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Engendering the Future of Electric Vehicles: Conversations with Men and Women

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ABSTRACT
This research examines early drivers of plug-in electric vehicles (PEVs) from a gendered perspective. Women and men may have differing responses to the new performance attributes of PEVs, for example, the relationship between driving range per battery charge and charging locations. Without knowledge of such potential differences, PEV sales and charging infrastructure deployment may create differential barriers and opportunities for women and men. Thus, understanding any gender differences is vital to policy, marketing, and infrastructure development for electric-mobility to ensure that sustainable mobility is appealing and accessible to all people. Clarifying gender differences in the experience of PEV drivers would also broaden the understanding of the persistence of gender roles in travel behavior. We pose two primary questions. (*1*) How does the speech of women and men PEV drivers compare? (*2*) What factors contribute to observed differences and similarities? Data are from two sets of focus groups conducted in 2011 and 2012 as PEVs entered the market in California. A content analysis of the themes in these group conversations reveals that while women and men talk about their experience in many ways that are similar, there are important differences. Within some themes, women are more likely to talk about their PEV in terms of its practicality as a travel tool and adapting to the present system of vehicle charging. Conversely, within these same themes men are more likely to talk in terms of research and development and how the system should change. The voices of women PEV drivers are underrepresented in conversations regarding future policy, marketing, and technology development both because there are so many fewer women PEV drivers and because the content of women and men's speech differ.

INTRODUCTION

This research seeks to understand whether differences in plug-in electric vehicle (PEV) purchase and use exist between men and women. Before posing our research questions, we first review gender in mobility studies and PEVs as motivation for exploring their possible nexus.

Plug-in Electric Vehicles

The category of PEVs contains both plug-in hybrid electric vehicles (PHEVs) and electric vehicles (EVs). PHEVs have both an electric motor and an internal combustion engine integrated such that it is fueled by either or both electricity from the grid or a liquid fuel such as gasoline or diesel. In contrast, EVs are powered solely by electricity.

Substituting electricity for liquid fuels has several goals including reducing emissions of pollutants and greenhouse gases (*1, 2*) while lowering cost, improving reliability, and enhancing the integration of renewable sources of electricity (*3, 4*). In response to policy, activist, and automobile manufacturer initiatives around the world, markets for PEVs have begun to reemerge. Of interest here, one vehicle manufacturer leased pre-production EVs to households in southern California in 2009-10 and a few started sales and leases of production PEVs in the US in late-2011.

PEV Charging Infrastructure

PEVs are able to charge at multiple rates. The slowest rate Level 1 charging is 1.1kW from 120V electrical outlets. Level 1 charging can restore about 3 to 5 miles driving

range per hour of charging. Faster charging requires more specialized electric vehicle supply equipment (EVSE). Most, but far from all, home charging is at a faster Level 2 supplied through an EVSE at up to 6.6kW. Level 2 charging can restore 10 to 20 miles per hour of charging. Away-from-home PEV charging stations are either Level 2 chargers or high voltage, direct-current (DC) fast charging stations up to 50kW. A DC fast charger can add between 60 and 80 miles of range to a PEV in approximately 20 to 30 minutes. While the PEV drivers we discuss here leased or purchased their PEVs with an expectation of coming DC fast chargers, none were in service at the time of this research.

One peculiarity shapes the conversations about away-from-home charging by our samples of PEV drivers. In California, electricity can't be bought and resold. At present operators of public charging stations typically bill for connection time, regardless of how much electricity is transferred. These prices vary by the charging provider. Though no DC quick charging existed in the study regions at the time of this research, it was imagined by respondents to be more expensive than Level 2.

Conceptualizing Gender

We use two analytical conceptualizations of gender. First, gender represents the socially agreed upon biological criteria that allow for bodies to be placed into a sex category, male or female. This conceptualization enables us to identify and analyze values and norms associated with men and women. If such gendered ideals are distinguished they can be understood not as an inherent characteristic of biological sex but as a normative behavior that is socially identified with a particular sex category. This approach permits an analysis of gender and mobility as we identify where and how men and women adhere to or deviate from the hegemonic conceptions of what is appropriate conduct for each sex category. That is, gender represents the learned behaviors associated with masculinity and femininity. Second and consequently, we also understand gender as a messy, ever-changing social construct that does not map clearly onto a biologically defined sex-binary.

Hanson (*5*) identify two strands of thinking about the question of gender and mobility. The first focuses on the ways in which mobility shapes gender ideologies, meanings, and practices. She explains that research in this strand sees mobility (and immobility) as deeply embedded in traditional gender ideologies:

> "…equate women and femininity with the home, the private, with domestic spaces and restricted movement (which translates into interactions that are routine, quotidian, familiar), and on the other, equate men and masculinity with the not-home, the public, with urban spaces and expansive movement (which translates into interactions that bring excitement, challenges, new experiences, encounters with the unknown)." (*5*)

Research in this strand defines gender not as a static entity but as a process of behaving in ways that adhere to the hegemonic conceptions of what is appropriate conduct for each sex category. That is, gender represents the learned behaviors associated with masculinity and femininity. Increased mobility among women is construed as a challenge to these traditional gender ideologies (*6*). Recent work examines how gender

norms and roles impact gender equality in transport policy and public agencies (*7,8*) and participation in public forums (*9*).

The second strand (*5*) identifies asks how gender shapes mobility. Work in this strand provides a breadth of evidence for the differences between male and female drivers (*10,11*). Many studies describe gender differences in travel behaviors: commute choices and trip chaining (*12,13*); automobile choice (*14*); and safe driving practices (*15*, *16, 17*). These studies show that women are more likely to work at home or close to home and consequently drive shorter distances to work compared to men. Women, in general, report higher percentages of total distance traveled per day devoted to non-work activities when compared with men; transporting passengers and running errands (*18*). Other evidence concludes women use the car less often, drive fewer miles, and engage in trip-chaining more frequently (*8, 18, 19*). It seems that despite changing socio-cultural factors in the home and the paid labor market, gendered differences in daily travel—and daily automobile travel—persist between men and women.

Gender and PEVs?

Pre-market experience and early PEV sales in the US suggest gender is playing a role. Of the people who leased a pre-production electric version of BMW's MINI in California, 14% were women. Descriptions of the early buyers (and lessees) of PEVs in California indicate that so far women have purchased or leased only 29% of Nissan Leafs, 24% of Chevrolet Volts, and 16% of Tesla's Model S. In contrast, women make or are involved in over half of all new and used vehicle purchase decisions in the US. Even if it turns out the relative paucity of women participating in the market for PEVs is short-lived, decisions are being made now about the design of future PEVs, PEV charging devices, and networks of such devices. Given the differences in daily automobile travel between women and men, and given that the vehicle and infrastructure designs are emerging from technical fields still dominated by men (*20*), the risk only increases that gendered differences will be "hard-wired" into PEVs and their supporting infrastructures if the initial feedback from users is also disproportionately male. Whether this is true depends not only on the proportion of women and men, but on whether the experiences of women and men with PEVs differ. The literature on gender and PEVs has used gender as a categorical independent variable to describe the research sample when explaining consumer choice, driving behaviors, and perceptions of electric vehicles. Though this research differentiates between male and female participants, gender differences are rarely discussed in detail. An exception is (*21*), who explores gender differences in concerns about EVs, EV safety, and belief in the sustainability of EVs. Our research lays a foundation for moving beyond the use of gender as an explanatory variable by drawing on both strands of gender and mobility research described by (*21*) to examine PEV purchase and use as behavior that may be experienced, and thus talked about, similarly or differently by men and women. Listening to PEV drivers talk about their vehicles, we can hear about the contextual conditions and gendered norms shaping (and being shaped by) the PEV experience. This approach supplements broad empirical data on gender differences in PEV drivers with information rich, detailed data. The following research questions guide our discussion of the role to date of women and men in the nascent markets for plug-in electric vehicles (PEVs).

1. How are women's locations in the PEV market and experience of PEVs' associated socio-technical systems different from men's?
2. Will user practices associated with femininity be overlooked in this electric vehicle market – from vehicle design to purchase and use of vehicles?
3. What do these mean for consumption and mobility practices pertaining to PEVs, and thus the private and social goals behind PEVs?

METHODS

Sampling

Data from two studies of PEV drivers in California are analyzed. In June 2011, two focus groups were conducted in Los Angeles (LA), California. The LA focus groups were convened in one of the regional markets in which a PEV underwent pre-market testing. LA Group 1 had eight participants; three women and five men. LA Group 2 had seven participants; one woman and six men. All these people leased for one year an electric-version of BMW's MINI. 180 of these "MINI Es" were leased to households in southern California. Because of the high monthly lease payment, the requirements by the vehicle manufacturer that the EV not be the only vehicle in the household and that there be a place at home where the EV could be regularly recharged, these EV drivers tended to be high-income homeowners.

In November 2012, four focus groups were conducted in San Diego (SD), California among buyers and lessees of commercially marketed PEVs. For the four SD focus groups researchers created differences between pairs of groups. SD Groups 1 and 2 were differentiated by gender. SD Group 1 consisted of eight women and SD Group 2, ten men. SD Group 3 and 4 were differentiated by technological interest and savvy: the less savvy SD Group 3 included two women and four men, while the more savvy SD Group 4 was comprised of two women and seven men.

Nearly all of the SD participants drove Nissan Leafs (an EV); one drove a Chevrolet Volt (a PHEV) but their results were omitted so that all results pertain to experience with the same type of car. As with the LA population, the population from which households were sampled had to own their home and have a suitable parking and charging location for their PEV on their premises. Thus, distributions of age, education levels, and income skewed upward compared to both the general population and the population of new car buyers.

MINI E drivers charged almost solely at home and rarely at dealerships or elsewhere. Since their experience was "pre-commercial," they were given no further expectation there would be an increasing number of charging locations during their lease. The PEV buyers and lessees in San Diego also charged their PEV mostly at home, and rarely at a dealership. However, early market PEV drivers in San Diego had both the actuality of a growing number of Level 2 charging locations, i.e., shopping centers, parks, museums, workplaces, etc., and expectations of a network of DC fast chargers.

All of these drivers ranged from 33-77 years old, were a mix of employed and retired, and had annual household incomes ranging from $80,000 to more than $150,000 per year. We did not collect occupational data.

Data Collection and Analysis

All focus groups were guided by an outline of topics with possible prompts and follow-up questions. However, given the exploratory approach of both the Los Angeles and San Diego research projects, the groups were moderated in a semi-structured manner. The Los Angeles protocol differed from the San Diego protocol in that it included a discussion linking PEVs to renewable fuels for electricity. Otherwise, all groups tended to cover similar topics such as PEV charging, driving range, and batteries. The moderator for all LA and SD groups was the same man, the third author.

The discussions were recorded and transcribed. Transcriptions were read as statements that might be several sentences, a phrase within a longer sentence, or a single word of agreement or disagreement with a prior more extensive statement. A researcher identified themes in these statements in a comparative and cumulative reading of the transcripts. Recognizing that the discussion outline imposes some limits on content, themes were identified in a three-step coding process: (a) open coding on the first reading to locate themes and assign initial codes, (b) axial coding to review and examine initial codes, and (c) selective coding to look for examples to illustrate themes (*22*). Theme creation and the selection of quotes to define and exemplify themes were carried out before being coded for the speakers' gender (the initial transcripts distinguish but do not identify individual speakers). Two researchers then reviewed the thematically organized quotes repeating the three-step coding process to identify sub-themes by gender. These reviews were then compared to identify differences and similarities between male and female participants within themes and across themes.

Similarities and differences between statements by women and men are assessed by their content, not their frequency. As with the populations from which they were drawn, there were more men than women summed across all the groups. Normalizing counts of statements for that imbalance would not account for possible differences in style, e.g., whether speakers of one gender are more likely to make longer statements (thus leaving less time for different statements). Thus as a first level of analysis we note whether women or men said anything about a particular theme. The content of those statements are then compared and contrasted. Content analysis allows the researcher to compare content across texts by systematic recording procedures (*22*). We do not apply statistical analysis to the textual coding, instead we analyzed if the content existed or not. Practical statements are comments that concern using the vehicle in its current form and tend to have a present time element; typically it is how a driver adapts to the PEV. R&D statements concern ways to improve the vehicle, how a driver hopes it will change over time, or methods to understand the technology better; these tend to have an orientation to the future and focus on innovation. Although practicality and R&D tend to have a time element, it is not mandatory for placement into either category.

RESULTS: HOW DO THE EXPERIENCES OF WOMEN AND MEN COMPARE?

To frame the rest of the discussion, we first state this result: while much of what women and men had to say is similar in content, women were more likely to frame their PEV and their use of it in present-oriented practical terms while men were more likely to frame their PEV and their use of it in terms of a research project, whether a present, personal one or with an eye to future R&D by vehicle and EVSE providers. Women spoke of their

PEV as a tool to use in their normal, every day lives. Men elaborated on their explorations of what PEVs are, how they work, and how they would like PEVs to improve in range, decrease in price, and increase body style and size options in the future.

We start by reviewing the themes for which this generalization holds: charging the PEV, driving range, community, environment, and money. We then describe those themes for which the generalization appears not to hold in our data, that is, both women and men talk about these themes in terms of practicality or R&D: family, batteries, electricity. Finally, for two themes neither women nor men spoke in terms of practicality or R&D: safety and politics. Following the order in Table 1, we will detail differences and similarities between women and men. Some material will be distinguished by whether the speaker was from the earlier, pre-market experience of MINI E drivers in Los Angeles or from the early market experience of PEV drivers in San Diego.

TABLE 1 Definitions of Themes

Theme	Definition
Stronger practical/R&D distinction between women and men	
Charging	The act of plugging a car into a charger and the contexts in which that occurs, including all away-from-home charging and incipient DC fast chargers.
Driving range	How far a car can go on a charge, including desired range, taking a risk of running out of charge, planning, and remaining range instrumentation.
Community	Do PEV drivers form a community or not? Through what types of exchanges and media are those who see or want community attempting to construct it. This includes "outreach" to non-PEV drivers.
Environment	The physical environment and the effects people, their driving, and their PEV may have on it.
Money	The costs associated with a PEV: cost savings compared to gasoline, cost to charge at home or away-from-home, potential cost of DC fast charging, home charger as an investment, buying more range as a dealership option
Both women and men speak in terms of either or both practicality and R&D	
Family	How a family uses the PEV, running out of charge with children in the car, size of the PEV as it relates to the family
Batteries	The PEV battery itself (not the services, e.g., driving range, that it provides), loss of battery performance, cost to replace
Electricity	The sources of electricity to charge PEVs and the effects of PEVs on the grid Solar photovoltaics, utility companies, grid impacts
Neither women nor men speak in terms of practicality or R&D	
Safety	Personal safety a public charger, crash safety
Politics	Road taxes, Reducing dependence of foreign oil, subsidies, getting public chargers installed

Women and practicality: Men and R&D

Charging

Women and men shared many similarities in discussions of charging their PEV. Faced with the disappointing pace of the deployment of workplace, public and other away-from-home charging, PEV drivers in San Diego relied mostly, if not solely, on home charging. Public charging was important for some; whether the respondent used the cost of gasoline or electricity for charging at home as the basis for assessing the cost of public charging influenced who would use public charging. Few had access to a workplace charger and some had negative experiences charging at work: confiscated cords and policies disallowing charging due to perceived safety hazards or not wanting to provide a new benefit to select employees. Etiquette to guide behavior at any away-from-home charger was something they wanted: "With the electric cars…nobody really knows yet, so anything you do, it sounds like you're being rude, if you unplug somebody because they're done charging…it'd be nice if a group of electric car owners got together and made up a code of ethics and published it somewhere just so you could refer to it" (*23*).

Respondents in Los Angeles and San Diego spoke of planning their PEV charging as a part of their daily routines. All were able to use their PEV for daily driving but were unable to go on long trips due to the unavailability of DC fast chargers. This caused frustration for many Leaf drivers because at the time they bought or leased their PEV they were told public charging would be increasingly available.

The distinction between the practical implications of charging a PEV and the R&D of charging between women and men arose in how they talked about trips too long to make on a single charge and public charging. Women who drove a Leaf discussed their options within the present slow deployment of Level 2 charging. One woman Leaf driver said, "Stopping at a [a restaurant] for six hours to charge…you'd have to go eat for a long time or shop at a mall while your car charged." Most women judged this to be impractical and said they would take a gasoline car on long distance trips. In contrast, men discussed long distance trips in their PEV in terms of using (imagined future) DC fast chargers. These men talked less about whether DC fast chargers would extend their PEV driving, rather—almost as if their use of DC fast charging was assumed—focused on the potential price of the service, politics surrounding installation, and desirable locations. Women in the all-women group in San Diego did not mention DC fast chargers; in mixed gender groups women participated in conversations about DC fast chargers but did not initiate or add to the discussion.

Driving Range

Women and men, MINI E and Leaf drivers, discussed most of the same topics within the theme of driving range. They confirmed the real-world driving range of 70 to 90 miles of their PEV met most of their daily driving needs: "Really, 99% of my driving is within 20 or 30 miles so it's perfect for me." Others would like a slightly longer range so they could include more daily destinations. As with charging, a few participants explained that planning is an important aspect of driving a PEV: "If I'm going to make a trip…look it up on a map, find out how many miles it is, what's the terrain, figure out if there are going to be any side trips besides where I'm going and include that into what I know my range is on the Leaf…Otherwise, I don't make the trip."

Concern about being running out of charge short of home or another charger was mentioned as a concern primarily when they first got their MINI E or Leaf but only occasionally once they became comfortable with the range. Rather than being anxious, some were excited to take risks testing the range: "I purposely did some test drives to see how far it could go to make sure I could get back to the house to figure out what my comfort level is." Others, in anticipation of not being able to make an entire trip, have chosen to drive a gasoline car instead.

Differences between women and men centered around their response to the remaining range information provided by their car's instrumentation. Almost all the Leaf drivers—women and men—believed the information was unreliable; the difference was in their response to this perceived unreliable information. Many women refused to drive the PEV before charging it again if it had less than a threshold amount of range left, generally double or triple the amount needed for a trip. They were frustrated with the rapid fluctuation of the indicator. Many women thought the Leaf to be impractical if they couldn't travel the distance they desired¯which is assessed partly through the remaining range indicator. Men also distrusted the Leaf range indicator, however, they were more likely to continue to drive the PEV and were more comfortable taking trips without having double the range required. Their lack of confidence in the remaining range information was less likely to deter men from driving and in some instances challenged them to push on. Many men decided to conduct their own research and devised a calculation to produce their own estimated remaining range.

Community

Both women and men discussed the idea of a community of PEV drivers. One Leaf driver shared an experience of charging at a popular charging station: "It just seemed like that was the convention hall. If you plug it in, the next thing you know two more would show up and we're all sharing ideas." Many had conversations with other PEV and non-PEV drivers about their vehicle. Some Leaf drivers turned to online forums, blogs, and crowd-sourced databases to learn from other PEV drivers. For most, the amount of time they spent on these sites diminished the longer they had their Leaf: "I learned a lot initially before I got it and maybe the first few months [after I got the car] and I was on the Nissan [Leaf] blogs and all that. But since I found out everything I need to know, that was it." In contrast some PEV drivers disdained the idea of a community: "I never felt like I was doing this to get into some sort of community."

While women and men all talked about community, they differed in their eagerness to seek out or form such a community. Men were very excited about talking to people about their PEV. Men were eager to share their ideas and exchange information to build on their own R&D. Women were willing to answer questions in a chance, face-to-face conversation but were less likely to seek communication or information online. Most cited a lack of time as the cause; devoting time to these conversations, interactions, and information searches was impractical.

Environment

For many women and men, the environment was the primary reason for purchasing a PEV, i.e., buying and driving a PEV was putting their environmental beliefs into action: "We are environmentalists, so we always try to support things we believe in. So we

thought an electric vehicle would be the logical choice." These motivations could be about doing something to reduce their environmental impact and about reducing feelings of guilt: "I literally had a sense of guilt driving a gas car so that's what brought me to buy a Leaf."

Of those women and men who were motivated by environmental concerns, buying and driving a PEV put those concerns into action in the here and now. For women, this tended to be where the conversation stopped. Environmentally motivated men were more likely to continue on to discuss R&D. Their environmental assessments were reached after they researched environmental impacts of gasoline and developed ideas about how to make PEVs desirable to a broader base of people. Some of these men looked to other aspects PEV, e.g., acceleration and driving performance as being as important—both as additional motivators for themselves now and as the way to continue to bring other people to PEVs. This research expanded their ideas about how PEVs changed the sources of pollution: "Even if there's pollution in manufacturing electricity, that can be redistributed someplace where it's not got near the impact [in] this basin we're in environmentally."

Money

Women and men shared several ideas regarding money and PEVs. Primarily, they appreciated what they perceive to be cost savings because they paid less for electricity than gasoline: "I like telling people that I can run for 3 cents a mile and they're running for 22 cents a mile. I just like the look on their face." Other positive important financial considerations included PEV purchase (or lease) incentives: a California state rebate of $2500 and a US federal tax credit of $7500.

When public charging first rolled out in San Diego the electricity was free. Public charging was shifting to a paid service at the time of the San Diego focus groups in Fall 2012. Women and men spoke about this change: "A dollar an hour isn't that big of a deal, but there's a big gap between $1 an hour and free." With the advent of pricing, some declined to use public charging unless they were going to run out of charge: "It's become in the event of an emergency." Some were no longer interested in charging in public because they could charge for less money at home and didn't need to charge in public to get home.

For women and men who drove a Leaf, much of the conversation about money was devoted to fairness. Women and men prefer to be billed for the amount of electricity required to charge their car, not how long their car is connected to the EVSE. DC fast chargers were not available at the time of the San Diego focus groups but drivers had heard rumors of the pricing and were displeased. This driver compared the cost of one DC fast charge to a month of home Level 2 charging, "My whole [bill for charging my PEV at home] for the month will be maybe $30. So if you tell me it's going to take me $15 to do one [DC fast] charge, that's ridiculous." All agreed that pricing for DC fast charging would be higher than they thought fair.

Differences between women and men appear in the additional topics men address. Women focused on monetary motivations for purchasing a PEV; they were tired of paying so much for gasoline and liked that electricity costs less. The perception that their PEV saved them money now won them over. Men were likely to also express concern about gasoline prices going up in the future; they were excited they didn't need to worry

about that. Men also discussed their home PEV charger as an investment: "This improves the value of my home because I've got a universal charger already built in." Men also talked about whether to pay more for more driving range in a future PEV.

Practicality or R&D, But Not Both

Three themes did not fit into the construct of women's interest in PEVs as a practical tool and men's interest in R&D: family, batteries, and electricity. Family was discussed only in terms of practicality, whereas discussions about batteries and electricity focused only on R&D.

PEVs and Families

Women and men with young children spoke about parenting needs and how their PEV fulfilled them in terms of the practicality; there was no discussion of R&D. They used their PEV for daily needs and only occasionally did their PEV not meet their parenting needs, generally for a long trip. For these occasions, the drivers were amenable to using a gasoline car in the household or renting one for the trip.

The prospect of running out of charge with a child in the car produced two different responses to public charging. On one hand, public chargers could be used to ensure the PEV met their daily needs of errands and parenting needs: "I can charge up while I'm running errands, then I can pick up my kids, run my kids around and then get home." Others avoided using public chargers with their children in the car because they didn't want to entertain their children while waiting.

Women and men were distinguished in their discussions of the size of the PEV: the MINI-Es were two-seaters and the Leafs are small five-seat hatchbacks. Women did not make any mention of the size of the vehicles in the context of whether or not they were practical cars. Men split on this matter in a way that illustrates how present vs. future tense verbs alone are insufficient to distinguish our categories of practical vs. R&D. Some men were pleased with the size of their (present tense) PEVs: "The Leaf it has everything – the range, the power, the space. The kids throw their baseball stuff in." Other men found the size impractical for their families. As one man said, "I want to grow my family. So where is, for lack of a better term, the minivan version of [a PEV]? Where is the wagon version with seven passengers?" These men wanted a PEV for their (future) family; the size of their present PEV would be impractical. Despite these men being concerned about the future, this isn't an example of speech about R&D, for example they were not doing research on what larger PEVs might be available.

Batteries

Here we distinguish the battery from the services it provides, e.g., driving range. Women and men spoke about R&D regarding the battery; no one discussed batteries in terms of practicality. Some were worried about a loss in battery performance over time. Some claim they are experiencing it now: "The battery capacity is going down. I've lost over 15% in my range in my car. So I'm needing to charge much more often." Many of the drivers charged their Leaf to 80% instead of 100% because they were told by the dealership and manufacturer this would forestall battery degradation; this was their attempt at conducting research on their own vehicle. The potential cost to replace the battery was an important issue to these drivers, Still, most remained confident—or maybe

hopeful—that in the future battery prices will come and driving ranges will go up. Most of the discussions about batteries came from men as they did their own research on battery technology and development and were eager to share their ideas with others.

Electricity

Electricity was another theme that men and woman talked in terms of R&D but not practicality. Many drivers spoke about researching solar photovoltaic (PV) systems for their home and appreciated the connection of driving a PEV powered by solar electricity, although not all drivers had PV installed at their homes. Drivers had concerns about the electrical grid and the demand that PEVs place on it: "The public chargers are mostly daytime and that's why people have been working hard on software systems for dynamic balancing and public charger infrastructure and the grid itself…You have to have some dynamic way of telling those chargers on the fly, 'whoa, doggie,' because we're already overloading the grid." Some agreed that time of use electricity pricing might mediate this problem.

When Practicality and R&D Did Not Apply

For two themes the ideas of practicality and R&D did not arise at all, and therefore can't distinguish whether the content of women's and men's speech are the same or different: safety and politics. Women did not speak of safety in practical matters and they did not discuss politics at all. Men did not talk about R&D regarding safety or politics, though they had a lot to say on both. Still, there are other similarities and differences in the statements of women and men on these topics.

Safety

Safety at public chargers was important to women and men, especially the safety of women at public chargers. Men also discussed safety of the vehicle itself. That a PEV was a good family car in part because of crash safety was explained by one man who was impressed by another focus group participant's experience: "You've got a woman with four children in four different schools doing all that you do and doing it in an electric car. Go back five years and she'd be in a Honda Odyssey. This is a true five-passenger car. You feel absolutely safe in it. It rides incredibly well…I can't think of a better ad."

Politics, From Personal to Global

The only incidence of a woman saying anything about politics, either in the all-women group or mixed groups, is when she agreed when a man said that PEV drivers should not be exempt from paying a tax to maintain roads. Men, on the other hand, had a lot to say about politics. For some it was their primary reason for purchasing a PEV, in part because of reducing dependence on foreign oil. Many men were pleased with the support for PEVs from the government, especially the subsidies to consumers. In contrast, many men were frustrated by perceived political barriers to the deployment of charging infrastructure. Finally, some believed that they were paving the way for the rest of the world: "Africa and in China and India and the Middle East they're just dumping oil and everything else and nobody seems to care. But it's nice to try and lead the way and I like to be able to brag a little bit."

DISCUSSION: WHAT FACTORS CONTRIBUTE TO DIFFERENCES AND SIMILARITIES IN THE EXPERIENCES OF THESE WOMEN AND MEN?

In general, these women and men discussed much in common regarding life with their PEVs. There were far more similarities than differences in conversations, regardless of group composition: all female, all male, or mixed gender. They agree their PEV meets their daily driving needs. They want to see a public charging network in their area—if not for themselves then for others so as to increase the number of PEVs on the road. They want to pay for the amount of electricity they take from a public charger instead of paying for the amount of time their PEV is connected to that charger.

Where there were differences between women and men, women PEV drivers in these focus groups talked about managing existing conditions and accomplishing immediate travel needs. They talked far less about active research, information gathering, and speculation about future conditions. Women talked little about longer driving range and public charging, but talked more about how they made the existing capabilities of their PEVs and extant charging opportunities work for them. It is not possible for us to conclude why women did not talk about certain things—no one says why they don't talk about something. We know they did not discuss DC fast chargers; not talking about something that isn't present in their day-to-day lives fits a pattern of focusing on what is present. Women found the rapidly fluctuating range indicator untrustworthy and impractical; they wanted an accurate tool so they could gauge their remaining travel before arriving home or at another charging location. They found charging their PEV at home provided a practical convenience compared to buying gasoline for their car. Some remained open to using public charging as it shifted to a paid service because public charging filled a present need.

While women would participate in live and virtual PEV communities if they needed information, the time required was seen as impractical and a deterrent for most. Women typically were not contributors to on-line media or participants in public outreach events and were more circumspect about casual questions from strangers. Paying less for electricity than gasoline—even when paying for public charging—as well as the vehicle purchase incentives were built into a case for the present cost savings of a PEV. Those with young children found the car to be a practical car.

Where there were differences, the men PEV drivers in these focus groups treated their PEV more as an R&D project. While they talked about problem solving for their PEV, this often extended to passing on solutions to problems they experienced as well as keeping up with, or even producing, information on technological developments. They spoke more about what they want from a future PEV. They were likely to be knowledgeable about technological developments, research, infrastructure technology, deployment, and talked about time spent to do research or gather information. They often looked at away-from-home charging in terms of as yet non-existent DC fast charging: locations, prices, contexts in which they would use them, and potential harm to the battery. They were less interested in public charging once it wasn't free. Rather, they were willing to push past their old comfort levels for driving range. They viewed the fluctuating range indicator as a challenge to overcome; a few developed their own range calculators. They viewed a PEV community as a resource for research and a platform to share their own developments; many devoted a lot of time to speaking with people in person and online. These men did considerable research regarding their PEV and the

environment, the political and environmental impacts of gasoline, how and where their electricity was produced, and developed ideas about how to conjoin the environmental benefits of driving a PEV to the larger population of vehicle drivers by promoting PEV driving performance.

Men spoke in detail about the theme of money, specifically about the potential future costs of DC fast charging and battery replacement. Through their research they learned about how battery degradation may impact them, future uses of batteries, and future battery chemistries. They wanted driving range options for future PEVs so they could purchase as much as they wanted. They researched PV energy systems for their homes. Some who had a home PV system prior to purchasing their PEV had designed the PV system for both their existing household demand and their anticipated PEV charging.

CONCLUSION: ARE WE HARDWIRING GENDER DIFFERENCES IN PEVS?

For all their similarities, the differences between women and men illustrate how each engage PEVs and highlight how PEV manufacturers, charging infrastructure companies, and policy makers can support both genders in their use of a PEV. There were differences in how women and men were likely to experience the PEV; women as a practical tool and men as an R&D opportunity. A similar distinction has been made in other contexts. In the context of management styles, (*24*) reported men were thought more likely to create innovative solutions, i.e., to change the system, while women were thought more likely to create adaptive solutions, i.e., to create change within the system. (*25*) found that graduate students perceive "men choose more theoretical subjects for their theses and women more practical ones."

However, noting the many similarities in the content of the statements of women and men on a variety of themes from conversation about their PEVs, we do not draw the conclusion that the biological female or socially-defined woman is inherently more practical than the biological male or socially-defined man. We do say that if the future course of PEV vehicle design, PEV charging infrastructure, and more generally the course of PEV market development is being determined by voices *such as* those we heard, at present the voices of women are more likely to be silent than the voices of men regarding these future developments. In the present PEV market, more than 70% of consumers are men and the women who are present are less likely to discuss future developments: the early consumer feedback is male dominated. Paired with male dominated technological production, (*26, 27*) argue that even objects that are ostensibly designed for everybody are designed unconsciously based on the male users' images. When the user is assumed to be universal it is often a masculine universal and masculine ideals are prioritized when thinking about vehicles. For example, (*28*) demonstrates how car design and manufacturing have limited women's access to public space and independent activity.

Much of women and men's use and experience with their PEVs sounds similar, but the differences indicate a gendered approach to PEVs. Women's location in the PEV market is secondary to men's: there are fewer women and those there are speak less to future developments than do the more numerous men. User norms associated with femininity, such as trip chaining or transporting family members, may be overlooked in the PEV market from vehicle design to use of the vehicles. This lack of voice to what women want and need from a PEV may slow the future adoption of PEVs by women and

therefore the total number of PEVs sold and the attainment of the policy goals underlying government support. Women may be left to adapt to a system designed by men for men, or not participate at all.

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