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Integrated assessment of large-scale plug-in hybrid electric vehicle penetration on the electric sector and the environment

E.M. Knipping, M. Duvall, C. Clark, N. Kumar, R. Graham
Electric Power Research Institute, Palo Alto, CA 94304, USA
(eknippin@epri.com / Phone: 650-855-2592 / Fax: 650-855-1069)

Interest in electric transportation in the United States, particularly plug-in hybrid electric vehicles (PHEVs), has increased dramatically as a realistic alternative to conventional gasoline powered vehicles. Major automobile manufacturers have earmarked PHEV development as part of a strategy to develop flexible fuel options. As PHEV market penetration increases, petroleum fuels are being displaced by grid electricity, likely changing the emissions signature and energy consumption patterns. The Electric Power Research Institute (EPRI) has begun groundbreaking research to better understand the CO_2 emission offsets and air quality impacts of plug-in electric hybrid vehicles. It is important for this analysis to incorporate present and future energy costs, varying levels of PHEV market penetration, vehicle technologies, and various portfolios of power generation technologies.

CO_2 Emission/Energy Analysis. EPRI is analyzing the impact of PHEV technology on CO_2 emissions by overlapping expected technology roadmaps for both new electricity generation and electric-drive vehicle technologies. Several scenarios examine different market penetration cases as well as energy costs and environmental constraints that may influence the mix of transportation and electric generation technologies available in the 21st century.

Air Quality Analysis. EPRI is performing air quality model simulations for a full calendar year to evaluate particulate matter, visibility, and deposition impacts that may occur year-round. Ozone impacts will be evaluated from the summer portions of the air quality simulations. PHEVs are expected to reduce emissions from on-road vehicles.

Refueling emissions should also decline because of lower fuel consumption. Greater electricity consumption as a result of PHEVs would influence the emissions from electric generating units, although total NOx, SO_2, and mercury emissions would still need to satisfy the requirements of the U.S. Environmental Protection Agency (EPA) Clean Air Interstate Rule and Clean Air Mercury Rule. EPRI will calculate the magnitudes of emissions changes and implement these changes in a future year (2030) emissions inventory.

EPRI is using the EPA Community Multiscale Air Quality (CMAQ) Model in the Air Quality Analysis. In the first phase of the air quality analysis, EPRI is examining the air quality impacts of PHEVs compared to a baseline scenario developed using assumptions consistent with the U.S Department of Energy's 2006 Annual Energy Outlook (AEO). EPRI will also modify the air quality analysis to ensure consistency with the California Energy Commission's 2005 Integrated Energy Policy Report (IEPR). In essence, the first phase of the air quality portion of the study explores the impact of PHEV on criteria emissions and air quality impacts in 2030 based on a scenario without any U.S. CO_2 emissions policy or greenhouse gas constraints.

The second phase of the air quality study (expected later in 2007) will examine how criteria emissions and air quality are influenced in 2030 by scenarios that offer plug-in hybrid electric vehicles as an option for satisfying a national CO_2 emissions policy or other greenhouse gas emissions constraints. Due to the computational burden of the air quality models used in this study, EPRI researchers will use information and lessons learned from the abovementioned CO_2 emissions/energy analysis to help guide the development of an appropriate greenhouse gas policy framework to use in the second phase of the air quality study.