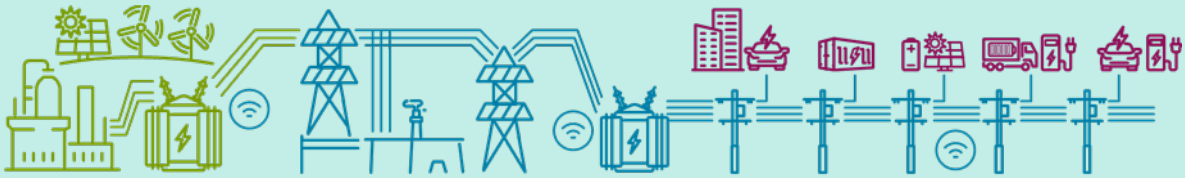
Decarbonized | Reliable | Resilient | Cost-effective



EVGrid Assist Webinar Highlights

U.S. DEPARTMENT OF ENERGY
EVGrid Assist
ACCELERATING THE TRANSITION

Charging Station Site Design Webinar

Electrification of transportation demands a rethinking of fueling infrastructure, as a system built around petroleum-based fuels shifts to the distribution of electricity. In the coming years, billions of dollars will be invested in electric vehicles and the charging infrastructure to support them.

Building an effective and useful charging station takes more than just installing equipment and switching on the power. Avoiding costly mistakes that leave chargers sitting idle because they are inaccessible or inconvenient can be as simple as asking the right questions and doing some research upfront. It all begins with knowing the characteristics of one's customers and how they will charge. This information will form the basis for the business model and define the station requirements, such as how many charging spaces will be needed. This in turn will influence the site selection and determine whether to build a new station or retrofit an existing one.

Determining a Business Model

Developing the business model for a charging station starts with understanding the customers who will use the station and identifying the class of vehicles that will charge there. Whoever the customers may be, it's important to know their needs and how to serve them, both in the short and long term. It's also important to understand what those vehicles will be used for, how quickly they will need to charge and get back on the road (i.e., their duty cycle), and both how many there currently are in service and how many are expected in the coming years.

FACTORS TO CONSIDER

EV Population
- Local: Current/projected
- Transitory: Current/projected

Vehicle Class
- Light-duty
- Medium-duty
- Heavy-duty

Duty Cycle
- Commuter
- Private/discretionary
- Ride-hailing
- Vocational
- Regional/long haul trucking

Dwell Times
- Short <~ 30 minutes
- Medium ~ 30 min – 4 hrs
- Long > 4 hrs

Location
- Urban/suburban/rural
- Road access: freeways/arterials
- Siting constraints: regulatory/ environmental
- Existing nearby resources
- Local electric rates, demand charges, submetering potential
- Futureproofing/ability to expand
- Seasonal climate factors

For example, some drivers will be looking for a quick turnaround, charging up and getting back on the road as soon as possible. Fast chargers complimented by fast food and drink options or quick, convenient shopping are going to appeal to these customers. On the other hand, a destination site, like an amusement park, or a truck stop that caters to long-haul drivers who are required by law to rest for several hours, can offer slower charging options.

With this knowledge at hand, charging station owners and operators can craft their business models, including peripheral elements of the operation. This then paves the way to considering specific details like station location or equipment.

In addition to logistical considerations for a charging location, such as power capacity and capability to host necessary equipment, a charging station owner will want to find a site that is not only accessible, but convenient to customers. Several points of data can be brought together to narrow down these areas.

Site Selection

There's no single solution for how an EV charging site should be designed nor where it should be located. These answers depend on the type of EVs being served, their location, and how customers will charge.

Site design will vary based on several characteristics of the vehicles and the region. A charging station in the middle of a bustling metropolis will differ from one in a rural area or a suburban neighborhood. Those various sites are also likely accessed by different types of roads. Narrow local roads around a charging station in an urban downtown are adequate for light-duty passenger cars and trucks but wouldn't be sufficient for heavy-duty tractor trailers. Charging stations looking to serve long-haul electric trucks would be best off finding sites along major highways outside city centers.

Likewise, sites will differ in size and how the land at the site is put to use. Regulations and other constraints, such as environmental restrictions, might limit what can be done at one site versus another. Designers must also consider vehicle access when laying out sites. Not only must EVs have room to maneuver, drive up, and connect to a charger, but other vehicles that are not charging may need consideration as well. If a business plan calls for EVs to queue up for charging, space must be allocated for those waiting their turns without blocking traffic on surrounding streets.

Vehicle profiles will also factor into the best choices for the charging equipment to be installed. It's tempting to just put in the best chargers available, but top-of-the-line chargers are not necessary nor cost-efficient in most scenarios. The faster and more powerful a charger is, the more expensive it can be to install, to operate, and to maintain, sometimes exponentially, so including design elements that allow for future expansion, like larger conduit to run more cables and additional space to deploy more charging stations and distributed energy resources (DERs) like on-site storage or generation when demand eventually calls for them.

On-Site Storage and Generation

When choosing a site, it is vital that local utilities be involved as early as possible. They have the information about the amount of energy available at potential locations, which can affect the

decision-making process. Some locations may easily absorb the demand of a new charging facility while others could require significant upgrades to provide adequate power that can add costs and delays.

In some cases, locations lacking in utility-provided capacity may still be viable options with the integration of DERs. While these measures can be costly and complicated to install, on-site energy storage and/or generation may be deployed to supplement the required infrastructure or offset demand charges.

Batteries can store energy during off-peak hours when rates are often a fraction of what they are during peak times. This stored electricity can be used during times of high demand to level station load and avoid or mitigate utility demand charges. Charging stations with limited grid access may even make use of dispatchable batteries charged off-site. Storage may also be used temporarily, such as when grid upgrades won't be complete in time for a facility to start operations, and then reallocated to other sites when no longer needed.

However, batteries, and other DERs can be expensive – both in terms of the equipment and the resources necessary to install and integrate them – and can take up considerable space. Before considering any such options, it's important to work with utilities to determine if they are viable options.

DERs can complicate interconnections and incur additional charges as some utilities view them as an additional load to be served instead of as a supplement to reduce demand. Utilities should always be informed about site design and operational plans as early as possible.

DC Architecture vs. AC Architecture

Site designers will have to decide whether there are greater benefits to setting up their facilities using a direct current (DC) architecture or alternating current (AC) architecture. Both have their own upsides and downsides when it comes to cost, efficiency, and other factors.

DC ARCHITECTURE	AC ARCHITECTURE
Advantages • Centralized AC/DC conversion • Potentially lower cost/management ease • Easier integration with Battery Energy Storage and renewables **Disadvantages** • Difficult to design/equipment not readily available • Power electronics expensive/above normal capabilities • Protection systems customized design and build	**Advantages** • Widespread, well known, minimal R&D required • Less expensive, commercial off-the-shelf equipment • Trained workforce, lower maintenance cost/time **Disadvantages** • Numerous power conversion (AC/DC) points • Controllability can be difficult

Smart Charge Management

Smart charge management (SCM) can help to level charging load and, at the most basic level, is simply a process for turning EV charging on or off. SCM requires access to real-time grid conditions which necessitates two-way communication between EVs, charging equipment, and the grid. There are countless ways to manage charging, and the right one for a given facility will be dictated by many factors, including the business plan, customers to be served, grid capacity, utility rates, and DER access.

SCM solutions may be limited now, but are expected to evolve and improve in the coming years. Therefore, a site designer will want to think about considering plans for SCM when deciding on the communication controls for managing a site's charging.

The Human Wildcard

Ultimately, whatever plans and controls are in place, EV drivers will be using the charging equipment and the vehicles, introducing a human factor. Designers may factor in all the necessary elements to charge the vehicle, but if people can't easily and safely access and use the equipment, customers won't use it. Key components to consider are sufficient lighting and the layout of the vehicle staging areas to ensure that they can be easily accessed and that critical areas aren't blocked.

Consideration must also be given to the Americans with Disabilities Act (ADA). The U.S. Access Board released a technical assistance document to assist in the design and construction of EV charging stations that are accessible to and usable by people with disabilities.[1] Be mindful, though, that accessibility requirements are often determined at a state-level, so specific requirements can vary from state to state. Additional information on ADA compliance is available through DOE Clean Cities EV Community Readiness Projects.[2]

Most importantly, charging must be safe. Accessibility and convenience are meaningless if drivers cannot be assured that their lives and well-being aren't at risk while charging their vehicles. This can include measures to keep cables off the ground, such as mechanisms that retract them; well-lit charging areas with good visibility, bollards that prevent vehicles from hitting chargers, and drainage to prevent water from pooling in charging areas.

Staff that will maintain a station need to be given high-voltage safety training. Cutoff switches must not only be accessible, but also visible and in close proximity to the charging equipment they control. Furthermore, hardware should be examined weekly, and software should be continuously monitored for trouble codes or other atypical behavior.

Charging stations are a vital element to the success of vehicle electrification. They are a costly investment, but a successful site design can improve the chances that customers will frequent the station, that the business will be viable, and that the investment will be recovered.

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[1] Design Recommendations for Accessible Electric Vehicle Charging Stations

[2] The Virginia, Ohio, and Northeast Regional State Readiness plans offer insights about accessibility.