Can & Should Vehicle Electrification be Part of Washington State's Transportation Future?

Plug In Hybrid Vehicles – HB1303

Tim Stearns
Energy Policy Division
February 28, 2008

CONTENTS

CAN AND SHOULD VEHICLE ELECTRIFICATION BE PART OF WASHINGTON STATE'S TRANSPORTATION FUTURE? 2

Exploration Activities 3
Plug in hybrids – original equipment vehicles 4
Status of Washington's Plug in-hybrid Demonstration Projects 4
Chelan School District – Plug in Bus 4
Joint Puget Sound Demonstration Project 6
City of Seattle – other electric tests 7
Tacoma City Light 7
Port of Chelan County –Plug-in Hybrid Electric Vehicle (PHEV) Pilot Project 8
Other activities to improve vehicles 9
How would electrification fit with Washington's infrastructure? 9
Who will make the rules? 9
Could Washington manufacture vehicles? 10
What about the Original Equipment Manufacturers? 10
Why is electrification potentially attractive? 11
Are there any key limitations or showstoppers for hybrids? 11
Climate Change Challenge Analysis of Vehicle Electrification 12
T-10 Acceleration and Integration of Plug-In Hybrid Electric Vehicle Use 13
Mitigation Option Description 13
Mitigation Option Design 13
Goals: 14
Timing: 14
Parties Involved: 14
Implementation Mechanisms 14
Related Policies/Programs in Place 15
Estimated GHG Savings and Costs per MtCO2e 16
Data Sources 16
Quantification Methods 16
Key Assumptions: 17
Contribution to Other Goals 17
Conclusions 18
Websites for plug-in hybrid electric vehicles (PHEVs) 18

Can and Should Vehicle Electrification be part of Washington State's transportation future?

Virtually all fossil fuels are imported to Washington State and transportation is the state's principle source of greenhouse gasses. Washington also has one of the world's largest hydroelectric resource bases making vehicle electrification an option which has attracted much interest as an emerging technology. However, while electrified transportation could complement our hydro based system, large scale deployment might complicate management in the short run. In the longer term electrified transportation could provide some significant backup benefits, since batteries will be dispersed throughout the system, but managing many batteries would also be challenging.

Engrossed Second Substitute House Bill 1303, passed by the legislature in 2007, directed the Department of Community, Trade and Economic Development (CTED) to explore vehicle electrification for Washington State.[1] The legislation provided latitude in subject areas which CTED could examine as part of the report. We have initially concentrated on the most viable opportunities. Since July 2007, when the legislation took effect, we have focused on vehicle electrification activities in two areas: 1) analysis of the vehicle electrification potential as part of the extensive stakeholder work of the Governor's Climate Change Challenge (CCC) process and, 2) assistance to several programs designed to jump start plug-hybrid vehicle demonstrations. This brief report to the legislature summarizes activities in these two areas. CTED, together with the Dept. of Ecology, expects to continue to work on vehicle electrification analysis, research and demonstration both through the continuing work of the CCC which will restart in April of this year, and through continued collaboration on the demonstration/research projects already underway.[2]

We recognize that significant investment would be required to expand electrification's usefulness and flexibility, thus one goal of our work to date has been to concentrate on key activities that will capture and enhance understanding and experience with in the field deployment of electrification equipment. The most straightforward way to implement widespread electrification is with plug in hybrid vehicles (PHEV) whose batteries can also provide some system storage and backup.[3] The Sound Transit's Tacoma Link Street Car began in 2003[4] and the South Lake Union Street Car in Seattle[5] started operating in December are noteworthy examples of the resurgence of electrified transportation. Streetcars are expected to expand to provide in city transportation along high usage fixed routes and over time could

[1] ESSHB 1303, Section 401.
[2] Note that although ESSB 1303 allowed CTED to provide financial support for plug-in hybrid projects, language in the approved 2007 state budget restricted CTED's ability to provide any direct funding for such projects. The Governor's proposed 2008 supplemental budget corrects these restrictions. Assuming that this expanded authorization is approved, we will look at the feasibility of financial support begin in July 2008.
[3] Other vehicle electrification work is also underway notably in truck stop electrification demonstrations, which allows for big rigs to avoid overnight idling, and shore power for large ships during docking. This report does not describe those activities. Additional information is available from the Puget Sound Clean Air Agency's web site at www.pscleanair.org
[4] http://www.soundtransit.org/x4621.xml
[5] http://www.seattlestreetcar.org/

expand into city wide systems. King County Metro and Sound Transit have been using hybrid electric/diesel buses since 2004.[6]

Washington State has a wide range of expertise that could facilitate and influence the next generation of vehicles and the future of transportation. The future of vehicle manufacturing is so speculative at this point it is far from clear whether Washington could play a large role in manufacturing vehicles. In any event thoughtfully addressing transportation issues through an integrated strategy will influence transportation well beyond Washington State.

Exploration Activities

There is widespread interest in Washington State and throughout the nation in reducing greenhouse gas emissions, decreasing imported oil and diversifying the energy system. Achieving any of these goals could have widespread positive impacts, but will require analysis, demonstration, action and investment.

Over the past year CTED has focused on advancing practical efforts to demonstrate technologies and expand transportation alternatives. CTED is working with several local governments and with stakeholders to expand biofuel production. In 2007, state bioenergy coordination responsibilities were transferred to CTED

For the longer term the legislature has adopted California clean car standards, set statewide levels of biodiesel and ethanol contents, and called for the use of biofuels and plug in electric vehicles for all public vehicles by 2015.[7] We would like our activities to feed into these efforts.

In the near term the state is investing in improving school buses by converting them to biodiesel and/low sulfur diesel. A coalition of Puget Sound Governments is working together to improve their fleet operations and to create measures for "green fleets"[8]. The City of Seattle has had a Green Fleets Action plan since 2002[9]

Governor Gregoire's Climate Action Team considered a wide range of alternatives to address climate challenges and made recommendations to take a suite of actions for Washington State to be a leader in addressing climate, but also to capitalize on the opportunities addressing climate change presents[10]. Improving planning, vehicles, fuels, transit were among the recommendations. Adding price signals was seen as a key addition.

[6] http://www.metrokc.gov/kcdot/news/2004/nr040527_hybrids.htm
[7] ESSHB 1303, Section 202 "Effective June 1, 2015, all state agencies and local government subdivisions of the state, to the extent determined practicable… are required to satisfy one hundred percent of their fuel usage for operating publicly owned vessels, vehicles, and construction equipment from electricity or biofuel."
[8] http://www.psgreenfleets.org/
[9] http://www.seattle.gov/environment/clean_air.htm
[10] http://www.ecy.wa.gov/climatechange/index.htm

Plug in hybrids – original equipment vehicles

Since the introduction of the Honda Insight and the Toyota Prius, the first two production hybrid vehicles, discussion over new vehicles has been transformed. Until then most interest had focused on California's now abandoned effort to require electric vehicles. In the near term, hybrid vehicles appear to be one of the most viable technological ways to diversify our transportation alternatives. Many car makers are offering hybrids and sales and options continue to expand.

At this 2008 Detroit auto show "plug in hybrids" were very prominent technologies with a number of companies announcing intentions to produce vehicles as early as 2009. Announcements and exciting "concept cars" are the norm at the auto show. However, the "real" viability of plug in hybrids will be when they begin to appear in meaningful quantities at competitive prices in showrooms nationwide.

The 2007 Washington legislature adopted House bill 1820 that expands the definition of motor vehicle to include Neighborhood electric vehicles (NEV) (speeds up to 25 miles per hour) or Medium Speed Electric Vehicles (MEV) (speeds up to 35 miles per hour) enabling them to travel on roadways subject to certain conditions. The vehicles are defined as four-wheeled motor vehicles that are self-propelled and electrically powered, and must conform to federal safety regulations. Medium Speed electric vehicles may be operated on a public highway having a speed limit of 35 miles per hour or less if the vehicle is licensed and displays plates, the vehicle is insured for liability, the vehicle may not operate on a state highway, and that the vehicle may not cross a highway with a speed limit over 35 miles per hour. The operator must have a valid driver's license. Seatbelt and child restraint laws are applicable, and the vehicle must meet federal standards for that type of vehicle.[11]

Status of Washington's Plug in-hybrid Demonstration Projects

There are currently at least five notable vehicle electrification demonstration and testing projects underway in the state. These projects should provide state and local governments with some valuable field experience with the emerging electrification technology

Chelan School District – Plug in Bus

The Lake Chelan School District (LCSD) in Wenatchee is one of 19 districts in 11 states demonstrating an Original Equipment hybrid (diesel and electric) school bus[12]. The demonstration bus arrived in June of 2007. When not in electric mode the bus runs on low-sulfur diesel blended with biodiesel. The Port of Chelan County's Advanced Vehicle Innovations (AVI) is assisting the school district with this project.

[11] http://apps.leg.wa.gov/billinfo/summary.aspx?bill=1820&year=2008
[12] http://www.plugincenter.com/index.php?page_id=264

Lake Chelan School District's plug-in hybrid electric school bus will cost $210,000. The school district has committed $70,000. Other funding sources include $55,000 in federal funding from the Hybrid Electric School Bus (HESB) consortium, $40,000 from the state Department of Ecology, and $10,000 from the Port of Chelan County, and $10,000 from private sources.

LCSD transportation supervisor Scott Logan has been involved with a national buyers' consortium working to acquire hybrid school buses: developing product specifications, seeking vendors and coordinating funding requests. The HESB Project has been facilitated by Advanced Energy, a nonprofit in Raleigh, NC. Advanced Energy awarded a bid to IC Corp. for 19 buses. IC is a subsidiary of International Truck & Engine, and is partnering with Enova Systems, Inc.

The power train for a hybrid plug-in electric bus couples a V8 diesel engine with an 80-kilowatt hybrid electric drive train, incorporating a transmission, batteries and an electric motor. The system recovers kinetic energy during braking - charging the batteries while the bus is slowing down. The bus is plugged in overnight to a standard 120-volt socket, recharging the hybrid drive system batteries (minimum storage 28 kilowatt hours). A battery management system allows the batters to be charged via a connection to the local electric utility (Chelan County PUD). Other equipment monitors the status of the batteries, and a dashboard indicator light tells whether the bus is operating in a "charge depleting" or "charge sustaining" mode. A system including temperature sensors protects components from heat damage due to electrical overload.

Hybrid technology greatly increases fuel efficiency, which lowers fuel costs and reduces the use of fossil fuels. Hybrid vehicles emit fewer pollutants, reducing greenhouse gases which contribute to global warming. The use of biodiesel also decreases fossil fuel use and creates a market for Northwest growers of canola, mustard seed and even used restaurant grease. A school bus, making frequent starts and stops, is an ideal vehicle for hybrid technology, which generates energy from braking. Fuel costs for the school district will be considerably reduced with this bus, which will likely achieve 18 miles per gallon. Standard buses get 5 to 7 miles per gallon of diesel.

As noted, the first buses were delivered in the summer of 2007 in order to demonstrate the feasibility of a new original equipment plug in hybrid bus. Over the next few years the buses will be intensively monitored by comparing operations in a variety of situations with a non hybrid bus. The nationwide tests have so far gone well and the bus consortium is seeking to create a large enough purchase quantity to make the buses price competitive with conventional busses on a lifecycle basis. The Federal government, State of Washington through the Department of Ecology and Lake Chelan School District were the main investors.

For further information contact Scott Logan at 509-682-2442

Joint Puget Sound Demonstration Project

The City of Seattle, King County, Port of Seattle, and Puget Sound Clean Air Agency are participating in a yearlong demonstration project testing the performance of plug-in hybrid electric vehicles in an urban area[13]. Thanks to funding and technical support from the U.S. Department of Energy's Idaho National Laboratory (INL), matched by funding from program participants, 13 existing Prius will be converted to plug-in hybrid electric vehicles (PHEV) at a total cost of $156,000.

The project will test technology used to convert the second generation Toyota Prius to 100 miles per gallon vehicles; test PHEV performance in an urban area; help evaluate PHEV-electric grid integration issues, and promote electricity as an alternative fuel for transportation. Expected greenhouse gas emissions from the PHEV Prius in this are 50 percent less than those of conventional Prius.

The sponsors hope that this demonstration project will accelerate the commercial introduction of PHEV vehicles and better prepare electric utilities for the day when drivers may be are plugging into the grid more than often than filling up at the pump. Automakers have indicated an interest in producing PHEVs if battery costs drop. But battery makers indicate that they will need volume orders to be able to reduce costs.

The DOE's Idaho National Laboratory is the lead federal laboratory for the field performance and life testing of advanced technology vehicles. The participants in Seattle/King County project will provide real-time, real-life information vital to better understanding if these technological advances become viable on a wide-scale basis.

A123Systems, a leading high-power lithium ion battery manufacturer based in Watertown, Mass., will provide the conversion kits. Through its Hymotion division, A123 manufactures battery modules that can convert existing hybrids into plug-in hybrids. Plug-in hybrids can be charged during periods when electricity demand is low, then use the stored energy to allow the car's hybrid engine to run on electricity, rather than gasoline, more of the time. In a year, a PHEV driven a typical mix of 12,000 city and highway miles will consume from 1,840 kWh to 2,477 kWh of electricity, depending on the battery size. This is equivalent to the energy used in three to five months by an electric water heater in a three-person household (based on 540 kWh per month).

The 13 vehicles should be converted by summer of 2008 to demonstrate how a number of vehicles perform in a range of government fleets. The data gathered will become part of the Advanced Vehicle Testing Activity efforts being coordinated by the Idaho National Lab[14]

For more information contact: Rich Feldman, (206)684-7037

[13] http://www.seattle.gov/news/detail.asp?ID=7850&dept=40
[14] http://avt.inl.gov/

City of Seattle – other electric tests

The City of Seattle fleet contains 36 electric off-road vehicles, including 16 carts used at Seattle Center by maintenance crews; one neighborhood electric vehicle used by maintenance crews at and for general transport around Seattle's 350-acre Warren G. Magnuson Park; and 19 Segways, used by a variety of city departments, including Seattle Center security and event staff, the Fire Marshal's office, parking meter collections staff, parks department staff commuting between their headquarters and downtown city offices, water meter readers and the motor pool.

This work is part of the City of Seattle's plan adopted in 2003 to have a 100% Green Fleet[15].

For more information contact: Rich Feldman, (206)684-7037

Tacoma City Light

Tacoma Public Utilities has retrofitted two of its pool cars with plug-in hybrid technology[16]. Employees use pool cars for work-related trips. Employees typically use them for short trips. Both cars feature a colorful wrap with the message, "Tacoma Power…Plugging in for our future."

Plug-in hybrids operate solely on battery power for the first 16 to 60 miles of travel. Vehicles automatically operate like a hybrid car upon battery depletion, cycling back and forth from electric to internal combustion power. Plug-in hybrid battery packs store more power than standard hybrid vehicles and can be recharged from a standard electrical outlet.

Besides the environmental benefits, the pilot program allows Tacoma Public Utilities to learn more about hybrid technology, while beginning to understand the long-term issues related to the electrical system. As this technology improves and becomes more prevalent, it will present larger issues such as identifying the resources that will be required to fill the demand of plug-in vehicles, understanding what's needed for people to conveniently recharge their vehicles and finding a way to bill the individual users who charge their cars at places other than their homes. Tacoma Public Utilities will stay involved in regional discussions about plug-in hybrid technology and will look for opportunities to help shape expanded use of plug-in hybrid vehicles.

Frank Castro, TPU vehicle fleet manager
Chris Gleason, Community & Media Services manager, (253) 502-8222

[15] http://www.seattle.gov/environment/clean_air.htm
[15] http://www.ci.tacoma.wa.us/tpu/News%20Rel/News%20Rel%202007/december_18_07.htm

Port of Chelan County –Plug-in Hybrid Electric Vehicle (PHEV) Pilot Project

The Advanced Vehicle Initiatives Consortium has proposed conversion of 14 Toyota Prius vehicles into Plug in hybrids[17]. The objective of this pilot project is to conduct research in diverse on-road environments in Washington State. The demonstration will primarily address questions about PHEVs and grid interaction, emissions, energy storage, charging cycles, fuel consumption, economics and driver behavior.

This diverse consortium is made up of Brooks Solar, City of Wenatchee, Chelan County Chamber of Commerce Alliance, Douglas County Public Utility District, LINK Transit, Chelan County Public Utility District, Lake Chelan School District, North Central Technical Skills Center, Port of Chelan County, Center for Sustaining Agriculture and Natural Resources, WSU Wenatchee Valley Transportation Council, Wenatchee Valley College Port of Douglas County has been exploring Plug in hybrids for 5 years.

Significant features of the proposed project:

• Hymotion conversion kits will be utilized in Toyota Prius conversions, utilizing A123 lithium battery packs.

• Public agencies that participate in the project will:

1) Provide a Toyota Prius from its fleet for conversion to PHEV;

2) Pay a portion of the conversion cost;

3) Send a fleet technician to a 2-day conversion workshop;

4) Allow installation and operation of data logging devices;

5) Respond to surveys and interviews from project researchers;

6) Participate in two quarterly meetings of the pilot project enrollees.

This project has just been awarded support from the Idaho National Laboratory's Advanced Vehicle Testing Activity group. This project would test plug in hybrid vehicles in a wide range of geographies and in medium size cities.

This project will move forward with conversions when partners have committed. The Idaho National Lab committed to this conversion project in February 2008. Conversions should happen by the fall of 2008. One key goal of this project is that the participating entities will be actively involved with the conversion process. CTED has committed $20,000 to the activities of the Advanced Vehicle Initiative.

[16] http://www.plugincenter.com/index.php?page_id=211

Other activities to improve vehicles

Because the turnover rate of vehicles takes significant time – about 7% are replaced per year – it is important to understand and manage the use of existing vehicles. The Public Fleets Advisory Committee will recommend to the Puget Sound Clean Air Agency and the Puget Sound Clean Cities Coalition a suite of policies and criteria that can be used to define a "green fleet" in the Puget Sound region.[18] It is hoped that this information can feed into the specifications that CTED will be developing for new vehicles.

How would electrification fit with Washington's infrastructure?

It is clear that vehicle electrification could be attractive, but can also be problematic. An analysis by the Pacific Northwest National Lab has demonstrated that 70% of the light duty vehicle fleet in the United States could be served with off-peak electric power thereby offsetting substantial foreign petroleum imports.[19] The same study demonstrates this capacity varies by region. The key conclusion is that "smart charger" technology would be required to ensure vehicles were being charged at the right times and to send the right price signals.

Coupled with a "smarter grid," plug in hybrid electric vehicles could provide backup for homes and ultimately system backup. Most utilities and decision makers are interested in plug in vehicles, but justifiably cautious and protective of the nation's power grid.

A "smart grid" is coming piece by piece but at present there is no clear national framework or protocol for the smart grid. As smart grid technology penetrates the system the increased functionality potential will allow the system to do more. At the same time there will be problems and a need for additional solutions.

Who will make the rules?

Utilities and building officials will need to be ready to specify the type of electric service for charging stations. Will the "smart chargers" be required and built into vehicles? At present plugs and service are determined by utilities and building officials. What is plugged in where and when it is operated is controlled by consumers. Companies generally decide what features are within their products. If smart charges are not built into vehicles the uncertainly about who is charging what, when, where could have dramatic effects on the utility system.

When protocols have been adopted for the internet or computers these standards have spawned significant innovation. Will these software / hardware interactions be open source technologies or proprietary?

[18] http://www.psgreenfleets.org/
[19] http://www.pnl.gov/energy/eed/etd/pdfs/phev_feasibility_analysis_combined.pdf

Could Washington manufacture vehicles?

Washington State does not currently manufacture passenger vehicles; however, we do have a range of innovative companies that could offer attractive technologies for future vehicles. The long term approach to manufacturing vehicles may again be up in the air. Will vehicle manufacturing become more regional, modular and decentralized?

A decade ago no one would have believed that large airplanes would be sourcing major components from around the world. Two decades ago no one would have believed that software may be the driving force in computers or most of us would have one on our desk or in our phone.

Some current Washington companies could play a role in vehicles of the future:

- large trucks – Paccar
- airplanes – Boeing
- software – Microsoft
- composites – Torrey
- molds – Janicki
- conversions – Green Car Company
- software – v2green
- new vehicles – AFS Trinity Power

Each of these companies is a major player in creating products or supplies a key component which could be tied to future electrified vehicles.

What about the Original Equipment Manufacturers?

Just a few years ago most people chose vehicles from the offerings of a handful of worldwide companies. Over the last few years new business models for vehicles have begun to predominate – just in time manufacturing combined with faster model changes focused on narrower niches has supplanted large factories with large economies of scale. Nimble companies can match production runs more precisely to satisfy changing demand and thus have proven to be more profitable.

The OEMs just a few years ago had little interest in Plug in hybrids; however, national grass roots activity, rising oil prices, competition and climate have transformed the OEMs marketing and new vehicle strategies.

California's move to change its commitment to electric vehicles gave the car companies more flexibility to design and market a wider range of cars. However, an electric vehicle demonstration program and the introduction of hybrid vehicles show how demand changes. Just a few years ago everyone seemingly need a mini van, but the car companies recognized that while the minivan was useful it left many consumers feeling "middle aged." The Ford Explorer launched the SUV, but its design and configuration problems led to the redesign of vehicles to move from truck chassis to back to car chassis. The point is that car companies know their

customers, but through demonstrations, education, demand and legislation vehicles design can be made safer and more efficient.

Why is electrification potentially attractive?

Interest in electrification has been reborn because imported petroleum prices are high have risen from $27 a barrel to a persistent $90 + a barrel. War in the Middle East has raised national security questions and questions about supply stability. Today there is more discussion of Peak Oil whereby oil is being pumped faster than it is being discovered. While there is ongoing debate about when Peak Oil will happen there is little debate that new supplies are harder and more expensive to find, are smaller sources and more challenging to deliver. Climate change has raised questions about transportation alternatives and new technologies. Technology advancement and a resurgence in a can do attitude is fueling interest.

Petroleum powered vehicles created significant flexibility allowing individuals to travel when and where they wanted. Over the last 100 years investments in the road and fuel infrastructure transformed development. Today planners, public officials and citizens are rethinking the role of the car in our culture and economy. Europe and Japan never had the space to embrace "car culture" and perhaps their cities are more livable and more efficient. Cars, transit, planning, walking and biking can coexist and provide other potential benefits:

- cleaner
- reduce imported fuels – national security
- keep dollars in the economy
- air pollution
- health affects
- water pollution

Are there any key limitations or showstoppers for hybrids?

Developing battery systems for plug in hybrids continues to be the biggest obstacle widespread adoption. Current lead acid batteries like most of us have in our current vehicles are too bulky taking up too much space and would add too much weight to power hybrids. New lithium batteries similar to what we use for many small electronic devices will be extremely expensive to scale up. To ensure adequate battery power over the life of the car either the batteries will need to be replaced or more will need to be used. There is ongoing research on improving batteries, but it is not clear when or which technology will win out.

The Advanced Battery Consortium (USCAR) has these objectives:

For high-energy and high power energy storage technologies and models, the USABC shall continue its focus on understanding and addressing the following factors:

- Continue development of high-power battery technologies to reduce cost to $20/kW and extend life to 15 years.
- Develop battery technology to support electric, hybrid and fuel cell vehicles.
- Develop ultra capacitor technology for hybrid electric vehicle applications.
- Conduct benchmarking activities for both high power and high energy batteries and ultra capacitors to validate technologies.
- Publish technical goals and associated test procedures to guide the development of electrochemical energy storage systems.[20]

The Department of Energy has recently awarded $20 million dollars to 5 projects to advance batteries.[21]

Climate Change Challenge Analysis of Vehicle Electrification

The following strategy, **T-10 Acceleration and Integration of Plug-In Hybrid Electric Vehicle Use,** was developed for the February 2008, Interim Report of the Washington State Climate Change Challenge.[22] This strategy was developed by the Transportation Technical Working Group (Transportation TWG) made of up representatives from a wide range of business, governmental, and public interest groups.[23] This strategy, along with all other strategies were reviewed and affirmed by the full Climate Advisory Team (CAT) and was selected as one of the subset of "most promising strategies by the CAT. In addition to T-10, several other Transportation TWG strategies examined other vehicle electrification opportunities. T-6 Improvements to Freight Railroads and Intercity Passenger Railroads and T-7 Diesel Engine

[20] http://www.uscar.org/guest/view_team.php?teams_id=12
[21] http://www.doe.gov/news/5523.htm
[22] See Appendix F, Transportation Sector TWG Policy Option Descriptions, a detailed description of all of the strategies developed by the working group.
[23] *The Members of the Transportation working group were:*

- Genesee C. Adkins, Transportation Choices Coalition
- Dennis Antonellis, Amalgamated Transit Union (ATU), Local 1015
- Dick Ford, WA Transportation Commission
- KC Golden, Climate Solutions
- Dennis Hession, Mayor of Spokane
- Jemae Hoffman, Seattle Department of Transportation
- Teresa Jones, Costco Wholesale
- Jay Larson, Snohomish County
- Jim Lopez, King County
- Steve Marshall, Cascadia Center
- Sue Mauermann, Port of Tacoma
- Mary McCumber, Futurewise
- Michael McGinn, Sierra Club
- Dennis McLerran, Puget Sound Clean Air Agency
- Dave Moore, Boeing
- Larry Paulson, Port of Vancouver
- Sister Sharon Park, Washington State Catholic Conference
- Dan Sinks, Conoco Phillips
- Megan White, WA Department of Transportation

Emissions Reduction and Fuel Efficiency Improvements considered opportunities ranging from electric engines to electrification of port and freight handling equipment. In addition strategy, T-11 Low Carbon Fuel Standard, analyzed the possible impact of establishing a performance standard for transportation fuels based on the level of greenhouse gas emissions from the fuel. Electrified vehicles, especially if served by hydroelectric generation and other renewables could be an attractive low carbon fuel alternative.

A reconstituted version of the CAT will convene again in April 2008 to begin to select which of the "most promising" strategies merit further detailed analysis and program design. At that time, we will determine if this strategy will undergo further work.

T-10 Acceleration and Integration of Plug-In Hybrid Electric Vehicle Use

Mitigation Option Description

Plug-in hybrid electric vehicle technology (PHEV) offers one of the best opportunities to reduce transportation carbon dioxide emissions in a cost effective way. Smart integration of PHEVs into the electric power grid and into the transportation system can provide significant additional reductions. Coupling biofuels with PHEVs would further enhance the capability of PHEVs to lower GHG emissions.

The goal of this option is provide a set of actions that would accelerate the deployment of this technology, remove barriers to more rapid adoption, create initial incentives and provide for the integration of PHEVs with other systems, including the power system and the transportation system.

Mitigation Option Design

The Legislature provided initial funding for a Washington State PHEV pilot project, which could be expanded to design a more comprehensive set of measures to accelerate and integrate the deployment of PHEVs. This option would include the following actions:

- Increase the percentage of plug-in hybrid electric vehicles on Washington state roads, with first vehicles appearing in 2010 and market share growing to 2020. To help initiate and accelerate PHEV purchases, goals for Washington state agency fleet purchases and local government purchases of PHEVs would be set on an increasing schedule.

- Integration and coordination with electric utilities to ensure that recharging of PHEVs is accomplished at off peak times and in a manner that would also assist in the integration of intermittent wind power and other renewable power that is under other mandates. This would require testing and establishing standard communication protocols and technology, whether by power line communication, wireless, smart metering or combinations.

- Testing and deployment of Vehicle to Grid technology (V2G) that would potentially provide for power back to the grid at peak times and for ancillary services. Testing of use of PHEVs for back up storm power for individuals would also be tested.

- Integration with transportation system planning, such as the provision of recharging stations at park and ride lots, that would increase the all electric range of PHEVs and potentially provide for "cash back hybrid" power services, as Federal Energy Commissioner Jon Wellinghoff has described. This would provide for additional incentives for transit use.

- Integration with transportation pricing options, such as urban congestion pricing as mitigation for reduced gasoline tax revenues.

Goals: By 2020, PHEVs would account for 10% of light-duty VMT statewide.

Timing: Introduction of PHEVs would start in 2011 with 1% of light-duty VMT. Goal of 10% VMT achieved in 2020.

Parties Involved: State of Washington, Federal energy and transportation agencies, counties and cities, electric power utilities, transit agencies, Puget Sound Regional Council.

Implementation Mechanisms

- Provide funding for state and local government conversions of standard hybrids to plug-in through the Energy Freedom Fund. Set a goal for 500 conversions at $10,000 apiece and allocate funding to reach that goal. Require that these vehicles be grid-aware and include funding for equipment to accomplish this task. This would build on the demonstration program was created as part of HB 1303 passed by the legislature in 2006.

- Provide funding for school districts to acquire plug-in hybrid school buses.

- Through legislative action and executive order, commit Washington state government to purchase plug-ins from OEMs as they become commercially available, allowing purchase at a price premium to reflect carbon-reduction benefits and reductions in state expenditures on imported fuels.

- Direct Washington Utilities and Transportation Commission to undertake a study to assess impacts of plug-in fleets on state power infrastructure at various levels of market penetration, and to identify technology and system requirements to maximize use of off-peak and underutilized power resources. Ask WUTC to engage Northwest Power and Conservation Council as partner in the study.

- Direct WUTC to provide rate recovery for utility R&D investments in pilot tests of vehicle-to-grid systems.

- Fund state General Services to assess electric vehicle charging needs in state parking facilities.

- Develop and fund at least one vehicle-to-grid pilot involving a fleet of public plug-ins parked in a state garage.

- Fund a study by the Department of Community, Trade and Economic Development to identify Washington companies and economic sectors with potential vehicle electrification markets including power electronics, software and telecommunications, and develop a strategy to help Washington companies position for success in those markets.

Related Policies/Programs in Place

The 2006 legislature passed HB 1303 directing Department of Ecology and CTED to report to the legislature by March 1, 2008 on an analysis of vehicle electrification.

This analysis may include:

- An analysis of state agencies' plug-in hybrid vehicles and plug-in availability at state locations;

- Incentives for the use of plug-in truck auxiliary power units and truck stop electrification;

- Use of plug-in shore power for cargo and cruise ship terminals, shipside technology, and use of electric power alternatives for port-related operations and equipment such as switching locomotives, vessels and harbor craft, and cargo-handling equipment;

- The potential for plug-in hybrid school busses;

- Environmental and electrical grid impacts on electrical power consumption of the potential amount of plug-in hybrid vehicles;

- State laws, rules, tariffs, and policies that impact plug-in adoption, including pricing with incentives for off-peak charging;

- Incentives for the public use of plug-in vehicles, resulting cost savings, and whether state and local agencies should be required to purchase plug-in hybrid vehicles (if it is determined that those vehicles are commercially available at a reasonably comparable life-cycle cost);

- The potential of electrification of fixed transit routes for magnetic levitation propulsion systems;

- Actions by the state to help industries located in the state participate in developing and manufacturing plug-in vehicles and vehicle-to-grid technologies; and

- Any additional ways the state can promote transportation electrification in the private and public sectors

Leadership in Energy and Environmental Design (LEED) program which requires publicly funded buildings over 5,000 square feet, with K-12 schools being phased in later, to install, among other options, alternative energy sources such as electric vehicle plug-ins.

In 2005 the King County Council adopted an ordinance that requires future county projects to seek the highest LEED certification possible.

Estimated GHG Savings and Costs per MtCO2e

		Reductions ($MMtCO_2e$)				
	Policy	**2012**	**2020**	**Cumulative Reductions (2008-2020)**	**NPV (2008 – 2020) ($ millions)**	**Cost Effectiveness $/tCO$_2$**
T-10	**Accelerate and Integrate PHEV Use**	**0.19**	**0.95**	**5.28**	**$2,007**	**$380**

Data Sources

Lifecycle impact of PHEVs obtained from Argonne National Laboratory's GREET model (v1.7). Costs information from EPRI, Comparing the Benefits and Impacts of Hybrid Electric Vehicle Options for Compact Sedan and Sport Utility Vehicles, 2002

Quantification Methods

The estimate of GHG emission reductions is based upon PHEVs accounting for a specified percentage of LDV VMT. A ramp-up period is estimated so that the 10% goal would be reached at the horizon year, 2020. A per mile emission reduction factor is applied to the affected portion of baseline light duty vehicle GHG emissions (reflecting the effect of the clean car program).

Vehicles that connect to the electricity grid, including plug-in hybrids and fully electric vehicles, can provide substantial per mile reductions in GHG emissions on a lifecycle basis. According to the GREET model (v1.7), a PHEV in Washington would have 37% lower GHG per mile than a conventional gasoline vehicle. This analysis assumes that the emissions associated with marginal electricity sources for powering PHEVs consistent with assumptions used in developing the state emissions inventory and used in analyzing other options, which are based on prior analysis by the Northwest Power Planning Council and other. The marginal electricity emissions rate is roughly consistent with natural gas power. To the extent that PHEVs through their electricity storage and regulation capabilities could enable a greater penetration of new

renewable energy resources that might otherwise be achievable, they could enable even greater emission reductions.

Estimations of costs based on information in EPRI, Comparing the Benefits and Impacts of Hybrid Electric Vehicle Options for Compact Sedan and Sport Utility Vehicles, 2002. Cost estimates assume: purchases of PHEVs begin in 2010 and increase linearly in order to reach a market penetration of 10% of registered light duty vehicles by 2020; assumed that half of PHEVs are compact vehicles and half are mid-sized SUVs; assumed that PHEVs have 20-mile all-battery range. Capital and operating cost assumptions shown below.

	Retail Price Equivalent		Gasoline cost/mile (cents)		Electricity cost/mile (cents)		Total fuel cost/mile (cents)		Annual Maintenance Costs	
	Compact	Mid SUV	Compact	Mid SUV	Compact	Mid SUV	Compact	Mid SUV	Compact	Mid SUV
Conv Veh.	$13,962	$30,977	6.27	10.63	0.00	0.00	6.27	10.63	$346	$626
PHEV 20	$19,235	$38,406	2.78	4.23	0.71	1.05	3.49	5.28	$254	$530
Diff.	$5,273	$7,429	-3.49	-6.40	0.71	1.05	-2.78	-5.35	-$92	-$96

Source: EPRI, *Comparing the Benefits and Impacts of Hybrid Electric Vehicle Options for Compact Sedan and Sport Utility Vehicles*, 2002

Key Assumptions:

- Program begins in 2010; first full year of emissions reduction is 2011.
- PHEV proportion of LDV VMT increases from 1% in 2011 to 10% by 2020.
- PHEVs would have 37% lower life-cycle GHG emissions than conventional gasoline vehicles in Washington.

Contribution to Other Goals

Contribution to Long-term GHG Emission Goals (2035/2050) - Not quantified.

Job Creation - None cited.

Reduced Fuel Import Expenditures - This option would reduce gasoline consumption in Washington, thereby reducing fuel import expenditures.

Key Uncertainties - None cited.

Additional Benefits and Costs - None cited.

Feasibility Issues - None cited.

Conclusions

Washington State will continue to participate in advanced vehicle and fuel efforts. Recently adopted state legislation has moved us to the front rank of states looking for ways to improve transportation's energy and greenhouse emissions profile. Examination of vehicle electrification should continue to be a part of that larger effort. The demonstration and testing programs that are already underway will go a long way in helping us determine if vehicle electrification can become a significant part of the state's transportation future.

CTED and state government should continue to work with and encourage Washington companies to active engage in this burgeoning area. We should not bank on ever becoming a significant manufacturer of next generation in vehicles. However, the combination of new business models focusing on energy efficiency and low carbon opportunities, a strong state-level entrepreneurial and research base, and a hydroelectric power system will mean that we will be a significant participant in emerging vehicle electrification work. The continued work of the Climate Change Challenge and results from the on-going demonstration projects will soon begin to provide the information and experience to determine our future directions.

Websites for plug-in hybrid electric vehicles (PHEVs)

National Renewable Energy Laboratory (NREL) - http://www.nrel.gov/vehiclesandfuels/hev/plugins.html

U.S. Department of Energy, Energy Efficiency and Renewable Energy Divisions (EERE) - http://www.eere.energy.gov/afdc/vehicles/plugin_hybrids.html

University of California-Davis (connected with California Public Interest Energy Research CA-PIER) - http://phev.ucdavis.edu/

CalCars: http://www.calcars.org/

Plug In America - http://www.pluginamerica.org/

Vehicle to Grid: http://www.udel.edu/V2G/

Plug in Center: http://www.plugincenter.com/

City of Tacoma demonstration: http://www.ci.tacoma.wa.us/tpu/News%20Rel/News%20Rel%202007/december_18_07.htm

King County Metro hybrid buses: http://www.metrokc.gov/kcdot/news/2004/nr040527_hybrids.htm