EPRI ELECTRIC POWER RESEARCH INSTITUTE

NRDC NATURAL RESOURCES DEFENSE COUNCIL

Electrifying Transportation Reduces Greenhouse Gases and Improves Air Quality: Executive Summary

The Electric Power Research Institute (EPRI) and the Natural Resources Defense Council (NRDC) produced the Environmental Assessment of a Full Electric Transportation Portfolio to provide in-depth analysis of the environmental impact of electrifying a range of vehicles, including U.S. light-duty and medium-duty transportation and industrial equipment such as forklifts.

The study simulates emissions and air quality impacts of a significant shift from internal combustion engines to electric vehicles and equipment.

Findings

The study bases its analysis on projections that the electric grid will rely more on renewable energy and non-emitting power generation. It corroborates earlier findings that a decarbonizing grid accommodating a fleet of electric vehicles would reduce emissions relative to scenarios in which transportation, industrial and other fleets continue to rely primarily on petroleum fuels. With the widespread adoption of plug-in electric vehicles (PEVs), greenhouse gas (GHG) emissions would be reduced, even when compared with more efficient conventional vehicles. Electrifying vehicles and non-road equipment will lead to better air quality.

The study analyzes two potential scenarios of the future electric sector, the "Base GHG" and "Lower GHG." Both show grid emissions decreasing over time, in part because of existing and potential regulations and plausible economic conditions. In the Lower GHG scenario, further reductions in carbon emissions result from an increasing price on carbon, resulting in faster deployment of low-emission generation technologies.

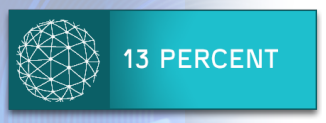
- In the Base GHG scenario, the study estimates that, by 2050, the electricity sector could reduce annual greenhouse gas emissions by 1030 million metric tons relative to 2015 levels, a 45% reduction.
- In the Lower GHG scenario, the study estimates that, by 2050, the electricity sector could reduce annual greenhouse gas emissions by 1700 million metric tons relative to 2015 levels, a 77% reduction.

The analysis modeled electric sector and transportation sector emissions with and without widespread vehicle electrification to determine the effect of electrification of light-duty vehicles, medium-duty vehicles and certain non-road equipment. The results indicate that electrification could displace emissions from conventional petroleum-fueled vehicles for each scenario:

- In the Base GHG scenario, emissions were reduced by 430 million metric tons annually in 2050—equivalent to removing 80 million passenger cars from the road.
- In the Lower GHG scenario, emissions were reduced by 550 million metric tons annually in 2050—equivalent to removing 100 million passenger cars.

When combining reductions from vehicle electrification, a cleaner electric sector, and existing programs that improve conventional vehicle efficiency, the modeled electricity and transportation sectors together achieve a 48% reduction in GHG emissions between 2015 and 2050 in the Base GHG scenario, and a 70% reduction in the Lower GHG scenario. In the Lower GHG scenario, in 2050, total emissions for the electricity and transportation sectors could be reduced by 2610 million metric tons relative to 2015 levels.[1]

[1]This reduction includes 1700 million metric tons (MM tons) from the utility sector, 550 MM tons from transportation electrification, and 360 MM tons from efficiency improvements in remaining petroleum-based transportation.



While electric vehicles are cleaner than petroleum-fueled vehicles today, the greenhouse gas reductions can be maximized by charging vehicles from a cleaner grid. With a 62% share of light- and medium-duty vehicles in 2050, electric vehicles would consume 13% of grid-supplied electricity.

Transportation electrification can lead to modest but widespread air quality benefits. The study's models project that PEVs can help reduce ground-level ozone and particulate matter in both urban and rural areas across the country. Air quality benefits from adoption of PEVs are expected to increase as the power system becomes cleaner and a greater portion of the transportation fleet is electrified.

Report Overview

The report examines the potential impact on greenhouse gas emissions and air quality of the widespread adoption of electricity in transportation energy use. It is based on a projection that by 2050 electricity replaces traditional fuels for approximately half of light- and medium-duty transportation and a significant portion of non-road equipment. This study builds on the 2007 Environmental Assessment of Plug-in Hybrid Electric Vehicles by EPRI and NRDC, which showed that plug-in hybrid electric vehicles could contribute to reductions in national greenhouse gas emissions, while also leading to improved air quality. As with the earlier assessment, this study consists of two separate, but related, analyses: greenhouse gas emissions from 2015-2050, and air quality impacts in 2030.

Volume 1: Background, Methodology and Best Practices

Background information includes recent emissions trends, a literature review, and a discussion of best practices for modeling large-scale changes in electricity sector load. Among the trends cited are those showing that U.S. grid emissions per kilowatt-hour are already declining. From 2003 to 2013, CO_2 emissions intensity decreased by 15%, SO_2 emissions intensity decreased by 70%, and NO_X emissions intensity decreased by 50%, while during the same period electricity generation increased by 6%. Greenhouse gas emissions reductions are occurring in every U.S. region, although regional emissions rates vary widely.

Volume 2: Greenhouse Gas Emissions

Volume 2 describes modeling and results for greenhouse gas emissions. It examines the potential for electrification to reduce transportation greenhouse gas emissions, accounting for the emissions of petroleum fuels and electric power as transportation fuels. The analysis considers the potential for clean generation sources to achieve deep reductions in overall electric sector emissions.

The analysis assumes that electric transportation technologies are widely adopted. For example, the electric vehicle market share grows from approximately 1% today, to a substantial share of total sales, such that by 2050 electricity is powering 53% of personal vehicle miles traveled. As transportation is electrified, a comprehensive grid model uses the incremental load growth to estimate power sector emissions. The analysis compares resulting grid emissions with emissions from conventional petroleum fuels, using a full-fuel-cycle method that accounts for the production, delivery and use of fuels in the transportation and electricity sectors. It estimates emissions for two generation scenarios, the Base Greenhouse Gas scenario and the Lower Greenhouse Gas scenario.

Without electrification, the results point to a 24% reduction in GHG emissions relative to 2015 levels, based on current policies that require greater efficiency for new vehicles, along with additional, assumed improvements.

The importance of electrifying transportation is emphasized by this analysis, which finds that GHG emissions can be reduced 52% in the Base scenario, and reduced 60% in the Lower scenario.

Volume 3: Air Quality

Volume 3 evaluates air quality impacts of electric transportation by simulating air quality in 2030 with and without electrification. The electrification case assumes that the overall fraction of vehicle miles traveled by the U.S. vehicle fleet using electricity stored in batteries is 17% for light-duty vehicles and 8% for medium-duty vehicles. For non-road equipment, the fraction in 2030 varies for electrified equipment types depending upon their characteristic applications and uses. Emissions from transportation and power sectors were calculated and subsequent effects on air quality were modeled in the continental United States, using a comprehensive three-dimensional atmospheric model.

Considering the electric power sector and transportation sectors together, net emissions of pollutants leading to atmospheric ozone and fine particulate matter ($PM_{2.5}$) decrease in the electrification scenario. Modeling simulations indicate that even considering recent Tier 3 vehicle emission standards, electrifying on-road vehicles can result in modest, yet widespread reductions in ozone and $PM_{2.5}$ levels throughout the United States. Electrifying non-road equipment provides significant air quality benefits, in some cases greater than those of on-road electrification, particularly in urban areas. The electrification scenario also showed reductions in the deposition of acids and nutrients that can damage ecosystems.

For More Information

To download a complete copy of the report, visit www.epri.com or scan this QR Code.

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