

How Do The EV Project Participants Feel about Charging Their EV at Home?

February 2015

Key Observations from the Survey of The EV Project Participants

- In June 2013, 72% of EV Project survey respondents were very satisfied with their home charging experience.
- 21% of survey respondents relied totally on home charging for all of their charging needs.
- Volt owners relied more on home charging than Leaf owners, who reported more use of away-from-home charging.
- 74% of survey respondents reported that they plug in their plug-in electric vehicle (PEV) every time they park at home. Others plugged in as they determined necessary to support their driving needs.
- 40% of survey respondents reported that they would not have or are unsure that in June 2013 whether they would have purchased an alternating current (AC) Level 2 electric vehicle supply equipment (EVSE) for home charging if it had not been provided by The EV Project.
- 61% of survey respondents reported that The EV Project incentive was very important or important in their decision to obtain a PEV.

Introduction

The EV Project is an infrastructure study that enrolled over 8,000 residential participants. These participants purchased or leased a Nissan Leaf battery electric vehicle or Chevrolet Volt extended-range electric vehicle and were among the first to explore this new electric drive technology. Collectively, battery electric vehicles, extended-range electric vehicles, and plug-in hybrid electric vehicles are called PEVs. The EV Project participants were very cooperative and enthusiastic about their participation in the project and very supportive in providing feedback and information. The information and attitudes of these participants concerning their experience with their PEVs was solicited in a 2013 survey. At that time, some participants had up to 3 years of experience with their PEVs.

Why Is How the Owner is Feeling About Home Charging Important?

PEVs require recharging to sustain the battery for electric drive transportation. The owner of the PEV essentially has three choices for charging: home, workplace, or publicly

accessible locations. The EV Project participants were the innovators and early adopters of electric drive transportation. Their feedback on how they felt about charging their PEV is of interest because it can shape this new technology for wider adoption.

Participant Information

Understanding the demographics of The EV Project participant is important in understanding their choices and attitudes toward electric transportation. The age, gender, average household income, and education level were explored in “Who are the Participants in The EV Project?”¹

Satisfaction of participants with their PEVs was explored in “How do The EV Project Participants Feel About their EVs?”²

The Nissan Leaf sales rollout plan defined the initial five regions of The EV Project, anticipating them to be the locations of the innovators and early adopters of PEVs. Later expansion of The EV Project included 16 metropolitan areas in nine states plus the District of Columbia. Within these regions, physical study boundaries were established. The views and attitudes of project participants nationally and regionally are explored in this report.

Which Plug-In Electric Vehicle did they Acquire?

The EV Project achieved full enrollment of residential participants early in 2013. Final enrollment in each market was ultimately determined by the PEV market conditions, which were driven by local PEV dealer promotions and local government incentives and local demographics. Table 1 identifies the number of participants driving Nissan Leafs and Chevrolet Volts in each region. Because of other U.S. Department of Energy (DOE) projects in the area, Chevrolet Volt drivers were not included in The EV Project in the San Francisco region.

Table 1. Regional participation in The EV Project.

	Leaf	Volt
Arizona	376	156
Los Angeles	471	344
San Diego	722	277
San Francisco	1,874	–
Oregon	558	136
Washington State	969	177
Tennessee	942	144
Texas	34	288
Washington D.C.	50	291
Atlanta	176	77
Chicago	34	129
Philadelphia	32	54
Overall	6,238	2,073

The original completion date of The EV Project was December 2012. Later expansion of the project also extended the completion date to December 2013. Some participants retired from the project at the end of the original period. In addition, some other participants retired because they sold their vehicles or their vehicles were destroyed in accidents.

Participant Survey

For participants in The EV Project, residential charging is accomplished through the use of the AC Level 2 EVSE. AC Level 2 uses a 240-volt circuit in the home similar to that used for a clothes dryer or hot water heater. The EV Project participants were provided the Blink AC Level 2 charging station for their residence at no cost, along with a specified credit toward the cost of installation of that station, in exchange for their agreement to allow The EV Project to collect and use their residential and non-residential charging and vehicle data.

One goal of The EV Project was to gain an understanding of participant experience and attitudes toward their PEV usage. In support of this goal, an online survey was sent to 7,730 active EV Project participants. The survey solicited 3,236 responses for a 42% response rate. Among the topics identified were questions related to charging their PEV battery at home. Table 2 presents the responses received by region and vehicle type.

Table 2. Survey responses by region.

	Leaf Responses	Volt Responses	Leaf and Volt Responses
Arizona	159	74	1
Los Angeles	133	120	7
San Diego	244	109	7
San Francisco	553	-	4
Oregon	211	74	2
Washington State	378	83	3
Tennessee	345	54	2
Texas	11	119	2
Washington D.C.	13	114	2
Atlanta	74	39	1
Chicago	15	67	-
Philadelphia	13	26	1
Unknown	159	2	2
Overall	2308	881	34

Thirty-four of the respondents reported having both a Leaf and a Volt in The EV Project and 13 reported they were no longer participating; 163 responses were provided that identified the type of vehicle, but not the region of The EV Project.

Charging at Home

The EV Project's quarterly reports have identified that about 74% of all charging events for the Leaf and 80% of all charging events for the Volt occur at home.³

Charging Needs

Participants were asked, "How much of your charging needs are met by home charging?" They were provided with seven possible responses. The response choices were (in increasing order of away-from-home charging) as follows:

- Away-from-home charging is not available in my area.
- Never use charging away from home.
- Occasionally use charging away from home.
- Frequently use charging away from home.
- Rely on away-from-home charging as much as home charging.
- Mostly use charging away from home.
- Rarely, if ever use home charging.

In all, 3,129 responses were received. Figure 1 shows the responses.

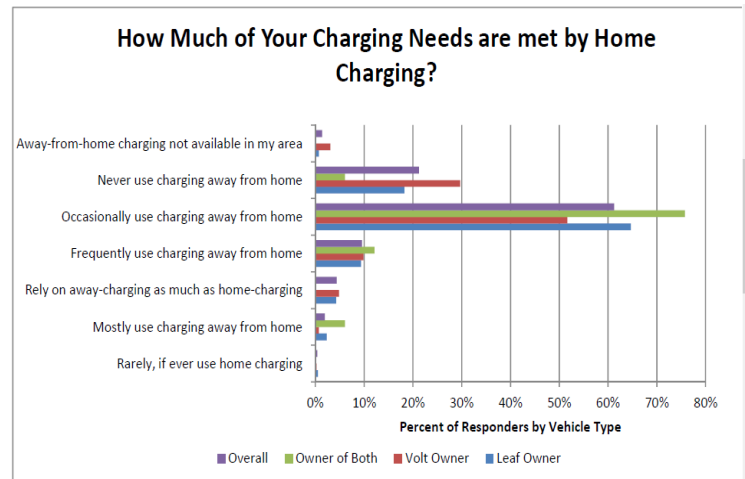


Figure 1. Charging needs.

For analysis, the responses were grouped in order to summarize whether the PEV owner's charging needs were met by home charging (see Figure 2).

Forty-two responses (1%) indicated that away-from-home charging was not available in their area. However, in all locations of The EV Project, public infrastructure was installed by The EV Project and others also may have installed public charging. This is interpreted as either the respondent was unaware of this availability or the EVSE was not in an area frequented by the respondent.

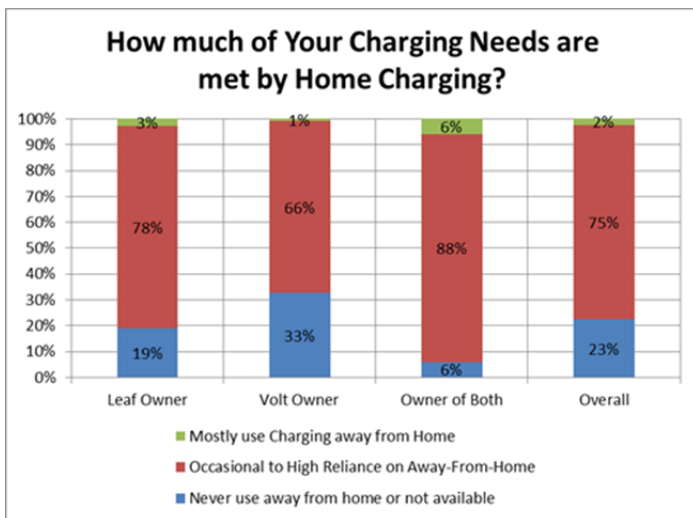


Figure 2. Charging needs met.

It is also of interest that 21% of the responders reported they never use away-from-home charging. How EV Project participants feel about away-from-home charging is explored in another report.⁴

The “Occasional to high-reliance on away-from-home charging” included the occasional, frequent, and those that rely on away-from-home charging as much as home charging. This was the highest ranking selection with 75% choosing this response.

Segmented Charging Needs

Prior to sending the survey, the participants were segmented by their vehicle type and charge data, which indicated they never charged away from home, they occasionally charged away from home, they frequently charged away from home, and those whose typical behavior could not be determined because of GPS or other data inconsistencies. In all, 3,049 of the responses self-identified in the segments reflecting their actual charging pattern, with 104 respondents skipping this question. The segmented groups are identified in the columns and their responses to this question are in the rows of Table 3.

Table 3. Segmented responses to charging needs met.

Meeting Charging Needs	Leaf Never	Leaf Occasional	Leaf Frequent	Leaf Unknown	Volt Never	Volt Occasional	Volt Frequent	Volt Unknown
Away from home charging is not available	2	4	0	10	9	11	1	4
Rarely use home charging	0	2	0	7	0	1	1	0
Mostly use away from home charging	0	4	7	22	0	2	4	0
Rely on both home and away from home equally	0	14	16	33	2	14	19	5
Frequently use away from home charging	1	67	19	84	0	32	43	8
Occasionally charge away from home	49	783	22	552	51	320	36	36
Never charge away from home	87	162	1	146	120	106	9	21

The red responses show inconsistency between the survey respondents’ responses and their charge data. For example, 50 Leaf Owners’ charging data show all charges were conducted at their residence, but their survey responses indicate they occasionally or frequently use away-from-home charging. In addition, 12 Volt owners whose charging data show they occasionally or frequently charge away from home responded that away-from-home charging is not available to them.

Yellow highlighted cells indicate questionable consistency and green indicates good consistency between the charge data and participant responses. Eighty-seven percent of the responses displayed consistency between their charge data and survey responses.

However, it must be recognized that subjective descriptions such as “never” or “rarely” may lose distinction for some. It is also possible that past charging at away-from-home locations occurred, but the intent of the participant is that they no longer charge away from home or even that they no longer desire to charge away from home.

Connecting to Home Charging

Participants were asked, “Do you intend to plug in your EV every time you park at home?” For those who responded “no,” additional comment space was allowed. In all, 2,970 responses were provided (see Figure 3).

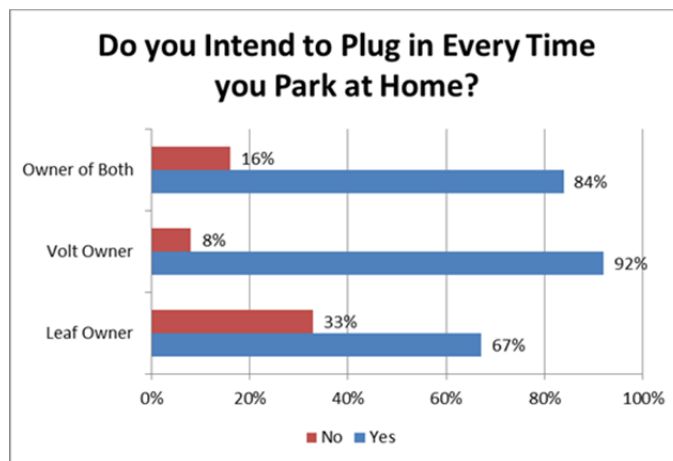


Figure 3. Intentions of plugging in.

Responses by Volt owners indicating the frequency of plugging-in at home is consistent with the charge data reported in The EV Project quarterly reports,⁵ which also indicate that the Volt owner plugs in more at home than the Leaf owner. However, it is quite interesting that Leaf owners intended to plug in at home only 2/3 of the time, while Volt owners were above 90%. Nissan has informally suggested that the Leaf should be routinely recharged to 80% capacity and as necessary to meet the respective

range needs. It does not need to be plugged in at every opportunity nor recharged to 100% on every charge.⁶

The regional “yes” responses to this question by Leaf and Volt owners are shown in Figure 4.

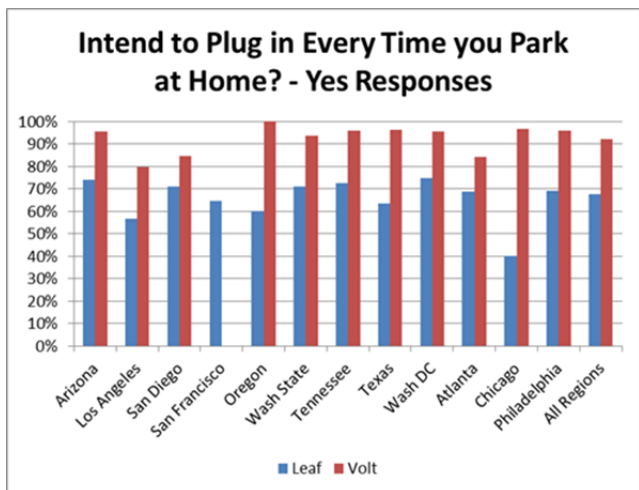


Figure 4. Regional responses to plugging-in intention.

Over all of the regions, the Volt drivers’ intent to plug in every time, more so than the Leaf owners’ intent, is evident and overall, 74% of respondents intend to plug in every time they park at home.

The average distance traveled per day when driven for the second quarter of 2013 is shown in Figure 5. This figure correlates closely with the responses of Figure 4, although the spread between Leaf and Volt owners evident in Oregon and Chicago are not borne out by distances traveled.

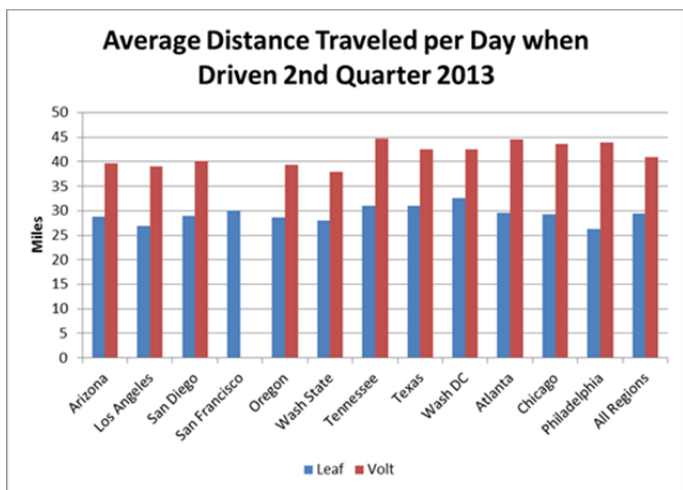


Figure 5. Average distance traveled per day in the second quarter of 2013.⁶

Seven hundred and seventy-seven free-form comments were received related to why a respondent did not intend to plug in on every park at home. The responses were aggregated into several typical responses as noted in Table 4. Overall, 9% of the responses indicated the decision to plug-in was based on personal criteria from information displayed by the vehicle (e.g., the battery state of charge or miles remaining or a sense that the charge is “low”). Overall, 5% of the responders noted that while they do not plug in every time at home, they do charge nightly. Some reported this as a nightly routine to plug-in as one might check that the doors are locked.

Table 4. Comments related to home charging intentions.

Decision to Plug-In Other than Every Time	Leaf	Volt	Total
I plug in when I need to for my known next trip	223	14	237
I plug in nightly unless I need to more often	124	30	154
I plug in mostly at work	51	8	59
I plug in if battery is below 80%	34	1	35
I plug in if battery is below 70%	19	2	21
I plug in if battery is below 60%	12	-	12
I plug in if battery is below 50% or less than 40 miles	61	1	62
I plug in if battery is below 40% or less than 30 miles	22	1	23
I plug in if battery is below 30% or less than 25 miles or "low"	75	5	80
I plug in if battery is below 20% or less than 15 miles	29	2	31
I plug in only every other day	33	1	34
Nissan recommended or I think I am to charge infrequently	8	1	9
I almost always plug in	8	-	8
I plug in at free public charging	4	-	4
I have Solar so I plug in when best times	2	1	3
I plug in based on cost of charging options	2	-	2
I no longer have AC L2 available at home	1	1	2
I plug into 120 VAC whenever I can	1	-	1

The most commonly stated reason for not plugging in every time when parked at home was the owner’s desire to plug in when it was necessary for the next day or next trip. This represents 8% of all survey responses received. Only 2% indicated that they mostly plug in at work.

Home Charging with AC Level 2 Electric Vehicle Supply Equipment

Participants were asked, “If you had not received an AC Level 2 charging station from the EV Project, do you think you would have purchased one?” For those who responded “no,” additional comment space was allowed to “please explain why your vehicle’s AC Level 1 cordset would meet your needs.” In all, 3,010 responses were provided and are shown in Figure 6.

The percentage of “No” or “Not sure” responses is significant. This can reflect the responder considering his/her desires at the time of purchase and/or his/her understanding of current driving and charging needs. Whether the PEV driver has changed his/her driving habits over time will be the subject of another report.

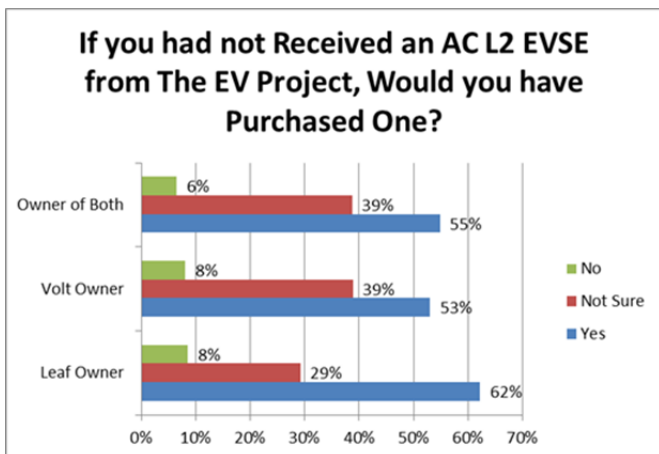


Figure 6. AC Level 2 EVSE desired at home.

The specific comments of those who reported “no” to this question are shown in Table 5. There may have been some confusion about this question, because the number one reason survey respondents provided for not purchasing the AC Level 2 for home use was that they needed it and would have purchased it. This comment is inconsistent with their “no” response. It is recognized that this question tries to understand a previous purchasing motivation but is also tainted by the owners experience since that purchase, which may be reflected in this specific response.

Table 5. Comments on why respondent would not have purchased a home AC Level 2 EVSE.

Why would you not have purchased AC L2?	Leaf Owner	Volt Owner	Overall
I need the AC L2 and would have purchased one.	54	5	59
I have plenty of time to charge with AC L1.	27	28	55
The AC L2 EVSE was too expensive	12	22	34
I would not have purchased or leased an EV.	34	4	38
I found, made or would have made a cheap AC L2.	24		24
I would have changed my use of my vehicles to match AC L1.	3	3	6
I thought at the time that AC L1 would be sufficient but it is not.	5	1	6
I would have used public charging.	5		5
I charge at Work	5		5
I already had an AC L2.	1	1	2
I thought the cordset was emergency only.	1		1

These comments for “no” responses represent just 8% of the total.

Electric Vehicle Supply Equipment and Installation Cost

Participants were asked, “When you decided to buy/lease an EV, how important was it to you that you could get a free AC Level 2 charging station and installation credit from The EV Project?” The response choices were as follows:

- Not Important – I appreciated the charging unit and credit but it did not factor in my decision.
- Not Important – I did not need AC Level 2 at home to meet my planned EV needs anyway.
- Somewhat important – I would have purchased the EV anyway, but this simplified the process.

- Important – I would have purchased the EV anyway, but overall cost was a significant concern.
- Very important – I would not have purchased the EV without The EV Project incentives.

In all, 3,116 responses were received and the results are shown in Figure 7

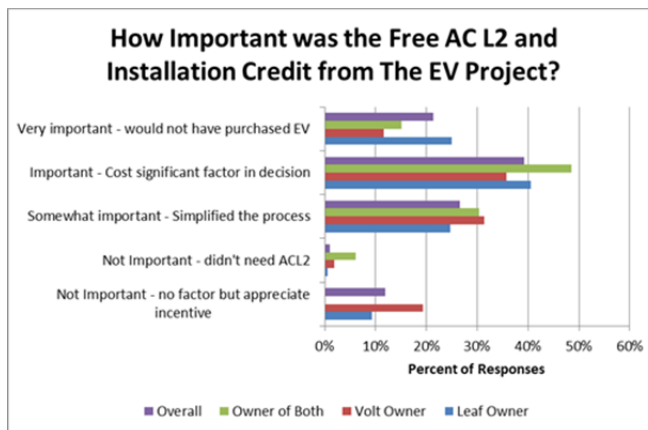


Figure 7. Importance of incentive in decision.

Sixty-one percent of all responders identified this incentive as “very important” or “important” in that it affected their decision on whether to purchase or lease a PEV, with 66% of Leaf owners and 47% of Volt owners in these categories. Twenty-five percent of Leaf owners responded that they would not have obtained their PEV without this incentive.

This response is somewhat unexpected. The early adopters of electric drive transportation are typically highly educated with a median household income of \$149,000.⁷ It was expected that the incentive would motivate owners to allow The EV Project to use their charging and vehicle data, but would not factor highly in a purchase decision.

Figure 8 provides the responses by region. Tennessee, San Diego, and Los Angeles reported the highest percentage of “important” or “very important” responses.

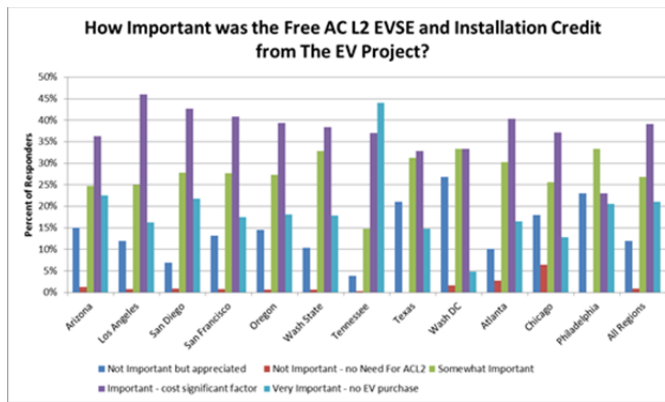


Figure 8. Importance of incentives by region.

Programming the Residential Electric Vehicle Supply Equipment

The Blink AC Level 2 residential EVSE and the Leaf and Volt vehicles have programming features that allow selection of a preset time at which the charge will begin. The vehicle may be connected to the EVSE, but the charge will not begin prior to this preset time, unless overridden by the driver. For those in electric utility service territories, where there are time-of-use (TOU) rates, this can be important in reducing charging costs. Participants were asked, "Which of the following responses best reflects your situation?" The response choices provided are as follows:

- My electric utility does not provide TOU rates and I do not program the charging unit or EV.
- My electric utility does not provide TOU rates, but I program either my charging unit or EV to start at a specific time anyway.
- My electric utility does provide TOU rates, but I do not program my charging unit or EV.
- I am on the TOU rate for my electric utility and I program the charging unit only.
- I am on the TOU rate for my electric utility and I program the EV only.
- I am on the TOU rate and I have programmed both the charging unit and the EV.
- I am on a special rate with my electric utility (such as home solar) and I do not program the charging unit or EV.
- I am on a special rate with my electric utility (such as home solar) and I do program either the charging unit and/or the EV.

In all, 3,124 responses were received and are shown in Figure 9.

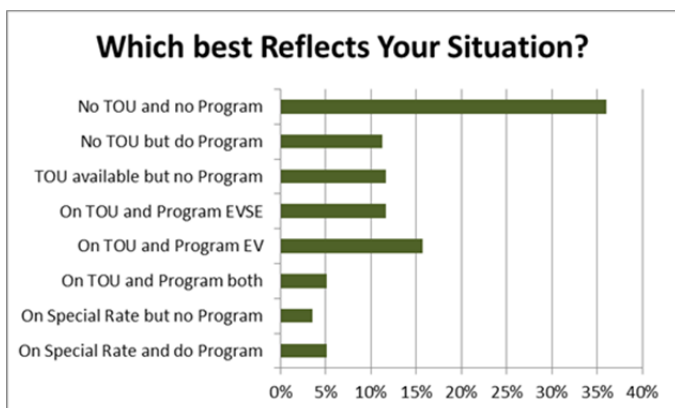


Figure 9. Programming the EVSE and/or EV.

A review of the regional responses shows a strong correlation between the areas where TOU rates are available and those who program their PEV, their EVSE, or both. It is noted that a significant percentage (i.e., 12%) of

respondents live in areas where TOU rates are available, do not program to take advantage of these rates. It is also interesting to note that 11% program the timing of their charge, even though TOU rates are not available and there is no apparent financial incentive to do so. These and other factors are investigated further in another report on PEV driver responses to TOU rates.⁸

Satisfaction with Residential Charging

Participants were asked, "How satisfied are you today with your residential charging experience?" A scale of 1 to 5 was provided with 1 = Very dissatisfied and 5 = Very satisfied. In all, 3,004 responses were received and Figure 10 provides the responses.

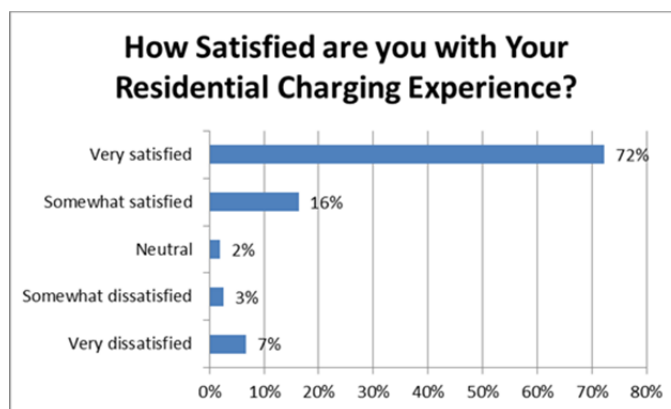


Figure 10. Participation satisfaction with residential charging.

The overall ranking was 4.45 on this scale. This indicates that 88% of respondents were satisfied with their home charging experience.

Conclusions

Overall, PEV owners in The EV Project are satisfied with their home charging experience. Twenty-one percent of responders report they never use charging away from home for their charging needs, 74% report they plug in every time they come home, and another 5% make sure they charge nightly. Overall, 60% reported they would have purchased an AC Level 2 EVSE at home if it had not been provided by The EV Project, although 61% reported the incentive was important or very important to their purchase decision.

This satisfaction is important in expanding the PEV market to the early majority.

About The EV Project

The EV Project was the largest PEV infrastructure demonstration project in the world. Equally funded by DOE through the American Recovery and Reinvestment Act and private sector partners, it supported the initial rollout of the

Nissan Leaf and Chevrolet Volt PEVs, as well as the first deployment of PEVS in an all-PEV ride share application. The EV Project deployed over 12,000 AC Level 2 charging stations and over 100 dual-port direct current fast chargers in 16 metropolitan areas in nine states plus the District of Columbia across the United States during the period January 1, 2011, through December 31, 2013. Drivers of approximately 8,300 Nissan Leafs, Chevrolet Volts, and Smart ForTwo Electric Drive vehicles were enrolled in the project.

Project participants allowed EV Project researchers to collect and analyze data from their vehicles and chargers. Data collected from project vehicles and charging infrastructure document nearly 125 million miles of driving and over 4 million charging events in significant detail, characterizing the earliest days of electric vehicle adoption through significant penetration of both the vehicles and charging infrastructure. The data reside at Idaho National Laboratory, which is responsible for analyzing the data and publishing summary reports, technical papers, and lessons learned on vehicle and charger use.

Company Profile

Idaho National Laboratory is one of 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. Idaho National Laboratory 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.

For more information, visit avt.inl.gov/evproject.shtml and avt.inl.gov/chargepoint.shtml.

References

¹"Who are the Participants in The EV Project," Lessons Learned, avt.inl.gov/evproject.shtml.

²"How do The EV Project Participants feel about their EV?" Lessons Learned, avt.inl.gov/evproject.shtml.

³*EV Project EVSE and Vehicle Usage Report 2nd Quarter 2013*, avt.inl.gov/evproject.shtml.

⁴"EV Project Participants and Away-From-Home Charging," Lessons Learned, avt.inl.gov/evproject.shtml.

⁵op.cit. 2nd Quarter 2013.

⁶<http://www.torquenews.com/1075/nissan-answers-questions-about-optimally-charging-nissan-leaf>.

⁷op.cit. Who are the Participants.

⁸<http://avt.inl.gov/pdf/EVProj/125348-714937.pev-driver.pdf>.