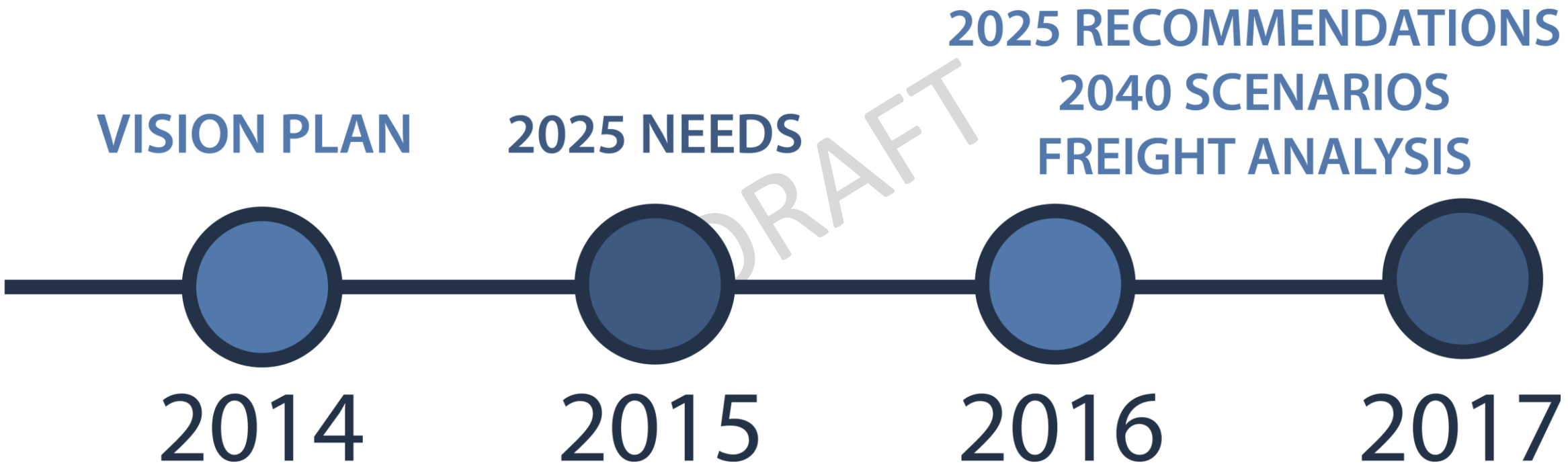
VTrans2040 Scenario Analysis

JUNE 2017

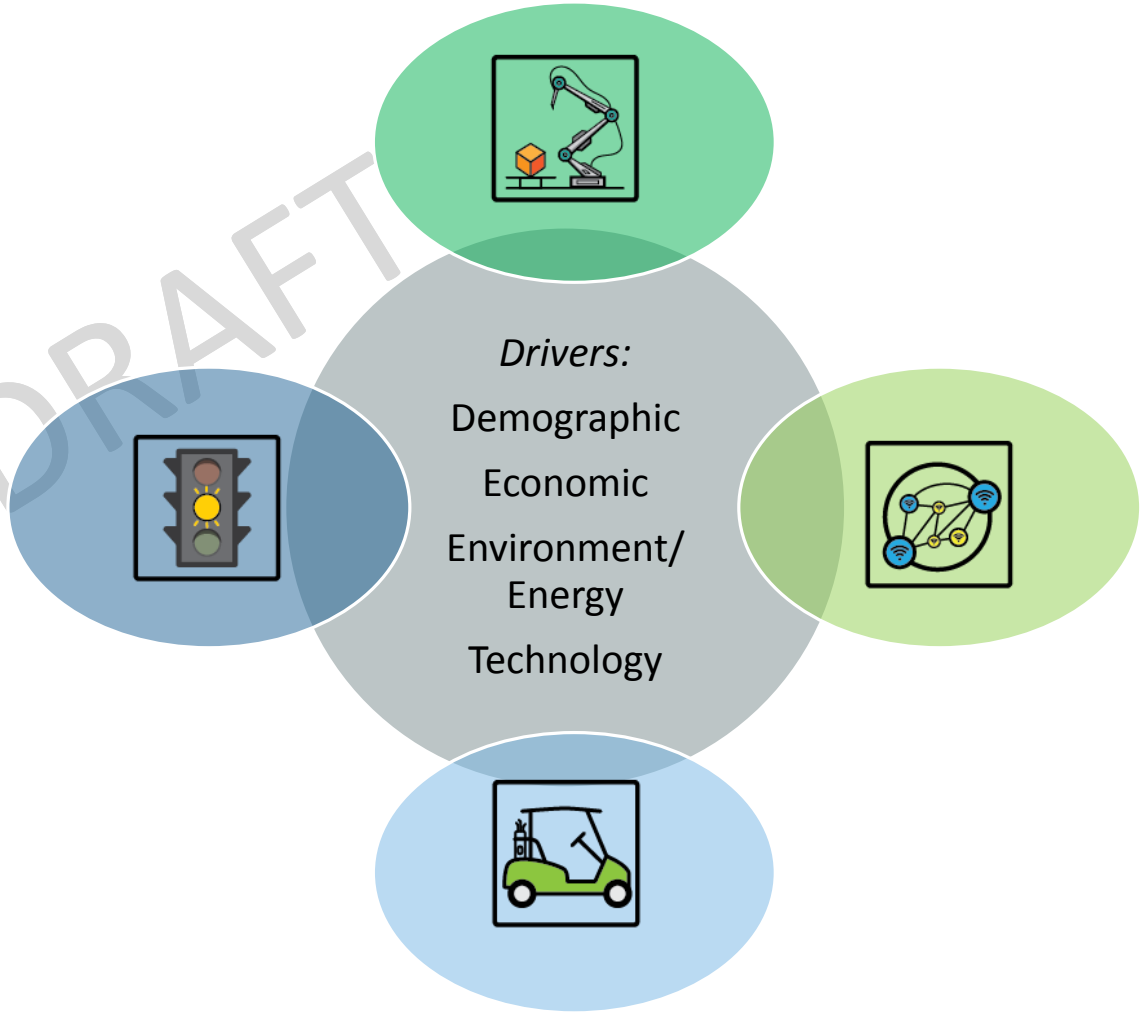
Timeline



Exploratory Scenarios

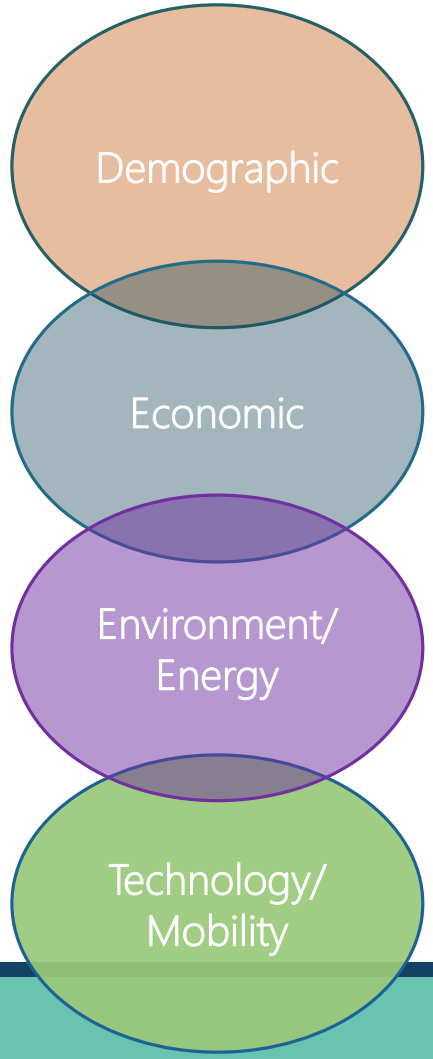
Ask “What Could Happen?” . . .
As opposed to, “What Should Happen?”

Not looking at What is Best, but rather, What to be Prepared for.



Scenario Planning Toolkit

DRIVERS



COMMUNITY TYPES

V6 – Multimodal Urban

V5 – High Density Suburban

V4 – Multimodal Suburban

V3 – Small Town/Suburban

V2 – Low-Density Suburban

V1 – Rural

GENERATIONS

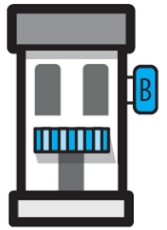
Baby Boomer

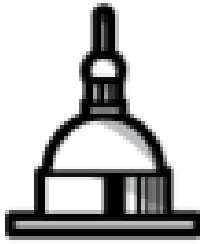
Generation X

Millennial

Generation Z

INDUSTRY MIX





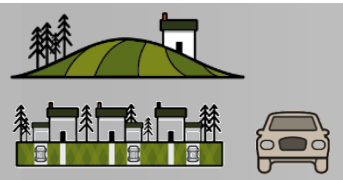
Scenarios Recap

Industrial Renaissance

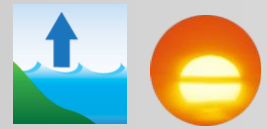


High Pop. Growth


Industrial


Suburban/Rural


Med. AV/MOD


Climate Extremes

Techtopia



High Pop. Growth

High Tech.


Urban


High AV/MOD


Climate Stability

Silver Age

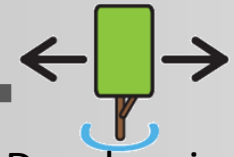


Comparable Pop. Growth


Small business/ Health Care


Walkable Places


Med.-High AV/ Low MOD


Develop. in less Vulnerable Places

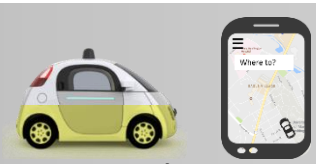
General Slowdown



Lower Pop. Growth

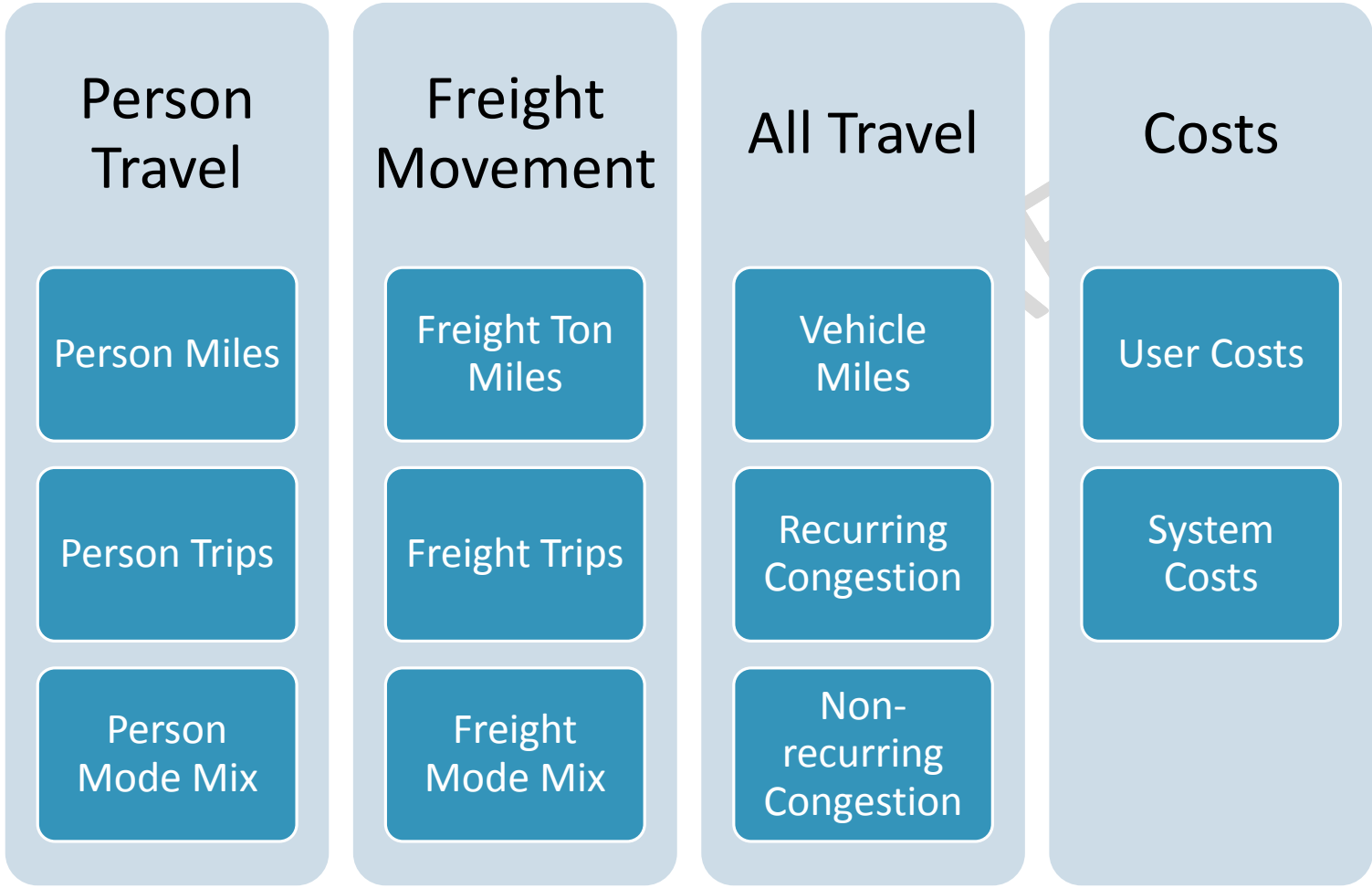

Reduced Spending


Less Urban

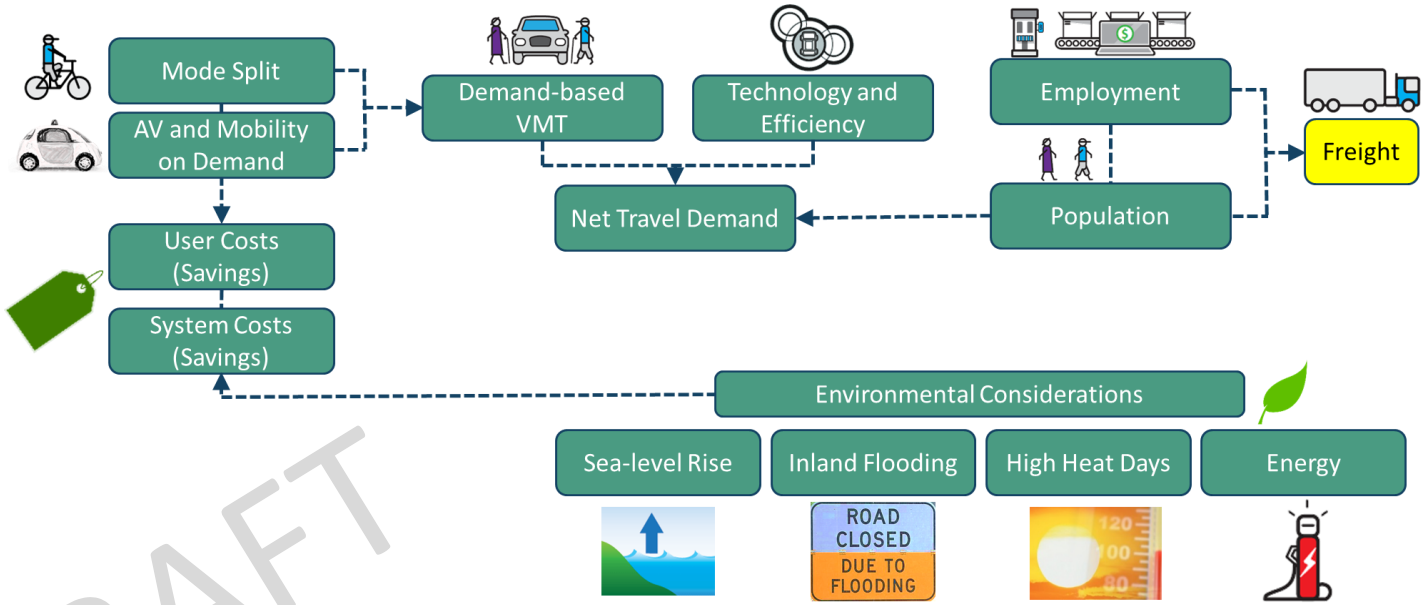

Low AV/MOD


Volatile Energy $

Sketch Planning Outputs



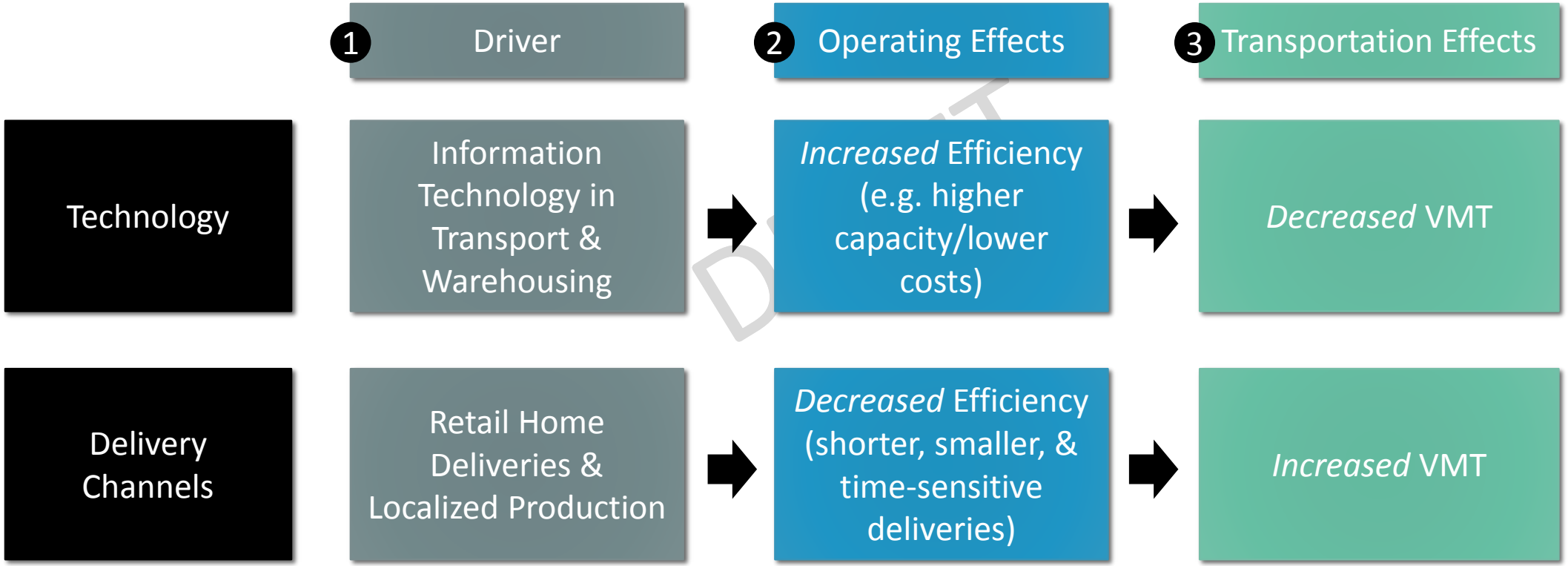
- Quantitative
- Qualitative
- Directional/Relative



Freight

DEMAND, MODE, EFFICIENCY, AND VMT

Supply Chain Dynamics



Freight Results: Industrial Renaissance

How does it differ from the Baseline?

Demand ↑

More People

Inbound and outbound freight increase due to high production demand

Mode Share

Truck mode share still high, but smaller trucks likely used. Air cargo increases to accommodate low weight, high value products.

Efficiency ↓

Efficiency losses as smaller trucks, haul smaller loads, more frequently

Truck VMT ↑

Increase in VMT

Freight Results: Techtopia

How does it differ from the Baseline?

Demand

More People

High consumption & retail demand and desire for just-in-time deliveries. Inbound freight activity exceeds outbound activity

Mode Share

High service trucking with lower unit weights, but higher value products. Intercity rail/trucking serve smaller distribution centers on fringe of metropolitan areas

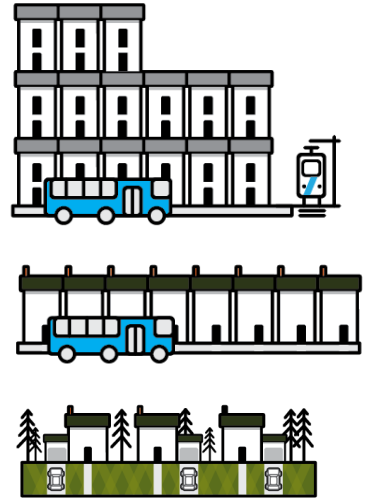
Efficiency

Less focus on stocking shelves and more focus on prompt delivery reduces productivity of freight system

At the same time, technology and automation could help increase efficiency

Truck VMT

Increase in VMT with disproportionate increases in metro areas. Potential VMT reductions in rural areas



Freight Results: Silver Age

How does it differ from the Baseline?

Demand

Older population

Dispersed population and demand. Less spending on goods and more spending on services, such as healthcare, that generate less freight demand

Mode Share

Less demand across all freight modes compared to Baseline

Efficiency

Less opportunity for reengineered supply chains due to population dispersion and growth in small towns

Truck VMT

Potentially higher VMT due to population dispersion

Freight Results: General Slowdown

How does it differ from the Baseline?

Demand

Fewer People

Lower government spending, less disposable income for products

Mode Share

Less demand across all freight modes compared to Baseline

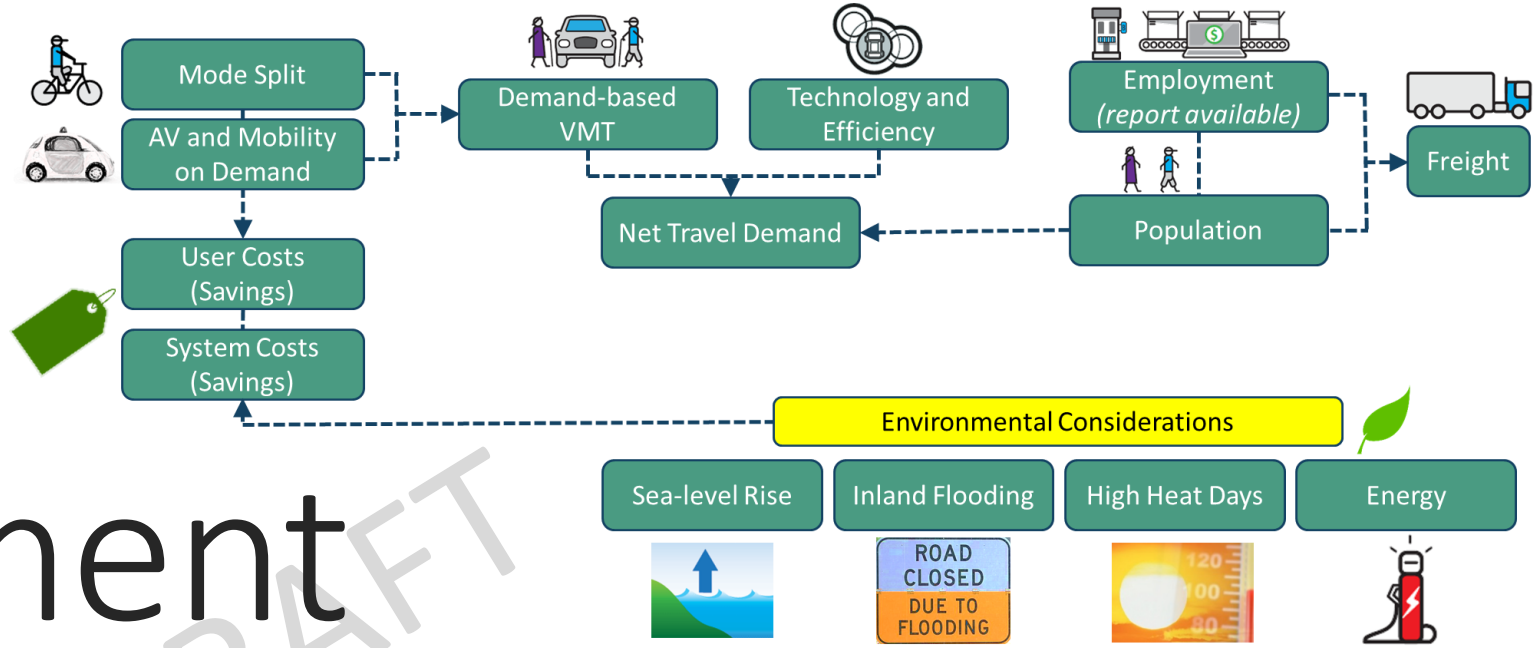
Efficiency

While freight carriers may adjust to volatile energy prices, technology adoption is limited, potentially slowing any efficiency gains

Truck VMT

VMT declines with reduction in demand

Environment & Energy



Industrial Renaissance and Techtopia: Climate Change

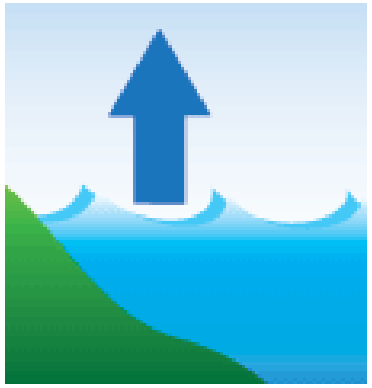
Hampton Roads is rated second only to New Orleans as the most vulnerable area to relative sea level rise in the country (http://www.centerforsealevelrise.org)

Former Norfolk Mayor, Paul Fraim, has stated, “We deal with stormwater flooding in the city now on a monthly basis” and…“in a severe Category 2 or Category 3 storm, if we were to receive a direct hit, almost all of the city would be underwater.” (http://www.centerforsealevelrise.org)

Industrial Renaissance and Techtopia: Climate Change Assumptions

Meters of Sea-level Rise

0.5 Meters



.124 Meters

Scen. 1 Scen. 2

Required Response:
Roadway reconstruction, roadway repairs

Inland Flood Events Per Year

1.3 Events

2.1 Events

1.7 Events

Today Scen. 1 Scen. 2

Required Response:
Bridge, road, culvert repairs

High Heat Days Per Year

10 Days

60 Days

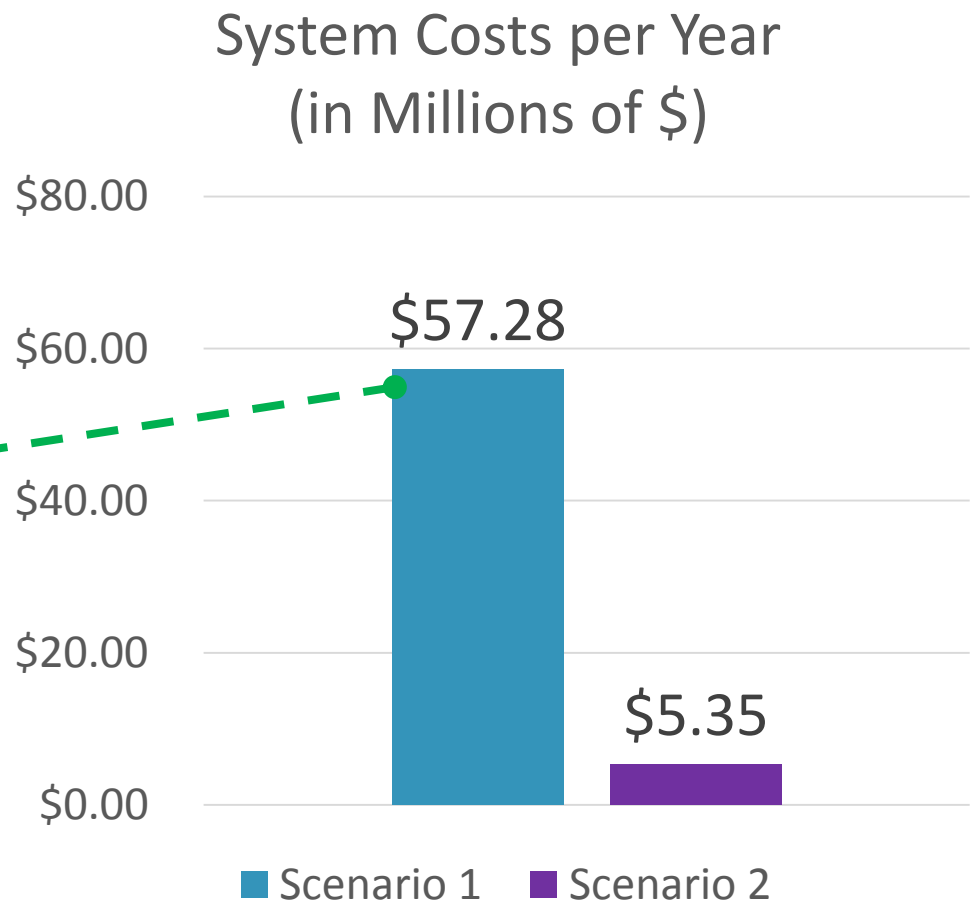
20 Days

Today Scen. 1 Scen. 2

Required Response:
Asphalt repairs (potholes)

Industrial Renaissance and Techtopia: Climate Change Assumptions

485 additional miles could be subject to flooding in Scenario 1 ($52.3 million in annual system costs)



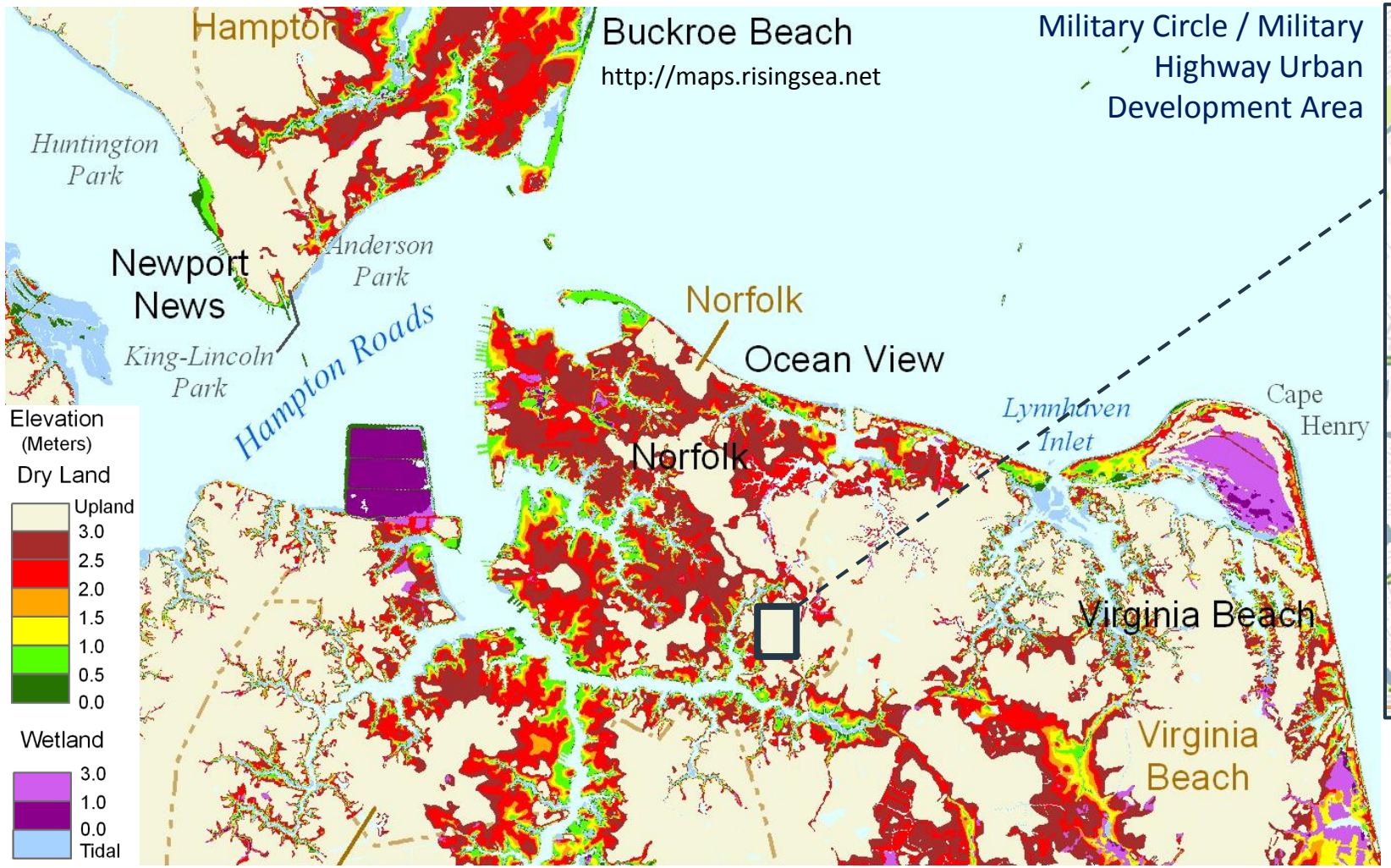
Scenario 3 Assumptions: Virginia develops away from the most vulnerable areas

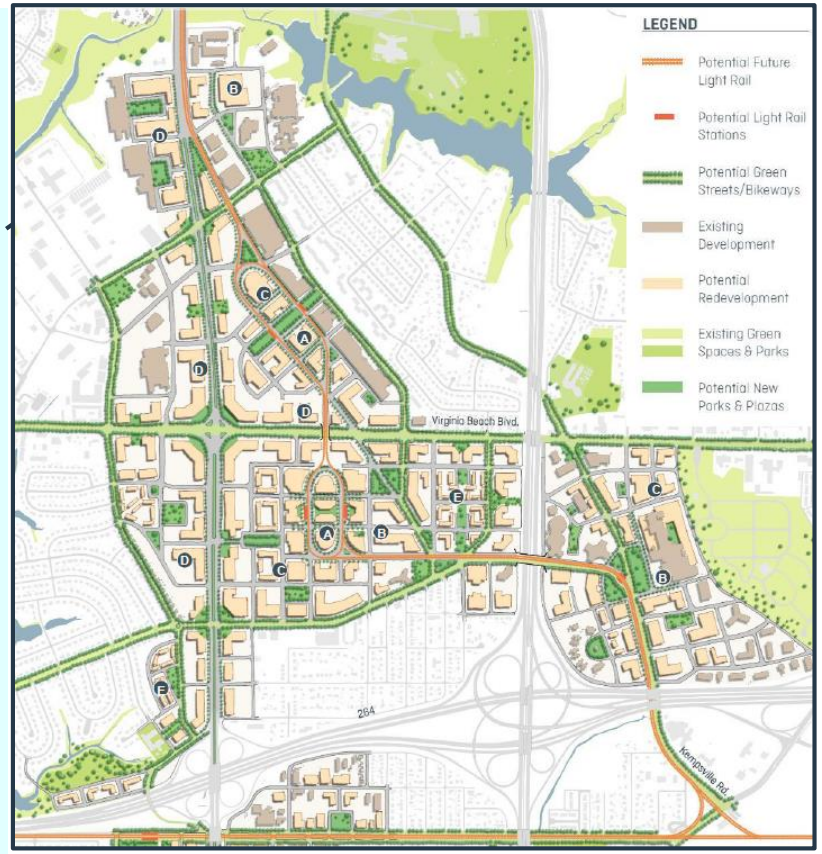
It's unknown where residents and businesses would relocate to in the event of extreme sea-level rise

Communities, like Norfolk, are developing Resilience Plans to acknowledge vulnerabilities and to work proactively to find solutions.

Ideas for Water Storage in Norfolk, Virginia. Source: Dutch Dialogues

Scenario 3 Results: Virginia develops away from the most vulnerable areas

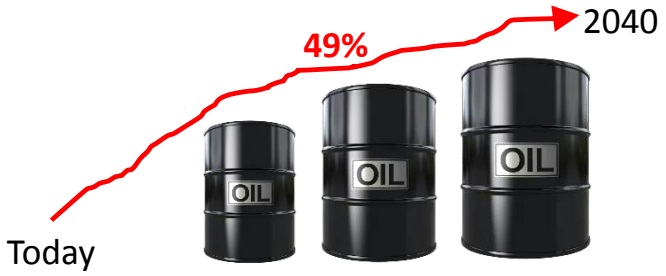




"Concentrating new development in areas relatively better protected from recurrent coastal flooding" -Military Circle/Military Highway UDA: A Vision for the Future (2017)

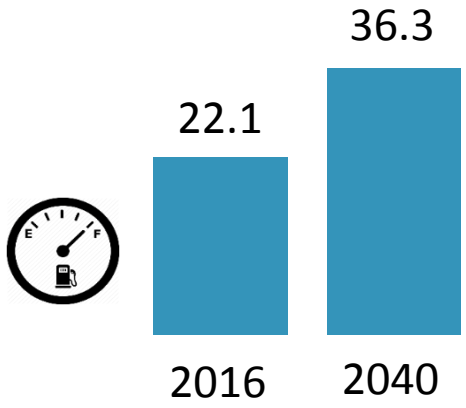
Scenario 4 Assumptions: Environment status quo; Volatile global energy prices

What does the research say?



The U.S. Energy Information Agency (EIA) predicts that gasoline will remain the dominant automobile fuel through 2040, and that the average cost of gasoline will increase by 49%

It does not appear as though 2040 roadway demand will be constrained by rising energy prices, particularly if fuel efficiency continues to improve

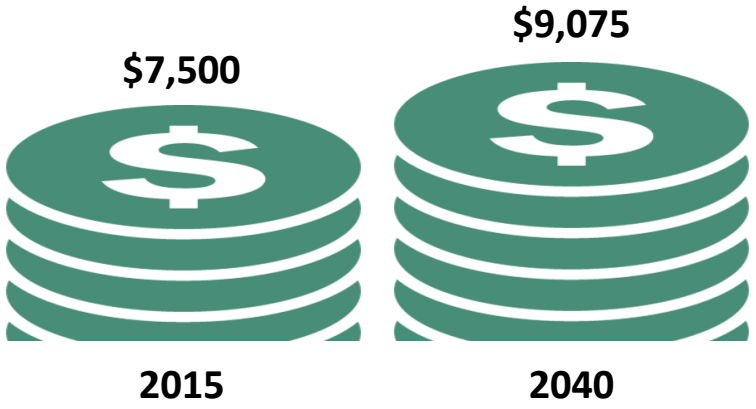


The EIA predicts that average vehicle efficiency will increase by 64%, from 22.1 miles per gallon to 36.3 miles per gallon

Scenario 4 Results: Environment status quo; Volatile global energy prices

What if energy prices outpace EIA expectations?

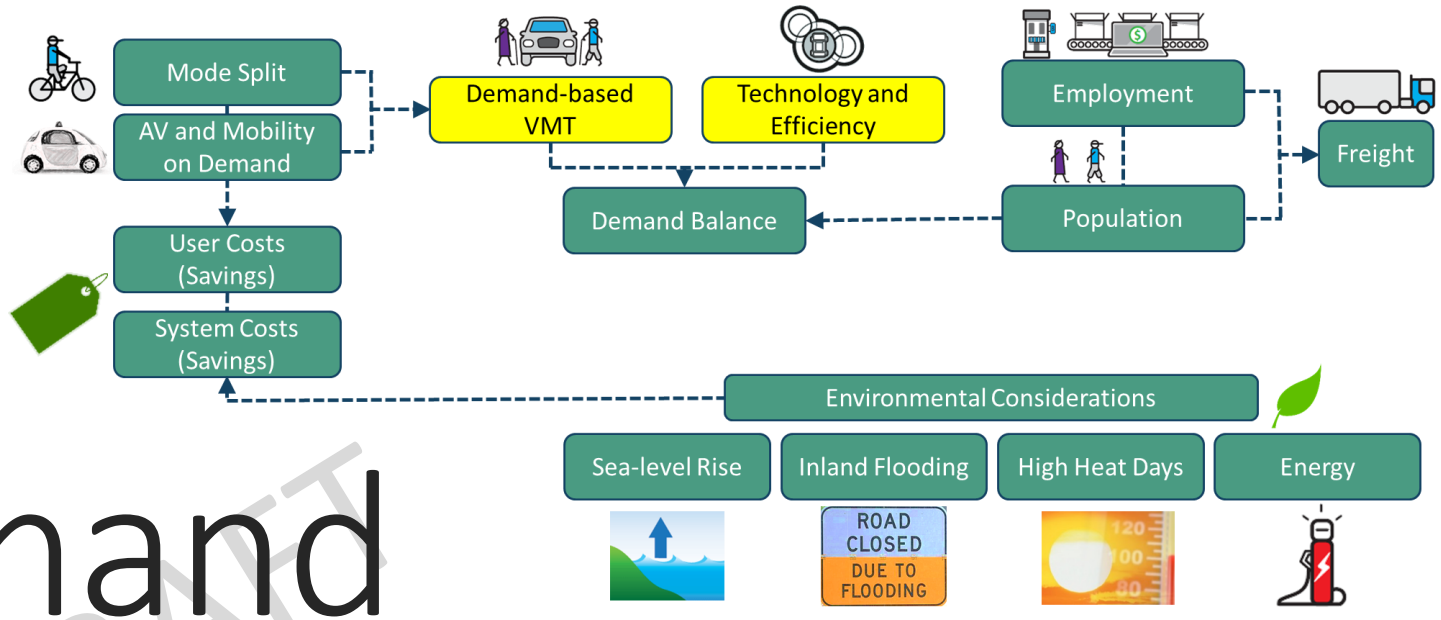
Driving Cost Per Year



If energy prices rise at double the rate that the EIA anticipates, **cost per mile will increase by 21%**

Transit Mode Share could **increase 1.9% in urban areas**

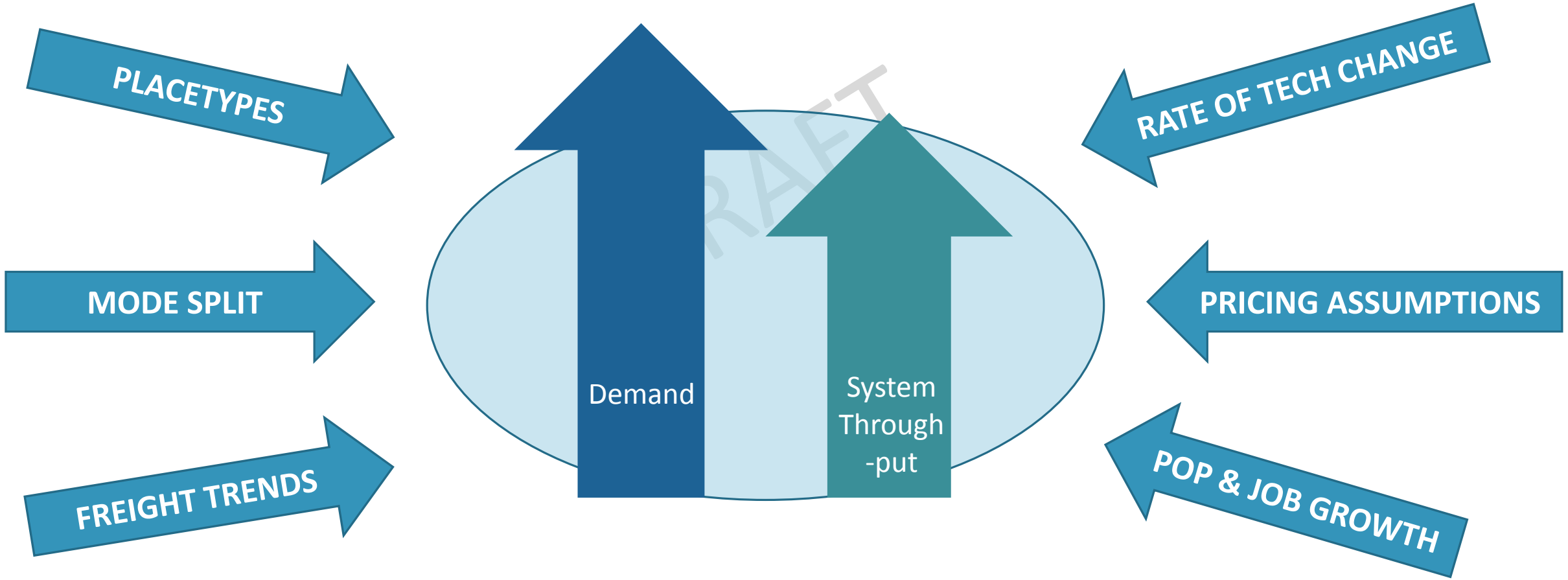
Overall VMT could **decline by 2.7%**



Travel Demand & Through-put

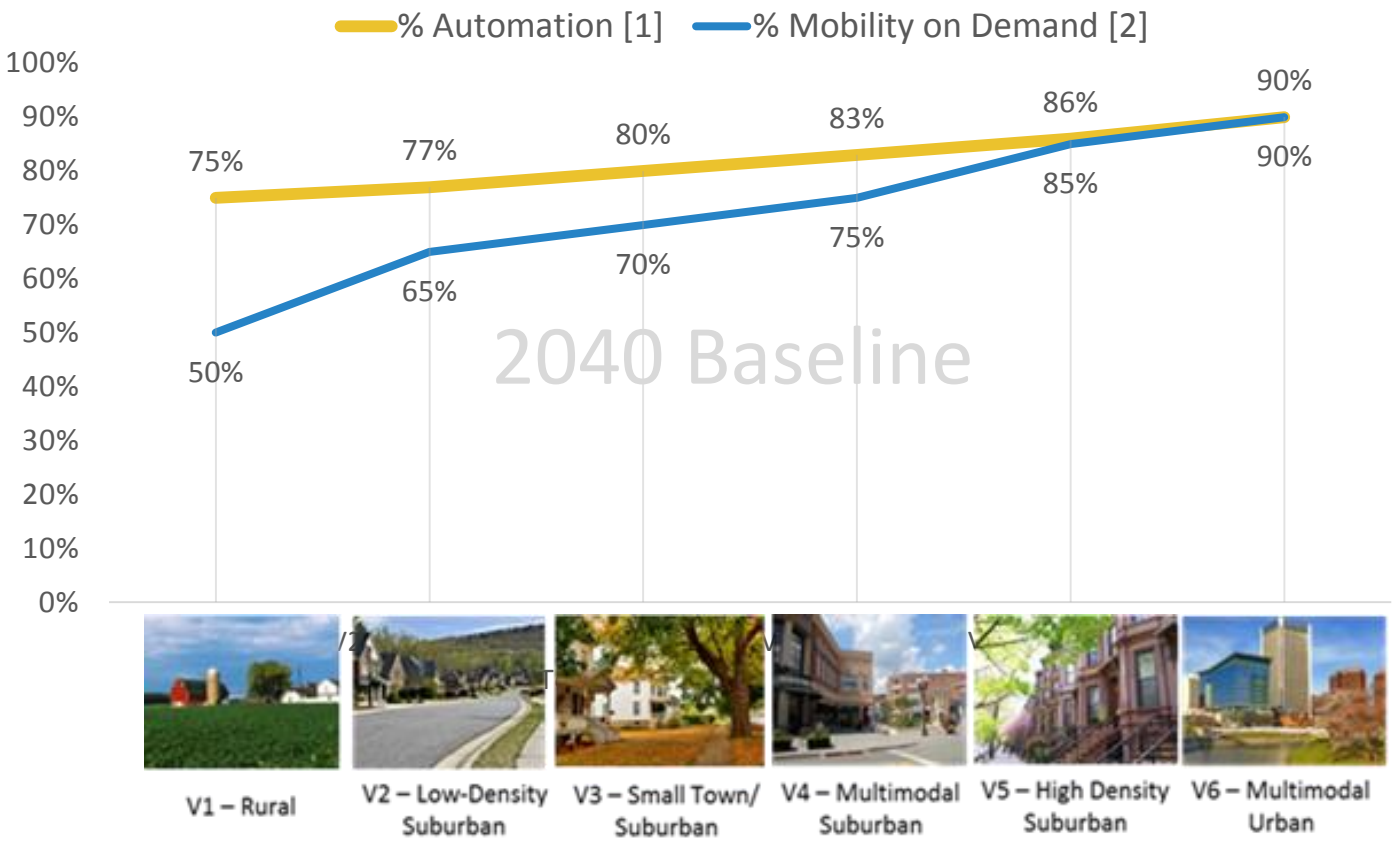
DEMAND-BASED VMT, TECHNOLOGY, AND EFFICIENCY

Factors Influencing Demand



Baseline Technology Assumptions

Percent passenger travel by autonomous vehicles and Mobility on Demand *in the 2040 Baseline*



By 2040…it is likely that autonomous vehicles and Mobility on Demand (ex: Uber and Lyft) will play a significant role in passenger travel, especially in urban areas.

Automation and Mobility on Demand assumptions vary across placetypes and by scenario.

★ Information above was inspired by input received at fall meetings

What's Driving Demand in 2040?

Photo credits: Karagetv, familypedia, Rand Corp, CBS, Bloomberg, Cleveland Clinic, TechCrunch, Autocar

Transit in 2040

Anticipate a Spectrum of Services…

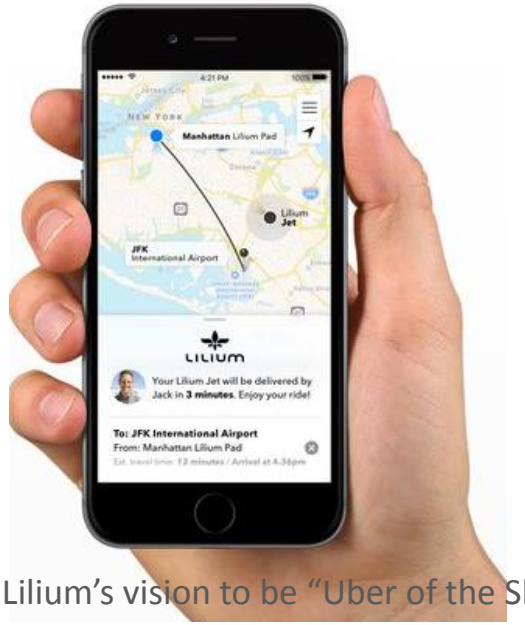
Rail | BRT | Fixed-Route Bus | Custom Route Bus | Circulator Shuttles | Personal Transit

Fixed Route
High Capacity

Demand-Responsive
Lower Capacity

Aviation in 2040

- More fuel-efficient, lower maintenance costs, and greater range and utility
- Affordable commuter services, like Southern Airways Express
- Vertical take-off and landing (VTOL)
- “Uber of the skies”



Lilium’s vision to be “Uber of the Skies”

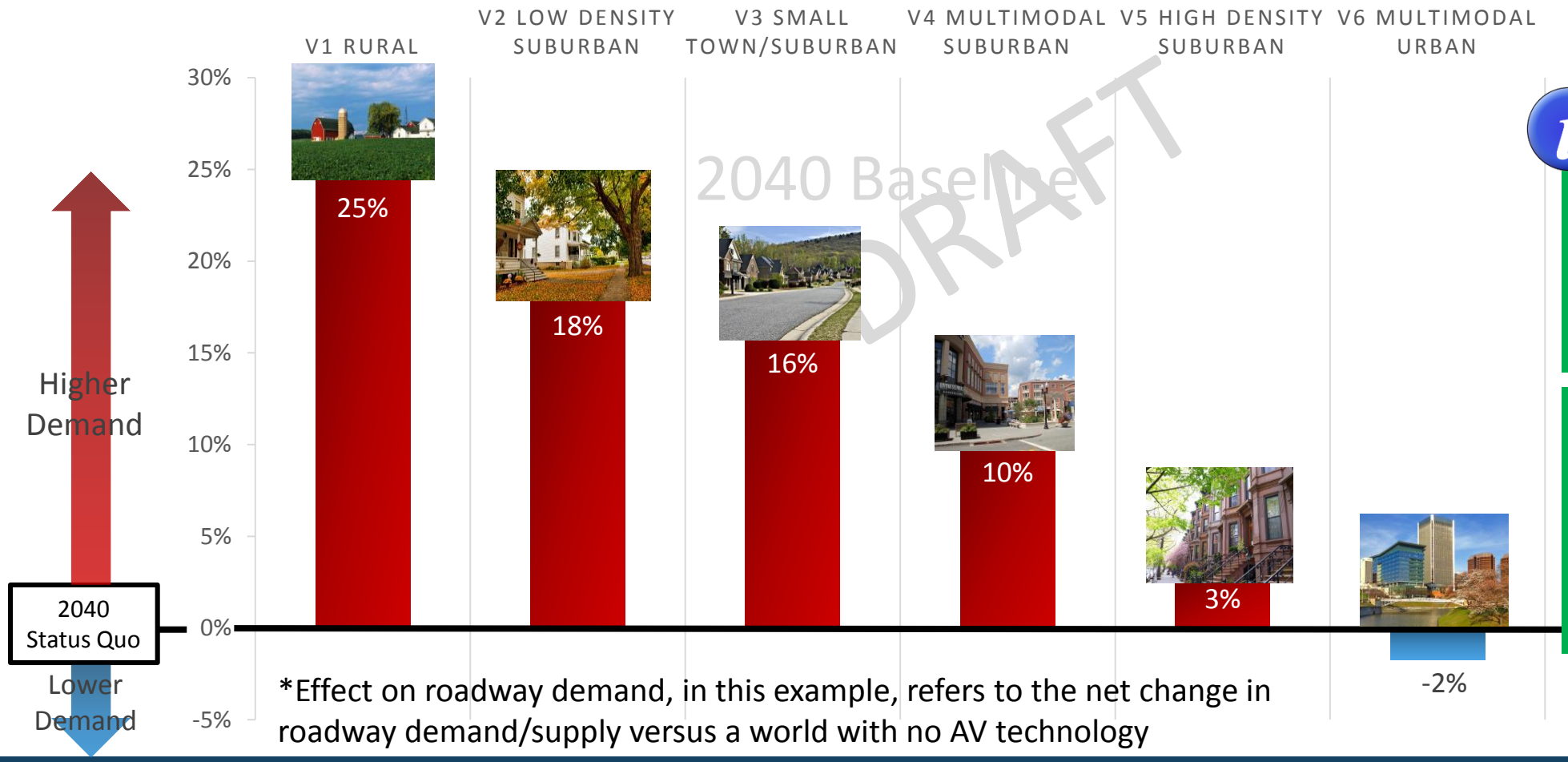
Lilium launched a “flying car” in Spring 2017

Southern Airways offers affordable commuter service

Results of Autonomous Vehicle Technology and Roadway Demand in 2040

ROADWAY DEMAND BALANCE BY PLACETYPE:

2040 BASELINE VS. 2040 "Status Quo" (NO AV INFLUENCE)



*Effect on roadway demand, in this example, refers to the net change in roadway demand/supply versus a world with no AV technology

VMT is expected to increase in the 2040 Baseline as AVs and Mobility on Demand take shape.

The majority of increased auto travel is expected to occur in Virginia's rural and suburban areas.

Roadway Demand

Technology and changing travel behavior are expected to increase roadway demand (VMT) by

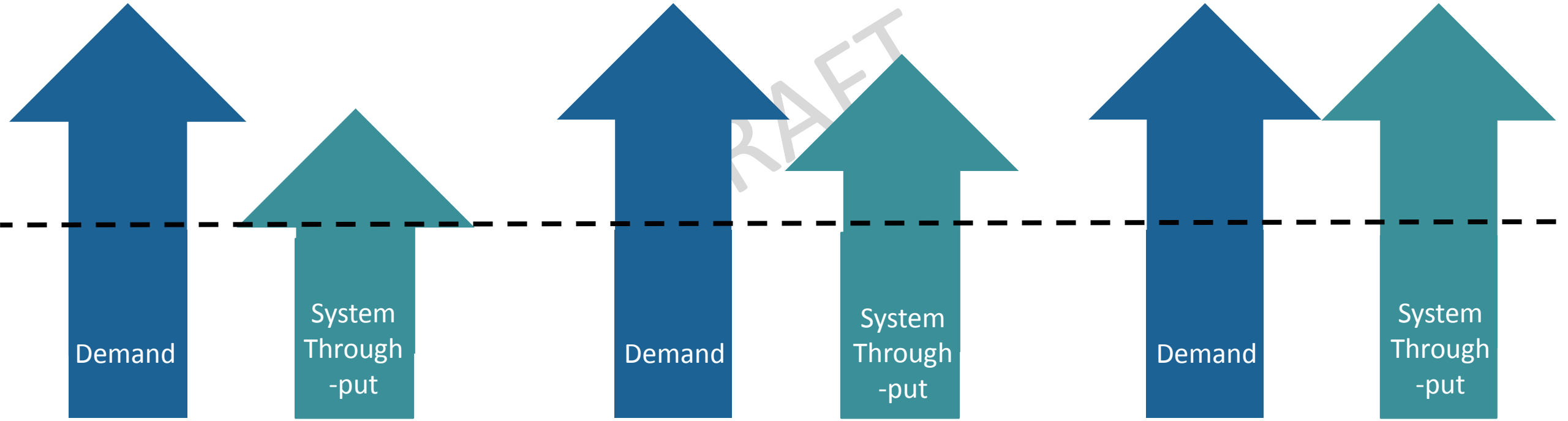
26%-39%

(depending on Scenario)

VMT is expected to increase as auto travel becomes safer, more accessible, and more enjoyable

Demand and System Through-put

Different Possibilities for System Through-put…

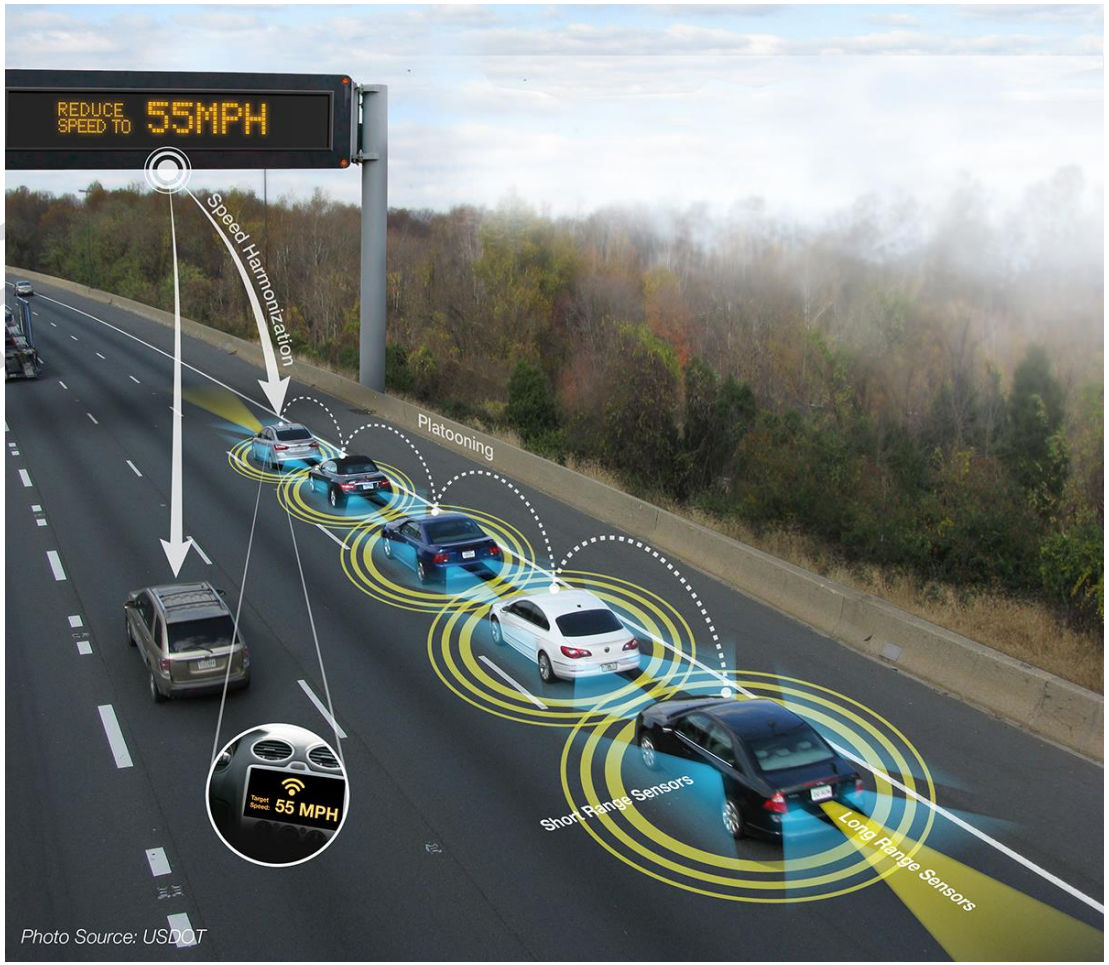


1 No Change

2 Slight increase

3 Matched increase

Technology and Efficiency

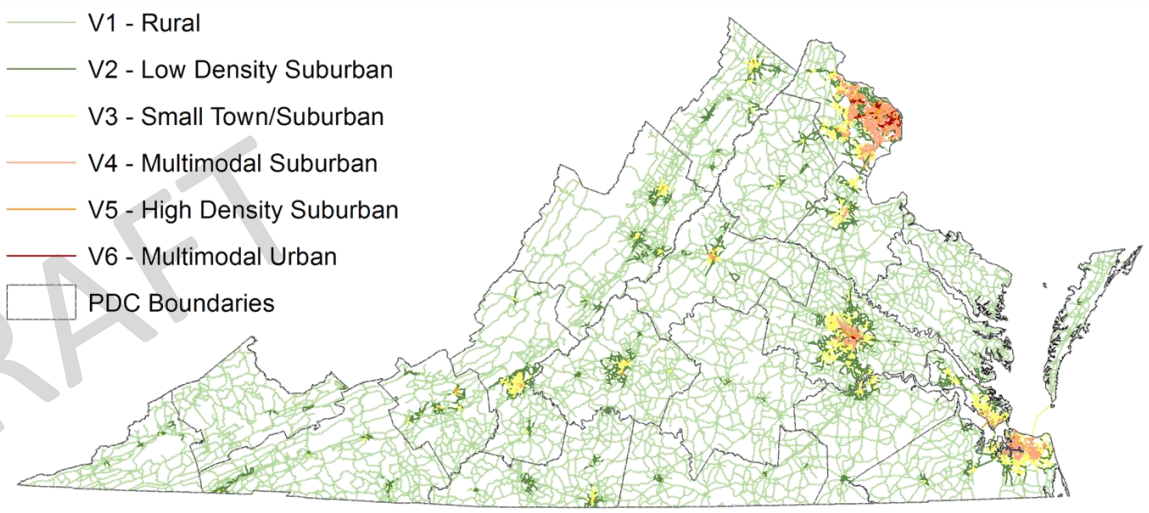


Induced VMT Change Results

Technology's most significant capacity/through-put benefits will likely occur on *interstates and arterials*

VDOT's interstate and arterial network was classified *by VTrans Placetype* to help capture the extent of technology benefits across the Commonwealth

Roadway Network Classified by Placetype



Interstates and Arterials by Placetype (2014)

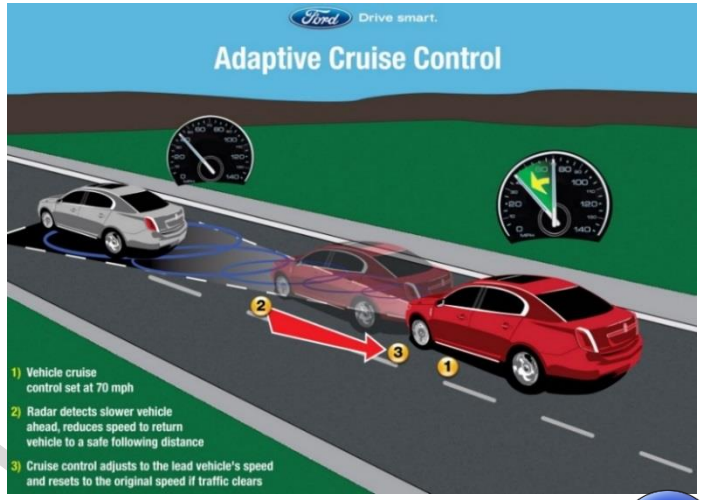
Placetype	Interstates as % of total network	Arterials as % of total network	**Total**
V1 Rural	4%	16%	**20%**
V2 Low Density Suburban	7%	24%	**31%**
V3 Small Town/Suburban	7%	30%	**37%**
V4 Multimodal Suburban	7%	31%	**38%**
V5 High Density Suburban	12%	35%	**47%**
V6 Multimodal Urban	10%	31%	**42%**

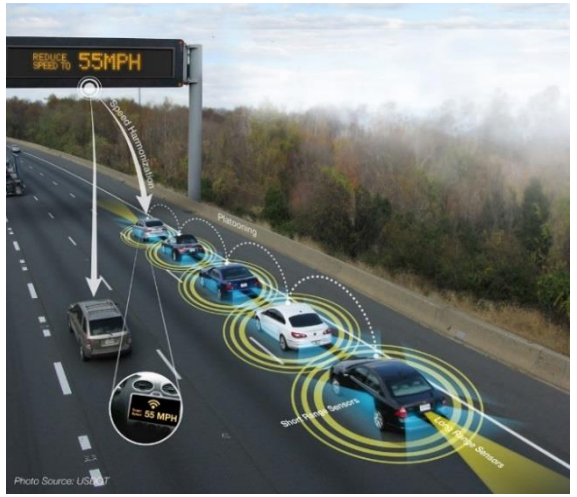
Technology, Efficiency and Throughput

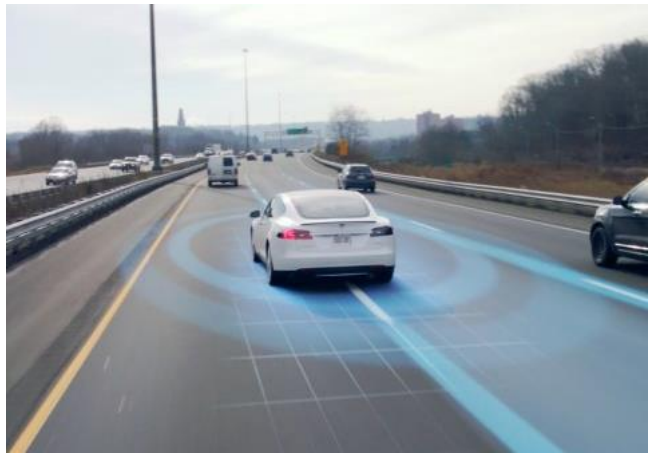
Technology and improved efficiency are expected to increase throughput by

9%-21%

(depending on Scenario)





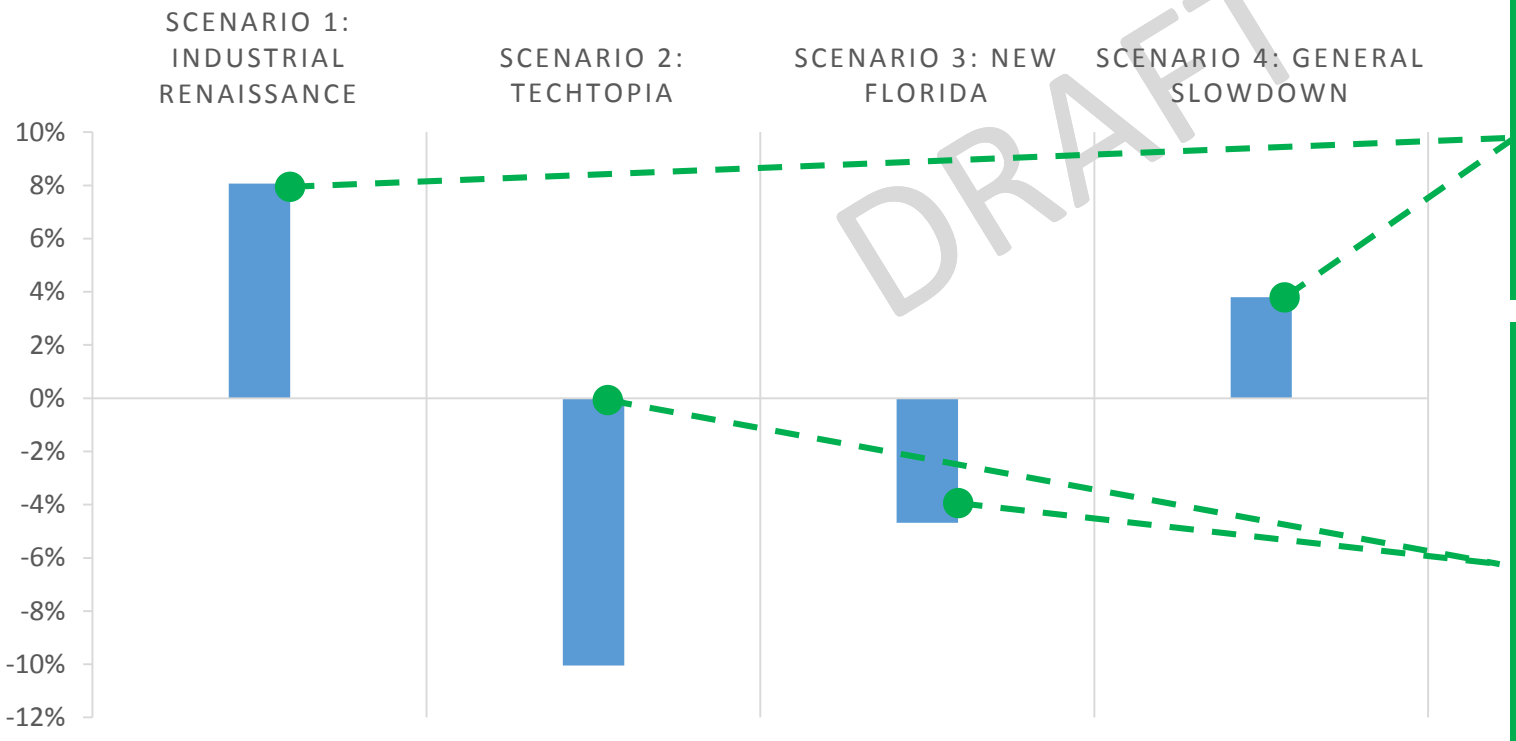


Although VMT is expected to increase, vehicle technology & infrastructure improvements will help increase travel efficiency and throughput (*effectively increasing roadway capacity*)

Net Change in Roadway Demand

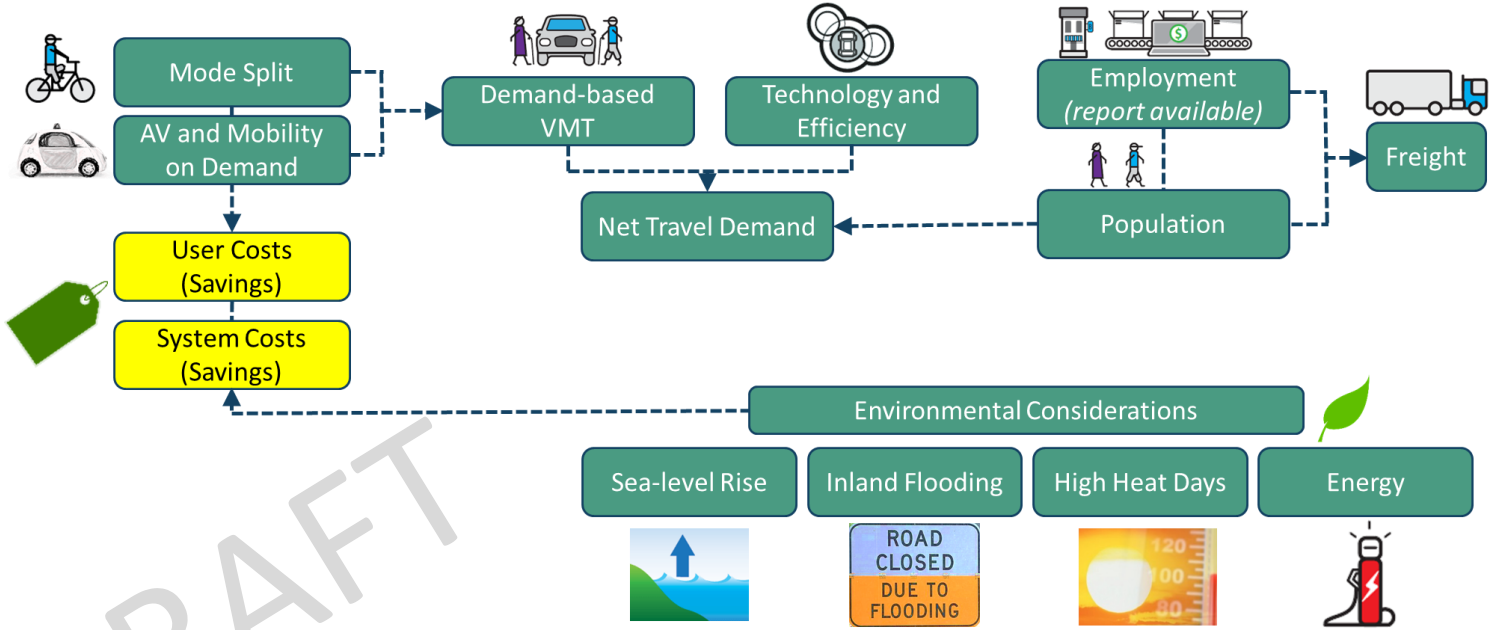
How can Technology and Travel Behavior Influence Demand in 2040:

EXAMPLE NET CHANGE IN ROADWAY DEMAND BY SCENARIO
(VS. 2040 BASELINE)



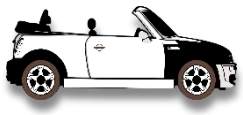
Net roadway demand is expected to increase in **Scenarios 1 and 4** as VMT outpaces the capacity and efficiency benefits provided by technology and alternative transportation.

Net roadway demand is expected to decrease in **Scenarios 2 and 3** as travel behavior and efficiency increase the "effective capacity" of the roadway network

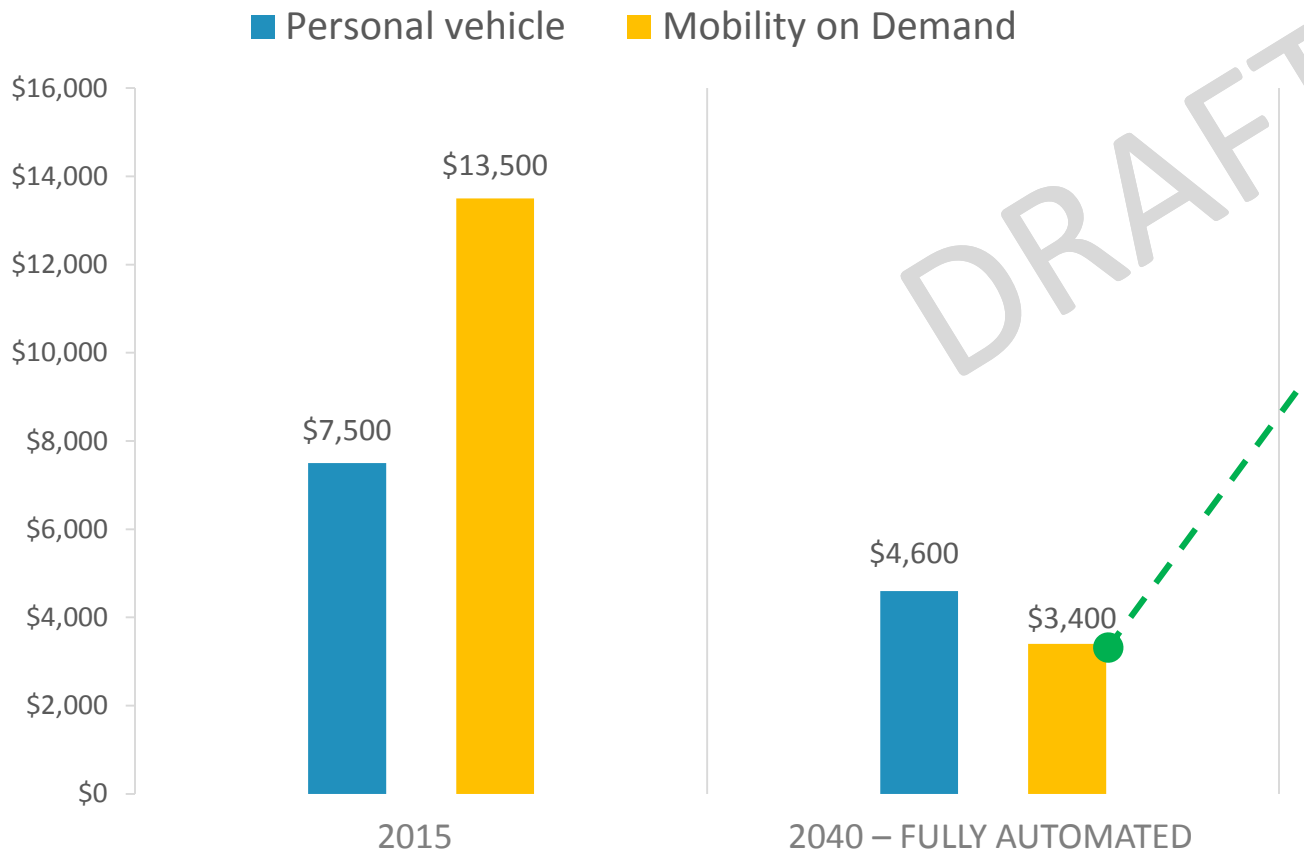


System & User Costs

The Assumed Cost of Driving, 2015 and 2040

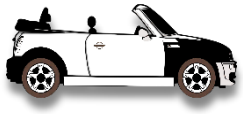


ESTIMATED COST OF DRIVING PER YEAR: 2015 AND 2040 (IN 2015 DOLLARS)

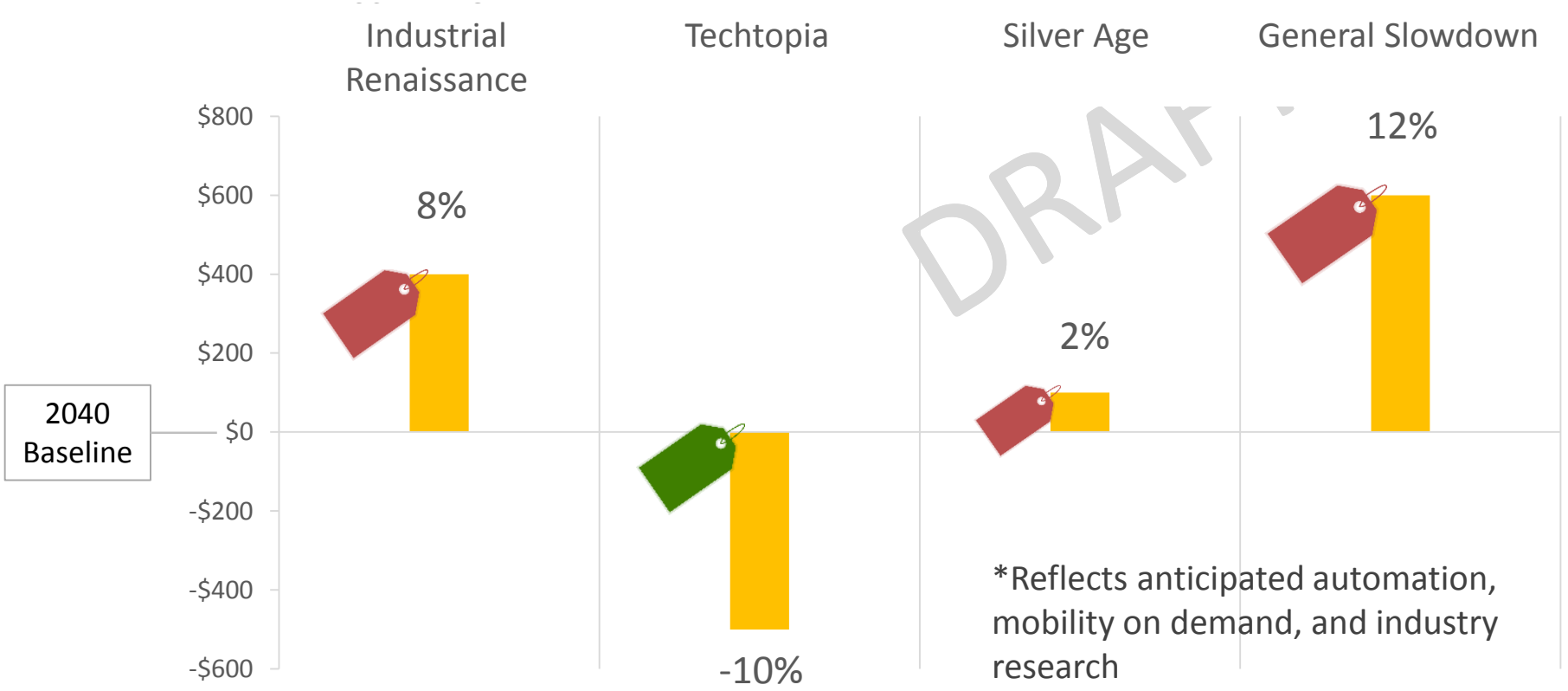


Industry economics, profitability, and affordability will influence the timing and extent of automation and mobility on demand.

Cost of Driving by Scenario Results



CHANGE IN ANNUAL DRIVING COST BY SCENARIO (VS. 2040 BASELINE)*



*Reflects anticipated automation, mobility on demand, and industry research

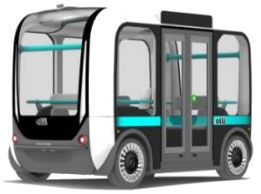
Autonomous vehicles and Mobility on Demand are expected to reduce annual driving costs

Cost Efficiencies and Mode Choice

Autonomous taxis and public transit services are likely complements rather than substitutes

Autonomous Taxis (and other Mobility on Demand services)

Autonomous Public Transit



Autonomous Taxis (and other Mobility on Demand services)		Autonomous Public Transit
• First and last mile connections • Commutes outside the urban core • Traditionally underserved communities	LOCATION ADVANTAGES	• High activity corridors • Downtowns, public spaces • Park and ride lots • College campuses, military bases, airports
• More flexible • Best for off-peak travel, short trips • Likely more cost-effective and convenient for paratransit providers and users	OTHER ADVANTAGES	• More affordable • Helps reduce VMT • Best for peak period travel and during congestion or “surge” pricing

Infrastructure Deployment Costs

The USDOT and AASHTO estimate that Vehicle to Infrastructure (V2I) technology could cost approximately $50,000 per site (ex: an intersection) and be 80% implemented by 2040

*Includes planning, design, equipment, installation, and backhaul (connecting roadside unit to the traffic management center/office). *Excludes operating & maintenance.*

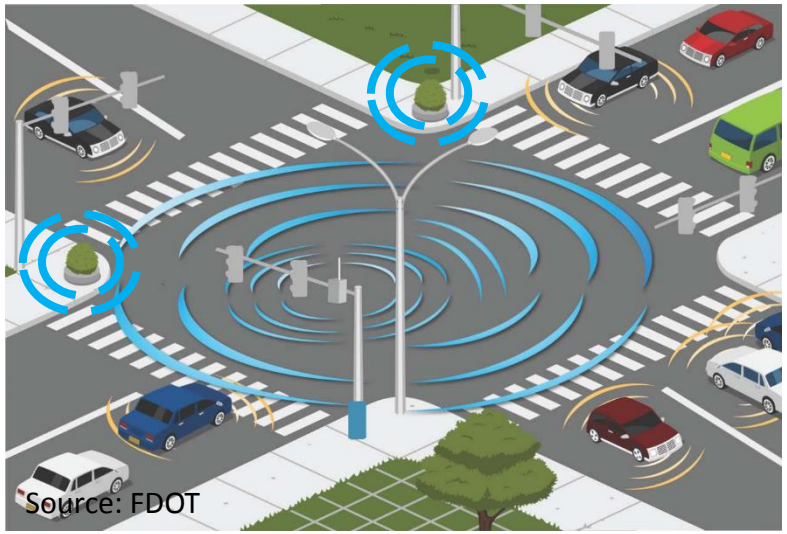
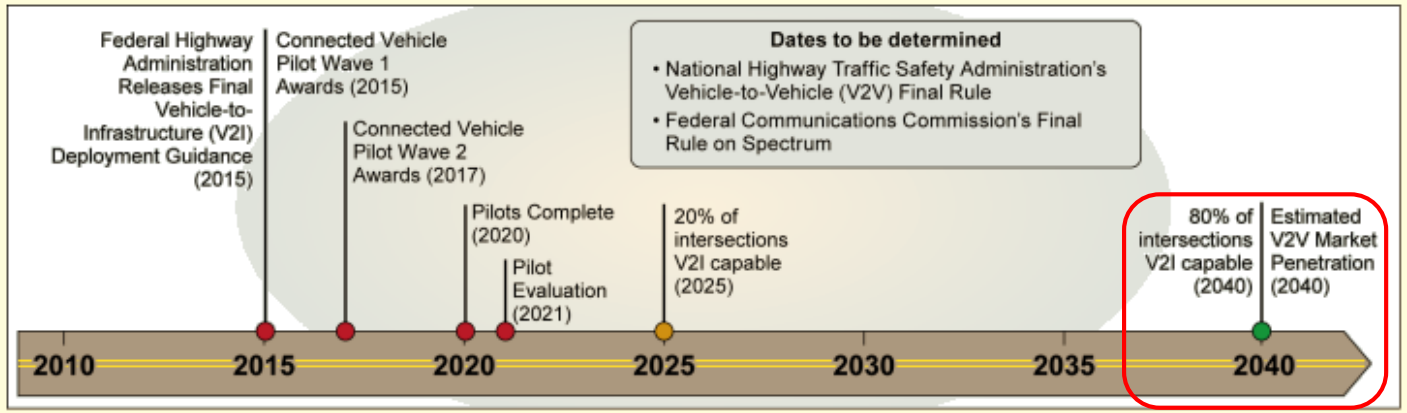

Source: FDOT

Figure 3: DOT's Planned Connected Vehicle Path to Deployment, 2010-2040



Source: GAO analysis of Department of Transportation documents. | GAO-15-775

Many states and localities may lack resources for funding both V2I equipment and the personnel to install, operate, and maintain the technologies.

Roadway Safety

There are approximately 120,000 roadway crashes per year in Virginia, accounting for 700 fatalities per year[1]

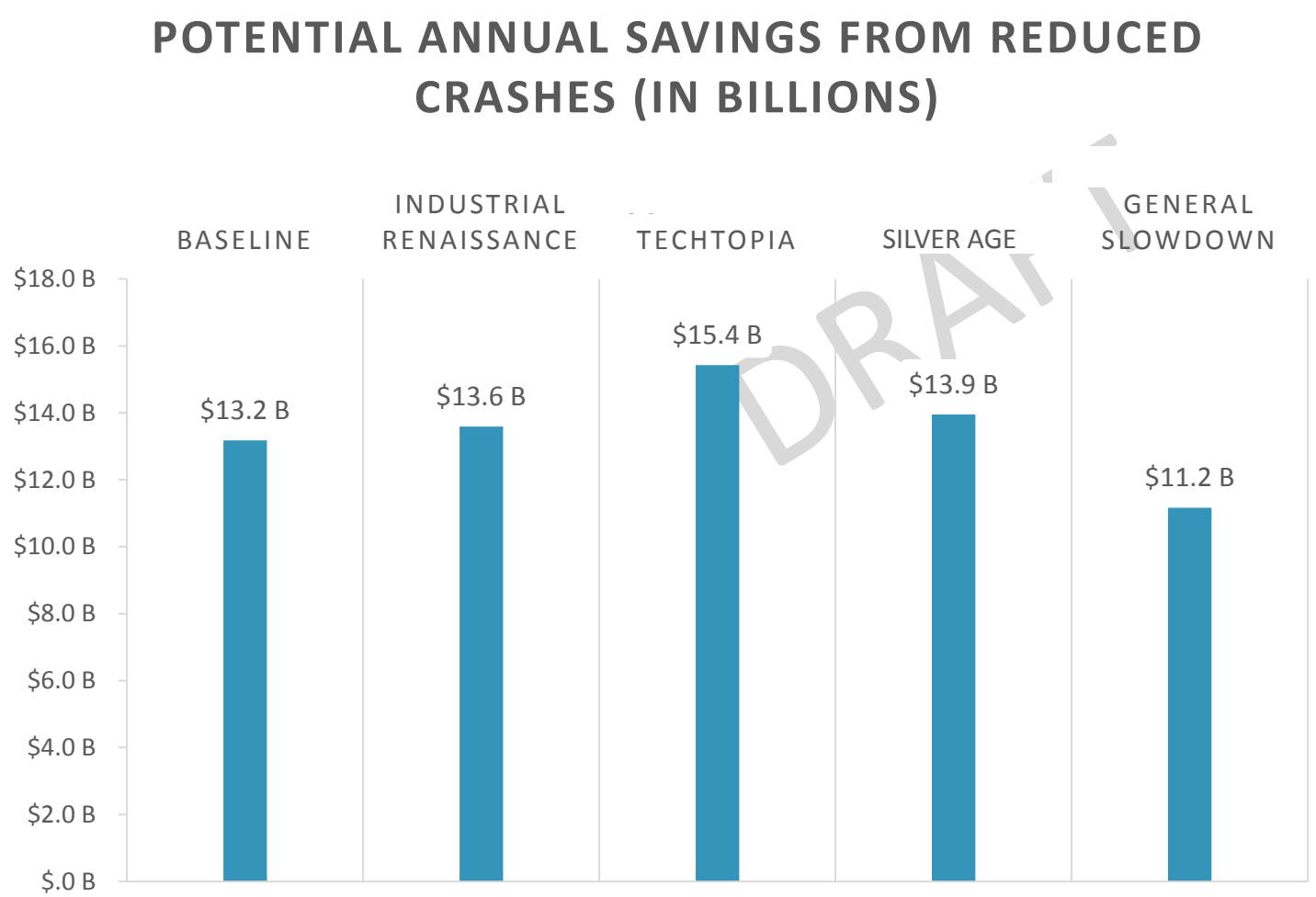
These crashes account for over $15 billion in costs per year (more like $20 billion in 2040)

Driver error is responsible for 80-90% of all crashes

Crash reductions will save lives, reduce user costs, reduce congestion and improve system reliability

[1] Based on averages from 2011-2015 crashes

Technology, Safety, and Societal Savings

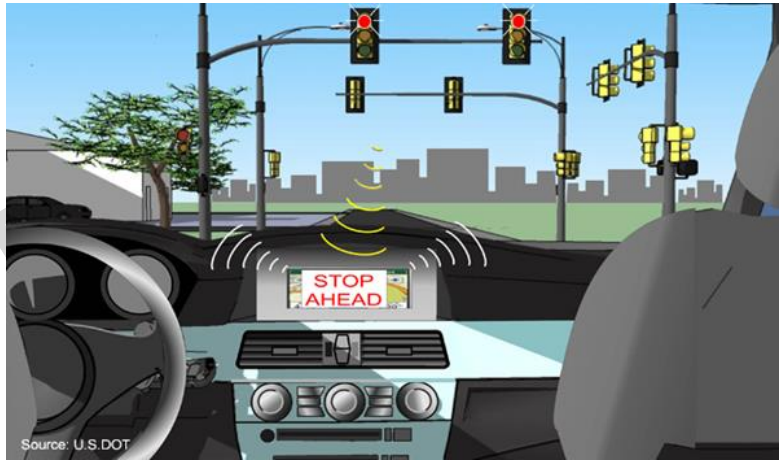


Autonomous vehicles are expected to significantly improve roadway safety and there could be tremendous savings to society as a result of fewer crashes.

Travel Time Savings

The USDOT estimates that *Connected Vehicle* technology could help reduce travel times by up to 27 percent

When cooperative adaptive cruise control and speed harmonization applications are optimized for the environment, they can potentially reduce travel time on freeways by up to 42 percent



Example technologies:

- Intelligent Traffic Signal System
- Freight Signal Priority, Transit Signal Priority

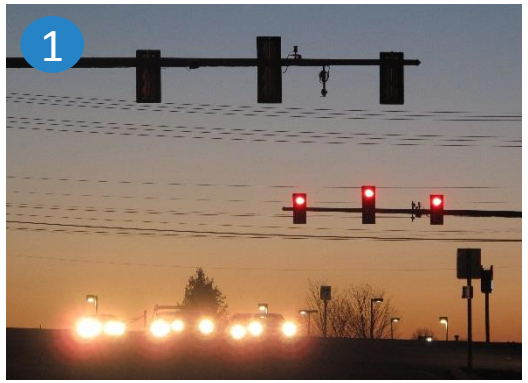
As technology evolves, connected vehicle solutions can help mitigate the impact of rising travel demand

System Savings from Connected Vehicles

VDOT estimates $1.1 billion could be saved by eliminating….

1. Traffic signals (3,200 signals x $250,000 per signal = $800 million)
2. Changeable messaging signs (550 signs x $200,000 per sign = $110 million)
3. Overhead guide signs (1,000 signs x $100,000 per structure = $100 million)

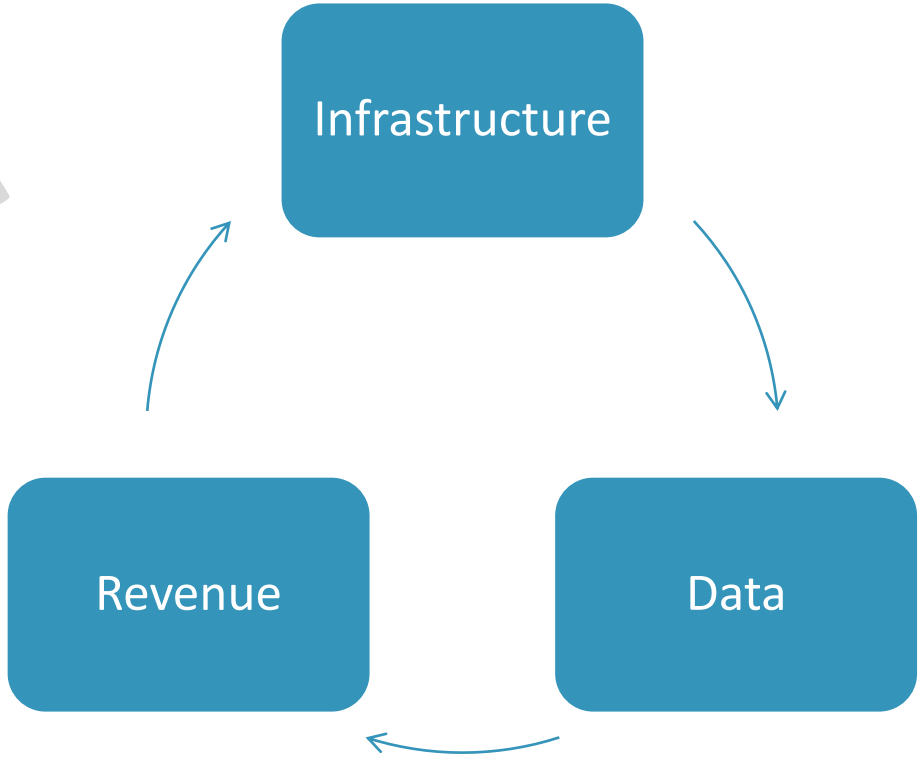
*Based on planning level cost estimates for removing VDOT-maintained signals and signs throughout Virginia



5G Telecommunications

Evolution to 5G

- Data: Faster processing speeds to handle massive data generated and needed by AVs
- Vehicle-to-Everything Connectivity (V2X): allowing vehicles talk to each other and the surrounding environment (giving vehicles additional “vision”)
- Timing: Expected as early as 2019



Summary

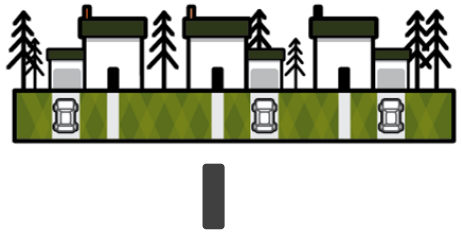
SCENARIO OVERVIEW, INVESTMENT CHOICES

Some Big Takeaways

- The transportation system of 2040 is going to look A LOT DIFFERENT!
- Freight supply chain dynamics are adaptive, helping to balance outcomes
- For environmental resiliency, we need land use-transportation coordination and vulnerability (risk) assessment
- User costs are expected to go down, especially if high demand for technology drives cost reductions. Lower costs + fewer mobility constraints = potentially significant increases in demand
- There will be challenges and opportunities in paying for our transportation system, such as the decline of gasoline-based revenue and the potential to leverage big data to fund new infrastructure
- New models of private sector involvement need to be carefully planned and negotiated

Industrial Renaissance - Trends

Growth



Industry

Mode

Autonomous Vehicles

Medium Adoption

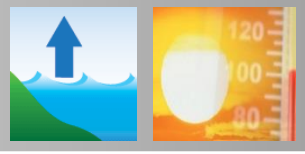
Mobility on Demand

Medium Adoption

Freight

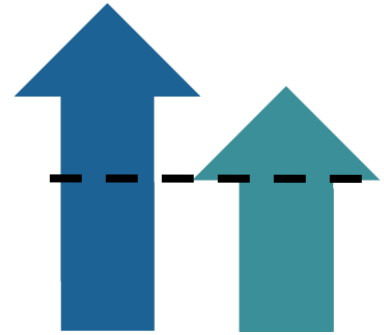
Increased demand, smaller trucks

Environment



Higher-than-expected sea-level rise, inland flooding, high heat

Travel Demand



Travel Costs

High

Industrial Renaissance - Outcomes

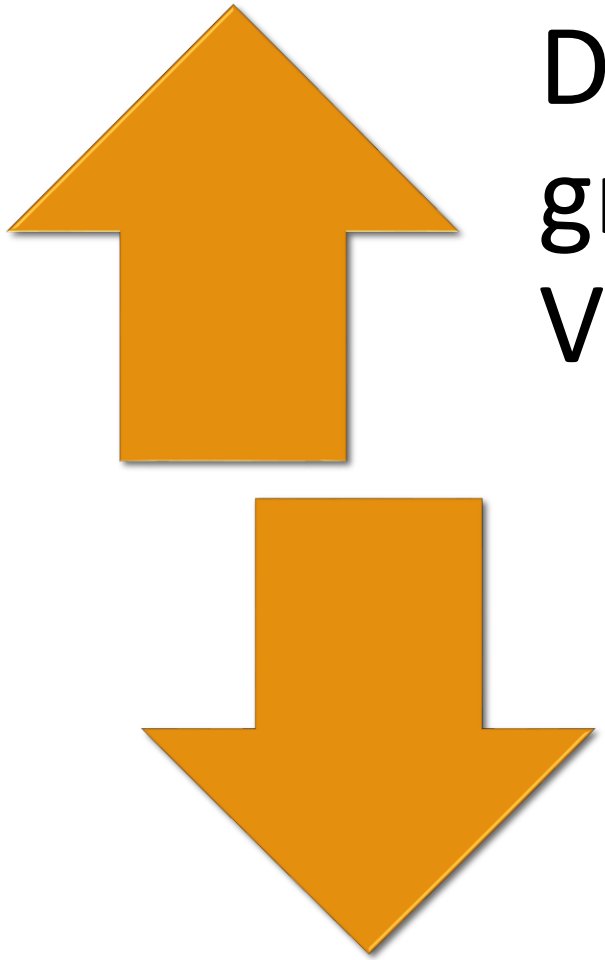
Person Travel	Freight Movement	All Travel	Costs
Person Miles	Freight Ton Miles	Vehicle Miles	User Costs
Person Trips	Freight Trips	Recurring Congestion	System Costs
Person Mode Mix	Freight Mode Mix	Non-recurring Congestion	

Relative Change from the 2040 Baseline

- Increase
- Neutral
- Decrease

*These results are intended to provide an illustration of potential trends and outcomes in each Scenario, *relative to the Baseline 2040 Scenario*.

Industrial Renaissance - Implications



Dispersed growth in VMT

Reduced throughput resiliency

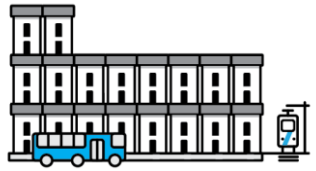
What are the congestion patterns?

What does this mean for investment choices?

What are the policy initiatives that will mitigate negative impacts & foster positive outcomes?

Techtopia – Trends

Growth



Industry

Mode

Autonomous Vehicles

High Adoption

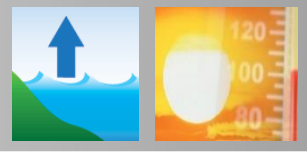
Mobility on Demand

High Adoption

Freight

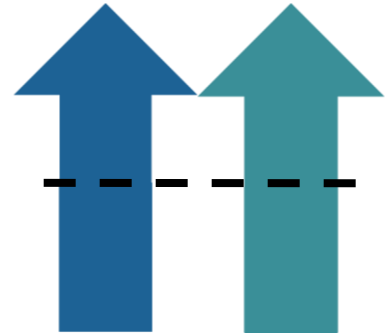
Increased demand, trucking/intercity rail

Environment



Lower-than-expected sea-level rise, inland flooding, high heat

Travel Demand



Travel Costs

Low

Techtopia – Outcomes

Person Travel	Freight Movement	All Travel	Costs
Person Miles	Freight Ton Miles	Vehicle Miles	User Costs
Person Trips	Freight Trips	Recurring Congestion	System Costs
Person Mode Mix	Freight Mode Mix	Non-recurring Congestion	

Relative Change from the 2040 Baseline

- Increase
- Neutral
- Decrease

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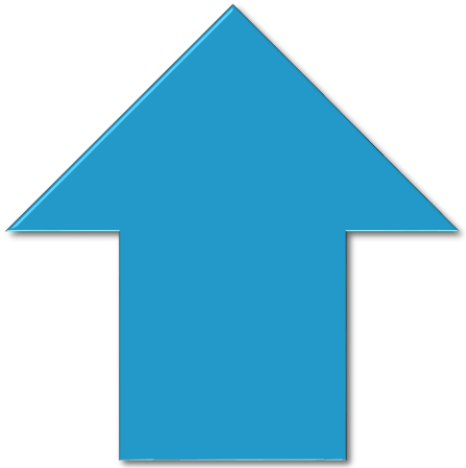
Techtopia – Implications

Reduced relative VMT growth



Increased throughput resiliency

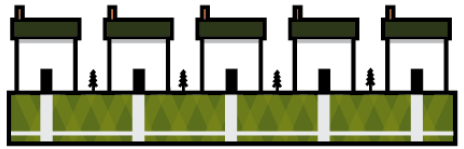
What are the congestion patterns?

What does this mean for investment choices?

What are the policy initiatives that will mitigate negative impacts & foster positive outcomes?

Silver Age – Trends

Growth



Industry

Mode

Autonomous Vehicles

Medium-High Adoption

Mobility on Demand

Low-Medium Adoption

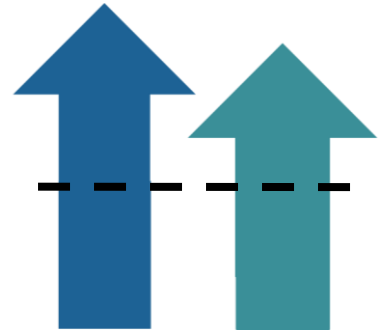
Freight

Less demand, reduced efficiency (pop. dispersion)

Environment

Developing away from vulnerable areas

Travel Demand



Travel Costs

Low-Med.

Silver Age – Outcomes

Person Travel	Freight Movement	All Travel	Costs
Person Miles	Freight Ton Miles	Vehicle Miles	User Costs
Person Trips	Freight Trips	Recurring Congestion	System Costs
Person Mode Mix	Freight Mode Mix	Non-recurring Congestion	

Relative Change from the 2040 Baseline

- Increase
- Neutral
- Decrease

*These results are intended to provide an illustration of potential trends and outcomes in each Scenario, *relative to the Baseline 2040 Scenario*.

Silver Age – Implications

Moderated VMT Growth

Moderated User & System Costs

What are the congestion patterns?

What does this mean for investment choices?

What are the policy initiatives that will mitigate negative impacts & foster positive outcomes?

General Slowdown – Trends

Growth

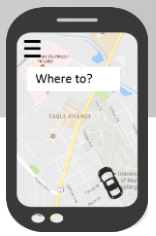
Industry

Mode

Autonomous Vehicles

Low Adoption

Mobility on Demand



Low Adoption

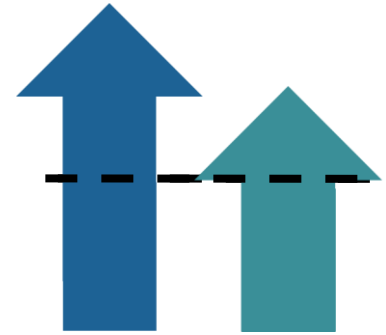
Freight

Less demand, reduced efficiency

Environment

Volatile global energy prices

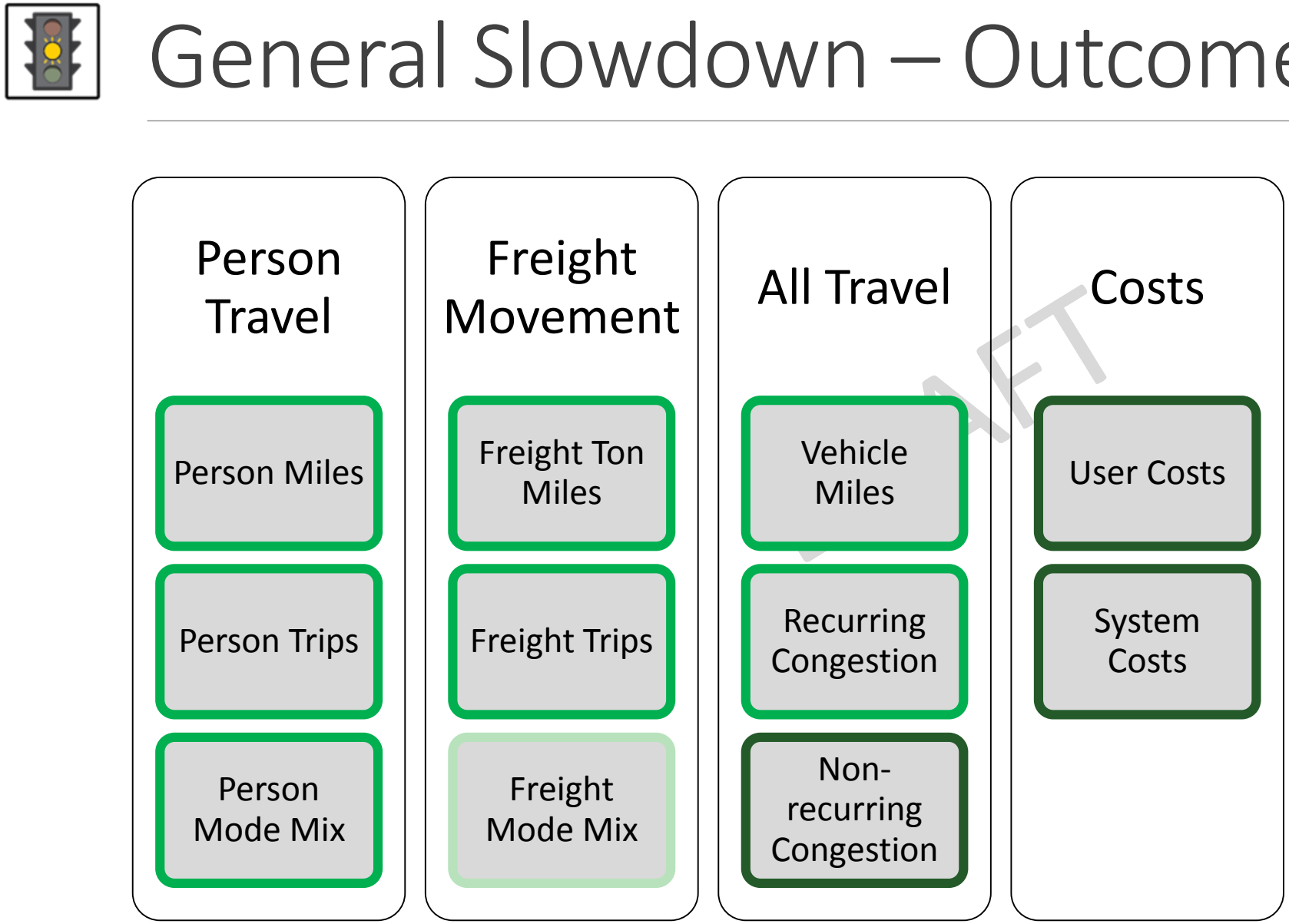
Travel Demand



Travel Costs

High

General Slowdown – Outcomes



Relative Change from the 2040 Baseline

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- Neutral
- Decrease

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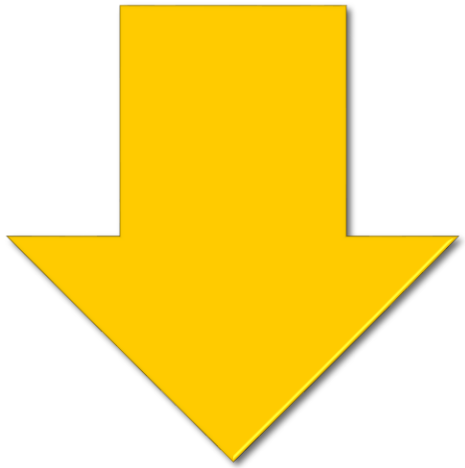
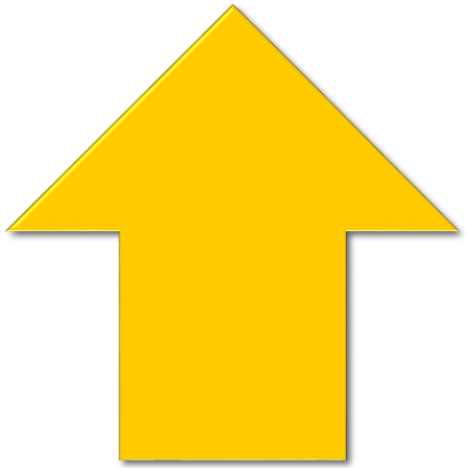
General Slowdown – Implications



AV delay & lower growth mitigate relative VMT growth



Increased User & System Costs

What are the congestion patterns?

What does this mean for investment choices?

What are the policy initiatives that will mitigate negative impacts & foster positive outcomes?

Next Steps

- VMTP “Stress Test”
  - Summarizing investments (operational, capacity, multimodal, etc)
  - Discussion of risks and resiliency in light of scenario findings
- Investment and Policy Findings
  - Digital outreach
  - Summarize scenario implications
  - Summarize Policy and Investment recommendations