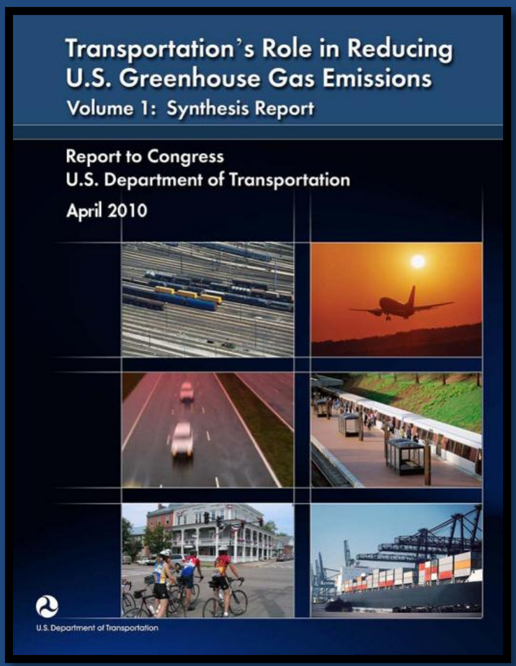


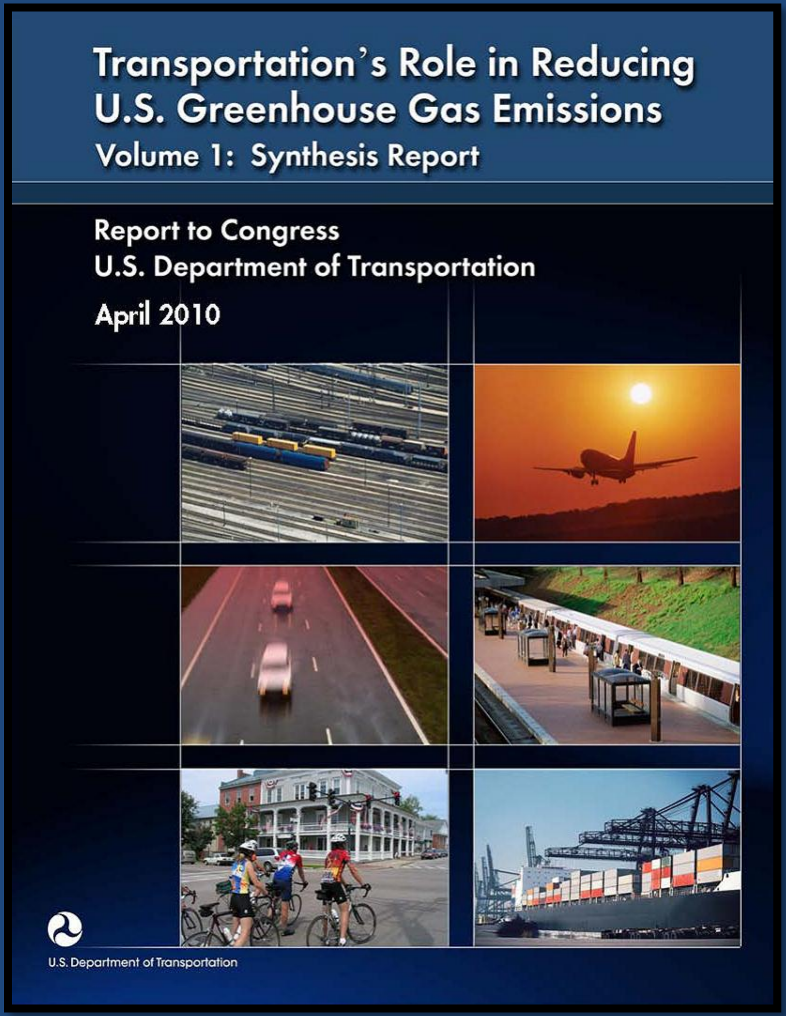
TRANSPORTATION'S ROLE IN REDUCING U.S. GREENHOUSE GAS EMISSIONS

US DOT REPORT TO CONGRESS

Northern Transportation and Air Quality Summit

August 24, 2010

Mandate and Scope



- Mandated by the Energy Independence and Security Act of 2007
- Produced by the U.S. DOT Climate Change Center
- Analyzes:
  - Transportation greenhouse gas (GHG) emissions levels and trends
  - Strategies for reducing these emissions
- Scope:
  - Full range of strategies
  - All transportation modes
  - Primarily synthesis
  - GHG reduction, costs, co-benefits, impact on DOT goals, key interactions

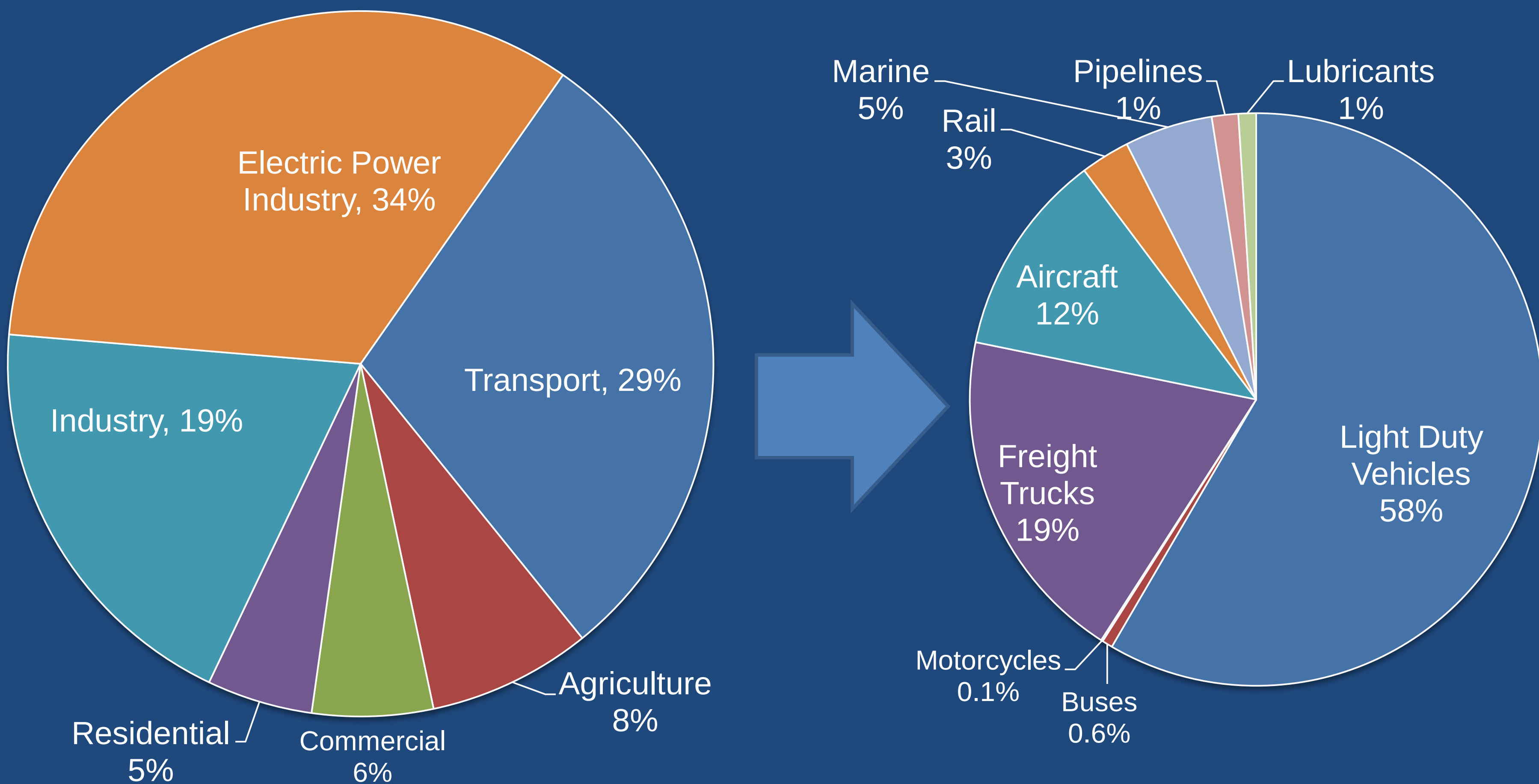
Background:

Climate impacts significant

- Average global temp. to rise 2 to 11.5 F by 2100 depending on scenario.
- Sea level rise 7-23" – IPCC; 3-4 feet by 2100 – USGCRP
- Impacts in US: increase in severity of storms, draughts, floods, heat waves, spread of pests, forest fires, decreased snow pack, changes in agricultural productivity.
- Widespread climate impacts are occurring now and expected to increase.
- However, the extent of climate change, and its impacts, depends on choices made today to mitigate human caused emissions of GHGs. – USGCRP

Emissions Levels and Trends:

On road sources largest share



Source: EPA. *Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990 to 2006.* 2008.
Note: Above figures include international bunker fuels purchased in the U.S.

Emissions Levels and Trends:

Life cycle emissions show full impact

Fuel Cycle

- Extracting petroleum, mining coal for electricity, growing and harvesting biofuel plants; transport; refining; distribution
- Combustion (tailpipe emissions)
- Disposal of products

Vehicle Cycle

- Raw material extraction, processing, transport; manufacture; assembly, distribution
- Maintenance
- Disposal of vehicles

Infrastructure Cycle

- Asphalt, steel, cement production; clearing land; construction
- Maintenance – resurfacing, cleaning
- Disposal

Greenhouse Gas Emissions

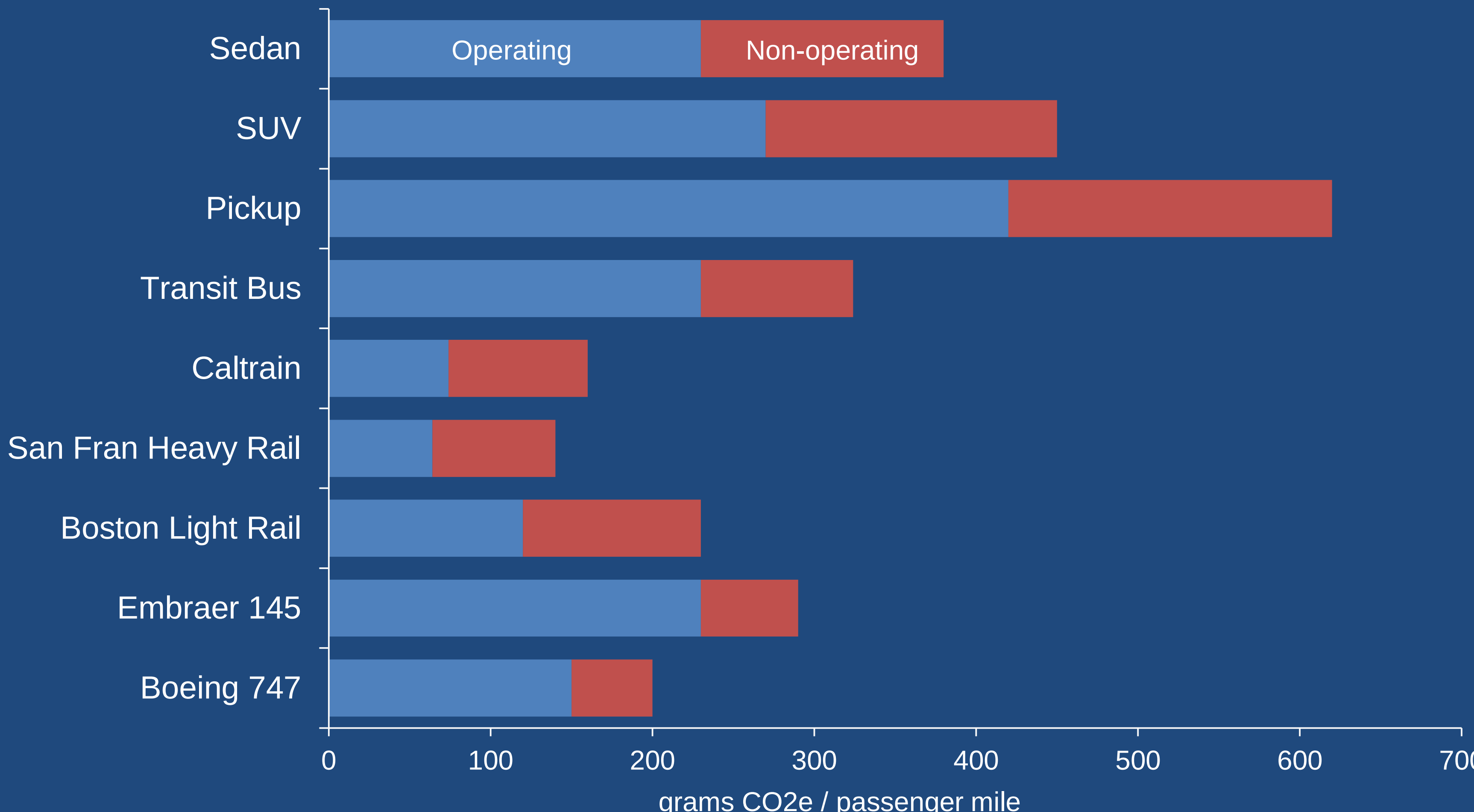
US Transportation's share of global GHGs:

5% combustion only

7-8% including all life cycle processes

Emissions Levels and Trends:

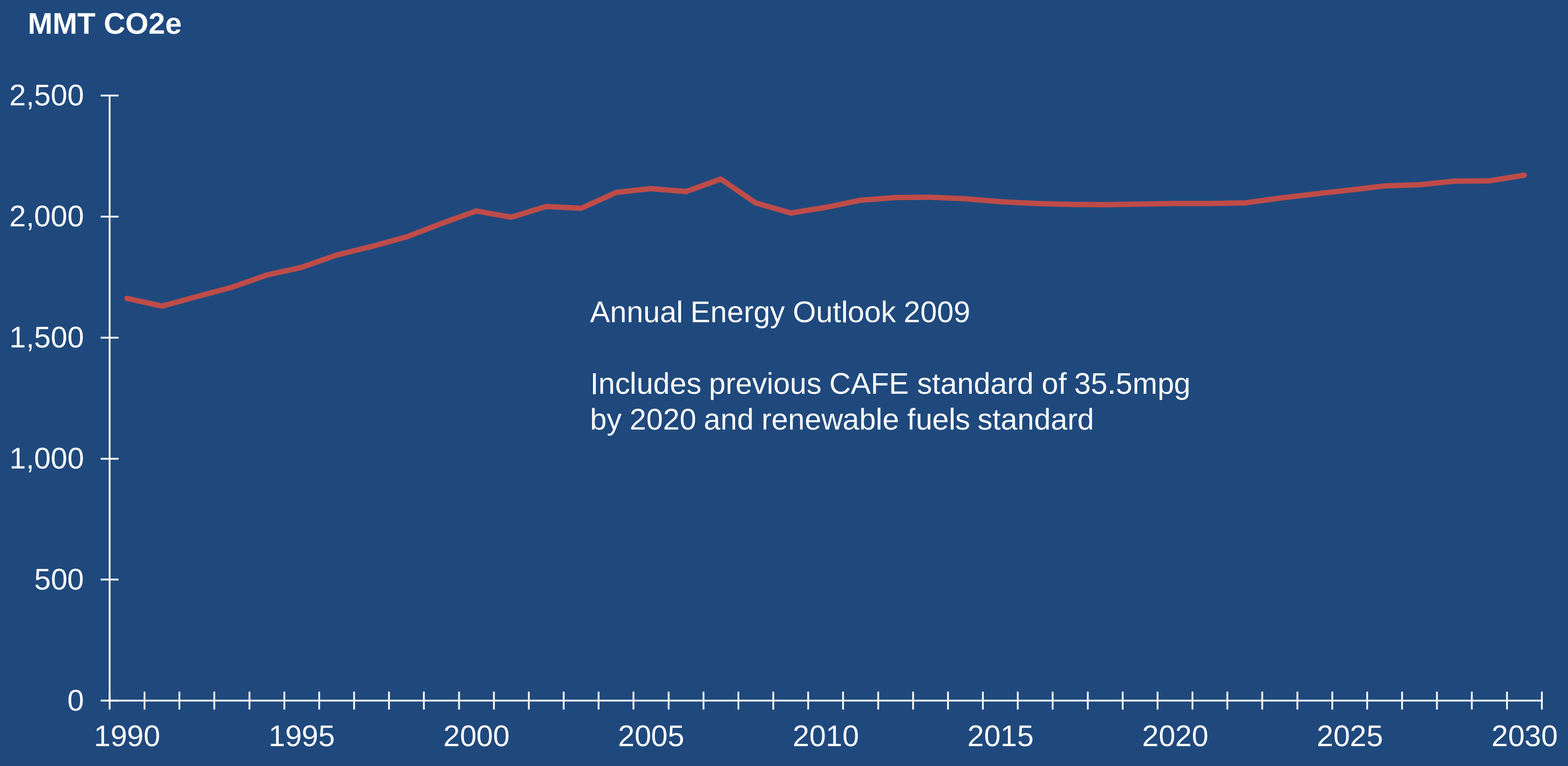
Including life cycle increases total



Source: Mikhail Chester, Life-Cycle Environmental Inventory of Passenger Transportation Modes in the United States, 2008.

Emissions Levels and Trends:

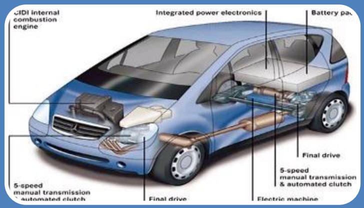
Projected U.S. transport GHGs



Source: Energy Information Administration, *Annual Energy Outlook 2009*, adjusted from CO2 only to include all transport GHGs.

Strategies for GHG Reduction

Low Carbon Fuels



Vehicle Fuel Efficiency

System Efficiency

Reduce Carbon Intense Travel Activity

Transport Planning and Investment

Price Carbon

Methods for analyzing strategies

- Primarily synthesis
- Discussed interactive effects but unable to quantify
- Snaps to common baseline
- “Snapshot” 2030 analysis year, also 2050 when needed to show long-term
- Key parameters: per unit benefits, implementation level, geographic coverage
- Professional judgment on assumptions
- Uncertainties:
  - unproven technologies
  - scale up feasibility
  - limited number of studies
  - wide ranges from literature
  - consumer response
  - unknown future circumstances
- Should be seen as rough order of magnitude

Low Carbon Fuels:

Biofuels

Fuel Cycle

Emissions depend on
•Feedstock
•production method
•carbon intensity of energy used in production
•land use change
•effect on agricultural markets
•evaluation timeframe

- Current generation fuels : Corn ethanol, biodiesel, LPG, CNG, diesel
  - EISA target of 20% lifecycle reduction for renewables, although results depend on feedstock and production method
- Next generation fuels: Cellulosic ethanol, biomass-based biodiesel, battery-electric and hydrogen
  - EISA target of 50-60% for biomass-based biodiesel and cellulosic ethanol
- Cellulosic and advanced biofuels offer steeper GHG reductions, but require more research and scaling up of production
- See detailed EPA analysis for Renewable Fuel Standard

Low Carbon Fuels:

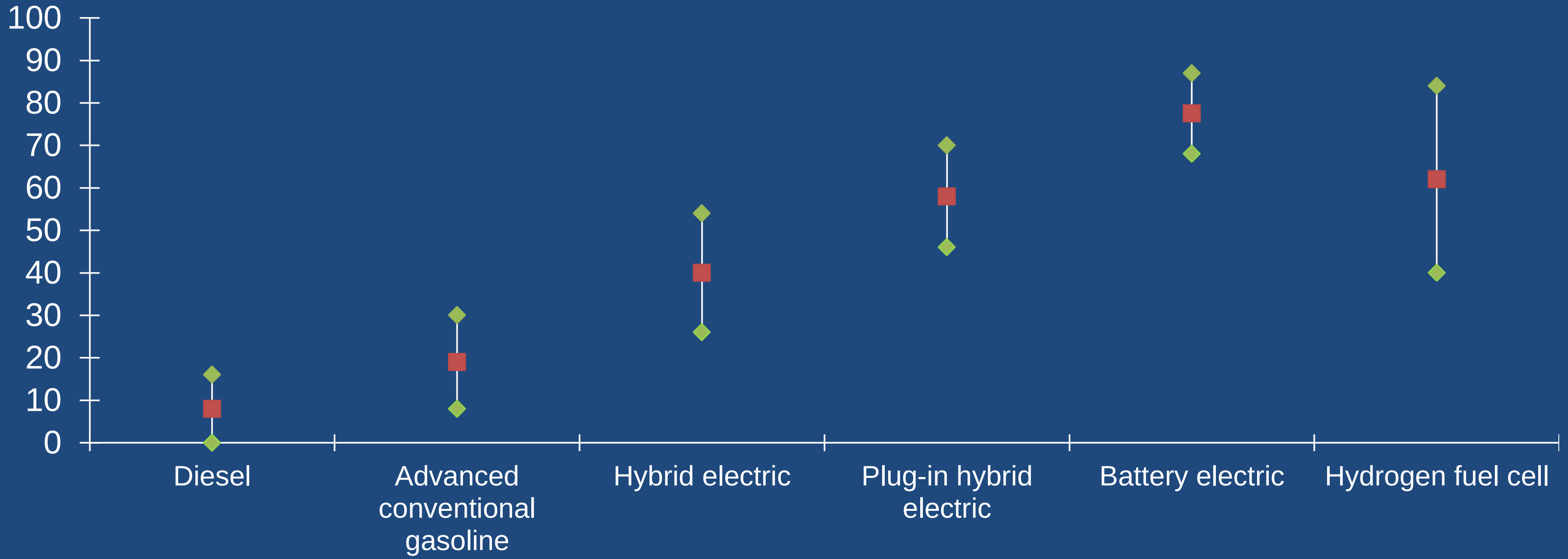
Next-Generation: Battery Electric and Hydrogen

	Electricity	Hydrogen Fuel Cell Vehicle
Engine Efficiency	More efficient than internal combustion engines	Twice the efficiency of internal combustion engines
GHG Reduction Potential	Highly dependent on electric power source •33% reduction at current grid average •80% reduction possible in 2050 with low emissions grid	Highly dependent on method of hydrogen production 84% reduction possible by 2050
Advantages	Does not require entirely new production, distribution infrastructure Electricity is cheaper than gasoline on a per mile basis	Reduced maintenance costs from fewer moving parts
Challenges	Research needed on battery technology to reduce costs and weight	Production Distribution network Cost of fuel cells More R&D needed

Vehicle Efficiency:

Range of Technologies

% Per Vehicle GHG Reduction vs. Conventional Gasoline, 2030 to 2050 timeframe



Incremental Vehicle Cost

Short-term		$1000	$4500	$16,000	$50,000	$25,000
Long-Term			$3000	$3,000-$8,000	$6,000-$10,000	$5,300

Vehicle Efficiency:

Truck, Rail, Aviation and Marine

- Heavy-duty trucks
  - Near term: retrofits with aerodynamic fairings, trailer side skirts, and low-rolling resistance tires, 10-15% per truck
  - Medium to long term: engine and powertrain technologies, 10-30% per truck
  - Yield net cost savings over vehicle life
- Rail – 20% or more from power system and train efficiency
- Aviation
  - Engine technology and airframe improvements, 10-40% per aircraft over 20-30 years
- Marine
  - Ship design, 4-15% per vessel
  - Diesel electric for vessels that change speed frequently (cruise ships, ferries, tugboats), up to 20%
- Fleet turnover is 20-40 years
- These sectors smaller share of transport GHGs, so smaller impact

System Efficiency:

Use existing system better

- Optimize design, construction, operation, and use of transportation networks
- Benefits:
  - Reduced congestion
  - Reduced travel time
  - Reduced travel costs
  - Economic benefits
- Challenges:
  - Induced demand for strategies that improve travel conditions (included in analysis)

System Efficiency:

Combined 3-6% GHG ↓

	Sub-sector	2030 GHG reduction subsector	2030 GHG reduction all transport	Key Parameters
Traffic management	On-road	0.1–0.9%*	<0.1-0.5%*	Signal coordination, faster clearance of incidents, ramp metering
Real-time traveler information	On-road	0.1-0.3%*	<0.1%*	Electronic message boards, 511, web
Highway bottleneck relief	On-road	0.1-0.4%*	<0.1-0.3%*	Improve top 100-200 bottlenecks by 2030
Reduced speed limits	On-road	1.7-2.7%	1.1-1.8%	55mph national speed limit
Truck idling reduction	HDV	0.4-1.2%	0.1-0.3%	26-100% of sleeper cabs with on board idle reduction tech
Freight rail and marine operations	HRV, rail, marine	<0.1-0.9%	<0.1-.4%	Reduce rail chokepoints, shore-side power for ships, reduce VMT in intermodal terminal, limited modal diversion
Air traffic operations	Domestic aircraft	2.5-6% (cumulative)	0.3-0.7%	Airport efficiency, direct routing, reduced separation, continuous descents
Construction materials			0.7-0.8%**	Recycled material in cement, low temp asphalt
Other			0.3%	Truck size and weight, freight urban consolidation centers, transportation agency energy efficient buildings, alt fuel fleet and construction vehicles
Combined Strategies			**3-6%**	

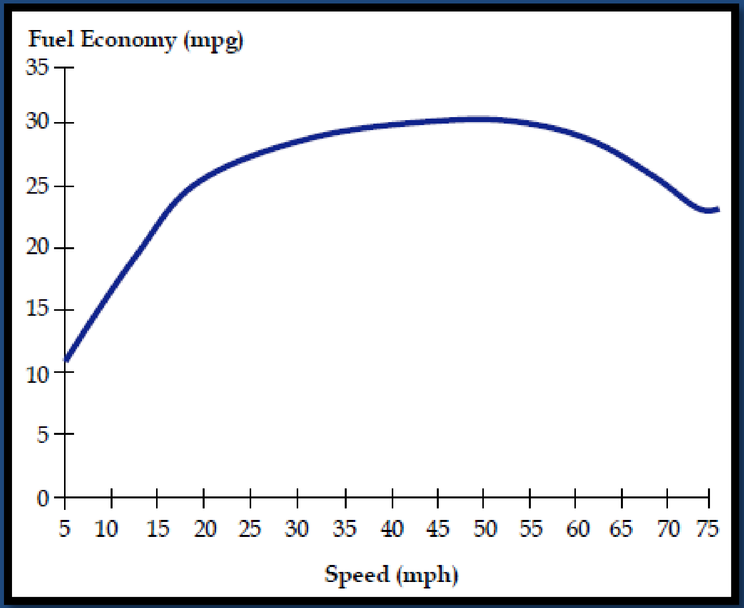
*Values from Moving Cooler. The DOT report did not quantify these strategies as more work is underway at FHWA.
**Construction emissions not included in the baseline. 15-18 MMT correspond to 0.7-0.8% of U.S. transport GHGs.

System Efficiency:

Highway Management

- Traffic management, traveler information, and bottleneck relief
- Reduce GHGs through smoothing traffic flow and reducing acceleration and deceleration
- Analysis challenging
  - Needs to account for potentially subtle changes in travel speeds and traffic flow
  - Also needs to account for additional system-level travel resulting from improvements in travel conditions (induced demand)
- Strategy impacts were evaluated using FHWA's HERS model
- Because of modeling limitations (including estimation of induced demand effects), results were not formally quantified in the report

Example MPG / Speed Relationship



Source: www.fueleconomy.gov

Travel Activity:

Reduce carbon intensive travel activity

- Influence travel activity patterns
- Encourage shift to low carbon modes – public transportation, walk, bike, intercity bus and rail, carpooling
- Shift fixed travel costs to variable costs
- Create land use patterns that reduce trip length and frequency
- Travel alternatives – telework, alternative schedules
- Public info campaigns and "eco-driving" (shift driver habits to slow acceleration, inflate tires properly, etc)

Travel Activity:

Combined 5-17% GHG ↓ in 2030

	2030 Red. Subsector	2030 Red. All transport	Key Parameters
Pay as you drive insurance	1.4-4.7%	1.1-3.5%	Require states to allow (low) Require companies to offer (high)
Congestion pricing	0.6-2.2%	0.4–1.6%	LOS D on all roads (avg 65c/mi for 29% of urban and 7% of rural VMT)
Public transportation	0.6-1.7%	0.2-0.9%	2.4-4.6% annual increase in service
Non-motorized travel	0.4-1.1%	0.2-0.6%	Comprehensive urban bike/ped improvements 2010-2025
Land use	2.5-7.8%	1.2-3.9%	60-90% of new urban growth in approx. >5 units/acre
Parking management	0.3%	0.2%	Downtown workers pay for parking ($5/day avg. for those not already paying)
Worksite trip reduction	0.2-1.1%	0.1-0.6%	Widespread employer outreach and alternative mode support
Telework/compressed work week	0.9-1.2%	0.5-0.7%	Doubling of current levels
Individualized marketing	0.5-0.8%	0.3-0.4%	Reaches 10% of population
Eco-driving	1.1-5.9%	0.8-4.3%	10-50% of drivers reached, half implement
Combined Strategies		**5-17%**	Does not include interactive effects. Includes induced demand.
VMT fee (not included above)		1.1-3.5%	2 to 5 cents per mile

Travel Activity:

Land use finding based on 3 reports

Finding: 1-4%⬇ (2030), 3-8%⬇ (2050)

How?: Relied primarily on three reports with independent methods and assumptions:

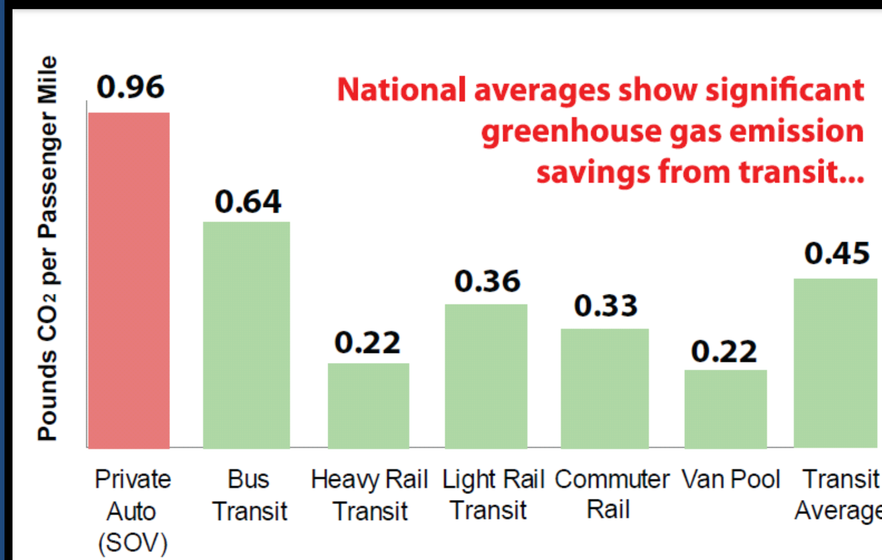
Year 2050	**TRB Special Report 298**	**Moving Cooler**	**Growing Cooler**
LDV VMT reduction	1-11%	1.7-12.6%*	12-18%*
% of new urban development "compact"	25-75%	43-90%	60-90%
Definition of "compact"**	1.98 DU/acre (~4 DU / residential acre)	>4000 persons per square mile (~>5 DU / residential acre)	Density, diversity, design, destination, accessibility, distance to transit
VMT in compact development	5-25% lower	23% lower	30% lower
% of structures re/developed present-2050	41-55%	64%	67%
U.S. transport GHG reduction (baselines vary)	**0.6-6.5%**	**2-3.4%**	**7-10%**

* Urban only

Travel Activity:

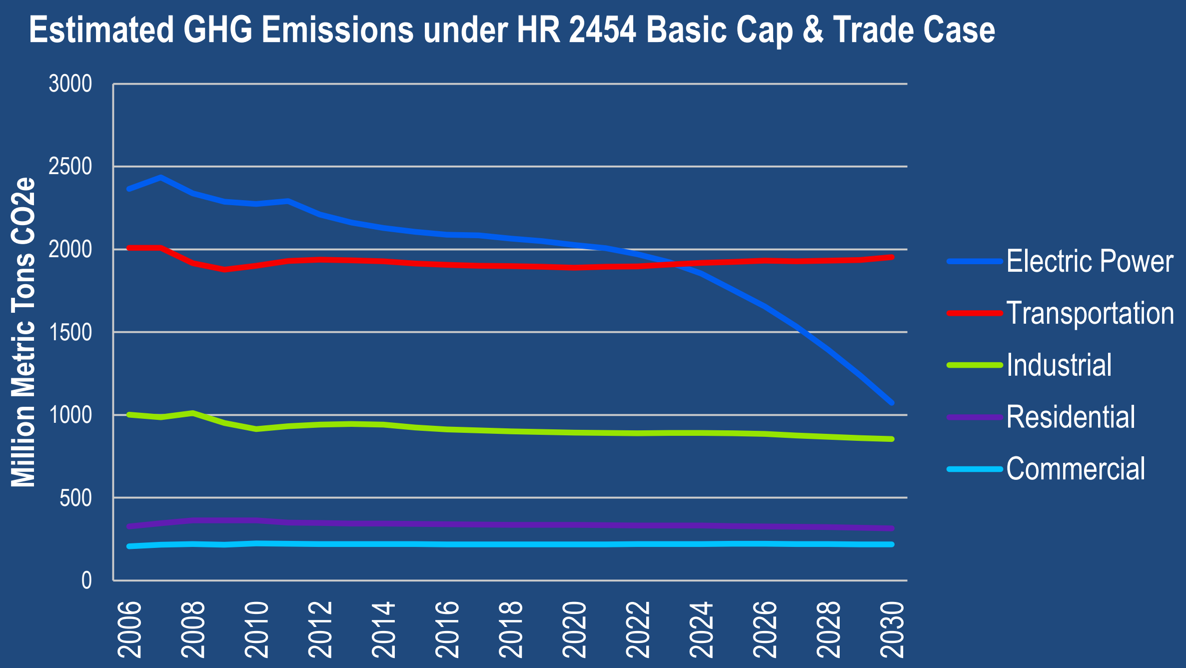
Transit importance varies by region

- **GHG Reduction:**
  - **0.3-0.8% (2030)**
  - **0.4-1.5% (2050)**
- Key Assumption:
  - 2.4-4.6% annual increase in ridership
- Starting from relatively low national mode share (2%)
- Only 5% of Americans live near rail transit
- Transit shares for commutes in US CBDs with major transit infrastructure are high
  - 55% in Chicago
  - 14% in Atlanta
  - 35% in Seattle
- Could be key in some areas
- Reduces household costs, but increases public costs



Source: FTA, *Public Transportation's Role in Responding to Climate Change*, 2010. Data sources: FTA National Transit Database, U.S. Department of Energy, U.S. Environmental Protection Agency

Price Carbon



- Market system encourages most cost effective GHG reductions
- ~ 40 cent increase in price of gas (from EPA projected allowance price of $65/ton)
- Near term inelasticity of transport response
- Long term price signal for innovation

Source: Energy Information Administration, "Energy Market and Economic Impacts of the American Clean Energy and Security Act of 2009," 2009. EPA, "Analysis of American Clean Energy and Security Act of 2009," June 23, 2009.

Transportation Planning and Investment

Federal options span the range…

Technical assistance

- Scenario planning, integrated transport and land use planning
- removing codes that require low density / single use development
- Data collection, modeling, GHG inventories

Regulations

- Climate change as a planning factor
- Requiring GHG analysis and strategies in plans
- GHG reduction targets with carrots and/or sticks

Investment

- Performance based investment
- Investment in transit, bicycle, pedestrian facilities; system efficiency improvements

Impacts on other Transportation Goals

- All result in reduced petroleum dependence
- Most improve air quality
- Land use, transit, bike/ped result in livability benefits
- System efficiency strategies reduce congestion, travel times, costs
- Most strategies reduce gas consumption, and consequently Highway Trust Fund Receipts
- Pricing strategies raise revenue

	Petroleum Savings in 2030 Billions of gallons saved, gas and diesel
System efficiency (on-road)	5-8
System efficiency (air, rail, marine)	2-5
Travel Activity	12-40

Research Gaps

- Elasticities, and how they shift under different conditions
- Key interactions
- Induced demand
- Cost effectiveness
- Life cycle emissions
- Data, tools, decision support for MPOs and states
- Information technologies to support efficiency
- Policy oriented research

Policy Options

Report does not contain recommendations, but does analyze policy options . . .

Efficiency standards

- Fuel economy / GHG emission standards
- Low carbon fuel standards

Transportation planning and investment

- Technical assistance in integrated transportation and land use planning
- Technical assistance in removing codes that require low density / single use development
- Requiring GHG analysis and strategies in plans
- Performance based investment
- Investment in transit, bicycle, pedestrian facilities; system efficiency improvements

Market-based incentives

- Tax credits, feebates, VMT fees, gas tax

Research and Development

- Advanced vehicles and fuels
- Data, tools, decision support, policy oriented research on costs and benefits

Economy-wide price signal

- Cap and trade, carbon tax

For Further Information

US DOT Report to Congress

http://ntl.bts.gov/lib/32000/32700/32779/DOT_Climate_Change_Report_-_April_2010_-_Volume_1_and_2.pdf

US DOT Transportation and Climate Change Clearinghouse
http://climate.dot.gov/index.html

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Annex: Additional Slides

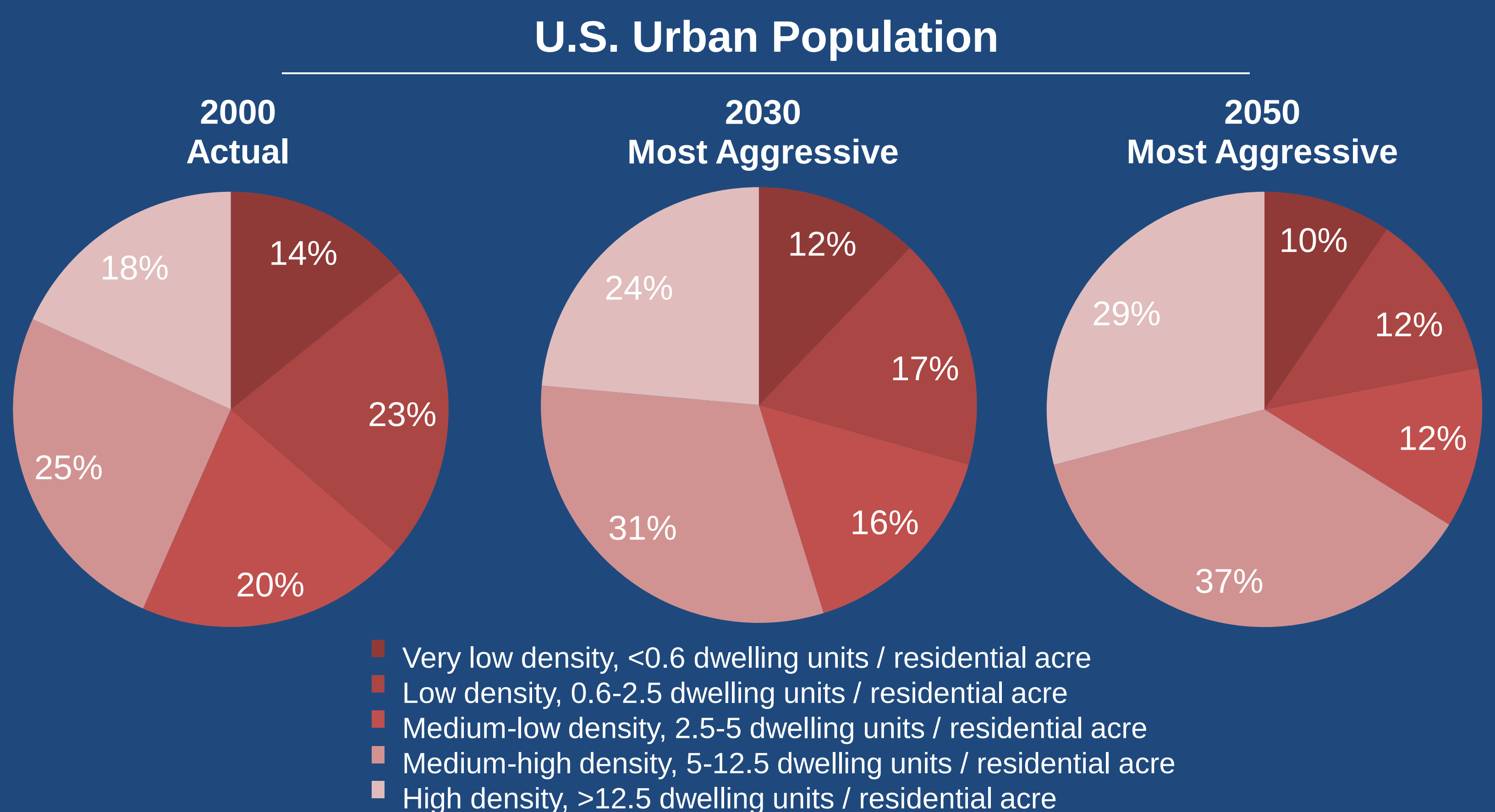
What DOT is already doing

- **CAFE** standards announced in April 2010 will save 900 mmt CO2e and 1.8 billion barrels of oil over life of vehicles
- **Medium and heavy-duty truck** fuel economy – new statutory authority
- **NextGen** to improve aviation mobility, performance, and efficiency
- **Sustainable Communities Partnership** supports low carbon transportation

Travel Activity: Land Use

Shift muted by existing development

Under Moving Cooler most aggressive scenario, new development at higher density, but low density areas remain, and rural unchanged.



Parting Thoughts

"Transportation is one of the major contributors to greenhouse gases, and the transportation sector must be a big part of the solution."
– Secretary Ray LaHood, April 22, 2010

"The ingenuity of transportation planners and engineers has produced a vast network of transportation infrastructure and services to support the mobility and economic vitality of the Nation. However, our historic approach to transportation and land use development has created an energy-intensive system dependent on carbon-based fuels and individual vehicles.

Our national talents and resources must now focus on shaping a transportation system that that serves the Nation's goals, including meeting the climate change challenge."

– U.S. DOT Report to Congress, April 22, 2010