Resilient Transportation Systems in the Face of Increasing Oil Demand

24th Annual Lake Arrowhead Symposium on Transportation, Land Use, and Environment: Resilient Cities and Regions

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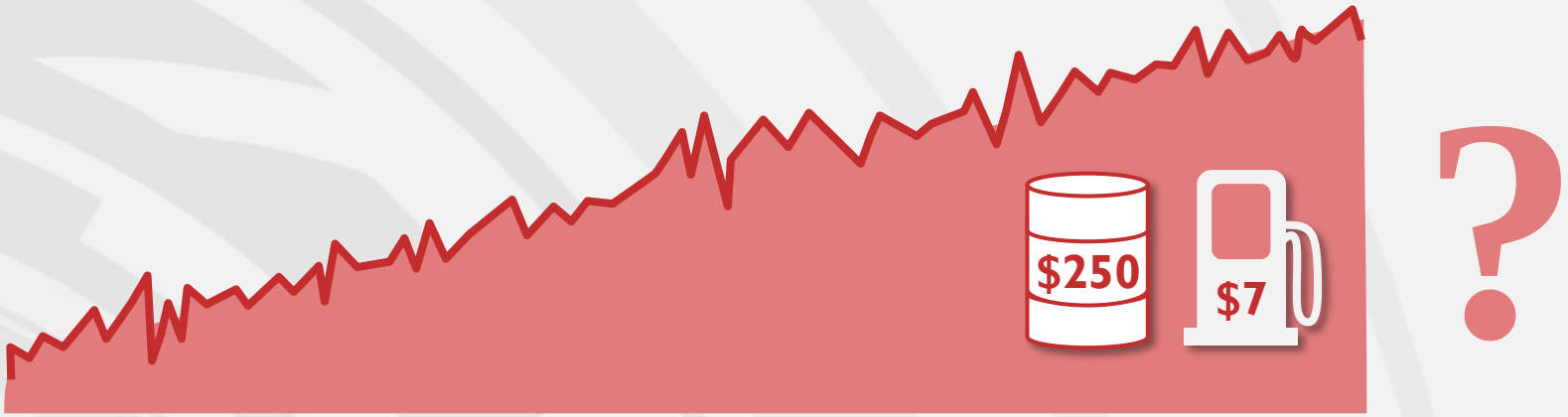
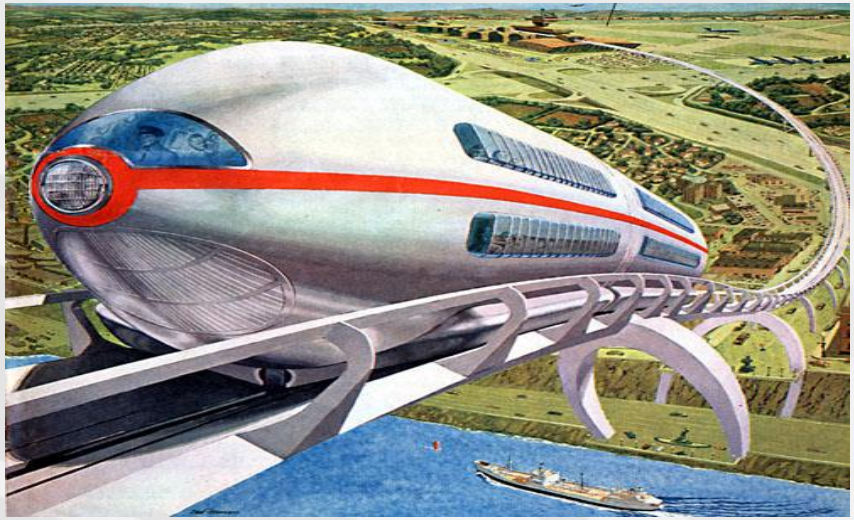
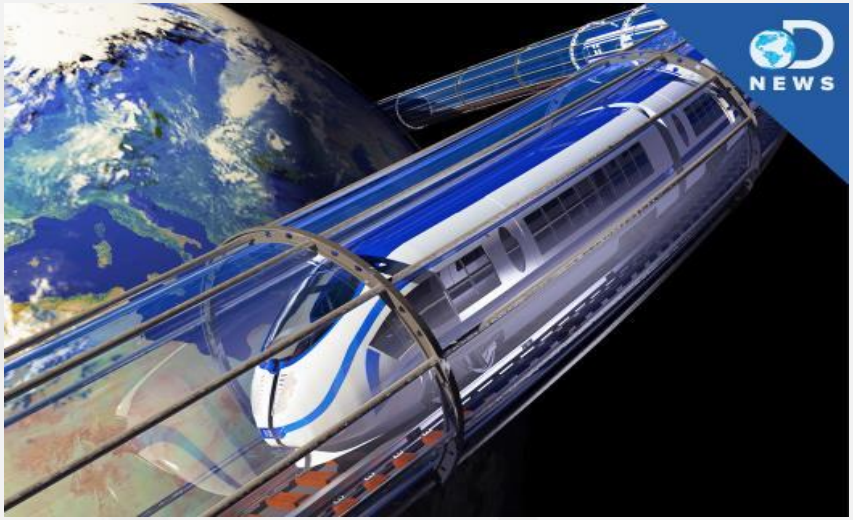
CAMBRIDGE SYSTEMATICS

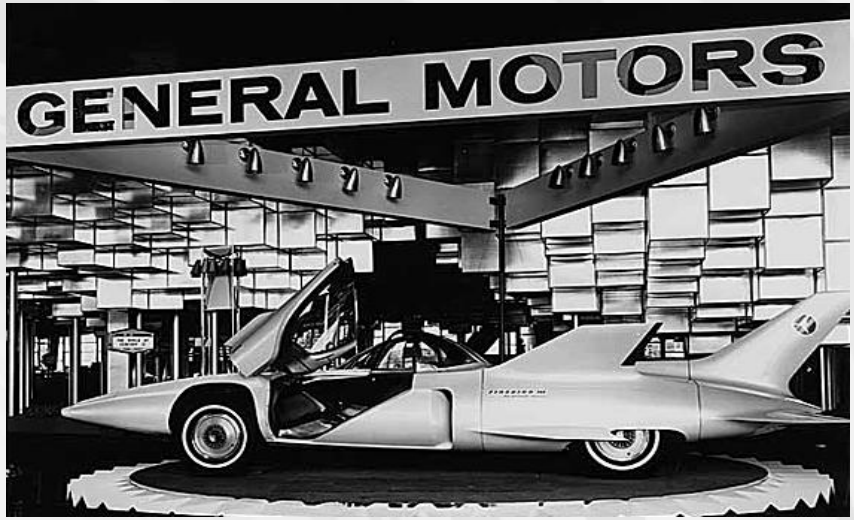
Will oil prices continue to rise?

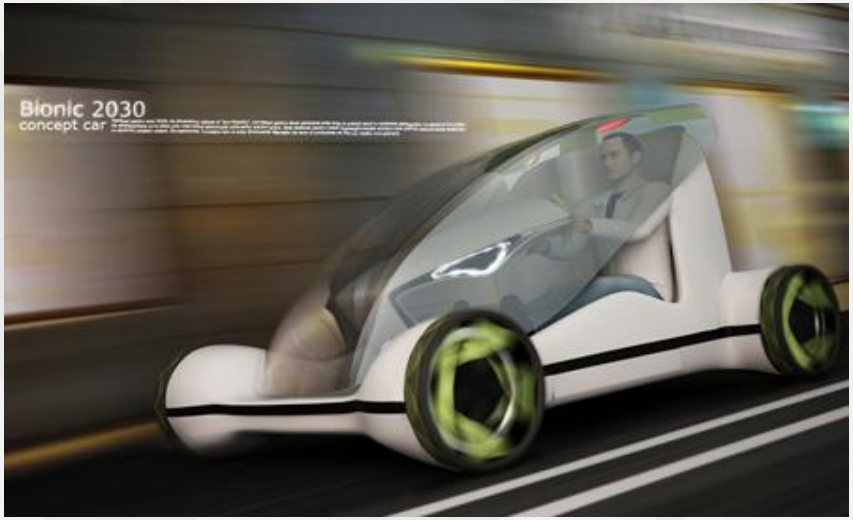


The future can be hard to predict









Our energy future appears highly uncertain

- What if gasoline prices rise to $5, or $6, or $7
  - » Rising world demand
  - » Finite resource

- Or what if prices hold steady or even decline?
  - » Resurgence in U.S. oil and natural gas production
  - » Much more stringent federal fuel economy standards
  - » Possible large-scale shifts to natural gas, liquid biofuels, electric vehicles, or hydrogen vehicles

Many experts expect petroleum to remain the dominant fuel through 2050

Incumbent technology with well established fuel and vehicle supply chains

Significant increase in economically-recoverable reserves with advent of enhanced extraction technologies

Rapid gains in fuel economy due to much more stringent federal standards and supporting technology innovations

Significant barriers confront all competing alternatives (natural gas, liquid biofuels, electric, and hydrogen)

Alternative fuels face an array of challenges

	Production	Distribution & Refueling	Vehicle Cost & Performance
Natural Gas	● ●	● ●	●
Liquid Biofuels	●	●	●
Electric	●		●
Hydrogen	●	●	●

Promised benefits of alternative fuels will motivate continued investment & innovation

	Urban Air Quality	GHG Emissions	Lower Cost of Driving	Domestic Production
Natural Gas			●	●
Liquid Biofuels		●		●
Electric	●	●	●	●
Hydrogen	●	●		●

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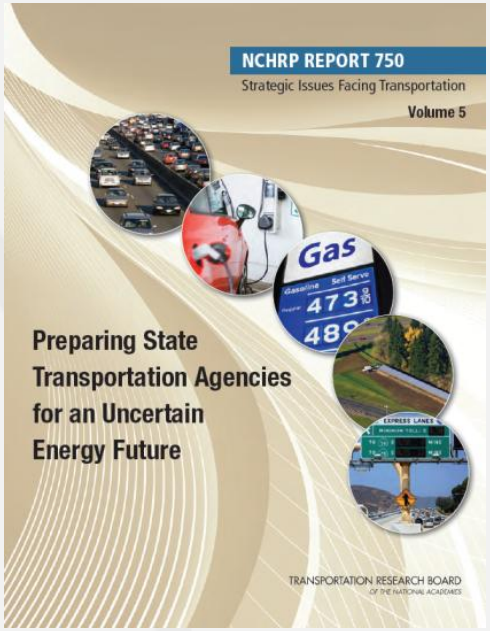
Preparing State Agencies for an Uncertain Energy Future

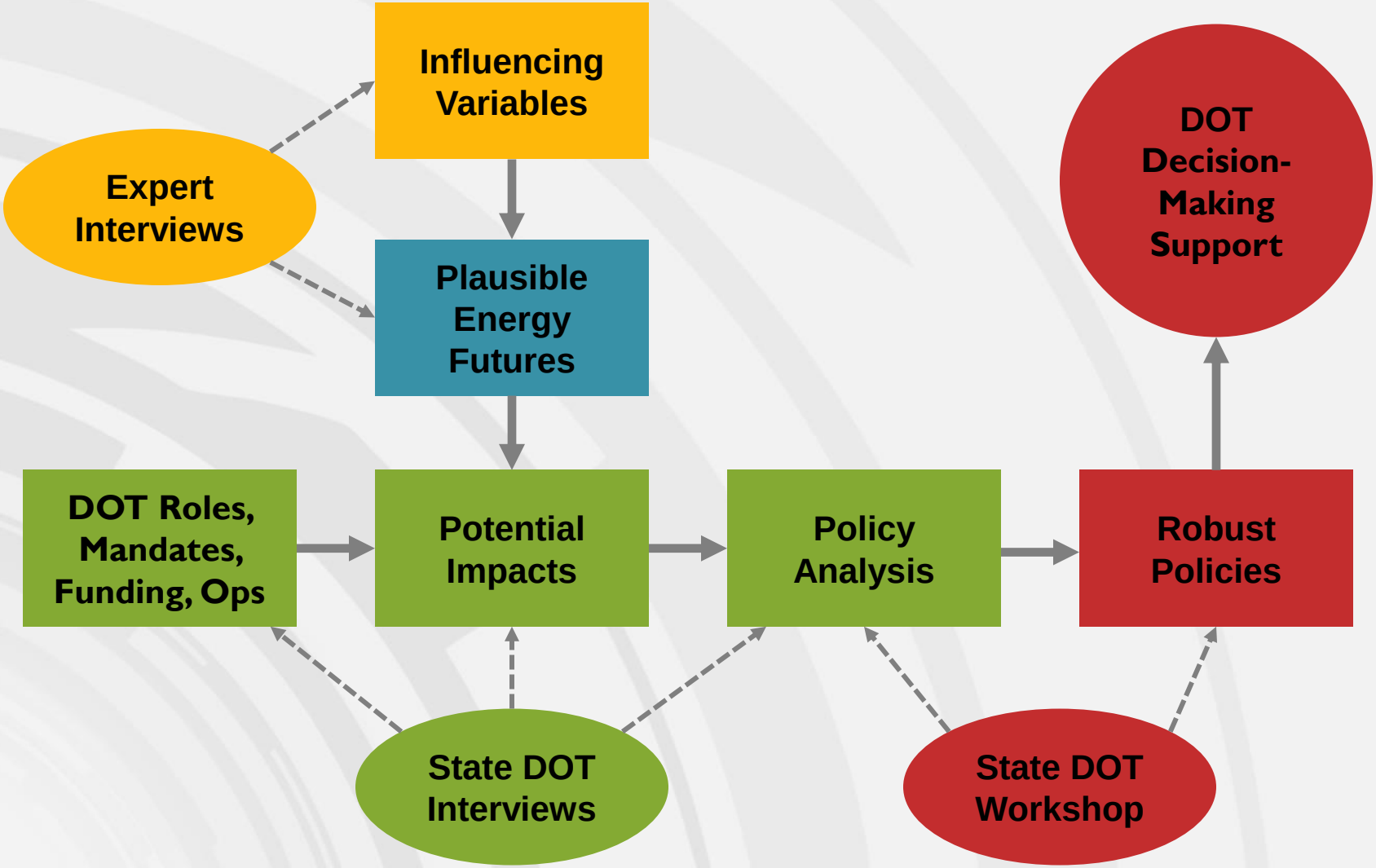
Develop plausible long-range surface transportation energy use scenarios for the 2050 timeframe

Identify potential impacts on state DOTs given their current roles, mandates, funding, and operations

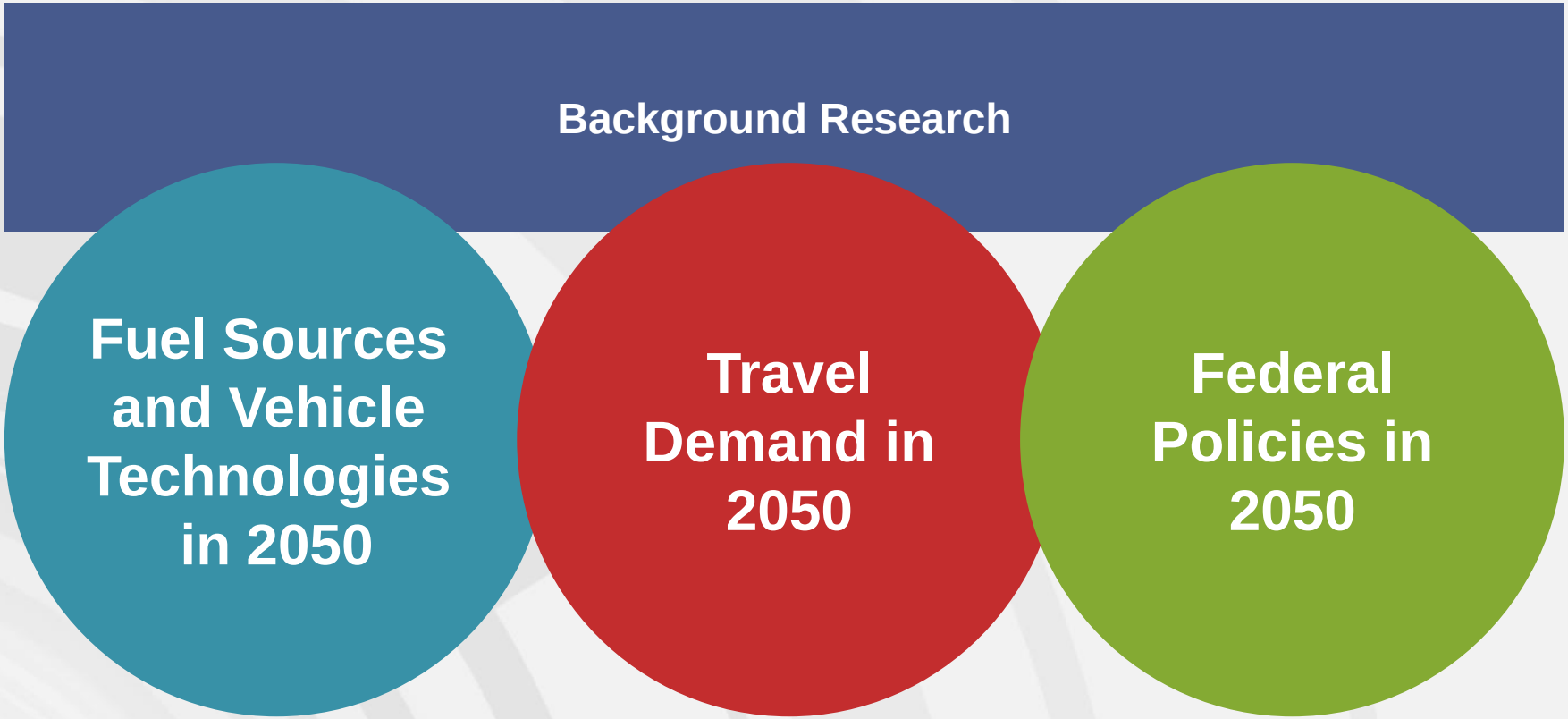
Employ robust decision-making principles to identify promising state policy options to address an evolving but deeply uncertain energy future



Research approach – analysis flow



The future scenarios encompass energy, travel, and federal policy elements

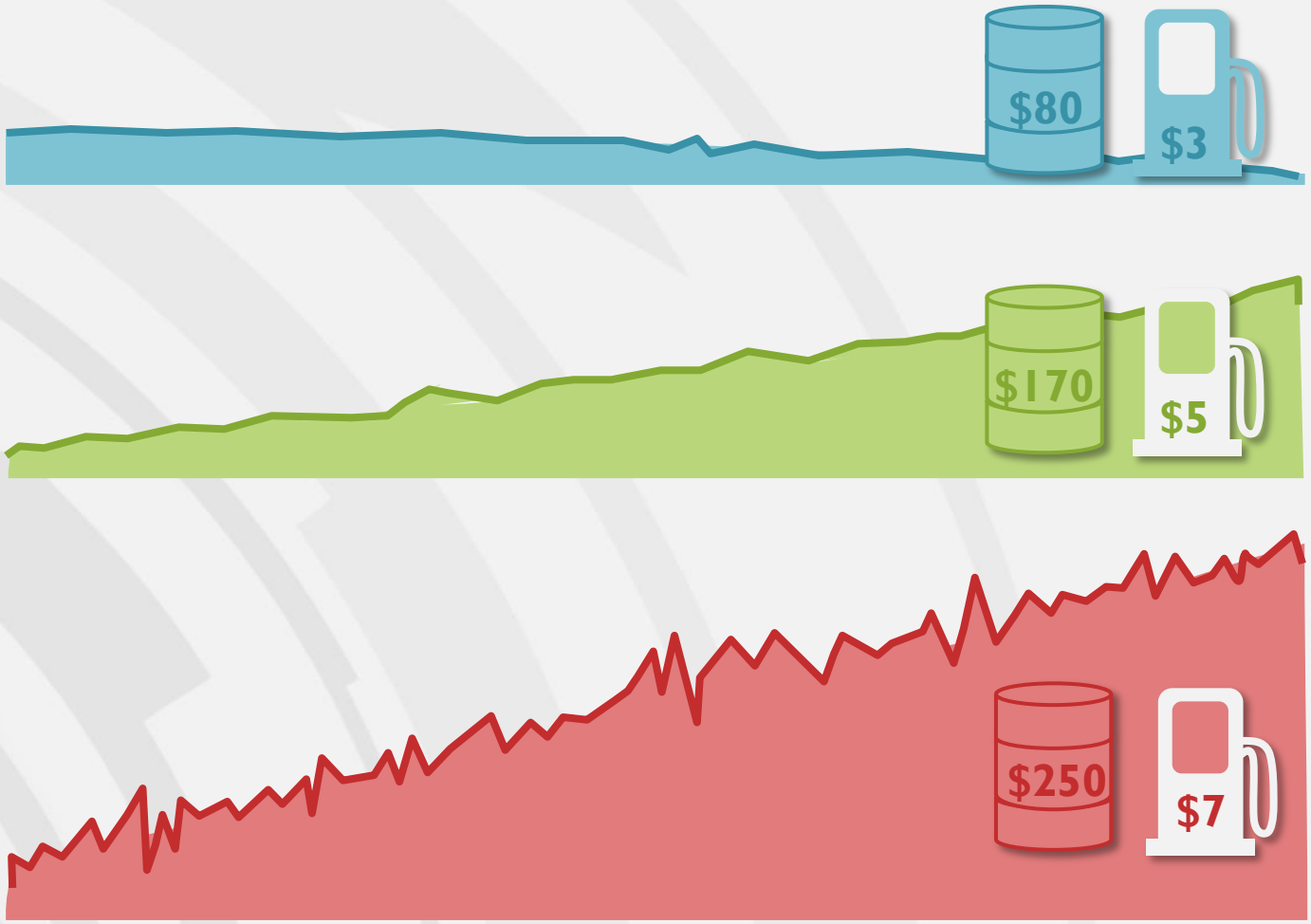


Energy factors – price of oil in 2050

Oil prices stabilize and decline

Oil prices rise slowly and consistently

Oil prices rise rapidly

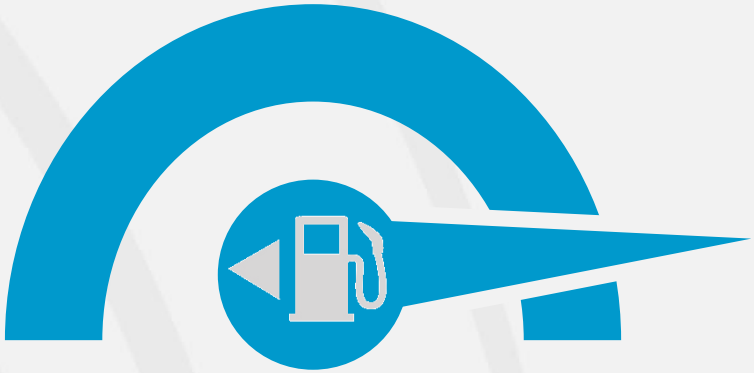


Consistent with EIA low, reference, and high oil prices for 2035

Energy factors – vehicle fuel economy in 2050

Average passenger vehicle fuel economy doubles

Average passenger vehicle fuel economy quadruples



Energy factors – energy mix in 2050

- Petroleum remains dominant **(> 90%)**
- Biofuels claim **30%** market share
- Natural gas achieves **50%** market share
- Electric vehicles gain **75%** market share
- Hydrogen achieves **75%** market share
- Multiple fuels combine to displace **75%** of petroleum use

Energy factors – energy cost of driving

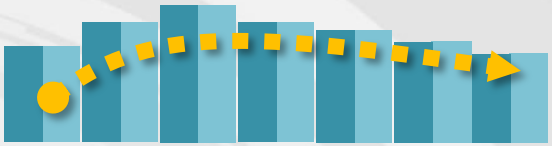
Per-mile cost declines by at least a half

Per-mile cost remains similar to current cost

Per-mile cost increases by a third

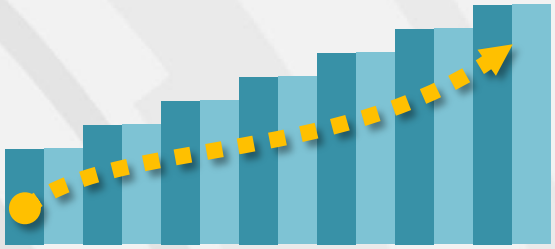
Travel factors – passenger vehicle travel

Low (or zero) growth in passenger VMT



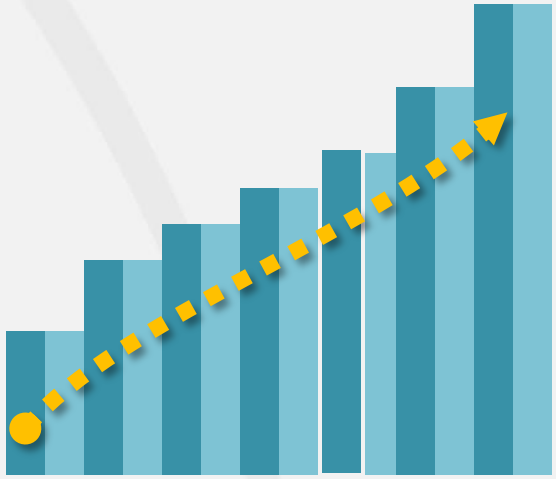
Change by 2050 = -10%

Moderate growth in passenger VMT



Change by 2050 = +60%

Rapid growth in passenger VMT



Change by 2050 = +80%

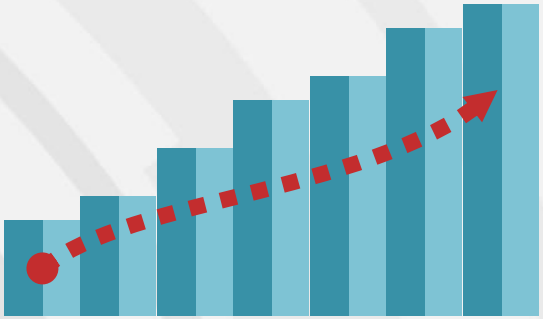
Moderate growth rate matches EIA reference case for 2035

Travel factors – truck travel

Zero growth, maintains current mode share

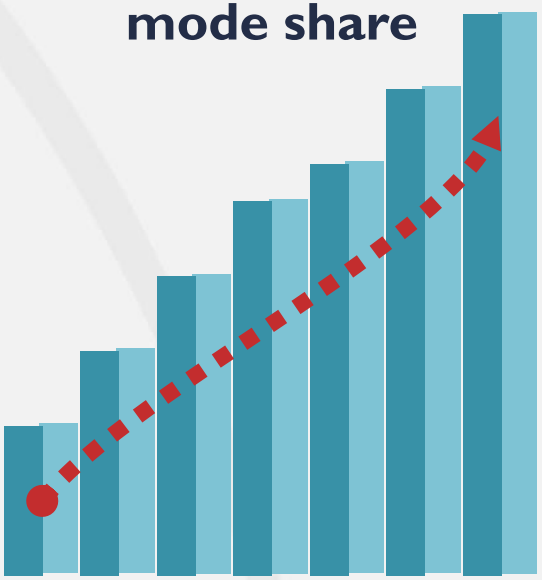
Change by 2050 = 0%

Moderate growth, small increase in mode share



Change by 2050 = +150%

Rapid growth, large increase in mode share

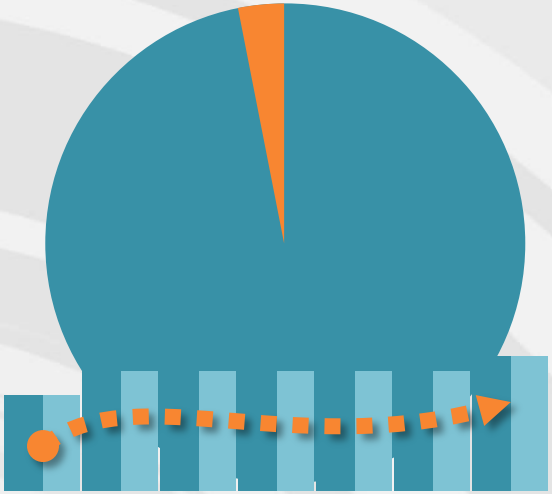


Change by 2050 = +200%

Moderate growth rate matches EIA reference case for 2035

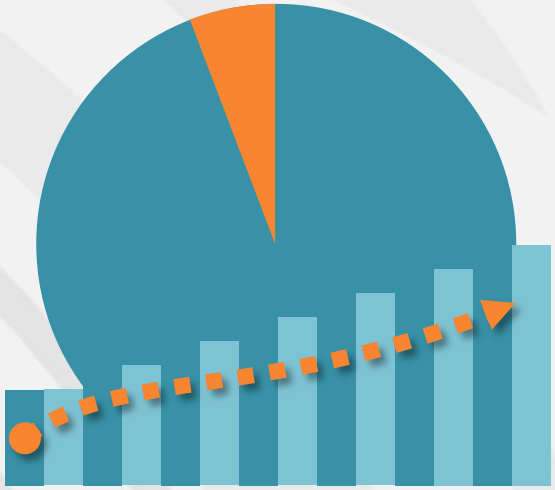
Travel factors – transit use

Low growth transit use



Mode Share in 2050 = 2%

Impressive growth in transit use

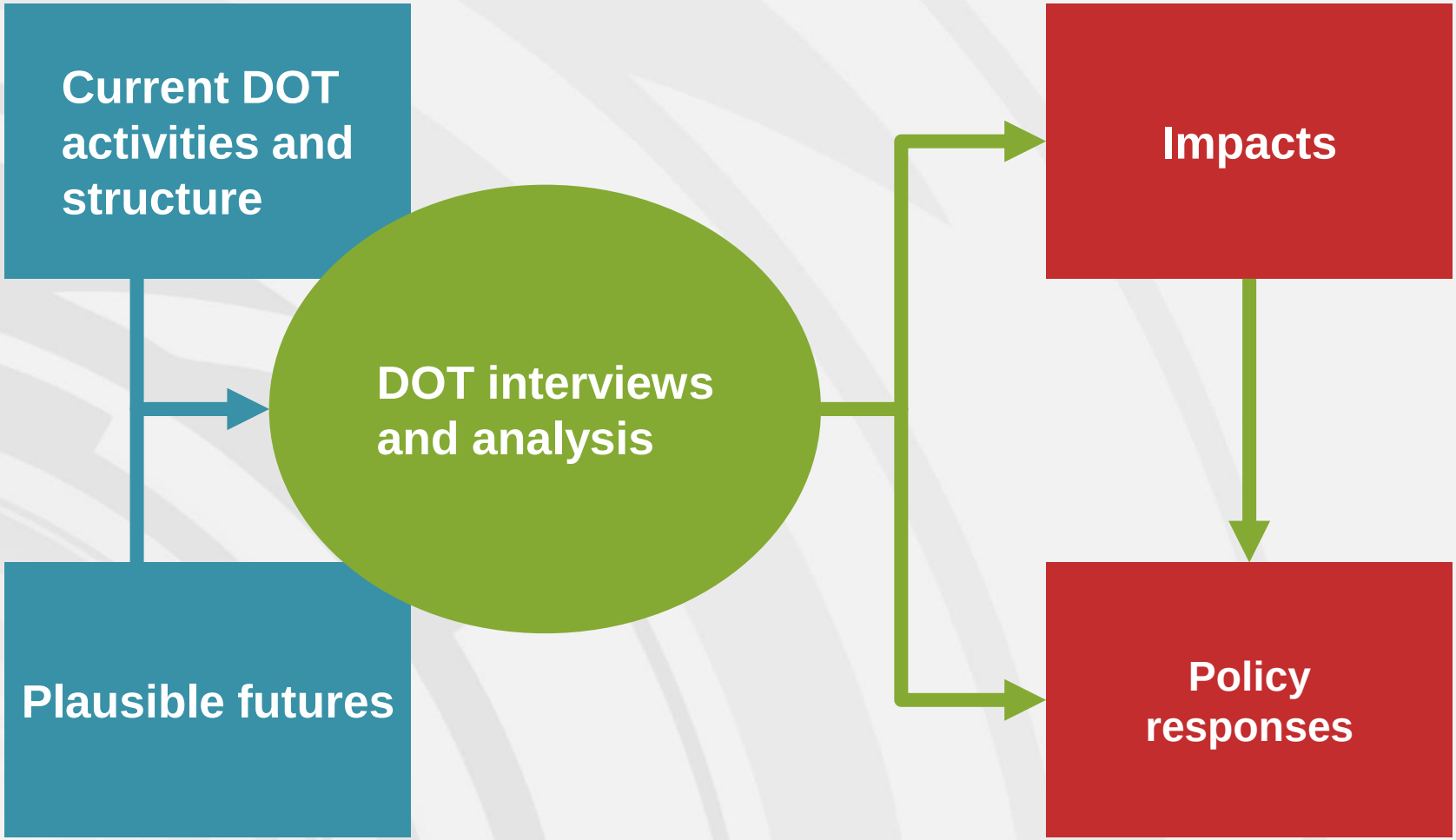


Mode Share in 2050 = 5%

Dramatic growth in transit use

Mode Share in 2050 = 10%

State DOTs helped identify impacts and possible policy responses



States identified a range of potentially challenging impacts …

Problematic in all futures:

- Reduced fuel-tax revenue

Problematic in some futures:

- Higher costs for DOTs
- Increased traffic congestion
- Increased crashes and fatalities
- Tougher to meet air-quality standards
- Pressure to mitigate GHG emissions
- Greater demand for alternative modes

States and DOTs have many potential policy responses

Revenue
- Tolls, mileage fees
- Fuel taxes
- Registration fees
- Beneficiary fees
- General revenue
- Private capital

DOT cost
- Efficiency
- Reduced scope

Auto and truck travel
- Road expansion
- Freight investments
- Congestion pricing
- ITS
- TSM&O
- Safety measures

Alternative travel modes
- TDM
- Transit investments
- Land use strategies

Energy and emissions
- Vehicle feebates
- Carbon pricing
- Fuel mandates
- Fuel production
- Agency energy use

Framework for evaluating potential policies

Mitigating Potential Impacts

- Increased revenue
- Reduced costs
- Reduced traffic
- Improved safety
- Reduced local air pollutants
- Reduced GHG emissions
- Improved alternative modes

Shaping the Future

- Reduced oil consumption
- Adoption of lower-carbon alternative fuels
- Low energy-cost of travel

General Merits

- Economy / efficiency
- Environment & public health
- Equity

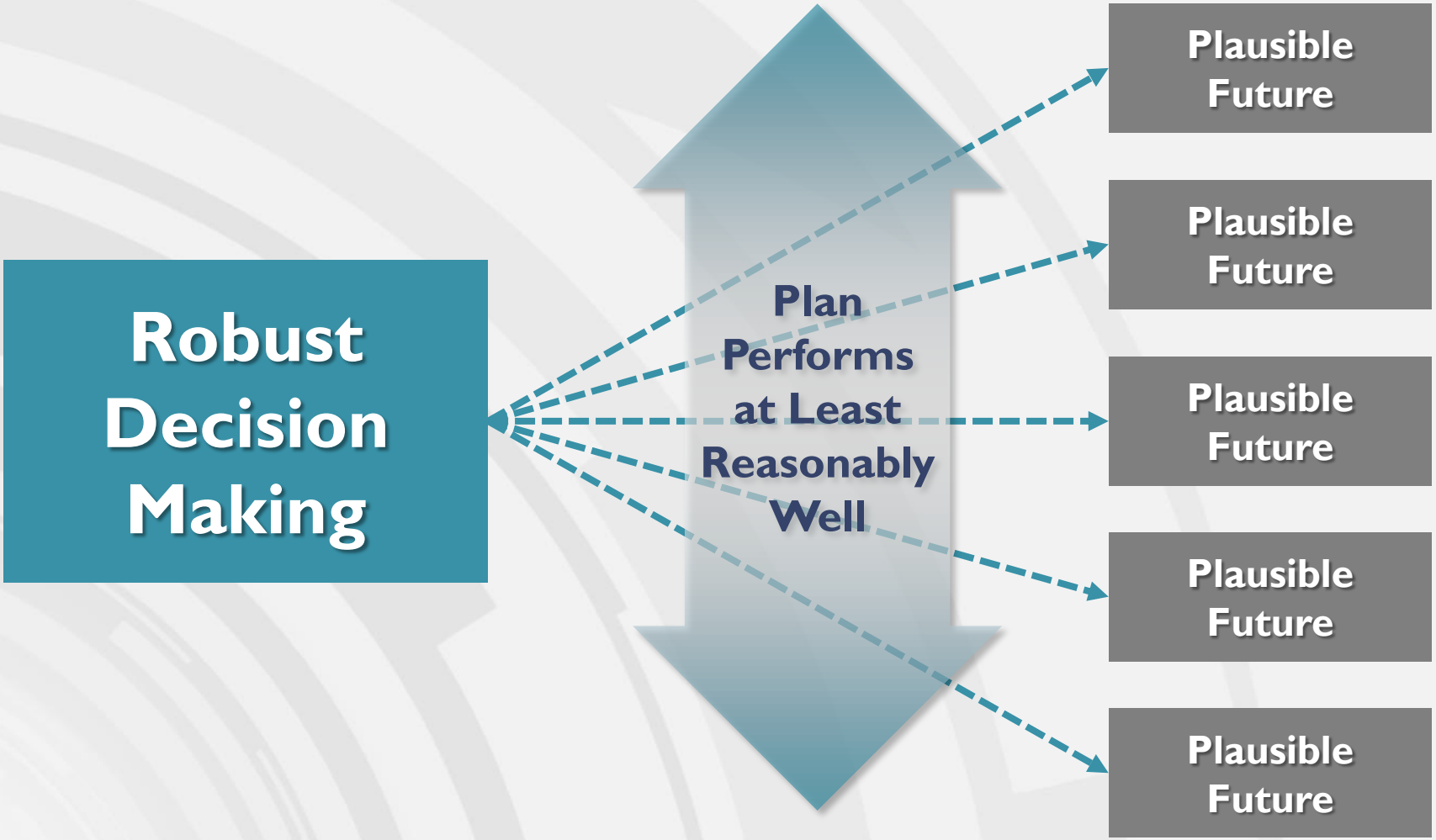
Potential Barriers

- Cost
- Public acceptance
- Technical risk
- Legislative requirements
- Institutional restructuring

When to pursue policies for potential but uncertain future challenges?

Uncertainty is problematic for traditional planning methods

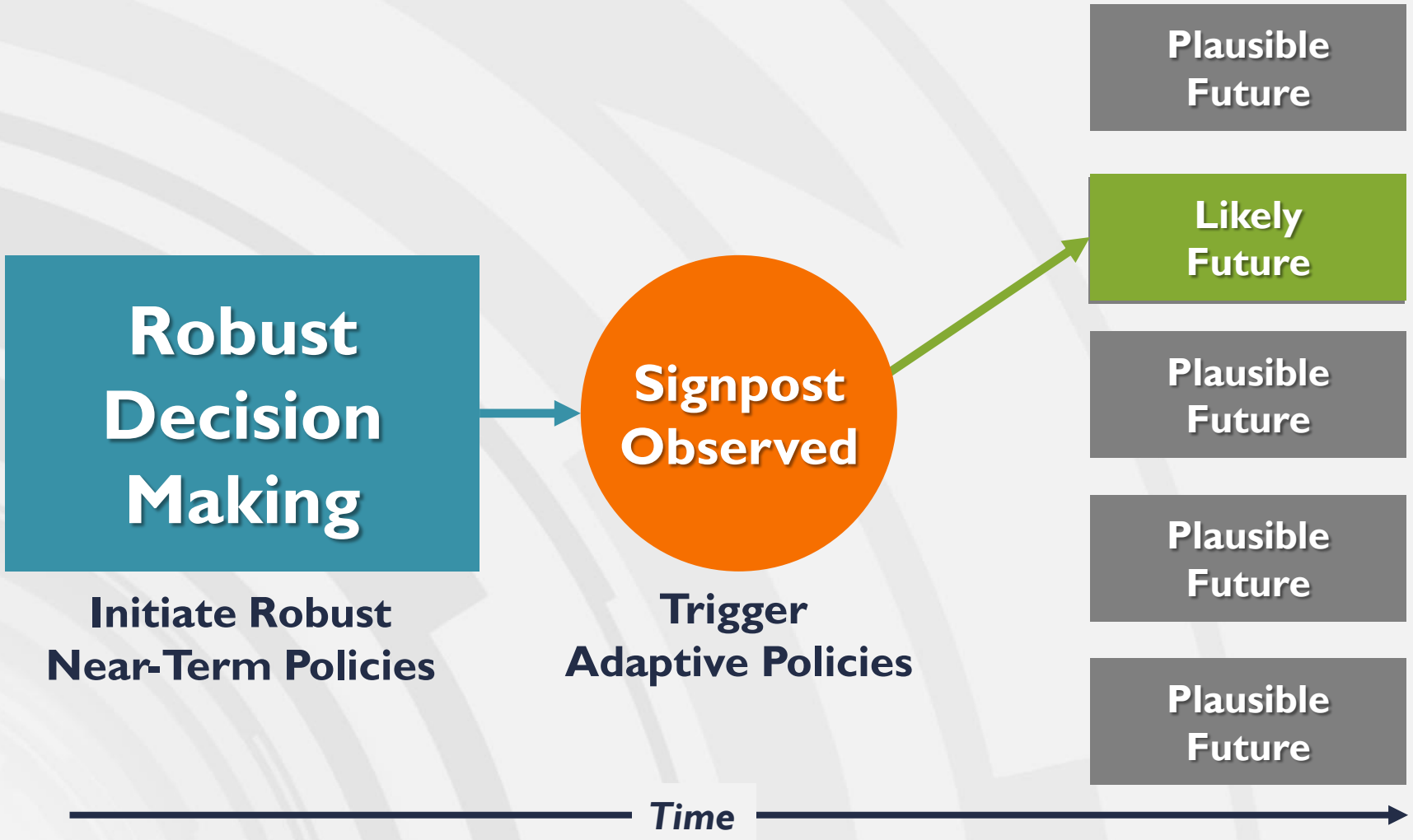
Robust decision making is explicitly designed to address uncertainty



Key robust decision making concepts

- ***Robust strategies:*** actions that should perform well regardless of how the future unfolds
- ***Adaptive strategies:*** actions that can evolve over time with new information to increase robustness
- ***Hedging strategies:*** actions with long required lead times that may be useful in some futures but not others
- ***Shaping strategies:*** actions intended to increase or decrease the likelihood of certain plausible futures
- ***Signposts:*** new information showing that a given future is either more or less likely, which may trigger the activation of an adaptive strategy

Adaptation is a foundation for robust plans

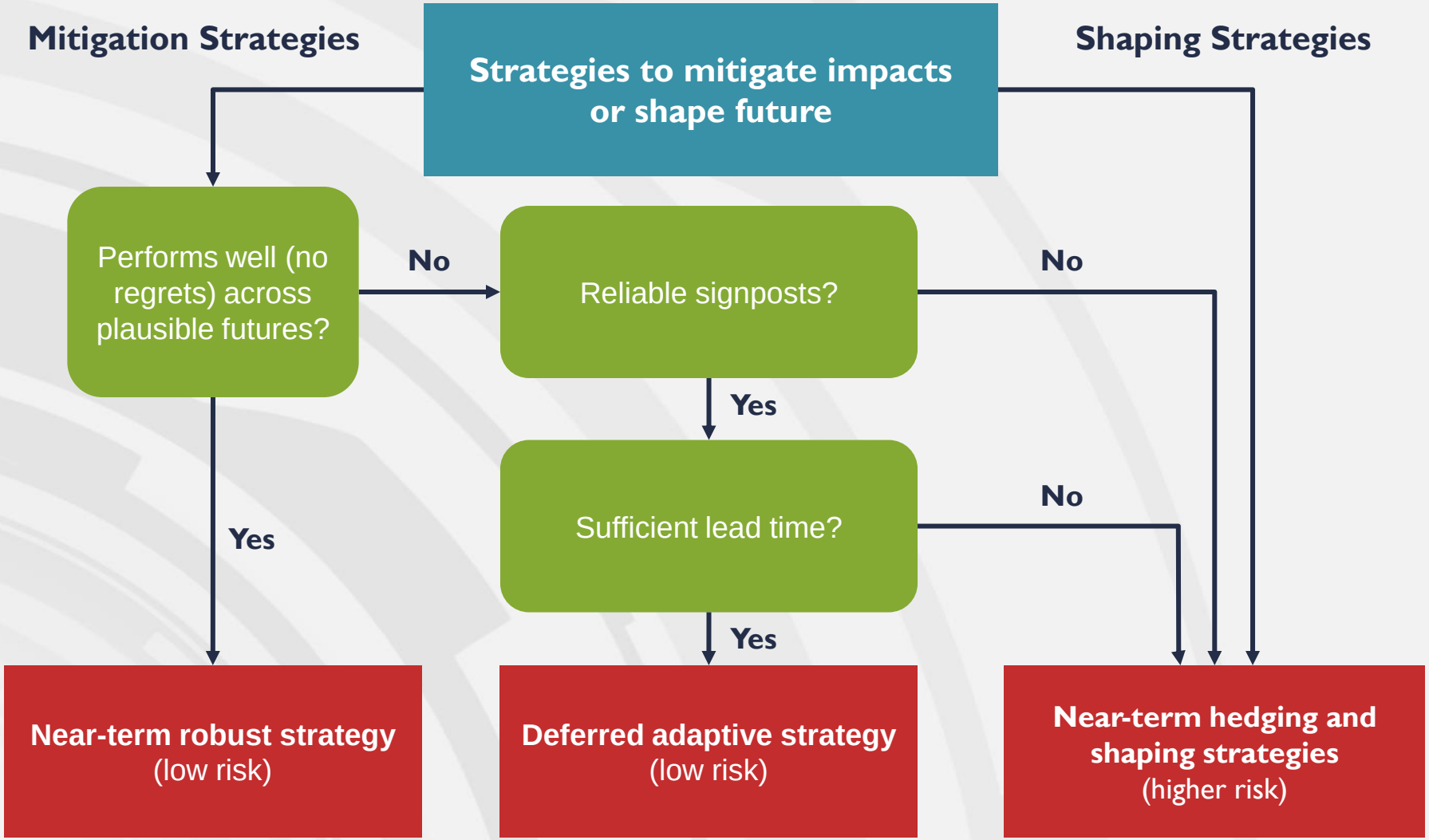


Robust decision making preserves maximum flexibility for future planners

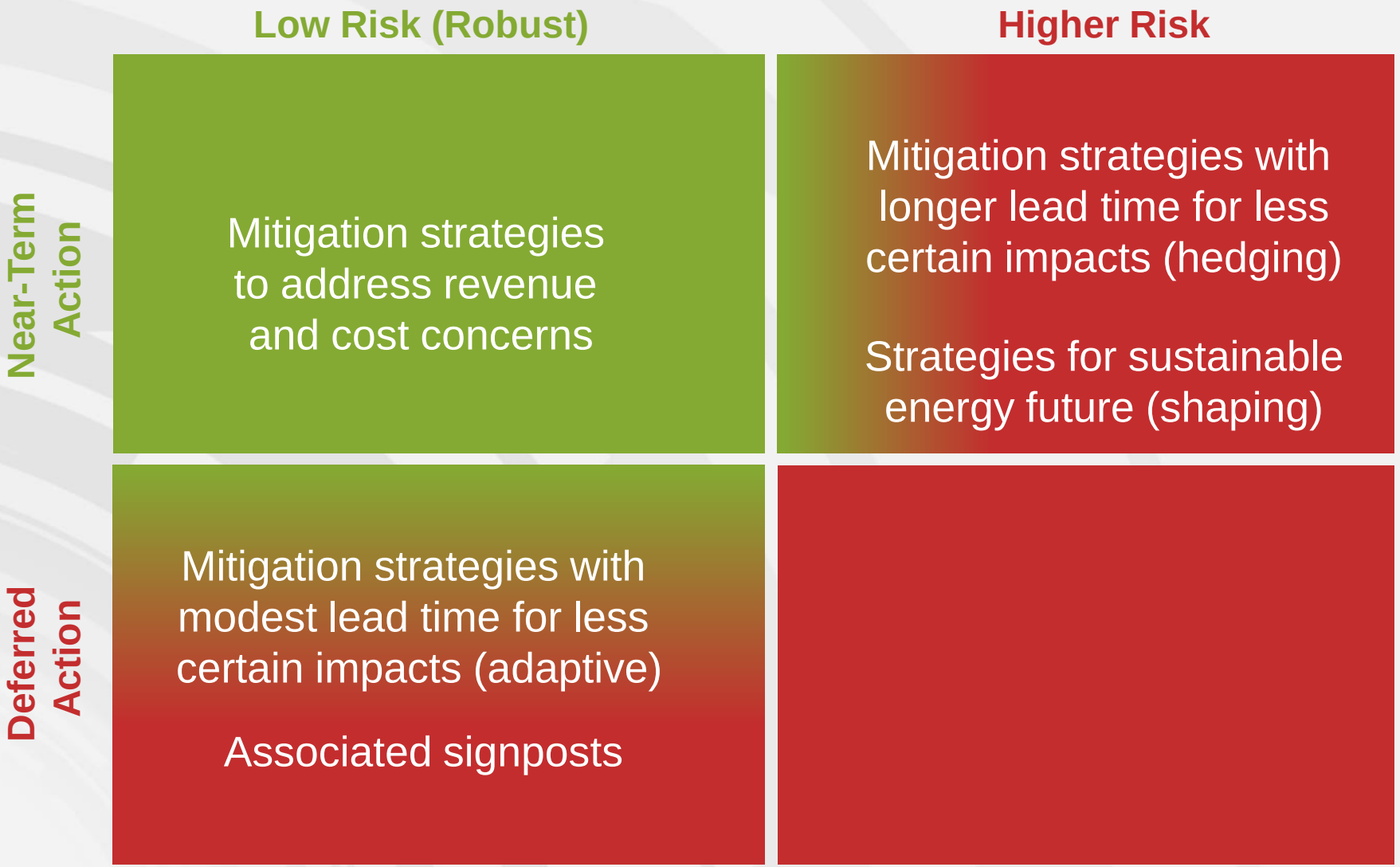
- **Do now what needs to be done now**
  - » Pursue policies that will be beneficial regardless of how the future unfolds
  - » Pursue hedging strategies, if needed
  - » Pursue shaping strategies, if desired

- **Prepare for an uncertain future**
  - » Develop signposts and adaptive strategies to be triggered, or not, as more information about how the future is unfolding becomes available

Approach to identifying robust strategies



A robust planning framework for states



Integrated framework for robust long-term plans

- *Near-term strategies* to address highly probably impacts

Objective	Most promising strategies	Optional high-impact strategies	Optional low-impact strategies
Stabilize or increase DOT revenues and/or decrease DOT costs	✓ Fuel taxes ✓ Tolling or MBUF ✓ Registration fees ✓ Beneficiary fees ✓ DOT efficiency ✓ Land use	✓ Carbon pricing ✓ Congestion pricing	✓ Private capital ✓ Agency energy use

Integrated framework for robust long-term plans

- *Deferred adaptive strategies* and *near-term hedging strategies* to address uncertain impacts

Objective	Most promising strategies	Optional high-impact strategies	Optional low-impact strategies
Mitigate traffic congestion	✓ Congestion pricing ✓ Goods movement ✓ TDM ✓ Public transportation	✓ ITS	✓ TSM&O
Improve traffic safety	✓ Traffic safety ✓ ITS ✓ Goods movement ✓ TSM&)		

Integrated framework for robust long-term plans

- *Deferred adaptive strategies* and *near-term hedging strategies* to address uncertain impacts

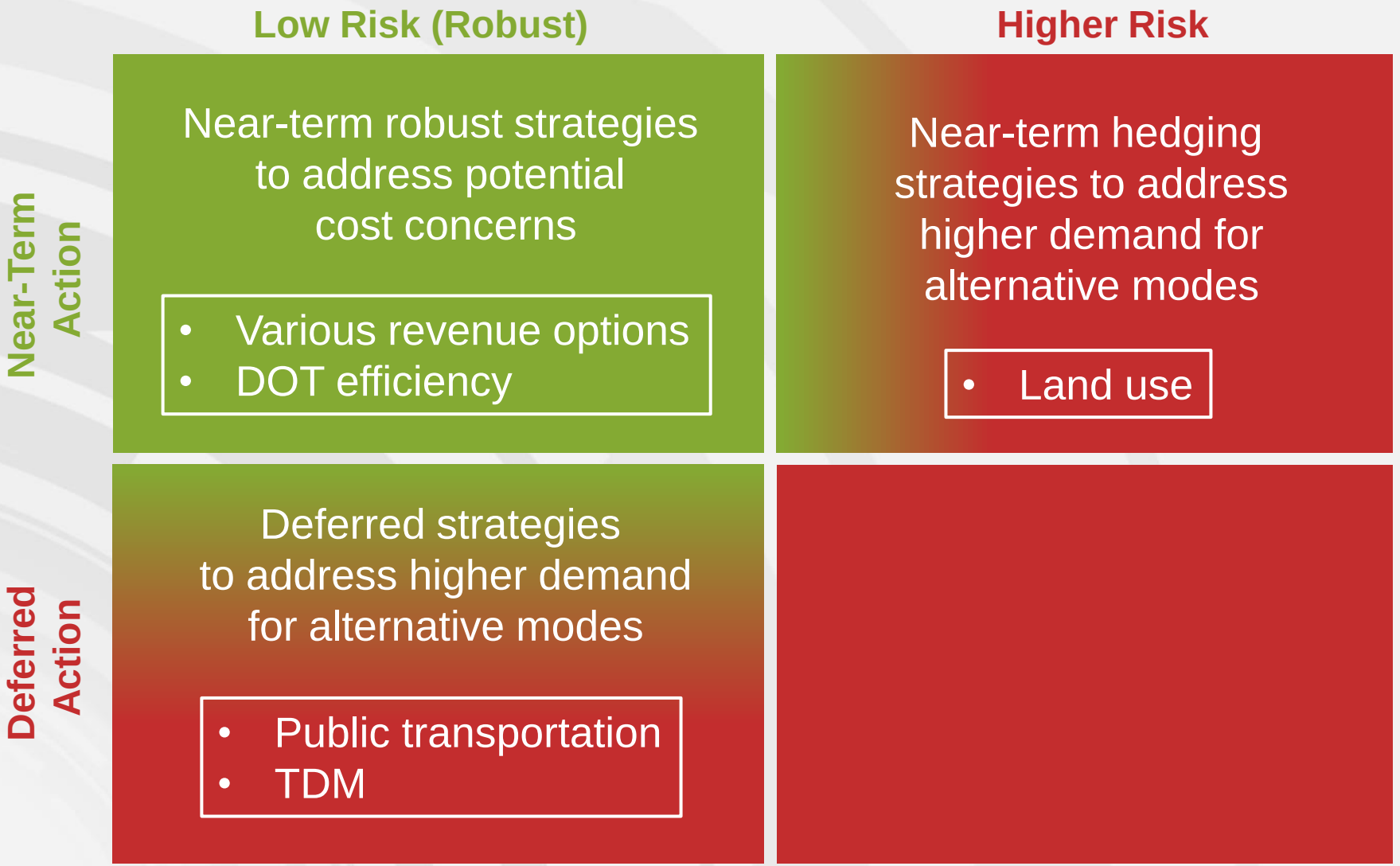
Objective	Most promising strategies	Optional high-impact strategies	Optional low-impact strategies
Improve air quality and/or reduce GHG	✓ Vehicle feebates ✓ Carbon pricing ✓ Goods movement ✓ TDM ✓ Land use	✓ Fuel mandates and programs ✓ Public transportation	✓ Alternative fuels production and distribution ✓ Agency energy use
Improve non-automotive travel options	✓ Public transportation ✓ TDM ✓ Land use ✓ Traffic safety	✓ Congestion pricing ✓ ITS	✓ TSM&O

Integrated framework for robust long-term plans

- *Shaping strategies* to influence future transportation energy outcomes

Objective	Most promising strategies	Optional high-impact strategies	Optional low-impact strategies
Promote a more sustainable energy future	✓ Vehicle feebates ✓ Fuel taxes ✓ Land use	✓ Carbon pricing ✓ Fuel mandates and programs ✓ Public transportation	✓ Alternative fuels production and distribution ✓ Agency energy use

Addressing potential impacts relating to cost and higher demand for alternative modes



But must we wait?

- Public transportation and TDM are viewed as safe to defer from the perspective of *uncertain future impacts associated with alternate plausible ENERGY futures*

- There may be many other reasons—e.g. equity, livability, sustainability—for pursuing these aggressively now…

Thanks!

For more, see: http://www.trb.org/Energy/Blurbs/170763.aspx