# Energy Impact of Plug-in Hybrid Electric Vehicles

## OVERVIEW

Plug-in hybrid electric vehicles (PHEVs) consume both gasoline and grid electricity. The corresponding temporal energy consumption and emissions are valuable to investigate. The 24-hour energy consumption and emission profile depends on different vehicle designs and driving and charging scenarios. This work assesses the potential energy impact of PHEVs in the South Coast Air Basin of California by considering different charging scenarios consisting of different charging powers, locations and time. Driving behaviors are derived from the National Household Travel Survey 2009 (NHTS 2009) and vehicle parameters are based on realistic assumptions consistent with projected vehicle deployments. Results show that petroleum reduction is significant; all electric ability is crucial to cold start emission reduction; the benefit of higher power charging is small; delayed and average charging are better than immediate charging for home; and non-home charging increases peak grid load.

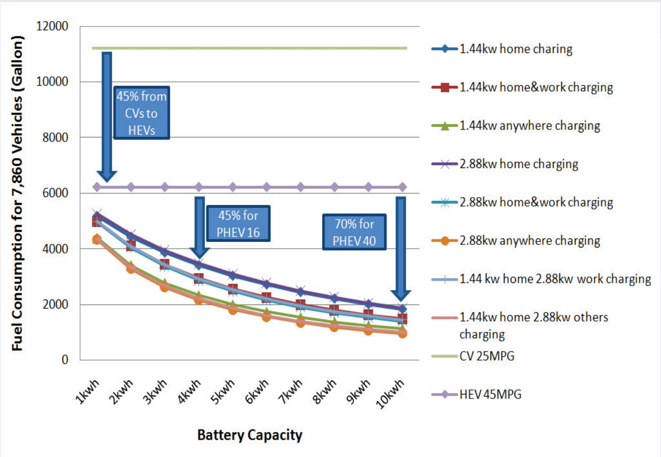
## GOALS

Evaluate the temporal fuel, electricity consumption and emissions in the South Coast Air Basin of California (SoCAB) based on different charging scenarios and vehicle parameters.

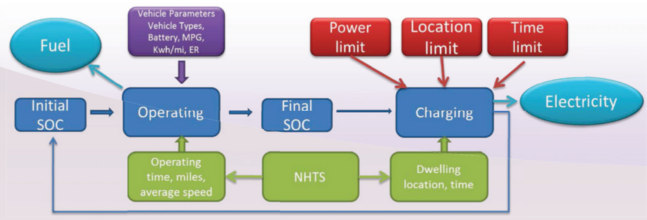
## RESULTS

Fuel reduction is significant. PHEVs with 16 and 40 miles all electric range can reduce fuel consumption by 45% and 70% respectively, compared to HEVs by only using 1.44 kW (SAE J1772 Level 1) home recharging.

Increasing charging power from 1.44 kW (Level 1) to 2.88 kW (Level 2) does not substantially benefit fuel reduction for any charging scenario. And, the impact of having more non-home charging locations is very limited. The main factor that drives the fuel consumption down is the battery capacity, i.e. the all electric range of the PHEVs.

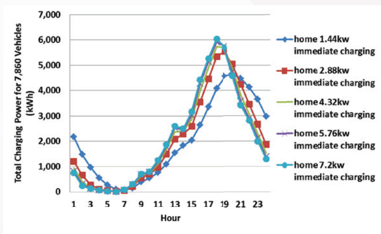



**Fuel savings as a function of vehicle type, PHEV battery size, and different charging scenarios.**

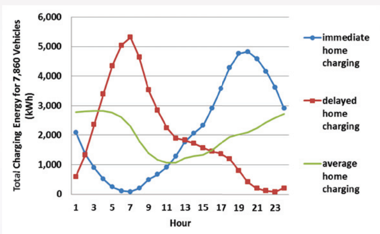



**PHEV operating and charging model.**

Higher charging power for immediate home charging pushes the PHEV fleet load peak earlier in the day, closer to the system wide load peak. Delayed charging has a similar profile shape to that of immediate charging, but the peak is delayed to between 5:00 am to 9:00 am in the morning, which coincides nicely with the nighttime dip in the SoCAB load curve to fill the concave valley on existing grid load.



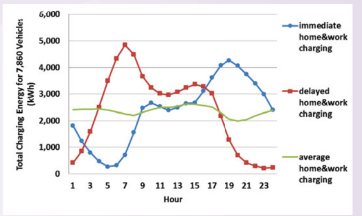

**Charging power effects on PHEV32 fleet charging load.**



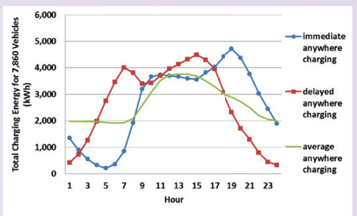

**Three time strategies for PHEV32 home Level 1 charging.**

## RESULTS (continued)

With respect to charging locations of home & work and anywhere, the instantaneous electricity consumption of immediate, delayed and average charging scenarios change in a similar way. During the day time, electricity consumption increases with the increased locations, while during other periods, the trend changes little. At non-home locations, neither the delayed nor average charging strategy can change the electricity consumption in the day time; all have similar characteristics in terms of trend and magnitude.




**Three time strategies for PHEV32 home and work Level 1 charging.**




**Three time strategies for PHEV32 anywhere Level 1 charging.**

## RECENT PUBLICATIONS/PAPERS


L. Zhang, T. Brown, G.S. Samuelsen (2011). Fuel reduction and electricity consumption impact of different charging scenarios for PHEVs. J. of Power Sources, Vol. 196, No. 15, pp. 6559-6566.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