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Consumers' Use of PHEV-Conversions: What it can tell us about CD driving, workplace charging infrastructure and grid impacts

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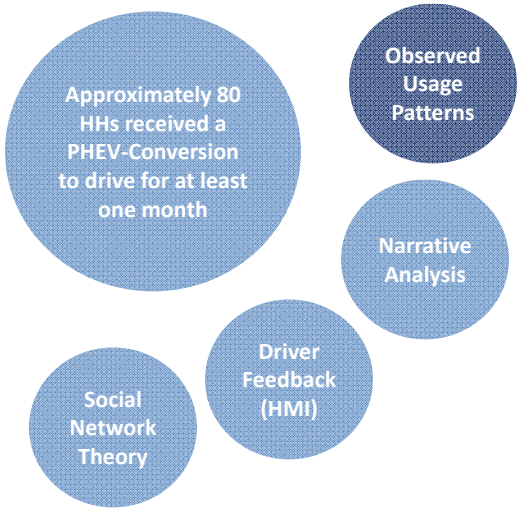
Analysis is Based on Usage Data from a PHEV Demonstration Project



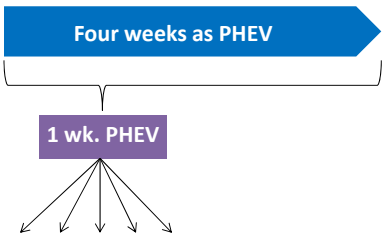
What did households do?

- Daily driving distance
- When did they plug in
- Fuel consumption*
- CD driving (utility factor)*

***Specific to PHEV-conversion**

Modeling results based on consumer usage of a PHEV-conversion: data is applied to a variety of scenarios

Modeling: What impacts might have been with different vehicles, charging infrastructure, or charging routines? Not a projection for all PHEV owners



PHEV usage data applied to different vehicle designs and charging scenarios by varying assumptions for, battery size, charging rate, efficiency, etc.

For PHEVs matching the design assumptions, provide results on:

- Fuel consumption
- CD driving (utility factor)
- Aggregated grid impacts
- Possibility of changing TOD load profiles to super off peak
- 120v /12 amp vs. 240/ 16 amp

Case 1: Electric VMT for PHEV 1 to PHEV40
Case 2: Case 1 + workplace charging
Case 3: Time of day charging as used
Case 4: Case 3 + workplace charging
Case 5: Super off-peak home + workplace

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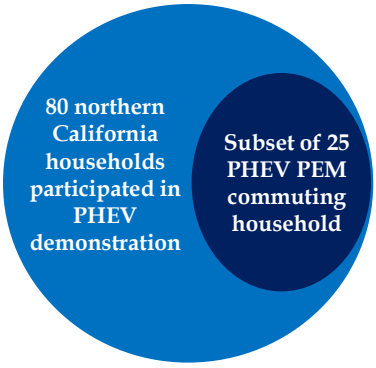
Study data based on 25 Households' actual driving and charging of a PHEV conversion for **one continuous week**



25 households selected from 80 are new car buyers, who commuted to a workplace and reported interest in purchasing a PHEV through survey design game.

One week of usage used for analysis is What most "weeks" are like, but certainly not every week of the Household's life.

Data is relevant within the context of the Households in the study

Other usage patterns, charging arrangements, behaviors and technologies (not yet observed or considered here) will exist.

This analysis is most realistic for:

- Sacramento & Yolo Counties (or people with similar travel)
- Households who can plug in at home
- No time of day tariffs or direction for charging
- Asked to avoid extended away from home travel
- Only commuters, so actual TOD impact for entire fleet would be different

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Observed Usage

Report the travel and charging behavior of 25 households' week with the PHEV-conversion which the modeling analysis is based on

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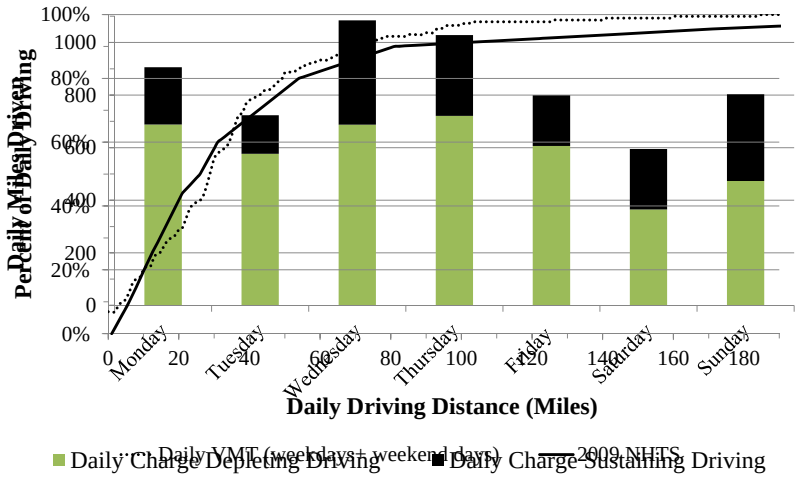
Observed Results: Participants' PHEV-Conversion Experience - Travel



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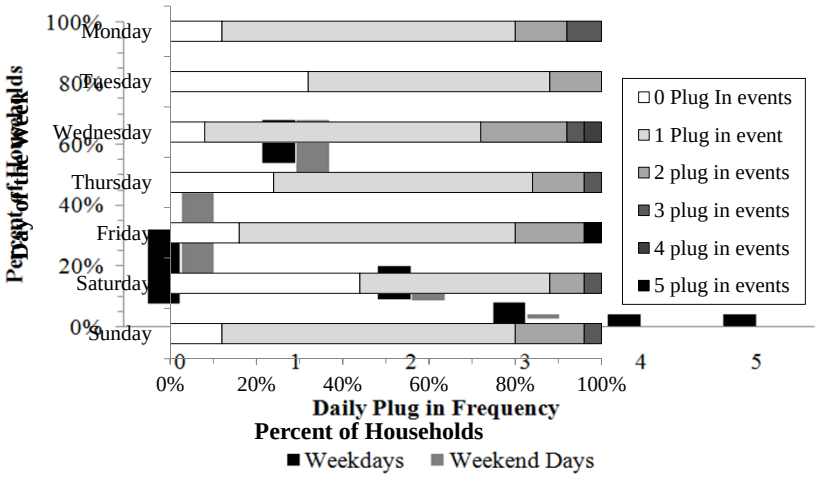
Observed Results: Participants' PHEV-Conversion Experience - Charging



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Travel & charging data used to model Impacts for a Hypothetical PHEV Fleet

Case 1: Electric VMT for PHEV 1 to PHEV40
Observed travel and charging combined with assumptions for PHEV designs. No changes to travel or charging timing.

Case 2: Case 1 + workplace charging
No changes to observed travel or charging timing. Known when households arrived at workplace and charging event is simulated every time.

Case 3: Time of day charging as used
A simulated vehicle market of 100 PHEVs is created (different CD ranges, efficiencies and charging loads). Travel and charging (timing) behavior from case 1 is applied to every vehicle in each market segment. Market segments are scaled according to proportion.

Case 4: Case 3 + workplace charging
Case 3 + workplace charging assumption from case 2

Case 5: Super off-peak home + workplace
When possible at-home charging is delayed to past midnight + case 2 workplace

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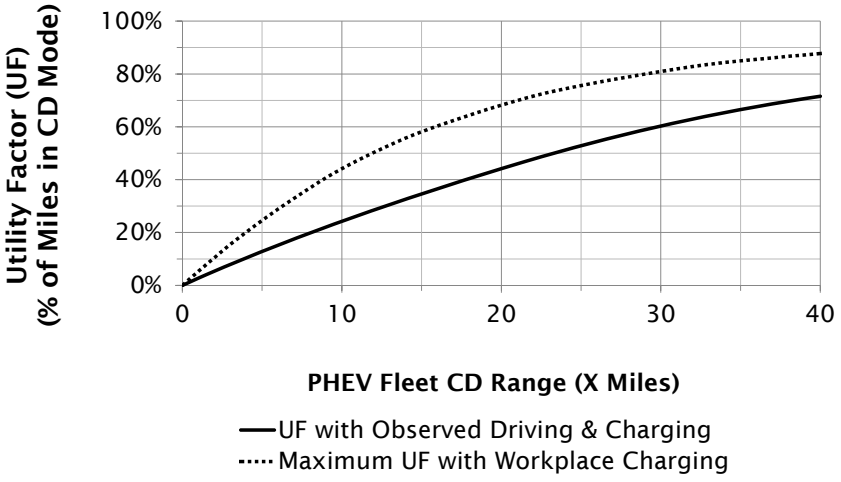
Impact of workplace charging on "Fleet" CD driving varies given PHEV CD range



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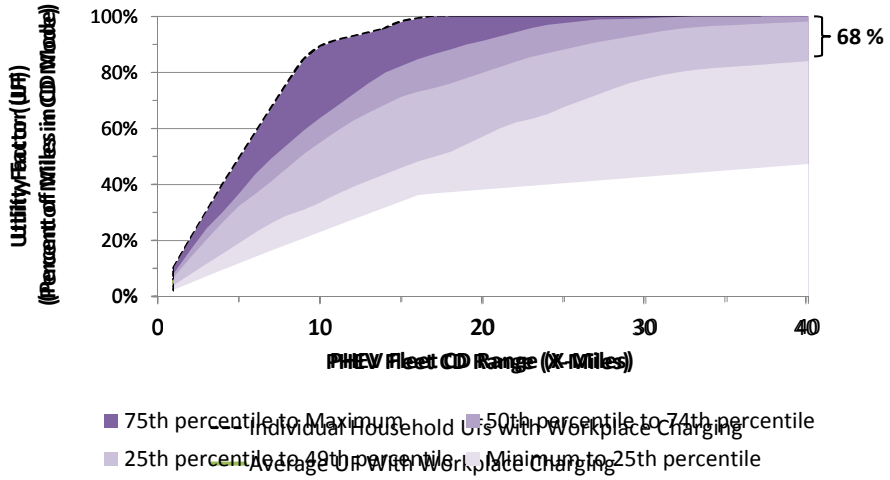
Impact of workplace charging on UF varies by household



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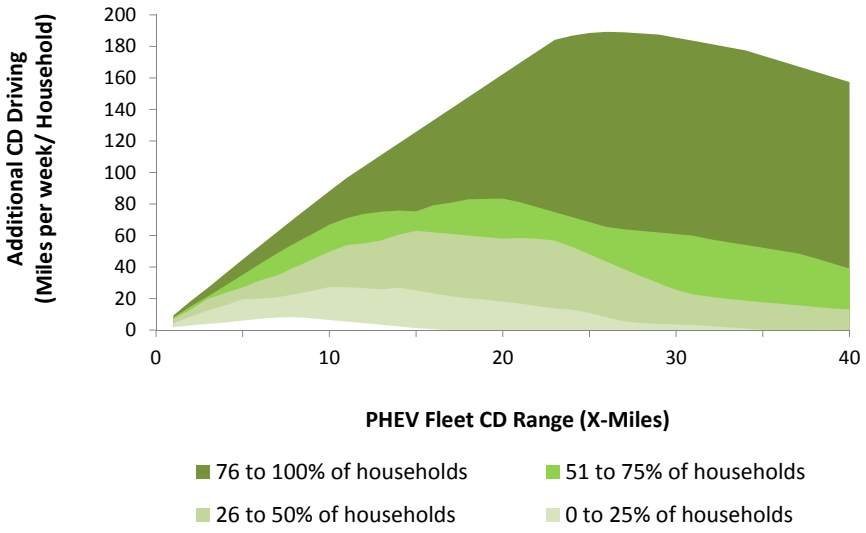
Increases in CD driving from workplace charging vary between households and vehicle CD range



Workplace charging infrastructure needs could vary

CD Range	Percent of PEM demo households needing chargers to achieve up to 90% of total possible CD driving benefit from workplace charging
PHEV10s	75
PHEV20s	50
PHEV40s	25

[1] 90 % measure was picked for demonstration purposes

For instance: For a fleet of PHEV40s, providing workplace charging to 25% of the sample would achieve 90% of the total possible CD driving benefit.

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TOD charging impacts & Scenarios

1. Describe the hypothetical market
2. Charging power
3. Charging scenarios (cases 3,4, & 5)

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Electricity Demand for a Hypothetical Market

A hypothetical PHEV market is created based on CD range and vehicle body style. Sedan/ Truck: 0.3 & 0.38 kWh/mi

CD Range	Sedan	Truck
PHEV10	18.5%	12.5%
PHEV20	16.6%	13.3%
PHEV40	23.6%	15.5%

Households' usage data is estimated for each of the 6 vehicle classes for cases 3, 4, & 5 and impacts are weighted/ combined by using PHEV market share, which Assumes similar behaviors would occur in each vehicle segment.

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Charging power used in modeling is based on HH usage patterns

- Charging power of 1.44 or 3.84 kW assigned to each household at their home & workplace.
  - Charging is only modeled with 3.84 kW charger if it increases CD driving for a household compared to a 1.44kW charger

Provides some measure of plausible infrastructure requirements, although is not based on direct input from households

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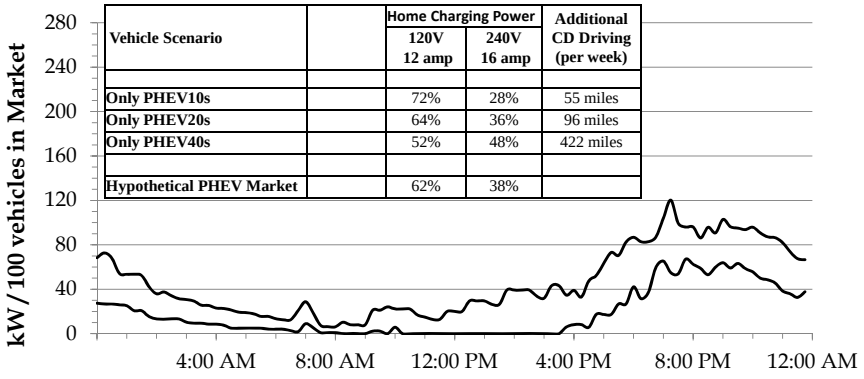
PHEV-conversion charging behavior

Vehicle Scenario		Home Charging Power 120V 12 amp	Home Charging Power 240V 16 amp	Additional CD Driving (per week)
Only PHEV10s		72%	28%	55 miles
Only PHEV20s		64%	36%	96 miles
Only PHEV40s		52%	48%	422 miles
Hypothetical PHEV Market		62%	38%	



—Range in Electricity Demand, Weekdays & PHEV-Conversion Charging Behavior

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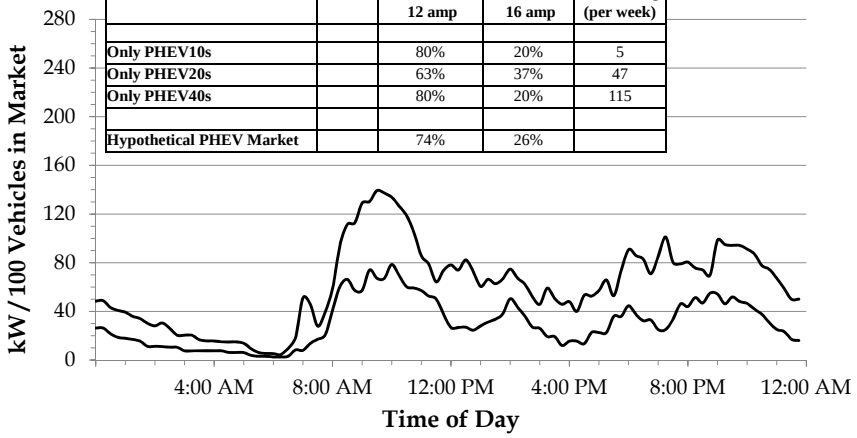
Ubiquitous workplace charging

Vehicle Scenario		Workplace Charging Power 120V 12 amp	Workplace Charging Power 240V 16 amp	Additional CD Driving (per week)
Only PHEV10s		80%	20%	5
Only PHEV20s		63%	37%	47
Only PHEV40s		80%	20%	115
Hypothetical PHEV Market		74%	26%	



—Range in Electricity Demand with Workplace Charging, Weekdays

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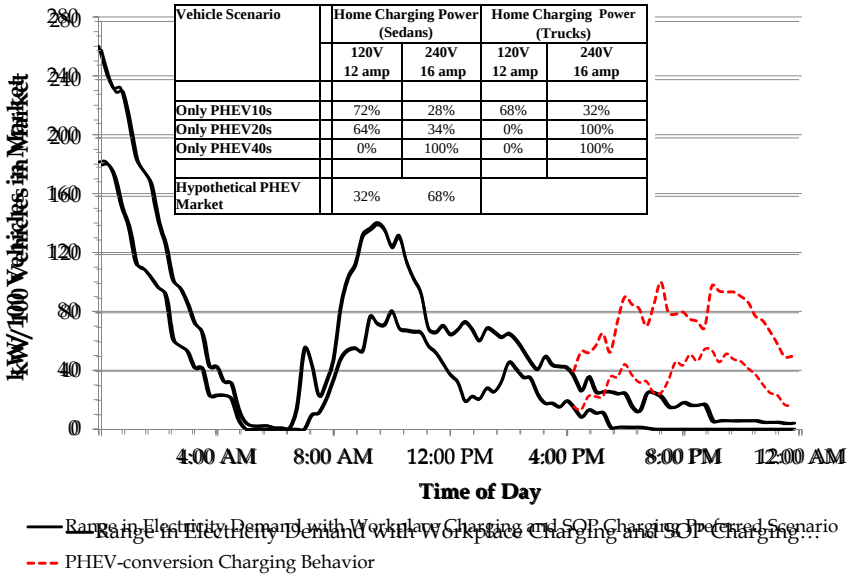
Super Off-peak (SOP) Preferred + Workplace

Vehicle Scenario	Home Charging Power (Sedans)		Home Charging Power (Trucks)	
	120V 12 amp	240V 16 amp	120V 12 amp	240V 16 amp
Only PHEV10s	72%	28%	68%	32%
Only PHEV20s	64%	34%	0%	100%
Only PHEV40s	0%	100%	0%	100%
Hypothetical PHEV Market	32%	68%		



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Summary

- There is variation in behavior, and thus impacts, between households with similar vehicles.
- Averages are not good indicators of what **most people** are doing
- Workplace charging increases CD driving, but benefits vary between households and vehicle configurations (0 to 200 CD Miles per week)
- 120v/12 amp workplace charging would have been sufficient for most households.
- SOP type charging has the potential to change nigh time load. Next step is to test in real life.
- Results are specific to these households and conditions of the study. Numerical results may change between samples.
- Methodology can be applied to other demonstration projects.

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Questions ?

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