Electric vehicle charging
Infrastructure, market and connectivity

JOE ELLWOOD
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
Proposed changes to building regulations
Consultation – closed 7th 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
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...

...based on standards...

...in all countries...

..with cloud connectivity..

...using ABB technology...

Present in >75 countries

and ABB manufacturing.
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 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
Market (cars & standards)
### Follow the car through Europe, and open standard protocols

<table>
<thead>
<tr>
<th>2010 - 2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022, ...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DC high-power charging CCS (≥ 150 kW @800V)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DC high-power charging CCS (≥150 kW @400 V)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DC fast charging CCS (50-150 kW @400 V)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DC fast charging CHAdeMO (50-150 kW @400 V)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AC fast charging 43 kW</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AC 22 kW OBC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AC 11 kW OnBoardConverter</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Only AC slow (3.6-7.2 kW)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Car Model</th>
<th>Year</th>
<th>Range (mi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tesla Model S</td>
<td>2022</td>
<td>310 mi</td>
</tr>
<tr>
<td>BMW i3</td>
<td>2022</td>
<td>125 mi</td>
</tr>
<tr>
<td>Audi e-tron</td>
<td>2022</td>
<td>250 mi</td>
</tr>
<tr>
<td>Nissan Leaf</td>
<td>2022</td>
<td>225 mi</td>
</tr>
<tr>
<td>Hyundai Kona</td>
<td>2022</td>
<td>280 mi</td>
</tr>
<tr>
<td>Peugeot 208 e-EV</td>
<td>2022</td>
<td>155 mi</td>
</tr>
<tr>
<td>Daimler Soul 2</td>
<td>2022</td>
<td>120 mi</td>
</tr>
<tr>
<td>Tesla Model 3</td>
<td>2022</td>
<td>310 mi</td>
</tr>
<tr>
<td>BMW iX</td>
<td>2022</td>
<td>370 mi</td>
</tr>
<tr>
<td>Volkswagen ID.4</td>
<td>2022</td>
<td>250 mi</td>
</tr>
<tr>
<td>Toyota Mirai</td>
<td>2022</td>
<td>225 mi</td>
</tr>
<tr>
<td>Mercedes-Benz EQC</td>
<td>2022</td>
<td>280 mi</td>
</tr>
<tr>
<td>Tesla Model Y</td>
<td>2022</td>
<td>310 mi</td>
</tr>
<tr>
<td>Kia Soul EV</td>
<td>2022</td>
<td>200 mi</td>
</tr>
<tr>
<td>Honda Clarity Plugin Hybrid</td>
<td>2022</td>
<td>400 mi</td>
</tr>
<tr>
<td>JLR i-Pace</td>
<td>2022</td>
<td>&gt;250 mi</td>
</tr>
<tr>
<td>Mazdaspeed</td>
<td>2022</td>
<td>200 mi</td>
</tr>
<tr>
<td>Genesis GV60</td>
<td>2022</td>
<td>310 mi</td>
</tr>
<tr>
<td>Jaguar I-PACE</td>
<td>2022</td>
<td>280 mi</td>
</tr>
<tr>
<td>Kia Niro EV</td>
<td>2022</td>
<td>280 mi</td>
</tr>
<tr>
<td>Nissan Leaf</td>
<td>2022</td>
<td>225 mi</td>
</tr>
<tr>
<td>Mini Cooper</td>
<td>2022</td>
<td>185 mi</td>
</tr>
<tr>
<td>Mercedes-Benz EQV</td>
<td>2022</td>
<td>280 mi</td>
</tr>
<tr>
<td>Renault Zoe</td>
<td>2022</td>
<td>225 mi</td>
</tr>
<tr>
<td>Toyota Prius Prime</td>
<td>2022</td>
<td>400 mi</td>
</tr>
<tr>
<td>Tesla Model S</td>
<td>2022</td>
<td>310 mi</td>
</tr>
<tr>
<td>BMW i8</td>
<td>2022</td>
<td>310 mi</td>
</tr>
</tbody>
</table>

©ABB  
November 15, 2019 | Slide 9
ABB is following the OEM Fast Charging standards

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

From Q4-2012 onwards
22-43 kW AC

From Q4-2013 onwards
CCS 2

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 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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mass market Evs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>~85 miles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 kWh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;110 mi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;30 kWh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;155 mi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40-60 kWh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;250 mi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;70 kWh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Premium EVs** |       |       |       |       |       |       |       |       |       |       |       |
| ~280 mi        |       |       |       |       |       |       |       |       |       |       |       |
| >80 kWh        |       |       |       |       |       |       |       |       |       |       |       |

**Small cars:** 50 - <150 kW

**Mid/high segment:** 120 - 150 kW

**Top segment:** ~300/350 kW
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

● = 50 kW fast charger
Different business cases for fast charging

Networks to serve short range EVs will expand fast

**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

©ABB
November 15, 2019 | Slide 17

● = 50 kW fast charger  HP = High power fast charger (>150 kW)
Public and commercial car charging – Use cases
Charging service should match charging application and demand

<table>
<thead>
<tr>
<th>AC destination</th>
<th>DC destination</th>
<th>DC Fast</th>
<th>DC High Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-22 kW</td>
<td>20-25 kW</td>
<td>50 kW</td>
<td>150 to 350 kW+</td>
</tr>
<tr>
<td>4-16 hours</td>
<td>1-3 hours</td>
<td>20-90 min</td>
<td>10-20 min</td>
</tr>
</tbody>
</table>

- 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 areas
- City ring service stations
- OEM R&D
Public and commercial car charging – Use cases
Charging service should match charging application and demand

<table>
<thead>
<tr>
<th>Public and commercial EV Charging</th>
<th>AC destination</th>
<th>DC destination</th>
<th>DC Fast</th>
<th>DC High Power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3-22 kW</td>
<td>20-25 kW</td>
<td>50 kW</td>
<td>150 to 350 kW+</td>
</tr>
<tr>
<td></td>
<td>4-16 hours</td>
<td>1-3 hours</td>
<td>20-90 min</td>
<td>10-20 min</td>
</tr>
</tbody>
</table>

- **AC destination**: Charging power range from 3-22 kW with charging times from 4-16 hours.
- **DC destination**: Charging power range from 20-25 kW with charging times from 1-3 hours.
- **DC Fast**: Charging power of 50 kW with charging time of 20-90 minutes.
- **DC High Power**: Charging power ranging from 150 to 350 kW+ with charging time of 10-20 minutes.
Public and commercial car charging – Use cases

Charging service should match charging application and demand

<table>
<thead>
<tr>
<th>Public and commercial EV Charging</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AC destination</strong></td>
</tr>
<tr>
<td>3-22 kW</td>
</tr>
<tr>
<td>4-16 hours</td>
</tr>
</tbody>
</table>

- Office, workplace
- Home
- Multi family housing
- Hotel and hospitality
- Overnight fleet
- Supplement at DC charging sites for PHEVs

- Office, workplace
- Multi family housing
- 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 areas
- City ring service stations
- OEM R&D
<table>
<thead>
<tr>
<th>Models</th>
<th>EVLunic B</th>
<th>Entry level chargers with basic options</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EVLunic B+</td>
<td>Entry level chargers, with full power range available and with authentication options</td>
</tr>
<tr>
<td></td>
<td>EVLunic Pro S</td>
<td>Smart chargers with energy meter, connectivity, OCPP and load balancing through a smart master</td>
</tr>
<tr>
<td></td>
<td>EVLunic Pro M</td>
<td>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</td>
</tr>
</tbody>
</table>
## EVLunic AC Wallbox
### Portfolio details

**Options**

<table>
<thead>
<tr>
<th>Outlet type</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Type 2 AC socket</td>
</tr>
<tr>
<td>-</td>
<td>Type 2 AC socket with shutters</td>
</tr>
<tr>
<td>-</td>
<td>Type 2 AC cable 4m</td>
</tr>
<tr>
<td>-</td>
<td>Type 2 AC cable 6m</td>
</tr>
<tr>
<td>-</td>
<td>Type 1 AC cable 4m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum power</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>4.6 kW</td>
</tr>
<tr>
<td>-</td>
<td>11 kW (type 2 cable models only)</td>
</tr>
<tr>
<td>-</td>
<td>22 kW (type 2 models only)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Authentication</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>None</td>
</tr>
<tr>
<td>-</td>
<td>Key (B+ models only, cylinder can be replaced)</td>
</tr>
<tr>
<td>-</td>
<td>RFID (MIFARE)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UMTS/3G</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>No</td>
</tr>
<tr>
<td>-</td>
<td>Yes (Pro_M models only)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pedestals (sold separately)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>None (wall mounted)</td>
</tr>
<tr>
<td>-</td>
<td>Pedestal for one wallbox</td>
</tr>
<tr>
<td>-</td>
<td>Pedestal for two wallboxes back to back</td>
</tr>
<tr>
<td>-</td>
<td>Pedestal for two wallboxes at a 90 degrees angle</td>
</tr>
</tbody>
</table>
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 mm² for 32 A supply
Public and commercial car charging – Use cases

Charging service should match charging application and demand

### Public and commercial EV Charging

<table>
<thead>
<tr>
<th>AC destination</th>
<th>DC destination</th>
<th>DC Fast</th>
<th>DC High Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-22 kW</td>
<td>20-25 kW</td>
<td>50 kW</td>
<td>150 to 350 kW+</td>
</tr>
<tr>
<td>4-16 hours</td>
<td>1-3 hours</td>
<td>20-90 min</td>
<td>10-20 min</td>
</tr>
</tbody>
</table>

- **Office, workplace**
- **Home**
- **Multi family housing**
- **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 areas**
- **City ring service stations**
- **OEM R&D**
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.
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$^2$

Cable diameter 22 – 32 mm
Public and commercial car charging – Use cases

Charging service should match charging application and demand

<table>
<thead>
<tr>
<th>Public and commercial EV Charging</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AC destination</strong></td>
</tr>
<tr>
<td>3-22 kW</td>
</tr>
<tr>
<td>4-16 hours</td>
</tr>
</tbody>
</table>

- 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 areas
- City ring service stations
- OEM R&D
Multi-standard charger solution Terra 54 & Terra 24

General explanation of naming convention

<table>
<thead>
<tr>
<th>Terra 54 (50kW)</th>
<th>Terra 24 (20kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C - (Combo) = Combined Charging Systems (CCS)</td>
<td>J - (Japan) = CHAdeMO</td>
</tr>
<tr>
<td>T - (Socket) = Type 2 Socket</td>
<td>G - (Grid) = Cable + Type 2 Connector</td>
</tr>
</tbody>
</table>

- DC
- AC

CHAdemo

HV = High Voltage
CCS: 200-920 V
CHAdeMO: 150-500 V
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:

<table>
<thead>
<tr>
<th>Model</th>
<th>DC+AC Charger</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terra 54HV CT</td>
<td>DC+AC Charger</td>
<td>50 kW DC CCS-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22 kW AC</td>
</tr>
<tr>
<td>Terra 54HV CG</td>
<td>DC+AC Charger</td>
<td>50 kW DC CCS-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>43 kW AC (also 22kW version)</td>
</tr>
<tr>
<td>Terra 54HV CJ</td>
<td>DC Charger</td>
<td>50 kW DC CCS-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50 kW DC CHAdeMO</td>
</tr>
<tr>
<td>Terra 54HV CJG</td>
<td>DC + AC Charger</td>
<td>50 kW DC CCS-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50 kW DC CHAdeMO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>43 kW AC</td>
</tr>
<tr>
<td>Terra 54HV CJT</td>
<td>DC+AC Charger</td>
<td>50 kW DC CCS-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50 kW DC CHAdeMO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22 kW AC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22 kW AC</td>
</tr>
</tbody>
</table>

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 mm² 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
### Public and commercial car charging – Use cases

Charging service should match charging application and demand

<table>
<thead>
<tr>
<th>Public and commercial EV Charging</th>
<th>AC destination</th>
<th>DC destination</th>
<th>DC Fast</th>
<th>DC High Power</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AC destination</strong></td>
<td>3-22 kW</td>
<td>20-25 kW</td>
<td>50 kW</td>
<td>150 to 350 kW+</td>
</tr>
<tr>
<td><strong>DC destination</strong></td>
<td>4-16 hours</td>
<td>1-3 hours</td>
<td>20-90 min</td>
<td>10-20 min</td>
</tr>
<tr>
<td><strong>Use cases</strong></td>
<td>Office, workplace</td>
<td>Office, workplace</td>
<td>Retail, grocery, mall, big box, restaurant</td>
<td>Highway corridor travel</td>
</tr>
<tr>
<td></td>
<td>Home</td>
<td>Hotel and hospitality</td>
<td>High turnover parking</td>
<td>Metro ‘charge and go’</td>
</tr>
<tr>
<td></td>
<td>Multi family housing</td>
<td>Parking structures</td>
<td>Convenience fueling stations</td>
<td>Highway rest stops</td>
</tr>
<tr>
<td></td>
<td>Hotel and hospitality</td>
<td>Dealerships</td>
<td>Highway truck stops and travel plazas</td>
<td>Petrol station areas</td>
</tr>
<tr>
<td></td>
<td>Overnight fleet</td>
<td>Urban fleets</td>
<td>OEM R&amp;D</td>
<td>City ring service stations</td>
</tr>
<tr>
<td></td>
<td>Supplement at DC charging sites for PHEVs</td>
<td>Public or private campus</td>
<td></td>
<td>OEM R&amp;D</td>
</tr>
</tbody>
</table>
### ABB High power charging 2018-2025

Toward 15 minute charging – 250 miles driving

#### Current specification, subject to standardization

<table>
<thead>
<tr>
<th></th>
<th>CCS</th>
<th>CHAdeMO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating voltage range:</strong></td>
<td>200 – 920 V&lt;sub&gt;dc&lt;/sub&gt;</td>
<td>150 – 920 V&lt;sub&gt;dc&lt;/sub&gt;</td>
</tr>
<tr>
<td><strong>Current:</strong></td>
<td>375 A (with 1 power cabinet)</td>
<td>200 A</td>
</tr>
<tr>
<td></td>
<td>500 A (with 2 power cabinets)</td>
<td></td>
</tr>
<tr>
<td><strong>Max. peak power level:</strong></td>
<td>350 kWp</td>
<td></td>
</tr>
<tr>
<td><strong>Charging cable &amp; connector:</strong></td>
<td>CCS 1&amp;2: Small diameter, active liquid cooling</td>
<td>CHAdeMO: conventional</td>
</tr>
</tbody>
</table>
Towards 15 minute charging – 250 miles driving

- Terra 54
- Terra HP – 1 cabinet
- Terra HP – 2 cabinets

**Dynamic DC:** patented by ABB

<table>
<thead>
<tr>
<th>1 cabinet expansion</th>
<th>2 cabinet expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power expansion</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>50 kW</th>
<th>175 kW_p</th>
<th>350 kW_p</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 A</td>
<td>375 A</td>
<td>500 A</td>
</tr>
</tbody>
</table>

- 3½x more power
- 7x more power
- 3x higher current
- 4x higher current

©ABB
November 15, 2019 | Slide 37
ABB’s Dynamic DC: A futureproof & field upgradeable system
Power sharing between power cabinets

175 kWp
Single system

2 x 350 kWp

Upgrade

Dynamic DC

175 kWp for two normal cars simultaneously
350 kWp available on each charge post for high-end cars

- 350 kWp
  high-end car

- 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\(^1\)

- 175 kWp Single system
- Upgrade
  - 2 x 350 kWp
  - Upgrade
  - 2 x 350 kWp
  - Upgrade
  - 2 x 500 kW\(^1\)

More BEVs with higher charging power on the road

Build up network & functionality according to market growth

\(^1\) 500 kW option depending on standardization
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

1 50-90% depends on exact time of arrival/ departure moment of both cars, SOC, etc.
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

©ABB
November 15, 2019 | Slide 42

1 50-90% depends on exact time of arrival/ departure moment of both cars, SOC, etc.
High Power charging
Installation – electrical configurations

175 kW system

350 kW system

1 50-90% depends on exact time of arrival/ departure moment of both cars, SOC, etc.
High Power charging
Installation – electrical configurations

350 kW Dynamic DC system

AC cable to Power Cabinet: maximum 240 mm$^2$

DC cable between Power Cabinet and Charge Post:
185 mm$^2$ – 240 mm$^2$ (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

<table>
<thead>
<tr>
<th>Location</th>
<th>Company</th>
<th>Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luxembourg, Lux Ville de Luxembourg</td>
<td>MDDI &amp; Sales Lentz</td>
<td>4 x HVC 150P</td>
</tr>
<tr>
<td>Namur &amp; Charleroi, BE TEC</td>
<td>TEC</td>
<td>15 x HVC 150P</td>
</tr>
<tr>
<td>Harrogate, UK Transdev</td>
<td>Transdev</td>
<td>3 x HVC 300P</td>
</tr>
<tr>
<td>La Rochelle, Fra Transdev</td>
<td>Transdev</td>
<td>3 x 150kW CCS2</td>
</tr>
<tr>
<td>Trondheim, NO Trondelag</td>
<td>HeuliezBus</td>
<td>8 x HVC 450P</td>
</tr>
<tr>
<td>Ostersund, SE Nettbus</td>
<td>Scania</td>
<td>2 x HVC 300P</td>
</tr>
<tr>
<td>Gothenborg, SE Volvo Busar</td>
<td>Scania Buses</td>
<td>1 x HVC 150P, 1 x HVC 300P, 1 x HVC 150C, R&amp;D</td>
</tr>
<tr>
<td>Södertälje, SE Scania Buses</td>
<td></td>
<td>1 x HVC 300P, R&amp;D test track</td>
</tr>
<tr>
<td>Plattsburgh, USA Novabus</td>
<td></td>
<td>1 x HVC 300P</td>
</tr>
<tr>
<td>Singapore</td>
<td></td>
<td>NTU Test track, 2 x HVC 300P</td>
</tr>
<tr>
<td>Munich, DE &amp; AT MAN Truck &amp; Bus</td>
<td>MAN Truck &amp; Bus</td>
<td>7 x HVC 150C, R&amp;D</td>
</tr>
</tbody>
</table>
3 main ways of charging buses

ABB supports all standardized solutions supported by main Bus OEMs

- CCS 2 connector
- Pantograph Up (PU)
- Pantograph Down (PD) - OppCharge
Connection to back-office & payment systems

Manage, monitor and connect to your business
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

- Audi
- BMW
- Daimler
- Ford
- GM
- Mitsubishi
- Nissan
- Peugeot
- Porsche
- Renault
- Tesla
- Volkswagen

Charging infrastructure

- CCS
- CHAdeMO
- GB
- AC

Solutions to run a charger network

- ABB
- Microsoft Azure
- NTT DATA
- Bosch
- Fortum
- Gridpoint
- NOW! Innovations
- CGI
- has-to-be eMobility
- Chargedcloud
- Pod Point
- Giant Leap Technologies
- Mobile
- Greenlots
- Ventryx

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

- Demand response
- Distribution system management
- Using alternative energy sources

Grid-side Functionality

Integration with APIs & advanced web tools

Consumer Functionality
- Authentication and billing
- Subscriber management
- Operational B2C services

Charger Management Functionality
- Hardware and software checks
- Charger management
- Charger maintenance

©ABB
November 15, 2019 | Slide 51
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 3rd 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

![Diagram showing the integration process]

- ABB EVCI platform
- Operator back-office, B2C functionality
- API based integration (OCPP)
- ABB managed connectivity with extended protocol
- Web tools customer
- Web tools ABB service

©ABB  November 15, 2019  Slide 52  SaaS (Software as a Service): for yearly fee per charger the APIs and web tools are made available to the customer
Digital integration of an ABB EV charger

OCPP 1.5 Single Uplink or OCPP 1.6 Dual Uplink

Network Operations Center (NOC)

Operator back-office, B2C functionality

API based integration (OCPP)

ABB managed connectivity with extended protocol

Web tools

customer

Web tools

ABB service

Direct OCPP

Extended protocol

Web tools

ABB service

WEB tools

customer

WEB tools

ABB service

©ABB
November 15, 2019 | Slide 53
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.

Secure connectivity of chargers monitored 24/7 by the Network Operation Center NOC.

ABB Connected Services Platform
on Azure Cloud 4 redundant systems in 2 locations

Server 1  Server 2  Server 3  Server 4

OCPP Server Operator

Other Applications

Driver Care Charger Care Web tool payment

Helios/EVE for ABB Service Organisation

OCPP API, POI API, ...

Driver Care Charger Care Web tool payment

Secure connectivity of chargers monitored 24/7 by the Network Operation Center NOC

©ABB
November 15, 2019  Slide 54
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