NREL Highlights RESEARCH & DEVELOPMENT

Tool Helps Utilities Assess Readiness for Electric Vehicle Charging

NREL research helps answer a fundamental question regarding electric vehicles: Is the grid ready to handle them?

Environmental, economic and security concerns regarding oil consumption make electrifying the transportation sector a high national priority. NREL's Center for Transportation Technologies & Systems (CTTS) has developed a framework for utilities to evaluate the plug-in vehicle (PEV) readiness of distribution transformers. Combining a wealth of vehicle performance statistics with load data from partner utilities including the Hawaiian Electric Company and Xcel Energy, NREL analyzed the thermal loading characteristics of distribution transformers due to vehicle charging. After running millions of simulations replicating varying climates and conditions, NREL is now able to predict aging rates for transformers when PEVs are added to existing building loads.

With the NREL tool, users define simulation parameters by inputting vehicle trip and weather data; transformer load profiles and ratings; PEV penetration, charging rates and battery sizes; utility rates; the number of houses on each transformer; and public charging availability.

Transformer load profiles, drive cycles, and ambient temperature data are then run through the thermal model to produce a one-year timeseries of the hotspot temperature. Annual temperature durations are calculated to help determine the annual aging rate.

Annual aging rate results are grouped by independent variables. The most useful measure is transformer mileage, a measure of how many electrically-driven miles must be supplied by the transformer. Once the spectrum analysis has been conducted for an area or utility, the outputs can be used to help determine if more detailed evaluation is necessary, or if transformer replacement is required.

In the majority of scenarios, transformers have enough excess capacity to charge PEVs. Only in extreme cases does vehicle charging have negative long-term impact on transformers. In those cases, upgrades to larger transformers would be recommended. NREL analysis also showed opportunity for newly-installed smart grids to offset distribution demands by time-shifting the charging loads.

Most importantly, the model demonstrated synergies between PEVs and distributed renewables, not only providing clean renewable energy for vehicles, but also reducing demand on the entire distribution infrastructure by supplying loads at the point of consumption.

This project is part of the Hawaii Clean Energy Initiative (HCEI) to increase the state's PEV use in pursuit of overall integrated deployment goals.

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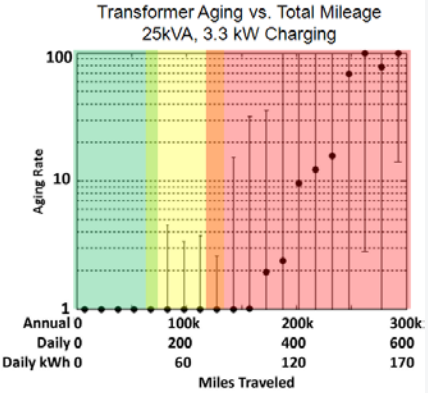

Relative thermal aging rate as a function of transformer mileage for a transformer serving 12 houses. In this case, homeowners owning 10 PEVs (50% PEV penetration) could each drive 20 miles per day before the transformer exhibited any thermal aging acceleration.

Key Research Results

Achievement

NREL now has a simulation tool that utilities can use to assess the potential effect of additional PEV loads.

Key Result

Preliminary test cases show that existing transformer capacity is capable of serving PEV power demands.

Potential Impact

The infrastructure required to charge PEVs must be assessed and possibly upgraded before these vehicles can be widely adopted. NREL's simulations provide actionable data on potential grid impacts, making important contributions in the effort to get more EVs on the road and, ultimately, diminish polluting emissions and reliance on fossil fuels.

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