

Plug-In Hybrid Electric Vehicles – What the Future Holds

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Rising energy demand, concern about global warming and the desire to shift the economy away from foreign energy resources have created new challenges and dynamics for the U.S. automotive industry. These challenges, especially with changing consumer preferences and volatile oil and gas prices, are formidable and will have widespread and lasting economic consequences.

Such challenges also create an environment for innovation. As we look to new technologies that hold great promise, the plug-in hybrid electric vehicle (PHEV) seems poised to bring significant changes to the U.S. auto market by tapping into the existing electric grid to reduce emissions, cut fuel costs for owners and lower U.S. dependence on foreign oil.

What are PHEVs?

Conventional hybrids like the Toyota Prius and Honda Civic Hybrid rely on gasoline for power, but PHEVs use an electric motor as the primary power source and have a gasoline internal combustion engine for backup and longer distance driving. The batteries in conventional hybrids are recharged through braking and decelerating; PHEVs are recharged through an electrical outlet.

Depending on the size of the battery, PHEVs have an electric-only driving range of 10-60 miles.¹ For some PHEV batteries, recharging could be done using a common 120-volt AC power outlet, but larger batteries would require a stronger 240-volt AC power supply. Lithium-ion (Li-ion) batteries, found in everyday consumer electronics like cell phones, are best for PHEVs because of their excellent power-to-weight capacity. However, Li-ion battery technology is relatively new and several issues, such as improving durability and cutting size, weight and cost must be worked out before Li-ion batteries can be used in large-scale production of PHEVs.

Many carmakers, including Ford, General Motors, Nissan, Toyota, and Volkswagen have PHEVs in different stages of production, and there is an unspoken race in the industry to deliver the first PHEV to market by 2010. Top competitors include the Chevrolet Volt, the Saturn Vue and Toyota with an updated Prius.

Benefits of PHEVs

Environmental

Plug-in vehicles will use significantly less gasoline than conventional vehicles and the hybrids already on the road. Most household vehicles travel less than 40 miles per day, and could rely solely on electric power, decreasing vehicle emissions. A joint study by the Electric Power Research Institute (EPRI) and the Natural Resources Defense Council (NRDC) found that widespread use of PHEVs could reduce vehicle

¹ American Council for an Energy-Efficient Economy, "PHEV Hybrids: An Environmental and Economic Performance Outlook" <http://www.aceee.org/pubs/t061.pdf>

greenhouse gas emissions by more than 450 million metric tons annually in 2050 – the equivalent of removing 82.5 million conventional passenger cars from the road.²

Economic

As with any new technology, the initial cost to purchase a PHEV will be higher than a conventional vehicle. However, the federal government has outlined tax rebates for the purchase of new PHEVs that will reduce some of the upfront costs.

In the long term, PHEVs could greatly cut the demand for gasoline, potentially reducing cost. By charging with off-peak, low-cost electricity, many PHEV owners will realize significant savings in their annual costs; indeed, estimates equate off-peak charging to buying gasoline at 60 cents per gallon.³ The U.S. National Renewable Energy Laboratory found that with current gas, electricity and battery prices added to manufacturing costs, PHEVs begin to provide a return on investment after 10 years. If battery and manufacturing costs decrease and gas prices escalate and remain steady at \$4-\$5 per gallon, owners would begin saving money after five years.⁴

Energy Independence and National Security

While the U.S. is consuming about 25 percent of the world's oil supply despite holding about only three percent of global reserves, energy independence has risen as an issue of national security. Scarcity (and resulting high prices) will only increase as global demand for oil continues from growing economies in China, India and elsewhere. According to the EPRI/NRDC report, expanded use of PHEVs in the U.S. could reduce oil imports by three to four million barrels per day by 2050,⁵ a solid step toward a more independent U.S. energy supply.

Challenges

A big obstacle to mass production of PHEVs has been the current limitations of the batteries. Chief among these is the hefty \$10,000 price tag for a battery that can go 40 miles on a single charge. Battery prices would have to come down to make PHEVs marketable. The industry is also working to reduce the size of the battery packs to increase the power-to-energy ratio. Additionally, Li-ion batteries have a limited lifetime and run hot, creating safety problems.

A major concern when considering full penetration of PHEVs into the market is the capacity and make-up of the electricity grid. Several studies predict that if most recharging occurs at night, minimal additional capacity may be needed. However, there could be unforeseen difficulties, such as the tendency of consumers to charge their PHEV when it is convenient, which could affect the reliability of electricity supplies nationwide.⁶ In the case of a national "smart grid" or use of technologies such as

² EPRI-NRDC Report Finds Environmental Benefits of Deploying PHEVs

<http://my.epri.com/portal/server.pt?open=512&objID=243&PageID=223132&cached=true&mode=2>

³ "Keeping Up with the Future – The Advent of the Age of the Plug-in Electric Vehicle," *Platt's Insight*, April, 2009.

<http://viewer.zmags.com/publication/04da31a3#/04da31a3/17>

⁴ *Battery Requirements and Cost-Benefit Analysis for Plug-in Hybrid Vehicles:*

<http://www.nrel.gov/vehiclesandfuels/energystorage/pdfs/42082.pdf>

⁵ EPRI-NRDC Report Finds Environmental Benefits of Deploying PHEVs

<http://my.epri.com/portal/server.pt?open=512&objID=243&PageID=223132&cached=true&mode=2>

⁶ Oak Ridge National Laboratory – "ORNL study shows hybrid effect on power distribution"

http://www.ornl.gov/info/press_releases/get_press_release.cfm?releasenummer=mr20080312-02

“smart chargers,”⁷ consumers and utilities could create an integrated system so cars only charge during low demand hours when electricity is abundant and less expensive.

However, many additional clean power plants may need to be built. A 2008 study by the Oak Ridge National Laboratory found that if just 25 percent of cars were hybrids by 2030, up to 160 additional power plants would be needed if everyone charged their cars at 5 PM.⁸ It could also be self defeating to power these cars with fossil fuel electricity sources.

Indeed, the environmental benefits associated with PHEVs are highly dependent on the electricity sources used to charge them. For example, according to the American Council for an Energy Efficient Economy, charging a PHEV with coal-generated electricity may actually result in a net increase of CO₂ emissions. In areas where the grid is fed by power sources with low CO₂ emissions (e.g. hydro, nuclear, wind, etc.), net CO₂ emissions will decrease correspondingly.⁹

Emissions, in effect, would shift greatly to power plants. Regions that are fueled by an abundant supply of coal would not realize the same benefits as a region where much of the electricity is generated by hydro-electric and/or nuclear sources. Additionally, base-load sources, which run 24 hours a day, all year round like coal, nuclear, and certain hydro sources, are especially critical to meeting the increased electricity demand from PHEVs.

Urban areas will receive greater benefits than suburban areas, which typically have longer driving distances, but urban areas will have the greater challenge with charging vehicles because many drivers park on the street and will not have easy access to a garage or charging station.

Conclusion

Drawing from clean and dependable sources of electricity, PHEVs promise great potential for tackling energy, economic and environmental challenges by reducing emissions and lessening our country's dependence on foreign oil.

Realizing the benefits continues to be a great challenge, and many obstacles remain before the full-scale deployment of PHEVs into the market can be achieved. With research, development and government subsidies, PHEVs could equal conventional vehicles in cost and penetrate the market in the near future.

⁷ Smart Charger – technology aimed at optimizing charging based on pricing and electricity demand to benefit consumers and electric providers.

⁸ “Potential Impacts of Plug-in Hybrid Electric Vehicles on Regional Power Generation.” Oak Ridge National Laboratory, January, 2008. http://www.ornl.gov/info/ornlreview/v41_1_08/regional_phev_analysis.pdf

⁹ American Council for an Energy-Efficient Economy, “PHEV Hybrids: An Environmental and Economic Performance Outlook” <http://www.aceee.org/pubs/t061.pdf>

About the Author: Dr. Patrick Moore has been a leader in the international environmental field for over 30 years. He is a co-founder of Greenpeace and served for nine years as President of Greenpeace Canada and seven years as a Director of Greenpeace International. As the leader of many campaigns Dr. Moore was a driving force shaping policy and direction while Greenpeace became the world's largest environmental activist organization.

In recent years, Dr. Moore has been focused on the promotion of sustainability and consensus building among competing concerns. He was a member of British Columbia government-appointed Round Table on the Environment and Economy from 1990 - 1994. In 1990, Dr. Moore founded and chaired the BC Carbon Project, a group that worked to develop a common understanding of climate change.

Dr. Moore currently serves as Chair and Chief Scientist of Greenspirit Strategies Ltd., a consultancy focusing on environmental policy and communications in forestry, agriculture, fisheries and aquaculture, mining, biodiversity, chemicals, energy and climate change. He is also an advisor to New York AREA.

About New York AREA: Founded in November 2003, the New York Affordable Reliable Electricity Alliance (New York AREA) is a diverse group of more than 125 business, labor, and community groups whose mission and purpose is to ensure that New York has an ample and reliable electricity supply, and economic prosperity for years to come. New York AREA helps to educate policy makers, businesses, and the general public regarding the necessity and importance of safe, low-cost and reliable electricity. For additional information visit: www.area-alliance.org.

Additional Resources:

National Renewable Energy Laboratory

Battery Requirements and Cost-Benefit Analysis for Plug-in Hybrid Vehicles

<http://www.nrel.gov/vehiclesandfuels/energystorage/pdfs/42082.pdf>

CalCars – The California Cars Initiative

<http://www.calcars.org/>

American Council for an Energy-Efficient Economy

Plug-in Hybrids: Environmental and Economic Performance Outlook

<http://www.aceee.org/pubs/t061.pdf>

Electric Power Research Institute

Environmental Assessment of Plug-in Hybrid Electric Vehicles

www.epri-reports.org

Natural Resources Defense Council

The Next Generation of Hybrid Cars: Plug-in Hybrids Can Help Reduce Global Warming and Slash Oil Dependency

<http://www.nrdc.org/energy/plugin.pdf>