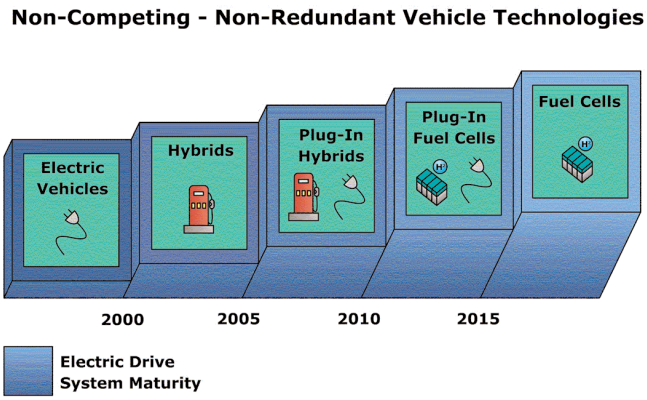
The Plug-In Hybrid Electric Vehicle: Today's Car for Tomorrow's Technology

An E2I Initiative



Emerging technologies offer many new opportunities for hybrid vehicles.

Many Americans today are becoming increasingly aware of the benefits of owning “Hybrid Electric Vehicles” (HEVs). The HEVs introduced by Toyota (Prius/52mpg) and Honda (Insight/61mpg) currently on the market achieve significant fuel economy benefits with a drive system that combines an internal combustion engine with a modest amount of battery energy storage. These HEVs and others scheduled by major U.S. automobile manufacturers for introduction in the marketplace rely exclusively on petroleum (gasoline/diesel) fuels. While this technology represents a significant improvement over a conventional internal combustion engine, an emerging technology offers even better opportunities to meet today's needs for fuel economy improvement and reduction of carbon dioxide emissions : the Plug-In Hybrid vehicle.

In Plug-In Hybrids, the primary power source is “hybridized” with a rechargeable battery that serves two purposes—supplementing the power delivered by the regular engine, and providing part of the propulsion energy from an off-board source of electricity. Petroleum is not used during the all-electric cycle to power these plug-in hybrid electric vehicles. With only the battery power, plug-in hybrid vehicles can be used for normal commuting

Plug-In Hybrid Vehicles can contribute to the efficient use of our nation's energy supply and reduce U.S. dependency on petroleum-based fuels

distances, thereby resulting in zero emissions, reducing petroleum-based fuel consumption, and leveraging energy costs by taking advantage of offpeak rates.

Operated in this way, Plug-In Hybrids provide most of the petroleum savings and emission reduction benefits of battery-powered electric vehicles without the range limitations and high battery costs that are preventing broad market acceptance of EVs. For example, Plug-In Hybrids with a battery providing a 40-mile electric range could accommodate more than 60% of the total annual miles traveled by the average U.S. vehicle in the all electric mode. A series of studies supported and coordinated by EPRI confirms that Plug-In Hybrid Vehicles have a greater potential than the types of hybrid vehicles currently available on the market to reduce petroleum consumption and the emissions of pollutants and carbon dioxide. The importance of shifting some of the U.S transportation from petroleum to electricity is illustrated by the fact that transportation accounts for nearly 2/3 of all U.S. oil consumption and at present is almost 97% dependent on petroleum-based fuels.

PROJECT DESCRIPTION

The Electric Power Research Institute (EPRI) and the Electricity Innovation Institute (E2I) have launched a public/private partnership to develop and commercialize hybrid vehicle options that builds on prior work initiated by EPRI and its partners in the Hybrid Electric Vehicle Working Group. This ongoing, collaborative research effort has brought together representatives from the utility and automotive industries, the U.S. Department of Energy (DOE) and other regulatory agencies, as well as university

research organizations. This effort is focusing on Plug-In Hybrid Vehicles as the advanced-technology vehicles with the highest realistic potential to contribute to the efficient use of our nation's energy supply, reduce U.S. dependency on petroleum-based fuels, and substantially curb the emission of carbon dioxide, the major greenhouse gas.

RESEARCH STUDY AND ANALYSIS

Phase I (Completed)

In 2001, the HEV Working Group completed a research study and analysis, Comparing the Benefits and Impacts of Hybrid Electric Vehicle Options, which is the first public domain, multi-variant study comparing conventional vehicles and hybrid electric vehicles. This scientific comparison focuses on the key attributes of hybrid electric vehicles—performance, fuel economy, fuel-cycle emissions, costs, consumer acceptance, and commercialization issues. The comparison was conducted using three hybrid concepts/ranges including:

1. HEV 0—Hybrids with no all-electric or zero-emission range
2. HEV 20—Hybrids with sufficient battery to provide 20 miles of all-electric or zero-emission range that are plugged in to recharge
3. HEV 60—Hybrids with sufficient battery to provide 60 miles of all-electric or zero-emission range that are plugged-in to recharge

Among the study's many conclusions is that HEVs offer major efficiency improvements as well as substantial reductions over conventional vehicles in the consumption of petroleum-based fuels and emissions of air pollution precursors (NOx and HC) and carbon dioxide. All of these benefits increase with the electric range capability of the HEV. Petroleum consumption reduction is critical to global sustainability and long-term energy security.

The complete study and analysis (Report #100034) are available for **NO COST** at www.epri.com, or by contacting EPRI Customer Assistance Center (CAC) at 800.313.3774, or askepri.com

Phase II (Underway)

A $1.6 million collaborative study is currently underway that builds upon the conclusions of Phase I and focuses on determining the Plug-In Hybrid Electric Vehicle configurations and technologies that generate the maximum market interest while enabling dramatic reductions in petroleum consumption. The high level tasks in Phase II include (1) Technical and Economic Assessment and Optimization, (2) Market Assessments and Strategy Development, and (3) Long-Term Opportunities for Advanced Technologies (i.e., fuel cell plug-in hybrids, vehicle to grid distributed generation, etc.).

Phase III: Plug-In Hybrid Prototype Design & Production (2003-2005)

The third phase of the project will involve developing prototypes of Plug-In Hybrid Electric Vehicles with internal combustion engines and fuel cells as primary power sources. Work will include building and testing both hybrid vehicle options in a production vehicle configuration. Additional testing will be conducted based on the results of the initial prototypes. The anticipated cost for Phase III is $16 million. Extending the plug-in concept to fuel cell vehicles will be especially significant because it has excellent potential to simplify fuel cell system design and operation and reduce fuel cell system capital and operating cost. Thus, plug-in hybridization promises not only to make our internal combustion engine-based transportation system much more efficient and cleaner in the near(er) term, but to speed the transition to fuel cells as the fundamentally more efficient and cleaner automotive power source of the future.

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