Transportation Technical Work Group
Summary List of Recommended High Priority Mitigation Options

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effective-ness ($/$tCO_2e$)	Status of Option
		2012	2020	Total 2008 2020			
T-0	New Funding Mechanisms	Not quantified					Ready for CAT review
T-1	Transit, Ridesharing, and Commuter Choice Programs	1.25	4.09	25.59	$6,111	$239	Ready for CAT review
T-2	State, Regional, and Local VMT and GHG Reduction Goals and Standards	1.31	7.39	39.0	Not quantified		Ready for CAT review
T-3	Transportation Pricing	0.15	1.22	7.19	Not quantified		Ready for CAT review
T-4	Promote Compact and Transit-Oriented Development (low end and high end)	0.35	1.76	9.67	<$0	<$0	Ready for CAT review
		0.82	4.10	22.5			
T-5	Quantification of GHG Impacts of Transportation Plans, Programs, and Projects	Not quantified					Ready for CAT review
T-6	Improvements to Freight Railroads and Intercity Passenger Railroads	0.03	0.09	0.58	$3,073	$5,341	Ready for CAT review
T-7	Diesel Engine Emission Reductions and Fuel Efficiency Improvements	0.16	0.96	5.13	$170	$33	Ready for CAT review
T-8	Local Transportation Financing Tools and Bicycle and Pedestrian Infrastructure Improvements	0.12	0.21	1.56	$146	$94	Ready for CAT review
T-9	Transportation System Management	Not quantified					Ready for CAT review
T-10	Actions to Accelerate and Integrate Plug-In Hybrid Electric Vehicle Use	0.20	1.08	5.76	$2,007	$348	Affirmed by CAT
T-11	Low Carbon Fuel Standard	0.38	3.90	16.2	$1,886	$117	Affirmed by CAT
T-12	Zero Emission Vehicle Standard and Low-GHG Refrigerants	0.05	0.44	1.81	$446	$246	Ready for CAT review

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effective-ness ($/$tCO_2e$)	Status of Option
		2012	2020	Total 2008 2020			
	Sector Total After Adjusting for Overlaps	1.8	11.4	57.0	TBD	TBD	
	Reductions From Recent Actions (table to be added below)	0.8	3.6	20.7			
	Sector Total Plus Recent Actions	2.6	15.0	77.6			

Mitigation Option T-0:
New Transportation Funding Mechanisms

Mitigation Option Description

Our current system for financing transportation programs and projects faces many challenges. The primary revenue source for transportation in Washington is the gas tax. The gas tax has many of its own challenges, including: 1) it is largely obligated to a series of programs and projects over the next 10-15 years, 2) it will begin to yield declining revenues around the middle of the next decade, and 3) its spending is restricted to highway purposes only. In addition to the gas tax, we have a number of other revenue fees and taxes that fund a variety of other transportation programs and projects.

It is important that existing revenue streams be examined to assure their best use, particularly in light of the new demands on the transportation sector in the face of climate change. It is also important that we continually strive to find the correct balance between broad revenue sources and user fees, with no one constituency shouldering a disproportionate share of the total cost. Many of these sources, however, are either fully obligated or do not generate significant revenue. Cities, counties, and Public Transportation Benefit Areas are authorized by the state to fund transit programs through locally-approved sales and use taxes, and a number of communities have already exhausted their full local funding authorization.

In order to adequately fund the maintenance and safety improvements necessary for the existing transportation system as well as fund many of the measures under consideration by the Climate Advisory Team to meet the Governor's stated objectives, Washington must develop additional, flexible, and reliable long-term funding mechanisms.

Mitigation Option Design

The state must better utilize existing revenue streams—those not already allocated or programmed—to support the Governor's Executive Order 07-02. The state should undertake a serious analysis of existing revenue sources and measures by which those pools of funds – transportation, public works, infrastructure, and capital– could be prioritized toward those projects, programs, and investments that provide greater benefit toward the achievement of the stated goals in E.O. 07-02. The Joint Transportation Committee is requested to undertake such an analysis and provide conclusions by December 2008 with recommendations for action in the 2009 Legislature.

The state should act in the 2008 legislative session to authorize additional or expanded revenue tools to fund a range of transportation needs.

The revenue tools that need immediate consideration in 2008 are the following:

- User Fees:
  - Tolls and/or congestion/value pricing
  - Fuel efficiency / Carbon emissions tax
  - Commercial and municipal parking fees
  - Vehicle-miles-traveled or odometer tax

- Local Option Taxes:
  - Local option gross weight fee
  - Tax Increment Financing
  - Local option gas tax

- Statewide Revenue Sources:
  - Sales tax on gas
  - Indexing of the state gas tax
  - Petroleum transfer fees

If the Legislature cannot authorize these revenue sources in the 2008 legislative session, at a minimum, the TWG would request that the Joint Transportation Committee study their projected revenue benefit and implementation costs during 2008, with recommendations ready by December 2008 for appropriate action by the 2009 Legislature.

Mitigation Option T-1:
Transit, Ridesharing, and Commuter Choice Programs

Based on Transportation Catalog Option 5.2, 5.3, and 5.6

Mitigation Option Description

The goal of this set of activities is for the state to provide the leadership and resources necessary to help create a transit and ridesharing system that connects activity centers on both an intra- and an inter-regional basis. Success at meeting the overall emissions reductions goals for 2020, 2035, and 2050 requires that substantial reductions be made in emissions from personal transportation. This will require that the state develop a reliable funding system that allows for near-term success and long-term major investments with the flexibility to invest in any type of solution. The set of activities and investments represented here attempts to reflect the diversity of needs across the state: what works in dense urban areas will be different than what is effective in low-density suburban or rural areas. Reduction of non-commute trips will require as much, if not more attention, that reduction of commute trips. The state will need to direct resources to increase transportation system capacity and to generate demand for non-SOV travel. The transit capital, operating support, ridesharing and trip reduction strategies assembled allow for local needs to drive the process. Further, a set of performance measures and measurement methodologies must be developed to allow the state, local jurisdictions, and others to track progress over time. Resource requirements will follow from the conclusion of this process.

The strategies outlined here reflect a process that was based on reducing travel in several of the various travel markets across the state. The markets are broken down by commute and non-commute sectors. Several sub markets exist within the non-commute sector: recreation, school, shopping, etc. There are also different environments and different levels of infrastructure in place to accommodate trips: dense urban, other urban, suburban, exurban, and rural.

Key Issue: The strategies in T-1 presume that the strategies in the other policy areas in development by the TWG are successful. The top priority options are: T-0, T-3, T-4, T-9, and T-11. In particular, the T-1 strategies are supported by pricing policies that prioritize speed and reliability of public transportation services. It is anticipated that the TWG and the CAT will vet the interaction among the issue areas and engage in a process of sorting out the resource requirements and VMT reductions where there is overlap among the issue areas.

Mitigation Option Design

Transit – Planning

- Identify dedicated transit corridor routes necessary and preferred for achieving vehicle miles traveled reduction goals.

- Use multimodal concurrency as a tool to link new development to a more efficient transportation system. The regulatory power of land development codes must be coordinated with planned investment in transit and non-motorized infrastructure.

Transit - Capital

- Park and ride capacity (new and expansion), Bus rapid transit, Vehicles, Passenger facilities (multi modal terminals, shelters)
- Technology improvements (real-time customer information, signal preemption. etc.)
- Expansion of Operations and Maintenance facilities (Transit bases, second or back-up ferry loading slip, etc.)
- Pedestrian, bicycle, and bus stop accessibility and safety projects
- Facilities that support multi-modal hubs
- Right-of-way and infrastructure investments for dedicated high-density transit corridors, including light rail

Transit – Operating

- Provide operating support to local transit agencies,
- Improve access within and between centers,
- Provide new service for developing areas,
  Provide assistance to rural areas,
- Increase resources available to elderly and disabled population (paratransit),
- Provide funding for promotion of use of transportation alternatives, and
- Coordinate schedules of transit services, including bus, rail, and ferry modes.

Transit – Funding

- Increase Regional Mobility Grant state program from $40 million per biennium to an amount that provides enough resource to meet the 2020, 2035, and 2050 reduction targets,
- Increase funding to ensure the mobility of persons with special transportation needs, and
- Provide funding for major investments in high capacity transit to match local and regional investments.

Ridesharing – Capital

- Meet vanpool fleet expansion needs of local service providers and provide funding for service and replacement of vans, and
- Create and maintain a state of the art ridematching system.

Ridesharing – Operating

- Fund ongoing statewide promotions, including incentives to employers and individuals,
- Create statewide marketing program to promote carpooling through education and incentives, and
- Fund incentives, including subsidized transit and vanpool fares for all State and local government employees.

Ridesharing – Cost

- Increase annual state funding from $8 million per biennium to an amount that supports reaching 2020, 2035, and 2050 reduction targets.

Commuter Choice – Operating

- Increase state CTR program statewide with emphasis on direct employer support, promotion, and incentives,
- Implement Growth and Transportation Efficiency Centers in all designated urban centers, and elevate trip reduction programs to promote multi-modal concurrency,
- Expand rideshare tax credit for employers that start employee incentive programs and retailers that reward customers who rideshare for shopping trips,
- Expand the Trip Reduction Performance Program, which uses pricing and market-based mechanisms to reduce SOV travel,
- Provide incentives to employers to allow telecommuting, and
- Implement major initiative to reach travelers at the home end of the trip: mobility education for 600,000 households per year for 10 years. This approach is critical to creating change in low density residential and employment areas across the state.

Commuter Choice – Cost

- Increase annual state funding to an amount that supports reaching 2020, 2035, and 2050 reduction targets.

Goals

Goals for this policy are identified for eight policy components, as follows.

T-1.1: Sustained operating support for public transportation.
Goal: 2% reduction in statewide urban area VMT.
Cost: Graduated investment that increases by $20 million annually, from 2009-2020. Cumulative investment level from 2009 – 2020 would be $1.56 billion.
Rationale: The current annual operating budget for public transportation among all transit agencies in the state is approximately $1.8 billion. The maximum amount of annual growth that the state's transit operators can collectively increase service levels is estimated to be about 200,000 hours annually. The transit operators could therefore increase service levels by 200,000 hours per year every year from 2009 until 2020. The cost of this investment is about $20 million per year, increasing by $20 million in each successive year through 2020. It is recommended that the central Puget Sound region receive 60% - 70% of the operating assistance due to population and employment density. It is also recommended that the investments be tied to actions taken at the local level that maintain and improve the operating environment for transit for travel speed and reliability.
Key linkage to other mitigation options: T-0, T-3.

T-1.2: Grants for Capital Programs
Goal: No VMT reduction goal associated with this policy component

Cost: $200 million per year
Rationale: This investment is required to support the expansion of the transit system statewide per T-1.1. It also will support park & ride expansion, bus rapid transit implementation, speed and reliability improvements, fleet and base expansion needs, and capital for vanpools. It would also represent state participation in funding of high capacity transit, such as light rail in Central Puget Sound. State participation in funding high capacity transit is intended, among other things, to accelerate the introduction of new transit capacity.
Key linkage to other mitigation options: T-0, T-9.

T-1.3: Subsidized fares in the urbanized area
Goal: 50% reduction in urban area transit fares
Cost: $180 million annually
Rationale: Reduction in cost of transit to the end user will offset market distortions that favor driving alone. The $180 million annual investment would reduce by half the average cost to ride transit in the state.
Key linkage to other mitigation options: T-0, T-4.

T.1.4: Traveler Information Systems
Goal: No VMT reduction goal associated with this policy component (enables other investments to be successful)
Cost: $3 million per year
Rationale: WSDOT is scoping out a multi-modal, multi-purpose real-time traveler information system. The system would provide real time options for mobility needs. Users would input where they wanted to go at what time, and the system would provide needed information on road conditions, transit trip planning, real-time ridematching, etc. For the users who choose the bus or vanpooling, the outcome of their choices are include in T-1.1. The users who choose other modes should be reflected here.
Key linkage to other mitigation options: T-9.

T-1.5: Commute trip reduction in dense urban centers
Goal: 20% reduction in VMT in urban centers (areas covered by CTR program)
Cost: $100 million per year
Rationale: Assuming there are 40 urban and manufacturing centers (22 in Central Puget Sound alone), equip each urban center with resources to implement aggressive trip reduction programs. This investment builds in the emerging Growth and Transportation Efficiency Centers (GTEC) program within the CTR program. Each GTEC would receive approximately $2.5 million per year, based on the identified resource needs by initial GTEC applicants. Require recipients of funding to: 1) identify SOV reduction targets and targets for increases in transit, ridesharing, and non-motorized market share, and 2) identify and implement strategies to use land use policies to assist in reductions in SOV commuting.
Key linkage to other mitigation options: T-4.

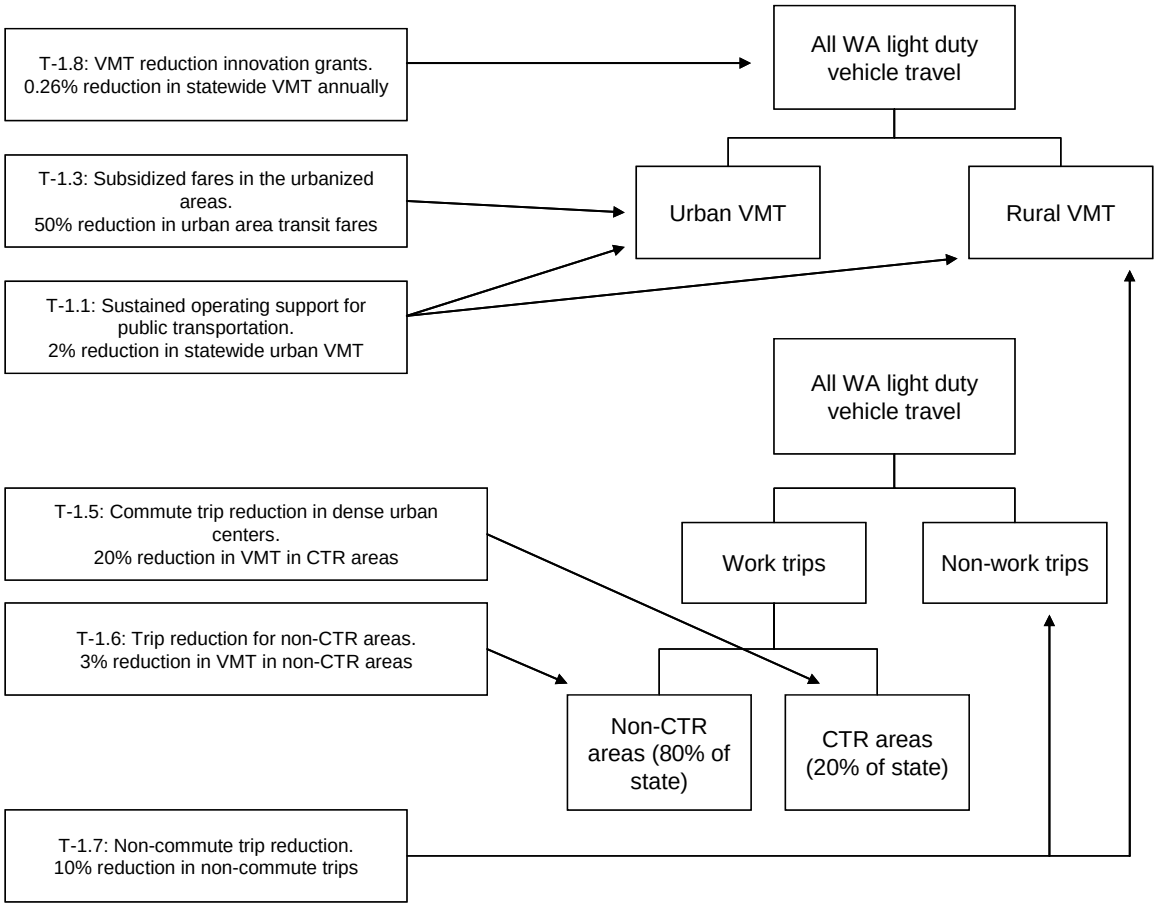
T-1.6: Trip reduction for commuters outside of dense urban centers
Goal: 3% reduction in VMT outside urban centers (areas not covered by CTR program)
Cost: $8 million per year

Rationale: This would provide resources for a "CTR-Lite" program in all areas of the state that do not currently participate in CTR. The emphasis would be on providing resources to local jurisdictions, transit agencies, and employers to implement incentives, promotions, ridesharing, and information programs. There would be no regulatory framework similar to the current CTR program.
Key linkage to other mitigation options: none

T-1.7: Non-commute trip reduction
Goal: 10% reduction in non-commute trips
Cost: $60 million per year
Rationale: Assuming each household makes 8 trips per day, and some of those trips are commute trips, set a goal of reducing 1 trip per day per household. How this is accomplished would vary tremendously by geography, density and infrastructure level, and trip purpose. Assist citizens to bike, walk, use transit and rideshare for an increasing proportion of trips each year.
Key linkage to other mitigation option: T-8

T-1.8: VMT reduction innovation grants
Goal: 0.26% reduction in VMT annually (based on WSDOT TRPP results)
Cost: $20 million per year
Rationale: There needs to be a resource to spur innovation for any VMT reduction scheme that is worthy of demonstration. The grant program would be performance-based, similar to the Trip Reduction Performance Program.
Key linkage to other mitigation option: none

The figure below illustrates schematically how these policy components interact and affect vehicle travel.



Timing: See above.

Parties Involved: Transit Agencies, State of Washington

Implementation Mechanisms

TBD

Related Policies/Programs in Place

WSDOT operates a trip reduction performance program (TRPP) that involves soliciting bids for avoided vehicle trips. The purpose of the program is to bring new services into the market, support broad based incentives, and reward entrepreneurs. WSDOT is spending $2.5 million this biennium for this program. It has eliminated vehicle trips at a state cost of about $200 - $300 per trip. For more information, see http://www.wsdot.wa.gov/TDM/TRPP/development.htm

[information on CTR program to be added]

Estimated GHG Savings and Costs per $MtCO_2e$

		Reductions ($MMtCO_2e$)				
	Policy	2012	2020	Cumulative Reductions (2008–2020)	NPV (2008–2020) ($ millions)	Cost-Effective-ness $/tCO_2$
T-1	Transit, Ridesharing, and Commuter Choice Programs	1.25	4.09	25.59	$6,111	$239

Data Sources

- Statewide VMT projections from WSDOT
- VMT by facility type from FHWA Highway Statistics, 2005
- VMT by trip type from PSRC Vision 2040
- Data on bus service and fuel consumption from National Transit Database, 2005

Quantification Methods

Impacts of policy option components calculated separately, as shown in table below.

Impacts of T-1.3 (Subsidized fares in the urbanized area) calculated as follows:

- In PSRC, transit passenger miles assumed to be 5.0% of total person miles (weighted average of 11.6% for work trips and 2.5% for non-work trips).
- In other urban areas, transit passenger miles assumed to be 1.3% of total person miles (weighted average of 2.0% for work trips and 1.0% for non-work trips – data for Clark County from Southwest Washington Regional Transportation Council).
- Elasticity of demand assumed to be -0.4, based on literature (for summary of literature, see Victoria Transport Policy Institute online TDM Encyclopedia, "Transportation Elasticities," www.vtpi.org/tdm)
- VMT reduction in PSRC calculated as 5% * (1- (0.4*50)) = 6%
- VMT reduction in other urban areas calculated as 1.3% * (1-(0.4*50)) = 1.5%

Total 2020 light-duty vehicle VMT reduction calculated to be 14.3%.

Annual VMT, 2020 (million)		Row Ref.	Source / Calculations
Statewide VMT	75,067	(1)	WSDOT projections
Statewide Light-duty VMT	68,311	(2)	Statewide total times 91% (a)
Statewide Urban Light-duty VMT	48,364	(3)	Statewide LDV total times 70.8% (b)
Statewide Rural Light-duty VMT	19,947	(4)	Statewide LDV total times 29.2% (b)
Statewide Light-duty Work VMT	18,876	(5)	Statewide LDV total times 27.6% (c)
Statewide Light-duty Non-work VMT	49,435	(6)	Statewide LDV total times 72.4% (c)
PSRC Light-duty VMT	38,555	(7)	PSRC V2040 (2020 interpolation)
Other Urban Light-duty VMT	9,809	(8)	(3) - (7)
T-1.1	967		(3) * 2%
T-1.3	2,470		(7) * 6% + (8) * 1.5% (see text)
T-1.5	755		(5) * 20% * 20%
T-1.6	453		(5) * 80% * 3%
T-1.7	4,944		(6) * 10%
T-1.8	178		(2) * 0.26%
Total VMT Reduction	9,767		
	14.3%	of total WA light duty VMT	

Note a: VMT projections by vehicle type from DOE Annual Energy Outlook (assumption used in CCS WA emission inventory)
Note b: VMT by urban vs. rural facility type from FHWA *Highway Statistics*, 2005 (data for Washington).
Note c: VMT for work vs. non-work trips from PSRC Vision 2040 modeling (2000 and 2040 Growth Targets Extended scenario).

Additional emissions from expanded bus service calculated as follows:

- Calculated average ratio of bus service hours to total vehicle hours for WA transit agencies
- Total vehicle hours = new service hours specified in T-1.1 * above ratio
- Calculated average fuel consumption by bus vehicle hour for WA transit agencies
- Current fuel mix held constant in future years: 84% diesel, 13% CNG, 3% biodiesel
- Fuel consumption in future years = total vehicle hours * fuel per hour
- Total emissions = fuel consumed * emissions per gallon
- Year 2020: 2.4 million additional bus service hours results in an additional 0.09 MMtC02e

Reduction in light-duty vehicle emissions offset by increase in bus emissions in order to calculate net reduction.

Key Assumptions

- VMT reduction benefits assumed to begin in 2010 and increase linearly through 2020.

Contribution to Other Goals

Contribution to Long-term GHG Emission Goals (2035/2050):

Job Creation:

Reduced Fuel Import Expenditures:

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Mitigation Option T-2:
State, Regional, and Local VMT Reduction Goals and Standards

Based on Transportation Catalog Option 4.4 and 5.10

Mitigation Option Description

While new technologies and cleaner fuels are vital to reducing GHG emissions, as long as annual vehicle miles traveled (VMT) continues to grow, we'll never be able to meet the state's 2020, 2035, and 2050 goals. Reduction of vehicle miles traveled – through a partnership between the state, regional, and local level – is critical. This approach seeks to maintain and increase personal mobility—not inhibit it—through expanded regional and local multimodal design, tools, and investments. Regional entities' and local governments' ability to achieve VMT reductions also depends a great deal upon other complementary policy tools considered in the CAT process. In many ways, T-2 serves as the accountability tool for progress on the collection of other GHG mitigation strategies recommended by the CAT process.

In 2007 lawmakers passed legislation that committed the state to develop a plan to gradually reduce per capita VMT. Vehicle miles traveled is commonly used a primary predictor in GHG output.

This option builds on that initial state action and would consist of the state establishing a schedule of targets for reducing statewide per capita VMT and working alongside local governments and regional planning organizations to achieve those targets.

Mitigation Option Design

Goals:

1. Develop a statewide plan with targets to reduce annual per capita VMT.
2. Apportion responsibilities of that plan to urban RTPOs, inclusive of local jurisdictions.

The state should adopt a schedule of statewide per capita VMT reduction targets, similar to the emissions reductions schedule in E.O. 07-02. Compared to a business as usual baseline, the state would commit to a plan to reduce annual per capita VMT 18% by 2020, 30% by 2035, and 50% by 2050. (To illustrate, the current statewide baseline projection shows approximately 10,000 VMT per capita in 2020, so an 18% reduction in that year would result in approximately 8,200 VMT per capita. This was the statewide VMT per capita average in the mid-1980s.) VMT projections for the 2035 and 2050 benchmarks are based on data that will become clearer over time, and periodic review and slight adjustment of those targets may warranted.

The per capita VMT reduction plan would be a partnership connecting the state, regional, and local levels. The state would design a plan that consists of both state actions and investments to achieve the targets. Significant state oversight is anticipated and much of the attainment in per

capita VMT reductions is expected to result from complimentary actions considered by the TWG. The statewide per capita VMT reduction targets serve as the accountability tool for progress on the collection of other GHG mitigation strategies recommended by the CAT process.

After the state has committed to a schedule of per capita VMT reductions, the state will then apportion to urban RTPOs –those that also function as federal Metropolitan Planning Organizations— their responsibility in achieving that goal. Here, urban RTPOs would adopt a regional per capita VMT reduction commitment in a low-med-high range (similar to how OFM allows local governments to choose to plan for population forecasts within a low-med-high range). Urban RTPOs would be accountable to the state for meeting the adopted targets.

Local governments within an urban RTPO area, in cooperation with their urban RTPO, would then adopt policies in their comprehensive plans that are consistent with those regional commitments, and development and infrastructure decisions would need to be consistent with the per capita VMT reduction plan. Urban RTPOs would review local government transportation elements for consistency with the GMA and the regional transportation plan, as currently required.

WSDOT and CTED would develop and provide guidance to urban RTPOs and local governments, with a wide range of tools and best practices in order to reach the identified benchmark.

Timing:

The legislature would adopt the per capita VMT reduction targets in the 2008 legislative session. WSDOT and CTED would develop guidance and best practices in 2008, with phased implementation at the local and regional level beginning in 2009 and 2010. Early adopters could receive incentives from the state in the form of preference for competitive local transportation revenues and all jurisdictions would be given additional revenue authority for implementation.

Parties Involved:

State Legislature

CTED

DOT

Regional air quality control agencies

Cities and Counties

Urban Regional Transportation Planning Organizations

Implementation Mechanisms

TBD

Related Policies/Programs in Place

In 2007, the Washington State Legislature passed Senate Bill 5412, which revised the state Department of Transportation's goals and benchmarks. In one section of the legislation, the state

committed to "develop strategies to gradually reduce the per capita vehicle miles traveled based on consideration of a range of reduction methods." The bill was passed with near unanimity.

The state requires large employers inside urban growth areas to participate in the Commute Trip Reduction program, where a variety of tools are used to incent commute trip reduction and reduce drive-alone trips. Under this program, employers work together with local jurisdictions, the state department of transportation, and regional transportation planning organizations.

Estimated GHG Savings and Costs per $MtCO_2e$

		Reductions ($MMtCO_2e$)				Cost-Effective-ness $/tCO_2$
	Policy	2012	2020	Cumulative Reductions (2008–2020)	NPV (2008–2020) ($ millions)	
T-2	State, Regional, and Local VMT Reduction Goals and Standards	1.31	7.39	39.0	NQ	NQ

Data Sources

Statewide VMT and population forecasts provided by WSDOT.

Quantification Methods

Using statewide VMT and population forecasts, we calculated VMT per capita out to 2020. The 2020 VMT per capita is reduced by 18%, and total on-road GHGs are reduced proportionately. To estimate the 2012 reduction and cumulative reduction, it is assumed that the percent reduction in VMT per capita begins in 2011 at 1.8% and increases by 1.8% every year to 2020. The table below shows historic VMT per capita, the 2020 forecast, and the GHG impact in 2020.

	Baseline						2020 Target
	1980	1990	2000	2005	2010	2020	18% reduction
Annual VMT (millions)	30,990	43,934	53,319	56,174	60,951	75,067	61,555
Population (millions)	4.13	4.87	5.89	6.20	6.54	7.43	7.43
Annual VMT per person	7,499	9,028	9,046	9,054	9,317	10,100	8,282
On-Road GHG emissions (MMtCO2e)	N/A	24.47	32.10	32.26	35.09	41.08	33.7
Reduction from Baseline (MMtCO2e):							7.4

Note: Scenario assumes GHG reduction directly proportional to VMT reduction.

Key Assumptions

GHG reduction will be directly proportional to VMT reduction.

Contribution to Other Goals

Contribution to Long-term GHG Emission Goals (2035/2050):

Job Creation:

Reduced Fuel Import Expenditures:

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Mitigation Option T-3:
Transportation Pricing

Based on Transportation Catalog Option 5.7, 5.9, and 5.12

Mitigation Option Description

Growing traffic congestion, particularly in the urban areas of our state, causes reduced fuel efficiency and increases emissions of greenhouse gases as well as criteria pollutants. The way we pay for transportation influences our decisions on when, where, and how we travel – or don't travel. A major reason for congestion is that there is little relationship between how a person travels and the cost (personal, social, and environmental) of that travel. Pricing sets a direct economic relationship between the costs and benefits of when, where, and how a person travels; by doing so, pricing manages demand and increases the efficiency of the transportation system and reduce adverse environmental impacts. When variable costs of automobile travel are comparatively low, transit and ridesharing have difficulty competing.

Pricing works on the principle of supply and demand. Congestion occurs when demand is so high that the system can no-longer efficiently handle the amount of traffic. Roadway pricing introduces or expands the use of user fees linked to existing congestion conditions to manage demand. As demand increases for a facility or service, the cost for that facility or service increases. With a cost associated with the use of a facility, travelers begin to think and react more to when, where, and how they travel. Travelers will alter their travel, reducing the demand for the facility or service and thus enabling it to operate at an efficient level. For example, peak-period pricing for air travel has become one of the most significant methods to balance supply and demand by encouraging travelers to alter their travel schedules. Other forms of transportation pricing work on similar principles, seeking to limit demand and maximize efficiency by sending more explicit price signals to users. While applying pricing to surface transportation is a recent development, pricing has been used successfully in other public service sectors such as water and electricity.

Parking management can also have a considerable influence on travel behavior. Converting free unrestricted spaces to time-restricted or paid parking and discouraging commuter parking in favor of short-term use helps to shift car-commute trips to alternative modes, especially during the peak commuter times. Ensuring sufficient availability of short-term spaces can also reduce circling for that last available space, and the associated greenhouse gas emissions from idling and congestion. Expensive parking motivates potential drivers to seek choices other than single-occupant cars, or to limit the number of trips that require paid parking. Studies examining the effect of higher parking prices on driving show that motorists are particularly sensitive to large-scale increases in parking fees, meaning that higher prices are likely to keep them from driving. While higher parking prices provide the incentive to using a travel option other than driving, the other side of the equation is just as important – having viable transportation options available. A

parking tax can serve as a funding source to fund improvements to our public transportation system needed to make transit a viable alternative to driving alone.

This option seeks to promote several forms of transportation pricing in both the near and longer term. Near-term options include:

- Expanded use of HOT (High Occupancy Toll) lanes in a manner that does not reduce capacity, performance, or demand for HOV modes and in situations where HOT lane expansion is likely to reduce GHG emissions
- Use of tolling to manage demand in selected corridors, including both variable and fixed tolling
- Start of a mileage-based insurance pilot program
- Increases in parking prices and prioritization of short-term parking in business districts through time-limits or meters in order to reduce cruising of local streets in search of on-street parking and reduce the use of street parking for commuter parking.
- Parking supply management including adoption of zoning regulations that eliminate minimum parking requirements and establish maximums to avoid requiring too much parking to be built; prohibit the construction of principal use long term parking; and allow shared parking.

Longer-term options include:

- Implementation of system-wide variable roadway pricing in major urban areas
- Broad offering of mileage-based insurance throughout the state
- Exploration of mileage-based vehicle pricing, greenhouse gas emissions pricing and vehicle weight charges. As vehicles using alterative fuels, such as biofuels and electricity, become increasingly available, there will be a need to replace lost gas tax revenues. Additional sources of revenue should not discourage alternative fuels. Oregon is experimenting with mileage based revenue, but other systems need to be explored.
- Change state legislation authorizing a commercial parking tax to allow monthly reserved parking to be taxed and require parking tax revenues to be spent on transportation alternatives to driving. If possible, create the ability to charge a higher parking tax for monthly, long-term or commuter parking than for short-term parking.

Funds generated by roadway pricing should be used to support alternative modes of regional transportation.

Mitigation Option Design

Near-term goals:

1. Implement HOT lanes in SR 167 corridor as planned. Explore implementation of HOT lanes on I-405 and conversion of Puget Sound HOV system to HOT lanes.
2. Use tolls to manage demand in SR 520 corridor and other corridors as appropriate (variable and fixed tolls).

3. Expand King County mileage-based insurance pilot program. By 2012, 5% of Washington drivers would by covered by mileage-based automobile insurance.
4. Implement 15% parking surcharge in the Puget Sound region; increase to 20% by 2009. (Bainbridge Island currently has a 24% parking tax; Seattle has a 5% parking tax scheduled to increase to 10%.) Explore creating a lower tax structure for parking spaces dedicated to short-term use.
5. Expand the use and valuation of the Commercial Parking License Fee (required to operate a parking garage) to reflect the environmental cost of parking to the cities and result in parking operators to charge high rates for off-street parking.
6. By 2010, ensure that 50% of employers who provide leased parking spaces to employees will offer parking cash-out.
7. Develop or improve tools that can be used to evaluate pricing options.

Longer-term goals:

8. By 2015, use variable pricing to manage demand on the highway system throughout the Puget Sound region.
9. By 2020, 20% of Washington drivers will be covered by mileage-based automobile insurance.

Timing: See above.

Parties Involved: WSDOT, RTPOs, counties

Implementation Mechanisms

- King County Metro, WSDOT, and partner agencies will conduct a statewide pilot of Pay-As-You-Drive Insurance, as planned. After the pilot, state agencies and counties will work with the insurance industry to achieve target market penetration levels of Pay-As-You-Drive Insurance. If necessary, state would use regulations and/or incentives ensure that mileage-based insurance is widely offered and adopted by consumers.
- State agencies would educate local governments about the importance of setting on-street parking rates high enough to discourage commuter parking and ensure adequate turnover and availability (thereby reducing traffic congestion and emission from vehicles cruising for open spaces).
- WSDOT will begin state's first HOT lane operation in 2008. WSDOT will lead the expansion of roadway pricing in major urban areas, working with regional and local agencies as appropriate.
- Local governments will implement the parking surcharge in the Puget Sound region.

Related Policies/Programs in Place

- HOT (High Occupancy Toll) or Express Toll Lanes. In April 2008, WSDOT will begin operations of the first HOT Lane in the state. The SR 167 corridor is heavily congested, but has excess capacity in the HOV (High Occupancy Vehicle) Lane. The HOT Lane

will allow non-HOV drivers to use the lane for a fee. The fee will be variable, changing based on the travel conditions and amount of capacity available in the HOT Lane. By managing the amount of vehicle in the lane through price, the HOT Lane will maintain transit, vanpool, and carpool travel times within the corridor, increase the efficiency of the lane, and increase vehicle efficiency.

WSDOT is exploring the use of HOT or Express Toll Lanes on I-405 as well as conversion of the existing HOV system within the Puget Sound.

- Corridor Pricing. The Lake Washington Urban Partnership proposal between WSDOT, King County, and the Puget Sound Regional Council are exploring the potential of tolling the SR 520 corridor, prior to construction, to test the use of tolling, technology, transit, and teleworking to reduce congestion within the corridor. King County, the Washington State Department of Transportation and the Puget Sound Regional Council have received a U.S. Department of Transportation Urban Partnership Grant that includes The Lake Washington Urban Partnership proposal.
- Mileage based insurance. King County is beginning a research project to test the potential for mileage based insurance with Unigard Insurance. The study will explore how insurance priced on when, where, and how you drive will influence driver behavior.
- PSRC recently conducted a pilot test of an in-vehicle taxi-like metering device to assess roadway user charges. This Traffic Choices Study involved 500 vehicles from more than 300 households.
- On July 6, 2007, the City of Seattle implemented a 5% parking tax. The tax will go up to 7.5% on July 1, 2008 and up to 10% on July 1, 2009. Drivers who rent parking stalls by the month, residential parking spots, and parking on city streets are not affected by the new tax.

Estimated GHG Savings and Costs per $MtCO_2e$

		Reductions ($MMtCO_2e$)			NPV (2008–2020) $ millions	Cost-Effective-ness $/tCO_2$
	Policy Component	2012	2020	Cumulative Reductions (2008–2020)		
T-3	Parking Cash Out, Seattle	0.01	0.01	0.15	NQ	NQ
T-3	Parking Surcharge, PSRC area	0.03	0.03	0.37	NQ	NQ
T-3	Mileage-Based Insurance	0.11	0.47	2.55	NQ	NQ
T-3	Variable Tolls on PSRC Highway System	N/A	0.71	4.12	NQ	NQ
T-3	Total (non-cumulative)	0.15	1.22	7.19	NQ	NQ

NQ: Not quantified

Data Sources:

- The Downtown Seattle Access Project Parking Cash Out Experience: Results and Recommendations, Draft Report. King County Metro, July 2003.
- PSRC Regional Parking Inventory, 2006
- PSRC Forecasts of Population, Households and Employment, 2006
- PSRC Vision 2040 VMT and trip forecasts
- SR-520 and 1-90 Toll Feasibility Analysis, Traffic and Revenue Forecasts Technical Memorandum. Parsons Brinckerhoff for WSDOT, May 2007.

Quantification Methods:

Parking cash-out

- EPA's Commuter model was used to assess the impact of an employer parking cash-out program on light-duty VMT in downtown Seattle. Key inputs include the number of affected employees (44,000) and the amount of the parking subsidy ($11.27 per day).

Parking surcharge

- Reduction in VMT = No. of parking spaces × vehicles per space per day × average vehicle round trip length × increase in parking charge × elasticity of demand. Elasticity of demand assumed to be -0.2, based on Vaca and Kuzmyak (2005).

Mileage-Based Automobile Insurance

The Arizona PIRG Education Fund analyzed the potential GHG savings from a pay-as-you-drive (PAYD) automobile insurance policy. The strategy for a PAYD policy analyzed assumes that insurers are required to offer mileage-based insurance for certain elements of vehicle insurance, including collision and liability. The PIRG Education Fund assumes the PAYD policy is required, phased in over time, and that all drivers in Arizona are eventually covered.

To calculate GHG savings, the Arizona PIRG Education Fund converted Arizona state automobile collision and liability insurance expenditures to an insurance cost per mile (6.4 cents/ mile). If insurance consumers pay 80% of their collision and liability insurance on a per-mile basis, then drivers would be assessed a charge of about 5.1 cents/mile. This per-mile insurance charge would reduce VMT by about 8%.[1] (To put this charge in context, at 20 mpg, 5.1 cents/mile = ~$1/gallon of gasoline.)

[1] Elizabeth Ridlington and Diane E. Brown, *A Blueprint for Action: Policy Options to Reduce Arizona's Contribution to Global Warming*, Arizona Public Research Interest Group Education Fund, April 2006, pp. 25–26. http://www.arizonapirg.org/AZ.asp?id2=23683. See also: http://www.serconline.org/payd/links.html, which links to a wide variety of PAYD studies and materials.

CCS compared the PIRG Education Fund results for estimated reductions in vehicle miles of travel with other studies of PAYD policies, including those produced by the Economic Policy Institute and Resources for the Future. CCS found that the Arizona PIRG estimates were comparable with other estimates, which ranged from 8% to 20%. The 8% reductions estimates CCS used for estimated reductions in VMT and GHG emissions reductions fell within the lower range of the comparable estimates.

- 2012 Reduction = LDV VMT × 5% of drivers × 8%
- 2020 Reduction = LDV VMT × 20% of drivers × 8%

Variable Roadway Tolling

A comprehensive variable tolling system on the PSRC region's freeways, expressways, and primary arterials would reduce total vehicle trips throughout the region. Some people who would otherwise drive alone would shift to carpools, transit, or other alternative modes. Route diversion is not likely to be the primary response of drivers.

The *SR 520 and I-90 Toll Feasibility Analysis*, conducted by Parsons Brinckerhoff (PB) in 2007, projected the response of drivers to two-way dynamic tolls on the two bridges that cross Lake Washington. The toll structure analyzed varies from $1 to $5 per crossing depending on the day of the week and the time of day. Vehicles with 3 or more passengers would not pay the toll. PB analyzed two scenarios. The first scenario included tolls on only SR 520. The second scenario included tolls on both bridges. In the first scenario, PB projected some route diversion from SR 520 to I-90. In the second scenario, there is no route diversion. PB projected that total cross-lake trips in passenger vehicles would fall by 7% under the first scenario, which allows for route diversion, in 2015. Under the second scenario, with no route diversion, trips would fall by 14%. The table below provides figures from the PB memo.

We calculate the impact of extending the variable tolling system to all freeways and expressways in the PSRC region. To account for a range of possible driver responses, we estimate a vehicle trip reduction of 10%, the midpoint of the two scenarios projected by PB. This estimate allows for some route diversion from freeways to local roads. To calculate the impact of the measure on regional VMT, we assume that the vehicle trips reduced are of average length. We reduce total passenger vehicle freeway VMT in the PSRC region by 10% starting in the year 2015. PSRC Freeway VMT for 2020 was obtained from PSRC Vision 2040 modeling; the "Growth Targets Extended" scenario was used as the business-as-usual baseline.

Impact of Dynamic Tolls on Lake Washington Vehicle Crossings

		Total Cross-Lake Daily Traffic			
		Tolled (SOV and HOV 2)	Untolled (HOV 3+)	Total	Change in Total Vehicle Traffic
2015	Toll Free Base Case	246,300	8,400	254,700	
	SR 520 Tolled / I-90 Toll Free	227,500	9,500	237,000	-7%
	SR 520 Tolled / I-90 Tolled	209,800	10,100	219,900	-14%
2030	Toll Free Base Case	269,100	10,000	278,200	
	SR 520 Tolled / I-90 Toll Free	246,700	12,800	259,500	-7%
	SR 520 Tolled / I-90 Tolled	227,600	13,500	241,100	-13%

Source: SR 520 and I-90 Toll Feasibility Analysis, Prepared for WSDOT, Prepared by PB, May 2007.

Key Assumptions:

Parking surcharge

- Each parking space accommodates an average of 2 vehicles per day, with an average round-trip length of 21 miles.
- We assume an elasticity of –0.2. Vaca and Kuzmyak (2005)[2] found that the price elasticity of vehicle travel with respect to parking pricing ranges from –0.1 to –0.3 (meaning that a 10% increase in parking price would typically be expected to reduce vehicle trips by 1%–3%, depending on the location, availability of transit and HOV options, and demographics).

Variable Roadway Tolling

- Drivers throughout the PSRC region will respond to variable highway tolling in a manner similar to that estimated for tolling scenarios on the Lake Washington bridges.

Contribution to Other Goals

Contribution to Long-term GHG Emission Goals (2035/2050):

Job Creation:

Reduced Fuel Import Expenditures:

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

[2] Vaca and Kuzmyak, 2005. "Parking Pricing and Fees" Chapter 13, TCRP Report 95, Traveler Response to Transportation System Changes, Transit Cooperative Research Program, Transportation Research Board.

Mitigation Option T-4:
Promote Compact and Transit-Oriented Development

Based on Transportation Catalog Option 4.1

Mitigation Option Description

Ensure that growth management plans promote compact and transit-oriented development to reduce VMT and GHG emissions. Transportation is the single largest source of GHG emissions in Washington State and we will not achieve our goals without significant reduction to its share of the emissions. Washington has already taken steps to manage growth and development and has begun efforts to reduce VMT and GHG emissions through the adoption and implementation of the Growth Management Act and related legislation. But with significant growth projected across the state, we must improve and build upon these efforts. Compact and transit-oriented development and VMT and GHG emissions reductions are feasible and necessary.

Washington State adopted the Growth Management Act (GMA) in 1990-91. Washington's approach recognizes the state's diversity from urban to rural and east to west. The approach puts forward state goals and requires cities and counties in the more populated areas of the state to plan for future population growth, establish urban growth areas, ensure adequate infrastructure, protect environmentally critical areas, and preserve the best agricultural and forest land for resource production. City and county comprehensive plans required by the GMA are valid unless challenged through a regional system of hearings boards. Washington's approach seeks to protect the important quality of life of our state, regions, and local communities while providing for local and regional flexibility in how the goals are met. The mitigation option proposed below fits into this framework. It would provide new direction for reducing VMT and GHG emissions, using solutions consistent with the state's diverse geography and communities.

Mitigation Option Design

Goal: Develop and implement policies and strategies that include funding, incentives and requirements to promote compact and transit-oriented development in urban areas. These actions, together with the actions in mitigation options T-1, T-3, and T-8, should be designed to reduce urban area VMT by 7%-15% in 2020 and by 25-50% in 2050 (compared to a business-as-usual baseline scenario). The high end of the 2050 range reflects a paradigm shift in land use patterns and travel behavior in Washington State.

- Encourage compact development within urban growth areas by designating urban centers for employment, services and housing growth, increasing urban residential densities while assuring adequate services, and encouraging "brownfield" development. Careful consideration should be used in expansion of urban growth areas, and when appropriate, development should reflect a compact development pattern.

- Promote transit-oriented development, including requiring planning/zoning for transit-oriented development to accompany high capacity transit investments, and declaring transit-oriented development a highway purpose that reduces congestion on public roadways (similar to public transportation facilities legislation).
- Promote amenities (such as green streets, small plazas and gathering plazas, frequent retail stops, noise control ordinances) that make high density living more attractive and encourage walking and biking.
- Promote sufficient affordable housing opportunities in urban areas with convenient access to transit to meet local and regional needs.

Timing: Amend the Washington State Growth Management Act and High-Capacity Transportation Systems Act in 2008. GMA implementation by cities and counties would be phased in through the regularly scheduled process for updating comprehensive plans, currently scheduled for 2011. Prior to a regularly scheduled update, any jurisdiction considering an urban growth area expansion would be required to meet the GMA's new climate change requirements. In addition, when a high-capacity transportation plan has been adopted and funded, local governments will initiate changes to comprehensive plans and codes for transit-oriented development at all major station areas. Depending on the timing, these changes may need to be completed prior to the regularly scheduled updates. The state should provide cities and counties planning grants to carryout the new requirements.

Parties Involved:

State Legislature

CTED

Cities and Counties

Regional Transportation Planning Organizations

Transit Agencies

Developers

Environmental Organizations

Public Interest Organizations

Implementation Mechanisms

Overall:

Mitigation Option T-4: Promote Compact and Transit-Oriented Development fits within the framework of the state's Growth Management Act (GMA). In order to implement the growth and transportation planning proposals being considered by the Washington Climate Advisory Team, the GMA should be amended to add a climate change goal (such as a reference to the state's goal established in SB 6001). In addition, regional and local GHG emission reduction targets should be established.

Encourage compact development within urban growth areas that result in reduced VMT and GHG emissions:

The GMA requires cities and counties planning under the act to adopt county-wide planning policies as the framework for county and city comprehensive plans. In the central Puget Sound region, the GMA also requires multi-county planning policies. An additional provision should be added requiring that the county-wide planning policies include defining and designating urban centers for employment, services and housing growth. The state should develop urban center guidelines that recognize the state's diversity, ranging from major metropolitan centers, suburban centers to rural towns. The new county-wide planning policies will be implemented by cities and counties through comprehensive plan updates. To assist with implementing these changes, the state should provide planning grants to cities and counties, as well as technical assistance and information transfer, to enable newly developing areas to benefit from the successes of other cities.

The GMA should establish standards for urban residential densities that recognize the state's diversity. Guidelines for contiguous urban areas and large cities should set densities sufficient to support frequent transit service (e.g. 10-15 minute headways). In these areas, an average of 8-10 units per acre (excluding environmentally sensitive areas) should be considered the minimum density. In addition, density guidelines for smaller cities should reflect walkable patterns of historic rural towns (e.g. Enumclaw, Prosser, historic Ellensburg and Wenatchee). These guidelines will be implemented by cities and counties through comprehensive plan updates.

Compact development provides an opportunity to conserve forest and farms lands through the use of transfer of development rights. Increased densities in urban areas could serve as receiving areas for transfer of development rights from forest and farm lands. (Option F-2: Reduced Conversion to Nonforest Cover identifies the need for urban receiving sites.)

Provide incentives for brownfield development within urban growth areas, such as grants and technical assistance to help jurisdictions identify the extent of problems, define workable mitigation measures, and complete redevelopment plans.

Future urban growth boundary expansions should be carefully considered. In cases where expansion is deemed appropriate, the city or county comprehensive plan for this area must provide for a compact development pattern and other measures to mitigate GHG emissions.

Promote transit-oriented development:

As part of planning for high-capacity transit, cities, counties and high-capacity transit agencies must develop and implement plans and codes that require transit-oriented development at all major station areas. High-capacity transit plans will identify station areas where transit-oriented developed is encouraged. In those areas, local government comprehensive plans and codes will include specific provisions for transit-oriented development.

There needs to be additional funding opportunities for transit-oriented development. One opportunity is to use city street, county road, and motor vehicle funds by declaring transit-oriented development a highway purpose that reduces congestion. (This change builds on RCW 47.04.083.)

Encourage walking and biking:

This action would be implemented by Mitigation Option T-8: Local Transportation Financing Tools and Bicycle and Pedestrian Infrastructure Improvements.

Promote affordable housing opportunities in urban areas:

Housing targets set by counties should assure that the supply of low income housing enabled by land use plans and regulations reflects job growth by subregion, e.g., so that workers can live within an easy transit or bike commute to work.

Sufficient affordable housing should be integrated into transit-oriented development plans and projects. (Easy access to transit is considered as ¼ mile to bus transit and ½ mile to rail transit.)

Related Policies/Programs in Place

Mitigation Option T-4: Promote Compact and Transit-Oriented Development builds on existing state legislation: Growth Management Act (RCW 36.70A); Regional Transportation Planning Legislation (RCW 47.80); High-Capacity Transportation Systems Legislation (RCW 81.104); and Urban Public Transportation Systems Legislation (RCW 47.04.083).

The centers approach is based on work that has been done in the central Puget Sound region (King, Kitsap, Pierce and Snohomish counties) through the Puget Sound Regional Council. The region's adopted growth, transportation and economic strategy is Vision 2020 (a 2040 update is underway). Since the early 1990s, a major component of the strategy is to identify urban centers within the designated urban growth areas as places for jobs, housing and services. The centers approach recognizes different types of centers from major metropolitan centers to suburban and neighborhood centers. Addressing the form of development within urban areas is currently not a GMA requirement.

Estimated GHG Savings and Costs per $MtCO_2e$

			Reductions ($MMtCO_2e$)				Cost-Effective-ness $/tCO_2$
	Policy	Scenario	2012	2020	Cumulative Reductions (2008–2020)	NPV (2008–2020) ($ millions)	
T-4	Promote Compact and Transit-Oriented Development	7% VMT reduction	0.35	1.76	9.67	net savings	net savings
		15% VMT reduction	0.82	4.10	22.54	net savings	net savings

Data Sources

- The 7% VMT reduction scenario based on PRSC Vision 2040 modeling of "Metropolitan Cities Alternative" and from land use scenario modeling in other metropolitan areas. PSRC's modeling shows that land use changes alone can significantly reduce VMT even when the transportation network is not optimized for that particular land use.

- The 15% VMT reduction based on estimates of the maximum potential VMT reduction that can be achieved through compact and transit-oriented development, major expansion of transit service (option T-1), roadway and parking pricing (option T-3), and improvement to pedestrian and bicycle infrastructure (option T-8).

Quantification Methods

- Mitigation option assumed to affect urban area VMT only.
- Statewide urban area VMT calculated as 70.8% of total statewide VMT, from FHWA's 2005 *Highway Statistics* for Washington. This ratio is assumed to remain constant (a conservative assumption, since the percent of urban VMT is likely to increase over time).
- Reduction in VMT will reduce GHG emissions, with a small offset due to reduction in average vehicle speeds in compact development. GHG emissions per mile assumed to increase 1% in compact development (based on Ewing et al, Growing Cooler: The Evidence on Urban Development and Climate Change, Urban Land Institute, 2007). Thus, a 7% VMT reduction reduces GHGs by 6.1% (100%-(93%*101%)), and a 15% VMT reduction reduces GHGs by 14.2% (100%-(85%*101%)).

Calculation of GHG impacts shown in table below.

	2000	2005	2010	2012	2020
Annual VMT (million)					
Statewide	53,319	56,174	60,951	64,059	75,067
Statewide Urban	37,747	39,768	43,150	45,350	53,143
Baseline Annual On-Road GHGs (MMtCO2e)					
Statewide	32.10	32.26	34.96	36.24	40.91
Statewide Urban	22.72	22.84	24.75	25.66	28.96
Impact of VMT Reduction (MMtCO2e)					
Low-end (7% VMT reduction)					27.20
High-end (15% VMT reduction)					24.86

- Emissions benefits assumed to begin 2011 and increase linearly to 2020.
- Cost of this option cannot be accurately quantified. A variety of literature finds that compact land development patterns produce net savings on the total costs of buildings + land + infrastructure + transportation. While some development components may have higher costs, the preponderance of literature suggests net savings overall (see US EPA, Our Built and Natural Environments: A Technical Review of the Interactions between Land Use, Transportation, and Environmental Quality, 2001). A National Academy of Sciences / Transportation Research Board review found substantial regional and state-level infrastructure cost savings from more compact development (see Robert Burchell, et al., The Costs of Sprawl—Revisited (TCRP Report 39), Transportation Research Board, Washington, D.C. 1998). An analysis of the New Jersey State Plan found that municipalities, counties, and school districts would save an estimated $160 million from 2000 to 2020 by pursuing smart growth patterns (see Robert Burchell, et al., The Costs and Benefits of Alternative Growth Patterns: The Impact Assessment of the New Jersey

State Plan, Center for Urban Policy Research, Rutgers University, 2000). The Envision Utah study found that a compact growth plan for the Salt Lake City region would save the region about $4.5 billion (17%) in infrastructure spending compared with a continuation of current sprawl development patterns (see Envision Utah, Quality Growth Strategy and Technical Review, Salt Lake City, Utah, January 2000).

Key Assumptions

- 7% to 15% reduction in urban area VMT by 2020 (compared to baseline)
- VMT reduction (compared to baseline) begins in 2010 and increases linearly to 2020.

Contribution to Other Goals

Contribution to Long-term GHG Emission Goals (2035/2050):

This mitigation option is a key component of Washington's efforts to achieve long-term emission reduction goals. The full effects of land use policy on VMT and emissions require decades to be fully realized. Studies have noted that vehicle and fuel technology improvements will not be sufficient to obtain the GHG emission reductions from the transportation sector necessary to achieve climate stabilization (see Ewing et al, *Growing Cooler: The Evidence on Urban Development and Climate Change*). Thus, significant long-term VMT reduction must be part of the state's climate action plan, and that VMT reduction cannot occur without ensuring that new urban development occur in a way that minimizes vehicle travel.

Job Creation:

TBD

Reduced Fuel Import Expenditures:

TBD

Key Uncertainties

Achieving the target reduction in VMT depends on implementation of policy initiatives at all levels of government. It is possible that required planning could be done in a way that does not sufficiently change development patterns, and thus does not reduce VMT and emissions by the goal levels. In other words, the policy language does not require these outcomes.

External forces can have a significant effect on VMT and land development patterns, which creates additional uncertainty regarding the impacts of this policy option. For example, fuel prices affect vehicle use. A major increase in fuel prices would help to encourage use of alternative travel modes, and would increase the benefits of this option. Conversely, a reduction in fuel prices would make it more difficult to reduce VMT through smart growth and multimodal transportation planning efforts. Land development patterns are strongly influenced by regional and state macro-economic forces. The ability of governments to influence land use patterns depends to some extent on developer demand.

Additional Benefits and Costs

- Studies have confirmed that compact development saves taxpayers money, particularly by reducing the cost of infrastructure such roads, and water/sewer lines. In addition, transit-oriented development significantly increases transit ridership.
- The 2005 King County LUTAQH study demonstrates the health benefits of compact communities. Another health benefit of compact development has been that it reduces accident rates.
- Focusing population growth in urban areas preserves productive forest and farmlands.
- Compact development requires less impervious surfaces and less forest clearing than less compact development patterns. This will help with carbon sequestration. It will also reduce water pollution and, in the Puget Sound basin, aid in the recover of Puget Sound.
- Compact development encourages densities needed for mixed income communities. While density alone is not sufficient to produce affordable housing, it is a necessary condition for affordable housing. Compact development makes mixed-income, more diverse neighborhoods possible.
- Compact development by allowing for reduced commuting times increases time people can spend with their families, on community activities, or work.

Feasibility Issues

TBD

Mitigation Option T-5:
Quantifying Greenhouse Gas Emissions from Transportation Projects

Based on Transportation Catalog Option 5.11

Mitigation Option Description

Transportation projects such as road expansion, increasing public transit, bicycle lanes and sidewalks can all potentially influence the amount of greenhouse gas (GHG) pollution emitted from the transportation sector. These projects can each directly affect travel demand and vehicle miles traveled (VMT), and indirectly affect land use/development patterns (both the location and design of development) which in turn impact travel demand.

Transportation projects that can reduce GHGs include:

- Increasing the frequency, convenience, quality, and types of transit service;
- Bicycle lanes or sidewalks that make non-motorized modes of travel safe and viable; and
- Programmatic approaches such as demand management or commute trip reduction strategies as well as pricing incentives or disincentives.

On the other hand, projects that reduce travel time by cars can increase auto use, and GHG emissions, through an increase in the relative utility of driving. Unfortunately, this can eventually offset or even reduce walking and transit use.[3]

More compact, mixed use land use patterns and interconnected street networks where people live and work can also help to reduce vehicle demand and reduction in vehicle use[4] extend to reductions in GHGs.[5] These relationships have been demonstrated in recent peer-reviewed studies in the Puget Sound Region and elsewhere in the country[6].

State and local agencies have influence over decisions that affect transportation projects. Both in the transportation planning as well as the program and project delivery process, transportation agencies should be required to evaluate and provide information to decision-makers and the public, about current and future GHG emissions associated with transportation system plans, programs and projects. This is especially important for transportation projects that include

[3]Frank, LD, Bradley M, Kavage S, Chapman J and Lawton TK (2007 in press). Urban Form, Travel Time, and Cost Relationships with Tour Complexity and Mode Choice. Transportation DOI 10.1007/s11116-007-9136-6. .
[4]Frank, et al, (2007 in press).
[5]Lawrence Frank & Company LUTAQH: A Study of Land Use, Transportation, Air Quality and Health in King County, WA. Prepared for the King County Office of Regional Transportation Planning, Seattle WA. December 2005. Also see Lawrence D. Frank, Sarah Kavage and Bruce Appleyard (2007). Â The Urban Form and Climate Change Gamble. Planning, Vol. 73 no. 8 (August/September), p. 18-23.
[6] Ewing, Reed; Growing Cooler: the evidence on urban development and climate change, Urban Land Institute: 2007

alternatives to capacity expansion of general purpose lanes, or other options which reduce GHG emissions. Decision-makers need to be given information regarding impacts on emissions to allow for a more informed debate. In addition, impacts of transportation investments on land use actions and longer term effects on travel behavior need to be taken into account.

Current measurement tools need to be more comprehensive and accurate because the amount of GHG pollution emitted from the transportation sector and individual projects is influenced by more than just the project itself. Information about how people and businesses will choose their locations, destinations and modes of travel (e.g. walk, bus or in a single occupancy vehicle) as a result of a transportation project will greatly influence the estimates of GHG emissions associated with it. Therefore, the relative availability and utility of public transit, bicycle lanes, sidewalks, other transportation modes, and infrastructure need to be more accurately evaluated.

It must be noted that quantifying GHG emissions from transportation projects does not, in and of itself, result in any reduction in those emissions. But such quantifications are absolutely necessary to provide information to decision-makers who are evaluating such projects.

Mitigation Option Design

Calculating CO2 emissions associated with an individual transportation would appear to be straightforward. However, in practice, this analysis can be quite complicated when analyzing multiple projects since transportation models often do not accurately predict the land use, induced demand, change in speed and fleet, and travel characteristics such as trip linking. In order to accurately predict GHGs associated with transportation projects, transportation planning agencies will need to evaluate and improve current models. Specifically, transportation agencies need to improve model predictions to capture:

- Differences in levels of travel demand and GHGs by implementing congestion pricing and travel demand management strategies such as multi-modal traveler information, incentives (e.g., carpool priority on ferries), disincentives, and informational campaigns.
- The potential impact of induced demand associated with transportation projects. Induced demand is a documented phenomena where the increased utility of auto travel resulting from capacity expansion and near term reductions in travel time results in nearer term temporal (time of day), and spatial (route choice) changes increases in VMT and the associated emissions.[7]
- Changes in land use patterns due to impacts on residential and business location choice and the resulting impact on citizen decisions regarding transportation modes and location choice. Land use is one of several factors that impact travel demand; however, current modeling structures are not effective at capturing how land use affects a variety of travel decisions. Modeling structures need to address how land use may also impact the effectiveness of nearer term travel demand management strategies. Research in the Puget Sound Region has found that compact, walkable neighborhoods with a mix of land uses and interconnected street networks are associated with more walking, bicycling, transit, and less driving. These relationships hold true even when accounting for socio-demographic and transportation system performance factors.

[7] Littman, Todd; Generated Traffic and Induced Travel, Victoria Transportation Institute, Sept 2007.

Travel decisions are made based on the relative tradeoffs between transportation modes, considering time and cost among other many factors. Transportation models should include an effective 'feedback loop' between the transportation and land use models to address induced demand. For example, re-running the land use model using the proposed transportation network with new zonal composite impedance factors adjusted based on proposed capacity improvements is one way to capture the "land use effect" of major transportation improvements.

Another approach would be to run parallel and distinct growth scenarios that have different land use assumptions at the outset coupled with different transportation investment packages. This requires additional resources but it provides a defensible way to overcome lack of feedback between land use and transportation investment in the modeling process. Moreover, it would allow a way to better capture growth that will occur in areas of the region where increased accessibility (lower composite impedance) is provided from increased transportation access resulting from highway, transit, or other types of investments.

> ***CASE STUDY: The Portland LUTRAQ Study***
> The LUTRAQ study in Portland developed a comparative land use/transportation investment scenario (the LUTRAQ alternative) at the front end of their modeling effort. The project compared an existing alternative that included the Western Bypass (highway capacity expansion) against the LUTRAQ alternative, which included a distinct land use pattern and a more aggressive expansion of the MAX light rail system. The LUTRAQ alternative performed better in reducing vehicle miles traveled and greenhouse gas emissions.[8] The LUTRAQ alternative also reduced congestion more than the Highways Only alternative. This case study demonstrates that distinct growth alternatives need to be tied to distinct transportation futures until a modeling framework is devised that can capture the feedback between land use and transportation investment. The LUTRAQ alternative was included in the Western Bypass MIS by ODOT, and chosen as the preferred alternative. This was the first time in the US that such an alternative was accepted by a state DOT as an option to a highway.

While these more sophisticated approaches are needed to address major regional modeling questions, less complex tools are also needed for local governments to begin to make trade-offs for both transportation and land use decisions. Some tools are currently being developed as part of the HealthScape study by King County along these lines.

In addition, transportation agencies should identify the uncertainties associated with the model assumptions and predictions, and indicate whether or not the models are likely to over-estimate or under-estimate emissions. Estimates must be provided to public officials, decision-makers, and the public before selecting transportation improvement projects and options within selected projects. Finally, the long-term impact of the projects on traffic patterns, land use, and other considerations need to be incorporated into the analysis.

Goals: All significant transportation system plans, corridor studies and projects would be required to have an evaluation of their contribution to GHG emissions. Current models would be

[8] 1000 Friends of Oregon. *Making the Land Use Transportation Air Quality Connection: Analysis of Alternatives*, Volume 5, Portland, OR, May 1996.

improved, and new models developed, to provide more accurate estimates of the changes in GHG emissions resulting from proposed projects.

Timing: Regional transportation planning organizations (RTPOs) would work with WSDOT to start developing methods to evaluate GHGs from transportation system plans, corridor studies, and projects immediately and would be required to finalize the methods in a report to the Governor by 2009. If necessary, the State Environmental Policy Act (SEPA) would be amended by 2010 in that RTPOs and transportation agencies would be required to conduct those evaluations for transportation plans and all "significant" transportation projects.

Parties Involved: RTPOs, WSDOT, regional air authorities, and other local jurisdictions as necessary.

Implementation Mechanisms

RTPOs could work with WSDOT to start developing methods to evaluate GHGs from transportation system plans, corridor studies and projects. The methods would include evaluating and comparing different modal alternatives. In addition, the RTPOs and WSDOT would identify aspects of proposed transportation improvements should be evaluated for GHG impact for each level of transportation system development (e.g., system plans, corridor studies and projects).

A logical framework for implementing this recommendation is the State Environmental Policy Act (SEPA). SEPA requires government agencies to evaluate potential impacts on the environment, and the legislation could be amended to include GHGs from transportation projects. SEPA arguably already requires evaluation of greenhouse gas impacts from significant transportation projects, but putting clear provisions into SEPA rules and policies will make this requirement explicit.

In addition, the existing SEPA regulations provide a framework for determining whether or not projects will have a significant impact on the environment and include certain thresholds for categorical exemptions from review. Thresholds for requiring project review could be included in any revisions to SEPA rules developed as a result of this strategy.

Because WSDOT's transportation plans are categorically exempt from SEPA, we recommend that WSDOT work with appropriate state entities to develop a binding mechanism for evaluating and reporting GHGs from transportation system plans and corridor studies.

Related Policies/Programs in Place

The Puget Sound Regional Council (PSRC) is in the process of developing a transit market sketch model which will relate transit usage to local land use characteristics, household demographics, and transit service. The walk-access-to-transit part of this model can be expanded to include walk-access-only trips. The resulting walk and transit mode shares can be linked to the regional travel model to demonstrate the VMT reductions (and corresponding emissions reductions), which would follow from an increase in compact development. The PSRC's time-line for the analysis and model development shows improvements in place by summer of 2008. Additional model improvements which capture the effects of alternative land use patterns and transportation modes (walking, cycling, transit) are planned for the future.

Estimated GHG Savings and Costs per $MtCO_2e$

No GHG reductions or costs are calculated for this option. This option will provide information to decision makers to facilitate implementation of other mitigation options, including T-1, T-3, T-4, T-8, and T-9.

Contribution to Other Goals

Contribution to Long-term GHG Emission Goals (2035/2050):

Transportation projects, from completion of the sidewalk network to adding capacity to the road system, can have a considerable impact on GHG emissions. Without sensitive and accurate models to estimate the magnitude of these reductions, decision makers will be missing critical information. In particular, transportation models are needed to evaluate Transit, Ridesharing, and Commuter Choice Programs (T-1), Transportation Pricing (T-2), Promote Compact and Transit-Oriented Development (T-4), Local Transportation Financing Tools and Bicycle and Pedestrian Infrastructure Improvements (T-8), and Transportation System Management (T-9).

Job Creation:

Reduced Fuel Import Expenditures:

Key Uncertainties

The primary uncertainty in the effectiveness of the estimates produced by the improved models is the political will to make decisions which will significantly reduce GHG emissions. Simply evaluating the emissions from a set of proposed projects will not have any effect. Political will is necessary to create a vision for a radically different urban system than the one we have now. Our current system requires so much time and money to be spent on transportation in order to meet the needs of daily life. For example, if the vision includes an absolute reduction in VMT as a means of reducing GHG emissions, then one would seldom need to add capacity to the road system.

Several issues regarding how and when GHG evaluations would be required under SEPA, or another mechanism, still needs to be resolved in order to facilitate effective implementation of this mitigation option. One of the unresolved issues is the need to identify the appropriate threshold for requiring the GHG evaluation of plans or projects. Currently, the use of "significant" to describe plan or project impacts under SEPA within a climate change context is unclear. Criteria and metrics will need to be defined and identified before GHG threshold decisions could be made. Another consideration is that the scalability of the models to be used for GHG assessment may limit what types of transportation projects can be effectively analyzed.

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Mitigation Option T-6:
Improvements to Freight Railroads and Intercity Passenger Railroads

Based on Transportation Catalog Option 6.1 and 6.2

Mitigation Option Description

Rail transport is one of the most energy efficient means to move people and freight over commonly traveled routes on land. Expansion of dedicated rail corridors and improvements to freight rail and intercity passenger rail will allow the Washington State rail network to increase volumes and reduce vehicles on the road. Movement of passengers and freight by an efficient rail system decreases overall greenhouse gas emissions by 2-4 times as compared to movement by highway. Technology-based improvements, such as anti-idle devices and more efficient engines, will reduce direct emissions from the locomotives operating on the rail network. A robust and efficient rail network using modern, efficient technology is a cornerstone for sustaining Washington's thriving economy under future carbon emission constraints while providing many social, economic, and environmental benefits.

Mitigation Option Design

In 2006, the Washington State Transportation Commission (WSTC) completed a "Statewide Rail Capacity and Systems Needs Study," as directed by the Washington State Legislature. The report from the WSTC study (December 2006) detailed specific statewide improvements that will be necessary to meet future demands for freight and passenger rail. It projects system needs to 2025 based on increases to freight movement and passenger transport using industry estimates and statewide passenger rail plans. The report also describes a framework for prioritizing the projects that would address these needs. If all of these improvements are implemented, the rail network will be able to support projected freight and passenger demands well within its practical capacity.

Several unique challenges face the design and implementation of these strategic improvements. Public funding would not likely be used to fund the majority of rail improvements, due to private ownership of the rail system. Rather, public funds would be used to incent private investments. This type of public private partnership would be used either to accelerate improvements or to help align improvement priorities more closely with public needs. A significant prerequisite, then, is to organize and prioritize the approximately 2 billion dollars worth of identified improvements in the Washington State rail system according to public needs, rates of growth, and system dependencies. The Washington State Department of Transportation is working with stakeholders to develop a strategic plan to prioritize and implement the WSTC study recommendations. Prioritizing improvements to the state's rail system based on a benefit/cost analysis that includes consideration of greenhouse gas emissions and market-driven carbon constraints will further support the goal of this priority.

Improved rail service and the ability of the rail system to meet future demand *implicitly* leads to system-wide greenhouse gas reductions by shifting projected freight and passengers to rail or by preventing a shift to a less efficient mode. Improvements to the rail system or associated equipment can also have *direct* impacts on greenhouse gas emissions. Locomotive idling produces significant emissions and can be mitigated by reducing system congestion and choke points and by using improved technology.

Currently available technologies, such as anti-idle equipment, newer and more efficient locomotive engines, and hybrid equipment can add significantly to engine owners' capital improvement costs. Smaller locomotive operators may lack capital to invest in these technologies even though future fuel savings would make them cost effective. Other added costs may not contribute to increased return on capital and thus may only be weighed as public priorities to the extent they are valued for their emission reduction potential. Likewise, investments in future technologies such as fully-electric equipment and electrified switch yards, require a distinct public commitment to funding emission reductions from hydrocarbon-based fuels.

Goals:

- Decrease inefficiencies and limitations in the existing WA rail network and increase overall capacity by reducing system congestion, bottlenecks, and chokepoints.
- Prevent modal shift of freight from rail to truck due to lack of capacity. Maximize the amount of freight that can be moved by rail in order to sustain projected growth in domestic and international goods movement in the State.
- For intercity travel on the heaviest traveled commuter and regional rail routes, shift passengers from road to rail.
    - Based on Sound Transit growth projections, and assuming full funding and implementation of their investment plan, ridership on commuter rail routes will increase from 1.6 million currently to 4 million by 2020.
    - Ridership on regional rail services on the Amtrak Cascades line would increase from 421,000 currently to 3 million by 2020, if the proposed implementation plan described in the WSTC study is followed.
- Standardize the use of anti-idle equipment and best practices for locomotives. Increase the number of modern, more fuel efficient locomotives in service. Develop electrified rail support systems and hybrid or fully-electric locomotives.
    - Through the use of anti-idle equipment, reduce switcher locomotive idling by 80% and line-haul locomotive idling by 50%.

Timing: Implementation of individual rail system priorities would be based on the outcome of prioritization exercises and dedication of funds by the legislature.

Parties Involved: WSDOT, private freight railroads (BNSF, UP), Sound Transit, Amtrak.

Implementation Mechanisms

1) Decrease system inefficiencies, accommodate growth in freight movement, and prevent modal shift of freight from rail.

Prioritize WA rail system needs described by the 2006 WSTC rail study using the benefit/cost approach outlined in the report. This approach should be amended to include consideration of greenhouse gasses and future carbon-constrained market conditions. Once the projects are prioritized, an implementation schedule and dedicated funding can be pursued.

The State has contributed significantly to rail expansion projects in the past and has on-going investments in projects to improve the system. Prior efforts have been based on varied degrees of analysis of long term or public benefits. With the current, extensive understanding of system needs and a prescribed method for prioritizing them, the timing is ideal to map long-term investments that preserve economic growth, ensure rail system viability, and reduce greenhouse gas emissions.

The Legislature has identified the State's priorities in ESHB 1094, Section 309, 7(a). Based on these directives, the Washington State Department of Transportation is working to create tools that account for public benefits and help refine the priorities. Significant additional data and analysis will be needed to account for the projects' effects on greenhouse gas emissions. Concurrently, the State will need to acknowledge the specific public benefit of reducing greenhouse gasses in its evaluation of funding for new projects.

2) Expand intercity passenger rail service and capacity

Sound Transit Commuter Rail Service

Sounds Transit currently operates the Sounder commuter rail service in the central Puget Sound region with approximately 1.7 million trips in 2006. Continued investments in this service are critical to accommodating over 1 million new residents projected to move to the area over the next 20 years. This service now provides fast and efficient transportation through the most congested corridors. Future expansions and improvements will further reduce congestion and sprawl and reinforce the region's vitality by connecting people with businesses in the most efficient manner possible. A proposition on the November 2007 ballot will significantly impact how quickly and effectively this commuter rail service is implemented.

Amtrak Cascades Line

The regional passenger service operating through Washington between Vancouver BC and Eugene Oregon is the Amtrak Cascades intercity rail program. Significant investment and support from WA State have allowed that line to transport over 600,000 passengers in the past year. Full build-out of the service based on the draft Long-Range Plan for Amtrak's Cascades program calls for additional investments of $6.5 Billion through 2023. To achieve this goal with the significant public funding required, it will be critical that project funding criteria recognize the value of greenhouse gas reductions and benefits to regional vitality that come from frequent, fast, and reliable intercity rail service.

3) Standardize anti-idle technology and practice, improve locomotive efficiency, and invest in developing technology to electrify equipment and systems in the rail network.

Major rail companies have already begun investing heavily in technologies to help curb the effects of rising fuel prices. Current fuel prices make many existing technologies, such as anti-idle devices and newer, more efficient locomotives, a cost effective investment. Estimates from a recent retrofit project that put anti-idle devices on switching locomotives showed that the investment would be repaid in as little as 2 years due to reduced fuel costs. New locomotives, though significantly more expensive, can also promise a positive return on capital from fuel savings in the long run.

Lack of capital, however, is a significant barrier for most small short-line and switching locomotive operators in the State. The State Department of Ecology and the Puget Sound Clean Air Authority have made grant funds available to small operators for anti-idle retrofits as part of their diesel emissions reduction efforts. These opportunities are very limited compared to the level of need. If these technologies are to become standard, the capital will have to be made accessible through enhanced grant or subsidized loan programs that leverage projected fuel savings.

Related Policies/Programs in Place

TBD

Estimated GHG Savings and Costs per $MtCO_2e$

			Reductions ($MMtCO_2e$)				
	Policy	**Component**	**2012**	**2020**	**Cumulative Reductions (2008–2020)**	**NPV (2008–2020) ($ millions)**	**Cost-Effective-ness $/tCO_2$**
T-6	Improvements to Freight and Intercity Passenger Railroads	Passenger Rail	0.032	0.096	0.622	3,074	4,945
		Freight Rail Idle Reduction	0.003	0.009	0.059	-0.5	-8.8
		Total	0.035	0.105	0.680	3,073	4,518

Data Sources

See below.

Quantification Methods

Passenger Rail Improvements

- Sounder and Amtrak service and ridership assumed to remain constant under baseline scenario.

- For expansion of Sounder and Amtrak service, increase in passenger miles assumed to eliminate vehicle miles of travel at a ratio of 1:0.9. This reflects an assumed vehicle trip to access the rail station equal to 10% of the total rail trip distance.
- Light duty vehicle fuel economy based on DOE's Annual Energy Outlook (consistent with Emission Inventory and Forecast). Assumes 50% automobiles and 50% light trucks. 2006 fuel economy = 19.5 mpg; 2020 fuel economy = 21.6 mpg.
- Emission reduction benefits assumed to increase linearly between 2009 and 2020.
- Sounder
    - 2006 Sounder ridership from Sound Transit Quarterly Performance Reports.
    - Sounder trip distances based roughly on highway mile distances (Tacoma-Seattle: 34 miles; Everett-Seattle: 30 miles). All passengers assumed to travel full distance.
    - Estimate of Sounder fuel use rate (63.6 passenger miles per gallon) based on 2005 data from MBTA (Boston) commuter rail service, as reported in the National Transit Database, Federal Transit Administration.
- Amtrak Cascades
    - Projected ridership, passenger miles, and train miles from Long-Range Plan for Amtrak Cascades, February 2006. (Assumes required capital projects are completed by 2023). To conduct analysis, passenger and train miles traveled outside Washington State were ignored.
    - Amtrak Cascades train miles and ridership figures include Coast Starlight ridership on the segment. 2006 ridership estimate from actual increase in Cascades only ridership (Long Range Plan Exhibit 3.5) plus 2002 base year figures (Amtrak Cascades Ridership and Revenue Forecasts Technical Report, Vol. 5). 2006 train miles estimate from 2002 base year figure plus one additional daily roundtrip between Seattle and Portland.
    - Estimate of Amtrak fuel use rate based on 2004 national system mileage and fuel consumption from U.S. EPA, *Draft Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder*, March 2007.
    - Comparable on-road trip distances calculated based on highway routes
    - Cost estimate includes out-of-state projects. Capital projects in British Columbia and Oregon will be required to achieve the ridership levels projected in the Long-Range Plan.

Impacts of Passenger Rail Improvements

	Sounder (Seattle-Tacoma)		Sounder (Seattle-Everett)		Amtrak Cascades (inc. Coast Starlight)	
	2006	2020	2006	2020	2006	2020
Trains	1,700	4,016	1,416	3,346	2,555	4,745
Boardings	1,491,463	3,523,896	201,508	476,104	635,502	2,698,827
Passenger-miles	50,709,752	119,812,453	6,045,231	14,283,130	89,803,331	375,735,993
Fuel use	797,141	1,883,413	95,029	224,526	1,522,535	3,517,908
GHGs (MtCO2e)	7,765	18,347	926	2,187	14,831	34,269
Eliminated veh-miles	45,638,777	107,831,208	5,440,708	12,854,817	80,822,998	338,162,394
Fuel use (gal)	2,339,790	4,993,194	278,932	595,251	4,228,367	15,658,830
Avoided vehicle GHGs (MtCO2e)	20,622	44,008	2,458	5,246	37,267	138,010
GHG difference (MtCO2e)	12,857	25,661	1,533	3,059	22,436	103,741
Net GHG reduction (MtCO2e)		12,804		1,526		81,306

Locomotive Idle Reduction

- Data on number of locomotives currently in service in WA (approximately 900) and annual rail fuel use (50 million gallons) provided by WSDOT.
- Assumed that line-haul engines consume 90% of WA locomotive fuel and switchers consume 10% (based on Gaines, Linda, "Reduction of Impacts from Locomotive Idling," presentation, Argonne National Laboratory, 2004. (http://www.transportation.anl.gov/pdfs/RR/290.pdf)
- Assumed that 1% of line-haul fuel use occurs at Idle notch setting and 20% of switcher fuel use occurs at Idle notch setting (based on U.S. EPA, *Locomotive Emission Standards, Regulatory Support Document*, April 1998).
- Idle reduction device assumed to be an automatic engine start-stop (AESS) device, such as the Smartstart AESS manufactured by ZTR Control Systems. AESS assumed to eliminate 50% of line-haul idling and 70% of switcher idling, based on Gaines, Linda, "Reduction of Impacts from Locomotive Idling," presentation, Argonne National Laboratory, 2004. (http://www.transportation.anl.gov/pdfs/RR/290.pdf)
- The initial capital cost of the ZTR Smartstart system was estimated to be $9,000 with an additional cost of $2,500 for installation and operator training, resulting in a total cost of $11,500 per unit. (based on information from ZTR)
- Total capital and installation costs ($10,350,000) assumed to be spread evenly across years 2008 to 2019.
- Diesel fuel prices (though 2020) from DOE's Annual Energy Outlook.
- Fuel savings and GHG reductions assumed to increase linearly from 2009 to 2020.

Impacts of Locomotive Idle Reduction

Parameter	2020	Note/Source
Total WA fuel use (gal)	50,000,000	WSDOT
Line-haul locomotives		
Total fuel use (gal)	45,000,000	Assumes 90% line-haul, based on presentation by Linda Gaines of ANL
Percent of fuel used in idling	1%	EPA RIA for 1998 locomotive emission standards
Fuel used in idling (gal)	450,000	
Potential reduction	50%	Based on presentation by Linda Gaines of ANL
Reduction (gal)	225,000	
Reduction (MtCO2e)	2,192	
Switchers		
Total fuel use (gal)	5,000,000	Assumes 10% switcher, based on presentation by Linda Gaines of ANL
Percent of fuel used in idling	20%	EPA RIA for 1998 locomotive emission standards
Fuel used in idling (gal)	1,000,000	
Potential reduction	70%	Based on presentation by Linda Gaines of ANL
Reduction (gal)	700,000	
Reduction (MtCO2e)	6,819	
Total GHG reduction (MtCO2e)	9,011	

Key Assumptions

See above.

Contribution to Other Goals

Contribution to Long-term GHG Emission Goals (2035/2050):

Job Creation:

Reduced Fuel Import Expenditures:

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Mitigation Option T-7:
Diesel Engine Emission Reductions and Fuel Efficiency Improvements

Based on Transportation Catalog Option 1.3 and 1.4

Mitigation Option Description

Reduce diesel emissions and the use of diesel fuel in public and private sectors, both on- and off-road, through promotion of a variety of technologies that provide alternatives to diesel fuel use or greater efficiency in diesel fuel use. On-road diesels alone produced approximately 7.5 million metric tons of CO2eq in 2005. This option also has the collateral benefit of improving air quality and reducing air toxics exposure.

Mitigation Option Design

Promote and fund technologies that provide alternatives to petroleum diesel fuel use and greater efficiency in diesel fuel use through continued implementation of effective existing state programs and support of new state programs. These programs include:

- Multi-sector technologies:
  - Broaden use of anti-idling technologies currently available but not widely used for locomotives, trucks and other diesel engines (Applicable sectors: freight, public and private fleets);
  - Engine rebuilds, repowers and replacements with more fuel efficient engines or add-on technologies (Applicable transportation sectors: ferries, freight, public and private fleets);
  - Technologies to reduce rolling resistance (such as single wide tires), low viscosity lubricants, weight reduction and improvements to aerodynamics (Applicable sectors: freight, public and private fleets);
  - Augment or replace petroleum fuel use with biodiesel, biogas, natural gas or other low carbon fuels (Applicable sectors: ferries, freight, ports, public and private fleets); and
  - Replace freight handling equipment with battery electric, hybrid or plug-in electric hybrid equipment (Applicable sectors: ports, freight).
- In addition to select technologies identified above, Washington State Ferries has the following opportunities to reduce fuel use on vessels:
  - Modify engine systems to enable ferries to run on fewer engines,
  - Install positive restraints to hold ferries steady during loading operations instead of keeping propellers rotating,

- Upgrade shore power capabilities so diesel generators can be shut down when ferries are secured.

Goals: Targets and timetables for fuel use reduction and installation of diesel idle reduction equipment in the sectors identified above are presented below. Provide funding for grant and incentive programs to augment the current funding provided by the Legislature in the upcoming legislative session.

1. Broaden use of anti-idling technologies currently available but not widely used for locomotives, trucks and other diesel engines:
   - Public fleets: 50% of vehicles by 2015 with 100% beginning in 2020.
   - Private long haul fleets and other fleets: 25% of vehicles by 2015, 50% by 2020, 75% by 2035 and 100% by 2050.
2. Engine rebuilds, repowers and replacements with more fuel efficient engines or add-on technologies
   - No goals are recommended. These are primarily applicable to marine and locomotive application. Although they have some limited potential, there is little information on which to base a goal.
3. Technologies to reduce rolling resistance (such as single wide tires), low viscosity lubricants, weight reduction and improvements to aerodynamics
   - Private long haul fleets: 25% of vehicles by 2015, 50% by 2020.
   - It is possible through additional incentives to achieve a greater degree of fleet penetration sooner since trucks are retired from long haul service in 7-12 years and it is expected that OEMs will include this technology on many of their trucks. Consultation with the trucking industry has confirmed the reasonableness of the goals as stated. However, efforts will be initiated with trucking industry stakeholders to provide those additional incentives in order to exceed the goals.
4. Augment or replace petroleum fuel use with biodiesel, biogas, natural gas or other low carbon fuels
   - Public fleets: 100% biodiesel use (B100) by 2015
   - Private fleets: 25% B20 use by 2015, 75% B20 use by 2020 and 100% B20 use by 2035.
5. Replace freight handling equipment with battery electric, hybrid or plug-in electric hybrid equipment
   - Battery: 10% of equipment by 2015, 25% by 2020, 50% by 2035
   - Diesel hybrids: 25% of equipment by 2015, 50% by 2020, reducing to 25% in 2035 and zero % in 2050 as they are replaced by plug-in hybrids.
   - Plug-in diesel hybrids: zero % in 2015, 10% by 2020, 25% by 2035 and 50% by 2050.

6. Modify ferry engine systems to enable ferries to run on fewer engines
    - Complete modification for 3 Jumbo Mk II ferries – 2008, save >800K gallons/year
    - Complete modification for 2 Jumbo Mk I ferries – 2009, save >140K gallons/year
    - Complete modification for 2 Super Class ferries – 2011, save >774K gallons/year
7. Install positive restraints to hold ferries steady during loading operations instead of keeping propellers rotating.
    - Complete modification for prototype installation 2008 on two ferries/one terminal in 2009, save >580K gallons/year
    - If determined to be a viable alternative, modify remaining vessels/ terminals by 2020, save 485K gallons/year
8. Upgrade shore power capabilities so diesel generators can be shut down when ferries are secured.
    - Complete assessment & develop upgrade plan 2007
    - Upgrade ferries & terminals by 2011, save >50K gallons/year
9. Install waste heat recovery systems on ferries to replace boilers.
    - Complete modification for 6 Issaquah Class ferries in 2015, save >367K gallons/year,
    - Complete modification for 4 Super Class ferries, save 245K gallons/year (schedule to be determined)
    - Complete modification for 2 Jumbo Mk I Class ferries, save 210K gallons/year (schedule to be determined)

Timing: See above. Initial goals achieved by 2015 with milestones in 2020, 2035 and 2050

Parties Involved: Washington State Legislature, Department of Ecology, Washington State Department of Transportation (Roadway, multi-modal, and Ferry divisions), Department of Community Trade and Economic Development, the Puget Sound Clean Air Agency and other regional clean air agencies, City and County Governments, Non-profit groups like Cascade Sierra Solutions, US Environmental Protection Agency, US Department of Energy, Washington Trucking Association, Burlington Northern Santa Fe Railway, Ports, Associated General Contractors.

Implementation Mechanisms

- Supplement Existing Programs: Where applicable, existing effective Washington State emission reduction programs for public fleets, such as those administered by the Washington Department of Ecology and the Puget Sound Clean Air Agency's Diesel Solutions program, and the Washington State Clean School Bus program will promote and fund the technological options listed above.

Supplemental support is needed for programs such as Puget Sound Diesel Solutions, EPA's National Clean Diesel Campaign, and the West Coast Collaborative, which targets diesel emission reductions and fuel savings in West Coast states, and the Washington State Ferries program to reduce fuel use and emissions in the vessel fleet.

- New Programs: New programs are also needed to reduce private fleet diesel emissions and diesel fuel use. Successful examples include programs similar to California's Carl Moyer grant program or the Texas Emission Reduction Program. Options could include development of a second State Infrastructure Bank targeting low and no interest loans and revolving funds for private and public sector use to support scrappage of inefficient technology with more efficient technology.

  Other options may include placing diesel emission reduction equipment and fuel use requirements into state and local government public construction contracts to leverage private fleet conversion or creating regulatory requirements to switch fuels and retrofit existing engines and equipment in various fleet sectors.

Related Policies/Programs in Place

- Additional options and advanced technologies to reduce diesel emissions and diesel fuel use that are applicable to Washington ports are included in the Draft Northwest Ports Clean Air Strategy that can be found at: http://www.maritimeairforum.org/news/NW_Ports_Clean%ADAirStrategy_Draft.pdf

Estimated GHG Savings and Costs per $MtCO_2e$

			Reductions ($MMtCO_2e$)				
	Policy	Component	2012	2020	Cumulative Reductions (2008–2020)	NPV (2008–2020) ($ millions)	Cost-Effective-ness $/tCO_2$
T-7	Diesel Engine Emission Reductions and Fuel Efficiency Improvements	HDV Idle Reduction	0.038	0.210	1.13	-65.4	-57.8
		Truck Efficiency	0.022	0.116	0.63	-80.1	-126.8
		Biodiesel	0.066	0.518	2.64	355.2	134.5
		Cargo Handling Equip.	0.011	0.085	0.39	N/A	N/A
		Ferries [a]	0.024	0.036	0.33	-39.0	-127.1
		Total [b]	0.161	0.965	5.13	170.6	33.3

Note a: Cost and cost-effectiveness does not include several ferry strategies for which cost information was not available.
Note b: Total does not include cost of cargo handling equipment strategies, for which cost information was not available.

Data Sources

- Truck population data provided by Ecology (based in part on U.S. EPA data)
- Assumption for annual growth in truck population (1.15%) provided by PSCAA
- Truck annual idling hours provided by PSCAA and Ecology

- Truck annual mileage assumptions based on U.S. EPA, User's Guide to MOBILE6.1 and MOBILE6.2, August 2003; Bureau of Census, Vehicle Inventory and Use Survey, 2002
- Current year truck fuel economy assumptions based on U.S. DOE, Transportation Energy Data Book, 2005 and information provided by PSCAA and Ecology. (Note that assumed heavy-duty vehicle fuel consumption rates are based in part on tests performed by EPA on a sample of Heavy Heavy-Duty (Class 8) trucks (greater than 33,000 lbs GVW), and may not be representative of fuel consumption rates for Medium Heavy-Duty trucks (14,000 – 33,000 lbs GVW). Therefore, the numbers presented here should be considered an estimate of the potential maximum.)
- Baseline future improvements in truck fuel economy based on DOE's Annual Energy Outlook (assumes 0.57% annual improvement in heavy-duty vehicle fuel economy)
- Fuel economy impacts of truck efficiency strategies based on U.S. EPA FLEET model
- Impacts of biodiesel (B20) on lifecycle GHG emissions per mile (-11%) based on CCS analysis using GREET model (v1.7)
- 2005 port cargo handling equipment GHG emissions from Puget Sound Maritime Air Forum Emission Inventory, April 2007
- Impacts of ferry strategies on fuel use provided by WS Ferries

Quantification Methods

See tables below.

Idle Reduction Strategies – Baseline Fuel Use

		2005		2012		2020	
Diesel Vehicle Type	Annual Idle Hours/Veh	Pop.	Gal. Burned While Idling	Pop.	Gal. Burned While Idling	Pop.	Gal. Burned While Idling
Intercity Bus	312	1,289	329,778	1,396	435,681	1,530	477,415
Transit Bus	312	599	153,248	649	202,462	711	221,855
School Bus	312	7,731	1,977,899	8,375	2,613,073	9,177	2,863,377
Refuse Truck	312	880	225,139	953	297,439	1,045	325,931
SU Short-haul Trk	312	39,150	10,016,136	42,412	13,232,673	46,475	14,500,223
SU Long-haul Trk	1,456	4,999	5,968,406	5,416	7,885,073	5,934	8,640,380
Comb. Short-haul Trk	312	14,973	3,830,692	16,221	5,060,864	17,774	5,545,641
Comb. Long-haul Trk	1,456	19,599	23,399,638	21,232	30,914,092	23,266	33,875,335
Total		89,220	45,900,937	96,655	60,641,356	105,913	66,450,156

Idle Reduction Strategies – Impacts of Mitigation

		2012			2020		
Diesel Vehicle Type	% of Idling Reduced/Veh	% of Pop Affected	Reduction in Gal. Burned	GHGs Reduced (MtCO2e)	% of Pop Affected	Reduction in Gal. Burned	GHGs Reduced (MtCO2e)
Intercity Bus	50%	10%	21,784	212	50%	119,354	1,163
Transit Bus	25%	10%	5,062	49	50%	27,732	270
School Bus	50%	10%	130,654	1,273	50%	715,844	6,973
Refuse Truck	25%	10%	7,436	72	50%	40,741	397
SU Short-haul Trk	25%	10%	330,817	3,223	50%	1,812,528	17,656
SU Long-haul Trk	50%	10%	394,254	3,841	50%	2,160,095	21,042
Comb. Short-haul Trk	50%	10%	253,043	2,465	50%	1,386,410	13,505
Comb. Long-haul Trk	90%	10%	2,782,268	27,103	50%	15,243,901	148,495
Total			3,925,317	38,238		21,506,605	209,502

Truck Efficiency Strategies – Baseline

		2005			2012			2020		
Truck Type	Annual Miles/Truck	Pop.	MPG	Fuel Use	Pop.	MPG	Fuel Use	Pop.	MPG	Fuel Use
SU Long-Haul	32,000	4,999	8.0	19,996,000	5,416	8.31	20,862,330	5,934	8.72	21,788,132
Comb. Long-Haul	100,000	19,599	5.7	343,842,105	21,232	5.92	358,739,120	23,266	6.21	374,658,791

Truck Efficiency Strategies – Impacts of Mitigation

		2012			2020		
Truck Type	Change in Fuel Use	% of Pop Affected	Reduction in Gal. Burned	GHGs Reduced (MtCO2e)	% of Pop Affected	Reduction in Gal. Burned	GHGs Reduced (MtCO2e)
SU Long-Haul	-6%	10%	125,174	1,219	50%	653,644	6,367
Comb. Long-Haul	-6%	10%	2,152,435	20,967	50%	11,239,764	109,490
Total			2,277,609	22,187		11,893,408	115,857

Biodiesel Strategies – Baseline

				Fuel Use (gal)		
Diesel Vehicle Type	2005 Population	Annual Mileage per Veh	2005 MPG	2005	2012	2020
Intercity Bus	1,289	34,838	3.8	11,817,416	12,329,408	12,876,547
Transit Bus	599	34,838	2.5	8,347,185	8,708,828	9,095,297
School Bus	7,731	9,939	8.0	9,604,801	10,020,931	10,465,627
Refuse Truck	880	21,335	8.0	2,346,850	2,448,528	2,557,185
SU Short-haul Trk	39,150	22,123	6.0	144,352,575	150,606,674	157,290,106
SU Long-haul Trk	4,999	32,000	8.0	19,996,000	20,862,330	21,788,132
Comb. Short-haul Trk	14,973	22,123	5.7	58,113,628	60,631,410	63,322,034
Comb. Long-haul Trk	19,599	100,000	5.7	343,842,105	358,739,120	374,658,791

Total	89,220	598,420,560	624,347,229	652,053,720

*Biodiesel Strategies – Impacts of Mitigation**

	2012		2020	
Diesel Vehicle Type	% using B20	Reduction in GHGs (MtCO2e)	% using B20	Reduction in GHGs (MtCO2e)
Intercity Bus	10%	1,319	75%	10,252
Transit Bus	10%	933	75%	7,287
School Bus	10%	1,060	75%	7,835
Refuse Truck	10%	262	75%	2,022
SU Short-haul Trk	10%	16,103	75%	124,950
SU Long-haul Trk	10%	2,180	75%	15,249
Comb. Short-haul Trk	10%	6,470	75%	49,775
Comb. Long-haul Trk	10%	37,912	75%	301,097
Total		66,237		518,468

* Accounts for fuel reduction benefits of idle reduction and truck efficiency strategies above.

Cargo Handling Equipment Strategies – Baseline and Impacts of Mitigation

	2006	2012	2020
Puget Sound Port CHE Emissions (MtCO2e)	101,236	129,358	179,363
Battery electric candidates			
Percent of baseline affected		5%	25%
GHG reduction per equipment		90%	90%
GHG reduction (MtCO2e)		5,821	40,357
Diesel hybrid candidates			
Percent of baseline		10%	50%
GHG reduction per equipment		40%	40%
GHG reduction (MtCO2e)		5,174	35,873
Plug-in diesel hybrid candidates			
Percent of baseline		0%	10%
GHG reduction per equipment		50%	50%
GHG reduction (MtCO2e)		0	8,968
Total GHG reduction (MtCO2e)		10,995	85,198

Ferry Strategies – Impacts of Mitigation

	Year of Start	1st Year Fuel Savings (gal)	2012 Fuel Savings (gal)	2012 GHG Reduction (MtCO2e)	2020 Fuel Savings (gal)	2020 GHG Reduction (MtCO2e)
Modify ferry engine systems						
Jumbo Mk II ferries	2008	800,000	848,933	8,270	967,469	9,424
Jumbo Mk I ferries	2009	140,000	146,375	1,426	166,813	1,625
Super Class ferries	2011	774,000	785,573	7,652	895,263	8,721
Install positive restraints						
Prototype on 2 ferries/1 terminal	2009	580,000	606,409	5,907	691,082	6,732
Upgrade shore power capabilities	2011	50,000	50,748	494	57,834	563
Install waste heat recovery systems						
Issaquah Class ferries	2015	367,000			400,030	3,897
Super Class ferries	2015*	245,000			267,050	2,601
Jumbo Mk I ferries	2015*	210,000			228,900	2,230
Total			2,438,037	23,750	3,674,440	35,794

* Assumption for analysis; actual start date to be determined.

To estimate costs, Truck Idle Reduction assumed to involve:

- Installation of PonyPack APU on new combination trucks, at a cost of $5,600.
- Fuel use in PonyPack is 0.2 gallons per hour, compared to average rate of 0.75 gallons per hour for the truck engine
- For other heavy-duty vehicle types, no equipment installation required. Idle reduction achieved through training, education, and regulation.

To estimate costs, Truck Efficiency Strategies assumed to involve:

- Installation of single-wide tires and wheels on new combination truck, in lieu of dual tires and wheels, at a cost savings of $1040 per truck
- Installation of trailer side skirts on a combination truck trailer at a cost of $2400 and installation of NoseCone on single-unit truck at a cost of $700
- Use of low-friction engine and drive train lubricants at a cost of $118 per year for combination trucks and $18 per year for single-unit trucks

To estimate costs, Biodiesel assumed to cost $1.00 more than conventional diesel (approximately equal to the current price differential in Seattle area when accounting for federal biodiesel subsidy).

Cost estimates unavailable for hybrid-electric cargo handling equipment.

To estimate costs, Ferry strategies the following was assumed:

- Modify ferry engine systems on 3 Jumbo Mk II ferries – Cost $360,000 for procurement, design and installation per ferry, or $1,080,000 total.
- Modify ferry engine systems on Jumbo 2 Mk I ferries – Cost $215,000 for design and installation of two ferries
- Modify ferry engine systems on 2 Super Class ferries – Cost $615,000 for engineering design, and $6.15M installation on two ferries.
- Install positive restraints on two ferries/one terminal – Cost $106,000 for engineering design and $559,000 for construction.
- Upgrade shore power capabilities – cost not quantified.
- Install waste heat recovery systems on ferries to replace boilers on 6 Issaquah Class ferries – Cost $100,000 for engineering and design and $3.366M for installation on 6 ferries.
- Install waste heat recovery systems on Super Class ferries and Jumbo Mk I Class ferries – cost not quantified.

Key Assumptions

Emission reduction benefits generally assumed to increase linearly between goal years (2015 and 2020). Emission reduction benefits for years before 2015 estimate by linear extrapolation.

Contribution to Other Goals

TBD

Contribution to Long-term GHG Emission Goals (2035/2050):

Job Creation:

Reduced Fuel Import Expenditures:

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Mitigation Option T-8:

Local Transportation Financing Tools and Bicycle and Pedestrian Infrastructure Improvements

Based on Transportation Catalog Option 5.4 and 5.5

Mitigation Option Description

To succeed, policy initiatives to reduce automobile use and promote compact communities must be accompanied by policies and funding to make it easier to walk and bike. There is a growing body of research demonstrating that communities with traditional neighborhood design, connected pedestrian and bicycle networks, available transit and a rich mix of uses are strongly correlated with decreased automobile use.[9]

One obstacle to success is that prior planning for local streets has often prioritized the movement and storage of cars over walking and biking. Another obstacle is that local governments do not have sufficient funding resources to maintain basic street infrastructure and invest in biking and walking.

Under this option, the state would explicitly prioritize funding for transportation facilities that support biking and walking, as well as provide significant new taxing authority for local government to support these priorities. This would be accompanied by policies at the state and local level to require that projects are designed to encourage biking and walking needs (e.g., context sensitive design).[10]

Mitigation Option Design

The following policy and funding initiatives are recommended:

1. The state would adopt a "Complete Streets" policy for its spending supported by context sensitive design standards. Complete Street policies require that new streets, or streets undergoing major maintenance, be designed to accommodate all users.
2. The state requires local governments to adopt Complete Street policies for their spending, or provides substantial incentives to localities to do so (e.g., making state transportation grants to localities contingent on project consistency with Complete Street policies).
3. The state should rewrite its Highway Design Manual and revise its scoping process to require all new engineering and construction facilitate the safe, convenient movement of bicycles and pedestrians along all non-limited access corridors as well as across corridors

[9] See LUTAQH Study. Also Frank L, Pivo G. Impacts of Mixed Use and Density on Utilization of Three Modes of Travel: Single Occupant vehicle, Transit, and Walking. TRB 1995; 1466: 44-52. – Key study supports Healthscape or LUTAQH

[10] Cite to Seattle Resolution, and www.completestreets.org – WSDOT's Context Sensitive Design Executive Order : http://www.wsdot.wa.gov/ta/operations/localplanning/pdf/1028.pdf

where these corridors act as barriers (e.g., I-5 in Seattle) unless exceptional circumstances exist.

4. In addition to making required ADA improvements, the state and local agencies should incorporate low cost safety solutions that improve conditions for bicycling and walking in maintenance projects like paving projects.
5. The state should increase funding available for bicycle and pedestrian projects and programs to $150 million in the near term (as recommended in Washington's Transportation Plan) and more in the long term, and expand the existing State Bicycle and Pedestrian Safety Program to include projects and programs that support mobility as well as safety.
6. The state should also provide local governments with new taxing authority and more flexibility with gas tax revenues to finance local improvements. If these taxes were based on vehicle usage (e.g., miles traveled or fuel used) or vehicle type (weight, EPA mpg), it could provide further incentives for users to choose more efficient vehicles, or shift their trips to less polluting modes. The goal would be provide sufficient funding for localities to build out their pedestrian and bicycle networks, invest in inviting streetscapes to accompany new development, and retrofit existing streets to prioritize transit, biking and walking. Similarly, local transit agencies should be granted additional voter-approved revenue sources
7. The state should provide policy support and planning grants to localities to develop plans and policies to encourage biking and walking, including public education, safety, engineering, and revisions to local land use policies.
8. The State should support local governments, through grants and technical assistance, in identifying and studying the gaps in bicycle and pedestrian infrastructure and determining how these gaps can be best filled by street-related improvements as well as those associated with other public right-of-ways (e.g., parks, inter-street links, specialized structures). Supportive local land use policies include requirements for shower and bike storage facilities in new buildings and design requirements to promote a pedestrian friendly environment.
9. The State should require or encourage RTPOs to quantify bicycle and walking mode share in order to allow tracking of progress of this mitigation option.

A number of local agencies, WSDOT, and FHWA have established the goal of increasing bicycling and walking to at least 15 percent of all trips, and simultaneously reducing the number of bicyclists and pedestrians killed or injured in traffic crashes by at least 10 percent. Currently, bicycling and walking account for approximately 9 percent of all trips in the Puget Sound Region (8.2% walk and 1.0% bicycle, from PSRC Vision 2040). According to the 2001 National Household Travel Survey, walking and bicycle modes account for 10.0% and 0.4% of all trips statewide.

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bicycling and walking account for approximately 9 percent of all trips in the Puget Sound Region (8.2% walk and 1.0% bicycle, from PSRC Vision 2040). According to the 2001 National Household Travel Survey, walking and bicycle modes account for 10.0% and 0.4% of all trips statewide.

Goals:

Increase the bicycle and walking mode share (all trips) in Washington urban growth areas to 15% by 2020.

Timing: See above.

Parties Involved: Washington State DOT, RTPOs, local governments

Implementation Mechanisms

1. Acknowledge in state law the need to support local walking and biking trips as a critical strategy in solving regional and statewide transportation needs, and align transportation spending to support growth management revisions proposed in this set of recommendations.
2. Adopt Complete Streets as a policy for state roads.
3. Require, or provide incentives, to localities to adopt Complete Streets policies, including qualifications for funding for local improvements.
4. Revise Highway Design Manual to facilitate bicycle and pedestrian movement on and across state roads.
5. Provide localities with new taxing authority for local improvements and actions, (including ADA transition planning and needs, mobility education, and improvements associated with maintenance projects and Complete Streets). Such taxes should encourage less driving, more efficient vehicles or both.
6. Fund State Bicycle and Pedestrian Programs at $150 million in the first year, expanding to meet the needs identified by a more robust bicycle and pedestrian planning process.
7. Elevate the status of the Bicycle and Pedestrian Advisory Board by having it appointed by the Governor.
8. Provide grants and technical assistance to localities taking growth under the Growth Management Act, to encourage good street design, fill in gaps in bicycle and pedestrian networks, and support building permitting decisions that support walking and biking (e.g., street design, bicycle parking and showers in buildings.)
9. Track trip modes, and the quality of the bicycle and pedestrian network, with support from RTPOs.

Related Policies/Programs in Place

TBD

Estimated GHG Savings and Costs per $MtCO_2e$

		Reductions ($MMtCO_2e$)			NPV (2008–2020) $ millions	Cost-Effective-ness $/tCO_2$
	Policy	2012	2020	Cumulative Reductions (2008–2020)		
T-8	Local Transportation Financing Tools and Bicycle and Pedestrian Infrastructure Improvements	0.12	0.21	1.56	$146	$94

Data Sources

- National Household Travel Survey, 2001
- PSRC Trip Forecasts, Vision 2040
- Cost effectiveness from analysis of bicycle projects funded through the Bay Area Air Quality Management District's Transportation Fund for Clean Air program.

Quantification Methods

The impact of the mitigation option was calculated on urban passenger trips statewide. Using data on average trip length by mode from the National Household Travel Survey, along with VMT and trip forecasts, we estimated baseline urban trips by mode in all future years to 2020.

We then calculated the effect of an increase in bike and pedestrian trips to 15% of all urban trips. Individuals can most easily travel by foot for short trips within neighborhoods. Travel by bicycle is typically feasible for trips within or between neighborhoods or smaller cities. We calculated the impact of the mode shift goal on light-duty VMT, using average bike and pedestrian trip lengths. The average pedestrian trip displaces an automobile trip of 2/3 mile. The average bike trip displaces an automobile trip of nearly 3 miles.

Cost effectiveness was estimated based on an analysis of 27 bicycle path and bicycle lane projects funded through the Bay Area Air Quality Management District's Transportation Fund for Clean Air program (unpublished data from *Performance Review of Selected TFCA Project Types Final Report*, Prepared for the Bay Area Air Quality Management District, Prepared by ICF Consulting, August 1, 2006). The results of this study suggest an average of $340 per ton of CO2 eliminated. Because this study did not account for fuel cost savings for drivers who shift to bicycle mode, we estimated fuel cost savings using the reduction in VMT, baseline vehicle fuel economy (from DOE's Annual Energy Outlook), and gasoline price forecasts (from DOE's Annual Energy Outlook). The net present value cumulative cost over the period 2008 – 2020 is $146 million, suggesting a cost effectiveness of $94 per metric ton of CO2-equivalent emissions.

Key Assumptions

- Baseline mode share in all years assumed to be 1.0% bicycle, 8.2% walk. (from PSRC)
- Under the proposed policy, mode share increases to 2.5% bicycle, 12.5% walk in 2020 (annual average for all trip types).
- Additional bike and walk trips displace SOV trips.

Contribution to Other Goals

Contribution to Long-term GHG Emission Goals (2035/2050):

Job Creation:

Reduced Fuel Import Expenditures:

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Mitigation Option T-9:
Transportation System Management

Based on Transportation Catalog Option 5.1

Mitigation Option Description

Transportation System Management is an interactive approach that allows transportation agencies to actively manage the transportation system to increase the efficient operations of the system and gives users better options in choosing paths that best work for them. This approach incorporates increased system performance, reliability, and safety. The result will be reduced congestion, smoother flows, reducing idling, and allowing more efficient vehicle operation on our roadway networks, thereby reducing emissions of GHGs as well as other pollutants.

Effective Transportation System Management requires the development of specific benchmarks and goals that establish definite improvements to better move people and goods throughout the state, with associated funding packages and programs to accomplish them. The greater the efficiency in the movement of people and goods, the greater the greenhouse gas benefit and connection within our economic systems.

Mitigation Option Design

A successful Transportation System Management package will include funding and implementation of a broad array of driver communication, incident response systems, speed control, and other strategies that will reduce congestion on our existing network, in addition to expanding and connecting important pieces of the network to function better as a whole. While some of these strategies are applicable in urban areas only, others can be applied in both urban and rural areas, wherever there might be congestion, extra need for traveler information, or special conditions such as major construction or seasonal traffic issues. A change in speed limit was evaluated and based on recommendations of the State Traffic Engineer it would not be a cost effective option. Actual speed reductions are not realized, enforcement is difficult, it would increase accidents, and GHG reductions would be minimal.

This option involves the following strategies.

- **Active Traffic Management**. The real-time variable control of speed, lane movement, and traveler information within a corridor and can improve traffic flow in the corridors where it is applied, including:

  Speed Harmonization/Queue Warning/Lane Control - the ability to smooth traffic flows and speeds as vehicles approach congested areas and reduce the speed of vehicles as they approach queues. In Europe, this strategy has been shown to reduce both primary and secondary accidents, reducing non-recurrent congestion. It has also been found to reduce

congestion, queuing, and improve throughput. Speed control allows the highway to continue operating nearer to its highest throughput capacity as volumes increase.

Specific performance measure is "increase operating speed for congested areas". Anticipated investment level to achieve it is medium.

Traveler Information and Dynamic Re-Routing - providing Traveler Information opportunities including travel times and the availability of alternative routes around incidents and congested areas. Dynamic re-routing uses modified destination guide-signs and other traveler information methods to assist drivers through alternative routes.

Specific performance measure is "reduction of delay" (time) from one destination to another. Other measures may include how much time it takes to change signals across various jurisdictions/alter signal timing dynamically for city streets. Anticipated investment level to achieve it is medium.

Overall, benefits of Active Traffic Management are reduced overall delay, reduced idling, and fewer secondary accidents which will also reduce delay and idling. Again, anticipated investment level to achieve it is medium.

- **Traffic Management Center(s).** Provides centralized data collection, analysis, and real-time management of the transportation system. System management decisions are based on in-road detectors, video monitoring, trend analysis, and incident detection.

  Specific performance measures are how quickly problems are identified and responded to and restored to normal, "reduced idling time", and "reduction of secondary accidents". Major Washington urban areas already have some traffic management centers, but to accomplish the various strategies listed in this document, further equipment and staffing investment is needed in coordination with state and local jurisdictions and link established management centers together. Anticipated investment level to achieve is medium to high.

- **Traffic Signal Synchronization.** The timing and operations of the traffic signal operations are synchronized to provide an efficient flow or prioritization of traffic, increasing the efficient operations of the corridor and reducing unwarranted idling at intersections. The system can also provide priority for transit and emergency vehicles.

  Specific performance is "reliability". Anticipated investment level to achieve is fairly low, though development of concurrent local jurisdiction support and coordination may raise the cost to medium.

- **Managed Lanes** are lane(s) which have special operational characteristics and restrictions that are intended to manage the operations of the lane(s). Management of the facility is typically a combination of physical design which limits access and regulation, and may include pricing. Examples are:

  High Occupancy Vehicle (HOV) lanes – are lane(s) exclusively used by transit, vanpools, and vehicles with a minimum number of occupants (typically a minimum of two or three). Full funding for the completion of the system is needed. In addition, periodic re-examination of the system will allow for improved use by deciding which areas should be maintained at 2+ vehicle capacity vs other locations that would be better served with 3+ vehicle capacity requirements where demand is high and where further extensions of HOV facilities would

best serve the traveling public. The existing segments of the HOV network are very effective to date. In some corridors, the usage of HOV lanes is so high that the reliable travel times in the HOV lane are compromised by the congestion in the lane at peak travel times.

Reversible Express Lanes – Lane(s) that change directions during peak periods to manage peak demand periods.

Direct Access Ramps – Highway ramps which provide direct access to a managed lane. An example is a direct access ramp that links a HOV lane to a park & ride facility.

Ramp Bypass Lane – A lane that provides priority bypass of ramp meters for vehicles.

Truck Only Lanes – a lane(s) exclusively used for trucks.

Transit Only Lane or Bus Ways – a lane(s) exclusively used for transit.

Green Lanes – a lane(s) exclusively for vehicles which meet specified environmental impact levels (this management strategy will require careful study, since our HOV lanes are already at capacity)

Limited Access Highways – are highways with limited access points.

High Occupancy Toll (HOT) or Tolled Express Lane – Lane(s) that charges tolls as a means of regulating access to or the use of the facility, to maintain travel speed and reliability. This type of facility will need additional evaluation to assure a balance between social justice in the use of the lanes. Social justice may be achievable through use of the collected fees to go back into the system to improve transit service for low income areas, improvement areas with high traffic demand, and the overall transportation corridor that the HOT lane(s) serves.

Specific performance measures: It is important to continuously review the definitions of the segments of the system to achieve the greatest travel time reliability without creating undue inefficiencies in the overall network. Reliability may be more useful measure than "delay", some other measures include "average operating speeds", "person through-put" and "VMT reduction" depending on facility type and improvement. Anticipated investment level to achieve is medium for conversion of existing lanes and high for construction of new lanes.

- **Pricing.** (Relates to Option T-3) The use of direct user fees (tolls) to manage demand on the transportation system. We recommend that strategies include a mix of the following options.

  Fixed – the toll is fixed and may vary by vehicle class or other set distinguishers.

  Time of Day Schedule – the toll varies by time of day, rising during set peak periods and lowering during non-peak periods.

  Dynamic or Variable – the toll changes to maintain a set operation performance based on real time traffic conditions. As congestion builds, the toll increases to reduce demand. The toll will rise to the point were it begins to influence drivers decisions to use the facility at that time. Additionally, trend analysis can be used to augment real time data to anticipate congestion and proactively adjust tolls.

  Electronic Tolling – Tolls are collected electronically at travel speed, no toll booths or delays. Tolls can be collected through electronic transponders installed in the car or by video license plate recognition.

Specific performance measure may include "delay", "person-throughput", "use/traffic counts during off-peak periods". Anticipated investment level to achieve is high based on infrastructure needs to achieve.

- **Increase Incident Response opportunities** – detection, assistance, and clearing of incidents on the highway so as to assist travelers, increase safety, and reduce non-reoccurring delay caused by incidences. This strategy is best served on limited access roadways where it is hard for drivers to find an alternative route to their destinations. However, perhaps expand incidence response activities to high volume and accident prone local streets and major arterials if appropriate.

  Specific performance measures are "response time to the scene", "time needed to clear an incident", "delay", and reduced "idle time". Anticipated investment level to achieve is medium to high.

- **Improve Traveler Information -** providing real time and projection of travel conditions and transit information to the public to aid in their decision about how, when, and where to travel.

  Reliability may be a more useful measure than "delay." Other measures include "speed/travel time". Anticipated investment level to achieve is medium to high.

- **Increase number of multi-modal connection points.** Co-location of bus, ferry vessel and light-rail terminals would encourage more walk-on passengers. Improved system of coordinating the different regional bus transit systems so that the transfer from one system to the other is seamless (this is an issue of scheduling and location of stops).

  Specific performance measures are transit patronage/ridership, mode choice, travel times on transit, wait times between modes – overall outcome "reduced VMT". Anticipated investment level to achieve is high due to increase trip frequency for bus services and other infrastructure development needs.

  Note: this measure has a connection with land use decisions and accessibility of land uses to transit. So it potentially overlaps with options T-1, T-4, and T-8).

- **Efficiency in operation of all public ferries** Optimize efficiency in operations, scheduling and/ or varying vessel size based on demand at different times of the day on a route, as currently seen in bus system management. This includes identifying and implementing feasible changes in vehicle loading/unloading procedures, traffic lane configuration, off terminal signal management, sailing frequency and crossing time, and, vessel speed control/optimization to reduce GHG emissions. (This includes Washington State Ferries and WSDOT Eastern Region Ferry (Keller Ferry).

  Specific performance measures are "delay" (gate times) and "total fuel consumption" by vessels. Anticipated investment level to achieve is medium to high.

Goals: Overall the goal of this option is to effectively implement a package of Transportation System Management strategies to reduce annual congestion delay and increase person and freight through-put. In keeping with state law, the goals are: To improve the predictable movement of goods and people throughout Washington state; To safely, reliably, and efficiently provide mobility to people and goods.

- In the PSRC region, reduce 2020 highway delay 76%, from 47,514,240 hours per year (1998 baseline) to 43,750,708 hours per year compared with no action scenarios (182,499,635 hours per year, no action).

Timing: Partial implementation of many of these strategies is already underway. Full implementation targeted for 2020.

Parties Involved: Application to freeways, US roadways, and State Roads (highways) involves a mixture of oversight by the Federal Highway Administration and others within US Department of Transportation like Federal Transit Administration, Washington State Legislature, and Washington State Department of Transportation

Roadway networks within unlimited access locations (for example city streets, county roads) are under the jurisdiction of City Councils, Mayors, Public Works Departments, County Councils, and County executives.

Ferry options involve Washington State Ferries/Washington State Department of Transportation and the Washington State Legislature, and appropriate labor unions.

Multi-modal options include rail operators, Washington State Ferries/Department of Transportation, transit agencies, city and county governments.

Implementation Mechanisms

At this time, the state is in the early stages of implementation on a number of system management options. We just started tolling on TNB and have two months worth of data on that. This session the legislature will consider the proposed actions for Urban Partnership grant on SR 520. In the near future we'll have the HOT lanes pilot on SR167.

Over the next two biennia we will gather information and develop regional strategies to expand implementation. MPOs will be looking at implementation in their updates (PSRC's Destination 2030 update to follow changes recommend by Vision 2040.)

Possible funding mechanism includes the federal funding in Urban Partnership Grants. http://ops.fhwa.dot.gov/tolling_pricing/value_pricing/resources/documents/upa.htm

Related Policies/Programs in Place

Traveler information and ITS: http://www.wsdot.wa.gov/NR/rdonlyres/0ECE7DB2-D955-4E0A-954B-1F55C220D5F8/0/GrayNotebookJun07.pdf#page=84

http://www.wsdot.wa.gov/NR/rdonlyres/0ECE7DB2-D955-4E0A-954B-1F55C220D5F8/0/GrayNotebookJun07.pdf#page=86

Washington Transportation Plan: http://www.wsdot.wa.gov/planning/wtp

And the Highway System Plan: http://www.wsdot.wa.gov/planning/HSP.htm

System efficiency and tolling studies http://www.wstc.wa.gov/Tolling/default.htm

Estimated GHG Savings and Costs per $MtCO_2e$

Data Sources:

Quantification Methods:

Key Assumptions:

Contribution to Other Goals

Contribution to Long-term GHG Emission Goals (2035/2050):

Job Creation:

Reduced Fuel Import Expenditures:

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Mitigation Option T-10:
Accelerate and Integrate Plug-In Hybrid Electric Vehicle Use

Based on Transportation Catalog Option 1.5

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 mitigation options would include the following actions:

1. 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.
2. 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.
3. 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.
4. 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 in turn provide for additional incentives for transit use.

5. 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

1. 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.
2. Provide funding for school districts to acquire plug-in hybrid school buses.
3. Through legislative action and/or 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.
4. 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.
5. Direct WUTC to provide rate recovery for utility R&D investments in pilot tests of vehicle-to-grid systems.
6. Fund state General Services to assess electric vehicle charging needs in state parking facilities.
7. Develop and fund at least one vehicle-to-grid pilot involving a fleet of public plug-ins parked in a state garage.
8. 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.
9. As part of HB 1303 passed by the legislature in 2006, a demonstration program was created to convert existing hybrid-electric vehicles to PHEVs. This program should be fully funded in 2008 and then implemented by CTED.

Related Policies/Programs in Place

The 2006 legislature passed HB 1303 directing Department of Ecology and CTED to report to the legislature by December 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 $MtCO_2e$

		Reductions ($MMtCO_2e$)				Cost-Effective-ness $/$tCO_2$
	Policy	2012	2020	Cumulative Reductions (2008–2020)	NPV (2008–2020) ($ millions)	
T-10	Accelerate and Integrate PHEV Use	0.20	1.08	5.76	$2,007	$348

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 Vehicle*s, 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 portion of affected light duty vehicle VMT.

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 GHGs 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 Vehicle*s, 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): TBD

Job Creation: TBD

Reduced Fuel Import Expenditures: TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

Mitigation Option T-11:
Low Carbon Fuel Standard

Based on Transportation Catalog Option 3.1

Mitigation Option Description

This option seeks to reduce GHG emissions by decreasing the carbon intensity of all passenger vehicle fuels sold in Washington. The Low Carbon Fuel Standard (LCFS) would require all fuel providers in Washington to ensure the mix of fuel they sell into the Washington market meet, on average, a declining standard for GHG emissions measured in CO2 equivalent gram per unit of fuel energy sold. The State should regulate quality standards for low carbon fuels. Low carbon fuels include, but are not limited to, biodiesel, cellulosic ethanol, hydrogen, compressed natural gas, liquefied petroleum gas, electricity, and low carbon blends such as E10 or E85. The standard would be measured on a lifecycle basis in order to include all emissions from fuel production to consumption.

Fuel providers (defined as refiners, importers, and blenders of on-road vehicle fuels) will need to demonstrate on an annual basis that their fuel mixtures provided to the market met the low carbon standard. Options for compliance may include: blending or selling increasing amounts of lower carbon fuels, using previously banked credits, and purchasing credits from fuel providers who earned credits by exceeding the standard. Penalties for noncompliance will be determined during the implementation process.

Mitigation Option Design

Goal levels: Create a Low Carbon Fuel Standard for transportation fuels (gasoline and diesel) sold in Washington that would reduce carbon intensity of Washington's on-road vehicle fuels by at least 10 percent by 2020. In addition the reduction standard and program timing, the following issues should be addressed in creating the program:

- Credit Generation and Trading
- Lifecycle Model and Boundary Conditions

Timing: Following design period, program would be implemented prior to 2020. Fuel providers would be required to meet the 10% reduction standard no later than 2020. If interim targets for reduction in carbon intensity are established, they will reflect the likely importance of cellolosic ethanol to meeting the standard and the likelihood that cellulosic ethanol will not be available in large commercially quantities until 2015 or later.

Parties Involved: Fuel providers, State Department of Ecology, State Department of Community, Trade and Economic Development, State Department of Agriculture

Compliance Pathways: The Low Carbon Fuel Standard does not specify any particular fuel or vehicle technology. The table below shows three possible compliance scenarios that would meet

the standard for gasoline in California. As envisioned in California, much of the reduction in passenger vehicle fuel carbon intensity would be met by increasing ethanol use.

Low Carbon Fuel Standard Compliance Scenarios for California

Scenario Number-->	1	2	3
Total Petroleum Displaced by Low-Carbon Fuels (B gal)	3	3.1	3.2
Low-Carbon Fuels			
Total Ethanol Demand (B gal)	2.7	3.8	4.7
Number of Flex Fuel Vehicles (millions)	3	6	8.5
Number of Plug-in Hybrids (millions)	4.1	1.7	0
Number of Hydrogen Fuel Cell Vehicles (millions)	0.5	0.5	0.2

Source: Office of the Governor (State of California), "The Role of a Low Carbon Fuel Standard in Reducing Greenhouse Gas Emissions and Protecting Our Economy." White Paper. January 8, 2007. http://gov.ca.gov/index.php?/fact-sheet/5155/

The table below shows lifecycle ("well-to-wheels") GHG impacts of various biofuels options.

Estimated Biofuel Impacts on GHG Emissions

Fuel/Technology	Blend	Feedstock	Reduction (grams of GHGs per mile)*
Ethanol	E10	corn	1.5%
Ethanol	E10	cellulosic	7.2%
Ethanol	E85	corn	17.6%
Ethanol	E85	cellulosic	83.2%
Biodiesel	B20	soy	9.9%
Biodiesel	B20	canola	11.2%
Biodiesel	B20	palm	12.0%
Biodiesel	B100	soy	53.9%

* Ethanol reductions estimated relative to gasoline; biodiesel reductions estimated relative to diesel fuel. Actual reductions depend on many factors in the production, distribution, and use of fuels.
Sources: GREET v1.7 outputs; $(S\&T)^2$ Consultants, *Sensitivity Analysis of GHG Emissions From Biofuels in Canada*, 2006.

Implementation Mechanisms

A Governor's Executive Order would initiate the process for development of the LCFS, followed by a detailed report and rule-making proceedings that would involve consultation before implementation. The appropriate state agencies will undertake a study to develop the framework for the Low Carbon Fuel Standard. Once the study is completed, it would be introduced to the State's legislative proceedings, at which point the appropriate state agency will conduct public hearings on the proposal. Once adopted, an appropriate state agency will initiate a rule-making proceeding, establishing and implementing the Low Carbon Fuel Standard.

The LCFS is market-based and performance-based, allowing averaging, banking and trading to achieve lowest cost and consumer-responsive solutions. A LCFS is also fuel neutral where fuel providers will choose which fuels to sell and in what volumes. This provides flexible options for compliance including: blending or selling increasing amounts of lower carbon fuels, using previously banked credits and purchasing credits from fuel providers who earned credits by exceeding the standard.

Fuel providers, defined as refiners, importers, and blenders of passenger vehicle fuels, would demonstrate on an annual basis that their fuel mixtures provided to the market met the target by using credits previously banked or purchased. Providers that exceed the performance target for the compliance period will be able to generate credits in proportion to the degree of over performance and quantity of fuel provided. These credits can be used for future use or sold to other regulated fuel providers. Penalties for noncompliance will be determined during the implementation process.

Related Policies/Programs in Place

State policies and programs

- In 2003, the Legislature passed four bills that provide various tax incentives to encourage the development, distribution, and sale of biodiesel and ethanol fuels.[11]
- In 2005, Governor Gregoire signed Executive Order 05-01 (superseding Executive Order 04-06), Establishing Sustainability and Efficiency Goals for the State Operations. Executive Order 05-01 directs agencies to reduce petroleum use 20% (state agency fuel use is about 36 million gallons per year) in the operation of state vehicles and privately owned vehicles used for state business by September 1, 2009. By that date standard diesel must be replaced with 20% biodiesel blend and as soon as practical, agencies must begin using a minimum 5% bio-blend.
- In 2006, the Legislature adopted the Fuel Quality Standards Act establishing minimum renewable fuel content requirements and fuel quality standards.[12] Beginning November 30, 2008, fuel suppliers must ensure a minimum of 2% of total annual diesel and 2% of total annual gasoline sold in the state must be biodiesel or ethanol. The law allows those numbers to be increased to 10% mandated ethanol and 5% mandated biodiesel, if in-state production supports higher levels.
- The 2006 Legislature established the Energy Freedom Program in the Department of Agriculture and appropriated $17 million for the Energy Freedom Loan Program to develop a viable bioenergy industry, promote research and development in bioenergy sources and markets and to support an agriculture industry to grow bioenergy crops.[13]

Federal policies and programs

- Under the 2005 federal Energy Policy Act (EPACT), approximately 5% of gasoline sales will be replaced by ethanol nationally by 2012.

[11] Chapter 261, Laws of 2003 (HB 1240); Chapter 63, Laws of 2003 (HB1241); Chapter 17, Laws of 2003 (HB 1242); Chapter 64, Laws of 2003 (HB 1243).
[12] Chapter 338, Laws of 2006 (ESSB 6508) available at http://www.leg.wa.gov/pub/billinfo/2005-06/Pdf/Bills/Session%20Law%202006/6508-S.SL.pdf.
[13] Chapter 171, Laws of 2006 (E3SHB 2939) available at http://www.leg.wa.gov/pub/billinfo/2005-06/Pdf/Bills/Session%20Law%202006/2939-S3.SL.pdf. The Energy Freedom Program was subsequently amended by Chapter 348, Laws of 2007.

Estimated GHG Savings and Costs per $MtCO_2e$

		Reductions ($MMtCO_2e$)				
	Policy	2012	2020	Cumulative Reductions (2008–2020)	NPV (2008–2020) ($ millions)	Cost-Effective-ness $/tCO_2$
T-11	Low Carbon Fuel Standard	0.38	3.90	16.16	$1,886	$117

Data Sources: Lifecycle impacts of biofuels obtained from Argonne National Laboratory's GREET model (v1.7).

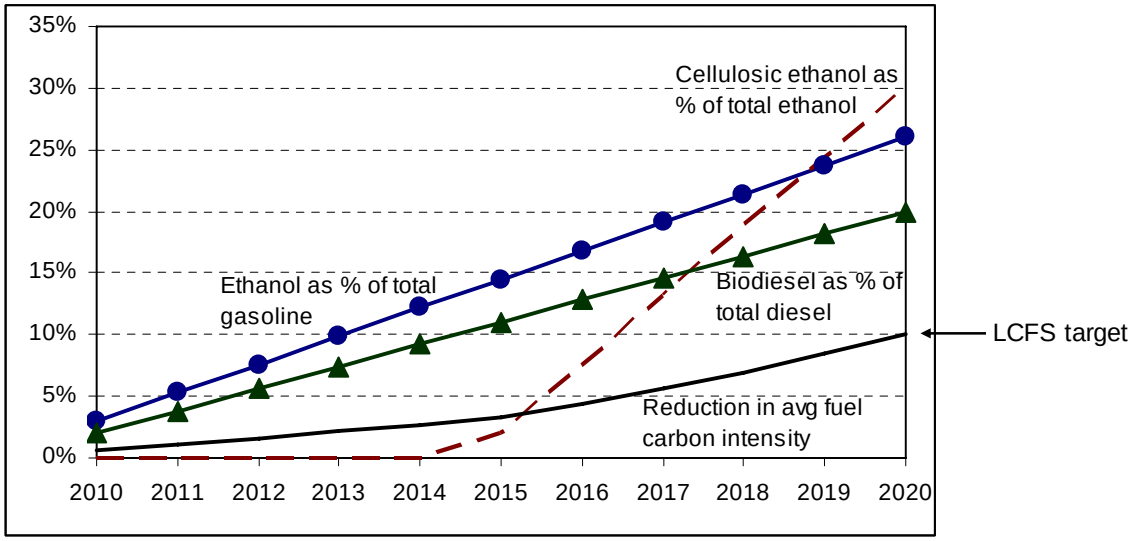
Quantification Methods: The estimate of greenhouse gas emissions reductions from the low carbon fuel standard is based upon a 10% reduction in average carbon intensity of gasoline and diesel fuel sold in Washington. It is assumed that the 10% reduction is in comparison to a reference year in which biofuels sales in Washington were essentially zero. A ramp-up period is estimated so that the 10% goal would be reached at the horizon year, 2020.

The GHG "credit" attributed to this mitigation option is the incremental reduction on top of any reduction due to current (baseline) use of biofuels and any reduction due to recent actions. Ethanol currently makes up approximately 2.67% of Washington gasoline sales; biodiesel sales are currently small and assumed to be zero. For recent actions, the Fuel Quality Standards Act of 2006 is assumed to require the minimum levels of ethanol and biodiesel (2% each). By 2020, the total GHG reduction from the recent actions relating to biofuels is 0.118 MMtCO2e. The table below shows these assumptions, as well as the incremental benefit of the LCFS.

	2006	2009	2012	2015	2018	2020
Current biofuels use						
Ethanol (as % of gasoline)	2.67%					
Biodiesel (as % of diesel)	0%					
Requirements of recent actions						
Ethanol (as % of gasoline)	-	2%	2%	2%	2%	2%
Biodiesel (as % of diesel)	-	2%	2%	2%	2%	2%
Benefit of recent actions						
Ethanol (reduction in MMtCO2e)	-	0	0	0	0	0
Biodiesel (reduction in MMtCO2e)	-	0.085	0.095	0.104	0.112	0.118
Incremental benefit of LCFS (reduction in MMtCO2e)	-	0	0.383	1.081	2.543	3.899

In order to estimate the likely ramp up in biofuels usage needed to meet the LCFS and the interaction with existing policies, we developed a scenario shown in the figure below. In this

scenario, by 2020, ethanol sales in Washington would represent 26% of gasoline sales, with 58% of the ethanol used in flex-fuel vehicles (E85) and the remainder used conventional vehicles operating on E10. All ethanol would come from corn feedstocks through 2014. Starting in 2015, the market share of cellulosic ethanol would ramp up so that by 2020, 30% of all ethanol would be from cellulosic feedstocks. Biodiesel (from soy) would make up 20% of total Washington diesel sales by 2020. The cumulative impact of this increase in biofuels is a 10% reduction in average fuel carbon intensity in 2020.



Cost: Cost is calculated as the incremental cost of biofuels per gallon of gasoline equivalent (for ethanol) or diesel equivalent (for biodiesel) multiplied by total consumption of each fuel. We account for the consumer price of fuel plus the federal subsidy, in the form of an excise tax credit to blenders, for ethanol and biodiesel. This subsidy amounts to 51 cents per gallon for ethanol and 1 dollar per gallon for biodiesel from virgin oils. Ethanol and gasoline prices in future years are drawn from the Energy Information Administration's Annual Energy Outlook, 2006. Based on recent anecdotal evidence from the Seattle area, which suggests that a gallon of biodiesel (B99) and a gallon of conventional diesel are hovering around the same price, we assume no difference in the consumer cost of these fuels. So the full cost of biodiesel is assumed to be $1 more per gallon than the cost of conventional diesel.

Key Assumptions:

- Program starts in 2010, first year of emission reduction
- Program reaches 10% carbon intensity reduction goal by 2020
- Program applies to all on-road vehicles, "replacing" current gasoline and diesel fuel.
- Baseline and existing policy accounts for:
    - 2% biodiesel market share in 2020, blended as B20.

- 2.67% ethanol market share in 2020, blended as E10, with ethanol feedstock for baseline usage assumed to be 100% corn.

Contribution to Other Goals

Contribution to Long-term GHG Emission Goals (2035/2050):

Job Creation:

Reduced Fuel Import Expenditures:

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Mitigation Option T-12:
Zero Emission Vehicle (ZEV) Standard and Low-GHG Refrigerants

Not in original Transportation Catalog

Mitigation Option Description

The Zero Emission Vehicle (ZEV) standard is a component of the California vehicle emission standards. It is a technology-forcing regulation that requires large vehicle manufacturers to produce zero emitting vehicles. The expected technology is either battery electric or fuel cell vehicles. The standards are phased to allow technology development and have been periodically adjusted to provide needed time and flexibility. Currently, the fully phased-in requirements are:

- In 2018, 16% of vehicles produced for CA must be ZEVs or partial ZEVs (PZEVs).
- Large numbers of efficient partial ZEVs can be substituted for the "true" ZEVs.
- In 2018, 1.7% of the vehicles produced must be "true" ZEVs
- Under the substitution ratios, in 2018, 43% of the fleet will be ZEVs, partial ZEVs or alternative technology PZEVs (conventional or plug-in hybrids).

The ZEV requirements are separate from the Pavley GHG standards and can be adopted in Washington regardless of the fate of California's GHG standards. ZEV requirements were first developed to reduce ozone pollution. They are not part of California's recent GHG standards. They can be adopted even if California's GHG standards are overturned in court.

A related component of this mitigation option concerns GHG emissions from vehicle air conditioning systems. The air conditioning refrigerant commonly used in today's vehicles is known as HFC-134a, which is a potent greenhouse gas when air conditioning system leak and the refrigerant is released to the atmosphere. Greenhouse gas emissions from passenger vehicles can be reduced by substituting refrigerants with less potent compounds. U.S. EPA has been working with auto manufacturers to develop air conditioning refrigerants with lower greenhouse gas potential than HFC-134a. The preferred alternative, known as HFC-152a, would be put into new automobiles as they are produced and would replace current vehicles in the fleet as they are retired. The new refrigerant would not be used in existing vehicles now on the road, but benefits would accrue due to normal fleet turnover.

In addition to the reduced greenhouse effects caused by leaking refrigerant, U.S. EPA indicates that substitution of HFC-152a also improves vehicle fuel economy, generating additional GHG

benefits.[14] (HFC-134a systems can also be engineered to be more fuel efficient, but this would not result in refrigerant emissions GHG savings.)

Mitigation Option Design

Goals

- Washington would adopt the ZEV standards.
- Washington would promote HFC 152a as a refrigerant substitute. Use of HFC 152a for auto refrigerant is currently prohibited in Washington State under a statute that was intended to prohibit the use of propane as a substitute auto air conditioning refrigerant.

Timing

- ZEV standards adopted by 2010.
- Eliminate the restriction on HFC 152a by 2009.

Parties Involved: Department of Ecology

Implementation Mechanisms

- ZEV Standards – TBD
- Amend Revised Code of Washington 46.37.470, Air Conditioning Equipment, to allow HFC 152a (but continuing to ban the use of propane).

Related Policies/Programs in Place

- The 2005 legislature adopted the California vehicle emission standards for use in Washington, ESHB 1397.
- In response to opposition by the auto manufactures and dealers, the legislature did not enact the ZEV component of the CA standards.
- The combination of Washington's commitment to a GHG reduction strategy and the promise of new battery technologies that could enable zero emission vehicles and partial zero emission vehicles could be the catalyst to overcome the previous opposition.
- Large automakers are embracing the new developments in battery technology. Ford and California Edison just agreed to a multi-million dollar effort to "figure out how to commercialize plug-in hybrids". GM has a target of producing a plug-in hybrid electric vehicle by 2010.
- Washington is the only one of the 11 opt-in states that does not have the ZEV standards.

[14] U.S. EPA. *Technology and Practices to Reduce Mobile Air Conditioning Refrigerant Emissions by 50 Percent at Vehicle Service and Vehicle End of Life; Associated Education and Outreach.* June 30, 2007 http://www.epa.gov/cppd/mac/Service%20Team%20Final%20Report.pdf

Estimated GHG Savings and Costs per $MtCO_2e$

			Reductions ($MMtCO_2e$)				
	Policy	Component	2012	2020	Cumulative Reductions (2008–2020)	NPV (2008–2020) ($ millions)	Cost-Effective-ness $/tCO_2$
T-12	ZEV Standard and Low-GHG Refrigerants	ZEV Standard	0.000	0.130	0.386	$532	$1,378
		Low-GHG Refrigerant	0.046	0.305	1.428	-$86	-$60
		Total	0.046	0.435	1.814	$446	$246

Data Sources

ZEV Standard

- Analysis conducted by Cambridge Systematics, Inc. for Dept of Ecology (spreadsheet results dated 10/18/2007)

Low-GHG Refrigerants

- Air conditioning charge size from Kristen Taddonio, U.S. EPA
- Various information sources supplied by Kristen Taddonio, U.S. EPA
- Registered vehicle population from WSDOT
- Vehicle population by model year from Dept of Ecology
- Effect on fuel economy in Washington from presentation by John Rugh (NREL), "Significant Fuel Savings and Emission Reductions by Improving Vehicle Air Conditioning." Available at http://www.nrel.gov/vehiclesandfuels/ancillary_loads/pdfs/fuel_savings_ac.pdf
- Incremental cost of HFC-152a systems from presentation by SAE Alternate Refrigerant System Symposium, 2003.

Quantification Methods

ZEV Standard

Dept of Ecology commissioned an analysis of the GHG impacts of the ZEV standards for Washington. The analysis, by Cambridge Systematics, Inc., was provided to CCS. It uses information on Washington's vehicle fleet (by model year and vehicle type), new vehicle sales, and emission factors. It estimates 2020 GHG emissions the light-duty vehicle fleet under a baseline scenario and under a ZEV scenario in which the requirement for "true ZEVs" is met with hydrogen fuel cell vehicles beginning in 2018. Fuel cell vehicles assumed to reduce full fuel cycle GHG emissions by 55% compared to conventional gasoline (calculated using GREET model).

Baseline emissions (no ZEV program)

	Total GHG Emissions (metric tons/day)			
	LDV	LDT12	LDT34	All LD
2020	30,155	37,769	18,702	86,626
2035	37,432	46,961	23,282	107,674

ZEV Scenario emissions

	Total GHG Emissions (tonnes/day)			
	LDV	LDT12	LDT34	All LD
2020	30,049	37,598	18,628	86,275
2035	37,069	46,491	23,055	106,614

Reduction

	Total GHG Emissions (tonnes/day)			
	LDV	LDT12	LDT34	All LD
2020	-0.4%	-0.5%	-0.4%	-0.4%
2035	-1.0%	-1.0%	-1.0%	-1.0%

The 2020 percent reduction shown above was applied to the light-duty baseline emissions. The result in 2020 is a reduction of 0.13 MMtCO2e.

The cost of the ZEV standard is calculated based on the additional per vehicle cost for a hydrogen fuel cell (HFC) vehicle minus savings on fuel cost. Fuel cost savings are included up to the year 2020 only, although owners of HFCs would continue to realize savings on fuel costs for the life of their vehicles. The per vehicle incremental cost of a HFC is projected at $9,270, based on a report for the California Energy Commission prepared by Arthur D. Little (Projected Automotive Fuel Cell Use in California, October 2001). This extra cost is assumed to be paid in full at the time of vehicle purchase. Per mile fuel costs for hydrogen (4 cents per mile in a passenger car) are drawn from a memo by Robert Rose of the Breakthrough Technologies Institute.[15] Per mile fuel costs for gasoline are calculated from projected fuel efficiency and consumer fuel prices in the Annual Energy Outlook, 2006. For the sake of comparison with hydrogen, the average per gallon fuel tax of 43 cents is subtracted from the price of gasoline.

Low-GHG Refrigerants

The average charge size of an HFC-134a system is 500 grams (Kristen Taddonio, U.S. EPA) and the GWP of HFC-134a is 1,430 (IPCC). HFC-152a secondary-loop AC systems have an average charge of 250 grams of refrigerant (Kristen Taddonio, U.S. EPA), and the GWP of HFC-152a is 124 (IPCC). Thus, replacing a HFC-134a system with a HFC-152a system will reduce system lifetime GHG emissions by 0.684 MtCO2e. [(500*1430 – 250*124)/1,000,000]

We assumed all new vehicles sold in WA beginning in 2010 will have HFC-152a system. We assumed 2006 new vehicle sales are equal to the population of model year 2006 vehicles registered in the state (310,114). We assumed new vehicle sales to grow in proportion to the total number of vehicles registered in WA (provided by WSDOT).

[15] Available for download at http://www.fuelcells.org/info/library/QuestionsandAnswers062404.pdf

New vehicles do not lose refrigerant uniformly over their lifetime. We assumed a new vehicle (sold in 2010 or later) would have a lifetime of 16 years and would lose refrigerant uniformly from year 6 through year 16 of the vehicle's life (based on USEPA. "Technology and Practices to Reduce Mobile Air Conditioning Refrigerant Emissions by 50 Percent at Vehicle Service and Vehicle End of Life," Associated Education and Outreach. June 30, 2007. http://www.epa.gov/cppd/mac/Service%20Team%20Final%20Report.pdf)

Thus, a vehicle sold in 2010 is assumed to achieve 1/10 of the per vehicle GHG benefits in each of the years 2016 – 2026. A vehicle sold in 201 would achieve 1/10 of the per vehicle GHG benefits in each of the years 2017 – 2027. And so on. The 2020 GHG reduction would be 122,460 metric tons CO2e.

Fuel economy benefits are relatively small in Washington (compared to other states) because most of the state's population lives in a mild climate and thus uses air conditioning relatively little. The per vehicle fuel savings in Washington is 5.0 gallons per year, based on presentation by John Rugh (NREL), "Significant Fuel Savings and Emission Reductions by Improving Vehicle Air Conditioning." Total annual fuel savings were calculated by multiplying 5.0 by the estimated number of vehicles in the fleet with HFC-152a systems. Fuel savings in 2020 is 20.7 million gallons.

Incremental equipment cost assumed to be $25 per system (applied to new vehicles sales beginning in 2010). Fuel saving costs calculated using gasoline price forecast from DOE's Annual Energy Outlook, 2006.

Key Assumptions:

- "Pure" ZEV standard met using hydrogen fuel cell vehicles.
- All new vehicles use HFC-152a starting in 2010.

Contribution to Other Goals

Contribution to Long-term GHG Emission Goals (2035/2050):

Job Creation:

Reduced Fuel Import Expenditures:

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD