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# The Private Charger — local charging station management from different perspectives

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**Executive Summary**

Charging electric vehicles at private premises goes beyond connecting just another electric appliance, as electric vehicle is a major consumer to be integrated in the local network, necessitating smart energy management systems to cater with tariff optimisation, autoproduction and bidirectional energy transfer. This article will focus on the technical and legal situation in Belgium a,nd also highlight the evolution of international standardization in the field.

*Keywords: standardization, regulations codes & standards, infrastructure, smart charging*

## 1 EV in the Belgian distribution network

### 1.1 The need for power

A private citizen acquiring an electric vehicle (EV) and having a garage or carport available may want to install a private charging post at home, and has to decide for the right power level.
Although it may be tempting to go for the maximum available power for the vehicle, this is not always advisable as it may imply an expensive power extension of the home network which is not always necessary.

Many vehicles for the European market now come with a three phase 16A charger allowing for 11kW on a 3×400V connection, some allowing a higher current. They charge single phase at 3,7kW (1×16A), sometimes at 7,4kW (1×32A), the latter configuration (single phase only 32A) also being common on some vehicles.

Typical power levels for Mode 3 private charging posts include 3,7kW (1×16A), 7,4kW(1×32A) and 11kW(3×16A) or 22kW (3×32A).
Low power Mode 2 charging (2,3kW, 1×10A) from a standard socket outlet is very slow and is really only advisable for vehicles with limited battery capacity such as plug in hybrids.

A simple 3,7kW charging post can be accomodated by all subscribers (the basic electrical connection being 1×40A or 9,2kVA, higher powers are usually three phase) and can charge all vehicles, albeit slowly. Faster charging with higher power is possible if the home installation accepts it, considering however the peak power and the capacity tariff (see 1.4).

### 1.2 Legal aspects

Belgium is quite are unique since wiring rules for electrical installations are not based on national or international standards, nor on industry regulations or codes of good practice, but are firmly enshrined in the law: the General Regulation on Electrical Installations (GREI) [1].

This was extended in 2022 with a special chapter 7.22 on EV charging posts, which defines the connection rules and more particularly the protection measures to be provided.

It states that EV charging posts are considered part of the fixed electrical installation (thus not to be connected via a plug and socket).
Every connection point shall have its dedicated current path with protection against overcurrent and indirect contact, the latter provided by a 30mA RCD which shall also cater for DC fault currents.

However, if a Type B RCD is used, any upstream RCD shall according to the GRIE also be Type B in order nor to be "blinded" (i.e. its magnetic core being saturated by a DC fault current >6mA). Replacing the (compulsory) main 300mA RCD by a Type B is expensive however; the protection against the 6mA DC fault currents can also be provided by a special "type A – EV" RCD according to IEC62955 [2] or by a residual current monitor inside the charging post.

In these cases, the main RCD can remain a Type A — providing only one charging post is present in the installation, otherwise a Type B is needed anyway. Permissible configurations of RCD are shown in fig. 1.

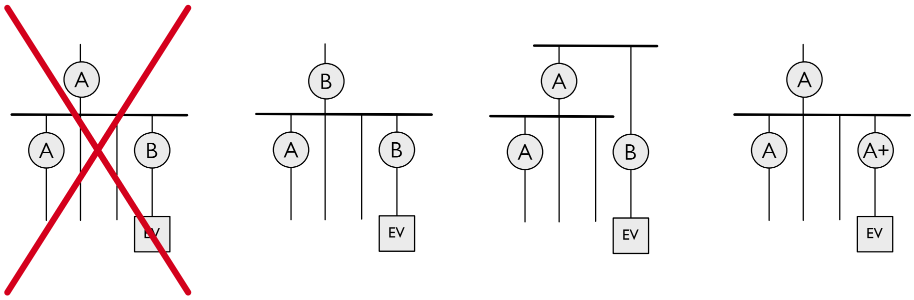

Figure 1: *RCDs for charging post*

The new GREI chapter also foresees the development of V2G stating that V2G-capable charging stations shall comply to the requirmenbts for decentral production units (such as PV panels).

### 1.3 3×230V

A peculiarity of the Belgian low voltage network is the use of the 3×230V without neutral, instead of the more common 3×400V+N network (see fig. 2). This system is ubiquitous particularly in urban areas in the centre of the country.

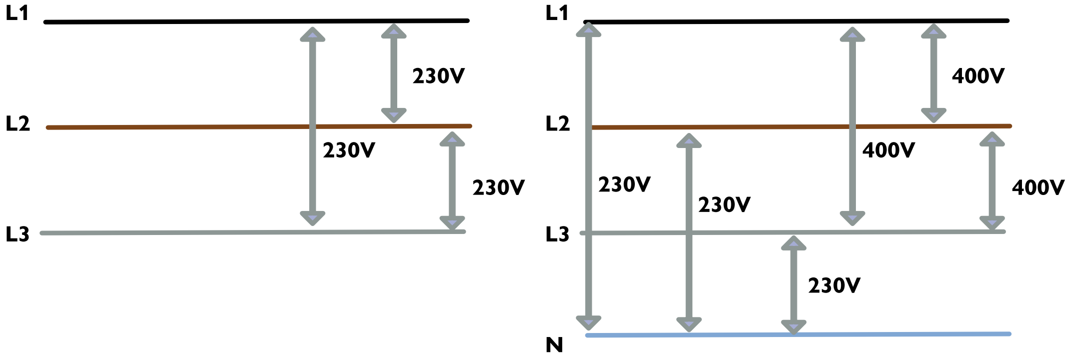

Figure 2: *3 × 230V and 3 × 400V+N*

This network configuration will have its impact on electric vehicle charging.
On one hand, some EV on the Belgian market refuse to charge without a neutral present. Such vehicles will need a single phase separation transformer.

On the other hand three phase charging is defined for 3×400V systems only and a (auto)transrormer is needed if one wants to charge three phase on 3×230V. Some vehicles are able to charge two phase, by connecting the three wires of the 3×230V supply to the terminals $L_1$, $L_2$ and $N$ of the charging post.

Such connection is however in violation of the standard IEC61851-1 [3] and will give an error with some vehicles. Furthermore, the current in the third phase will be $\sqrt{3}$ times the rated charging current in the other phases. Nevertheless this connection is recommended by some vehicle manufacturers; it might be acceptable for private charging stations of well-informed users only.

Changing the connection to 3×400V+N is not always an easy or affordable option.

Some Belgian distribution system operators (DSO) do favorize the general adoption of 3×400V+N in the framework of the energy transition, but due to the extension of the network the 3×230V network will still be around for many years to come.

### 1.4 Capacity tariff

From January 1, 2023, low voltage subscribers on the Belgian electricity network will be subject to the so-called capacity tariff as part of the grid fee, independent of their actual supplier [4] (see fig. 3).

The tariff is based on the peak power measured in 15-minute intervals by the subscriber's digital electricity meter; for those not having such a meter yet, a lump sum is levied. The capacity tariff aims to better reflect the actual cost for the DSO.

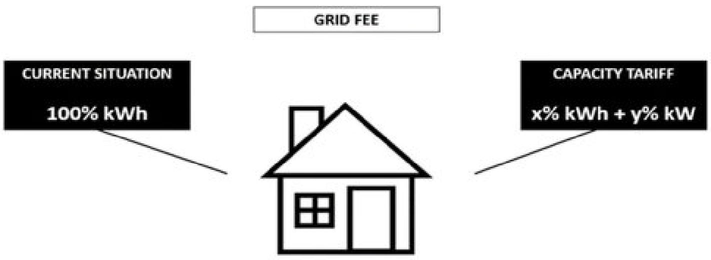


Figure 3: *Capacity tariff [5]*

While at first it seems that the capacity tariff will discourage high power home charging, the real impact may be more complex since the alternative, extended time low power charging, will most likely start at vehicle arrival in the early evening contributing to the heavy evening peak. The capacity tariff will however necessitate more active charge management systems.

### 1.5 Autoproduction and storage

The widespread deployment of photovoltaic panels has made many subscribers autoproducers. The generalised use of digital electricity meters however has changed the scene: whileas classical electricity meters turned back and invoicing only covered the energy difference from the grid over the invoicing period, digital meters separate the invoicing for consumption and production, paying a lower rate for the latter (but doing away the "prosumer rate" levied with the turningback meter). This makes it interesting to use the produced energy on the actual moment of production.

The use of "house batteries" is spreading for this purpose to allow local storage; the availability and the implementation of Vehicle to Grid (V2G) will give another dimension to "smart" charging, with EV battery capacity significantly higher than the typical "house battery". V2G opportunities are today very limited in Belgium however, with few enabled vehicles and only one V2G certified charging post.

### 1.6 Fiscal aspects

The aspect of "smart" charging also comes to the front considering the fiscal incentives for charging stations offered in Belgium [6].

These incentives, available for private citizens as a tax deduction and for corporations as an augmented amortization, require the installation of an "intelligent" charging post, where charging power and time can be regulated. Private citizens furthermore need a subscription to so-called "green" current, whileas corporations need to make the charging posts publicly accessible.
The incentives will decrease over time and cease by end 2024.

## 2 Relevant international standardization

All these points necessitate the development for Belgium, just as for other countries, of standardized protocols for ”smart” charging, and more in particular for communication issues.

For most public charging stations, the consortium standard Open Charge Point Protocol (OCPP) [7] is is use. This will be eventually developed as International Standard in the IEC63110 series [8] .
However, these documents are mostly aimed at public charging stations where there is a charging infrastructure backend and might be ”overkill” for private applications, except in some cases where third-party access and remote billing systems are required.

To deal with the needs of local charging station management where a backend is not involved, a new project IEC63380 *Local Charging station management systems and Local Energy Management Systems network connectivity and information exchange* has been launched by IEC TC69, with several parts having reached CD stage:

- Part 1 General Requirements, Use Cases and abstract Messages [9]
- Part 2 Specific Data Model Mapping [10]
- Part 3 Communication Protocol and Cybersecurity Specific Aspects [11]

These documents aim to define a standardized interface for the connected consumers and generating facilities, which also includes the charging infrastructure for electric vehicles, including both power management (to avoid overloads) and energy management (to optimize tariff).
To this effect, the information exchange between Local Charging Station Management Systems, which may be part of charging stations or implemented as separate systems, and local Energy Management Systems/Customer Energy Managers in buildings are defined.
The proposed standard describes a number of use cases and scenarios where the EV is integrated in the building’s energy management system (EMS) (fig. 4).

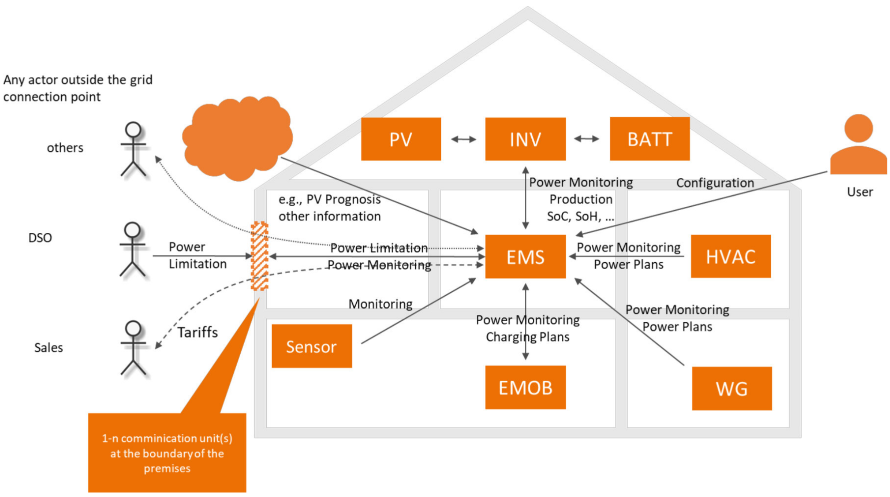


Figure 4: *Energy management system [9]*

The use cases include all possible operation and error configurations including optimization of autoconsumption and bidirectional charging. Figure 5 shows one typical case: the monitoring of active power consumption.

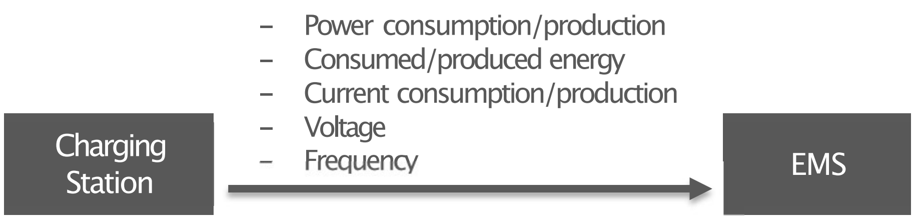


Figure 5: *Monitoring of active power consumption [9]*

The energy management system hereby acts both as ”energy broker”, choosing the most advantageous source of energy at each moment (fig. 6), and as an ”energy guard” ensuring system safety and avoiding overloads.

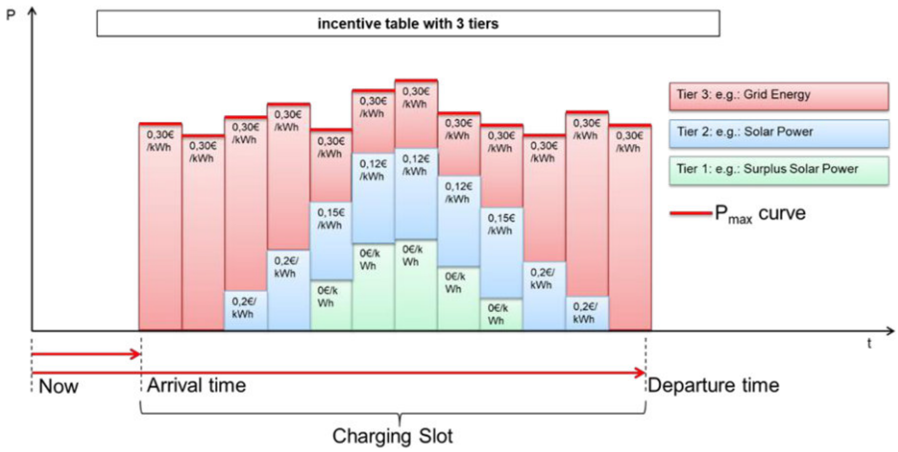


Figure 6: *Incentive table [9]*

Part 2 of the proposed standard maps the generic use case functions defined in Part 1 to specific data model, whileas Part 3 specifies the application of relevant transport protocols; in this case, SPINE (Smart Premises Interoperable Neutral-Message Exchange), SHIP (Smart Home IP), and ECHONET Lite. Figure 7 represents the use of transport protocols within th e standards.

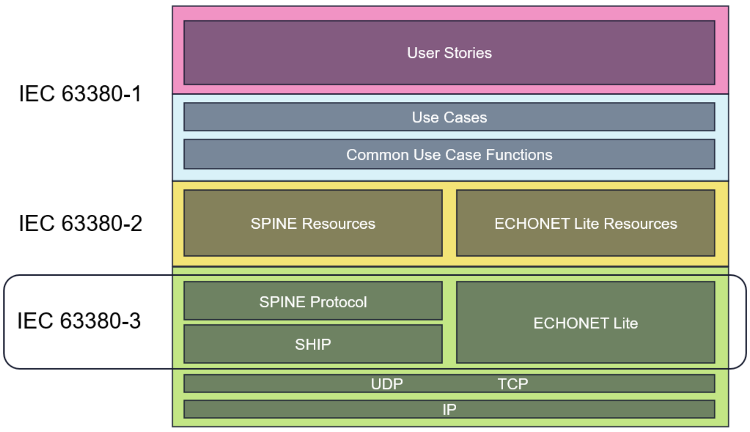


Figure 7: *Structure of 63380 [11]*

The IEC63380 standard is now at an early stage and may change connsiderably before publication; its further development will have to take into account the perceived overlap between this project and the IEC63110 series which it should complement.

# 3 Conclusions

As seen for the case study Belgium, the implementation of EV charging stations in residential distribution networks will face specific challenges to ensure optimal use of the available resources at a minimal installation and optimization cost.
The practical implementation will need the development of widely accepted international standards to ensure smooth communication.

## Acknowledgments

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## Presenter Biography

Peter Van den Bossche, civil mechanical-electrotechnical engineer, promoted in Engineering Sciences from the Vrije Universiteit Brussel on the PhD thesis "The Electric vehicle, raising the standards" He is currently lecturer at the Vrije Universiteit Brussel. Since more than 25 years he is active in several international standardization committees, currently acting as Secretary of IEC TC69 and CLC TC69X.