Testimony for the Record

Dr. Mark Duvall
Senior Project Manager – Transportation
Power Delivery and Markets Sector
Electric Power Research Institute
Energy Subcommittee of the Science Committee
May 17, 2006

On behalf of the Electric Power Research Institute, I appreciate the opportunity to address your committee. My remarks will offer a brief history of plug-in hybrid electric vehicle development, the current status of the technology and answers to some questions posed by committee staff.

Recent History of Plug-in Hybrid Electric Vehicle Development

In 2000, EPRI created a Hybrid Electric Vehicle Working Group (HEVWG) in conjunction with Ford, General Motors, Argonne National Laboratory, National Renewable Energy Laboratory, New York Power Authority, Southern Company and Southern California Edison. The HEVWG was supported by a consulting team with a strong background in marketing, emissions, and cost analysis.

The resulting study that compared the benefits, costs and challenges between conventional vehicles, hybrid vehicles and plug-in hybrid vehicles (PHEV) set the stage for additional research over the past six years on battery technology, control system development, infrastructure, and environmental analysis. While R&D continues, EPRI has worked with other advocates to inform federal and state policy makers about the energy security benefits of plug-in hybrids—reducing U.S. dependency on petroleum while maintaining the usefulness and utility of conventional automobiles.

This R&D work identified the challenges facing plug-in hybrid commercialization. We found that the cost and durability of advanced battery technologies was the highest priority, followed closely by battery system and drive system vehicle integration and coordinated energy management. The analysis to date suggests that the technology, control systems and advanced battery systems are sufficient to move plug-in hybrid technology to the market at an early entry level. It further suggests that continued R&D on key component technologies is critical, especially advanced batteries. Additional analysis and experience with the vehicle and systems can lead to further optimization as test data is applied to the design of motor and engine systems, and engine/motor coordination strategies are further refined.

Current Status

At this time, plug-in hybrid technology is at the prototype stage, although with excellent prospects for near-term commercial development. As one example, EPRI and DaimlerChrysler are working with several electric utilities and the South Coast Air Quality Management District to test a small fleet of PHEVs with advanced battery technology. These prototypes are undergoing testing in Germany and Los Angeles. They are demonstrating excellent performance, and have the potential to demonstrate long-term durability.

Current battery technology is also proceeding well. The most recent batteries demonstrate excellent safety, power performance, and laboratory life. Future challenges will include verifying lifetime testing in field testing, and developing production facilities to ramp up the availability of this technology.

Questions

What major research, development, and demonstration work remains on plug-in hybrid electric vehicle technologies? How should this work be prioritized?

What are the largest obstacles facing the widespread commercial application of plug-in hybrid electric vehicles and what steps need to be taken to address these hurdles (batteries, infrastructure, consumer preference, automotive inertia, cost-competitiveness, etc.)?

There are three main technical challenges which will need to be addressed in the commercialization of plug-in hybrid electric vehicles: first, proof of concept of high performance energy batteries capable of PHEV operation; second, the development of a robust supplier base for automotive electric motors and hybrid vehicle components; third, the coordination of a safe and usable set of charging standards.

The first and primary challenge is the validation of batteries capable of meeting PHEV operation requirements. This is a considerable challenge which has been under evaluation for many years, but this work has made tremendous progress and the batteries which are currently available in prototype form are capable of meeting PHEV requirements. Although more basic research can always be helpful, the best way to address the battery challenge is to increase testing of current pre-production technology and push forward towards meeting the production challenges.

The development of a robust supplier base is an important second step. Plug-in hybrid vehicles are generally similar to conventional hybrid vehicles, so an important first step is increasing the potential pool of component users and component suppliers so that economies of scale can be generated as quickly as possible. This is a broad effort that will have to be addressed on a nationwide basis.

The third challenge is the coordination of a safe and usable set of charging standards. Americans need to know that charging their vehicles is as safe and easy as charging their cell phones. This is the easiest challenge to meet from a technical standpoint, but it will require active participation from regulators, the automotive industry, and the electric power industry.

How does the federal government support the development of plug-in hybrid electric vehicle technologies? What can the federal government do to accelerate the development and deployment of plug-in hybrid electric vehicles?

The most important question is what the federal government can do to help. The primary hurdle to plug-in hybrid development is the uncertainty of the market for electric transportation. In order to build batteries and components at a reasonable cost, considerable up-front capital investment is required. Although public comments by national leaders in support of PHEVs have been tremendously helpful, government can help further address this challenge by sending a clear signal that it supports this technology in the future. The following measures can be an important first step:

- Establish a program with the automotive manufacturers to create prototype demonstrations with a focus on near-term applications.
- Develop a plan for acquiring a fleet of plug-in hybrid electric vehicles in various configurations to be operated in multiple locations across the United States.
- As fleet data becomes available, collect and share the operating data to appropriately inform consumers and fleet operators about the benefits of plug-in hybrid technology.
- Direct the appropriate regulators to develop a certification test protocol for plug-in hybrid drive systems to maximize the benefits received by the manufacturer and consumer.
- Create an education program that informs the general public on the attributes of plug-in technology. In addition, create a program which reaches into the university level to educate science and engineering students on all types of electric-drive technology.
- Direct the national research programs to focus development on increasing the performance of batteries, electric drive systems, and power electronics. The Department of Energy recently held a summit laying out the research challenges; this effort should be fully funded and expanded as much and as soon as possible.

Does the discussion draft address the most significant barriers to the widespread adoption of plug-in hybrid electric vehicles?

EPRI has reviewed the discussion draft and is of the opinion that it addresses the most critical technical challenges to the development and adoption of plug-in hybrid vehicles. There is a high degree of correlation between the discussion draft and the six priorities listed by EPRI in response to the previous question.

How much additional energy demand could the electricity grid and utilities absorb if PHEV users decided to charge their vehicles in the middle of the day during peak power demand?

It is important to place the energy requirements of plug-in hybrids in perspective with current and projected U.S. electrical energy demands. A typical battery charger for a plug-in hybrid will draw about 1400 watts of power from a 120-volt outlet and be active for about 2-8 hours per day. This is roughly equivalent to an electric space heater. Several analyses by EPRI or the DOE estimate the energy demand of plug-in hybrids, even at 50% market penetration, at between 4-7% of total U.S. electricity demand. By 2050, total U.S. electrical demand is projected by the EIA to grow by almost 100%, 200 million plug-in hybrids (with an equivalent of 20 miles of electric range), driven and charged daily by their owners, would be responsible for approximately 4-7% of this growth.

It will take many years to reach even this level of electrical energy consumption—the charging load from PHEVs will grow slowly and predictably. The total PHEV charging load is anticipated to be relatively consistent and electric utilities and system operators will be able to accurately monitor and react to the adoption of the vehicles.

What would be the likely net impact in criteria pollutant emissions and greenhouse gas emissions with the commercialization of PHEVs?

There are two primary components to the criteria pollutants of PHEVs—upstream emissions—produced by the refineries that produce the gasoline or diesel fuel and power plants that generate the electricity to recharge the batteries—and tailpipe emissions produced when driving the vehicles.

Utilities today operate under a number of different compliance requirements for criteria emissions. In many cases key pollutants are capped. The recent EPA Clean Air Interstate Rule (CAIR) has established new, lower limits on the emissions of SOx and NOx. The Clean Air Mercury Rule (CAMR) will set a strict limit on mercury emissions. When these federal regulations are combined with state and local requirements, the general result is that each year utilities must generate more and more energy while decreasing the total amount of pollutants generated. A historical review of electric sector emissions in the U.S. shows a steady growth in demand (typically 1-2% per year) alongside a steady decline in emissions.

There is significant potential for PHEVs to improve urban air quality by the elimination of a portion of the tailpipe emissions. PHEVs with a moderate ability to operate in an all-electric driving mode can reduce the emissions associated with "cold starts" of the combustion engine. These vehicles can also operate using only electricity for extended stop-and-go driving in cities or other congested areas.

The greenhouse gas emissions of a plug-in hybrid are the sum of tailpipe emissions from the combustion of fuel, refinery emissions, and power plant emissions. Plug-in hybrids use less hydrocarbon fuel and have lower refinery and tailpipe greenhouse gas emissions than either conventional vehicles or non-grid hybrids that are commercially available today. PHEVs have the added greenhouse gas emissions produced by generating electricity to recharge the battery.

Plug-in hybrids that are recharged from today's national electric grid will have 37% fewer GHG emissions than conventional cars and 13% fewer than comparable hybrids. However, it is more useful to look at the future characteristics of electricity in the U.S. when there would be significant numbers of PHEVs in the market.

The carbon intensity of the electric sector is declining year-over-year. This is due to several factors, including the retirement of old, inefficient fossil plants (many of which are more than 50-70 years old), construction of new more efficient power plants, and introduction of renewables and other non-emitting technologies. As the utility sector reduces carbon intensity, the greenhouse gas emissions of PHEVs that are recharged from this electricity will also decline.

The degree to which the electric sector reduces carbon intensity depends on a number of factors, including the rate of introduction and cost of new technologies, cost of different energy feedstocks, and governmental policy. EPRI has simulated a number of future cases for up to 200 million PHEVs in the U.S. by the year 2050 as part of our current work characterizing the emissions characteristics of plug-in hybrids. Each of these cases, including a "worst case" scenario of minimum technology introduction and no downward drivers on CO2, resulted in a minimum GHG reduction of 44% compared to a conventional car.