



## Plug-in Hybrid Electric Vehicle Research Center

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**Work Authorization #:** MR-955

**Contractor:** The Regents of the University of California, Office of the President/CIEE

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**Match Funding:** N/A

**Contractor Project Manager:** Carl Blumstein

**Commission Project Manager:** Philip Misemer

### PROGRAM GOAL

The goals of this program are to:

- Enhance the commercial viability of plug-in hybrid electric vehicles (PHEVs).
- Provide timely and valuable information for policy makers, industry professionals, consumers, and the environmental community on strategies and policies for PHEVs to address California's transportation energy challenges.
- Support PHEV demonstration and related efforts in California.

### THE ISSUE

California's dependency on petroleum for transportation energy makes it extremely vulnerable to price volatility and to environmental degradation. The use of petroleum in transportation accounts for over half of the state's energy demand, nearly 70 percent of smog-forming pollutants, and over 40 percent of the State's greenhouse gas emissions. The share of refined fuel the state must import is above 60 percent and is growing since California, as well as global, fuel demand, is rising despite high prices. Fuel price volatility is exacerbated by increasingly competitive global oil markets and potential geopolitical conflicts. Supplying a clean, affordable, and diverse transportation system is quickly becoming one of the most daunting and important challenges of the 21st century.

PHEVs are a promising and potentially revolutionary technology for reducing California's petroleum dependency, safeguarding the environment, and supporting the continued success of California's economy. These vehicles are similar to conventional hybrid electric vehicles (HEV), such as the Toyota Prius, in that the vehicle operates on battery-electric power as well as power derived from an internal combustion engine (ICE). PHEVs have larger batteries and electric drive systems than HEVs and can therefore operate in an all-battery, or all-electric, mode for longer distances. However, unlike HEVs, PHEVs do not rely on the ICE to recharge the on-board battery; rather the battery can be plugged-in to the electricity grid for recharging. Because these vehicles can be fueled with grid electricity, their fuel economy could be substantially higher than that of an average U.S. light-duty vehicle (24 mpg) or a conventional (non-plug-in) hybrid electric vehicle (HEV) (45 mpg). These vehicles could offer Californians the following benefits:

- Reduced petroleum dependency and corresponding improvements in economic insecurity.
- Reduced environmental and public health risks through reductions in greenhouse gas emissions and criteria pollutant emissions.
- Increased diversification of the transportation energy supply via the use of electricity as a transportation fuel, the production of which could use renewable energy sources such as wind and solar.

The recent success of HEV commercialization and advances in hybrid battery technology could mean that the near-term implementation of PHEVs is probable.

### **PROGRAM DESCRIPTION**

To address the commercial viability of PHEVs, the Public Interest Energy Research Program's Transportation Research Area (PIER-TRA) is establishing the Plug-In Hybrid Electric Vehicle Research Center. Center activities will be directed at forming partnerships with the research community and other organizations. The PHEV Research Center will be hubbed within the Institute of Transportation Studies at UC Davis (ITS-Davis). ITS-Davis will organize center development and provide technical, operational, and planning leadership.

The PIER PHEV program will be complemented by the broader ITS-Davis Sustainable Transportation Energy Pathways program (STEPs), which is a four-year, multi-disciplinary, consortium-supported research program that will compare electricity, biofuels, and hydrogen as potential transportation energy pathways. Research activities will also be coordinated with the UC Davis Energy Efficiency Center (UCD EEC), helping to ensure that market and commercialization issues are fully addressed. Matching funds may be available through the center.

### **PHEV CENTER GOALS AND OBJECTIVES**

The goals of the PHEV Research Center are to enhance the commercial viability of plug-in hybrid electric vehicles (PHEVs); to provide timely and valuable information for policy makers, industry professionals, consumers, and the environmental community on strategies and policies for PHEVs to address California's transportation energy challenges; and to support PHEV demonstration and related efforts in California.

The following objectives will be key to achieving these goals:

- Establish the PHEV Center Research Advisory Council (PHRAC).
- Create a PHEV Research Roadmap by identifying, conducting and contracting the RD&D necessary to understand and address practical and technical PHEV issues.
- Establish multi-institutional partnerships to broaden the expertise of center researchers and leverage funding.
- Foster connections with stakeholders through outreach efforts.
- Sustain long-term attention to PHEV research topics.
- Conduct PHEV-related research, development, demonstrations, and outreach activities that:
  - Evaluate the potential role of PHEVs in addressing long-term energy and climate change challenges relative to other vehicle technology and fuel alternatives.
  - Develop tools and methods to provide insight on key issues identified in the roadmap and to identify government actions that could most efficiently and effectively overcome barriers to accelerate commercialization.

- Convey research results in a manner that allows easy access to policy makers, regulatory agencies, business professionals, environmental community members, and the public.
- Advance the implementation of PHEVs and maximize benefits to California's electric ratepayers.

### **PHEV CENTER PROPOSED RESEARCH AND INITIAL RESEARCH ACTIVITIES**

The PHEV Center will explore several broad research areas and will derive its strategic direction through the development of its research roadmap as well as input from the PHRAC. Research areas are likely to include, but will not be limited to, the potential impacts of vehicle charging on the electricity grid as well as potential environmental impacts of vehicle use and impediments to commercialization. As an example, the size and management of batteries as well as the size of the electric drive system will be key factors in the commercial viability of vehicles since larger batteries increase the vehicle's all-electric range, reduce environmental impacts, and allow for more off-peak charging, which improves the efficiency of the electricity system. However, larger batteries increase cost, and deep discharges shorten battery life. These types of tradeoffs need to be researched to provide a thorough and balanced assessment of the effects of PHEV commercialization and to minimize any undesirable impacts. Additionally the knowledge gained from this type of research can be used to develop strategies that enhance the commercialization of PHEVs.

In addition to establishing the research center and creating the research roadmap, ITS-Davis will conduct three initial research projects. Each project builds upon previous successful research done at UC Davis.

#### **PHEV Component and Charging Technology Evaluation**

This research will advance PHEV component and charging technology modeling science to provide sufficient information on vehicle performance and cost comparisons of a wide range of plug-in hybrid powertrain and battery options relative to conventional ICE, battery-electric, and charge sustaining hybrid vehicles. This information will be applied by vehicle developers as well as to inform policy makers.

#### **Lifecycle Emissions Analysis and Social-Cost Analysis**

This research will build upon existing tools and methods developed at ITS-Davis to analyze the lifetime social costs and lifecycle emissions of PHEVs compared to other advanced light-duty vehicles, providing important information for policy makers regarding the potential contribution of PHEVs for meeting California's transportation energy priorities.

#### **Consumer Demand and Energy Use Research**

This research will further develop advanced analytical tools and will strengthen the knowledge base for informed transportation policy and future decision-making by building upon methods developed at ITS-Davis that have successfully been used to study advanced vehicle markets. The information gained from these developed tools and methods will be used as fundamental inputs to the Vehicle and Charging Technology research project as well as in the Lifecycle Emissions and Social-Cost Analysis.

The Sustainable Transportation Technology Branch of the Air Resources Board supports the creation of this research center and the three initial research projects.

### **PIER STRATEGIC OBJECTIVES AND ANTICIPATED BENEFITS FOR CALIFORNIA**

Because PHEVs rely primarily on electricity, full advantage can be taken of California's unique and diverse electricity supply while providing Californians with an energy-efficient, low-emission vehicle option. The goals and objectives of the PHEV Research Center meet the following PIER strategic objectives for accomplishing a clean and diverse transportation system in California:

- Improved transportation efficiency.
- Support for development of alternative fuel supplies for transportation.
- Development of knowledge base and advanced analytical tools for future decision-making and informed transportation policy to benefit California's electricity system.

This project also complies with SB 76, and will benefit electricity ratepayers by improving electric service reliability and reduce health and environmental impacts from air pollution and greenhouse gas emissions.

#### **RESULTS AND OUTPUTS**

Program progress will be reported in regular progress reports and the results from individual research areas will be summarized in final reports. Preliminary and partial results will be presented in stakeholder workshops, program meetings with the Energy Commission, and in regular progress reports.

#### **FINAL REPORT**

Final reports will be prepared for each individual project, and a comprehensive summary report will be prepared that discusses the interactions between program research areas.

#### **CONTACT**

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