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Building on what is already working: Describing a more nuanced understanding of rebated EV consumer groups

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Executive Summary

To reach ambitious 100% EV market share goals by 2035, the California EV market must rapidly expand its frontiers and build on what is already working to accelerate EV adoption. The Clean Vehicle Rebate Project incentivizes just under half of those purchasing or leasing new EVs in California, and data collected through the program's administration present an opportunity to identify and characterize not just potential but actual EV consumer groups using survey and application data. A more detailed look at subsets of participants can provide inputs to more nuanced outreach and education strategies aimed at increasing EV acquisition among similar consumers.

Keywords: consumers, electric vehicle (EV), market development, policy, marketing

1 Introduction

Though the electric vehicle (EV) portion of new car market has grown rapidly in recent years – nearing 20% market share in California during 2022 [1] – there is still a long road left to travel to 100% electric new car sales. Achieving a 100% EV market share will require expanding the EV market to parts that have not yet been reached and growing participation among those who have already begun transitioning to electric drive.

During its 12-year project life, the California Air Resources Board's Clean Vehicle Rebate Project (CVRP) has incentivized more than 500,000 new EV purchases or leases with a $500 to $7,500 cash rebate. Participants range from EV-enthusiast early adopters to EV sceptics who require an incentive to motivate or enable acquisition. Information about participant characteristics, motivations, and purchase processes provides the opportunity for a nuanced understanding of existing EV drivers. That understanding presents opportunities for more specific and resonant outreach strategies aimed at encouraging additional participation from consumers who have not yet entered the EV market.

This paper begins by updating the picture of the typical CVRP participant with the latest available CVRP Consumer Survey data. It then details six consumer groups identified from those participants using statistical clustering methods. Outreach opportunities are then explored based on the characteristics, motivations, and information environment of each group with the intention of providing a jumping-off point for EV stakeholders to reach similar audiences.

2 Methods

The analysis was done in three phases, as shown in Figure 1. First, the data were cleaned, weighted, and enhanced to add additional detail to the survey responses. Then, latent class analysis was used to cluster like consumers. Finally, additional descriptive statistics were calculated to add context and additional depth to the findings.

Figure 1. Analytical flow diagram

2.1 Data

The 2017–2020 edition of the CVRP Consumer Survey, which covers vehicles purchased or leased between June 2017 and November 2020, was used for the analysis. Individual (non-fleet) CVRP participants who purchased a plug-in hybrid (PHEV), battery-electric (BEV), or fuel-cell electric (FCEV) vehicle were invited to participate in the survey at the time their application was approved. A reminder invitation was also sent when their rebate check was placed in the mail. Select CVRP application data was added to survey records to provide additional information for analysis. The survey data and associated application data are summarized in Table 1.

Table 1: Data Description

Summary of CVRP Application and Consumer Survey Data	
Purchase/Lease Dates	1 June 2017 – 30 November 2020
Total Program Participants	198,922
PHEV	57,162
BEV	136,005 (*Tesla: 92,142; Non-Tesla BEV: 43,863)*
FCEV	5,755
Survey Response Dates	1 August 2017 – 24 March 2021
Total Responses (unweighted)	33,524
PHEV	9,599
BEV	22,925 (*Tesla: 14,597; Non-Tesla BEV: 8,328)*
FCEV	1,000
Weighting Method	Iterative Proportional Fitting (a.k.a. raking)
Representative Dimensions	Vehicle technology type (PHEV vs. BEV), model, purchase vs. lease, residence county, purchase year
Program as a % of the EV Market	43% (with FCEV, 42% without FCEV)

Although the CVRP incentivizes FCEVs, differences in vehicle availability, fuelling, and use considerations suggested analyzing them separately from plug-in EVs. The survey data were therefore filtered to remove FCEV participants from the analysis. Additional responses were removed if the respondent indicated they were less than 21 years old or if they did not respond to questions about whether they would have purchased their vehicle without the rebate, their initial interest in an EV, or the rated importance of the federal tax credit for EVs in making it possible to acquire an EV.

To increase confidence in the representativeness of the survey data relative to program participants, non-response weights were created using iterative proportional fitting (or "raking") along the dimensions: vehicle technology type (i.e., BEV vs. PHEV), vehicle model, whether the vehicle was purchased or leased, the applicant's residence county, and the year the vehicle was purchased. These non-response weights are used in descriptive statistics, where appropriate.

2.1.1 Data Preparation

Several data preparation steps were performed to enhance the information available for analysis or retain as much information as possible while transforming it into a form usable in the subsequent analyses. Tesla's large EV market share, direct sales model, and differences in vehicle capabilities and marketing during the time period covered by this analysis suggest analyzing Tesla buyers separately.

Survey questions with text write-in responses for the option "Other, please specify" were then transcoded based on matching the response to the closest existing categories for the question. This methodology was done for the questions: "What type of residence do you live in?" and "Do you have solar panels that produce electricity at your residence?"

Additionally, the question "How do you prefer to describe your racial/ethnic identity?" which invites participants to check all that apply, was recoded into a categorical data type. Those who selected multiple options were grouped as a new "Multiple selections" value.

Household income was recategorized to equal $50,000 increments up to "$500,000 or more."

2.2 Descriptive Summary

The data were summarized descriptively to provide 1) an updated characterization of the program as a whole and its "average" participant" and 2) a point of comparison for the classes identified in the latent class analysis. In addition to variables used in the latent class analysis, several variables of practical interest were described. Weighted data were used to increase confidence in the representativeness of the data relative to the program population.

2.3 Latent Class Analysis

A latent class analysis was performed to classify groups of like consumers within the CVRP. The latent class analysis was processed on demographic and household characteristics, which include the following: household size, the number of licensed drivers in the household, respondent age, highest education achieved by a member of the household, respondent gender, household income, whether the respondent owns or rents their home, residence type, if solar was installed at the residence, and the respondent's racial/ethnic identity.

The number of classes was determined by balancing the following metrics: the total number of cases in each class, the relative percentage of cases in each class, Bayesian information criterion (BIC), entropy, and average latent class posterior probability [2]. After exploring potential latent class sizes of sizes three to eighteen, the resulting groups were portioned into six like-consumers. The six classes are shown in Table 2.

Table 2: Percent of respondents by LCA-derived class

Class	Description	%
1	Single-person households with lower incomes	11%
2	Older, white, environmentally motivated couples	23%
3	High-income, white families	18%
4	Smaller, more diverse households	23%
5	Young renters	12%
6	Larger, more diverse households	14%

3 Findings

General participant statistics were calculated to provide perspective about the typical CVRP participant for comparison to the classes identified in the LCA. The average CVRP participant is:

- male (72%),
- identifies as solely white or Caucasian (52%),
- age 30 to 69 years old (82%),
- a homeowner (82%),
- of a detached house (77%),
- without solar (72%),
- who lives in a two-to-four-person household (80%),
- with two drivers (63%),
- and two to three cars (71%),
- with a household income ranging from $75,000 to $175,000 (52%),
- and includes a member with at least a bachelor's degree (83%).

The average participant was further characterized by examining their responses regarding influential information sources to acquire the rebated vehicle, concerns about shopping for an EV, awareness of EV incentives, ease of finding information online and motivations for acquiring an EV.

Respondents were asked to "please rank the top three most influential information sources when you were deciding whether to acquire a plug-in electric vehicle (PEV)." To determine the most influential sources by both the number of selections and the positioning within the top three selections, the responses were summarized using modified Borda counts (i.e., the top-ranked reason was assigned a score of 3, the second-ranked a score of 2, and third-ranked a score of 1, scores were summed then rank ordered) [4]. Overall, the top three selections of most influential information sources were experience-based: another plug-in electric vehicle driver, vehicle test drives, and third-party vehicle review or car buying sites. Rounding out the top five were manufacturer website information and news stories. Ranked 6-12 were: online discussion forums, social media, dealer/salesperson, other [or not listed sources], electric utility, my employer, and non-profit organizations.

Respondents were also asked, "Regardless of what you think now, when you were shopping for your [rebated vehicle], please rank the top three perceptions about [all-battery electric or plug-in hybrid electric vehicles, corresponding to rebated vehicle type] that gave you concern about choosing one (1 being your greatest concern)." The three biggest concerns, again as determined by modified Borda counts "vehicle range on a single charge is too limited," "vehicle price is too expensive," and "too few opportunities for charging away from home." Respondents also indicated vehicle recharging times being too long was another common concern about EVs (the fourth-ranked), reinforcing the range anxiety and charging-related concerns. Concerns about battery life and replacement costs were the fifth-ranked concern.

Consumers had lower-ranked concerns about the technology being too new or still developing (sixth), the variety of vehicle models and body styles being too limited or unappealing (seventh), the cost of electricity for charging at home being too high (eighth), charging at home being too difficult or charging equipment being too expensive (ninth), other [unlisted] concerns (10th), or vehicle safety record being too short (last ranked).

To understand the impact of various avenues for marketing the availability of EV incentives, respondents were asked whether they had heard about CVRP from a variety of sources. The most selected sources were "from a dealer or retail store representative" or via "word of mouth (e.g., friend, relative, co-worker, accountant)." Via internet search engine was the third most common source, followed by auto manufacturer websites (fourth), and the CVRP rebate website (fifth). Online blogs and forums were the sixth most common source of CVRP information, followed by electric utility websites and news stories. California's DriveClean.ca.gov was the ninth most common source, followed by the Plug-in Electric Vehicle Resource Center, Other [not listed sources], CVRP outreach, and Ride & Drive events and vehicle expos.

Relatedly, respondents were asked to describe how easy or difficult it was to find EV-related information online. Information about electricity rates and metering options was the most difficult thing for participants to find online. The easiest topic to research online was the comparison of PEV model features and costs.

Figure 2 shows the gap in ease of finding information about electricity rates and metering options, and all other topics.

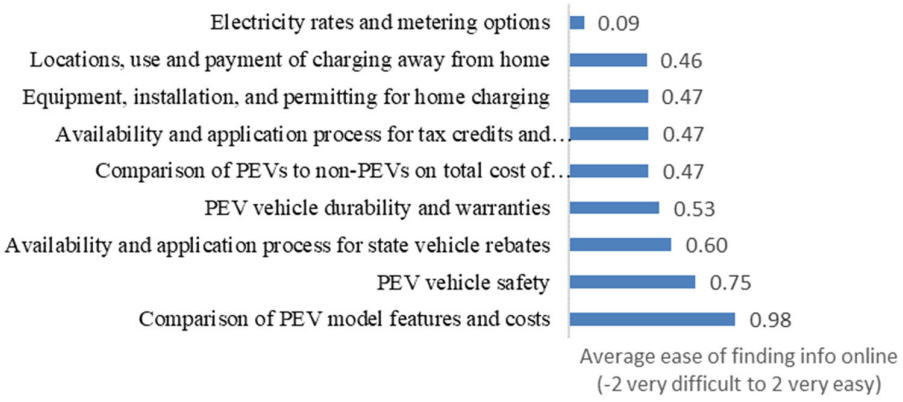

Figure 2: Average ease of finding information online

When asked about the importance of various motivations for acquiring an EV, participants reported high levels of importance for all factors presented. The highest-ranked factors were reducing environmental impact, saving money overall, and vehicle performance. When asked to identify the most important factor in their decision to acquire an EV, 32% indicated reducing environmental impact was the most important motivation for acquisition. Practical and convenience-related considerations comprise the next three most selected reasons: 23% say saving money on fuel costs, 16% say saving money overall, and 10% say access to HOV lanes. Despite the relatively large number of respondents selecting access to HOV and carpool lanes as the most important factor in their decision to acquire an EV, it had the lowest average relative importance out of the reasons presented. This suggests that for those participants with access to HOV or carpool lanes, it is an extremely important factor, but for those who live in areas without HOV or carpool lanes, it is not.

Respondents were also asked, “do you charge your plug-in electric vehicle at home?” The majority of respondents reported having access to charging outlets or Level 1 and 2 charging stations (86%), whereas only 14% had no access to home charging. Forty-four percent of respondents had access to charging at work, either for free or for a fee.

Slightly fewer than half of the respondents reported they were *Rebate Essential* or would not have purchased their vehicle without the CVRP incentive [5]–[7].

Characterization of each of the six classes identified in the LCA is reported below. Each class is summarized in detail and compared to the typical CVRP consumer.

3.1 Class 1: Single-person households with lower incomes

Class 1 has 11% of overall survey respondents. This class consists of the following:

- the highest percentage of female members of any class (41%)
- members more often identify as white (63%), East Asian (12%), South Asian (5%) and Black or African American (4%), and less often as Native American or Alaska Native.
- lower income (58% with household income less than $100,000)
- more renters (35%)
- a higher percentage of apartment/condo (36%) and attached house (14%) dwellers
- single-person households (93%), with one driver (100%), and one car (73%)

Class 1 had the second-highest percentage of PHEV rebates (32%). Though a low rate overall, they also have among the highest percentage of first-time car buyers (5%), and the second-highest percentage of first-time EV buyers (86%). Class 1 has the second-highest percentage of members who do not have access to charging at home (26%). Seventy-four percent of this class have access to charge their vehicle at home

or the workplace. Of those who charge at home or workplace, a higher percentage of this class use a standard 120V household outlet (36%), or Level 1 or Level 2 charging stations (37%).

Class 1 had relatively low levels of *Rebate Essentiality* among members: 47% said they would not have purchased their vehicle without the rebate.

In contrast to participants overall, members of Class 1 valued information from third-party vehicle review sites slightly more highly than vehicle test drives. Though the top concerns about EVs were similar to general EV adopters, Class 1 was more concerned about charging at home being too difficult and home charging equipment being too expensive (sixth-ranked concern) than the average respondent (ninth-ranked concern). Class 1 had a significantly (H = 10.73, p < 0.01) more difficult time finding online information about equipment, installation, and permitting for home charging. They also had a more difficult time finding information about the availability and application process for state rebates (H = 4.80, p = 0.03) and tax credits (H = 5.47, p = 0.02), but an easier time finding information about PEV vehicle safety (H = 9.83, p < 0.01).

3.2 Class 2: Older, white, environmentally motivated couples

Class 2 has the highest percentage of survey respondents: 23%. Relative to the typical consumer, consumers in this class tend to be:

- almost entirely white identifying (97%),
- older (70% older than 60 years old),
- higher income (57% have a household income greater than or equal to $125,000)
- detached house dwelling (89%),
- homeowners (97%),
- who more often have solar (40%),
- in two-person households (99%), with two drivers (97%), and own two cars (60%).

This class is replacing vehicles (91%), rather than adding them to their household fleet, more frequently than typical (84% replacement). A higher percentage of this class than typical is charging at home using installed Level 2 charging stations (33% vs. 23% for all respondents). This class has a higher percentage of residents outside the Los Angeles area (63%) than would be expected based on all respondents, and more people aren't commuting to a workplace (49%).

Class 2 found it more difficult to find information about the following: comparing the total cost of ownership between EVs and non-EVs (H = 11.35, p < 0.01), about locations, use, and payment for charging away from home (H = 7.41, p = 0.01), and availability and application process for the state rebate (H = 12.53, p < 0.01). However, they had an easier time than other consumers finding information about home charging equipment (H = 97.66, p < 0.01), electricity rates and metering options (H = 23.45, p < 0.01), and vehicle durability and warranties (H = 38.71, p < 0.01). This is a high-EV proclivity group: 65% of the class was only interested in an EV when they started looking for a new car, as compared to 57% of respondents overall.

Motivationally, this group is more motivated by the societal and environmental benefits of EV adoption than typical respondents (environmental impacts extremely important: 60%, energy independence extremely important: 37%), and generally places a lower value on practical benefits of EV ownership and incentives such as a carpool/HOV lane access.

It follows logically that this group has lower levels of both *Rebate Essentiality* (37%) and *Increased Rebate Essentiality* (48%) than typical, and a higher percentage of respondents would have purchased their exact vehicle had the rebate not been available (49%), as opposed to purchasing a different vehicle or not making a purchase. A higher percentage of this group received standard (i.e., not low-to-moderate increased rebates) rebates (96%) than average.

3.3 Class 3: High-income white families

Class 3 has 18% of overall survey respondents. This class has:

- a higher percentage of members who identify as white or Caucasian (94%),

- are more often age 40 to 59 (64%),
- be higher income (60% have a household income of over $150,000),
- own their residence (92%),
- have households with three to seven people (100%), two to five drivers (99%), and three or more cars (54%).

Class 3 had the highest percentage of non-Tesla BEV rebates (27%). This group is more interested in saving money on fuel (72% said it was a very or extremely important motivation) and saving money overall (60%) compared to all the other segments. This group is less interested in the importance of charging (61%) relative to the typical consumer (64%), which may be associated with applicants in this class having higher accessibility to charging in their home or workplace (94%). Furthermore, this group is relatively less interested in the importance of their vehicle's performance and styling (68% and 62%, respectively). Additionally, this group has the lowest importance of desire for the newest technology (47%). Class 3 had among the lowest rates of *Rebate Essentiality*: 47% said they would not have purchased their vehicle without the rebate.

Class 3 had more difficulty finding information about electricity rates and metering options than other participants ($H = 18.84$, $p < 0.01$). They had an easier time finding comparisons of EV model features and costs ($H = 19.33$, $p < 0.01$), locations, uses, and payment for charging away from home ($H = 7.13$, $p = 0.01$), vehicle safety ($H = 10.39$, $p < 0.01$), and PEV vehicle durability and warranties ($H = 11.75$, $p < 0.01$).

3.4 Class 4: Small, more diverse households

Class 4 has among the highest percentage of survey respondents: 23%. This class has:

- the highest percentage of East Asian (40%) and South Asian (23%) identifying respondents. Fifteen percent identify as Latino(a) or Hispanic, 6% as a not listed race or ethnicity, 4% as Black or African American, 3% as Middle Eastern, 3% as Native Hawaiian or other Pacific Islander, 0.3% as Native American or Alaska Native, and 6% as multiple races or ethnicities. No respondents in this class identify as solely white or Caucasian.
- tend to be higher income (61% making more than $125,000),
- almost entirely homeowners (99%),
- living in detached houses (86%),
- with smaller household sizes (92% between two to four people), with two drivers (97%), and two cars (60%)

This class had the highest percentage of Tesla rebates (53%). This group is relatively more interested in saving money on fuel (79% said it was a very or extremely important motivation) and saving money overall in comparison to all the other segments (72%). The majority of this group is highly influenced by access to HOV or carpool lanes (56%). Class 4 had a higher percentage of *Rebate Essential* participants than average: 56% said they would not have purchased their vehicle without the rebate. Compared to 14% of Class 2, only 9% do not charge at home.

Class 4 had a more difficult time finding information comparing EV model features and costs ($H = 11.42$, $p < 0.01$), vehicle safety ($H = 79.19$, $p < 0.01$), and vehicle durability and warranties ($H = 83.99$, $p < 0.01$). They had an easier time finding information about electricity rates and metering options ($H = 5.22$, $p = 0.02$) and the application process for tax credits and other incentives ($H = 11.3$, $p = 0.01$).

3.5 Class 5: Young renters

Class 5 has 12% of survey respondents and primarily comprised of:

- members are between 21 and 39 years old (66%), making this group the youngest of the classes,
- with lower household income (55% earning less than $125,000),
- but higher education levels (80% have at least a bachelor’s degree),
- are mostly renters (90%),

- of multi-unit dwellings such as apartments or condos (60%),
- without solar (99%),
- in two-person households (55%), with two drivers (84%), and one to two cars (85%).

This group has the highest percentage of applicants who leased their vehicle (37%), the highest percentage of PHEVs (35%), the lowest percentage of Tesla rebates (43%) and the highest percentage of increased rebates (16%) compared to all other classes. Compared to all other segments, this group has the highest percentage of members who do not have access to charging at home (41%). Though a low percentage, Class 5 has among the highest percentage of first-time car buyers (7%), and the highest percentage of first-time EV buyers (77%).

This group is relatively more interested in saving money on fuel (80% said it was a very or extremely important motivation) and saving money overall (72%) in comparison to all the other segments. This group is also relatively more influenced by access to HOV or carpool lanes (51%). On average, Class 5 was more *Rebate Essential* than typical participants: 56% said they would not have purchased their vehicle without the rebate.

Class 5 had a more difficult time finding information about home charging equipment ($H = 94.35$, $p < 0.01$), electricity rates and metering options ($H = 35.94$, $p < 0.01$), and availability and application process for tax credits ($H = 5.73$, $p = 0.02$). They had an easier time than other participants finding information about location, use and charging away from home ($H = 13.32$, $p < 0.01$), and vehicle safety ($H = 30.46$, $p < 0.01$).

3.6 Class 6: Large, more diverse households

Class 6 has 14% of overall survey respondents and has:

- the highest percentage of respondents who identify as Latino(a) or Hispanic (19%). Thirty-seven percent identify as East Asian, 22% as South Asian, 7% as a not-listed race or ethnicity, 4% as Native Hawaiian or other Pacific Islander, 3% as Black or African American, 3% as Middle Eastern, 0.3% as white or Caucasian, 0.2% as Native American or Alaska Native, and 4% as multiple races or ethnicities.
- respondents have a more even age distribution than participants as a whole,
- mostly homeowners (88%) living in detached houses (90%),
- with at least three members (100%), at least two drivers (100%), and more than three cars (81%).

Class 6 had the second-highest percentage of Tesla rebates (52%) and the lowest percentage of non-Tesla BEV rebates (17%). This group is most interested in saving money on fuel (84% said it was a very or extremely important motivation) and saving money overall in comparison to all the other segments (79%). The majority of this group charges their rebated vehicle at home (89%). This group is also most influenced by access to HOV lanes (58%), which may be partly due to their large household size (100% said they have at least three members) and a necessity for more driving. Class 6 reported higher-than-average *Rebate Essentiality*, 57% said they would not have purchased their vehicle without the rebate.

Class 6 had a more difficult time than other participants finding information about vehicle safety ($H = 6.93$, $p = 0.01$) and vehicle durability and warranties ($H = 3.99$, $p = 0.05$). They had an easier time finding information comparing EVs to non-EVs on the total cost of ownership ($H = 35.80$, $p < 0.01$) and electricity rates and metering options ($H = 9.52$, $p < 0.01$).

4 Discussion

The latest data provides a profile of the average CVRP-participating EV buyer and suggests some education and outreach strategies that are broadly applicable for prospective EV buyers with similar profiles as current EV drivers. They tend to identify as male, most commonly between the ages of 40 and 59. A slight majority of respondents identify as white or Caucasian, while 17% identify as East Asian, 10% as South Asian, and 8% as Latino(a) or Hispanic. CVRP participants tend to be homeowners of detached houses without solar. Households are most commonly two-person, though 41% have three to four people, with two drivers and at least two cars.

The most influential information sources for CVRP participants tend to be experience-based and high-bandwidth: learning from the experiences of other EV drivers, personal test drives, and trusted third-party reviewers. EV stakeholders could consider building or partnering with groups with information channels that rely on personal or trusted advisor experiences as a source for conveying information about EVs. Connecting prospective EV buyers with more experienced EV drivers may provide a high-impact if a low-bandwidth, way to encourage potential buyers to choose an EV. Higher-bandwidth avenues may include working with car reviewers and similar public personalities to share accurate and useful information about supportive policies.

Car shoppers who go on to acquire an EV are most concerned about battery and range-related limitations of EVs and EV-specific costs: specifically, vehicle range, charging times and availability; battery reliability and maintenance costs; and overall vehicle costs. Range and charging-related anxiety remain a prevalent obstacle for EV drivers who managed to overcome that anxiety, so increased stakeholder attention on addressing gaps in infrastructure and, crucially, communicating about how those barriers may not be as tall as they are perceived to be may help bring high-EV-proclivity new car buyers over to EV acquisition in greater numbers. Similarly, EV stakeholders may find value in publicizing findings about EV maintenance costs relative to internal combustion engine maintenance costs, such as those published by Consumer Reports [8], Argonne National Lab [9], and other stakeholders.

While there are rich online information sources for finding and comparing EV features and policies, most participants had more difficulty finding information about electricity rates and metering options and information about charging costs and federal incentives. CVRP participants were most motivated by reducing environmental impacts, followed by practical reasons such as saving money on fuel and saving money overall, along with access to HOV or carpool lanes.

In general, an EV stakeholder seeking to amplify market support could start with the overall profile as a map of where they might concentrate their efforts to maximize participation among groups that have already begun acquiring EVs at modestly high rates. Those intending to support more specific groups of consumers can look for opportunities in the LCA-derived classes for opportunities to pair targeted outreach and education with resonant messaging.

Class 1 indicates that lower-income single-person households may be more reachable through third-party review sites than their peers. Higher rates of home renting and multi-unit home dwelling among this group, more concern about factors related to charging at home, and more difficulty finding information about charging at home online suggests this group might be particularly in need of targeted messaging about installing (or facilitating installation of) home charging, metering options, and supportive incentives. This group also indicated they had a more difficult time finding out about state and federal incentives. Combined with their higher rates of living in low-income or disadvantaged communities, EV stakeholders supporting participation in incentive programs may be particularly interested in reaching out to this group to help them understand the EV incentive landscape. A high percentage of Class 1 participants are first-time EV buyers (86%), which suggests including messaging that focuses on overcoming uncertainty in outreach materials may be valuable.

Class 2 is comprised of older, white, environmentally motivated couples with higher income levels living in detached homes that they own. They tend to live in two-person, two-driver households with two cars. Encouraging further expansion of this part of the EV market could be encouraged by providing more easily accessible information about comparing the total cost of ownership between EVs and non-EVs, information about away-from-home charging, and about applying for incentives. The high levels EV interest in this group suggests a small amount of encouragement or support could go a long way in expanding EV acquisition in this group. That said, this group is among the least influenced by EV incentives and may not be as cost-effective in terms of enabling purchases with consumer rebates or other financial incentives. Class 2 participants more commonly have solar installed at home (40%) than other classes. Additional information about the co-benefits of charging and solar for fuel cost savings and environmental impacts can be emphasized when reaching out to these groups.

Class 3, high-income white families, is less motivated by saving money than other classes but still has a high percentage indicating saving money is a very or extremely important factor in their decision to acquire an EV. Class 3 consumers are predominantly detached house (95%) homeowners (92%), and, like Class 1, Class

3 members had a more difficult time finding information about electricity rates than participants in general. Class 3, along with other majority detached-house homeowner classes, may be more receptive to outreach with specifics on utility incentives and home charging benefits.

Class 4, smaller and more diverse households, had more trouble finding information about EV model features and costs, vehicle safety, durability and warranties than other groups. This may reflect a high priority being placed on acquiring safe, reliable transportation, and there may be opportunities to focus outreach on those aspects of EV acquisition. Class 4 is more motivated by practical considerations such as money savings and access to carpool and HOV lanes than typical consumers.

Class 5, young renters, had the highest rates of home renting (90%) and multi-unit home dwelling (60%) of any class and also had the most difficulty finding information online about charging at home and electricity rates and metering options. The uncertainty of in-home charging is also reflected in the relatively high rates of vehicle leasing and PHEV acquisition relative to other groups. Class 5 is also relatively more motivated by saving money, though they have less access to complementary technologies such as home solar energy generation. Contrasted with classes with high home ownership rates, Class 5 may benefit most from outreach based on spreading awareness of nearby public charging stations, along with an emphasis of charging speeds via DC fast chargers, as renters tend to have the greatest barriers to charging at home.

Class 6, larger and more diverse households, is highly motivated by practical considerations such as cost savings and access to HOV lanes. They can be supported by providing easier access to information about vehicle safety and durability, and warranties. Larger households, like many of the households in Class 6, may be particularly interested in information about newer EV models as manufacturers continue expanding their electric vehicle models with larger-sized crossovers and SUVs.

In general, many of the characteristics and resonant messaging for EV adopters will apply to each of the individual classes described in this paper. For example, the importance of saving money and reducing environmental impact was high. However, a more nuanced understanding of consumer subsets suggests more tailored and intentional messaging and outreach focus is possible and that some information may be more useful than others to different groups.

5. What's next?

The work summarized in this paper represents the first part of an analysis of CVRP participants. In the second part of the analysis, each LCA-derived class will be statistically compared to a reference group to look for significant factors that differentiate the two groups. That analysis will supplement this descriptive comparison of the differences and similarities between classes by indicating where differences are statistically meaningful and suggesting areas for future inquiry.

This analysis of CVRP participants is also the first step in a Consumer Segmentation Roadmap (as described by Brett Williams in work done for the New York State Energy Research and Development Authority [10]) that points the way from enthusiastic early adopters to mainstream car buyers and beyond. While increasing the rate at which those with a high proclivity to acquire an EV will help speed the EV market toward the goal of 100% market share, EV stakeholders must also increase EV acquisition among parts of the market that have not yet begun acquiring EVs at high rates. To reach 100% market share, the EV marketplace will need to expand into new frontiers. Future work will seek to describe *Rebate Essential* participants in more detail to identify how best to bring more people highly influenced by supportive policies into the new EV market. A stop after *Rebate Essential* consumers will be *EV Converts* or those who had little to no interest in an EV when they started their new car search but decided to acquire an EV somewhere along the way. As the market moves along the diffusion of innovation curve from early adopters to the mainstream market, more sceptical consumers will need to be convinced to convert from gas-powered vehicles to EVs.

Additionally, addressing the new car market alone will not be enough to solve the problem of carbon in the U.S. transportation system. EV stakeholders must also take an equitable approach to bring clean transportation options such as EVs to groups historically excluded from new car markets or lacking the financial resources to purchase a new car, let alone pay the price premium for an EV. Future work will seek to examine characteristics, motivations, and resonant messaging for those groups.

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