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PERD program on electric mobility: plug-in hybrid electric vehicles Davidson, Isobel

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The logo for the National Research Council of Canada (NRC-CNRC) is displayed in white, bold, sans-serif font. The background of the slide features a stylized periodic table of elements in the top left, a portion of the Earth's globe, and a red maple leaf on the right side.

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From Discovery to Innovation...

PERD Program on Electric Mobility - Plug-in Hybrid Electric Vehicles

PHEV2007 Conference

Winnipeg, Manitoba – November 1 & 2, 2007



National Research
Council Canada

Conseil national
de recherches Canada

Canada

Overview

- *Introduction – PERD program*
- *Rationale for PHEV program*
- *Relevance*
- *Steps to development of Electric Mobility Program*
- *Objectives*
- *Proposed research activities*
- *Current research projects*
- *Next steps*

Program of Energy Research and Development

- *The Program of Energy Research and Development (PERD) is a long standing Federal Energy program, which began in 1974 as a result of the first Energy Crisis in 1973*
- *Annual budget of approximately \$58 million*
- *NRC can manage PERD and operates the program through 13 federal departments and agencies*

PERD (cont'd)

- *Promotes the development and use of Canada's energy resources in a clean and safe manner by*
 - *Helping the federal government fulfill its direct energy R&D responsibilities (standards, regulations, policy knowledge)*
 - *Conducting energy R&D for the public good*

PERD (cont'd)

- *PERD's portfolio of activities responds to the three pillars of Sustainable Development: Economic growth, Environmental protection, and Secure and reliable supplies.*
- *Energy research and development activities are mainly focused on: cleaner fossil fuel production; cleaner transportation; energy-efficient buildings and communities; energy-efficient industry; and clean electricity generation.*

PERD's Federal Partners

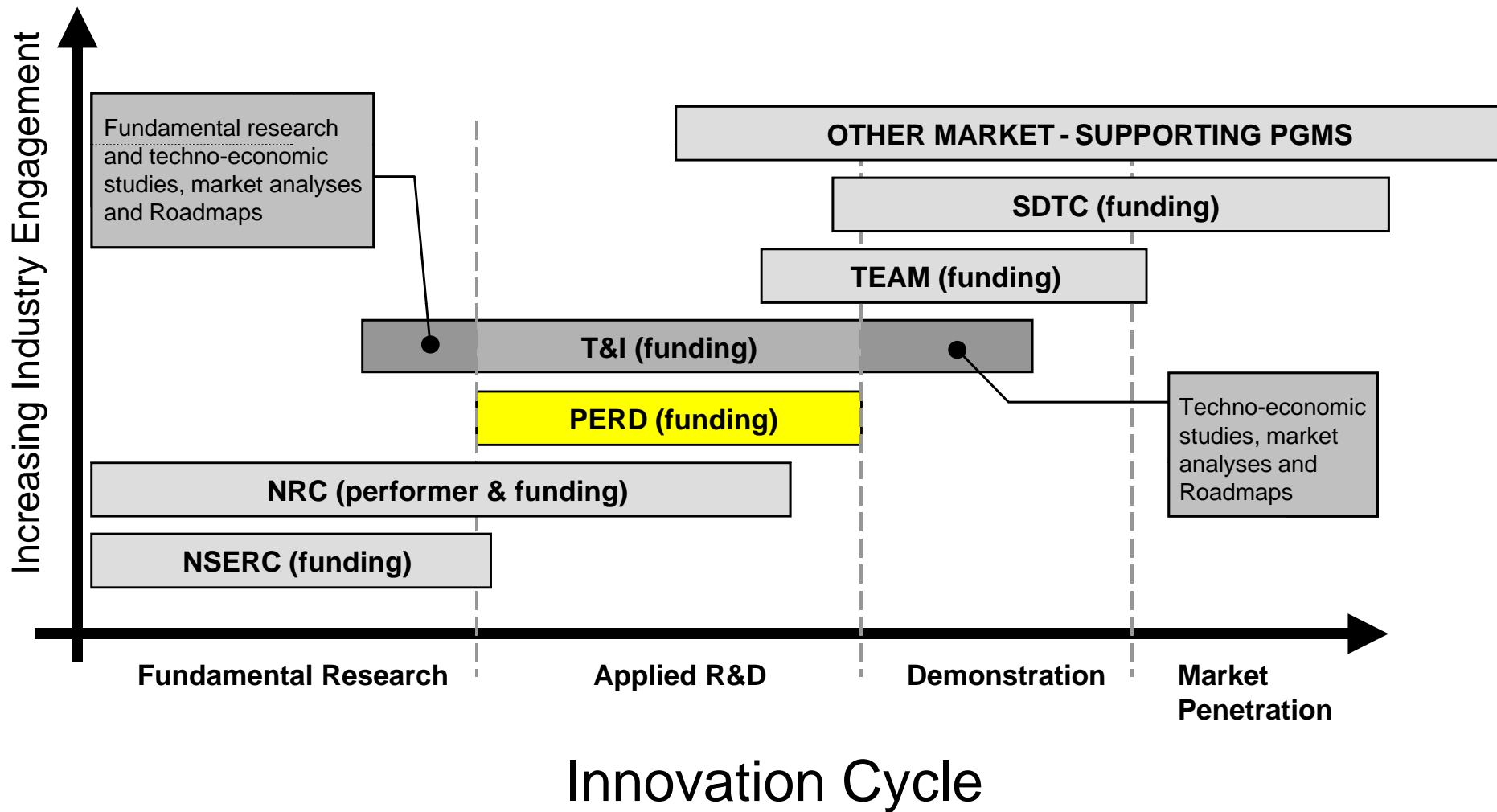
PERD support R&D in 13 Federal Departments and Agencies, including:

- Agriculture and Agri-food Canada
 - Canada Mortgage and Housing
 - Environment Canada
 - Fisheries and Oceans
 - Health Canada
 - Indian and Northern Affairs
 - Industry Canada
 - National Defense
 - National Research Council
 - Natural Resources Canada
 - Public Works and Government Services Canada
 - Transport Canada
-
- Atomic Energy of Canada Limited (2006)

International Linkages

- International collaboration important to PERD
- OERD is focal point for coordination of many international R&D activities:
 - International Energy Agency (Working Parties, Implementing Agreements)
 - US DOE/NRCCan
 - EU S&T Agreement
 - Asia Pacific Economic Cooperation
 - Bilaterals with several countries

PERD and Innovation



Features of a PERD Program

- A PERD Program may contain one or more activities
- The Program plan details the activities and their associated outputs, outcomes, and impacts, as well as management, risk, accountabilities and budget
- Program committees consist of R&D performers, OERD S&T Advisor, and representatives from regulatory agencies, industry and academia
- Led by Program Leaders selected from the PERD community
- Program committees form an extensive collaborative network

Rationale the Electric Mobility Program

- Transportation ranks second only to industrial processes, including electrical generation, in contributing GHG emissions in Canada
- Leading source of smog precursors
 - NO_x, VOCs, CO, CO₂, Benzene, PM, SO₂
- High health and environmental costs
 - Ontario (2005) \$3.3B environmental and \$6.6B health costs, including 5,000 preventable deaths
 - Kyoto targets will likely not be meet (PM - Harper)

Rationale (cont'd)

- PHEV – HEV that can be fueled conventionally or from the electrical grid
 - longer range on electric power due to larger battery
 - lower emissions – lifecycle GHGs
 - Canada - 44% (PHEV50) versus 28% (HEV)
 - US - 15% reduction (PHEV65) relative to HEV
 - PHEV ~ HEV – carbon intensive generation
 - cleaner grid or CO₂ capture – lower emissions
 - lower urban emissions - smog, particulates, CO
 - uses existing infrastructure – more efficiently
 - diversification of fuel for transportation - response to “Peak Oil”

- **Sustainable Development**

- *Next generation vehicles will contribute to improved energy efficiency, reduced emissions and increased economic benefit to Canada*
- *More efficient usage of existing electrical distribution infrastructure*
 - *off peak charging*

- **Climate Change**

- *44% reduction in GHGs with current technology and present mix of electrical generation – further improvements with whole system optimization, cleaner grid and CO₂ capture*

Relevance

- **Clean Air**

- *Lower emissions, particularly in urban areas*
- *Hydro, wind, solar and nuclear energy will supply transportation sector*
- *Centralize power generation – simplified emission control*
- *Economic benefit with lower health costs and less time loss to illness*

Steps in development of Electric Mobility – PHEV Program

- *Environmental Scan*
 - interviews with experts in the technology
 - assessment of the current state-of-development
 - identification of activities and expertise in Canada
- *Experts Workshop*
 - held at NRC in July 2006
 - brought together interested parties in government, industry and academia
 - analyzed opportunities for Canada
 - assisted in defining the scope of the Program's activities
- *Program Planning Document (PPD)*
 - a working group assisted with further defining the opportunities identified in the environmental scan and workshop

Environmental Scan

- Based on comprehensive literature survey and interviews with 33 leading developers of PHEV related technology in Canada and the US
- Energy storage identify as number one technology gap for PHEVs
- Broad range of expertise in Canada in development of advanced batteries and associated materials, automotive systems integration, electric motors, chargers and electric buses and vans

Some Examples of Canadian Expertise



advanced lithium power



umicore



NEW FLYER



Electric
Mobility
Canada

Mobilité
électrique
Canada



Phostech Lithium



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Experts Workshop on PHEVs – July 2006

- 60 participants from industry, government and academia
- Including program managers from DOE Freedom Car Initiative
- Morning had presentations from leading experts on PHEV development
- Afternoon consultation with stakeholder community on priorities for Canadian program on PHEVs
- Improved electrical storage systems and R&D to support policy and regulation development identify as top priorities
- Opportunities for development of electric drive components and powertrain optimization were also identified

Electric Mobility Program Development

- Technical committee participated in develop of EM Program Planning Document
- Submitted to NRCan's Office of Energy R&D in October 2007
- Presentation made to OERD's managers and S&T advisors in November 2007
- New PERD Program approved by inter-departmental Panel on Energy R&D in April 2007 - \$7M over five years

Objective

Strategic Intent 2: Foster cleaner sustainable transportation fuels and systems in order to **improve the environment, reduce emissions, including GHGs**, and to increase economic activity through development of domestic and export markets.

Strategic Direction 2: Provide **S&T to improve energy efficiency, reduce emissions and provide economic benefits to Canada** from next generation vehicles and systems.

Objective 6: Identify and undertake key activities where Canadian research and development can be brought to bear on **issues currently limiting the development and adoption of plug-in hybrid electric vehicles in Canada**, and to **strengthen the scientific basis for policy and regulatory decisions** affecting the adoption of PHEV technology in Canada.

Vision

- *Canada is well positioned to take a leading role in Electric Mobility, and more specifically in PHEVs*
 - *Second highest percentage of hydro-electric generation in world – increasing usage of renewable sources (wind, solar,) – nuclear also low carbon intensity*
 - *World-class scientific expertise in niches critical to PHEV technology (electric storage, motors, inverters, chargers and their integration), and policy and regulatory development*
- *Electric Mobility Program will identify and undertake key activities where Canadian R&D can address issues currently limiting adoption of PHEV technologies in Canada*
 - *strengthen science base to support policy and regulatory development*
 - *improved energy efficiency in transportation sector*



Program Activity Areas

1- Energy Storage Systems

Investigate existing and emerging energy storage technologies, particularly advanced battery technologies, which can lead to significant advances in the performance, safety and environmental impacts of PHEVs.

Develop improved proof-of-concept and prototype systems, as appropriate.

Program Activity Areas

2 - Electric Drive Components

Investigate on-board charging technologies capable of fast recharging while ensuring safety and prolonging battery life.

Optimize control systems, motors and other key electric drive components for reduced size and weight and increased efficiency and durability.

Investigate existing and emerging technologies for on-board power integration, as well as intelligent systems for residential and opportunity charging.

Develop improved proof-of-concept and prototype systems, as appropriate, with a focus on technologies having the potential to accelerate commercialization of PHEV components in Canada.

3 - Powertrain Optimization

Develop and apply a suite of modelling tools capable of simulating a hybrid powertrain, with emphasis on electric drive components and energy storage systems that might be developed in Canada, or be integrated into Canadian products, in order to evaluate the influence of various designs on emissions and energy efficiency and to lead to the deployment of more optimized pHEV powertrain systems.

Develop improved proof-of-concept and prototype systems, as appropriate.

4 - Development of Regulations for Emissions and Fuel Efficiency

Investigate and develop suitable emissions and fuel economy measurement methods and models for evaluating pHEVs to support development of Canadian policies and regulations.

Evaluate proposed methods on a sample of hybrid electric vehicles.

The testing method and model development will be coordinated with US and international efforts in this area with a view to achieving global harmonization of hybrid vehicle test methods.

Electrical Storage Systems:

- *Battery Building Block for PHEVs*
 - *development of a 50V, 0.5 kWh Li Ion battery module*
 - *lead organization - Electrovaya*

- *Combining Safety and Performance in Lithium Ion Batteries for PHEVs*
 - *development of safer electrolytes and electrodes*
 - *lead organization – National Research Council*

Electric Drive Components:

- *Digital Control for Bi-directional DC-DC Converter*
 - *compact, low cost, dc-dc converter for ZEV mode and increased overall system efficiency*
 - *lead organization – TM4*
- *PHEV10 Development Project*
 - *integrate a 5 kWh lithium ion battery pack to a Ford Escape to displace up to 16 km of engine operation per charge*
 - *lead organizations – Advanced Lithium Power and E-One MoliEnergy*

Current Projects (2007/08)

Powertrain Optimization:

- *Advanced Vehicle Powertrain Research Network*
 - *research network for simulation of powertrains*
 - *lead organizations – Transport Canada and McGill University*

Outreach:

- *Capabilities Guide – Canadian Resources for Plug-In Hybrid Vehicles*
 - *compendium of capabilities in Canada that relate to the development of PHEVs*
 - *lead organization – Electric Mobility Canada*

Next Steps

- *Complete and disseminate capabilities guide to further collaboration and economic growth within Canada relating to PHEV development*
- *Establish Powertrain Simulation Network to provide industry, government and academic researchers with a forum for collaboration on evaluation and optimization of PHEV powertrains*
- *Develop stronger international linkages: IEA, DOE etc...*
- *Encourage collaboration on R&D relating to PHEVs between academics, industry and government researchers within Canada through programs such as PERD, Auto21 and eco-ETI*



Thank you for your attention

Questions?

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