Electric Vehicle Public Charging – Time vs. Energy

March, 2013

A critical factor for successful PEV adoption is the deployment and use of charging infrastructure in non-residential locations. Vehicle operators utilize this infrastructure to extend the electric range of their PEV. Without charging infrastructure in commercial locations, PEVs are "tethered" to their overnight charging location.

Through The EV Project, charging infrastructure at commercial locations has been deployed in various cities across the country. To stimulate use of this charging infrastructure and familiarize EV owners with its operation, access to the infrastructure was initially provided at no cost. This Lesson Learned paper presents issues and options considered by The EV Project in determining the metric to be utilized for introducing access fees for commercial charging infrastructure.

Free Charging is Not Viable

While free access to commercial charging infrastructure provides an effective means of initializing infrastructure use, it does not support a "viral" expansion of charging infrastructure. Widespread deployment of charging infrastructure at commercial locations must either be subsidized or it must generate sufficient income to provide a return on the investment made by the infrastructure owner. It is assumed that a small amount of charging infrastructure may be subsidized by local, State or Federal government funding its installation, and some businesses may choose to subsidize it by providing free charging as an enticement to attract customers. However, the quantity of charging infrastructure necessary to support widespread adoption of PEVs must be supported by private investment, anticipating a return. Access fees provide one mechanism to provide this return on investment.

Assessing Access Fees

The EV community currently employs three means to assess fees when an EV owner accesses commercial charging infrastructure, 1) by time connected to the unit for the charge; 2) by the energy used, measured in kilowatt hours (kWh), 3) by means of a subscription wherein all in-network charging is included in a monthly fee.

This paper intends to address only the time and energy consumption based methods as currently the networks that employ these are more prevalent across the country.

Level 2 EVSE Charging Station at Monti's la Casa Vieja, Tempe, AZ

Time Based Access Fees

Time based access fees are applied to the user of the charge infrastructure for all time that the vehicle is connected to the charge unit. This is regardless of whether or not there is energy being delivered or the rate at which it is delivered. Once authorized to charge and connected to the vehicle, the charging costs accumulate in increments of time, and continue until the charge is stopped or interrupted. The total cost reflects the total time that the vehicle had access to the charging station.

Addresses Investment in Infrastructure

The total cost for an EVSE charging station installed at a business location is thousands of dollars. Normally this investment will need to be recouped over time.

Following are a few of the items that a commercial charge infrastructure owner/host pays up-front to have an EVSE charging station installed:

- Parking space – This is typically one of the closest parking spaces to the building, to provide economic access to supply power, for visibility and access for compliance with the Americans with Disabilities Act.

- EVSE unit costs – This cost could range from $800 to $3,000 for the Level 2 charger[1] and $30,000 to $80,000 for a DCFC unit. The greater the charging rate available, the more complex and expensive the EVSE unit.
- Installation costs – This cost could range from $3,000 to $15,000 [2] per site. The fees may consist of installing the EVSE unit, concrete and asphalt cutting, trenching, connection to electrical utility box, resurfacing the asphalt parking lot, striping, signage, and replacing concrete.
- Permit costs – These costs vary from city to city and could be from a few hundred to a few thousand dollars.

On-going costs, once the EVSE unit is installed, include costs to maintain the parking lot (resurfacing, cleaning, lighting, etc.), insurance costs, property taxes and the cost of electricity consumed. The cost of electricity for EV charging is actually one of the least expensive items associated with hosting an EV charging station.

To recover the cost of owning and operating a charging station, both the fixed initial costs and the on-going operating costs must be recovered. Access fees based on time connected to the charger reflect the significant fixed initial cost in the charging station as well as time based on-going operating costs (such as taxes), but completely ignore the cost of electricity actually transferred during a charge. Therefore the fee assessed per unit of time to connect to the charger must reflect an average energy transfer. This average can accurately reflect energy transfer for low power charging. For example at a 3.3 kW level 2 AC charge rate, PEVs generally charge at the full 3.3 kW until very near the end of charge. However, at higher power charging, particularly DC fast charge, the charge rate can vary significantly over time.

Discourages Charger Overuse

An EVSE charging station can be compared to a table or booth at a popular restaurant. Even though the booth may only cost a few hundred dollars itself, several factors make the booth more valuable. These include the location, cost of the building where it resides, cost of employees to service the clients at the booth, costs to maintain the building to keep the booth secure, insurance costs, food costs, etc. The business owner makes a small profit every time a client sits at the booth and orders from the menu. This profit over time pays for the booth, the building, the employees and all costs related to the business. Comparing the table at a popular restaurant to the EVSE charging station, if a customer does not order from the menu at a restaurant but occupies the table, they are preventing other customers from using the table as well as not providing income for the restaurant. Similarly, if the restaurant customer eats his meal but then stays and chats for two more hours, they are likewise preventing other customers for using the table and providing income for the restaurant. The same is true when an EV is plugged into the EVSE charging station and not charging. Charging by time connected to the charger encourages PEV owners to move their vehicles out of the charging location promptly upon charge completion. This ensures that the charger is available to as many PEVs as possible and prevents a single PEV from dominating the charger location while providing no revenue to the charger owner

Simple Administration

When being billed by time, an EV owner knows the amount they are going to have to pay for the time they are plugged into the EVSE charging station. They can determine how much they want to spend and how long they can visit the local business before their charging is complete.

As will be shown in the following section, paying for charger access by kWh consumed can be less predictable, presenting the PEV owner with uncertainty concerning the amount they will pay for charging.

Fees Based on Energy Consumed

Fees assessed for vehicle charging based on energy consumption measure the amount of energy disbursed and bills the EV driver based on total energy consumed. The user of the charging unit only pays for the energy consumed and therefore requires prior authorization to charge and connection to the vehicle. The EV driver pays a set fee per kWh regardless of what the host/EVSE owner pays for energy or any other operational cost.

Investment in Infrastructure

Fee collection based on energy consumption (kWh) does not provide the same consistent benefit the business owner or the customer. There is no real way to monitor kWh transfer, since the electrical utility meter cannot be reset every time someone begins a charge. The business owner has no real way of collecting data, to know how many charges occurred in a specific time period. The charge rate that a vehicle accepts depends upon battery condition and the customer does not know the amount they are going to be charged every time the use the EVSE unit, since kWh

[1] Financial Viability of Non-Residential Electric Charging Stations, UCLA Luskin School of Public Affairs, August 2012

[2] Public Charging Stations Fuel Desire for Electric Cars, CNN, October 24, 2012

fluctuate, their charging session amount could fluctuate at every charge.

Access fees based on energy transferred during charge very accurately recover the on-going cost of energy for charging. This provides the user of the charger consistent value (energy priced in kWh) for the fee paid to access the charger. However, as much of the investment in charging infrastructure is associated with the fixed initial cost of equipment and installation, access fees based on energy transferred during charge must be adjusted to provide an average return on this investment as well. This adjustment is complicated by charge events during which the vehicle completes charging, yet remains connected to the charger. The only cost that ceases is electricity, and with it all revenue to the host. Much like the restaurant customer who eats their meal but then stays and chats for two more hours, these charge events that deliver no energy for extended periods of time must be compensated for by higher fees for energy actually transferred.

Must be Licensed to Sell Electrical Energy in Most States

Electric utilities have huge financial investments in generation, transmission and distribution infrastructure which provides electricity to its customers. In exchange for making these investments, electric utilities are typically chartered as the exclusive provider of electricity in a specific service territory. As such no other companies are permitted to charge for the sale of electricity. When EVSE equipment suppliers charge by the kWh, they fall into the category of an electric utility. As a result, the sale of electrical energy from an EVSE in most states (and electric utility service territories) is illegal unless specifically provided for in regulations. According to the DOE's Alternative Fuel Data Center, (http://www.afdc.energy.gov/laws/state) the jurisdictions that have amended regulations to allow sale of electricity by kWh from EVSE include;

- California
- Colorado
- Virginia
- Florida
- Washington
- Oregon
- Minnesota
- Illinois
- Maryland

The ECOtality white paper "Regulatory Issues and Utility EV Rates" takes a detailed look at utility regulation in numerous states related to EV charging.

Meter Certification

In jurisdictions that do allow sale of electricity from EVSE, questions arise related to accurately measuring the amount of electricity sold. Typically items sold by measure (in this case - energy) require third party certification of measurement system to ensure consumer protection. Electric utilities have rigorous meter certification programs governed by both national standards, such as ANSI C.12, and by State regulation. Additionally, electric utility meters are sealed to prevent energy theft and are removable to allow verification of accuracy by laboratory testing. Meters incorporated in EVSE typically do not meet many of these typical electric utility requirements. Efforts have currently been set in place by the California Public Utility Commission to define specific requirements for electric meters embedded in EVSE.

Conclusion

Widespread deployment of EV infrastructure requires successful implementation of fees for charger access. There are two prevalent means for assessing access fees currently in use – by time and by energy consumed. Experience to date with these fee metrics has identified the following characteristics of each.

Time Based Fees

- Provide a simple, understandable metric for access fees,
- Facilitate a simple metering scheme (clock) with uncomplicated certification of accuracy,
- Discourage vehicles from parking at chargers for extended periods after charging is complete, and
- Accurately represents the overall cost of providing charge infrastructure, but is not proportional to the actual quantity of energy delivered.

Advantages

- Simple
- Accurate measure
- Encourages turnover

Disadvantages

- Paying for blocking access for others when not getting energy from the charge unit

Energy Based Fees (kWh)

- Allow fees charged to be proportional to the actual amount of energy delivered,
- Require regulatory changes in most States to allow non-utility entities to "sell electricity",

- Do not proportionally reflect time related costs (e.g. equipment and installation cost) of providing PEV charging infrastructure, and
- Allow vehicles to remain connected to charging infrastructure at no cost.

Advantages

- EV driver only pays for energy used

Disadvantages

- EV driver can block access to charge unit for others with no penalty
- Does not encourage turnover of potential business customers for the host
- Not allowed in most states
- Accuracy of energy measurement can be called into question without an established 3rd party qualification system

Because one of the primary objectives for the EV Project is to encourage and determine ways to encourage the widespread adoption plug-in vehicles, ECOtality has elected to charge access fees by time on the Blink network of chargers. This defines the space as a "charging space" rather than a parking space, and this approach promotes PEV charging for a greater number of drivers.

About The EV Project

The EV Project is the largest electric vehicle infrastructure demonstration project in the world; designed and managed by ECOtality North America, with a budget of over $230 million USD, equally funded by the U.S. Department of Energy through the American Recovery and Reinvestment Act and ECOtality North America and its partners. The EV Project will deploy and study approximately 13,000 Level 2 EVSE charging stations for residential and commercial use, as well as 200 dual-port DC Fast Chargers in conjunction with the usage data from 8,000 Nissan LEAF™, Chevrolet Volts. This project will collect and analyze data, and publish lessons learned on vehicle and EVSE use, and driver behavior. This material is based upon work supported by the Department of Energy under Award Number DE-E0002194.

Company Profile

ECOtality, Inc. (NASDAQ: ECTY), headquartered in San Francisco, California, is a leader in clean electric transportation and storage technologies. Its subsidiary, Electric Transportation Engineering Corporation (eTec) dba ECOtality North America (ECOtality), is the leading installer and provider of charging infrastructure for electric vehicles (EVs). ECOtality has been involved in every major EV or plug-in electric vehicle (PEV) initiative to date in North America and is currently working with major automotive manufacturers, utilities, the United States (U.S.) Department of Energy (DOE), state and municipal governments, and international research institutes to implement and expand the presence of this technology for a greener future.

For more information, visit www.theevproject.com

Electric Transportation Engineering Corporation
dba **ECOtality North America**
430 S. 2nd Avenue
Phoenix, Arizona 85003-2418
(602) 716-9576