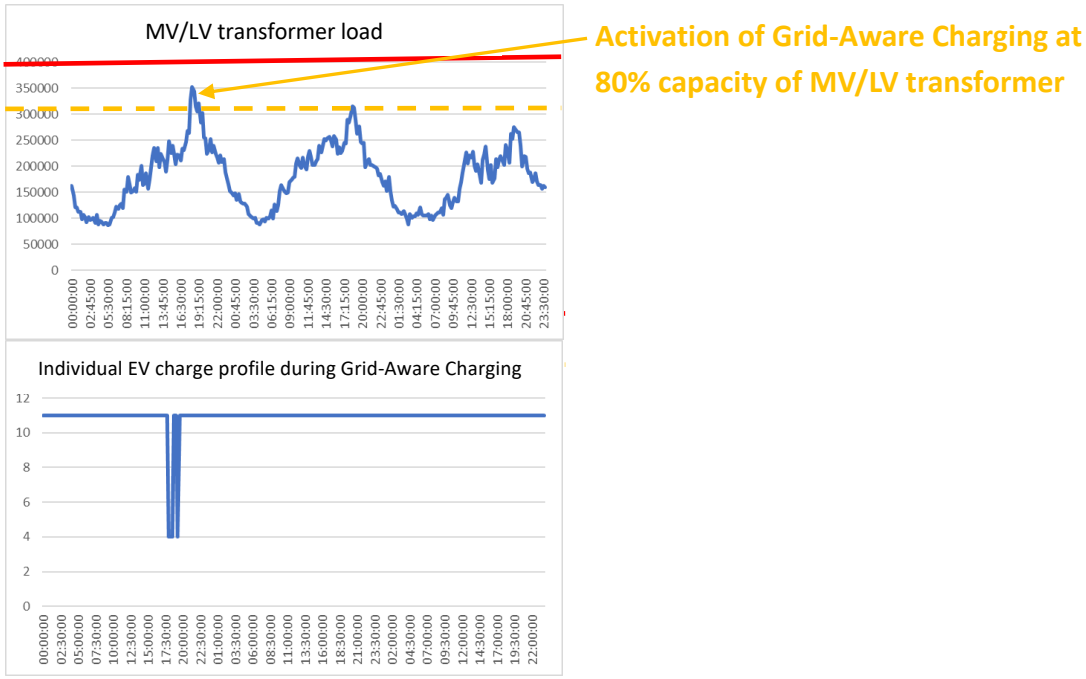

Figure 2: Reduction of power during peak moments

The available capacity within the LV networks is shared by grid operators based on forecasting. The charge point operator (CPO) is responsible for activating and applying the charging profiles. The CPO can allocate the available grid capacity among the charging electric vehicles (EVs) by *reducing power* output, pooling, and *regular power* output. Pooling refers to the ability of the CPO to combine and redistribute the available capacity from multiple charging points located behind a MV/LV-transformer (or potentially another geographic area in the future, to be discussed with the regional grid operator and concession grantor).

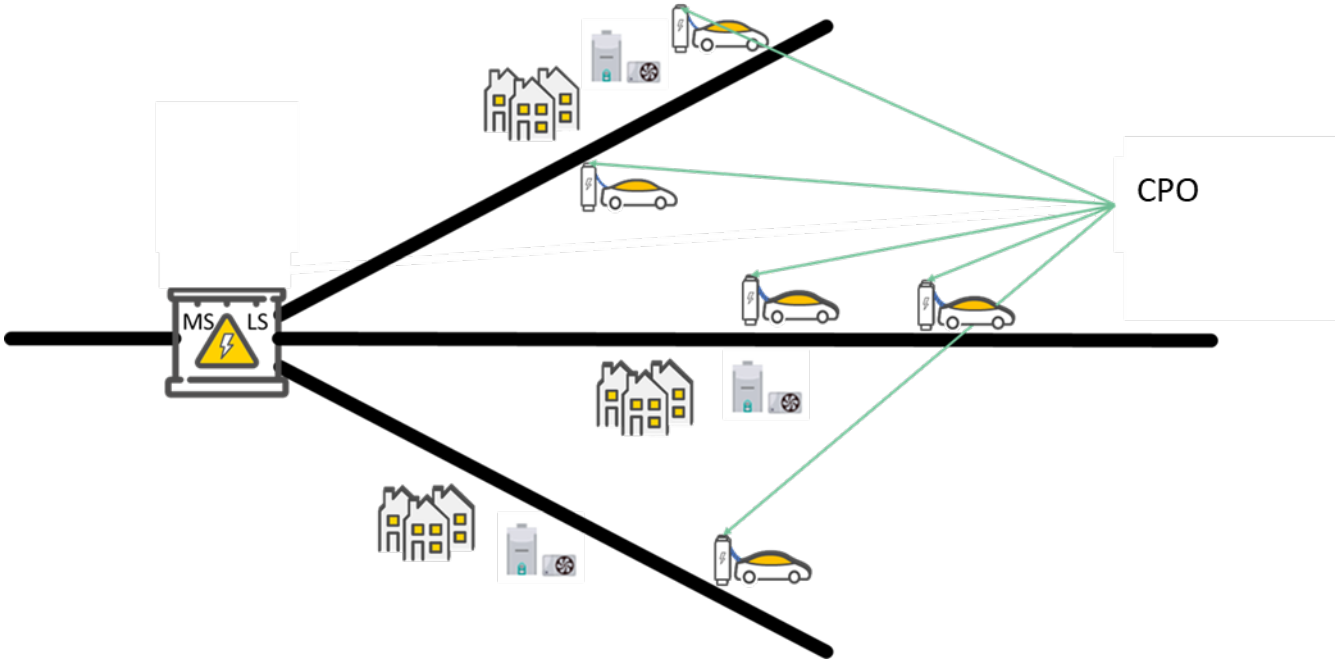

*Figure 3: **The Grid-Aware Charging Concept.** In normal operating conditions, each charging station has access to its full power capacity. In cases of (impending) capacity shortages, this power will be reduced to a lowered capacity of 4 kW per charging point. The CPO is free to decide how to allocate the available grid capacity across EVs by using reduced power, pooling, and regular capacity.*

Why introducing Grid-Aware Charging?

In various areas of the Netherlands, there is already local grid congestion. Studies and calculations by the grid operators show that local grid congestion will increasingly occur in the coming years, affecting both the offtake and the injection of electricity into the grid.
Regional grid operators in the Netherlands estimate that implementing Grid-Aware Charging will greatly reduce the number of bottlenecks in MV/LV-transformers. By 2030, they expect a 10-15% reduction nationwide, and by 2035, a 15-20% reduction on average.

In the calculations, a lower limit of reduced power of up to 4 kW per charging point has been used, as outlined in the calculations within the *'Smart Charging for Everyone'* action plan. Local congestion issues during the concession period may require a further reduction in the *reduced power* at the regional level. It is recommended to consult with the regional grid operator to determine the appropriate *reduced power* level. Concession grantors have the option to implement a further reduction in the *reduced power* within the concession. If the 4 kW per charging point limit is lifted, grid congestion can be more effectively

addressed on the existing electricity grid. Pilots such as Flexpower in Amsterdam and FLEET (Flexible Energy Tariffs) in Utrecht have shown that EV drivers experience little to no disruption from a further reduction in the *reduced power* and/or the principles of Grid-Aware Charging when the combination of smart charging (based on, among other factors, price and sustainability) and Grid-Aware Charging is effectively implemented.

By implementing Grid-Aware Charging, electricity grid upgrades can be made at a natural time (e.g. during the implementation of the *Wijkuitvoeringsplannen* (Neighborhood Execution Plans), a Dutch concept). This leads to more efficient service from the grid operators, resulting in lower societal costs. Additionally, it reduces the need for frequent digging, minimizing disruption for residents.

3. Implementation of Grid-Aware Charging in Concessions

In the previous chapter, the principle of Grid-Aware Charging was explained. This chapter provides a more detailed explanation of how Grid-Aware Charging works. For successful implementation, arrangements are necessary between the CPO (Charge Point Operator), the grid operator, and the concession provider (such as a municipality or region) regarding how and when Grid-Aware Charging will be activated. Implementing Grid-Aware Charging is a development process in which grid operators, concession providers, and CPOs collaborate. The specific details may evolve during the implementation period.

Principles for Implementation

The following principles apply for the implementation of Grid-Aware Charging at public charging stations:

1. ***Reduced power*** **(firm) 4 kW per charging point[1] and** ***regular power*** **(non-firm): full power available at the connection**
    - *Reduced power:* Only in cases of (imminent) capacity scarcity (where the LV/MV transformer is operating at 80% capacity or more) will the power be reduced to a firm level of 4 kW per charging point behind the MV/LV transformer.
    - *Regular power:* The principle is that under normal operating conditions, the full capacity of the connection is available (for a 3 * 25 A connection: 17.25 kW).
    - *Charging Assurance:* To provide charging assurance for the user, each charging point must deliver a minimum of 30 kWh over 6 hours during the day (08:00 – 17:00) for EVs that charge in 3-phase mode. This assurance applies to vehicles that remain connected for the entire 6-hour period. In the evening and night (17:00 – 08:00), there is no minimum delivery requirement to enable optimal charging based on the availability of renewable energy. The Charge Point Operator (CPO) rewards users for smart charging.
      The CPO is expected to ensure charging assurance through pooling. If, despite pooling, it is not possible to meet the charging assurance due to limited grid capacity or technical issues on the EV's side, a suitable solution will be jointly sought by the CPO, grid operator, and concession provider.
    - *SoC*: If the Charge Point Operator (CPO) automatically has access to State of Charge (SoC) data at the start of the charging session and the SoC is below 20%, the CPO may, without intervention from the EV driver, initially charge 10 kWh at the maximum available power. After this, the session must continue according to the (default) set preferences. The CPO is expected to offer this SoC service through pooling. As a result, the average reduced power per charging point behind the MV/LV transformer should not be exceeded.

[1] See textbox *Explanation of Reduced Power*, page 9

- Both delayed charging and charging at reduced power must be supported by the Charge Point Operator (CPO). Vehicles that do not properly support delayed charging (see textbox *explanation on reduced power*) must be charged with sufficient power to prevent them from entering sleep mode. The Charge Point Operator is expected to provide the minimum charging power per EV using pooling. As a result, the average reduced power per charging point behind the MV/LV transformer should not be exceeded.

The grid operators note that, if the regional grid situation requires it, alternative agreements may be made through consultation. The effects and impacts will be evaluated periodically, and based on these evaluations, adjustments to the *reduced power* and *charging assurance* may be made.

Explanation of Reduced Power (4 kW)

The guideline refers to a reduced power of 4 kW. When determining the lower limit of 4 kW, the prevention of technical issues during charging was taken into consideration. The European IEC 61851 standard, which is also included in the smart charging requirements, stipulates that vehicles must be able to charge with a minimum current of 6A, and that a charging session should not be interrupted until a power level of 0A is reached. Not all vehicles currently comply with this. For electric vehicles charging with 1-phase and 3-phase, the following applies:

- *1-phase vehicles* (and thus almost all Plug-In hybrids) generally charge with 1x16A (=3.7kW) and are not affected by this lower limit. This ensures protection for the first group of electric drivers.
- *3-phase vehicles* can, according to the IEC 61851-1 standard, charge with a minimum current of 6A. This corresponds to 4.14kW. For readability, this limit is rounded to 4 kW in the guideline.

2. **Pooling of the capacity of public charging stations behind a Medium Voltage (MV)/Low Voltage (LV) transformer**

   The available power (firm) of charging points behind an MV/LV transformer can be distributed across the charging points of a single Charge Point Operator (CPO) that are occupied at that time. Pooling ensures that the available capacity is optimally distributed. The CPO may also implement their own optimizations to enhance the user experience.

3. **Uniform information exchange on locally available grid capacity**

   In the final situation, it should make no difference for CPOs in which grid operator area they are active, as this concerns both:

   - The method of sharing information;
     The timeliness of sharing information (periodic forecasting/daily maximum available grid capacity).

4. **Opt-out Smart Charging**

   It must always be possible for an e-driver to charge with *regular power* (non-firm). To facilitate this, the CPO provides a user-friendly opt-out functionality. The Charge Point Operator is expected to offer the Opt-out smart charging using pooling. As a result, the average reduced power per charging point behind the MV/LV transformer should not be exceeded.

The above principles have been translated into requirements and will be specified in the concession in conjunction with additional requirements and wishes for smart charging.

Processes

For CPOs, it is necessary to have clarity on how, when, and where Grid-Aware Charging is applicable. These agreements will be implemented through two processes: the Grid-Aware Charging activation process and the Grid-Aware Charging control process.

Grid-Aware Charging activation process

For activation, the following steps are followed. After completing the activation process, no actual control takes place; it is only the preparation and implementation.

1. The grid operators determine at least once per year whether, and if so, on which LV grid (Low Voltage) there is expected (or impending) capacity scarcity. This applies to MV/LV transformers with a peak load of 80% or higher. For charging stations connected to those LV grids where capacity scarcity has been resolved, the obligation for Grid-Aware Charging based on the control process is no longer required.
2. The grid operator shares the locations of LV grids with limited capacity, on which the CPO will activate Grid-Aware Charging within two months.

Tender documents will include an overview of the MV/LV transformers where the load is already at 80% or higher during peak times.

Grid-Aware Charging control process

In the second process (the daily control process), the grid operator provides daily insight into the maximum available grid capacity for charging electric vehicles in areas where Grid-Aware Charging has been activated.

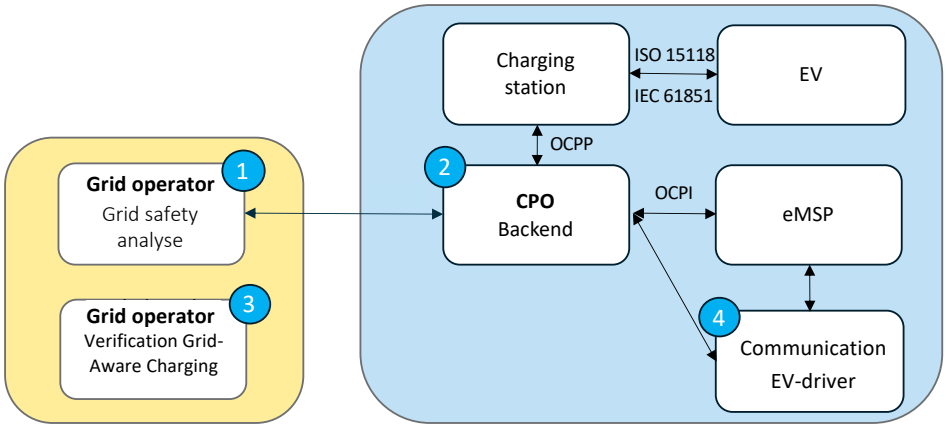

Figure 4: Grid-Aware Charging control process

1. For the MV/LV transformers where Grid-Aware Charging has been activated, grid operators provide the CPO with daily insight into the available grid capacity on an LV grid, based on a grid safety analysis. This analysis results in a capacity profile that is applied per quarter hour and may change daily. This information will be exchanged via a standardized interface (to be developed).

2. CPOs charge the EVs connected to these LV grids within the maximum available grid capacity and/or based on the minimum threshold of 4 kW per charging point (or specific regional agreements). The CPO is free to make decisions on how to distribute the available grid capacity among the EVs, based on *reduced power*, pooling, and *regular power*.
3. Grid operators monitor the follow-up/effectiveness to prevent capacity issues and provide feedback on the results to CPOs, NAL regions, and/or municipalities.
4. CPOs provide information at the charging stations to e-drivers about whether a charging station is in a grid congestion area, which smart charging profile is applied, and what options are available for activating the opt-out.

4. Requirements for Grid-Aware Charging in Concessions

In the previous chapter, the principles and operation of Grid-Aware Charging were outlined. The granting organizations (municipalities and regions) are responsible for translating these guidelines into requirements in the concession contract, which will ensure the implementation of Grid-Aware Charging. The requirements in the table below can be included in the concession contracts. It should be emphasized that the implementation of Grid-Aware Charging is a development process, and the exact details may change during the implementation period. Overlap may occur between these requirements and the requirements set by the concession provider regarding smart charging. It is important to take this into account and engage with the grid operator to avoid any contradictions.

Requirements Grid-Aware Charging	
Grid-Aware Charging	The concession holder shall apply Grid-Aware Charging to charging points in such a manner that the charging power does not exceed the available (transport) capacity for charging behind a MV-LV transformer at any given time.
Implementation of Grid-Aware Charging	The concession holder must implement Grid-Aware Charging within 12 months of the concession award. The concession holder acknowledges that Grid-Aware Charging is a developmental process, and that various components will be further developed throughout the duration of the concession.
Activation of Grid-Aware Charging	• In order to facilitate the energy and mobility transition, even in the case of (impending) capacity scarcity, the grid operators propose activating Grid-Aware Charging. • The grid operators shall determine at least once per year whether, and if so, on which LV grid (Low Voltage) there is expected (or impending) capacity scarcity. This applies to MV/LV transformers with a peak load of 80% or higher. • The grid operator shall provide the locations of LV grids with limited capacity, on which the concession holder must activate Grid-Aware Charging within two months.
Capacity Grid-Aware Charging	• The grid operator shall provide, the day before, a control signal to the concession holder in accordance with the day-ahead market schedule. This signal shall consist of a profile detailing the maximum available grid capacity on a quarter-hourly basis for an LV grid, based on a grid safety analysis. This information shall be exchanged via a standardized interface.

	• The concession holder shall charge the electric vehicles connected to these LV grids within the maximum available grid capacity and/or based on the minimum threshold of 4.14 kW per charging point. The concession holder is free to make decisions on how to distribute the available grid capacity among the electric vehicles based on reduced capacity, pooling, and regular capacity. • The concession holder is free to discharge electric vehicles; no maximum power applies for this. • *Regular power:* The principle is that under normal operating conditions, the full capacity of the connection is available (for a 3 * 25 A connection: 17.25 kW). • *Reduced power*: Only in cases of (imminent) capacity scarcity (where the LV/MV transformer is operating at 80% capacity or more) will the power be reduced to a level of 4 kW per charging point behind the MV/LV transformer.
Pooling	When the grid operator limits capacity through a control signal, the concession holder is obligated to comply with this signal and is granted the right to Pool. Pooling refers to the ability to combine and redistribute the available capacity from multiple charging points behind the same MV/LV transformer (or, in the future, possibly another geographic area, to be agreed upon with the regional grid operator and concession grantor) by the concession holder. In this process, the concession holder determines the charging profile (the redistribution of capacity from the charging facilities behind the same MV/LV transformer), including, but not limited to, the simultaneous occupancy of charging facilities behind the same MV/LV transformer. However, this power must never exceed the reduced power per charging point.
Opt-out	It must always be possible for a user to charge with regular capacity (non-firm). To facilitate this, the concession holder offers a user-friendly opt-out functionality. In coordination between the concession holder and the concession grantor, the additional cost of the opt-out option for the e-driver (on top of the charging price) will be determined.
Charging Assurance	To provide the user with charging assurance, there is a minimum supply of 30 kWh per 6 hours per charging point during the day (8:00 AM – 5:00 PM), based on three-phase charging. The charging assurance applies to vehicles that are connected for 6 hours during this time period. The required power for charging assurance is managed by the concession holder through Pooling, ensuring that the total power on the MV/LV transformer does not exceed the reduced power per charging point.
State of Charge	If the concession holder has access to State of Charge (SoC) data at the start of the charging session and the SoC is below 20%, the concession holder can charge 10 kWh with the maximum

	available capacity without the intervention of the e-driver, after which the charging session will continue according to the (standard) preset preferences. The required power for the SoC service is managed by the concession holder through Pooling, ensuring that the total power on the MV/LV transformer does not exceed the reduced power per charging point.
Delayed charging	The concession holder supports both delayed charging and charging at reduced power. Vehicles that do not properly support delayed charging must be charged with sufficient power to prevent them from entering sleep mode. The required power for these vehicles is managed by the concession holder within the Pooling, ensuring that the total power on the MV/LV transformer does not exceed the reduced power per charging point.
Control signals for Grid-Aware Charging	As part of the "Smart Charging for Everyone" program, a choice will be made regarding a protocol for control signals for Grid-Aware Charging, which will be supported by all regional grid operators in the Netherlands. Until then, the concession holder must comply with the current communication interface of the grid operator. If the concession holder wishes to propose an alternative open protocol, this must be agreed upon in consultation with the regional grid operator and in coordination with the concession grantor. Any updates to the protocol to a new version must also be made in consultation with the grid operator and concession grantor to ensure compatibility.
Information Provision	The concession holder provides e-drivers with information about whether a charging station is in a grid congestion area, which smart charging profile is being applied, and the options available for activating the opt-out. A nationally standardized communication for the operation of Grid-Aware Charging will be developed and shared with the concession holder(s).
Monitoring	The grid operator verifies, based on smart meter data, the compliance and effectiveness in preventing capacity issues and discusses the results with the concession grantor and concession holder. For verification purposes, the connection must be equipped with a smart meter, and the Smart Meter Allocation (SMA) process must be activated. The consumption data per quarter-hour will be made available to the grid operator for verification purposes.
Evaluation	Periodically, the effect and impact will be determined and evaluated in consultation between the concession grantor, concession holder, and regional grid operator. Based on this, the requirements for reduced power and charging assurance may be adjusted.

1 november 2023