Electric vehicle charging
Infrastructure, market and connectivity

An ABB Specification Team Training Series Presentation
Knowledge Check

Learning objectives

- In line with the consultation which closed 7 October 2019, an understanding of the new building regulations
- Full consideration of the market, European open protocol standards and segmentation by product.
- Consideration of the difference between DC and AC charging within buildings
- The back office, connected services and solutions to run a charger network
Proposed changes to building regulations
Expected Q3 2021

**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
- New standards on energy smart appliances (PAS1878 and PAS1879)

**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 >85 countries

and ABB manufacturing.
ABB, eMobility and EV Charging
ABB’s focus and investments in eMobility

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.
The I-PACE is 2019 World Car of the Year.
ABB provides 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

- R&D partners
  - DC fast chargers at dealers
  - Global partnership R&D partners
  - Partnership R&D partners
  - DC charging testing & R&D
  - R&D partners
  - DC fast chargers at dealers
  - R&D partners
  - DC Wallbox Formula E
  - R&D partners
  - Swiss market activation
  - DC charging testing & R&D
  - R&D partners
  - Bus R&D partners
  - Cooperation R&D partners
  - Truck R&D & joint project
  - R&D partners
  - Joint projects
  - R&D partners
  - Cooperation R&D partners
  - Cooperation R&D partners
  - Joint projects
  - R&D partners
  - Cooperation R&D partners
  - Cooperation R&D partners
  - Joint projects
  - R&D partners
  - DC wall box for Denza EV
ABB offers end-to-end solutions for the complete value chain

Your one-stop shop for e-mobility infrastructure

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

AC chargers
- Terra AC

DC fast chargers
- Terra systems

E-bus chargers
- HVC 150

Energy Management
- EV Site Solution

Integrated solutions
- Energy storage
- eHouse with chargers

Substations
- Transformers

Charging network software services
- ABB Ability

Building automation
- KNX, energy mngr.

Components
- DIN rail & LV and MV distribution boards

Renewable integration
- HVDC, solar, wind

Service
- Asset management
- Extensions, upgrades & retrofits
- Installation & commissioning
Market (cars & standards)
Follow the car through Europe, and open standard protocols

- All cars can be charged with AC via the On-Board Converter (OBC) of the car.
- Fast charging is realized via DC charging.
ABB is following the Car-OEM’s Fast Charging standards

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

Very roughly said: A standard in fact is defined as the combination of the physical connector + the communication protocol
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
AC charging versus DC charging
On-board versus Off-board equipment

Every vehicle needs to have its own onboard equipment
Infrastructure investment is shared with hundreds of users
Market segments & products
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>
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- 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
Public and commercial car charging – Use cases

Charging service should match charging application and demand

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[Image of charging stations]
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AC Wallbox

Product features

**Built in safety**
- overcurrent
- overvoltage, undervoltage
- ground fault
- Surge protection

**Metering**
- Built in energy meter (1% accurate)
- *MID option*
- Power management / smart charging

**Connectivity**
- 1 x Ethernet,
- 1 x Bluetooth 5.0
- Wi-Fi
- *4G option*
- OCPP1.6
- RS485

**Authentication**
- Smartphone
- *RFID option*

**Prepared features**
- 2x Ethernet (daisy chain)
- ISO 15118 (plug & charge and V2G)
- PTB certification
- Display

**APP**
- Authentication & control of the charging
- Configuration of the charger & a charger network

**Installation**
- 40 A supply (7 kW 1 phase, 22 kW 3 phase)
- Type A RCD – one needed per charger
- 6 mm² – 10 mm² cable
Pedestals and accessories

**Plastic adapter box**

- Plastic box on a standard 60 mm pole with ground plate
- Room for 5 x 4-slot DIN rail components
- IP54
- Sold with and without pole
- Can hold one or two chargers back-to-back
- Space saving cost efficient solution

**Metal pedestals**

- Metal, free standing
- Room for 6 x 4-slot DIN rail components
- IP54
- Offers a big space for customized foiling
- Can hold one or two chargers back-to-back
- Basic versions without DIN rails available for 1 or 2 chargers

Other accessories: extra RFID cards, spare cables and charge cables (T2-T2 and T2-T1)
### Public and commercial car charging – Use cases

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- Urban fleets
- Public or private campus
- Sensitive grid applications

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This 920 V DC wallbox is available in the following configurations:
- Single outlet CCS2
- Dual outlet CCS2 + CHAdeMO

Available with 3.5m or 7m cable

EMC Class B

The connector holders for outside use have to be ordered separately.
If RCD is required, then a Type B high immunity device should be used

40 A supply

Cable CSA – maximum 35 mm²

Cable diameter 22 – 32 mm
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Multi-standard charger solution Terra fast chargers

General explanation of naming convention

<table>
<thead>
<tr>
<th>Terra 24</th>
<th>(20kW)</th>
<th>C - (Combo) = Combined Charging Systems (CCS) - DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terra 54</td>
<td>(50kW)</td>
<td>J - (Japan) = CHAdeMO - DC</td>
</tr>
<tr>
<td>Terra 94</td>
<td>(90kW)</td>
<td>Z - (China) = GB - DC</td>
</tr>
<tr>
<td>Terra 124</td>
<td>(120kW)</td>
<td>T - (Socket) = Type 2 Socket - AC</td>
</tr>
<tr>
<td>Terra 184</td>
<td>(180kW)</td>
<td>G - (Grid) = Cable + Type 2 Connector - AC</td>
</tr>
</tbody>
</table>

HV = High Voltage
CCS: 200-920 V
CHAdeMO: 150-500 V
Terra x4
High Voltage Charger: for cars with drive trains of 400 V and 800/900 V

Available for the Terra 54, 94, 124 and 184

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
Terra EV Fast Charger
Power modules and upgradability

Terra 24
- Based on 2 (Terra 24) and 5 (Terra 54) 10 kw power modules
- Almost 10.000 chargers installed worldwide
- Terra 24 is upgradable to Terra 54
- Terra 54 is available also in High Voltage variant (150-920 Vdc)

Terra 54
- Based on new 30 kw power modules
- Terra 94 and 124 upgradable to higher power rating, up to 180 kW
- Terra 54 cannot be upgraded to the new power modules due to different rating of the electrical components
- Terra 94-124-184 provide High Voltage capability (150-920 Vdc)
Terra EV Fast Charger
Power modules layout

Mode 1 - Full power on outlet 1 OR outlet 2

Mode 1 - Full power on outlet 1 OR outlet 2

Mode 2 – Each outlet can deliver up to 50% of total power
Terra EV Fast Chargers
Power allocation strategies

Sequential

Outlet 1 OR 2 always charge at up to 120 kW (Terra 124) or 180 kW (Terra 184). The outlets are mutually available.

Concurrent

Outlet 1 and 2 can always charge at up to 60 kW (Terra 124) or 90 kW (Terra 184). Both outlets always available.

Dynamic (FIFO)

If EV-1 can charge at more than 60 kW (Terra 124) or 90 kW (Terra 184), the charger allocates all the power to that EV. Outlet 2 is not available during the charging session. Otherwise, both outlets are available delivering up to 60 kW (Terra 124) or 90 kW (Terra 184).

Dynamic (SHARE)

If EV-1 can charge at more than 60 kW (Terra 124) or 90 kW (Terra 184), the charger allocates all the power to that EV. Outlet 2 is available and if a second EV connects, the power is shared equally, up to 60 kW (Terra 124) or 90 kW (Terra 184).
Highway and metropolitan segment

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

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

Input AC rating:
- 50 kW: 88 A (DC outlets) – 143 A (DC + AC outlets)
- 90 kW: 140 A (DC) – 170 A (DC + AC)
- 120 kW: 187 A (DC) – 217 A (DC + AC)
- 180 kW: 280 A (DC) – 310 A (DC + AC)
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ABB High power charging 2018-2025
Toward 15 minute charging – 250 miles driving

Current specification, subject to standardization

<table>
<thead>
<tr>
<th>Operating voltage range:</th>
<th>CCS: 200 – 920 V&lt;sub&gt;dc&lt;/sub&gt;</th>
<th>CHAdeMO: 150 – 920 V&lt;sub&gt;dc&lt;/sub&gt;</th>
</tr>
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<tbody>
<tr>
<td>Current:</td>
<td>CCS: 375 A (with 1 power cabinet)</td>
<td>500 A (with 2 power cabinets)</td>
</tr>
<tr>
<td></td>
<td>CHAdeMO: 200 A</td>
<td></td>
</tr>
<tr>
<td>Max. peak power level:</td>
<td>350 kWP</td>
<td></td>
</tr>
<tr>
<td>Charging cable &amp; connector:</td>
<td>CCS 1&amp;2: Small diameter, active liquid cooling</td>
<td>CHAdeMO: conventional</td>
</tr>
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</table>
ABB High power charging 2018-2025
Towards 15 minute charging – 250 miles driving

Terra 54

Terra HP – 1 cabinet

Terra HP – 2 cabinets

Dynamic DC: patented by ABB

Power expansion

1 cabinet expansion

2 cabinet expansion

Terra 54

Terra HP – 1 cabinet

Terra HP – 2 cabinets

- 3½x more power
- 7x more power

- 3x higher current
- 4x higher current

50 kW → 175 kWp → 350 kWp

125 A → 375 A → 500 A
ABB’s Dynamic DC: A future proof & field upgradeable system

Power sharing between power cabinets (expected November 2019)

- **175 kWp** Single system
- **2 x 175 kWp** Dual system

**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 future proof & field upgradeable system

Power sharing between power cabinets

- **175 kWp Single system**
- **2 x 175 kWp Dual system**
- **3 x 175 kWp Triple system**
- **4 x 175 kWp Quadruple system**

More BEVs with higher charging power on the road

Build up network & functionality according to market growth

- **2017**
- **2018**
- **2019**
- **2020**
- **2021**
- **2022**
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

AC cable to Power Cabinet: maximum 240 mm²

DC cable between Power Cabinet and Charge Post:
185 mm² – 240 mm² (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.
High Power charging
Installation

Positioning of multiple cabinets

- **2 x 175 kW**
  - Height: 2078 mm
  - Width: 1540 mm
  - Depth: 1170 mm

- **6 x 175 kW**
  - Height: 3500 mm
  - Width: 1740 mm

- **4 x 175 kW**
  - Height: 2540 mm
  - Width: 1540 mm

- **4 x 175 kW, alternative**
  - Height: 2340 mm
  - Width: 1740 mm

---

Electrical connection to power cabinet

3 Phase 400 V AC

- Main switch
- **OPTIONAL** Surge Protection Device (Class 1 or Class 1 + 2) with backup protection
- **OPTIONAL** Residual Current Breaker adjustable for 30 to 300 mA
- **315A** g50 Fuse
- **320A Circuit Breaker**
- **EMC Filter**
  - Schaffner: FN 335HV-400-99
  - Only needed when EMC conducted emission class B is required.

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

Overnight charging (at the depot)

Opportunity charging (on route or end stop)
eBus charging landscape

- **Overnight charging** (at the depot)
- **Connector charging**
- **Pantograph charging**
- **Opportunity charging** (on route or end stop)
Electric bus charging landscape
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
## HVC Product portfolio

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<tr>
<th>Power</th>
<th>24kW</th>
<th>50kW</th>
<th>100kW</th>
<th>150kW</th>
<th>300kW</th>
<th>450kW</th>
<th>600kW</th>
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<tbody>
<tr>
<td><strong>Connector</strong></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DC-Wallbox</td>
<td>Terra 54HV</td>
<td>HVC 100C 1-3 depot box</td>
<td>HVC 150C 1-3 depot box</td>
<td></td>
<td></td>
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| **Pantograph Down** | | | | | | | |
| HVC 150PD kit / HVC 150PD | HVC 300PD | HVC 450PD | HVC 600PD |

| **Pantograph Up** | | | | | | | |
| Terra 54HV PU | HVC 100PU-S / HVC 100PU | HVC 150PU-S / HVC 150PU | HVC 300PU | HVC 450PU | HVC 600PU |
Local Interface based on OPC UA
Why onsite load management?
Business case example

**Without load management:**
Charging of 11 vehicles @ 50 kW
Peak consumption: 450 kW
Annual Energy Cost: 31,500€

**With load management:**
Charging of 11 vehicles @ 50 kW
Peak consumption: 200 kW (-55 %)
Annual Energy Cost: 14,000 €

- **CAPEX Savings**
  30,000 €
  (~ new 300 kW transformer + construction)

- **OPEX Savings**
  ~17,500 €/year
  (70 €/kW/year peak price)

- **ROI**
  Immediate

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Slide 47
Clear need for local interface used by many industries

“Advanced energy services”
- Weather Forecast
- Predictive load profiles
- Fleet schedules
- Energy trading
- Bi-directional inc. V2G

“Charging site”
“Site energy optimization”
“Peak shaving”
“Don’t blow the fuse”

OPC UA field bus

Charger
Charger
Charger
Charger
Charger
BESS
Solar
Wind
Buildings
Substation

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Onsite load management

“Don’t blow the fuse” with EVSS Control 100

Remote Access:
- Customer
- 1st line service local ABB
- 2nd line PG-service

“Charging site”

- EVSS Control 100
- OPC UA field bus
- ABB chargers with OPC UA interface
- Terra 54, Terra HP, Terra 94/124/184, HVC
- Secure link

- Substation
- Mission critical

Connect up to max. 10 OPC UA field devices with the standard product EVSS Control 100

Increase the # of connected OPC UA field devices connected to the Control 100 to max. 50 in total with the EVSS Extension switch

ABB chargers with OPC UA interface
Connection to back-office & payment systems
Manage, monitor and connect to your business
Run a successful and profitable business with connected ABB chargers

Connectivity is needed to:

1. Monitor and operate a network of chargers
2. Get paid for charge sessions
3. Help EV-drivers in case of questions
4. Maintain and service chargers at the lowest cost

Reliable 24/7 connectivity is fundamental for the commercial operation of a network of chargers!
The ABB Ability platform: years of experience and thousands of connected EV chargers

Connected Services are required to successfully run a commercial charger network

Reliable 24/7 connectivity is fundamental for the commercial operation of a network of chargers!
Positioning connected services

Electric cars

- Audi
- BMW
- DAIMLER
- Ford
- GM
- MITSUBISHI
- Nissan
- Peugeot
- Porsche
- Renault
- Tesla
- VW

Charging infrastructure

- CCS
- CHAdeMO
- GB
- AC

Solutions to run a charger network

- ABB Ability™
- Microsoft Azure
- MasterCard
- VISA
- VIRTU
- BOSCH
- Fortum
- NTT DATA
- GRIDPOINT
- CGI
- has-to-be eMobility
- chargecloud
- podPOINT
- MOBILE
- greenlots
- VENTYX

ABB does not have exclusive cooperation with any of the solutions
Digital integration of an ABB EV charger
OCPP 1.5 API compared to Direct OCPP 1.6

OCPP 1.5 API

- ABB Ability™
- ABB managed connectivity (extended protocol)
- Web tools ABB Service
- Web tools Customers
- API based integration (OCPP 1.5)

Direct OCPP 1.6 via Dual Uplink

- Operator back-office, B2C functionality
- Web tools ABB Service
- Web tools Customers
- Direct OCPP 1.6
- Extended protocol

©ABB
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.

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

OCPP Server Operator

Other Applications

Driver Care
Charger Care
Web tool payment

Helios/EVE for ABB Service Organisation

OCPP API,

POI API, ...

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

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.