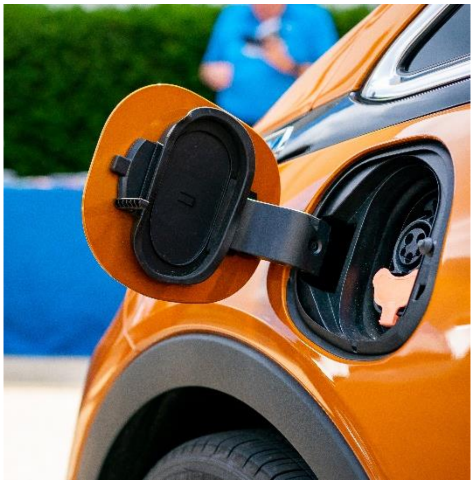
The Electric Connection: Best Practices for EVs, Smart Charging, and Utility Storage Mandates

The future of transportation is widely seen to be electric. Plug-in electric vehicles (PEVs) can provide significant benefits to ratepayers in utility service territories, the electric grid and to each state. Given the number of benefits, it's no surprise that states and utilities around the country are preparing for the accelerated growth of this market through supportive state level PEV policies and utility PEV programs. The American driver simply wants more of these convenient, clean vehicles that save consumers money today.



PEV sales are increasing at a rapid pace, and the infrastructure to meet these vehicles' needs will need to be deployed rapidly as well. As the PEV market grows, utilities and regulators should consider the larger picture of the intersection of smart and effective charging for PEVs and utility storage mandates, and adopt best practices to incorporate PEVs into storage goals.

Not all EV charging needs to be "smart." It is important first and foremost to install well-advertised charging infrastructure to meet the needs of drivers. Smart charging can conflict with other priorities, such as the low capital cost of Level 1 chargers or the rapid charging accomplished with DCFC systems. Still, it is useful to understand how PEV charging offers load flexibility to the benefit of the grid, and where PEV charging with storage integration can reduce costs overall.

Background: Storage, Flexible Loads, and the Electricity Grid

Improvements in battery technology have led to greater interest in using batteries to support the electricity system. This has become particularly important with the increasing deployment of wind and solar power. These forms of renewable energy have increased so much that, at times, they produce *more* electricity than a local grid needs, even driving wholesale prices negative. Batteries can absorb the surplus renewable electricity, then return it to the grid during times of peak demand.

Another option is to *move the demand* to times when there is an over generation of renewable energy. Utilities can encourage energy consumption at predictable times of renewable energy surplus with time-of-use (TOU) rates, or during more unpredictable real-time events with programs like real-time pricing (as SDG&E proposed) or PG&E's Excess Supply Pilot.

Flexible loads such as PEVs, electric water heaters, commercial ice chiller air conditioners and agricultural water pumps all have some leeway as to when they take power from the grid. Given the right price signals, these flexible loads can shift demand away from peak periods to times of surplus renewable electricity. In California, this might be late morning and early afternoon hours when solar power is creating a 'duck curve.' In the Great Plains, this might be hours at night when wind is blowing but demand is low. Flexible loads can also provide 'grid services' such as frequency regulation, demand response, voltage support and other products. None of these flexible loads (with the exception of PEVs configured for vehicle-to-grid) send electricity back to the grid. While this limits their functionality compared to dedicated storage (which effectively shifts supply *and* demand), it also limits installation and interconnection costs.

Level 1 charging (using a basic 120 V outlet) is not well-suited to serving as a flexible load. A major advantage of Level 1 charging is its low capital cost, which could be subverted by the additional cost of communication capabilities. In addition, the value of grid services delivered by such a system would not be as great due to the lower power draw. A Level 2 charger might be able to provide 5 kW of demand response, whereas a Level 1 charger can only provide 1 kW. In fact, a Level 1 charger might not even be network-connected.

DC fast charging is also not well-suited to serving as a flexible load. DC fast chargers are used by drivers looking to recharge quickly and get back on the road. As a result, there is little to be gained by modulating the charging speed for grid services, even though DCFC should generally be networked to report availability and operational status to navigation apps. There *may* be significant benefits to integrating dedicated storage batteries with DCFC systems, such as reducing demand charges or reducing the costs of required infrastructure upgrades.

A Level 2 charger at a long dwell-time location (such as a workplace) is among the best options for leveraging the load flexibility of PEVs. The business case for "smart charging" will depend on network costs, markets for grid services and the needs of the drivers. Driver needs must take priority over the fairly modest revenue that can be garnered from participation in grid services markets.

Storage Mandates

Several states that have chosen to deploy storage technologies to accommodate increased renewable energy have not recognized the full spectrum of flexible loads. For example, in California's storage mandate, only one type of flexible one-way load is classified as energy storage (ice systems for commercial air conditioning).[1] The mandated systems provide the grid services that could be done by flexible loads, depriving those technologies of the opportunity to earn revenue.

Researchers from the National Renewable Energy Laboratory found that PEVs would have a greater value to the grid if the storage mandate in California was not in place.[2] "Smart charging" of PEVs could provide much of the same grid benefits as the storage mandate, but at a lower cost. If regulations require a substantial storage capacity, and "smart charging" does not count toward this requirement, then it has only modest additional value as a flexible load.

A coalition of groups petitioned California to make flexible loads eligible under the storage mandate. The petition noted that if uni-directional storage technologies such as ice storage were eligible resources under the storage mandate, it would be reasonable for smart PEV charging and other flexible loads to be eligible. The petition noted the concern that low-cost grid services from flexible loads could make dedicated storage uneconomical and proposed solutions. The CPUC did not change its position in response to the position, reasoning that vehicle-grid integration (VGI) was being addressed through a separate process. However, as the NREL researchers showed, decisions on storage affect the economics of different VGI concepts for PEVs.

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[1] Find more on the CA storage mandate at the Public Utilities Commission website on energy storage: http://www.cpuc.ca.gov/General.aspx?id=3462

[2] Denholm, P., and R. Margolis. 2016. *Energy storage requirements for achieving 50% solar photovoltaic energy penetration in California*. NREL/TP-6A20-66595. Golden, CO: National Renewable Energy Laboratory. Online at *www.nrel.gov/docs/fy16osti/66595.pdf*

Other states have adopted energy storage targets or mandates, including Oregon, Massachusetts, and New York. Arizona and Nevada are considering such measures. Plug In America recommends that flexible loads be eligible for such programs, including PEVs enrolled in "smart charging" programs. Even if the rebate or incentive levels are not identical to those of dedicated stationary batteries, flexible loads should be eligible for incentives, and should count as partial credit towards state goals.

Storage Incorporated into PEV Charging Systems

If PEVs cannot *compete* with dedicated grid batteries in the grid services markets due to mandates, then another opportunity arises: *incorporating* those mandated stationary batteries into high-speed charging systems.

A DC fast charger draws a substantial amount of electricity – typically at least 50 kW, though sometimes up to 150 kW and even up to 350 kW. These high powered charging stations are likely to be utilized for electric trucks, or ride-sharing services that will want vehicles to charge quickly to maximize availability, whether the vehicles are driven by humans or are autonomous. This high power draw leads to considerable installation costs and high demand charges. Batteries provide a way to mitigate both of these costs. The battery can be charged by drawing power at a lower power rate over a long period of time, while providing high power output for short periods of time when needed.

This approach does require good advance knowledge of the likely utilization rate of the DCFC; storage is best for low-to-moderate-utilization systems. As a system increases in utilization rate, the battery will not be able to reduce demand charges as much, but can continue to provide other grid benefits.

Batteries integrated into DCFC can qualify for rebates under storage mandates, provide grid services, and also limit the cost of DCFC grid connection and operation. Such projects have been installed by Tesla, Greenlots, ChargePoint, and others.[3]

Recommended Best Practices

The plug-in electric vehicle (PEV) market is growing. Sales of PEVs are expected to reach at least 35% of light-duty vehicles by 2030, growing to at least 60% of light-duty vehicles by 2040.[4] Properly managing this additional electric load will benefit ratepayers and the electric grid. Plug In America highly encourages utilities and regulators to adopt best practice policies that recognize the role PEVs have to play as flexible loads under storage mandates and targets. These include:

- Adopt a Vehicle Grid Integration Strategy, to prudently plan for expanded PEV adoption and to *enable* (but not require) vehicles to use smart charging to benefit the grid;
- Move towards providing charging at all workplace and residential building parking places, with stand-alone stations in the near term and connected load-sharing systems in the long-term;
- Consider 'Smart Charging' of PEVs (also referred to as 'V1G') and other flexible loads when developing energy storage goals, targets, and mandates;

[3] Hawaiian Electric and Greenlots partnered on a battery storage and DCFC project in Hawaii: https://www.hawaiianelectric.com/Documents/about_us/news/2016/20160225_greenlots_and_hawaiian_electric_testing_ev_chargers_with_batteries.pdf

[4] https://data.bloomberglp.com/bnef/sites/14/2017/07/BNEF_EVO_2017_ExecutiveSummary.pdf

- Credit flexible loads appropriately given their capability of achieving the goals of the energy storage targets (such as better alignment of supply and demand);
- Allow flexible loads to compete against stationary energy storage systems in providing grid services;
- Consider incorporating storage into publicly-funded EVSE where doing so would reduce installation costs, demand charges, or other expenses; and,
- Allow such storage to generate multiple revenue streams.

About Plug In America

Plug In America is the nation's leading independent consumer voice for accelerating the use of plug-in electric vehicles in the United States to consumers, policymakers, auto manufacturers and others. Formed as a non-profit in 2008, Plug In America provides practical, objective information collected from our coalition of plug-in vehicle drivers, through public outreach and education, policy work and a range of technical advisory services. Our expertise represents the world's deepest pool of experience of driving and living with plug-in vehicles. The organization conceived National Drive Electric Week and has advanced workplace charging by pioneering ride-and-drive events at such leading corporations as Google, Mattel and Paramount Pictures. We drive electric. You can too. www.pluginamerica.org