When EV Project participants program their PEV charge, do they program their vehicle, their EVSE unit or both?

April, 2013

In certain regions of The EV Project, electric utilities provide a rate structure that charges higher rates during their peak usage times and lower rates during the off-peak usage times compared to their basic or standard rate. These time-of-use (TOU) rates are established to provide incentives to their customers to shift their high electrical usage to the off-peak times. The charging behavior of The EV Project participants in these regions show this incentive to be very effective (See Utility TOU Lesson Learned). The Blink Electric Vehicle Supply Equipment (EVSE) unit provided to residential participants is programmable, as are the participating vehicles: Chevrolet Volt and Nissan Leaf. The question then is which one do participants prefer to program for their charging needs?

Why is this important?

The introduction of large scale production of plug-in-electric vehicles (PEVs) led to the entry of many EVSE providers into the market. Some have selected to provide basic units, which provide the power to the vehicle with no services other than the required safety features. Others provide smart units, such as the Blink units deployed in The EV Project, that contain many extra features, including the ability to program the charge start and stop times. Knowing which type of unit the customer prefers is important for car manufacturers and EVSE suppliers in deciding which features to provide with their products.

Measuring vehicle or EVSE unit programming

Among the many smart features of the Blink EVSE unit is its ability to provide event and charge information through the Blink Network to the database at ECOtality. Among the events provided are:

Plug-event start and stop: indicate that the charge connector is inserted or removed from the vehicle charge port.

Charge event start and stop: indicate that the contactor in the EVSE unit has closed or opened. A closed contactor means the EVSE is ready to charge the vehicle.

Power event start and stop: indicate that charge current is flowing or has stopped flowing to the vehicle.

Once the EVSE unit is connected to the PEV and the contactor has closed, the charge is largely controlled by the PEV. While the EVSE unit signals the PEV its maximum current output capabilities, it is the PEV's on-board charger and battery management system (BMS) that monitors the on-board battery to determine the best way to conduct the recharge. It draws the amount of charge current necessary to provide this control. If the vehicle is programmed to schedule charge start and/or stop times, it determines when the battery will accept the charge. Both the vehicle and the EVSE unit must be set to charge before energy will flow to the vehicle.

Using the three types of EVSE events and knowledge of the BMS control, four possible scenarios are identified in the EVSE event data, as indicated in Figure 1.

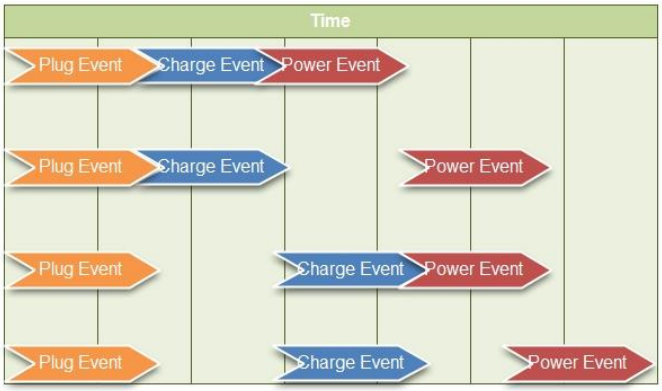

Figure 1. EVSE Event Sequence

1. **No Program:** When the Plug, Charge and Power events happen at nearly the same time, it indicates that the connector has been plugged into the vehicle, the contactor has closed and the charge has begun. No time delay would indicate that there is no program controlling the start of the charge.
2. **Vehicle Programmed:** The gap between the Charge event and the Power event indicates that the EVSE unit is ready to charge the vehicle, but the vehicle has not yet begun drawing power.
3. **EVSE Unit Programmed:** The gap between the Plug and Charge event followed immediately by the Power event indicates that the connector has been inserted into the vehicle but the EVSE unit is not allowing the charge to commence until later. Once the EVSE unit timer allows the charge, the contactor closes and the power flows.
4. **Both Programmed**: As in No. 3 above, the EVSE unit timer is active. However, because the power did not flow immediately upon the EVSE unit contactor closing, the vehicle is not allowing the charge. Thus

both the PEV and EVSE have been programmed by the participant.

EV Project participants have charged their vehicles according to each of these scenarios. Table 1 provides the proportion of plug-in events performed in each scenario. Results shown in Table 1 describe plug-in events that were performed in each EV Project region over the entire project to date.

Table 1. Percent of Plug-In Events by Each EV Project Region

Percent of Plug-in Events				
Territory Name	Not Scheduled	Vehicle Scheduled	EVSE Scheduled	Both Scheduled
Atlanta	72%	10%	17%	1%
Chattanooga	83%	11%	5%	0%
Chicago	86%	8%	5%	1%
Dallas/FW	95%	3%	2%	0%
DC	87%	7%	6%	0%
Houston	93%	6%	1%	0%
Knoxville	78%	16%	5%	1%
Los Angeles	62%	18%	19%	1%
Memphis	85%	11%	4%	0%
Nashville	89%	5%	5%	0%
Oregon	75%	17%	7%	1%
Philadelphia	92%	4%	4%	0%
Phoenix	66%	17%	16%	1%
San Diego	38%	34%	25%	3%
San Francisco	43%	31%	23%	3%
Tucson	61%	24%	12%	2%
Washington State	82%	12%	5%	1%
Total	63%	21%	15%	2%

Utilities with TOU Rates in The EV Project

Several electric utilities in The EV Project provide TOU rates for residential customers and some provide special EV rates for PEV owners. Among the larger utilities providing these special rates in The EV Project regions are Arizona Public Service (Phoenix region), Georgia Power (Atlanta region), Los Angeles Department of Water and Power, (Los Angeles region), Pacific Gas & Electric (San Francisco region), Portland General Electric (Portland region), Salt River Project (Phoenix region), San Diego Gas & Electric (San Diego region), Southern California Edison (Los Angeles region) and Tucson Electric Power (Tucson region). These special rates provide an incentive for residential customers to charge their PEV during the off-peak times. Thus, there is a motivation for the PEV driver to program when their vehicle will start charging. The ability to program the PEV or EVSE is a convenience that enables the electric vehicle (EV) driver to plug-in when arriving home rather than having to plug-in after the start of the TOU rate period. Some TOU rates commence at midnight.

Even though special rates may apply in a region, the PEV driver may certainly determine when they will charge their vehicle, regardless of the rate.

The behavior of The EV Project participants in two of these utility service territories was examined. The electric utilities were Portland General Electric (PGE) and Pacific Gas and Electric (PG&E), which provide basic or standard whole-house rates and TOU rates. PG&E also provides an EV rate.

Residential EVSE usage data from 1,097 EV Project participants in these areas was analyzed to determine the percentage of participants who have and have not scheduled home charging in the last six months of 2012. Those who scheduled charging were broken into groups, based on whether they program their vehicle, EVSE, or both. Figure 2 shows the results.

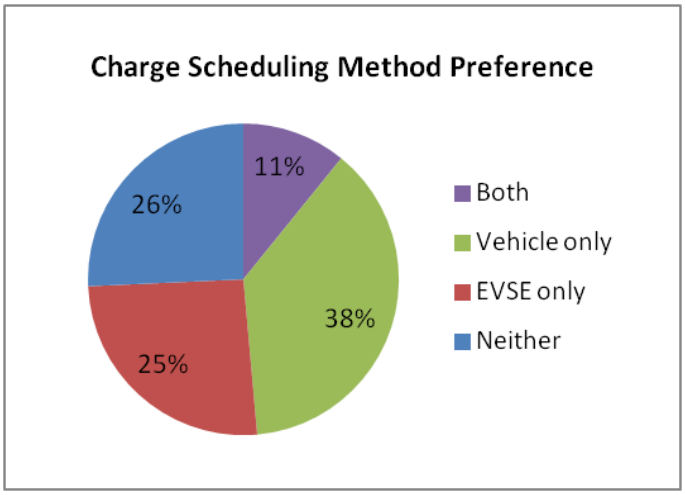

Figure 2. Preference for Charge Schedule Programming

Three quarters of participants have scheduled charging, either by programming only their vehicle, only their EVSE, or programming both.

Programming Survey

EV Project participants in the PGE and PG&E service territories were requested to respond to a survey on this topic. There were 347 responses. The participant identified their current electric rate, as shown in Figure 3.

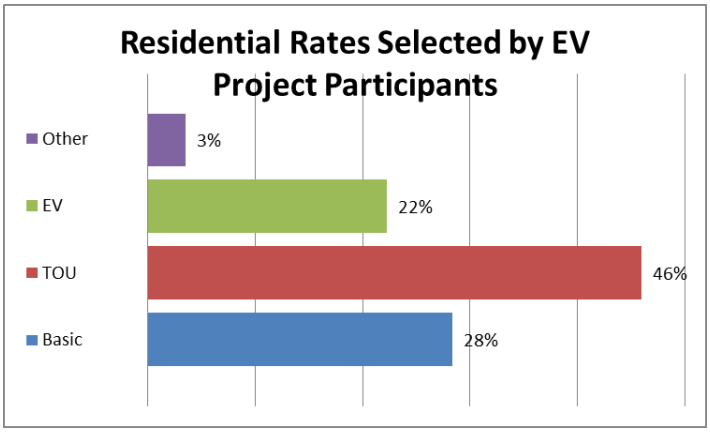

Figure 3. Electric Rates Self-Identified by Respondent

The high percentage of responses indicating that they had the Basic rate may be because the PEV driver either needs to charge at a time during the day (peak period) or may be unaware of the special rates. The "Other" rate was selected by those with a rate for home solar photovoltaic units or by those who were in process of changing rate plans.

Another survey question asked if participants have scheduled charging, and if so, by using the vehicle and/or EVSE user interfaces. Figure 4 summarizes the responses to this question.

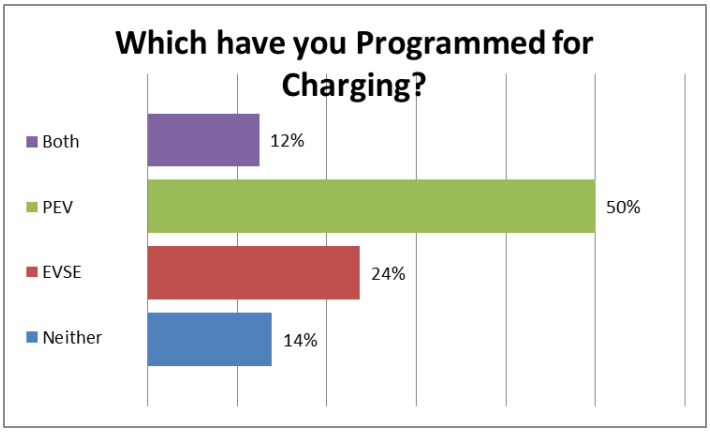

Figure 4. Programming Medium

Note that the percentages in Figure 4 are similar to the charge scheduling behavior demonstrated by EVSE event data shown in Figure 2. Results do not match exactly because not all participants responded to the survey.

The survey also asked those who programmed either or both, how difficult they found the process? Figures 5 and 6 show the responses.

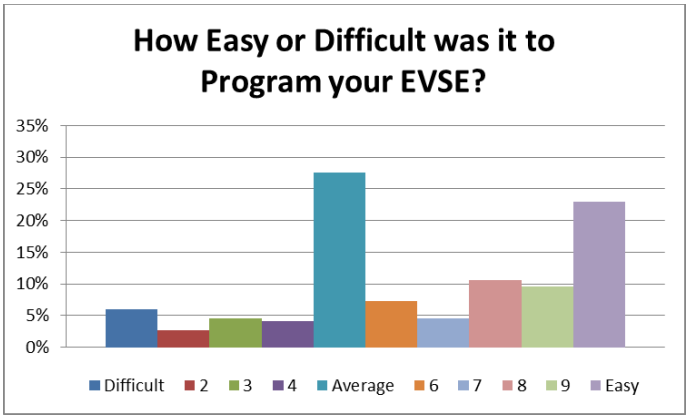

Figure 5. Ease of Programming EVSE Unit

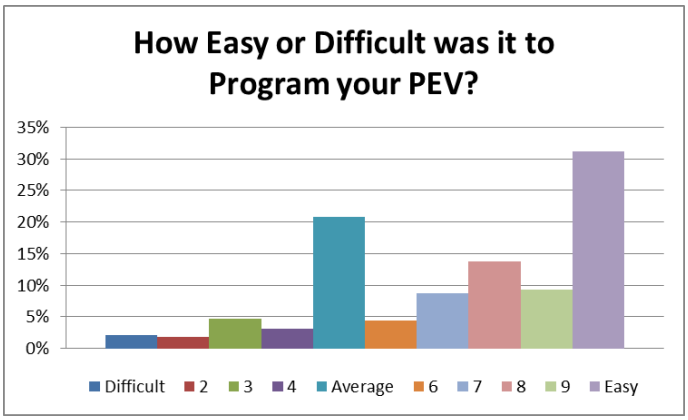

Figure 6. Ease of Programming PEV

Survey Respondent Comments

As shown in Figures 5 and 6, most participants found it relatively easy to program either the EVSE unit or the PEV. Some general comments reflected some EVSE units had programming issues early in The EV Project, which caused the participant to program the PEV instead. However, all thought these issues were resolved.

Survey respondents commented on some technical aspects of charge schedule programming, which may confuse some users.

Respondents noted that there are potential conflicts if both the EVSE unit and PEV are programmed. If the PEV's programmed start time is before the EVSE's programmed start, the charge will not start until the EVSE unit programmed start is reached. Vehicle owners who have disconnected their vehicle before the programmed start time of the EVSE were disappointed when they found no charge had occurred.

If the vehicle is programmed to start charging at night and the PEV driver elects to charge at a publicly accessible

EVSE unit during the day, the PEV programming must be overridden.

The programming on one of the PEVs is such that a charge will not initiate if the PEV is connected after the programmed start time unless overridden. That is, if the vehicle is programmed to start a charge at midnight and the connect event occurs at 12:05, the charge will not commence.

It has also been reported that if the vehicle is programmed to start before the EVSE unit, the vehicle can command the commencement of the charge, but stops it if no current flows. The vehicle will then not charge when the EVSE unit program actually closes the contactor. Some responders noted that they would like the EVSE unit to make charging decisions based upon the PEV battery's State of Charge (SOC). Vehicles do not yet make that information available to the EVSE.

Participants noted that once the programming is completed, it is very convenient to connect upon arriving home and letting the program control the charge. Also, most felt the TOU rate (or EV rate) helped them save money.

Conclusion

Most EV Project participants in the PGE and PG&E service territories program their PEV and/or EVSE unit to schedule charging at home. About half the participants prefer to program only their vehicle. One quarter prefer to program only their EVSE. Over two-thirds of survey respondents in the PGE and PG&E service territories have selected TOU rates (either whole-house or EV rate plans), which provide an incentive for them to schedule their home charging times during off-peak hours. Whether they program the PEV or the EVSE unit appears to be a matter of consumer choice, which is not difficult to do in either case. It is understandable why participants in areas without the TOU rate do not program either (although some do anyway). Of survey respondents, 28% are on a basic rate plan, despite the fact that their electric utility offers TOU rates.

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 (ECOtality), 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 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-EE-0002194.

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 a leading installer and provider of charging infrastructure for PEVs. ECOtality has been involved in PEV initiatives since 1989 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.

Idaho National Laboratory (INL) is one of the U.S. DOE's 10 multi-program national laboratories. The laboratory performs work in each of DOE's strategic goal areas: energy, national security, science and the environment. INL is the nation's leading center for nuclear energy research and development. Day-to-day management and operation of the laboratory is the responsibility of Battelle Energy Alliance (BEA).

For more information, visit www.theevproject.com.

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