CLIMATE CHANGE and TRANSPORTATION

A Workshop for the Regional Planning Commission

Jefferson, Orleans, Placquemines, St. Bernard, St. Tammany

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Parsons Brinckerhoff

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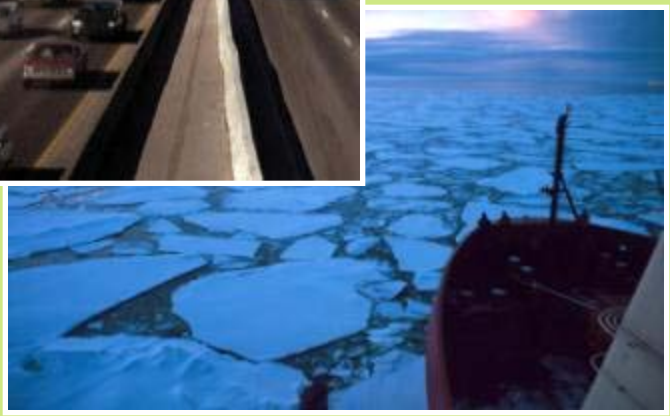
Workshop Purposes

- To provide key information on climate change and transportation
  - Latest science
  - Federal policies
  - MPO and state activities
  - Transportation strategies to reduce greenhouse gases (GHG)
  - Adapting transportation to climate change
- To brainstorm potential climate change planning activities for the New Orleans region



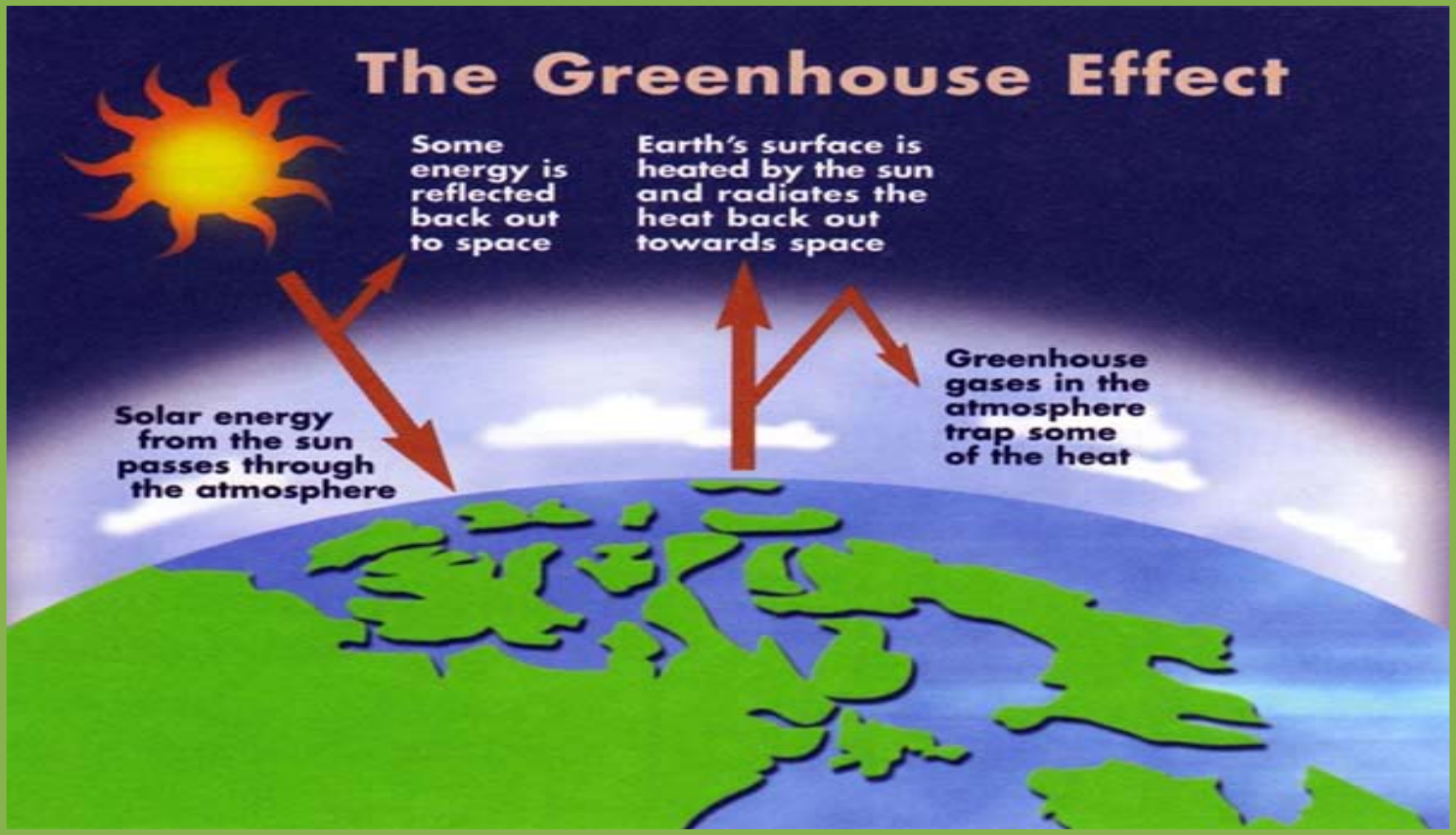
I. Climate Change Science, Sources and Trends

What is climate change?

The United Nations Framework Convention on Climate Change (UNFCCC) defines Climate Change as:

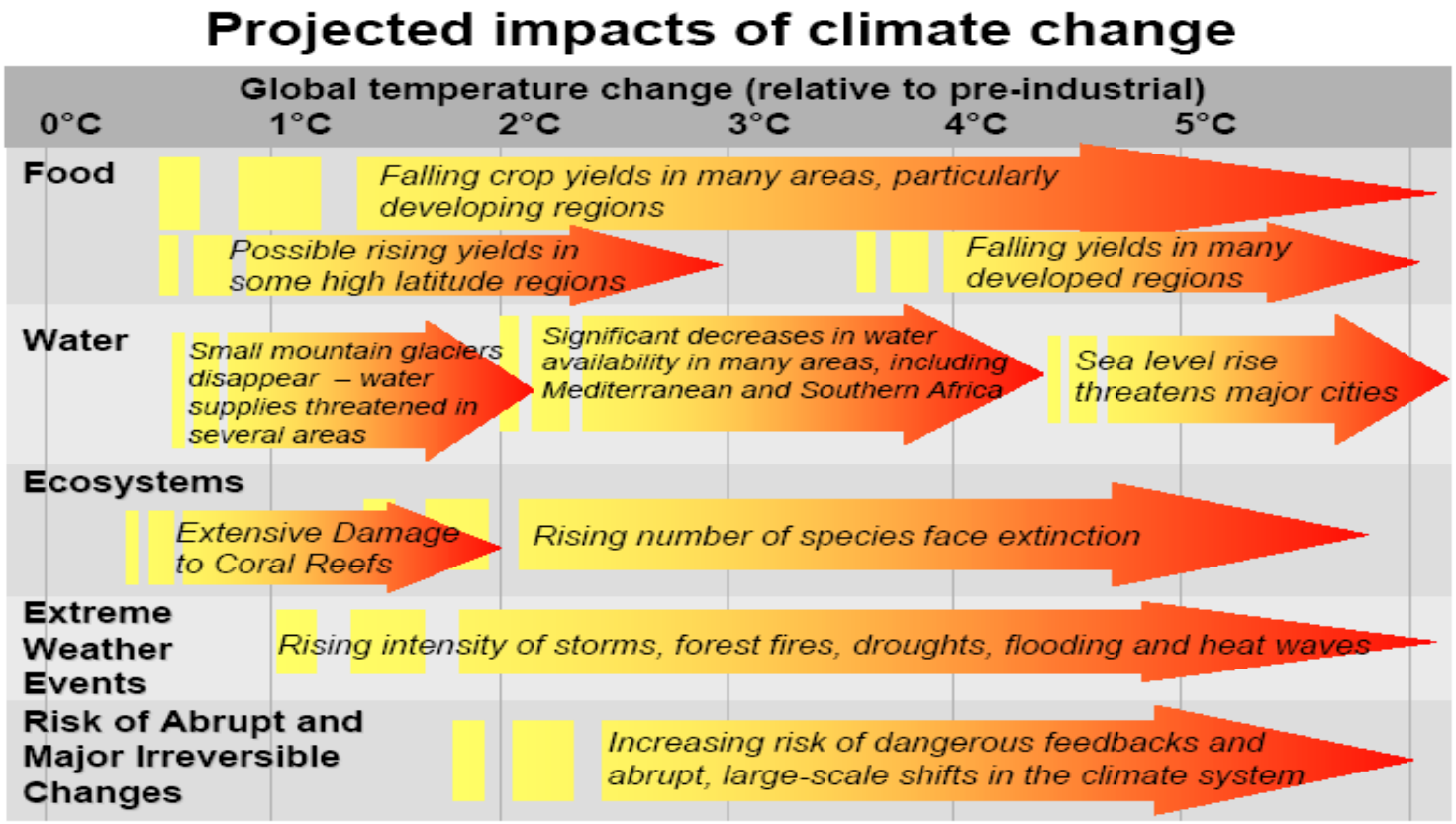
"A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is <u>in addition to natural climate variability</u> observed over comparable time periods."

How does the “Greenhouse Effect” cause climate change?



Source: Pew Center on Climate Change, Vicki Arroyo, 2007

What are the potential impacts?



Source: Stern Review on the Economics of Climate Change, 2007

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 changes have already occurred?

- 14% increase in human GHG since 1990 – USA
- 26% increase in human GHG since 1990 – world
- GHG levels are at highest in 1000s of years
- 2000-2009 was the warmest decade on record worldwide
- Heat stored in oceans has increased substantially
- Sea surface temperatures have been higher during the past three decades than at any other time since large-scale measurement began in the late1800s.
- In recent years, a higher percentage of precipitation in the United States has come in the form of intense single-day events.

Source: EPA, Climate Change Indicators in the U.S., May 2010

…changes already occurred? (continued)

- 8 of top 10 years for extreme one-day precipitation events occurred since 1990.
- The occurrence of abnormally high annual precipitation totals has increased.
- Intensity of tropical storms in the Atlantic, Caribbean, and Gulf has risen noticeably over the past 20 years.
- 6 of the 10 most active hurricane seasons have occurred since the mid-1990s.
- Sea level has increased at roughly 0.6” per decade since 1870 – and has accelerated to more than 1”/decade in recent years.
- Oceans have become more acidic over the past 20 years, due in part to rising CO2 absorption.

Source: EPA, Climate Change Indicators in the U.S., May 2010

…changes already occurred? (continued)

- Arctic sea ice in 2009 was 24 percent below the 1979-2000 historical average.
- Glaciers in U.S. and around the world have generally shrunk since the 1960s and the rate at which glaciers are melting appears to have accelerated over the last decade.
- Glaciers worldwide have lost more than ***2,000 cubic miles of water*** since 1960.
- The growing season in the lower 48 states has increased by about two weeks the since beginning of the 20th century.
- North American bird species have shifted their wintering grounds northward by an average of 35 miles since 1966, with a few species shifting by several hundred miles.

Source: EPA, Climate Change Indicators in the U.S., May 2010

How is climate change affecting the Gulf Coast?

Temperatures rising

Sea levels in Gulf of Mexico likely to rise 2-4 feet over next 50-100 years

Both are leading to impacts on transportation:

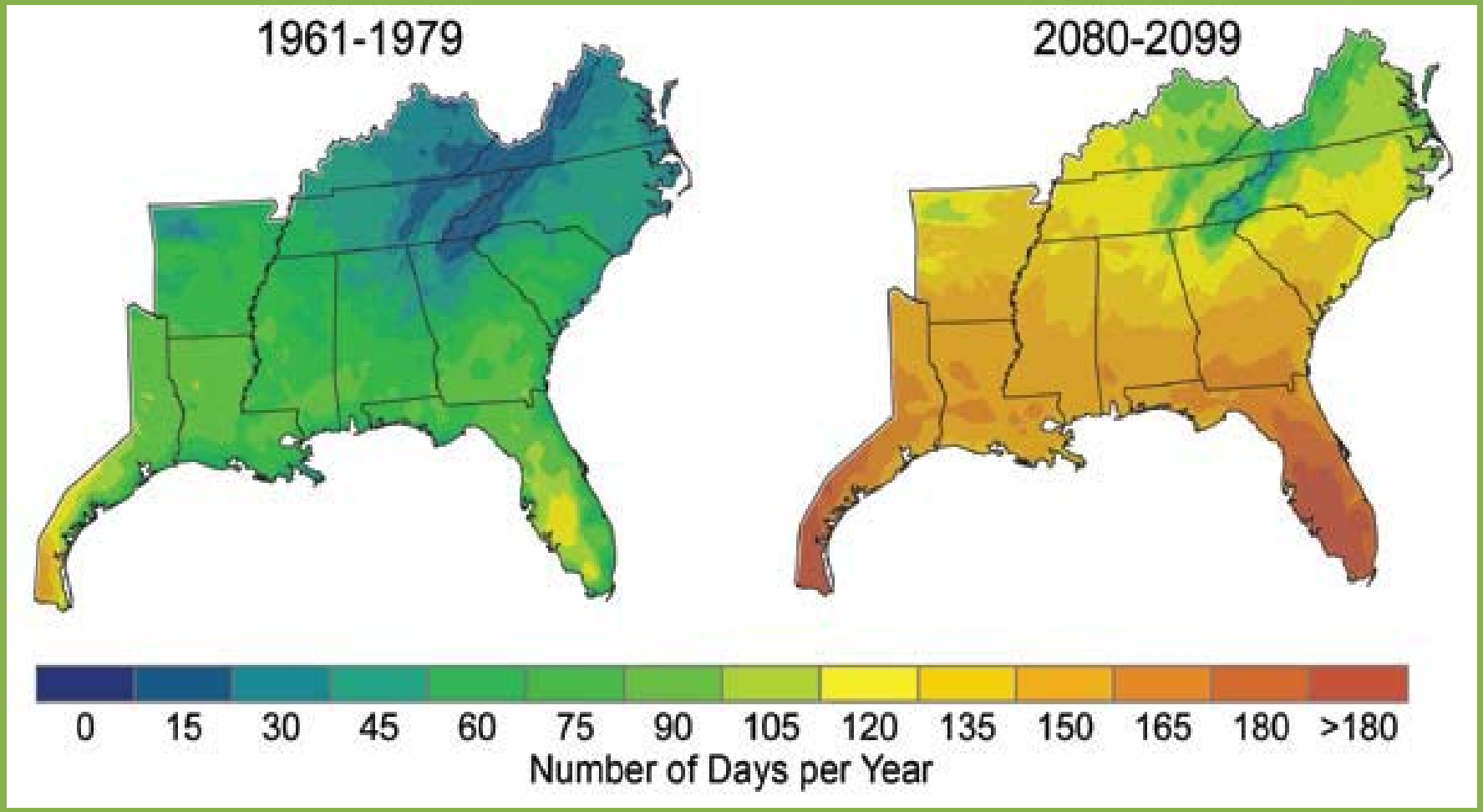
"The expected impacts of these climate effects on transportation are striking. An untenable portion of the region's road, rail, and port network is at risk of permanent flooding if sea levels rise by four feet. This includes more than 2,400 miles (27%) of the major roads, 9% of the rail lines, and 72 % of the ports."

"More than half (64% of interstates; 57% of arterials) of the area's major highways, almost half of the rail miles, 29 airports, and virtually all of the ports are subject to temporary flooding and damage due to increased storm intensity."

Source: "*Gulf Coast Study, Phase I Impacts of Climate Change and Variability on Transportation Systems and Infrastructure," March* 2008.

How will temperatures change in the Southeast?

(number of days with peak temperatures over 90F)



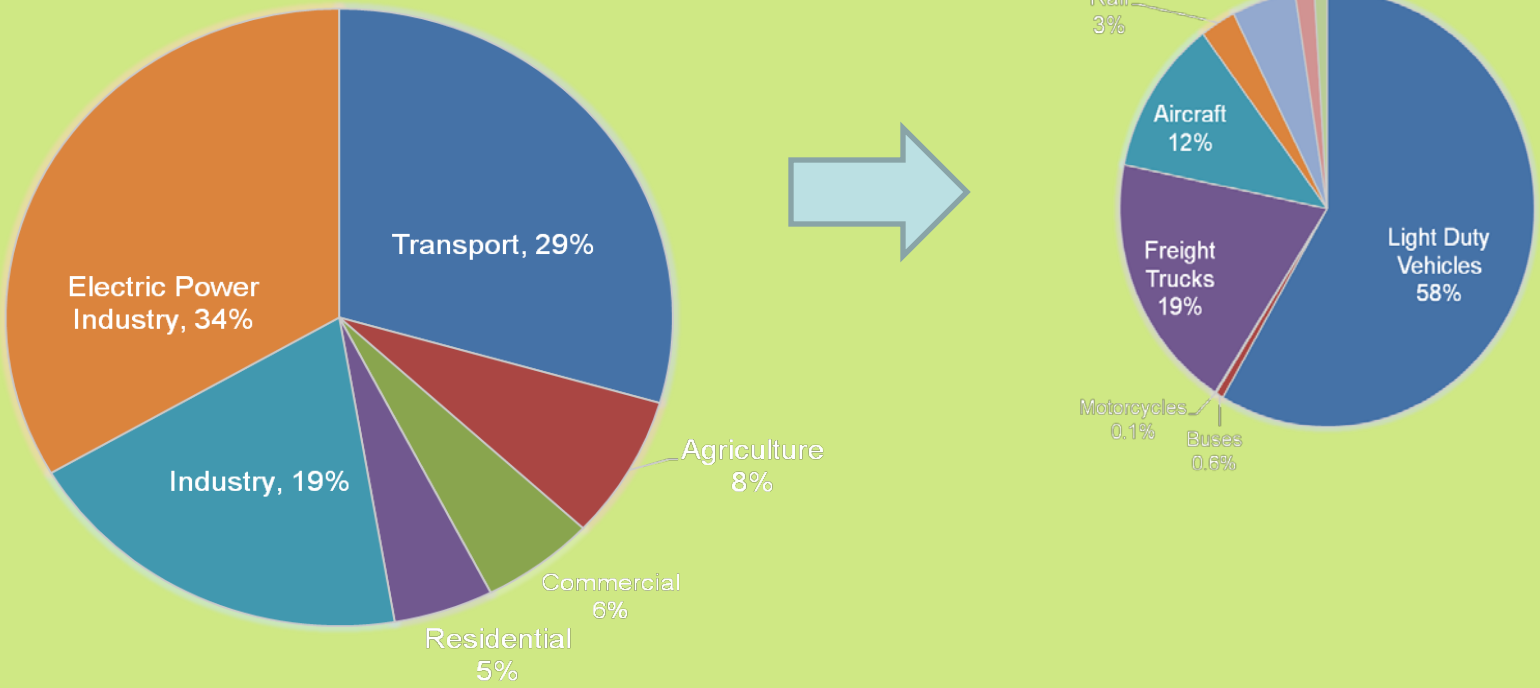
Source: http://www.globalchange.gov/images/cir/pdf/southeast.pdf

What targets have been set?

- Scientists recommend **60-80% GHG reduction below 1990 level by 2050**
- Many states and countries have adopted targets in this range
- President Obama's budget: **80%** GHG reduction below 2005 by 2050
- Waxman-Markey bill: **17%** below 2005 by 2020 and **83%** below 2005 by 2050
- Kerry-Lieberman bill: **17%** below 2005 by 2020 and **83%** below 2005 by 2050

Sources: Intergovernmental Panel on Climate Change, 2007, Union of Concerned Scientists, Pew Center on Climate Change, and others

What is transportation's share of U.S. GHG?



Source: U.S. DOT, "Transportation's Role in Reducing U.S. Greenhouse Gas Emissions," April 2010

What are transportation GHG trends?

	Change, 1990-2006
All U.S. GHG Sources	15%
U.S. Transportation	27%
Light Duty Vehicles	24%
Freight Trucks	77%
Commercial Aircraft	4%

Source: U.S. DOT, "Transportation's Role in Reducing U.S. Greenhouse Gas Emissions," April 2010

Science, Sources, & Trends: Summary Points

- Climate change is already occurring and is intensifying
- Climate impacts = rising sea levels, higher temperatures, more intense storms, changes in precipitation, impacts on ecosystems, and more
- The Gulf Coast is particularly vulnerable
- 60-80% reductions in GHG are recommended by scientists to avoid the worst impacts of climate change
- Transportation accounts for 29% of GHG emissions in the United States and is rising almost twice as fast as U.S. GHG overall
- The largest sources of transportation GHG are light duty highway vehicles (58%) and trucks (19%)

II. Federal Climate Change Policies and Legislation

Federal Climate Policies Can Take Many Forms

- Legislation
  - Cap and trade bill
  - Energy bill(s)
  - Transportation authorization
- Regulations
  - EPA regulations under Clean Air Act
  - Transportation planning regulations
  - NEPA regulations
- Guidance
  - CEQ guidance on NEPA/climate change
  - FHWA/FTA guidance on transportation planning/climate change
- Funding
- Research
- FHWA/FTA Technical Assistance

Divergent Views Hamper Policy Decisions

- Climate skeptics: Climate change isn't happening, or isn't human-induced
- Environmental view: Transform land use, increase transit, and reduce VMT
- Techno-optimist view: Transform vehicle/fuel technology and improve highway/driver operations
- Pragmatic view: Combination -- mostly vehicles/fuels, some operational efficiency, plus modest role for land use, transit, and VMT moderation
- Economy/Jobs: Overshadow everything

Federal Cap and Trade Legislation

Cap-and-trade legislation <u>would likely</u>:

- Stimulate energy efficiency by consumers and businesses
- Stimulate investment in low-carbon technologies
- Reduce GHG emissions
- Rise energy prices
- Raise gas prices
- Generate billions in annual revenue – which could be used for many different purposes

Cap-and-trade legislation <u>could</u>:

- Generate revenue for transportation needs (e.g., $6.25 B/year in one bill, but this is only about 10-30% of higher fuel costs that would be paid by transportation users, according to APTA-AASHTO)

Federal Climate Legislation: Status

- House: Passed cap-and-trade bill in 2009
- Senate: Cap-and-trade bill stalled on the floor in 2009
- Senate: Kerry-Lieberman “discussion draft” bill released May 12, 2010 – then stalled
- President Obama: Strongly supports cap-and-trade legislation
- But cap-and-trade legislation is doubtful, due to economy and many complex issues
- Action on energy bills is more likely

Federal Legislation: Proposed Transportation Planning Requirements

Similar provisions are in many different bills

- **TARGETS AND STRATEGIES**: States and large MPOs must develop GHG reduction targets and strategies, as part of transportation plans
- **PROGRESS**: States and large MPOs must "demonstrate progress in stabilizing and reducing" GHG emissions
- **METHODOLOGIES**: EPA must issue regulations on transportation GHG goals, standardized models, methodologies, and data collection
- **CERTIFICATION**: US DOT shall not certify state or MPO plans that fail to "develop, submit or publish emission reduction targets and strategies"

These would apply to New Orleans region

Federal Requirements for Considering Climate Change for Projects

- Federal EISs should consider climate change for projects
- Courts have already ruled on many cases
- Council on Environmental Quality issued draft guidance
  - Evaluate proposed actions that are reasonably expected to cause *direct* emissions of 25,000 metric tons or more of CO2-equivalent *on an annual basis, and,*
  - Consider *impact of climate change on the project*
- CEQ guidance has generated many questions

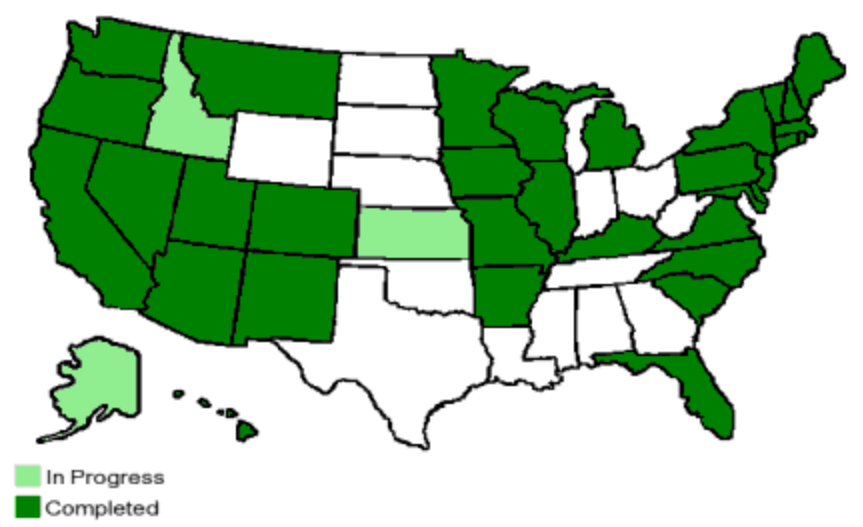
Federal Policies & Legislation: Summary Points

- Congress is considering many bills
  - Cap-and-trade legislation appears to be stalled
  - Energy legislation is more likely
- Many bills contain transportation planning requirements for MPOs and states
- Even without legislation, Federal policies on climate change/transportation can advance through regulations, guidance, funding choices, technical assistance, and research
- If Federal policies require transportation GHG planning, better data and modeling will be needed
- For projects, both GHG analysis and adaptation analysis will be needed

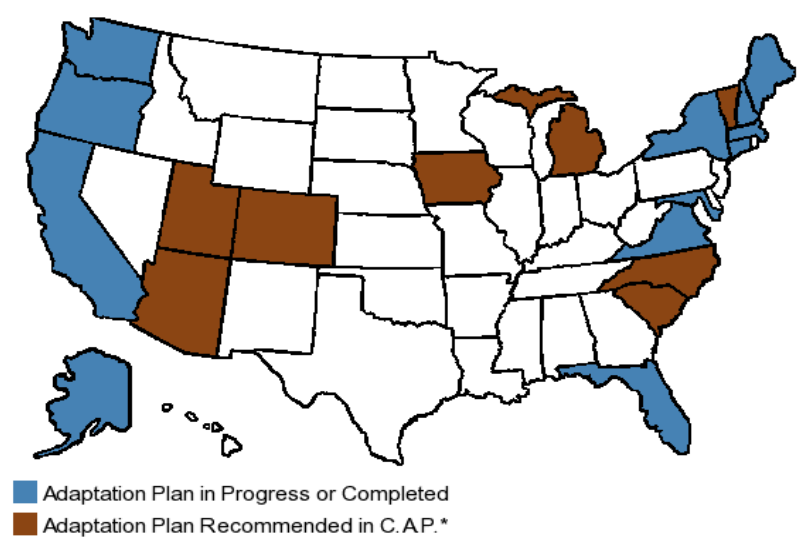
III. State & MPO Climate Planning

State Climate Plans

33 states have climate plans to reduce GHG:



12 states have or are working on climate adaptation plans:



Source: Pew Center on Climate Change

State Climate (GHG) Plans

- Cover major sectors: Electricity, Buildings, Agriculture, Industry, Transportation
- Very ambitious GHG targets
- Conducted in limited time frames
- Often relied on “cookbook” analysis
- Transportation stakeholders often excluded or had limited role
- Transportation strategies are highly “aspirational”
- Cost estimates are often weak or lacking altogether
- Some plans have been “officially” adopted, others are just reports

State Climate Plans: Wide Variation in % Reduction in Transportation GHG

State	Target Year	% Reduction in Transportation GHG
Montana	2020	**9%**
New York	2020	18%
South Carolina	2020	19%
Colorado	2020	22%
Maine	2020	23%
Oregon	2025	25%
Minnesota	2025	27%
New Mexico	2020	30%
Pennsylvania	2025	30%
North Carolina	2020	**31%**

Source: NCHRP 20-24, Task 59, 2009

State Climate Plans: Even Wider Variation in Transportation Strategies

State	Year	Vehicle Efficiency	Low Carbon Fuels	Smart Growth and Transit	Other
PA	2020	53%	15%	<1%	28%
CT	2020	51%	38%	8%	2%
ME	2020	53%	25%	21%	1%
MN	2025	15%	35%	25%	25%
NY	2020	59%	11%	27%	4%
SC	2020	14%	15%	29%	1%
RI	2020	46%	10%	31%	14%
NC	2020	35%	12%	38%	15%
MD	2025	24%	12%	45%	20%
VT	2028	21%	14%	49%	17%

Source: NCHRP 20-24, Task 59, 2009

MPO Climate Action Planning

- MPO climate planning is in the early stages
- MPOs which have done climate change analysis:
  - California MPOs (LA, SFO, San Diego, Sacramento, etc.)
  - Seattle
  - Washington DC
  - Atlanta
  - Boston
  - Philadelphia

MPO Climate Action Planning (continued)

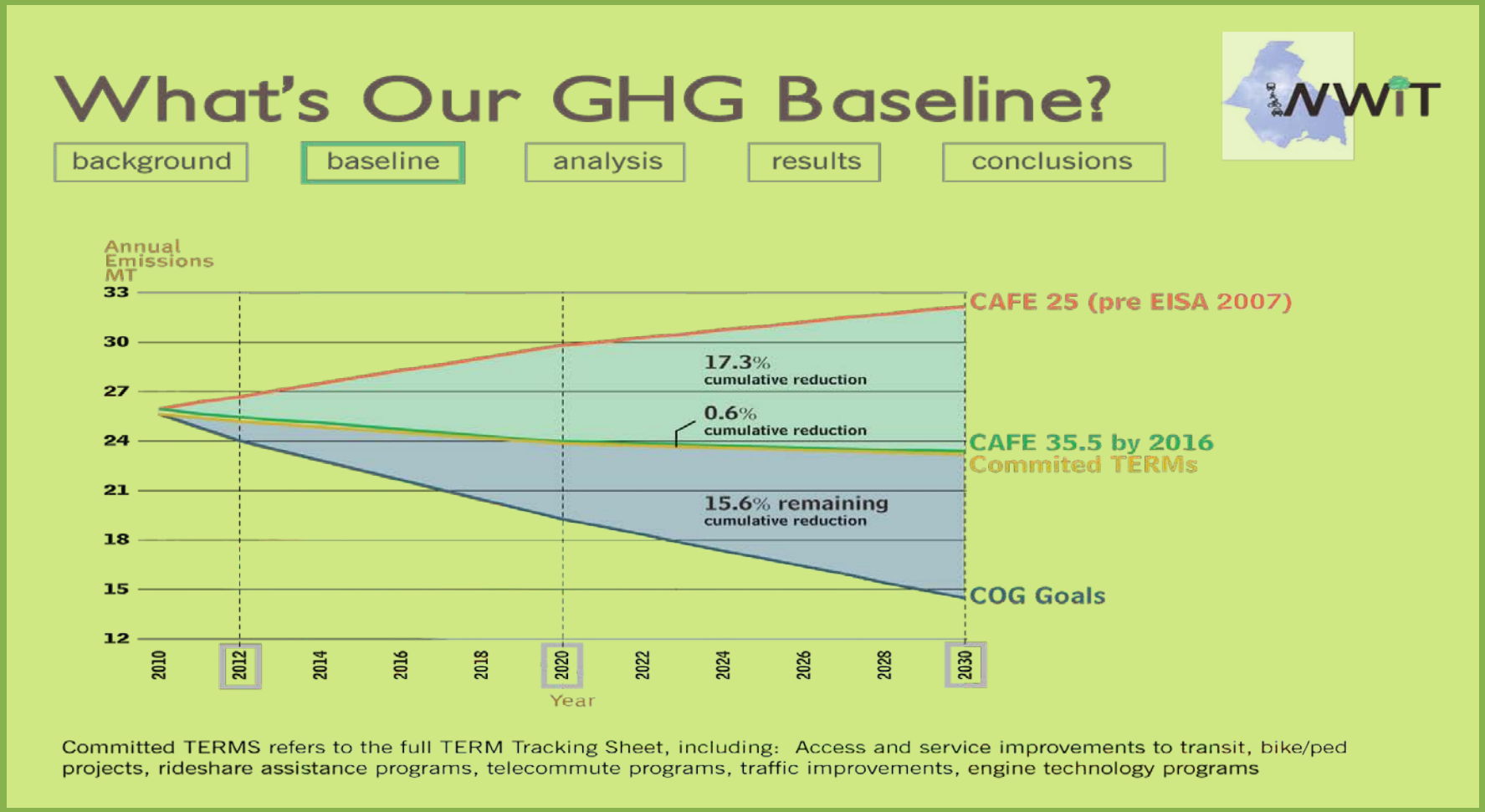
- MPO analyses to date reveal difficulty of reducing transportation GHG through planning strategies:

- California: New MPO targets leveraging land use would reduce ***per capita*** GHG for households – but ***total*** GHG would rise in 2020 & 2030 (compared to 2010)

- Atlanta: All scenario tests result in an increase of at least 50% in transportation CO2 in 2030 (compared to 1990)

- Washington DC: Analyzed 51 strategies as to meeting target of 33.5% GHG reduction below 2010 by 2030 – and fell short

Washington DC MPO GHG Estimates



Source: WASHCOG, at
http://www.mwcog.org/transportation/committee/committee/documents.asp?COMMITTEE_ID=230

Washington DC MPO GHG Estimates

Short-term Strategies

background | baseline | analysis | results | conclusions

Some short-term strategies can be implemented now.

Category	Example Strategies	Reduction (% off BAU)
1. **Increase transit and bike/ped use**	Implement kiosks, feeder buses and circulators, real-time bus information, bus priority, free transfers, bike stations, improved bike/ped access to transit, bike sharing	-0.3%
2. **Pricing**	Implement parking impact fees, pay-as-you drive insurance, parking cash-out subsidies	-1.5%
3. **Improve operational efficiency**	Promote eco-driving (public education campaign), incident management, traffic signal optimization, idling reduction	-1.8%
4. **Reduce travel**	Expand telecommuting, carpooling and vanpooling, car-sharing	-0.3%
	TOTAL	**-3.9%**

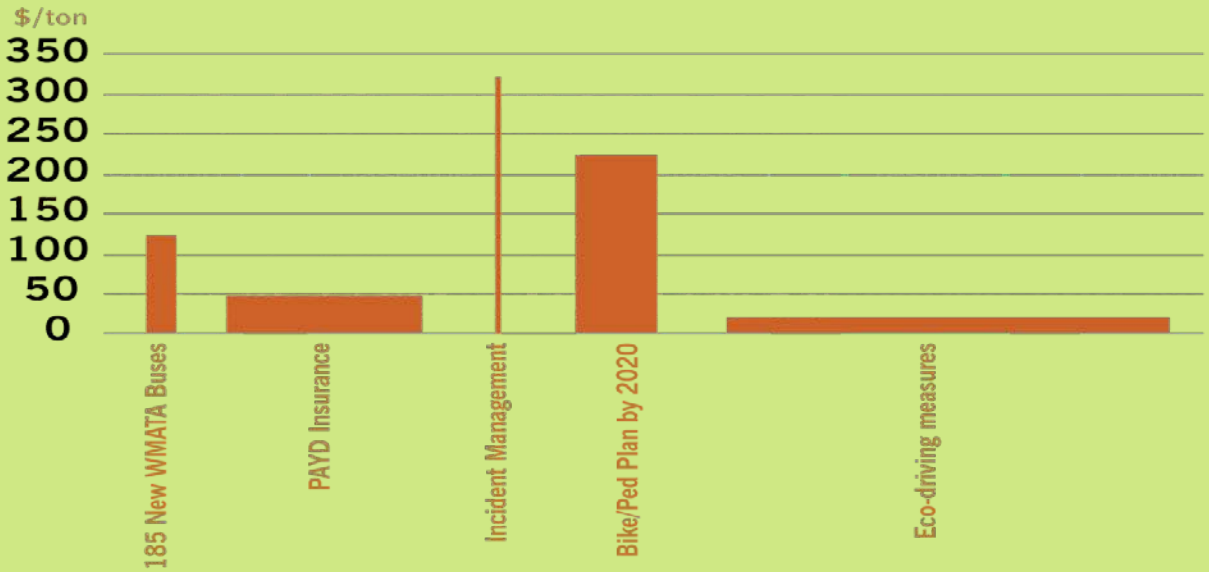
Source: WASHCOG, at http://www.mwcog.org/transportation/committee/committee/documents.asp?COMMITTEE_ID=230

Washington DC MPO GHG Estimates

Cost-Effectiveness

background | baseline | analysis | results | conclusions

Some strategies are both cost-effective and effective.



1 million tons of cumulative reduction 2010-2030

(width of bar indicates 20 year CO_2 reduction effectiveness)

Assumes current federal/local action

USG assumes the Social Cost of CO_2 to be $21 in 2010 rising to $45 in 2050.

Source: WASHCOG, at http://www.mwcog.org/transportation/committee/committee/documents.asp?COMMITTEE_ID=230

Washington DC MPO GHG Estimates

What Next?

background | baseline | analysis | results | conclusions

TPB can begin designing some actions that the region could consider for the near-term:

1. Expand **pay-as-you-drive insurance** to the whole region
2. Accelerate the **TPB Bike/Ped Plan** completion
3. Begin an **eco-driving** public education campaign (potentially through Commuter Connections)
4. Promote state/local incentives to accelerate use of **fuel efficient/ alternative fuel vehicles** for both public fleets and private use
5. Strengthen long-term focus on **mixed use activity centers** and **transit-oriented development**

Source: WASHCOG, at http://www.mwcog.org/transportation/committee/committee/documents.asp?COMMITTEE_ID=230

State & MPO Climate Planning: Summary Points

GHG reduction planning:

- 33 states have prepared climate action (GHG) plans (not LA)
- State climate action plans vary widely, are very “aspirational,” and have many limitations
- MPOs are in the early stages of analyzing potential GHG reductions
- MPO analyses underscore the difficulty of achieving the level of GHG reductions recommended by scientists (60-80% reduction by 2050)

Climate adaptation planning:

- About a dozen states have started climate adaptation planning
- Climate adaptation planning is in its early stages
- More localized climate science is needed and expected

IV. Transportation Strategies to Reduce GHGs

Transportation GHG Reduction

Transportation GHG reduction has 5 "legs"

1. Vehicle efficiency
2. Low-carbon fuels
3. VMT reductions
4. Operational efficiency
5. Construction, maintenance, and agency operations

Examples

- Higher CAFE* standards
- Low carbon fuel standard
- Less travel
- Signalization, ITS, eco-driving
- Low-carbon pavement, maintenance practices

* CAFÉ = Corporate Average Fuel Economy

Vehicle/Fuel Improvements will be the Dominant Source of Transport GHG Reductions

- 50% cut in GHG/mile is feasible from conventional technologies and biofuels by 2020-2030

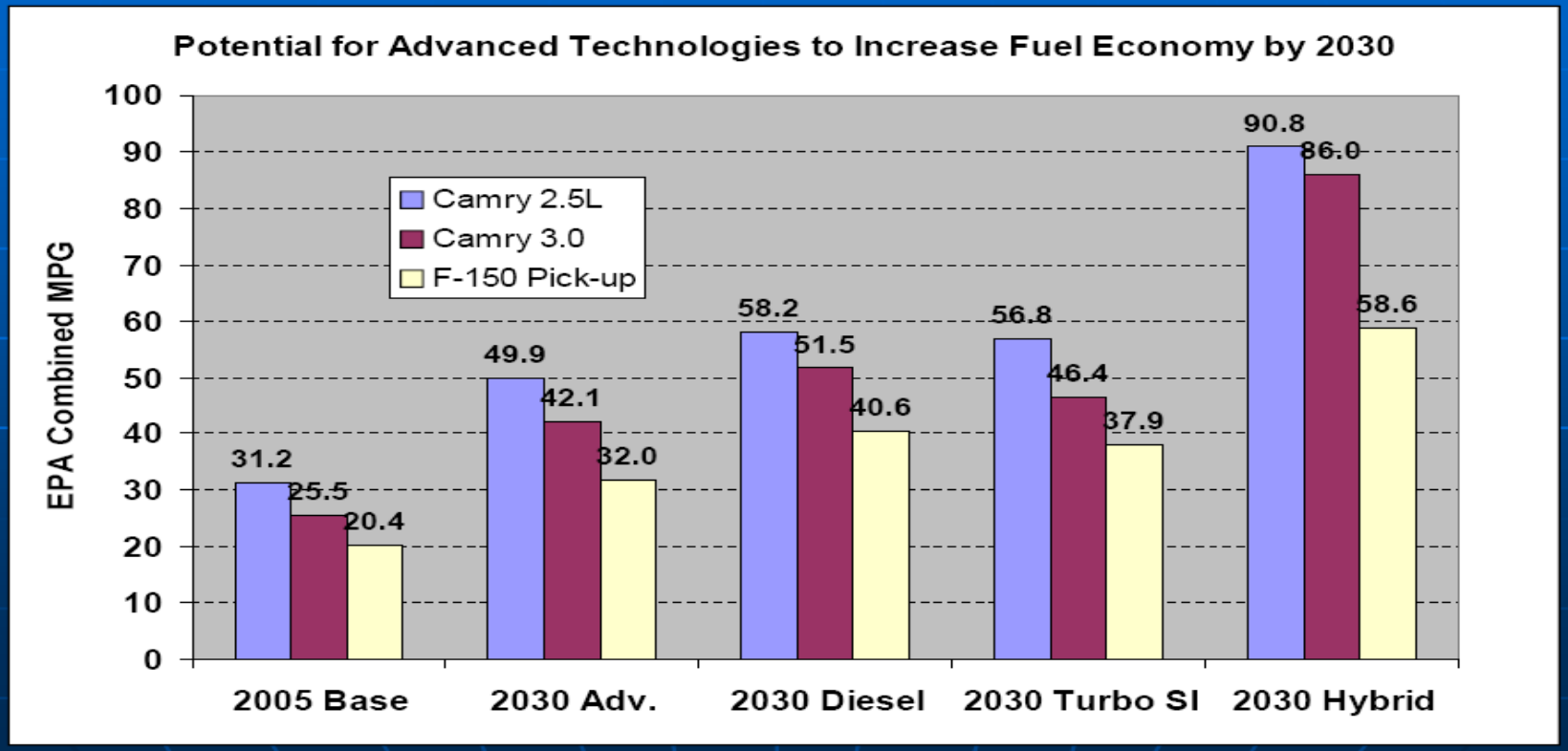
- Compare these GHG rates in U.S. and Europe:

380 grams/mile	2009 in the U.S.
250 grams/mile	2016 under latest U.S. CAFE 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

- Auto purchase cost will rise, but fuel savings will be greater than vehicle cost increase

Potential Fuel Economy Increase by 2030

A 2007 MIT study predicts MPG gains of 80-85% for model year 2030 vehicles via continuous improvement of conventional technology at a rate of 2-2.5%/year.



Source: Kasseris & Heywood, SAE Technical Paper 2007-01-1605, April, 2007.

Low Carbon Fuels

- Many different low-carbon fuel possibilities:
  - Corn ethanol
  - Sugar cane ethanol
  - Biodiesel
  - Cellulosic biofuel
  - Algae biofuels
  - Hydrogen
  - Electricity from renewable energy or nuclear power
  - Electricity from utilities with carbon capture & storage
- Carbon intensity measured as GHG/unit of energy – must account for “life-cycle” emissions

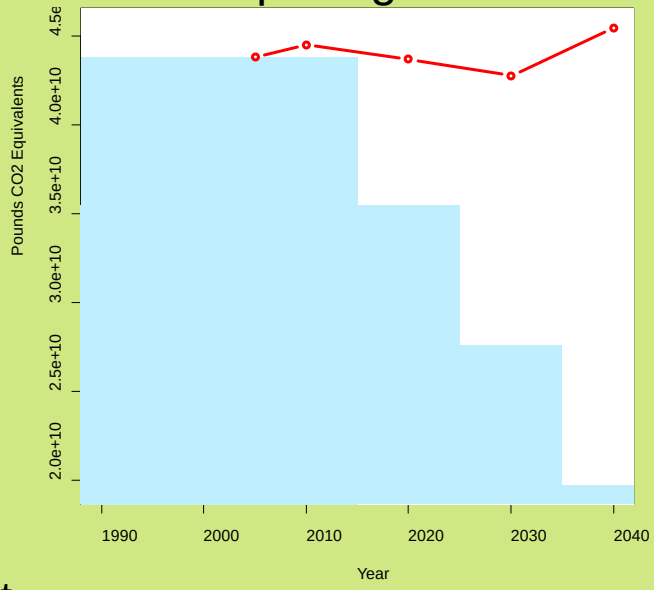
MPOs and Local Governments can Help Advance Low-carbon Vehicles and Fuels

1. **Influence state policies** on low-carbon fuels/vehicles
2. **Use planning scenarios** to emphasize need for decarbonization
3. **Plan/provide plug-in infrastructure** for electric and PHEV vehicles (coordinate with utilities)
4. **Support federal transportation funding** for technology/fuel R&D
5. **Educate** the public and elected officials
6. **Provide incentives** for consumers to use lower carbon f**uels/vehicles** (lower fees for low-carbon vehicles/fuels)
7. **Support** low-carbon fleet conversion for local vehicle fleets
8. **Adjust** facilities and operations to accommodate decarbonized vehicles and fuels

Strategy Scenarios from Oregon

Vehicle efficiency
and low-carbon fuel:

Vehicle efficiency
and pricing:



Urban planning:

Blue steps above represent
Oregon's GHG reduction targets

Many Strategies to Moderate/Reduce VMT

- Pricing incentives
  - Economy-wide carbon pricing
  - Transportation pricing (PAYD insurance, parking pricing, tolls, higher user fees, cordon pricing, congestion pricing, etc.)
- Carpooling and vanpooling (currently carry 3-5 times as much work trip PMT* as transit)
- Bike/ped
- Transit (in high-density corridors)
- Trip chaining
- Tele-working, tele-shopping, tele-education, tele-medicine
- Compact land use/urban design

* PMT = passenger miles travelled

The Importance of Pricing

- Without price signals, reducing VMT is very hard
- Pricing encourages/rewards:
  - Purchase of lower-carbon vehicles and fuels; and
  - Lower VMT
  - Eco-driving behavior
- Many different pricing tools are available:

  auto “feebates,” carbon/fuel prices, PAYD insurance, mileage fees, parking pricing, congestion pricing, etc.
- <u>Pricing produces revenue to invest in alternatives</u>

Mode Shift Policies Must Focus on Occupancy

National Averages (individual metro areas will vary)

	Occupancy	Lbs of GHG/Passenger Mile
Auto, single occupant	1.00	0.99
SUV, average	1.72	0.71
Transit Bus	8.80	0.71*
Auto, Average	1.57	0.58*
Carpools	2.10	0.47
Amtrak	20.50	0.39
Rail Transit	22.50	0.39
Motorcycles	1.20	0.37
Commuter Rail	31.30	0.36
Vanpools	6.10	0.21
Walking and Biking	1.00	0.00

*With 8.8 passengers/mile, the average transit bus is more carbon intensive than the average automobile, for the nation as a whole.

Sources: U.S. DOE Energy Data Book and NCHRP 20-24, Task 59, 2009

Carpooling & Vanpooling

- Important but underappreciated (5-7 times as many PMT for work trips nationally are in carpools and vanpools as on transit)
- Low cost for government, wide availability, saves users money
- Effective in all kinds of areas – rural, small urban areas, suburban, urban
- Nearer-term payoff than most transportation strategies
- Atlanta MPO and WASHCOG pay for commuters to carpool ($3/day Atlanta, $2/day WASHCOG)

Land Use

- "Growing Cooler" finds compact development can achieve 3.5-5% reduction in transportation GHG, 2007-2050
- GC's assumptions of land use change are very aggressive:
  - 67% of all development in place in 2050 will be constructed or rehabbed after 2005
  - 60-90% of that development is compact (comparable to 13.3 housing-units per acre)
  - Compact development has 30% less VMT than very sprawling development
- "Moving Cooler" finds smaller GHG effect, even with 90% compact land use for future urban development

Less VMT via Land Use: the 8 Ds

1. Diversity (mix) of land uses
2. Density of urban form – e.g. UGB
3. Design - quality of the (ped/bike) environment
4. Destination accessibility – O/D links
5. Distance to transit
6. Development scale (site, sector, municipality, region)
7. Demographics
8. Demand Management

“Moving Cooler”

- Evaluated non-technology transportation strategies for (a) GHG reductions and (b) cost-effectiveness in reducing GHG
- Analyzed 46 individual transportation strategies and 6 “bundles” of strategies
- The 46 individual strategies: pricing strategies, transit strategies, land use strategy, operational strategies, freight strategies, nonmotorized strategies, regulatory strategies, bottleneck/capacity strategies, etc.

Source: “Moving Cooler,” by Urban Land Institute, 2009

“Moving Cooler” Findings

Individual strategies achieve GHG reductions ranging from <0.5% to 4.0% cumulatively 2010-2050, compared to on-road baseline GHG

- 15,186 mmt - carbon pricing equiv to $2.71/gallon
- 3,361 mmt – VMT fees equiv to $2.53/gallon
- 2,428 mmt – speed limit reductions
- 2,233 mmt – PAYD auto insurance (100%)
- 1,815 mmt – eco-driving by 20% of drivers
- 1,445 mmt – at least 90% of new urban development is compact, with high quality transit
- 1,241 mmt – congestion pricing fully implemented in 120 metro areas at 65 cents/mile
- 575 mmt - $1.2 trillion transit expansion
- 352 mmt – combination of 10 freight strategies

Source: “Moving Cooler,” by Urban Land Institute, 2009

Efficient Operations

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

Source: NCHRP Report 20-24, Task 59, March 2009

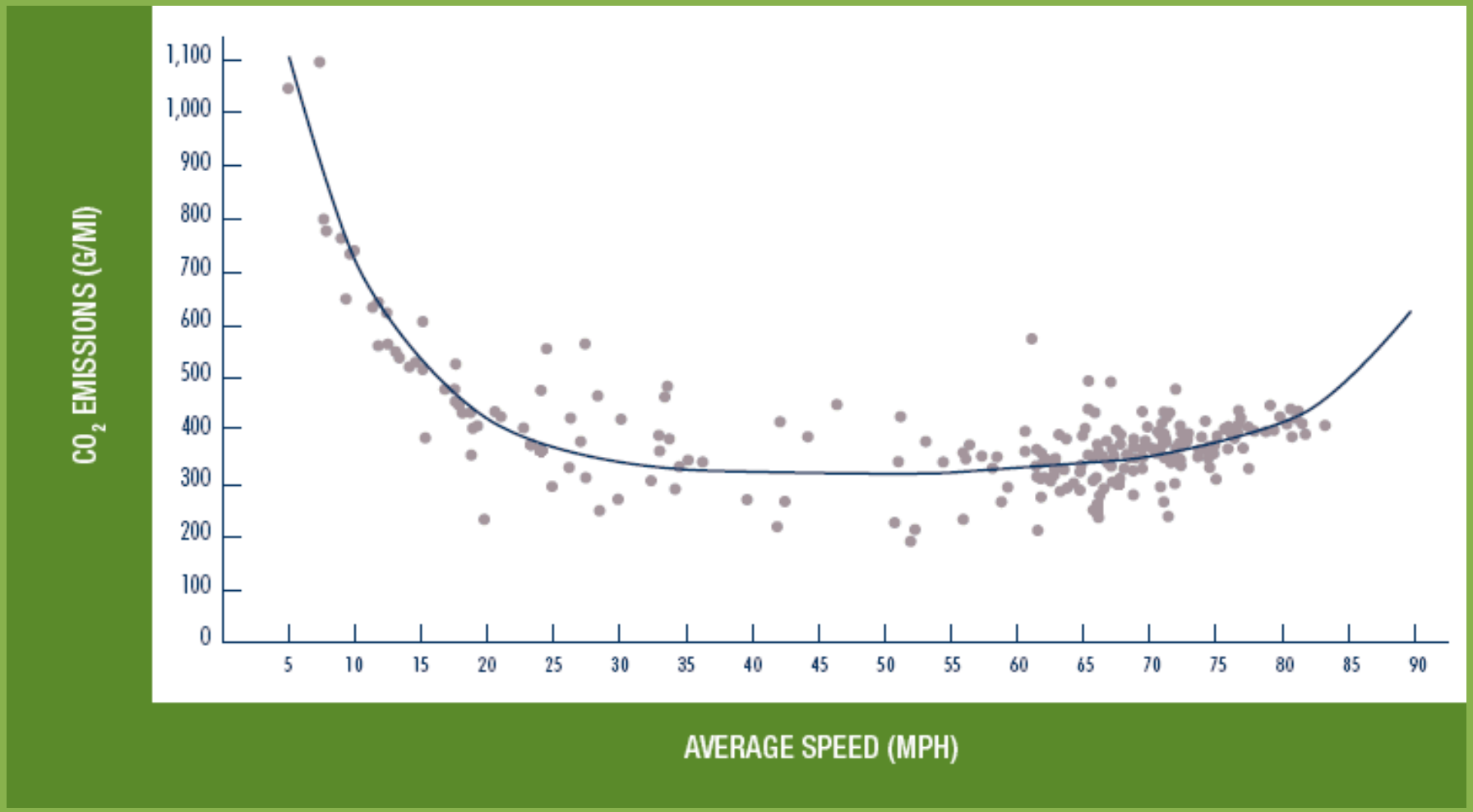
Eco-Driving

- EcoDrivers can reduce fuel and CO2 by an average of 15% through smart driving and vehicle maintenance.
- If 50% of drivers practiced EcoDriving, CO2 would drop by 100 million tons annually (the equivalent of heating and powering 8.5 million households)
- Pilot in 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

Ecodriving Tools and Information

- EcoDrivingUSA™ -- nationwide effort to increase overall vehicle fuel economy and preserve the environment
- Partnership of Governors, auto industry, environmental groups
- Website: 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
  - Link this website on your blog or site

Speed & Congestion Matter: GHG is lowest at 35-55 MPH



Source: Barth and Boriboonsomsin, "Traffic Congestion and Greenhouse Gases, Access Magazine, Fall 2009

Construction, Maintenance, and 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
  - Alt fuels and hybrid vehicles in DOT fleets
  - Alt fuel buses

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
- Bottleneck reduction
- Pre-clearances at scale houses
- Truck driver training
- EPA SmartWay up-grade kits & loans & diesel retrofits
- Efficient Intermodal Facilities
- 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
- Retrofits - PM and “Black carbon” reduction technologies 85% reduction in PM

Source: NCHRP 20-24, Task 59, 2009

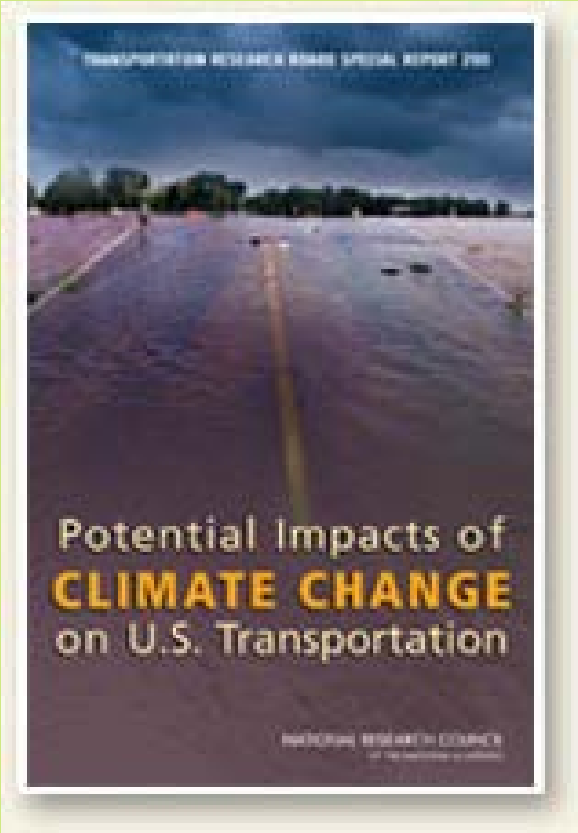
GHG Strategies: Summary Points

Many strategies are needed to reduce transport GHG. No silver bullet. Will need full mix of strategies ("silver buckshot"):

- Maximum energy efficiency of current vehicle technology
- New technologies to decarbonize vehicles and fuels world-wide
- Pricing measures to reward conservation and tech innovation
- "Eco driving" and system/speed management
- More efficient land use
- Carpools & vanpools, biking, walking, transit use, trip chaining, telecommuting
- Low carbon, energy-conserving strategies in construction, maintenance, and agency operations
- Retrofitting legacy fleets to reduce PM and black carbon
- Wide-ranging freight technology and logistics improvements

V. Climate Adaptation for Transportation

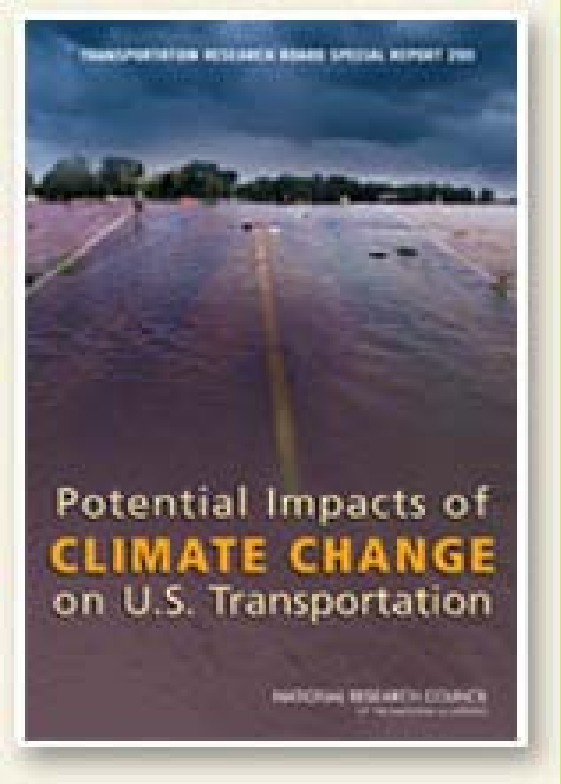
TRB Special Report 290



Climate change will affect every mode of transportation and every region in the United States, and the challenges to infrastructure providers will be new and often unfamiliar.

State and local governments and private infrastructure providers will need to incorporate adjustments for climate change into long-term capital improvement plans, facility designs, maintenance practices, operations, and emergency response plans.

TRB Special Report 290



Design standards will need to be re-evaluated and new standards developed as progress is made in understanding future climate conditions and the options for addressing them.

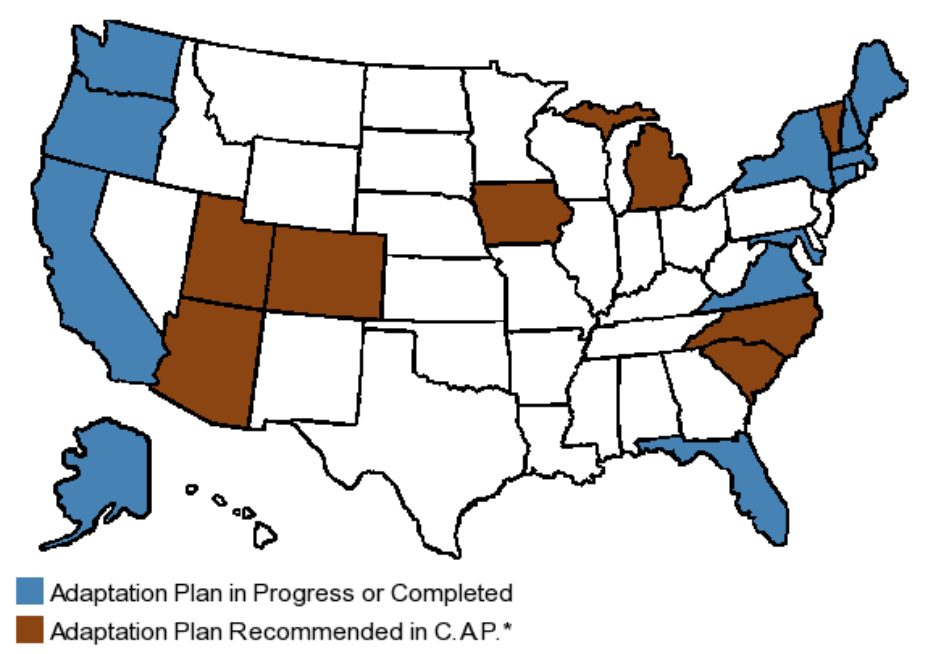
Transportation planners will need to consider climate change and its effects on infrastructure investments. Planning timeframes may need to extend beyond the next 20 or 30 years.

Institutional arrangements for transportation planning and operations will need to be changed to incorporate cross jurisdictional and regional cooperation.

What is “climate adaptation”?

- Climate adaptation:

  “Actions by individuals or systems to <u>avoid, withstand, or take advantage of</u> current and projected climate changes and impacts. Adaptation <u>decreases a system’s vulnerability, or increases its resilience</u> to impacts.”



- 12 states have or are developing climate adaptation plans.
- Climate adaptation plans cover many areas: infrastructure, ecosystems, agriculture, water supply, human health and disease, the economy, etc..

Source: Pew Center on Climate Change

Why must transportation plan for and adapt to climate change?

- 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

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

Proposed Federal Guidance

"…environmental analysis and documents …should provide the decision maker with relevant and timely information about….the relationship of climate change effects to a proposed action or alternatives, including the relationship to proposal design, environmental impacts, mitigation and adaptation measures."

"Climate change can affect the integrity of a development or structure …. increase the vulnerability of a resource, ecosystem, or human community…. magnify the damaging strength of certain effects of a proposed action."

"Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions," White House Council on Environmental Quality, February 18, 2010

Climate Change Implications for Design

- Changes in bridge height
- Changes in bridge foundation and superstructure
- Changes in materials specifications
- Changes in suspended and cable-stay bridges to withstand more severe wind and turbulence
- Changes in culvert design, capacity, and location
- Changes in slope design
- Changes in pavement drainage systems

Climate Change Implications for Operations

- Pavement rutting and rail buckling
- Longer construction season
- Closures and detours due to rock slides, soil erosion, flooding
- Speed reductions
- Flooding of culverts
- Change in weight restrictions
- More grass cutting/less snow plowing
- Work crew limitations during severe heat periods

U.S. DOT / USGS Gulf Coast I Report:
Potential Impacts of Climate Change and Variability on Transportation Systems and Infrastructure

Gulf Coast I Report: Sea Level Rise and Storm Surge

- Relative sea level will likely rise 1 to 6 feet; a 2 - to 4-foot increase is probable
  - Massive inundation due to relative sea level rise
  - Relative sea level includes:
    - Climate-induced impacts of thermal expansion and ice melt; and
    - Sinking land masses (subsidence) in the central Gulf Coast
- Hurricane vulnerability is bad today and may worsen
  - Potential for 5 – 20% increase in storm intensity due to climate change

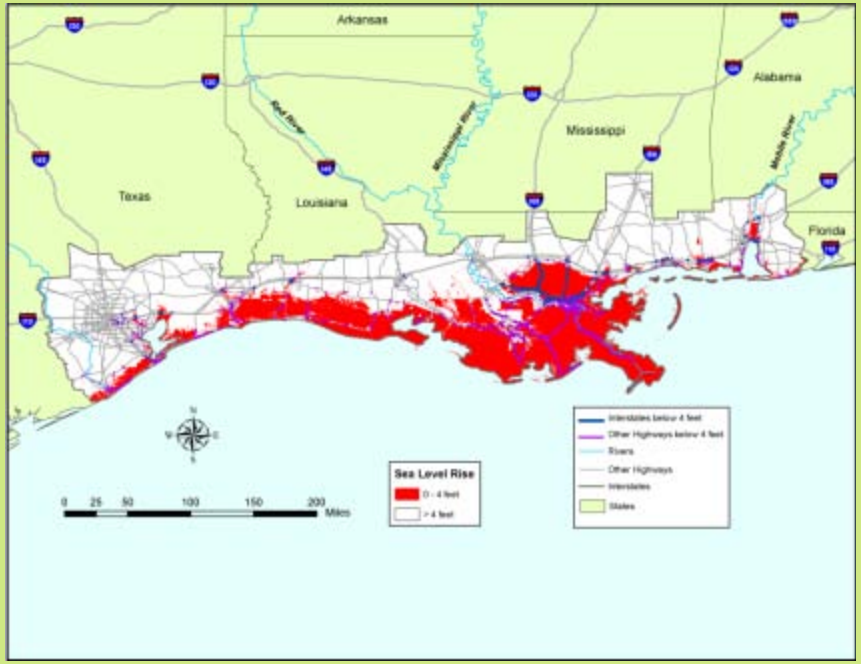
Gulf Coast I Report: Vulnerability Due to Relative Sea Level Rise

- Relative sea level rise (due to climate change and subsidence) of 4 feet could permanently flood:
  - 24% of interstate miles, 28% of arterial miles, New Orleans Transit
  - 72% of freight, 73% of non-freight facilities at ports
  - 9% of the rail miles operated, 20% of the freight facilities, no passenger stations
  - 3 airports
  - Temporary flooding in low-lying areas due to increased heavy downpours will broaden affected areas

Gulf Coast I Report: Highways Vulnerable to Relative Sea Level Rise

Baseline (Present Day)

4 Feet of Sea Level Rise



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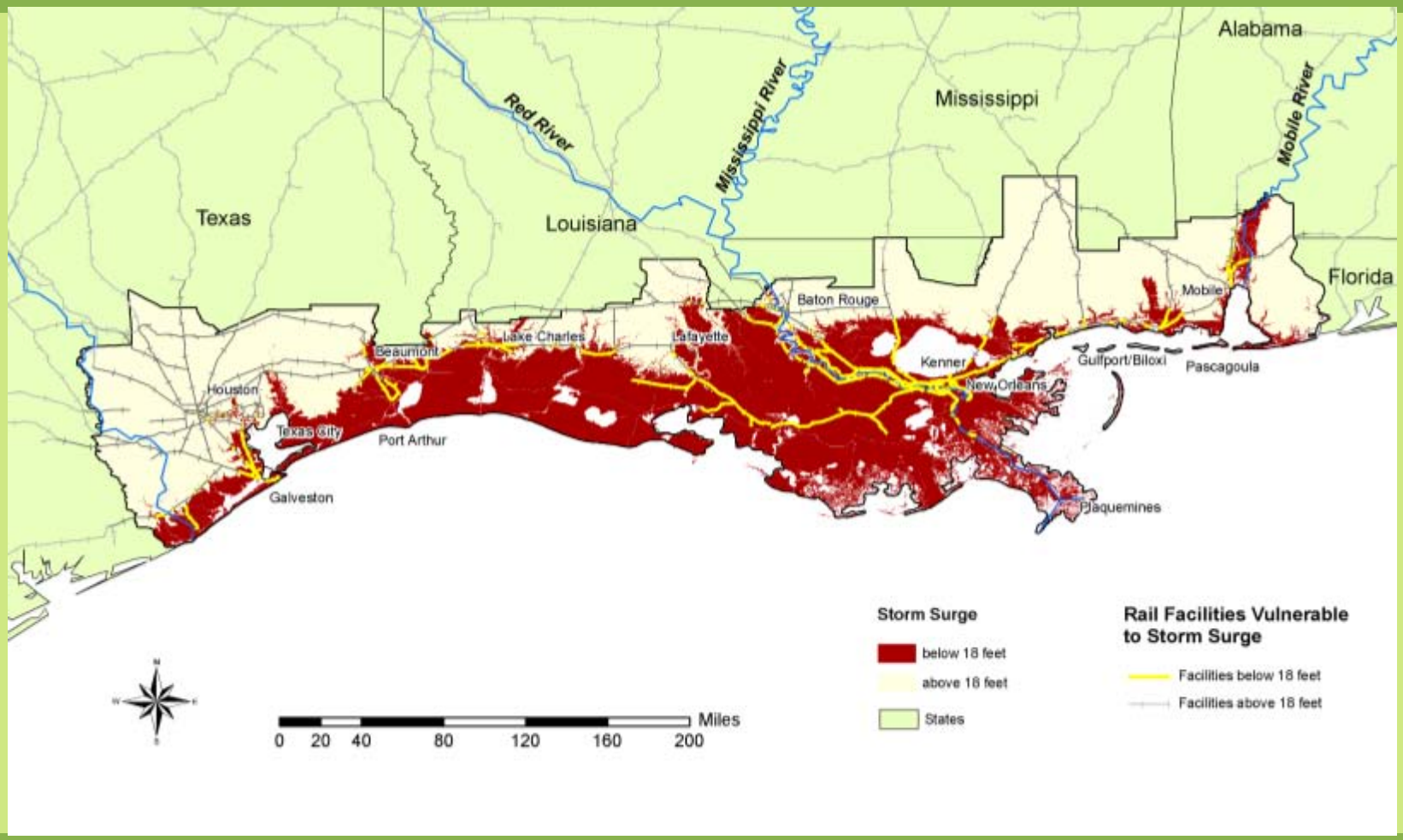
Gulf Coast I Report: Vulnerability Due to Storm Surge

- Transportation infrastructure that is vulnerable to 18 feet of storm surge includes:
  - 51% of interstate miles, 56% of arterial miles, and most transit authorities
  - 98% of port facilities vulnerable to surge and 100% to wind
  - 33% of rail miles operated, 43% of freight facilities
  - 22 airports in the study area at or below 18 feet MSL
  - Potentially significant damage to offshore oil & gas facilities

Gulf Coast I Report: Freight Rail Lines Vulnerable to Storm Surge of 18 feet



Gulf Coast I Report: Caveats – Relative SLR and Storm Surge

- Analysis of impacts is based on land elevation rather than the height of facilities
- Analysis does not consider the presence of possible protective structures (levees, sea walls, etc.)
- A small flooded segment may render a larger portion of the infrastructure inoperable, due to the connectivity of the intermodal system
  - Many transportation facilities depend on local roads (not elevated)

Gulf Coast I Report: Temperature and Precipitation

- Average temperature is likely to increase by 2 - 4 F by 2050
  - More hot days: # of days > 90 F may increase by 50%
  - Extreme daily high temps will also increase
- Models show mixed results for changes in average precipitation
  - Intensity of rainfall events, however, will likely increase
- The impacts worsen as GHG concentrations increase across the range of scenarios

Gulf Coast I Report: Vulnerability Due to Temperature Increases

As temperatures increase, operations will be affected:

- Potential rise in maintenance and construction costs
- Increased use of energy for refrigerated storage
- Potential rise in rail buckling
- May result in impacts to aircraft performance and runway utilization

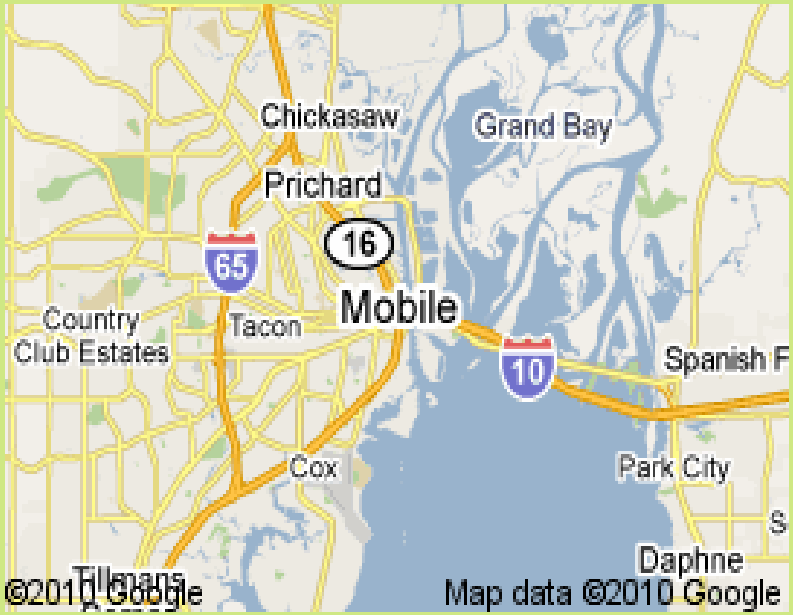
Web Link to Gulf Coast I Report

"Impacts of Climate Change and Variability on Transportation Systems and Infrastructure – The Gulf Coast Study, Phase I"

http://www.climatescience.gov/Library/sap/sap4-7/final-report/

Gulf Coast II – Now Underway

- Focus on Mobile, ALA
- Work closely with stakeholders in Mobile region
- Assess critical transportation infrastructure, project climate change effects, evaluate vulnerability, and conduct detailed engineering assessments for vulnerable assets in Mobile
- Identify lessons learned and replicable processes that could inform similar analyses in other MPOs
- Develop transferrable tools and resources to assist other MPOs



Gulf Coast II: Study Timeline

Early 2010

- Determine the new climate stressors the transportation system will face
- Identify most critical transportation links & assets

Early 2011

- Determine vulnerability of critical assets to expected climate stressors

Early 2012

- Develop tools to identify and manage climate-related risks

Late 2012

- Final report & presentations

Working with Mobile MPO & other key groups

NCHRP 20-83(5): Climate Change and the Highway System: Impacts and Adaptation Approaches

1) Synthesize the current state of knowledge on the range of impacts of climate change on the highway system by region of the United States for the period 2030-2050

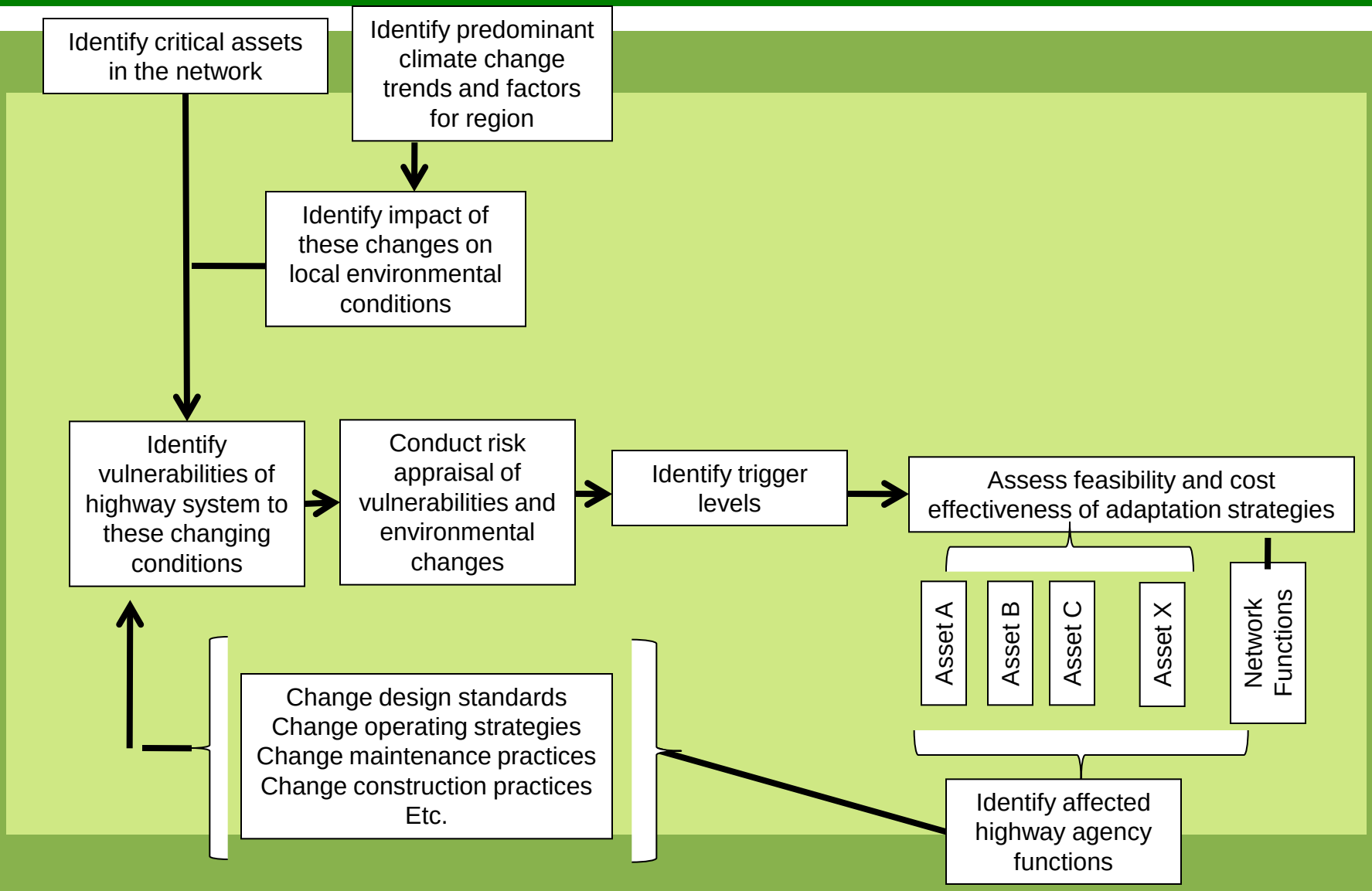
2) Recommend institutional arrangements, tools, approaches and strategies that state DOTs can use during the different stages of planning and project development and system management to adapt both infrastructure and operations to these impacts

NCHRP 20-83(5): Climate Change and the Highway System: Impacts and Adaptation Approaches

3) Prepare guidance, materials and methods for dealing with these impacts, and

4) Identify future research and activities needed to improve our understanding of possible impacts and on the steps needed for adaptive system management.

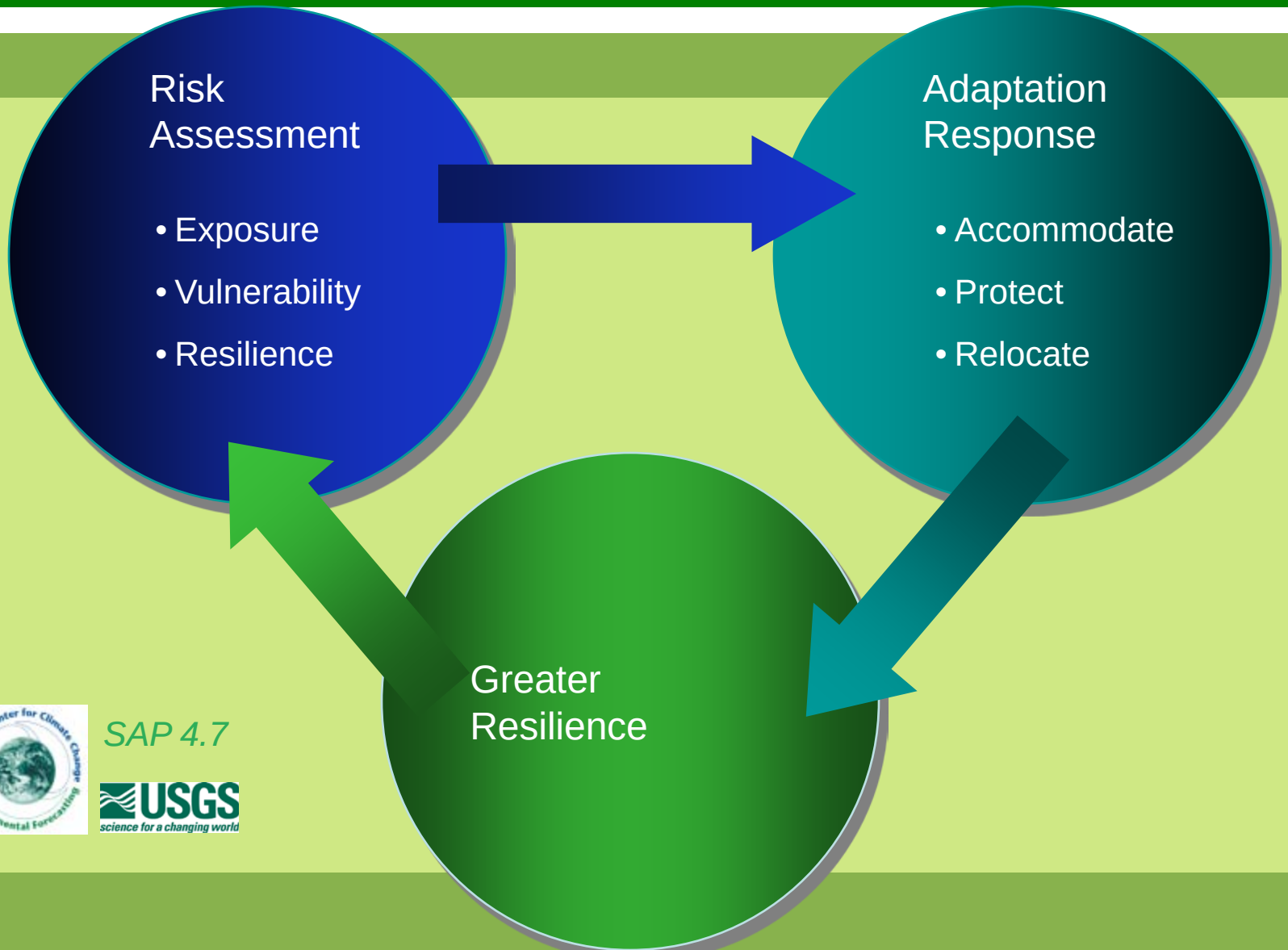
Adaptation Planning Framework



What Are Possible Adaptation Responses?

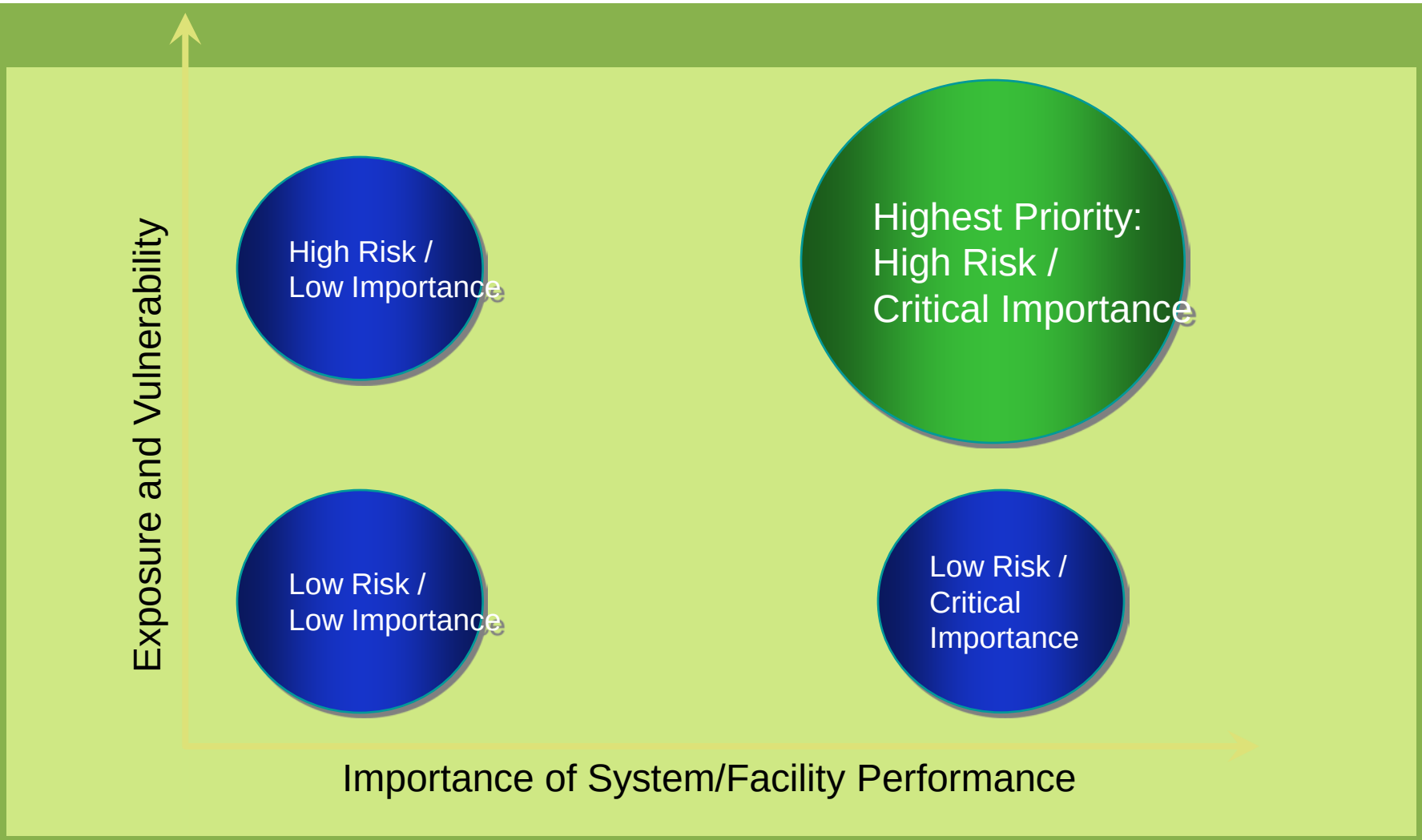
- Accommodate: Maintain and manage
  - Absorb increased maintenance / repair costs
  - Improve real-time response to severe events
- Strengthen structures / protect facilities
  - Design changes when rebuilding / new investment
  - Promote buffers, sea walls, etc.
- Relocate / avoid
  - Move key facilities
  - Site new facilities in less vulnerable locations
- Abandon and Disinvest
- Enhance redundancy
  - Identify system alternatives

A Risk Assessment Approach to Transportation Decisions



SAP 4.7

But We Need More Than Just Degree of Risk to Prioritize Investments…



Adaptation: Summary Points

- Transportation is vulnerable to climate change due to higher sea levels, storm surges, more intense storms, changes in precipitation, and higher temperatures
- All modes of transportation and all regions are affected
- Gulf Coast transportation is especially vulnerable
- Adapting transportation to climate change will require:
    - Design changes
    - Maintenance changes
    - Operations changes
- Better information on climate risks are needed on a local/regional level to inform adaptation decisions
- Important research projects on adaptation are underway

VI. Discussion – Next Steps?
A Menu of Ideas

Next Steps? A Menu of Ideas

- Develop a regional “policy plan” – a framework for collaborative planning and action
- Form an interagency climate change working group
- Identify transportation vulnerabilities & risks
- Prioritize adaptation actions
- Develop a transportation GHG carbon footprint
- Conduct outreach to the public (schools, media, civic groups, business community, etc.)

A Menu of Ideas (continued)

- Consider near-term strategies for reducing GHG
  - -Regional ridesharing program
  - -Eco-driving initiative
  - -Signal synchronization/congestion reduction emphasis
  - -Transit (promotion, routing efficiencies, vehicle fleets, fuels)
  - -Other?
- Consider longer-term strategies (land use, etc.)
- Conduct a regional energy audit
- Support “clean energy” infrastructure and fleets
- Evaluate pricing/revenue/finance implications for transportation

Thank you!

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Key Resources

- 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,” 2010 (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”
- AASHTO: http://climatechange.transportation.org/
- 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/hep/climate/index.htm
- The Pew Center on Global Climate Change: http://www.pewclimate.org/
- EPA Climate Change Program http://www.epa.gov/climatechange/