Knowledge and innovation center in the field of Smart Charging infrastructure in the Netherlands.

Elaadnl

Founded in 2009 by the Dutch grid operators.

- Prognoses and outlooks.
- Smart charging innovation and implementation.
- EU largest testing site.
  - Interoperability
  - Smart Charging
  - Cyber security
  - PQ
- Tender support.
- Promoting open innovation & open protocols.

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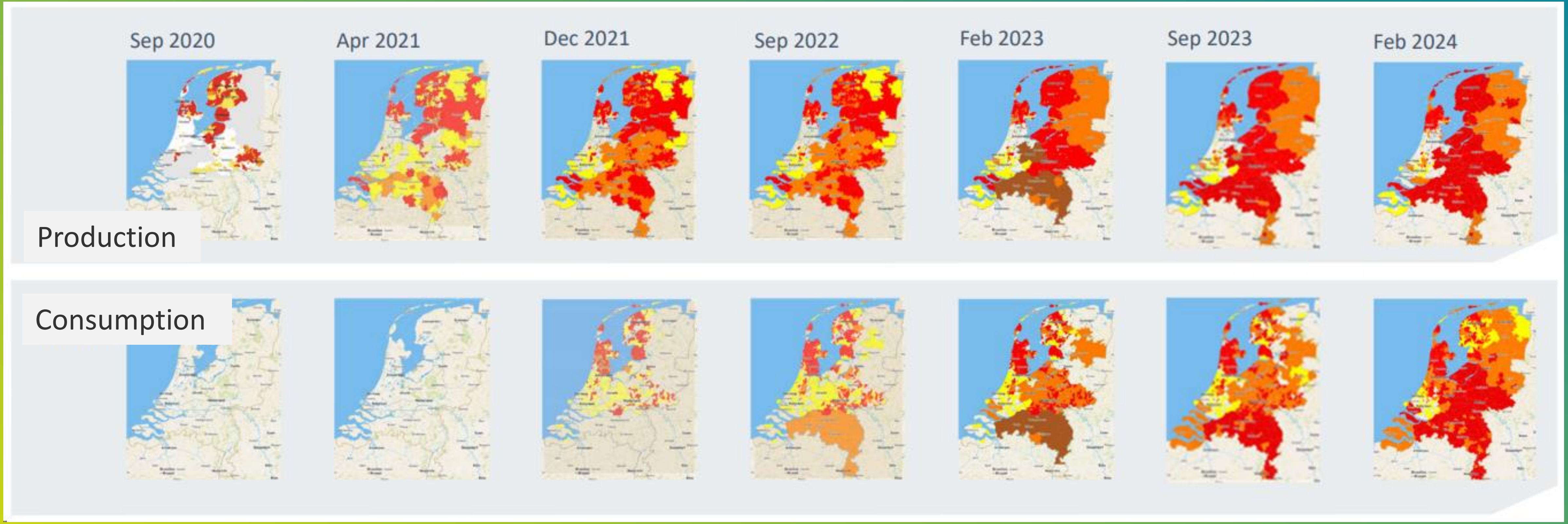
OpenADR
for Grid-Aware Charging

Elaadnl

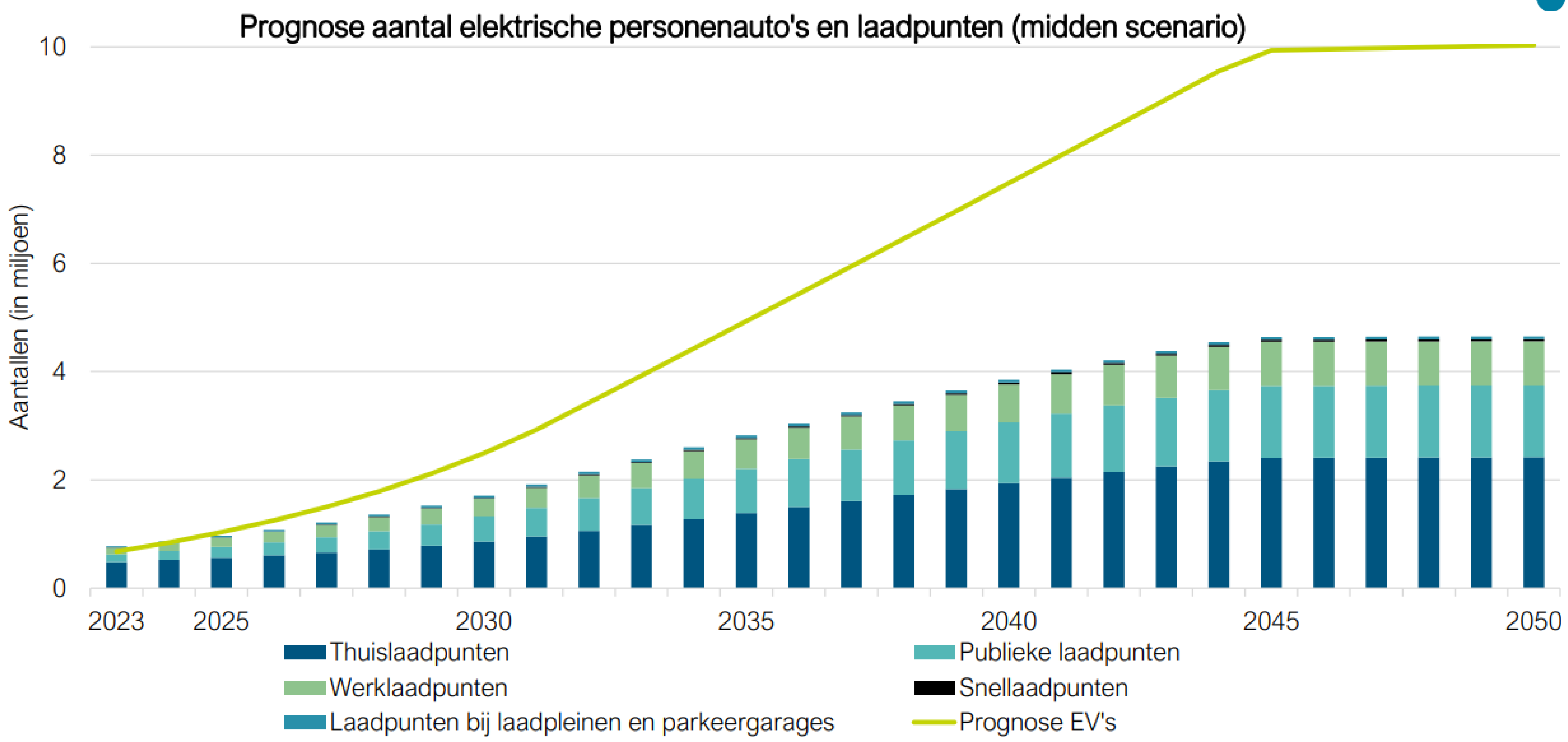
Agenda

- Introduction (Congestion, e-Mobility prognoses and solutions)
- DSO – CPO Interface
- From public to private (roadmap NetbeheerNederland)
- V2X (impact assessment, RfG, pilots & developments

Development of Congestion

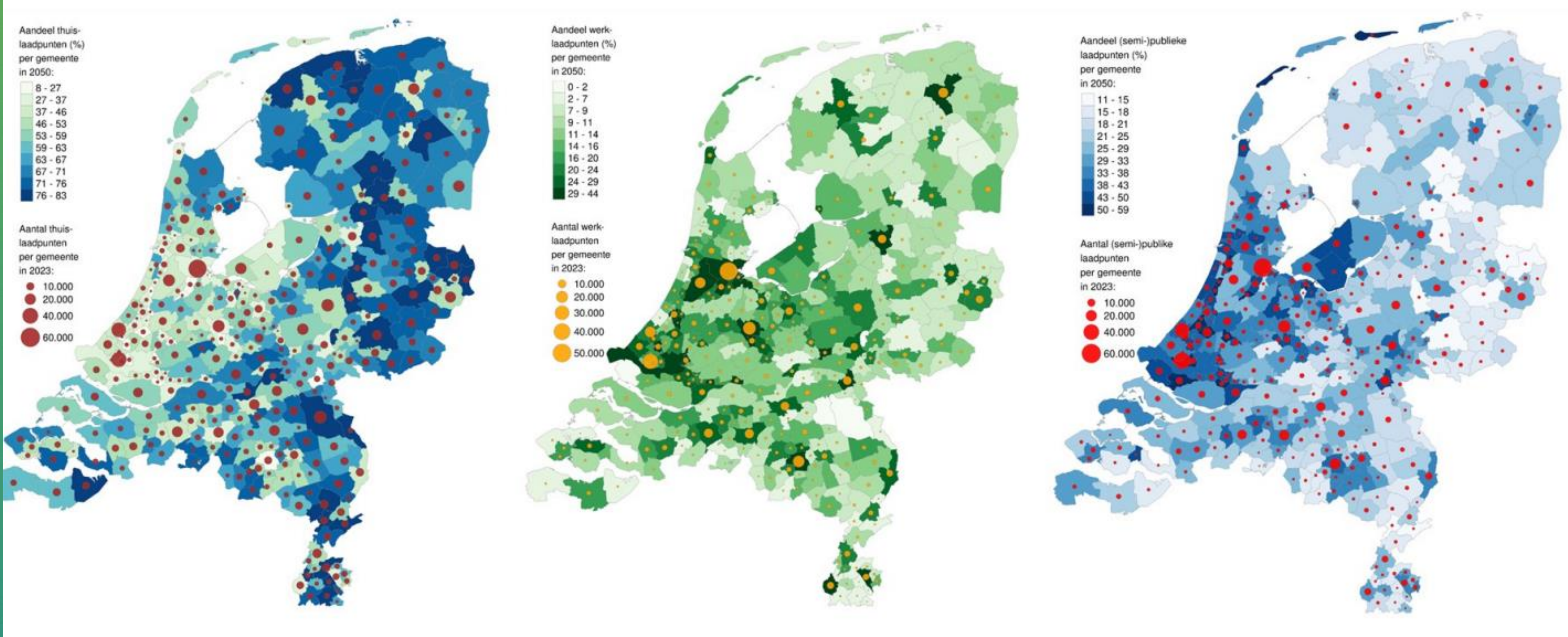


EV + EVSE growth prognoses



Source: ElaadNL outlook: Elektrificatie van personenauto's tot 2050

Regional spread EV adoption leads to EV hotspots

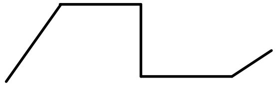


Source: ElaadNL outlook: Elektrificatie van personenauto's tot 2050

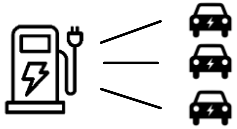
OpenADR applied

DSO-CPO Interface

Grid aware charging (public chargers)



Reduced power during peak



Distribute capacity over active charging sessions

New and existing charging points

Automatic messaging DSO-CPO

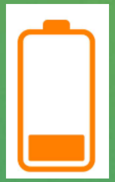
Considering the user experience of the EV driver

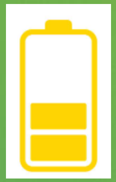
Based on the 'Grid-aware Charging Guidelines' (May 2024):

- On 3x25A grid connections for charging stations on which grid-aware charging is active, the DSO guarantees a minimum average power of 10kW per day.
- The DSO will only reduce the power on the connection if actual bottlenecks are expected.
- It is possible that a grid operator will temporarily reduce the power to 0kW.
- The power limits indicated by the grid operator are absolute.
- If multiple charging stations of a CPO are installed in the same congestion area, the available power of charging stations in this area may be distributed among these charging stations.

Grid aware charging

In phases towards increasing automation and accuracy





Static profile (MVP)

Via grantor

- Capacity profile and application area determined based on raw measurement data.
- Capacity profile and application area is sent manually without linking systems.
- Update frequency is maximum 2x per year.

Automated static profile (NBL 1.0)

From DSO to CPO

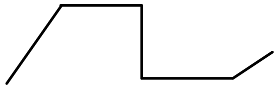
- Capacity profile and application area determined where possible based on actual data (Dali boxes in combination with algorithm)
- Capacity profile and application area is sent automatically via a link between systems (e.g. OpenADR)
- Frequency of update is on a weekly/monthly basis.

Dynamic profile (NBL 2.0)

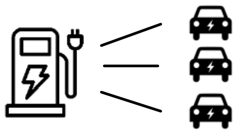
From DSO to CPO

- Data is read in real time and the capacity profile and application area are controlled day ahead on available grid capacity.
- Capacity profile and application area are sent day ahead via a system link (e.g. OpenADR)

Grid aware charging (public chargers)

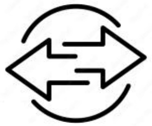


Reduced power during peak



Distribute capacity over active charging sessions

New and existing charging points

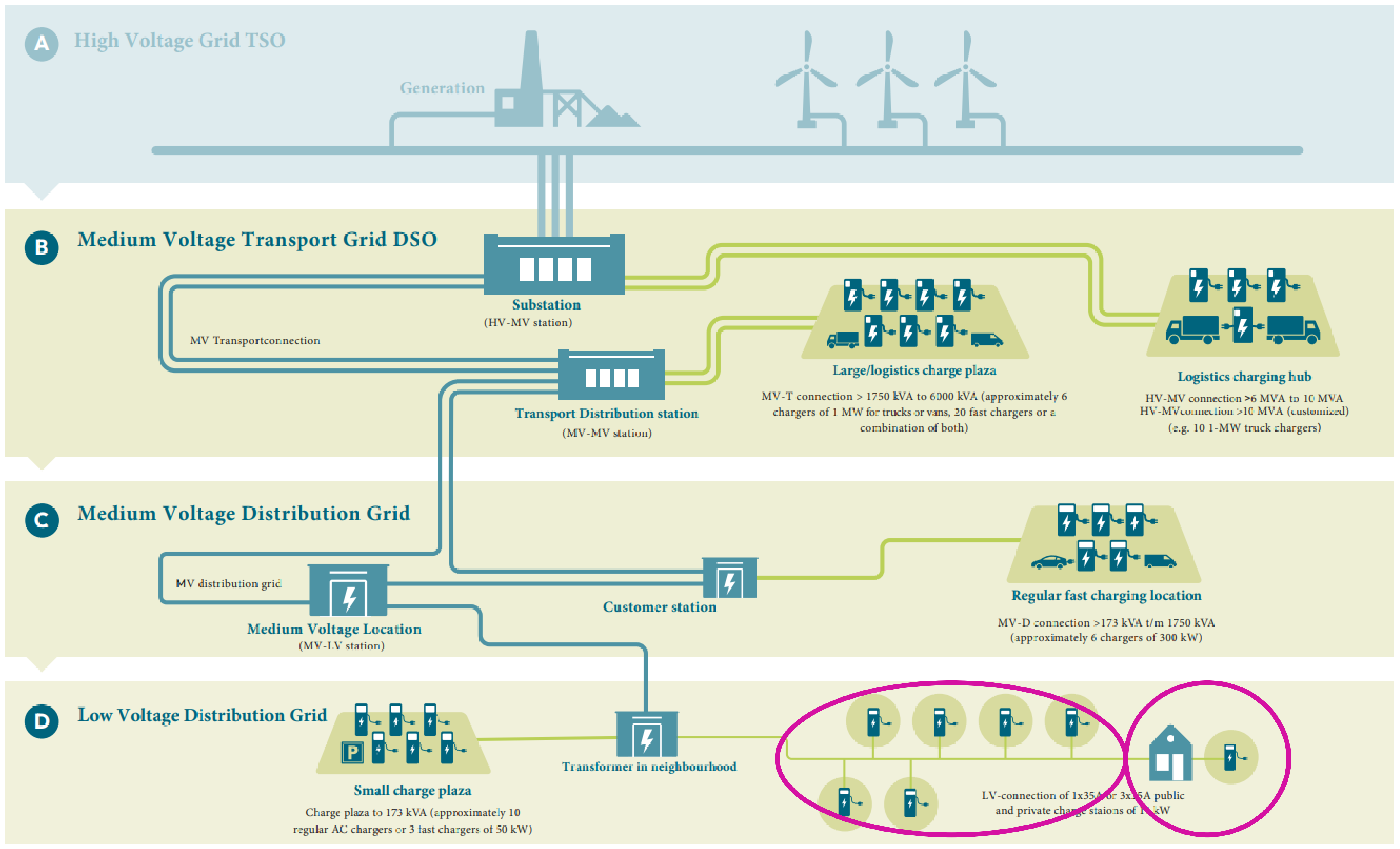


Automatic messaging DSO-CPO

Considering the user experience of the EV driver

Based on the 'Grid-aware Charging Guidelines' (May 2024):

- To be implemented in ‘specific’ time-bound grid contracts as of 2025



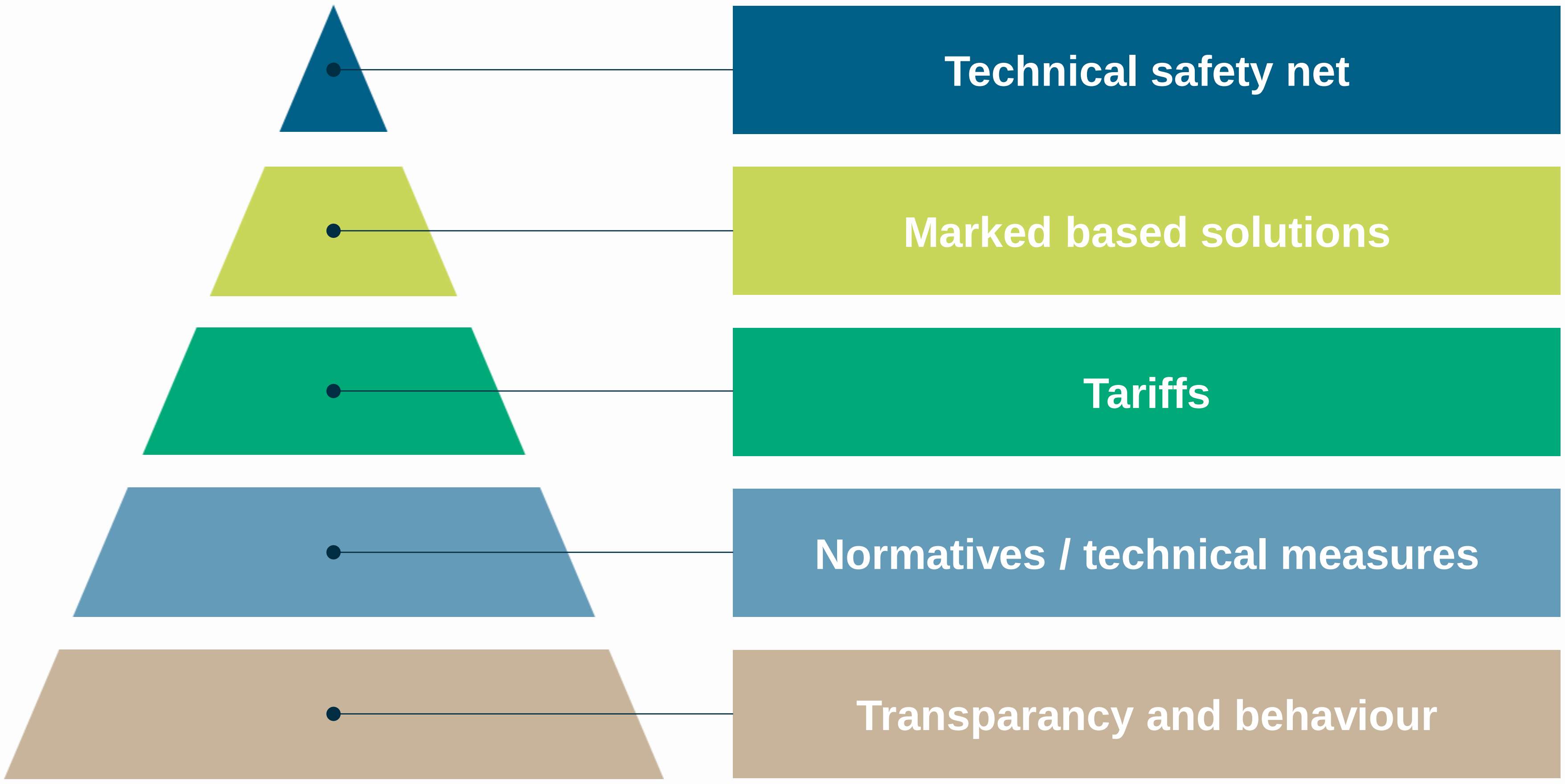
A
High Voltage Grid TSO
Generation
B
Medium Voltage Transport Grid DSO
Substation
(HV-MV station)
MV Transportconnection
Transport Distribution station
(MV-MV station)
Large/logistics charge plaza
MV-T connection > 1750 kVA to 6000 kVA (approximately 6 chargers of 1 MW for trucks or vans, 20 fast chargers or a combination of both)
Logistics charging hub
HV-MV connection >6 MVA to 10 MVA
HV-MVconnection >10 MVA (customized)
(e.g. 10 1-MW truck chargers)
C
Medium Voltage Distribution Grid
MV distribution grid
Medium Voltage Location
(MV-LV station)
Customer station
Regular fast charging location
MV-D connection >173 kVA t/m 1750 kVA
(approximately 6 chargers of 300 kW)
D
Low Voltage Distribution Grid
P
Small charge plaza
Charge plaza to 173 kVA (approximately 10 regular AC chargers or 3 fast chargers of 50 kW)
Transformer in neighbourhood

Netbeheer Nederland

Initiative: LV measures up to 2030

National Action Plan Grid Congestion on LV (LAN-LS)

Flex piramid



Roadmap LV measu

	2025	2026	2027	2028	2029
Technical safety net					Technical safety net / direct control
Marked based solutions	Public charge points via 3th party	Private charge points via 3th party	Heatpumps via 3th party	Private HEMS via 3^{e} partij	
Tariffs					New ToU grid tariffs
Normatives / technical measures	Fasulator	Smart fasulator Dynamic power limitation PV	Dynamic power limitation EV		
Transparancy and behaviour	Support dynamic energy tariffs	Provide congestion information			

Scale-up unlocking residential flex

(technical) Aspects to address

1. Mandatory, standardized, open, connectivity of devices
2. Functional and technical specification and proposition from DSO
3. Clear system perspective (or limited number of architectures) and established mechanisms for control
4. Standardized protocols for control (both from the DSO towards HEMS and from HEMS towards CAs)

Scale-up unlocking residential flex

(technical) Aspects to address

1. Mandatory, standardized, open, connectivity of devices

Dutch technical agreement

NTA 8043

(en)

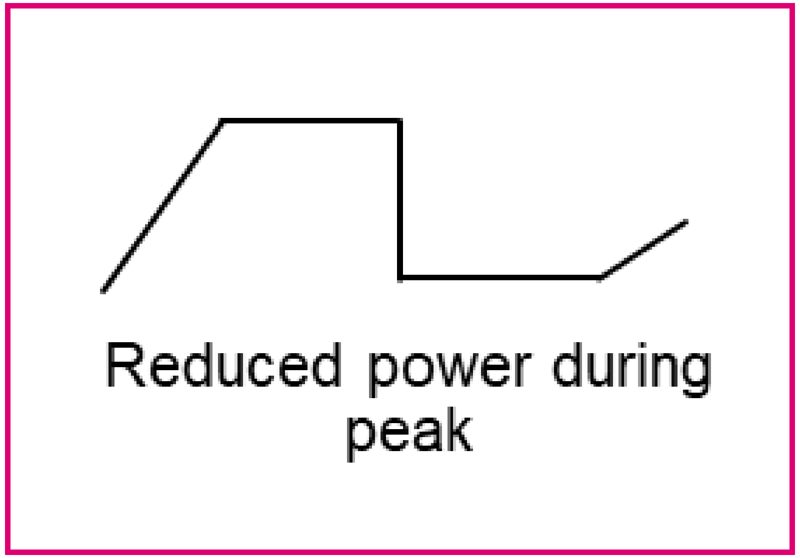
Smart private recharge points and recharging services

Slimme particuliere laadpalen en laaddiensten

Scale-up unlocking residential flex

(technical) Aspects to address

2. Functional and technical specification and proposition from DSO



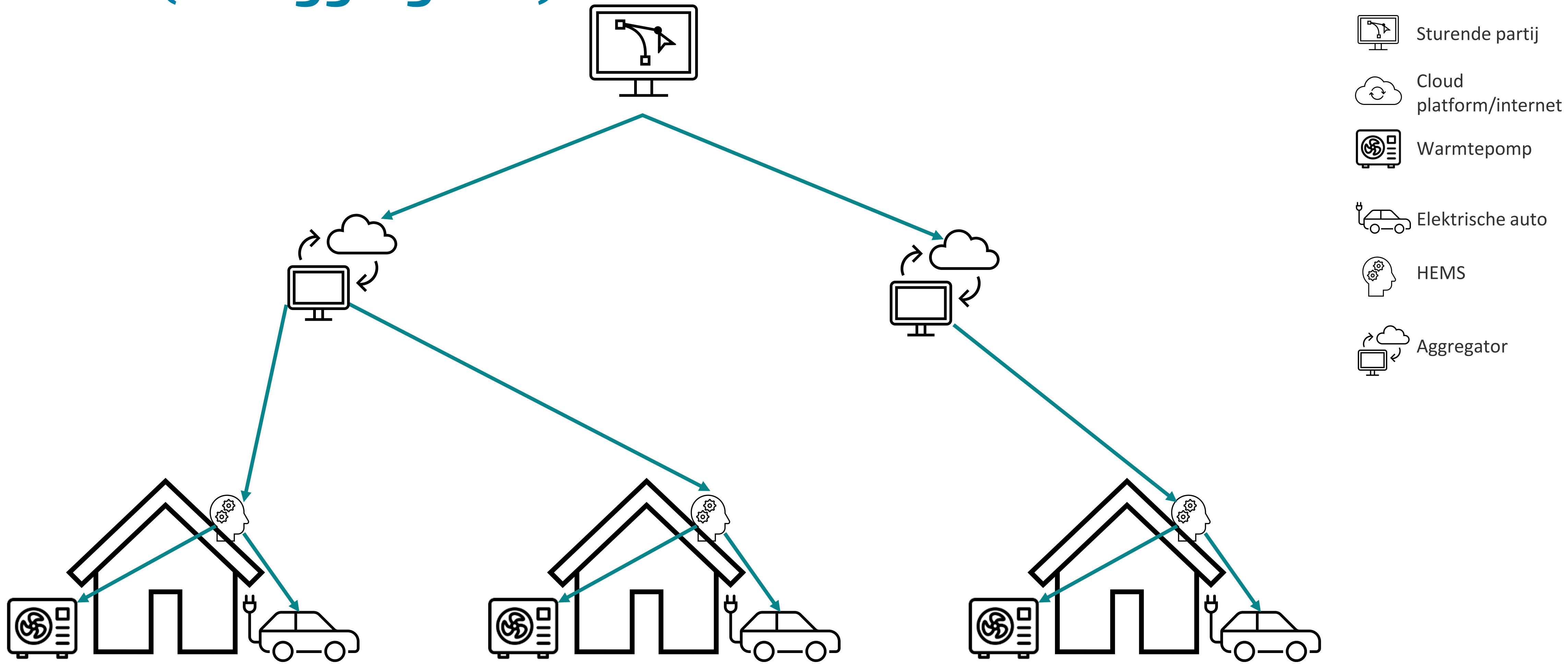
Scale-up unlocking residential flex

(technical) Aspects to address

3. Clear system perspective (or limited number of architectures) and established mechanisms for control

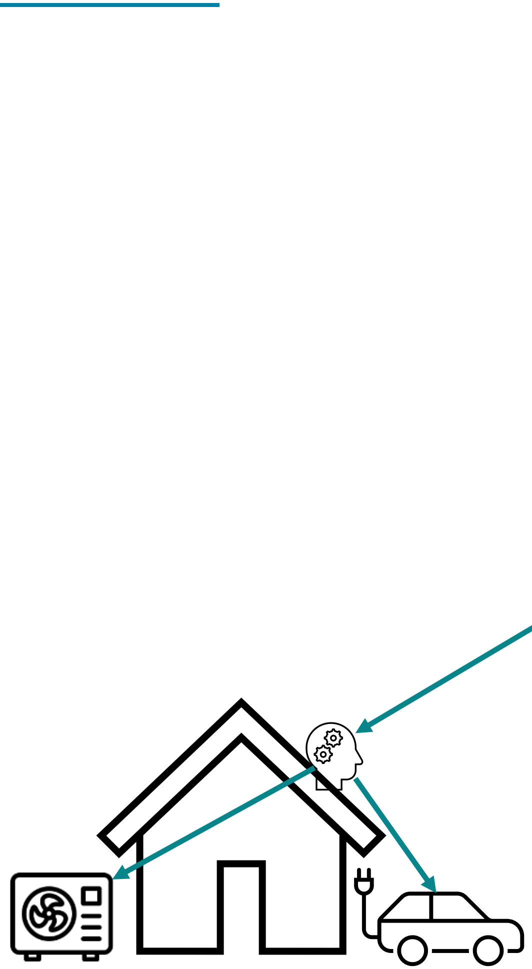
Via control signal internet

to HEMS (via aggregator)



Via control signal internet

to HEMS



Via control signal internet

to HEMS via aggregator

+ Takes into account customer requirements
+ Technically challenging but feasible
+ Takes into account main connection
+ Coordination between devices possible

- Lead time several years to get this arranged
- HEMS requires additional investment from the consumer

Sturende partij

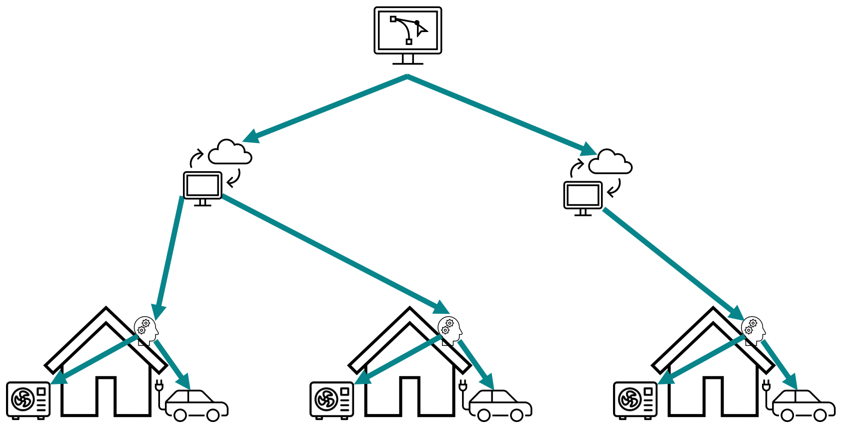
Cloud platform/internet

Warmtepomp

Elektrische auto

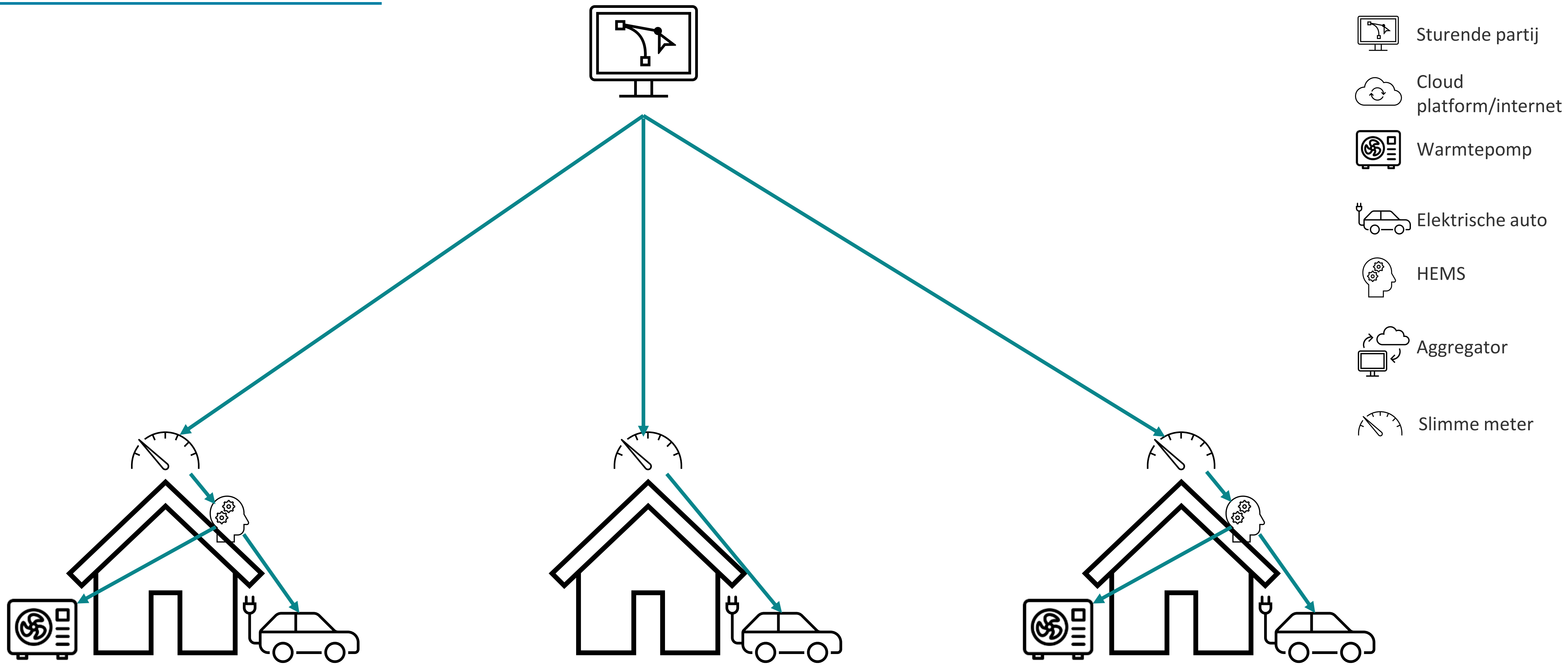
HEMS

Aggregator



Via smart meter

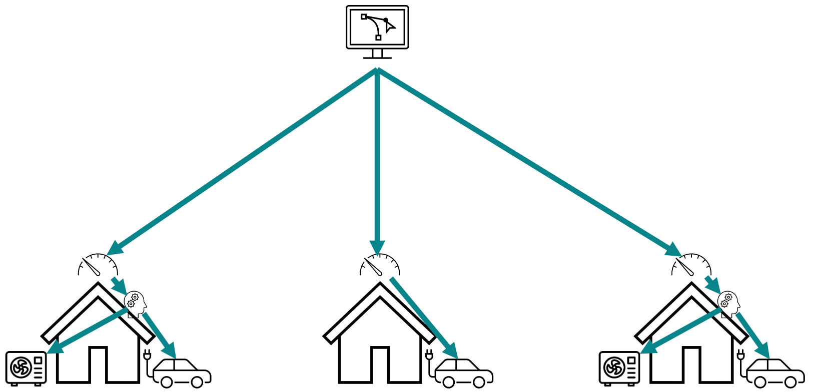
to HEMS or device



Via smart meter to HEMS or device

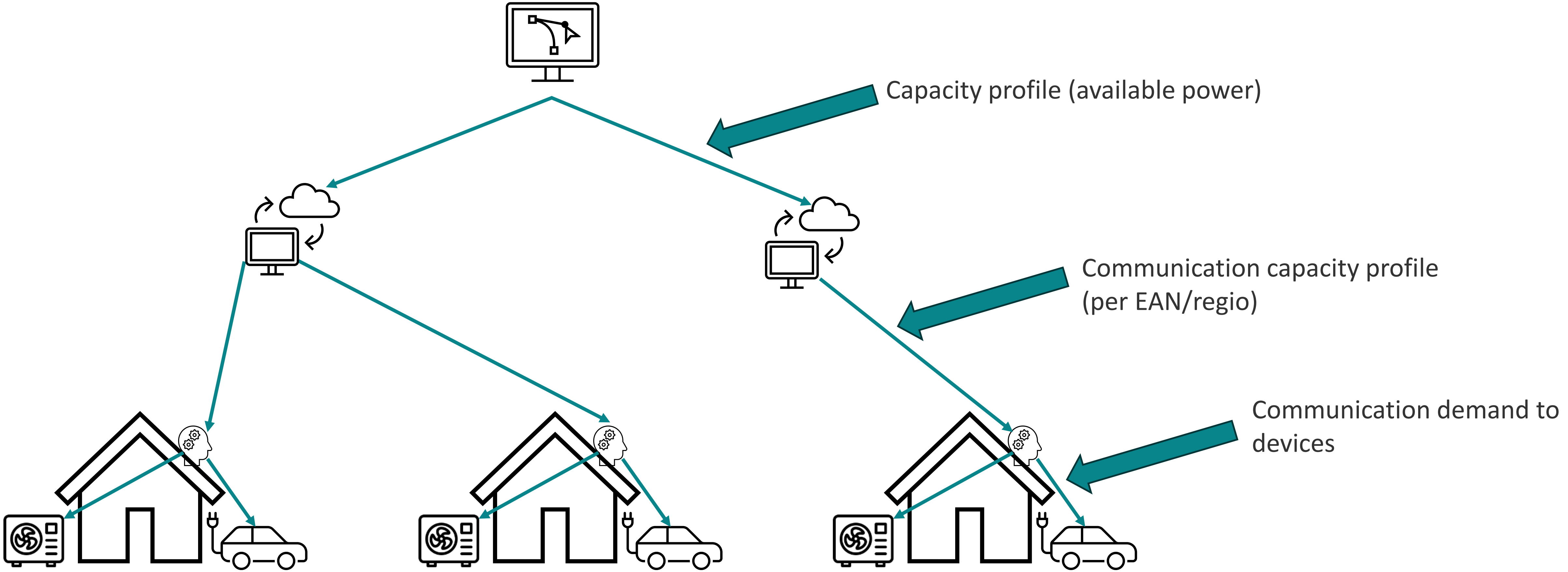
+ Uses (existing) DSO infrastructure
+ Takes into account customer requirements
+ Technically challenging but feasible
+ Takes into account main connection
+ Coordination between devices possible

- Lead time several years to get this arranged
- HEMS implicitly requires additional investment from the consumer

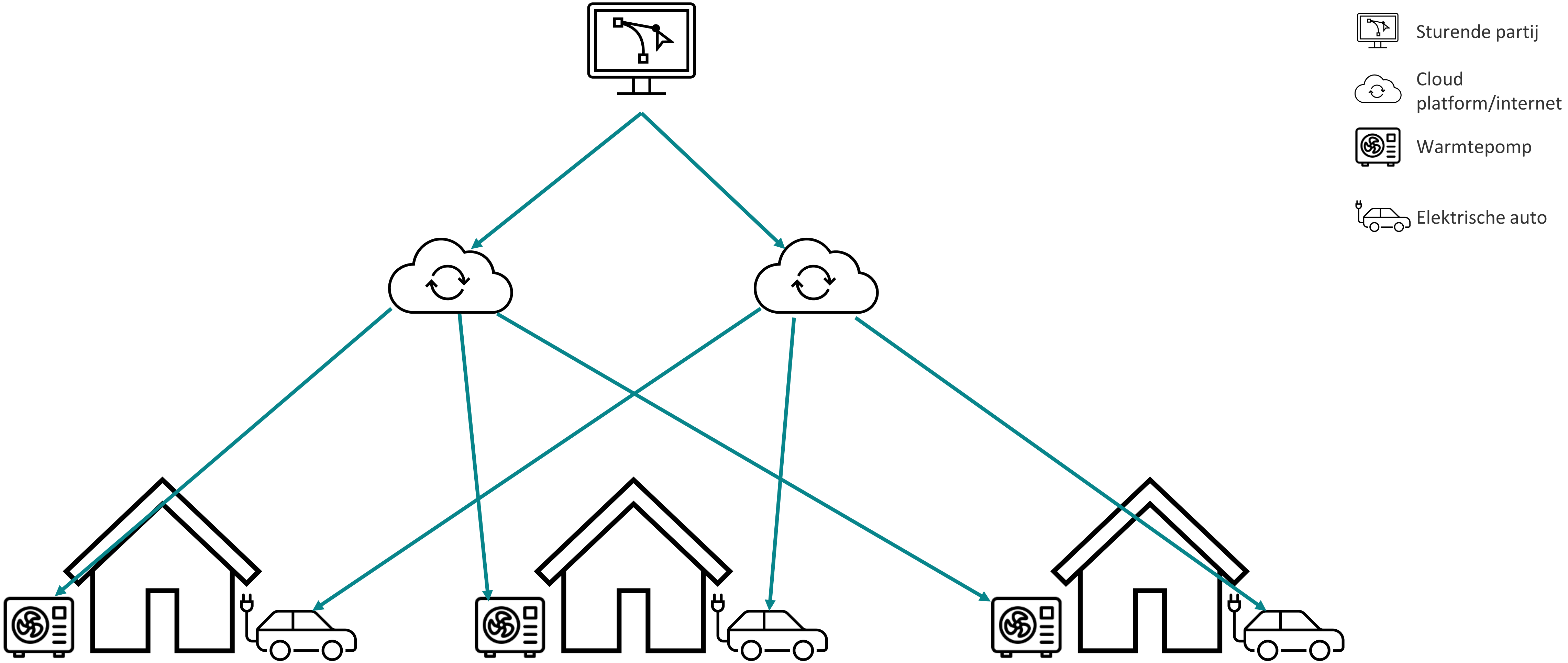


Standaardisation

All solutions require standardization (of protocols), at various levels. Devices and systems must now be (technically) prepared to make this possible in the future. Protocol selection and standardization must now be initiated (internationally).



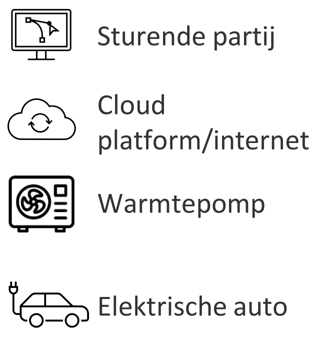
Via cloud manufacturer

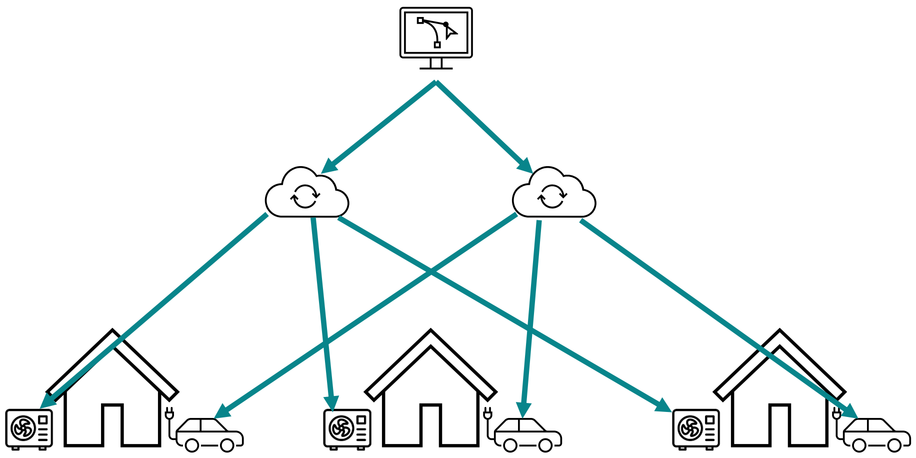


Via cloud manufacturer

+ Quick to arrange
+ Technical integrations often ready

- No account for main connection
- No coordination between devices
- Local wishes/coordination not (well) possible





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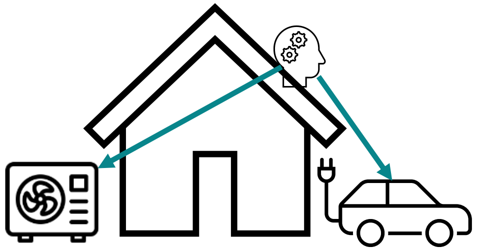


- S2
- EEBus
- Modbus (Sunspec)
- Matter

Aspects of

V2X

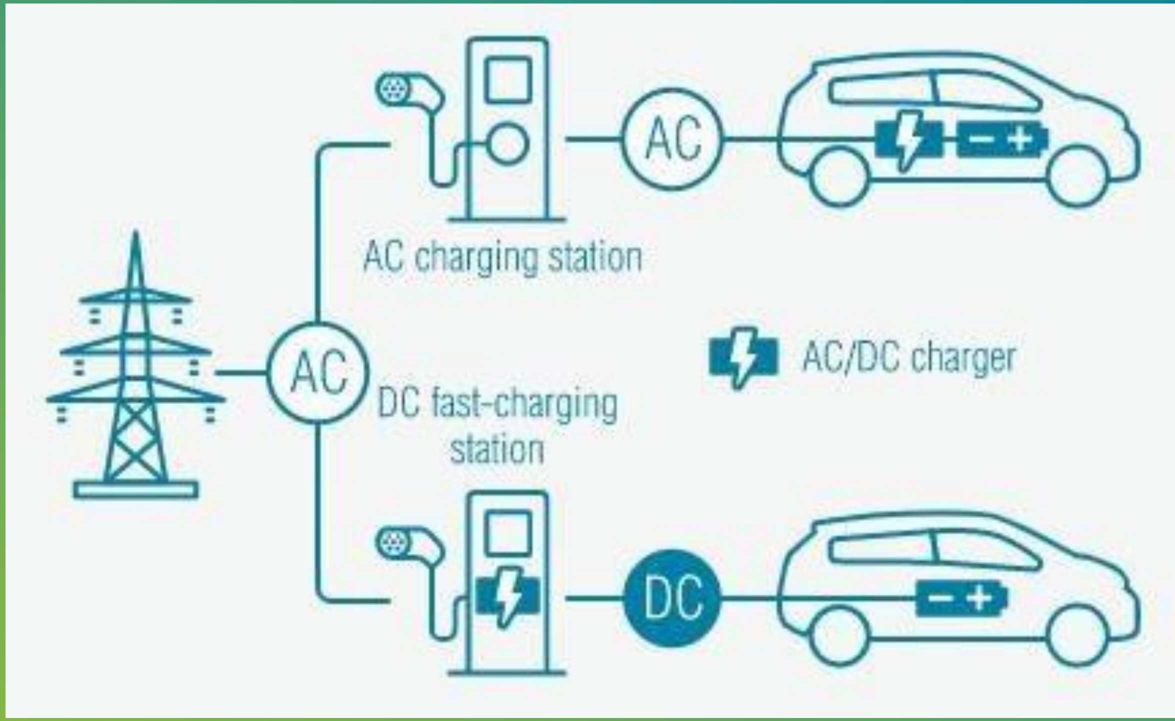
- RfG requirements
- Grid impact on V2X
- Testing (ISO 15118, OCPP, OpenADR) and pilots (integration of V2X in HEMS)

RfG

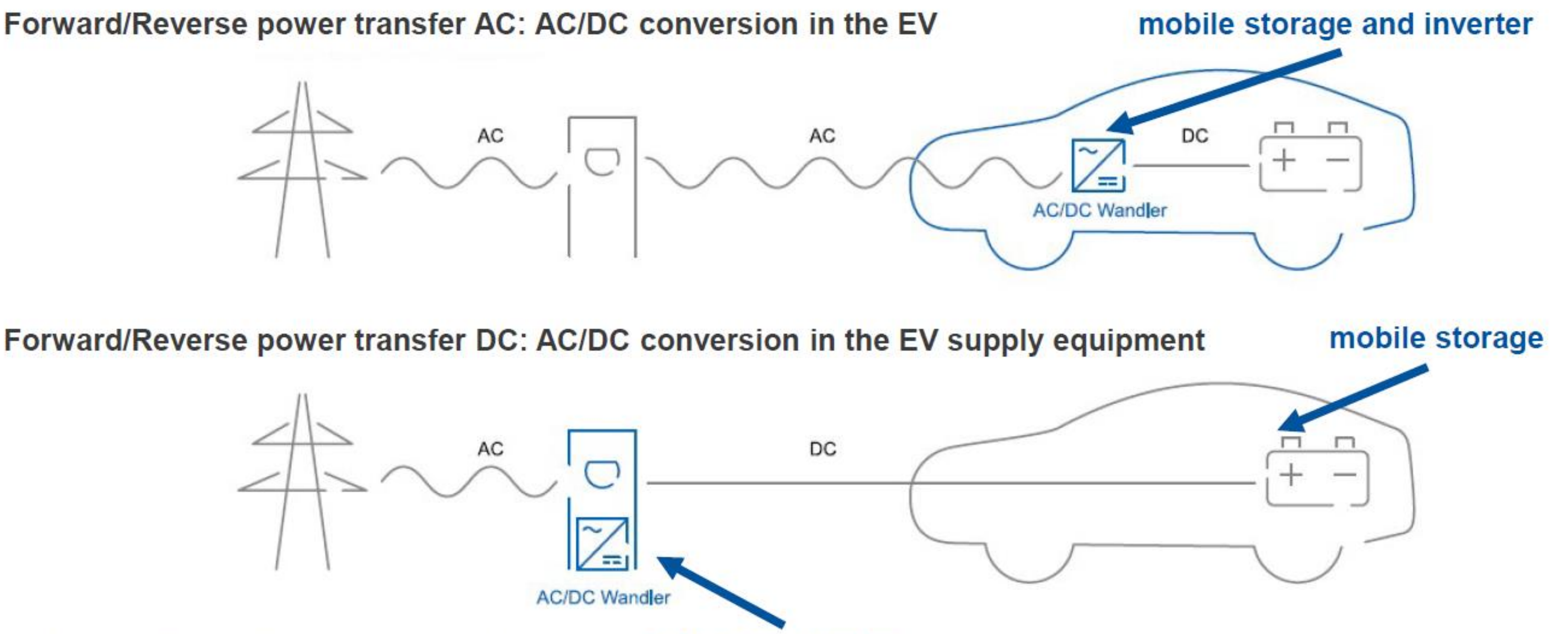
Charging basics

AC charging:
- AC/DC converter in the vehicle
- Charging speed up to 44 kW (3x64A), in reality in most cases 11 kW ((3x16A)
- Some vehicles able to switch from 3x16A to 1x32A
- Mostly low-level communication (though some new stations are 15118-20 ready

DC charging:
- AC/DC converter in the charging station
- Ranges from 11 kW at home DC chargers, to 400 kW at the highways
- Development in Megawatt Charging systems underway
- HLC is necessary for charging

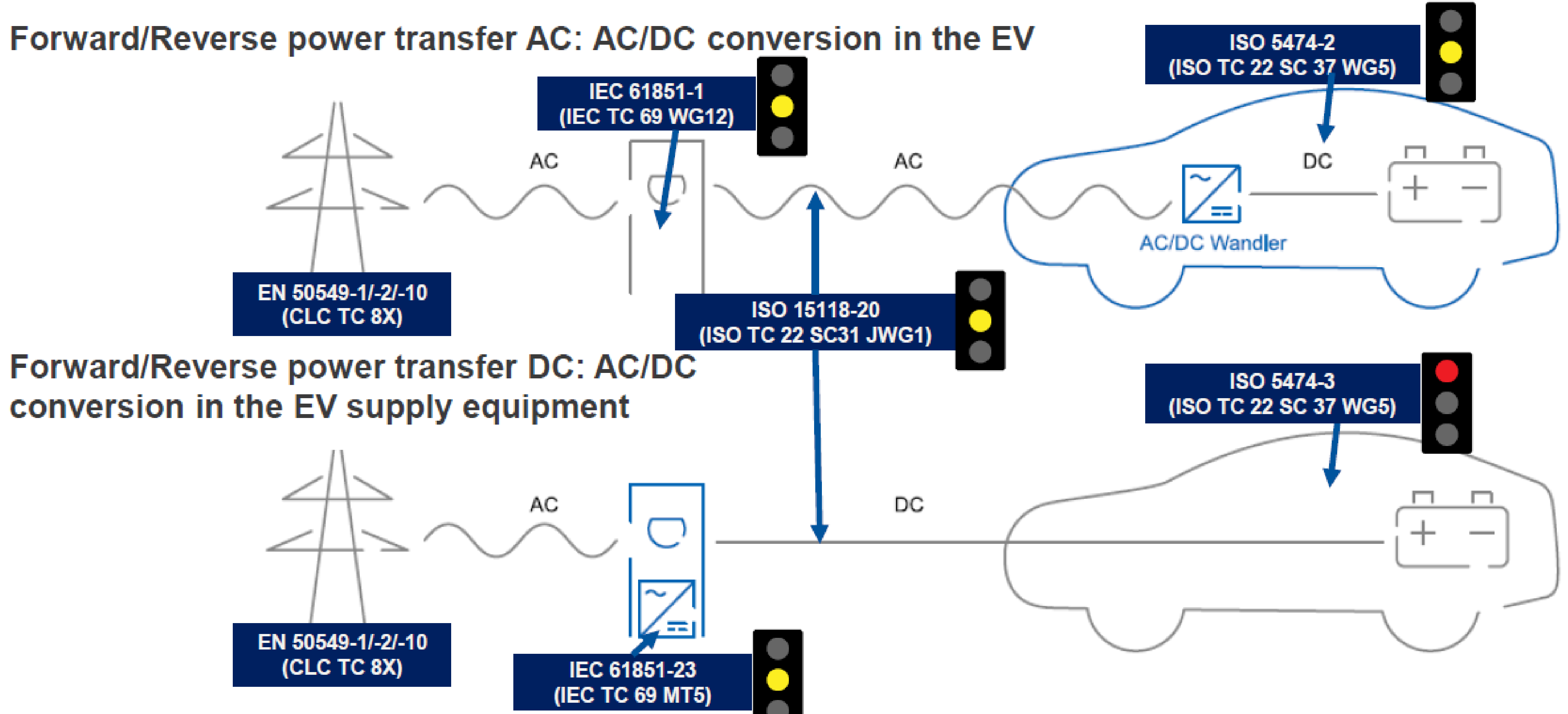


System overview V2X in AC and DC



Source: VDE FNN note BPT from grid perspective (05/2024)

System overview BPT in AC and DC



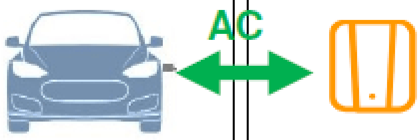
Source: VDE FNN note BPT from grid perspective (05/2024)

Grid code function allocation in AC-BPT system

- IEC TC 69 WG12 function allocation
- Actual status of IEC 61851-1 ED4 (2nd CD)

EV

- Certification of protective and immunity functions as required by EN 50549-1/-2/-10 today
  - ROCOF-, FRT- and phase jump immunity
  - EMC and power quality (harmonics, flicker, DC-injection)
  - grid synchronisation (follow EVSE setpoints)
  - dynamic grid support (OVRT, UVRT, zero current)
  - active power control (P(f), P(U))
  - reactive power control (Q(U), cosφ(P), Q(P))
  - remote control functions (follow EVSE setpoints)
- Certification of AC-BPT specific functions
  - reception and processing of local grid-code parameters



EV supply equipment

- Certification of protective and immunity functions as required by EN 50549-1/-2/-10 today
  - Interface protection (incl. re-connection and islanding detection)
  - ROCOF-, FRT- and phase jump immunity
- Certification of AC-BPT specific functions
  - grid synchronisation (power ramp setting and monitoring of EV behaviour)
  - storage, transmission of local grid-code parameters
  - **Verification of EV capabilities** over a **qualified communication before allowing reverse power transfer (RPT)**

NO country specific certification because of harmonized exhaustive requirements between all EU member states by NC RfG

country specific certification of the EV supply equipment for **protective functions** that are not covered by NC RfG!

Grid impact of V2G

V2G compared to smart charging

- If we do smart charging optimally to avoid grid congestion, i.e. delaying charging sessions only when there is grid congestion, smart charging van also reduce grid congestion (blue line)
- The potential of V2G is significantly better, as it can provide power to the grid to actually solve congestion caused by other(s) (assets). Green line

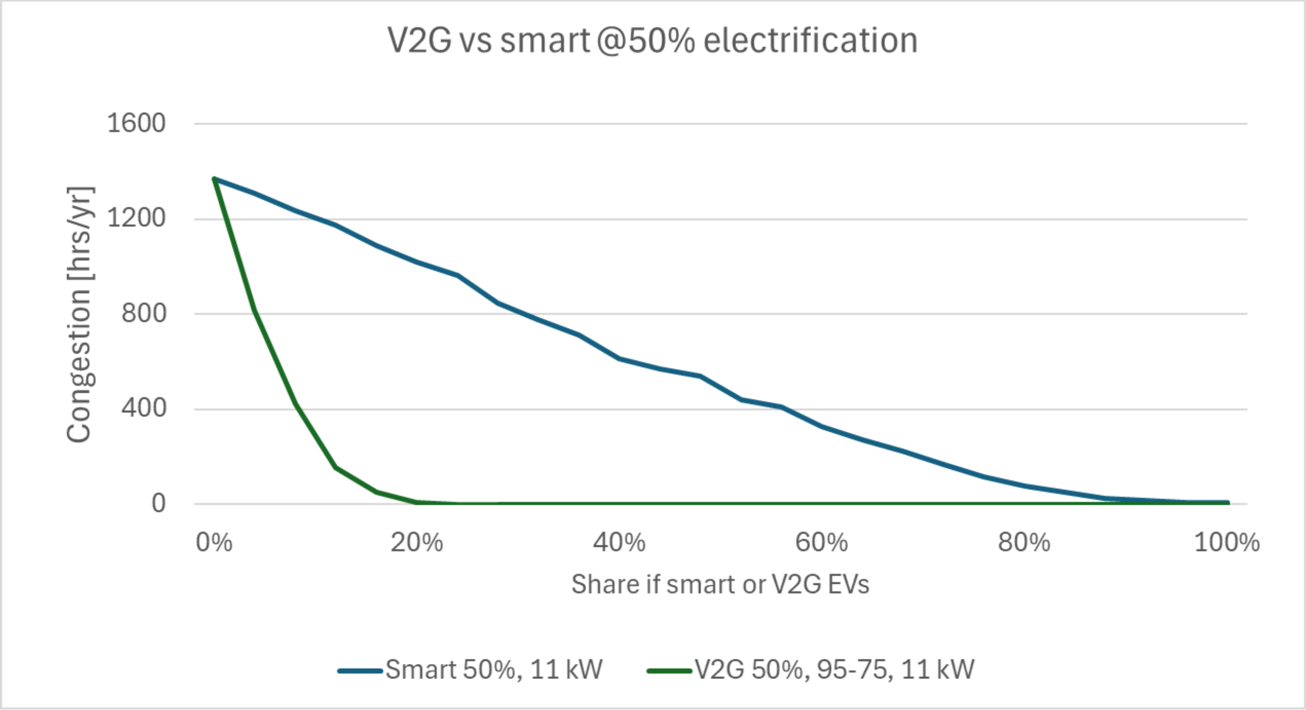


Chart demonstrating the effectiveness of V2G EVs vs smart charging EVs

Can V2G introduce new problems?

- Multiple EVs attempting to play the market (spot or imbalance) may result in massive grid congestion
- Four different scenarios are plotted. How sensitive consumers are to prices plays a crucial role. But in any case, if multiple V2G EVs react to the same price signals (which is likely) congestion will be induced by EVs instead of solved.

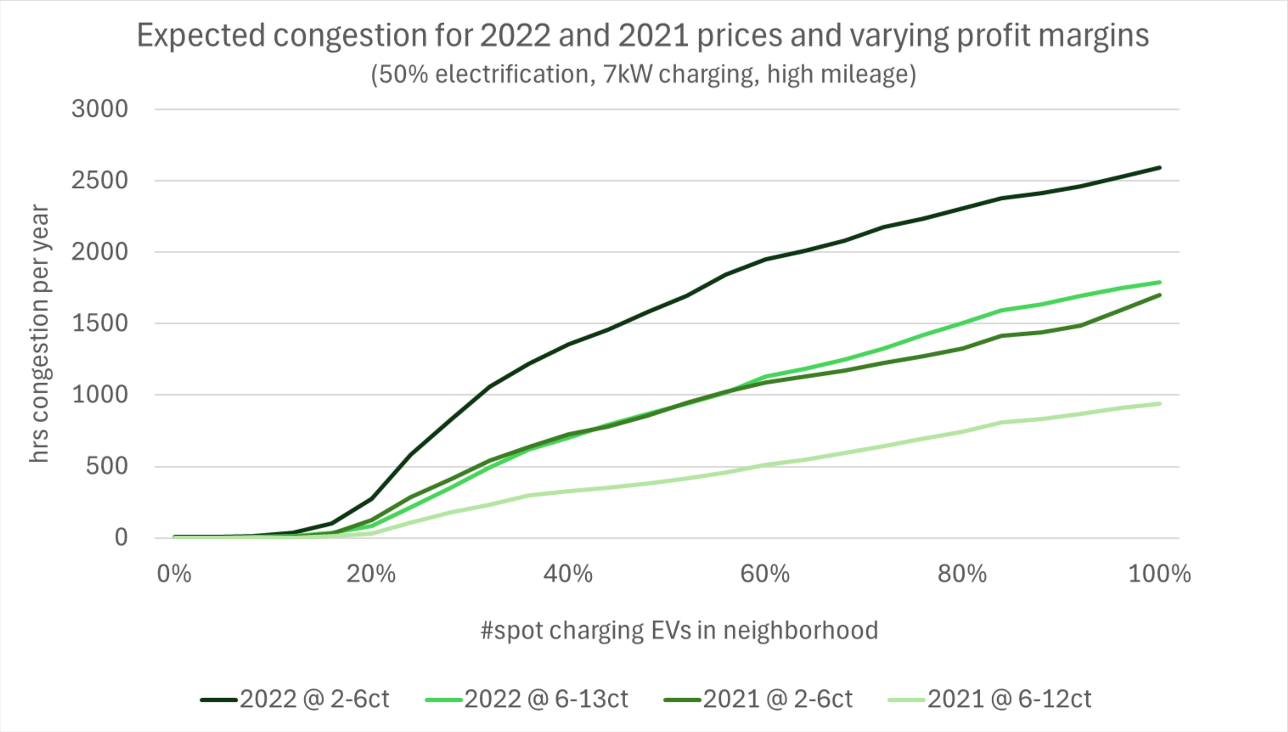


Chart demonstrating that the expected hours of congestion will greatly increase when multiple V2G EVs on a low voltage grid acting on the same prices

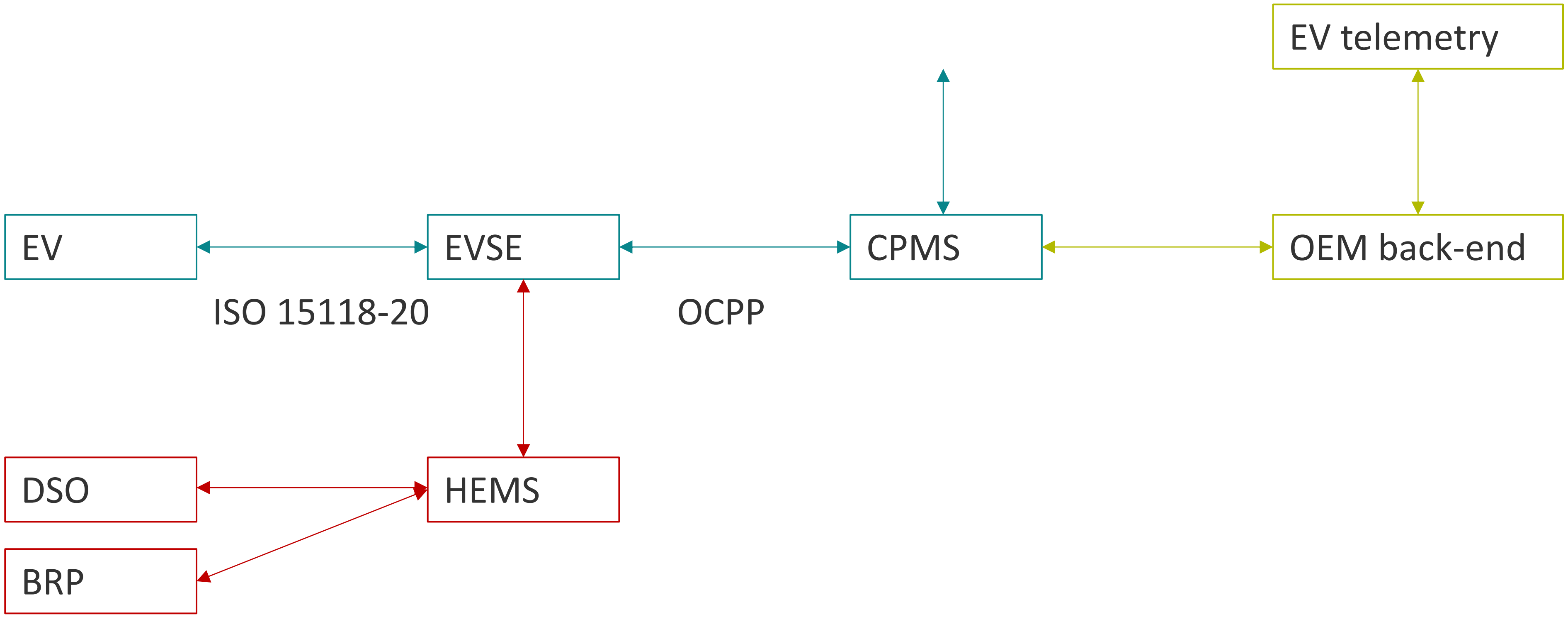
Grid impact of V2G

- ✓ V2G vehicles have great **potential to avoid grid congestion** and significantly delay required grid reinforcements in urban areas

- ✓ Trading on energy markets (spot or imbalance) with V2G will likely cause significant grid congestion because the price signals are the same for each EV, hence simultaneous charging and de-charging is massively increased.

- ✓ New net standards of 5 kW per household seems to be future proof

Tests and pilots
in development

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RESEARCHING AN
D TESTING SMART
AND SUSTAINABL
E CHARGING