The Electric Vehicle Utility 2.0: White Paper

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How can utilities help accelerate the adoption of plug-in electric vehicles and why should drivers consider buying or leasing an electric vehicle? In Austin, the equivalent price of electricity powering a plug-in electric vehicle (PEV) is approximately $1 per gallon. There are many other benefits for the adoption of PEVs including:

- reduced emissions,
- decreased U.S. trade deficit,
- reduced dependence on unstable regions with the greatest oil reserves,
- fewer petro-dollars potentially funding activities counter to national interests,
- improved energy security, and
- fuel price stability.

PEVs also provide many direct advantages for the driver over a conventional gasoline or diesel vehicle, including:

- lower operating costs,
- improved noise-vibration-harshness characteristics within the vehicle,
- convenience of home refueling,
- reduced maintenance, and
- improved performance.

The concept of electric vehicles is well over a century old, but only in the past decade have technological advancements in batteries, power electronics, computer controls, and powertrain architecture enabled the first wave of mass-market viable and luxury/performance PEVs.

PEVs represent new unique loads (and potential energy storage) for the electric grid: they are large, flexible, and intelligent. Given these characteristics, electric vehicles not only provide real benefits to the U.S. as a whole and to the individual driver, but they can also synergistically interact with the grid. By deploying Smartgrid technology, intelligent electric vehicle charging has the potential to increase grid stability, improve electrical grid fixed asset utilization, and provide the ability for utilities to incorporate more renewable generation on the grid.

In addition to promoting PEVs and educating their customers on the benefits of electric drive, utilities are uniquely positioned to increase PEV adoption and unlock many of the advantages of electric vehicles by focusing on areas related to 1) charging infrastructure installation and costs, 2) intelligent charging capabilities and re-charging costs, and 3) autonomous charging infrastructure and convenience.

1. Intelligent, fast, and more pervasive charging infrastructure

One of the advantages with PEVs is the ability to charge/refuel at home. Home charging is the dominant charging location today and is expected to remain so in the future. As an example, PEV charging flexibility can be leveraged since a vehicle may need only 4 hours to fully charge but be plugged in for over 12 hours at home (say, 7pm to 7am). The vehicle could be charged at a pace slower than its maximum rate, thus taking advantage of nighttime wind production, while further reducing the demand on the distribution grid. As long as the process is automated and still charges the vehicle by the departure time, such managed charging does not create an inconvenience to the driver.

Home charging stations are now being introduced that allow utilities and their customers to work together to enable smart charging while still ensuring the electric vehicle is charged when needed. The core communications and computing technologies needed to implement intelligent charging are known and mature. The home charging station can be equipped with WiFi communications and a relatively modest embedded computer. The WiFi equipped charging station could coordinate with the utility through the internet just as a NEST thermostat does today.

An interesting example would be to align PEV charging with the availability of wind energy from West Texas that tends to peak at night. Utilities could also include vehicle charging in their Demand Response (DR) programs to reduce stress on the grid and minimize CO2 emissions just as their thermostat, water heater, or pool pump DR programs can today. For example, Austin Energy conducted one of the first demand response pilot programs in the U.S. that successfully integrated electric vehicle charging into a uniform platform with thermostat vendors to curtail charging during peak demand periods. With residential solar panel electricity production growing rapidly, intelligent PEV charging is being considered as a means to increase grid stability when there is excess solar power or a rapid change in solar panel output.

Utilities are generally enthusiastic about the ability to grow revenue by selling more electricity for PEV charging and at the same time advancing grid reliability. These benefits are leading many utilities to offer rebates for charging station installation to encourage PEV adoption in their service area. The ability to temporarily throttle down PEV charging is of great economic value to a utility when wholesale electricity prices spike or when the grid is stressed. To not strand a driver, a PEV owner should be able to manually override the utility signal and enable full charging of their vehicle so they can still drive to their desired destination.

Given the large number of single-family homes in the U.S., some estimate that over 80 million of the 231 million vehicles in the U.S. could be charged at home. However, residential charging is more of a challenge for those drivers who rent an apartment, live in a multi-family complex, or who must park on the street. To address this challenge, some regions are implementing building code changes that will eventually require landlords or condo associations to accommodate electric vehicle charging.

Some utilities are also creating programs that encourage landlords to install PEV charging. Austin Energy has been working with pioneering apartment complexes to install their first chargers. Light post charging using cords with embedded wireless smartmeters is another useful concept that utilities could implement to support PEV drivers who park on the street.

Some utilities, including Austin Energy, have implemented workplace charging programs that reduce the costs and complexity for firms to install PEV charging equipment for their employees. These programs can help companies achieve their environmental sustainability goals as well as attract and retain employees.

As battery prices decline over the next few years, more 200+ mile range Battery Electric Vehicles (BEVs) will be introduced. Utility installation of the highest capacity urban Direct Current Fast Charger (DCFC) would be useful for BEV taxis, BEV car sharing, street-parkers, or multifamily residents. The general rule of thumb is that DCFC can provide an 80% charge in less than 30 minutes. While charging takes longer than gasoline refueling, a driver does not need to stay with their vehicle while it charges. It would be attractive to co-locate these DCFC stations in innovative ways with grocery stores, retail shopping, coffee shops, bakeries, movie theaters or taxi stands so that the drivers can take care of other errands while their vehicle charges.

While individual utilities may already have payment methods that are convenient and low cost for drivers from their own service area, the cost of charging an electric vehicle outside a driver's home utility service can be far greater than the equivalent cost of gasoline and less transparent than the prices posted on a gas station pump. Eventually, a nationwide charging infrastructure should be created with transparent prices that are more comparable to home charging (or at least not punitively high), and with convenient payment methods similar to self-service gas stations.

2. Innovative pricing programs to guide intelligent charging

Intelligent charging must have signals to automatically reduce or vary the charge rate. Time-of-use (TOU) rates are published electricity tariffs that vary by the time of day.

The simplest form of TOU rates can be structured to have peak and off-peak rates. Peak rates in Austin occur during the heat of the day. Off-peak rates offer lower retail prices when the grid is less stressed in the night. However, classically structured TOU rates may provide little ability to dynamically signal grid stress. In addition, some homeowners may not select TOU rates for electric vehicle charging if this forces their entire home to adopt a TOU rate structure. Today, some utilities are already providing a second meter specifically to offer special "TOU-EV" (Time of Use-Electric Vehicle) rates separate from the rate for the rest of the house.

Utilities can provide more dynamic signals that can be transmitted at specific times of grid stress or high wholesale prices. Given the flexibility of PEV charging to potentially increase or decrease charging, it is possible to create new signals from the utility that could be called "CO2-EV" rates if they are based upon emissions or "RTP-EV" (real time prices) rates if they are based upon real time wholesale prices. Acceptable implementations may need to include price caps or a baseline rate with a varied rebate mechanism.

3. Deploying advanced infrastructure & autonomous PEVs

Wireless PEV charging eliminates the charge cord by deploying matching inductive coils: one on the underside of the PEV and the other on or under the ground. Autonomous or self-driving vehicle capabilities have been under development for a number of years. Some of us may have already seen Google self-driving cars driving around Austin. While initially raising some concerns about computer driven cars, new generations of radar and cameras, laser sensors, and more powerful computers and algorithms have demonstrated considerable capabilities today. In 10 to 15 years manufacturers may offer wireless autonomous PEVs that allow street parkers or multifamily PEV owners to have their car automatically drop them off at their front door, negotiate a wireless charging reservation, drive to a temporary parking spot until a wireless charging spot is open, vacate that spot after charged, and then pick up their owner in the morning with a full charge. The electric vehicle utility of the future could create automated wireless parking lots that create a far more convenient parking and refueling experience than a conventional vehicle.

Conclusion

The combination of commonly available affordable energy from the electricity grid, advances in Lithium batteries, semiconductor based power electronics, and embedded computing have created viable PEVs. To date, the basic electric powertrain technology is proven and the PEVs on the road have demonstrated that they are safe, reliable, and satisfying to drivers. While adoption at a large scale may take a number of years, there are many actions that utilities can take to increase adoption rates and support the increasing number of electric vehicles locally.

First, utilities can create a more convenient vehicle ownership experience compared to a conventional gasoline/diesel vehicle, lower costs of charging stations and fuel for drivers, and use intelligent charging to improve grid stability, emissions, and economics. Far-sighted utilities will develop intelligent, fast, and more pervasive charging infrastructure. Secondly, utilities can create innovative emissions or cost-variant signals to guide intelligent charging and leverage flexible PEV charging. Finally, to unlock the advantages of PEVs, utilities and planners should invest in innovative urban PEV infrastructure designs to support wireless autonomous charging.

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