

# Two-year study finds households manage plug-in hybrids without help from online tools

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(Phys.org)—Households with plug-in hybrid vehicles, or PHVs, and smart meters actively managed how, when and where they charged their cars based on electricity rates but rarely took advantage of online

feedback, a University of Colorado Boulder study found.

CU-Boulder's Renewable and Sustainable Energy Institute, or RASEI, today presented findings from the two-year study—one of the only of its kind, combining both household and vehicle data in a smart-grid context.

"Although households had access to online feedback on electricity use, we were surprised that most were not interested in using it to control their vehicle charging," said Barbara Farhar, principal investigator and senior research associate at RASEI. "However, households still actively managed their charging in other ways."

The study was sponsored by [Toyota Motor](#) Sales U.S.A. Inc. with the integral partnership of Xcel Energy.

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Households had access to two websites. One served as a nearly instantaneous meter of vehicle [electricity consumption](#) when the car was plugged in. The other website gave delayed feedback on overall household electricity use. Approximately 90 percent of the households looked at the websites only a few times or less. Some never looked at the websites.

Households created distinct methods of managing their vehicle charging based on personal preferences, pricing and convenience.

Initially, approximately half the households were randomly assigned to

an "unmanaged" scenario, allowing PHV charging through their in-home smart plug at any time of day. The other half were randomly assigned to a "managed" scenario, which meant their smart plugs were initially programmed to charge only from 10 p.m. to 6 a.m. daily.

Households were shown how to change their charging scenarios from "managed" to "unmanaged" or vice versa and were free to alter the scenarios in any way they wanted. Approximately half of the households had standard and the other half had time-of-use [electricity rates](#).

Most of those with standard electricity rates preferred the "unmanaged" scenario, and most of those with time-of-use rates preferred the "managed" scenario, many using a "set it and forget it" approach. Quite a few found the time constraints of the "managed" scenario inconvenient.

"Electricity pricing appeared to drive charging behavior and time cost or convenience was also very important," said Farhar. "People loved not having to go to the gas station."

Other findings of the study included a high level of satisfaction among households with the car, but a low level of satisfaction with its electric-only range, about 14 miles of cruising from a full charge, which took three hours in a regular 110-volt outlet.

The PHVs averaged 68 mpg on gasoline and were used for an average of 3.2 trips per day. Altogether, the cars used 27 megawatt-hours of electricity. It was less expensive to drive on electricity as a fuel than gasoline, even when paying higher on-peak electricity rates, according to an [Xcel Energy](#) analysis.

Some [households](#) charged at locations other than home. Using data from the vehicles, study investigators are continuing to look into where and when away-from-home charging took place.

The two-year study also allowed Toyota to test the PHVs in the Colorado environment including high altitudes, temperature extremes and mountainous terrain.

"The RASEI study demonstrates the importance of testing new technologies with real customers in everyday circumstances," said Bill Reinert, Toyota advanced technology vehicle national manager. "The results are often unexpected but help us understand the needs of potential customers and how to successfully introduce advanced technologies to the market."

**More information:** [rasei.colorado.edu/](http://rasei.colorado.edu/)

Provided by University of Colorado at Boulder

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