Fleet Electric Vehicle (EV) and Charging Considerations

Summary
This whitepaper presents the considerations around EV charging infrastructure for fleet vehicle deployments. With increasing EV adoption, understanding the EV operations profile and charging needs is a necessary step in the planning process to optimize costs, streamline deployments, and enable future growth while maintaining deployment schedules.

About Enerlogics Networks, Inc.

A developer of behind-the-meter projects utilizing solar, energy storage systems, EV charging infrastructure, and related technologies for commercial, industrial, government, and educational customers across the US. Founded in 2009, Enerlogics has focused exclusively on project development since 2021.

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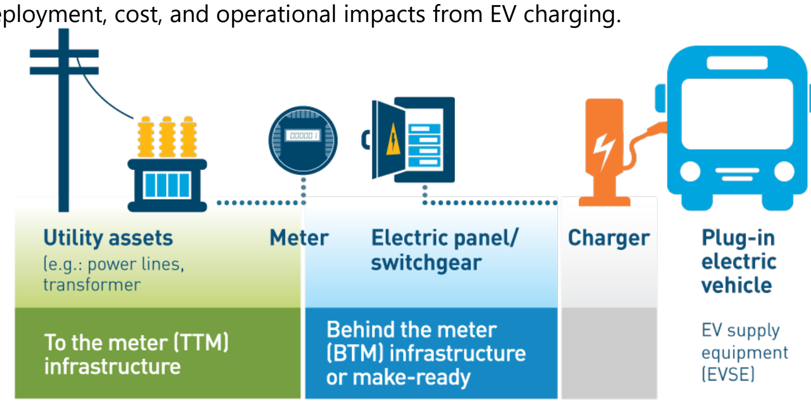
Electric vehicles (EVs) are increasingly becoming a part of the transportation solution particularly for vehicle fleets. The fleet deployments of EVs include passenger vehicles, light duty trucks, delivery vehicles, school buses, and even semi-trucks and refrigerated trailers. These fleets are increasingly deployed for facilities including municipal / government, utilities, schools, and private sector clients.

With increasingly pervasive deployments of EVs into the marketplace, consideration of the EV charging needs today and in the future is required *before* fully deploying EVs. Without intentional understanding and decisions on the charging needs, EVs deployments will result in headaches on facilities teams that are unprepared for the deployment, cost, and operational impacts from EV charging.

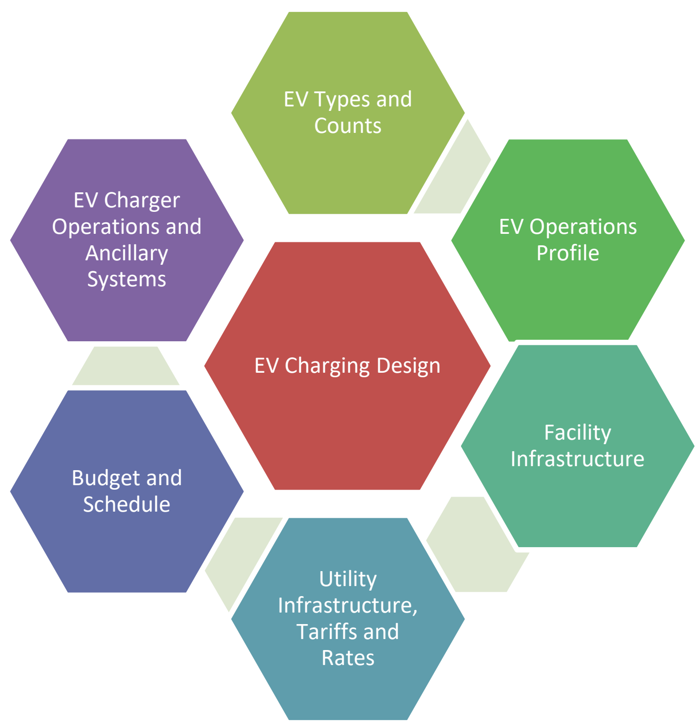


Why are the charging considerations important?

In our experience, facilities that do not consider the charging needs are in for late surprises. We've worked with facility planners that have been told by the electric utility that utility and transformer upgrades are required to accommodate the charging needs with leads times of 24+ months and significant costs. Additionally we've worked with facilities where the utility has sufficient infrastructure to accommodate EV charging, but significant facility upgrades are required to enable EV charging with the costs not accounted for in the initial EV budget. Collectively these failures in planning have resulted in cancellations and delays of EV deployments.

Planning for EV Charging

In contrast, our approach is to baseline and evaluate your facility and anticipated EV charging needs as part of the EV charging design process. This enables a more holistic approach that enables cost effective deployment with flexibility for future growth



These considerations include an understanding of factors including:

- **Type of vehicles being deployed:** Vehicle type, battery capacity, and range are all required as part of the selection of the vehicles for the application.
- **Vehicle operating profile:** Factors including range, usage, and expected battery depletion are valuable in understanding the charging needs.
- **Vehicle and Facility daily operations:** Anticipated daily and weekly usage (e.g., weekday vs. 7-days-per week), as well as anticipated intraday charging needs are critical to the charging needs.
- **Seasonal Effects:** Seasonal variability on operations including additional heating or cooling needs (and impact on range) should be considered.
- **Available Facility Infrastructure:** Facility infrastructure including the physical arrangement as well as electrical considerations is valuable baseline information for deciding where the chargers will be deployed as well as what electrical infrastructure is available for charging capacity.
- **Available Utility Infrastructure:** Electric utility infrastructure including the available capacity for electrical growth is necessary for any larger scale increase in power needs for the facility to accommodate EV charging.
- **Utility Power Rates and EV Charging Incentives:** Electric utility tariff structures and any potential EV charging tariffs or EV charging incentives enable optimization of EV charging deployments.
- **Available Budget and Timeline:** Available budget for both EVs and the charging as well as the anticipated timeline and expected EV delivery schedule are all considerations for the charging.
- **Future EV Growth:** Initial deployments of EVs are typically a pilot/phased approach with later growth; EV charging should consider not just the initial phase but also later phases with likely greater than 1:1 vehicle to charger needs.
- **EV Charging Needs During Grid Outages:** In a world of increasing climate change, EV charging capacity during grid outages can be a consideration for facilities providing critical transportation needs and/or facilities where outages are likely.
- **Ancillary Energy Systems, EV Charger Operations and Software Systems:** The holistic system should be operated in concert with ancillary energy systems (building control systems, onsite distributed energy systems including solar and storage, etc.) to streamline operations and optimize around utility costs / EV charging needs. Additionally, software operations including the interface mechanism (RFID, etc.) are part of the operational needs for the system.

In practice, the initial focus is on the EVs themselves, with the charging needs very often an afterthought in the purchasing process.

Vehicles and Vehicle Operating Profile

The type of electric vehicles under evaluation are the necessary first step. This whitepaper assumes that the vehicle type, range considerations, etc. are performed as part of the selection of the vehicles themselves – i.e., a facility has selected the vehicle type, model, and battery capacity (range) necessary for the fleet use cases. The vehicle type (passenger, light duty truck, medium duty truck, school bus, class 8 semi, etc.) including the manufacturer, model, and range / battery capacity are part of the inputs to evaluating EV charging needs.

For each vehicle type, we need to understand the expected operating profile including: anticipated usage during a normal work day, anticipated usage (if any) on non-work days, expected battery depletion (miles traveled vs. range), recharging window including needs/options for mid-day charge, etc.

For example for school buses, most suburban and urban school bus routes are relatively short with options for charging overnight. In contrast, rural school bus routes have longer routes which may require mid-day recharge for those routes where range and range anxiety are a consideration particularly in winter months. Other considerations include special events (field trips, away sports trips, etc.) where range may be challenged with limited recharge options.

Similarly for delivery vehicles, routes may have less consistency with a focus on keeping vehicles deployed during the workday. For vehicles that leave in the morning and return at the end of the day, this often results in selection of vehicles with sufficient range for a full day (plus additional battery capacity for those atypical situations including traffic) and an ability to recharge overnight. In contrast, a delivery vehicle with multiple “home runs” can have the opportunity to recharge when it returns to base during the day to pick up deliveries.

In short, the vehicle recharge needs and dwell time potential significantly impact the selection of the EV charger types and capacity. Collectively the fleet vehicle type, range, battery capacity, and operations profile have the most significant impact on vehicle EV charging design.

Facility Infrastructure

Facility infrastructure considerations include the potential locations for charging including proximity to the electrical infrastructure of the facility. Particularly when considering e.g., charging islands for fleets, the location of these charging stations can have significant impact on the selection of the charger types and the deployment strategy. In contrast, deployments of chargers in parking lots for passenger vehicles has similar infrastructure needs.

The electrical infrastructure of most buildings is not designed to support future growth with the electrification of everything. Accordingly, most facilities will require and upgrade to the facility electrical infrastructure to accommodate larger EV charging deployments.

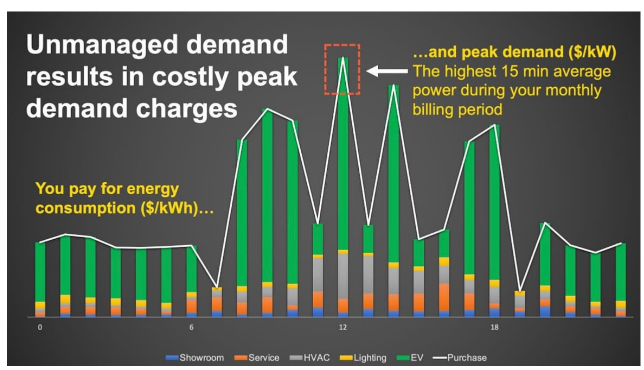
For example, charging islands can include common energy infrastructure for flexible EV charger selection as well as combined energy storage systems to buffer impact on facility electrical infrastructure and demand costs during EV charging windows.

By evaluating the planned locations for EV chargers combined with understanding the electrical infrastructure and capacity, EV charging can be designed to work in concert with your plans.

Utility Infrastructure and Tariffs

Upstream of the facility, the utility infrastructure can include transformers and distribution lines that deliver power to the facility. These systems were often sized to the facility’s original usage and needs; accordingly upgrades to the utility infrastructure may be necessary to accommodate EV charging and facility electrical upgrades. With increasingly long lead times for utility upgrades (often 24+ months), these utility upgrades can be a significant impact to the timing and cost of EV deployments.

Utility tariff structures can have significant impact to the EV charging design and operations. For example, some utilities have dedicated EV charging tariffs that require dedicated utility services to support the EV charging only; when coupled with utility upgrade costs and schedules these can impact the schedule and future flexibility around EV charging. Similarly, the normal utility tariff structure (including considerations of time of use, demand charges, etc.) can have a significant cost impact to the operations of EV charging, with impact to the design and selection of the EV charging infrastructure.



Lastly, many utilities offer incentives for EV charging infrastructure. Often these incentives require an ability for the EV charging to be publicly accessible – which may impact the location of the deployments of the EV chargers as well as the type of charger and charger operations software. Additionally many dedicated EV tariffs dictate the ability to restrict charging during certain periods of the day, with higher power costs during peak hours.

Collectively, these utility considerations impact the EV charger infrastructure design and operations.

Available Budget and Timeline; Future EV Growth

The budget available and planned schedule for EVs and EV charging infrastructure can impact the EV charging design. For example, a project with a limited budget and a required timeline for e.g., grants may move towards a quick to deploy solution that can be at odds with facility and utility upgrade requirements.

Understanding a facility's budget for both the vehicles planned now and in the future influences the charger selection and design. But evaluating future growth needs and potential future flexibility, facilities can design systems that are "fleet ready" from the start, even though only a limited number of vehicles may be included in the initial phase. This smart growth strategy enables a pay as you grow type deployment to have the infrastructure ready for EV charging as the EV fleet grows.

Additionally, the charger to vehicle ratios will likely change as the fleet electrification continues in later phases. What is currently a one vehicle per charger model could ultimately change to e.g., a two vehicle per charger model which has impacts on the EV charging operations, available time to charge, etc.

Consider also that the vehicles and chargers on the market today will expand and change – the EV charging infrastructure should be designed in a way to accommodate future changes in the makeup of vehicles and chargers.

The budget, timeline, future growth potential, and potential fleet mix impacts all will influence the EV charging infrastructure design.

Grid Outage Considerations

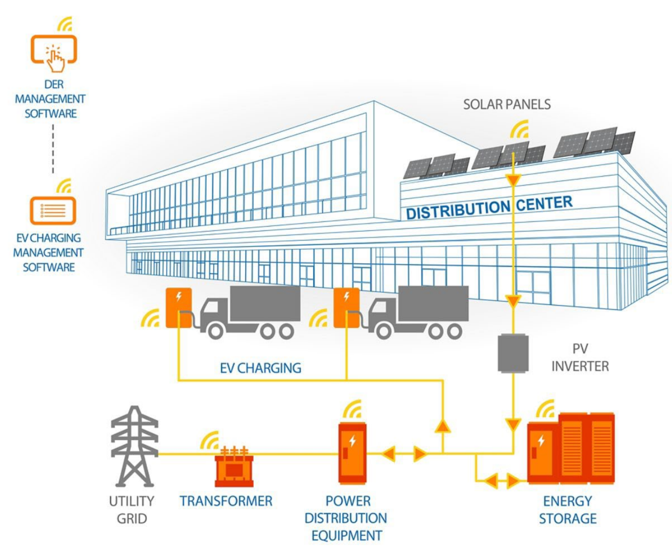
Grid outages not only impact facility operations, but impact a facility's ability to recharge vehicles during an outage. For mission critical operations, not being able to recharge a vehicle can negatively impact operations particularly as fleets increasingly move to all-electric. Having a backup plan in place for facilities that are likely to experience grid outages is critical to the EV charging infrastructure.

In areas where grid outage is likely, such as California public safety power shutoffs (PSPS) or hurricane prone coastal areas of the Southeast US, systems where backup power can be provided are critical to ensuring seamless operations during grid outages. These systems include considerations of primary power (fuel cells, cogeneration, etc.) combined with onsite distributed generation from renewables (solar and wind) with additional capacity from energy storage systems and backup power (generally fossil fuel based generation). While these microgrids are technically feasible, they are generally expensive solutions utilized only where critical operations are needed during grid outages.

While grid outage is not part of the EV charger selection per se, it does influence the overall EV charger infrastructure design.

Ancillary Energy Systems, EV Charger Operations

The entire energy infrastructure of the facility should be designed to accommodate flexible operations. Deployments of distributed generation systems, in particular onsite solar, energy storage systems, cogeneration/CHP, and fuel cells are all part of the energy mix available to facilities. These systems can be tailored to the needs of both the facility and the EV charging, and should consider utility cost structure as well as overall power needs.

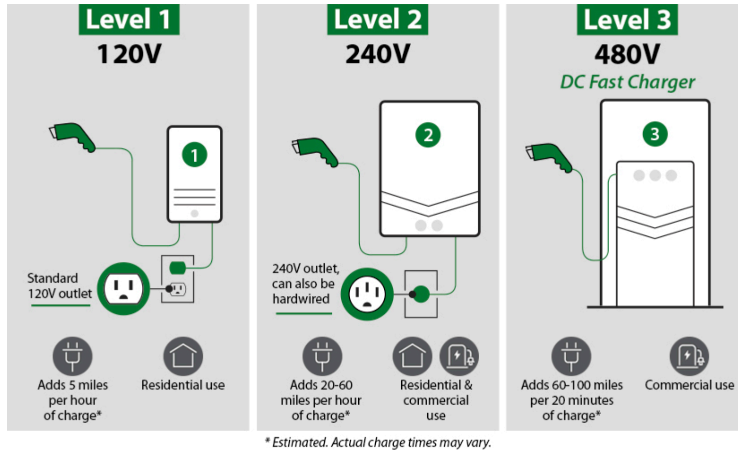


As an example, a facility with limited power infrastructure can utilize onsite solar combined with energy storage to provide flexible generation capacity for EV charging and facility power needs.

In addition to the equipment, the operations and control of the energy and EV charging system must be integrated to enable the ability to operate in a cost effective manner.. For example, by combining dynamic EV charging via OCPP with the overall facility operations and utilization of onsite power and energy storage, a facility can reduce costs while maximizing the effectiveness of the existing electrical infrastructure.

In short, the entire facility energy infrastructure and plans is part of the EV charging design and optimization.

EV Charger Types and Architecture



The selection of the EV charger types and sizes is based on the considerations above. In particular, vehicle dwell time and recharge needs most impact the EV charging selection, as well as the ratio of vehicles to chargers (both now and in the future).

EV charging generally falls into three main types of chargers:

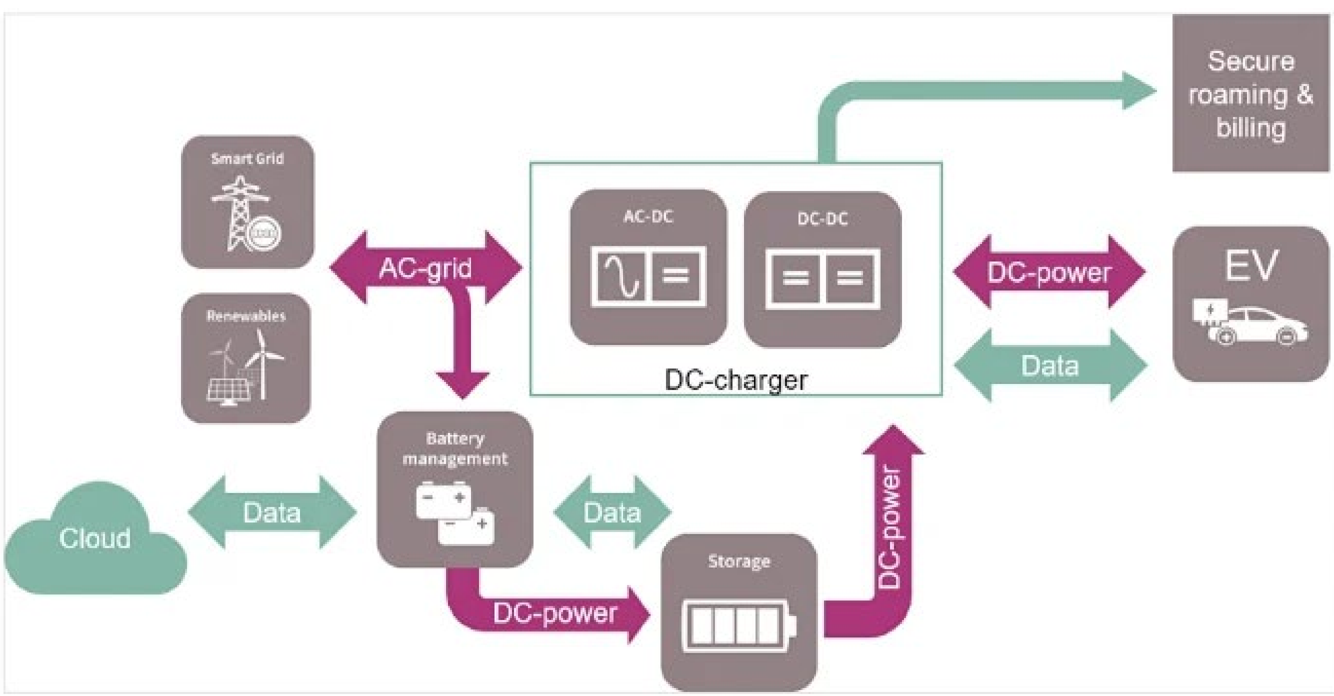
- Level 1 chargers for residential use at 120V
- Level 2 chargers for residential and commercial use at 240V
- Level 3 chargers for commercial use at 480V

Fleet applications generally utilize level 2 and level 3 chargers only.

The level 2 chargers can draw up to 20 kW of power when actively charging. Level 3 chargers draw significantly more power, ranging from 50 kW to chargers that can draw 400 kW or more of power. These level 3 chargers have the most dramatic impact on the power needs of a facility to support EV charging infrastructure. With level 3 charges drawing significant power (e.g., one manufacturer's 175 kW level 3 chargers requires a 250A power feed), the addition of only a few level 3 chargers to a facility can result in requirements to upgrade switchgear and facility power infrastructure.

In addition to the power of the charger, manufacturers have begun to differentiate on the mechanism of the chargers to include features such as:

- Number of dispensers per charger: Generally 1 or 2 dispensers per charger; 2 dispensers allows a level 2 or level 3 chargers to charge 2 vehicles simultaneously, with dynamic low control between the chargers
- Split architecture: Level 3 chargers are being released with a split architecture utilizing a single AC cabinet with a series of DC chargers (with 2 dispensers per DC cabinet) to support e.g., 12 vehicles from a single AC connection.
- Integrated battery systems: Level 3 chargers with integrated battery systems enable the battery to act as a flywheel to offset the demand impact from charging; in these systems the battery on the charger is "trickle charged" throughout the day, with the battery capacity utilized to recharge the vehicles that are connected to the charger. Additionally these battery systems can be utilized to perform facility level curtailment, load shedding, and demand response to provide a double benefit.
- Bidirectional charging: Level 2 and level 3 charges are being released with bidirectional charging capability, which enables a facility to tap into battery capacity for facility demand management or backup power. These will increasingly become part of the deployment mix and consideration as utilities become comfortable with these systems.

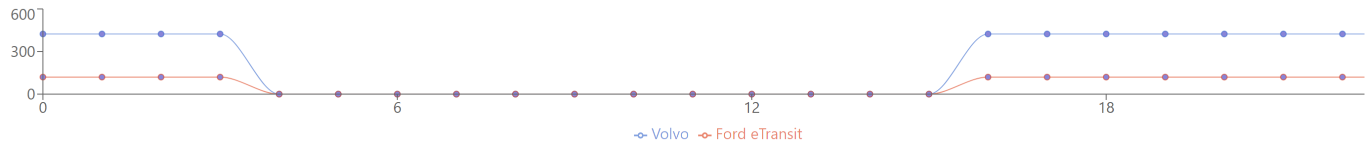


Collectively the charger types (and power capacity), count, architecture, etc. are part of the EV charger deployment strategy;.

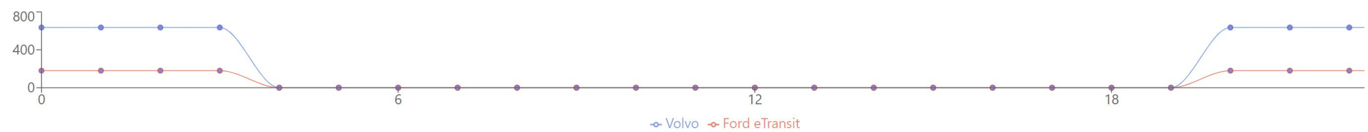
Real World Implications

Consider for example just the impact of charging windows (dwell time) and its impact on power demand. The graphs below reflect the energy demand from a hybrid deployment of Volvo Class 8 trucks and Ford eTransit delivery vehicles, with different charging windows: the top chart represents an operationally tied model with charging once the vehicles are done for the day; in contrast the bottom represents an optimized charging window to minimize peak demand charges during high TOU periods. The effect of this is a significant swing on the steady state power demand during the smaller charging window (~600 kW in the first case vs over 800 kW in the second case). When looking at the utility tariff, simply moving demand from the high TOU to a lower TOU period can have significant cost impact that reduces the overall operating costs.

EV Charging Impact on Facility Power in kW with Charging from 4:00 PM to 3:00 AM



EV Charging Impact on Facility Power in kW with Charging from 9:00 PM to 3:00 AM



From a practical standpoint, these various considerations impact the EV charging system design, including ancillary systems. This further influences the selection of chargers, charger types and architecture, etc.

Conclusions

Considerations of EV deployments in concert with the EV charging design, government mandates, operational impacts, ancillary equipment, and overall ESG/carbon reduction goals require an integrated approach to baseline, analyze, and design a cost effective solution that maximizes flexibility. In our experience, there is not a "once size fits all" approach but instead a solution that integrates common building blocks into a customized solution for each facility's unique needs.

Our team is uniquely qualified to help your facility navigate these decisions, enabling you to right size the deployment while enabling operational flexibility now and in the future.

About Enerlogics Networks, Inc.

Enerlogics Networks, Inc. ("Enerlogics") is a developer of intelligent energy solutions for commercial, industrial, governmental, and educational customers across the US. Enerlogics provides customized solutions using solar, energy storage, EV charging infrastructure, and related technologies to provide cost-effective solutions that reduce facility's operating costs and enhance facility sustainability. As a pure play developer, Enerlogics streamlines the development process with a focus on rightsizing solutions to optimize the customer benefits. Contact us a www.enerlogics.com | 216.362.3000 x303