BATTERY COUNCIL INTERNATIONAL

ESSENTIAL ENERGY EVERYDAY

INFORMATION BRIEF

DC Fast Charge Coupled with Energy Storage:

Key to EV Adoption and Infrastructure Protection

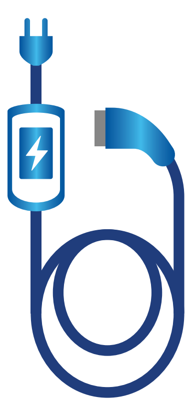
Electric Vehicles (EVs) continue to take market share across the world. As battery costs continue to drop, more automobile manufacturers are producing a wider range of models to meet consumer needs.

EVs offer many benefits to consumers and the environment. However, the industry still faces a major challenge — developing an EV that charges in the same time it takes to fill an internal combustion vehicle (ICE).

Overview of EV Charging Levels

There are currently three levels or rates of charging that have been standardized in the EV industry.

Level 1: Alternating Current (AC) Charger



Level 1 charging can be performed anywhere that a 120V AC outlet is available by using a charge station provided by the EV manufacturer or a third party. The power output of these chargers is limited to between one and two kW (approximately four to 10 miles of range added each hour) which could take up to 30 hours or more to charge an average sized battery pack (60 kWh) from a low state of charge.

Level 1 chargers are great for plugging in an EV overnight at your home to top off the battery. They are also often used at a place of business where a car will be parked for eight hours or more.

The amount of power available to the level 1 chargers is limited by two key factors:

- Most 120V outlets are rated at 15 to 20 amps (2.4 kW max). As a result, most EV manufactures limit charging to 12 amps (approximately 1.2 kW) to reduce the risk of damaging the home electrical system or causing fires.
- The AC power from the wall socket is converted to high voltage direct current (DC) required by the EV's battery pack, via an onboard AC/DC converter which limits the amount of power passing into the battery.

Level 2: Alternating Current (AC) Charger

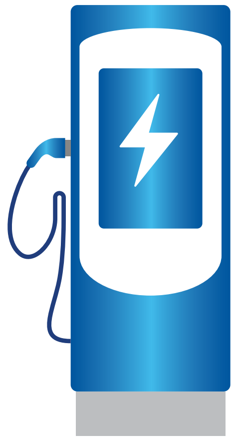
Level 2 charging uses a similar charging station as level 1, but a 240V AC outlet is utilized. These are sometimes portable stations similar to level 1 chargers. They are often found hardwired as a more permanent fixture.

Level 2 chargers are sometimes referred to as destination chargers and are often found at shopping centers, parking garages and other public places. Using a 240V AC outlet provides flexibility in how much current can pass through into the battery, enabling up to 80 amps with some chargers.

Each charger has a different maximum rating, and it should be noted that as with the level 1 charger, the AC power has to pass through the onboard AC/DC converter that is built into the EV's electronics. Every model of EV has its own charge limitation dictated by the installed converter and this value varies significantly from 12 amps for a Chevrolet Volt to 50 amps for a Tesla.

Level 2 charging is a great solution for adding miles of range at a faster rate but still falls short of meeting the need of those traveling longer distances who don't have 4 to 5 hours of available time to recharge.

Level 3: Direct Current (DC) Fast Charger



Level 3 or DC fast charge gets around the limitations of using the onboard AC/DC power converter and instead provides high voltage DC electricity directly to the battery.

These charge stations are much larger than the level 1 and level 2 charging pedestals as a significant amount of 480V AC power is being converted to DC power to charge the EV's battery.

This requires larger, more sophisticated electronics and sometimes liquid cooling to handle the higher power output.

DC fast charging allows the EV to charge at up to 300 kW and can often take a battery pack from near zero percent state of charge (SOC) to 80% SOC in 15 to 45 minutes depending on the model of EV.

DC fast charging is a great solution for those needing to fill up and hit the road, but it is not without challenges. This type of charger uses a substantial amount of peak power for brief intervals and can put significant strain on local grids and infrastructure.

DC Fast Charge Rollout Challenges

Infrastructure Limitations

Many locations where DC fast chargers are installed or needed do not have sufficient incoming power infrastructure to handle the increased load that these chargers would add. It is very costly to upgrade the infrastructure of a typical shopping center, truck stop or rest stop and in some cases, the local grid is unable to support the high-power demands of DC fast chargers. This is especially true in rural and less populated locations along highways where there are sometimes gaps of 75 to 100 miles without any services.

Managing Peak Demand Charges

Those who install DC fast charge stations also face the challenge of increased use of demand rates by utilities.

An electricity demand charge is a fee that some utilities charge their commercial and industrial customers based on the customer's maximum electricity usage during a billing period, usually a month.

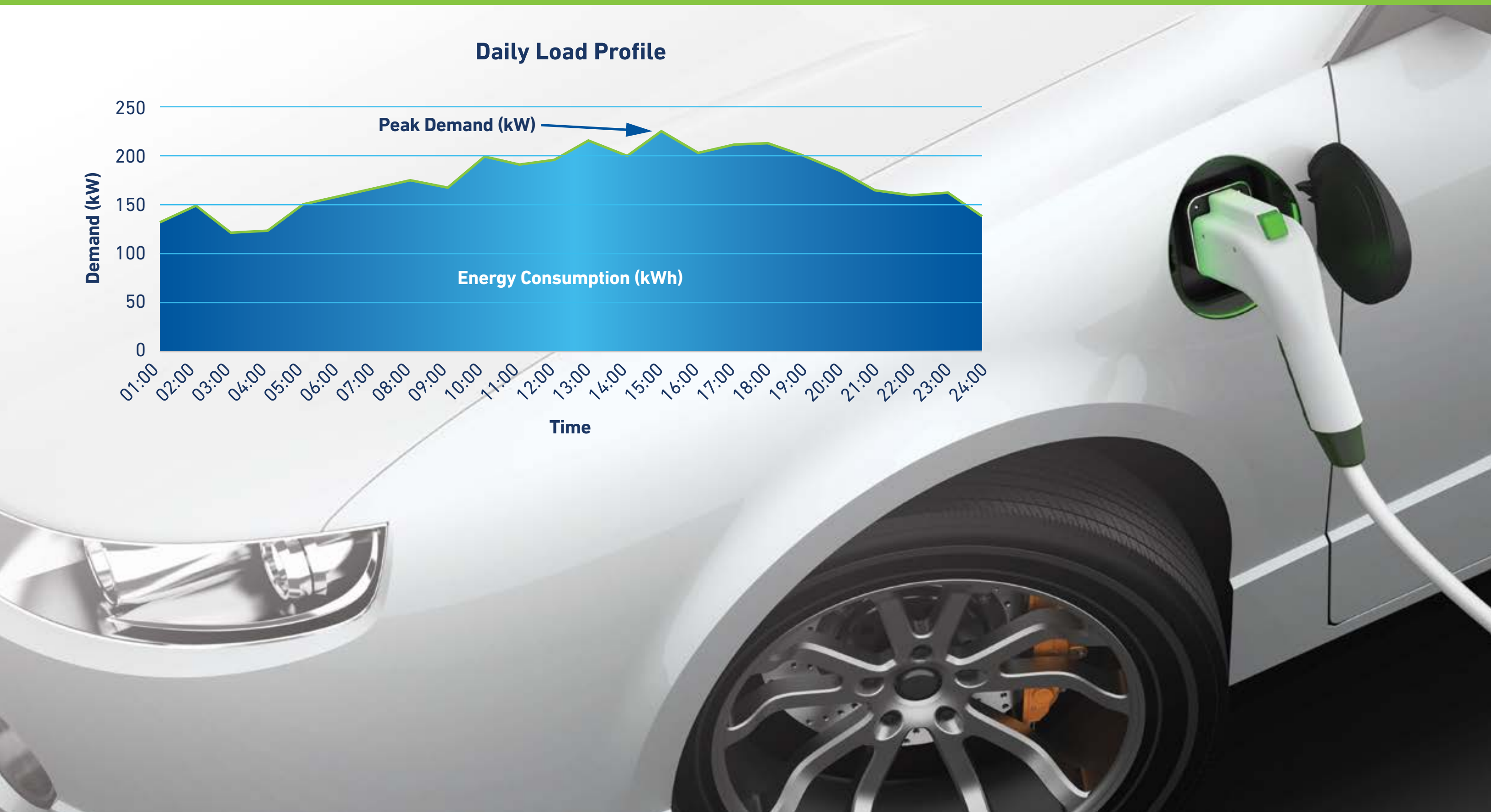
This charge is separate from the charge for the total amount of electricity consumed. The purpose of demand charges is to recover some of the utility's costs for maintaining the infrastructure required to meet peak electricity demand.

According to the U.S. Energy Information Administration (EIA):

"Demand charges are based on the customer's peak level of electricity demand (measured in kilowatts) and are independent of the customer's total electricity consumption (measured in kilowatthours). Demand charges are intended to reflect the costs that a utility faces to provide sufficient electricity generation and transmission capacity to meet a customer's peak demand."

DC fast chargers located in areas with demand-charge-based rate structures would create significant costs for the site owner of the asset, especially during high demand times like "rush hour" type charging.

For these, and other reasons, the rollout of DC fast charging installations has not kept pace with the adoption of EVs and there are many parts of the country where insufficient DC fast chargers are available. One way to alleviate these challenges is by coupling DC fast chargers with battery energy storage systems (BESS).



DC Fast Charge and Energy Storage Together Protect Infrastructure

Energy Storage Offsets Spikes of Power Demand on the Grid

The ultimate goal of combining energy storage with DC fast charge stations is to avoid large spikes of power usage from the grid that can negatively impact the infrastructure and increase demand rates of the site owner.

Coupling DC fast chargers with energy storage allows the site owner to utilize the battery as a buffer between the incoming grid power and the power being used to charge the EVs.

As the power demand from EVs charging throughout the day fluctuates, the intelligent controls driving the energy storage are able to adjust outputs and inputs to provide a more level load on the grid.

During times when multiple EVs are charging and power demand is at its highest, the battery system will provide a significant amount of the required power to minimize spikes in energy usage and mitigate costly demand charges during these peak usage periods. Once the demand drops or as the battery reaches a specified state of charge, power from the grid is then funneled back into the batteries at a controlled rate so that they will be ready for the next high demand need.

These energy storage installations can range in size from 350kWh (8 x 12' shipping container in size) to several megawatts (multiple 40' shipping containers in size) depending on the projected load profile of the charging station.

Additionally, solar panels installed on parking canopies (circumventing the typical large footprint issues associated with solar) can be added to help charge the batteries and offset power needs from the local grid.

Furthermore, the market opportunity for energy storage for DC fast chargers is vast. If it is assumed that an installation of 10 x 100 kW chargers is backed up with 1 hour of battery reserve sized at 50% of nominal capacity, i.e. 2 MWh for 10 chargers, in the U.S. alone there are hundreds of thousands of DC fast chargers to be publicly funded. Across the world applying energy storage to DC fast chargers not only provides the most dynamic and cost-effective solution to curbing spikes in energy consumption at peak times, but will also represent an over $10 billion new market for energy storage in the next five years.

Conclusion

In order for consumers to overcome range anxiety and for the market to be willing to replace all ICE vehicles with EVs over the next 20 to 30 years, a robust network of DC fast chargers must be implemented across the country. Currently, the best technology available to overcome the challenges associated with DC fast charging is to include energy storage with most charging installations.

BATTERY COUNCIL INTERNATIONAL Recently celebrating its 100th anniversary, BCI was formed in 1924 and joins together battery manufacturers and recyclers, marketers and retailers, suppliers of raw materials and equipment, and battery distributors from across North America and around the world. BCI members are committed to responsible manufacturing and recycling processes, and serve as a unified voice for environmental, health and safety stewardship.

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