The Vital Role of Operations and Maintenance in Supporting and Enhancing Sustainability

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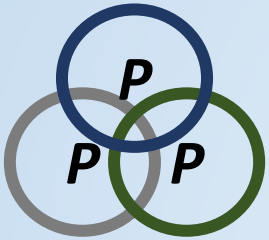
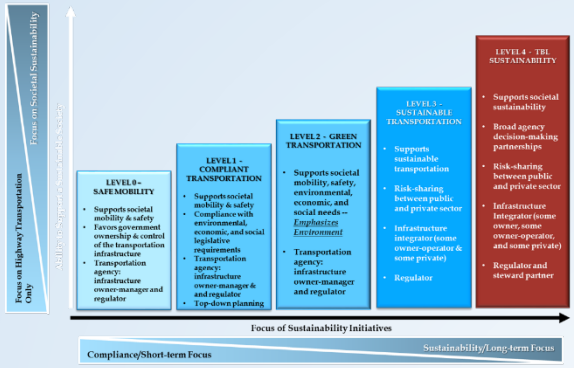




Section 1 (Presenter: Dr. McVoy)

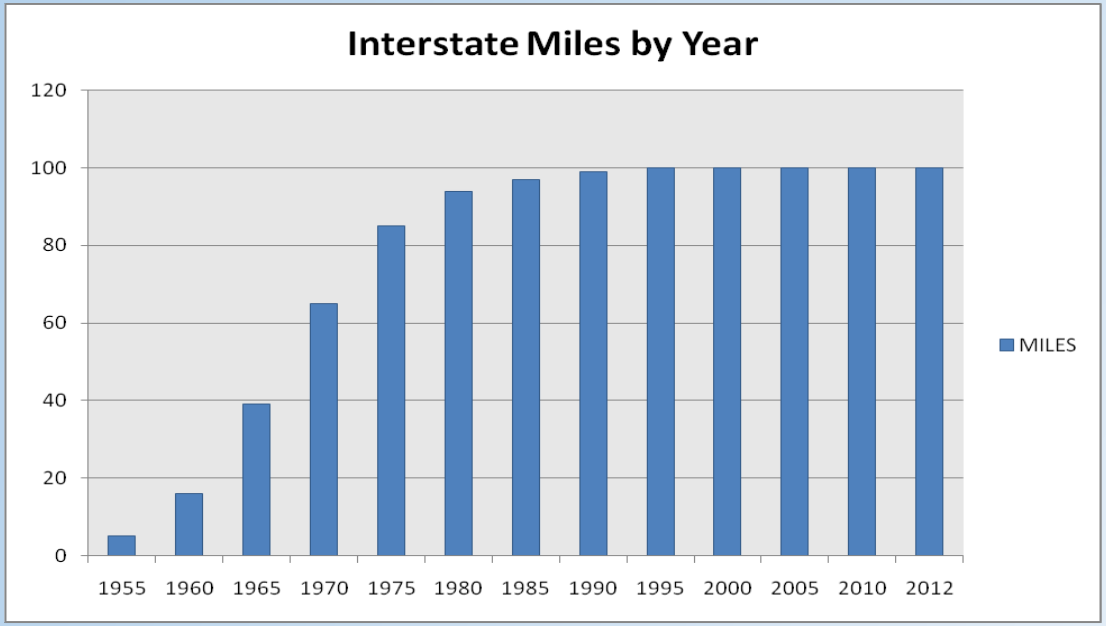
Operations and Maintenance

Supporting Sustainability in its Pragmatic Way

- ***Background: Operations and Maintenance***
- **Potential Objective:** Transportation in support of a sustainable society (NCHRP Report 750, Vol. 4)
- **Future Prospects:** Maintenance and Operations per NCHRP Report 750, Vol 4. Sustainability Maturity Model
- **Current State in Perspective:** Operations & Maintenance – Environment and Sustainability, per NCHRP 25-25 Task 73: Improved Environmental Performance of Highway Maintenance

Background: Operations & Maintenance vs. Capital

- Demand responsive culture of stewardship
- Line vs. Expert Staffing
- Cash vs. Bonding
- Fixed funding



From http://www.publicpurpose.com/hwy-intmiles.htm

Section 1 (Presenter: Dr. McVoy)

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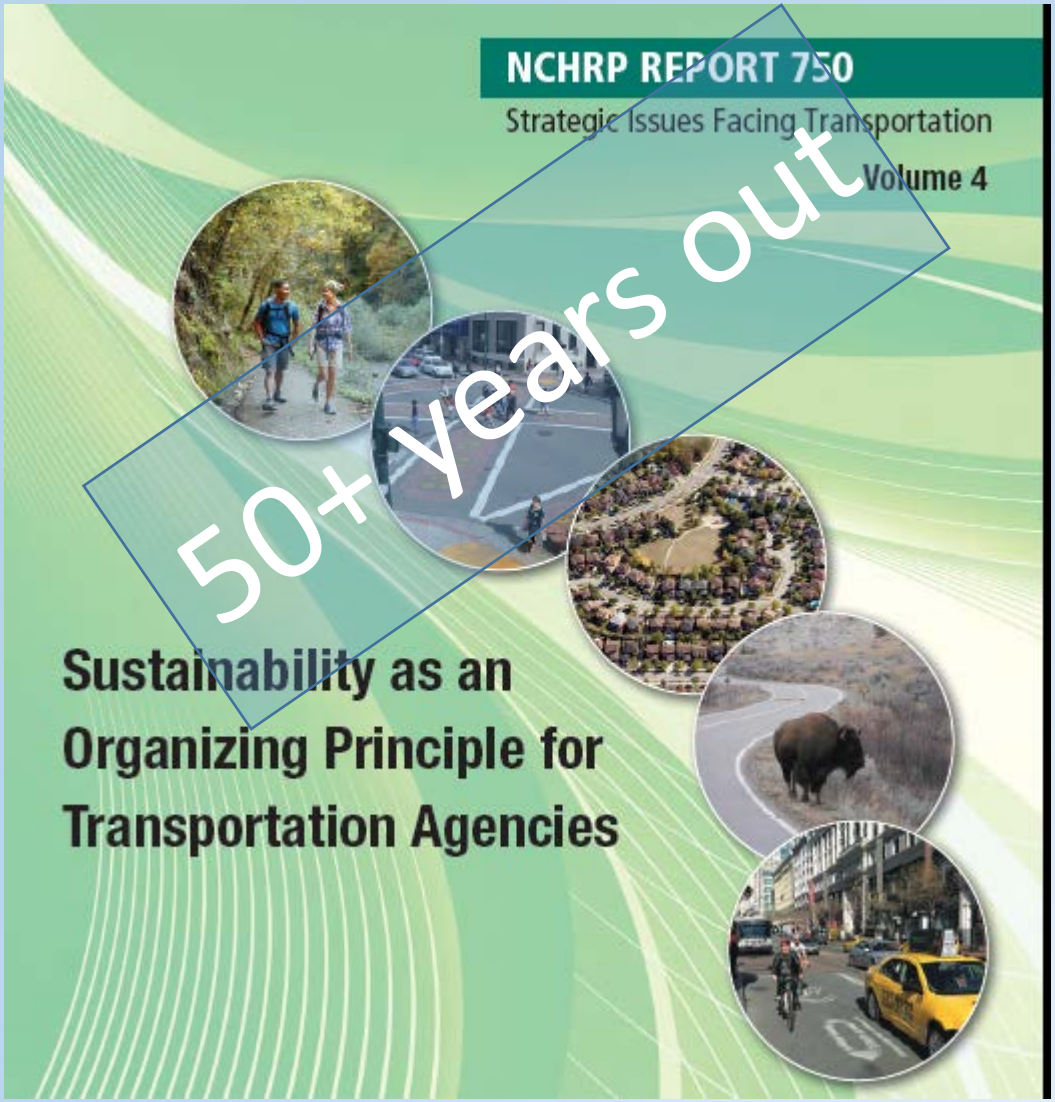
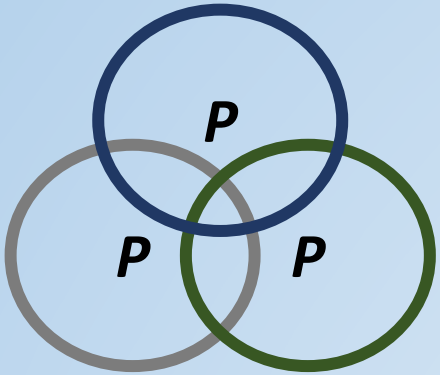


http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750v4.pdf

Why

"Transportation in support of a more sustainable society"

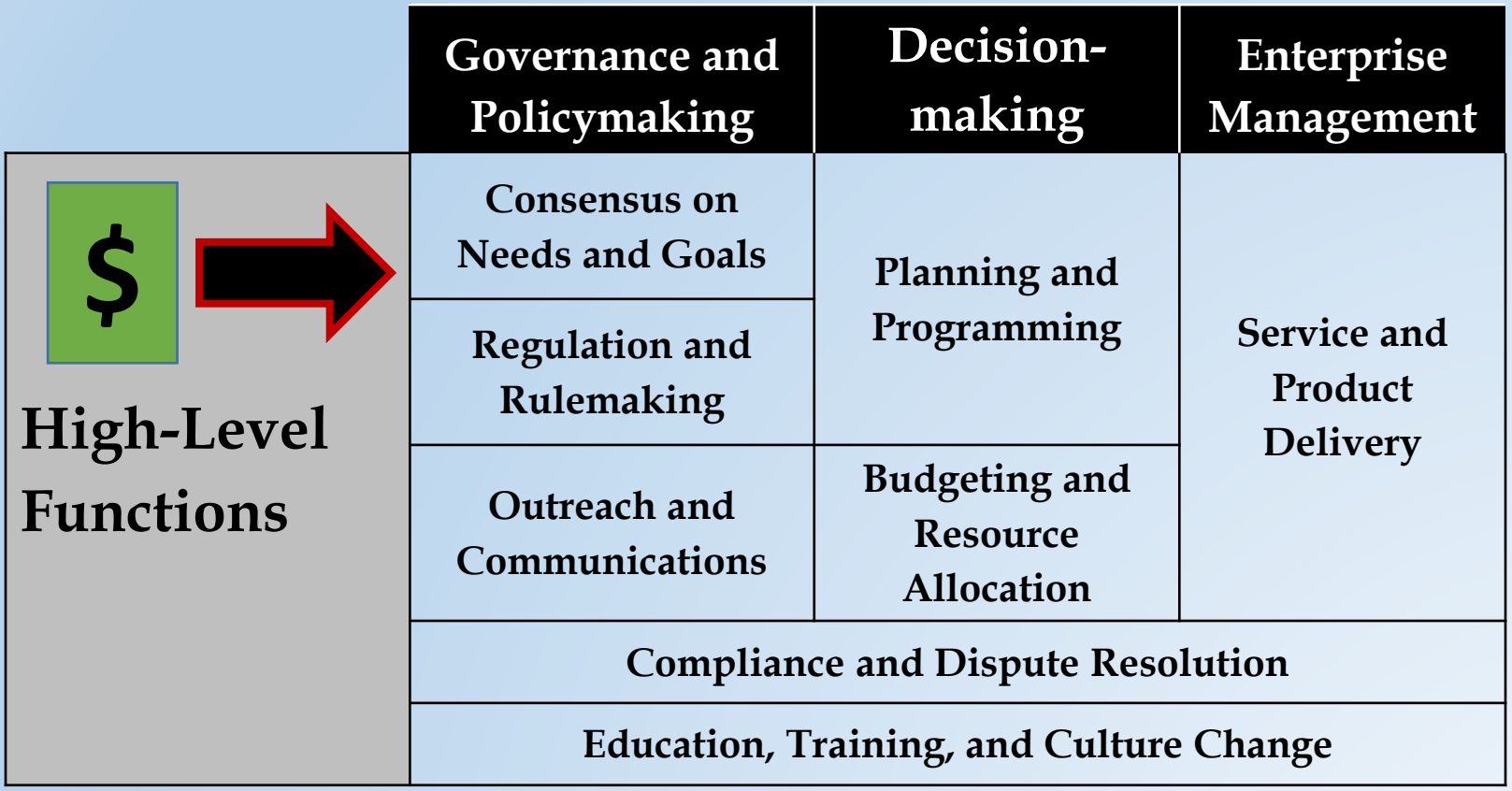
What



How!

	Governance and Policymaking	Decision-making	Enterprise Management
$	Consensus on Needs and Goals	Planning and Programming	Service and Product Delivery
	Regulation and Rulemaking		
	Outreach and Communications	Budgeting and Resource Allocation	
	Compliance and Dispute Resolution		
	Education, Training, and Culture Change		

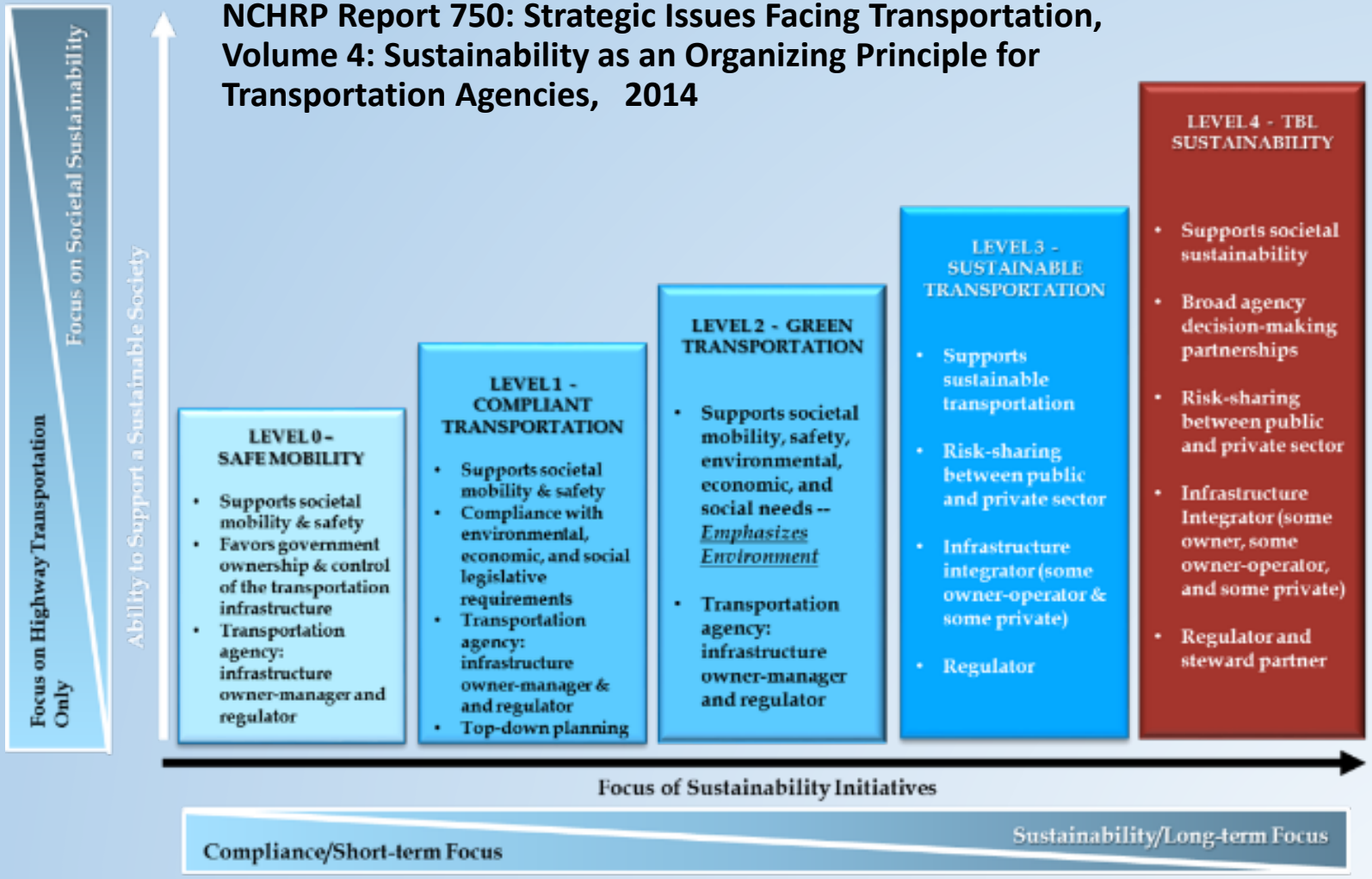
Transportation Agency functions (**How**)



NCHRP Report 750: Strategic Issues Facing Transportation,
Volume 4: Sustainability as an Organizing Principle for Transportation Agencies
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750v4.pdf

Transportation Agency Sustainability Maturity Model

NCHRP Report 750: Strategic Issues Facing Transportation, Volume 4: Sustainability as an Organizing Principle for Transportation Agencies, 2014



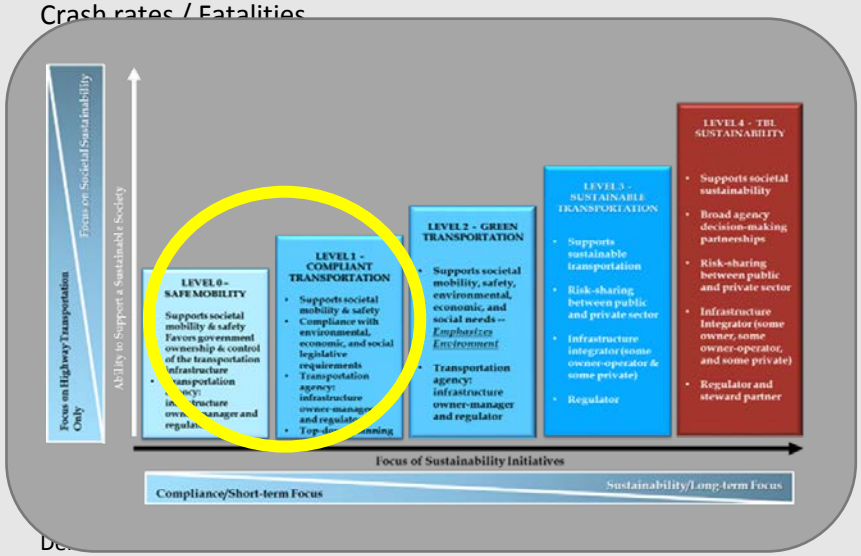
Benchmarking Tool (Conversation Starter)

Maturity level	Characteristics	Score
Safe Mobility	• Support societal mobility • Favors government ownership & control of the transportation infrastructure • Transportation agency as infrastructure owner–manager & regulator	8 to 11
Compliant Transportation	• Support societal mobility • Compliance with environmental, economic, and social legislative requirements • Transportation agency as infrastructure owner–manager & regulator • Top-down, planning	12 to 19
Green Transportation	• Support societal mobility & environmental, economic, and social needs—*emphasizes environment* • Transportation agency as infrastructure owner–manager & regulator	20 to 27
Sustainable Transportation	• Support sustainable transportation • Favors partnerships between public and private sector • Transportation agency as infrastructure coordinator & regulator	28 to 36
Support TBL Sustainability	• Support societal sustainability • Agnostic on issues of ownership or control of transportation infrastructure—whatever is most sustainable • Transportation agency as transportation system steward	37 to 40

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750v4.pdf

Maturity Level / Goals / Metrics

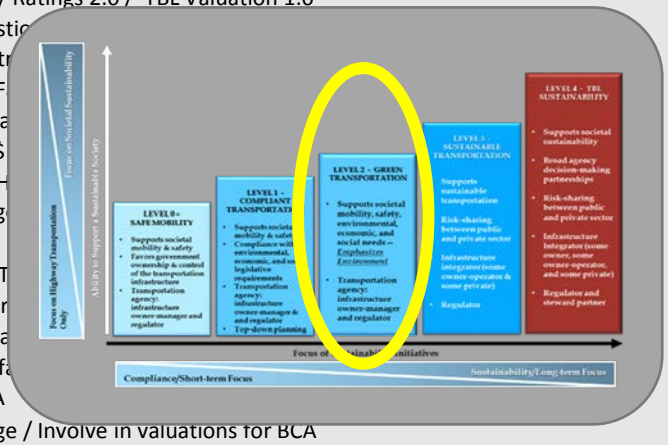
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750v4.pdf
As adapted

Maturity Level	Goals	Metrics
Level 0 Safe Mobility	1. **Mobility** 2. **Safety** 3. **Economic development**	**AADT / Speed** **Crash rates / Fatalities** **Stakeholder Satisfaction**
Level 1 Compliant Transportation	1. **Mobility** 2. **Safety** 3. **Economic development** 4. **Environmental** 5. **Public participation**	**AADT / Speed / delay** **Crash rates / Fatalities** **Stakeholder Satisfaction** **NEPA / Project delay** **Compliance**
Level 2 Green Transportation	1. Mobility 2. Accessibility 3. Safety 4. Economic development 5. Environmental 6. Public participation	AADT / Congestion / Emissions Transit Ridership Crash rates / Fatalities
Level 3 Sustainable Transportation	1. Sustainability (Green) 2. Mobility 3. Accessibility 4. Safety 5. Economic Development 6. Connectivity 7. System efficiency 8. Public Participation	
Level 4 TBL Sustainability	1. Sustainability (TBL): 1. Mobility and safety 2. Accessibility 3. Connectivity 4. System efficiency	Valuation BCA

Maturity Level / Goals / Metrics

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750v4.pdf
As adapted

Level 0 Safe Mobility	1. Mobility 2. Safety 3. Economic development	AADT / Speed Crash rates / Fatalities Stakeholder Satisfaction
Level 1 Compliant Transportation	1. Mobility 2. Safety 3. Economic development 4. Environmental compliance 5. Public participation	AADT / Speed / delay Crash rates / Fatalities Stakeholder Satisfaction Project delay Compliance
Level 2 Green Transportation	**1. Mobility 2. Accessibility 3. Safety 4. Economic development 5. Environmental 6. Public participation**	**AADT / Congestion / Emissions Transit Ridership Crash rates / Fatalities Stakeholder Satisfaction NEPA / Appearances / Inform / Comply** **~Ratings 1.0**
Level 3 Sustainable Transportation	1. Sustainability (Green) 2. Mobility 3. Accessibility 4. Safety 5. Economic Development 6. Connectivity 7. System efficiency 8. Public Participation	Appearances / Ratings 2.0 / TBL Valuation 1.0 AADT/ Congesti Transit / Paratr Crash rates / F Stakeholder Sa Multi-modal $ Congestion / H Inform /Engag
Level 4 TBL Sustainability	1. Sustainability (TBL): 1. Mobility and safety 2. Accessibility 3. Connectivity 4. System efficiency 2 Public Participation	Ratings 3.0 / T AADT / Crash r Stakeholder Sa Demand satisf Valuation BCA Inform /Engage / Involve in valuations for BCA



National and State Level Rating Systems

System	Sponsor	Scope	Organization	Review	link
Envision™	Institute for Sustainable Infrastructure	Infrastructure	checklist includes 60 credits in five categories (Quality of Life, Leadership, Resource Allocation, Natural World and Climate and Risk);	Fee-based review	http://www.sustainableinfrastructure.org/rating/
GreenLITES	New York State DOT	Highways	checklist includes 180 criteria planning through operations and maintenance	Self-assessment	https://www.dot.ny.gov/programs/greenlites
INVEST	FHWA (USDOT Federal Highway Administration)	Highways	checklist includes 64 Criteria planning through operations and maintenance	Self-assessment	https://www.sustainablehighways.org/
GreenRoads™	Greenroads Foundation	Highways	checklist includes 48 criteria focused on design and construction	Fee based review	https://www.greenroads.org/
STARS	North American Sustainable Transportation Council (STC)	Multi-Modal Transportation	checklist includes 29 credits planning through operations	Fee-based review	http://www.transportationcouncil.org/
TIGER	USDOT	Transportation - All Modes	Benefit / Cost - dollar based valuation across many aspects of the Triple Bottom Line	Grant Program Application	http://www.dot.gov/policy-initiatives/tiger/tiger-bca-resource-guide-2014

Maturity Level / Goals / Metrics

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750v4.pdf
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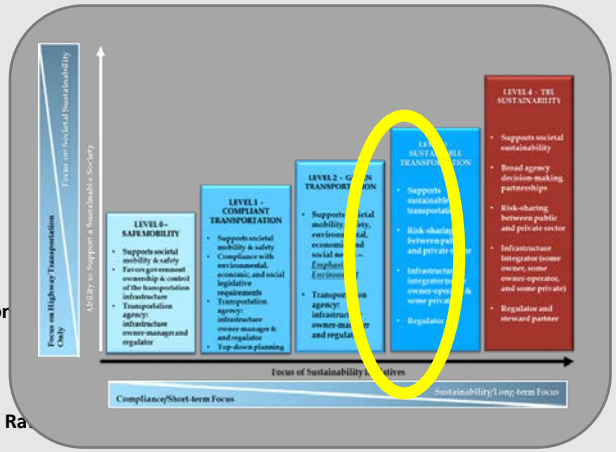
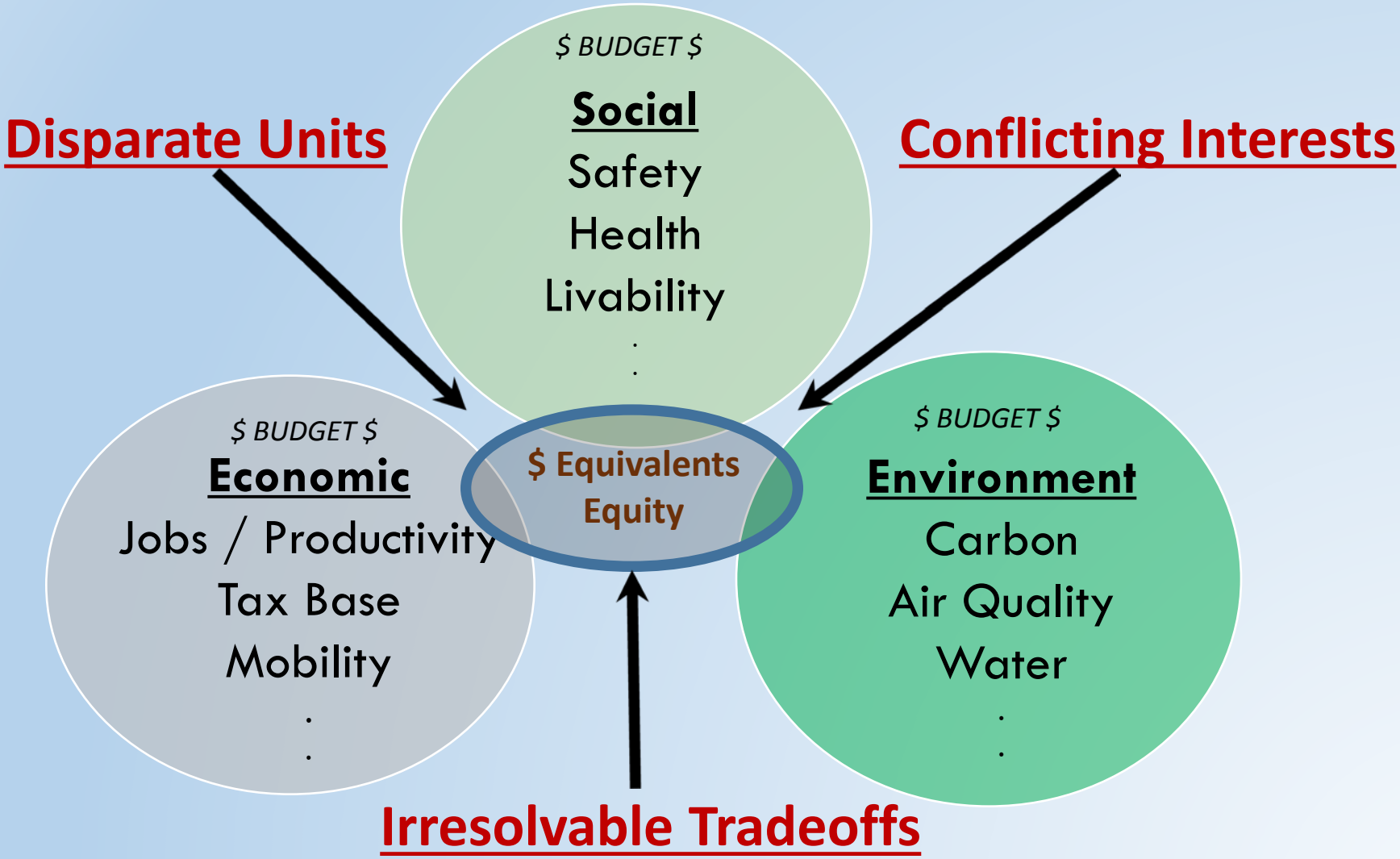
Level 1 Compliant Transportation	1. Mobility 2. Safety 3. Economic development 4. Environmental compliance 5. Public participation	AADT / Speed / delay Crash rates / Fatalities Stakeholder Satisfaction Project delay Compliance
Level 2 Green Transportation	1. Mobility 2. Accessibility 3. Safety 4. Economic development 5. Environmental stewardship 6. Public participation	AADT / Congestion / Emissior Transit Ridership Crash rates / Fatalities Stakeholder Satisfaction Compliance / Appearances / Ra Inform / Comply
Level 3 Sustainable Transportation	1. **Sustainability (~Green)** 2. **Mobility** 3. **Accessibility** 4. **Safety** 5. **Economic Development** 6. **Connectivity** 7. **System efficiency** 8. **Public Participation**	**Ratings 2.0 / TBL Valuation 1.0** • **AADT/ Congestion / Emissions** • **Transit / Paratransit Ridership** • **Crash rates / Fatalities** • **Stakeholder Satisfaction** • **Multi-modal $** • **Congestion / Hours of delay** • **Inform /Engage**
Level 4 TBL Sustainability	1. Sustainability (TBL): 1. Mobility and safety 2. Accessibility 3. Connectivity 4. System efficiency 2 Public Participation	Ratings 3.0 / TBL Valuation 2.0 AADT / Crash rates / Fatalities Stakeholder Satisfaction BCA Demand satisfaction Valuation BCA Inform /Engage / Involve in valuations for BCA



$$$ -- "The Dismal Science" -- $$$



Tiger Criteria ~ Triple Bottom Line (TBL)

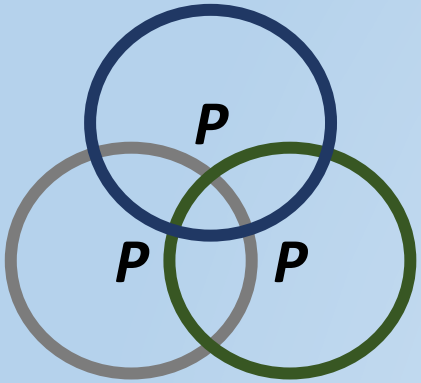


TABLE 3 U.S. DOT TIGER Considerations

Long-Term Outcome	Type of Societal Benefits
Livability	Land Use Changes that reduce VMT Accessibility Property Value Increases
Economic Competitiveness	Travel Time Savings Operating Cost Savings
Safety	Prevented Accidents (property damage), Injuries and Fatalities
State of Good Repair	Long Term Replacement Maintenance & Repair Savings Reduced VMT from not closing bridges
Environmental Sustainability	Environmental benefits from reduced emissions

Source: Federal Register Volume 77, No. 20, January 2012.

Maturity Level / Results / Metrics

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750v4.pdf
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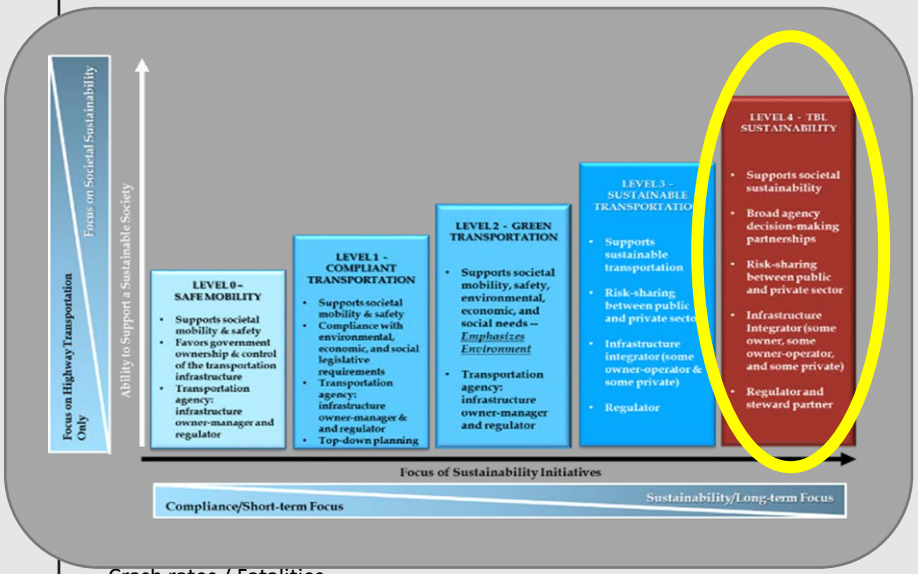
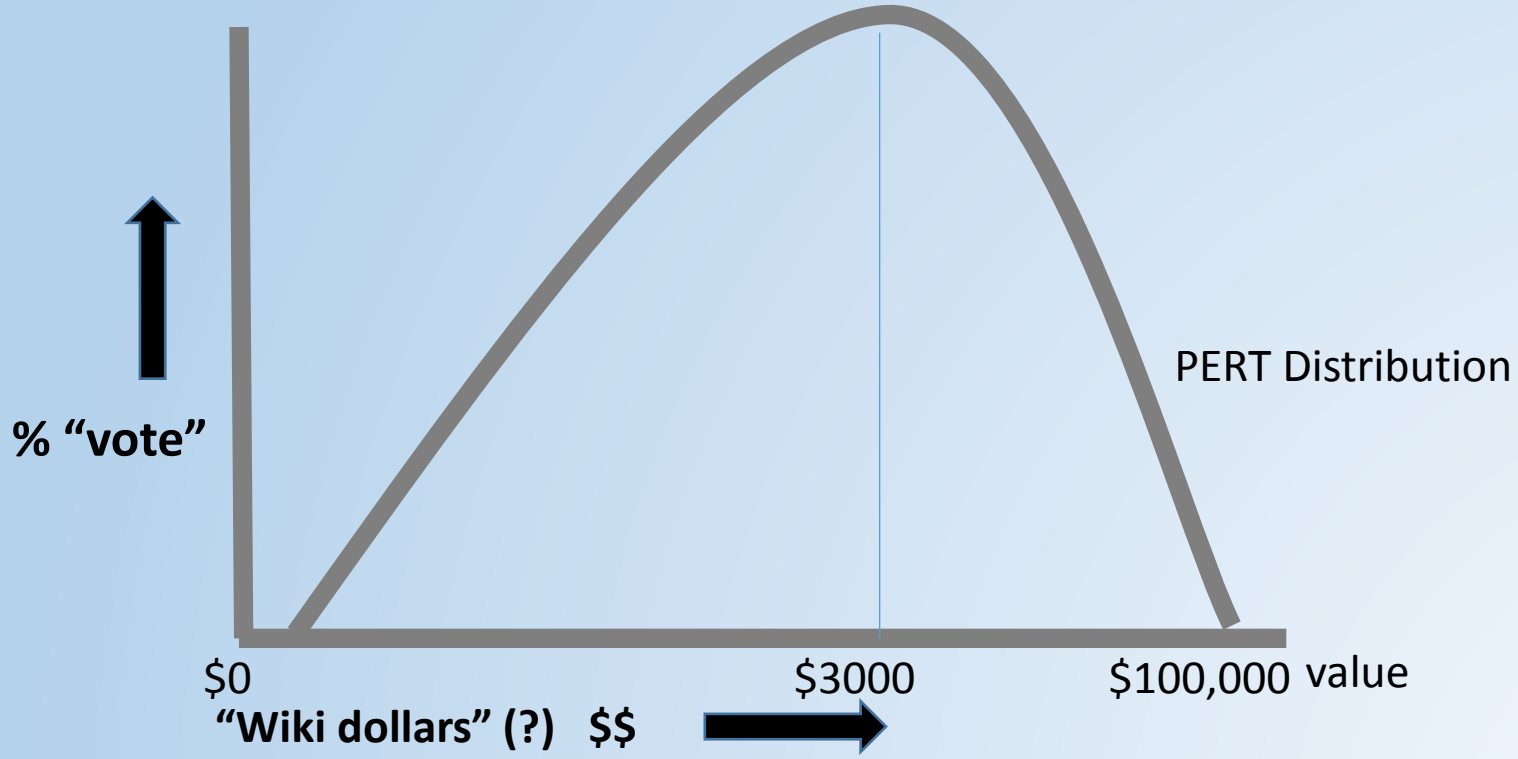


Community input / values…

Low	Most Likely	High
Value of an enhanced acre of habitat?		



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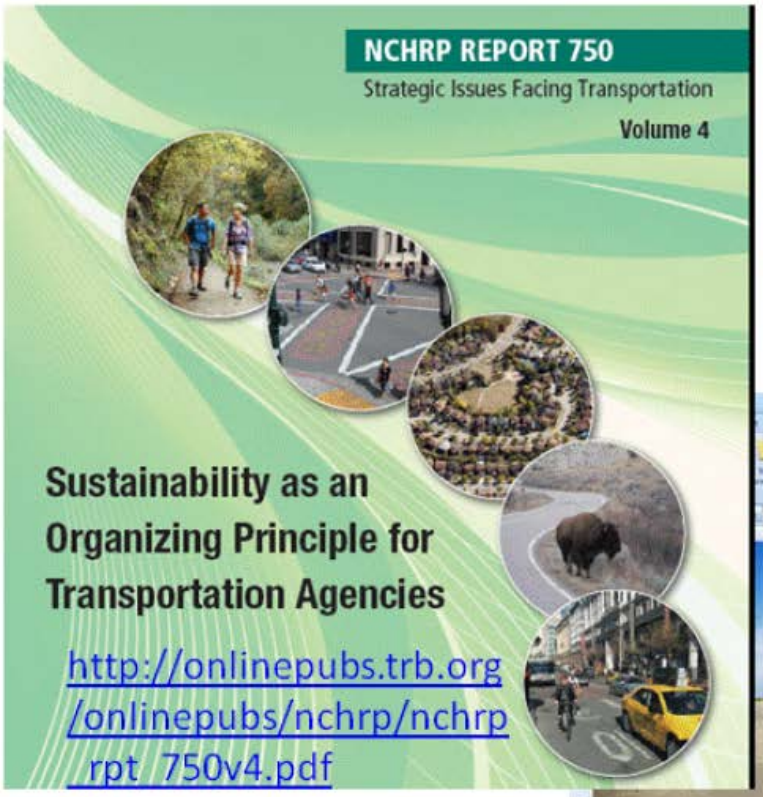
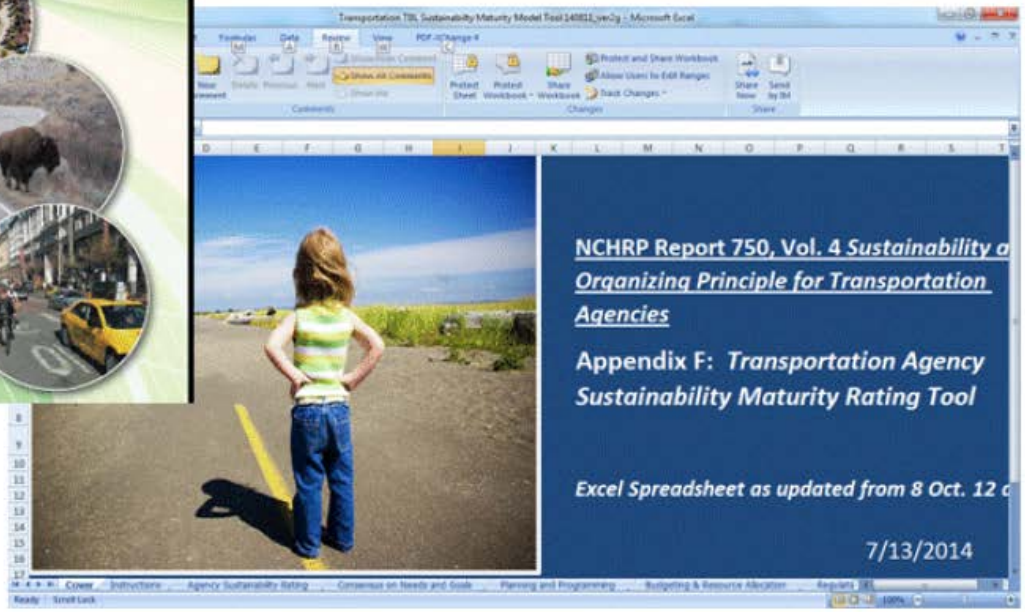


Sustainability Maturity Model Survey as adapted by Panel Chair, Gary McVoy from Appendix F. NCHRP Report 750 Vol. 4; Sustainability as and Organizing Principle for Transportation Agencies



Operations and Maintenance

Supporting Sustainability in its Pragmatic Way

- **Background:** Operations and Maintenance
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- ***Future Prospects: Maintenance and Operations per NCHRP Report 750, Vol 4. Sustainability Maturity Model***
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What would sustainability in maintenance look like?

Transportation Effects

Economic	Environmental	Societal
Congestion	Air Pollution	Impact Inequity
Mobility	Carbon Emission	Property value
Crash Savings	Habitat Loss	Health
Facility Benefits	Water Quality	Cohesion
Consumer Benefits	Hydrologic	Livability
Improved Commerce	Noise	Aesthetics

Source: Adapted from "Sustainable Transportation and TDM: Planning That Balances Economic, Social and Ecological Objectives;" Victoria Transport Policy Institute (An independent Canadian research organization)

5

Program	Activity	Cycle (yrs)
Bridges	Bridge Cleaning	1
	Bridge Painting	12
	Deck Sealing	5
	Deck Treatment	12
	Joints	10
	Bearing Restoration	10
	Punch list From Inspection	2
Pavement		
Drainage		
Signals & Lighting		
Roadside		
Guiderail		
Signs		
SNOW & ICE		
Facilities		
Markings		
Signs		
SLOPES		
WALLS		
Fleet		
ETC		

Program	Activity	Cycle (yrs)
Bridges	Bridge Cleaning	1
	Bridge Painting	12
	Deck Sealing	5
	Deck Treatment	12
	Joints	10
	Bearing Restoration	10
	Punch list From Inspection	2
	Environmental Protection	1
	Storm Water Facility	2
	Stream Channel	2
	Check for Invasive Species	2
	Regulatory Cost (Fines)	1
	Safety	2
	Public Parking / Access	2
	Historic / Cultural Signing	2
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Program	Activity	Cycle (yrs)	#	#/YR TARGET	# STATE FORCES.	# CONTRACT	CAPITAL $	STATE CASH $	LIFECYCLE $
Bridges	Bridge Cleaning	1							X
	Bridge Painting	12							X
	Deck Sealing	5							X
	Deck Treatment	12							X
	Joints	10							X
	Bearing Restoration	10							X
	Punch list From Inspection	2							X
	Environmental Protection	1							
	Storm Water Facility	2							
	Stream Channel	2							
	Check for Invasive Species	2							
	Regulatory Cost (Fines)	1							x
	Safety	2							
	Public Parking / Access	2							
	Historic / Cultural Signing	2							
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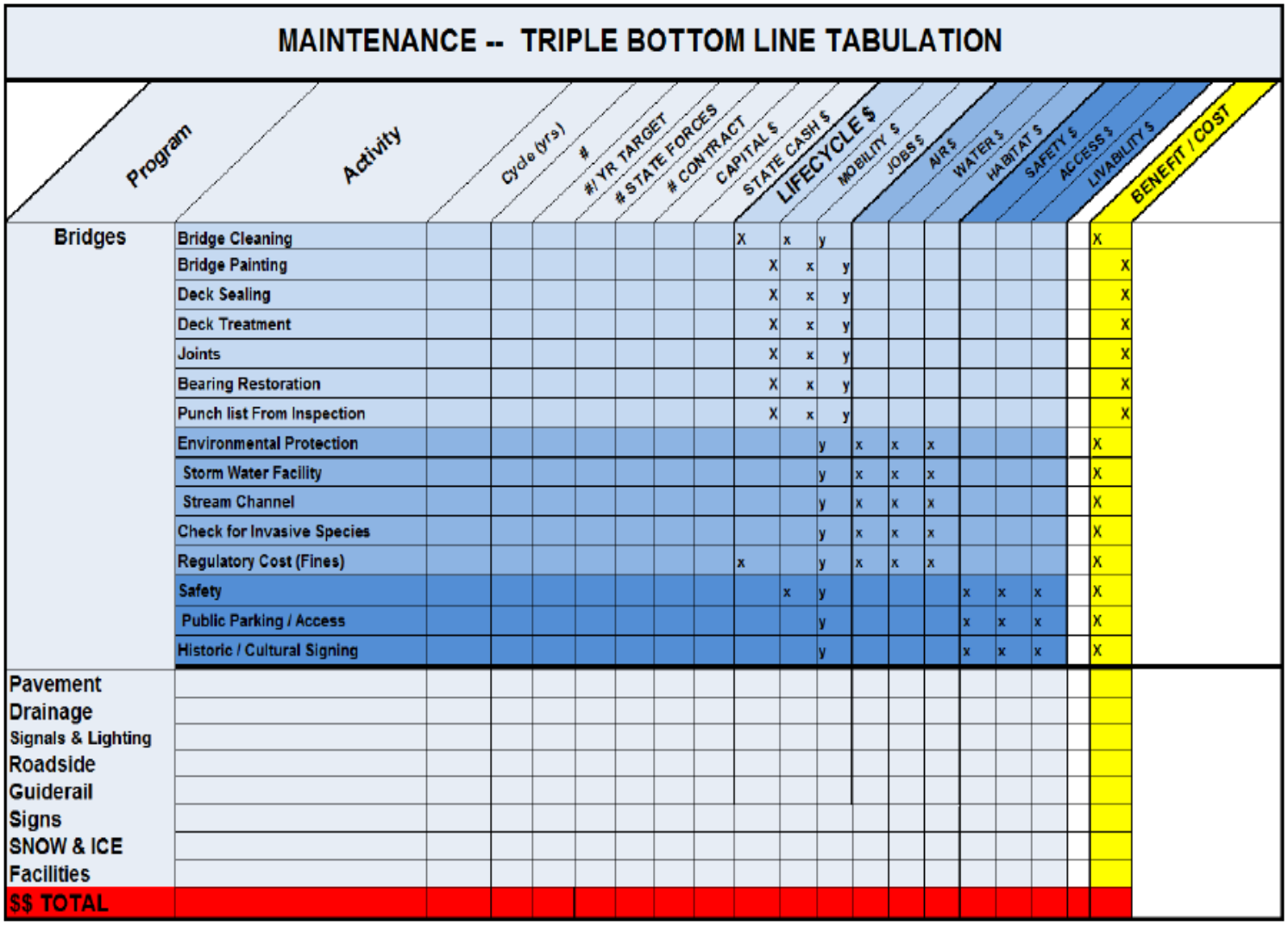
Activity	Cycle (yrs)	#	#/ YR TARGET	#STATE FORCES.	#CONTRACT	CAPITAL $	STATE CASH $	LIFECYCLE $ MOBILITY $	JOBS $	AIR $	WATER $	HABITAT $	SAFETY $	ACCESS $	LIVABILITY $	BENEFIT / COST
Bridge Cleaning	1						X	x	y							X
Bridge Painting	12						X	x	y							X
Deck Sealing	5						X	x	y							X
Deck Treatment	12						X	x	y							X
Joints	10						X	x	y							X
Bearing Restoration	10						X	x	y							X
Punch list From Inspection	2						X	x	y							X
Environmental Protection	1								y	x	x	x				X
Storm Water Facility	2								y	x	x	x				X
Stream Channel	2								y	x	x	x				X
Check for Invasive Species	2								y	x	x	x				X
Regulatory Cost (Fines)	1						x		y	x	x	x				X
Safety	2							x	y				x	x	x	X
Public Parking / Access	2								y				x	x	x	X
Historic / Cultural Signing	2								y				x	x	x	X

Figure 2.1 Maintenance Activities and the Triple Bottom line



MAINTENANCE -- TRIPLE BOTTOM LINE TABULATION

Program	Activity	Cycle (yrs)	#	#/ YR TARGET	# STATE FORCES	# CONTRACT	LIFECYCLE $ CAPITAL $	STATE CASH $		MOBILITY $	JOBS $	AIR $	WATER $	HABITAT $	SAFETY $	ACCESS $	LIVABILITY $	BENEFIT / COST
Bridges	Bridge Cleaning						X	x	y									X
	Bridge Painting							X	x	y								X
	Deck Sealing							X	x	y								X
	Deck Treatment							X	x	y								X
	Joints							X	x	y								X
	Bearing Restoration							X	x	y								X
	Punch list From Inspection							X	x	y								X
	Environmental Protection									y	x	x	x					X
	Storm Water Facility									y	x	x	x					X
	Stream Channel									y	x	x	x					X
	Check for Invasive Species									y	x	x	x					X
	Regulatory Cost (Fines)						x			y	x	x	x					X
	Safety								x	y				x	x	x		X
	Public Parking / Access									y				x	x	x		X
	Historic / Cultural Signing									y				x	x	x		X
Pavement																		
Drainage																		
Signals & Lighting																		
Roadside																		
Guiderail																		
Signs																		
SNOW & ICE																		
Facilities																		
$$ TOTAL																		

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http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3116

NCHRP Project 25-25, Task 73

FY 2011

Research for the AASHTO

Standing Committee on the Environment

Improved Environmental Performance of Highway Maintenance

Benefit of Bridge Corrective Maintenance

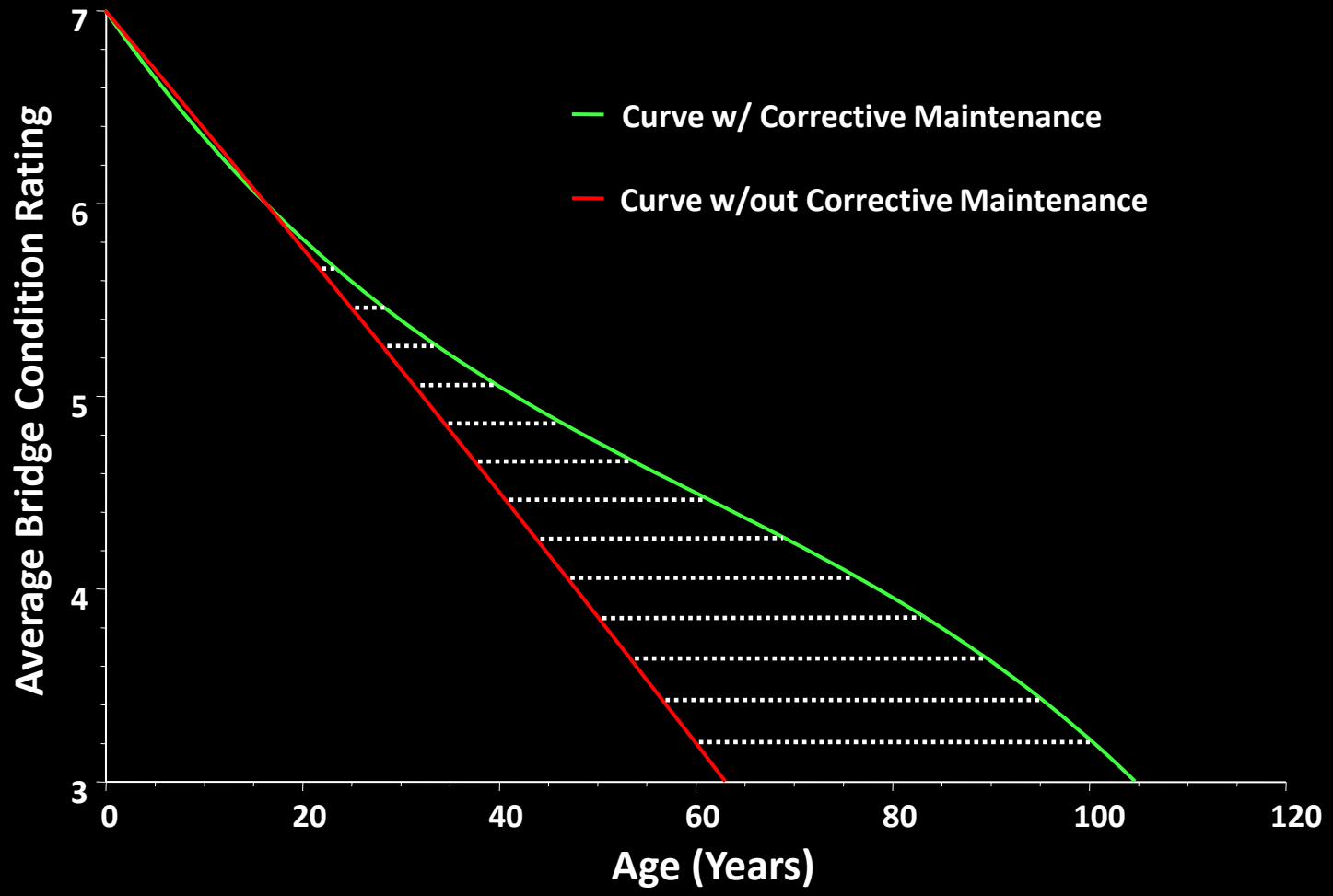


Table A.1 Excerpt – Typical Maintenance Activities

[1] Activity	[2] Examples of Selected Best Management Practices	[3] Examples of Some Potential Environmental Offsets	[4] Examples of Probable Environmental, Social, and Economic Benefits	[5] AASHTO Maintenance Manual for Roadways and Bridges (Links)	[6] AASHTO Compendium (Links)
Traveled Way		Energy usage in all cases, plus impacts noted below		2.1.2 Maintenance of Roadway Surfaces	5.0 Pavement, Materials, and Recycling
Sweep and vacuum roads and bridges	Remove dust and sediments from roadways and bridges	Air and water pollution, waste generation	Reduce impacts to water from sediment loading; improve air quality		10.10 Sweeping and Vacuuming Roads, Decks, Water quality Facilities, and Bridge Scuppers
Maintain pavement markings	Restore pavement stripes and markings	Air pollution, waste generation, hazmat disposal	Improve traveler safety		5.5 Pavement Marking
Patch deteriorated pavements	Cold patch potholes	Waste generation	Extend the pavement life; reduce waste and energy consumption		
Seal cracks and joints	Clean and fill cracks and joints	Waste, noise, dust and odor generation	Extend the pavement life; reduce waste and energy consumption		

Table A.2 Excerpt –Triple Bottom Line Linkages

(--) potential environmental impact

(+) potential for minimization, mitigation, or enhancement

(X) potential for material cost or benefit

Maintenance Activities	Environmental						Social			Economic		
	Air Resources	Water Resources	Noise Effects	Waste Reduction /Recycling	Wildlife Habitat	Energy Conservation & Efficiency	Access	Safety	Equity	Costs	Jobs	Mobility
Traveled Way												
Sweep and vacuum roads and bridges	--	+										
Maintain pavement markings	--							+				
Patch deteriorated pavements				+						X		
Seal cracks and joints				+						X		
Resurface pavements	--			+			X	X				X

NCHRP 25-25 Task 73: Improved Environmental Performance of Highway Maintenance

…... This study found that DOT maintenance organizations have a strong environmental ethic and support sustainability precepts.

However, as reflected in maintenance staffing, training, and management, the focus is on ***compliance***….

Figure 2.1 Maintenance Activities and the Triple Bottom line

MAINTENANCE -- TRIPLE BOTTOM LINE TABULATION

Program	Activity	Cycle (yrs)	#	#/ YR TARGET	# STATE FORCES	# CONTRACT	LIFECYCLE $ CAPITAL $	LIFECYCLE $ STATE CASH $	LIFECYCLE $	MOBILITY $	JOBS $	AIR $	WATER $	HABITAT $	SAFETY $	ACCESS $	LIVABILITY $	BENEFIT / COST
Bridges	Bridge Cleaning						X	x	y									X
	Bridge Painting						X	x	y									X
	Deck Sealing						X	x	y									X
	Deck Treatment						X	x	y									X
	Joints						X	x	y									X
	Bearing Restoration						X	x	y									X
	Punch list From Inspection						X	x	y									X
	Environmental Protection								y	x	x	x						X
	Storm Water Facility								y	x	x	x						X
	Stream Channel								y	x	x	x						X
	Check for Invasive Species								y	x	x	x						X
	Regulatory Cost (Fines)						x		y	x	x	x						X
	Safety							x	y				x	x	x			X
	Public Parking / Access								y				x	x	x			X
	Historic / Cultural Signing								y				x	x	x			X
Pavement																		
Drainage																		
Signals & Lighting																		
Roadside																		
Guiderail																		
Signs																		
SNOW & ICE																		
Facilities																		
$$ TOTAL																		

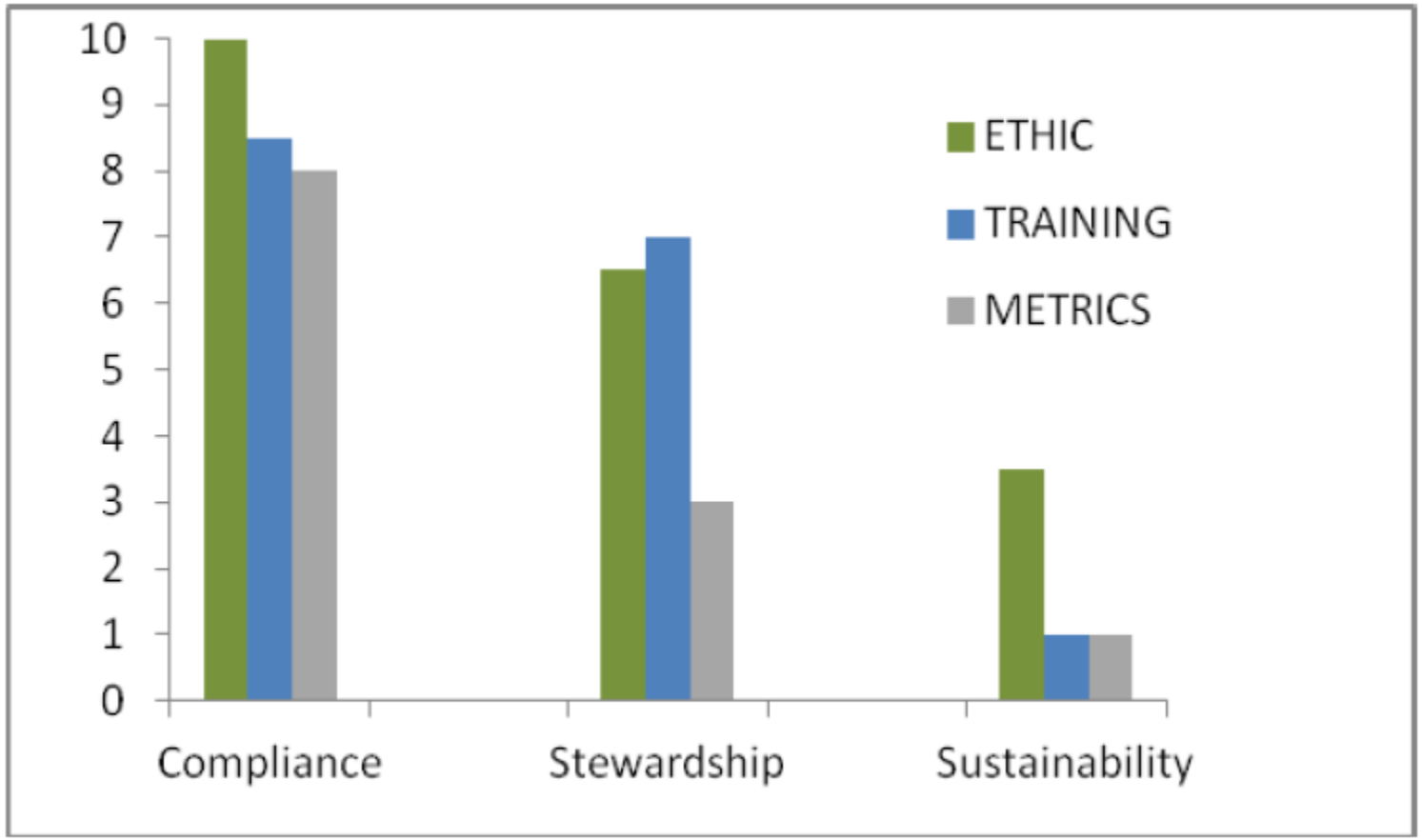


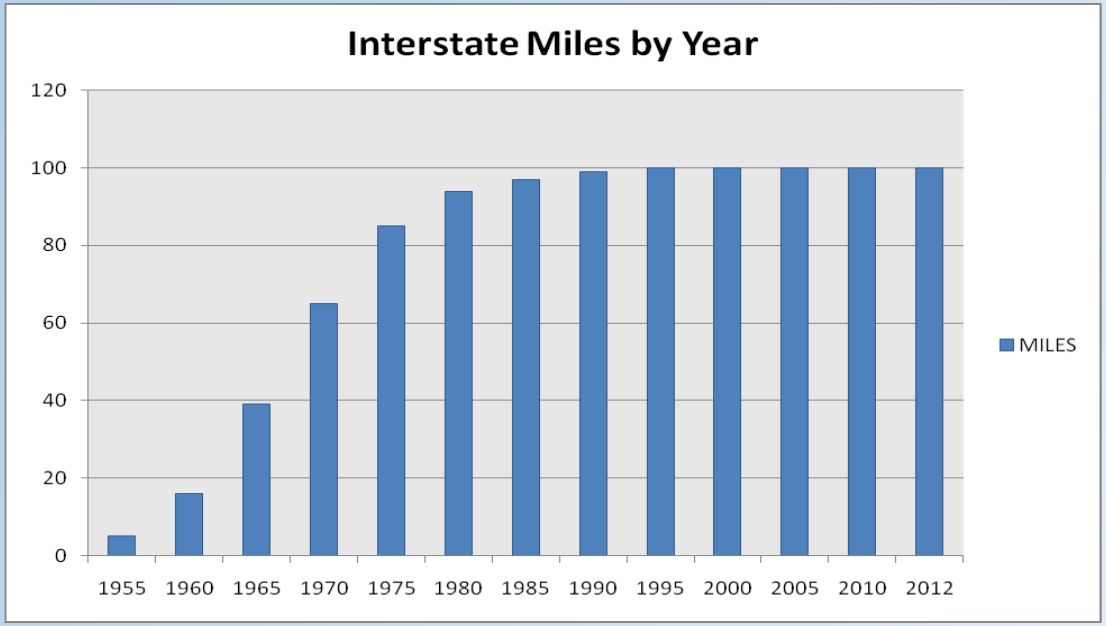
Figure 0.1: Environmental Compliance, Stewardship, and Sustainability

Transportation Maintenance / Sustainability Maturity Model

NCHRP Report 750: Strategic Issues Facing Transportation, Volume 4: Sustainability as an Organizing Principle for Transportation Agencies, 2014

Baseline: Operations & Maintenance vs. Capital

- Demand responsive culture of stewardship
- Fixed funding
- Cash vs. Bonding
- Line vs. Expert Staffing



From http://www.publicpurpose.com/hwy-intmiles.htm

Section 1 (Presenter: Dr. McVoy)

Operations and Maintenance

Supporting Sustainability in its Pragmatic Way

- ✓ **Background:** Operations and Maintenance
- ✓ **Potential Objective:** Transportation in support of a sustainable society (NCHRP Report 750, Vol. 4)
- ✓ **Future Prospects:** Maintenance and Operations per NCHRP Report 750, Vol 4. Sustainability Maturity Model
- ✓ **Current State in Perspective:** Operations & Maintenance – Environment and Sustainability, per NCHRP 25-25 Task 73: Improved Environmental Performance of Highway Maintenance

Sustainability Performance Measurement Framework
- *Putting Together the Pieces*

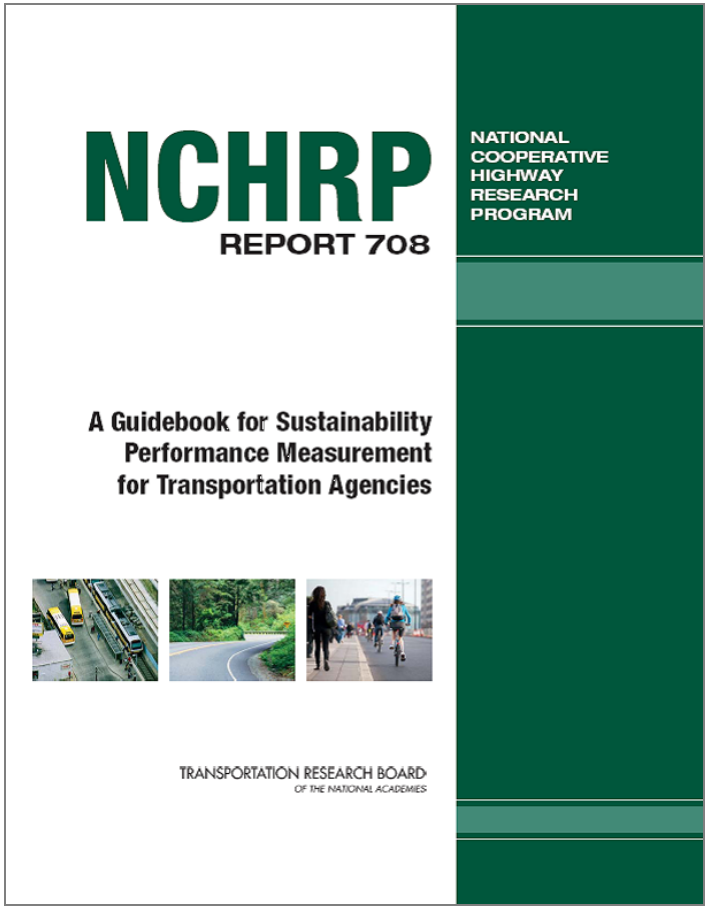
Presented By
Joe Zietsman. Ph.D., P.E.

Presentation Overview

- Broader context - sustainability and sustainable transportation
- Functional areas and their roles
- Using the framework approach
- Sustainability in Operations and Maintenance
  - Role of private and public sector players
  - Sustainability planning and implementation

NCHRP Report 708

- *A Guidebook for Sustainability Performance Measurement for Transportation Agencies*
- Spreadsheet-based "compendium" of performance measures
- Research report



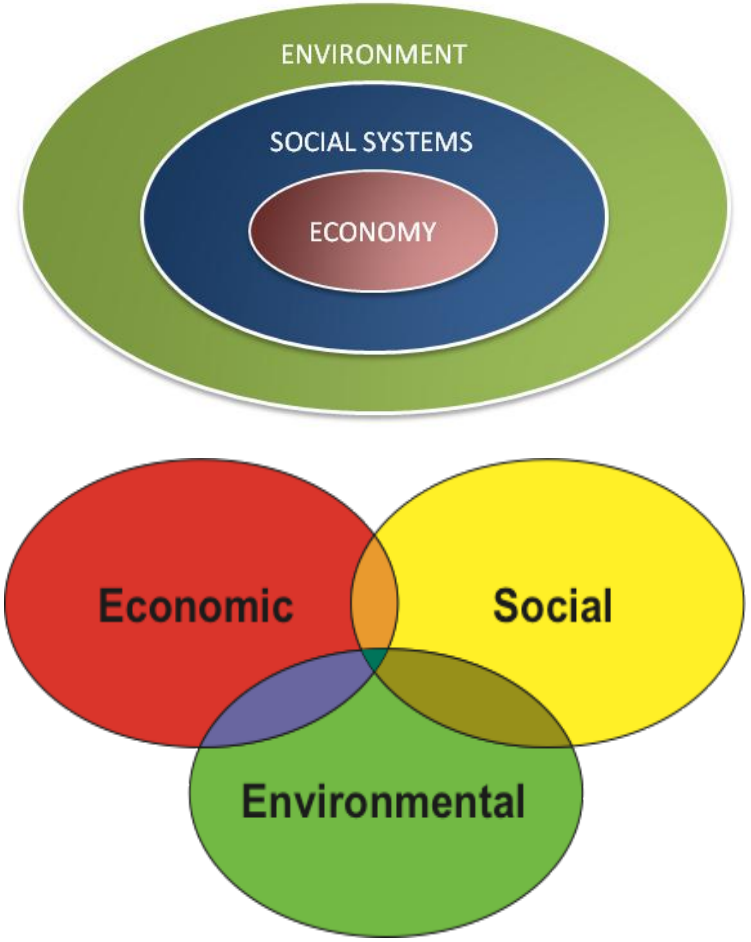
http://www.trb.org/Main/Blurbs/166313.aspx

Best Practices

- Have a clear vision
- Adopt measurements and targets
- Strong committed leadership
- Sufficient resources
- Good communication
- Involve the private sector

Overview of Sustainability

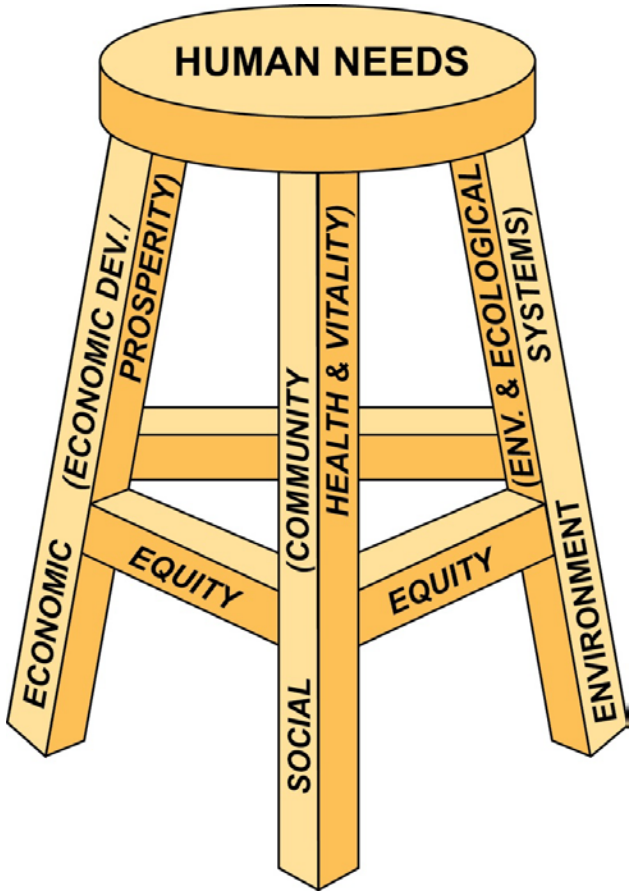
- *"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs"*
- Sustainability dimensions – environmental, economic, social



Sustainability Principles

Sustainability entails meeting human needs for the present and future, while:

- *preserving and restoring environmental and ecological systems;*
- *fostering community health and vitality;*
- *promoting economic development and prosperity; and*
- *ensuring equity between and among population groups and over generations.*



Sustainability in Transportation

- *Safety*
- *Accessibility*
- *Mobility*
- *System Efficiency*
- *Security*
- *Prosperity*
- *Economic Viability*
- *Ecosystems*
- *Waste Generation*
- *Resource Consumption*
- *Emissions and Air Quality*

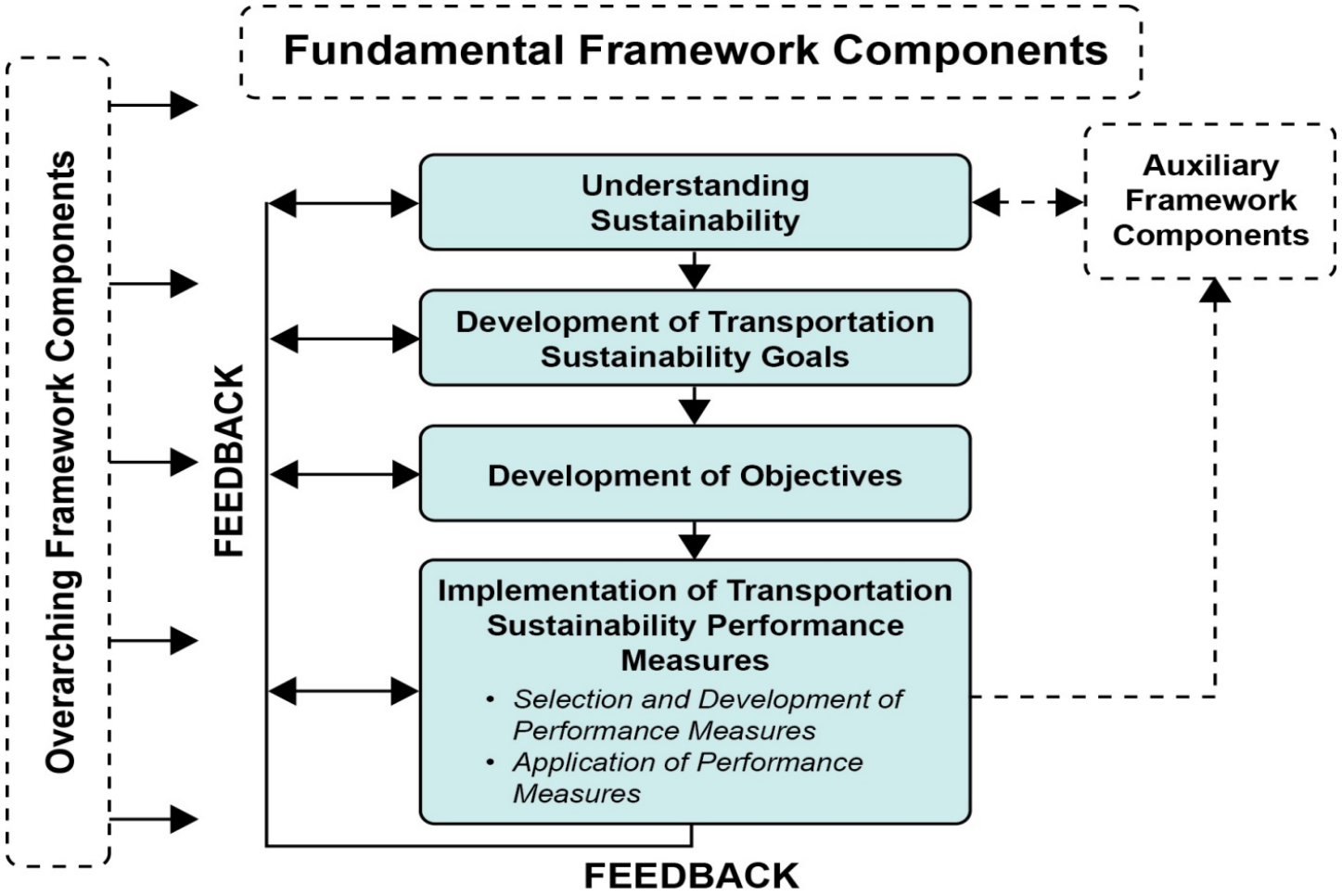
Functional Areas

- Planning
- Programming
- Project development
- Construction
- Maintenance
- Operation

Sustainability in Operations and Maintenance

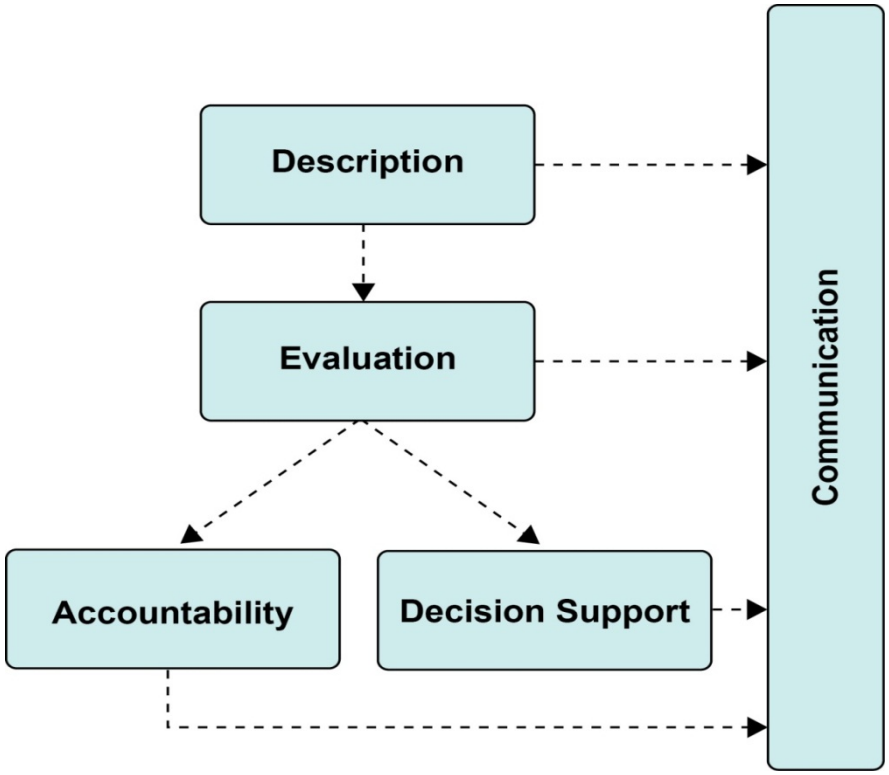
- *Safety*
- *Accessibility*
- *Mobility*
- *System Efficiency*
- *Security*
- *Prosperity*
- *Economic Viability*
- *Ecosystems*
- *Waste Generation*
- *Resource Consumption*
- *Emissions and Air Quality*

Framework for Sustainability Performance Measurement



Implementing Performance Measures

- Application level
  - Focus areas/business units
  - Whole agency
- Application type
  - Describe
  - Evaluate
  - Accountability
  - Decision Support
  - Communication



Application by Functional Area

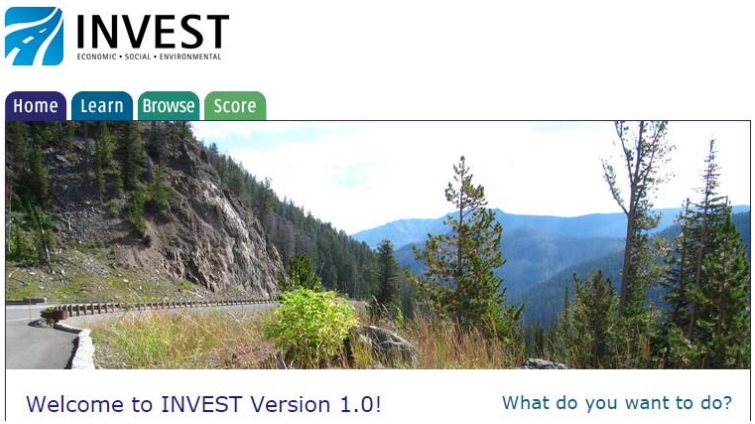
- Planning
- Programming
- Project development
- Construction
- *Operations*
- *Maintenance*

Compendium of potential performance measures based on functional area and other filters

10/4/2015		TITLE
RESET EXPORT		
Goal	**Objective**	**Measure**
9. Waste Generation	Reduce total waste created during maintenance	Change in the amount of waste generated by type, weight and/or volume during maintenance
9. Waste Generation	Increase the percentage of waste diverted during maintenance	Change in the amount of maintenance waste diverted (from landfull) by type, weight and/or volume
9. Waste Generation	Increase the percentage of waste diverted during maintenance	*Change in the percentage of maintenance projects with a recycling plan or waste diversion goal*
9. Waste Generation	Reduce hazardous waste generated during maintenance	Change in the amount of hazardous waste generated during maintenance
10. Resource Consumption	Use biofuel for nonroad maintenance equipment	*Percentage of machine-hours or gallons of biofuel used during maintenance*
10. Resource Consumption	Purchase regionally-produced maintenance materials	Total weight/volume/cost purchased within a certain radius [e.g. 500 miles] from the project
10. Resource Consumption	Reduce energy usage due to maintenance	Total machine-hours of energy efficient nonroad equipment as a percentage of all maintenance-related machine-hours

Rating Systems

- FHWA's INVEST
- Greenroads
- GreenLITES
- ENVISION
- I-LAST
- LEED
- STARS
- …



O&M Criteria in INVEST

- OM-01: Internal Sustainability Plan
- OM-02: Electrical Energy Efficiency and Use
- OM-03: Vehicle Fuel Efficiency and Use
- OM-04: Reduce, Reuse and Recycle
- OM-05: Safety Management
- OM-06: Environmental Commitments Tracking System
- OM-07: Pavement Management System
- OM-08: Bridge Management System
- OM-09: Maintenance Management System
- OM-10: Highway Infrastructure Preservation and Maintenance
- OM-11: Traffic Control Infrastructure Maintenance
- OM-12: Road Weather Management Program
- OM-13: Transportation Management and Operations
- OM-14: Work Zone Traffic Controls

Sustainability and O&M

- O&M is an important part of transportation sustainability
  - Large portion of DOT activities
  - Opportunities with “low-hanging fruit”
- Considerations
  - Role of the private sector
  - Stewardship/Corporate Social Responsibility
  - Can have co-benefits (savings, efficiencies)

Role of Sustainability Plan

- Signifies a *commitment* to sustainability
- Allows for strategic, holistic approach

Final Thoughts

- O&M – important component to achieving sustainability
- Need a plan with a framework
  - Performance measures
  - Applications
  - Targets and benchmarks
- Apply best practices and avoid “greenwashing”
- Look beyond transportation and involve the private sector
- Make it happen!

TRB Webinar on Our Vital Role Supporting & Enhancing Sustainability

Next Gen - What's up and coming?

Marie Venner, President/Principal

Venner Consulting, Chair, TRB AF0003, Climate Change Impacts, Energy, & Sustainability

Moving the World Forward:

Exploring a future in public service

Together we make the difference

Lots of projects relating to DOT Maint & Ops

14-25 Establishing Level of Service Targets for Asset Management
25-31 Evaluating and Selecting Modifications to Existing Roadway Drainage
25-40 Long-Term Performance and Life-Cycle Costs of Stormwater BMPs
20-81 Strategies to Attract and Retain a Capable Transportation Workforce
20-86 Recruiting and Retaining Skilled Staff for Transport System Operation
20-59/53 FloodCast: Framework for Enhanced Flood Event Decision Making
25-25/04 Maintenance Environmental Stewardship Practices & Procedures - 9 volumes:
organizational process improvement strategies, winter maint., facilities, pavement, veg. mgmt., etc.
25-25/73 Improved Environmental Performance of Highway Maintenance
25-25/10 Alternative/Early Mitigation: Streamlining and Achieving Net Benefits
25-25/50 Incentive-based Approaches to Compliance
25-25/51 Asset Management of Environmental Mitigation Features
25-25/58 Methods to Address GHG Emissions from Maintenance/Operations
25-25/60 Increased Use of Environmentally Preferable, Non-Toxic Products
25-25/63 Transportation Corridor Environmental Management Framework
25-25/75 Evaluation of Transfer of Compensatory Wetland Creation Sites
25-25/82 Permeable Shoulders – Design, Development & Maintenance
25-25/83 Current Practice of Post- Construction Structural Stormwater Control
25-25/86 Toxicological Effect of Chloride Based Deicers
08-36/86 Corridor Approaches to Integrating Land Transportation and Land Use
08-36/61:Monetary Value per Dollar of Investment by Performance Areas
Syntheses: Invasive Species Management Practices, Life Cycle Cost Assessment in Asset Mgmt.

Where we've been…

- **Regulation** – Don't really want to be there
- **How are *you* doing it?** – AASHTO best practice compendium from all 50 states
- **(Let's leave it) better than before**
- **Cost-effectiveness/complete costs**
- **Do the right thing** - How can we help?
  - Landscape conservation
  - Environ./sustainability enhancement
- **Climate change** – the phenomenal costs of doing the *wrong* thing
- **EMS –** Let's be systematic about the improvements we're going to make

Where are we now?

Dire Straits, Exciting Times, or Both?

- We're always poised between the past and future
- But we really are at a major / significant point (think just before the WWII mobilization)

We're here today to talk about the **environment in relation to our work, maintenance & operations** of the transportation system.

So **what *is* the environment now?**

- **What is the status or state of it now?**
- **(What are we headed to) 10 years from now?**
- **In 15-20 years from now?**

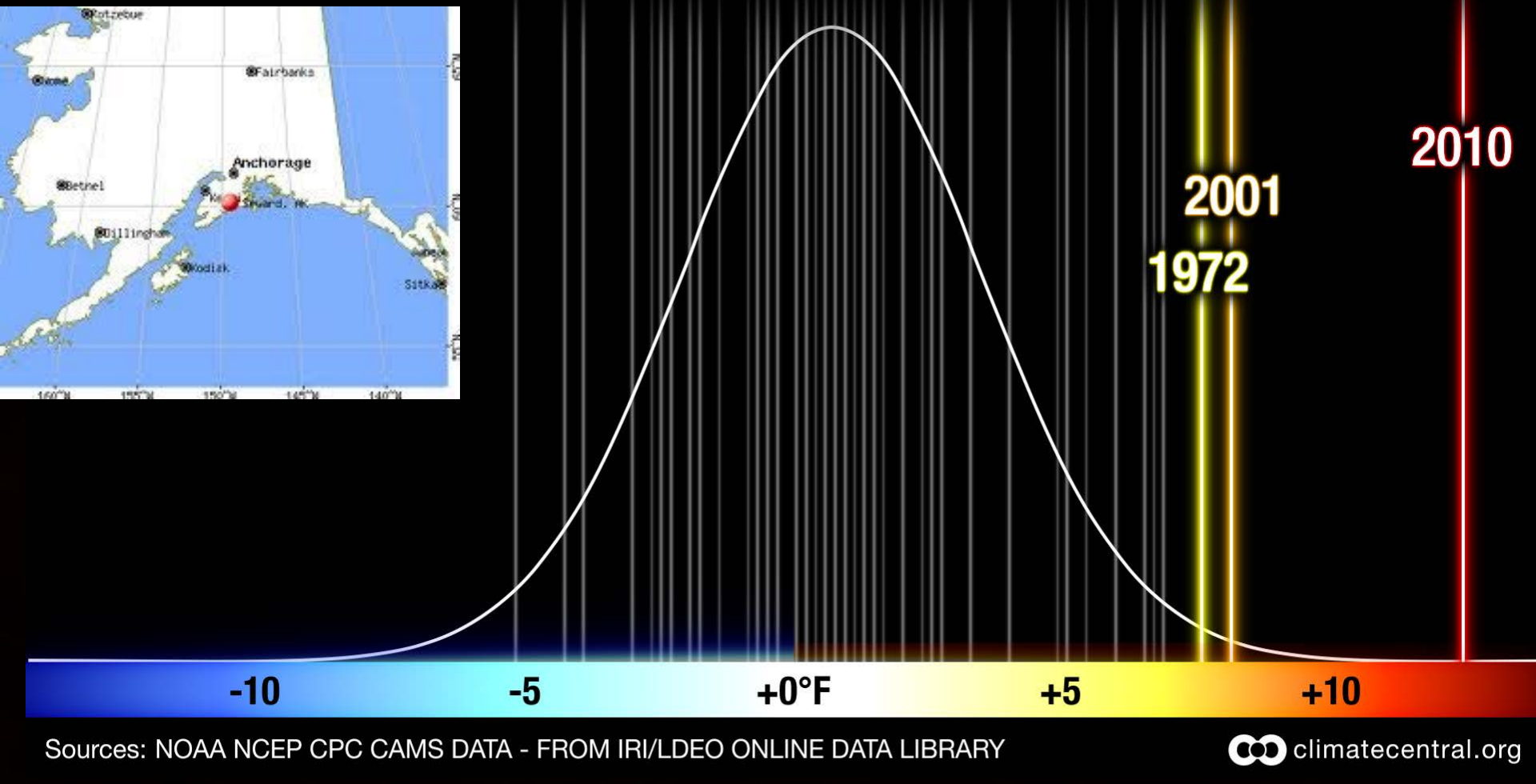
If we aren't asking these questions *we may be* ***missing the boat in understanding our context for decision making****. What can we do for (and do we owe) the future, our kids, other kids, the public in this context?*

How far out, are we?

One way to assess: look at the degree by which we are breaking records:

In recent years, some towns and cities in the US have seen heat records broken by 3

Or see the standard deviation of heat waves in Moscow…

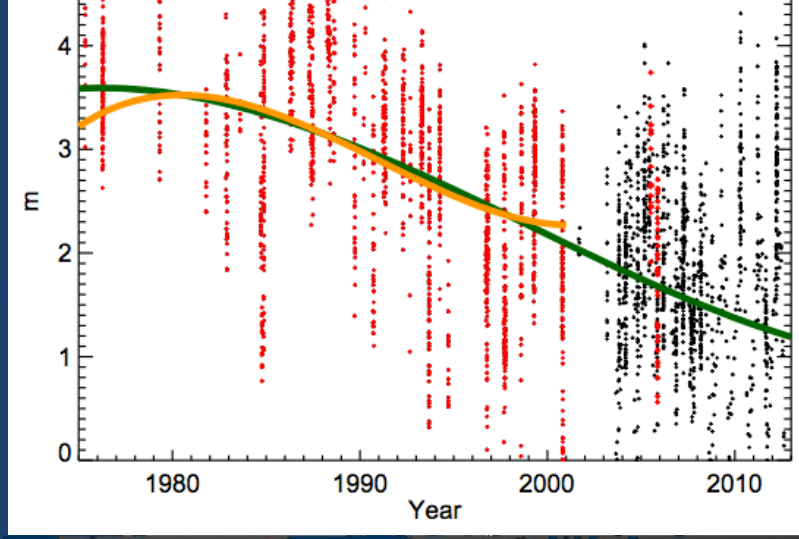


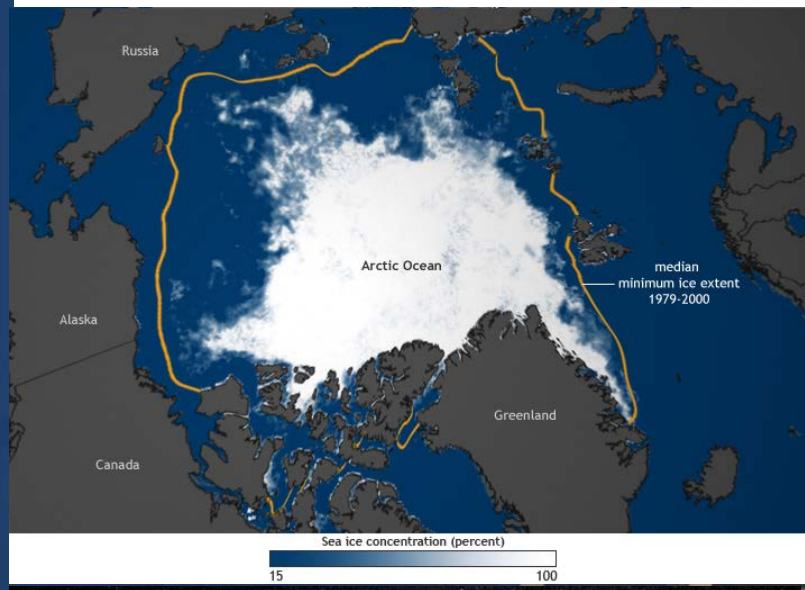
Sources: NOAA NCEP CPC CAMS DATA - FROM IRI/LDEO ONLINE DATA LIBRARY

climatecentral.org

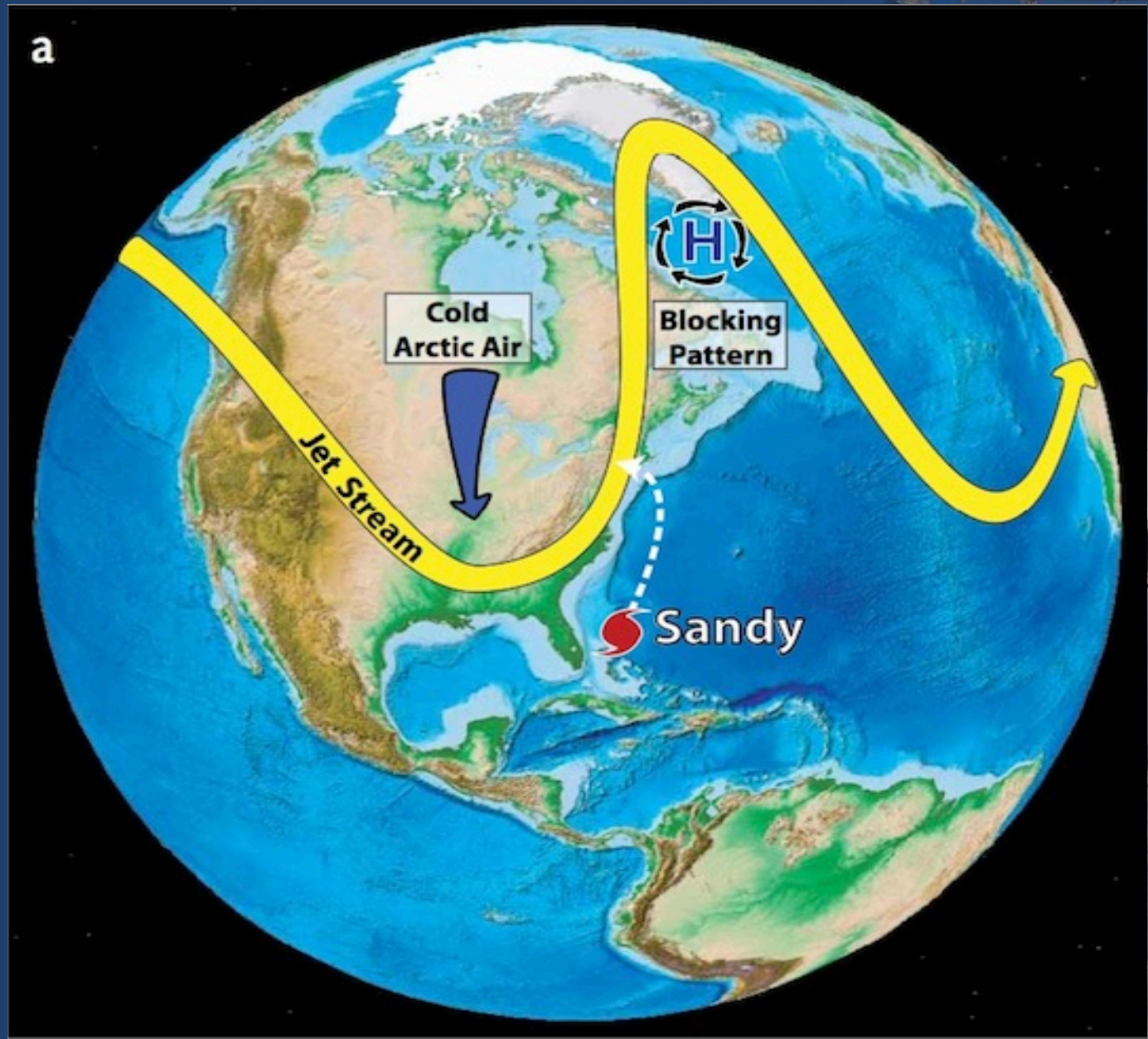
Extreme Melting/Ice Loss with rising temps thus far

- Both extent & thickness have dropped precipitously–much faster than estimated.
- Summer arctic ice thickness dropped **85% from 1975 to 2012** (recent study, Cryosphere, Feb 2015).
  - Decline in annual mean ice thickness is DOUBLE the decline estimated earlier.
  - In September the mean ice thickness has declined from 3.01 to 0.44 m [from 9.9 to 1.4 feet 85%!
- In Antarctica, new research (Oct 2015) based on satellite observations of ice surface melting predicts a doubling of surface melting of the ice shelves by 2050, with the possibility of ice shelf collapse by century's end.
- Implications for sea level rise, permafrost melt, and extreme weather.





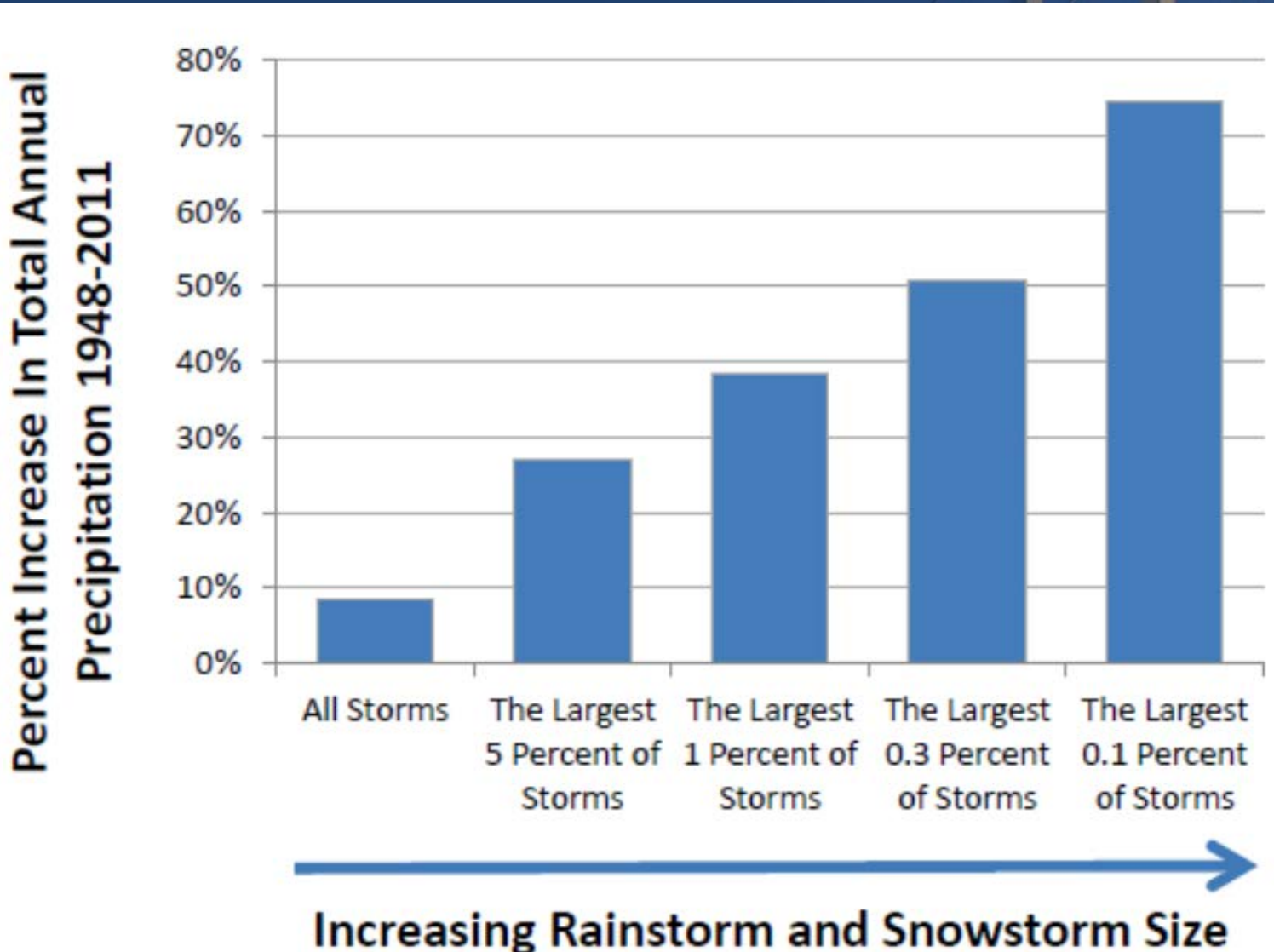
Messing with the Jet Stream…



Largest Storms are Getting Bigger, Faster, Than Other Storms

The amount of precipitation falling in the heaviest 1% of rain events increased nearly 20% in the last 50 years

(for example, three “1000 yr” events since 2004 in Minn.)



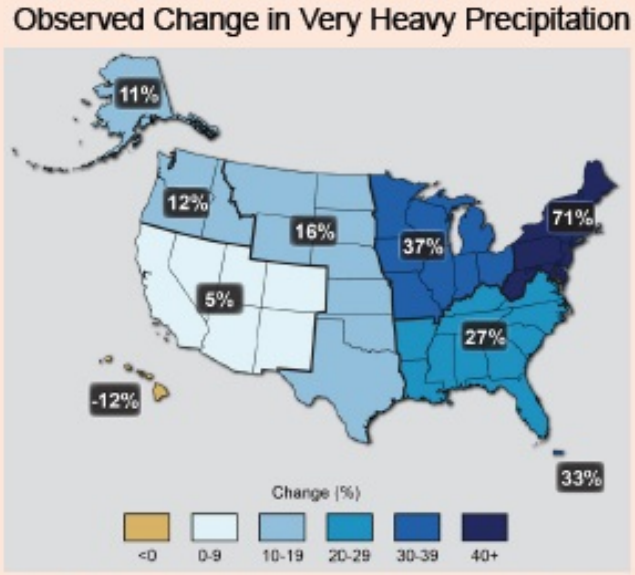
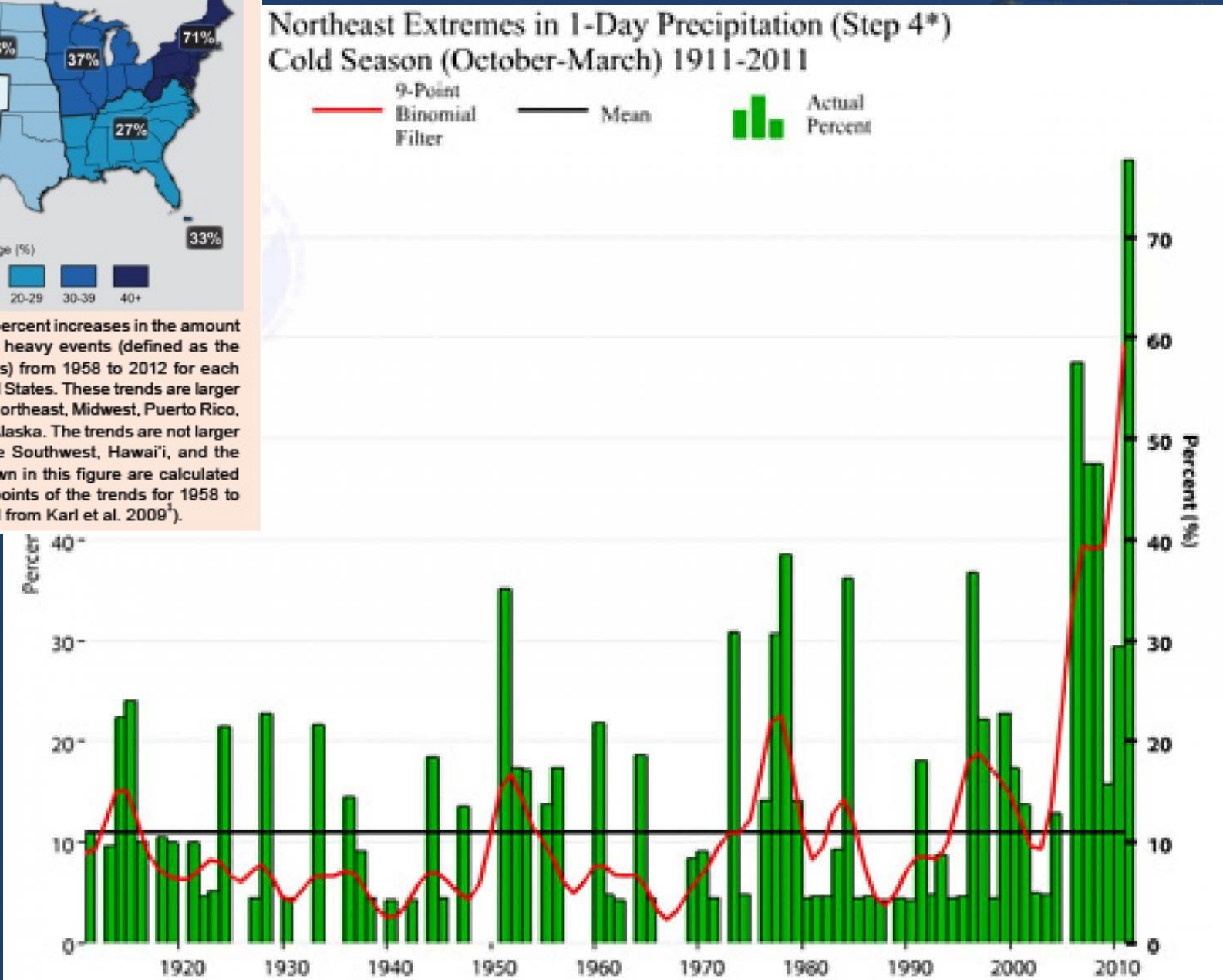
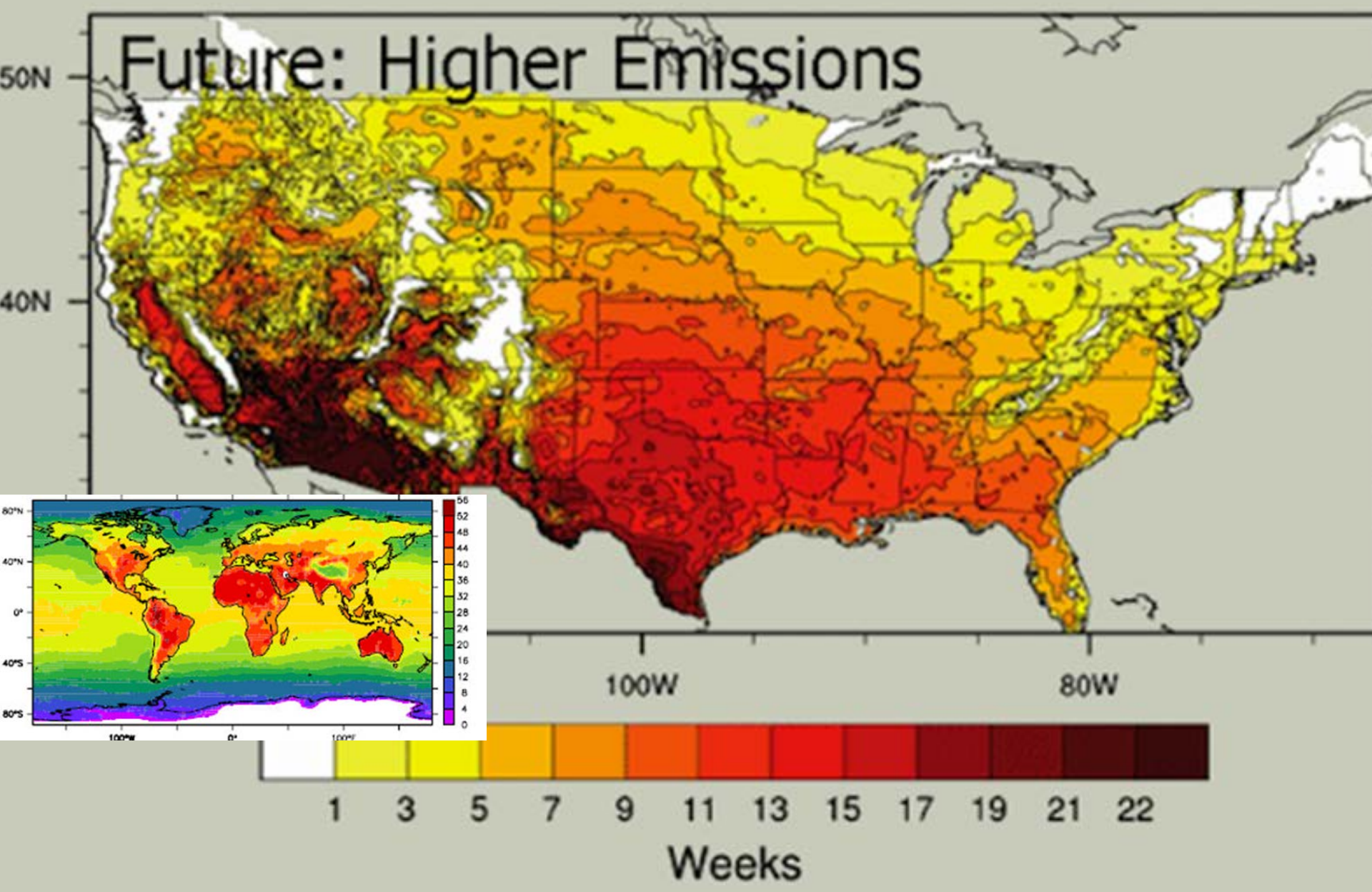


Figure 2.18. The map shows percent increases in the amount of precipitation falling in very heavy events (defined as the heaviest 1% of all daily events) from 1958 to 2012 for each region of the continental United States. These trends are larger than natural variations for the Northeast, Midwest, Puerto Rico, Southeast, Great Plains, and Alaska. The trends are not larger than natural variations for the Southwest, Hawai'i, and the Northwest. The changes shown in this figure are calculated from the beginning and end points of the trends for 1958 to 2012. (Figure source: updated from Karl et al. 2009[4]).



Weeks per Year > 100°F (38°C)



930s
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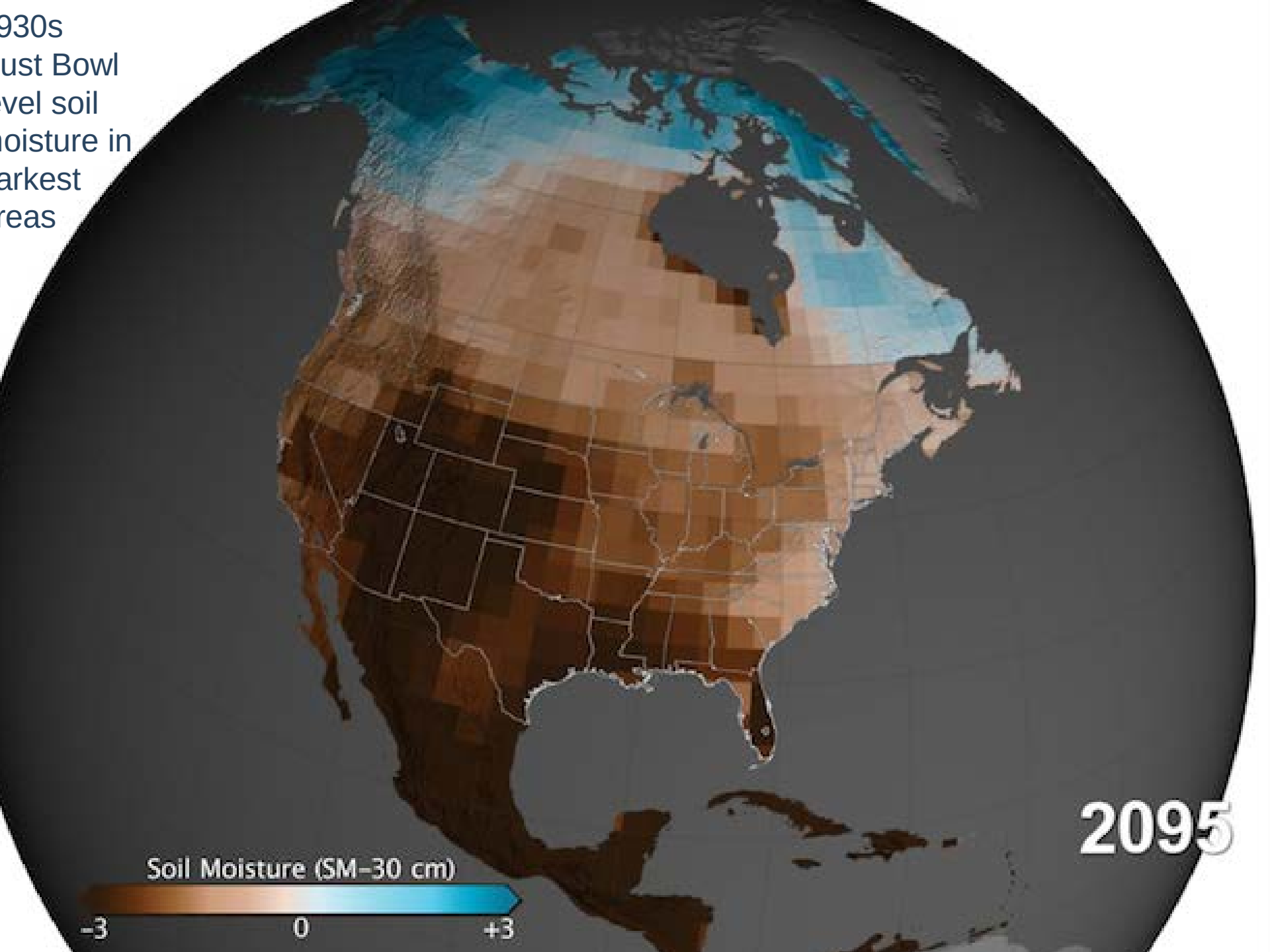
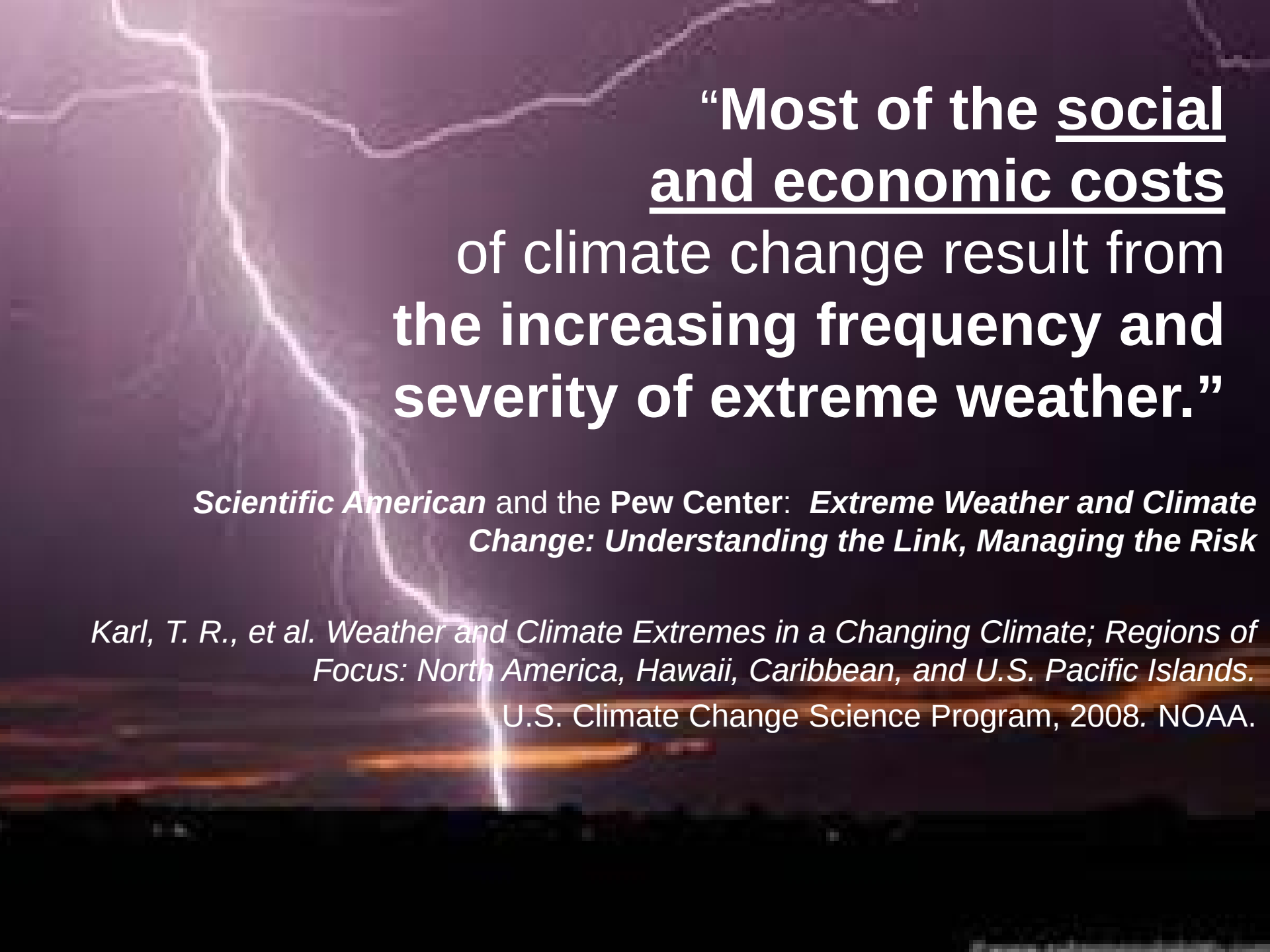




“Most of the <u>social and economic costs</u> of climate change result from **the increasing frequency and severity of extreme weather.”**

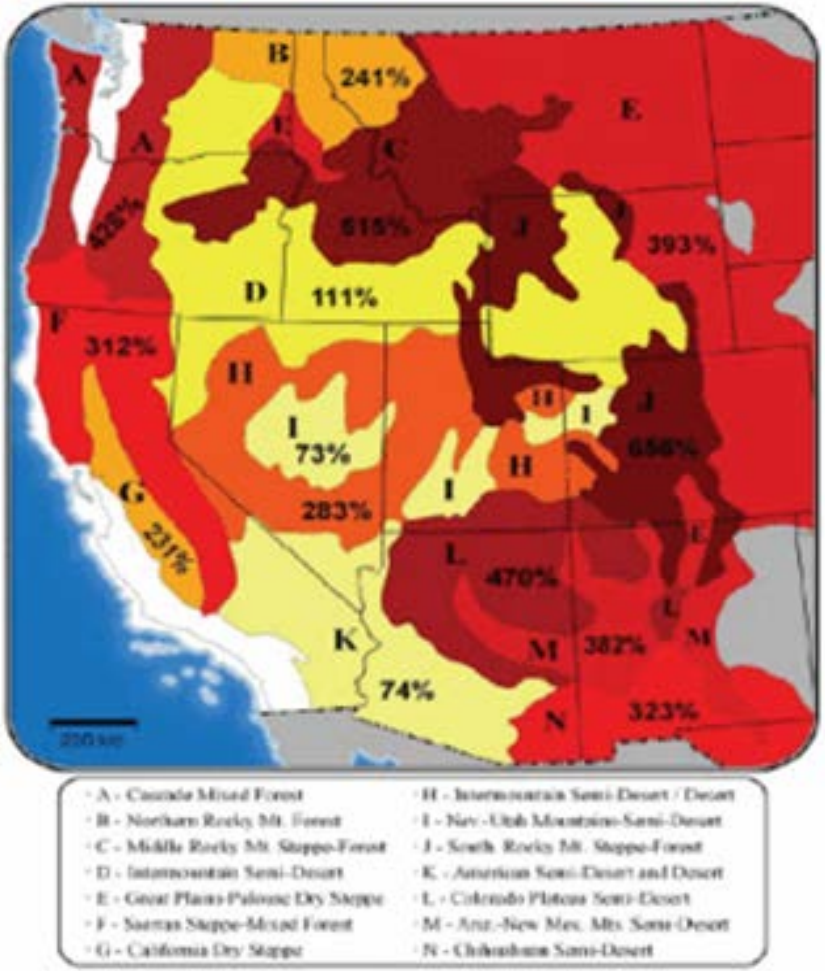
Scientific American and the **Pew Center**: ***Extreme Weather and Climate Change: Understanding the Link, Managing the Risk***

Karl, T. R., et al. Weather and Climate Extremes in a Changing Climate; Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands. U.S. Climate Change Science Program, 2008. NOAA.

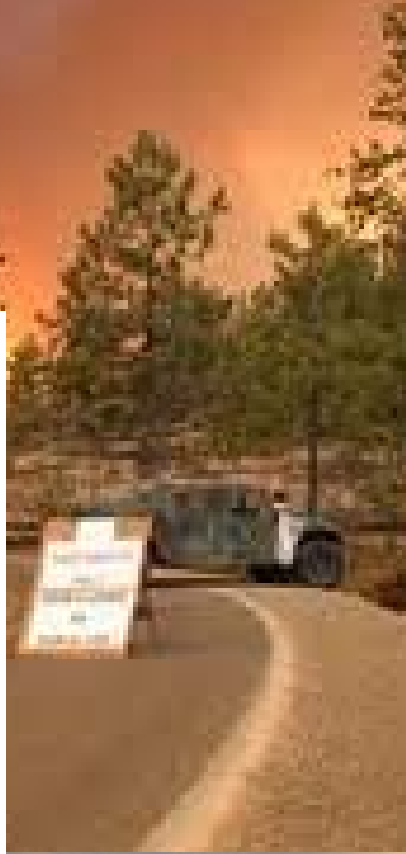
Increased Wildfires

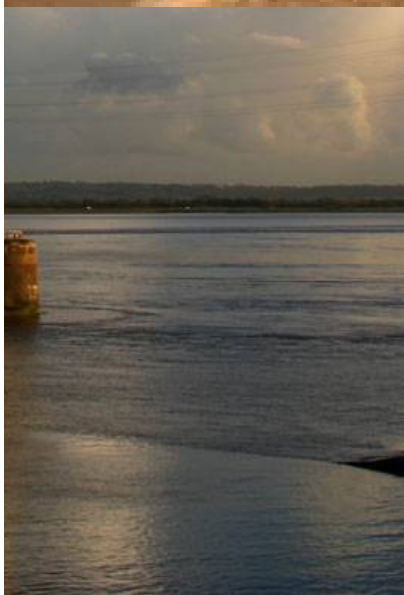
What's expected: worse wildfires

Percentage increases in median annual area burned for a 1°C increase in global average temperature



National Academies, Stabilization Targets, 2010



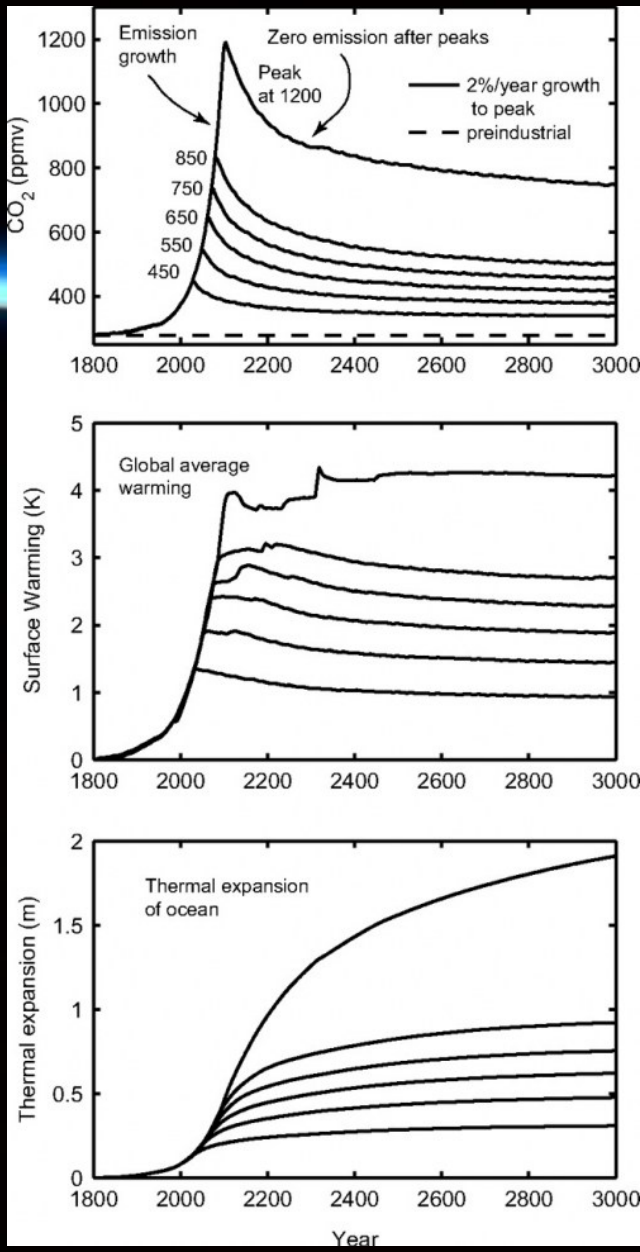


Why is this happening?

Every 24 hours we dump another 110 million tons of GHG emissions into the thin shell of atmosphere surrounding our planet (thinner than a peel relative to an apple). That pollution traps the same amount of heat as 400,000 Hiroshima atomic bombs going off every 24 hours.

20% of the global-warming pollution we emit will still be there in 20,000 years!

Climate change due to increases in CO2 concentration is largely irreversible for 1,000 years after emissions stop



Solomon et al., 2009
http://www.pnas.org/content/106/6/1704.full.pdf+html

"Houston, we have a problem." Jim Lovell

Sustainability, as defined

Meeting human needs for the present and future, while doing this…Are we able to do this with our current system?

- Preserve & restore environmental & ecological systems?
- Foster community health and vitality *(e.g., adequate/solid jobs for all who need? Decent length of work days, etc.?)*
- Promote economic development and prosperity? *(Are we preparing for the future we need; e.g., clean energy? Are we training our kids/the next gen for up and coming fields, for a world of health and well-being?)*
- Ensuring equity between and among pop. groups *(i.e., not excessive unemployment or reduced access for certain groups)* and over generations? *(air pollution,global warming impacts are life and world changing – whole context)*

If our physical world is changing greatly & the ability of people (kids, grandkids, nieces, nephews, others) to live in it (have jobs to fund the standard of living and transport we are accustomed to) is also, it's going to affect us & transportation.

A good starting place may be…

What's happening with the next generation, to people in the US and abroad, with jobs, environmental context, livability, weather disasters, and risk, in the future?

Are things even worse for the next/coming generation?

How sustainable is this system? What is/would be a sustainable system? That is where we are going. Our job is to get there and have transportation work/contribute in that context.

This way, we see / understand that sustainability goes far beyond conventional categories or what we say we have control over. All this is part of our context and what is determining, for us. It is also an input for our thinking with regard to what we and transportation can do to help the current/coming transition, in supporting a sustainable society:

- Transportation, Access, Healthy, Emissions, Air Quality
- Resource Consumption
- Waste Generation
- Ecosystems

The return interval for the 2015 record low was found it be beyond 1000 years (95% interval) at low elevations in the Sierra Nevada, where temperature plays an important role in the snowpack variability

Methods to keep systematically improving

- **Commitment** (& policies and statements that reflect)
- **Be systematic** (e.g., EMS - planning, impl., training, tracking, correction, re-evaluation, listen, re-planning)
- **Keep an eye on the moving target/new world/realities**
- **Thinking about how the coming changes** relate to us
  - Changing fleets to electric, reducing maintenance burden
  - Reducing waste and resource consumption
  - Dramatically improving energy/AQ/emissions choices and systematic implementation, with tracking & targets
  - Installing solar panels and wind where we can
  - Conserving and restoring watersheds and habitats
- **Costing more components** and drawing attention to other impacts, true **cost-effectiveness and trade-offs**. Ultimately physical systems like climate though have their own limits though, regardless of our CBA. Calculations of utility and cost-productiveness are not the only tests of viability or sustainability. Physical reality/limits trump!
- **Tracking performance measures** (Joe's project- 708, Material Usage and Recycling, Energy & Resource Use, Noise, Congestion, Air Quality, GHG Emissions, Ecological Preservation, Safety, Water Quality)

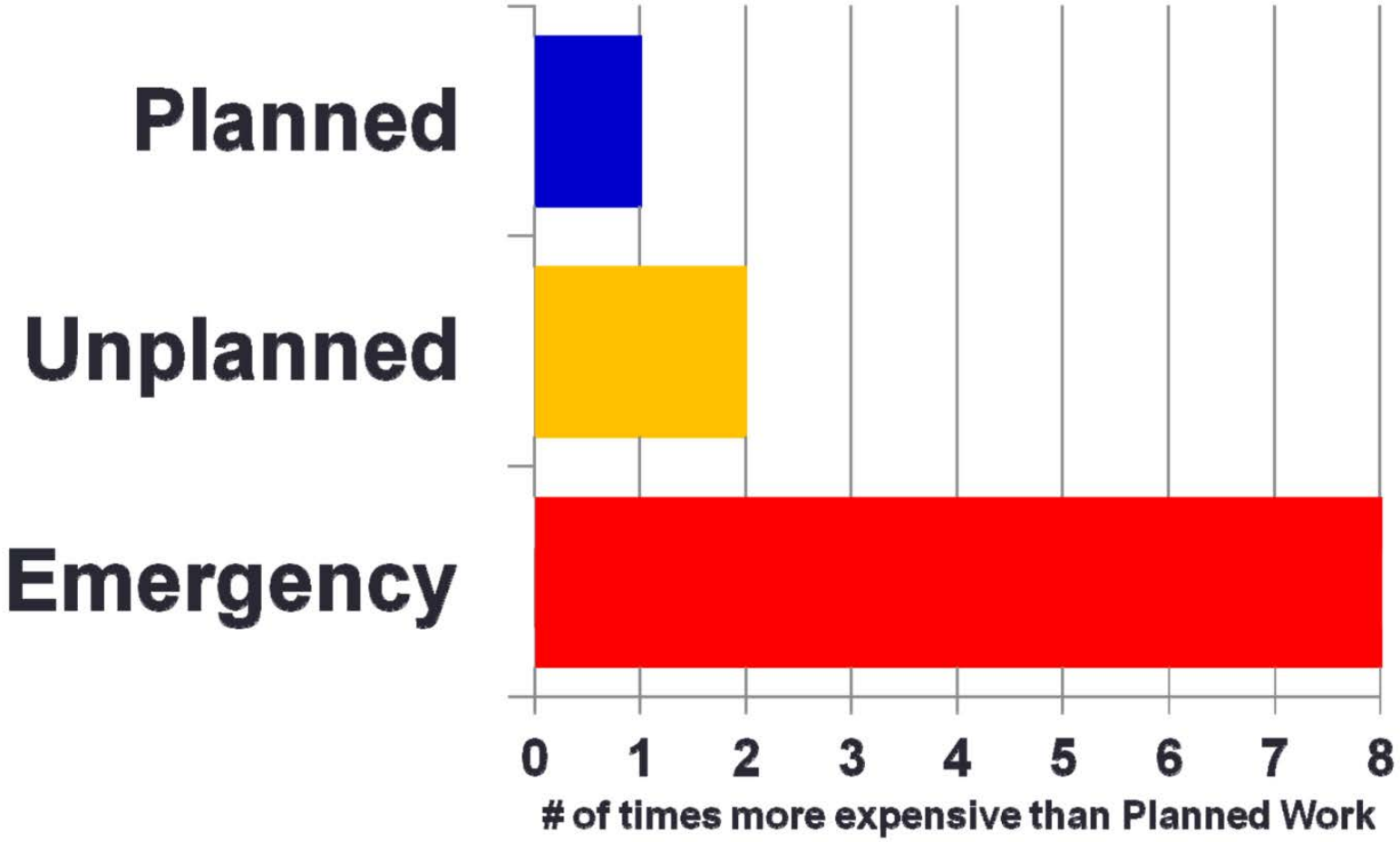
There are a lot of co-benefits (green arrows) with reduced GHGs or decarbonisation

Mitigation measures	Effect on additional objectives/concerns		
	Economic	**Social (including health)**	**Environmental**
Reduction of fuel carbon intensity: electricity, hydrogen, CNG, biofuels, and other fuels.	↑ Energy security (diversification, reduced oil dependence, and exposure to oil price volatility) (1,2,3,32,33,34,94) ↑ Technological spillovers (e.g., battery technologies for consumer electronics) (17,18,44,55,90)	Health impact via urban air pollution (59,69) by ? CNG, biofuels: net effect unclear (13,14,19,20,36,50) ↓ Electricity, hydrogen: reducing most pollutants (13,20,21,36,58,63,92) ↑ Shift to diesel: potentially increasing pollution (11,23,25) ↓ Noise (electricity and fuel cell LDVs) (10,82,61,64–66) ↓ Road safety (silent electric LDVs at low speed) (56)	Ecosystem impact of electricity and hydrogen via: ↓ Urban air pollution (13,20,69,91,92,93) ↑ Material use (unsustainable resource mining) (17,18) ? Ecosystem impact of biofuels (24,41,42,89)
Reduction of energy intensity.	↑ Energy security (reduced oil dependence and exposure to oil price volatility) (1,2,3,32,33,34)	↓ Health impact via reduced urban air pollution (22,25,43,59,62,69,84) ↑ Road safety (crash-worthiness depending on the design of the standards) (38,39,52,60)	↓ Ecosystem and biodiversity impact via reduced urban air pollution (20,22,69,95)
Compact urban form and improved transport infrastructure. Modal shift.	↑ Energy security (reduced oil dependence and exposure to oil price volatility) (77–80,86) ↑ Productivity (reduced urban congestion and travel times, affordable and accessible transport) (6,7,8,26,35,45,46,48,49) ? Employment opportunities in the public transport sector vs. car manufacturing jobs (38,76,89)	Health impact for non-motorized modes via ↓ Increased activity (7,12,27,28,29,51,64,70,73,74) ↑ Potentially higher exposure to air pollution (19,27,59,69,70,74) ↓ Noise (modal shift and travel reduction) (58,61,64–66,81,82,83) ↑ Equitable mobility access to employment opportunities, particularly in developing countries (4,5,8,9,26,43,47,49) ↑ Road safety (via modal shift and/or infrastructure for pedestrians and cyclists) (12,27,37,39,40,87,88)	Ecosystem impact via ↓ urban air pollution (20,54,58,60,69) ↓ land-use competition (7,9,58,71,75)
Journey distance reduction and avoidance.	↑ Energy security (reduced oil dependence and exposure to oil price volatility) (31,77–80,86) ↑ Productivity (reduced urban congestion, travel times, walking) (6,7,8,26,45,46,49)	↓ Health impact (for non-motorized transport modes) (7,12,22,27,28,29,30,67,68,72,75)	Ecosystem impact via ↓ urban air pollution (20,53,54,60,69) ↑ new/shorter shipping routes (15,16,57) ↓ Land-use competition from transport infrastructure (7,9,58,71,75)

References: 1: (Greene, 2010b); 2: (Costantini et al., 2007); 3: (Bradley and Lefevre, 2006); 4: (Boschmann, 2011); 5: (Sietchiping et al., 2012); 6: (Cuenot et al., 2012); 7: Creutzig et al., 2012; 8:Banister, 2008; 9: (Geurs and Van Wee, 2004; Banister, 2008);10: (Creutzig and He, 2009); 11: (Leinert et al., 2013); 12: Rojas-Rueda et al., 2011; 13:(Sathaye et al., 2011b); 14: (Hill et al., 2009); 15: (Garneau et al., 2009); 16: (Wassmann, 2011); 17: (Eliseeva and Bünzli, 2011) 18: (Massari and Ruberti, 2013); 19: (Takeshita, 2012); 20: (Kahn Ribeiro et al., 2012); 21: (IEA, 2011a); 22: Woodcock et al., 2009; 23: (Schipper and Fulton, 2012); 24: see Section 11.13.6; 25: (Kirchstetter et al., 2008); 26: Banister, 2008; Miranda and Rodrigues da Silva, 2012; 27: (Rojas-Rueda et al., 2011; Rabl and de Nazelle, 2012; 28: (Jacobsen, 2003); 29: (Hultkrantz et al., 2006); 30: (Goodwin, 2004); 31: (Sorrell and Speirs, 2009); 32: (Jewell et al., 2013); 33: (Shakya and Shrestha, 2011); 34: (Leiby, 2007b); 35: (Duranton and Turner, 2011); 36: (Trubka et al., 2010a) 37: (WHO, 2011); 38: Santos et al., 2010; 39: (Tiwari and Jain, 2012b); 40: (Sonkin et al., 2006); 41: (Chum et al., 2011); 42: (Larsen et al., 2009); 43: (Steg and Gifford, 2005); 44: (Budde Christensen et al., 2012) 45: (Schrank et al., 2011); 46: (Carisma and Lowder, 2007); 47: (World Bank, 2002); 48: (JICA, 2005); 49: (Kunieda and Gauthier, 2007); 50: see Section 11.13.5; 51: (Maizlish et al., 2013); 52: (WHO, 2008); 53: (ICCT, 2012b); 54: (Yedla et al., 2005); 55: (Lu et al., 2013); 56: Schoon and Huijskens, 2011; 57: see Section 8.5; 58: see Section 12.8; 59: Medley et al. 2002; 60: Machado-Filho 2009; 61: Milner, Davies, and Wilkinson 2012; 62: Kim Oanh et al., 2012; 63: Fulton, et al., 2013; 64: de Nazelle et al., 2011; 65: (Twardella and Ndrepepa, 2011); 66: (Kawada, 2011); 67: (Grabow et al., 2012); 68: (Pucher et al., 2010); 69: Section 7.9.2 and WGII 11.9; 70: de Hartog et al., 2010; 71: Heath et al. 2006; 72: Saelens, et al. 2003; 73: (Sallis J.F., B.E. Saelens, L.D. Frank, T.L. Conway, D.J. Slymen, K.L. Cain, J.E. Chapman, and J. Kerr); 74: Hankey and Brauer, M. 2012; 75: Cervero and Sullivan 2011; 76: Mikler 2010; 77: Cherp et al. 2012; 78: Leung 2011; 79: Knox-Hayes et al., 2013; 80: Sovacool and Brown 2010; 81: WHO 2009; 82: Oltean-Dumbrava et al., 2013; 83: Velasco et al., 2013; 84: Smith et al., 2013; 86: see Section 8.4; 87: Schepers et al. 2013; 88: White 2004; 89: UNEP/GEF, 2013; 90: Rao and Wang 2011; 91: (Notter et al., 2010); 92: Sioshansi and Denholm, 2009; 93: (Zackrisson et al., 2010); 94: (Michalek et al., 2011); 95: See Section 8.2.2.1.

Also Planning Saves Both Lives and Costs

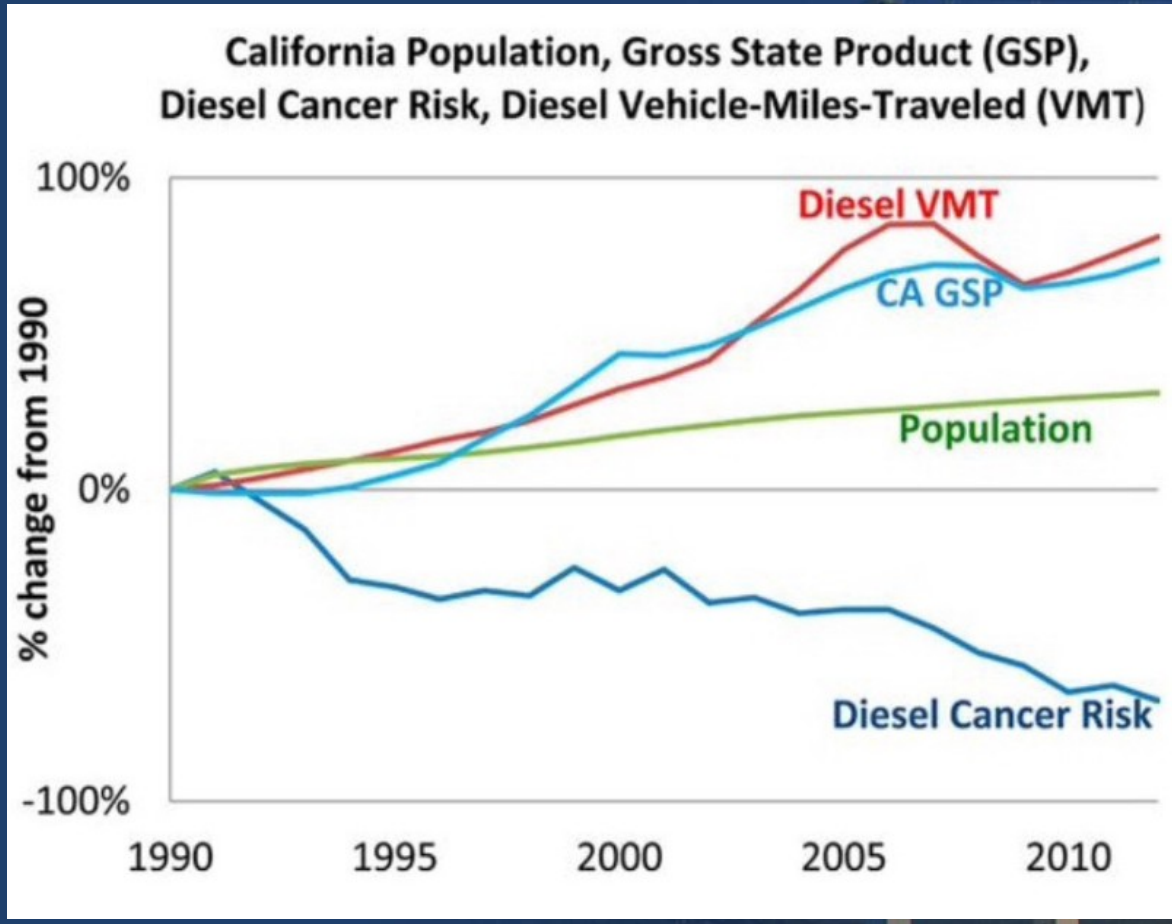
Why Does Planning Matter?



Current Progress (trans., fossil fuels, health)

Diesel particulate matter is known to be the most relevant to cancer risk (mostly trucks, buses).

Overall collective risk of cancer via exposure to 7 toxic air contaminants in CA declined by 76%.
Concentrations of diesel particulate matter fell by 68% between 1990 and 2012, even though population grew by 31%, CA GDP rose by 74%, and diesel VMT increased by 81%. Improvements were due to a heavy-duty diesel truck roadside inspection program, reformulated gas, particle pollution standards implemented, requiring diesel particulate filters on trucks, reducing diesel particulate matter from exhaust gas of diesel engines.



Based on monitoring data, ***concentrations of benzene; 1,3-butadiene; perchloroethylene; and hexavalent chromium declined 88–94%.***
The new research was published in the ACS journal *Environmental Science & Technology*.

- **Transitioning to renewable energy is the only way to significantly decrease carbon emissions**. The most accurate projections of any major analysis, worldwide, says that for the first time, the path to 100 percent renewable is cost-neutral and by 2030, two-thirds of the world's electricity could come from renewable sources such as wind and solar. The cost of developing renewable energy sources has fallen steeply in recent years, and, at this point, the fuel savings are "cost neutral" with investment in renewable energy, even though governments are paying $5.3 trillion annually to subsidize fossil fuels (IEA study)
- "Despite the fact that the playing field isn't level and is tilted in the favor of fossil fuels, renewable energy sources are still winning."
- "Renewable energy definitely means more on the jobs front," too. By 2030, renewable energy will account for 87 percent of the jobs in the energy sector, the report says. The authors estimate there will be 9.7 million people working in solar PV.
- SolarCity announced this month that its Buffalo, NY "gigafactory" will be producing solar panels that are more efficient and 30% more powerful than its previous version. Solar installed costs are already down 9% from last year and costs have dropped 50% in last 5 years.
- CA now requires state-regulated utilities to get 50% of their electricity from renewable energy sources, such as wind, solar, and hydro, by 2030 and a 50% increase in energy efficiency in buildings by 2030.

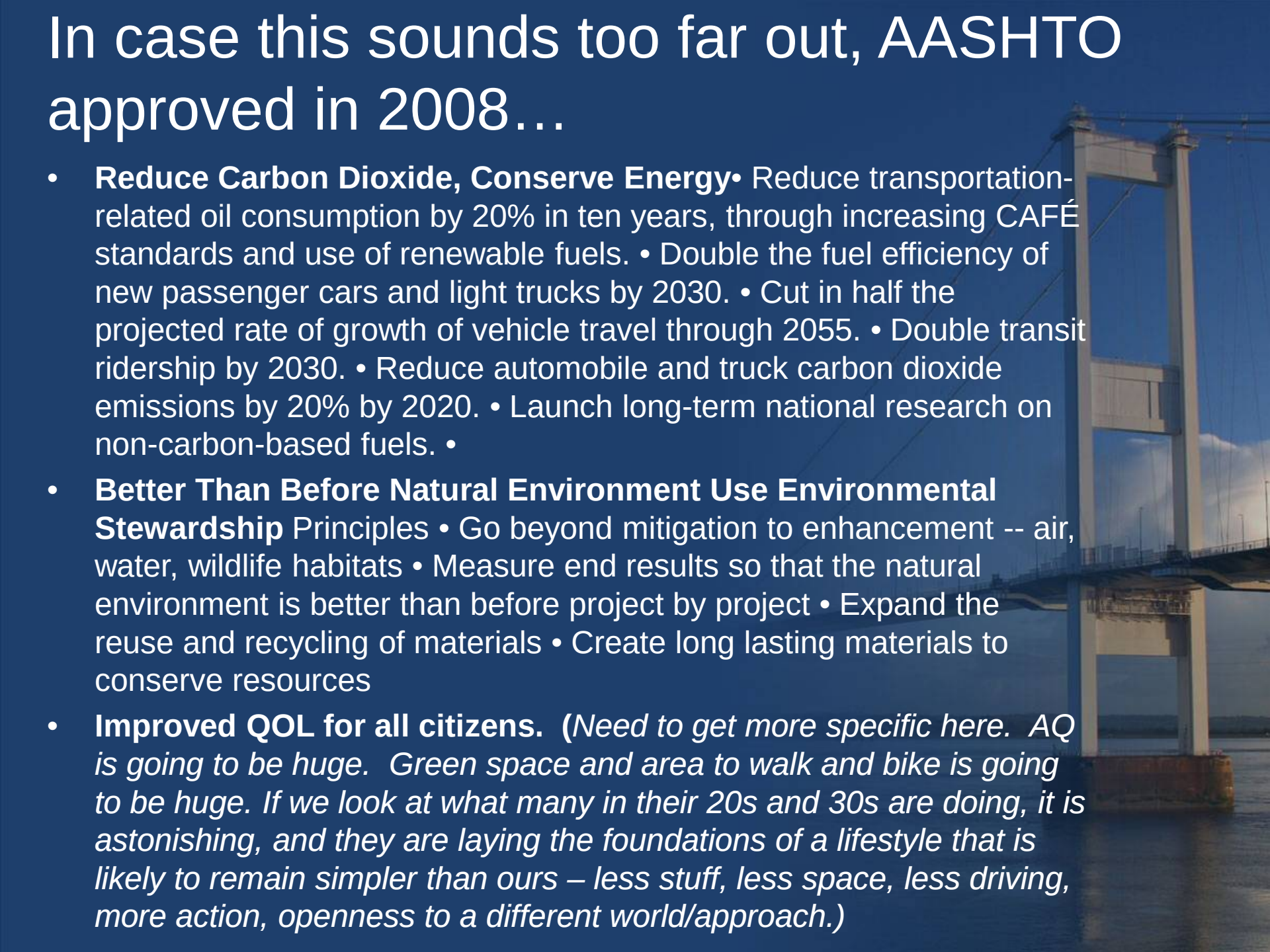
This Texas City of 60K Will Soon Be Powered Entirely By Wind And Sun (*June 11, 2015*)

Solar, Wind, & Electric are Cheaper all the time (it gets better every quarter!)

- Bloomberg (BNEF) findings are **that wind power is now the cheapest electricity to produce** in Germany and the UK, **even without government subsidies. Renewables are really becoming cost-competitive, and they're competing more directly with fossil fuels**. Wind provides up to 40% of Denmark's instant electric demand. We're seeing the utilization rate of fossil fuels wear away."
- **"It's a self-reinforcing cycle. As more renewables are installed, coal and natural gas plants are used less**. As coal and gas are used less, the cost of using them to generate electricity goes up. **As the cost of coal and gas power rises, more renewables will be installed**."
- **Evidence of shift taking place**. Monday last week Citigroup announced a new policy to cut its lending to the global coal mining industry. "The scale of the challenge posed by climate change calls for the financial sector to transition away from financing high-carbon energy sources in addition to scaling up financing for low-carbon energy." Bank of America and Crédit Agricole withdrew support for coal mining earlier.

In case this sounds too far out, AASHTO approved in 2008…

- **Reduce Carbon Dioxide, Conserve Energy**• Reduce transportation-related oil consumption by 20% in ten years, through increasing CAFÉ standards and use of renewable fuels. • Double the fuel efficiency of new passenger cars and light trucks by 2030. • Cut in half the projected rate of growth of vehicle travel through 2055. • Double transit ridership by 2030. • Reduce automobile and truck carbon dioxide emissions by 20% by 2020. • Launch long-term national research on non-carbon-based fuels. •
- **Better Than Before Natural Environment Use Environmental Stewardship** Principles • Go beyond mitigation to enhancement -- air, water, wildlife habitats • Measure end results so that the natural environment is better than before project by project • Expand the reuse and recycling of materials • Create long lasting materials to conserve resources
- **Improved QOL for all citizens. (***Need to get more specific here. AQ is going to be huge. Green space and area to walk and bike is going to be huge. If we look at what many in their 20s and 30s are doing, it is astonishing, and they are laying the foundations of a lifestyle that is likely to remain simpler than ours – less stuff, less space, less driving, more action, openness to a different world/approach.)*



AASHTO Surface Transportation Vision continued…

- **Improved Quality of Life for All Citizens Coordinate Land Use and Transportation** • Encourage collaborative land use and transportation planning • Promote infill development in central cities and close in suburbs • Encourage new development in outlying suburban areas to be mixed-use and friendly to transit, walking and biking • Preserve small towns • Reduce sprawl and consumption of open space and farmland
- When AASHTO polled the state DOTs:
  - From 54% to 61% were supportive – clear majority
  - Form 21% to 35% were NOT supportive (but this was several years ago)
  - Score of 3.9 or higher placed in top 10 of 27
  - All top 10 were “hard core” transportation issues
  - Sustainable Transportation scored 3.4 to 3.7
  - Sustainable Transportation made it to the “mainstream” (among transportation professionals while “competing” with hardcore transportation issues)

In sum: Our environment, our context, our economy are likely to look massively different in the next 15 years…

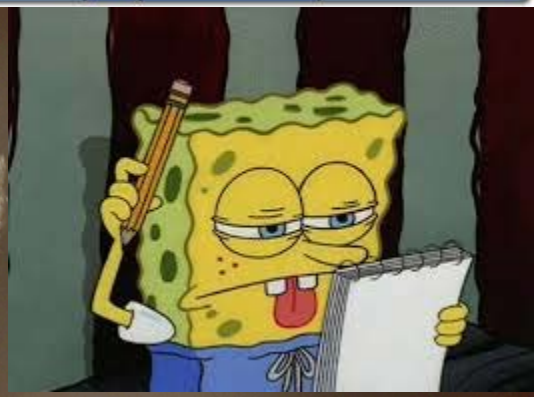
- How will this change the picture for DOTs?
- What are we going to do to help our agencies prepare for this shift?
- How can DOT M&O contribute or even play a forward edge role?

While we are thinking…What mind-set will help us build a low-carbon economy in which all can thrive – a rapid shift, that requires mass re-engineering of our global infrastructure, economic systems? Lessons from tech:

VISION. Visionary is not a word we tend to use in government or among political leaders now. But there are iconoclastic leaders who hold an unwavering expectation and belief in what they see is possible, and people follow them.

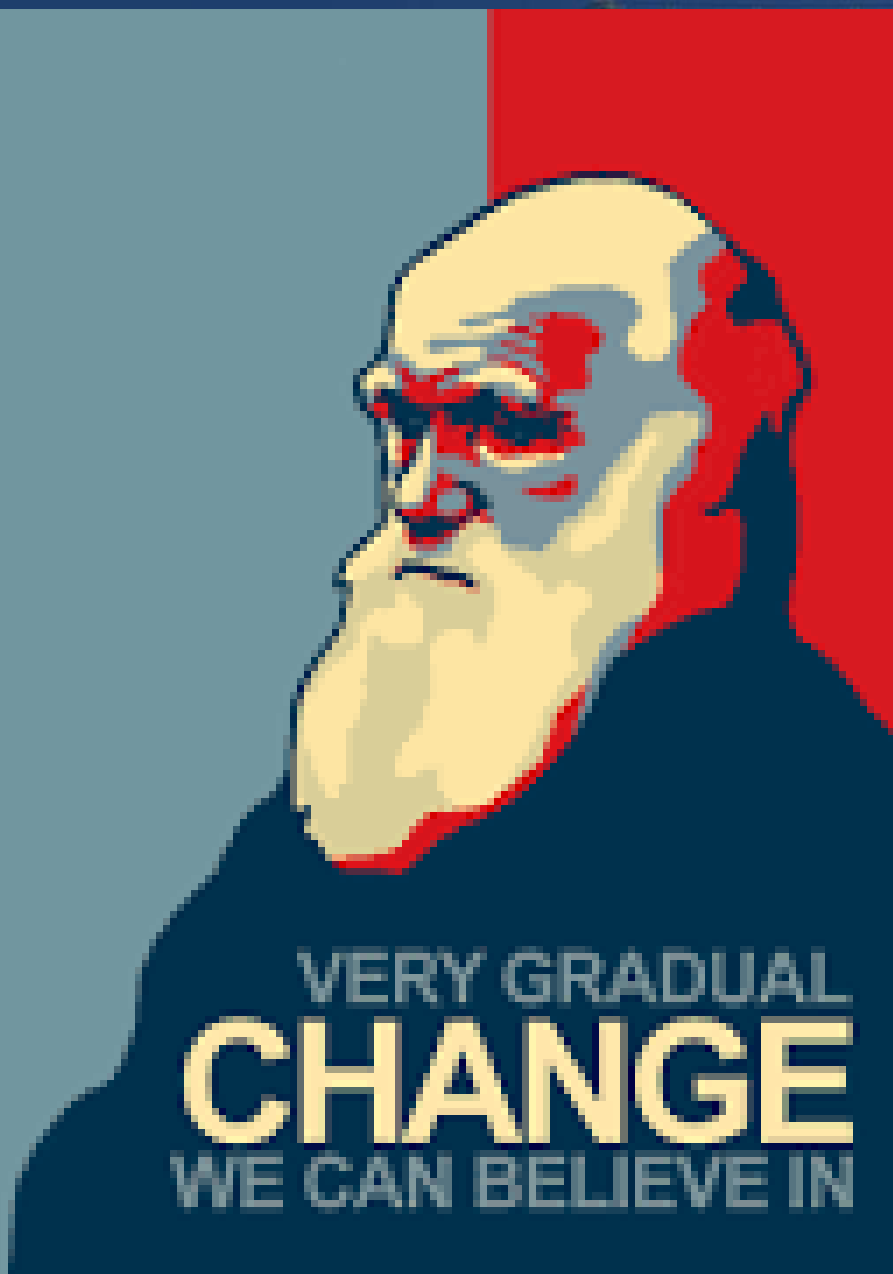
COLLECTIVE BENEFIT. Value of shared learning (opposite of consultant competition) & a sense of community. We need creative new partnerships for effective low carbon transition.

TRY & FAIL FAST. Dweck spoke of a fixed mindset that doesn't allow for flexibility, growth or failure. That's also the root of 'fail-fast' - another tech term. Both reflect an acceptance of trying, learning from failures and not expecting perfection from yourself or others. Fear of critics dampers the innovative failures we could all learn from.

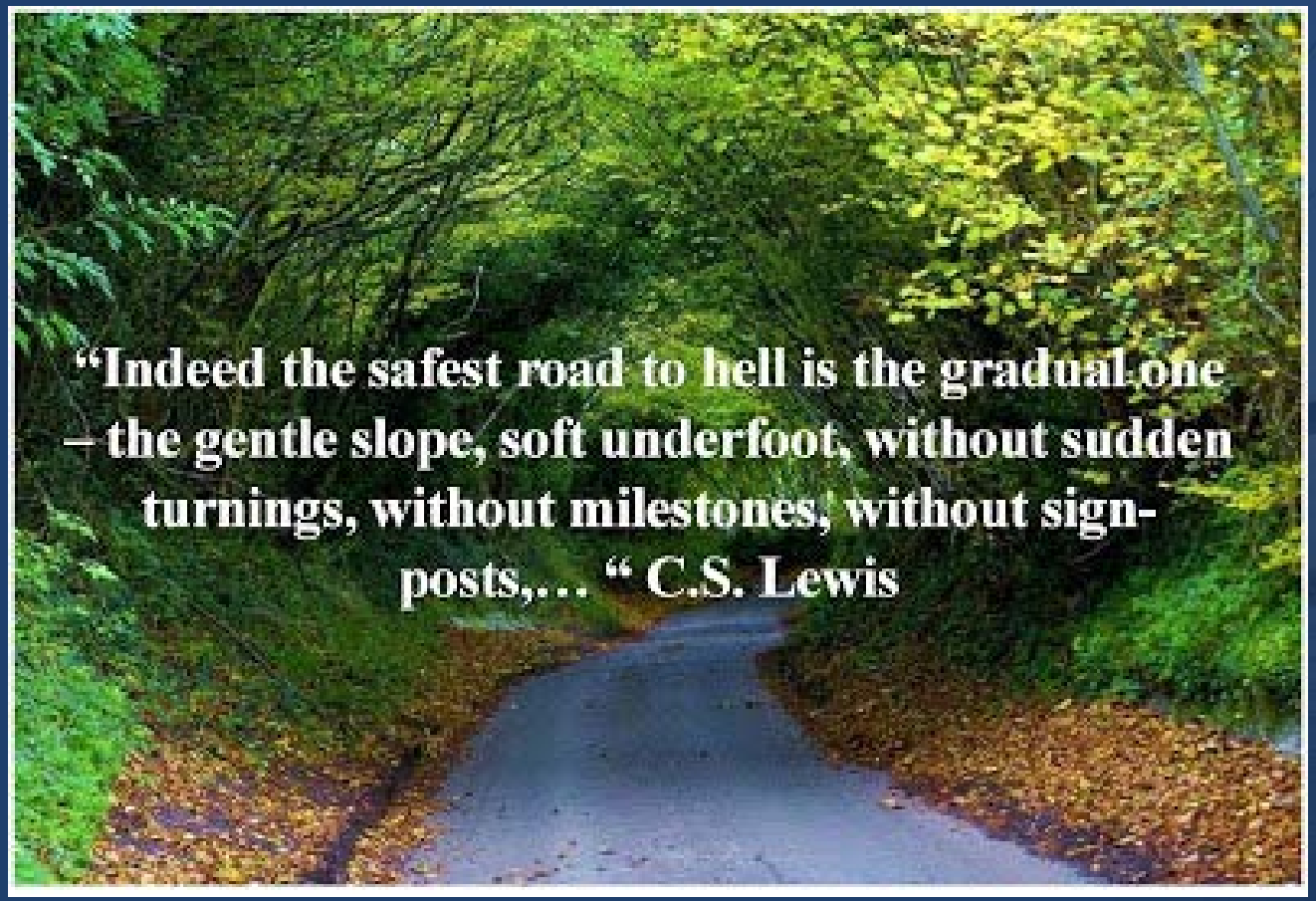


UX. User Experience is the way a technology user (you and I) behaves and feels using a particular product. The holy grail of UX is for a technology to be frictionless – a word for a service so beautifully designed that it's intuitive with inefficiencies and annoyances smoothed out. We need to improve the User Experience of low-carbon lifestyles. How do we help that?

What we are used to… (and what we've been doing the last two decades plus)



We are at an urgent point and nothing justifies staying on our current path.



reset

Recalibrate!

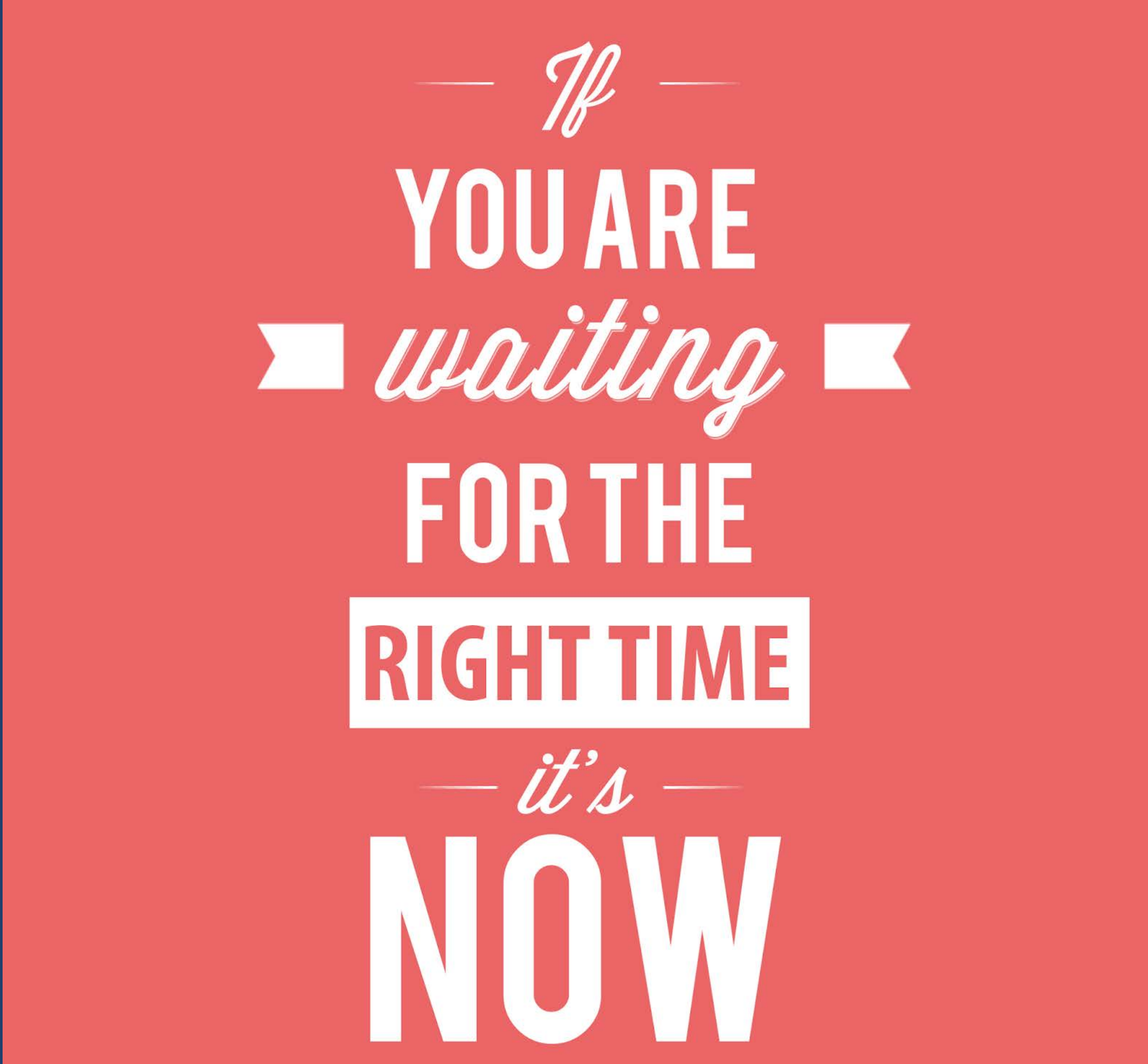
Review - Refresh - Refocus

What is our response? How good of a job are we going to do?







You (and your group) are the change you have been waiting for! The time to start thinking about it and the rapid shift ahead, is now!

TRB Webinar on Our Vital Role Supporting & Enhancing Sustainability

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