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Unlocking EV smart charging to reduce grid congestion - lessons from the Netherlands

March 2024

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Stichting ElaadNL
For the attention of Baerte de Brey
Westervoortsedijk 73
6827 AV Arnhem

Subject: Unlocking smart charging of EVs for avoiding and resolving congestions in the DSO grid

Dear Mr. de Brey,

We are delighted to present our report into the regulatory barriers preventing the scale up of smart charging of EVs for avoiding and/or resolving congestions in the DSO grid in the Netherlands and EU. The intention of the report is to present a clear & concise overview of the most important barriers based on existing literature and input from market experts/ stakeholders across the value chain. The report also presents clear recommendations for addressing these barriers at either EU or Dutch level (depending on where the change is required).

This report is an outcome of the work we agreed to undertake in accordance with the confirmation of the assignment dated 6 November 2023. Our report is supplied on the understanding that it is solely for the use of ElaadNL and for the purpose stated in the report. No other parties than ElaadNL are authorised to use or rely on the report. We will therefore not accept any responsibility, duty of care or liability to any unauthorised reader of our report – whether in contract, tort (including negligence) or otherwise, to any other party than ElaadNL, including the stakeholders that contributed to this report through interviews and/or workshops.

If you have any questions related to the report, please feel free to contact me.

PricewaterhouseCoopers Advisory N.V.

Prof. dr. Gülbahar Tezel

Partner Strategy&

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EV batteries can be a source of flexibility for grid operators, reducing peaks and avoiding investments

Electrification of passenger vehicles is expected to occur at a rapid pace across the EU towards 2030

- At a **European level**, several **climate agreements and regulations** have been introduced, calling for **accelerated adoption of passenger Electric Vehicles (EVs)**
- In March 2023, the **European Council set a target of 55%** CO_2 emission reduction for **new cars from 2030 to 2034** compared to 2021 levels. From **2035, the target is set at 100%** CO_2 reduction compared to 2021. The **Dutch Climate Agreement** is more ambitious and aspires **all new passenger cars to be zero emission by 2030**
- These **targets** and ambitions at both EU and NL levels are **expected to drive large scale electrification** within the fleet of passenger cars. It is expected that there will be ca. **1.9 million passenger EVs in NL by 2030**. Across the **EU**, the **amount of passenger EVs** is expected to climb to **ca. 35 million by 2030**

The transition to electric vehicles (EVs) will put additional pressure on electricity grids, but it can also be an opportunity for grid operators

- The **alternative fuels infrastructure regulation (AFIR)** adopted in July 2023 **sets a target of maximum 60 km between recharging** and refueling **stations on main roads.** This is expected to drive a sharp increase in (fast) charging stations that are connected to the grid
- **In combination with the typical charging patterns** of EV users, the increased number charging stations are **expected to put additional strain** on the grid, **intensifying current peaks & congestions.** In this light, **grid operators are expected to face** challenges while meeting their **security of supply obligations**
- **Grid operators can also view EVs as sources of flexibility** i.e., demand sources that are **able to change their consumption pattern** or even act as prosumers/**supply energy to the grid if they receive the right incentives**

Flexibility from EV batteries can help grid operators manage peaks and avoid investments in two ways i.e., via controlled charging and Vehicle to Grid/Grid to Vehicle (V2G/G2V)

- **There are two ways in which batteries can become providers of flexibility:**
  1. <u>Controlled charging</u>: With this form of flexibility, EV owners align their charging decisions with the needs of the grid i.e., they delay their charging to a later time if there is congestion on the grid in exchange for a compensation received from the grid operator
  2. <u>Vehicle to grid/Grid to Vehicle (V2G/G2V):</u> With this form of flexibility, EV batteries become providers of extra grid capacity by charging from the grid when the grid is overloaded (during times of over-supply) and discharging back into the grid when there is a need (during times of under-supply)
  - Collectively, <u>these two ways of generating flexibility from EV batteries are brought under the umbrella term of **'smart charging'**</u> in this report
- **Smart charging (i.e., Controlled charging and V2G/G2V) can provide several benefits to the grid operator and the EV user**:
  - With controlled charging exclusively, research shows that **6x more charging stations can be installed & made operational** behind a transformer **at the same peak capacity**
  - If all EVs in NL engage in smart charging (i.e., both controlled charging & V2G/G2V), **approximately 0,9 €bn DSO grid investments can be avoided** between 2025-'30 and **peaks can be reduced by 10-15% (in 2030)**[3]
  - From a **EV user** perspective, engaging in smart charging (i.e., both controlled charging & V2G/G2V) can help in **generating additional revenues**. Research suggests that this **can be in the order of 7-13% of total charging costs**[2]

1) High smart meter penetration in NL provides a strong basis for dynamic tariff differentiation (more than 2 time periods/ day); 2) Assuming that EV users receive a compensation equivalent to the wholesale market price of electricity for providing flexibility from their EV batteries; 3) Handreiking Netbewust Laden - Slim laden voor iedereen, Nationale Agenda Laadinfrastructuur (Nov. 2023)

7 key barriers currently hinder the unlocking of full EV flex potential for the purpose of addressing DSO congestions

Building blocks for enabling smart charging				Barriers identified for NL (mainly regulatory)		Applies to…		Is also an issue in[3]…
						CC[1]	V2G[2]	
Activating smart charging for congestion management in LV grid	Incentives for demand side management	*Indirect control*	*Ability to differentiate tariffs to reflect peaks*	1	**Lack of incentive from network tariffs** to charge at low peak times as time/location differentiation is not possible	✓	✗	🇧🇪 🇩🇪
			Taxation related incentives	2	**Presence of a financial disincentive within the current energy tax structure** while performing V2G/G2V	✗	✓	🇧🇪 🇩🇪 🇫🇷
		Market-based control	*Availability of flex price/ compensation*	3	***Absence of a LV congestion market mechanism*** *through which DSOs can compensate V2G/G2V from EVs*	✗	✓	🇧🇪 🇫🇷
		Direct load control	*Ability to engage in direct load control*	4a	**Unclarity over the possibility of DSOs to curtail charge points as last resort**, creating an incentive to keep expanding the grid	✓	✗	🇫🇷
			Ability to have interruptible programs	4b	*DSOs engage in **load interruptible programs** for large users, but **do not do this with small end-users due to transaction costs***	✓	✗	*Not tested*
	Availability of enabling infrastructure	*Communica-tion and coordination*	*Data requirements & sharing*	5	**Absence of a comprehensive communication standard b/w the DSO & CPO/Aggregator** to enable smart charging	✗	✓	🇧🇪 🇩🇪 🇫🇷
			Interoperability b/w service providers	6	**Interoperability issues due to differences in standards (plugs, sockets, settlements etc.) adopted** by CPOs & OEMs	✓	✓	🇧🇪 🇩🇪 🇫🇷
		Grid monitoring	*Digitally enabled grid*	7	**Lack of incentive** (or potential penalization) **for digitalization & grid modernization** within the DSO tariff regulation	✓	✓	🇧🇪 🇩🇪 🇫🇷

▨ Regulatory ▨ Non-regulatory ✓ Barrier applies to this form of smart charging ✗ Barrier does not apply to this form of smart charging

1) CC – Controlled Charging; 2) V2G – Vehicle to Grid and Grid to Vehicle; 3) Within the EU countries tested during the project (mainly via stakeholder workshops i.e., Belgium (BE), France (FR) and Germany (DE). These countries were chosen due to a combination of relatively high penetration rate of EVs (expected towards 2030) and their ability to serve as frontrunners/examples for other member states in the EU

We propose several concrete actions to be taken by regulators, DSOs, policymakers & industry to scale up smart charging

Barriers identified	Required actions to address the barriers
1 **Lack of incentive from network tariffs to charge at low peak times as time/ location differentiation is not possible**	• The Dutch regulator ACM is advised to assess the impact of introducing alternative forms of distribution tariffs (with either capacity or volume based differentiation in time and/or location) on congestions in the LV grid • Based on the outcome of this analysis, a proposal should be developed towards policymakers to amend existing tariff codes
2 **Presence of a financial disincentive within the current tax structure while performing V2G/G2V**	• In the long-run, policymakers are advised to develop an automated exemption-based solution to reduce administrative burden • If the netting rule ('salderingsregeling') would be abolished, policymakers could consider introducing a refund mechanism. This would require a database of battery capacities connected to the grid and an effective monitoring mechanism for energy flows
3 **Absence of a LV congestion market mechanism through which DSOs can compensate V2G/G2V from EVs**	• Dutch DSOs are advised to either setup bilateral agreements with CPOs (where transaction costs are low) or use learnings from SINTEG Enera & Piclo Marketplace platforms to develop and design the LV congestion module within GOPACS[2]. Some key learnings that could potentially be borrowed are low minimum bid size, pay-as-bid and/or capacity-based pricing etc.
4 **Unclarity over the possibility of DSOs to curtail charge points as last resort, creating an incentive to keep expanding the grid**	• Dutch DSOs are advised to develop a joint proposal directed towards policymakers highlighting the costs and benefits of introducing different forms of Direct Load Control (DLC) mechanisms. This proposal should make concrete recommendations on the design and explicit changes required in network codes to allow a DLC mechanism under specific conditions[1]
5 **Absence of a comprehensive communication standard b/w the DSO & CPO/Aggregator to enable smart charging**	• EU Working Groups developing standards for smart charging (incl. representatives from regulatory bodies like ACER) are advised to engage with the charging infrastructure players and research institutions to jointly establish a robust DSO-CPO communication standard that can be rolled out across Europe. The new standard could build upon both OSCP and OpenADR
6 **Interoperability issues due to differences in standards adopted by CPOs & OEMs**	• The European standards authority is advised to take steps to ensure that all charge points and EVs comply with ISO15118-20. This can be achieved through clear guidance within existing regulations (e.g., AFIR) or by establishing an appropriate governance structure around the standard, enabling the industry to adopt it voluntarily through a de facto approach
7 **Lack of incentive (or potential penalization) for digitalization & grid modernization within the DSO tariff regulation**	• Regulators in individual member states are advised to adjust the DSO tariff regulation in NL to incentivize grid modernization and other smart grid related investments through either ex-post recalculations or making current estimation mechanism forward-looking rather than historical-based

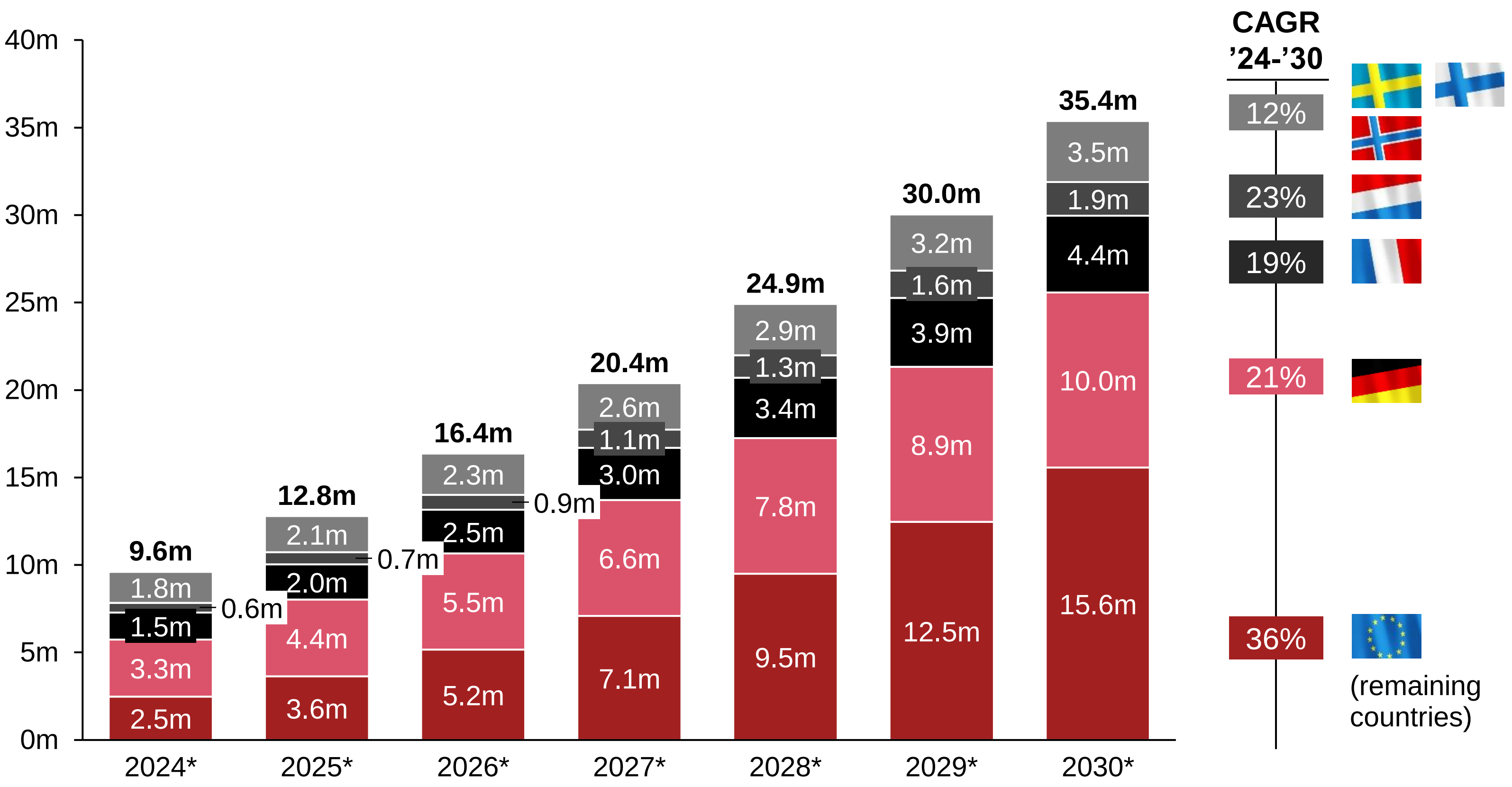
1) The proposed approach can be either consent-based or default opt-in based, but it must align with Article 13 of the EU's Electricity Market Regulation (2019/943); 2) The existing MV/HV congestion platform run by Dutch DSOs

1. The need for smart charging & its impact

EV fleet size across the EU is expected to grow rapidly – NL to experience a growth of ~23% CAGR ('24-'30)

EV market, Europe

Total number of EVs in Europe *(2022 – 2030, in m units)*



Comments

- The total **Dutch fleet** of over **0.6m EVs in 2024** is expected to grow **threefold towards 2030,** reaching **~1.9m EVs**
- Growth is primarily driven by both **Dutch and EU legislation**
  - The Dutch government wants all cars sold from **2030 to be zero-emission vehicles**
  - The EU has formulated the goal of having a European fleet consisting of **100% zero-emission cars by 2050**
  - EU has announced that **all new cars and vans registered in Europe should be zero-emission starting 2035.** As an intermediary step towards zero emissions, the new CO2 standards will also require average emissions of new cars to come down by 55% by 2030
- Secondly, **decreasing total cost of ownership (TCO)** due to increased focus of OEMs drives adoption
  - Currently, prices of high and medium-end EV cars are often already lower than combustion-engine counterparts
  - From 2026/2027 onwards **prices of almost all EVs are expected to be lower** than the prices of their combustion-engine cars counterparts

* Forecast years

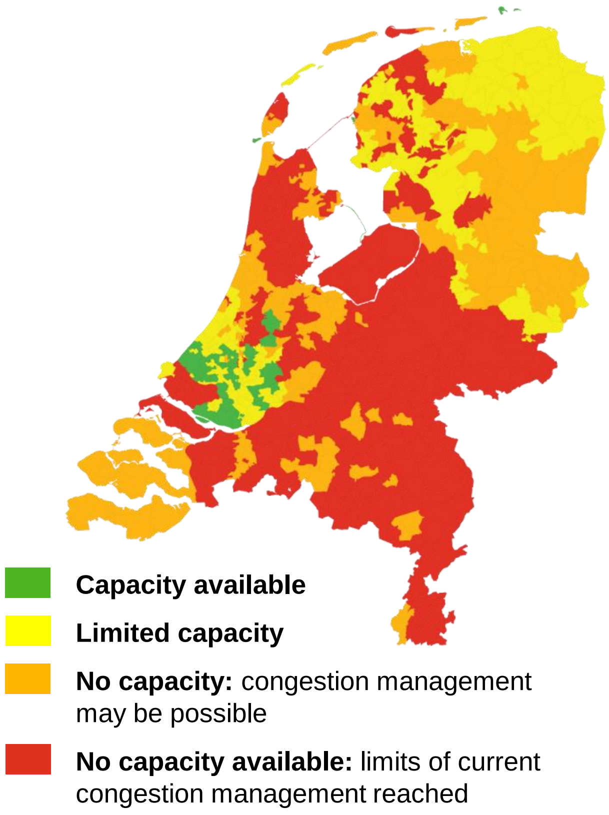
Source: Mid scenario of ElaadNL Outlook for The Netherlands (Link); ECEA, EAFO, OECD, Deutsche Bank for other countries

Typical charging pattern of EV users is expected to put more strain on the LV grid, intensifying current peaks & congestion

Electricity grid load changes

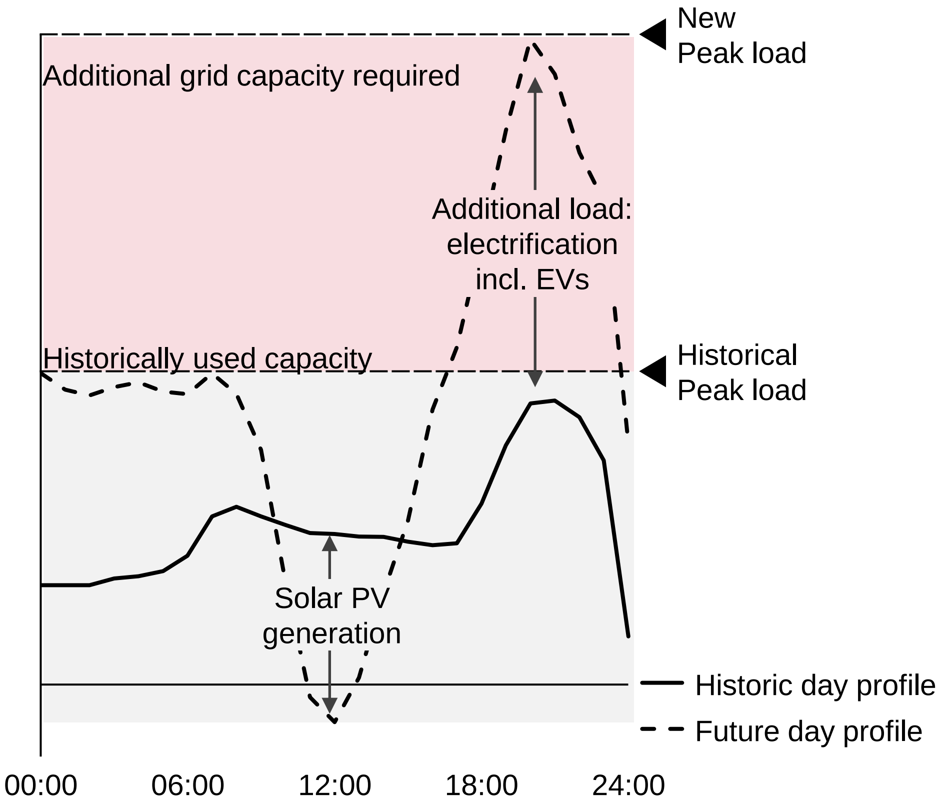
The HV and MV grid is already facing congestion issues

NL MV grid capacity, December 2023



However, electrification and increasing renewables % is likely to cause LV congestion issues going forward

ILLUSTRATIVE



Comments

- Currently, **peaks and congestion** is **contained to** the **high and medium voltage grid in NL**
- The **low voltage (LV) grid does not yet experience congestion in The Netherlands** however this is expected to change with **ongoing electrification** and **higher share of renewables**
- **Electrification drives higher transport volumes** e.g. from EVs, heat pumps, large power consumers
- The daily **transport profile** changes, among other things **due to decentralised generation** (e.g., renewables) and EV charging patterns
- For example, EV charging patterns associated with higher EV adoption **will intensify the peak load** pressure on the LV grid: high EV adoption is expected to **double the LV grid peak load** compared to low take-up scenarios
- The increased peak load is caused by:
  - More **transport volumes;** and
  - High **simultaneously in EV charging** moments
  - In response **existing networks are being reinforced and extended**, leading to **additional costs** for the sector

Source: NBNL, NEDU; Elaad; Strategy& analysis

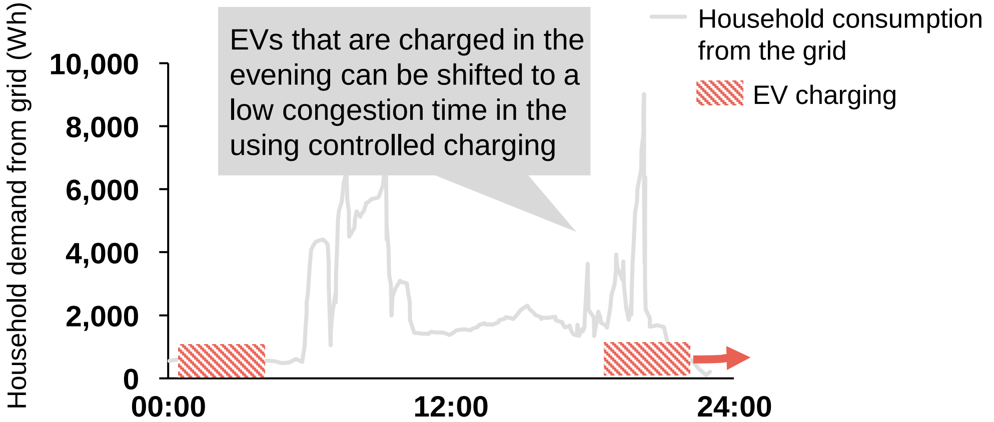
By spreading charging/discharging throughout the day, smart charging (CC & V2G/G2V) can reduce peak loads by 10-15%

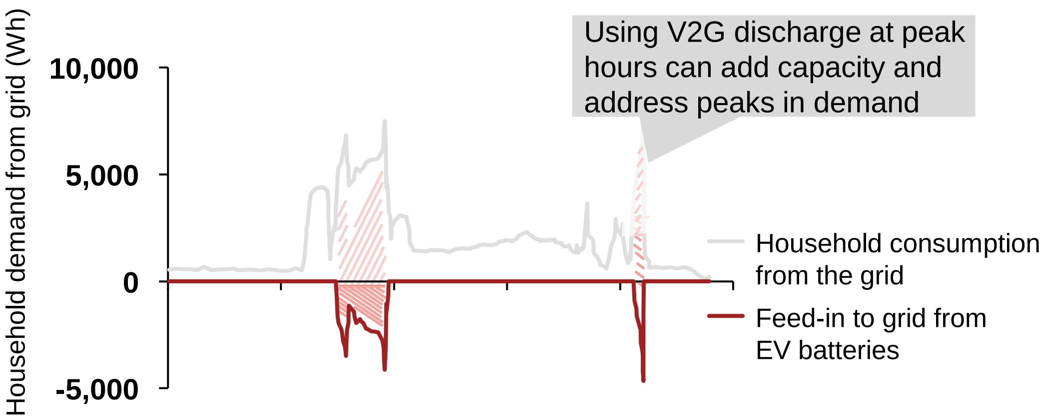
Impact of smart charging on peak loads

Definitions

Smart charging	**Controlled charging (CC)**	Using an external signal to regulate the charging rate and/ or timing of an EV, to optimise energy use, grid stability and cost-effectiveness. Controlled charging can help in (ex-ante) avoiding peaks. *E.g., delaying the charging of an EV to a period which avoids peak electricity demand*
	Vehicle to grid/ Grid to Vehicle (V2G/ G2V)	Making an EV battery's capacity available for bi-directional energy flows between EV and the grid. V2G/G2V can help in (ex-ante) avoiding peaks and (ex-post) resolving congestion

Illustration of the effect


EVs that are charged in the evening can be shifted to a low congestion time in the using controlled charging


Using V2G discharge at peak hours can add capacity and address peaks in demand

Comments

- **Smart charging creates flexibility** via controlled charging and V2G/G2V (Vehicle to Grid and Grid to Vehicle)
- **Rapid increases in grid demand** or supply can **risk** short-term **situations where DSOs have insufficient capacity** and have to determine capacity allocation between parties – **a form of congestion management**
- Studies show that **smart/grid aware charging can reduce LV peak grid loads by 10-15% in 2030 and by 15-20% in 2035 (national average)**[1]
- **Smart charging helps in avoiding/ managing congestions by**:
  1. **Reducing demand** by flattening EV charging peaks
  2. **Managing excess supply** by providing a store of energy when production of variable renewables is high
  3. **Increasing grid capacity** by feeding energy stored in EV batteries back into the grid

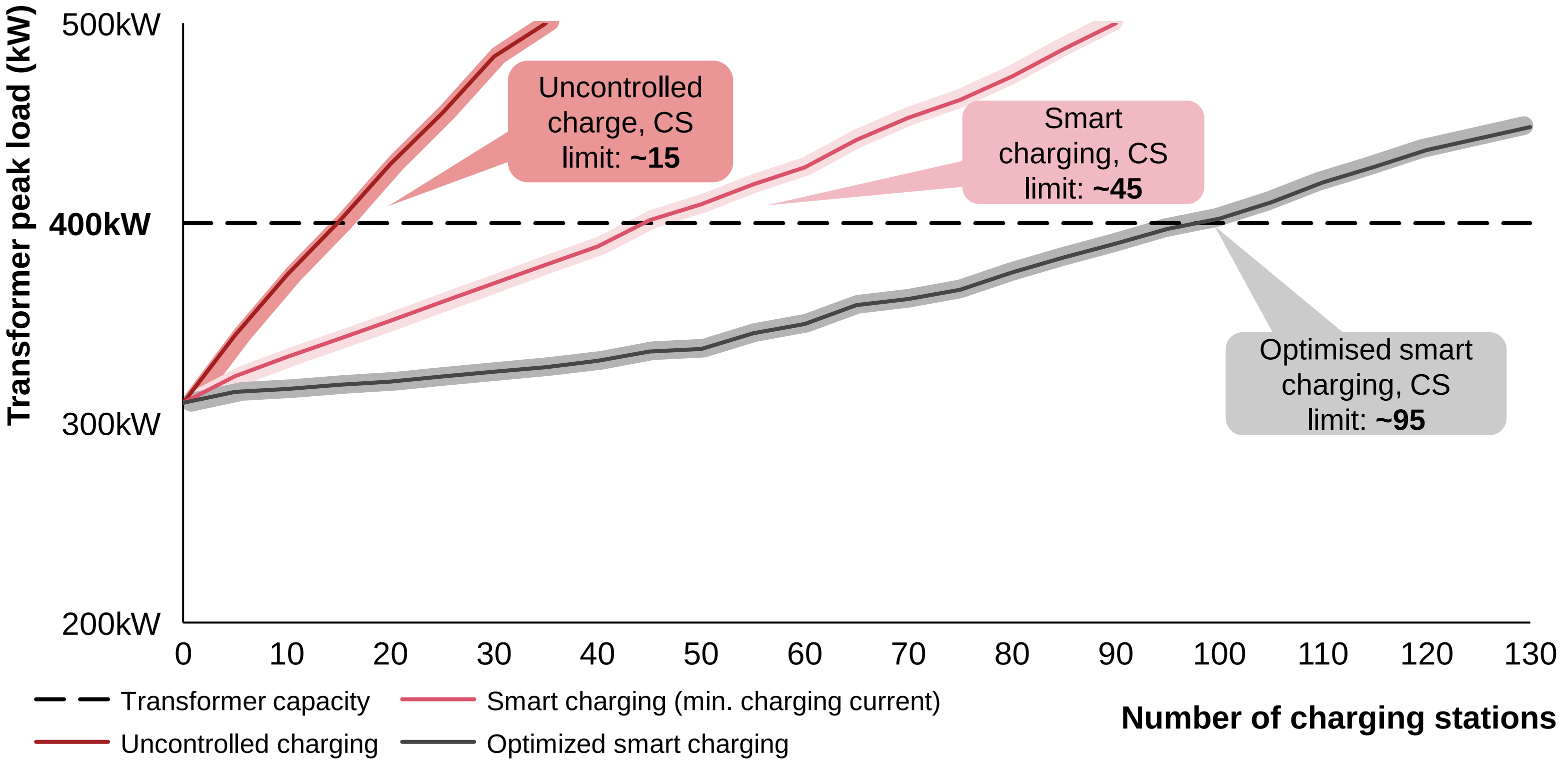
Source: Unlocking the Full Potential of Smart Charging: Addressing Delayed Charging Problems in Electric Vehicles (2023); Kuiken and Mas (2019); E-Act; Netcode 2016; IRENA EV smart charging (2019); 1) Handreiking Netbewust Laden - Slim laden voor iedereen, Nationale Agenda Laadinfrastructuur (Nov. 2023)

Smart charging allows more charging stations to be installed and operational behind a transformer at the same capacity

Impact of smart charging on mitigating grid congestion

Average peak transformer charging station capacity under different EV charging regimes

Line shows the average outcomes for different charging regimes, with a range indicating range of outcomes



Uncontrolled charge, CS limit: **~15**

Smart charging, CS limit: **~45**

Optimised smart charging, CS limit: **~95**

Comments

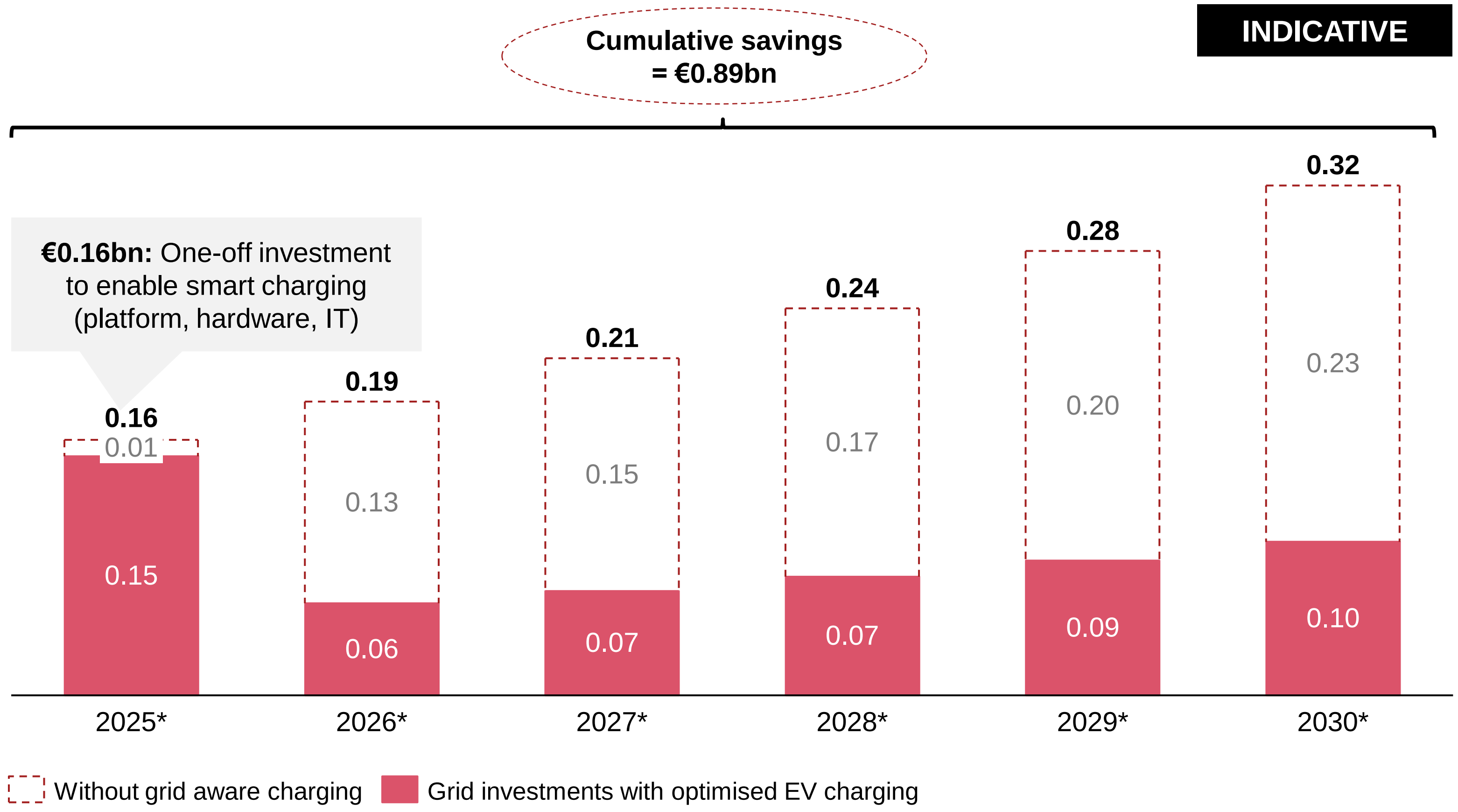
- **Smart charging provides extra capacity to low voltage grids**, allowing more connections to be made to one transformer before the transformer capacity is exceeded
- This **minimizes the need for grid expansion** and reinforcements and **allows customers to be connected more quickly**
- Smart charging shifts charging moments from periods with high grid load to low grid load resulting in the **maximum number of charging stations** that can be **hosted** on one transformer station can be **increased by up to six-fold**
- In the studies, two smart charging protocols were examined:
  - <u>Smart charging</u>: possible to reduce charges to 0A, when required (i.e., in periods of high congestion)
  - <u>Optimized smart charging</u>: charge current of 6A required at a minimum throughout the charging session

Source: Unlocking the full potential of smart charging: addressing delayed charging problems in EVs (research by Utrecht University researchers, currently under peer review, to be published in 2024)

If NL EVs performed grid-optimal smart charging, €0.89bn of EV-associated grid investments could be avoided 2025-'30

Impact of smart charging on daily electricity demand

EV-related electricity grid investments NL, with and without grid-aware charging (in €bn)



Comments

- By **2030**, Electric Vehicles **(EVs)** in the Netherlands **(NL)** are expected to **add an additional 3GW** to **peak loads** if **charging is not smart**
- With **smart charging, peak demand is expected to rise by 1GW.** While peak demand will still increase, **the risk of (local) overloading of the electricity grid is reduced**
- **Additional demand** on the grid requires investments by DSOs to manage the additional peak and risks of overloading (~€916 per additional KW)
- **Less grid enforcements due to** reduced risk of grid overloading results in **~€0.2 bn** of **investments being avoided/ year** in the LV grid by **2030 in a smart charge scenario**
- Annual investments of ~**€0.1 bn still required to manage additional peaks** and recurring costs for smart grid management and maintenance, which will amount to **€5 million**
- If investments are not made, the **rapid increases in demand** for grid capacity **may lead to** short-term **situations where DSOs have insufficient capacity** for all parties. In such cases, **DSOs have to choose** how to allocate capacity between different parties, a process known as **congestion management**

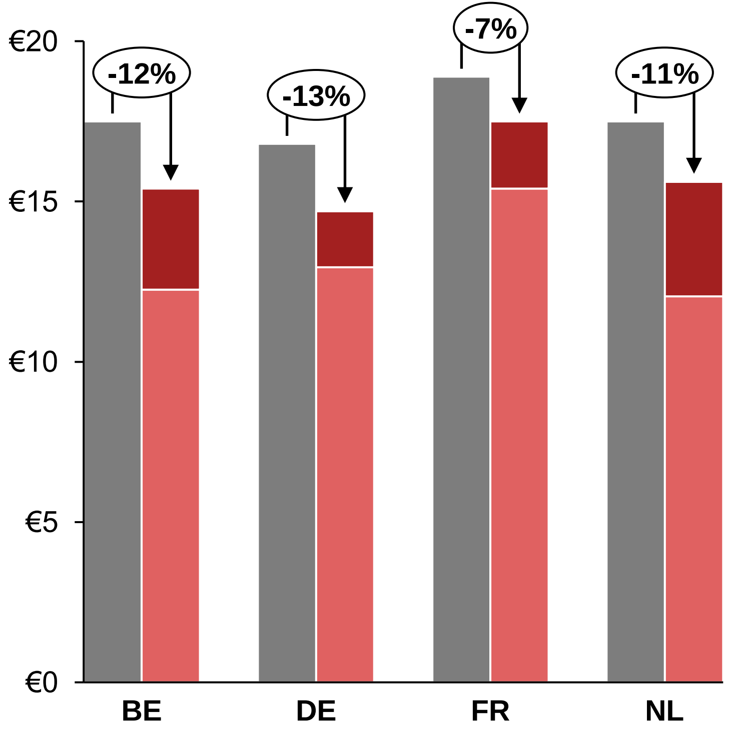
Notes: For the cost off addressing additional load on the LS network, an investment of € 916 per additional kW is calculated, each new EV is assumed to add 1000kwh demand/ year
Source: NAL Actie Plan Smart Charging for all 2022-2025; Scholten and Idema 'Slim laden must have bij groei elektrisch vervoer'(2019) Unlocking the Full Potential of Smart Charging: Addressing Delayed Charging Problems in Electric Vehicles (2023); Kuiken and Mas (2019);

If EV flex. is compensated at day-ahead market prices, users generate revenues in the order of 7-13% of their charging costs

Revenue potential from EV flex at day-ahead market price levels

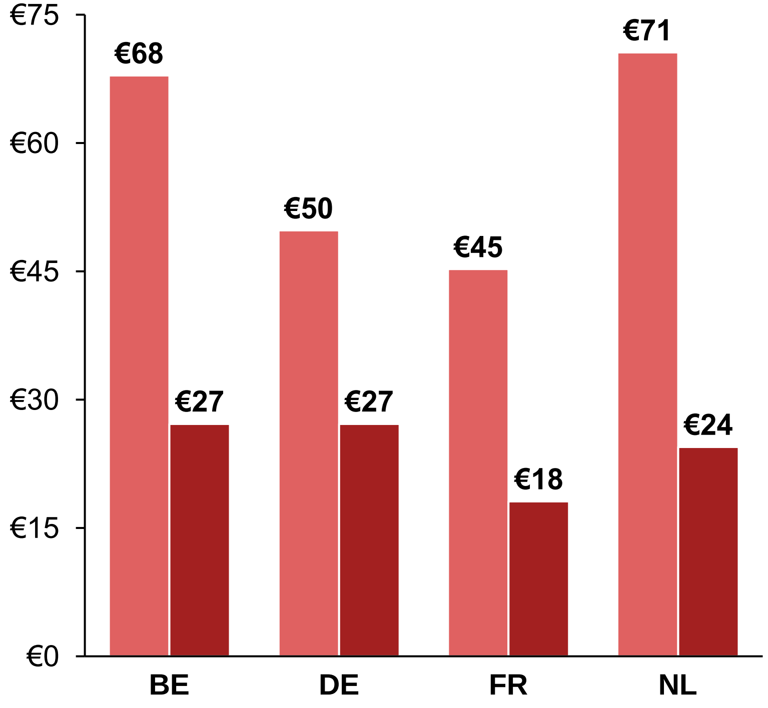
Net EV full-charge costs by charge type if EV flex is compensated at day-ahead market prices

Net EV charge cost, €/charging session*



Potential annual revenue for an average EV driver

*Average annual** revenue, €/yr*



■ Without controlled charge ■ Optimal controlled charge ■ Non-optimal controlled charge (min. charge current 6A)

Comments

- Controlled charging and V2G/G2V offers EV users the potential to **generate additional revenues,** thereby reducing their net costs for charging
- In practice this means that EV users either **charge** at times when **electricity prices are low (for controlled charging) or they consume electricity from the grid when prices are low and supply electricity when prices are high (for V2G/G2V)** thus capturing the price difference between different moments in time
- Studies have shown that **EV users can generate a revenue of ca. €71/yr only from controlled charging** if their flexibility is reimbursed at day ahead market price levels i.e., representing the time variation in day-ahead market prices in 2023. With V2G/G2V, this revenue potential can be higher

*Assuming a battery capacity of 70kWh; ** Assuming average annual charges of 905.2kWh
Source: Unlocking the full potential of smart charging: addressing delayed charging problems in EVs (unpublished); EV-database

2. Barriers and solutions to unlocking smart charging for DSO grid purposes

Focus of this study is to identify barriers to using EV-based flexibility for addressing congestions on the LV grid of DSOs

Use cases for EV flexibility & focus of current study

Use cases for EV flexibility

There are five key use cases for EV flexibility	Description	Typical time frame	Feasible today?
1 Serve as supply or demand on the **day-ahead and intra-day markets**	*EV battery power (demand/ supply) is traded to provide power to the grid when demand is high and charge when prices are low*	Day-ahead, intra-day	Feasible e.g., Jedlix, Ampcontrol etc.
2 Offered to BRPs for performing **portfolio balancing**	*EV batteries provide a resource to help suppliers/ BRPs to maintain balance at the portfolio level and reduce imbalance charge risks*	Real-time	Feasible e.g., Jedlix, Ampcontrol etc.
3 Avoiding and/or resolving **congestion in TSO grid**	*EV batteries respond to congestion signals from the TSO grid, e.g., reducing demand when there is HV grid congestion*	In advance, near-term, day-ahead	Not feasible
4 Avoiding and/or resolving **congestion in DSO grid**	*EV batteries respond to congestion signals from the DSO for the LV grid, either changing demand or supplying capacity*	In advance, near-term, day-ahead	Not feasible
5 Serve as a balancing reserve in the **balancing market**	*EV battery capacities are traded to keep the overall supply and demand in balance physically to ensure grid stability*	Real-time	Feasible e.g., Equigy platform

Study focus

Comments

- EVs **possess significant flexibility** – provided by both **controlled** charging and **V2G/G2V**
- **Flexibility can be used as supply or demand** on the **day-ahead & intra-day markets**. It can also be offered to Balance Responsible Parties (BRPs) for portfolio **balancing purposes** in return for a financial reward
- Flexibility can be used by grid operators to **avoid and/or resolve congestions in either the DSO or TSO grid**. Currently, small end-users are not able to participate in congestion markets because the product characteristics are defined from a large user perspective, but theoretically EV-based flexibility can help in alleviating congestions
- In this report, **we identify barriers that prevent the use of EV-based flexibility** (both via controlled charging & V2G/G2V) **for avoiding and/or resolving congestions in the LV grid of DSOs**

We assess potential barriers to: (1) provide the required financial incentives, and (2) have the required infrastructure

Framework of analysis for identifying barriers

		Required building blocks for enabling smart charging		Pre-requisites to have in place
Preventive	Required incentives for demand side management	**Indirect load control**	• Indirect control via differentiated tariffs, connection conditions and taxation incentives	• **Time-differentiated** and **location-based** network tariffs to reflect congestions in grid • **Tax structures** that **facilitate** the business case for providing flexibility to grid operators
		Market based control	• Indirect control through incentives provided via price signals (that are typically generated via platform-based market solutions)	• **Creation of a price signal (to serve as an incentive)** during congestion moments – this can be done via a Low Voltage congestion management market for example • **Communication of the price signal with providers of flexibility** (for both initial flex provisioning and for activation of flex)
Reactive		**Direct load control**	• Direct control performed through remote management of loads by DSOs as a last resort	• **Permission from regulatory authorities to engage in load curtailment** as a last resort during times of congestion, to prevent further social losses • **A mechanism to reimburse users** who were curtailed by the grid operator
	Required enabling infrastructure	**Communication & coordination**	• The ability to share required data/ information in a language that different parties understand in a safe and secure manner	• **Clear specification of required data points** needed along the value chain to enable controlled charging and vehicle to grid (V2G)/ grid to vehicle (G2V) • **Standardisation of communication protocols** between different points in the chain • **A mechanism to monitor and enforce implementation** of standards
		Grid monitoring	• The ability to monitor and control the grid and connection points remotely using digital tools	• **Deployment of automation and remote control systems along the grid** • Penetration of smart meters within the customer domain

Source: Strategy& analysis based on input from experts and literature (Action Agenda for Grid Congestion in Low Voltage Grids (2024) and R.J. Hennig et al., (2023) 'Congestion Management in Electricity Distribution Networks')

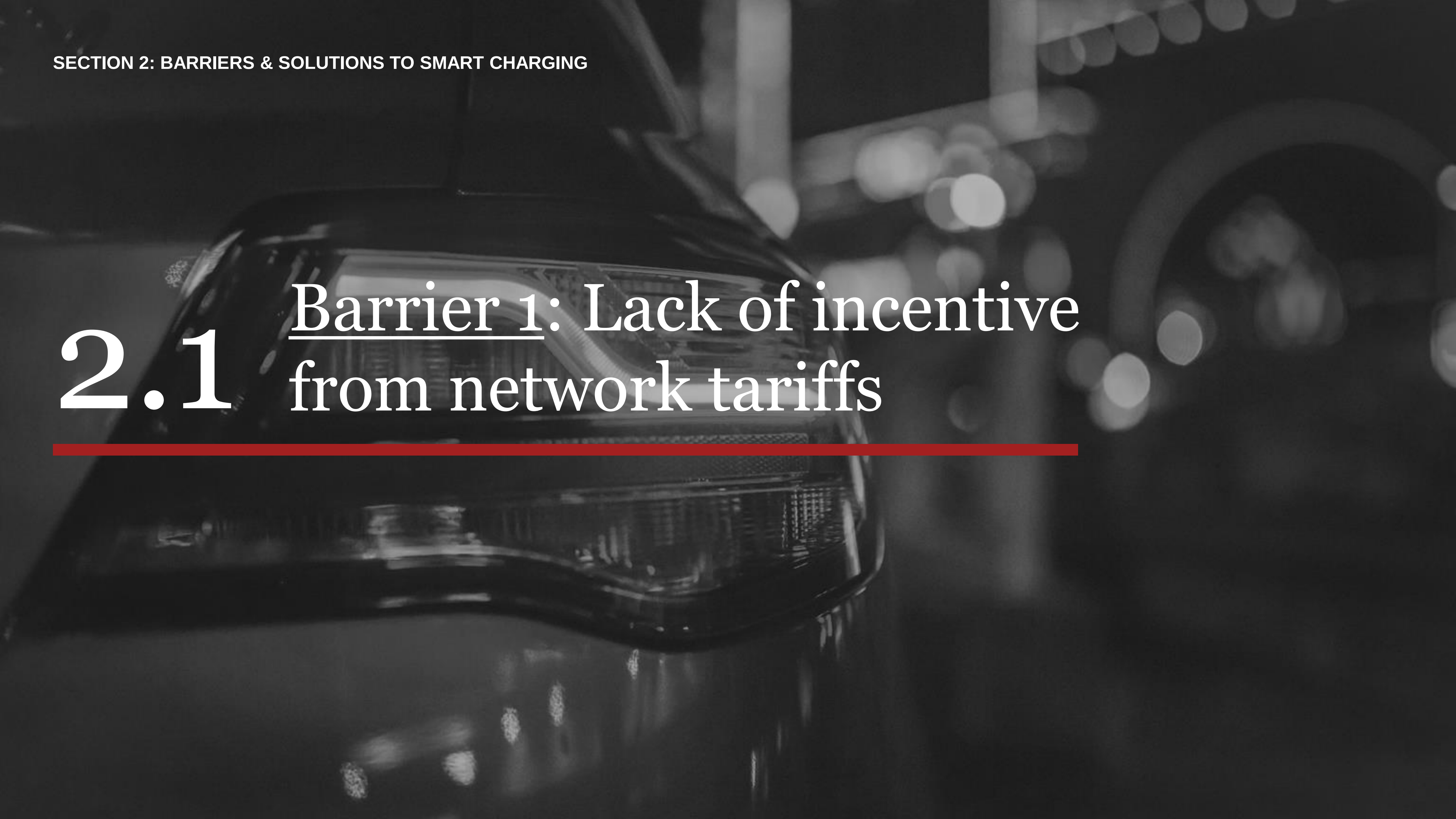
See next pages for deep dives

7 key barriers are found to hinder the unlocking of full EV flex potential along the dimensions of our assessment framework

Building blocks for enabling smart charging					Barriers identified for NL (mainly regulatory)	Applies to…		Is also an issue in[3]...
						CC[1]	V2G[2]	
Activating smart charging for congestion management in LV grid	**Required incentives for demand side management**	*Indirect control*	*Ability to differentiate tariffs to reflect peaks*	1	**Lack of incentive from network tariffs** to charge at low peak times as time/location differentiation is not possible	✓	✗	🇧🇪 🇩🇪
			Taxation related incentives	2	**Presence of a financial disincentive within the current energy tax structure** while performing V2G/G2V	✗	✓	🇧🇪 🇩🇪 🇫🇷
		Market-based control	*Availability of flex price/ compensation*	3	***Absence of a LV congestion market mechanism*** *through which DSOs can compensate V2G/G2V from EVs*	✗	✓	🇧🇪 🇫🇷
		Direct load control	*Ability to engage in direct load control*	4a	**Unclarity over the possibility of DSOs to curtail charge points as last resort**, creating an incentive to keep expanding the grid	✓	✗	🇫🇷
			Ability to have interruptible programs	4b	*DSOs engage in* ***load interruptible programs*** *for large users, but* ***do not do this with small end-users due to transaction costs***	✓	✗	*Not tested*
	Required enabling infrastructure	*Communica-tion and coordination*	*Data requirements & sharing*	5	**Absence of a comprehensive communication standard b/w the DSO & CPO/Aggregator** to enable smart charging	✗	✓	🇧🇪 🇩🇪 🇫🇷
			Interoperability b/w service providers	6	**Interoperability issues due to differences in standards (plugs, sockets, settlements etc.) adopted** by CPOs & OEMs	✓	✓	🇧🇪 🇩🇪 🇫🇷
		Grid monitoring	*Digitally enabled grid*	7	**Lack of incentive** (or potential penalization) **for digitalization & grid modernization** within the DSO tariff regulation	✓	✓	🇧🇪 🇩🇪 🇫🇷

🟥 Regulatory ▨ Non-regulatory ✓ Barrier applies to this form of smart charging ✗ Barrier does not apply to this form of smart charging

1) CC – Controlled Charging; 2) V2G – Vehicle to Grid and Grid to Vehicle; 3) Within the EU countries tested during the project (mainly via stakeholder workshops i.e., Belgium (BE), France (FR) and Germany (DE). These countries were chosen due to a combination of relatively high penetration rate of EVs (expected towards 2030) and their ability to serve as frontrunners/examples for other member states in the EU



2.1

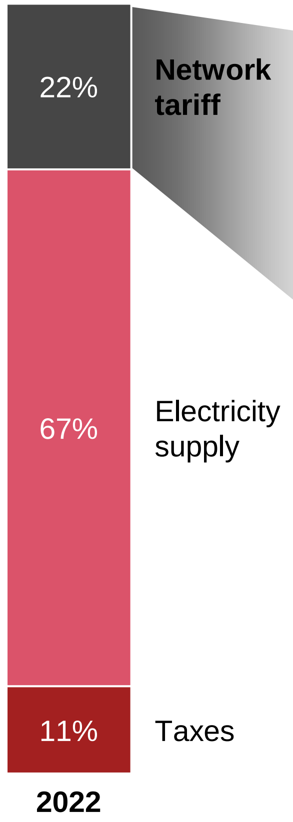
Barrier 1: Lack of incentive from network tariffs

EV owners are not sufficiently incentivised to control charge (CC) as network tariffs do not reflect actual costs of grid use

Barrier description

Only the electricity supply portion can differentiate by time

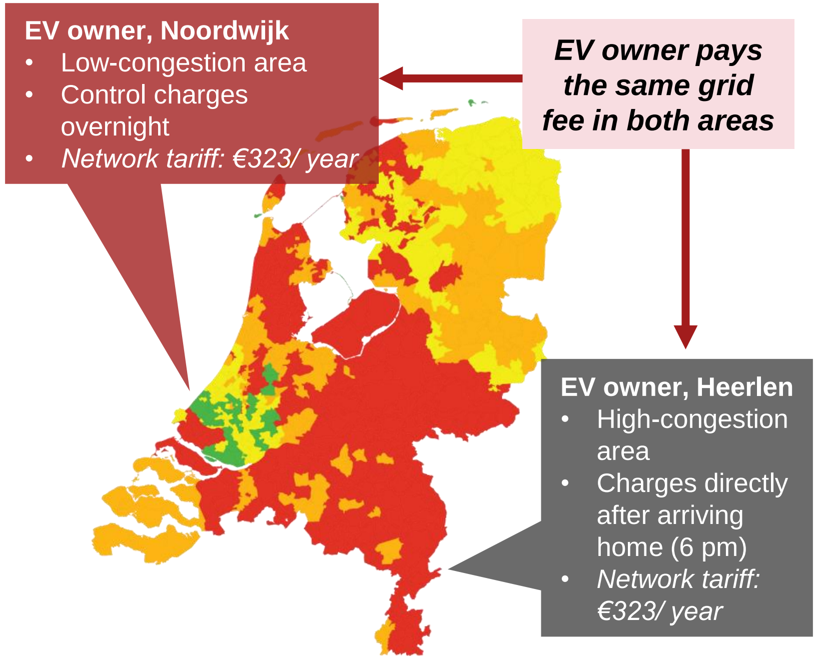
(*Electricity bill composition of a typical NL household*[1] *2022, annual consumption of 2200 kWh/yr*)



	Time or location differentiation possible?
✗	All small scale users (up to a set capacity) pay the same fee, as stipulated in article 2.3 of the Electricity Tariff Code
✓	Electricity tariffs that vary by time of day (peak/ off-peak) are available, location differentiation is not
✗	Taxes are charged on the volume of electricity consumed

As a result, network tariffs are not reflective of actual costs of grid use

ILLUSTRATIVE



EV owner, Noordwijk
- Low-congestion area
- Control charges overnight
- *Network tariff: €323/ year*

EV owner pays the same grid fee in both areas

EV owner, Heerlen
- High-congestion area
- Charges directly after arriving home (6 pm)
- *Network tariff: €323/ year*

Illustrative congestion situation

🟩 **Capacity available**

🟨 **Limited capacity**

🟧 **No capacity:** congestion management may be possible

🟥 **No capacity available:** limits of current congestion management reached

Comments

- **Congestion costs** in the low voltage grid of DSOs **should be reflected** in the **grid tariff structure** to incentivize controlled charging with the goal of avoiding congestions
- This **requires time or location-based differentiation** within the tariff structure
- **Time/location based differentiation is currently not allowed** due NL Electricity tariff code – *detailed in next slide*
- **Electricity retail contracts** now offer **dynamic pricing which financially incentivise smart charging** savings are relatively small ~5% and periods of cheaper electricity do not completely overlap with low grid congestion
- The **flexibility** generated in this way **helps suppliers balance their portfolio**, but **does not** necessarily **avoid grid congestion**

---

1) Not including energy tax rebates

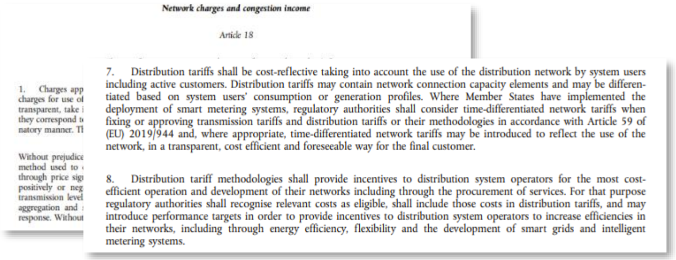
Sources: CBS average energy prices for consumers, CBS energy consumption private dwellings; EU Electricity Regulation (2019); Netherlands E-Directive (1998); Netherlands Tarievencode Elektriciteit (2016)

The lack of incentive is caused by the way electricity tariff codes are defined – they do not create space for differentiation

Grid tariff in NL – lack of differentiation based on time of use

While EU regulation encourages differentiating tariffs based on network use…

EU: Article 18 of the Electricity Regulation (EU) 2019/943



Network charges and congestion income

Article 18

1. Charges app
charges for use of
transparent, take i
they correspond t
natory manner. Th

Without prejudice
method used to
through price sig
positively or neg
transmission level
aggregation and
response. Without

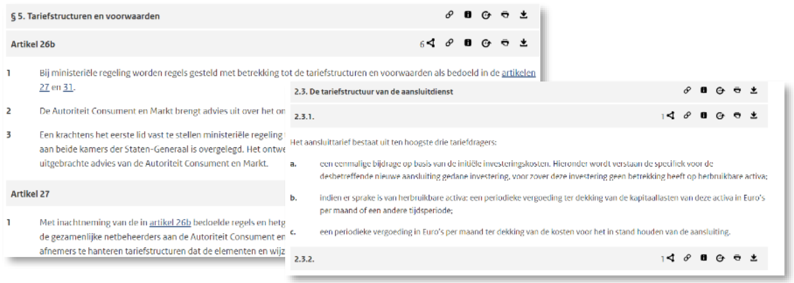
7. Distribution tariffs shall be cost-reflective taking into account the use of the distribution network by system users including active customers. Distribution tariffs may contain network connection capacity elements and may be differentiated based on system users' consumption or generation profiles. Where Member States have implemented the deployment of smart metering systems, regulatory authorities shall consider time-differentiated network tariffs when fixing or approving transmission tariffs and distribution tariffs or their methodologies in accordance with Article 59 of (EU) 2019/944 and, where appropriate, time-differentiated network tariffs may be introduced to reflect the use of the network, in a transparent, cost efficient and foreseeable way for the final customer.

8. Distribution tariff methodologies shall provide incentives to distribution system operators for the most cost-efficient operation and development of their networks including through the procurement of services. For that purpose regulatory authorities shall recognise relevant costs as eligible, shall include those costs in distribution tariffs, and may introduce performance targets in order to provide incentives to distribution system operators to increase efficiencies in their networks, including through energy efficiency, flexibility and the development of smart grids and intelligent metering systems.

- **Article 18(1):** Charges for network access should be cost-reflective, transparent, account for network security/ flexibility, reflect actual costs for the DSO and be non-discriminatory
- **Article 18(7):** Distribution tariffs may be differentiated based on network users' consumption. When there is high smart metering penetration, regulators should consider differentiating network tariffs to reflect network use
- **Article 18(8):** Tariff methodologies should incentivise DSOs to operate efficiently, including through service procurement. This may include performance targets for the development of smart grids and intelligent metering systems

NL grid tariff code does not create space for differentiated tariffs for small users…

NL: Articles 26b-29 of the NL Electricity Act 1998; Article 2.3 of the Electricity Tariff Code



§ 5. Tariefstructuren en voorwaarden

Artikel 26b

1 Bij ministeriële regeling worden regels gesteld met betrekking tot de tariefstructuren en voorwaarden als bedoeld in de artikelen 27 en 31.

2 De Autoriteit Consument en Markt brengt advies uit over het on

3 Een krachtens het eerste lid vast te stellen ministeriële regeling
aan beide kamers der Staten-Generaal is overgelegd. Het ontwe
uitgebrachte advies van de Autoriteit Consument en Markt.

Artikel 27

1 Met inachtneming van de in artikel 26b bedoelde regels en hetg
de gezamenlijke netbeheerders aan de Autoriteit Consument en
afnemers te hanteren tariefstructuren dat de elementen en wijz

2.3. De tariefstructuur van de aansluitdienst

2.3.1.

Het aansluittarief bestaat uit ten hoogste drie tariefdragers:

a. een eenmalige bijdrage op basis van de initiële investeringskosten. Hieronder wordt verstaan de specifiek voor de desbetreffende nieuwe aansluiting gedane investering, voor zover deze investering geen betrekking heeft op herbruikbare activa;

b. indien er sprake is van herbruikbare activa: een periodieke vergoeding ter dekking van de kapitaallasten van deze activa in Euro's per maand of een andere tijdsperiode;

c. een periodieke vergoeding in Euro's per maand ter dekking van de kosten voor het in stand houden van de aansluiting.

2.3.2.

<u>Electricity Act</u>

- **Article 28(1):** Tariffs for customers connections must be based solely on the cost of connecting the customer to the network, the maintenance of facilities to establish a secure network and the cost to establish and maintain a connection with the customer
- **Article 29(2):** Rates charged to customers may differ depending on customer's voltage level when connected

<u>Electricity tariff code</u>

- **Article 2.3:** Connections up to a specified capacity pay the same connection tariff which is reflective of the average cost of maintaining the grid connection

Comments

- **Electricity network tariffs** in NL are determined by the ACM (Authority for Consumers & Markets) in accordance with EU legal frameworks outlined in the **Energy Act (E-Directive) 2019/943**
- Currently, small scale users in NL with capacities up to **3x25A, pay the same annual flat fee for network connection**. There is no time-differentiated price component included in their tariffs
- In the **2019 EU electricity regulation, provisions were made for differentiated network tariffs,** allowing for differentiation based on users' consumption profiles. These provisions provide the opportunity to introduce grid transport tariffs that incentivize users to participate in smart charging
- However, as of now, **these directives have not been implemented** into the national tariff regulations in the Netherlands. Nevertheless, they offer the potential for the introduction of grid transport tariffs that encourage users to engage in smart charging

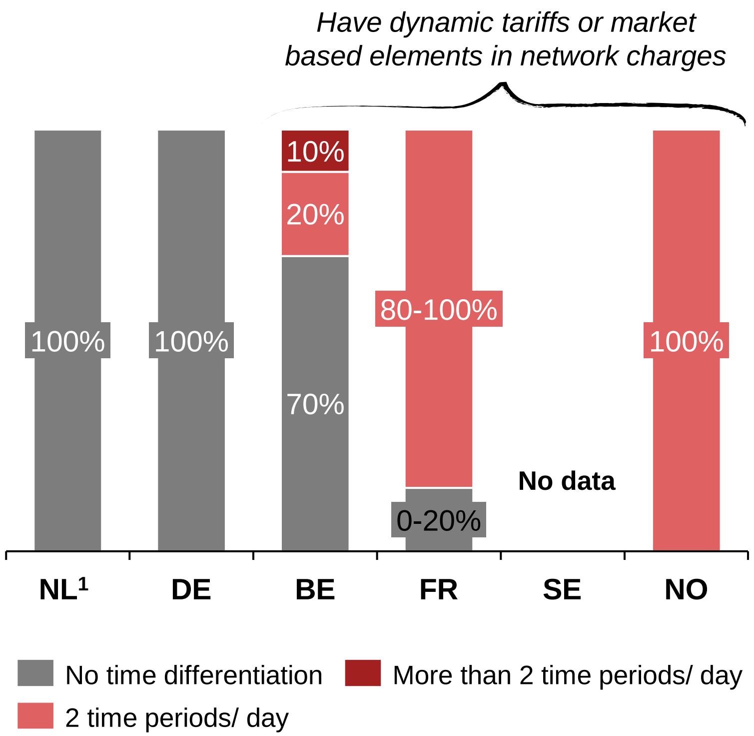
Sources: EU Electricity Regulation (2019); Netherlands Electricity Act (1998); Netherlands Tarievencode Elektriciteit (2016)

Several EU countries have ToU based network tariffs; this can help in reducing peak usage, as seen in Sweden

Time differentiation in grid tariffs – examples from other countries

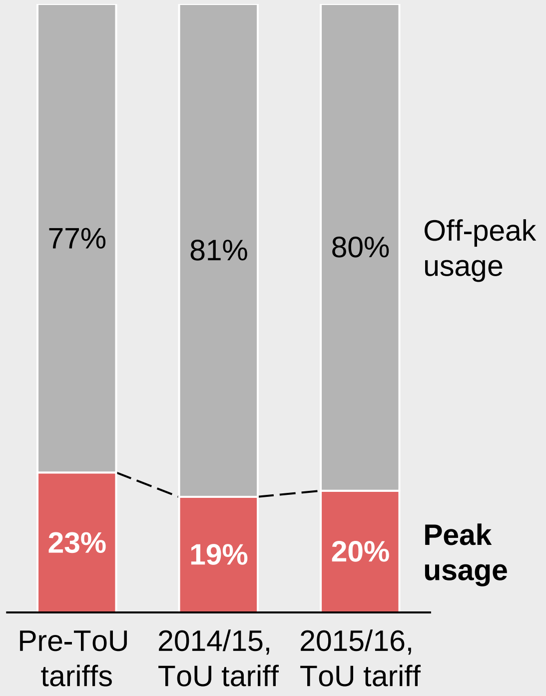
Several EU member states have Time of Use based network tariffs

Time differentiated network tariffs for households, 2022



- France has ToU-based network tariffs under TURPE 6, which offers different rates for peak and off-peak hours. This provides an incentive to private charge point owners to charge their Evs at low congestion moments
- Belgium has a small penetration rate for ToU tariffs, particularly in the Flanders region. These tariffs are structured to encourage consumption during off-peak hours, with lower rates during these times
- Germany is currently in the process of implementing time of use based network tariffs in some regions, but currently there is no time-based tariff differentiation
- Sweden has a well-established system of ToU tariffs – the tariffs can vary throughout the day and are typically lower during the night and higher during peak demand hours. This system is facilitated by the widespread use of smart meters
- Norway also employs ToU tariffs, with electricity prices fluctuating based on the time of day, season, and market conditions. The country's extensive use of electric heating and high penetration of electric vehicles make ToU tariffs particularly helpful in providing an incentive to consume at off-peak moments

Impact: Benefits of having ToU grid tariffs on peak usage in Sweden



Introducing time-of-use based distribution grid tariffs reduced peaks in household usage for 5 most congested hours in Gotland, Sweden

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1) The Netherlands is shown as 'no time differentiation in network tariffs' as time differentiation applies to only a very small fraction of network users

Sources: Enefirst (2020) 'International Examples with Efficiency First'; EU Electricity Regulation (2019); ACER Electricity Network Tariff Report (2023); ACER barriers to demand response (2023); Svalstedt and Lof (2017), 'Behaviour of active household customers on the electricity market: findings from market test smart grid Gotland'; ACM

Two tariff differentiation options can be used to incentivise CC and V2G with the goal of avoiding grid congestion

Distribution tariff differentiation, solutions

Approaches to introducing a price	Design options	Suitability	Pros +	Cons -
***Static pre-set tariffs** for the full year that differ based on Time-of-Use and/or location*	• Measured peak capacity: fee per kW of personal peak use • Contracted capacity for capacity subscription tariffs[1] • Energy for volumetric tariffs: a fee per kWh of energy delivered through the network	• Suited to resolve structural congestion through rough signals • Not suited for sporadic congestions • V2G incentive would require energy component in tariff, while CC can be enabled by differentiation in ToU within the capacity fee	• Simple, not discriminating	• Not adaptable to sporadic congestion
***Dynamic tariffs** – network access prices adjusted dynamically based on expected or observed network conditions*	• Critical Peak Pricing (CPP) • Network Coincident Peak Charges (NCPC)[2] • Distribution Locational Marginal Prices (DLMP)[3] • Capacity or "Double" Auctions[4]	• Suited to resolve all types of congestion problems • Not suited for risk-averse or inflexible consumers	• Adaptable, no price risk for DSOs	• Price discrimination • User price risk

Comments

- There are **2 approaches** to introducing differentiated tariffs for end-users to engage in smart charging (both Controlled Charging and V2G offerings) from the perspective of resolving congestions in the DSO grid:
  1. **Setting static tariffs** – this has the advantage of being simple & effective but does not help resolve sporadic congestions
  2. **Dynamic tariffs** – depending on the design choice can help in resolving all types of congestions but could limit the flex potential that is activated as it introduces user price risk

NL context makes dynamic tariffs possible:

\+ **High smart meter penetration** provides a **strong basis** for **dynamic tariff differentiation** (more than 2 time periods/ day) which align with the needs of the grid

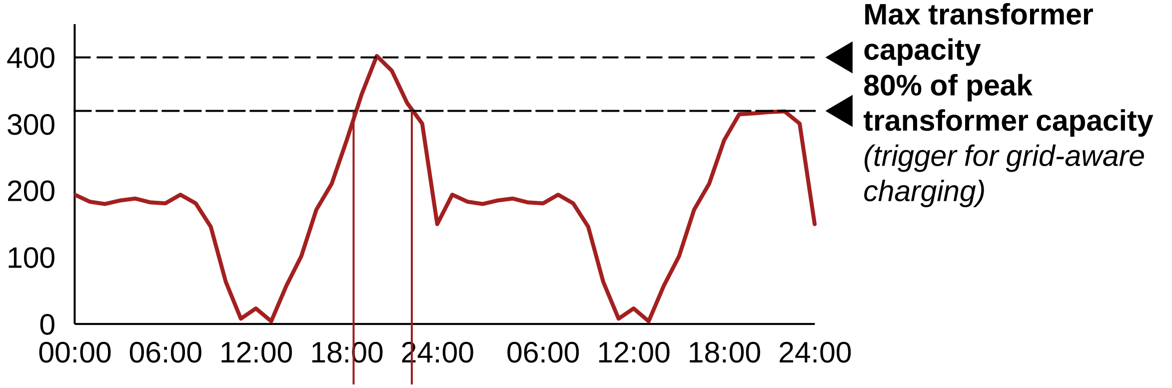
Source: Strategy& analysis based on *EU (2023) Energy Directive* & *Congestion management in electricity distribution networks: Smart tariffs, local markets and direct control, Hennig, R. J., de Vries, L. J., & Tindemans, S. H. (2023)*; [1]End-user can choose different power levels (kW). Energy consumption up to the selected level is free or at a low price, while consumption above the chosen level is penalized; [2]Under this, charges are based on the network-coincident peak, not the personal peak of the end-user; [3]This approach is an extension of locational marginal pricing (LMP) for wholesale power markets to the distribution level; [4]In this approach, end-users or aggregators of flexible loads submit a bid curve with their willingness to pay for energy. The network operator can aggregate all these bid curves and clear them on the wholesale market, considering the network limits

The guidance provided for enabling grid aware charging under the ‘Smart Charging for all’ initiative in NL is a good first step

Distribution tariff differentiation, solutions

Grid aware charging proposal by NAL in The Netherlands

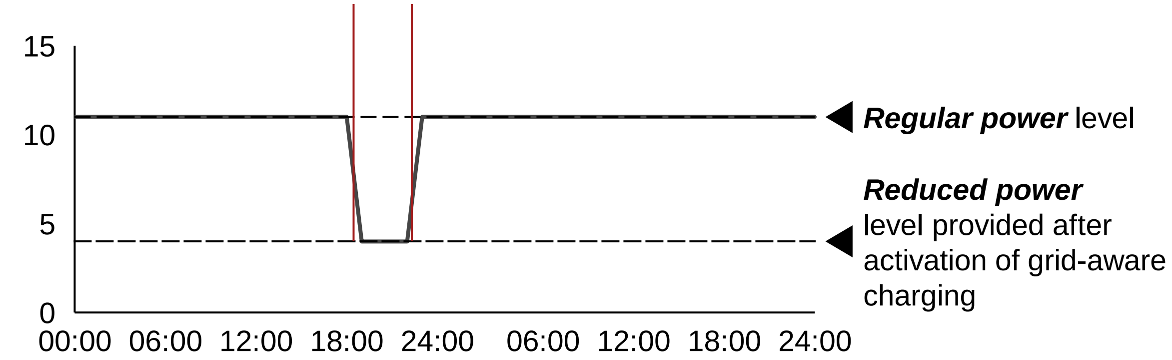
Power usage of MV/LV transformer (kW) in 2 days



Max transformer capacity

80% of peak transformer capacity *(trigger for grid-aware charging)*

Individual charging profile of an EV (kW) during Grid-aware charging



Regular power level

Reduced power level provided after activation of grid-aware charging

Comments

- The Nationale Agenda Laadinfrastructuur (NAL) defines ‘Grid-aware charging’ as charging within the limits of the capacity of the local medium and low-voltage transformer station (MS/LV transformer station) and provides clear guidance on when & how it can be activated by Charge Point Operators (CPOs)
- It proposes a threshold of 80% for activating Grid-aware charging i.e., if the DSO predicts in advance that the total available capacity behind a MV/LV transformer in the district will be lower than 20%, it activates Grid-aware charging via the Charge Point Operators (CPOs)
- Upon activation, the available capacity within the LS network is distributed by the CPO among the charging electric vehicles (EVs) based on *reduced power*, *pooling* and *regular power.* Pooling here refers to the combining & redistribution of available capacity at all charging points behind a transformer area by the CPO
- The guidance document (*Handreiking Netbewust Laden by NAL*) also provides specific implementation principles that could be adopted by municipalities, CPOs and grid operators. Examples of these guiding principles are:
  - Only in case of (impending) capacity shortage (i.e., LS/MS transformer is at 80% capacity of higher), the power provided is reduced to 4 kW per charge point behind that transformer
  - To ensure charge security, if the State of Charge (SoC) of an EV is lower than 20%, the CPO can first charge 10 kWh with the maximum available power
- While the NAL provides operational & technical guidance, it leaves room for commercial agreements to be setup bilaterally through negotiations b/w the grid operators, CPOs and cities/regions. The tariff differentiation options explored in the previous page can serve as a good basis for DSOs to create the right incentives for CPOs to engage in Grid-aware charging

Source: Handreiking Netbewust Laden - Slim laden voor iedereen, Nationale Agenda Laadinfrastructuur (Nov. 2023)

In summary, the Dutch regulator is advised to assess the impact of introducing alternative distribution tariff structures

Summary: Barrier 1

Overall barrier description

Currently **EV users are not sufficiently incentivized to charge at times of low-demand** and/or charge at locations where there are no congestions **because network tariffs do not reflect the actual costs of grid** usage i.e., they are **not differentiated based on time or location of use**. This barrier is **applicable only for enabling controlled charging** and not for Vehicle to Grid (V2G)/Grid to Vehicle (G2V) because the incentive intends to cause a shift in charging pattern and not to make EV batteries available as flexible storage capacity along the grid

Cause of the barrier in The Netherlands

- NL tariff structures are set according to Article 2.3 of the Electricity Tariff Code and this specifies that "Connections up to a capacity of 3x25A pay the same periodic fee which reflect the cost of maintaining the connection to the grid"

Reflection on other EU countries

- Varying degrees of time-based DSO tariffs are in place in France, Belgium, Norway & Sweden. There is evidence that Time of Use (ToU) based tariffs reduced peaks in household demand during 5 most congested hours in Sweden

Recommendation

- The Dutch regulator ACM (being in charge of setting network tariffs through method decisions and defining conditions on network access) is advised to assess the impact of introducing alternative forms of distribution tariffs (where there is either capacity or volume based differentiation in time and/or location) on congestions in LV grid
- Such an assessment can also be carried out by DSOs and a proposal can be presented to ACM. It is advised to carry out such an analysis well before the start of upcoming regulatory period (2027) to allow sufficient time for discussions & amendments
- Based on the outcome of this analysis, a proposal should be developed towards policymakers to amend existing tariff codes, allowing for the new design to take effect

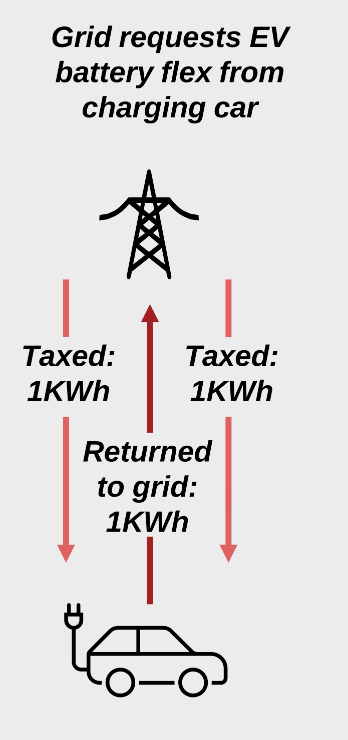
2.2

Barrier 2: Financial disincentive from energy tax perspective

Even if the grid tariff differentiation issue is resolved, current tax structures in several EU member states discourage V2G

Taxation on V2G, barrier

ILLUSTRATIVE: double energy tax in practice

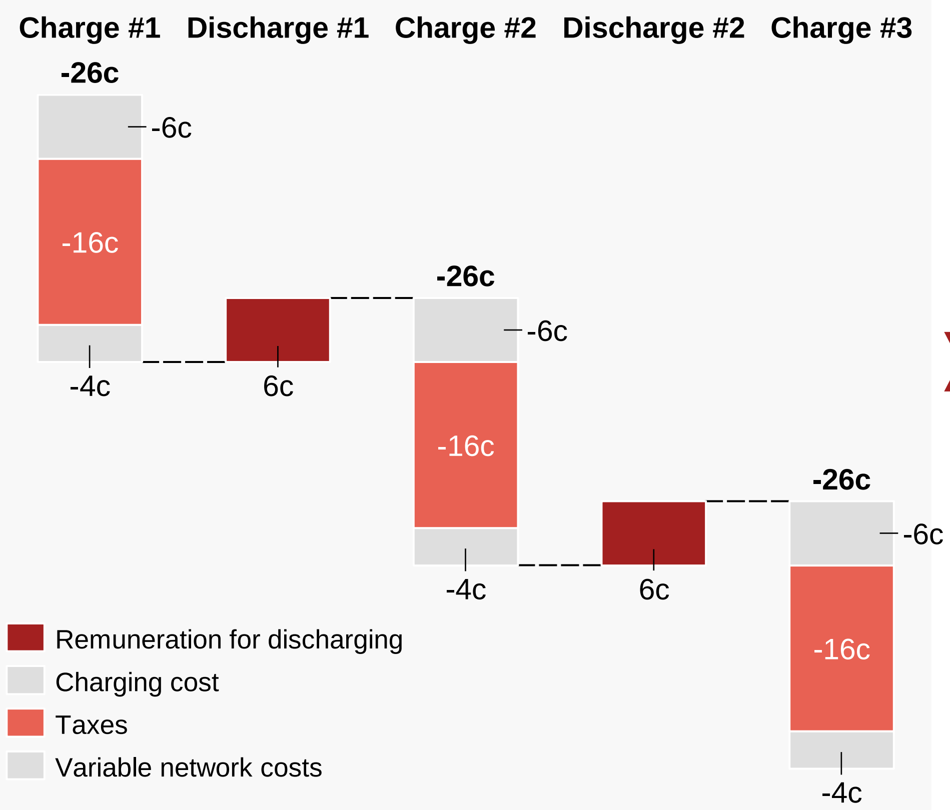


Car charged additional 1 kWh, taxed for 2 kWh

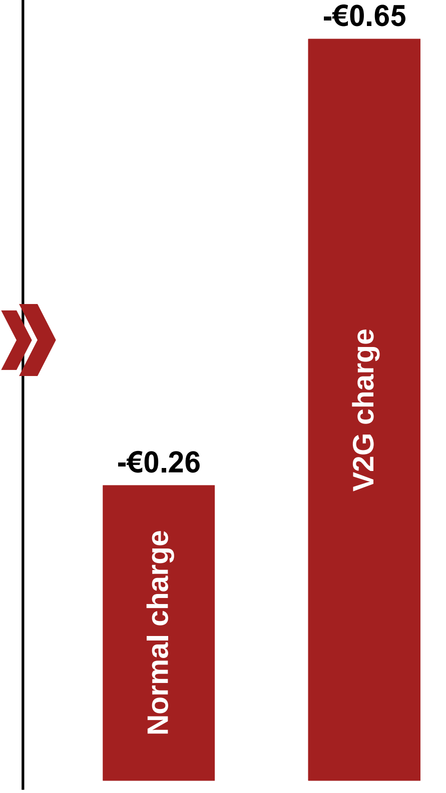
Double tax can occur since storage is not defined as an activity in the electricity market

Indicative costs of charging and discharging (e.g., for congestion management) 1 kWh eurocent/kWh

Cumulative cost of a V2G charge session, 1 kWh



Total cost: normal and V2G, 1 kWh



Comments

- **Energy taxation is an important instrument** to incentivise efficiency on the demand side, however an underlying principle of **taxation is that one should not tax the same good twice**
- **With V2G, a unit of energy gets taxed multiple times** because **every withdrawal of energy from the grid** (even if returned at a later time) by a battery **is taxed**
- Key reason being that **storage is not identified as a separate activity** that might benefit the grid **by providing additional capacity**
- In the NL **the netting rule (‘salderingsregeling’) currently offsets some of the negative impact** from double energy taxes

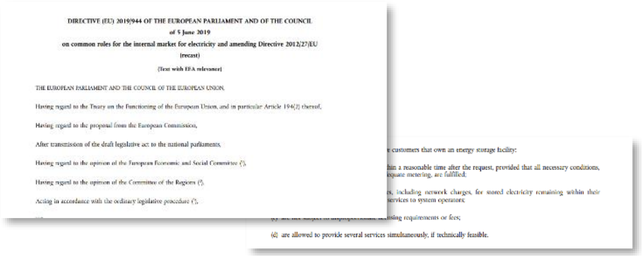
Source: EU Energy Prices Costs and their impact on Industry and Households; Ministerie van Financien Dubbele Enerrgiebelasting bij Opslag Achter de Kleinverbruikaansluiting (2023)

International double energy tax persists across many European countries despite EU regulation to remove it

Taxation on V2G status in Europe

The EU's electricity directive is clear that member states should remove double tax

EU: Article 15 of the EU Electricity Directive (2019/943)



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)
(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 194(2) thereof,

Having regard to the proposal from the European Commission,

After transmission of the draft legislative act to the national parliaments,

Having regard to the opinion of the European Economic and Social Committee (¹),

Having regard to the opinion of the Committee of the Regions (²),

Acting in accordance with the ordinary legislative procedure (³),

customers that own an energy storage facility:

thin a reasonable time after the request, provided that all necessary conditions, equate metering, are fulfilled;

s, including network charges, for stored electricity remaining within their services to system operators;

(c) are not subject to disproportionate licensing requirements or fees;

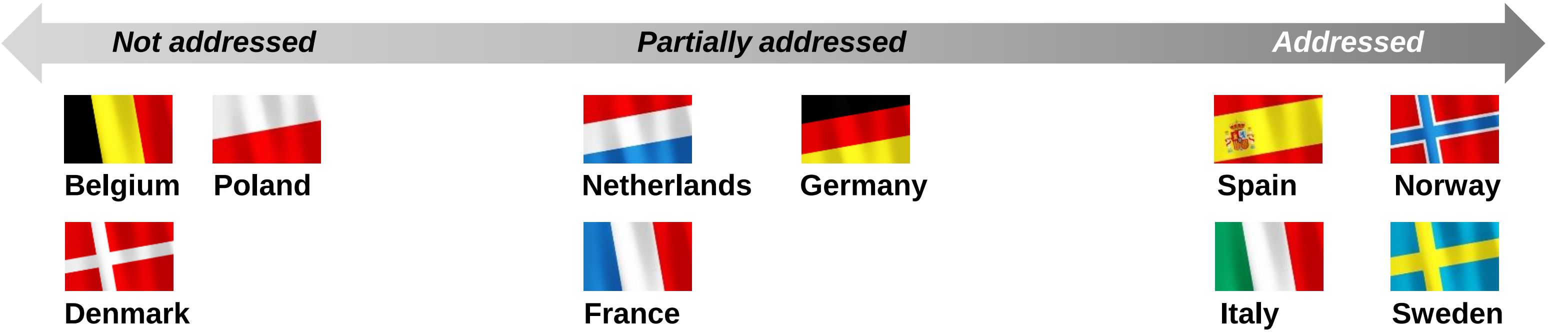
(d) are allowed to provide several services simultaneously, if technically feasible.

Article 15 (5):

Member states shall ensure that active customers that own an energy storage facility:

- *Are not subject to any double charges, including network charges, for stored electricity remaining within their premises or when providing flexibility services to system operators*

However the issue has not been addressed in many member states



Case Study: In Germany, policy has begun to address but regulation for EVs still not clear

Germany: Energiefinanzierungsgesetz – EnFG
Applicable from: 20/07/2022

Abschnitt 2: Addresses levies for electricity storage and energy loss. It states that these levies shall be reduced to zero for intermediate storage that is withdrawn from and injected into the grid within the same year, explicitly including charging points for electric vehicles (EVs)

- ➢ There is still a challenge when it comes to intermediate storage in mobile storage, which is still subject to grid fees and energy tax. The double charge undermines the viability of the business case for mobile storage

Case Study: Sweden have eliminated the double energy tax using the refund method

Sweden: Om skatt på energi Act 1994:1776 (ch.11)
Applicable from: 01/01/2018

'Battery owners are able to apply annually for a refund for any energy excise duty paid on electricity that you have stored in a battery, and then fed back into the same electricity network with a mandatory permit, from which it was originally drawn. The repayment option is not limited to companies but is also available to private individuals who have returned taxable electricity to the concession-required grid after battery storage '

Source: EU Electricity Directive (2019/943); SmartEN V2X Enablers and Barriers (2023); Om skatt på energi Act 1994:1776 (ch.11); SmartEn and DNV 'Assessment of the regulatory framework of bidirectional EV Charging in Europe'

Two solutions can be implemented to resolve the tax disincentive barrier: implementation remains a challenge

Taxation on V2G, solution

Recommended solution

Solution	Requirements	Pros +	Cons -	Comments
1 **Exemption** *Tax is applied to the difference in energy balance between the start and end of the charging session*	- *EV SoC must be measured on arrival and departure at CP (requiring advanced communication standard)* - *Measuring instruments according to the EU's MID must be used* - *Change in tax liability from energy supplier to CPO*	- *EV drivers pay the correct amount of tax immediately (i.e., are not overcharged)* - *Conversion losses do not need to be calculated and taxed*	- *Will create a complex administrative system that will be difficult to audit by tax authorities* - *More parties will have to report to tax authorities and may not be familiar* - *Not possible to account for BTM supply*	- The **exemption and refund method** have been considered as the **most promising solutions** to double energy tax of EVs - **Both these solutions currently overlap with the netting rule** ('salderingsregeling') in the Netherlands, would entail a high admin burden and require advanced communication standards - Expected **changes to the EU's Network Code**, recommended by ACER (2023) focus on **expanding the definition of storage and suggest including V2G in this category**, providing scope for ACM to ensure that V2G for congestion management purposes is exempted i.e., taxed only once (when the energy is consumed)
2 **Refund** *Battery owners submit a tax return to claim for the extra tax they were subject to*	- *Measurement of electricity fed from the EV battery into the grid* - *Approved measuring instruments according to the MID must be used for levying and settling taxes* - *Calculation and taxation of conversion losses*	- *Battery owners can recoup double energy tax via a refund request*	- *Number of tax returns will increase significantly, placing a major burden on tax authorities* - *Complex and probably in-auditable system for tax authorities* - *Not possible to account for BTM supply*	

Sources: Ministerie van Financien Dubbele Enerrgiebelasting bij Opslag Achter de Kleinverbruikaansluiting (2023); EU Measuring Instruments Directive (2004); Acer recommendation no 03/2023 of the European Union Agency for the cooperation of energy regulators (Annex 1a and 2a)

In the long run, either the EU's network code could be changed or an exemption-based solution could be developed

Summary: Barrier 2

Overall barrier description

There is a **financial disincentive/penalty faced by EV owners** because **every time a battery charges-discharges-and-recharges from the grid, energy tax is charged twice** to the EV owner. This issue is generally faced by batteries (incl. stationary storage) and is not an exclusive a problem for EVs

Cause of the barrier in The Netherlands

- Each withdrawal of energy from the grid (even if returned at a later time) is considered as energy consumption because storage is not defined as a separate activity within the current roles defined in the Dutch electricity market

Reflection on other EU countries

- Many countries including BE, PL & DK charge double taxation on V2G. Sweden has resolved the issue using the refund method which allows households to reclaim additional taxation annually

Recommendation

- Expected changes to the EU's Network Code, recommended by ACER (2023) focus on expanding the definition of storage and suggest including V2G in this category. If this is implemented, ACM can ensure that V2G activities are exempted from energy taxation i.e., they are taxed only once (when the energy is consumed)
- If the changes to network code are not implemented, Dutch policymakers are advised to develop an automated exemption-based solution to reduce administrative burden on tax authorities
- If the netting rule ('salderingsregeling') would be abolished in the short-run, policymakers could consider introducing a refund mechanism on a temporary basis
- A refund mechanism would require a database of battery capacities connected to the grid and an effective monitoring of energy flows, to provide evidence for refund eligibility. This can be taken up by the Dutch DSOs

2.3

Barrier 3: Absence of a LV congestion market (i.e., price) for EV flexibility

Currently, there is no compensation mechanism for reimbursing consumers’ flexibility (i.e., V2G/G2V)

Lack of compensation mechanism for flexibility, barrier

Reasons why Dutch DSOs have not introduced a clear compensation mechanism for flexibility

High transaction costs for contracting small end-user flexibility

The transaction costs related to contracting flexibility provided by EV owners directly are very high due to the number of EVs and/or aggregation service providers that need to be contracted with for the same MW of flexibility

Insufficient scale of available flexibility within congested areas

Flexibility provided by individual EVs is in the order of a few kWs. If DSOs would like to resolve congestion in specific areas, they would require several hundred kW capacity to be made available. Current scale of EV penetration does not satisfy the needs of a DSO even after aggregation

A congestion market that gives access to small end-user flex would be required

Market mechanism required

Supply: Flexibility both in terms of capacity & energy from small end-user flex like EVs & batteries

Demand: Location based and time-bound requirements for flexibility to resolve expected congestions

Example

GOPACS

Congestion management platform for HV & MV grid in NL

- High **minimum bid sizes** *(1-5 MW day-ahead and intraday)*
- **Contract length** tied to capital expenditure requirements
- **Long-lead time** between auction and payment
- Participants required to provide **open-ended** (unlimited hours) **capacity**

Comments

- Currently, there is **no compensation mechanism in place for small end-user flex** if it makes itself available to the DSOs for resolving congestions in the Low Voltage (LV) grid
- Due to **high transaction costs related to contracting with each individual provider** of EV flex, direct one-on-one contracts are not a solution. A **market mechanism would be required**
- There **is such a mechanism for large end-user flexibility via the GOPACS platform** which aims to connect congestion requirements (demand bids by DSOs) with available flexibility (supply bids by generators and/or large loads). **Due to insufficient scale of flexibility from EVs, DSOs have not yet invested in building out the GOPACS platform further** to include flex from EVs
- Article 20A of the revised Renewable Energy Directive (EU) 2023/2413 provides a strong basis for providing access to congestion markets/price signals by stating – “*Member States shall ensure that the national regulatory framework allows small or mobile systems such as domestic batteries and electric vehicles and other small, decentralised energy sources to participate in the electricity markets, including congestion management […] including through aggregation*”. This has a **direct binding legal mandate** (effective from 20/11/2023) and compliance is **required within an 18-month timeframe**

Source: PwC Strategy& analysis based on expert input, GOPACS website and *EU (2023) Energy Directive* & *Congestion management in electricity distribution networks: Smart tariffs, local markets and direct control, Hennig, R. J., de Vries, L. J., & Tindemans, S. H. (2023)*

In other EU countries, congestion market platforms allow small end users/EVs to participate, providing learnings for NL

Congestion management markets in other EU countries

Existing congestion management platforms	Suitable for EV flex?	Platform overview	Key takeaways
GOPACS	*Not yet ready*	**Product (flex) launched in 2020** GOPACS allows large and small market parties to monetise their available flexibility to resolve congestion in the electricity grid It uses existing energy trading platforms to buy and sell orders that are suitable for congestion resolution (i.e. include time/location)	**1. Focus on inclusive and transparent participation** GOPACS does not have opaque or lengthy pre-qualification processes allowing (large) market parties with available flex to be able to contribute to congestion management and generate revenue
SINTEG SCHAUFENSTER INTELLIGENTE ENERGIE *Enera*	✓	**Pilot (2017-2020)** SINTEG's Altdorfer Flexmarkt aimed to use demand-side flexibility, including installations such as heat pumps, to manage grid congestion Flex was then accessed via DLC by the trial operators	**2. Technology as a key component of flex market** SINTEG focused on providing an easily accessible user interface and providing appropriate technology to automate activation of small scale user flexibility (via a smart meter and separate control box)
piclo® *Flex*	✓	**Product (flex) launched in 2019** Registered capacity of 17GW from over 55,000 flexibility service providers (FSPs) Auction-based marketplace where FSPs (e.g., Evs) offer flexibility to DSOs	**3. Standardisation enables increased participation** This has enabled Piclo to streamline processes through standard terms, procedures and qualification processes. This enables greater small scale participation and thus scale to address congestion effectively
centrica Energy *Cornwall Local Energy Market*	✓	**Pilot (2018-2021)** Involved 100 households in Cornwall, UK The auction took place with supply offered by Centrica (via DLC of households) to meet the DSO demand for congestion management	**4. Flex markets incorporating direct load control (DLC) simplifies the process for users** Designing a system where user flex is accessed via DLC and renumerated accordingly can reduce transaction costs for users and increases certainty for DSOs

Sources: GOPACS, Piclo, D'etorre (2022) Exploiting demand-side flexibility: State-of-the-art, open issues and social perspective

In NL, several design choices can be made in the process of developing GOPACS further/compensating EV flexibility

Compensation for flexibility – congestion market approach, solution

There are several design choices to settle upon if a flexibility market approach is used

Design choice	Options	Examples of existing platforms
Reference load – *against which the load profile change is to be realised*	• *Baseline agreed b/w DSO & EV/Aggregator* • *Current consumption/delivery of the trading party (individual EV user or sum of connections managed by an aggregator)* • *Capacity limit to usage (kW)*	• **All markets**: flexibility providers sell the **deviation from their assets' baseline**; Typically, they do so for 15-minute or 60-minute intervals
Minimum bid size	• *kW or kWh of flexible load over particular time intervals*	• **SINTEG Enera**: no min. • **GOPACS**: 1 MW min.
Matching & clearing mechanism	• *Closed auction: time limit-based merit order clearing* • *Automatic continuous matching based on location-based book orders* • *Continuous matching of supply and demand manually by DSO after bids are received*	• **SINTEG Enera, Nodes Market & GOPACS** have **location-based continuous matching process**
Price formation, payment type & penalties	• *Pay-as-bid v/s regulated price v/s bids with price cap* • *Dispatch payment v/s availability payment* • *To ensure delivery of flexibility, a penalty should be specified in the contract – to be imposed after verification*	• Almost all platforms except **Bne Flexmarkt** have **pay-as-bid** • **SINTEG Enera & GOPACS**: dispatch payment; **Nodes Market**: dispatch & availability payment – incl. activation fee for options
Activation lead time (option trades)	• *Day-ahead* • *Few hours ahead of anticipated congestion* • *Minutes ahead of anticipated congestion*	• **Piclo Flexibility Marketplace**: Determined individually – can range from one season to several yrs

Comments & recommendations

- **To reduce transaction costs** and **encourage wide participation from end-users**, DSOs would ideally introduce a **platform** that performs market clearing based on automatic matching of supply (congestion requirements in a certain location) and demand (flexibility from EVs in that location) bids
- **Designing such a platform would require choices along several criteria** – with the goal of minimizing entry barriers for individual EVs and aggregators. To have a well functioning market, **DSOs should engage with both internal experts and external market parties** (e.g., CPOs, aggregators and suppliers) to see what works best for the country in terms of:
  - Reference load
  - Minimum bid size
  - Matching & clearing mechanism
  - Price formation, payment type & penalties
  - Activation lead time (for option trades)
- **Current** DSO congestion **market platform in NL (GOPACS)** has been **designed from the perspective of large users** and is **not suited for EV flex participation until certain scale of aggregation is achieved** e.g., in terms of minimum bid requirement
- **Piclo Flexibility Marketplace (UK) & SINTEG Enera (DE)** are **good examples to borrow learnings from** and implement changes in GOPACS going forward – assuming Dutch DSOs would choose the market approach

Source: PwC Strategy& analysis based on *Markets for Local Flexibility in Distribution Networks,* Radecke, J. et al. (2019); RAP The joy of Flex; GOPACS platform; Dronne et al., '*Local Flexibility Markets for Distribution Network Congestion-Management in Center-Western Europe: Which Design for Which Needs?*' (2021); EU Commission '*Local Flexibility Markets in Europe*' (2022); Rebenaque et al., '*Success of Local Flexibility Market Implementation*' (2023)

To address the barrier, Dutch DSOs are advised to explore both bilateral agreements & marketplace routes

Summary: Barrier 3

Overall barrier description

There is currently **no price incentive provided by the DSOs to EV owners for providing their batteries as sources of V2G/G2V based flexibility**[1]. In the absence of such an incentive, EV owners do not see the value of helping DSOs resolve congestions at the expense battery life

Cause of the barrier in The Netherlands

- DSOs face high transaction costs while contracting small end-user flex and hence would require a market/platform based approach to generating a price for V2G/G2V based flexibility. However, due to insufficient EV battery capacity available in the market currently and the lack of major LV congestions, Dutch DSOs have not yet invested in developing such a market/platform as the costs are expected to outweigh the benefits. This is expected to change in the near future as LV congestions are forecasted to rise

Reflection on other EU countries

- Germany (with SINTEG Enera) and UK (with Piclo flex marketplace) have developed their congestion market platforms to also provide access to small end-user flex and they provide sufficient financial incentives to suppliers of V2G/G2V based flexibility through capacity tariffs. Transaction costs within the platforms are lowered through simplified qualification processes and use of automation

Recommendation

- Dutch Distribution System Operators (DSOs) are advised to either engage in setting up bilateral agreements (where possible, assuming the number of users are small) or to leverage insights/learnings from SINTEG Enera & Piclo Marketplace platforms to further develop the LV congestion module within GOPACS
- Particular learnings (for adjustments needed in GOPACS) highlighted by experts are – (1) setting a low minimum bid size (aligned with also the requirements of the grid), (2) implementing an automated location-based market clearing mechanism, (3) introducing pay-as-bid and/or capacity-based pricing, and (4) offering longer activation lead times

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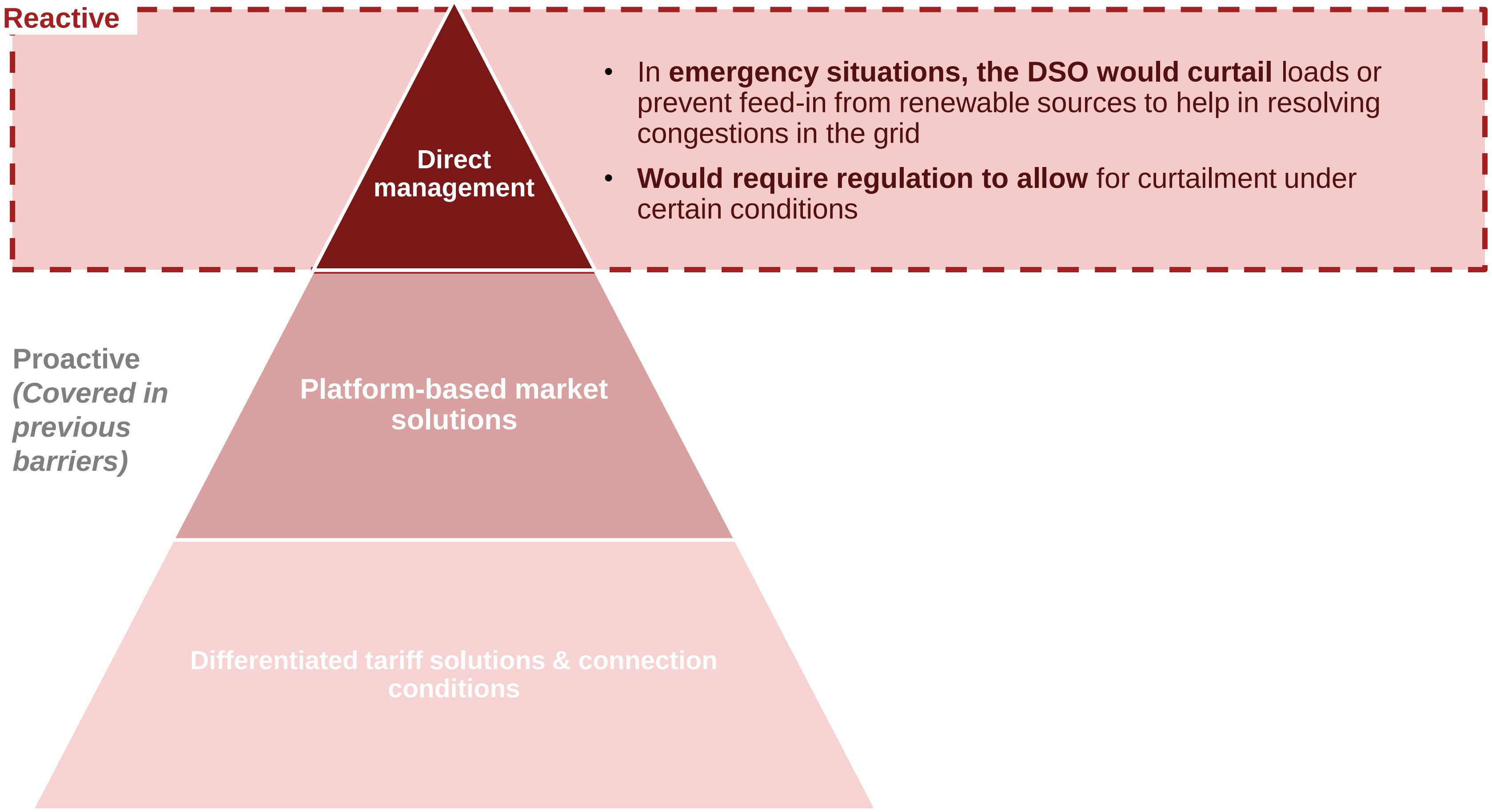
[1] Note that this is not a regulatory barrier, but it is mentioned here due to the potential it has in creating additional incentives for EV users that are in-line with the requirements of the grid. Dutch DSOs are currently working on incorporating a separate module that relaxes some of the existing requirements which only large loads can meet

2.4

Barrier 4: Unclarity over the possibility of DSOs to curtail chargers

DSOs should be allowed to directly control loads as a last resort according to EU legislation: NL regulation is not clear

Inability of DSOs to perform load control as last resort



Reactive

Direct management

- In **emergency situations, the DSO would curtail** loads or prevent feed-in from renewable sources to help in resolving congestions in the grid
- **Would require regulation to allow** for curtailment under certain conditions

Proactive ***(Covered in previous barriers)***

Platform-based market solutions

Differentiated tariff solutions & connection conditions

Comments

- **Price incentives**, through market mechanisms **encourage consumers to change their own behaviour**, reducing the need for the system operator to intervene via grid expansion/ reinforcement which comes at a higher cost
- **DSOs would ideally create incentives (either through differentiated tariffs or market-based mechanisms) to avoid/prevent congestions** – barriers related to this and potential solutions have been highlighted in section 2.1
- However, in **emergency scenarios, DSOs should have the possibility to curtail loads by sending signals to the relevant connection points in order** to avoid black-outs/ brown-outs i.e., to maintain the structural and functional integrity (reliability) of the grid
- Currently, **regulation in NL is not clear whether it is allowed for DSOs to curtail EV charging points to tap into their flexibility.** This could generate an incentive to keep further expanding the grid in anticipation of congestions – which could sometimes be incidental & thus avoided through curtailment

Source: R.J. Hennig et al., (2023) 'Congestion Management in Electricity Distribution Networks' Action Agenda for Grid Congestion in Low Voltage Grids (2024), EZK

Clear regulation and compensation mechanisms for users can enable direct load control by DSOs, e.g., from Germany

DLC implementation in BE, FR and DE

Flanders, Belgium

DSO curtailment is permitted, compensation mechanisms are less clear

Regulation: Article 1.5.1 Technisch Reglement voor de Distributie van Elektriciteit in het Vlaamse Gewest

Introduced: 25/06/2021

- ⊕ DSOs can use DLC as an emergency measure in 9 clearly defined situations, including black-outs
- ⊖ Although indicated by art.2.3.9, the exact compensation mechanism for such DLC is less clear

Germany

Differentiated tariffs are applied for controllable consumption facilities (e.g., EVs, head pumps)

Regulation: Section 14a EnWG

Introduced: 01/01/2024

- ⊕ DSOs can use DLC where it has been agreed with customers with controllable consumption facilities
- ⊕ As compensation, owners of controllable consumption facilities are offered two alternative grid tariff options. These provide tariff discounts or remuneration for consumers when their loads are controlled by DSOs

France

DLC not done by DSOs. An independent aggregator, Voltalis, offer reduced bills for customers that opt in to having their loads controlled

Regulation: NA

Introduced: NA

- ⊖ It is not clear if DSOs can use DLC as a last resort
- ⊕ Compensation mechanisms for customers that opt into DLC are clear

Comments

- **Germany's new regulation** (14.a EnWG) sets the **clearest conditions** for **DLC by DSOs** of controllable consumption devices **stating the circumstances it can be used** and the **compensation users should receive**
- **German regulation** is **popular with grid operators** due to the **certainty of response** and the requirement for **newly connected controllable devices** to **participate**
- However, the low base of smart meters in Germany (~0.06% in 2020) will make the implementation challenging in reality
- In **France** a **market-based approach is taken**, whereby Voltalis, an **independent aggregator**, directly controls customers electronic devices and **sells the aggregated energy flexibility** to the RTE (French TSO)
- In Flanders, Belgium, while **DLC is permitted in regulation in certain circumstances**, the payment for users is not clear, **limiting DLC usage**

Sources: Technisch Reglement voor de Distributie van Elektriciteit in het Vlaamse Gewest (2021), NvWG (2024);'D'etorre (2022) Exploiting demand-side flexibility: State-of-the-art, open issues and social perspective; Bergsträßer, J., 2022. Herausforderungen bei der Digitalisierung der Energieversorgung

Two types of Direct Load Control (DLC) solutions can be considered for implementation in The Netherlands

Solutions to DSO load control issue

Approaches to direct load curtailment (DLC)	Suitability	Pros +	Cons -
***Consent-based** direct load curtailment schemes*	• Suited to resolve congestions mainly in areas where loads have consented to be curtailed	• Quality of Service (QoS) not unfairly compromised for selected users – like under the default sign-up scheme	• Potential reliability issue if insufficient loads have signed up for the program
***Default sign-up based** load curtailment schemes e.g., UK, DE etc.*	• Suited to resolve all types of congestion problems • Not suited for must-run or tight constraint loads	• High level of reliability as DSO has greater control over all the loads	• Discrimination can exist in the form of Quality-of-Service (QoS) • Can be percieved as unfavourable and heavy-handed by EV users

Comments

- **DLC schemes tend to have high reliability**, as the DSO controls the load and can steer as many devices as necessary to resolve congestion. This observation holds for both small and large-scale problems and structural and sporadic congestion
- A **potential reliability problem may occur in consent-based schemes** when not enough loads have signed up for the program
- **Default sign-up-based schemes (as implemented in UK and DE) are more reliable** as they give greater control to the DSO but may also be seen as unfavorable and heavy-handed by consumers
- Since **prices for the scheme are set by the DSO long-term**, they may not remove congestion strictly at the marginal cost of shifting flexible loads. On the other hand, they are also **not likely to considerably overpay flexibility providers –** which is more likely under the market based price setting approaches. Moreover, the **DSOs can adjust prices over several billing periods to move closer to an efficient solution**
- **Feasibility:** To enable the implementation of DLC in NL, it is **recommended to develop clear guidelines on curtailment in line with EU's Electricity market regulation (2019/943) Article 13,** where it is stated that *"redispatch (including curtailment) is permitted, but only as a last resort when all other options (market-based alternatives have been used) and DSOs must report annually the reasons for curtailing".* A choice could be made between Default sign-up based scheme v/s Consent-based DLC scheme

To address the barrier, Dutch DSOs are advised to develop a joint proposal highlighting the costs & benefits of a DLC scheme

Summary: Barrier 4

Overall barrier description

Curtailment is an extreme form of controlled charging, where grid operators are given the right to limit an EV from charging in order to prevent the grid from overloading. As a last resort, when system costs of non-curtailment are high, DSOs should be allowed to curtail loads as a temporary measure as per EU's Electricity Market Regulation (2019/943). However, **it is unclear if Dutch DSOs are allowed to directly curtail EVs and other loads on the LV grid even as a last resort**, potentially creating a skewed incentive for further grid expansion

Cause of the barrier in The Netherlands

- The Dutch regulatory framework incl. the network codes lack clarity on whether and/or under which conditions DSOs can curtail loads connected to the LV grid. It is also undefined if there will be any compensation provided to EV owners/other loads upon curtailment

Reflection on other EU countries

- At the beginning of 2024, Germany implemented a Direct Load Control (DLC) regulation under the EnWG, establishing a default opt-in scheme for all controllable loads, including EV charge points and Solar PVs. DSOs are required to register these controllable loads and provide pre-specified compensation for instances of curtailment
- Other EU countries also use DLC mechanisms, often in combination with incentive structures like Time of Use based reimbursement

Recommendation

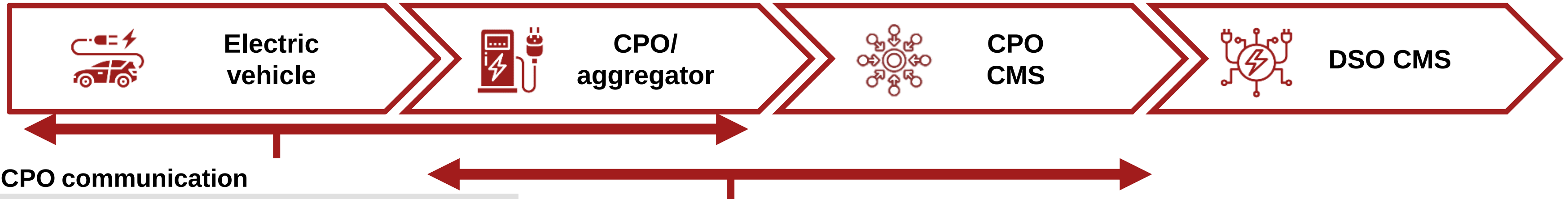
- Grid operators in the Netherlands are advised to develop a joint proposal directed towards policymakers highlighting the costs and benefits of introducing different forms of Direct Load Control (DLC) mechanisms
- This proposal should make concrete recommendations on the proposed design and provide explicit changes required in the network codes to allow a DLC mechanism under specific conditions for controllable loads.
- The proposed approach can be either consent-based or default opt-in based, but it must align with Article 13 of the EU's Electricity Market Regulation (2019/943)

2.5

Barrier 5: Absence of a communication standard b/w DSO & CPO

There is no DSO<->CPO communication standard that allows for sharing of all the data needed to activate 'V2G/G2V'

Standards and protocols enabling smart charging



EV-CPO communication

Data points needed	IEC 61851	15118-2	15118-20
Charging limit (e.g., voltage, current)	✓	✓	✓
State of charge	✓	✓	✓
Charging schedule	✓	✓	✓
Vehicle ID	✓	✓	✓
Dynamic charging profile	✗	✗	✓
V2G preference	✗	✗	✓

Current standards insufficient for advanced SC & V2G; V2G standard available but not widely used. All are ineffectively verified and enforced

Discussed in the following chapter

EV-CPO communication

Data points needed	OCPP
Transaction details	✓
Customer metering information	✓
Charging limit (e.g., voltage, current)	✓
State of charge	✓
Charging schedule	✓

Advanced V2G standard available, but enforcement, monitoring & verification mechanism unavailable

Discussed in the following chapter

Comprehensive standard not available

CPO-DSO communication

Data points needed	OpenADR	OSCP
Consumption/ capacity (time, location)	✗	✓
Tariff information	✓	✗
Generation capacity (time, location)	✗	✓
Customer ID	✓	✓

No comprehensive communication standard available- existing ones should be developed further

Comments

- Currently, **two communication protocols are available/adopted** to ensure **standardized data sharing** between the backend of a DSO and the Charge Point Operator (CPO):
  - OpenADR 2.0b
  - OSCP
- However, **both are currently inadequate** to enable advanced smart charging/V2G oriented communication from the DSO
- **New standards are under development**/ evolution and **could address** current shortcomings:
  - OpenADR 3.0[1]
  - OSCP 2.1
  - IEC 62746-4
- **Flexibility codes** are currently **being developed** which could **provide the regulatory framework** to mandate the required standard

Key: EV = Electric Vehicle; CPO = Charge Point Operator; CMS = Central Management System; DSO = Distribution System Operator

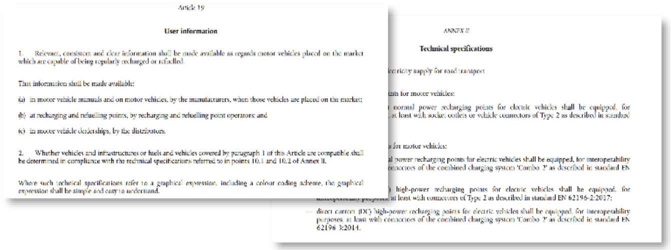
Sources: EV Related Protocol Study Version 1.1.; Open Charge Point Protocol; ENCS; ISO 15118; IEC 61851; DIN SPEC 70121; RAP Standards for EV smart charging (2022); 1) OpenADR = IEC 62746-10-1

A DSO<->CPO communication standard building on e.g., OSCP is required to enable transparent data sharing across EU

DSO-CPO communication standard, solution

The EU has included a provision in AFIR to set DSO-CPO communication standards

EU: Article 19 and Annex II of the Alternative Fuels Regulation (EU) 2023/1804



Article 19

User information

1. Relevant, consistent and clear information shall be made available as regards motor vehicles placed on the market which are capable of being regularly recharged or refuelled.

That information shall be made available:

(a) in motor vehicle manuals and on motor vehicles, by the manufacturers, when those vehicles are placed on the market;

(b) at recharging and refuelling points, by recharging and refuelling point operators; and

(c) in motor vehicle dealerships, by the distributors.

2. Whether vehicles and infrastructures or fuels and vehicles covered by paragraph 1 of this Article are compatible shall be determined in compliance with the technical specifications referred to in points 10.1 and 10.2 of Annex II.

Where such technical specifications refer to a graphical expression, including a colour coding scheme, the graphical expression shall be simple and easy to understand.

ANNEX II

Technical specifications

ctricity supply for road transport

nts for motor vehicles:

normal power recharging points for electric vehicles shall be equipped, for at least with socket outlets or vehicle connectors of Type 2 as described in standard

s for motor vehicles:

al power recharging points for electric vehicles shall be equipped, for interoperability onnectors of the combined charging system 'Combo 2' as described in standard EN

high-power recharging points for electric vehicles shall be equipped, for at least with connectors of Type 2 as described in standard EN 62196-2:2017;

— direct current (DC) high-power recharging points for electric vehicles shall be equipped, for interoperability purposes, at least with connectors of the combined charging system 'Combo 2' as described in standard EN 62196 3:2014.

Article 19(2) includes a provision (via a delegated act) for:

- *Whether EVs and charging infrastructure are compatible will be determined in compliance with specifications set out in Annex II*

Annex 2 (2.4):

- *'Technical specifications regarding communication between the recharging point operator and the distributed system operators'*

Defining a DSO-CPO communication standard requires government, industry and research institution collaboration

New EU DSO-CPO standard: *To enable smart charging, the communication standard could build on OSCP and OpenADR*

OSCP	+	OpenADR/ IEC 62746-10-1

OSCP

- The open smart charging protocol (OSCP) communicates 24-hour electricity grid capacity predictions to the charge point
- Defines data formats and supports features including dynamic pricing load management and renewable energy integration
- Application: Increasingly required in major grid infrastructure work

OpenADR/ IEC 62746-10-1

- Open Automated Demand Response (OpenADR) is a standard communication protocol which managed and controls energy demand in response to grid conditions and/ or price signals
- Defines dynamic price and reliability signals to exchange in a uniform, interoperable way between DSO and energy management system
- Application: Basis of IEC 62746-10-1 (2018)

Comments

- **DSOs are required to cooperate** with individuals or entities establishing or **operating a charge point** (CP) in accordance with **EU Directive 2019/944**
- The **manner of communication** between these parties **is not yet specified** via a set standard **in all the EU countries covered** (NL, FR, BE, DE)[1]
- The **communication standard** for **DSO-CPO communication** defines **data formats and security protocols**, including for payments
- **A DSO-CPO communication** standard is **necessary** to enable **smart charging and congestion management through an API** (the software sending SC commands)
- In NL, the '**Real-Time Interface**' serves as an API for **communication** between **DSOs** and **larger generators** – this **platform** could be **adapted** to handle small scale (EV) connections

Source: Netbeheer Nederland; Using OpenADR with OCPP; RAP Standards for EV smart charging (2022); 1) As per input from industry and regulatory experts, gathered via stakeholder workshops

De facto standards (e.g., OSCP) require a less formal approval process, allowing for faster adaptation to the needs of industry

Options for introducing standards

Options for introducing communication standards

Formal

Informal

	Key characteristics/ features	Advantages	Disadvantages
De jure	• *A standard officially recognized and established by a governing body or authority (e.g., ISO)* • Consensus-based development process • Adoption driven by voluntary or mandatory compliance • Examples of specific de jure standards like ISO 15118	• Formally recognition in law allows de jure standards to be mandated in e.g., EU regulation • Long-term stability, providing industry certainty	• Time consuming process to develop and approve de jure standards • Inflexible – formal approval process limits their ability to adapt quickly to technological advancements/ industry needs
Hybrid	• Combination of de jure and de facto can be used e.g. de jure standards form the basis of de facto standards or vice versa, generally not formally recognized/ legally backed • Builds on de jure stability and de facto adaptability • Examples include IEC 62746-10-1, which started as a de facto standard	• Encourages innovation and openness through testing in de facto phase before being formalized • Leverages legal recognition of de jure which allows enforcement in some circumstances	• Less legal protections and mandates that those associated with de jure standards • Challenges verifying formally due to a range of standard owners
De facto	• *A standard widely adopted and used in practice, generally not formally recognized/ legally backed* • Generally developed by industry bodies and market practices • Adoption driven by market forces and effectiveness • Examples include Open Charge Point Protocol (OCPP)	• Favored by industry (e.g., OEMs and CPOs) as long as backed by required government mechanisms • Flexible and agile meaning they can evolve more quickly to meet changing industry needs	• Lack of formal recognition, requires good-faith compliance agreements • Potential fragmentation by industry can lead to interoperability issues

As a next step, it is advised that EU working groups develop a robust communication standard in collaboration with industry

Summary: Barrier 5

Overall barrier description

To enable V2G/G2V, several data points (e.g., energy consumption, battery capacity, state of charge, time, location, tariff information, reference/base load and charge profiles) ought to be shared at a high level of frequency between a DSO and CPO. However, **currently there is no communication standard that enables the sharing of all data points at the required level of granularity between a DSOs back-end system and a CPOs back-end system**

Cause of the barrier in The Netherlands

- This is not an exclusively Dutch issue. Existing communication standards (OpenADR 2.0b and OSCP 2.0.1) do not enable the sharing of all necessary data types for V2G/G2V. Specifically, OpenADR's current version lacks the ability to share essential capacity and charge information in real-time, while OSCP 2.0.1 does not support the sharing of tariff information from the DSO – necessary to serve as a price signal for activation

Reflection on other EU countries

- According to industry and policymakers, this issue is prevalent across EU countries[1]. While EU regulation mandates DSOs to collaborate with charge point operators (CPOs), it does not impose specific communication standards or specify data sharing requirements necessary to facilitate V2G/G2V in order to address grid congestions

Recommendation

- Since this is a pan-European issue, it is advised that the solution be driven at an EU level. Working Groups on the topic of smart charging and/or standards development commissioned by the EU (incl. representatives from regulatory bodies like ACER) should engage with the EV charging infrastructure players and research institutions currently developing such a standard in order to understand current gaps and steps needed towards the establishment of a robust DSO-CPO communication standard that can be rolled out across Europe
- To avoid multiple standards from emerging and/or duplication of work, a coordinated approach would be the best way forward. The new standard could build upon OSCP and OpenADR

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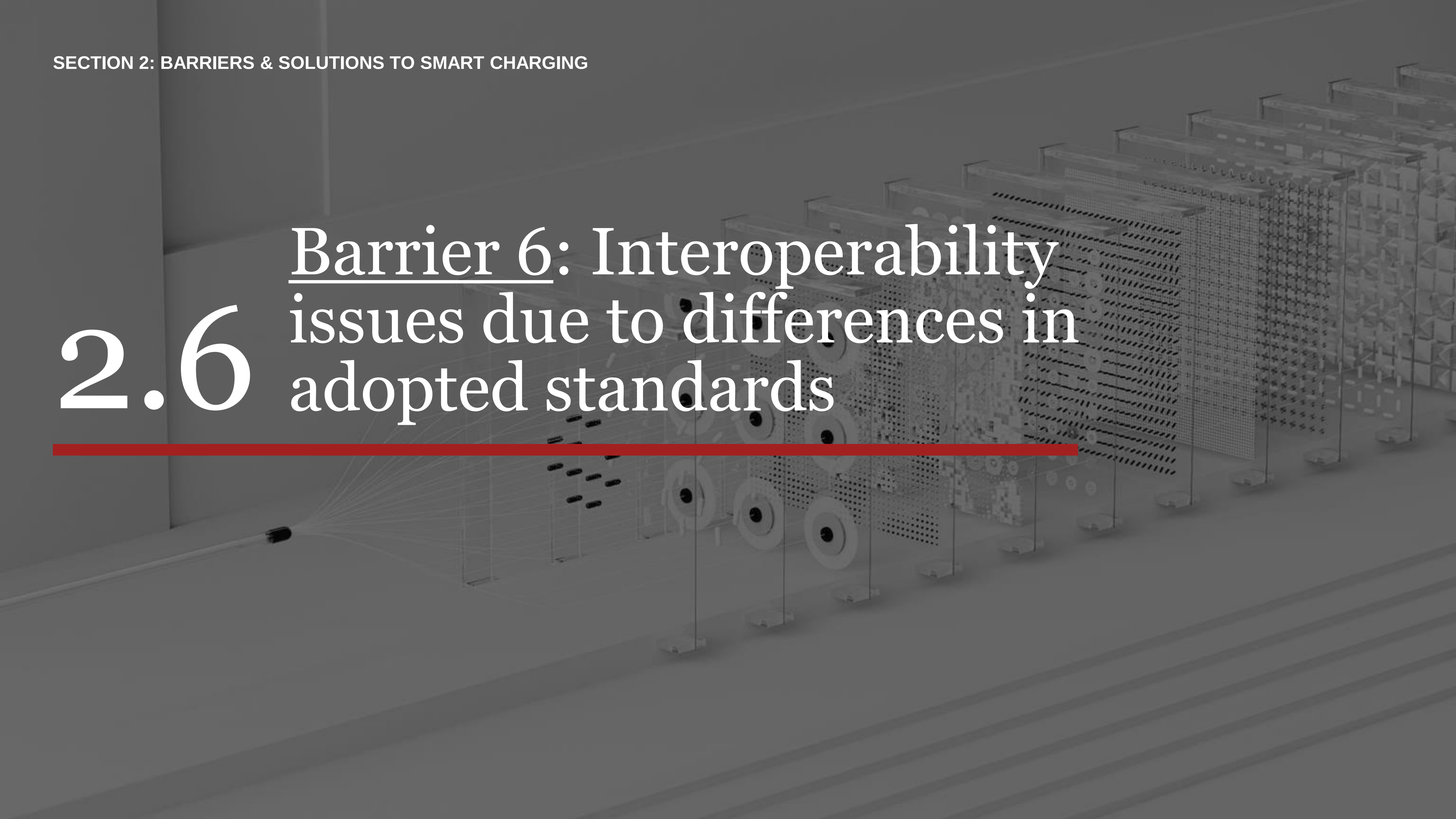
1) Based on inputs received during stakeholder workshops conducted during the project

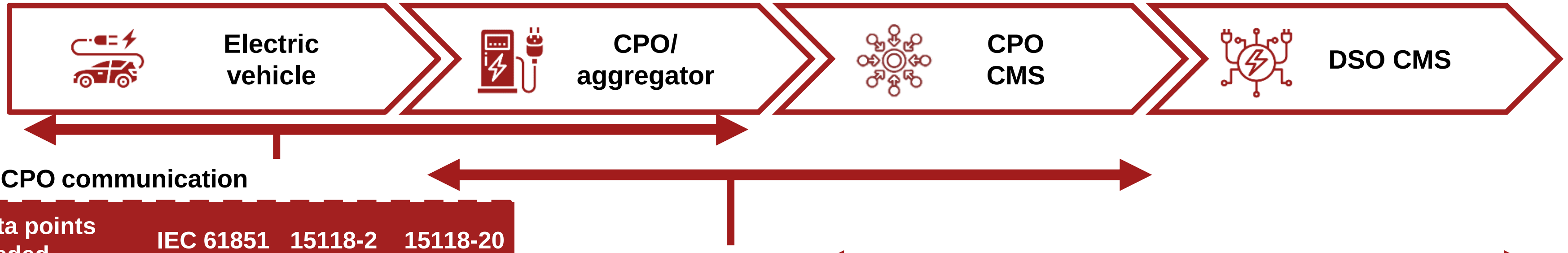


2.6

Barrier 6: Interoperability issues due to differences in adopted standards

There are multiple communication standards b/w the EV-CPO points - none is enforced by regulation

Standards and protocols enabling smart charging



EV-CPO communication

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Charging schedule	✓	✓	✓
Vehicle ID	✓	✓	✓
Dynamic charging profile	✗	✗	✓
V2G preference	✗	✗	✓

Current standards insufficient for advanced SC & V2G; V2G standard available but not widely used. All are ineffectively verified and enforced

EV-CPO communication

Data points needed	OCPP
Transaction details	✓
Customer metering information	✓
Charging limit (e.g., voltage, current)	✓
State of charge	✓
Charging schedule	✓

Advanced V2G standard available, but enforcement, monitoring & verification mechanism unavailable

Comprehensive standard not available

CPO-DSO communication

Data points needed	OpenADR	OSCP
Consumption capacity (time, location)	✗	✓
Tariff information	✓	✗
Generation capacity (time, location)	✗	✓
Customer ID	✓	✓

No comprehensive communication standard available- existing ones should be developed further

Discussed in the previous chapter

Comments

- **ISO 15118-2 enables basic smart charging** communication between EV and CPO, and is **adopted by several** EV and CPO original equipment manufacturers (**OEMs**)
- **To enable advanced smart charging** (including V2G) **a standard such as ISO 15118-20 allows the required data to be communicated**
- **EU regulation AFID** (2014/94/EU) required **CPs comply with the communication standard IEC 61851** for safety reasons
- The Revised Alternative Fuels Infrastructure Regulation **(AFIR 2023/1804) does not mandate a set communication standard**, however a placeholder allows a communication standard to be included in future once there is consensus
- Due to **unclarity on which protocol should be adopted as a standard** across OEMs operating in Europe, **interoperability issues can arise**

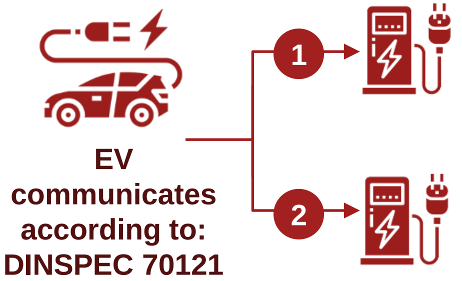
Key: EV = Electric Vehicle; CPO = Charge Point Operator; CMS = Central Management System; DSO = Distribution System Operator

Sources: EV Related Protocol Study Version 1.1.; Open Charge Point Protocol; ENCS; ISO 15118; IEC 61851; DIN SPEC 70121; RAP Standards for EV smart charging (2022);

Interoperability issues (prevalent across EU) arise due to different levels and speeds of implementing available standards

Interoperability, barrier

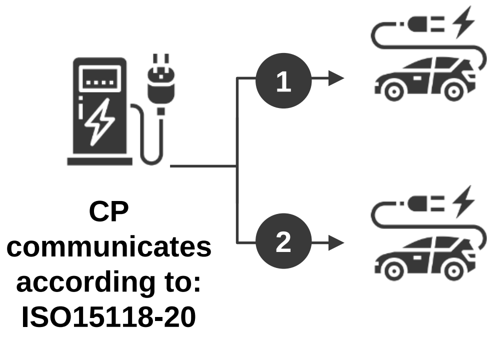
Example: EV/ CP interoperability



EV communicates according to: DINSPEC 70121

CP uses:	Reflections	Basic CC	Advance CC	V2G
IEC 61851	• Charging limits, SoC, and payment data shared • Advanced smart charging profiles and V2G not communicated	✓	✗	✗
DIN SPEC 70121	• Charge start/ stop data sharing • SoC information not shared by car under the DIN standard	✗	✗	✗

Example: CP/ EV interoperability



CP communicates according to: ISO15118-20

EV uses:	Outcome	Basic CC	Advance CC	V2G
DIN SPEC 70121	• Charging limits, SoC, and payment data shared • Advanced smart charging profiles and V2G not communicated	✓	✓	✗
ISO15118-20	• Charging limits, SoC, and payment, advanced smart charging profiles and V2G data shared	✓	✓	✓

Comments

- **Interoperability** is necessary to allow different brands and types of EVs and CPs to **talk the same language** to activate smart charging
- The **absence of commonly** enforced **communication protocols**/ standards **creates interoperability** issues
- Interoperability issues prevent **consumers from engaging in smart charging** across different EV brands or energy suppliers without replacing software/hardware e.g., charging equipment. **These issues are prevalent across the EU countries covered[1] i.e., it is not a Dutch specific problem**
- Communication standards **create consensus** across the value chain on data exchange, interconnection formats and prevent **divergent approaches being adopted across member states**
- **Without the right enforcement mechanisms** being in place e.g., testing/certification, the internet-connected nature of smart chargers can also **lead to data privacy and safety issues for EV owners**

Source: RAP Standards for EV smart charging (2022); Open Charge Point Protocol; ENCS; ISO 15118; IEC 618151l; DIN SPEC 70121

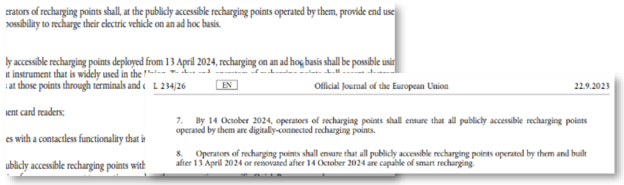
1) EU countries covered via stakeholder workshops – DE, FR, BE and NL

EU legislation should specify consistent CPO-EV communication standards to prevent interoperability issues

Interoperability, solution

AFIR (EU) will drive significant public smart meter roll out in next 2 years

EU: Article 5 of the Alternative Fuels Regulation (EU) 2023/1804
Direct **binding legal force from September 2023** relating to publicly accessible charge points



erators of recharging points shall, at the publicly accessible recharging points operated by them, provide end use
ossibility to recharge their electric vehicle on an ad hoc basis.

ly accessible recharging points deployed from 13 April 2024, recharging on an ad hoc basis shall be possible usir
it instrument that is widely used in the
at those points through terminals and

ent card readers;

es with a contactless functionality that is

ublicly accessible recharging points with

L 234/26 EN Official Journal of the European Union 22.9.2023

7. By 14 October 2024, operators of recharging points shall ensure that all publicly accessible recharging points operated by them are digitally-connected recharging points.

8. Operators of recharging points shall ensure that all publicly accessible recharging points operated by them and built after 13 April 2024 or renovated after 14 October 2024 are capable of smart recharging.

Article 5 (7)

- *By 14 October 2024, operators of recharging points shall ensure that all publicly accessible recharging points operated by them are **digitally-connected recharging points***

Article 5 (8)

- *Operators of recharging points shall ensure that all publicly accessible recharging points operated by them and built after 13 April 2024 or renovated after 14 October 2024 are capable **of smart recharging***

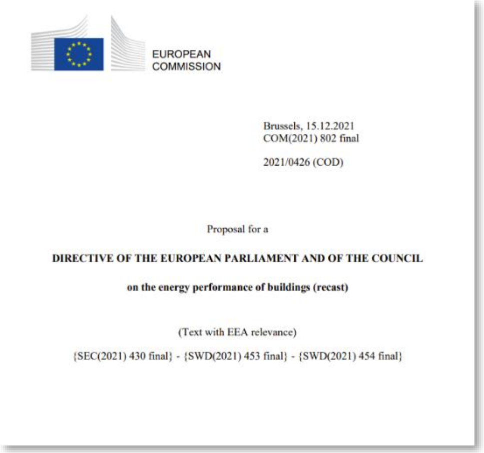
'Digitally-connected recharging point' means a recharging point that can send and receive information in real time, communicate bi-directionally with the electricity grid and the electric vehicle, and that can be remotely monitored and controlled, including in order to start and stop the recharging session and to measure electricity flows

'Smart recharging' means a recharging operation in which the intensity of electricity delivered to the battery is adjusted in real-time, based on information received through electronic communication

Communication standards are not defined in AFIR, however **a provision** (via a delegated act in Article 19) to define future non-proprietary and non-discriminatory communication protocols and standards between EV and CPO **is included**

And revisions to the EPBD (EU) will drive private charge point roll out

EU: Article 12 of the Energy Performance in Buildings (EU) 2018/844
Provisionally agreed: December 2023; **formal adoption expected Early 2024**



EUROPEAN
COMMISSION

Brussels, 15.12.2021
COM(2021) 802 final

2021/0426 (COD)

Proposal for a

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on the energy performance of buildings (recast)

(Text with EEA relevance)

{SEC(2021) 430 final} - {SWD(2021) 453 final} - {SWD(2021) 454 final}

Article 12 (6)

*'Member States shall ensure that the recharging points referred to in paragraphs **1, 2 and 4** are capable of smart charging and, where appropriate, bidirectional charging, and that they are operated based on non-proprietary and non-discriminatory communication protocols and standards, in an interoperable manner, and in compliance with any legal standards and protocols in the delegated acts adopted pursuant to **Article 19(6) and Article 19(7) of Regulation (EU) 2023/1804 [AFIR].***

Charging points installed in residential and non-residential buildings

Links to the provision in AFIR for EU to define technical specifications for interoperable communication protocols & standards via a delegated act

Source: EU (2023) Alternative Fuels Regulation (EU) 2023/1804;
Note: Article 19(6) and 19(7) EU 2023/1804 (AFIR) 'In accordance with Article 10 of Regulation (EU) No 1025/2012, the Commission may request European standardisation organisations to draft European standards defining technical specifications for areas referred to in Annex II to this Regulation for which no common technical specifications have been adopted by the Commission. The Commission shall be empowered to adopt delegated acts in accordance with Article 17 to: supplement this Article with common technical specifications, to enable full technical interoperability of the recharging and refuelling infrastructure in terms of physical connections and communication exchange'

Ensuring CPs and EVs are ISO15118-20 compliant will address interoperability and unlock the full benefits of smart charging

Interoperability, solution

European Standards Authority & policy makers could consider…

Publicly accessible charge points

- ***Ensure all publicly accessible charge points are digitally connected and capable of smart charging in accordance with AFIR***
- ***For publicly managed charge points, ensure equipment procured complies with ISO15118-20 to enable V2G***

Private charge points

- ***Encourage owners of private charge points to install a smart, V2G capable and ISO 15118-20 compliant charger when fitting new infrastructure or replacing existing infrastructure through subsidies***

Electric vehicles

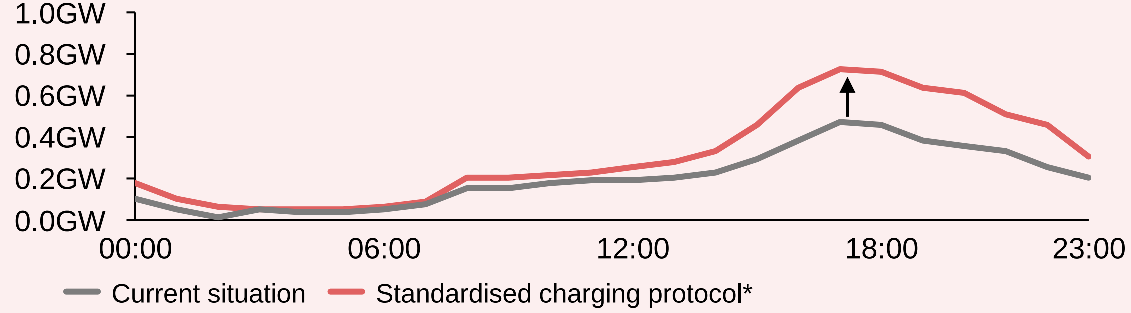
- ***Work with OEMs to identify possible software updates***
- ***Ensure new EVs can control charge and V2G through mandating ISO15118-20 and setting up the certification & testing frameworks around it***

CASE STUDY: V2G in US

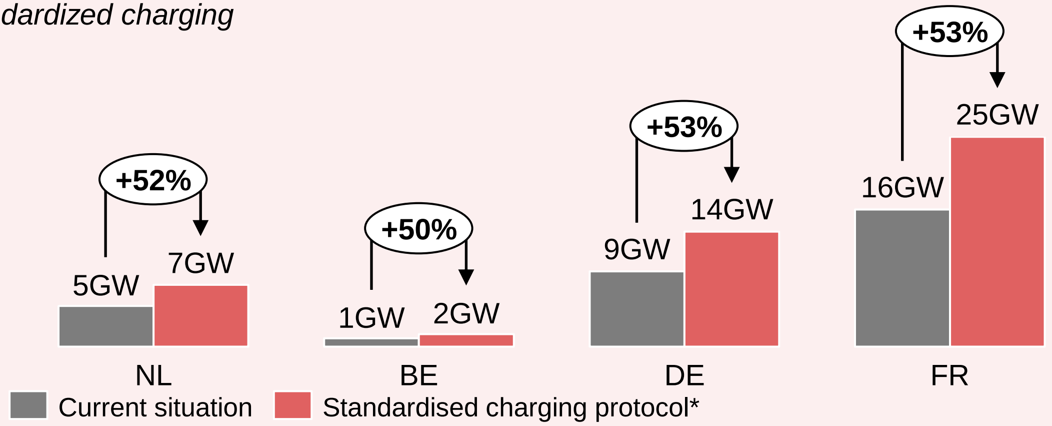
- The US took a **hybrid approach for communication standards** to enable V2G
- Policymakers **implemented a modified ISO 15118-2** which was **V2G compliant** for DC charging, **avoiding** a **long development/ approval time** for ISO 15118-20

Introducing the changes could unlock the following benefits:

Hourly potential flexibility from EVs in NL, with and without standardized charging i.e., no sleep mode issues are experienced by EVs



Daily cumulative flexibility from EVs in NL, BE, DE and FR, with and without standardized charging



*Assuming availability at 50% of chargers in NL; Standardised charging protocol assumes that there are no sleep mode issues

Source: Unlocking the full potential of smart charging: addressing delayed charging problems in EVs

In summary, it is advised to either ensure compliance with ISO 15118-20 or setup appropriate governance structure around it

Summary: Barrier 6

Overall barrier description

To activate either controlled charging or V2G/G2V, **it is important that the EV is able to communicate with the charge point in a language that it understands. This is not always possible** because some charge points are designed to comply with a different communication standard compared to the EV, causing communication errors/interoperability issues. This **reduces the total smart charging potential by causing EVs to enter into "sleep/pause" mode in some cases**

Cause of the barrier in The Netherlands

- Several communication standards are available for facilitating data sharing between EVs and charge points, such as IEC 61851, ISO 15118-2, and DIN SPEC 70121. These standards were historically adopted in varying degrees by different CPOs and EV manufacturers across Europe

Reflection on other EU countries

- This barrier exists across the EU. Certain member states (including NL) have specified a communication standard that should be adopted by all public charge points however in the wider market divergence still occurs

Recommendation

- The European standards authority could take steps to ensure that all charge points and EVs comply with ISO15118-20 since this standard is able to communicate all data points needed for enabling smart charging
- This can be achieved by either:
  - Providing clear guidance within existing regulations (e.g., AFIR) or
  - Establishing an appropriate governance structure around the standard, enabling the industry to adopt it voluntarily through a de facto approach
- Policy makers and municipalities in individual member states can take following actions:
  - Ensure all publicly accessible charge points are digitally connected and capable of smart charging in accordance with AFIR
  - For publicly managed charge points, ensure equipment procured complies with ISO15118-20
  - Consider providing incentives/subsidies for ISO15118-20 compliant charge points being installed by private home owners

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1) Based on inputs received during stakeholder workshops conducted during the project

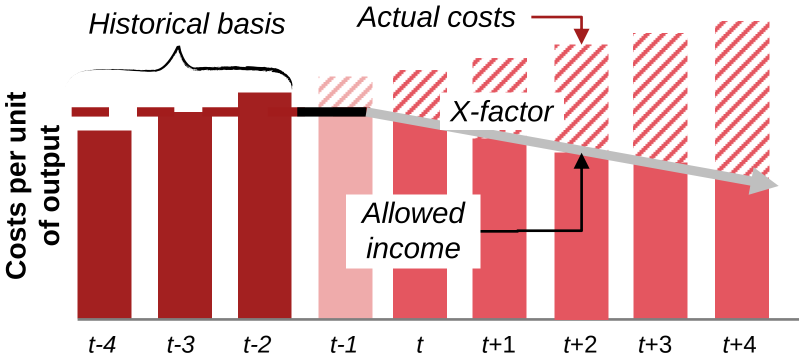
2.7

Barrier 7: Lack of incentive for digitalization & grid modernization

Tariff regulation of EU DSOs does not always incentivize, and can even penalize, grid digitalization & modernization costs

Barrier: Lack of DSO incentive to invest in smart charging enablement

Allowed income can be lower than expected costs because historical costs are used in benchmark



- **Benchmark competition:** In the current DSO tariff regulation, the costs per unit of output for the entire sector is used as the benchmark against which the resulting profits for network operators would be determined
- **Use of historical estimates:** An important implicit assumption of the current regulation is that the average costs and output from the past (average over 't-4' to 't-2') form a good basis for the benchmark (efficient costs per unit of output) in the coming regulatory period. The same assumption applies to the estimation of productivity change (X-factor)

To enable smart charging, DSOs need to make non-output generating expenditures

Type of expenses & contribution to output

1	**Grid monitoring:** Related to data management (storage, processing, cybersecurity), real-time measurements etc.	**No direct impact** on output
2	**Automation**: Of substations and transformers, including the ability to control remotely	**No direct impact** on output
3	**Smart meters**: To enable behind the meter monitoring and improving observability in the LV grid	**No direct impact** on output
4	**Modernisation:** Replacement and modernisation of grid assets (e.g., lines, transformation centres) to maintain high levels of robustness	**No direct impact** on output

Comments

- In a **stable situation** (where future costs are reflective of historic costs), **current tariff regulation for DSOs is effective** and encourages efficiency
- **To enable smart charging** and the broader energy transition, **DSOs are expected to make additional capital and operational expenditures**. In this case, DSO **costs per unit of output are expected to be out of sync with historic values**
- Figure on the left shows how the use of historical costs in the benchmark compared to the actual costs leads to **returns that are too low**. Assuming costs continue to rise, the **"actual" additional costs in t-1 are now higher than the average for the years 't-4' to 't-2'**, which is shown by the (light pink) shading
- The "actual" additional costs compared to the permitted income **during the regulatory period** (represented by the dark pink shaded blocks per year) lead to **further operating deficit**. This operating deficit applies to the entire sector and implies that the sector as a whole will not achieve a reasonable return
- Therefore, the use of historic cost estimates leads to a general disincentive for DSOs to increasingly invest in costs that are **non-output generating** as **they lead to further worsening of position against the benchmark – thereby penalising DSOs.** As shown on the left, most investments & expenditures that will enable smart charging are non-output generating

Source: Tariff regulation in transition – report for NBNL, Strategy& (2023)

DSO tariff regulation in NL can be adjusted to give incentives for proactive roll-out of smart charging infrastructure

Potential solutions to the DSO disincentive issue

Several solutions can be implemented to address the issue

Category	Solution	Description
① **Ex-post recalculation**	*Sector-wide ex-post recalculation*	Actual costs are calculated annually at sector level
② **Correction to historical costs to make it more forward-looking**	*Extrapolate historical trend in sector costs*	Base initial estimates on the trend in historical costs rather than on their historical average
	Use investment plans	Base initial results on the investment plans by DSOs for the future regulatory period
	Econometric estimation of future costs	Base initial earnings on regression analysis conducted upon a historical data set
	Shortening the historical cost base	Use only the last year (or two years) of the current historical cost base
	Shortening the regulatory period	Reduce the regulatory period e.g., from 5 years to 3 years

Comments

① Conceptually, the **difference in actual costs for the DSO sector** as a whole and the **permitted income per year** (for the sector as a whole) can be **calculated** after **each regulatory year** and still be **expressed in the permitted income** (and the benchmark) of **later years**: this is the **sector-wide recalculation approach**. It has the following advantages:

+ **Additional costs are passed on more quickly** than in the current system
+ The **sensitivity for the calculation of the initial income decreases**
+ **Influence of the X-factor is reduced** because it is always included in the actual calculated income
+ **Current benchmark competition continues** to exist
+ The **incentive that exists in principle** in the current system to **incur costs as much as possible in the years that determine the initial income** (which increases the permitted income for the next regulatory period) **may also reduce**

② A **forward looking estimate** using a historically observed trend is **simple to implement**, and can **reduce the incentive problem** significantly. However, it **can incentivize DSOs to delay investments to the last year in the regulatory period**. **Alternative** forecasting methods can also be considered such as **forecasts provided by the DSOs based on investment plans** or **econometric forecasting** methods. While these methods provide a better basis for accurate forecasting**, they can be prone to error d**epending on assumptions driving the forecasts

- **Shortening the historical cost base** or the regulatory period lead to similar advantages as that of using a historical trend based forecast. However a shorter historic cost base **can incentivize delays in investment until the year that determines the calculation** of the starting revenues of the new regulatory period. A shorter regulatory period **can lead to more uncertainty** and **higher administrative burden** while the **problem of under remuneration persists** with anticipated rise in investments needed for smart charging enablement

Source: Tariff regulation in transition – report for NBNL, Strategy& (2023)

To address this barrier, regulators are advised to introduce ex-post recalculations or use forward looking cost estimates

Summary: Barrier 7

Overall barrier description

Grid digitalisation & modernization is necessary for enabling controlled charging and V2G/G2V as there is a need to generate real-time insights into congestions along the LV grid based on location and time. This will serve as an important input for the LV congestion market/platform (covered under barrier #3). However, **current DSO tariff regulation in NL does not incentivize, and could potentially penalise, the costs related to grid digitalisation and modernization** thus hindering the deployment of enabling infrastructure needed for DSOs to tap into the flexibility provided by EVs

Cause of the barrier in The Netherlands

- Allowed income for DSOs is calculated based on a yardstick benchmarking approach that uses historical cost estimates as a starting point to encourage efficiency. This could result in DSOs being penalized for investing in non-output generating activities (which are the activities required for enabling smart charging) e.g., modernization of the grid

Reflection on other EU countries

- This barrier is expected to apply in all the EU member states covered (FR, DE, BE, NL). Specific DSO regulations differ between countries, however some countries (e.g., UK) have introduced separate incentives to compensate for smart-grid investments

Recommendation

- The regulatory authorities (e.g., ACM in NL) are advised to explore the costs and benefits of different adjustments to DSO tariff regulation proposed in the previous page
- To incentivize grid modernization and other smart grid related investments, it is key to either:
  - Introduce ex-post recalculations, or
  - Make current estimation mechanism forward-looking rather than historical-based

1) Based on inputs received during stakeholder workshops conducted during the project

3. Summary of recommendations & next steps

We propose several concrete actions to be taken by regulators, DSOs, policymakers & industry to scale up smart charging

Recommendations & next steps

Barriers identified	Required actions to address the barriers
1 Lack of incentive from network tariffs to charge at low peak times as time/ location differentiation is not possible	• The Dutch regulator ACM is advised to assess the impact of introducing alternative forms of distribution tariffs (with either capacity or volume based differentiation in time and/or location) on congestions in the LV grid • Based on the outcome of this analysis, a proposal should be developed towards policymakers to amend existing tariff codes
2 Presence of a financial disincentive within the current tax structure while performing V2G/G2V	• In the long-run, policymakers are advised to develop an automated exemption-based solution to reduce administrative burden • If the netting rule ('salderingsregeling') would be abolished, policymakers could consider introducing a refund mechanism. This would require a database of battery capacities connected to the grid and an effective monitoring mechanism for energy flows
3 Absence of a LV congestion market mechanism through which DSOs can compensate V2G/G2V from EVs	• Dutch DSOs are advised to either setup bilateral agreements with CPOs (where transaction costs are low) or use learnings from SINTEG Enera & Piclo Marketplace platforms to develop and design the LV congestion module within GOPACS[2]. Some key learnings that could potentially be borrowed are low minimum bid size, pay-as-bid and/or capacity-based pricing etc.
4 Unclarity over the possibility of DSOs to curtail charge points as last resort, creating an incentive to keep expanding the grid	• Dutch DSOs are advised to develop a joint proposal directed towards policymakers highlighting the costs and benefits of introducing different forms of Direct Load Control (DLC) mechanisms. This proposal should make concrete recommendations on the design and explicit changes required in network codes to allow a DLC mechanism under specific conditions[1]
5 Absence of a comprehensive communication standard b/w the DSO & CPO/Aggregator to enable smart charging	• EU Working Groups developing standards for smart charging (incl. representatives from regulatory bodies like ACER) are advised to engage with the charging infrastructure players and research institutions to jointly establish a robust DSO-CPO communication standard that can be rolled out across Europe. The new standard could build upon both OSCP and OpenADR
6 Interoperability issues due to differences in standards adopted by CPOs & OEMs	• The European standards authority is advised to take steps to ensure that all charge points and EVs comply with ISO15118-20. This can be achieved through clear guidance within existing regulations (e.g., AFIR) or by establishing an appropriate governance structure around the standard, enabling the industry to adopt it voluntarily through a de facto approach
7 Lack of incentive (or potential penalization) for digitalization & grid modernization within the DSO tariff regulation	• It is advised to adjust the DSO tariff regulation in NL to incentivize grid modernization and other smart grid related investments through either ex-post recalculations or making current estimation mechanism forward-looking rather than historical-based

1) The proposed approach can be either consent-based or default opt-in based, but it must align with Article 13 of the EU's Electricity Market Regulation (2019/943); 2) The existing MV/HV congestion platform run by Dutch DSOs

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Scope and process

Our scope

This report presents the outcome of the work we agreed to perform in accordance to the engagement letter dated 6 November 2023. The aim of this report is to inform policy makers of the regulatory barriers and potential changes needed to scale-up smart charging of electric vehicles (EVs) for avoiding and/or resolving congestions in the low voltage DSO grid. It was commissioned by Stichting Elaad NL. The research was conducted between December 2023 – February 2024. This report does not incorporate effects of events or circumstances that may have occurred, or information that may have come to light, after this period.

Our information is based on desk research and interviews/workshops with stakeholders from across the EV charging value chain in the Netherlands, France Belgium, Germany, Norway, UK and Italy. The intention of the report is to present a clear & concise overview of the most important barriers (therefore, the list shown is not exhaustive). We primarily analysed the applicability of these barriers in the Netherlands. For developing insights into potential solutions, we also tested the status of these barriers in 3 other EU countries i.e., Germany, Belgium and France – to see if there are best practices that can be borrowed over (in case the barrier had been resolved in one of the 3 countries).

Access and clarity of information

Our work was carried out on the basis of publicly available information and input from market experts. The information was processed under the assumption that it is reliable, accurate and complete in all material aspects. Unless explicitly stated in our report, we did not verify or check if the information with respect to accuracy or completeness is in accordance with international audit and review standards.

This report and any dispute which may arise out of or in connection with it, shall be governed by and construed in accordance with the laws of the Netherlands.

The *Clean Energy Package* was introduced to stimulate energy transition and have implications for smart charging

Clean energy package

EU Commission
"Clean energy for all Europeans package"

- Comprehensive update of **EU energy policy** to facilitate transition from fossil fuels to cleaner energy and deliver on Paris Agreement commitments
- **Topics covered:**
  - Energy performance buildings
  - Renewable energy
  - Energy efficiency
  - Governance & regulation
  - Electricity market design
- Legislative form:
  - **Regulation:** binding legal force in all member states
  - **Directive:** defined goals which have to be achieved through national legislation

Recast Energy Performance of Buildings *Directive (2018/884)*

The recast Renewable Energy Directive (RED 2) *(2018/2001)*

The revised Energy Efficiency *Directive (2018/2002)*

Governance of the Energy Union and Climate Action *Regulation (2018/1999)*

Regulation of risk-preparedness in the electricity sector *Regulation (2019/941)*

Regulation establishing EU ACER *Regulation (2019/942)*

On the internal market for electricity *Regulation (2019/943)*

On common rules for the internal market for electricity *Directive (2019/944)*

Deep-dive on each legislation on next slides

Relevant for smart charging

RED, EU directive 2018/2001

- The legal framework for development of clean energy across all EUU economy sectors
- Revised, October 2023

EU regulation 2019/943

- Sets basis for an **efficient achievement** of 2030 climate objectives and principles for a well-functioning, integrated **wholesale market**

EU directive 2019/944

- Establishes integrated, competitive, flexible, fair and transparent **electricity markets**
- Aims to ensure affordable, transparent **energy prices** and a high degree of **security of supply**

Source: European Commission (a); Strategy& research

Regulation has direct legal force in all member states; directives have to be implemented in national law

EU legislation on the Internal Market for Electricity

Summary - Regulation 2019/943

- **Network charges** shall not create disincentives for Demand Response and may be differentiated based on system users' consumption or generation profiles
- Customers should be enabled to act as a **market participant in the balancing, day-ahead and intraday** markets, either individually or through aggregation. Market participants must either be **BRPs** or have **contractually delegated** their balance responsibility to a balancing responsible party of their choice
- Market participants should be able to **trade as close as possible to real-time** on the day-ahead and intraday markets, with **minimum bid sizes of 0.5 MW or less** and time intervals of max. **15 min (i.e. ISP)**
- **Transaction curtailment** by the DSO for congestion management is only allowed in emergency situations

Legislative status

- Published on June 2019
- **Direct binding** legal force as of **January 1st 2020** in all member states
- **Overrides** all national laws dealing with the same subject matter and subsequent national legislation must be consistent with and made in the light of the regulation

Summary - Directive 2019/944

- National law may not **unduly hamper consumer participation through Demand Response**, and shall ensure that electricity prices reflect actual demand and supply
- Member states shall **make sure that storage facilities are not subject to any double charges**, including network charges, when these are for own use or to provide flexibility into the market
- **Smart metering systems shall provide near real-time data** in order to **support Demand Response** services and shall be metered and settled at the ISP (i.e. 15 min)
- **Ancillary services**, procured by TSOs and DSOs, shall be **made available for demand side response** by setting the specifications (e.g. technical requirements) for these balancing products in such a way as to ensure transparent, effective, non-discriminatory and market-based participation

Legislative status

- Published on June 2019
- **Implemented** in national law as of **December 31st 2019** for majority of the articles, with remainder one year later
- Adopted by all member states in scope (**NL, BE, DE, FR)**
- **Non-compliance** may initiate legal action against the member state in the European Court of Justice and incur damages

Source: EU (2019/943); EU (2019/944) Strategy& research

The European Commission's *Fit for 55 package* was introduced in 2021 to raise GHG emission reduction ambition

Fit for 55

EU Commission "Fit for 55 package"

- Comprehensive update of **EU energy policy** with the goal of achieving a 55% reduction in EU emissions by 2030
- **Topics covered:**
  - Carbon pricing
  - Renewable energy
  - Energy efficiency
  - Governance & regulation
  - Transport, buildings and fuels
- Legislative form:
  - **Regulation:** binding legal force in all member states
  - **Directive:** defined goals which have to be achieved through national legislation

Reformed ETS
Directive (2021/0211)

Effort Sharing Regulation
Regulation (2023/857)

Amended Regulation on LULUCF
Regulation (2023/839)

TBD: Recast Energy Performance of Buildings
Regulation (2024/)

Carbon Border Adjustment Mechanism
Regulation (2023/956)

Revised Alternative Fuels Infrastructure Regulation
Regulation (2023/1804)

Revised Renewable Energy Directive (RED 3)
Directive (2023/2413)

Energy Efficiency Directive
Directive (2023/1791)

Deep-dive on each legislation on next slides

Relevant for smart charging

EPDB, EU regulation 2024/

- Aims to promote highly energy efficient, decarbonized buildings

AFIR, EU regulation 2023/1804

- Aims to establish a common framework of measures for the deployment of alternative fuels
- Mandates public EV charging infrastructure targets for EVs and bidirectional charging

Revised RED, EU directive 2023/2413

- The legal framework for development of clean energy across all EU economy sectors

Source: European Commission (a); Strategy& research

Regulation has direct legal force in all member states; directives have to be implemented in national law

AFIR and RED

Summary - Alternative Fuels Infrastructure Regulation 2023/1804

- Introduces targets on deployment of publicly accessible recharging and refueling stations for alternative fuels across Europe, enabling the transport sector to significantly reduce its carbon footprint
- Operators of recharging points shall ensure that all publicly accessible recharging points operated by them and built after 13 April 2024 or renovated after 14 October 2024 are capable of smart recharging
- Communication standards supporting controlled and V2G recharging should be adopted to ensure interoperability – common technical standards have not yet been defined
- When introducing standards the commission will consider the data types required to enable controlled and V2G charging, cybersecurity and data protection of customers

Legislative status

- Published July 2023
- Smart charging related legislation in force from April and October 2024

Summary - Renewable Energy Directive 2023/2413

- Legal framework for the development of clean energy across all EU economic sectors
- To improve data access and granularity of data, member states shall provide incentives for upgrades of smart grids to better monitor grid balance and make available real time data from DSOs (e.g., on share of renewables, demand response potential, self-consumer injections)
- Vehicle manufacturers must make available real-time data related to the battery state of charge, capacity and (where appropriate) the EV location to EV owners/ users and third parties acting on behalf of owners/ users
- Electric vehicles must be able to participate in (among other things) congestion management markets and provide flexibility services, including through aggregation. Member states should works with regulators and market participants to establish the technical requirements to ensure a level playing field

Legislative status

- Renewable Energy Directive (EU/2018/2001) was revised in 2023
- The amended directive entered into force November 2023
- Member states then have an 18-month period to transpose most of the directive into national law – provisions related to renewable permitting have a shorter deadline of July 2024

Source: EU (2023/1804) EU (2023/2413); Strategy& research

Further legislative revisions expected for EPDB and the internal market for electricity

EPBD and RED

Summary - Energy Performance of Buildings Directive (2024/ x)

- Aim of the directive is to promote **energy efficient, decarbonized buildings**
- While **not directly related to smart charging** it includes requirements for **charging points installed in residential and non-residential buildings to have smart charging functionality**

Legislative status

- Provisionally agreed December 2023
- Formal adoption expected 2024

Proposed changes by ACER: the Internal Market for Electricity Directive and Regulation

- Reform proposals include a requirement for member states to set **objectives for demand side management** as well as **battery storage**
- The proposals also include **design principles** for **demand side management schemes** including demand response and storage
- **Acceleration** of progress implementing elements of **2019/944 Electricity Market Design Directive** also recommended
- Together intend to accelerate progress and ensure legal framework is in place for demand response

Status

- ACER published their recommended changes December 2023 for EU consideration
- Proposed reforms expected to be made 2024

Source: EU (2018/844) EU (2018/2001); Strategy& research

Interview list

Country	Organization type	Name organization
NL	Research institute	Elaad
NL	Research institute	Elaad
NL	Research institute	Elaad
NL	Research institute	Elaad
NL	Research institute	Elaad
NL	Research institute	Elaad
NL	Energy services	Equigy
NL	Government	Min I&W
NL	Branch association	NVDE
NL	Research institute	NKL
NL	Energy services	Jedlix
NL	Research institute	University of Utrecht
NL	DSO	Stedin
NO	Energy services	Current

Workshop list, Amsterdam

Country	Organization type	Name organization
NL	Association for Electric Mobility	NL EV Drivers assoc.
NL	DSO	Alliander
NL	Research institute	RAP
NL	Association for Electric Mobility	Doet Doet
NL	DSO	Stedin
NL	Regulator	ACM
NL	Regulator	ACM
NL	Government	Min I&W
NL	DSO	Stedin
NL	Research institute	Formula-E team

Workshop list, Brussels

Country	Organization type	Name organization
BE	OEM	EV Box
BE	Automotive	Tesla
BE	Branch association	EV Belgium
EU	Municipilaties	Polis
EU	Association for Electric Mobility	Avere
EU	DSO body	EDSO for Smart Grids
EU	DSO body	EDSO for Smart Grids
EU	Research body	Eurelectric
EU	Research body	Charge-Up Europe
FI	DSO	DSO Entity
GE	DSO	Hedno
IE	DSO	ESB Networks
IT	DSO	DSO ENTITY
IT	DSO	Terna
LV	DSO	Sadalestikls
NL	Research body	Elaad
NL	Government	NL Transport & Env. Rep
NL	DSO	Enexis
NL	DSO	Stedin
NO	CPMS	Current
PT	DSO	ERedes
UK	DSO	Energy Networks Association

Workshop list, Paris

Country	Organization type	Name organization
FR	Automotive	Stellantis
FR	DSO	Enedis
FR	Smart energy systems	Dcbl
NL	Government	Dutch Embassy
FR	Research institute	Vedecom
FR	Government	Ademe
FR	Automotive	Renault
FR	Consultancy	Afry

Workshop list, Dusseldorf

Country	Organization type	Name organization
DE	Energy	Ex-Eon
DE	Government	E-Mobil bw
NL	Government	NL Embassy Berlin
DE	Government	German Federal Agency Climate and Economics
DE	Research institute	VDI/ VDE-IT
DE	OEM	ABB
NL	Government	NL Embassy Berlin
DE	Government	German Federal Agency Climate and Economics
DE	DSO	EWE netz
DE	Government	German Federal Agency Climate and Economics
DE	Energy	Ex-EON
DE	Government	E-Mobil bw
DE	Research institute	NOW GMBH

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ACM/UIT/556547	ACM	Method Decision for Regional Electricity Grid Operators	2021	Regulation
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Agora and RAP (2019)	Agora and RAP	Distributed Grid Planning for a Succesful Energy Transition - Focus on Electromobility	2019	Document
Banks (2021)	Nick Banks	V2G: Barriers and Opportunities	2021	Document
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Brinkel, AlSkaif and van Sark (2022)	Brinkel, N., AlSkaif T., & van Sark W.	Grid Congestion Mitigation in the Era of Shared EVs	2022	Document
BZ 14a	Bundesnetzaguntur		2023	Regulation
DfT00428	BEIS, UK	The Electric Vehicles (Smart Charge Points) Regulations	2021	Regulation
Elaad (2021)	Elaad NL	Smart Charging Factsheets	2021	Document
Elaad (2023)	Elaad NL	Regular and Grid-Aware Charging: Outlook Loading Profiles Passenger Cars	2023	Document
Elaad (2024)	Elaad NL	Annual Plan 2024	2024	Document
Element Energy (2021)	Element Energy	Barriers and Opportunities for Shared BEVs	2021	Document
EU (2019/943)	European Commission	Regulation EU 2019-943; on the internal market for electricity	2019	Regulation
EU Commission (2023)	EU Commission	Q&A on the EU Action Plan for Grids	2023	Document
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Hijnk (2023)	Marc Hijink, NRC	How the electric car can save the gridlock	2023	Article
IRENA (2019)	IRENA	Innovation Outlook: Smart Charging for Electric Vehicles	2019	Document
IRENA (2023)	IRENA	Renewable Capacity Statistics	2023	Statistics
MvF (2023)	Ministerie van Financien	Solutions for Double Energy Tax When Sotring Behind the Small-Scale Consumption Connection	2023	Document
NAL (202	NAL	Smart Charging Requirements		Document
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NBNL (2024)	Netbeheer Nederland	Code Amendment Proposal for Alternative Transport Rights	2024	Letter
RAP (2022)	Yule-Bennet, S., & Sunderland, L.	The Joy of Flex: Embracing Houseold Demand-Side Flexibility as a Power System Resource for Europe	2022	Document
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Zweistra, Janssen and Geerts (2020)	Zweistra, M., Janssen, S., & Geerts F.	Large Scale Smart Charging of Electric Vehicles in Practice	2020	Document