A global leader in power and automation technologies
Leading market positions in main businesses

<table>
<thead>
<tr>
<th>Product Line</th>
<th>Revenues 2012</th>
<th>Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Products</td>
<td>$10.7 billion</td>
<td>36,000</td>
</tr>
<tr>
<td>Power Systems</td>
<td>$7.9 billion</td>
<td>20,000</td>
</tr>
<tr>
<td>Discrete Automation and Motion</td>
<td>$9.4 billion</td>
<td>29,000</td>
</tr>
<tr>
<td>Low Voltage Products</td>
<td>$6.6 billion</td>
<td>31,000</td>
</tr>
<tr>
<td>Process Automation</td>
<td>$8.2 billion</td>
<td>28,000</td>
</tr>
</tbody>
</table>

(2012 revenues)

- **ABB’s portfolio covers:**
  - Electricals, automation, controls and instrumentation for power generation and industrial processes
  - Power transmission
  - Distribution solutions
  - Low-voltage products
  - Motors and drives
  - Intelligent building systems
  - Robots and robot systems
  - Services to improve customers productivity and reliability
Why ABB?
Solutions for the whole EV charging value chain

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

DC Fast Chargers
- Terra systems

Charging Network Software Services
- Galaxy services
- OCPP / API

Energy storage
- B.E.S.S.

Power Quality
- PQF, PCS100

Substations
- Power systems

Grid Automation
- SCADA & Ventyx

Building Automation
- KNX, energy mngt.

Components
- DIN rail & distribution boards

Renewable Integration
- HVDC, solar, wind
Business Models require the merge of Power and IT. A consistent and clear positioning is key.
ABB DC fast charge installations
Proven technology in the field since May 2010

- **Actual:**
  Germany, Norway, The Netherlands, UK, Ireland, Finland, Denmark, Sweden, Switzerland, Austria, France, Czech, Estonia, Turkey, Hungary, Italy, Hong Kong, China, USA, Taiwan, Slovenia, South Africa, Belgium, Slovakia, Bulgaria, Poland, China, Canada, Chile, Singapore, Northern Ireland

- **Nearly 2000 DC fast chargers installed**
Connecting countries with fast-charging networks
Building experience, one nation at a time

Estonia
Estonia’s ELMO fast-charging network enables travel for EV drivers across the country, using technology provided by ABB. The chargers are installed in populated areas and on major roads throughout the country, creating one of the highest concentrations of charging infrastructure in Europe.

Highlights
- The world’s first nationwide EV fast charging network
- 165 connected DC fast chargers
- Deployed in cities and along highways
- Open payment options, support and services network

Netherlands
Fastned, with ABB providing the charging infrastructure, is building a large network of fast-charging stations with national coverage directly on the highways of the Netherlands.

Highlights
- 200+ fast chargers across the provinces of the Netherlands
- Multi-standard charging to meet the needs of more EV drivers
- Stations feature solar canopies to manage demand from the cars to the grid
- Open standards-based cloud connectivity gives Fastned a user-friendly payment and access service for all drivers

Canada
BC Hydro, an electric utility serving over 200,000 customers throughout western Canada, wanted to include fast charging as part of their Clean Energy Vehicle Program. ABB was selected to install several DC fast chargers around Vancouver and in popular tourism destinations in lower British Columbia.

Highlights
- Charging performance under rugged winter climate conditions
- Enabling drivers along the Canadian West Coast Green Highway
- Open network protocols allow operation with one network management solution

United States
Innovative companies like U-Go Stations are recognizing the regional business potential of DC charging for the average EV owner and deploying ABB charging technology and intelligent connectivity into their solution portfolio.

Highlights
- DC chargers to support East Coast electric vehicle drivers
- Open standard payment systems for easy network flexibility
- Multi-stage integration to allow for developing experience and response to market and industry changes
ABB’s Experience
The Global Leader in DC Charging Infrastructure

CE Units

- Estonia
  - Europe’s Largest:
  - 200 DC Chargers in 2012

- Norway
- Netherlands
- Belgium
- Ireland

- Denmark
  - 50 DC Chargers in 3 months

UL Units

- British Columbia
  - 13 DC Chargers in 2013
  - 7 ABB, 6 Eaton
  - GreenLots integration via OCPP
  - Ave Install ~ $65,000 USD

- Mexico
  - 6 DC Chargers to support
    Nissan LEAF taxi fleet
  - (Mexico City)

- East Coat
  - U-Go Stations rolling out
    network: DC to Boston
Fastned: Nationwide fast charging network  
More than 200 fast charging stations in the Netherlands

- Always a charger within 50km.
  - https://www.youtube.com/watch?v=AVDvF-GGchM (min 6-7)

- Each station equipped with several multi-standard fast chargers and solar canopies.

- Serving EVs from all major car brands, including CCS, CHAdeMO and Type-2 standards.

- ABB’s open standard cloud connectivity platform enables user-friendly payment and access for all drivers.

- Connectivity features include smart software upgradability enabling upgrades to the network as technology evolves.

- ABB’s remote servicing tools ensure best in class uptime and user satisfaction.
Denza

ABB selected for charging across China

- Joint venture between Diamler and BYD
  - (BDNT)
- The car
  - 200 km range
  - GBT Standard
    - Chinese government heavily behind this car/technology
- ABB’s contracted for 6-year rollout of EV chargers
  - servicing tools ensure best in class uptime and user satisfaction.
San Diego, CA; 1st public Combo1 charger in NAM
Charged both the BMW i3 & Chevrolet Spark EV
# Introduction

## Charging Standards

### SAE Charging Configurations and Ratings Terminology

<table>
<thead>
<tr>
<th><strong>AC level 1</strong> (SAE J1772™)</th>
<th><strong>DC Level 1</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>PEV includes on-board charger</td>
<td>EVSE includes an off-board charger</td>
</tr>
<tr>
<td>120V, 1.4 kW @ 12 amp</td>
<td>200-450 V DC, up to 36 kW (80 A)</td>
</tr>
<tr>
<td>120V, 1.9 kW @ 16 amp</td>
<td>Est. charge time (20 kW off-board charger):</td>
</tr>
<tr>
<td>PHEV: 7hrs (SOC* - 0% to full)</td>
<td>PHEV: 22 min. (SOC* - 0% to 80%)</td>
</tr>
<tr>
<td>BEV: 17hrs (SOC – 20% to full)</td>
<td>BEV: 1.2 hrs. (SOC – 20% to 100%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>AC level 2</strong> (SAE J1772™)</th>
<th><strong>DC Level 2</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>PEV includes on-board charger (see below for different types)</td>
<td>EVSE includes an off-board charger</td>
</tr>
<tr>
<td>240 V, up to 19.2 kW (80 A)</td>
<td>200-450 V DC, up to 90 kW (200 A)</td>
</tr>
<tr>
<td>Est. charge time for 3.3 kW on-board charger</td>
<td>Est. charge time (45 kW off-board charger):</td>
</tr>
<tr>
<td>PHEV: 3 hrs (SOC* - 0% to full)</td>
<td>PHEV: 10 min. (SOC* - 0% to 80%)</td>
</tr>
<tr>
<td>BEV: 7 hrs (SOC – 20% to full)</td>
<td>BEV: 20 min. (SOC – 20% to 80%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>AC level 3 (TBD)</strong></th>
<th><strong>DC Level 3 (TBD)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 20 kW, single phase and 3 phase</td>
<td>EVSE includes an off-board charger</td>
</tr>
<tr>
<td>*Not finalized</td>
<td>200-600V DC (proposed) up to 240 kW (400 A)</td>
</tr>
<tr>
<td>Voltages are nominal configuration voltages, not coupler ratings</td>
<td>Est. charge time (45 kW off-board charger):</td>
</tr>
<tr>
<td>Rated Power is at nominal configuration operating voltage and coupler rated current</td>
<td>BEV: 22 min. (SOC* - 0% to full)</td>
</tr>
<tr>
<td>Ideal charge times assume 90% efficient chargers, 150W to 12V loads and no balancing of Traction Battery Pack</td>
<td>BEV: 1.2 hrs. (SOC – 20% to full)</td>
</tr>
</tbody>
</table>

Notes:
1. BEV (25 kWh usable pack size) charging always starts at 20% SOC, faster than a 1C rate (total capacity charged in one hour) will also stop at 80% SOC instead of 100%
2. PHEV can start from 0% SOC since the hybrid mode is available.

Copyright SAE 2011

EV’s in North America: Who/When?
Which infrastructure is required?

**On the roads**

- **Only AC slow charging (3 – 7.2 kW)**
  - Toyota RAV4 EV
  - Ford Focus Electric
  - Nissan Leaf
  - Mitsubishi i-MiEV
  - Nissan Leaf
  - Zero Model S
  - Mitsubishi Outlander PHEV

- **CHAdeMO DC fast charging**
  - Mitsubishi i-MiEV
  - Nissan Leaf
  - Chevrolet Spark EV
  - Tesla Roadster

- **CCS “Combo” DC fast charging**
  - Toyota Prius Plug-in
  - Honda Fit EV
  - Tesla Model S
  - Chevy Volt

- **Specials (proprietary)**
  - Tesla Model S
  - Tesla Model X
  - Cadillac ELR
  - Toyota RAV4 EV

**Beyond**

- **2014**
  - Honda Accord Plug-In
  - Volkswagen e-Golf
  - Nissan e-NV200
  - Toyota Prius Plug-in
  - Honda Fit EV

- **Beyond**
  - BMW x5
  - Mercedes B-class EV
  - KIA Soul EV
  - BMW i3
  - Volkswagen e-Golf
  - BMW i8
  - Buddy trucks

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## Introduction

### Charging Standards

<table>
<thead>
<tr>
<th>SAE J1772 AC</th>
<th>CHAdeMO</th>
<th>SAE J1772 CCS (Combo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC; &lt; 19.2 kW</td>
<td>DC; &lt; 62.5 kW</td>
<td>DC; &lt; 90 kW</td>
</tr>
<tr>
<td>Typical 3.3, 6.6 kW</td>
<td>Typical 20-50 kW</td>
<td>20-50 kW</td>
</tr>
<tr>
<td>4-8 Hour Charge</td>
<td>15-60 min. Charge</td>
<td>15-60 min. Charge</td>
</tr>
</tbody>
</table>

“Universal”

- KIA
- NISSAN
- MITSUBISHI MOTORS
- GM
- BMW
- Porsche
- Volkswagen
- Mercedes-Benz
- TESLA
- SUBARU
- TOYOTA
- Zero Motorcycles

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Use cases in electric vehicle charging
Different solutions for each specific use case

- **Highway / En-route**
  - DC Charging - CHAdeMO
  - 15-30 minutes

- **Office**
  - AC & DC charging
  - 30-120 min. (fast)
  - 8 hours (workday)

- **Commercial**
  - DC & AC charging
  - 30-120 min. (fast)

- **Home**
  - AC & DC charging
  - 8 hours (overnight)
  - 2 hours (top-off)
AC and DC Charging Overlap
Fitting the EV driver’s lifestyle

DC Charging
(10 to 40 minutes)
- Convenience Stores
- Grocery Stores
- Highway / Rest Area
- Retail Shops
- Office (meeting)

Overlap
(30 to 90 minutes)
- Valet
- Theaters
- Malls
- Gym
- City Parking
- College campus

AC Charging
(1 to 8+ hours)
- Home
- Office (workday)
DC charging versus AC charging
On-board versus Off-board equipment

- Every vehicle needs to have its own onboard equipment
- Infrastructure investment is shared with hundreds of users
Terra 53 Charge Station
The dual-standard DC fast charger

- Intelligent web-connected DC charger
- 15-30 minutes charge time
- All-in-one design for CHAdeMO & SAE Combo

<table>
<thead>
<tr>
<th>Product</th>
<th>Terra 51</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Input</td>
<td>3Φ, 480 VAC±10%</td>
</tr>
<tr>
<td>Maximum output power</td>
<td>DC 50kW</td>
</tr>
<tr>
<td>Output voltage</td>
<td>50-500 V</td>
</tr>
<tr>
<td>Output current</td>
<td>120A</td>
</tr>
<tr>
<td>Efficiency</td>
<td>&gt; 92%</td>
</tr>
<tr>
<td>Power factor</td>
<td>&gt; 0.98</td>
</tr>
<tr>
<td>RFID system</td>
<td>13.56MHz, ISO 14443A</td>
</tr>
<tr>
<td>Communication</td>
<td>CDMA / 3G / Ethernet</td>
</tr>
<tr>
<td>Protection class</td>
<td>Type 3R</td>
</tr>
<tr>
<td>Temperature range</td>
<td>-35°C … +40 °C, with low-temp option</td>
</tr>
<tr>
<td>Software</td>
<td>Remote update / download</td>
</tr>
<tr>
<td>User interface</td>
<td>High brightness full color touchscreen HMI, RFID &amp; Credit Card reader options</td>
</tr>
</tbody>
</table>
Data Architecture
Designed for reliability and security

Houston APIs
Your data can be accessed via a Houston API, a reliable server-to-server interface which enables you to connect your own back office or user administration system directly to your charging network.

Galaxy
Via your Galaxy web interface you have the ability see real time status, charger usage and energy delivered of your sites and configure the chargers at your sites. Galaxy utilises a secure HTTPS connection to access your data.

Houston server
Your data is professionally stored at an independent third party data center, utilising strict security standards and professional backup systems. Software updates go via Houston, separated from your data. ABB cannot access your raw data.

Data transportation
Your charger data, settings and software updates are transported via a secure connection. ABB uses TLS and X509 certificates, a security standard widely used to protect classified industrial and government information.

ABB Network Operations Center
The ABB Network Operations Center (NOC) is always stand-by to provide online support and field service assistance. The NOC will keep your software updated and helps you to improve the performance of your operation.
Key Takeaways

- DC Charging is not damaging to batteries
  - Boundaries of actual DC charging are blurring
  - (All battery charging is DC charging)
- DC Charging infrastructure builds “Range Confidence” and results in higher BEV sales and public support
- Installations can get very expensive
  - Workplace charging can consider sponsoring DC nearby
- There is no “standards war”
  - First UL Terra 53CJ installed in August 2014
- Defining up-time requirements is critical
  - What is it worth?
  - Network flexibility is key
Contact information

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