Transportation and Climate Change Resource Center

REAL SOLUTIONS FOR CLIMATE CHANGE

Climate Change 101:
An Overview of Climate Change for State DOTS

FEBRUARY 24, 2010

Presented by:

PAULA HAMMOND
Secretary of Washington State DOT & Chair of AASHTO Climate Change Steering Committee

CINDY BURBANK
Vice President Climate Change Practice Leader, Parsons Brinckerhoff

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Climate Change 101:

An overview of climate change science, linkages to energy security, greenhouse gas (GHG) reduction strategies for surface transportation, and risk-based adaptation to climate change.

A presentation sponsored by **AASHTO**, **FHWA**, and **FTA**

Climate Change Steering Committee

- Responsibilities include:
  - Climate Change policy review and recommendations
  - Oversight of the Climate Change Technical Assistance Program
- Chaired by Paula Hammond
- Members include 17 state Department of Transportation CEOs
- Members also serve on a diverse range of AASHTO committees, including
  - Environment
  - Planning
  - Highways
  - Rail Transportation
  - Aviation
  - Public Transportation
  - Center for Environmental Excellence

Climate Change Technical Assistance Program (CCTAP)

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- Voluntary, pooled-fund program
- 30 member states this year
- Goal: to supply AASHTO members with timely information, tools and technical assistance to help them meet the difficult challenges that arise related to climate change

CCTAP Activities

- National Symposium on Climate Change
- On-site State DOT Workshops on Climate Change
- Climate Change Webinars
- Weekly Climate Change Newsletters
- Updated Climate Change Website

Balanced approach for a changing environment

Transportation accounts for nearly half of the greenhouse gas emissions in Washington State.

We created a multifaceted approach to reduce greenhouse gas emissions including—

- Increasing travel options to reduce vehicle miles traveled per capita;
- Supporting improved vehicle technology;
- Lowering the carbon content of fuels;
- Improving the efficiency of the transportation system; and
- Adding capacity to complete critical corridors and support concentrated growth and transit oriented development.

All of these strategies will be necessary to adequately reduce emissions.

Lessons learned

Have a plan up front—Be proactive instead of reactive. Stay connected with regulatory agencies; anticipate potential legislation; and consider terminology and word choice when talking about your efforts.

Structure your program using defined priorities— Ensure program is based on science, strategic with multiple elements and scalable to various communities throughout the state.

Don't recreate the wheel—Use resources available from other states and AASHTO to improve your program and to educate yourself and your agency.

Take some credit—Get the word out about the good and innovative work that you are already doing.

Action items for transportation agencies

- Work with other agency's on a comprehensive, statewide plan to adapt to and prepare for an already changing environment
- Repurpose, reuse and recycle road and other materials and retrofitting ferry vessel engines to use less fuel and oil
- Investigate long-term and viable funding solutions to maintain infrastructure and reduce our effect on climate change
- Improve and support rail as a low-carbon alternative
- Use lower temperature asphalt mixes to save energy and reduce emissions
- Evaluate energy policies to identify potential transportation solutions—from land use to fuel use, develop policies to lessen transportation-related energy consumption and reduce fossil fuel dependency

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Overview

I. Climate Change Science, Sources, and Trends
II. The Importance of Climate Change to State DOTs
III. Strategies to Reduce GHG Emissions from Transportation
IV. Climate Adaptation for Transportation Agencies
V. Climate Legislation and Policy

I. Climate Change - Science, Sources and Trends

What are the scientific findings?

Climate Change 2007: The Physical Science Basis

- Developed by the Intergovernmental Panel on Climate Change (IPCC)
- Contributions from 2,000 scientists assessing the Earth's environment and the effects of global warming

…a summary for policy makers…

There is 90% certainty that humans are the cause of global warming.

Notable findings in the report:

- Atmospheric CO_2 levels are at their highest levels in 650,000 years.
- Average global temperatures have risen ~1.3°F since the industrial age began.
- Sea level rose ~4.8 – 8.8" worldwide during the 20th century, at a rate more than double that of the past decade

How certain are the scientists?

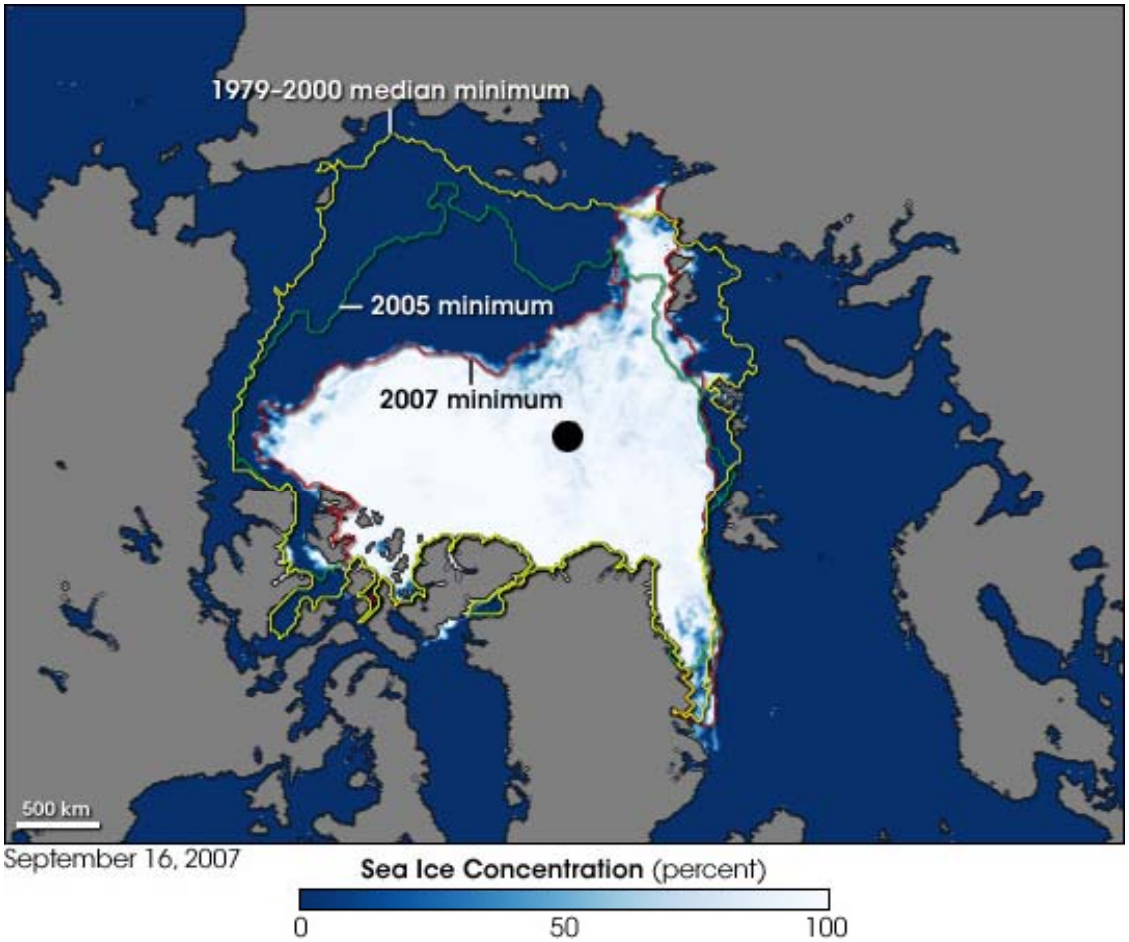
- "Warming of the climate system is unequivocal…"

-- Intergovernmental Panel on Climate Change

- "An overwhelming body of scientific evidence paints a clear picture: climate change is happening, it is caused in large part by human activity, and it will have many serious and potentially damaging effects in the decades ahead."

-- Pew Center on Climate Change

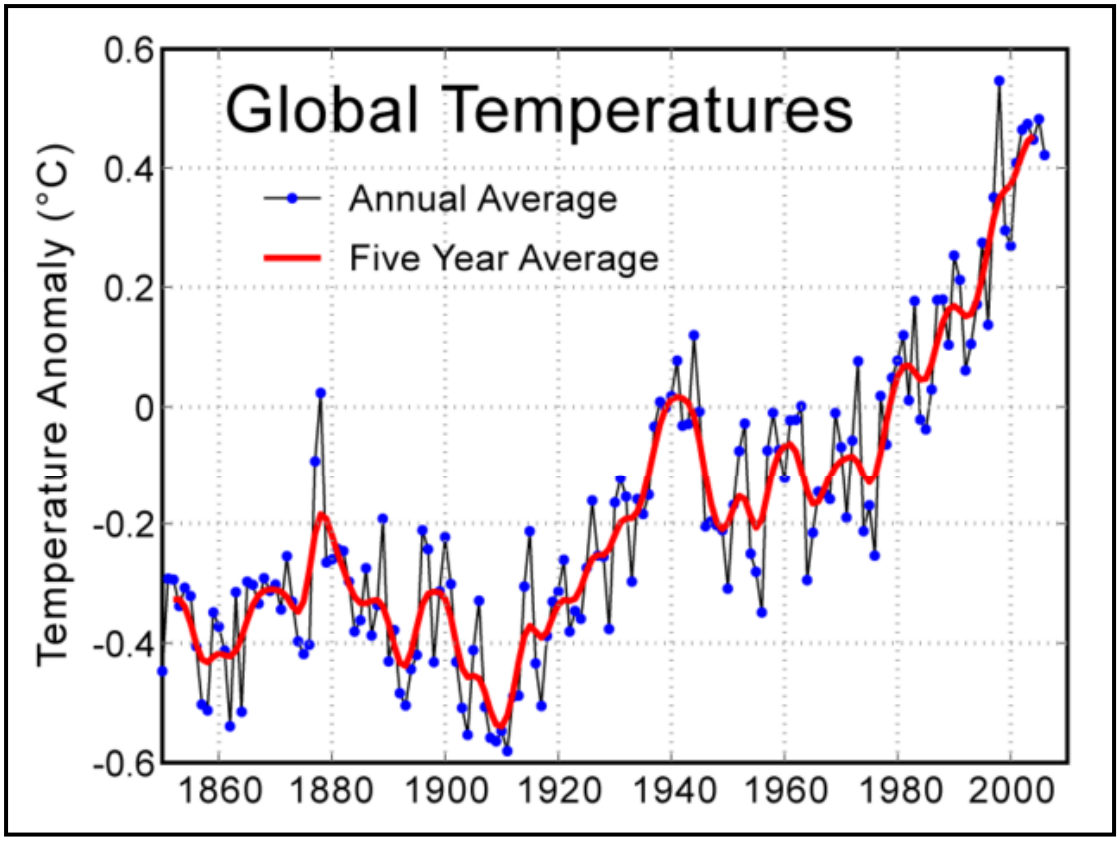
What is the physical evidence?



Source: NASA

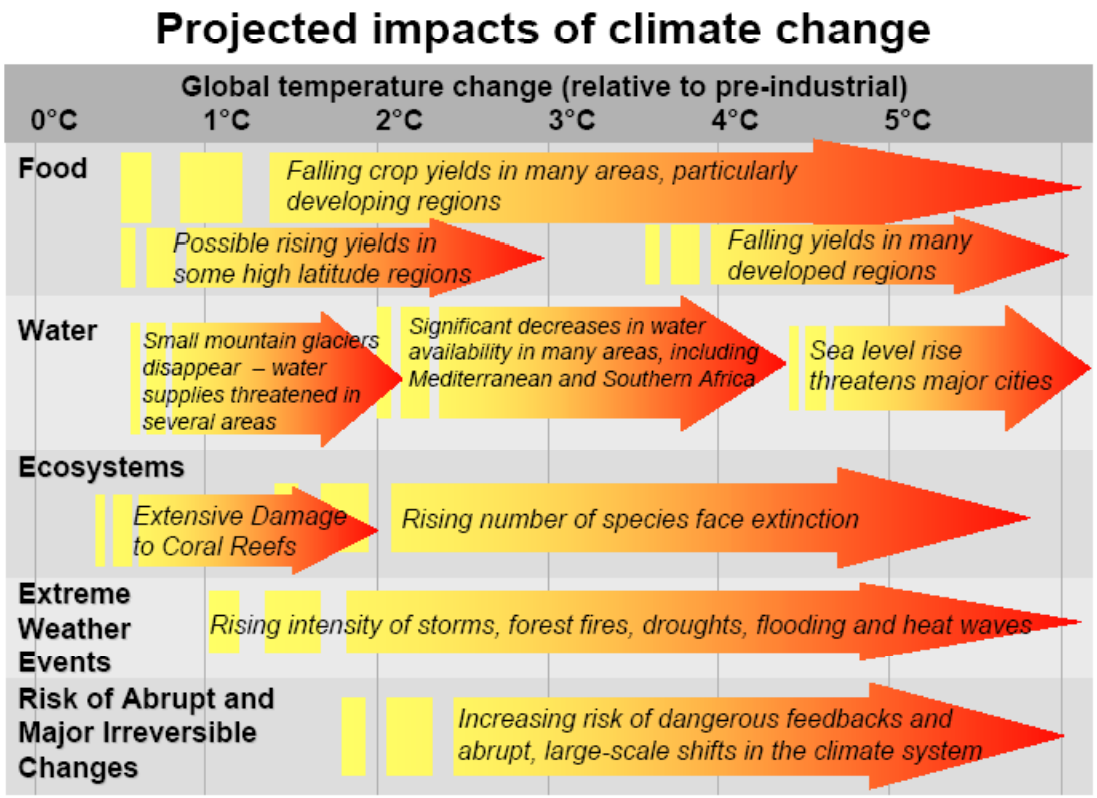
- Arctic sea ice is retreating –
- a measurable change in climate that can be seen

What is the evidence on temperatures?



Source:
http://www.globalwarmingart.com/wiki/Image:Instrumental_Temperature_Record_png

What are the impacts at different temperature increases?



Source:
Stern Review, 2008

How much GHG reduction is needed?

- Scientists recommend **60-80% GHG emission reduction below 1990 level by 2050**
- Many states and countries have adopted targets in this range
- GHGs are cumulative, with a long half life (100 years)
- The longer we wait to make reductions, the deeper future cuts will have to be

II. The Importance of Climate Change to State DOTs

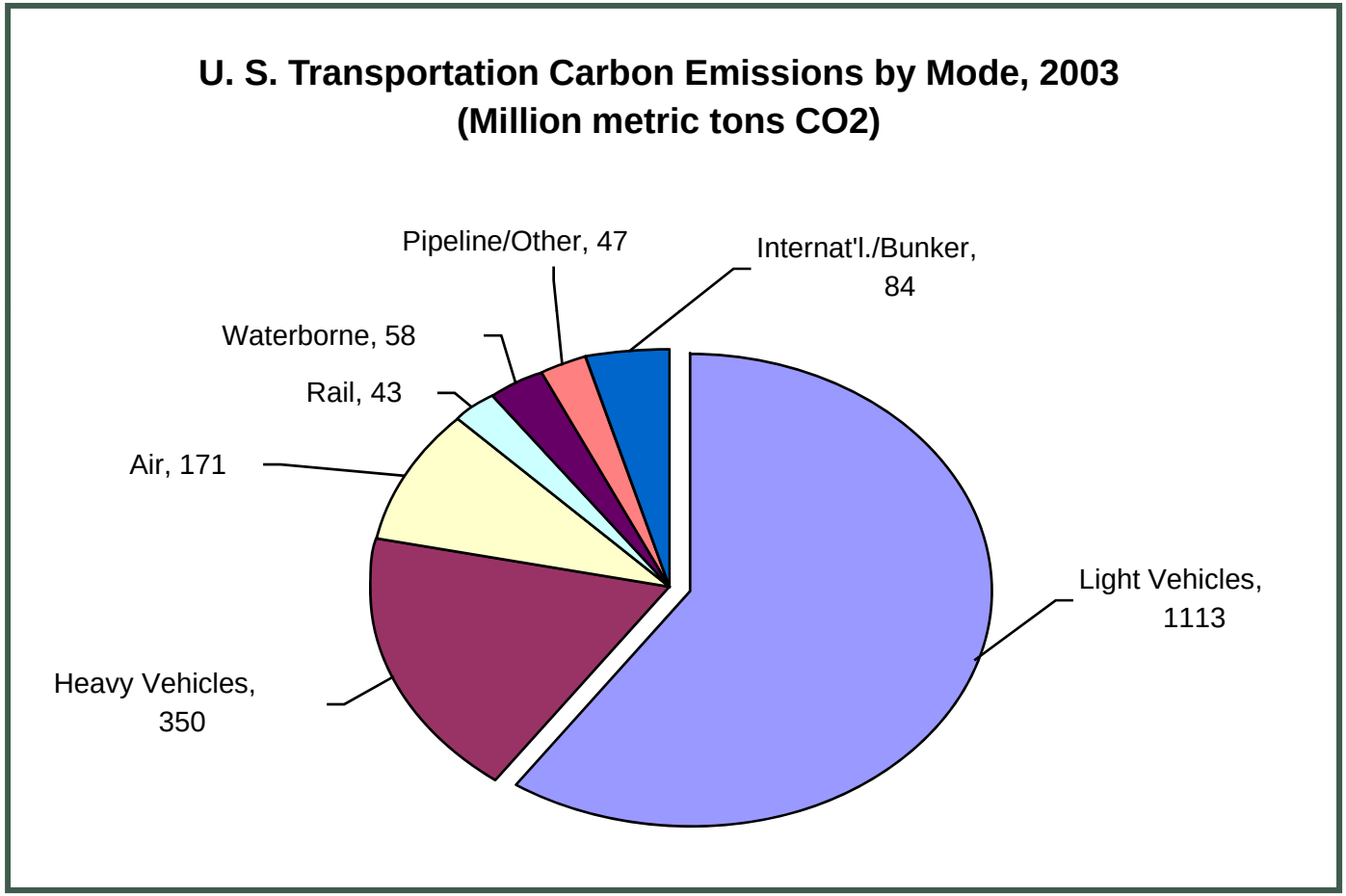
A Three-Part Challenge to State DOTs

1. Reduce transportation GHG 60-80% by 2050

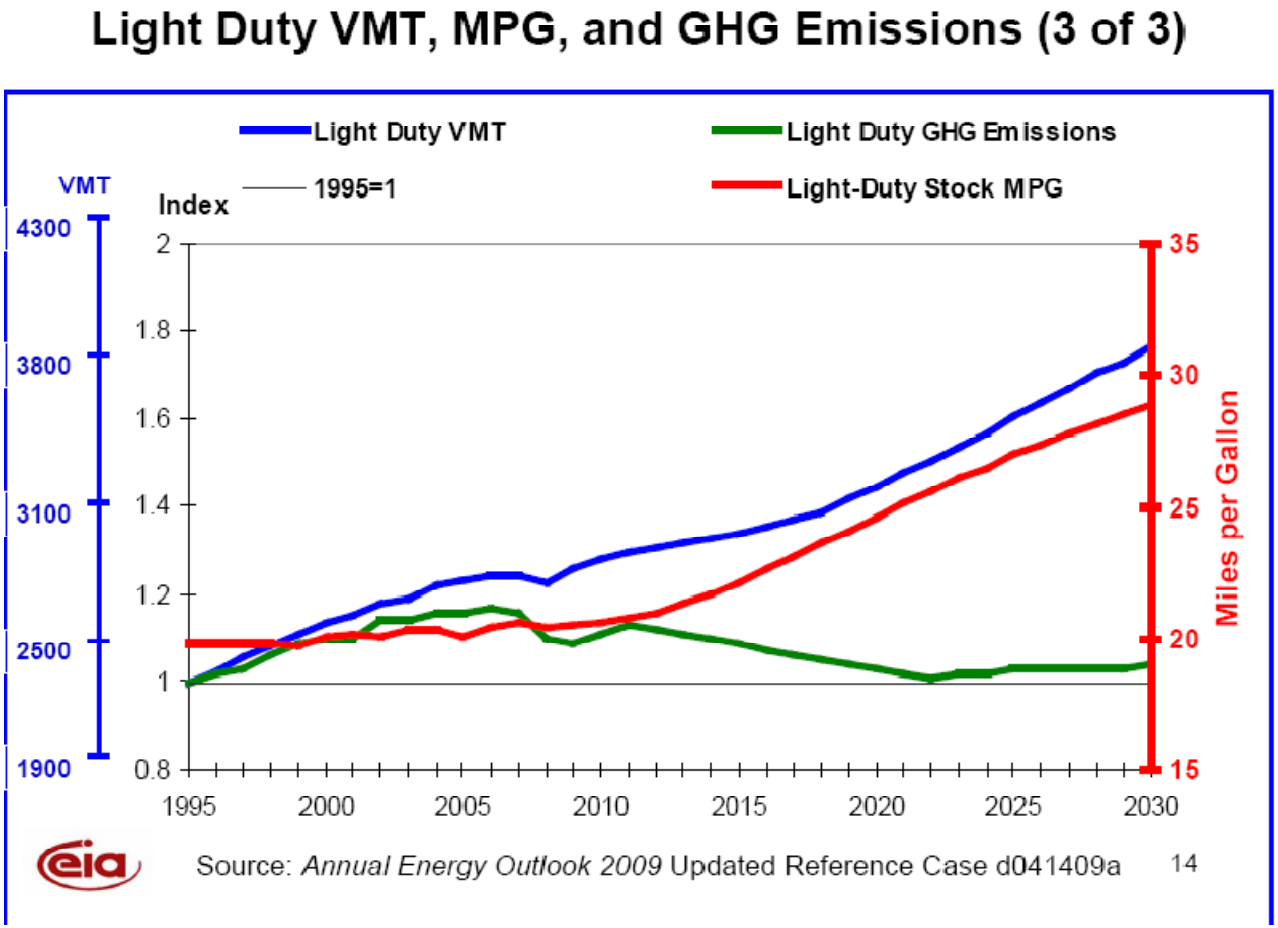
2. Adapt transportation infrastructure to rising sea levels, more severe storms, higher temperatures, and flooding

3. Find a new revenue stream suitable for low-carbon fuels

Highway Vehicles Account for 82% of Transportation CO2 Emissions – and 23% of all U.S. CO2



As VMT and MPG rise, GHG is nearly flat -- for Light Duty Vehicles



What should the GHG reduction target be for the transportation sector?

- Economists:
  - Reduce GHG emissions as cost-effectively as possible, even if that means much larger reductions in some sectors than others
  - Evidence is accumulating that reducing transportation GHG 80% would be more costly than same % reduction in other sectors
  - Ergo: Transportation GHG reduction targets probably should be lower

- Political reality:
  - Transportation will be expected to contribute its "fair share“
  - Room for debate about what "fair share" means.
  - Often-cited goal is **60 to 80%** from current levels.

III. Strategies to Reduce GHG Emissions from Transportation

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Five GHG Reduction "Legs"

Transportation GHG reduction has 5 legs:

1. Vehicles
2. Fuels
3. VMT
4. Operating Efficiency
5. Construction, Maintenance, and Agency Operations

Examples:

- Higher CAFE standards
- CA's low carbon fuel standard
- Telework, trip-chaining
- ITS, Eco-driving
- LED traffic lights

Vehicle/Fuel Improvements Will be the Dominant Source of GHG Reductions for LDVs

- 50% cut in GHG/mile is feasible from conventional technologies and biofuels by 2020-2030
- Compare these GHG rates in U.S. and Europe:

380 grams/mile	2009 in the U.S.
250 grams/mile	2016 under new Obama standard
256 grams/mile	2007 actual in the E.U.
209 grams/mile	2012 under E.U. regulation
153 grams/mile	2020 under E.U. regulation

Vehicle “decarbonization” is essential

“In the long term, carbon free road transport fuel is the only way to achieve an 80-90% reduction in emissions, essentially “decarbonization.”

--The King Review for the U.K. Government, by Professor Julia King, Vice-Chancellor of Aston University and former Director of Advanced Engineering at Rolls-Royce plc, March 2008

“[I]n the period beyond 2100, total GHG emissions will have to be just 20% of current levels. It is impossible to imagine this without decarbonization of the transport sector.”

-- Sir Nicholas Stern, Stern Review to the U.K. Government, 2007

Trends in developing world underscore the need for vehicle/fuel decarbonization

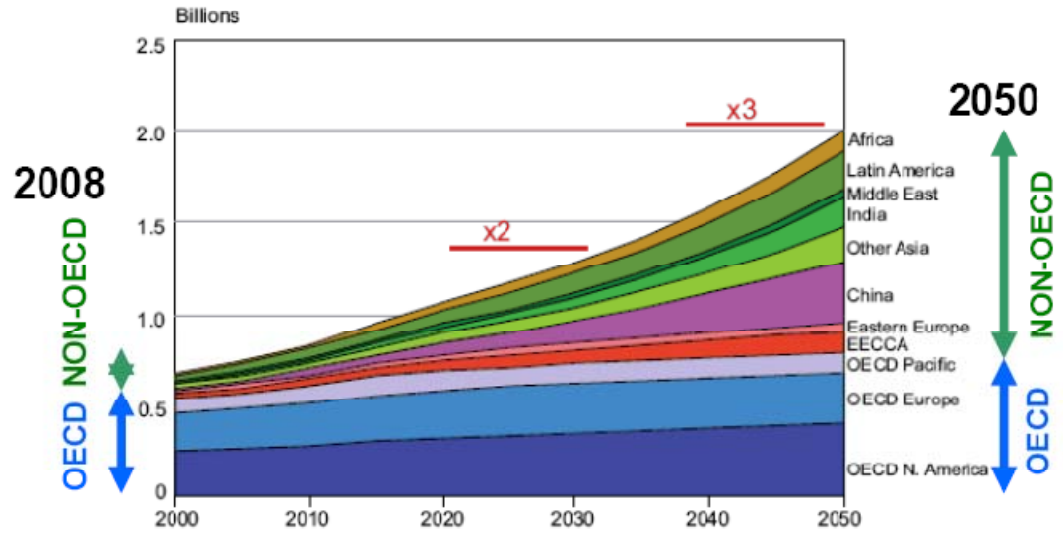

Figure 5.5: *Total stock of light-duty vehicles by region*

Source: WBCSD, 2004a.

Source: WBCSD, 2004a: Mobility 2030: Meeting the Challenges to Sustainability

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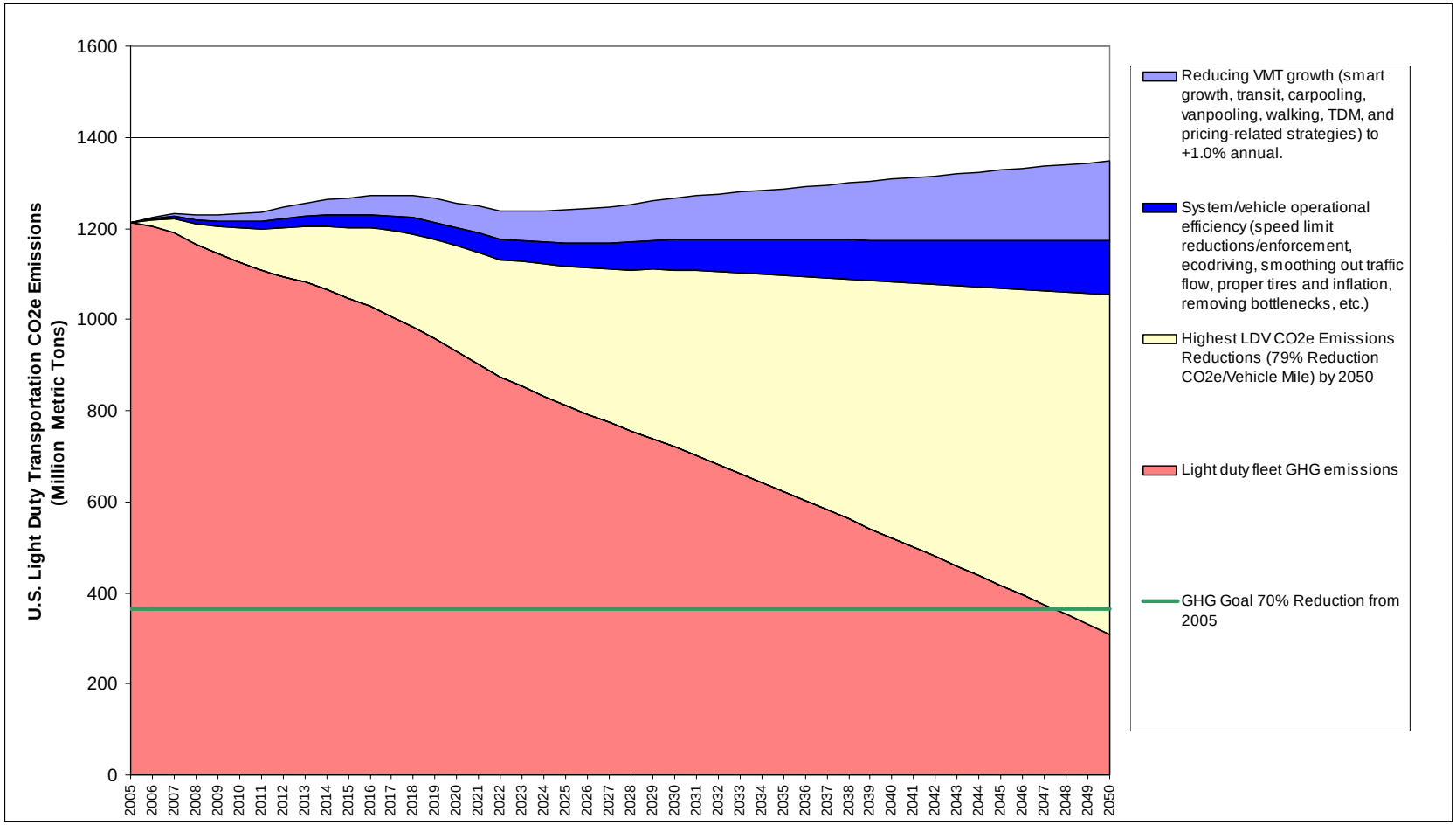
Possible State DOT Roles in Decarbonization

1. Influence state policies on low-carbon fuels/vehicles
2. Plan/provide plug-in infrastructure for electric and PHEV vehicles
3. Support federal transportation funding for technology/fuel R&D
4. Educate the public
5. Provide incentives for consumers to use lower carbon fuels/vehicles (lower fees for low-carbon vehicles/fuels)
6. Use planning scenarios to emphasize need for decarbonization
7. Maximize use of low carbon vehicles/fuels in state DOT fleets

One Scenario to Achieve 74% LDV GHG Reduction by 2050

1% Annual VMT Growth + 100 mpgge LDV Fleet + 10% Operational Efficiency



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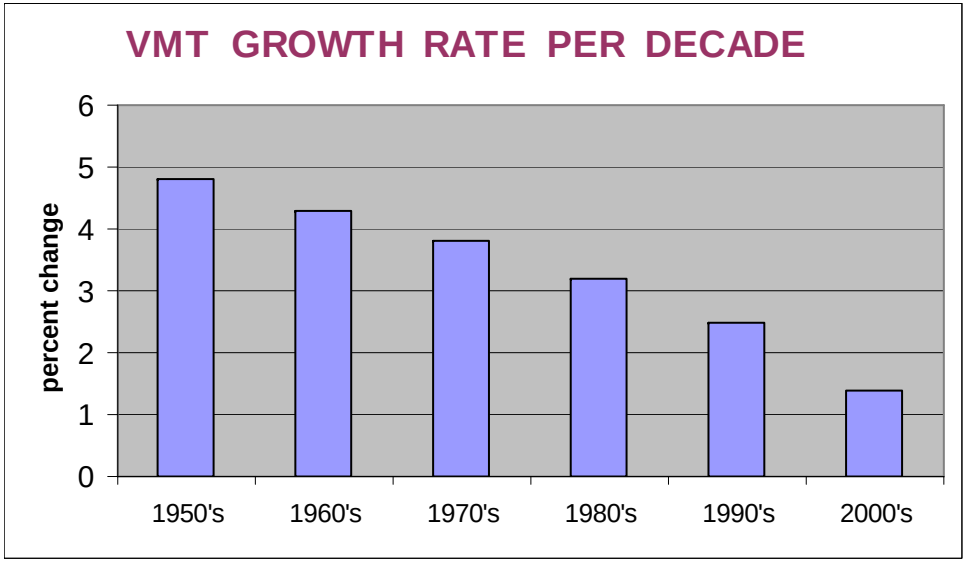
U.S. VMT growth rates are declining– but will zero or negative VMT growth be expected?

- VMT growth has been steadily declining since the 1950s
- VMT growth slowed to about 1.5% in early 2000s
- AASHTO supports reducing VMT growth rate to 1% per year



Source: Alan Pisarski and Cambridge Systematics

Many Strategies to Reduce LDV VMT

- Economy-wide carbon cap and trade (raises fuel prices)
- Transportation pricing (PAYD insurance, parking pricing, tolls, higher user fees, cordon pricing, congestion pricing, etc.)
- Carpooling and vanpooling
- Bike/ped
- Transit in high density corridors
- Trip chaining
- Tele-working, tele-shopping, tele-education, tele-medicine
- Compact land use

Pricing – A Necessary and Powerful Tool

- Without price signals, trying to reduce GHG is swimming upstream
- Pricing encourages many helpful changes:
  - Consumer purchase of lower-carbon vehicles and fuels
  - Business investment in low-GHG technology
  - Lower VMT
  - Eco-driving
  - More efficient land use
- Many different pricing tools available: auto "feebates," carbon/fuel prices, PAYD insurance, mileage fees, parking pricing, congestion pricing, etc.
- Pricing produces revenue to invest in alternatives

CO_2e Emissions Per Passenger Mile for Various Modes

NATIONAL AVERAGE	Energy Intensities		Load Factor	CO_2e
	(Btu or kWhr per vehicle mile)	(Btu or kWhr per passenger mile)	Persons Per Vehicle	(Estimated Pounds CO_2e Per Passenger Mile)
Single Occupancy Vehicle (SOV) LDVs	5,987	5,987	1.00	0.99
Personal Trucks at Average Occupancy	6,785	4,329	1.72	0.71
Transit Bus	37,310	4,318	8.80	0.71
Cars at Average Occupancy	5,514	3,496	1.57	0.58
Electric Trolley Bus	5.2	0.39	13.36	0.52
High Occupancy Vehicle (HOV) LDVs at 2+ Occupancy	5,987	2,851	2.10	0.47
Intercity Rail (Amtrak)	54,167	2,760	20.50	0.39
Light and Heavy Rail Transit	62,797	2,750	22.50	0.39
Motorcycles	2,226	2,272	1.20	0.37
Commuter Rail	92,739	2,569	31.30	0.36
Vanpool	8,048	1,294	6.10	0.21
Walking or Biking	-	-	1.00	0.00

REGIONAL EXAMPLE (SEATTLE/PUGET SOUND REGION)	Energy Intensities		Load Factor	CO_2e
	(Btu or kWhr per vehicle mile)	(Btu or kWhr per passenger mile)	Persons Per Vehicle	(Estimated Pounds CO_2e Per Passenger Mile)
Cars (64%) and Personal Trucks (36%) at Average Occupancy	5,987	4,468	1.34	0.74
King County Metro Diesel and Hybrid Buses	33,024	2,854	11.57	0.47
Sound Transit Buses	33,024	2,517	13.12	0.42
King County Electrically-Powered Trolley Buses	5.33	0.44	12.12	0.11

Carpooling and Vanpooling

- Important but not appreciated (carpools/vanpools provide far more passenger miles than transit)
- Low cost for government, wide availability, saves users money
- Effective in all kinds of areas – rural, small urban, suburban, urban
- Near term payoff
- Atlanta and DC MPOs pay for commuters to carpool ($2/day)

Transit helps reduce GHG – but 1-2% effect nationally

- Transit serves many different goals, has broad support
- But as a national GHG strategy:
  - Transit serves 1% of PMT and 0% freight in the U.S.
  - DOE: Bus transit has higher GHG/passenger mile traveled than average auto use
  - APTA studies: (a) Transit reduced GHG by 6.9 MMT in 2005; or (b) by 35 MMT in 2005. This is 0.3% to 1.7% of U.S. transportation GHG
- Transit GHG benefits are realized with highly patronized services in high volume corridors -- a market limited to high volume, generally densely developed corridors

Land Use Effect on GHG Depends on Assumptions -- 3 studies, 3 results

- ***"Growing Cooler":*** 3.5-5% reduction in transportation GHG, 2007-2050, with aggressive assumptions about land use change:
  - 67% of all development in place in 2050 will be constructed or rehabbed after 2005
  - 60-90% of that development is compact (13 housing-units per acre)
  - Compact development has 30% less VMT than very sprawling development
- ***"Moving Cooler":*** 2% on-road GHG reduction cumulatively, 2010-2040, if 90% of new urban land use is compact, bike/ped friendly, with high quality transit
- ***2009 TRB study***: <1 to 11%* reduction in passenger LDV GHG in the year 2050 from compact land use

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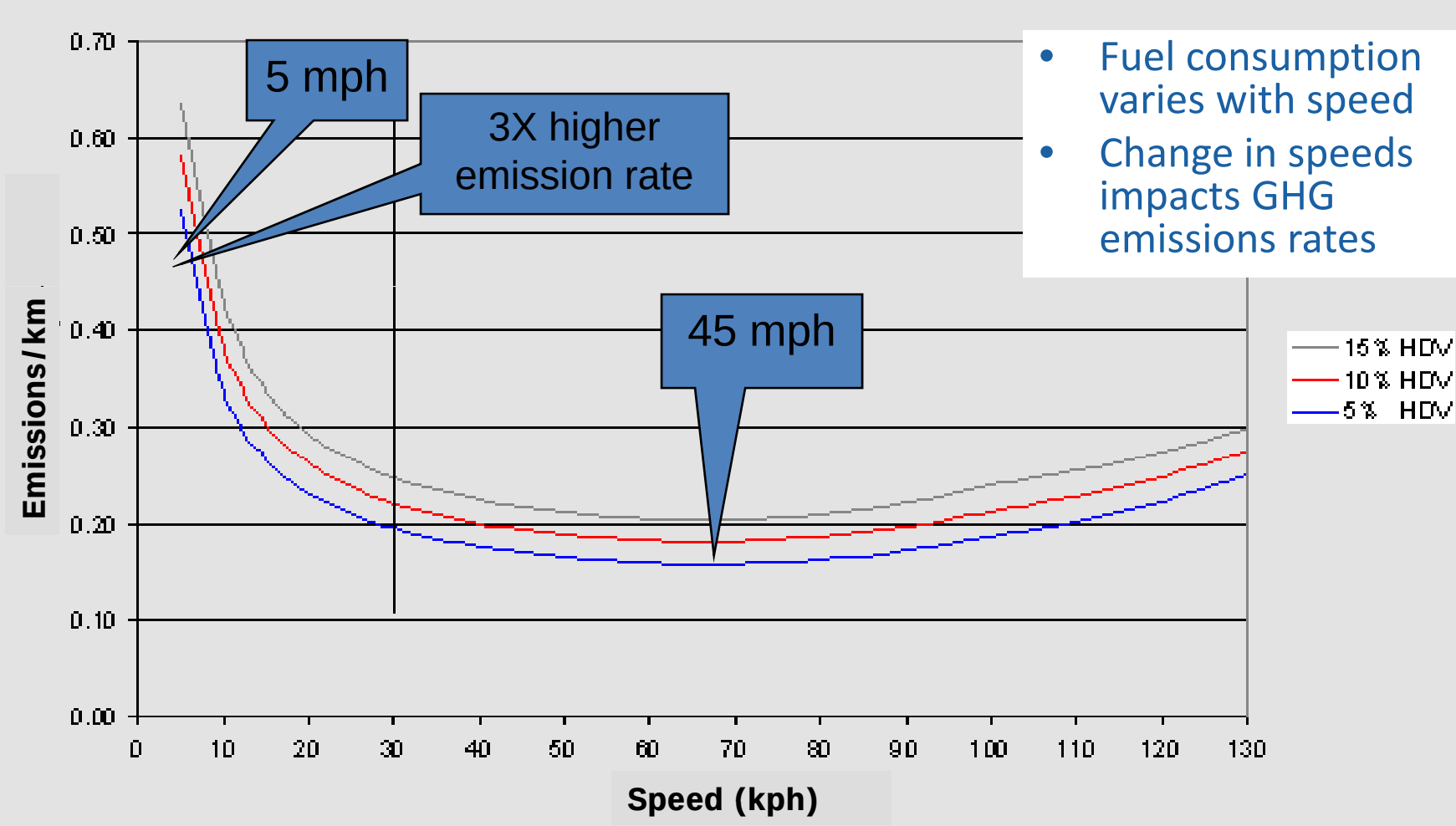
* TRB panel split on whether 11% is possible

Vehicle/System Operations to Reduce GHG

Potential for 10-20% LDV GHG reduction by:

- Managing speed (35-55 MPH is optimal)
- Speed limits/enforcement (could reduce fuel use 2-4%)
- Eliminating bottlenecks
- "Active" traffic management to smooth traffic flow
- Improving signal timing (could reduce 1.315 MMT CO_2/yr)
- Roundabouts (multiple benefits)
- Reducing car and truck idling
- Work zone management to smooth flow
- Encouraging eco-driving

How does speed affect GHG?



- Fuel consumption varies with speed
- Change in speeds impacts GHG emissions rates

Source: Colin McConnaha, Parametrix, Inc.

Eco-Driving – 15% GHG Reduction Potential

- EcoDrivers can reduce fuel and CO2 by an average of 15% through smart driving and vehicle maintenance
- If 50% of drivers practice EcoDriving, CO2 would drop by 100 million tons annually (the equivalent of heating and powering 8.5 million households)
- Pilot by City of Denver with 300 drivers achieved 10% fuel reduction and similar GHG reduction
- Useful for HDV, MDV, and LDV drivers
- Major push in Europe as GHG strategy
- Aided by dashboard displays of real-time MPG & other “smart” technology

www.EcoDrivingUSA.com

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- EcoDrivingUSA™ : A nationwide effort to increase overall vehicle fuel economy and preserve the environment
- Partnership of state Governors, environmental organizations, auto industry
- More info on EcoDrivingUSA™: www.EcoDrivingUSA.com
  - Be an EcoDriver
  - EcoCalculator
  - EcoDriving Quiz
  - Virtual Road Test
  - Is Your Community EcoDriving?
  - Educational Tools
  - News and Events
  - Join the EcoDriving Movement

- Compare these GHG reductions in "Moving Cooler," for 2010-2050:
  - 1,815 MMT - If 20% of drivers adopt ecodriving
  - 1,445 MMT - If at least 90% of new urban development is compact, bike-ped friendly, with high-quality transit

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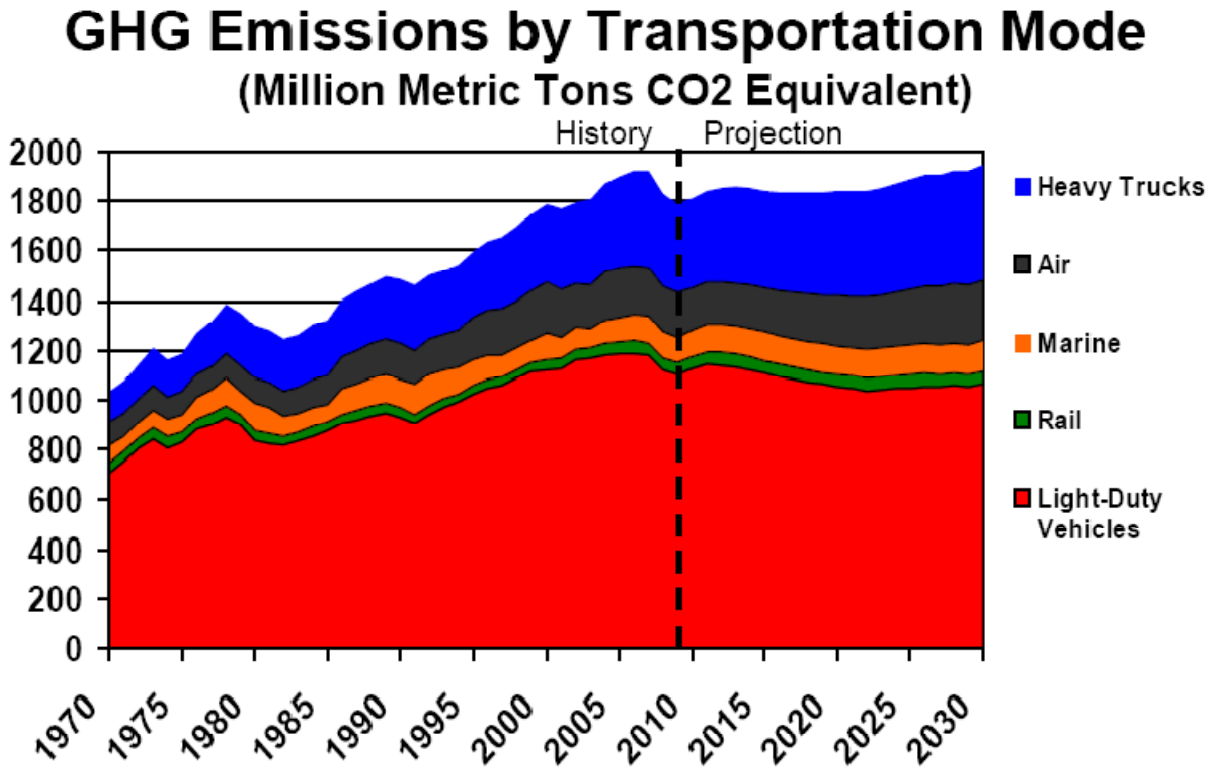
Truck GHG is Growing Faster than Other Transportation GHG



Source: History: *Transportation Energy Databook 28th Edition*
Projection: *Annual Energy Outlook 2009* Updated Reference Case d041409a

“Best Practices Guidebook for GHG Reductions in Freight Transportation”

- NC State University report to US DOT, 2007
- Covers trucks, freight rail, marine, air freight, pipeline
- Identifies 33 “best practices” for reducing truck GHG (plus 26 for other freight modes)
- All 33 could reduce truck GHG in 2025 by 12% below 2003 (compared to 67% increase in truck GHG if best practices are not implemented)

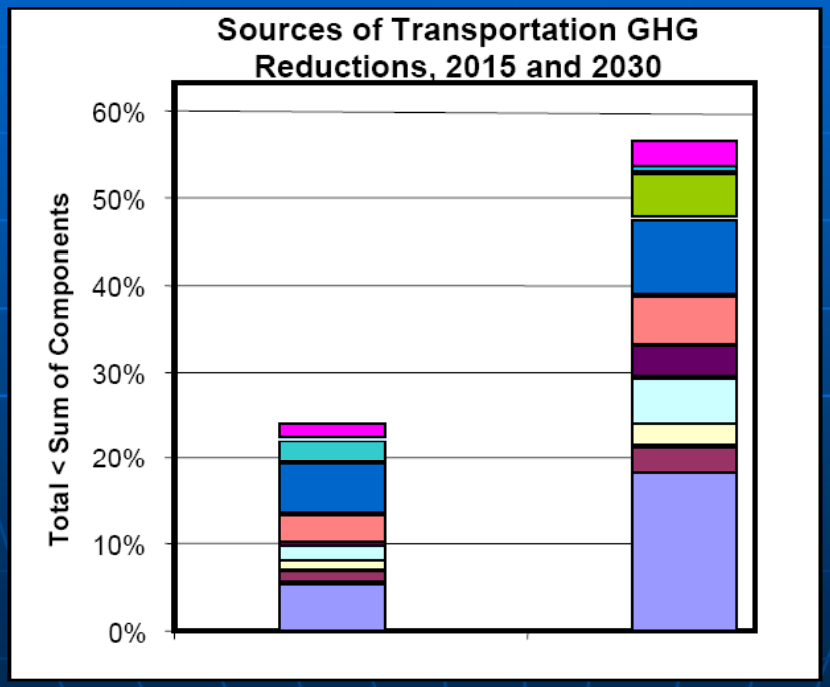
Freight GHG Strategies in State Climate Action Plans

- Anti-idling programs
- Truck stop electrification
- Speed limit enforcement
- Freight villages/consolidation centers
- Feeder barge container service
- Traffic flow improvements
- Pre-clearances at scale houses
- Truck driver training
- EPA SmartWay up-grade kits & loans
- Incentives to retire older trucks
- Freight logistics improvements
- Shifting freight from truck to rail
- Hybrid power trucks
- Low-viscosity lubricants
- Single wide-base tires
- Automatic tire inflation systems
- “Black carbon” control technologies

Detailed info available in NCHRP 20-24(59), Appendix C

Combination of Strategies to Achieve 50% Transport GHG Reduction by 2030

Greene & Schafer (Pew Center, 2003) concluded that a comprehensive, tailored set of strategies could cut U.S. transportation emissions in half by 2030.



Source: Greene and Schafer, Pew Center on Global Climate Change, May 2003.

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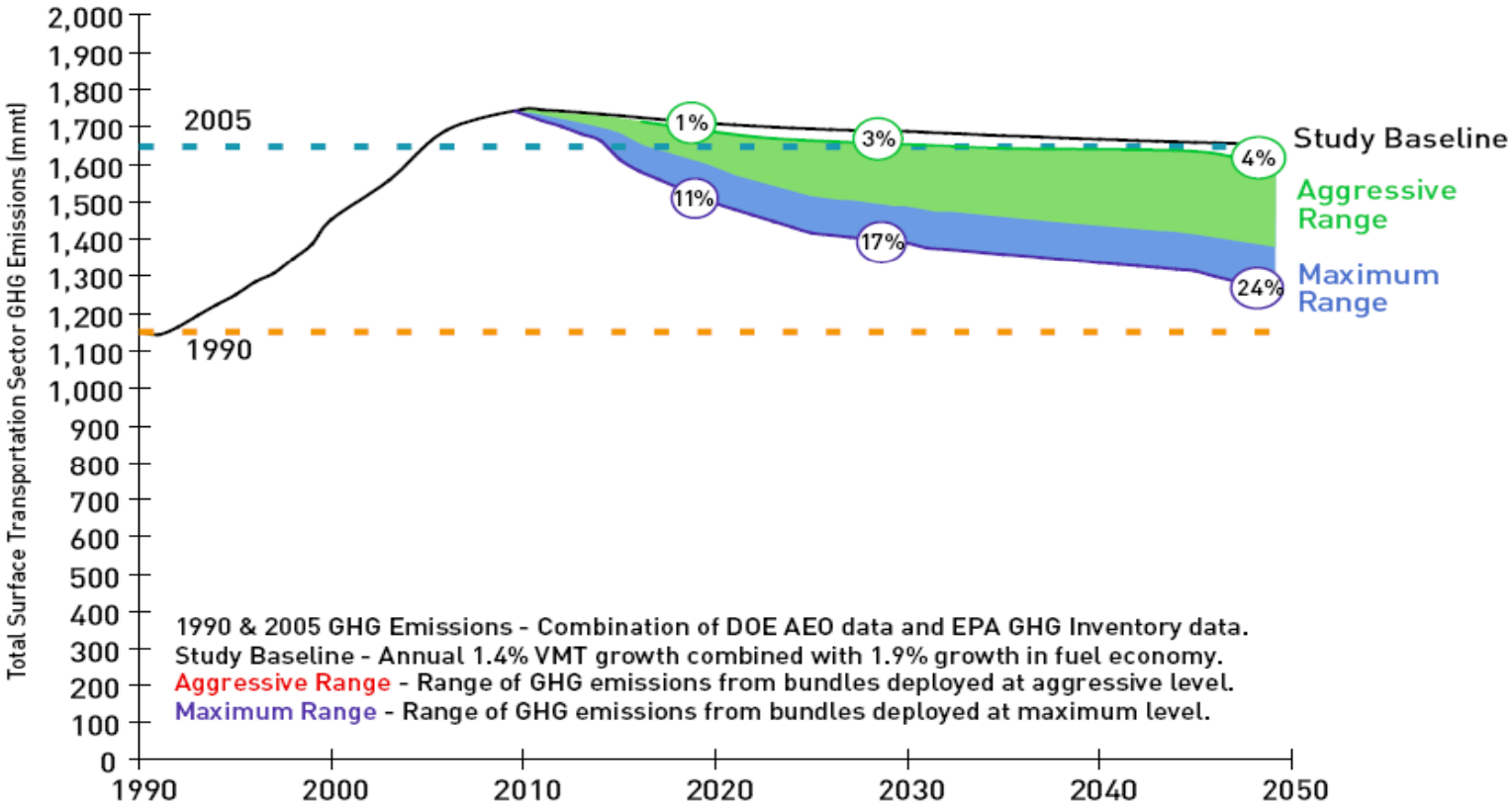
Moving Cooler - Maximum Bundle (non-technology)

"Maximum-Aggressive" strategy bundle can reduce cumulative on-road GHG by 16% compared to on-road baseline, over 40 years

- Intercity tolls imposed in 2010 at 5 cents/mile
- Congestion pricing fully implemented at 65 cents/mile in 120 metro areas
- $400 permit fee to park on neighborhood streets
- $1.2 trillion transit expansion
- Bike lanes every 1/4 mile
- New and increased parking fees
- 90% of new urban development is compact, in dense Census tracts, with high quality transit
- Eco-driving by 20% of drivers
- Speed limit reductions
- And more…

What "Moving Cooler" Demonstrates: **Maximum Behavioral Strategies Reduce GHG 16% Cumulatively, 2010-2050**



Green/blue colored area above represents a cumulative GHG reduction of 16%, 2010-2040, for Moving Cooler's "Maximum" bundle of strategies, without "economy-wide" pricing.

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Strategies: Construction, Maintenance, & Agency Operations

- Significant sources of GHG and energy use
- Many opportunities to reduce GHG and energy cost from current system:
  - LED traffic lights
  - Low carbon pavement
  - Energy-efficient buildings
  - Reduced roadside mowing
  - Solar panels on ROW (Oregon DOT pilot)
  - Alt fuels and hybrid vehicles in DOT fleets
  - Alt fuel buses

Starter Menu of GHG Strategies – Low Hanging Fruit

- Eco-driving programs
- Carpool/Vanpool programs
- Telework promotion
- Traffic signal synchronization
- Adaptive signalization
- LED traffic lights
- Lower-carbon pavements
- Reduced roadside mowing
- Partnering with local govts to better coordinate land use/transportation planning
- Truck stop electrification
- Roundabouts

IV. Climate Adaptation for Transportation

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Why Transportation Agencies Should Plan for Adaptation

- Sea level rise & storm surges
  - Destruction of bridges
  - Erosion & permanent inundation of roads
  - Disruption of evacuation routes & road network
  - Bridge clearance limitations
- Other types of impacts
  - Increased flooding
  - Pavement and rail buckling
  - Increased flooding
  - More severe inland storms
  - Increased maintenance

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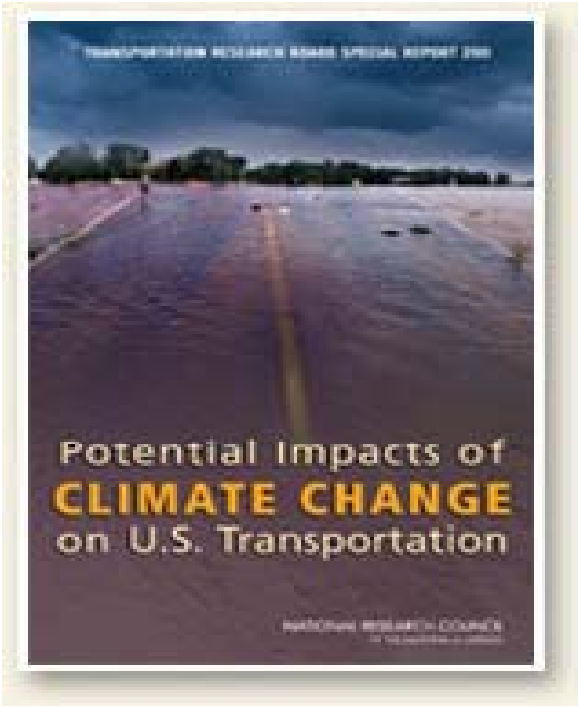
Source: http://mceer.buffalo.edu/research/Reconnaissance/Katrina8-28-05/05BiloxiBay1/09lg.jpg

Transportation Research Board Special Report 290



Potential Impact of Climate Change on U.S. Transportation

(TRB Special Report 290)

Transportation Research Board
Division on Earth & Life Studies
National Research Council

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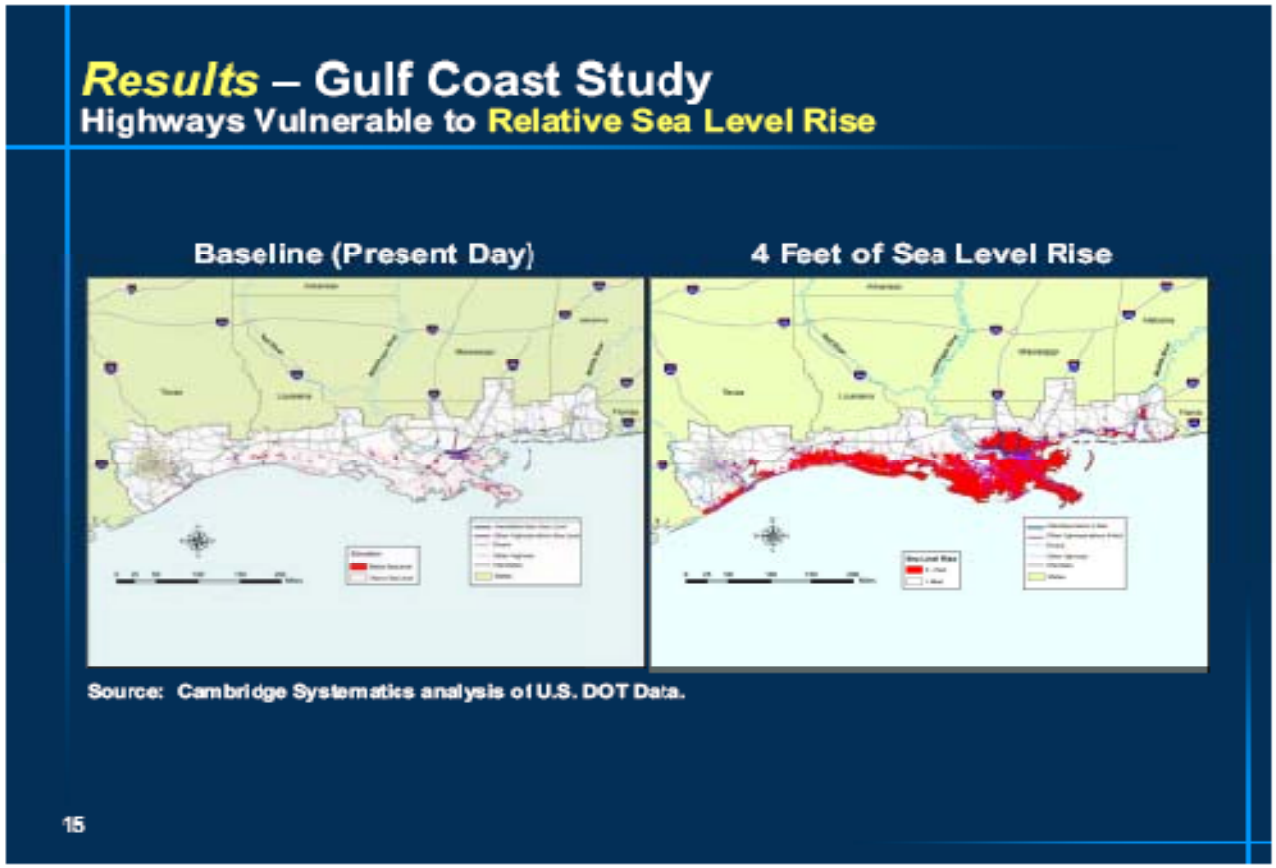
Gulf Coast Study on Climate Change – Highways and Relative Sea Level Rise



Source: Mike Savonis, FHWA

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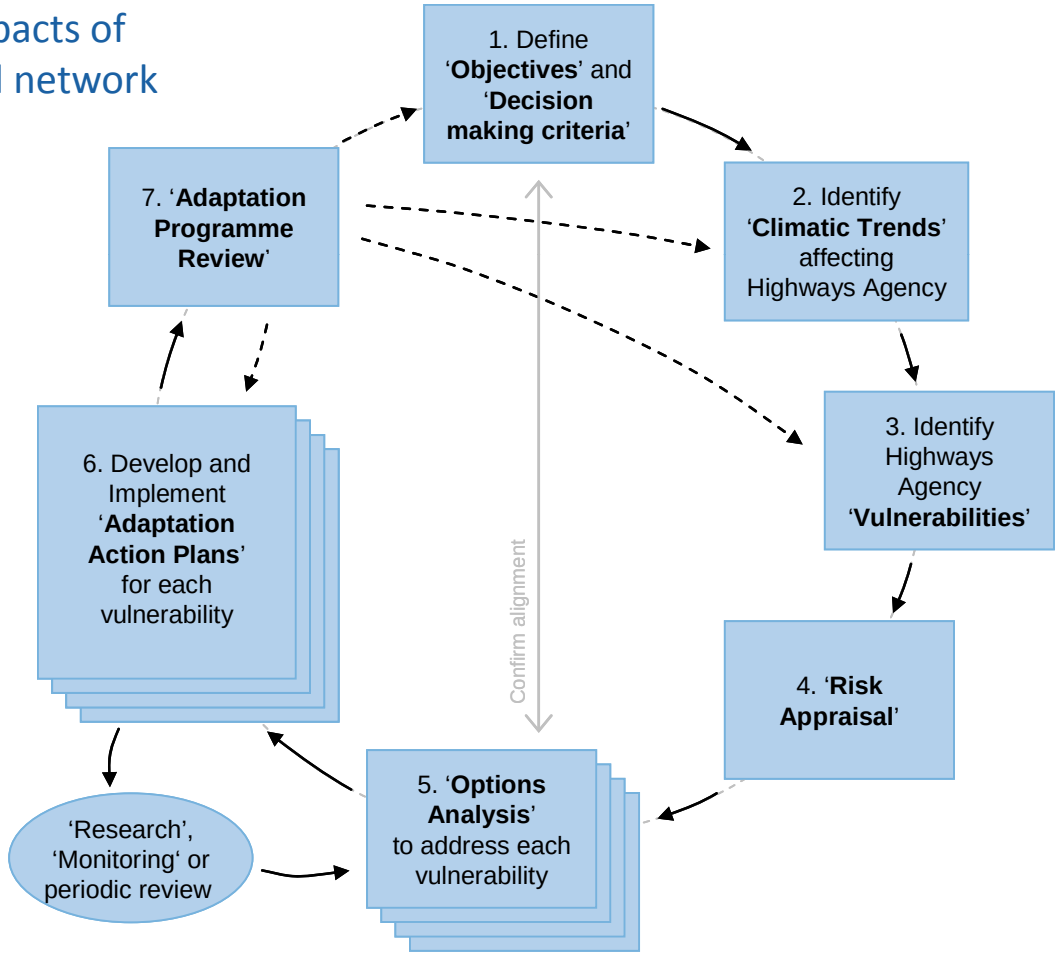
U.K. Highways Agency Adaptation Strategy Model

- Model identified potential impacts of climate change of the UK road network
- Resulted in a climate change adaptation strategy
- Strategy addresses design, construction, and maintenance
- Includes a risk appraisal for all operations



V. Climate Legislation & Policy

NEPA and Climate Change

- NEPA/GHG litigation to date: mixed results
- CEQ proposed new NEPA guidelines on 2-19-10
  - Consider both project effects on GHG and effects of climate change on projects
  - Proposed threshold of significance: increase of 25K tons of GHG/year
- Several states require climate analysis in state environmental documents (CA, WA)
- Transport project GHG effects are small
- DEIS for transit/highway Columbia River Crossing project: All build alternatives have lower GHG than no-build for facility operations – but construction GHG is large

Federal Legislation – Cap and Trade – Transportation Implications

- HR 2454 would reduce overall GHG 70-80%
- But cap-and-trade has much smaller impact on transportation GHG
- So H.R. 2454 has other sections on transportation GHG reduction:
  - Incentives for plug-in vehicles and other advanced technology vehicles
  - Grants to build plug-ins and other advanced vehicles
  - State and MPO planning requirements

Federal Legislation – Cap and Trade - Transportation Planning Provisions

- States and TMA MPOs must develop GHG reduction targets and strategies, as part of transportation plans
- States and TMA MPOs must "demonstrate progress in stabilizing and reducing" GHG emissions
- EPA must issue regulations on transportation GHG goals, standardized models, methodologies, and data collection
- US DOT shall not certify state or MPO plans that fail to "develop, submit or publish emission reduction targets and strategies"
- US DOT must establish requirements, including performance measures, "to ensure that transportation plans… sufficiently meet the requirements.., including achieving progress towards national transportation-related GHG emissions reduction goals."

AASHTO Position on Climate Change

- Invest in R&D to decarbonize vehicles/fuels (comparable to “man on the moon”)
- Reduce VMT growth to 1%/year
- Double transit ridership
- Increase intercity passenger rail
- Provide $100 M/year Federal funding for coordinated land use/transportation planning

State Climate Action Plans

Most (not all) state climate action plans:

- Highly “aspirational”
- Managed by state environmental agencies
- Followed “cook book” approach
- Steering Committees included multiple environmental advocates and rarely had transportation agency reps
- State DOT involvement was at a technical advisory level, whose input was often rebuffed
- Example: VT transit/land use strategies would reduce 2030 VMT from 10.5 billion (base case) to 3.9 billion VMT

State Climate Plans – Transportation Elements Vary All Across the Map

State	Year	Vehicle	Low Carbon Fuels	Smart Growth and Transit	Other
MN	2025	15%	35%	25%	25%
NC	2020	35%	12%	38%	15%
SC	2020	14%	55%	29%	1%
CT	2020	51%	38%	8%	2%
ME	2020	53%	25%	21%	1%
MD	2025	24%	12%	45%	20%
NY	2020	59%	11%	27%	4%
PA	2025	45%	36%	18%	0%
RI	2020	46%	10%	31%	14%
VT	2028	21%	14%	49%	17%

Information Resources

Resources -- Websites

- AASHTO: http://www.transportation1.org/RealSolutions/
- Intergovernmental Panel on Climate Change (IPCC): http://www.ipcc.ch/
- US DOT Transportation and Climate Change Clearinghouse: http://climate.dot.gov/index.html
- FHWA Climate Change Program: http://www.fhwa.dot.gov/environment/global.htm
- The Pew Center on Global Climate Change: http://www.pewclimate.org/
- EPA Climate Change Program: http://www.epa.gov/climatechange/
- TRB Climate Change Activities: http://tris.trb.org/climatechange/

Resources – Key Documents

- AASHTO, “Primer on Transportation and Climate Change,” 2008
- NCHRP 20-24 (59), “Strategies for Reducing the Impacts of Surface Transportation on Global Climate Change,” 2009
- European Council of Ministers of Transport, “Review of CO2 Abatement Policies for the Transport Sector,” 2006
- U.S. DOE, “Annual Energy Outlook,” 2009 (primary source of official U.S. data on energy and GHG)
- TRB Special Report 290: “Potential Impacts of Climate Change on U.S. Transportation,” 2008
- Pew Center on Climate Change, “Climate Change 101”

For copies of these slides and webinar recording, go to AASHTO's website:
http://environment.transportation.org/center/products_programs/

For more information on climate change, go to AASHTO's website:
http://realsolutions.transportation.org/Pages/default.aspx

Thank you!