Electrification of vehicle miles travelled within the household context

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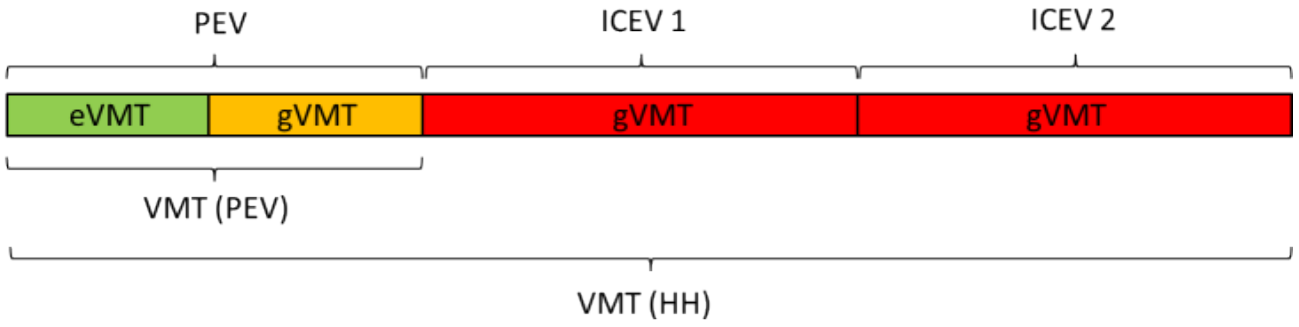
Purpose of the study

- Two main approaches to assess UF: (1) running simulations based on test cycles or transportation surveys, (2) using empirical data.
- Purpose of our study is to assess the utility factor within the household context and investigate how household factors impact **eVMT**, **UF of the PEV** and **UF of the household**, using an empirical dataset.
- Household context defined under four categories: (1) PEV technology in the household, (2) household vehicle usage, (3) ICEVs in the household and (4) driver identity.



$$\text{UF (PEV)} = \frac{eVMT}{VMT(PEV)}$$

$$\text{UF (HH)} = \frac{eVMT}{VMT(HH)}$$

Data

- Data is from Phase 1.0 of the Advanced Plug in Electric Vehicle Travel and Charging Behavior Project, initiated by the PH&EV Research Center at UC Davis.
- Summer 2015 to Summer 2016
- 71 PEV households in California: 18 Toyota Plug-in Prius, 17 Ford C-Max/Fusion Energi, 18 Chevrolet Volt and 18 Nissan Leaf (169 vehicles in total including ICEVs)
- Monitor placed in all household vehicles except the ones driven less than 1000 miles per year.
- Raw data cleaned by PH&EV Center, provided datasets: trip data, charging data and survey data.

Compiled Dataset

Selecting and computing variables that we labelled as factors corresponding to the categories of the household context.

PEV technology in the household: *range*, *frequency of charging*

Household vehicle usage: *number of drivers*, *commute distance*, *frequency of overlaps*, *frequency of long distance trips*.

ICEVs in the household: *size of ICEVs in the household*, *MPG of ICEVs in the household*

Driver identity: *share of PEV usage of the main driver*

Methods

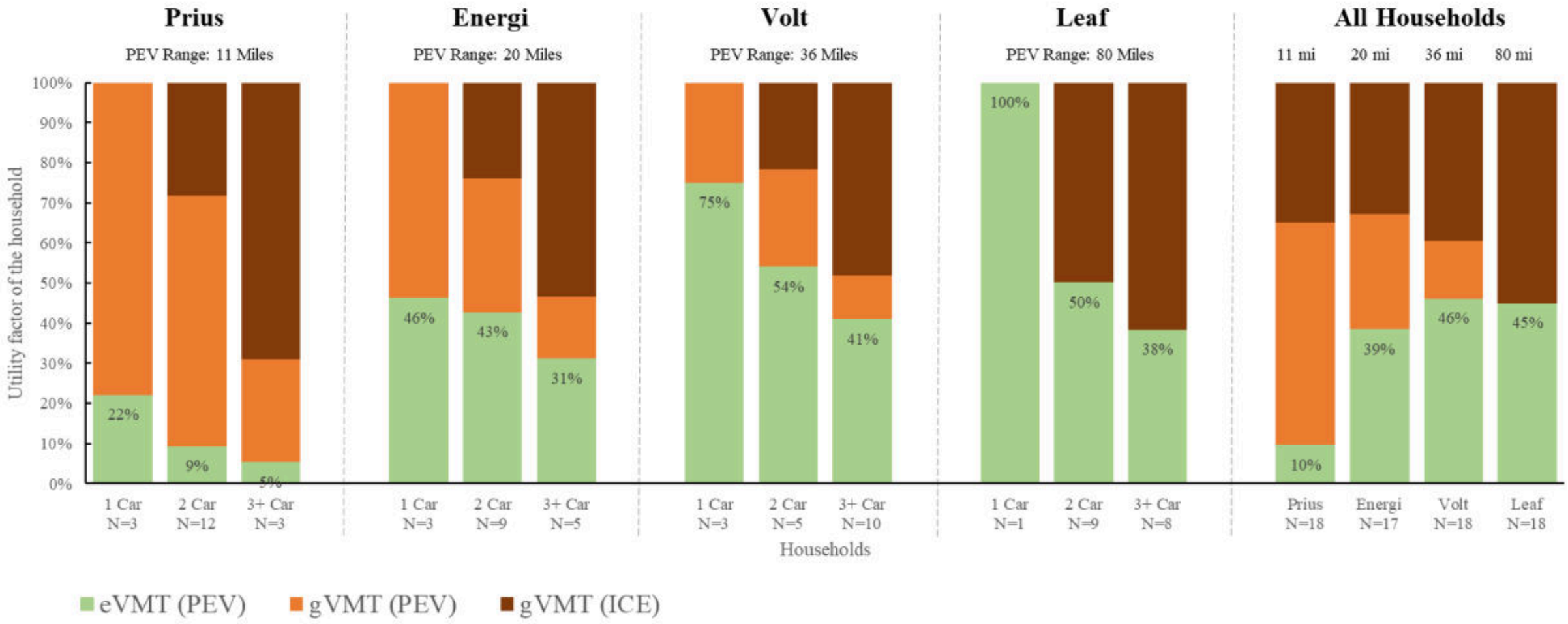
- Descriptive and inductive statistical methods, regression analysis on the compiled dataset.
- Generic regression model where we use the same independent variables for all:

$$Y_i = \beta_0 + \beta_1 Range_i + \beta_2 Number\ of Drivers_i + \beta_3 Commute\ Distance_i + \beta_4 PEVShare_i + \beta_5 FreqCharging_i + \beta_6 FreqLongdistance_i + \beta_7 FreqOverlaps_i + \beta_8 ICEVSize_i + \beta_9 ICEVMpg_i + \varepsilon$$

$$i = \{1, \dots, 3\}\ where\ Y_1 = eVMT, \quad Y_2 = UF\ of\ the\ PEV, \quad Y_3 = UF\ of\ the\ household$$

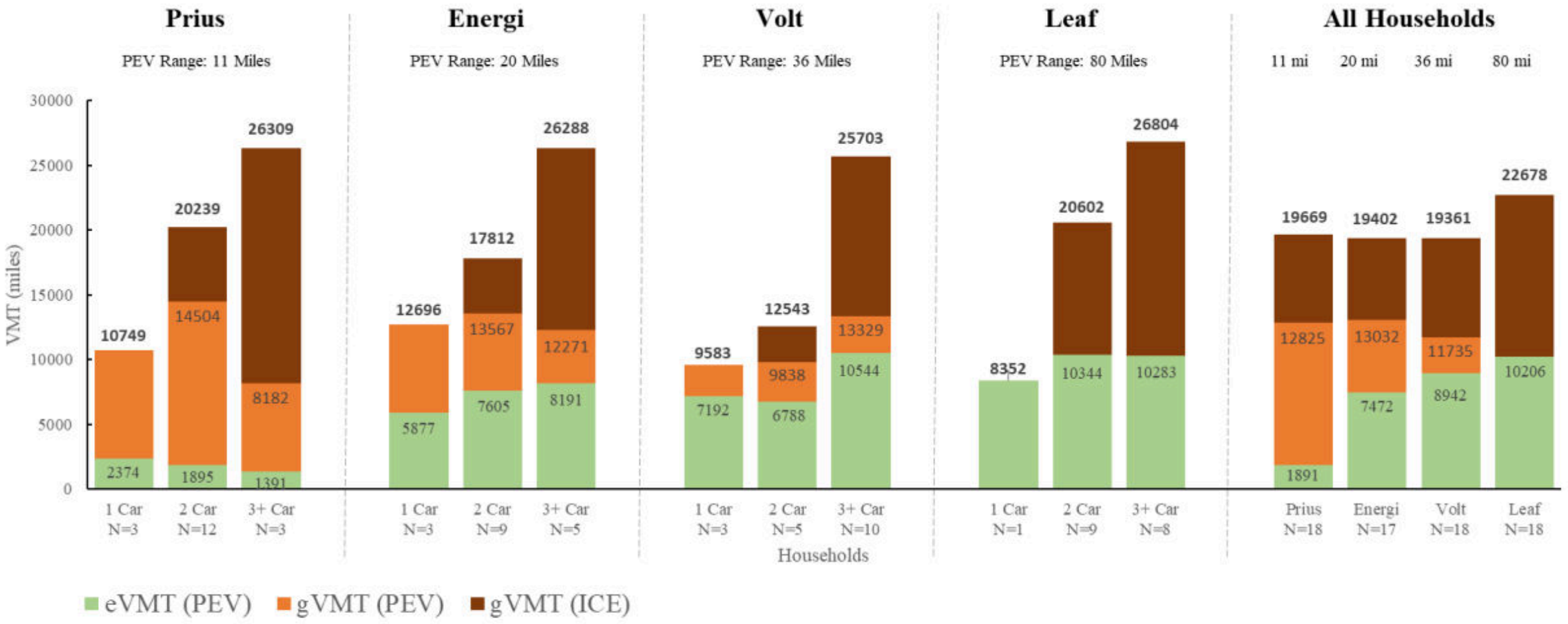
Results – Descriptive Statistics (1/2)

Utility factor of households, categorized by PEV-type and total number of cars in the household



Results – Descriptive Statistics (2/2)

VMT of households, categorized by PEV-type and total number of cars in the household

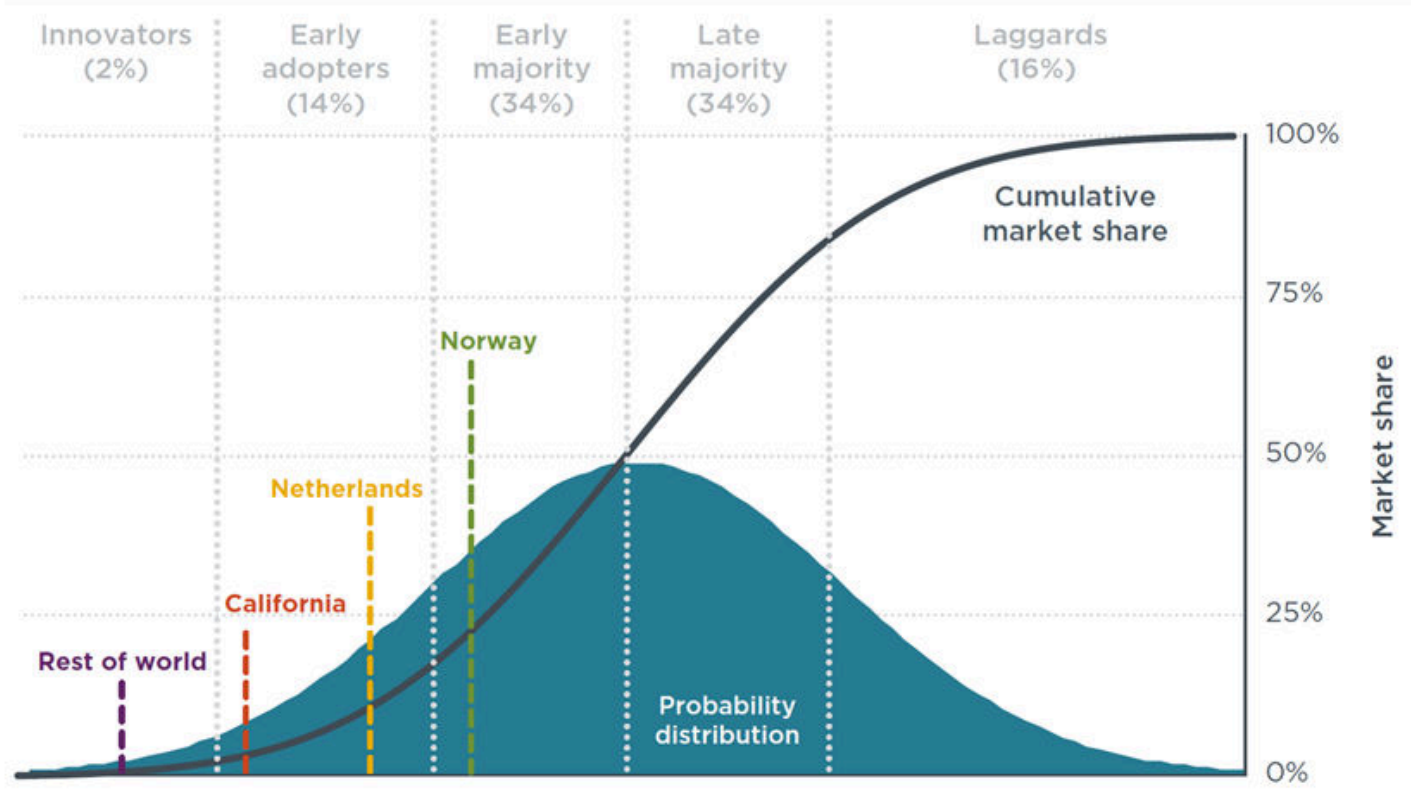


Results – Regression Analysis

Dependent:	eVMT		UF of the PEV		UF of the hh	
Intercept	-2073		-0.334		0.310	.
	(3318)		(0.209)		(0.182)	
Range	93.97	***	0.023	***	0.004	***
	(14.26)		(0.002)		(0.001)	
Number of drivers	404.60		0.066		-0.047	
	(565.10)		(0.040)		(0.031)	
Commute distance	26.83		0.001		-0.002	
	(23.53)		(0.001)		(0.001)	
Share of PEV usage of the main driver	1187		0.136		0.063	
	(2809)		(0.180)		(0.154)	
Frequency of charging	3885	***	0.152	*	0.173	**
	(1092)		(0.064)		(0.060)	
Frequency of long-distance trips	10180		-1.940	**	0.040	
	(12320)		(0.715)		(0.675)	
Frequency of overlaps	9058		-1.047		-1.458	*
	(1120)		(0.659)		(0.604)	
Size of ICEVs in the household	-515.5		0.019		-0.049	
	(763.7)		(0.047)		(0.042)	
MPG of ICEVs in the household	0.008		0.001		-0.004	*
	(30.760)		(0.002)		(0.002)	
Multiple R-squared	0.545		-		-	
Adjusted R-squared	0.478		-		-	
Confidence levels	*** %99.9, **%99, *%95, .%90					
Values represent estimates, standard error is given in parentheses.						

Limitations

Technology adaption curve including select electric vehicle markets



Source: Lutsey, N. P. (2016). Evolution of incentives to sustain the transition to a global electric vehicle fleet, (November). https://doi.org/10.13140/RG.2.2.36368.81920

- Sample size
- Regionally bound to California
- Early adopter bias and high education & income profile

Conclusions

Key take-away points and implications:

- Potential of PHEVs within the household context to electrify a similar share of total household miles as some BEVs
- Significant role of all-electric-range in electrification of vehicle miles travelled, both for the PEV and household
- More frequent charging results in higher electrification of miles
- More frequent long-distance trips lower the UF of the PHEV
- ICEVs with higher MPGs have a higher likelihood to replace trips from the PEV and lower the UF of the household