

# Characterizing Residential Recharge Potential for Plug-in Electric Vehicles

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## Research Question

**Plug-In Electric Vehicles (PEVs)** are promoted as solutions to climate change and petroleum use. At least initially, consumers will rely on home recharging of PEVs.



**How do measures of home recharge potential vary by power level and region?**  
We measure home recharge potential for Level 1 (110/120 v) and Level 2 (220/240 v) charging by surveys of households. We measure at different regional scales to explore how variation may affect PEV markets and grid operation



## US & San Diego, CA New Car Buyers

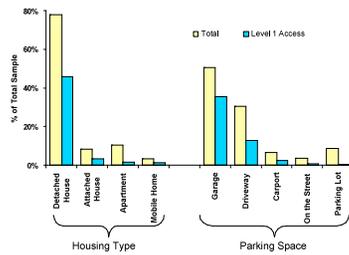
Survey 1: US sample: n = 2,373.  
Survey 2: San Diego sample: n = 548.  
Households in both had purchased a new vehicle within no more than five years prior to the survey.

## Comparing measures of recharge access

- Simply assume access, i.e., 100 percent, either
    - At home at night, or
    - Whenever a vehicle is parked at home
  - Measure the housing stock, prior estimates:
    - 15 to 30 percent, California
    - 28 percent, US
  - User-driven methodology: Ask people!
- We asked new car buying households.**
- Study 1: Level 1 recharge access** if at some point during their diary day they parked within 25 feet of a 110/120V outlet at their home.
- Study 2: Level 1 and Level 2 recharge access** defined similarly, plus a cost model to estimate the cost to overcome obstacles between the vehicle parking space and necessary electrical infrastructure.

## Study 1: US and Regional Level 1 Access

- What proportion of U.S. new vehicle-buyers has access to electrical infrastructure that supports Level 1 recharging at home?
  - Level 1: 52 percent of new car buying households
- How does this access vary by residence type and parking location?



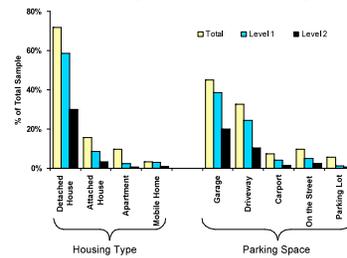
- How does this access vary by region?

EIA electrical grid region*	U.S. Residential Level 1 Access by EIA Region			
	West (TX)	Mid-West (MW)	Northeast (NE)	Southeast (SE)
WEC-SW, WEC-MP, ANM, WEC-CA	ERCOF	ECAK, MAIN, MAPP	MAAC, NPCC-NE	FRECC, SERC, SPP
States included	WV, KY, VA, WV, MD, DC, WV, PA, NY, NJ, DE, CT, ME, MA, NH, RI, VT, HI	IN, KY, MI, OH, WV, IL, IA, MO, WI, MN, NE, ND, SD	DE, DC, MD, OH, WV, IL, IN, PA, NY, NJ, ME, MA, NH, RI, VT, CT, ME, MA, MN, NE, ND, SD	FL, AL, AR, GA, LA, MS, NC, SC, TN, VA, KS, OK
Sample size, US weighted	636	156	479	583
Percent	26.8%	6.6%	20.2%	24.6%
Home Level 1 access**	<b>52.0%</b>	<b>51.8%</b>	<b>57.1%</b>	<b>54.4%</b>
Planned next vehicle**				
Truck	49.2%	52.5%	52.0%	41.4%
Car	50.8%	47.5%	47.4%	58.6%
Want to buy PEV?*	<b>63.0%</b>	<b>50.7%</b>	<b>61.0%</b>	<b>60.2%</b>

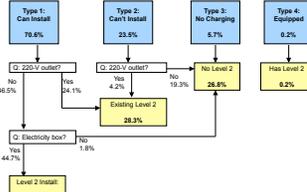
\* Regional variations significant at a 95% Confidence level  
\*\* Regional variations significant at a 99% Confidence level

## Study 2: San Diego Level 1 and Level 2 Access

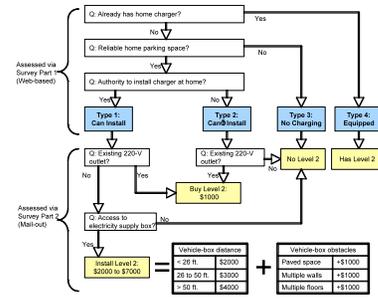
- What proportion of San Diego new vehicle-buyers already has access to electrical infrastructure that supports Level 1 and Level 2 recharging at home?
  - Level 1: 72 percent; Level 2: 35 percent
- How does access in San Diego vary by residence type and parking?



- What proportion could feasibly install Level 2?



- And, at what estimated cost?



- How many "PEV buyers" might want to pay for Level 2 installation?

Level 2 potential price	% of sample	% wanting PEV	% wanting PEV and Level 2
No Level 2	26.8	48.4	0.0
Existing Level 2 \$1000	28.3	82.5	36.1
Install Level 2 \$2000	14.2	77.9	25.6
\$3000	12.6	76.2	21.7
\$4000	9.5	72.3	21.1
\$5000	6.0	69.0	12.1
\$6000	2.2	100.0	41.7
\$7000	0.2	0.0	0.0
<b>Total*</b>	<b>99.8</b>	<b>70.5</b>	<b>20.3</b>

## Conclusions

From Study 1, just more than half the population of new car buying households in the U.S. are estimated to have the potential to recharge a vehicle at home with at least Level 1 service. This estimate is larger than previous estimates for the population of American and California households. The present analysis 1) targets new vehicle buying households, and 2) draws information directly from the respondent's identification of recharge opportunities rather than relying on proxies from data on the housing stock.

Across three different scales—national U.S., five interstate regions, and a single electric utility, we find that while residing in a single-family dwelling or regularly parking a vehicle in a private garage at home is positively correlated with home access to Level 1 recharging, neither is sufficient.

Within the area of one electric utility, Study 2 implemented an even more user-driven definition of recharge access for both Level 1 and 2 charging, as well as an assessment of household authority to change existing infrastructure within the service area of a single electric utility. The results indicate higher percentages of households with access to Level 1 recharging than we previously estimated at interstate and national scales.

Consumer-based estimates of home recharge potential can improve understanding of PEV demand, use, and energy impacts, and prioritizations for developing recharge infrastructure.

Substantively important differences in infrastructure access and interest in PEVs exist across different scales of analysis. National analysis of our access and PEV-interest data averages out these regional differences. Thus, it is advantageous to match data to the regional scale of analysis of the research question.

Paper: Axsen, J. and K. S. Kurani (submitted) Who can recharge a plug-in electric vehicle at home? *Transportation Research, Part D*.