Revolutionizing Fast Charging for Electric Vehicles

ABB* charging stations, built with Intel® processors, enable new business opportunities based on solutions for short and long stay customers.

The proliferation of electric vehicles (EVs), such as the Nissan* Leaf* and the Mitsubishi* i-MiEV*, are getting a boost from new charging solutions that allow drivers to quickly recharge and keep going. Today, a typical EV has a range of approximately 150 km (90 miles), which requires drivers to recharge their cars quite often, either from standard household connections or at public charging stations.

Key to increasing the adoption of electric vehicles is addressing consumers’ fears of running out of charge and getting stranded. This concern, commonly known as range anxiety, can be alleviated by a pervasive network of fast charging systems capable of recharging vehicles in 15 to 120 minutes, much faster than the eight or so hours required by standard residential systems. Such networks are being deployed countrywide in Belgium and Estonia, where 200 of ABB*’s fast charging systems are installed no more than 50 km (30 miles) apart on main roads.

This paper describes how ABB’s Terra Smart Connect* (SC) and Terra SC Duo* charging stations open the door to new business opportunities for companies looking to offer convenient electric vehicle charging to short and long stay customers. The station, based on the Intel® Atom™ processor, will charge a car in 30 minutes to two hours while the driver works in the office, goes shopping or to the cinema, or has a meal. The Intel Atom processor was selected because of its high performance, multitasking capabilities, integrated graphics, low power consumption and exceptional connectivity used to support pin code and RFID authorization via GPRS. The processor also helps the charging stations deliver exceptional flexibility and reliability, which are critical requirements in this industry.

“The Terra SC and Terra SC Duo are specifically designed for convenient fast charging in commercial and office areas.”

Gert Miedema
Senior Product and Marketing Manager
EV Charging Infrastructure
ABB
The launch of the Terra SC* and the Terra SC Duo*, demonstrates our commitment to deliver the optimal charging solution for every possible location in the network—both in terms of functionality and affordability,” said Gert Miedema of ABB.

Electric Vehicle Charging Methods

Today’s technology supports two charging methods: an alternating current (AC) on-board charger (slow and fast charging) and a direct current (DC) off-board charger (fast charging), as illustrated in Figure 1.

Table 1 provides a list of charger market segments and the equipment available to serve them.

At home or at work locations, vehicles are typically charged using an AC wallbox, which takes about eight hours. When on the road, people can use public AC charge posts or DC fast chargers, depending on their needs and the car they’re driving.

For charging operators, DC fast chargers typically require a higher initial investment than AC slow chargers, but the required time per charging session is considerably lower. That’s because DC chargers produce much more power; they can charge a vehicle in 15 minutes to two hours, compared with up to 8 hours when using an AC charge post. As a consequence, 20 kW DC chargers, for instance, can serve up to 15 vehicles a day, while AC charge posts can serve only 1 to 2 cars.

This difference in service capability is a critical factor in the business model of the various charging methods; although the faster charging methods often have higher equipment cost, the return on investment is, in many cases, better. Because of the higher throughput, DC chargers also ensure a much more efficient use of high-cost parking spaces in urban areas compared to AC chargers.

All electric cars currently on the market can be slow-charged using AC charging equipment. In addition, more and more electric vehicle models support 15 to 120 minute DC fast charging. In the near future, some cars will use an on-board charger that allows for an AC fast charge.

<table>
<thead>
<tr>
<th>Market Segments</th>
<th>Equipment</th>
<th>Charge Time / Service Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office/Home (Work/Sleep &amp; Charge)</td>
<td>AC Wallbox</td>
<td>4 – 8 hours 1 - 2 vehicles/day</td>
</tr>
<tr>
<td>Public (e.g., Parking Lot)</td>
<td>AC Charge Post</td>
<td>4 – 8 hours 1 - 2 vehicles/day</td>
</tr>
<tr>
<td>Commercial/Office (Park &amp; Charge)</td>
<td>Convenient Fast Charger DC 20 kW AC 22 kW</td>
<td>30 – 120 minutes 10 - 15 vehicles/day</td>
</tr>
<tr>
<td>Highway (Charge &amp; Go)</td>
<td>Fast Charger DC 50 kW AC 43 kW</td>
<td>15 – 30 minutes 12 – 24 vehicles/day</td>
</tr>
</tbody>
</table>

Table 1. Segmentation: Different Charging Solutions for Different Applications
Daily charging practices
Fleets and companies typically use slow chargers installed in parking lots during the day, and most consumers use them at night when their cars are parked at home. Those who travel beyond the range of their electric vehicle can recharge at places they visit along the way, using public fast charging systems. 50 kW fast chargers – offering 15-30 minute charging – are perfectly suited for highway locations, targeting drivers who want to quickly charge and keep going (Charge & Go, as shown in Figure 2). 20 kW fast chargers – offering 30-120 minutes charging – have been designed for commercial and office locations and allow drivers to park their cars, go to the movies or a restaurant and return to fully charged vehicles (Park & Charge, as shown in Figure 3).

Demands on the Electric Grid
Moving forward, mass-produced electric vehicles are expected to significantly stress electricity transmission and generation networks. Therefore, utility companies, who are in the business of generating and distributing electricity, will need to control the supply and demand (e.g., demand-response management) of electricity. There are several methods to do this, which include implementing time-of-day price plans and/or throttling the charger output. Access to these control mechanisms is vital to these stakeholders, which will drive a global market opportunity for sophisticated monitoring systems and software to support the electric grid.

Fast Charging Business Opportunities
Some multinational oil companies are already successfully operating small-scale EV fast charging networks, but in general, there is also a lot of opportunity for a new breed of entrepreneurs. This is because the barriers to entry are modest, and charging services can be coupled with other business ventures, such as retail, financial, medical services or nearly any bricks-and-mortar service-oriented business. Chargers can easily be placed at or close to commercial areas such as shopping malls, restaurants, cinemas, concert halls and inside parking garages. For that reason, drivers may soon be able to recharge their vehicles practically anywhere.

To establish a fast charging station, a company will need to install equipment approved by the local authorities after obtaining the applicable standard construction permits. Compared to the construction of a new gas station, the number of legislative restrictions and required capital investment remains minimal. This landscape will open the charging industry to small and medium-sized companies, as described in the following:

- **Workplaces**: New players can install, rent and maintain charging systems in parking lots of companies that want to make it easier for employees who adopt environmentally-friendly electric vehicles.
- **Fleets**: Some commercial and government fleet managers will contract system integrators to design and install charging infrastructure to charge their fleets.
- **Commercial Locations**: There is an opportunity for new players to operate charging stations at strategically chosen locations in commercial areas. Operators can use pin-code, RFID access or third-party payment platforms, like smartphone applications, to charge EV drivers for usage. These stations are preferably sponsored by site-owners, like restaurants or shopping malls, looking for ways to attract more customers to their existing business.
- **Parking Garage**: Parking garage operators can create a new revenue stream by letting drivers charge their vehicles while parked.
- **Retail**: A store owner or a shopping mall, looking to attract electric vehicle owners, can install a single charging station for customer use. This service can generate loyalty with customers who consider charging as a special bonus.

“You don’t have to be a multinational petrol company to start your own service station or offer your customers the convenience of refueling when shopping,” said Gert Miedema of ABB.
ABB* expects that in the future, several connection standards will exist next to each other. The situation can be compared with the current petrol market, in which diesel, petrol and LPG have coexisted for ages,” said Gert Miedema of ABB.

Fast Charging System Requirements
The electric vehicle industry is still in its infancy, which means change is inevitable until comprehensive standardization takes hold. Consequently, the associated infrastructure must be flexible enough to handle requirements that vary across geographies and vehicles. Furthermore, the infrastructure must be highly reliable because drivers depend on its availability.

Need for flexibility
Flexibility is an essential trait of a fast charging system, especially since various groups of vehicle makers have put their support behind different fast charging technologies, such as:

- CHAdeMO is a DC charging method supported by the Japanese automotive industry, including Toyota*, Nissan, Mitsubishi and Subaru*.
- EN61851-1:2010 AC charging is an AC fast charging method promoted by Renault*.
- Combined Charging System is a DC charging method agreed to by major U.S. and German automakers, including Ford*, General Motors*, Chrysler*, Audi*, BMW*, Daimler*, Porsche* and Volkswagen*.

Charging systems must also be flexible with respect to the human machine interface (HMI) features they support today and in the future. Some important customer-oriented features are touchscreen panels and non-cash transaction processing.

Highly reliable
Most charging systems are unmanned and are expected to operate for a minimum of 10 to 15 years; therefore, reliability is of utmost importance. These systems are usually installed outdoor, so they must be designed to withstand harsh environments. They must also allow for remote monitoring and maintenance, so glitches are discovered and fixed before they can affect the customer.

Revolutionizing Fast Charging
The ABB Terra Smart Connect (SC) is a fast charging station capable of recharging an electric vehicle in 30 minutes to two hours while the driver goes shopping, attends a meeting or conducts other short-stay activities.

Flexibility in configurations to support charging of all EVs
The standard Terra SC is a 20 kW DC charger that services all fast-charge-capable cars currently on the market, including the Nissan Leaf, Mitsubishi i-MiEV, Peugeot* iOn* and Citroen* C-Zero*. ABB also offers the Terra SC Duo with an additional 22 kW AC output, which supports the AC fast-charge-capable cars that will become available. All other mainstream, slow-chargeable cars and plug-in hybrids can be connected to a slow charging AC wallbox that is compatible with the Terra SC (Duo). The Terra SC Duo allows for the simultaneous fast charging of two cars (DC and AC), which provides higher throughput and shorter waiting times. This flexibility is due, in part, to the Intel Atom processor, which supports the communication protocol associated with the fast charging technology adopted by the vehicle.

“To truly drive growth of the EV market, ABB* firmly believes that its Terra SC* and Terra SC Duo* chargers should be able to service all cars in the same network. ABB’s future-proof connectivity solutions are designed to support all existing and future connection standards and communication protocols,” said Gert Miedema of ABB.

Maximum uptime
The charger’s IK10 stainless steel housing has been designed to withstand outdoor climatic conditions and vandalism. The system is rated for extended temperature since the cabinets may reach 40°C when exposed to sunlight. To promote a long product lifetime, the Intel Atom processor-based controller of the ABB Terra SC is designed for low power consumption, known to increase the lifetime of electronic components. The processor supports ABB’s web-based interface, which allows chargers to be managed and serviced remotely, thus increasing availability and reducing maintenance time.

Connectivity and interactivity
The Terra SC is a web-connected charger that comes with a full range of connectivity features, including remote assistance, management and servicing, and smart software upgradeability. The applications run on the Intel Atom processor, as do other optional features: RFID and PIN code authorization via a GPRS modem; a billing interface for parking operators; and a web-based statistics module with data per user to support energy usage reporting. Connectivity will also play a crucial role in integrating fast charging into a smart electricity grid. For instance, ABB’s electric-vehicle chargers will offer the possibility to only allow charging when energy is available, rather than randomly, mitigating the impact of the additional load on the grid. ABB’s connectivity suite supports all existing and future connection standards within the same network. ABB also offers the Galaxy online management tool. This user-friendly web application allows charging infrastructure operators to access status information and statistics, including kWh consumption and session statistics, from the Terra chargers at their sites on a daily, weekly or monthly basis.
Quick and easy installation
The Terra SC is quick and easy to install at almost any location due to its ultra-thin design, and simple floor and wall-mount connections, which create maximum space efficiency. On top of that, the Terra SC – unlike some other fast chargers - uses the widely available 3-phase 32A input, which eliminates the need for a costly grid connection upgrade to support the charger.

Other features
The Terra SC has an 8-inch, daylight-readable touchscreen, outdoor stainless steel housing and the smart connectivity features of ABB’s Terra charger line. The display also allows users to keep track of the fast charging progress in real time, so they know how much charging time is left. The screen can play Flash-based advertisements that run on the graphics engine of the Intel Atom processor, allowing charging operators to tap into additional revenue streams.

Family of chargers
In addition, a special fleet version of the Terra SC fast charger is available, equipped with 2 AC charge ports that enable an eight hour charge during a workday. This convenient feature allows three cars to connect simultaneously, such that this single comprehensive charging solution provides both fast charging and workday charging.

The Terra SC and Terra SC Duo complement ABB’s existing portfolio of fast charging solutions. ABB’s highway fast chargers – the Terra 51, Terra 52 and multi-port Terra Base Station 100.2 – are mainly used along highway locations to offer a 15 to 30 minute “Charge & Go” service. The Terra SC and Terra SC Duo are the more cost-effective solutions for locations where people can easily spend a couple of hours and don’t necessarily require a 15 to 30 minute fast charge.

The Intel® Atom™ Processor in Charging Stations
ABB designed in the Intel Atom processor because it supplied the necessary computing and graphics performance, while operating fanless in extended temperatures (up to 80°C). Since multiple applications are running on the systems at the same time, it was necessary that the processor be multitasking capable.

Boosting performance
Providing an extra level of multitasking, the processor can simultaneously process two threads per core using Intel® Hyper-Threading Technology (Intel® HT Technology). Each core has separate data paths for two tasks, enabling it to process another task if the task it’s executing stalls (e.g., waiting for an I/O device), which eliminates wasteful idle time. On Intel Atom processors, this technology creates two logical cores for every physical core.

Roadmap to the future
Intel® architecture processors allow customers to take advantage of the innovative and extensive Intel roadmap that allows for easy software scalability and portability. For example, Intel customers have the option to upgrade to the Intel® Core™ processor family, which provides the additional computing and graphics capabilities needed to unlock future applications and services, while preserving their code base. Moreover, such a transition opens the door to using many advanced Intel® technologies, such as Intel® Active Management Technology (Intel® AMT), which provides robust management and repair functions that work even if a system is powered-off or has corrupted software, like operating systems, applications and drivers.
Fast Charging Creates New Business Opportunities

The growing number of electric vehicles is driving a global market opportunity for charging solutions, and fast charging stations from ABB are enabling new players to serve short and long stay drivers. The Terra SC and Terra SC Duo, based on the Intel Atom processor, can be installed at the workplace, near retail stores, malls and in parking garages, just to name a few locations. These stations dramatically reduce charging time so drivers can enjoy more flexibility and extend the range of their trips. Equally important, ABB charging stations are flexible, supporting all major electric vehicle manufacturers.

For more information about the ABB Terra SC, visit www.abb.com/evcharging.
For more information about Intel® solutions for in the energy industry, visit www.intel.com/go/energy.