Supplementary Material

Appendix A: Share of PHEVs in the alternative fuel vehicle market

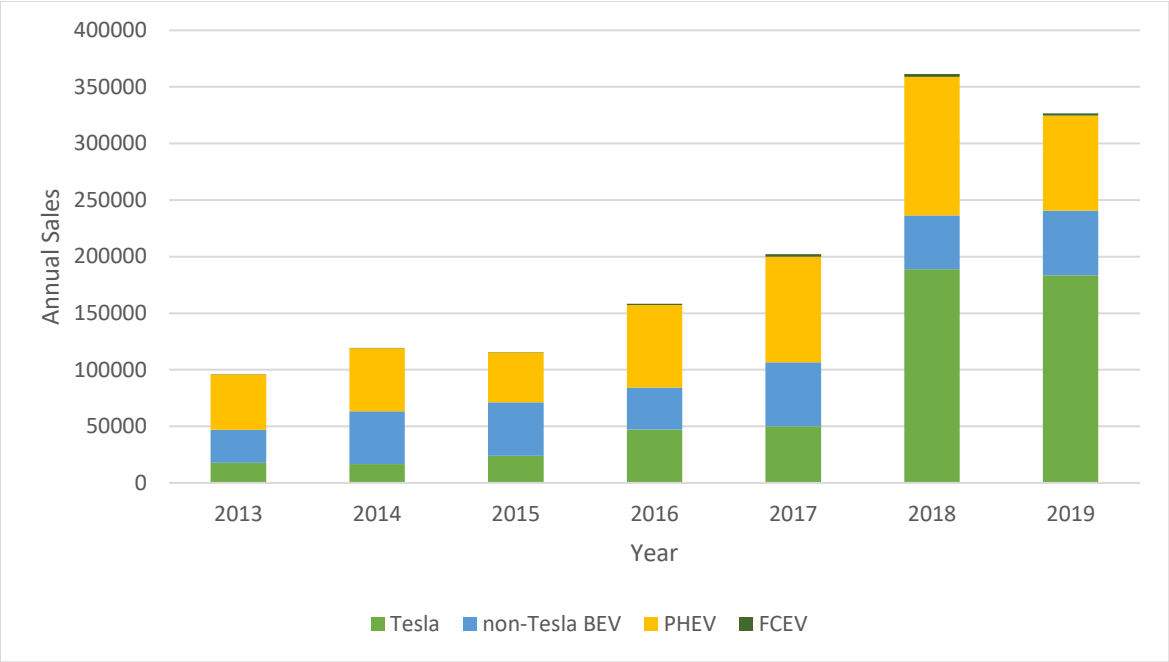

Figure A1: Non-Tesla BEV, Tesla BEV, PHEV, and FCEV sales in the USA 2013-2019.

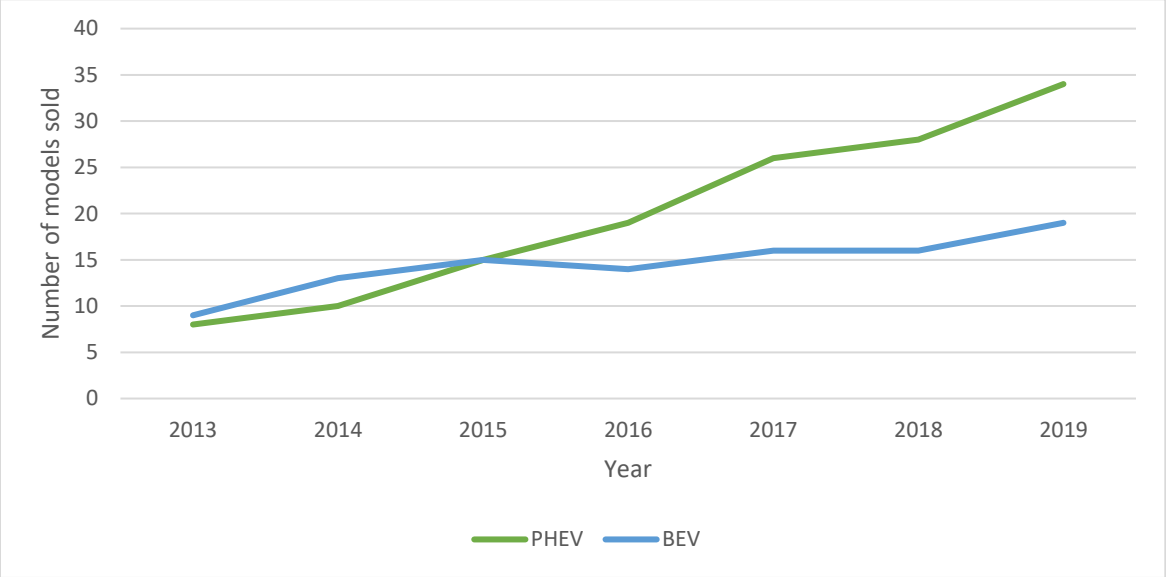

Figure A2: Number of PHEV and BEV vehicle models sold in each year 2013-2019. Models are counted as being sold if more than 1 unit is sold in that year.

The data source for the two figures is EV Volumes. According to the data collected by EV volumes, in 2019, 34 PHEVs were available for purchase compared to 19 BEV models. Additionally, 22 more PHEV models have been proposed by major automakers in the next two years

Appendix B: Calculation of Potential Cost Savings

The potential cost saving from a full charge at home is calculated as the difference between the cost of driving a distance equal to the electric range of the PHEV (using battery mode) and the cost of driving the equivalent distance using gasoline. In other words, what would be the cost of driving distance 'd' only in the hybrid mode versus the cost of driving the same distance in electric mode. Here the distance "d" is equal to the electric range of the PHEV model or the maximum electric miles possible.

$$\text{Potential cost saving from a full charge at home} = \text{Cost of gasoline} * \frac{Distance"d"}{Miles\ per\ gallon} - Cost\ of\ electricity * Distance\ \text{"d"} * Energy\ consumed\ (kWh) per\ 100\ mile$$

For example, assuming gasoline price is $3 per gallon and the price of electricity is 18 cents per kWh, the Chevrolet Volt (Gen 2) with electric range of 53 miles will have potential cost savings

= (3*53/42) - (0.18*53*31/100) =3.79 – 2.96=$0.83 cents per full charge at home.

Appendix C: Coefficient (Log-Odds) Estimates of Logistic Regression Model, Correlation Matrix, and Results of Multi-collinearity Test

Survey Question used to construct the dependent variable of the logistic regression model: s5q1a. Which of the following best describes your charging over the last 30 days?

Possible responses: In the last 30 days we plugged in our car more than 4 times, In the last 30 days we drove the car as a hybrid car, we did not plug it in, In the last 30 days we drove the car mostly as a hybrid car, we plugged in 1-4 times

Table C1: Log-Odds Estimates of Logistic Regression Model

VARIABLES	(Model 1) Charger or not	(Model 2) Charger or not	(Model 3) Charger or not
Rate Paid @ home (cents/kWh)	-0.045***	-0.045***	-
	(0.0073)	(0.0072)	-
Cost saving ($/charge)	-	-	0.390***
	-	-	(0.0697)
Solar @ home	0.862***	0.890**	0.858***
	(0.1949)	(0.1942)	(0.1931)
Work available X Paid charging	0.273	0.297	0.305
	(0.1922)	(0.1923)	(0.1916)
Work available X Free charging	0.981***	1.001***	1.013***
	(0.2004)	(0.2006)	(0.2002)
Number of chargers @ work	0.018	0.018	0.016
	(0.0126)	(0.0126)	(0.0125)
Condominium dweller (base: detached)	-0.662***	-0.658***	-0.652***
	(0.1689)	(0.1690)	(0.168)
Apartment dweller (base: detached)	-1.988***	-1.985***	-2.001***
	(0.1571)	(0.1568)	(0.1564)
Age of primary driver	0.170***	0.171***	0.171***
	(0.0448)	(0.0448)	(0.0446)
Gender of primary driver (Male:1)	0.473***	0.487***	0.487***
	(0.1242)	(0.1240)	(0.1238)
Age of PHEV (in months)	-0.019***	-0.0189***	-0.020***
	(0.0051)	(0.0047)	(0.0046)
Electric range of PHEV (in miles)	0.019***	-	-
	(0.0047)	-	-
Power/Weight of vehicle (kW/metric ton)	-	0.021***	0.020***
	-	(0.0057)	(0.0056)
Gasoline miles in commute	-0.010**	-0.011***	-0.010**
	(0.0040)	(0.004)	(0.0040)
Importance of HOV benefit	-0.068***	-0.070***	-0.072***
	(0.0217)	(0.0217)	(0.0216)
Importance of parking benefit	-0.015	-0.0178	-0.021
	(0.0807)	(0.0807)	(0.0804)
Gas Price ($/gallon)	-0.228	-0.019	-
	(0.2232)	(0.2314)	-
Positive Environmental attitude	0.132**	0.137**	0.133**
	(0.0581)	(0.0580)	(0.0577)
Constant	3.232***	2.145**	1.203***
	(0.7171)	(0.8548)	(0.3519)
Log-likelihood	-1010.34	-1010.72	-1013.91

Table C2: Results from Test of Multicollinearity

VARIABLES	(Model 1) Charger or not	(Model 2) Charger or not	(Model 3) Charger or not
Rate Paid @ home (cents/kWh)	1.03	1.03	-
Cost saving ($/charge)	-		1.06
Solar @ home	1.10	1.10	1.10
Work available	2.05	2.05	2.05
Free/Paid charging	1.95	1.95	1.95
Number of chargers @ work	1.07	1.07	1.07
Dwelling Type	1.17	1.17	1.17
Age of primary driver	1.12	1.13	1.13
Gender of primary driver (Male:1)	1.08	1.08	1.07
Age of PHEV (in months)	1.20	1.11	1.08
Electric range of PHEV (in miles)	1.26	-	-
Power/Weight of vehicle (kW/metric ton)	-	1.16	1.15
Gasoline miles in commute	1.12	1.11	1.11
Importance of HOV benefit	1.06	1.06	1.06
Importance of parking benefit	1.04	1.04	1.04
Gas Price ($/gallon)	1.03	1.08	-
Positive Environmental attitude	1.05	1.05	1.05
Mean VIF	1.22	1.21	1.22

Though the acceptable cut-off for the VIF value is relative and depends on the reader, in all three model we observe that the VIF values are low enough and there should not be a multicollinearity issue..

Tables C3: Variance-Covariance Matrix shown as a Correlation Matrix

For all the models, the variance-covariance matrix does not reveal any serios multicollinearity issue. The highest correlation that we observe in all the tables is between cost of charging at work when charging is available and number of chargers. However, as the correlation is still below 0.5we decided to keep both variables in the model. The hypothesis for adding/keeping number of chargers was that more chargers can represent greater chance of finding charging opportunity that may in turn encourage charging behavior. We ran the model without number of chargers and there is no change in the sign of the coefficients of other factors included in the model

NOTE: the highlighted cells indicate negative values

Model 1: with electric range of the PHEV

e(V) |	Rate_paid	Solar	Work Available *Paid	Work Available * Free	Number of charger	Condo mimiu m	Apartmen t	Age of PHEV Owne r	Gender	Age of PHEV	Electric Range	Gas miles	Hov Lane Access Benefit	Parking Benefit	Gas price	Attitude towards environ ment
Rate_paid	1.00															
Solar	-0.11	1.00														
Work Available*Paid	-0.01	0.04	1.00													
Work Available* Free	-0.04	0.03	0.39	1.00												
Number of charger	-0.02	0.00	-0.47	-0.48	1.00											
Condomimium	0.01	0.19	-0.01	-0.02	-0.02	1.00										
Apartment	-0.08	0.24	-0.04	-0.14	-0.03	0.32	1.00									
Age of PHEV Owner	-0.04	-0.03	0.06	0.07	0.02	0.07	0.19	1.00								
Gender	-0.04	0.04	-0.03	-0.08	0.00	-0.02	-0.10	-0.15	1.00							
Age of PHEV	-0.01	-0.04	0.01	0.01	0.00	0.01	0.06	-0.04	-0.04	1.00						
Electric Range	0.06	-0.05	-0.02	-0.02	-0.01	-0.01	-0.03	0.04	-0.10	0.37	1.00					
Gasoline miles	0.05	-0.02	-0.04	-0.03	0.00	0.02	0.11	-0.03	-0.11	-0.11	0.17	1.00				
Hov Lane Access Benefit	0.03	0.03	-0.02	0.01	-0.03	0.00	0.07	0.01	0.00	-0.01	0.04	-0.11	1.00			
Parking Benefit	-0.01	0.01	-0.02	0.01	-0.01	-0.01	-0.06	0.02	-0.02	-0.01	-0.02	0.01	-0.17	1.00		
Gasoline price	-0.03	-0.03	-0.02	0.00	-0.01	0.02	-0.04	0.00	-0.01	0.12	-0.03	-0.02	0.06	-0.04	1.00	
Attitude towards environment	-0.02	0.00	0.03	0.07	-0.02	-0.02	-0.08	-0.08	0.08	-0.01	-0.03	0.08	0.06	-0.12	-0.06	1.00

Model 2: with power-to-weight ratio

e(V) |	Rate_paid	Solar	Work Available* Paid	Work Available * Free	Number of charger	Condomi mium	Apartmen t	Age of PHEV Owner	Gender	Age of PHEV	Gas miles	Hov Lane Access Benefit	Parking Benefit	Gas price	Attitude towards environm ent	Power-to-weight ratio
Rate_paid	1															
Solar	-0.11	1.00														
Work Available*Paid	-0.01	0.04	1.00													
Work Available* Free	-0.04	0.04	0.40	1.00												
Number of charger	-0.02	0.00	-0.47	-0.48	1.00											
Condomimium	0.01	0.19	-0.01	-0.02	-0.02	1.00										
Apartment	-0.08	0.24	-0.05	-0.14	-0.02	0.32	1.00									
Age of PHEV Owner	-0.04	-0.03	0.06	0.08	0.02	0.07	0.19	1.00								
Gender	-0.03	0.04	-0.04	-0.08	0.00	-0.02	-0.09	-0.15	1.00							
Age of PHEV	-0.03	-0.02	0.02	0.02	0.01	0.02	0.07	-0.06	-0.02	1.00						
Gasoline miles	0.05	-0.01	-0.04	-0.03	0.00	0.02	0.11	-0.03	-0.10	-0.15	1.00					
Hov Lane Access Benefit	0.03	0.04	-0.02	0.00	-0.03	-0.01	0.07	0.01	0.00	-0.02	-0.11	1.00				
Parking Benefit	-0.02	0.01	-0.02	0.00	-0.01	-0.01	-0.06	0.02	-0.02	-0.01	0.00	-0.17	1.00			
Gasoline price	-0.02	-0.04	-0.02	0.00	-0.02	0.02	-0.05	0.01	-0.03	0.18	0.03	0.06	-0.05	1.00		
Attitude towards environment	-0.01	0.00	0.03	0.07	-0.02	-0.02	-0.08	-0.08	0.08	0.00	0.08	0.07	-0.13	-0.07	1.00	
Power-to-weight ratio	0.05	-0.02	0.00	-0.01	-0.03	0.00	-0.03	0.05	-0.09	0.19	0.16	0.01	-0.03	0.26	-0.01	1.00

Model 3: with cost saving potential

e(V) |	Cost Saving Potential	Solar	Work Available *Paid	Work Available * Free	Number of charger	Condomimium	Apartment	Age of PHEV Owner	Gender	Age of PHEV	Power-to-weight ratio	Hov Lane Access Benefit	Parking Benefit	Gas price	Attitude towards environment
Cost Saving Potential	1														
Solar	0.09	1.00													
Work Available*Paid	0.02	0.04	1.00												
Work Available* Free	0.05	0.03	0.39	1.00											
Number of charger	0.01	-0.01	-0.47	-0.48	1.00										
Condomimium	0.00	0.19	-0.01	-0.02	-0.02	1.00									
Apartment	0.08	0.24	-0.05	-0.14	-0.02	0.33	1.00								
Age of PHEV Owner	0.04	-0.04	0.06	0.07	0.02	0.07	0.19	1.00							
Gender	0.04	0.03	-0.03	-0.08	-0.01	-0.02	-0.10	-0.15	1.00						
Age of PHEV	-0.03	-0.02	0.02	0.02	0.01	0.02	0.07	-0.06	-0.01	1.00					
Power-to-weight ratio	-0.02	-0.02	0.01	-0.01	-0.02	0.00	-0.02	0.05	-0.09	0.16	1.00				
Benefit	-0.02	-0.01	-0.04	-0.03	0.00	0.02	0.11	-0.03	-0.10	-0.15	0.16	1.00			
Parking Benefit	-0.06	0.04	-0.02	0.00	-0.03	-0.01	0.08	0.01	0.01	-0.03	0.00	-0.12	1.00		
Gas price	0.01	0.01	-0.02	0.00	-0.01	-0.01	-0.07	0.02	-0.02	-0.01	-0.02	0.01	-0.17	1.00	
Attitude towards environment	0.01	0.00	0.03	0.07	-0.02	-0.02	-0.09	-0.08	0.08	0.01	0.01	0.09	0.07	-0.13	1.00

Appendix D: Tailpipe Emission Savings Calculations

Table D1: Greenhouse Gas Emission Cost of Not-Plugging in

PHEV model	Annual miles (A)	Comb UF (D)	E- Range (E)	MPG (F)	Max. E miles (G)= D*A	Gas miles (H)=A-G	Gas to Drive Max. E Miles(I) =G/F	Tailpipe C02 (gm) Add (J)=I*11405.85	Tailpipe CO2 (gm) usual (K)=(H/F)*11405.85	kWh/100 miles (L)	kWh Emiles(M)=(L/100)*G	Grid Emission (gm) (N)=M*378.54	Plug in emissions (O)=K+N	Non Plug in emissions (P)=(A/F)*11405.85	% increase (P-O)/O)
Volvo XC 90	15000	0.437	17	27	6555	8445	242.7778	2769086.917	3567496.417	55	3605.25	1364731.335	4932227.75	6336583.333	28%
BMW 3 Series	15000	0.359	14	31	5385	9615	173.7097	1981306.524	3537653.153	47	2530.95	958065.813	4495718.97	5518959.677	23%
BMW 5 Series	15000	0.388	16	29	5820	9180	200.6897	2289036.103	3610541.483	46	2677.2	1013427.288	4623968.77	5899577.586	28%
Chevrolet Volt Gen 1	15000	0.66	38	37	9900	5100	267.5676	3051835.541	1572157.703	35	3465	1311641.1	2883798.8	4623993.243	60%
Honda Clarity	15000	0.731	48	42	10965	4035	261.0714	2977741.554	1095776.304	31	3399.15	1286714.241	2382490.54	4073517.857	71%
Chrysler Pacifica	15000	0.617	33	32	9255	5745	289.2188	3298785.68	2047706.508	40	3702	1401355.08	3449061.59	5346492.188	55%
Chevrolet Volt Gen 2	15000	0.761	53	42	11415	3585	271.7857	3099947.089	973570.7679	31	3538.65	1339520.571	2313091.34	4073517.857	76%
Hyundai Sonata	15000	0.564	28	39	8460	6540	216.9231	2474192.077	1912673.308	34	2876.4	1088832.456	3001505.76	4386865.385	46%
Mitsubishi Outlander	15000	0.488	22	25	7320	7680	292.8	3339632.88	3503877.12	45	3294	1246910.76	4750787.88	6843510	44%
Audi A3 etron	15000	0.393	16	39	5895	9105	151.1538	1724038.096	2662827.288	40	2358	892597.32	3555424.61	4386865.385	23%
Prius Prime Gen 2	15000	0.529	25	54	7935	7065	146.9444	1676026.292	1492265.375	25	1983.75	750928.725	2243194.1	3168291.667	41%
Hyundai Ioniq	15000	0.572	29	52	8580	6420	165	1881965.25	1408183.788	28	2402.4	909404.496	2317588.28	3290149.038	42%
Kia Optima	15000	0.572	29	40	8580	6420	214.5	2446554.825	1830638.925	33	2831.4	1071798.156	2902437.08	4277193.75	47%
Ford C-Max Energi	15000	0.4506	20	38	6759	8241	177.8684	2028740.53	2473568.68	37	2500.83	946664.1882	3420232.87	4502309.211	32%
Ford Fusion pre-2019	15000	0.478	20	42	7170	7830	170.7143	1947141.536	2126376.321	37	2652.9	1004228.766	3130605.09	4073517.857	30%
Kia Niro	15000	0.54	26	46	8100	6900	176.087	2008421.413	1710877.5	32	2592	981175.68	2692053.18	3719298.913	38%
Prius Plug-in Hybrid	15000	0.29	11	50	4350	10650	87	992308.95	2429446.05	29	1261.5	477528.21	2906974.26	3421755	18%

Note: 1) We assume that the annual miles driven using a PHEV is 15,000

2) The vales of utility factor and MPG is derived from the dataset of fueleconomy.gov

3) The value average emission factor at the grid level and the conversion factors used here is as follows:

- Well-to-wheel CO2 emission (gCO2e/Kwh) =378.54 (Source: California Air Resource Board Report)
- Well to wheel CO2 emission (gCO2e/gallon) = 11405.85 (Source: California Air Resource Board Report)
- 1 MJ=0.2778kWh, 1lb=453.59 gms=0.0005ton