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JOE ELLWOOD

# Electric vehicle charging

Infrastructure, market and connectivity

**ABB**

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# Agenda

Changes to building regulations

ABB and EV charging

Market (cars & standards)

DC versus AC charging

Market segments & infrastructure – choosing the correct charger

Connectivity – Operational and Economic

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# Proposed changes to building regulations

Consultation – closed 7<sup>th</sup> October

## **New residential buildings**

Chargepoint to be required in every building with off-street parking

Multi-dwelling buildings with more than 10 spaces to include cable routes for all spaces

## **New non-residential**

Every new non-residential building and every non-residential building undergoing major renovation with more than 10 car parking spaces to have one chargepoint and cable routes for a charger for one in five spaces

## **Existing non-residential**

At least one chargepoint in existing non-residential buildings with more than 20 car parking spaces (from 2025)

## **Product requirements**

Minimum 7kW

Universal socket (untethered)

Mode 3 or equivalent

Smart functionality

Certified to new BS (due to be published June 2020)

## **Interoperability of public chargers**

Full access to EV drivers

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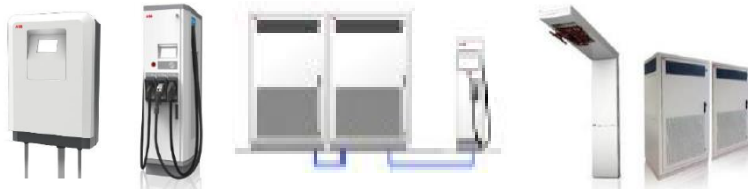
# ABB and EV charging

# ABB EV charging

Mission statement – EV Infrastructure team

**We offer AC and DC charging solutions for Electric Vehicles...**

**...from 3-600kW...**



**..with cloud connectivity..**



**...based on standards...**



**...using ABB technology...**



**...in all countries...**



Present in  
**>75** countries

**and ABB manufacturing.**



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# ABB, eMobility and EV Charging

ABB's focus and investments in eMobility are also recognized in the market place

## ABB and Formula E

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Together, Formula-E and ABB are defining the roadmap for electric mobility through motor sports.



## Jaguar I-PACE eTROPHY Series

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Jaguar I-PACE eTROPHY announces ABB as Official Charging Partner

ABB provide custom-made, compact Terra fast chargers for the series



# ABB is global charging partner for Car, Bus and Truck OEMs

Strong presence in China, USA and Europe

**VOLVO** – R&D partners

**BMW** – R&D partners  
DC fast chargers at dealers

**VW** – R&D partners  
DC fast chargers at dealers

**PORSCHE** – R&D partners  
– DC Wallbox

**Audi** – R&D partners

**JAGUAR** – R&D partners

**RENAULT** – R&D partners

**KIA** – DC fast chargers at dealers

**VOLVO** – Global partnership  
R&D partners

**MAN** – Bus  
– R&D partners

**MAN** – Truck  
– R&D & joint project

**SCANIA** – R&D partners

**HEULIEZBUS** – Cooperation  
– R&D partners

**TOYOTA** – R&D partners

**Ford** – DC charging testing & R&D

**NOVA BUS** – Partnership  
– R&D partners

**NEW FLYER** – Cooperation  
– R&D partners

**MOTOR COACH INDUSTRIES** – R&D partners

**tm4** – Joint projects

**Cummins** – Cooperation  
– R&D partners

**HESSE** – Cooperation  
– R&D partners

**HONDA** – R&D partners

**GM** – DC charging testing & R&D

**DONG FENG** – R&D partners  
– DC fast chargers at dealers  
– Cooperation Dong-Feng

**NISSAN** – R&D partners

**长安汽车 CHANGAN** – R&D partners

**北汽集团 BAIC Group** – R&D partners

**SAIC 上汽集团 SAIC MOTOR** – R&D partners

**BYD** – R&D partners  
DC wall box for Denza EV

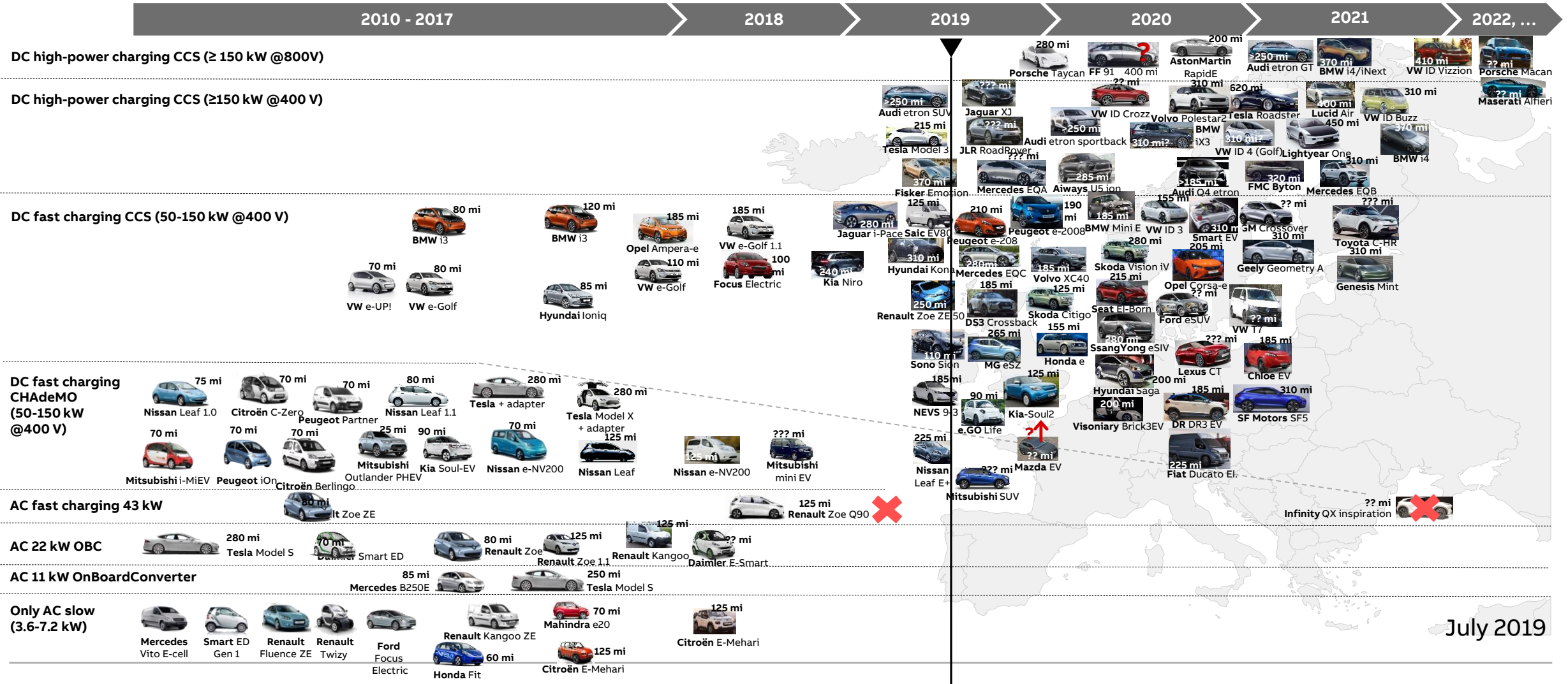
**DAIMLER** – R&D partners

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## Market (cars & standards)



# Follow the car through Europe, and open standard protocols



# ABB is following the OEM Fast Charging standards

20-100 kW CHAdeMO/ 22-43 kW AC/ 20-350 kW CCS 2



From Q4-2013 onwards  
CCS 2

From Q4-2012 onwards  
22-43 kW AC



From Q4-2010 onwards  
CHAdeMO

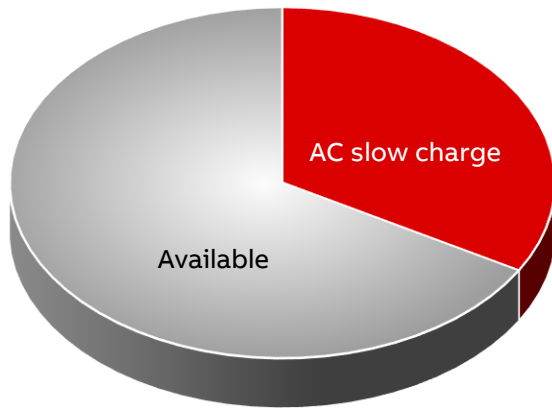


# DC versus AC charging

# Influence on range and availability by AC slow and DC fast charging

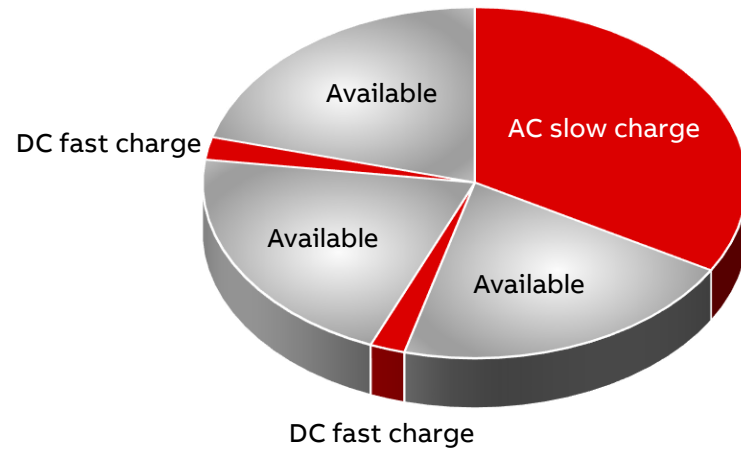
Possibility to strongly extend the range of a BEV by DC fast charging

Only AC slow charge (8 hrs)



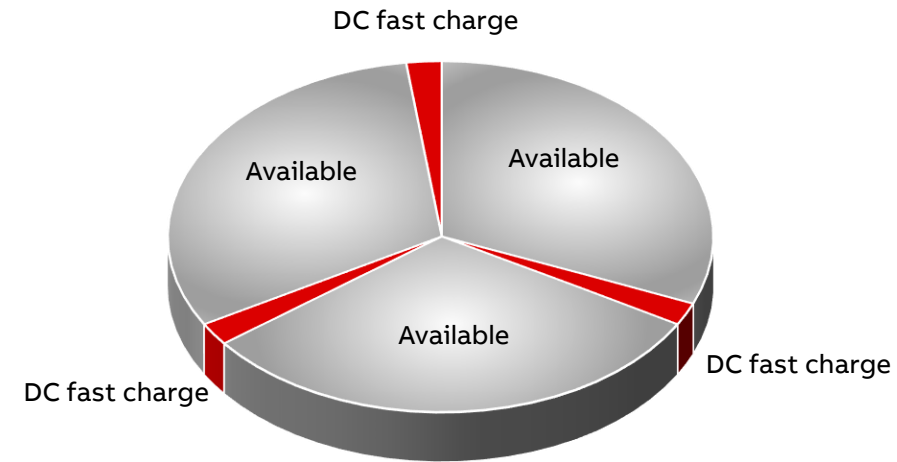
Availability 16 hours  
Total range: 186 miles

AC slow charge (8 hrs) +  
2x DC fast charge (each 30 min)



Availability 15 hours  
Total range: 560 miles

Extreme: for e.g. fleet owners:  
3x DC fast charge (each 30 min)



Availability 22.5 hours  
Total range: 560 miles

# Only few EVs can charge with 22 kW at an AC charge post

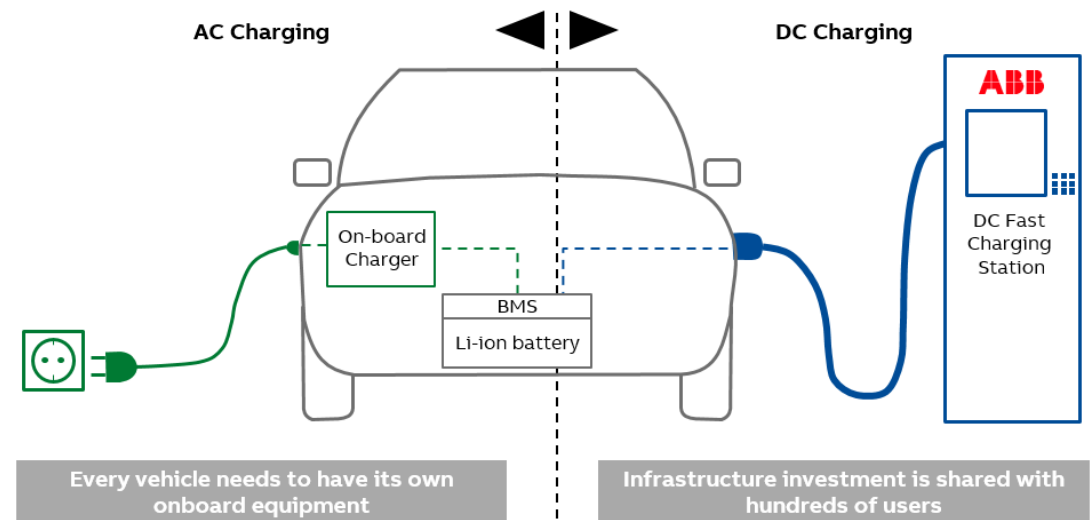
In most cases, the AC charging speed is limited by the EV onboard converter (OBC)

Only a very small number of EVs can charge at 22 kW:

- Renault Zoe
- Tesla Model S with the optional 22 kW OBC. This was default initially, but later changed to an 11 kW OBC (cheaper).
- Smart ED, only with the very expensive 22 kW OBC option. Default is a 3 kW to max. 6 kW OBC.
- Audi Quattro e-tron with 11 kW OBC (optional 22 kW OBC)
- Mercedes B-Class which is hardly sold, with 11 kW OBC.

Other BEVs typically AC-charge with 3 kW to max. 6 kW.

The same holds for PHEVs: almost no car can AC-charge at 22 kW.

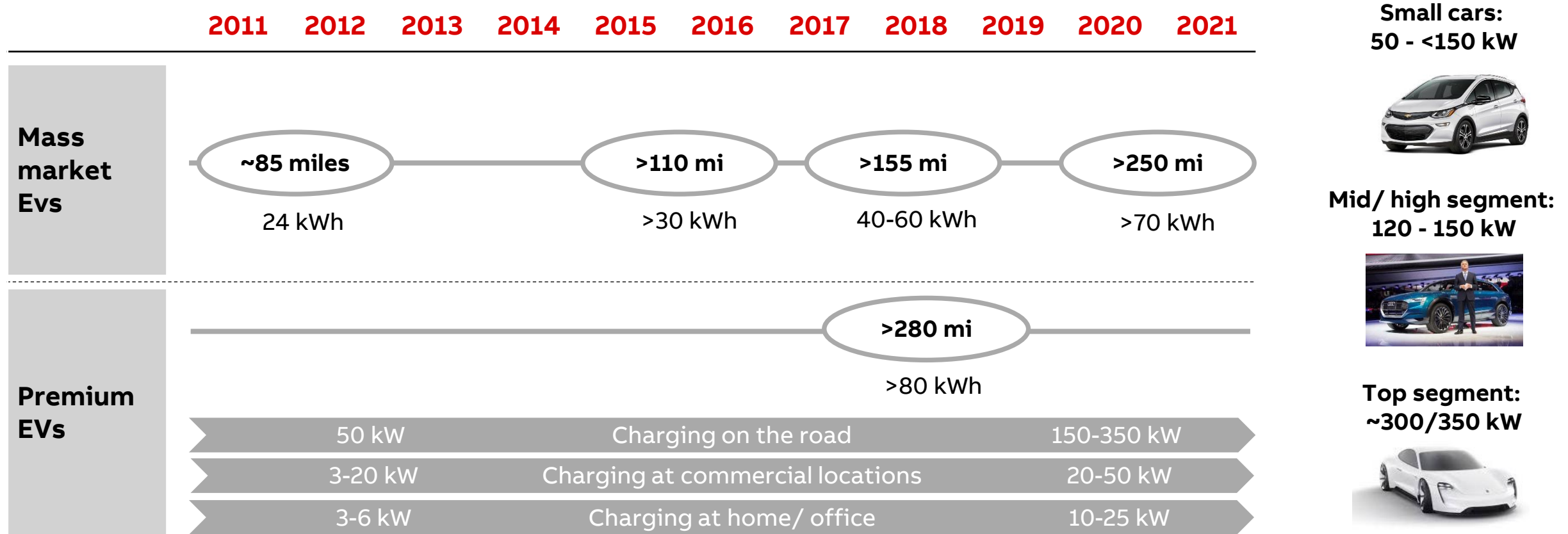




# Market segments & products

# Driver: The EV range roadmap

Batteries get bigger, range gets longer, DC charging power increases in the coming years

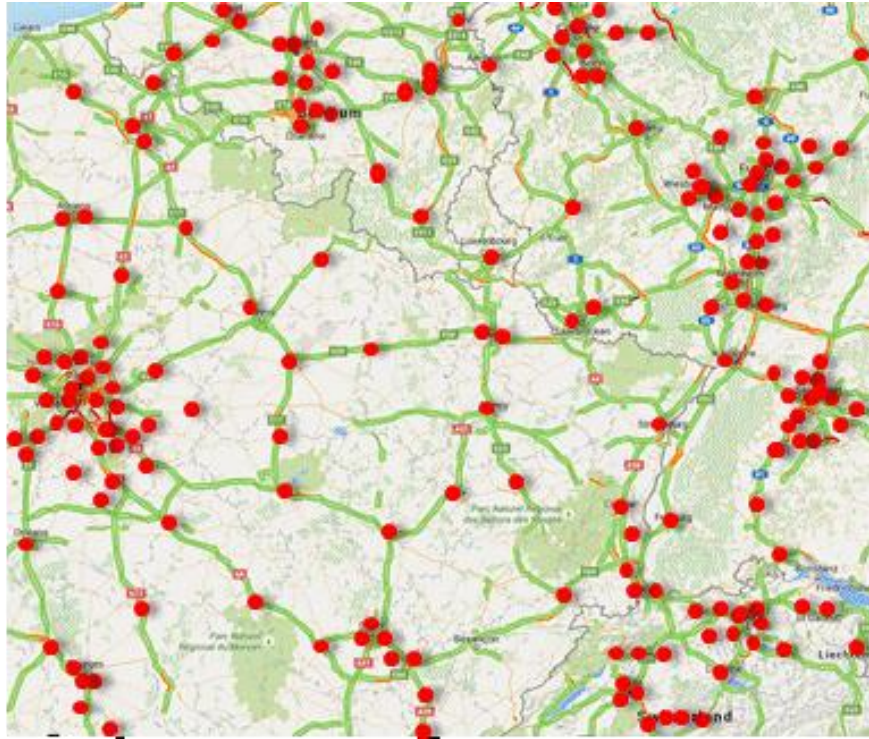


# Different business cases for fast charging

Networks to serve short range EVs will expand fast

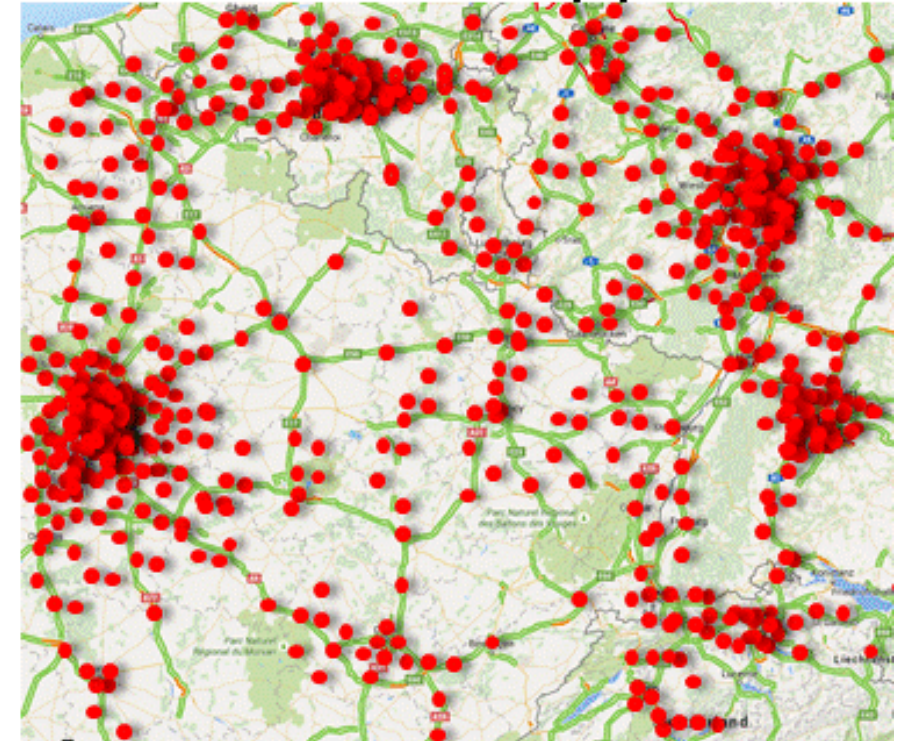
## 2017 and before

Short distance  
small EVs  
62-93 mile range  
50 kW charging  
networks are  
growing



## Early 2018

Fast growth of  
short/ medium  
distance small  
EVs (93-186  
miles)  
Higher density  
50 kW networks



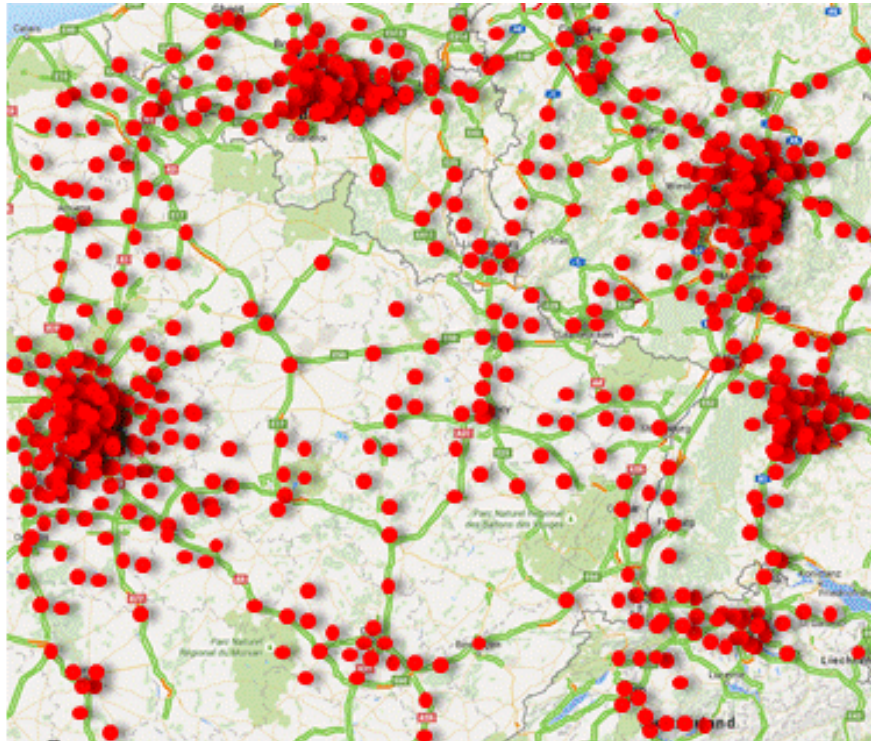


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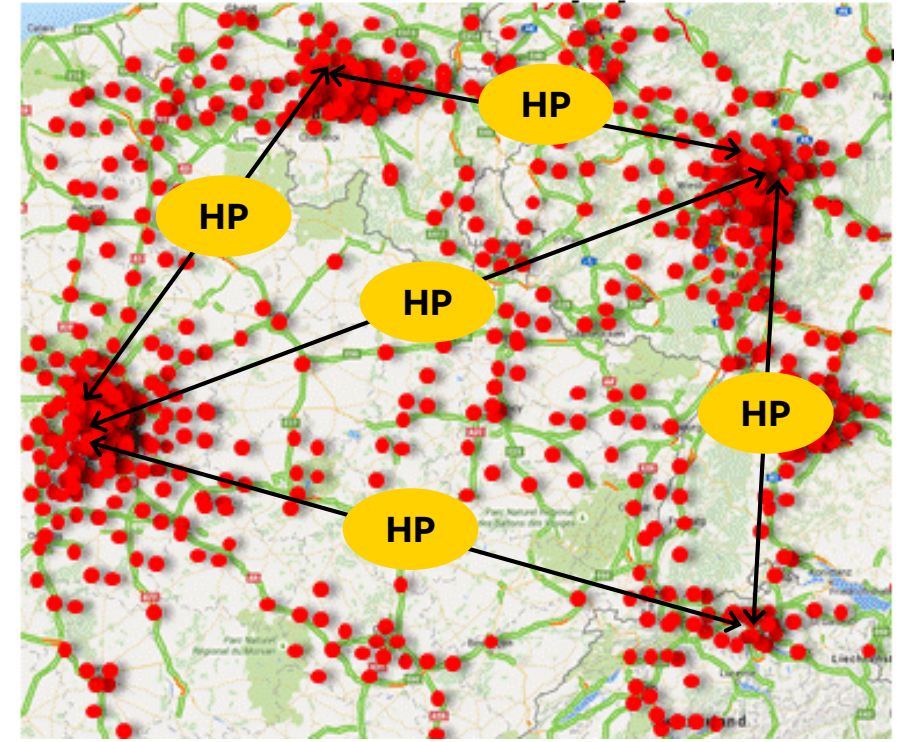
## Today

Short distance  
small EVs  
62-93 mile range  
50 kW charging  
networks are  
growing







## 2018 and onwards

Fast growth of  
short/ medium  
distance small  
EVs (93-186  
miles)  
Higher density  
50 kW networks  
**Introduction  
long distance  
premium EVs  
(>250 mile  
range)**  
**High power  
corridors  
between cities**







# Public and commercial car charging – Use cases

Charging service should match charging application and demand

| Public and commercial EV Charging   |  |   |  |
|---|--|---|--|
| AC destination  | DC destination   | DC Fast   | DC High Power  |
| 3-22 kW   | 20-25 kW   | 50 kW   | 150 to 350 kW+   |
| 4-16 hours  | 1-3 hours  | 20-90 min   | 10-20 min  |
|    |    |    |   |
| <ul style="list-style-type: none"><li>– Office, workplace</li><li>– Home</li><li>– Multi family housing</li><li>– Hotel and hospitality</li><li>– Overnight fleet</li><li>– Supplement at DC charging sites for PHEVs</li></ul> | <ul style="list-style-type: none"><li>– Office, workplace</li><li>– Hotel and hospitality</li><li>– Parking structures</li><li>– Dealerships</li><li>– Urban fleets</li><li>– Public or private campus</li><li>– Sensitive grid applications</li></ul> | <ul style="list-style-type: none"><li>– Retail, grocery, mall, big box, restaurant</li><li>– High turnover parking</li><li>– Convenience fueling stations</li><li>– Highway truck stops and travel plazas</li><li>– OEM R&amp;D</li></ul> | <ul style="list-style-type: none"><li>– Highway corridor travel</li><li>– Metro ‘charge and go’</li><li>– Highway rest stops</li><li>– Petrol station areas</li><li>– City ring service stations</li><li>– OEM R&amp;D</li></ul> |


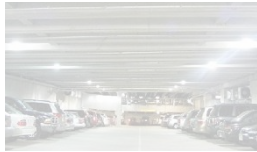


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# EVLunic AC Wallbox

## Portfolio details

### Models



|                |              |   |
|----------------|--------------|---|
| <b>EVLunic</b> | <b>B</b>     | – Entry level chargers with basic options   |
|                | <b>B+</b>    | – Entry level chargers, with full power range available and with authentication options   |
| <b>EVLunic</b> | <b>Pro S</b> | – Smart chargers with energy meter, connectivity, OCPP and load balancing through a smart master  |
|                | <b>Pro M</b> | – Smart chargers with energy meter, connectivity, OCPP and load balancing. Can serve as the central device for OCPP and load balancing for up to 15 Pro S devices |

# EVLunic AC Wallbox

## Portfolio details

### Options



#### Outlet type

- Type 2 AC socket
- Type 2 AC socket with shutters
- Type 2 AC cable 4m
- Type 2 AC cable 6m
- Type 1 AC cable 4m

#### Maximum power

- 4.6 kW
- 11 kW (type 2 cable models only)
- 22 kW (type 2 models only)

#### Authentication

- None
- Key (B+ models only, cylinder can be replaced)
- RFID (MIFARE)

#### UMTS/3G

- No
- Yes (Pro\_M models only)

#### Pedestals (sold separately)

- None (wall mounted)
- Pedestal for one wallbox
- Pedestal for two wallboxes back to back
- Pedestal for two wallboxes at a 90 degrees angle

# EVLunic AC Wallbox

## Installation

Must have dedicated RCD (minimum Type A)

Maximum 32 A supply (minimum 10 A)

Can be configured as single phase, or three phase

Cable CSA – 6 – 16 mm<sup>2</sup> for 32 A supply

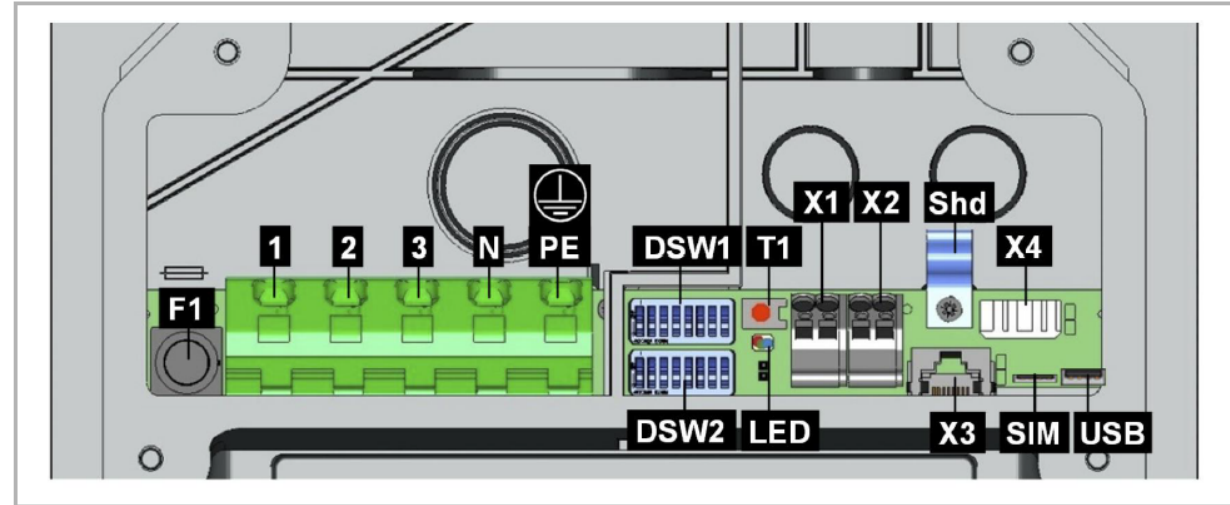
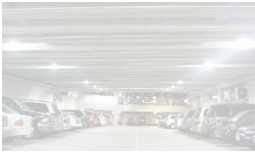





Fig. 16: Connection overview

|        |  |        |                                     |
|--------|--|--------|-------------------------------------|
| [F1]   | Fuse holder  | [1]    | Mains connection phase conductor 1  |
| [2]    | Mains connection phase conductor 2                 | [3]    | Mains connection phase conductor 3  |
| [N]    | Mains connection neutral conductor                 | [PE]   | Mains connection earthing conductor |
| [DSW1] | DIP switch   | [DSW2] | DIP switch                          |
| [T1]   | Service button                                     | [LED]  | Status LED                          |
| [X1]   | Enable input                                       | [X2]   | Switch contact output               |
| [Shd]  | Shield clamp (mass for ETH)                        | [X3]   | Ethernet2 connection (RJ45)         |
| [X4]   | Ethernet1 connection (LSA+ <sup>®</sup> terminals) | [SIM]  | SIM card slot (optional)            |
| [USB]  | USB interface                                      |        |                                     |

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# ABB Terra DC Wallbox 24

## Versions & Timing



The DC Wallbox is available in the following configurations:

- Single outlet CCS2
- Dual outlet CCS2 + CHAdeMO

All variants with 3.5m and 7m cable

The ABB DC wallbox is currently under development.

Expected availability is as given below, but can differ per country:

- EU versions (Class A EMC): production from April 2019 onwards
- EU versions (Class B EMC): production from August 2019 onwards

# ABB Terra DC Wallbox 24

Connector/cable holders for inside use: delivered with the DC Wallbox

There are two versions available:

- For CCS-2
- For CHAdeMO

With a single out DC Wallbox, one holder will be supplied, and with a dual DC Wallbox, two holders.



Assembly with cable holder



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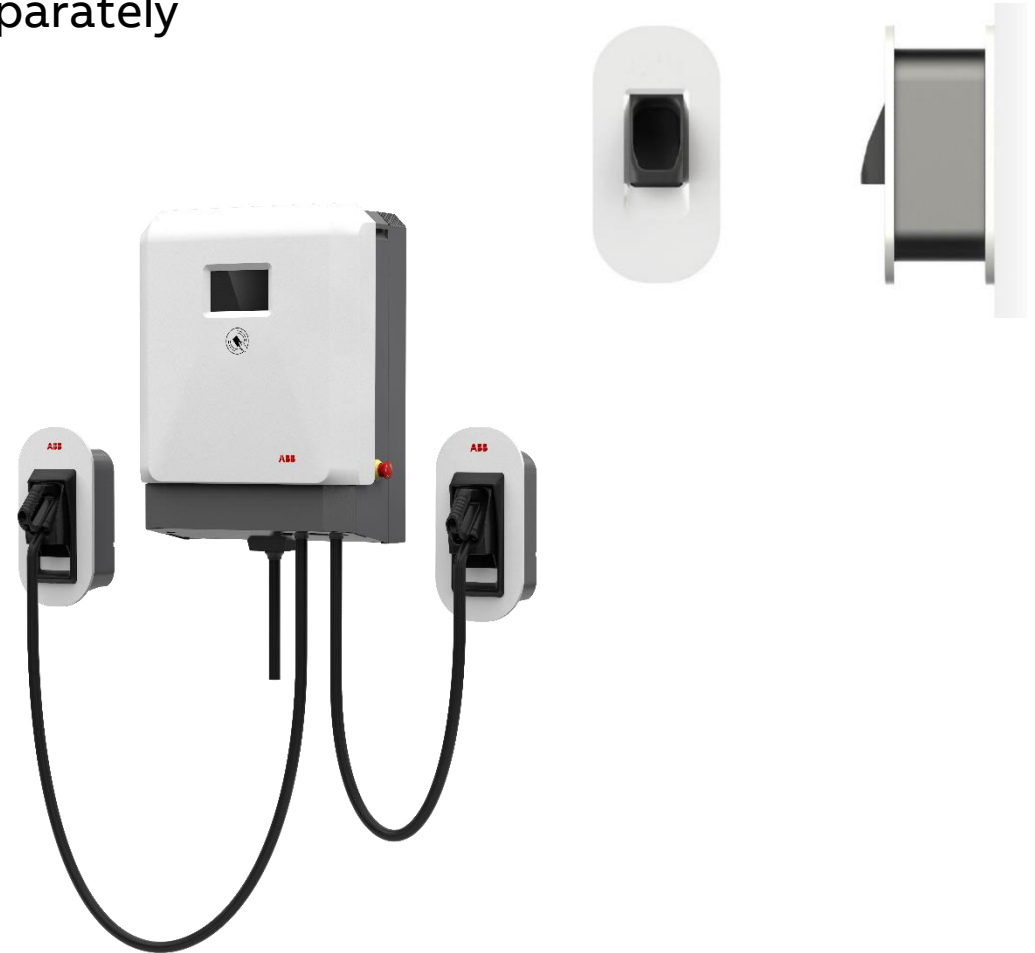
# ABB Terra DC Wallbox 24

Connector/cable holders for outside use: to be ordered separately

There are two versions available:

- For CCS-2 (Product code 6AGC076603)
- For CHAdeMO (Product code 6AGC076601)

The connector holders for outside use have to be ordered separately



# ABB Terra DC Wallbox 24

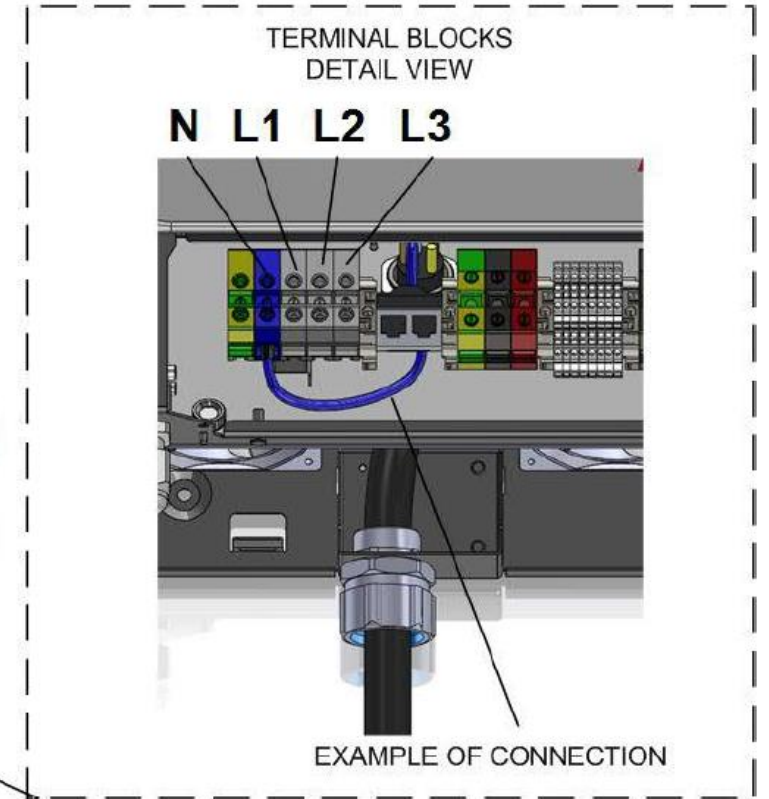
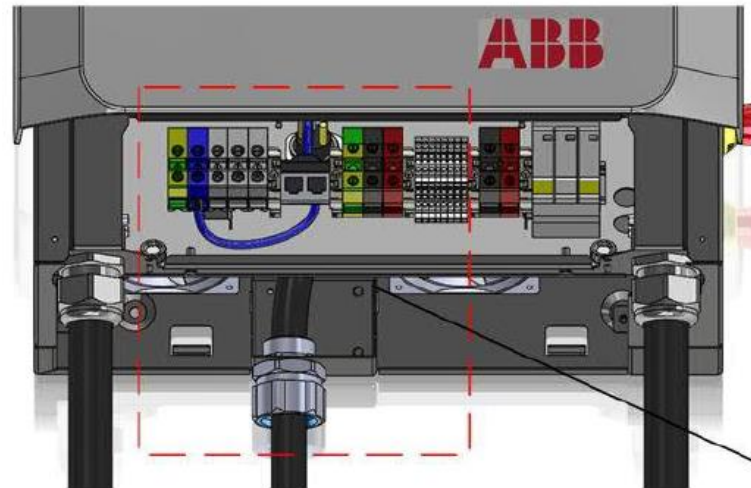
## Installation

If RCD is required, then a Type B high immunity device should be used

Maximum 63 A supply

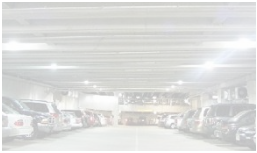
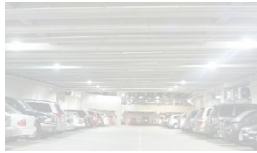


Cable CSA – maximum 35 mm<sup>2</sup>

Cable diameter 22 – 32 mm



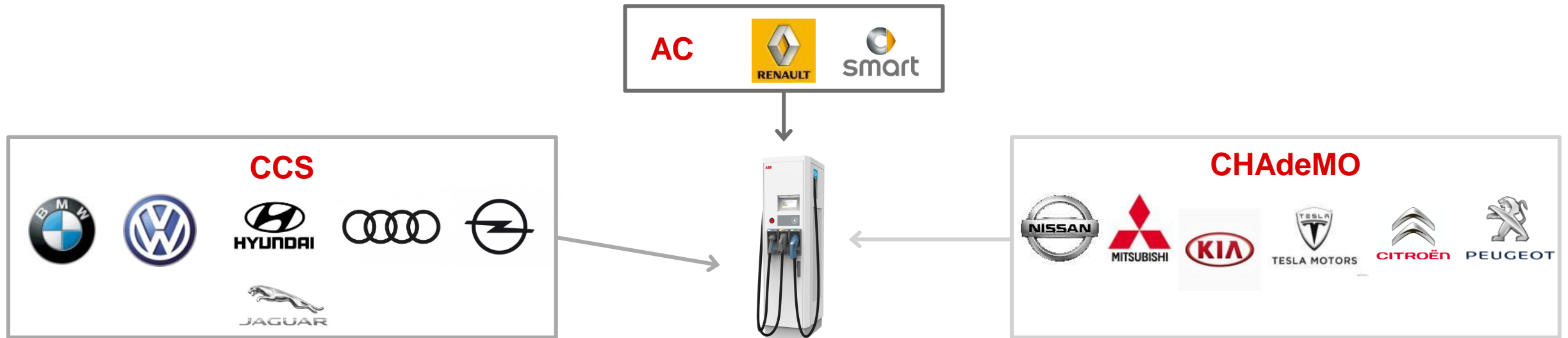
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# Multi-standard charger solution Terra 54 & Terra 24

General explanation of naming convention



Terra 54 (50kW)

Terra 24 (20kW)

**C** - (Combo) = Combined Charging Systems (CCS)

**J** - (Japan) = CHAdeMO

**T** - (Socket) = Type 2 Socket

**G** - (Grid) = Cable + Type 2 Connector

- DC

- DC

- AC

- AC

**HV = High Voltage**

CCS: 200-920 V

CHAdeMO: 150-500 V

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# Terra 54HV

50 kW High Voltage Charger: for cars with drive trains of 400 V and 800/900 V

## Voltage range

- CCS: 200 - 920 V
- CHAdeMO: 150 - 500 V

## Fit for CCS-charging of:

- Standard cars with 400 V drive-train
- Premium, high voltage cars with 800/900 V drive-trains
- eTrucks
- eBusses

## New Gun holders

A wide range of versions is already available: CCS/CHAdeMO/AC



# Highway and metropolitan segment

Terra 54: CE-approved 50 kW Multi-standard chargers – Input: 3x 400V, some possible configurations:

## Terra 54HV CT DC+AC Charger

50 kW DC CCS-2  
22 kW AC



Available

## Terra 54HV CG DC+AC Charger

50 kW DC CCS-2  
43 kW AC (also 22kW version)



Available

## Terra 54HV CJ DC Charger

50 kW DC CCS-2  
50 kW DC CHAdeMO



Available

## Terra 54HV CJG DC + AC Charger

50 kW DC CCS-2  
50 kW DC CHAdeMO  
43 kW AC



Available

## Terra 54HV CJG DC + AC Charger

50 kW DC CCS-2  
50 kW DC CHAdeMO  
22 kW AC



Available

## Terra 54HV CJT DC+AC Charger

50 kW DC CCS-2  
50 kW DC CHAdeMO  
22 kW AC

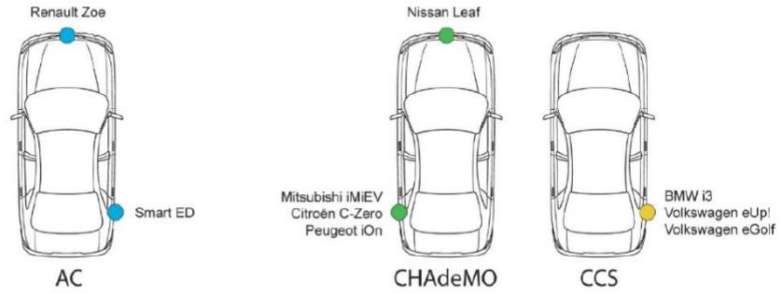


Available

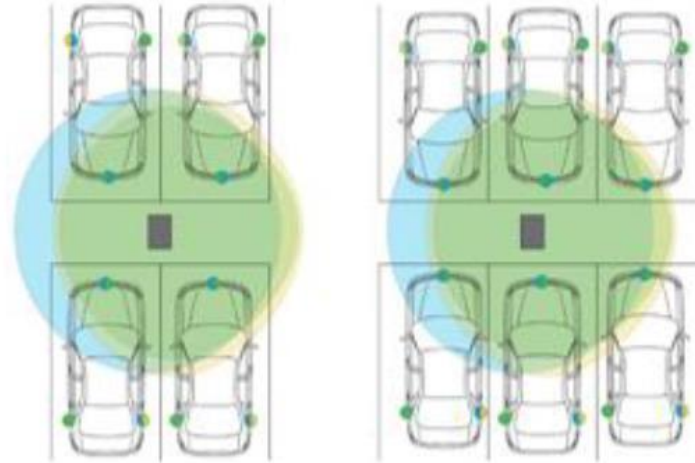


# Terra 54HV

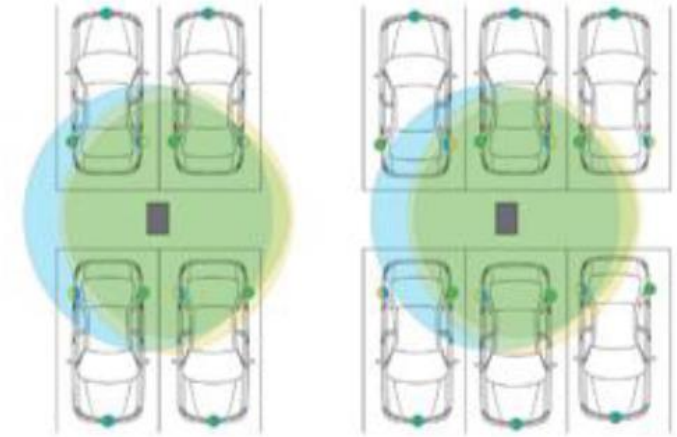
## Positioning options



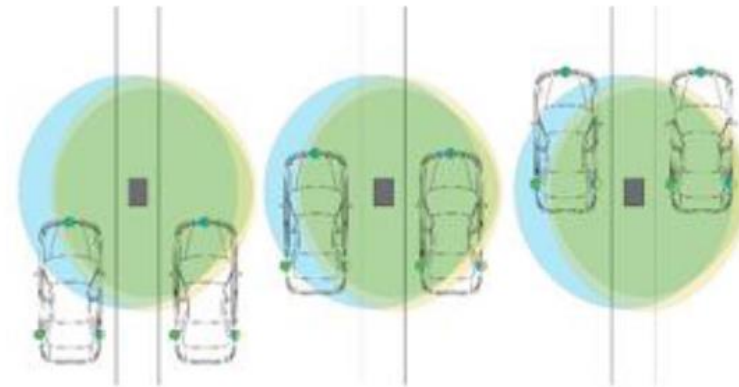
Forward parking



Backward parking



Drive through



# Terra 54HV

## Installation

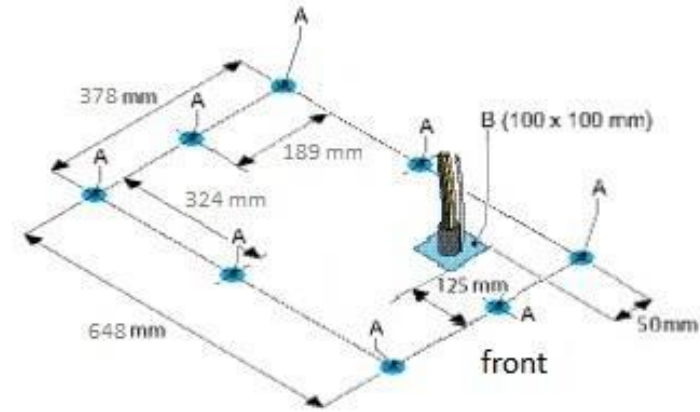
Cable diameter: 35-45 mm

Earth and neutral connections, maximum 95 mm<sup>2</sup> via M8 lugs

Units with AC charging have built in Type B RCD. Any upstream RCD should also be Type B, with high immunity





Maximum supply:

- DC only – 80 A
- DC + 22 kW AC – 125 A
- DC + 43 kW AC – 160 A



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| 4-16 hours  | 1-3 hours  | 20-90 min   | 10-20 min  |
|    |    |    |   |
| <ul style="list-style-type: none"><li>– Office, workplace</li><li>– Home</li><li>– Multi family housing</li><li>– Hotel and hospitality</li><li>– Overnight fleet</li><li>– Supplement at DC charging sites for PHEVs</li></ul> | <ul style="list-style-type: none"><li>– Office, workplace</li><li>– Hotel and hospitality</li><li>– Parking structures</li><li>– Dealerships</li><li>– Urban fleets</li><li>– Public or private campus</li><li>– Sensitive grid applications</li></ul> | <ul style="list-style-type: none"><li>– Retail, grocery, mall, big box, restaurant</li><li>– High turnover parking</li><li>– Convenience fueling stations</li><li>– Highway truck stops and travel plazas</li><li>– OEM R&amp;D</li></ul> | <ul style="list-style-type: none"><li>– Highway corridor travel</li><li>– Metro ‘charge and go’</li><li>– Highway rest stops</li><li>– Petrol station areas</li><li>– City ring service stations</li><li>– OEM R&amp;D</li></ul> |

# ABB High power charging 2018-2025

Toward 15 minute charging – 250 miles driving

## Current specification, subject to standardization

|  |                               |   |
|--|-------------------------------|---|
| <b>Operating voltage range:</b>        | CCS:                          | 200 – 920 V <sub>DC</sub>                                     |
|  | CHAdeMO:                      | 150 – 920 V <sub>DC</sub>                                     |
| <b>Current:</b>                        | CCS:                          | 375 A (with 1 power cabinet)<br>500 A (with 2 power cabinets) |
|  | CHAdeMO:                      | 200 A   |
|  | <b>Max. peak power level:</b> | 350 kWp   |
| <b>Charging cable &amp; connector:</b> | CCS 1&2:                      | Small diameter, active liquid cooling                         |
|  | CHAdeMO:                      | conventional  |

# ABB High power charging 2018-2025

Towards 15 minute charging – 250 miles driving

**Terra 54**



**Terra HP – 1 cabinet**



**Terra HP – 2 cabinets**



3½x more power

50 kW → 175 kW<sub>p</sub>

7x more power

350 kW<sub>p</sub>

3x higher current

125 A → 375 A

4x higher current

500 A



**Dynamic DC:**  
patented by ABB

**Power expansion**

1 cabinet expansion



2 cabinet expansion



# ABB's Dynamic DC: A futureproof & field upgradeable system

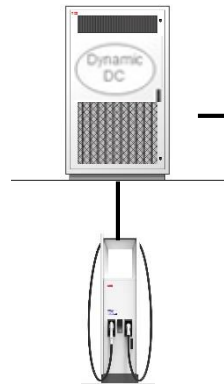
Power sharing between power cabinets

## Dynamic DC

175 kWp for two normal cars simultaneously

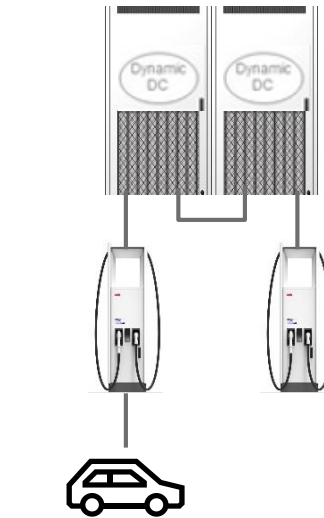
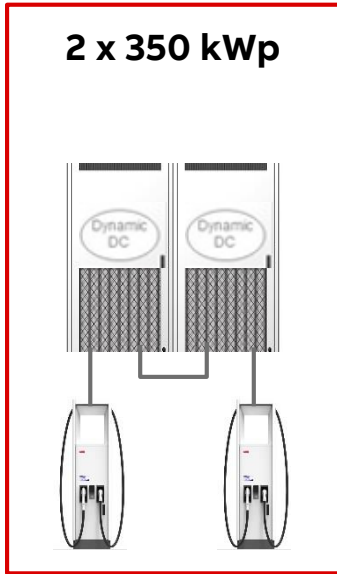
350 kWp available on each charge post for high-end cars

175 kWp  
Single system

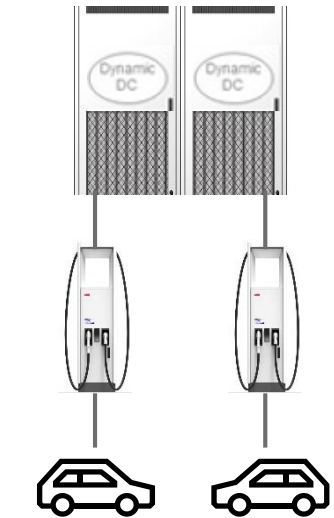


Upgrade →

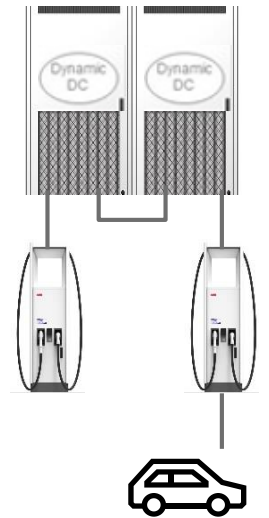
2 x 350 kWp



350 kWp  
high-end car



175 kWp 175 kWp  
normal cars



350 kWp  
high-end car

# ABB's Dynamic DC: A futureproof & field upgradeable system

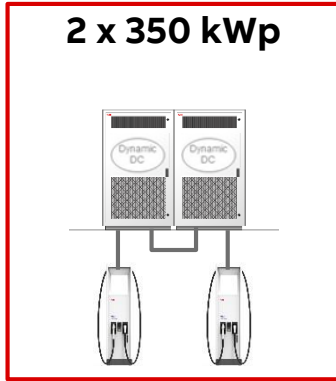
Power sharing between power cabinets up to 500 kW<sup>1</sup>

175 kWp  
Single system



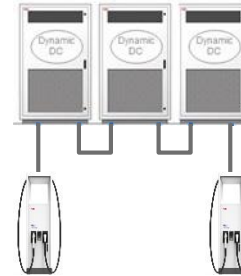
Upgrade →

2 x 350 kWp



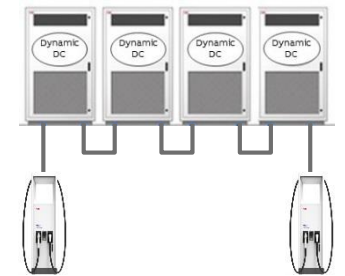
Upgrade →

2 x 350 kWp



Upgrade →

2 x 500 kW<sup>1</sup>



More BEVs with higher charging power on the road

2017

2018

2019

2020

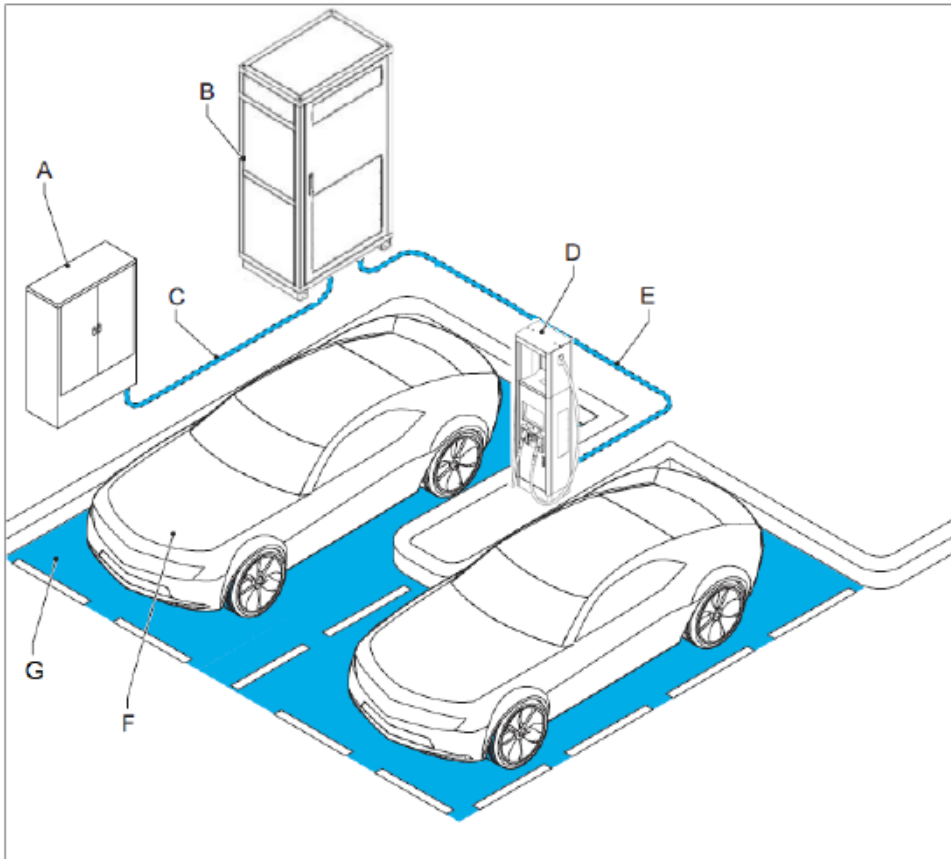
2021

2022

Build up network & functionality according to market growth

# High Power charging

## Installation - overview



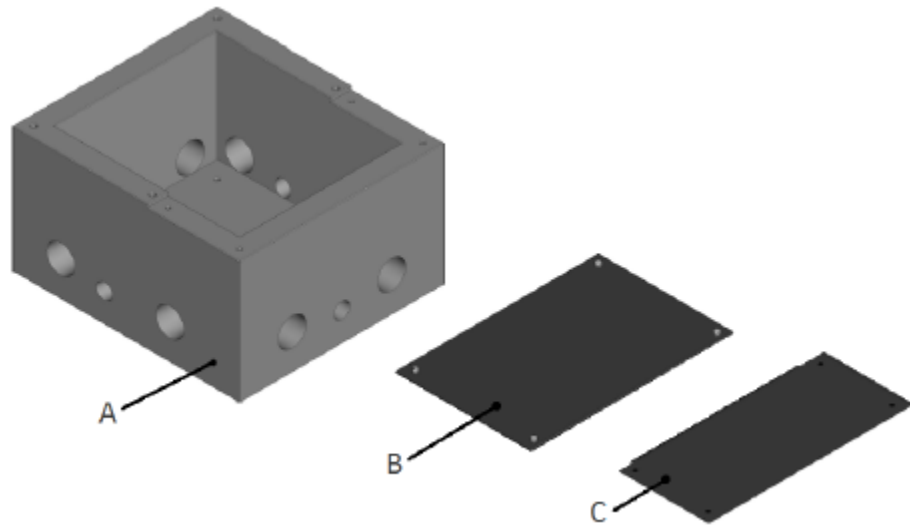
- A. LV power distribution cabinet
- B. Power cabinet – 175 kW (Terra HP 175)
- C. Input power cables in cable conduit
- D. Charge Post
- E. Cables between Power Cabinet and Charge Post in cable conduits
- F. Electric vehicle
- G. Parking space for charging



# High Power charging

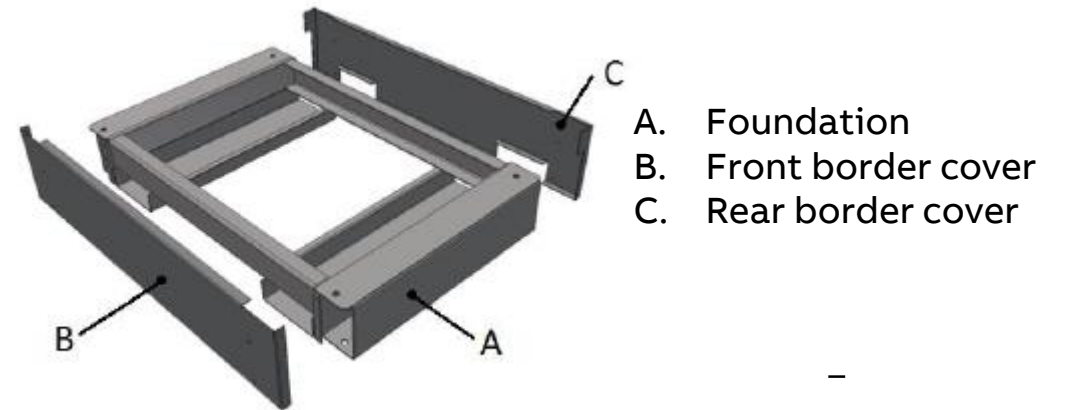
## Installation - foundations

Concrete foundation for installing power cabinet on soil



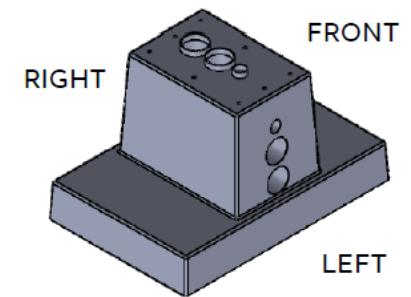
- A. Foundation
- B. Top cover plate
- C. Front cover plate

Metal foundation for installing power cabinet on a solid surface



- A. Foundation
- B. Front border cover
- C. Rear border cover

Foundation for mounting Charge Post on soil



# High Power charging

## Installation

### Positioning of multiple cabinets

2 x 175 kW



6 x 175 kW



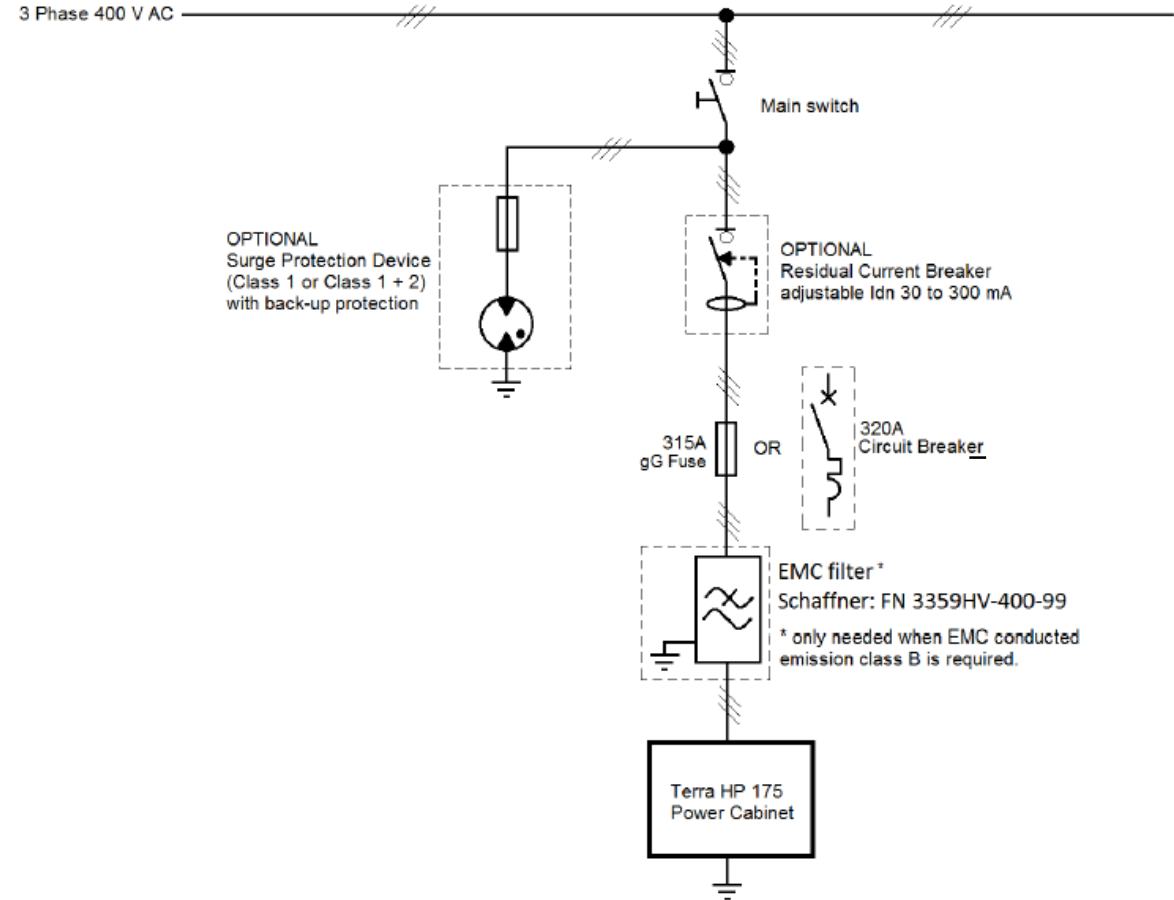
4 x 175 kW



4 x 175 kW, alternative



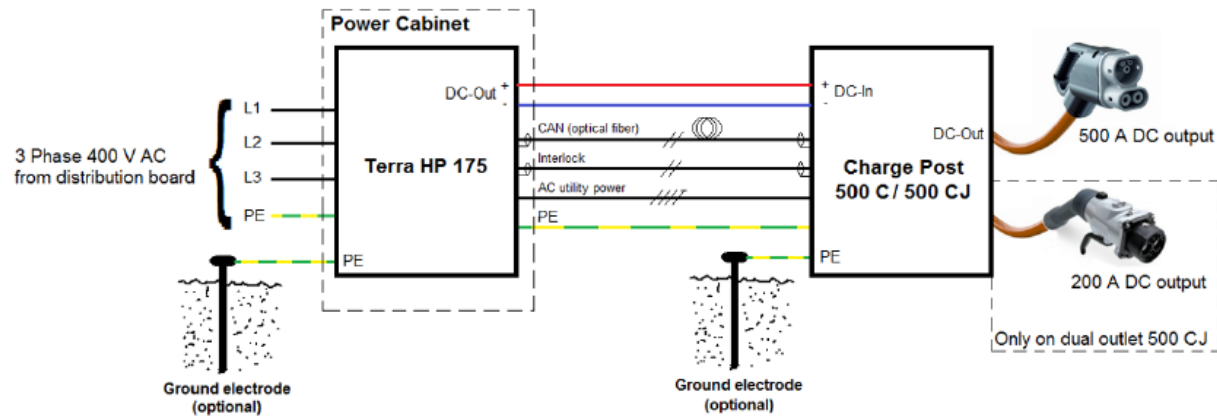
### Electrical connection to power cabinet



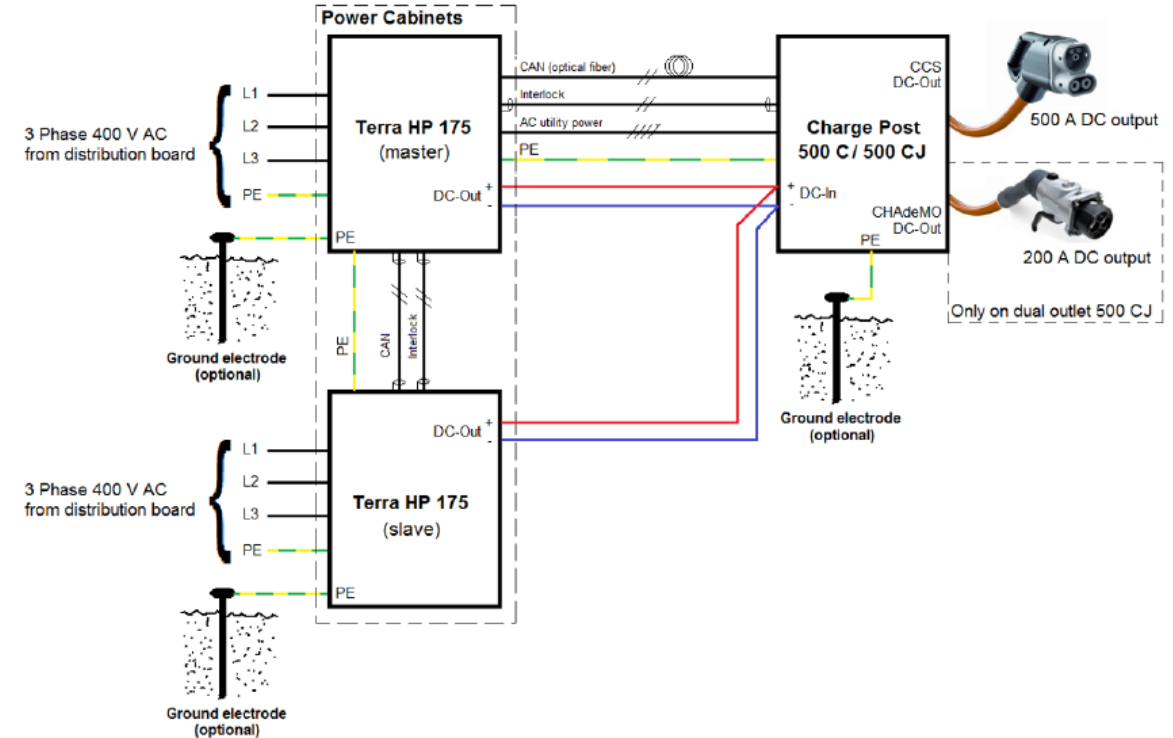
# High Power charging

## Installation – electrical configurations

175 kW system



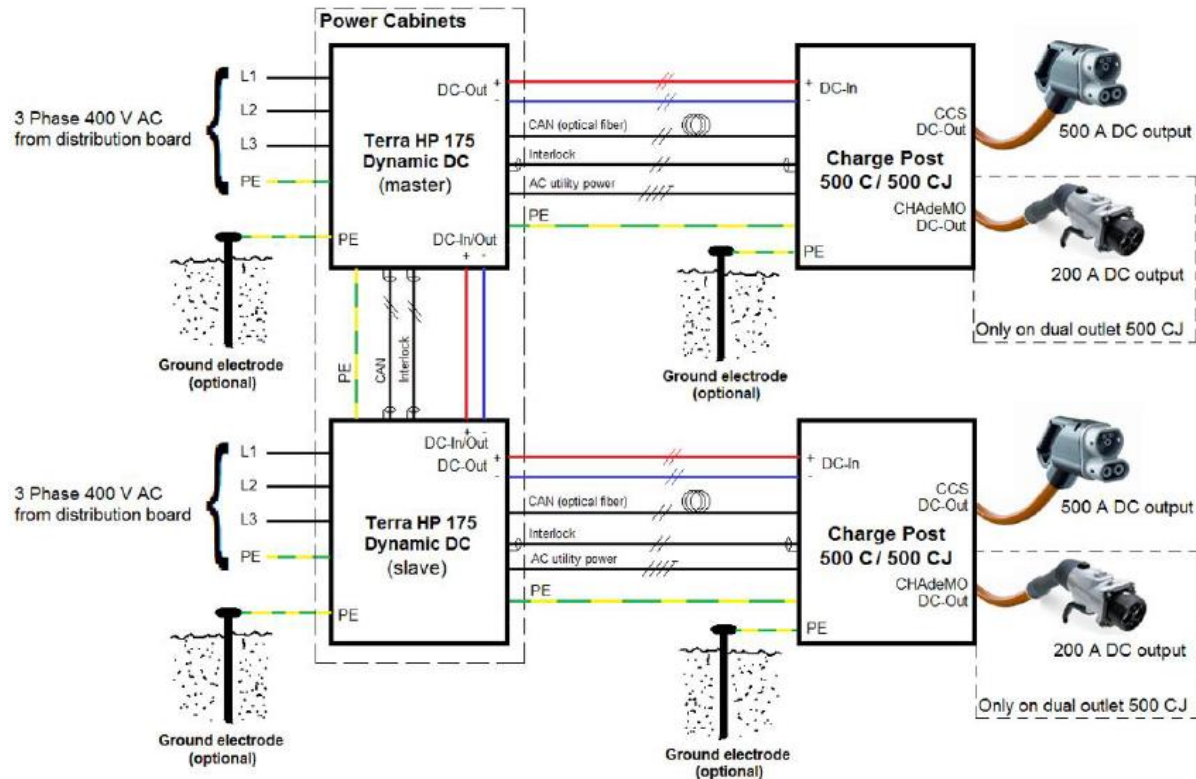
350 kW system



# High Power charging

## Installation – electrical configurations

350 kW Dynamic DC system



AC cable to Power Cabinet: maximum 240 mm<sup>2</sup>

DC cable between Power Cabinet and Charge Post:  
185 mm<sup>2</sup> – 240 mm<sup>2</sup> (for 350 kW)  
Maximum length 60 m

AC supply to DC cabinet – 320 A (for 175 kW)

Type A RCD (100 mA) built into Power Cabinet. Need for upstream device to be determined by electrical designer.



# eBus Charging

# ABB eBus charging – Reference projects



**Namur & Charleroi, BE**  
TEC  
– 15 x HVC 150P



**Trondheim, NO**  
Trondelag  
– 8 x HVC 450P



**Ostersund, SE**  
Nettbus  
– 2 x HVC 300P



**Gothenburg, SE**  
Volvo Busar  
– 1 x HVC 150P  
– 1 x HVC 300P  
– 1 x HVC 150C  
– R&D



**Luxembourg, Lux**  
Ville de Luxembourg  
– 4 x HVC 150P  
MDDI & Sales  
Lentz  
– 4 x HVC 150P



**Harrogate, UK**  
Transdev  
– 3 x HVC 300P



**La Rochelle, Fra**  
Transdev  
– 3 x 150kW CCS2



**STL, Laval, Canada**  
1 x HVC 450P



**Singapore**  
– NTU Test track  
– 2 x HVC 300P



**Södertälje, SE**  
Scania Buses  
– 1 x HVC 300P  
– R&D test track



**Plattsburgh, USA**  
Novabus  
– 1 x HVC 300P



**Munich, DE & AT**  
MAN Truck & Bus  
– 7 x HVC 150C  
– R&D



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## 3 main ways of charging buses

ABB supports all standardized solutions supported by main Bus OEMs

### CCS 2 connector

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### Pantograph Up (PU)

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### Pantograph Down (PD) - OppCharge

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# Connection to back-office & payment systems

Manage, monitor and connect to your business



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# Connected services

## Connectivity is needed to

- Monitor and operate a network of chargers
- Get paid for a charge session
- Help EV-drivers in case of questions
- Maintain and service a charger at lowest cost

**Reliable 24/7 connectivity is fundamental for a commercial operation of a network of chargers!**



# Positioning connected services

## Electric cars



DAIMLER



RENAULT

## Charging infrastructure

CCS  
CHAdeMO  
GB  
AC



Connected  
Services



ABB  
Ability™

## Solutions to run a charger network



NTT DATA



GRIDPOINT



has-to-be  
eMobility

chargecloud



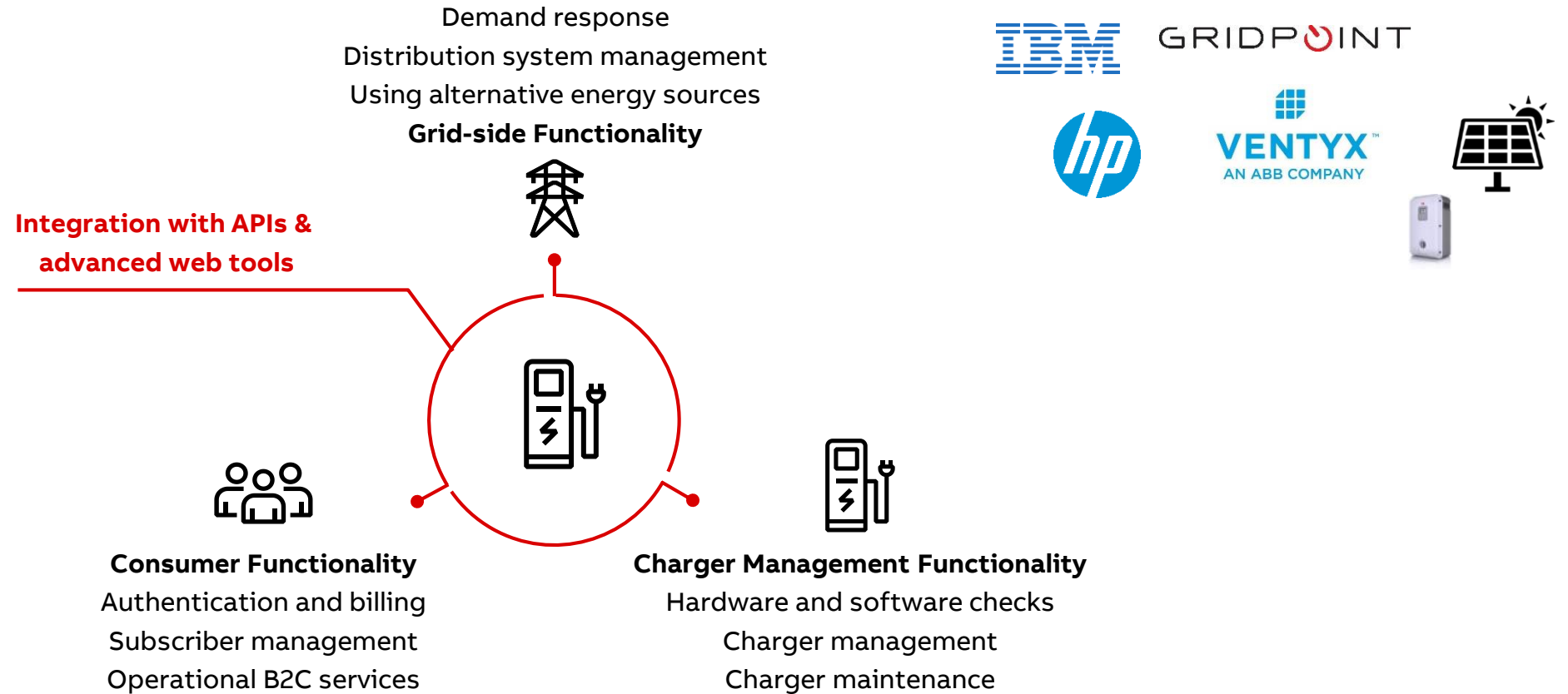
greenlots®



ABB does **not** have exclusive cooperation with any of the solutions

# Platform based integration of an ABB EV charger

Enabling you to face the dynamic challenges of the industry



# Digital integration of an ABB EV charger

## Customer benefits

Highly redundant cloud platform

24/7 network operation center, enforcement of SLA with GSM provider, outage mitigation & resolution

Software updates and car interoperability updates

Advanced remote service concept (by ABB or 3<sup>rd</sup> party)

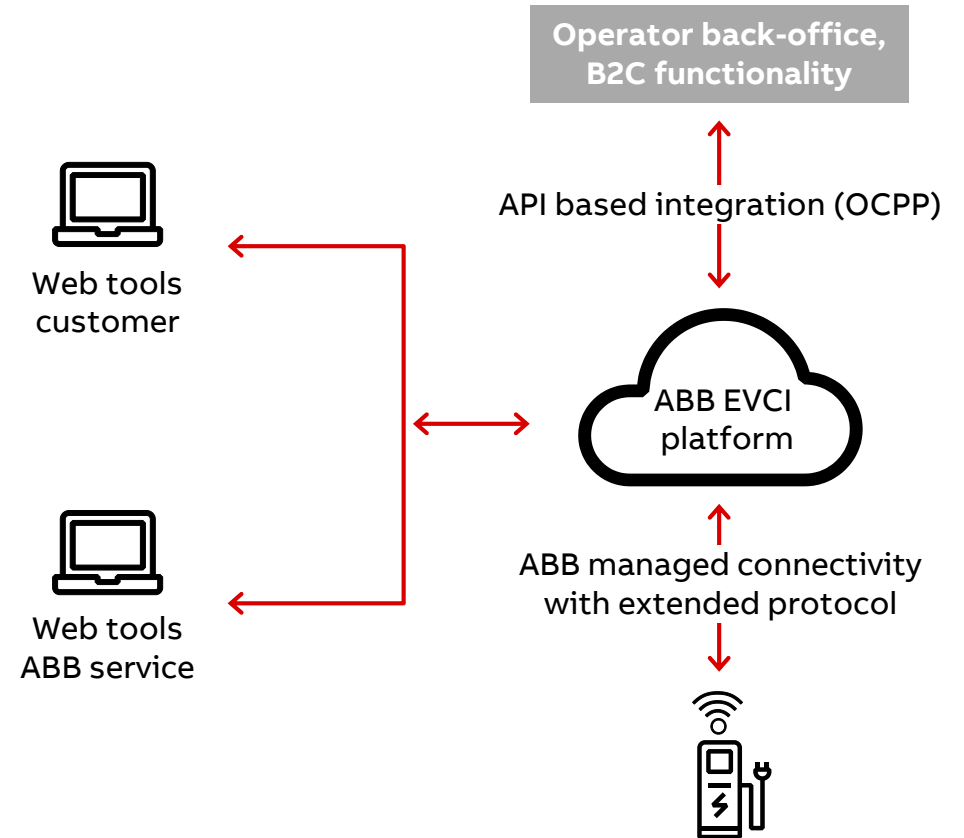
APIs & web tools available based on a SaaS model

Minimize investments in own IT infrastructure and SW solutions

High uptime due to reliable connectivity

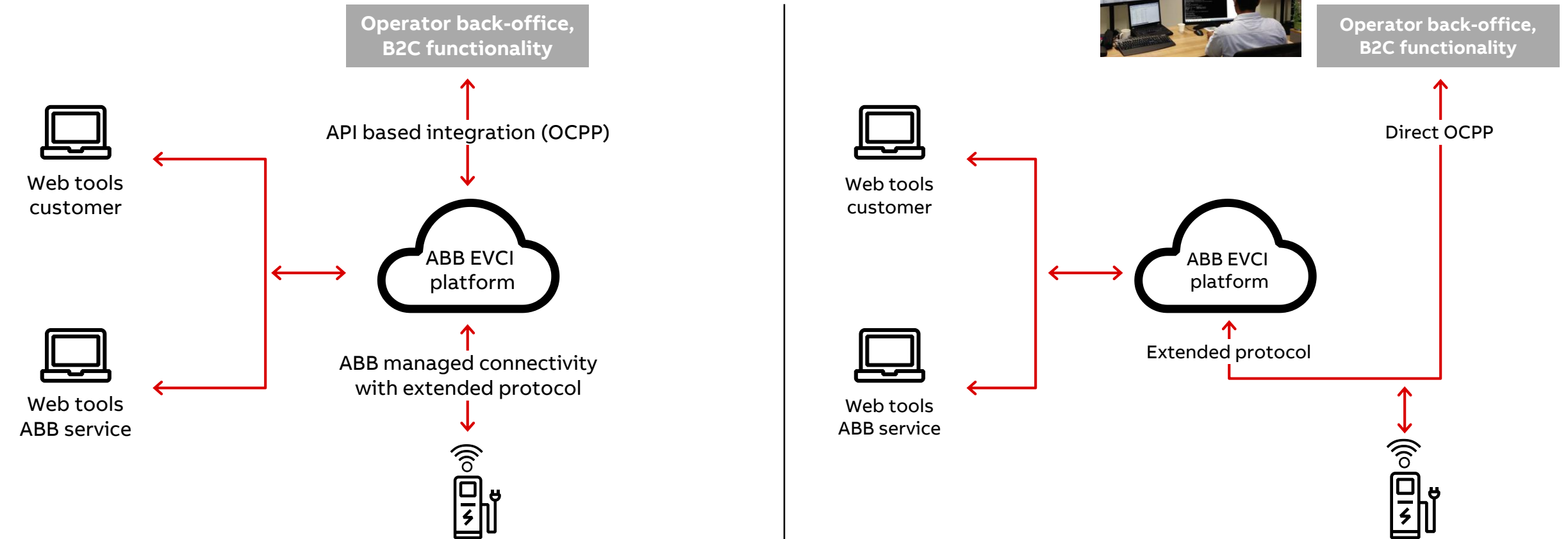
Reduced operational cost

Fully scalable setup that can adapt to changing requirements



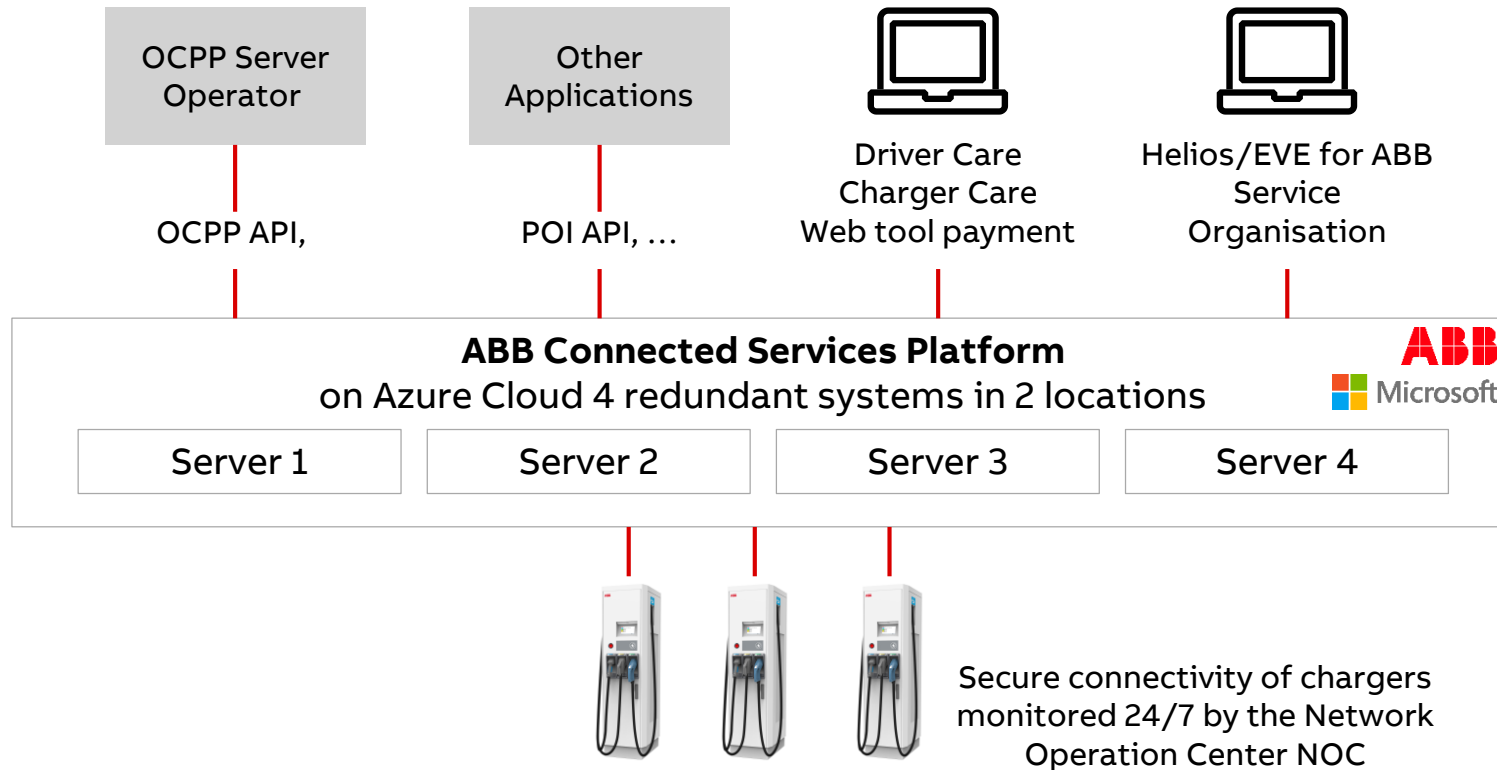
# Digital integration of an ABB EV charger

OCPP 1.5 Single Uplink or OCPP 1.6 Dual Uplink



# ABB Connected Services Platform

## High level architecture



Platform **enables** customers and partners to integrate with the ABB chargers via web tools and APIs and to launch new/ innovate services

Worldwide availability of the Connected Services Platform ensuring stability, global scalability and advanced, innovative features for ABB customers & partners.

Best-in class Charging Stations for all charging protocols (CCS, Chademo, GB) and for all markets

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# Summary

Changes to building regulations will mandate EV chargers in most new buildings

Selection of charger depends on budget and desired charge time

Increasing power (reduced charge time) of chargers in line with longer range of EVs

Public rapid chargers to accept debit / credit card payments and move towards interoperability

Connectivity of chargers to allow remote software updates, diagnostics and facilitate back office management

**ABB**