Transportation Research Center
Connecticut Energy Advisory Board
May 1, 2009
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University of Vermont Transportation Research Center
• Founded in Fall 2006
(SAFETEA LU)
• One of 10 National
Transportation Centers
• Theme: Sustainable Systems
and Advanced Technologies for Northern
Communities
• Multi-disciplinary research
• 21st Century Issues

Research, Education, Outreach
UVM Transportation Research Center
• Energy and environmental impacts of
the transportation system
• Tailpipe emissions, including GHG and
particles
• Land use patterns
• Rural mobility and accessibility
• Travel behavior
• Transportation efficiency and
PHEVs and IVs
• Clean Cities Program for
Vermont

May 1 Presentation
• Phase 1 Scoping Study
• Phase 2 Study
• Transportation and GHG emissions

"We will soon lay down thousands of miles
of power lines that can carry new
energy to cities and towns across this
country…. And we will put one million
plug-in hybrid vehicles on America’s
roads by 2015."
– President Obama, March 19, 2009,
Southern California Edison
Electric Vehicle Technical Center.

PHEVs Coming to Market
<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Vehicle (All Electric Range)</th>
<th>Anticipated Release Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>BYD</td>
<td>F3DM (60 miles)</td>
<td>Released Late 2008*</td>
</tr>
<tr>
<td>Toyota</td>
<td>Plug-in Prius (10 miles)</td>
<td>Late 2009**</td>
</tr>
<tr>
<td>General Motors</td>
<td>Chevy Volt (40 miles)</td>
<td>2010</td>
</tr>
<tr>
<td>Chrysler</td>
<td>Jeep Wrangler (40 miles)</td>
<td>2010</td>
</tr>
<tr>
<td>Fisker</td>
<td>Karma (50 miles)</td>
<td>2010</td>
</tr>
<tr>
<td>Ford</td>
<td>Escape (40 miles)</td>
<td>2012</td>
</tr>
</tbody>
</table>

* Only available in China
** Limited numbers — not available to the general public

U.S. GHG Emissions

Transportation GHG Emissions by Source, 2004

Dependence on Automobiles
1. Vehicle Efficiency (CAFE standards, alternative fueled vehicles, anti-idling, etc.)
2. Lower carbon fuels (low carbon fuel standard)
3. Increasing Transportation System Efficiency (reducing vehicle miles traveled, switching modes, walking, biking, increase vehicle occupancy rates, public transportation, etc.)

Vermont Electric Industry Emissions

Greenhouse Gas Implications
Vary Considerably by Region

Greenhouse Gas Implications Cont.

Phase 1 PHEV Vermont Scoping Study
- How many PHEVs could the Vermont electric power system charge assuming three plausible consumer charging patterns?
- What is the MPG equivalent cost of displacing gasoline with electricity?
- How much gasoline could be displaced annually from three different PHEV penetration scenarios?
- What are the net regional emissions impacts from the introduction of PHEVs in Vermont?
Phase 1 Study: Literature Review

Three Scenarios & Four Charging Regimes

1) Uncontrolled Evening Charging: Charging start times are evenly distributed between 6:00 pm, 7:00 pm, and 8:00 pm. Each PHEV charges for 6 continuous hours.

2) Uncontrolled Evening Charging / Twice Per Day Charging: Each vehicle is fully charged twice each day, once when arriving at work in the morning and once when arriving home in the evening.

3) Delayed Nighttime Charging: This scenario assumes that either off-peak rates for PHEV charging or direct load control are used to delay PHEV charging times until 12:00 am.

4) Optimal Nighttime Charging: The vehicles are charged in a pattern that increases utility load factors by charging during the periods of lowest demand.

Worst Case Load Impacts

Best Case Load Impacts

GHG Emissions

• Switching 50,000 vehicles to PHEVs could reduce carbon emissions by 31%
### End User Costs

- PHEV20 delivers 2.38 miles of travel per kWh.
- CVPS off-peak rate of $0.7/kWh.
- PHEV would require 12.6 kWh to travel the same distance as one gallon of gasoline (30 mpg).
- Electricity equivalent cost = $.88.

### Phase 2 Study

- PHEVs relationship to carbon caps in the Northeast Region (RGGI).
- Distribution circuit load impact of PHEVs.
- Public Policy Initiatives related to PHEVs in the Northeast.
- Actual performance of PHEVs in Vermont’s cold weather and hilly terrain.

### Ongoing Research Questions on PHEVs and RGGI

- How will PHEV adoption impact carbon prices?
- How will RGGI impact PHEV competitiveness?

### PHEV Policy - Federal

<table>
<thead>
<tr>
<th>Policy</th>
<th>Impact on PHEVs</th>
<th>Cost Primarily Born By</th>
<th>Status by state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research and Development Funding</td>
<td>Potential reduction in battery costs would decrease PHEV price premiums</td>
<td>Tax payers at large</td>
<td>On-going Vehicle funding expanded under ARRA</td>
</tr>
<tr>
<td>Tax Credits for PHEV purchases</td>
<td>Reduction in PHEV price premium</td>
<td>Tax payers at large</td>
<td>Created under ESA, expanded under ARRA</td>
</tr>
<tr>
<td>CAFE Standards</td>
<td>PHEVs may benefit from stricter fuel economy standards which cause automobile manufacturers to engage in mix shifting</td>
<td>Automobile manufacturers and purchasers of vehicles with lower fuel efficiency</td>
<td>Strengthened by NISA</td>
</tr>
</tbody>
</table>

### PHEV Policy - State

<table>
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<tr>
<th>Policy</th>
<th>Impact on PHEVs</th>
<th>Cost Primarily Born By</th>
<th>Status by state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel efficiency/GHG emissions based fees</td>
<td>Reduction in PHEV price premium relative to CVs due to differential pricing in RGGI PHEV demand</td>
<td>Tax payers at large</td>
<td>Under development in MA, under consideration in CT, ME, RI, VT</td>
</tr>
<tr>
<td>PHEVs sales tax waiver</td>
<td>Reduction in PHEV price premium</td>
<td>Tax payers at large</td>
<td>Under consideration in CT</td>
</tr>
<tr>
<td>ME 1401 Standards</td>
<td>Requires reductions in multipath GHG emissions which may reduce mix shifting relative to PHEVs</td>
<td>Automobile manufacturers and purchasers of vehicles with lower fuel efficiency</td>
<td>Adopted by CT, MA, ME, RI, VT</td>
</tr>
<tr>
<td>Low Carbon Fuel Standards</td>
<td>LVCS credits for PHEVs could provide a revenue stream for vehicle owners</td>
<td>Fuel providers</td>
<td>Under development Regional plan including all 5 NE states</td>
</tr>
</tbody>
</table>

### Vehicle Data Collection

1) Converted Toyota Prius
   - Four volunteer drivers
   - Collect operating and CPS data
      - Gasoline and electricity use
      - Air conditioner status
      - Temperature, trip length, elevation change
   - Compare data across temperatures and terrains.

2) GMP, EVermont & CVPS Vehicles