



# Consumer Views on Plug-in Electric Vehicles – National Benchmark Report (Second Edition)

Mark Singer  
*National Renewable Energy Laboratory*

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**Technical Report**  
NREL/TP-5400-67107  
December 2016

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Prepared under Task No. VTP2.2B00

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# Consumer Views Quick Facts

## Vehicle Purchasing Behaviors

- 58% of respondent households owned two or more vehicles.
- 56% of respondents stated their last vehicle purchases were sedans.
- 45% of respondents stated their next vehicle purchases would likely be sedans.
- 27% of respondent households had purchased vehicles in the last year.

## Plug-in Electric Vehicle Awareness

- 46% of respondents were able to name a specific plug-in electric vehicle make and model.
- 43% of respondents reported having seen plug-in electric vehicles in parking lots.
- 46% of respondents stated plug-in hybrid electric vehicles were just as good as, or better than, traditional gasoline vehicles.
- 41% of respondents stated all-electric vehicles were just as good as, or better than traditional gasoline vehicles.
- 23% of respondents stated they would consider or expect to purchase plug-in hybrid electric vehicles for their next vehicle purchase or lease.
- 19% of respondents stated they would consider or expect to purchase all-electric vehicles for their next vehicle purchase or lease.

## Barriers to Plug-in Electric Vehicle Acceptance

- An all-electric vehicle would need to be able to travel 300 miles on a single charge in order for 46% of respondents to be willing to consider purchasing one.
- 20% of respondents were aware of charging stations on the routes they regularly drove.
- 49% of respondents could consistently park their vehicles near electrical outlets at home.
- 49% of respondents would be willing to pay incremental costs for plug-in electric vehicles.

## Plug-in Electric Vehicle Acceptance

- Respondents aware of plug-in electric vehicle charging stations were more likely than respondents overall to view plug-in electric vehicles positively and be willing to consider purchasing them.
- Respondents who were able to name one of the top best-selling plug-in electric vehicles were more likely than respondents overall to view plug-in electric vehicles positively and be willing to consider purchasing them.
- Respondents aged 35 or younger were more likely than respondents overall to view plug-in electric vehicles positively and be willing to consider purchasing them.

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The above findings are based on a February 2016 study that is the second in a series of annual studies tracking consumer attitudes toward plug-in electric vehicles. The study covered a 1,008-household sample designed to be representative of the United States population.

## Acronyms

ACS	American Community Survey
AEV	all-electric vehicle
EV	electric vehicle
HEV	hybrid electric vehicle
NREL	National Renewable Energy Laboratory
ORC	Opinion Research Corporation
PEV	plug-in electric vehicle
PHEV	plug-in hybrid electric vehicle

## Acknowledgments

This work has been supported by the U.S. Department of Energy’s Vehicle Technologies Office. Additional support came from the National Renewable Energy Laboratory, which is a national laboratory of the U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy operated by the Alliance for Sustainable Energy, LLC.

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All judgments in the final analytic methodologies and interpretations are the responsibility of the author.

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## Introduction

This report details broad American public sentiments toward issues that surround plug-in electric vehicles (PEVs) and is supported by the U.S. Department of Energy's Vehicle Technologies Office in alignment with its mission to develop and deploy these technologies to improve energy security, enhance mobility flexibility, reduce transportation costs, and increase environmental sustainability.

A PEV is broadly defined as a vehicle that can be plugged in, is powered by an electric motor, and uses energy stored in an onboard battery. The definition includes all-electric vehicles (AEVs) that are powered by electric motors only and plug-in hybrid electric vehicles (PHEVs) that can also be powered by an internal combustion engine fueled by petroleum fuel. The most recent generation of PEVs has been commercially available in the United States since December 2010. A PEV is different from a hybrid electric vehicle (HEV). An HEV is similar to a PHEV, as it is powered by an internal combustion engine and an electric motor that uses energy stored in a battery. However, the battery in an HEV cannot be plugged in; it is completely charged by fuel used in the internal combustion engine, either through a generator, or more indirectly through regenerative braking.

Understanding consumer sentiments can influence the prioritization of development efforts by identifying barriers to, and opportunities for, the broad acceptance of new technologies. The data detailed in this report represents the first two years of similar studies that are planned to be completed annually, allowing for tracking of public perception associated with PEV deployment efforts. This report is intended to support the evaluation of whether advancing vehicle technologies and changing vehicle availability align with evolving consumer expectations and interests over time.

This report primarily summarizes data captured in a February 2016 study that focused on respondents' sentiments about factors that influence PEV adoption.

- Section 1 captures respondent vehicle purchasing behavior independent of a particular vehicle technology.
- Section 2 details current consumer awareness and acceptance of PEV technologies.
- Section 3 captures metrics associated with known barriers to PEV acceptance, including battery capacity and vehicle costs.
- Section 4 highlights segments of the respondents in which PEV acceptance may be higher than the respondent group in total.

It is important to acknowledge that a person's stated preference in an interview about a hypothetical setting often does not match his or her revealed preference, which is demonstrated in an actual decision-making situation (Keane and Wasi 2013). This difference makes tracking actual consumer actions ultimately more valuable in understanding potential behavior. However, when technologies are not yet available or are new to a marketplace and actual behaviors cannot be tracked at scale, stated preferences provide some insights into how consumers may react in new circumstances. In this context, this report provides a supplemental source to validate other data and a new resource when no data are available.

Most of the data presented in this report are the results of interviews conducted by the Opinion Research Corporation (ORC) for the National Renewable Energy Laboratory (NREL). The studies were conducted via telephone with randomly selected telephone numbers. The study in this report used a dual-frame sampling design in which the sample was drawn from independent landline and cell phone sample frames and is based on responses from individuals across the country who were at least 18 years old. Response samples were weight-adjusted to better ensure that the sample reflects the general U.S. population. The study relied on ORC's weighting mechanism, which pulls from data reported in the National Health Interview Survey and the U.S. Census Bureau's Current Population Survey. When ORC study data are presented, the specific ORC study number is noted along with the year of the study and the study sample size. The February 2016 study included 1,008 respondents and had a margin of error of  $\pm 3\%$  at the 95% confidence level. Smaller subgroups of the respondents will have larger error margins.

Most findings are compared to a similar study done one year prior to this one (Singer 2016), allowing the assessment of trends between years. In many instances throughout this report, the response percentages in tables and figures do not sum to exactly 100% because the raw data are rounded. For the same reason, summary data points called out in the body of the report may not match the results that were obtained by summing data from the tables and figures.

# 1 Vehicle Purchasing Behaviors

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## 1.1 Vehicle Purchasing Behaviors

The February 2016 study began by investigating aspects of the respondents' vehicle purchasing behaviors that are independent of a specific vehicle technology. Capturing these inherent metrics about the market highlights some particular barriers or benefit to PEV or other advanced vehicle technology adoption.

The first of these metrics covered is the number of household vehicles. If vehicle ownership decreases, the number of new purchases of any vehicle technology may also decline. Conversely, an increase in household vehicle ownership may provide additional opportunities for all vehicle technologies. Multivehicle households may be better suited for PEVs than single-vehicle households because AEVs specifically can be limited by battery capacity on longer trips. A household with multiple vehicles might be better able to provide alternative transportation for those trips than one without multiple vehicles. This study found little change in household vehicle ownership. The number of households owning two or more vehicles decreased from 60% in 2015 to 58% in 2016, but this change is within the 3% margin of error for the study. In relation to a study completed in April 2007, the percentage of zero- and single-vehicle households increased slightly.

PEV acceptance depends, in part, on their availability in the vehicle types that consumers desire. Initial PEV offerings were focused in smaller sedans and have become available in a broader set of vehicle types. More than half (56%) of respondents stated their last vehicle purchases were sedans; 45% stated their next vehicle purchases would likely be similar. Although these are large percentages of the vehicle market, PEVs need to be available in a broad set of vehicle types preferred by consumers if PEVs are to achieve very high percentages of vehicle purchases.

PEVs must also be available in the vicinity of the consumer. Currently, PEVs are not uniformly available across the country. While these regional differences are not investigated in this report, the lack of PEV availability in some areas can be a barrier to broad consumer acceptance.

Consumers' buying habits for vehicle purchases vary. An individual customer may purchase or lease a new vehicle every 3 years or even more frequently; others may keep their vehicles for 10 years or longer. This study found that 39% of respondents (consistent with 2015 results) either purchased vehicles in the last year or expected to purchase vehicles in the next year. Purchasers' interests in new or used vehicles also vary. A majority (56%) of respondents stated they might consider a new vehicle for their next vehicle purchase; 43% stated they would be unlikely to consider a new vehicle and would likely purchase a used vehicle. These results were similar to 2015 results.

Finally, the study investigated the vehicle fuel types that respondents currently owned. As expected, the overwhelming majority of respondents (82%) owned at least one traditional gasoline vehicle, but this number declined by 4% from 86% in 2015. Nearly a fourth of respondents (23%) stated they owned an alternative vehicle technology including diesel, ethanol, compressed natural gas, HEV, or PEV. Very small percentages (1% each) of all respondents reported owning PHEVs or AEVs. Respondent ownership rates of traditional gasoline vehicles tracked closely with actual vehicle registration data. However, as shown in Figure 8, respondents consistently reported higher alternative vehicle technology ownership rates than those shown by actual vehicle registration data.

## 1.2 Household Vehicle Ownership

Vehicle ownership appeared to be similar to prior study results. In February 2016, the mean number of vehicles owned by respondent households was 2.1. A significant majority (75%) reported owning two or fewer vehicles, while 58% reported owning two or more vehicles. Results were consistent with those from February 2015. Compared to an April 2007 study, responses showed a slight decline in the number of two-vehicle households and a slight increase in zero- and single-vehicle households. Compared to the latest U.S. Census Bureau American Community Survey (ACS) data from 2013, February 2015 respondents had fewer one- and two-vehicle households and more households with four or more vehicles.

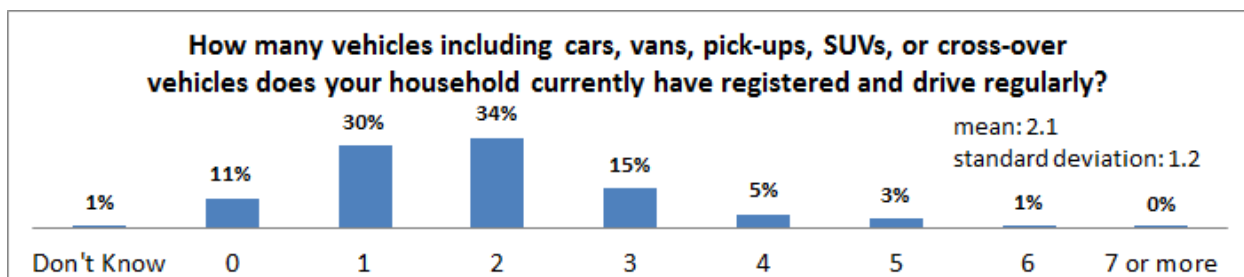


Figure 1. Question 1: Registered vehicles per household

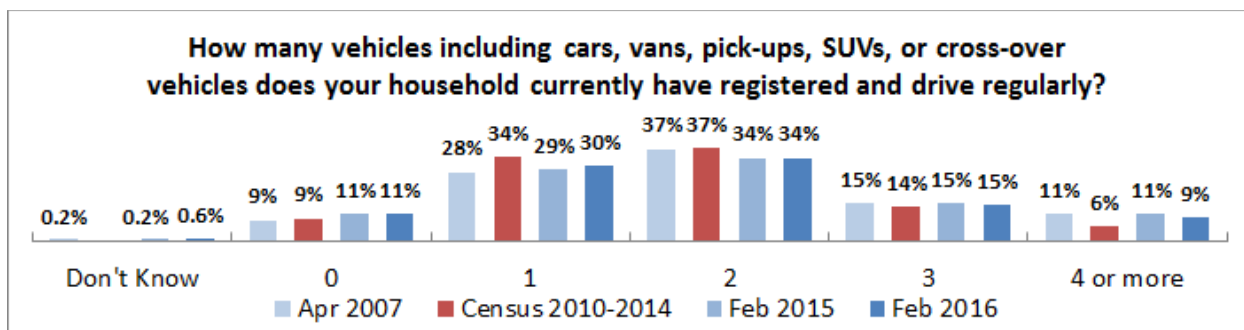


Figure 2. Comparison of registered vehicles per household over time

**Sources:** For 2016: ORC for NREL (2016), Study No. 725068, n=1,008. For 2015: ORC for NREL (2015), Study No. 724068, n=1,015. For 2007: ORC for NREL (2007), Study No. 716159, n=1,000.

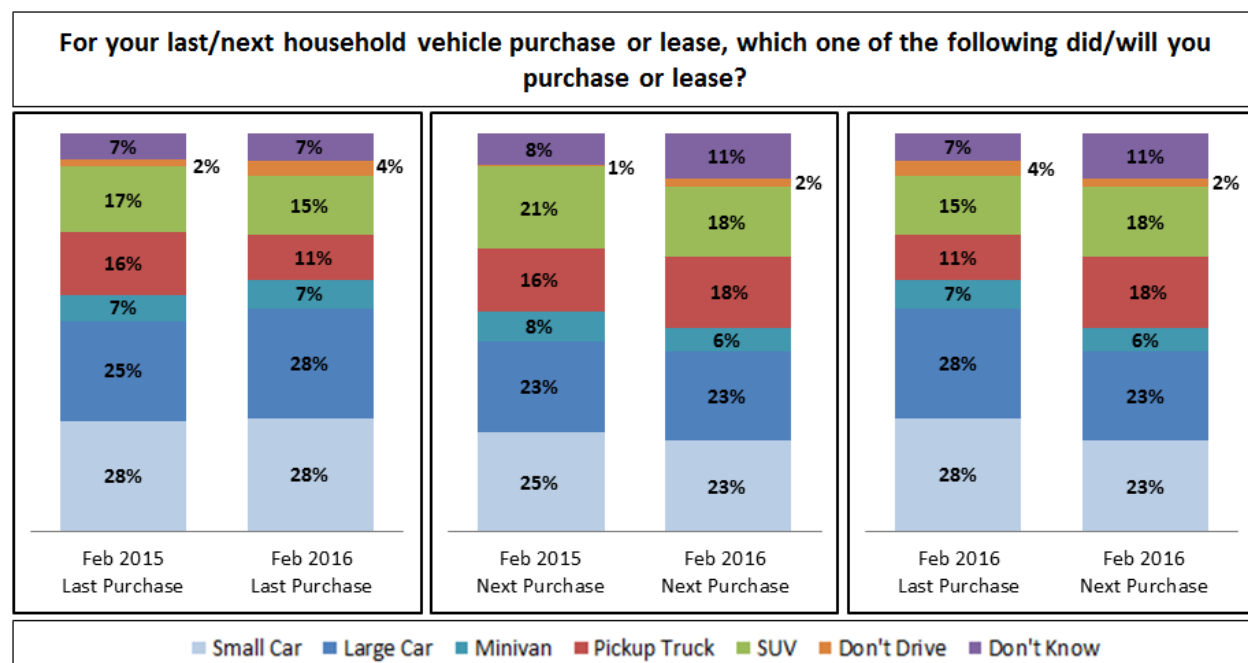
U.S. Census Bureau. 2010-2014. "Household Size by Vehicles Available." American Community Survey 5-Year Estimates, USACS\_14\_5YR\_B08201. Washington, D.C.: U.S. Census Bureau. Accessed August 3, 2016: [http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS\\_14\\_5YR\\_B08201&prodType=table](http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_14_5YR_B08201&prodType=table).

**Notes:** Given that the current study covered 1,008 households and the ACS covered more than 3.5 million households, it is not concluded that the current study identifies a clear change in household vehicle ownership rates from those captured by the ACS. Rather, the comparison is shown to put the respondent group in context with the broader general public.

Section 4 of this report uses these results to classify single- and multivehicle households for investigation of how PEV acceptance may vary by respondent segments.

### 1.3 Household Vehicle Types

The February 2016 study asked respondents to provide the vehicle types of their last vehicle purchases and the vehicle types they expected to purchase next. Respondents showed the strongest interest in sedans, which were categorized in the study as small and large cars. When their latest purchase choices were compared to what they expect to purchase next, the responses showed that interest may be shifting slightly away from sedans and toward pickup trucks and sport utility vehicles. This shift may represent the respondents' aspirations to shift to a new vehicle type rather than what their next vehicle purchase will ultimately be. Results are generally consistent with 2015 results.



**Figure 3. Questions 2 and 3: Last and next vehicle type choices**

**Sources:** For 2016: ORC for NREL (2016), Study No. 725068, n=1,008. For 2015: ORC for NREL (2015), Study No. 724068, n=1,015.

**Note:** Small cars were defined as being “smaller than the Chevy Malibu, Toyota Camry, or Ford Fusion” and large cars were defined as being the “same size or larger than the Chevy Malibu, Toyota Camry, or Ford Fusion.”

## 1.4 Time Since Last and Until Next Vehicle Purchase

Respondents in February 2016 were asked how long it had been since their last vehicle purchases and how long it would be before their next vehicle purchases. Consistent with 2015, a majority (60%) of respondents purchased vehicles in the last 3 years, and 46% expected to purchase vehicles within the next 3 years.

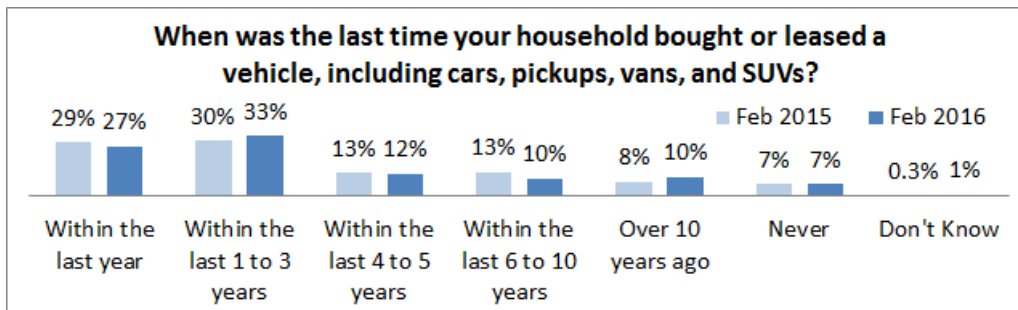


Figure 4. Question 4: Time since last vehicle purchase

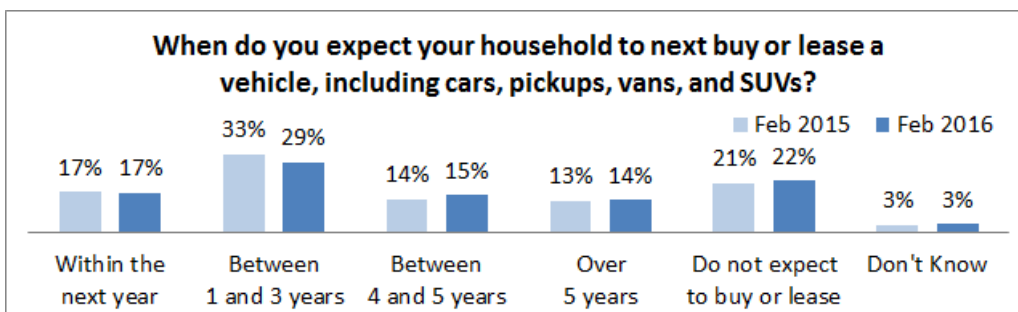


Figure 5. Question 5: Time until next vehicle purchase

Figure 6 displays a measure of how active respondents are in the market. Respondents who had either purchased a vehicle in the last year or intended to do so in the next year were classified to be within one year of a vehicle purchase. Of the remaining respondents, those that had purchased a vehicle in the last 1–3 years or intended to do so in the next 1–3 years were classified as being within 1–3 years of a vehicle purchase. The remaining segments followed similarly. Ultimately 39% of respondents were within 1 year of vehicle purchases.

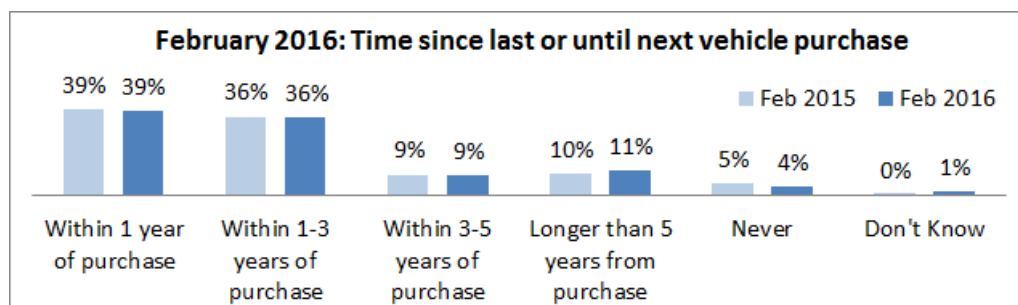
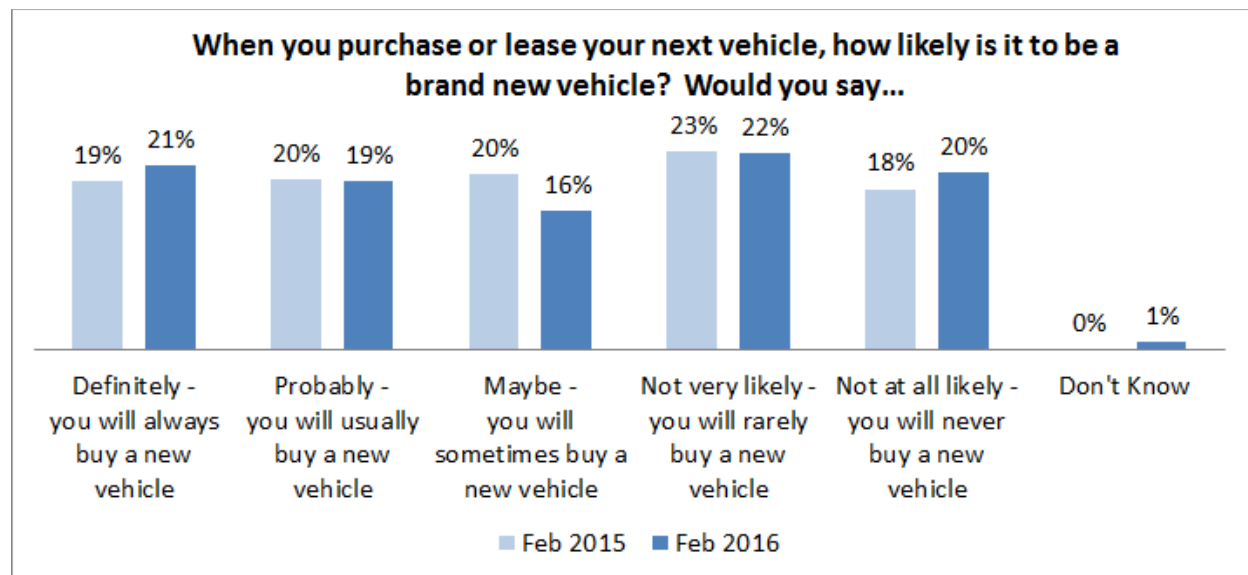


Figure 6. Time since last or until next vehicle purchase

**Sources:** For 2016: ORC for NREL (2016), Study No. 725068, n=1,008. For 2015: ORC for NREL (2015), Study No. 724068, n=1,015.

## 1.5 New and Used Vehicle Purchasers

Respondents in February 2016 were asked how likely they would be to purchase brand new vehicles versus used vehicles. Those that stated they “probably” or “definitely” will buy new vehicles made up 40% of respondents, and a similar percentage (43%) stated that they were “not very likely” or “not at all likely” to buy new vehicles. The remaining 16% stated they would maybe purchase new vehicles. Results were similar to the 2015 study data. Those respondents who stated they would maybe purchase a new vehicle (down 4% from 2015) changed beyond the 3% margin of error.



**Figure 7. Question 5A: Likelihood of purchasing a new versus a used vehicle**

**Sources:** For 2016: ORC for NREL (2016), Study No. 725068, n=789. For 2015: ORC for NREL (2015), Study No. 724068, n=806.

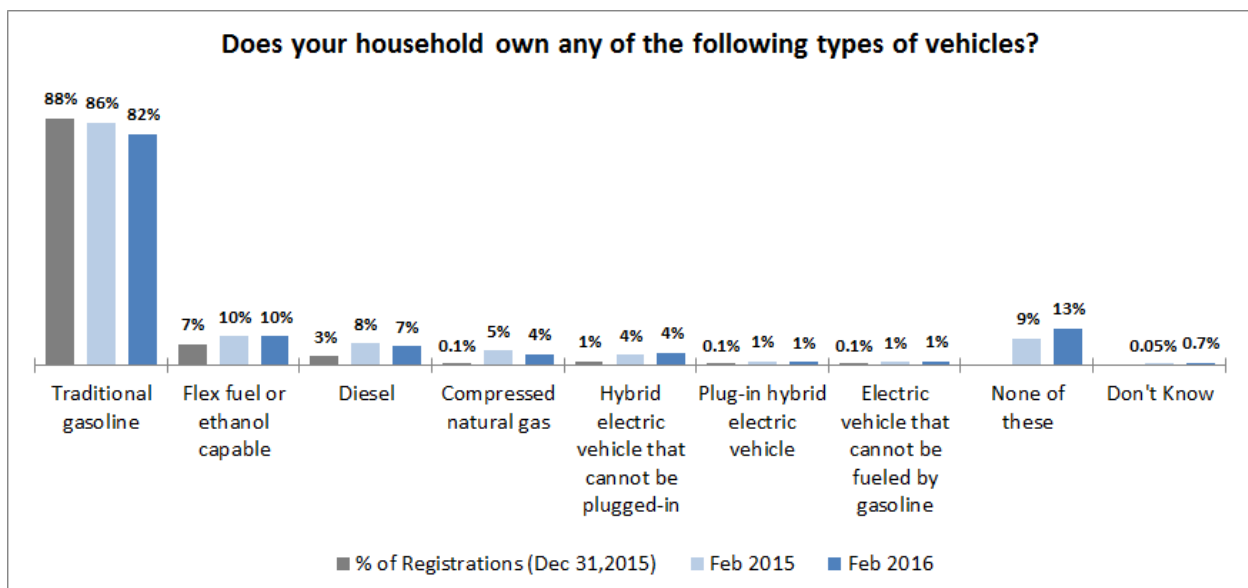
**Notes:** Those respondents who answered “do not expect to buy or lease another vehicle” when asked about the time until their next vehicle purchase in question 5 were not asked about the likelihood they would purchase a new or used vehicle in question 5A.

In Section 4 of this report, the 56% of respondents who stated they would “definitely,” “probably,” or “maybe” purchase new vehicles were classified as “new vehicle purchasers” because they all seemed to be stating they would consider new vehicles. The 43% of respondents who stated they were “not very likely” or “not at all likely” to purchase a new vehicle were classified as “used vehicle purchasers”. This classification is not intended as a measure of an expected split between new and used car sales; rather, it is interpreted as an indication of whether or not a respondent would even consider a new vehicle. To put this split in context, in 2014 more than 42 million used vehicles were purchased while 16.5 million new vehicles were sold (NIADA 2015)—28% of vehicle purchases in 2014 were for new vehicles.



## 1.6 Household Vehicle Fuel Types

The overwhelming majority of households (82%) owned traditional gasoline vehicles in February 2016. Ethanol-capable and diesel vehicles were owned by 10% and 7% of respondents, respectively. Compressed natural gas and PEV technologies were owned by small percentages of respondents. Nearly a quarter (23%) reported owning vehicles other than traditional gasoline vehicles. A small percentage (4%) owned only vehicles of fuel type(s) other than traditional gasoline. Respondent ownership rates of technologies other than traditional gasoline were all higher than percentages of overall vehicle registrations. This is expected as respondent households can and do own multiple vehicles. Results are generally consistent with 2015 results, but a small decline was reported in the percentage of respondents who owned traditional gasoline vehicles and a similarly small increase was reported in the percentage of respondents who stated they did not own any of the technologies.



**Figure 8. Question 6: Household vehicle fuel types**

**Sources:** For 2016: ORC for NREL (2016), Study No. 725068, n=1,008. For 2015: ORC for NREL (2015), Study No. 724068, n=1,015.

Polk, R.L. 2016. "POLK\_VIO\_DETAIL\_2015." Golden, CO: National Renewable Energy Laboratory. Accessed April 20, 2016.

## 2 Plug-in Electric Vehicle Awareness

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## 2.1 Plug-in Electric Vehicle Awareness and Acceptance Overview

Consumers will purchase PEVs in large numbers only after they are aware of the technologies and are willing to consider purchasing PEVs. This study attempted to quantify respondent PEV awareness, acceptance, and interest.

The study asked respondents if they were able to name a specific PEV make and model. Nearly half (46%) were able to name a specific PEV make and model and 41% were able to name one of the top 10 best-selling makes and models at the time of the study. Conversely, 54% were not able to name a specific PEV make and model. In comparison with the 2015 results, there was a drop in the percentage of respondents able to name a specific PEV make and model, but the decrease was within the 3% margin of error of the study.

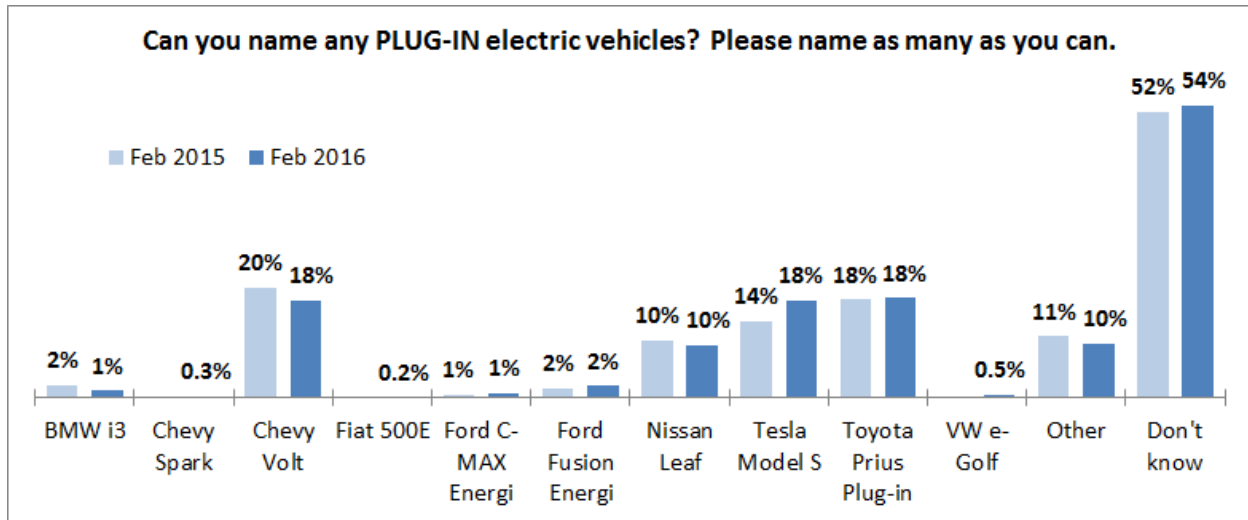
Respondents were also asked about their levels of exposure to PEVs. The theory of diffusion of innovations (Rogers 2010) describes how new technologies become accepted. Accordingly, a measure of exposure can serve as a prerequisite and proxy measure for future vehicle purchases. Some respondents reported direct exposure to PEVs through having sat in or driven one (13% and 7%, respectively). Respondents in 2015 reported a higher percentage (49%) having seen PEVs in parking lots than respondents in 2016 (43%).

PEV acceptance is measured in this study by how respondents view the technology compared to the current standard technology (i.e., traditional gasoline vehicles). This study found that PHEVs are viewed by 46% of respondents as being as good as or better than gasoline vehicles. This measure is down from 53% in 2015 and the change is greater than the 3% margin of error of the study. A smaller percentage (41%) said the same about AEVs (down from 45% in 2015). The largest changes were decreases in the percentages of respondents stating the technologies were better than traditional gasoline vehicles and increases in the percentages of respondents not having an opinion. As a matter of context, gasoline prices per gallon dropped from \$2.30 in February 2015 to \$1.87 in February 2016 (EIA 2016). The sentiments of respondents toward alternatives to traditional gasoline vehicles may have been affected in part by this decline.

Finally, respondents reported their willingness to consider purchasing PEVs. Nearly a quarter of respondents (23%) stated they expected to purchase or expected to consider purchasing PHEVs. Similarly, 19% stated the same about AEVs. These percentages were similar to 2015 results, but the largest change in willingness to consider PEVs was an increase of those stating definitively that they will not purchase PEVs. The top reasons given for considering PEV purchases were that PEVs were viewed as being better for the environment and they would save money on fuel. The top reason for not considering the technology was that PEVs were viewed as being too expensive.

## 2.2 Ability to Name a Specific Plug-in Electric Vehicle Make and Model

Respondents were asked if they could name a PEV, and 46% were able to name a specific vehicle make and model. Further, 41% were able to name at least one of the 10 top best-selling makes and models at the time of the study. These results are consistent with results from 2015. Only the Tesla Model S showed a measurable increase in respondent awareness.



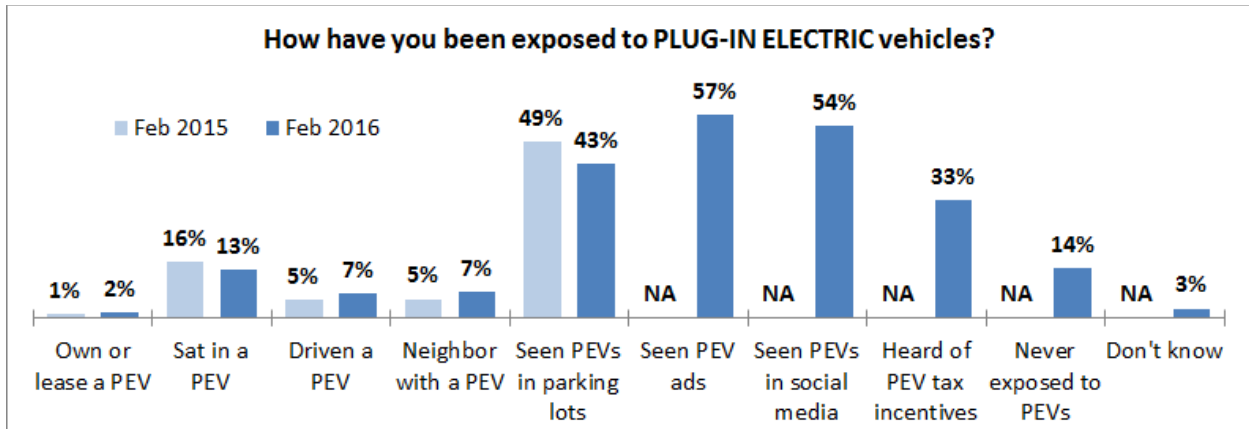
**Figure 9. Question 7: Ability to name a PEV make and model**

**Sources:** For 2016: ORC for NREL (2016), Study No. 725068, n=1,008. For 2015: ORC for NREL (2015), Study No. 724068, n=1,015.

**Note:** The Toyota Prius was available at the time of the study as both an HEV and a PHEV; some respondents may have confused the two versions. A follow-up question asked respondents who mentioned only the Toyota Prius Plug-in in the initial question to name another make and model. Just 6.7% of respondents overall could name only the Toyota Prius Plug-in. If all these respondents were actually unaware of the Toyota Prius Plug-in PHEV, the percentage who were unable to name a PEV make and model would climb to 60% and the percentage who were aware of the Toyota Prius Plug-in would fall from 18% to 12% (rounding).

## 2.3 Exposure to Plug-in Electric Vehicles

Respondents were asked how they had been exposed to PEVs. Nearly half (49%) reported having firsthand exposure to PEVs by having been in one, having a neighbor with one, or having seen one in parking lots. A large majority (75%) reported exposure to PEVs from advertisements or social media. A third of respondents (33%) have heard of PEV tax incentives. Overall, 84% of respondents reported having been exposed to PEVs by one of the categories described in Figure 10. Respondents in 2015 were not asked about PEV ads, PEVs in social media, or PEV tax incentives.



**Figure 10. Question 8: Exposure to PEVs**

**Sources:** For 2016: ORC for NREL (2016), Study No. 725068, n=1,008. For 2015: ORC for NREL (2015), Study No. 724068, n=1,015.

**Note:** Respondents were given the following information before being asked about their exposure to and opinion of PEVs beginning with question 8: "Plug-in electric vehicles can be charged by being plugged into a household-type outlet or specially designed charging equipment. These can be defined as plug-in hybrids or pure electric vehicles. Not included in this definition are hybrids, such as the original Toyota Prius, that cannot be plugged in. The Chevy Volt is an example of a plug-in hybrid electric vehicle that can be powered by either the battery or the gasoline engine. The Tesla Model S or the Nissan Leaf are examples of pure electric vehicles powered only by their batteries."

## 2.4 Opinions of Plug-in Electric Vehicles

When asked about their opinions of PEVs, respondents showed a preference for PHEVs over AEVs compared to traditional gasoline vehicles. Nearly half (46%) stated PHEVs were “just as good as” or “better than” traditional gasoline vehicles; 41% stated AEVs were “just as good as” or “better than” traditional gasoline vehicles. Lower percentages of respondents in 2016 felt the technologies were “better than” traditional gasoline vehicles, but that decline did not result in an increase in the percentage of respondents stating the vehicles were “not as good as” traditional gasoline vehicles. Instead there was an increase in the percentage of respondents stating they did not know how the technologies compared.

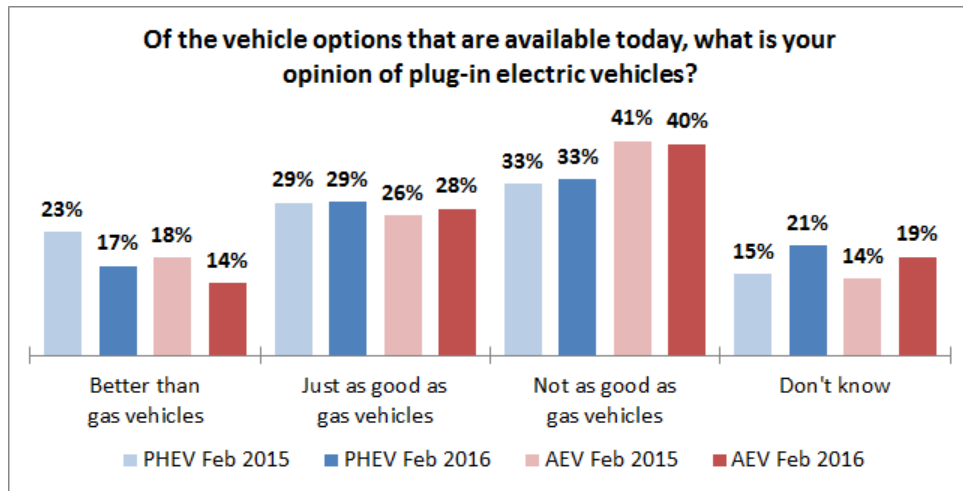


Figure 11. Questions 9 and 11: Comparison of PHEVs and AEVs to gasoline vehicles

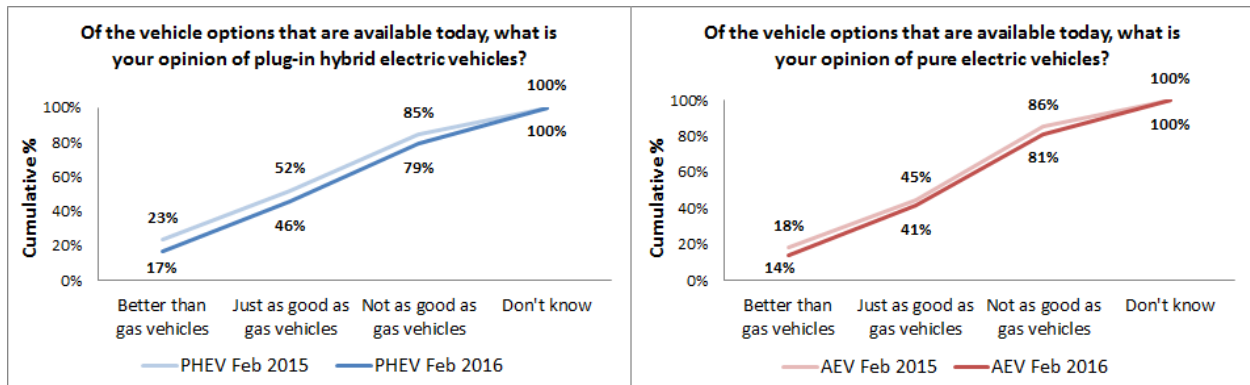


Figure 12. Questions 9 and 11: Cumulative comparison of PHEVs and AEVs to gasoline vehicles

**Sources:** For 2016: ORC for NREL (2016), Study No. 725068, n=1,008. For 2015 PHEVs: ORC for NREL (2015), Study No. 724068, n=506. For 2015 AEVs: ORC for NREL (2015), Study No. 724068, n=509.

**Note:** Respondents were given the following information before being asked about their exposure to and opinion of PEVs beginning with question 8: “Plug-in electric vehicles can be charged by being plugged into a household-type outlet or specially designed charging equipment. These can be defined as plug-in hybrids or pure electric vehicles. Not included in this definition are hybrids, such as the original Toyota Prius, that cannot be plugged in. The Chevy Volt is an example of a plug-in hybrid electric vehicle that can be powered by either the battery or the gasoline engine. The Tesla Model S or the Nissan Leaf are examples of pure electric vehicles powered only by their batteries.” In the 2015 study, the respondent group was split. Roughly half of the respondents were asked about PHEV sentiments. The second half of respondents was asked about AEV sentiments.

## 2.5 Consumers Considering Plug-in Electric Vehicles and Why

Respondents showed a greater interest in PHEVs compared to AEVs when asked if they would consider purchasing the vehicles. Nearly a quarter of respondents (23%) stated they would consider or expect to purchase PHEVs; 19% stated they would consider or expect to purchase AEVs. A majority, 57% and 62%, stated they would not purchase or lease PHEVs or AEVs, respectively. There was an increase in the percentage of respondents who said they will not purchase or lease PEVs from 2015. While within the margin of error, there was also a slight increase in the percentage stating they expected to purchase or lease PEVs.

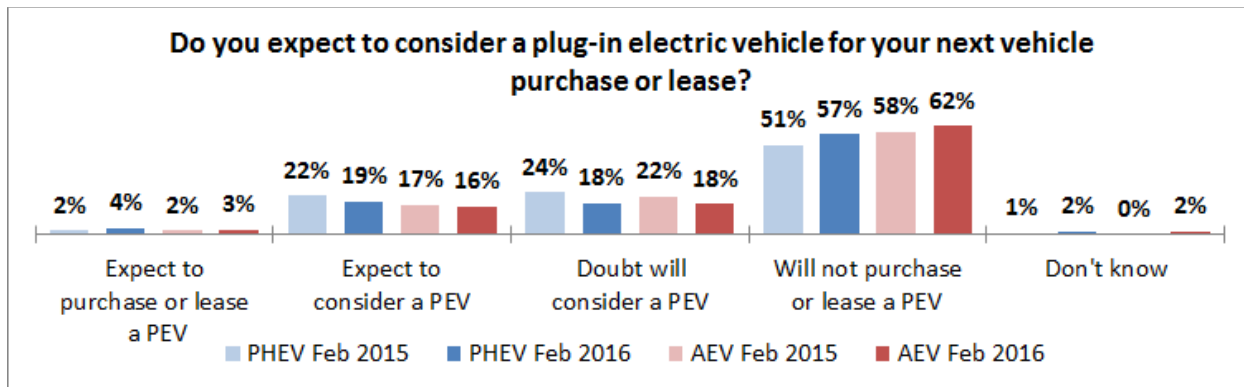


Figure 13. Questions 10 and 12: Willingness to consider purchasing PHEVs and AEVs

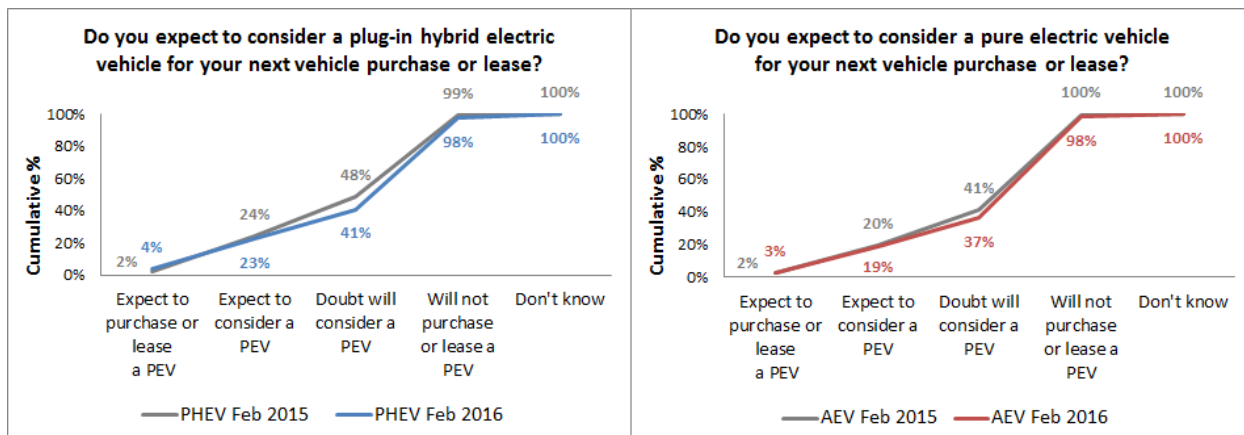


Figure 14. Questions 10 and 12: Cumulative willingness to consider purchasing PHEVs and AEVs

**Sources:** For 2016: ORC for NREL (2016), Study No. 725068, n=1,008. For 2015 PHEVs: ORC for NREL (2015), Study No. 724068, n=506. For 2015 AEVs: ORC for NREL (2015), Study No. 724068, n=509.

**Note:** Respondents were given the following information before being asked about their exposure to and opinion of PEVs beginning with question 8: "Plug-in electric vehicles can be charged by being plugged into a household-type outlet or specially designed charging equipment. These can be defined as plug-in hybrids or pure electric vehicles. Not included in this definition are hybrids, such as the original Toyota Prius, that cannot be plugged in. The Chevy Volt is an example of a plug-in hybrid electric vehicle that can be powered by either the battery or the gasoline engine. The Tesla Model S or the Nissan Leaf are examples of pure electric vehicles powered only by their batteries." In the 2015 study, the respondent group was split. Roughly half of the respondents were asked about PHEV sentiments. The second half of respondents was asked about AEV sentiments.

## 2.6 Reasons for Considering Plug-in Electric Vehicles

The top reasons for considering PEVs were that PEVs were viewed as better for the environment and would provide fuel cost savings. Fewer respondents agreed with each reason for considering a PEV than in 2015. The primary reason for not considering PEVs (given by 55%) was that the vehicles are too expensive. None of the other reasons given for not considering PEVs were given by a majority of respondents. Those not considering PEVs were asked about factors that might influence them to consider PEVs. A majority (59% and 55%, respectively) stated that if PEVs were truly better for the environment, or if they saved money on fuel, they would be more likely to consider PEVs.

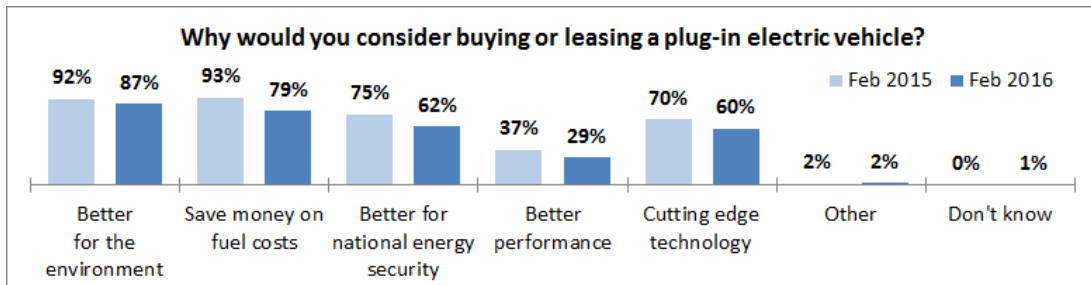


Figure 15. Question 13: Reasons for considering PEVs

**Sources:** For 2016: ORC for NREL (2016), Study No. 725068, n=256. For 2015: ORC for NREL (2015), Study No. 724068, n=223.

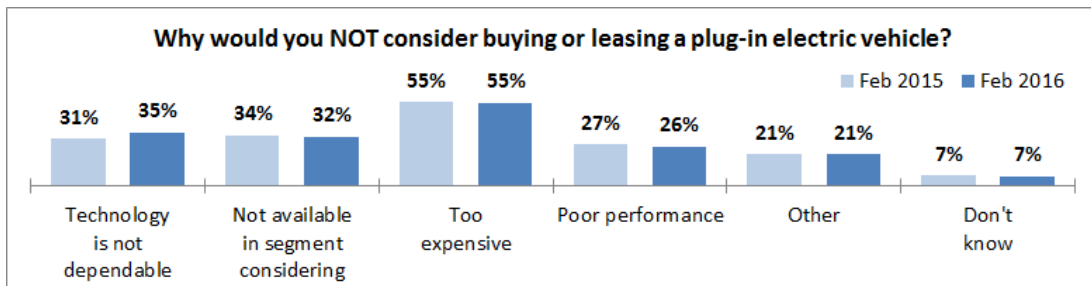


Figure 16. Question 14: Reasons for not considering PEVs

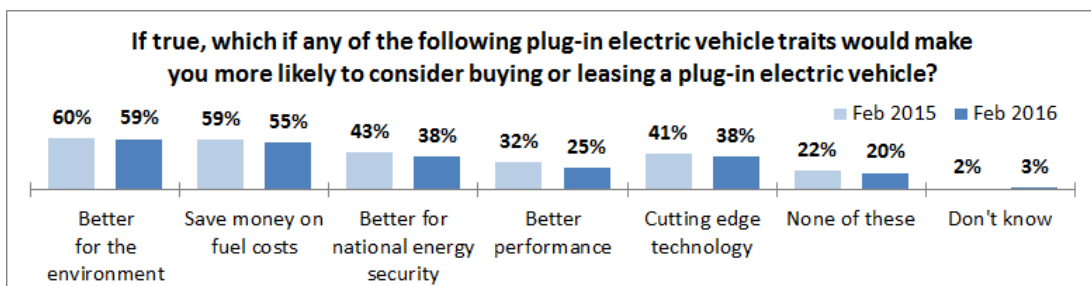


Figure 17. Question 15: PEV traits that could increase purchase consideration

**Sources:** For 2016: ORC for NREL (2016), Study No. 725068, n=728. For 2015: ORC for NREL (2015), Study No. 724068, n=787.

**Note:** See note about the information provided to respondents before question 8 in Section 2.3.



## 3 Barriers to Plug-in Electric Vehicle Acceptance

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### 3.1 Barriers to Plug-in Electric Vehicle Acceptance Overview

Advanced vehicle technologies may have characteristics that require some familiarization by the market before they are considered by potential purchasers. Understanding barriers to broad acceptance can help determine the market for those vehicles and future potential.

The electric distance, or range, AEVs can travel on a single charge is limited by battery size or capacity. Depending on the size of the AEV battery and the type of charging equipment available, the vehicle may require considerable time to recharge. A gasoline vehicle is limited by the distance the vehicle can travel on a single tank of gasoline, but gasoline stations are relatively prevalent, and gasoline vehicles are relatively quick to refuel.

This study asked respondents to provide the vehicle range they would require of an AEV in order for them to consider purchasing one. The results show that a broad set of vehicle ranges would be sufficient for different respondents. The vehicles would need to travel 100 miles on a single charge for 20% of respondents to consider the vehicles; however, the vehicles would need to travel 400 miles for a majority (55%) of respondents to consider purchasing the vehicles. Of those respondents providing a range, the median required vehicle range increased from 250 miles in 2015 to 300 miles in 2016.

Recharging opportunity can also influence PEV acceptance. This study found 20% of respondents were aware of charging stations that they passed regularly, were at their places of work, or were at the stores and places they frequented. This percentage is an increase (within the margin of error) compared to 18% in 2015. A large majority (76%) of respondents were not aware of any charging stations. The percentage who stated they could park their vehicles near electrical outlets at home is down from prior years and in this study was just below half (49%).

The purchase price of PEVs may deter some purchasers. PEVs are available in a range of prices, but as a new technology they are often more expensive than similar gasoline vehicles. Federal and state tax incentives can play a role in reducing the cost for the purchaser (AFDC 2016). This study found a range of vehicle prices respondents were expecting to pay for their next vehicles. A majority (69%) stated they expected to pay \$30,000 or less for their next vehicle, and 43% expected to pay \$20,000 or less. Although price is a barrier, current top-selling nonluxury PEV offerings fall within the reported expected price range of 44% of respondents, if they could all take advantage of the federal tax credit (IRS 2016). Expected purchase prices showed little change from 2015 results.

Respondents showed some willingness to pay increased upfront costs for a PEV that would reduce their fuel costs by one-third. The percentage of respondents who would pay an incremental cost for a PEV decreased within the margin of error from 51% in 2015 to 49% in 2016. An additional 22% would consider a PEV, but would not pay an increased cost. The percentage stating they would not consider a PEV increased from 14% in 2015 to 18% in 2016.

### 3.2 Required Electric Vehicle Range

Respondents provided a wide array of AEV mile ranges that would be necessary for them to consider purchasing AEVs. Respondents in 2016 responded with higher vehicle ranges than in 2015. Of those respondents providing a range, the median provided range was 300 miles in 2016 compared to 250 miles in 2015. A majority of all respondents (55%) provided a range of 400 miles or less. Similarly 33% provided a range of 200 miles or less. A fifth of respondents (20%) stated a range of 100 miles or less. A smaller percentage of respondents (9%) would not consider purchasing AEVs regardless of the vehicle range. To put these ranges in context, the median driving range for model year 2016 gasoline vehicles is 412 miles (EERE 2016).

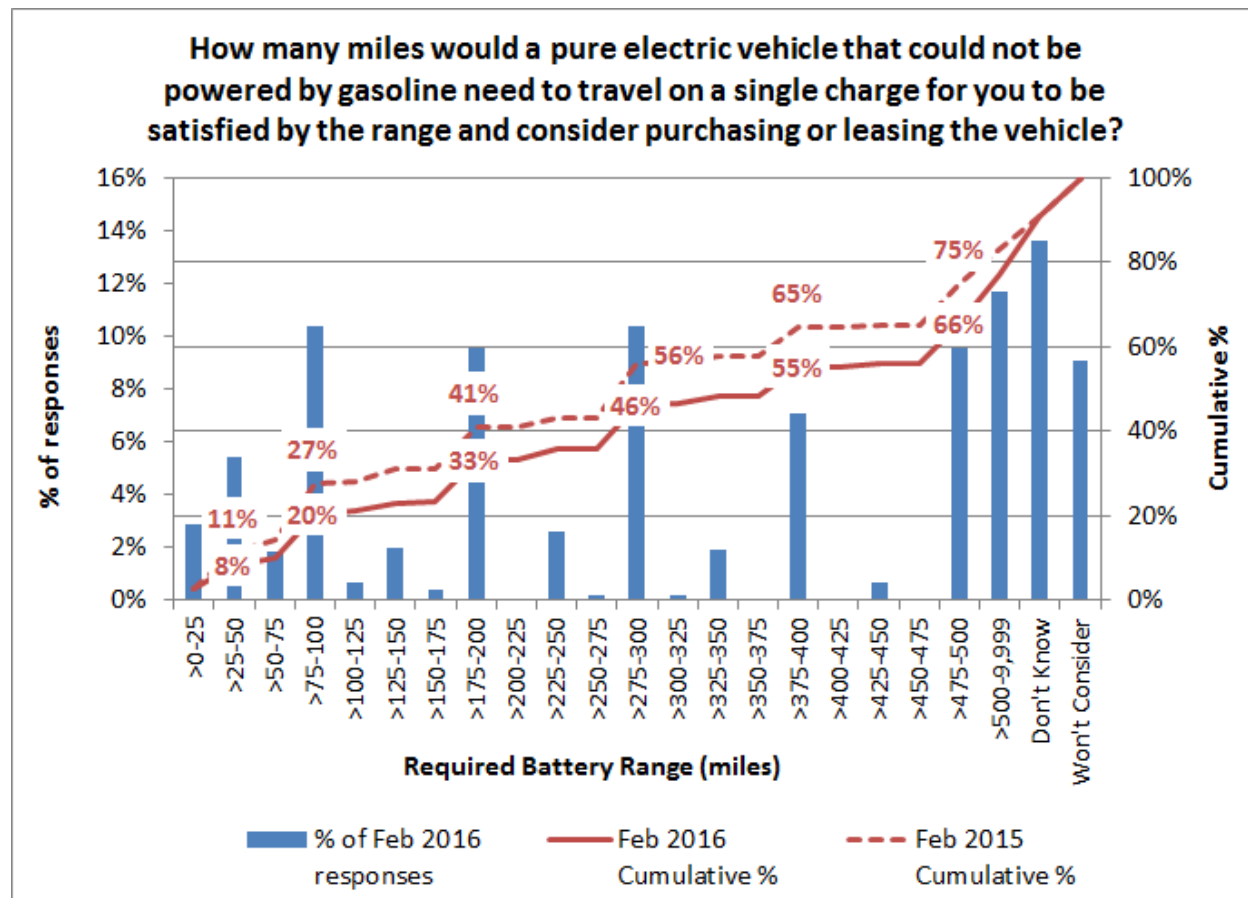


Figure 18. Question 16: Required AEV range for purchase consideration

**Sources:** For 2016: ORC for NREL (2016), Study No. 725068, n=1,008. For 2015 ORC for NREL (2015), Study No. 724068, n=1,015.

**Note:** Respondents were given the following information before being asked about their exposure to and opinion of PEVs beginning with question 8: “Plug-in electric vehicles can be charged by being plugged into a household-type outlet or specially designed charging equipment. These can be defined as plug-in hybrids or pure electric vehicles. Not included in this definition are hybrids, such as the original Toyota Prius, that cannot be plugged in. The Chevy Volt is an example of a plug-in hybrid electric vehicle that can be powered by either the battery or the gasoline engine. The Tesla Model S or the Nissan Leaf are examples of pure electric vehicles powered only by their batteries.”

### 3.3 Perceived Ability to Charge a Plug-in Electric Vehicle

Respondents reported a low perceived availability of PEV charging stations. Overall, only 20% of respondents were aware of any charging stations that were on the routes they drove regularly, were at their places of work, or were at the stores and places they frequented. This percentage is up within the margin of error from 18% in 2015. Nearly half (49%) stated they park their primary vehicles near electrical outlets at home. Thus, feasibly, these vehicles could be charged at the respondents' homes. The percentage of respondents who parked near outlets was lower than when respondents were previously asked in April 2006 and February 2015. Section 4 of this report investigates PEV acceptance by different respondent groups including those who are aware of charging stations and those who are able to plug in at home.

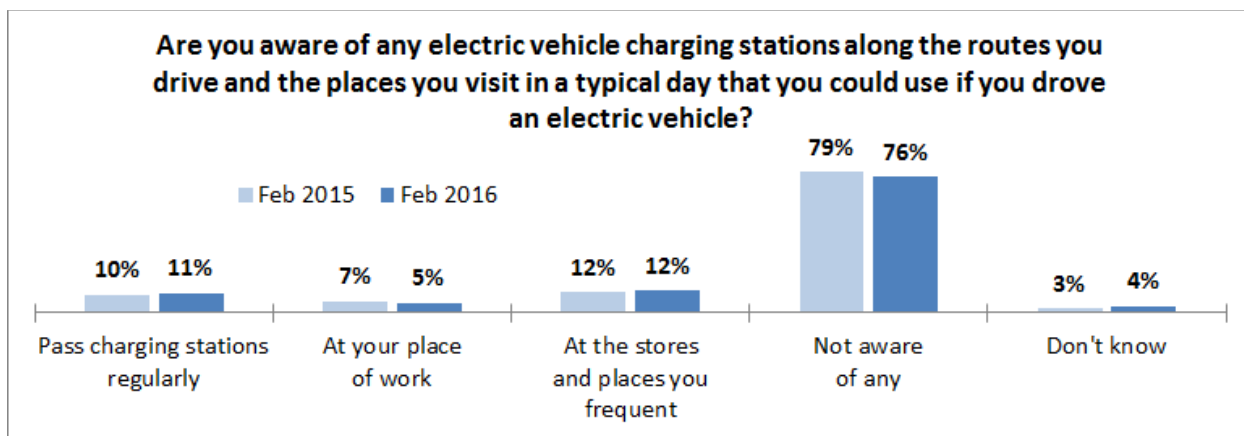


Figure 19. Question 17: Awareness of PEV charging stations

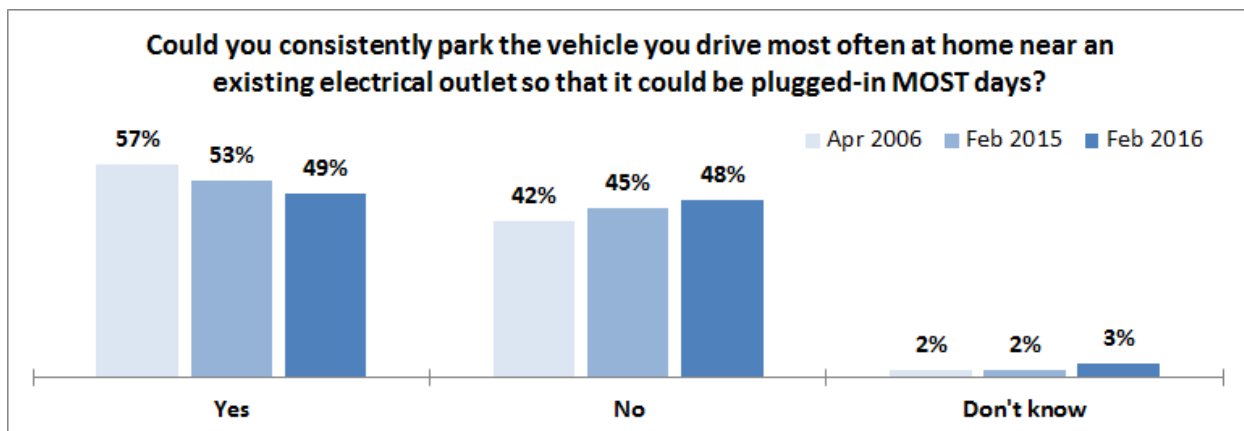


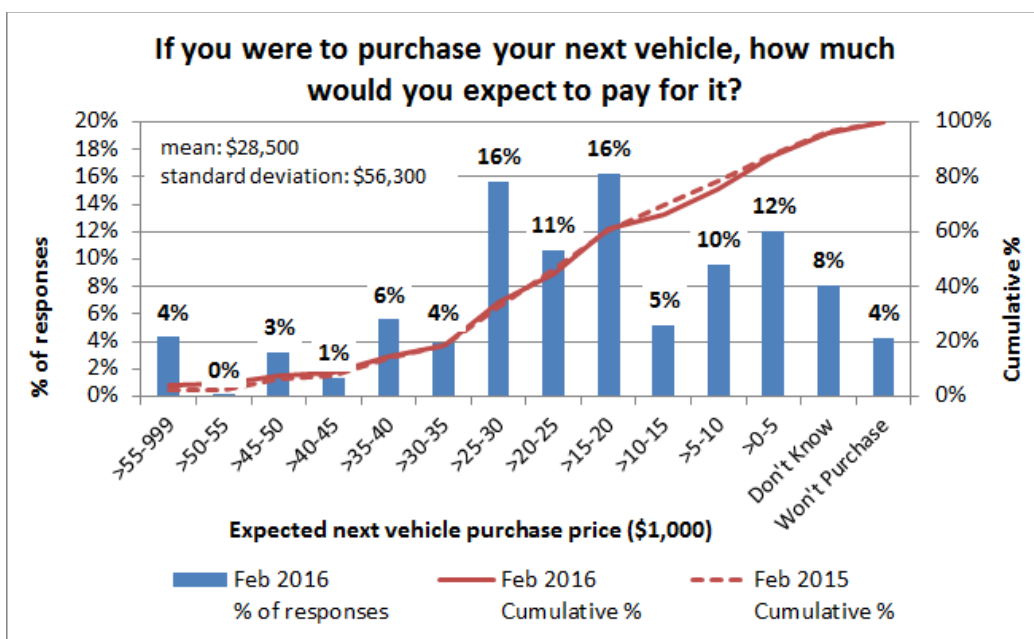
Figure 20. Question 18: Ability to charge a PEV at home

**Sources:** For 2016: ORC for NREL (2016), Study No. 725068, n=1,008. For 2015: ORC for NREL (2015), Study No. 724068, n=1,015. For 2006: ORC for NREL (2006), Study No. 715168, n=480.

**Note:** In Section 4 of this report, the 20% segment of respondents who were aware of any charging stations that were on the routes they drove regularly, were at their places of work, or were at the stores and places they frequented were classified as “aware of PEV charging stations.”

### 3.4 Vehicle Purchase Price

Respondents provided a wide range of expected purchase prices for their next vehicles. A majority (69%) expected to spend \$30,000 or less, and 43% expected to pay \$20,000 or less. In January 2016, the top-selling PHEV was the Chevrolet Volt and the top-selling nonluxury AEV was the Nissan Leaf (ANL 2016). In March 2016, the Volt retail price was \$33,170 (Chevrolet 2016) and the Leaf retail price was \$29,010 (Nissan 2016). If the federal tax credit of \$7,500 is subtracted from the vehicle prices (IRS 2016), the Leaf cost of \$21,510 would be in the price range of 44% of respondents; the Volt cost of \$25,670 would be in the range of 34% of respondents. The distribution of expected purchase prices by respondents was consistent with 2015 results.



**Figure 21. Question 19: Expected next vehicle purchase price**

**Sources:** For 2016: ORC for NREL (2016), Study No. 725068, n=1,008. For 2015: ORC for NREL (2015), Study No. 724068, n=1,015.

**Notes:** The results of this question are not intended to show what respondents have paid or will actually pay for their vehicles. The data are reflecting respondent current expectations, which may differ significantly from final purchase decisions.

The federal tax credit begins to phase out after a specific manufacturer sells 200,000 qualifying PEVs (IRS 2016). Chevrolet and Nissan are not expected to reach the cap soon as the Volt and Leaf had each sold roughly 100,000 units as of October 2016 (ANL 2016).

### 3.5 Willingness to Pay for a Plug-in Electric Vehicle

Respondents showed a diverse willingness to pay incremental costs for PEVs that would cut their fuel costs by one-third. Roughly half (49%) stated they would be willing to pay an incremental cost, and an additional 22% of respondents would not pay an incremental cost, but would consider the hypothetical PEV. Finally, 18% would not buy PEVs regardless of incremental costs. Respondent willingness to pay an incremental cost for a PEV was similar to 2015 results. There was a small increase (16% in 2015 compared to 19% in 2016) in respondents reporting a willingness to pay an incremental cost more than \$5,000. There was also an increase in respondents who would not buy a PEV even without an incremental cost (14% in 2015 and 18% in 2016).

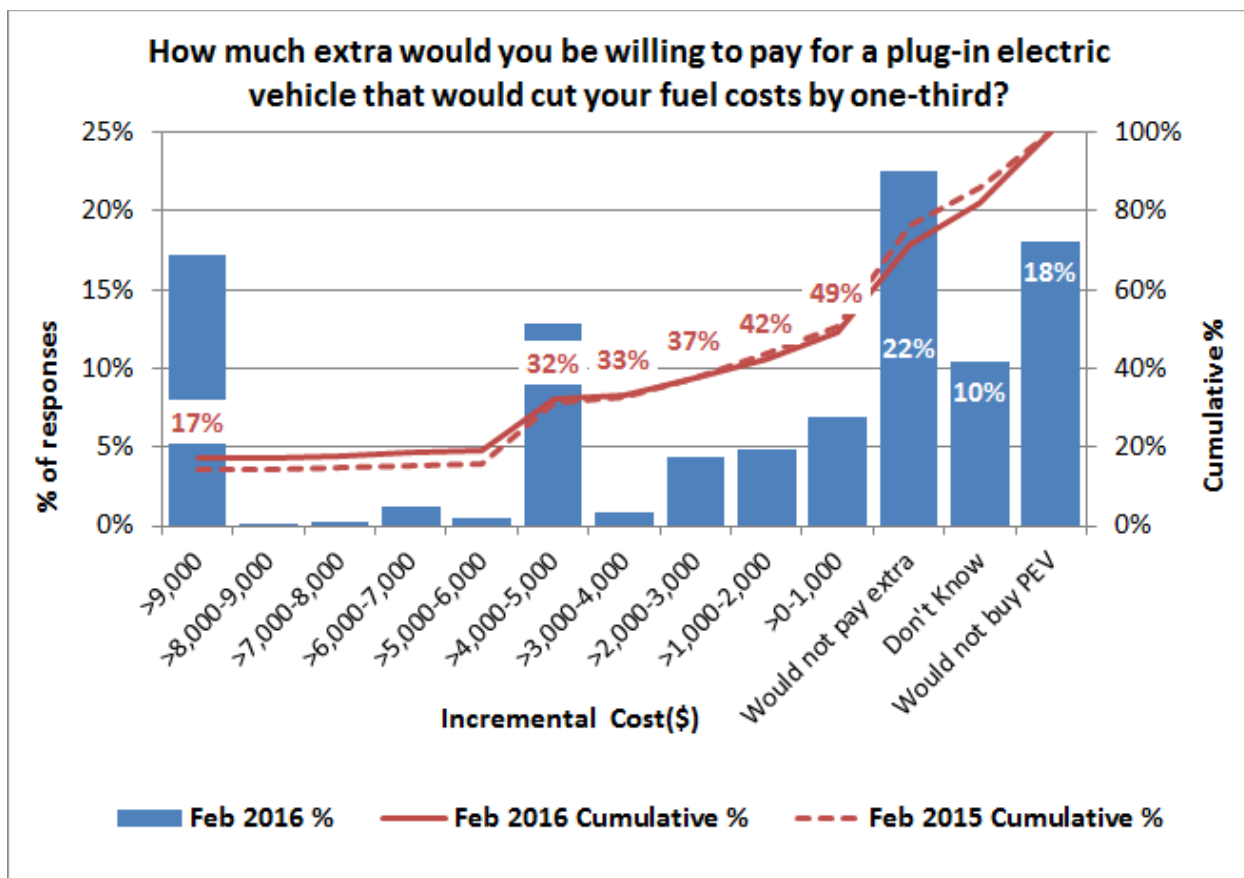


Figure 22. Question 20: Willingness to pay for a PEV

Sources: For 2016: ORC for NREL (2016), Study No. 725068, n=1,008. For 2015: ORC for NREL (2015), Study No. 724068, n=1,015.

## 4 Plug-in Electric Vehicle Acceptance

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## 4.1 Plug-in Electric Vehicle Acceptance Overview

A broad set of factors affect consumers' willingness to purchase vehicles. Even when considering established technologies, consumers' interest and purchase behavior varies to meet their transportation needs. For a new vehicle technology to succeed, consumers will need to become aware of the technology and accept how the new technology can meet their needs.

Questions 9 and 11 (see Section 2.4) identified segments of respondents who believe that PEVs are just as good as or better than traditional gasoline vehicles. Similarly, questions 10 and 12 (see Section 2.5) identified segments of respondents who either expect to purchase PEVs or expect to consider purchasing PEVs. These response sets were used as measures of PEV acceptance.

This section identifies additional segments and compares their levels of PEV acceptance to each other and the overall respondent group. The sample sizes for these investigations, as noted in the coming pages for each graphic, are smaller than the study overall, but the comparisons highlight where stronger acceptance of PEVs originated in this study. Select segments of respondents were defined as follows:

- New or used vehicle purchasers (see Section 1.5)
- Vehicle purchasers who bought or plan to buy within one year (see Section 1.4)
- Single- or multivehicle households (see Section 1.2)
- Respondents able to name one of the top 10 best-selling PEVs (see Section 2.2)
- Respondents who have seen PEVs in parking lots (see Section 2.3)
- Respondents who have seen PEV advertisements (see Section 2.3)
- Respondents who have seen PEVs in social media (see Section 2.3)
- Respondents who are aware of PEV tax incentives (see Section 2.3)
- Respondents aware of PEV charging stations (see Section 3.3)
- Respondents able to plug in at home (see Section 3.3).

Additionally, respondent demographics captured by the ORC study allowed investigation of variations in PEV acceptance by respondent age, household income, and education levels.

Overall, respondents were more likely to view PHEVs positively than AEVs. This relationship held true across all respondent sub-groupings investigated. The only exception was single-vehicle households, which were slightly more likely to believe AEVs, in comparison to PHEVs, were as good as or better than traditional gasoline vehicles (47% to 46%, respectively). This difference was within the margin of error.

In comparison to all the respondent segments investigated, those who were aware of existing PEV charging stations in their vicinity were most likely to report that PEVs were as good as or better than traditional gasoline vehicles and were most likely to consider purchasing a PEV. Respondents who were aware of PEV charging stations were twice as likely to report a willingness to consider purchasing a PEV. Similarly, respondents able to plug in at home were more likely to agree with the positive PEV sentiments.



More broadly, in addition to charging station awareness, respondents with more exposure and awareness of PEVs reported the positive PEV sentiments. Respondents who have seen PEVs in parking lots, PEV advertisements, or PEVs in social media; were able to name a specific PEV make and model; or were aware of PEV tax incentives consistently reported higher levels of PEV acceptance and willingness to consider purchasing PEVs.

PEV acceptance did not vary greatly between single-vehicle and multivehicle households. Single-vehicle households more often than multivehicle households reported that AEVs are as good as or better than traditional gasoline vehicles—in 2015 multivehicle households more often agreed with the positive view of AEVs. Multivehicle households were slightly more likely than single-vehicle households to report an expectation to consider purchasing a PHEV (25% and 22%, respectively). Single-vehicle households were slightly more likely to expect to consider an AEV than multivehicle households (21% and 19%, respectively), although the difference was within the margin of error.

New and used vehicle purchasers showed little variation in PEV sentiments. New vehicle purchasers were more likely than used vehicle purchasers to consider PHEVs to be just as good as or better than traditional gasoline vehicles.

Those respondents most recently active in the market, which was determined by their having purchased a vehicle in the last year or their expectation to purchase in the next year, did not show a large difference in their PEV sentiments from the overall respondent group.

Compared to 2015, fewer respondents viewed PEVs as just as good as or better than traditional gasoline vehicles. Only the percentage of respondents having the positive view of AEVs increased significantly from 2015.

The percentages of respondents overall who would be willing to consider purchasing PEVs declined only slightly from 2015. Used vehicle purchasers were more likely to consider PEVs in 2016, while new vehicle purchasers were less likely to do so than in 2015. Those respondents aware of PEV charging stations, while already much more likely to consider PEVs than the overall respondent group, were even more likely in 2016 than in 2015 to consider purchasing PEVs.

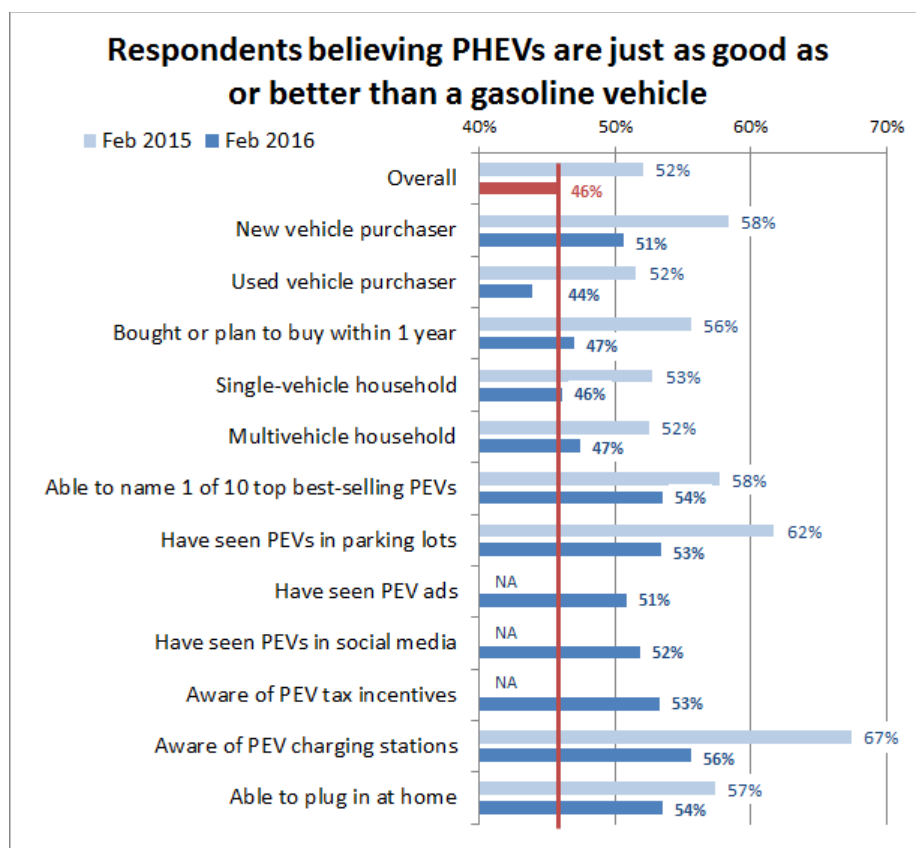
Of the demographic groups investigated, respondents aged 35 or younger were most likely to state that PEVs were as good as or better than traditional gasoline vehicles and were most likely to consider purchasing a PEV. Respondents over 55 were least likely to have the positive PEV sentiments.

When investigating respondent income levels, those respondents with an annual household income less than \$50,000 were most likely to state AEVs were as good as or better than traditional gasoline vehicles. However, the income groups above \$50,000 were more likely to say PHEVs were as good as or better than traditional gasoline vehicles. When asked about their willingness to consider purchasing a PEV, income groups showed more distinct variations. Respondents with a household income under \$50,000 were less likely than the full respondent set to state a willingness to consider purchasing a PEV, while respondents with household incomes over \$50,000 were more likely to consider purchasing a PEV.

Finally, respondents with some college education or college degrees were more likely to view PHEVs to be as good as or better than traditional gasoline vehicles. Respondents with some college, but without a college degree were most likely to view AEVs to be as good as or better than traditional gasoline vehicles. Respondents with some college or college degrees were more likely to report a willingness to consider purchasing PEVs.

## 4.2 Perception of Plug-in Hybrid Electric vs. Conventional Vehicles

Overall, 46% of respondents stated that PHEVs were just as good as or better than gasoline vehicles. A sampling of respondent segments is shown in Figure 23. Acceptance of PHEVs based on this measure was down from 52% in the 2015 study. Respondents who reported being aware of charging stations had the highest percentage (56%) reporting a positive view. Similarly, respondents able to plug-in at home were more likely to report the positive view. Respondents reporting an awareness of PEVs (those who could name one of the top best-selling PEVs, those who had seen PEVs in parking lots, seen PEV ads, seen PEVs in social media, or were aware of PEV tax incentives) were more likely to report a positive view. PHEV acceptance was higher among new vehicle purchasers than used vehicle purchasers. Little difference in PHEV acceptance was reported between single and multivehicle households.



**Figure 23. Segments of PHEV acceptance**

**Sources:** For 2015 (Singer 2016). For 2016: ORC for NREL (2016), Study No. 725068, see note for sample sizes.

**Note:** Respondents were not asked about PEV advertisements, PEVs in social media, or PEV tax incentives in 2015. The overall sample size was n=1,008. Sample sizes for the respondents who also fit in the additional segments were generally small and were as follows: new vehicle purchasers (n=444), used vehicle purchasers (n=338), bought or planned to buy within one year (n=390), single-vehicle households (n=307), multivehicle households (n=583), able to name one of the 10 top-selling PEVs (n=414), have seen PEVs in parking lots (n=434), have seen PEV ads (n=576), have seen PEVs in social media (n=543), are aware of PEV tax incentives (n=332), are aware of PEV charging stations (n=197), and able to plug in at home (n=495).

### 4.3 Perception of All-Electric vs. Conventional Vehicles

Overall, 41% of respondents stated that AEVs were just as good as or better than gasoline vehicles. A sampling of respondent segments is shown in Figure 24. Acceptance of AEVs based on this measure was down from 45% in the 2015 study. Respondents who reported being aware of charging stations had the highest percentage (55%) reporting a positive view. Respondents able to plug-in at home were also more likely to report the positive view. Respondents reporting an awareness of PEVs (those who could name one of the top best-selling PEVs, those who had seen PEVs in parking lots, seen PEV ads, seen PEVs in social media, or were aware of PEV tax incentives) were more likely to report a positive view. Little difference in AEV acceptance was reported between new and used vehicle purchasers. Single-vehicle households reported a higher acceptance of AEVs than multivehicle households, after the opposite was reported in 2015.

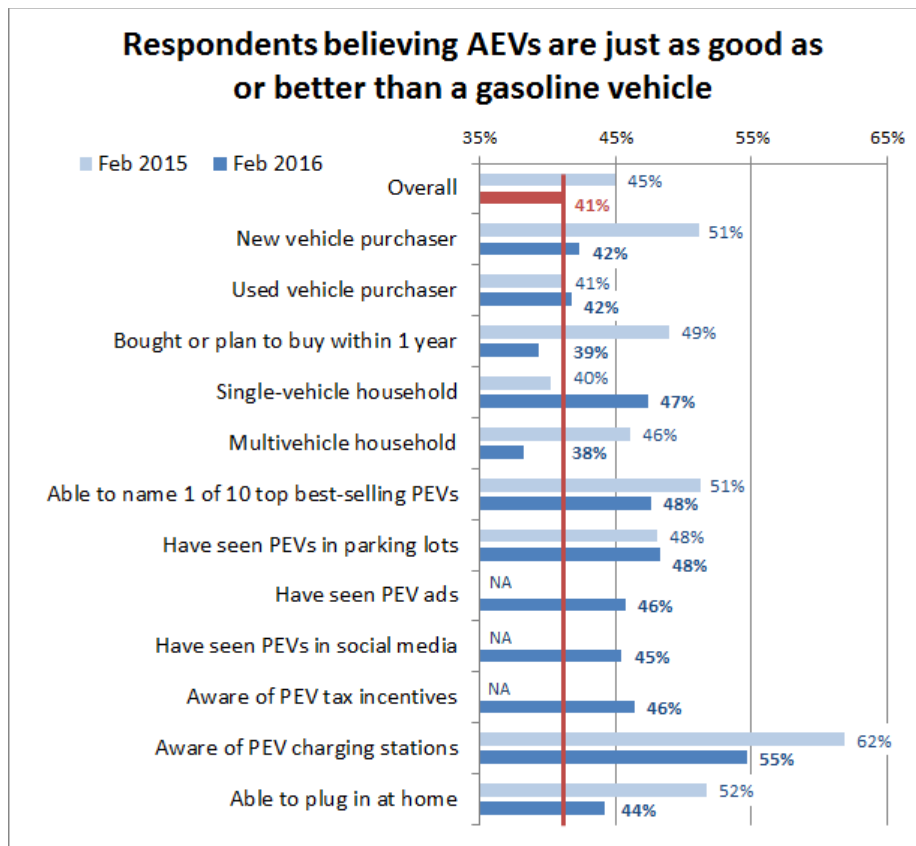


Figure 24. Segments of AEV acceptance

**Sources:** For 2015 (Singer 2016). For 2016: ORC for NREL (2016), Study No. 725068, see note for sample sizes.

**Note:** Respondents were not asked about PEV advertisements, PEVs in social media, or PEV tax incentives in 2015. The overall sample size was n=1,008. Sample sizes for the respondents who also fit in the additional segments were generally small and were as follows: new vehicle purchasers (n=444), used vehicle purchasers (n=338), bought or planned to buy within one year (n=390), single-vehicle households (n=307), multivehicle households (n=583), able to name one of the 10 top-selling PEVs (n=414), have seen PEVs in parking lots (n=434), have seen PEV ads (n=576), have seen PEVs in social media (n=543), are aware of PEV tax incentives (n=332), are aware of PEV charging stations (n=197), and able to plug in at home (n=495).

## 4.4 Willingness to Consider Plug-in Hybrid Electric Vehicles by Segment

Overall, 23% of respondents stated they would purchase or consider PHEVs for their next vehicle purchases or leases. A sampling of respondent segments is shown in Figure 25. Willingness to consider PHEVs based on this measure was down within the margin of error from 24% in the 2015 study. Respondents who reported being aware of charging stations had the highest percentage (46%) expecting to consider a PHEV. Similarly, respondents able to plug-in at home were more likely to report the positive view. Respondents reporting an awareness of PEVs (those who could name one of the top best-selling PEVs, those who had seen PEVs in parking lots, seen PEV ads, seen PEVs in social media, or were aware of PEV tax incentives) were more likely to consider a PHEV. Willingness to consider a PHEV was slightly higher among new vehicle purchasers than used vehicle purchasers, although used purchaser interest increased from 2015. Multivehicle households were slightly more likely to consider purchasing PHEVs than single-vehicle households.

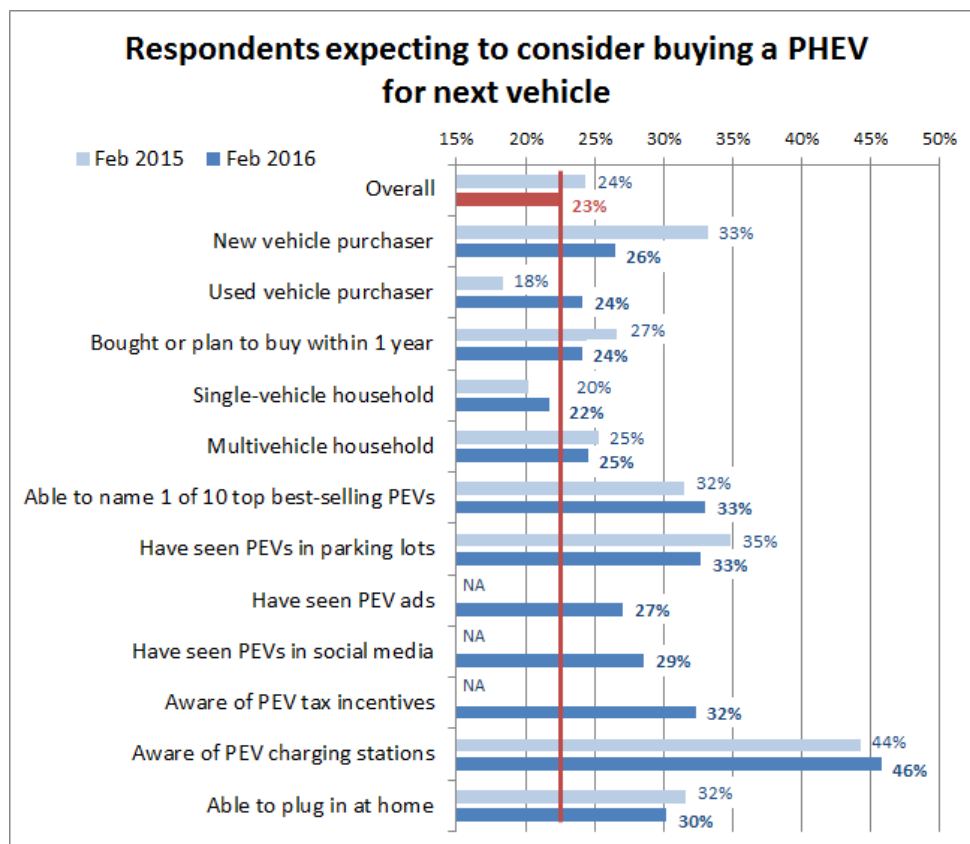


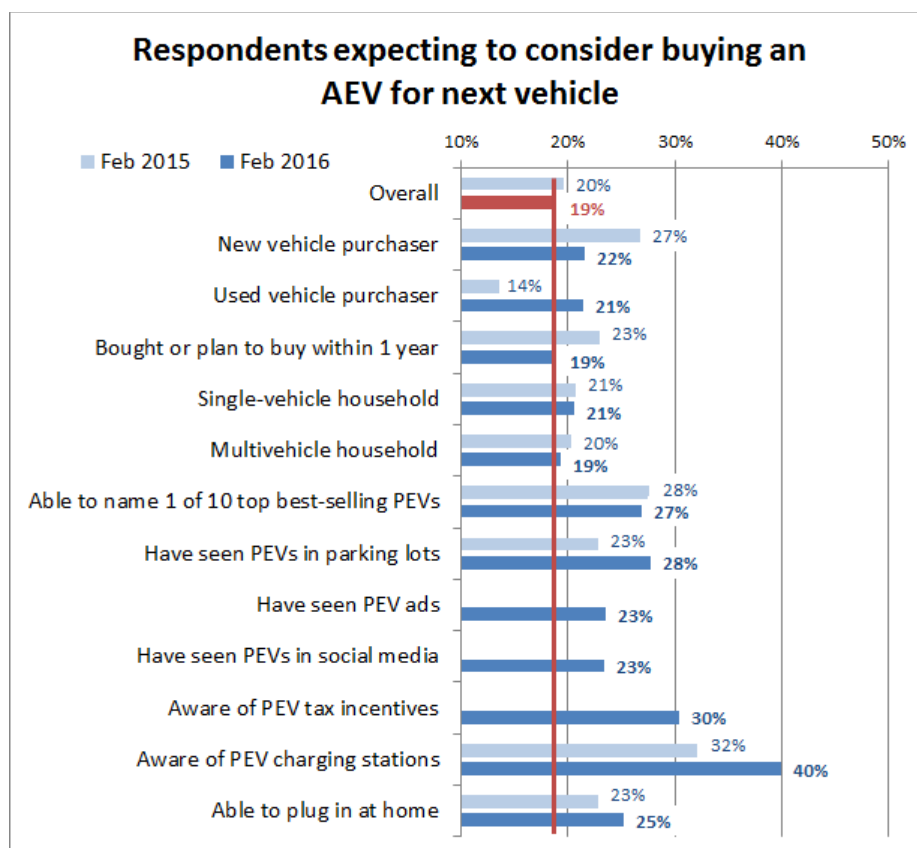
Figure 25. Willingness to consider PHEVs by segment

**Sources:** For 2015 (Singer 2016). For 2016: ORC for NREL (2016), Study No. 725068, see note for sample sizes.

**Note:** Respondents were not asked about PEV advertisements, PEVs in social media, or PEV tax incentives in 2015. The overall sample size was n=1,008. Sample sizes for the respondents who also fit in the additional segments were generally small and were as follows: new vehicle purchasers (n=444), used vehicle purchasers (n=338), bought or planned to buy within one year (n=390), single-vehicle households (n=307), multivehicle households (n=583), able to name one of the 10 top-selling PEVs (n=414), have seen PEVs in parking lots (n=434), have seen PEV ads (n=576), have seen PEVs in social media (n=543), are aware of PEV tax incentives (n=332), are aware of PEV charging stations (n=197), and able to plug in at home (n=495).

## 4.5 Willingness to Consider All-Electric Vehicles by Segment

Overall, 19% of respondents stated they would purchase or consider AEVs for their next vehicle purchases or leases. A sampling of respondent segments is shown in Figure 26. Willingness to consider AEVs based on this measure was down within the margin of error from 20% in the 2015 study. Respondents who reported being aware of charging stations had the highest percentage (40%) expecting to consider an AEV. Similarly, respondents able to plug-in at home were more likely to report the positive view. Respondents reporting an awareness of PEVs (those who could name one of the top best-selling PEVs, those who had seen PEVs in parking lots, seen PEV ads, seen PEVs in social media, or were aware of PEV tax incentives) were more likely to consider an AEV. Willingness to consider an AEV was similar between new vehicle purchasers and used vehicle purchasers, but used purchaser interest increased from 2015. Multivehicle households were slightly less likely to consider purchasing AEVs than single-vehicle households.



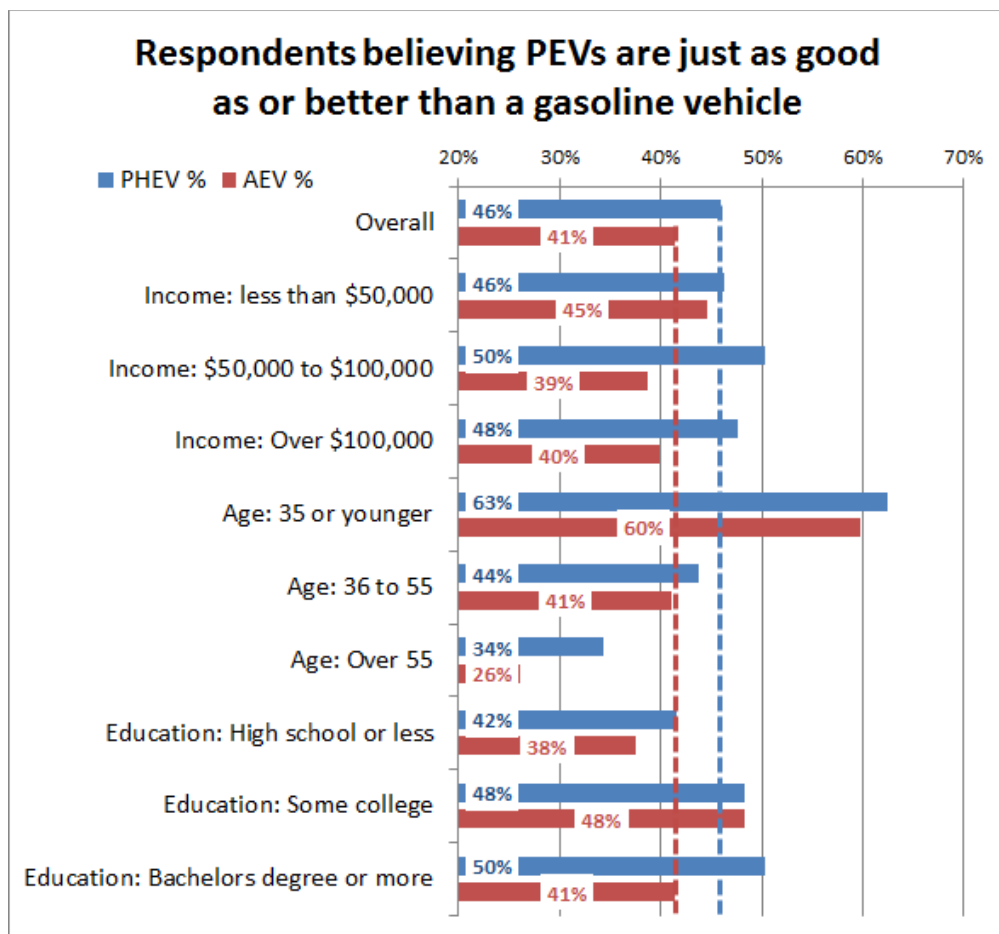
**Figure 26. Willingness to consider AEVs by segment**

**Sources:** For 2015 (Singer 2016). For 2016: ORC for NREL (2016), Study No. 725068, see note for sample sizes.

**Note:** Respondents were not asked about PEV advertisements, PEVs in social media, or PEV tax incentives in 2015. The overall sample size was n=1,008. Sample sizes for the respondents who also fit in the additional segments were generally small and were as follows: new vehicle purchasers (n=444), used vehicle purchasers (n=338), bought or planned to buy within one year (n=390), single-vehicle households (n=307), multivehicle households (n=583), able to name one of the 10 top-selling PEVs (n=414), have seen PEVs in parking lots (n=434), have seen PEV ads (n=576), have seen PEVs in social media (n=543), are aware of PEV tax incentives (n=332), are aware of PEV charging stations (n=197), and able to plug in at home (n=495).

## 4.6 Demographics of Plug-in Electric Vehicle Perceptions

PEV acceptance varied by respondent demographics captured in the study. A sampling of respondent segments is shown in Figure 27. Respondents age 35 or younger reported the highest levels of PEV acceptance. AEV acceptance was highest across income levels among respondent households making less than \$50,000 a year in comparison to other income brackets. PHEV acceptance was highest across income levels among those households earning between \$50,000 and \$100,000. PHEV acceptance was highest among respondents with college degrees in comparison to other levels of education. Across education levels AEV acceptance was highest among those respondents with some college education, but without a bachelor's degree.



**Figure 27. Demographics of PEV acceptance**

**Source:** ORC for NREL (2016), Study No. 725068, see note for sample sizes.

**Note:** The overall sample size was n=1,008. Sample sizes for the respondents of the demographic groups were smaller and were as follows: income less than \$50,000 (n=489), income \$50,000 to \$100,000 (n=213), income over \$100,000 (n=154), 35 years and younger (n=307), 36 to 55 years of age (n=339), over 55 years (n=333), high school diploma or less (n=398), some college (n=269), and bachelor's degree or higher (n=309).

## 4.7 Demographics of Willingness to Consider Plug-in Electric Vehicles

Respondents from different demographic groups reported varied levels of willingness to consider purchasing PEVs. A sampling of respondent segments is shown in Figure 28. Respondents age 35 or younger were most likely to consider purchasing PEVs. Interest declined as age increased. Willingness to consider PEVs was higher for the two higher income segments, while those making less than \$50,000 were less likely to consider PEVs. Respondents with a high school education or less were less likely to consider PEVs. The two respondent segments who reported having at least some college education reported a similar increased willingness to consider PEVs.

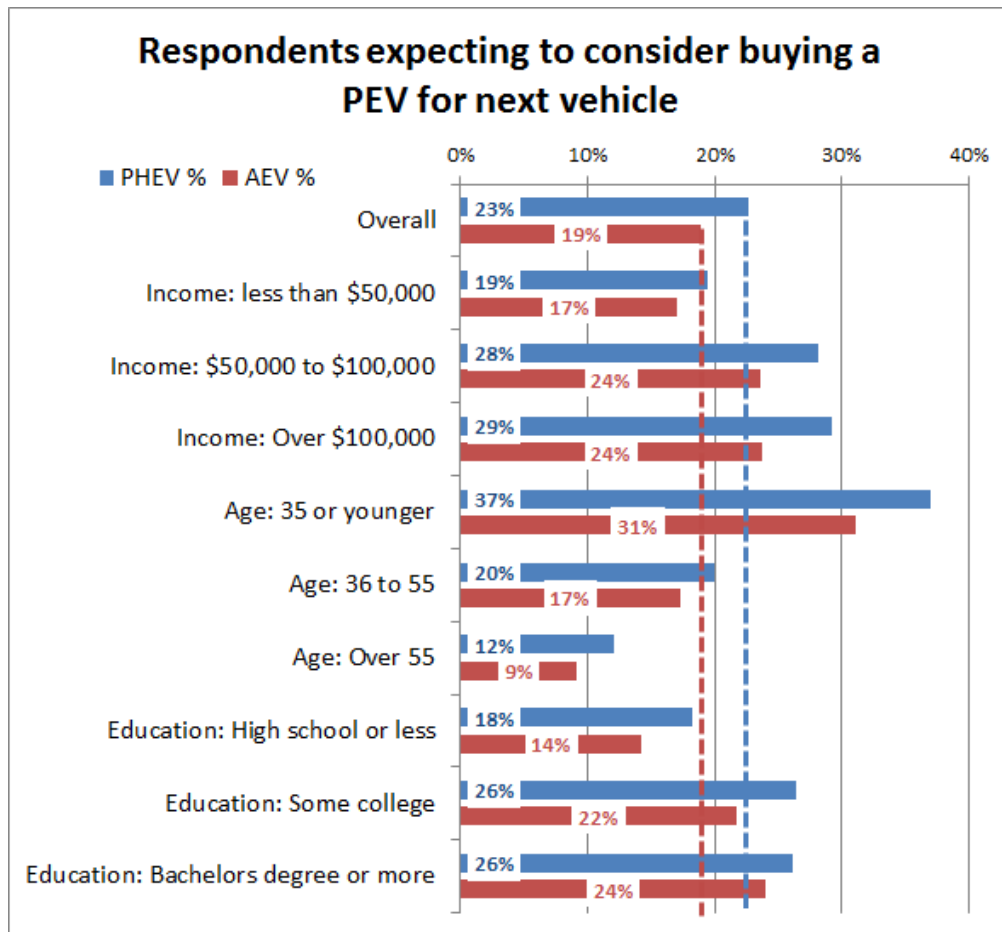


Figure 28. Demographics of willingness to consider PEVs

**Source:** ORC for NREL (2016), Study No. 725068, see note for sample sizes.

**Note:** The overall sample size was n=1,008. Sample sizes for the respondents of the demographic groups were smaller and were as follows: income less than \$50,000 (n=489), income \$50,000 to \$100,000 (n=213), income over \$100,000 (n=154), 35 years and younger (n=307), 36 to 55 years of age (n=339), over 55 years (n=333), high school diploma or less (n=398), some college (n=269), and bachelor's degree or higher (n=309).



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