Feature—More Cars = Cleaner Air?

Study: Millions of EVs Charged by a Cleaner Grid Could Dramatically Reduce Greenhouse Gas Emissions

By Chris Warren

With global momentum building toward a lower carbon economy, the electric power sector is poised to play an important role. According to growing body of research by EPRI and others, decarbonizing electricity and then using electricity to enable greenhouse gas emissions reductions in other sectors is one of the most efficient pathways to a low-carbon economy.

What happens to greenhouse gas emissions if millions of electric vehicles take to the road, powered by a cleaner grid? EPRI and the Natural Resources Defense Council (NRDC) addressed this question in the study, *Environmental Assessment of a Full Electric Transportation Portfolio*. A follow-up to a *similar analysis in 2007*, the researchers used several models to project greenhouse gas emissions reductions by 2050 from widespread adoption of electric transportation.

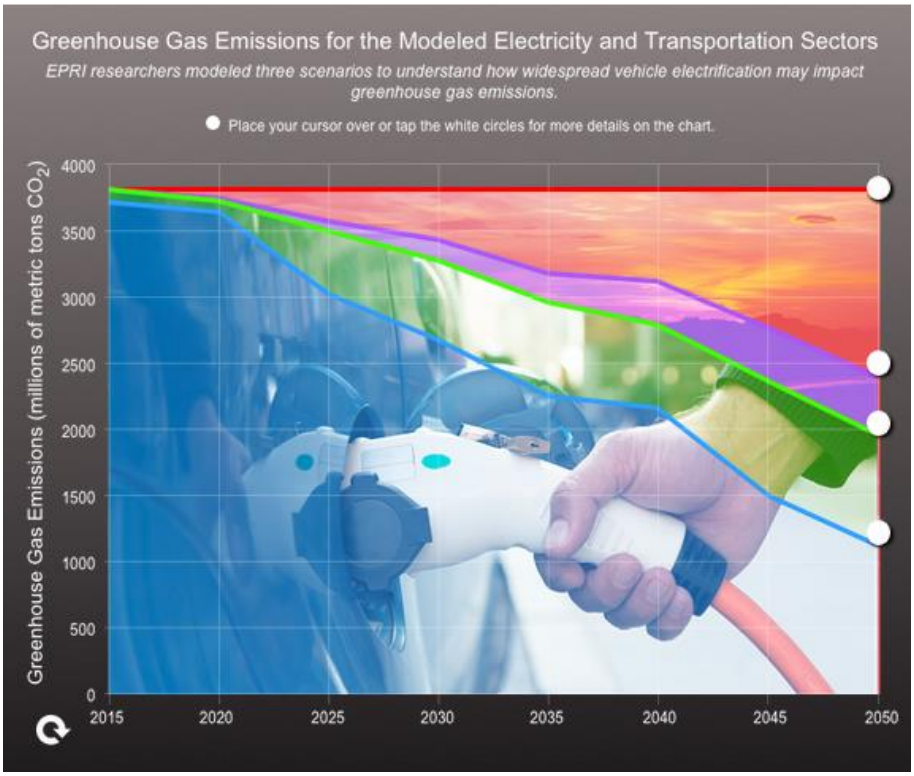
The Electric Car in 2050

This *EPRI Journal* series examines the future of electric transportation and its potential impacts on emissions, the grid, business models, and driver experience.

Researchers analyzed two power sector scenarios for 2050, both of which assumed that electric vehicles would account for 53% of all miles driven by cars and trucks—up from less than 1% today—and that carbon capture and storage would be available by 2025. In the conservative scenario, the combined emissions reduction in 2050 from electricity generation and transportation is about 48% relative to today's levels. In the more aggressive scenario, the reduction is about 70%. The main difference between the two scenarios is that the latter assumes that a carbon tax of $20 per ton of carbon dioxide emissions begins in 2025, then increases 5% each year.

"We consider these scenarios to be reasonably aggressive but achievable," said Marcus Alexander, a principal technical leader at EPRI, who worked on the report. "The main point is that increased electrification in transportation means substantial reductions in greenhouse gas emissions. Even with today's electricity

generation mix, electrification reduces emissions because electric motors and batteries convert energy into motion more efficiently than internal combustion engines."



Four Steps, Four Models

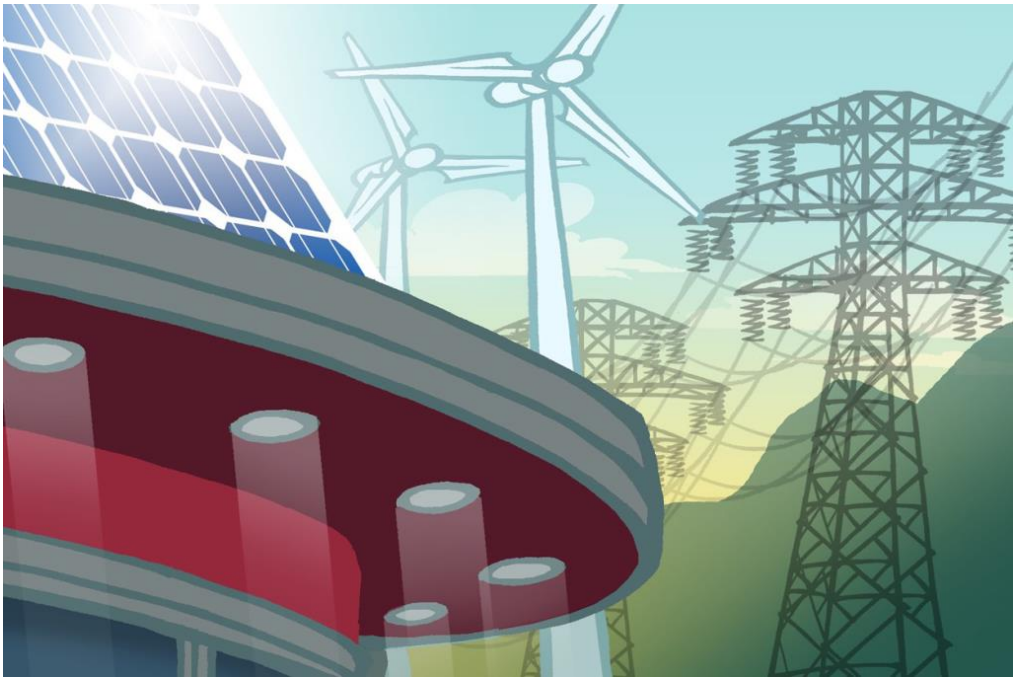
Because no single model can project emissions reductions from a large increase in electric vehicles, researchers based their analysis on four established models that enable projections of electric vehicle adoption rates, driving habits, changes in electricity generation, and more.

EPRI's Market Analysis Tool software charted electric vehicle market share over the next few decades, as well as electricity and fuel consumption in the transportation sector. EPRI analysis of national transportation statistics resulted in a set of *utility factors*—ratios of electric- to gasoline-powered mileage based on daily driving patterns and characteristics of plug-in hybrid electric vehicles. To determine total emissions, researchers built a model that used these ratios, along with per-mile emissions figures for gasoline- and electric-powered driving.

The Argonne National Laboratory's Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation model, or GREET, provided data on life cycle emissions from transportation fuels, and EPRI's U.S. Regional Economy, Greenhouse Gas, and Energy model (US-REGEN) evaluated how energy policies and power sector and economic trends may impact the future generation mix.

The analysis involved four steps:

1. Model baseline emissions assuming no electrification.
2. Model an electrified transportation sector, quantifying the reduction of petroleum use and the increase of electricity consumption for vehicle charging.
3. Use US-REGEN to determine the generation mix charging all the new electric vehicles in the aggressive and conservative grid scenarios.
4. Based on the generation mix, calculate emissions from both grid scenarios, including emissions from battery production. These were compared to the baseline emissions projections.



Greater Reductions Possible

While the 70% reduction in greenhouse gas emissions projected by the EPRI-NRDC study is ambitious, steeper cuts are possible. The analysis did not include the Clean Power Plan, which could speed the transition to a cleaner generation portfolio. Researchers also assumed that two significant drivers of renewable energy development—the federal Investment Tax Credit for solar and the Production Tax Credit for wind—will not be renewed for an extended period. The solar tax credit was slated to fall from 30% to 10% in 2017, though it was recently extended to 2021. The wind Production Tax Credit has expired and received a series of short-term extensions in recent years. If these tax credits remain, grid electricity could be even cleaner.

Also, the analysis did not factor in possible breakthroughs in energy storage or an expansion of vehicles fueled by natural gas, hydrogen or biofuels, which could significantly reduce transportation sector emissions. Nor did it consider a more expansive definition of electrified transportation. “We looked at emissions reductions that are possible without significant changes across many transportation sectors,” said Alexander. “For example, replacing long-distance trucking with electrified rail is an economically viable option by 2050, but because it would require large changes in multiple sectors, we decided not to include that.”

The results indicate that electric vehicles can be a powerful tool to reduce greenhouse gas emissions. “The study shows that electricity is a low-emissions transportation fuel today and has the potential to be significantly lower-emitting in the future,” said Alexander.

Key EPRI Technical Experts

Marcus Alexander, Eladio Knipping