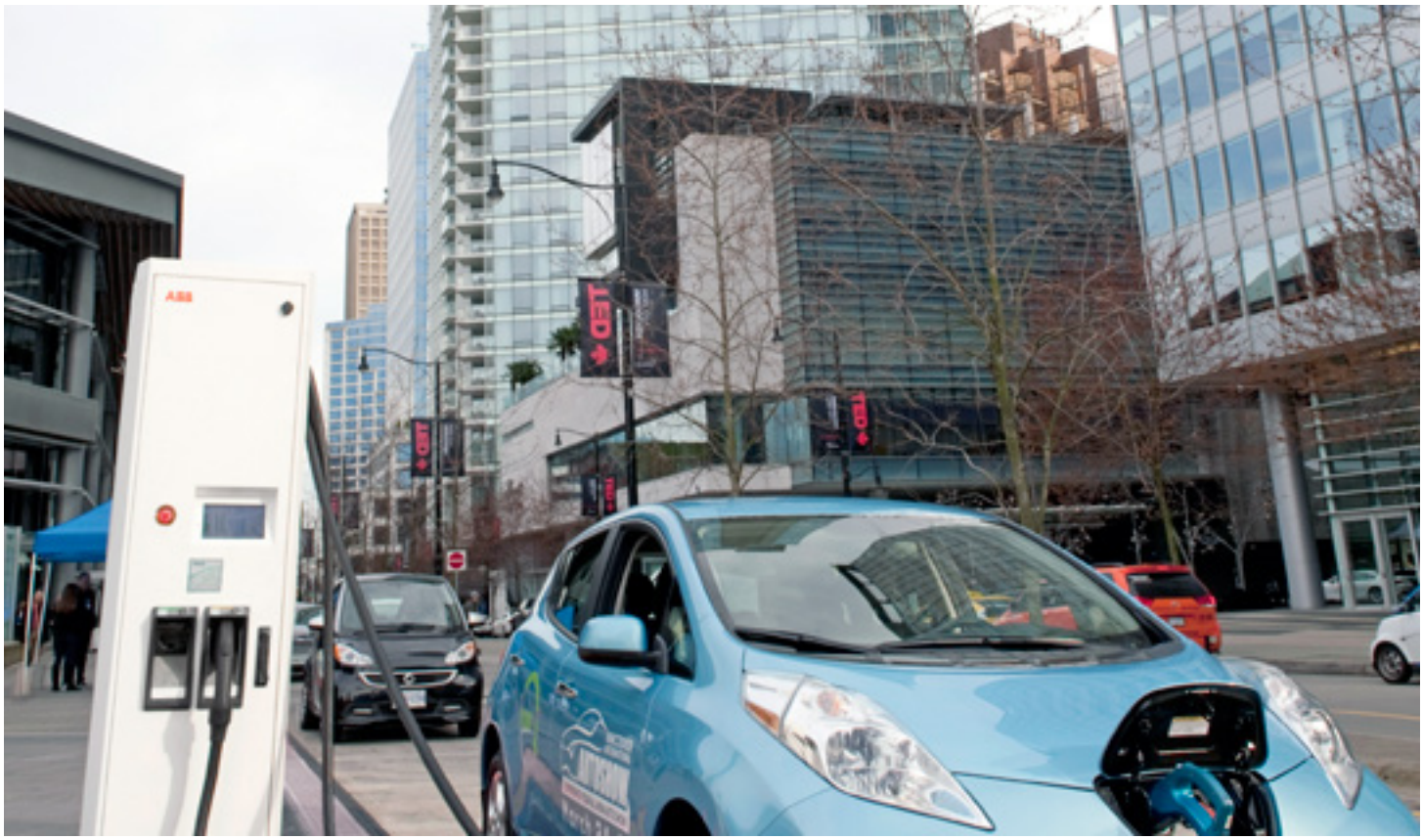
White paper

Electric Vehicle Charging Infrastructure

An evaluator's guide to DC fast charging stations



Availability of charging infrastructure is a driving force in the mass adoption of electric vehicles. DC fast charging technology quickly extends battery capabilities and promotes driver convenience. Charging station hardware and software will also need to perform under all conditions and demands for many years in order to justify the investment. This paper will cover the questions to ask of any charging station provider when making the decision to incorporate fast charging EV infrastructure in your business plan.

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Invest in a faster future

The keys to return on investment lie not with the upfront cost, but with operational performance and longevity.

Introduction: Why fast charging?

As market forces push electric vehicles in more cities, across regions and into malls, hotels, waysides and fuel stations, the demand to charge faster will only grow more. DC fast charging technology offers the most technologically feasible, efficient and practical means to that end. However, these stations are not throwaway products. They are a capital investment in both equipment and installation. Electric vehicle service providers, site hosts and operators should always look closely at the technical and commercial offering available to consider both short-term and long-term economic factors in their investment decision.

Before addressing what a DC fast charger should offer its owner and host, this paper will cover why fast charging is becoming a necessity for the electric vehicle market to grow, for both the cars and their drivers.

DC fast charging delivers more electric miles to more drivers in a shorter period of time.

More cars, more models, more drivers

In 2011, there were only a couple of production EV models available across the United States. In 2017, there will be more than 30 plug-in models to choose from. With hundreds of thousands of plug-in cars now on US roads, and monthly sales of battery electric vehicles now exceeding plug-in hybrids, the trend is clear: every day, week and month that passes, both automakers and consumers require charging infrastructure to meet their needs. Fast charging technology helps meet this need not only through sheer speed, but also by complementing AC charging as a shared, aggregated power delivery resource for many drivers across a region.

Bigger batteries have more needs

Battery technology has undergone a rapid transformation in recent years, in terms of both cost reduction and power density improvement. BEV models introduced a few years ago offered 50-80 mile electric range with battery capacities in the 16-25 kWh size, while today's and tomorrow's announced models are reaching above 50 kWh batteries, reaching well past the 200 mile range. As these battery packs grow, the longer it will take to charge to 80% capacity at a given power rating.

Battery limitations in extreme weather

It's chemistry: batteries don't like extreme temperatures. In fact, most machines, tools and devices, from mechanical to electro-chemical, prefer a mild climate to operate efficiently, regardless of energy source. Of course, the humans operating those machines need heat too. As such, EV drivers in cold weather climates report losing 25 to 30% of maximum range during the coldest winter months when temperatures dip well below freezing. Fortunately, this is not a permanent condition, as those batteries bounce back along with the spring thaw. But drivers still commute on the coldest of days. For those who commute distances greater than the US average of less than 40 miles (cite), a public charging station will get those higher-need commuters and errand runners back on the roads quickly and safely.

Charging infrastructure for multi-family housing

Most electric vehicle charging happens at home using standard 120V or 240V AC service. This is a convenient and existing solution that meets a majority of the charging needs at single-family detached homes with direct utility service.

Fast charging stations are a shared, aggregated power delivery resource for many drivers across a region.

But what about the significant numbers of vehicle owners who live in apartment, condominium, townhome and duplex housing, where they do not own their garage or have dedicated utility service? Shared EV infrastructure charging is an optimal solution to the needs of those individuals who want to choose an electric vehicle. This need rises in higher-density real estate developments, where the number of drivers per charger can be higher. DC fast charging offers a quick and convenient way to deliver more electric miles to more residents in a shorter period of time.

Expect the most from your charging station investment.

With fast charging demand growing and evolving, the next step is implementation. This paper will cover what's important to ask when reviewing DC fast charging station options. This equipment has more advanced technology and communications requirements to work reliably, and therefore, requires more upfront investment than a standard plug. What factors should be considered when evaluating solutions?

Does the supplier have both technical and commercial experience?

How many installations have they done in your region? Globally? How long have they been in the e-mobility business? How long have they been delivering electrical equipment and power electronics? With investment dollars at stake, a manufacturer should have longevity in deploying standardized equipment, with an established presence and service network to meet the needs of individual stations as well as networks that stretch across regions and countries.

What's that charging station housing made of?

Public charging infrastructure equipment is exposed to a variety of elements, from weather events, and climate extremes to seismic activity and even vandalism. A rugged, stainless steel NEMA 3R enclosure will protect sensitive electronics so the unit can withstand harsh conditions better than thinner, cheaper materials such as aluminum and plastics. Look to manufacturers with extensive power electronics experience to understand this critical reliability approach.

A rugged, stainless steel enclosure will protect sensitive electronics and withstand harsh conditions better than thinner, cheaper materials.

How does the manufacturer address installation and safety?

Is the charging station you are considering certified to UL? Has installation concerned grounding, shock protection, overload protection and more? What kind of power service is required to install? Ensure you discuss these issues so you understand how the manufacturer has built these concerns into their design.

What are EMC standards and why should you care?

Nearly all electrical and communications equipment emit electromagnetic interference (EMI) or radio-frequency interference (RFI). This phenomenon can cause interference in nearby devices via conducted devices, digital signals as well as radiated into free space.

Unchecked, this interference can disrupt the proper functioning of other electromechanical devices and wireless communications. As such, Electromagnetic Compatibility (EMC) regulations were developed to ensure as much safety and reliability as possible within and around all of the electrical appliances, industrial power equipment and the critical health devices that we all rely on each day.

The IEC 61000 EMC standard addresses this issue for EV charging infrastructure, and is divided into two categories: Class A for industrial applications, and class B for residential applications, business offices, and commercial shopping centers, with class B being the much more stringent requirement.

This compliance level is especially important for any fast charging stations placed in proximity to a residential area, offices and retail sites. In these cases, EVSE providers must have Class B compliance. If they do not, they will have to display a warning label to caution users that magnetic fields around it can be problematic. In some cases, high enough to affect individuals with pacemakers and other critical medical devices. Ensure your equipment meets the highest EMC compliance for optimal safety and lowest user risk.

Does the charger make a lot of noise when it's charging? And, how about when it's idle?

A noisy charger's fan cooling system can be a nuisance at any site, especially where the general public is shopping, working and living in close proximity. Excessive noise is also a contributor to equipment

Ensure charging equipment meets the highest EMC compliance for optimal safety and lowest user risk.

A station certified to meet the latest versions of all fast charging standards can ensure optimal safety and interoperability.

wear and tear, and a potential precursor to vibration and early failure. Ask what kind of noise levels can be expected during and after charging operation, and visit existing installations to ensure data validity.

Does 50 kW really mean 50 kW?

It does to ABB, but not all 50 kW charging stations are really 50 kW charging stations. While some standards govern power and nameplating, actual real-world charging can vary among models. Discuss real-world charging rates that you expect drivers to achieve, and stations to execute; and review the testing they do to verify their charging equipment actually delivers what it says it will deliver.

Will all current and future EVs be able to charge on that DC fast charger?

There are three standards for fast charging found on all battery electric vehicles sold in the Americas: CHAdeMO, SAE CCS and Tesla's proprietary standard. To get the most from the station installation investment, a manufacturer should meet the needs of all electric vehicles in a single unit.

Also ask about certification. A station that is certified to meet the latest versions of all charging standards can ensure optimal safety and interoperability. Your provider should be at the forefront of standards development in order to secure the most future-proof equipment. With new vehicles always entering the market, equipment that doesn't meet the latest standards may have compatibility issues with some newer vehicles.

As an example, CHAdeMO 1.0 enhances safety and protection of the vehicle over CHAdeMO 0.9, such as better detection of equipment grounding problems and better defined fusing to protect the car in case of serious failures. Furthermore, improved software communication timings and diagnostic abilities enhance the reliability of the connection to the vehicle.

Why does third party verification matter?

EV drivers and station operators both require dependable DC charging operation and interoperability between cars and

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Independent third party testing and certification is the most trustworthy way to validate equipment standards and safety.

chargers is key. There are two interfaces which need to work together: the charger and the car. Independent third party testing and certification is the most trustworthy way to validate equipment, and critical to assuring a seamless charging experience with all electric vehicle models.

Talk to your EV infrastructure provider about interoperability and how they have tested their equipment to all fast charging standards, and whether they use third party verification to ensure compliance with all vehicle models.

How does the system design address redundancy to support uptime?

Power electronics are at the core of technology for power conversion and control, enabling fast charging of batteries in minutes instead of hours. Redundancy is a critical feature for the reliability of those components. Ask the manufacturer how they design their equipment for redundancy to prevent failure and support uptime in the field.

What does "continuous operation" mean for DC fast charging?

Some EVSE equipment fares better than others with continuous output power demand, where cars are lined up requiring a constant power delivery over time. Excessively warm or cold environments can further affect this output power and can stress some equipment. A good manufacturer should be able to tell you how well their charging equipment can handle prolonged use, and have done performance testing with all electric vehicle models in the marketplace.

What kind of payment options can the equipment offer to meet both network and driver needs?

Does the charger offer flexible hardware and software that enable payment options in multiple forms? Can the charger be supported on an OCPP network? RFID and PIN code? Credit card transactions? NFC smart phone payment systems? Investing in DC fast charging means investing in future-proof capabilities that adapt to an ever-changing payment landscape. Make sure your supplier can easily integrate with membership model payment systems and back-offices.

When do credit cards make sense?

While membership-based payment models offer advantages, not all drivers travel in the same regions served by local infrastructure providers. With electric vehicles' ever-increasing range, it's clear that EVs will be traveling farther from those regions as well. In these cases, credit cards provide the ultimate interoperability solution. Ask a manufacturer what they can offer to accommodate current and future needs with credit cards, secure contactless and smart phone payment systems.

Is the station user-friendly for drivers?

Does the display screen offer intuitive touchscreen interactive functionality, giving the driver complete information about charging status, even during harsh sunlight hours? EV drivers prefer charging stations that are easy to access and give them a clear interface with relevant session information.

Redundancy is a critical feature for the reliability of all components in power electronic systems.

EV drivers prefer charging stations that are easy to access and give them a clear interface with relevant session information.

Is the charging station designed with accessible service doors for fast and easy maintenance?

Also, is the position of the HMI awkward? Will drivers have to bend over, squint and struggle to understand their session status? Equipment should always provide the most comfortable, ergonomic experience to ensure repeat business.

Another important aspect of station design is compliance with Americans Disabilities Act Guidelines (ADA) as well as other state and municipal codes supporting universal charging access in terms of operable parts, displays and clearances.

What about service? Remote and hands-on?

Evaluating DC fast charging solutions does not end in an equipment purchase order. Managing and maintaining your investment will continue long after the initial purchase.

Does the charger software monitor all health parameters of the chargers? Can remote trouble-shooting and upgrades be done to minimize on-site service? Is the charging station designed with accessible service doors for fast and easy maintenance and service? How often do filters have to be replaced? Does your manufacturer have a full service program, with a standard parts kit and regional service network? There are several questions to ask when thinking about real-world use and ease of maintenance that should be looked at closely when looking at DC fast charging technologies.

What experience does the supplier have with utility and grid concerns?

What does your supplier know about grid impact? Demand charges? Utility infrastructure? Do they have expertise with distributed energy resources, grid integration, energy storage and other smart grid technologies? EV charging infrastructure will play a significant role in the future of distributed energy resources and smart grid development. Having a partner on the leading edge of this trend will help EV service providers navigate the power delivery evolution more proactively.

Does the charging station have power management options that can address peak demand concerns?

Utility demand charges can be levied for peak power demand due to higher power draw by DC fast charging. Be sure to

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verify whether the station manufacturer offers input power limiting software to avoid expensive demand charges and even potential grid upgrades.

Can I leverage telematics with this fast charger?

Telematics offer charging station owners a way to manage the operation of a charging station. In addition, objective data and usage metrics can proactively help site owners and operators engage and attract users to the station, while facilitating better decisions for further development and growth of their network.

Will a warranty ensure reliable equipment?

A warranty program is important from any supplier as a commitment that they will take care of you should the equipment require parts, service, or replacement. But a warranty does not guarantee quality, uptime, headache-free operation, nor will it give you an investment payback. Consider a warranty as an insurance policy against loss, but not a replacement for a reliable station with a lower cost of ownership.

Will the station build my brand?

What does the station look like? Will it look nice on commercial sites meant to attract consumers, or look like an awkward eyesore? Can it easily be wrapped and branded for your site visibility and promotional needs?

In addition, maximum uptime and quick maintenance send the right message to customers that your site is a reliable place to visit. Electric vehicle drivers need to know they can count on your site to get to work, run errands, enjoy their travels, and most importantly, get home safely.

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Discussion checklist

Equipment design and safety
☐ UL and other relevant certifications
☐ EMC certification level for EMI/RFI
☐ Structural quality materials
☐ Real-world power delivery vs nameplate rating
☐ Reliability design for cooling, redundancy
☐ ADA compliance for operable parts, displays and clearances
☐ Ergonomic and usability features for user comfort
☐ Noise levels tested and in the field, both working and idle
☐ Visual design and branding options
Future-proofing features
☐ Dual standards, CHAdeMO and SAE CCS
☐ Latest standard versions, i.e. CHAdeMO 1.0
☐ Testing experience with OEMs
☐ Third party verification
☐ Power management options to manage peak demand
☐ Telematics and data
☐ Support and knowledge of OCPP

Payment interface flexibility
☐ RFID and PIN support integration with back-end systems
☐ Credit card and NFC mobile payment options
☐ Support for the latest OCPP
Service concerns
☐ Servicable design
☐ Proactive service plans and parts kits
☐ Remote management and troubleshooting
☐ Remote monitoring of health parameters
☐ Service support team
Experience and leadership
☐ Company history, longevity
☐ Number of DC fast charging units installed in region
☐ Number of DC fast charging units installed globally
☐ Experience with smart grid technology and utility applications
☐ Experience with DC technology, power electronics

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