CONFIDENTIAL

JUNE 18TH, 2019/ STEVEN DORRESTEIJN/ ELSP – EVI

EV Infrastructure

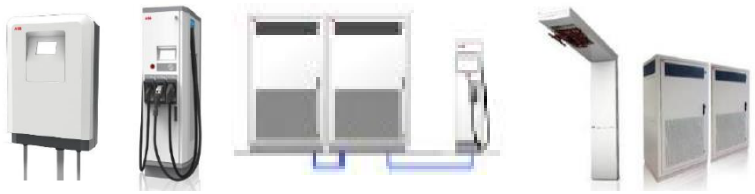
Actual status and trends in fast charging for Ionica in Zell am See

ABB EV charging

Mission statement – EV Infrastructure team

We offer AC and DC charging solutions for Electric Vehicles…

…from 3-600kW…



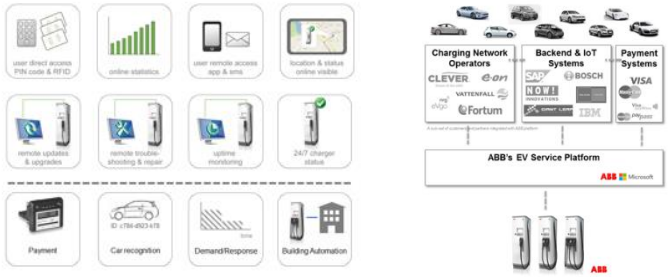
…based on standards…

…in all countries…

Present in
76 countries

and ABB manufacturing.

..with cloud connectivity..



…using ABB technology…

ABB offers solutions for the complete value chain

From power generation to the vehicle

DC fast chargers

– Terra systems

E-bus chargers

– HVC 150

Energy storage

– B.E.S.S.

Power quality

– PQF, PCS100

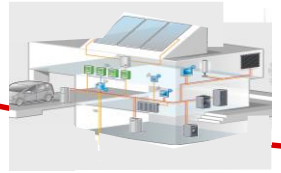
Substations

– Transformers

ABB's solutions will work together seamlessly throughout the whole value chain

Charging network software services

– ABB Ability



Building automation

– KNX, energy mngt.

Components

– DIN rail & distribution boards

Renewable integration

– HVDC, solar, wind

Grid automation

– SCADA & Ventyx

ABB, eMobility and EV Charging

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

ABB and Formula E

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

Jaguar I-PACE eTROPHY Series

Jaguar I-PACE eTROPHY announces ABB as Official Charging Partner

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

Fortune Magazine's August 20th 2018

Recognizing ABB’s groundbreaking leadership in e-mobility, Fortune Magazine today selected ABB as #8 on its 2018 “Change the World” list, a global ranking of companies whose innovative work is making a significant, positive social impact around the world.

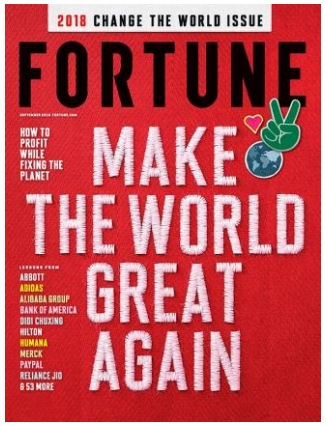


ABB DC fast charge installations

Proven technology in the field since May 2010, now in 76 countries

Actual

Argentina, Australia, Austria, Azerbaijan, Bahamas, Belgium, Bosnia Herzegovina, Brazil, Bulgaria, Canada, China, Chile, Colombia, Croatia, Cuba, Czech, Denmark, Ecuador, Egypt, Estonia, Faroe Islands, Finland, France, Germany, Georgia, Greece, Greenland, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Kazakhstan, Kosovo, Latvia, Liechtenstein, Lithuania, Luxembourg, Malaysia, Mexico, Monaco, Montenegro, Morocco, The Netherlands, New Zealand, Norway, Peru, Philippines, Poland, Portugal, Reunion Island, Romania, Russia, Saudi Arabia, Serbia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Sri Lanka, Sweden, Switzerland, Taiwan, Thailand, Turkey, United Arab Emirates, Ukraine, United Kingdom, USA.

Total more than 11.000 pcs DC fast charging units sold (≥10 kW), of which more than 1.800 pcs 150-450 kW High Power Charging systems (for car and bus)

ABB as well in IONITY as in ELAM (Electrify America)

First public liquid cooled cable installations on May 3rd, 2018 in the USA, and on June 21st, 2018 in Europe

IONITY / ABB

IONITY will implement and operate a network of approximately 400 fast charging stations across 24 European countries by 2020.

ABB has been selected as technology partner and supplier for Terra HP charging systems by IONITY.

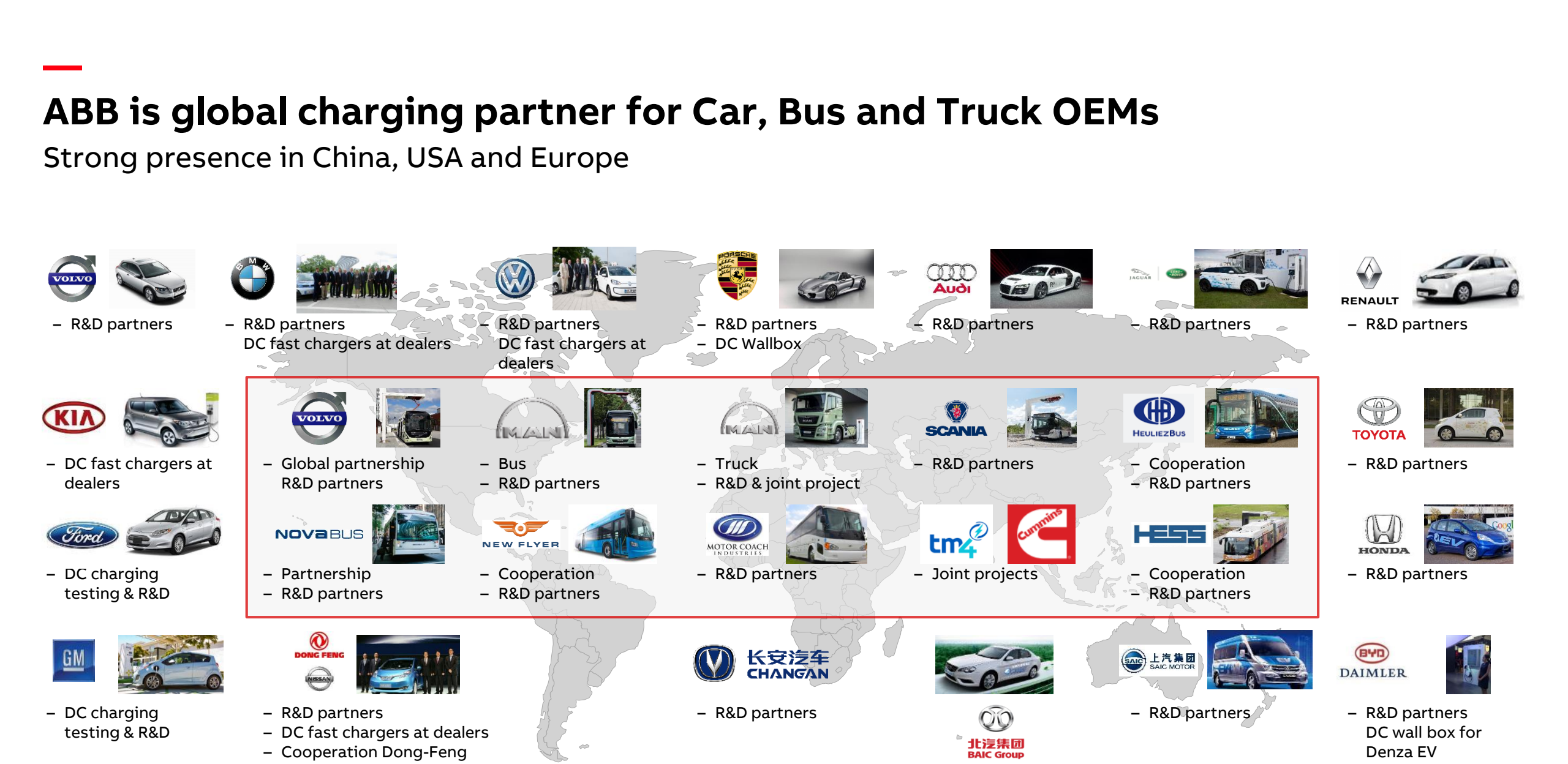
ELAM /ABB

Over a 10-year period ending in 2027, Electrify America will invest $2 billion in ZEV infrastructure, access, and education programs in the United States.

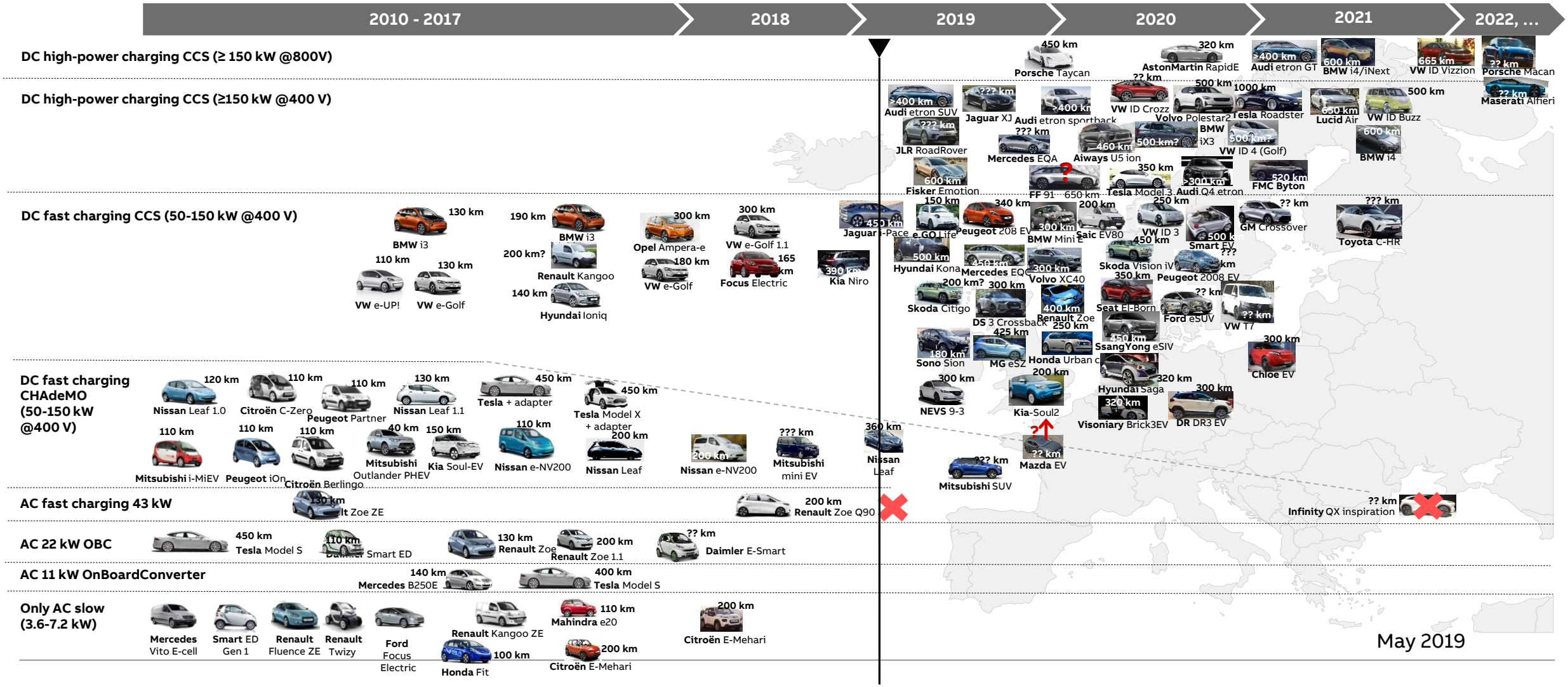
ABB has been selected to supply its Terra HP charging stations as part of the biggest electric vehicle infrastructure project to date in the United States.

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

Strong presence in China, USA and Europe



Follow the car through Europe, and open standard protocols

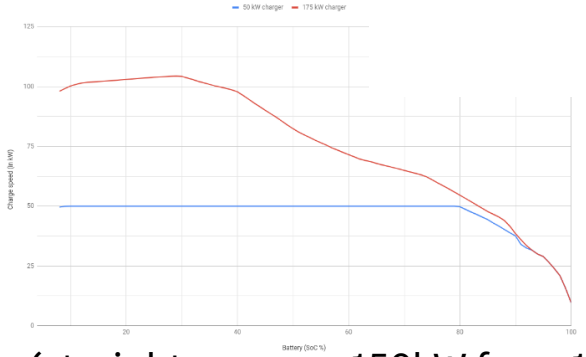


Charging powers going up from 100 => 150 => 250kW

Some recent reports from the marketplace: just a few examples

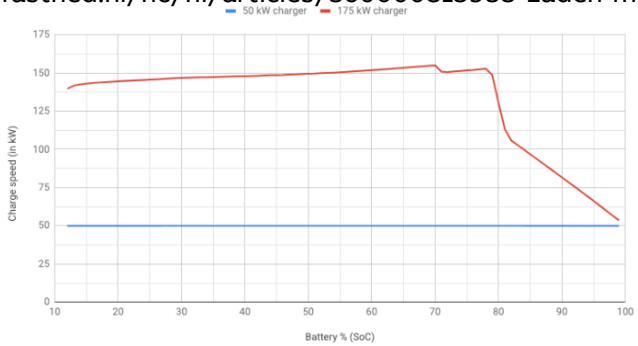
Jaguar i-Pace (max. around 105kW)

(Source: https://support.fastned.nl/hc/nl/articles/360000788848-Laden-met-een-Jaguar-I-PACE



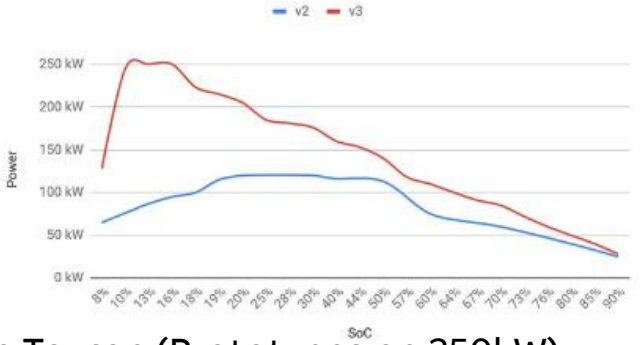
Audi Quattro e-tron - (straight curve on 150kW from 10-80% SOC)

(Source: https://support.fastned.nl/hc/nl/articles/360000815988-Laden-met-een-Audi-e-tron)



Tesla Model 3 Long Range – (250kW - 3C for short moment !!)

(source: https://insideevs.com/tesla-model-3-charging-v3-supercharger-taper/



Porsche Taycan (Prototypes on 250kW)

(Source: https://electricrevs.com/2019/01/28/porsche-taycan-owners-will-get-free-ultra-fast-charging-for-3-years/)

- Prototypes of the car's powertrain have been seen charging at 250 kW

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
			
– Office, workplace – Home – Multi family housing – Hotel and hospitality – Overnight fleet – Supplement at DC charging sites for PHEVs	– Office, workplace – Hotel and hospitality – Parking structures – Dealerships – Urban fleets – Public or private campus – Sensitive grid applications	– Retail, grocery, mall, big box, restaurant – High turnover parking – Convenience fueling stations – Highway truck stops and travel plazas – OEM R&D	– Highway corridor travel – Metro ‘charge and go’ – Highway rest stops – Petrol station area’s – City ring service stations – OEM R&D

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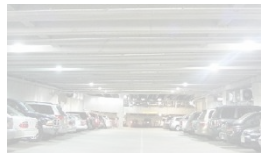			
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ABB Terra DC Wallbox 24

Versions & Timing for Wave1 countries (e.g. Austria)

The DC wallbox will be available in the following configurations:

- Single outlet CCS1
- Single outlet CCS2
- Dual outlet CCS1 + CHAdeMO
- 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
- US versions (FCC): production from April 2019 onwards

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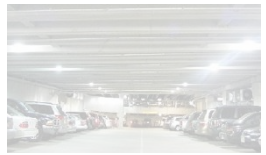	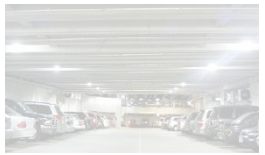		
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Highway and metropolitan segment

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

Terra 54 CT DC+AC Charger

50kW DC CCS-2

22kW AC

Available

Terra 54 CG DC+AC Charger

50kW DC CCS-2

43kW AC (also 22kW version)

Available

Terra 54 CJ DC Charger

50kW DC CCS-2

50kW DC CHAdeMO

Available

Terra 54 CJG DC + AC Charger

50kW DC CCS-2

50kW DC CHAdeMO

43kW AC

Available

Terra 54 CJG DC + AC Charger

50kW DC CCS-2

50kW DC CHAdeMO

22kW AC

Available

Terra 54 CJT DC+AC Charger

50kW DC CCS-2

50kW DC CHAdeMO

22kW AC

Available

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

New Gun holders

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

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ABB High power charging 2018-2025

Toward 15 minute charging – 400 km/ 250 Mi driving

Current specification, subject to standardization

Operating voltage range:	CCS:	200 – 920 V_{Dc}
	CHAdeMO:	150 – 920 V_{Dc}
Current:	CCS:	375 A (with 1 power cabinet)
		500 A (with 2 power cabinets)
	CHAdeMO:	200 A (also a version with 125 A cable is available)
Max. peak power level:	350 kWp	
Charging cable & connector:	CCS 1&2:	Small diameter, active liquid cooling
	CHAdeMO:	conventional

ABB High power charging 2018-2025

Towards 15 minute charging – 400 km/ 250 Mi driving

Terra 54

Terra HP – 1 cabinet

Terra HP – 2 cabinets

3½x more power

50 kW → **175 kW_p**

7x more power

→ **350 kW_p**

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


High Power (150-350 kW) versus Medium Level Power Charging (80-120 kW)

It is all about the Amps……

Most all-in-one chargers, without liquid cooled cables, can only do up to 200 A. With a 400 V drive train that is typically around 80 kW (= 200 A x 400 V)

So this e.g. also holds for charging an Audi Quattro e-tron, which has a 400 V drive train.

At the same time, the ABB Terra HP can do with one power cabinet 375 A x 400 V = 150 kW continuously, so almost double the power.

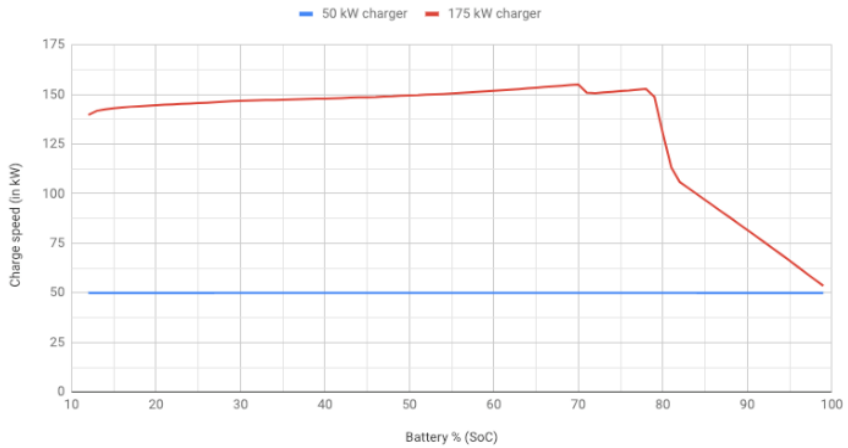
As the Audi charges flat from 0-80% SOC on 150 kW (see below graph on the Fastned website), the Terra HP charger charges almost double as fast as the all-in-one, 200 A chargers

So when e.g. the Audi comes in with 10% SOC, and wants to drive away with 80%, he has to charge 70% of 95 kWh = 66 kWh (= approx. 330 real kilometers)

1. With a 80-120 kW charger that is: 66/80 x 60 = approx. 50 mins
2. With a 150k W charger that is: 66/150 x 60 = approx. 26 mins

So there is a huge difference in charging time…

And.. if you are a driver, and in a hurry, which charger would you pick: charger 1. or charger 2. ?



(Of course, outside temperature etc. can influence the BMS of the car, and thus the charging speed).

3 main ways of charging buses

ABB supports all standardized solutions supported by main Bus OEMs

CCS 2 connector (overnight/depot)

Pantograph Up (PU)

Pantograph Down (PD) - OppCharge

It is all about making your business work

We are looking forward to empowering you!

Contact information

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