



COMMONWEALTH of VIRGINIA
Office of the
SECRETARY of TRANSPORTATION

**VTrans Economic and Technology Trends
Informational Webinar**

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Katie Schwing, AICP

April 14, 2021



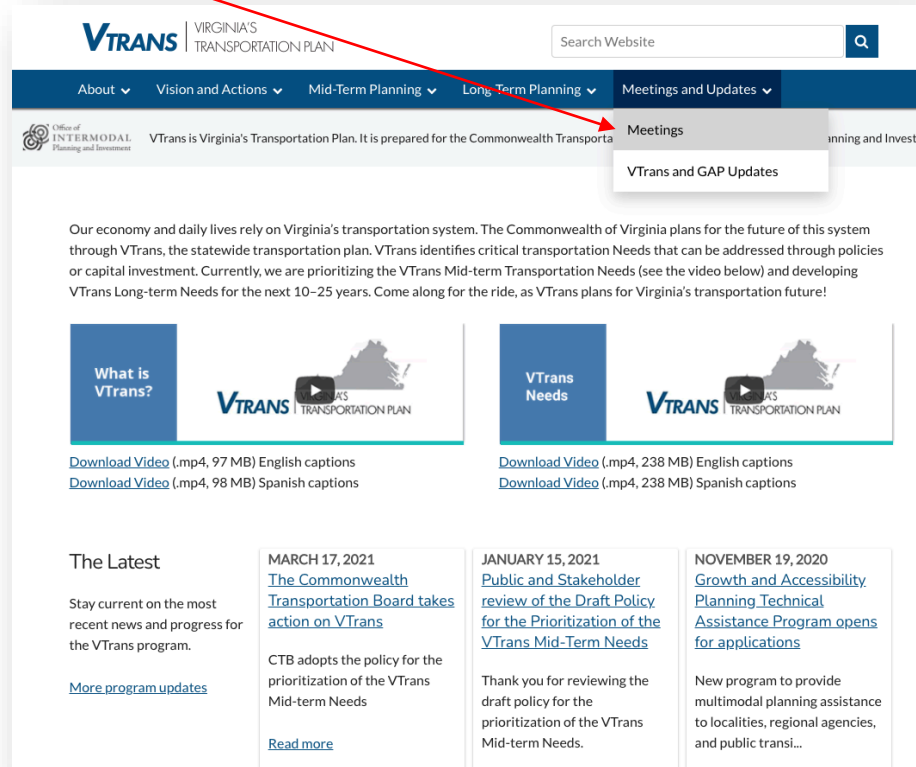
PURPOSE AND DISCUSSION ITEMS

- **Resources**
- **Purpose of the Webinar**
- **Approach to Trends Analysis**
- **VTrans Macrotrends**
- **Next Steps**



RESOURCES

- [Meetings Page](#) contains information and materials presented at this webinar



The screenshot shows the VTRANS website header with a search bar and navigation menu. A red arrow points from the 'Meetings Page' text in the list above to the 'Meetings' dropdown menu. The dropdown menu is open, showing 'Meetings' and 'VTrans and GAP Updates'. Below the navigation, there is a main content area with a paragraph about Virginia's transportation system, two video thumbnails for 'What is VTrans?' and 'VTrans Needs', and a 'The Latest' section with three news items.

VTRANS VIRGINIA'S TRANSPORTATION PLAN

Search Website

About ▾ Vision and Actions ▾ Mid-Term Planning ▾ Long-Term Planning ▾ **Meetings and Updates ▾**

Office of INTERMODAL Planning and Investment

VTrans is Virginia's Transportation Plan. It is prepared for the Commonwealth Transportation Board. Meetings and Updates

Meetings

VTrans and GAP Updates

Our economy and daily lives rely on Virginia's transportation system. The Commonwealth of Virginia plans for the future of this system through VTrans, the statewide transportation plan. VTrans identifies critical transportation Needs that can be addressed through policies or capital investment. Currently, we are prioritizing the VTrans Mid-term Transportation Needs (see the video below) and developing VTrans Long-term Needs for the next 10-25 years. Come along for the ride, as VTrans plans for Virginia's transportation future!

What is VTrans?

VTrans Needs

[Download Video](#) (.mp4, 97 MB) English captions
[Download Video](#) (.mp4, 98 MB) Spanish captions

[Download Video](#) (.mp4, 238 MB) English captions
[Download Video](#) (.mp4, 238 MB) Spanish captions

The Latest

Stay current on the most recent news and progress for the VTrans program.

[More program updates](#)

MARCH 17, 2021
[The Commonwealth Transportation Board takes action on VTrans](#)
CTB adopts the policy for the prioritization of the VTrans Mid-term Needs
[Read more](#)

JANUARY 15, 2021
[Public and Stakeholder review of the Draft Policy for the Prioritization of the VTrans Mid-Term Needs](#)
Thank you for reviewing the draft policy for the prioritization of the VTrans Mid-term Needs.

NOVEMBER 19, 2020
[Growth and Accessibility Planning Technical Assistance Program opens for applications](#)
New program to provide multimodal planning assistance to localities, regional agencies, and public transi...

- [Frequently Asked Questions](#) page addresses five (5) questions related to the VTrans Freight Element

The screenshot shows the VTRANS website with a navigation menu. The 'Frequently Asked Questions' option is highlighted with a red arrow. The main content area features two video thumbnails: 'What is VTrans?' and 'VTrans Needs', each with download links for English and Spanish captions. Below this is a 'The Latest' section with three news items dated March 17, 2021, January 15, 2021, and November 19, 2020.

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Office of Intermodal Planning and Investment

About VTrans

About GAP Technical Assistance

Frequently Asked Questions

Previous VTrans Updates

Contact Us

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VTrans Needs

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PURPOSE OF THE WEBINAR

PURPOSE OF THE WEBINAR | BACKGROUND

- The Office of Intermodal Planning and Investment (OIPI) is assisting the [Commonwealth Transportation Board \(CTB\)](#) with the development of statewide multimodal transportation plan, VTrans.
- VTrans has a 20+ year planning horizon per the [23. U.S.C. 135](#) and Code of Virginia [§ 33.2-353](#).
- OIPI is conducting trends analysis for the following:
 - Vulnerability Assessment
 - Demographic Trends
 - Economic Trends
 - Technology Trends
 - Revenue Trends

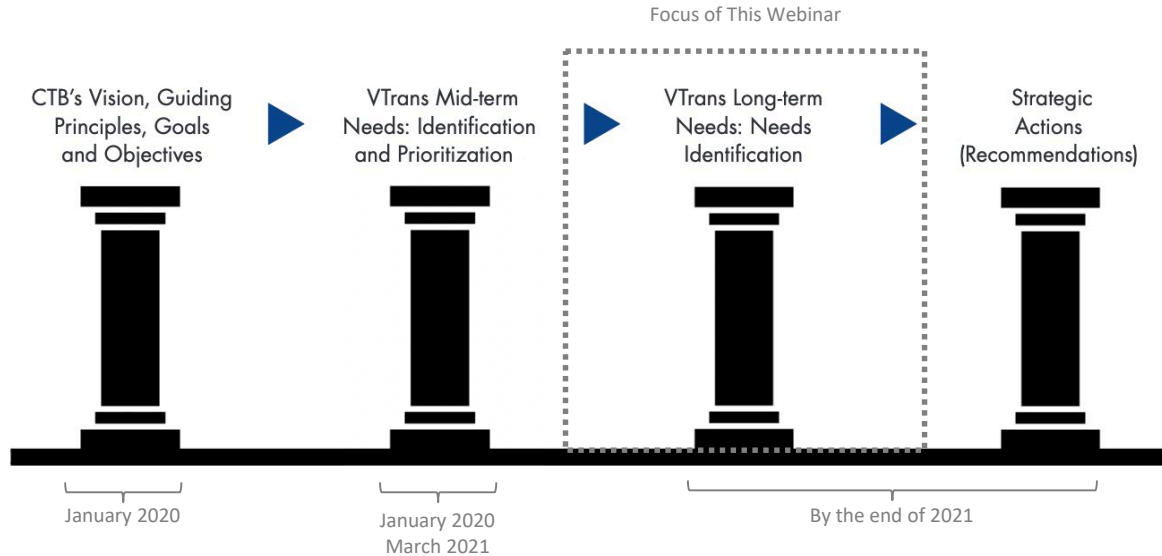
The screenshot shows the VTrans website homepage. At the top, there is a navigation bar with the VTrans logo and the text "VIRGINIA'S TRANSPORTATION PLAN". A search bar is located on the right side of the navigation bar. Below the navigation bar, there is a sub-navigation bar with links for "About", "Vision and Actions", "Mid-Term Planning", "Long-Term Planning", and "Meetings and Updates". The main content area features a paragraph about the state's transportation system and the VTrans plan. Below this, there are two video thumbnails: "What is VTrans?" and "VTrans Needs". Each video thumbnail has a "Download Video" link with details about the file format, size, and caption availability. At the bottom, there is a "The Latest" section with three news items, each with a date, a link to the article, and a "Read more" link. A footer section at the very bottom contains a subscription form with the text "Stay current by subscribing to VTrans News" and a "SUBSCRIBE" button.

PURPOSE OF THE WEBINAR | BACKGROUND

- In [December 2018](#), CTB directed OIPI to:
 - Evaluate mid- and long-term [viability of federal, state, and regional revenues](#) for multimodal transportation investments
 - [Identify surface transportation infrastructure needs and associated policy and legislative requirements](#) to ensure Virginia’s readiness for shared mobility, and autonomous & connected vehicles
 - [Complete a resiliency assessment](#) of Virginia’s multimodal network from a transportation planning perspective.
- In [January 2020](#), CTB directed OIPI to [develop scenarios to assess the impacts of divergent trends to identify Long-term Needs](#)
- In [July 2020](#), OIPI presented a framework for the development of VTrans Long-term Needs to the CTB
- In [March 2021](#), CTB reaffirmed that direction provided in January 2020
 - “.....develop [VTrans Strategic Actions](#) to advance the Board’s Vision and Goals adopted on January 15, 2020 by providing policy- and program-specific recommendations to address the identified and prioritized VTrans Mid-term Needs, as well as to address the [VTrans Long-term Needs identified based on divergent future trends and a vulnerability assessment](#) per the policy framework presented to the Board on July 14, 2020. “

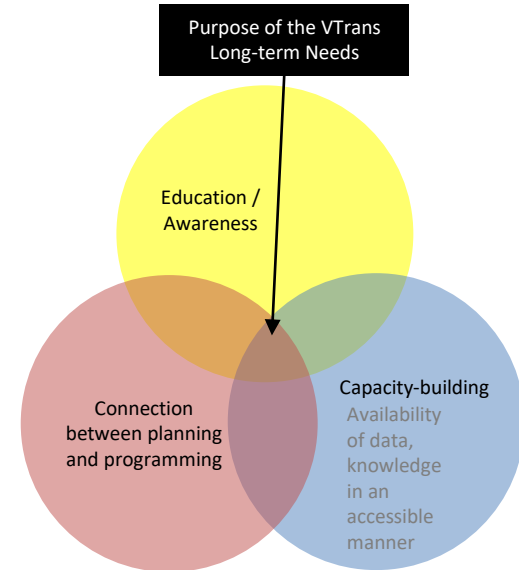
PURPOSE OF THE WEBINAR | SIGNIFICANCE OF TRENDS ANALYSIS

- VTrans Trends Analysis will, in addition to other tasks, **inform VTrans Strategic Actions** that will be submitted to the General Assembly and the Office of the Governor by the end of 2021.



PURPOSE OF THE WEBINAR | PREVIOUS AND UPCOMING OUTREACH ACTIVITIES

- **The primary purposes of these webinars are to:**
 - Solicit feedback from localities, regional entities, and the public on initial or in-progress prior to the development of VTrans Long-term Needs.
- **This is first of three Long-term Needs related webinars that focus on different trends, drivers, and associated needs**
 - **2019-2020:** [Periodic updates](#) for MPO and PDC staff
 - **June 2019:** [VTrans Demographic Trends](#) presentation to the CTB
 - **April 2021:** [VTrans Economic and Technology Trends](#)
 - **May 2021:** VTrans Vulnerability Assessment
 - **June/July 2021:** VTrans Long-term Needs
- **Information presented during this and other webinars is subject to change based on feedback received, additional research, refinement, and associated modifications.**





APPROACH TO TRENDS ANALYSIS

APPROACH TO TRENDS ANALYSIS

- All VTrans analysis **centers around VTrans Goals** set by the Commonwealth Transportation Board (CTB) ([Webpage](#))
- The **purpose** of VTrans Trends Analysis, VTrans Mid-term and Long-term Needs as well as of the VTrans Strategic Actions is to **continue advancements towards achievement of CTB's goals.**



APPROACH TO TRENDS ANALYSIS | FRAMEWORK

1. Identify External Factors (Mega and Macro Trends)

- Demographic Trends
- Technology Trends
- Economic Trends
- Vulnerability Assessment (flooding and sea-level rise)

2. Board's Vision and Goals

- Key Performance Indicators (KPIs) based on Board Vision, Goals, and Objectives

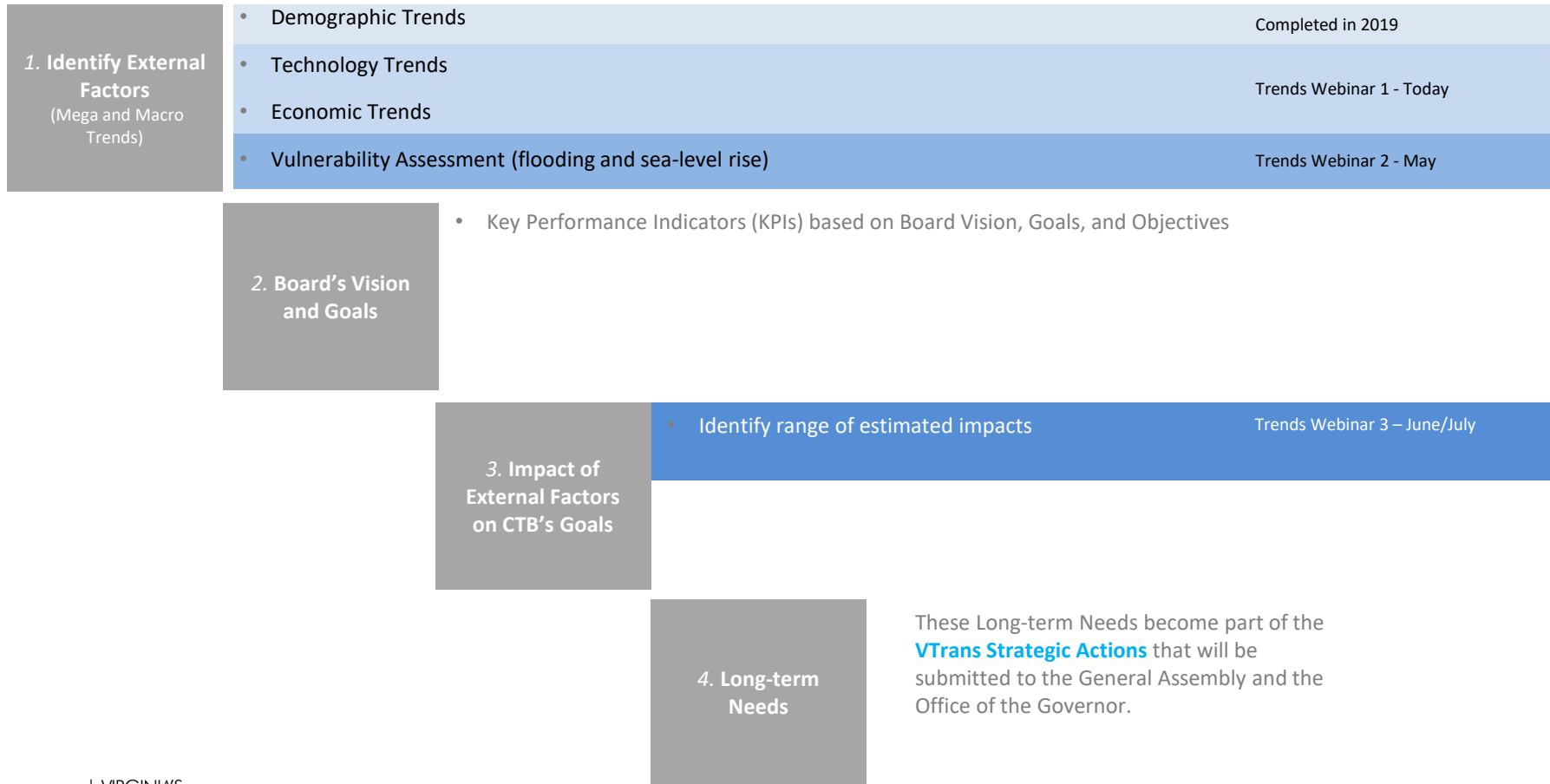
3. Impact of External Factors on CTB's Goals

- Identify range of expected impacts (**Develop three scenarios**)

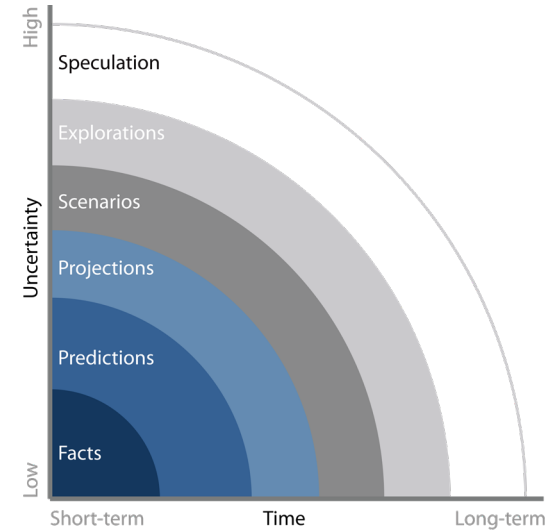
4. Long-term Needs

These Long-term Needs become part of the **VTrans Strategic Actions** that will be submitted to the General Assembly and the Office of the Governor.

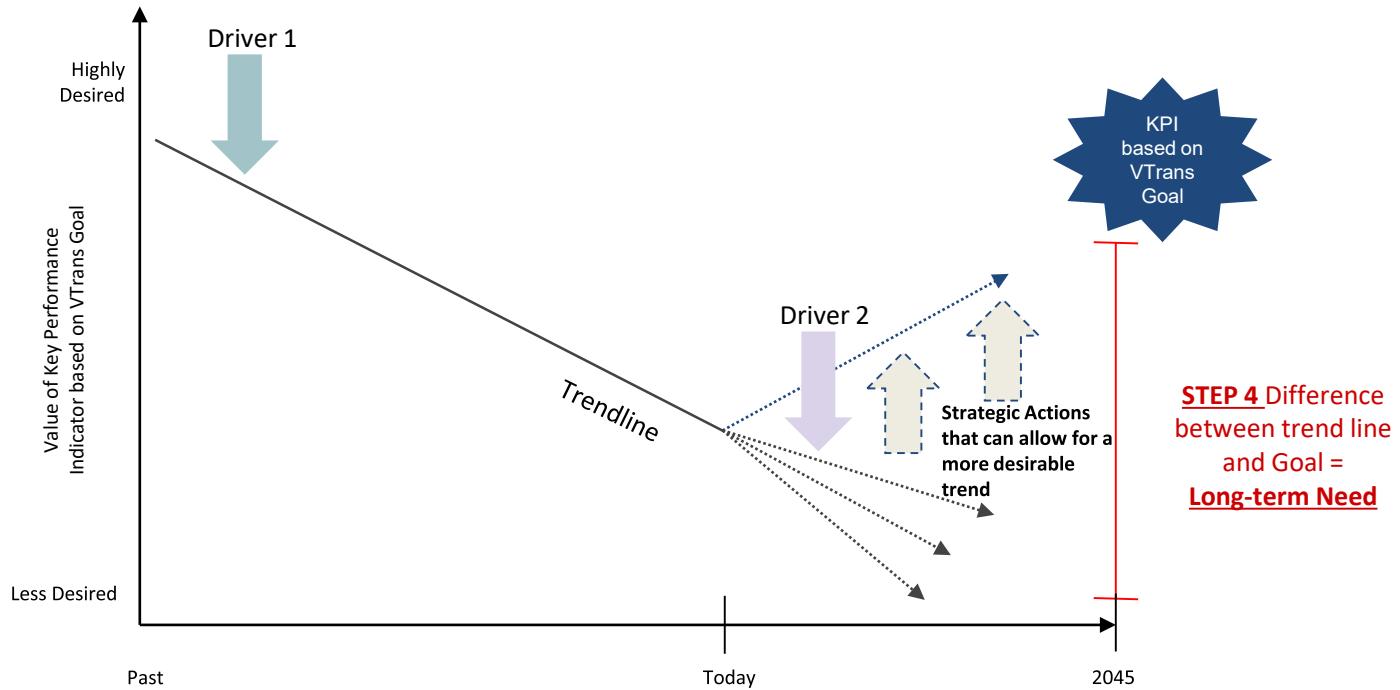
APPROACH TO TRENDS ANALYSIS | FRAMEWORK



- **The purpose of VTrans Trends Analysis is to provide information for the development of VTrans Long-term Needs. Example:**
 - Trend: Automated Vehicles lower barrier for additional driving which in turn leads to increase in per-capita VMT
 - Long-term Need: CTB's goals seek to lower per-capita VMT so the VTrans Long-term Need could be lower per-capita VMT by utilizing available policy tools
 - Strategic Action: A specific recommendation for one or more specific policy tools to achieve the identified need as well as Key Performance Indicator(s) to monitor progress
- **VTrans Approach**
 - Avoid [“SOS or Shiny Object Syndrome”](#) - focus on significant and meaningful trends
 - Rely on reputed, preferably peer-reviewed, research
 - Setting up a process that can be replicated and repeated as more precise data becomes available.
- **Caveats**
 - Focus is on planning that helps prepare, not necessarily predict
 - **Policies and external factors can change projections and make them more desirable**
 - “All predictions are wrong, that's one of the few certainties granted to mankind.” — Milan Kundera, *Ignorance*
 - For each trend projection, there are a number of assumptions and calculations. These assumptions and calculations will be further refined and made available in detailed technical memorandums



APPROACH TO TRENDS ANALYSIS | EXAMPLE





VTRANS MACROTRENDS

VTRANS TRENDS | DEFINITIONS




Term	Definition	Notes	Example
Trend Analysis	Trend analysis is the practice of collecting information and attempting to spot a pattern in the information. It may be used to predict future events.		Collecting information about fleet mix by energy source

Sources:

- Gordon, Theodore Jay (1994) "Trend Impact Analysis" Futures Research Methodology. Jerome C. Glen, ed. Washington, D.C: American Council for the United Nations University, 1994.
- [Transportation Policy Task Force Suggested State Legislation Docket](#). 2009. California
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MacroTrend / Trend	An emerging pattern of change likely to impact state government and require a response. Multiple macrotrends can be associated with a megatrend.	Discerning macrotrends and associated responses to trends affecting states involves these questions: <ul style="list-style-type: none"> • Does the megatrend/trend impact Virginia? • Is it significant? • Is it broad-based? • Is it national or regional in scope? • Is it short-term or long-term? • Is it measurable/trackable/observable? • Is it actionable? • Is there an innovative response to address new circumstances? 	Potential for gradual decline in revenue from gas tax



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Microtrend	A very small and specific vogue	The most active, diverse and appearing very fast one after another	

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Driver	A driver is the cause of one or more effects.	Drivers indirectly affect or shape the future.	Availability of battery technology



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VTRANS TRENDS | DEFINITIONS

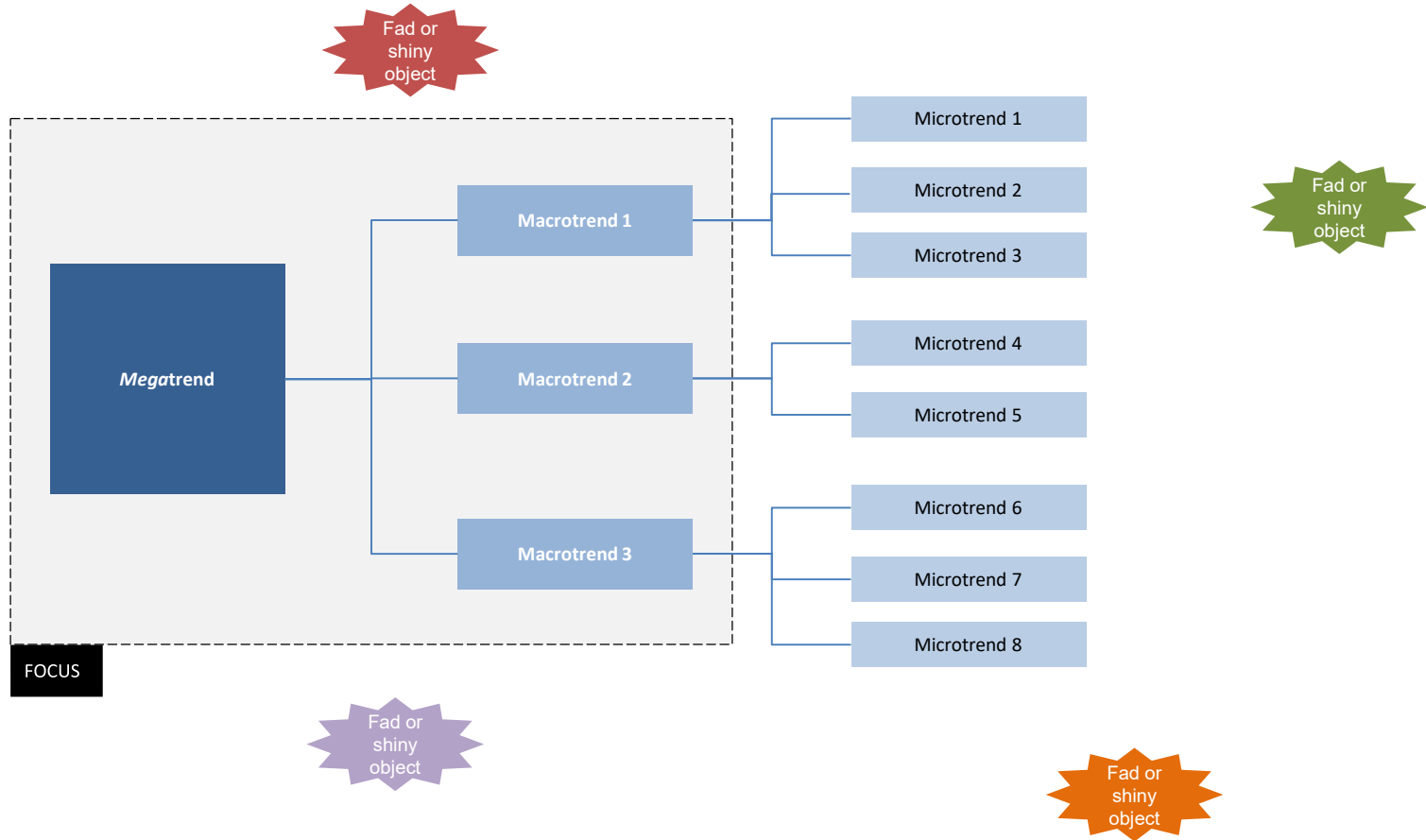
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Driver	A driver is the cause of one or more effects.	Drivers indirectly affect or shape the future.	Availability of battery technology
Issue	An issue is a topic or an innovative state action which might be subject to debate, deliberation, and evaluation.		Virginia's response over the next 20 years



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- Gordon, Theodore Jay (1994) "Trend Impact Analysis" Futures Research Methodology. Jerome C. Glen, ed. Washington, D.C: American Council for the United Nations University, 1994.
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VTRANS TRENDS | EXAMPLE OF DEFINITIONS



- **Our focus is on megatrends that have consequences for transportation systems.**
- **We have identified four such megatrends and associated 14 macrotrends:**
 - Climate patterns
 - Socio-demographic and employment changes
 - Advancement of Vehicle Technologies
 - Consumption patterns
- **Ordering of these macrotrends is important but not deterministic as far as Long-term Needs are concerned.**

Order	Megatrend	Macrotrend
In'dent	Climate Patterns	1. Increase in System Vulnerability due to flooding
In'dent	Socio-demographic / Employment Changes	2. Growth of 65+ Cohort
1	Socio-demographic / Employment Changes Advancement of Vehicle Technologies	3. Increasing Job Flexibility/Remote Work
		4. Highly-Autonomous and Connected Vehicle Adoption (Passenger)
		5. Highly-Autonomous and Connected Vehicle Adoption (Commercial)
		6. Increase in number of Electric Vehicles
		7. Mobility as a Service (MaaS)
		8. Greater Production Automation
		9. E-Commerce
2	Consumption patterns	10. E-Commerce Delivery Methods
		11. 3D Printing
		12. Professional Services Industry Growth
3	Socio-demographic / Employment Changes	13. Population Shift
		14. Urbanization

 Focus of today's webinar



TREND # 3: INCREASING JOB FLEXIBILITY/REMOTE WORK

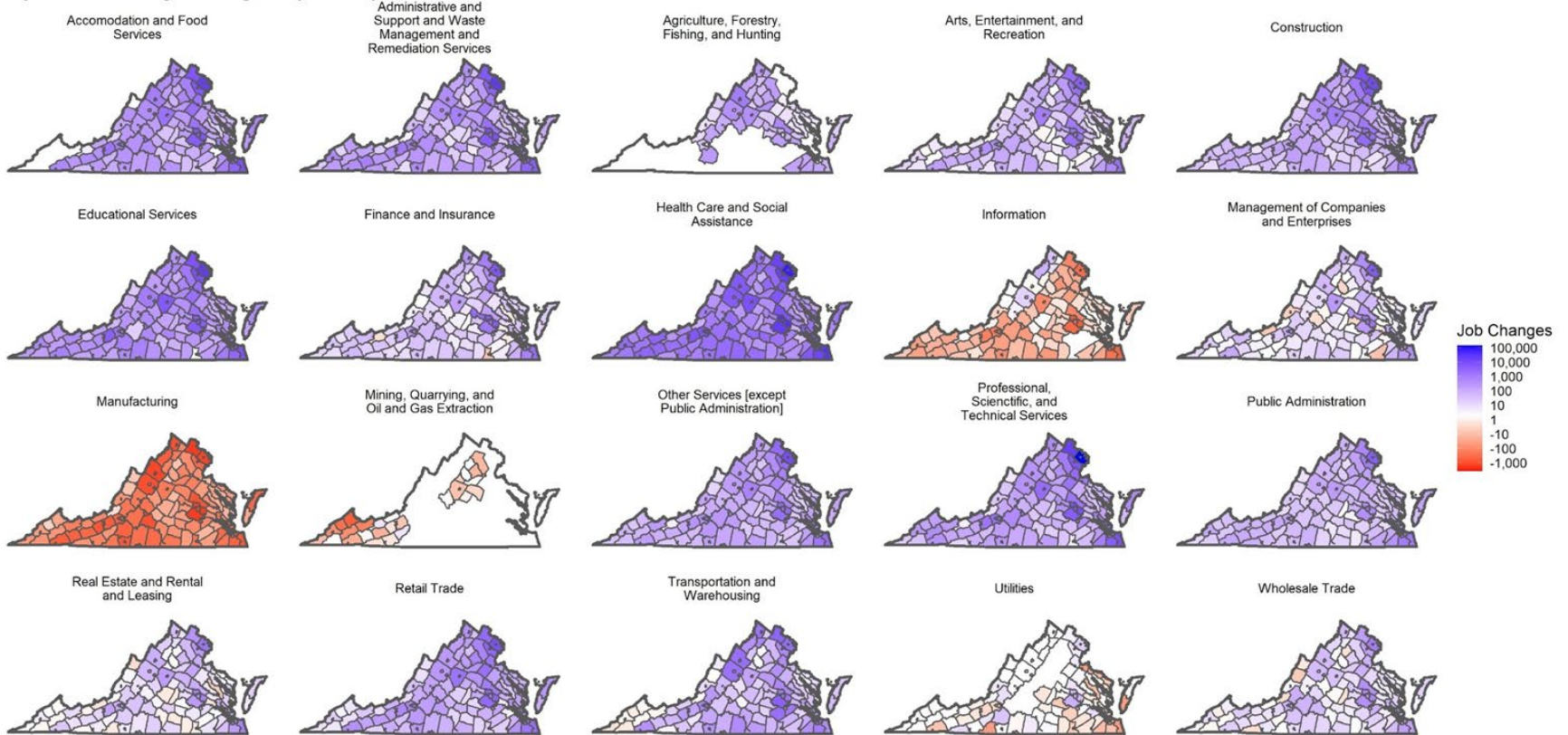
TREND # 3: TELEWORK | DEFINITION AND STATUS

- **Telework is the ability to work at home or in a location other than the employer office or jobsite through the use of internet, email, and telephone**
- **Importance**
 - Increased flexibility in the nature of work has been changing job profiles and worker location, leading to altered commuter travel
- **Current Capability and Usage of Telework**
 - About **41% of jobs** in Virginia are telework **capable**
 - Industries with highest capability for telework:
 - Management of Companies and Enterprises (83% of jobs)
 - Finance and Insurance (77% of jobs)
 - Professional, Scientific, and Technical Services (75% of jobs)
 - Industries with lowest capability for telework:
 - Accommodation and Food Services (8% of jobs)
 - Agriculture, Forestry, Fishing and Hunting (8% of jobs)
 - Construction (18% of jobs)
 - **Pre-COVID, about 9.5% of Virginia** jobs made significant use of telework
- **Projected (2045) Capability and Usage of Telework**
 - Existing capability is expected to increase slightly due to the projected change in industry mix in Virginia



TREND # 3: TELEWORK | JOB GROWTH IN VIRGINIA BY INDUSTRY

Projected Job changes in Virginia by Industry, 2018-2048



Data Sources: Virginia Employment Commission (Long-term Workforce Area Industry Projections 2018-2028), LEHD/LODES (2018 jobs by 2-digit NAICS distribution)

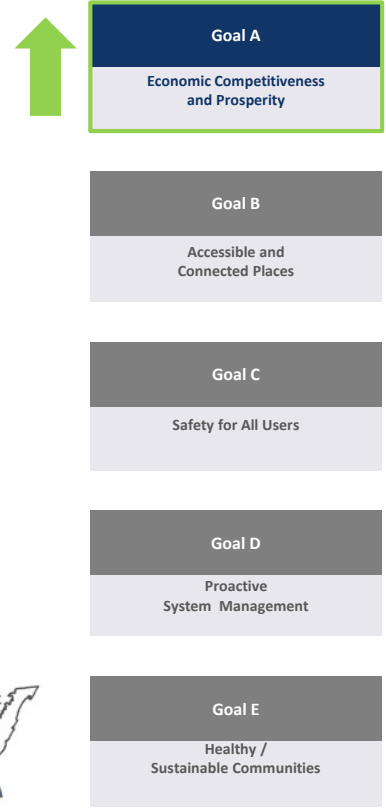
TREND # 3: TELEWORK | KEY TAKEAWAYS

- **Projected Transportation Consequences (Reduction in commute round-trips):**

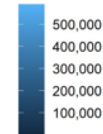
- Low scenario: **3%-23% reduction**
- Medium scenario: **4%-41% reduction**
- High scenario: **6%-55% reduction**

- **The impacts (benefits) of the projected reduction in trips will be experienced unevenly across Virginia as employment in different regions varies.**

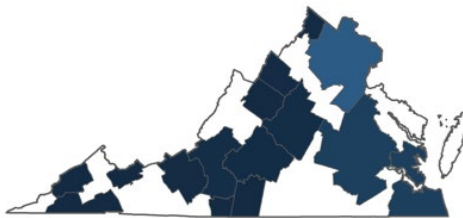
- This macrotrend impacts trip generation rates as well as "trip assignment" or where and how a trip is conducted.
- Urbanized (MSA) areas likely to see higher reduction in trips due to industry mix
- Top MSAs for potential roundtrip reduction (by work location) include:
 - o Washington-Arlington-Alexandria
 - o Virginia Beach-Norfolk
 - o Richmond



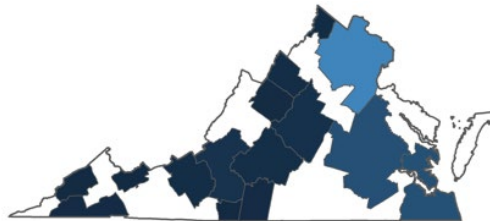
Avoided work commute roundtrips



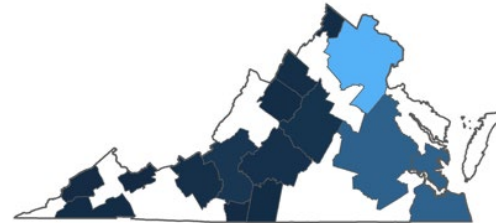
Low Scenario



Medium Scenario



High Scenario

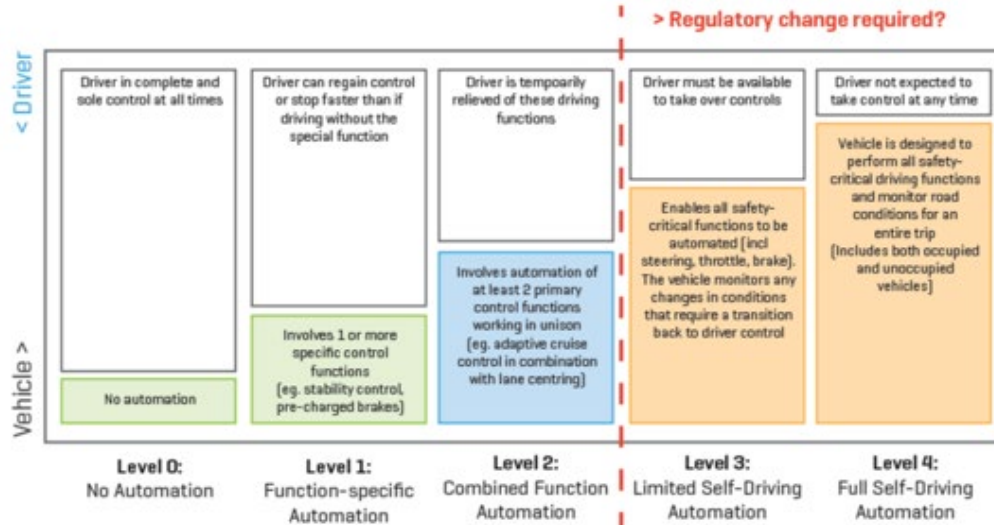




Trend # 4: Highly-Autonomous and Connected Vehicle Adoption (Passenger)

TREND # 4: CAV PASSENGER I DEFINITION

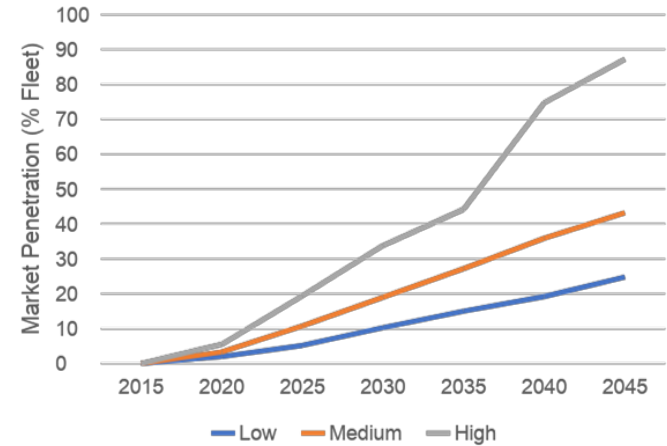
- Level of Automation Definitions (National Highway Traffic Safety Administration or NHTSA)



TREND # 4: CAV PASSENGER I STATUS

- **This macrotrend focuses on Automated and Connected Vehicles (CAV) for Passenger trips**
- **Noteworthy Items**
 - National survey suggests that willingness to adopt CAVs will increase as the cost of technology reduces
 - Trend shows that market penetration of Level 4 CAVs likely to increase over time
- **Current Market Penetration**
 - Level 1/2 AV: 4-13% of the passenger fleet (2015)
 - Level 4 AV: In testing phase
- **Projected (2045) Market Penetration**
 - Low scenario: 25%
 - Medium scenario: 44%
 - High scenario: 88%

Projected Market Penetration of Vehicles with Level 4 Technology



TREND # 4: CAV PASSENGER I KEY TAKEAWAYS

- **Highly autonomous (Level 3 and Level 4) personal vehicle adoption will continue to grow with potential impacts to capacity and safety.**
 - As operating costs of personal vehicle operation drop, additional demand and travel may be induced.

Category	Projected (2045) Impact (Medium Scenario)
Roadway Capacity (compared to current level)	Freeway: +/- 22% Merge: +/- 26% Urban Arterial: +/-6%
Safety Benefit (compared to current level)	Property Damage Only: -40% Severe Injury -28%
Vehicle Operating Cost (compared to current level)	- 28% to - 83% depending on the type of vehicle.
Vehicle Miles Traveled (compared to current level)	+12% to +41% depending on the type of vehicle.




Goal A

Economic Competitiveness and Prosperity

Goal B

Accessible and Connected Places



Goal C

Safety for All Users

Goal D

Proactive System Management



Goal E

Healthy / Sustainable Communities

Kevin Heaslip, Noah Goodall, Bumsik Kim & Mirla Abi Aad (2020) (VTRC): Assessment of Capacity Changes Due to Automated Vehicles on Interstate Corridors
 Stanek, David. (2019). A Procedure to Estimate the Effect of Autonomous Vehicles on Freeway Capacity.
 Qiong Lu , Tamás Tettamanti , Dániel Hörcher & István Varga (2020)



Trend # 5: Adoption of Highly-Autonomous and Connected Vehicles (Commercial)

TREND # 5: CAV COMMERCIAL I DEFINITION AND STATUS

- This macrotrend focuses on **Automated and Connected Vehicles (CAV) Vehicles** for Commercial/Freight Use.

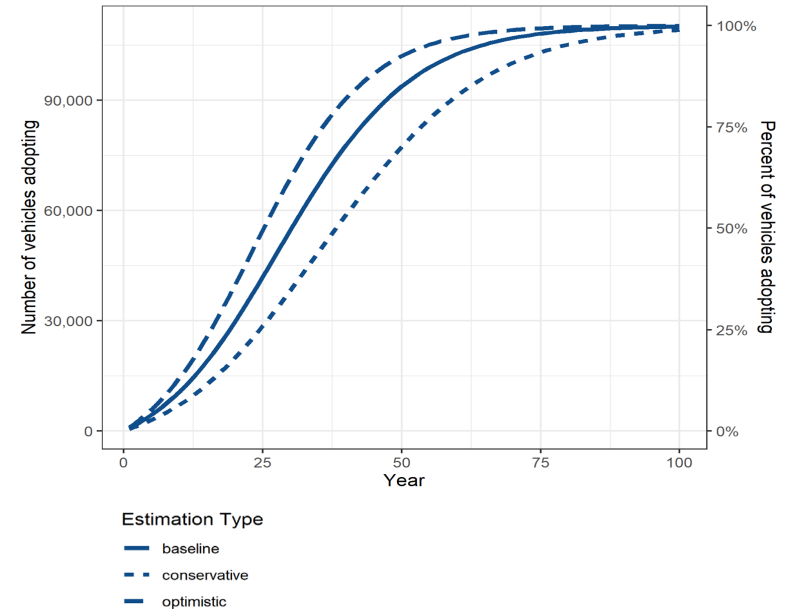
- **Current Technology Adaptation**

- Adaptive cruise
 - Automated manual transmission
 - Predictive cruise
- } Less than 2%

- **Projected (2045) Technology Adaptation**

- Adaptive cruise: 40%
- Automated manual transmission 80%
- Predictive cruise control 47%
- Level 4 automation 12%
- Platooning 18%

Projected Market Penetration of Vehicles with Level 4 Technology



Mishra, Sabya, Mihalis Golias, and Evangelos Kaisar Modeling Adoption of Autonomous Vehicle Technologies by Freight Organizations, ATRI, An Analysis of the Operational Cost of Trucking: 2020 Update, November 2020, Federal Motor Carrier Safety Administration (2021) data regarding number of transportation firms, workers, and vehicles registered in VA, U.S. Department of Commerce, Bureau of the Census, 2002 Vehicle Inventory and Use Survey, Microdata File on CD, 2005.

TREND # 5: CAV COMMERCIAL I KEY TAKEAWAYS

Projected Transportation Consequences

- Adoption of commercial AVs will lead to reduction in operating costs of commercial vehicles.
- Class of commercial vehicle with highest reduction in operation cost:
 - o Class 1 (light trucks) by 82.5%
 - o Class 2b (vans) by 63.2%
 - o Class 3 (walk-in/delivery) by 56.4%
- Prevalence of commercial CAV is projected to have the following impacts:
 - o Costs for vehicles to operate
 - o Socio-demographic and employment
 - o Roadway capacity
 - o Safety
 - o Travel demand

Impact on Socio-demographic and Employment Factors – Jobs in Affected Industries

	Current (2019)	Projected Affected Jobs (2045)			
		Number		Percent (%)	
		IHS Markit	Woods & Poole	IHS Markit	Woods & Poole
Charlottesville	82,800	99,001	120,928	0.79%	0.69%
Lynchburg	92,500	107,162	130,787	0.80%	0.70%
Northern Virginia	139,900	162,960	199,259	0.90%	0.80%
Richmond	573,900	683,165	832,855	0.88%	0.77%
Roanoke	634,500	747,027	910,801	0.81%	0.72%
Virginia Beach	1,273,200	1,562,600	1,864,656	0.79%	0.70%
Rest of State	530,900	606,169	741,157	0.88%	0.78%





Trend # 6: Increase in number of Electric Vehicles

TREND # 6: ELECTRIC VEHICLES | DEFINITION AND STATUS

- **This macrotrend focuses on adoption of electric vehicles**

- **Noteworthy Items**

- Increased vehicle availability
 - o Approx. 50 -75+ models
 - o Medium- and heavy-duty options
 - o Automaker commitments
 - o Used EVs
- Decreasing manufacturing costs
 - o Battery as main component
- Compelling total cost of ownership
 - o Fuel, maintenance savings
 - o Magnified for fleets
- Supportive policy
 - o Federal, state, and local levels
 - o e.g., ZEV mandates, ICE sales bans
- Innovative utility offerings
 - o Rebates, time-based rates
 - o Technical assistance

- **Current Market Penetration**

- 1.78 million EVs sold
 - o ~2% light-duty market share
 - 65% Battery EV
 - 35% Plug-in hybrid EV

- **Projected (2045) Market Penetration**

	Low	Medium	High
Cars and SUVs	40%	50%	100%
Buses	23%	35%	92%
Light-duty Trucks	41%	50%	100%
Medium Duty Trucks	1%	10%	48%
Motorbikes	38%	40%	92%

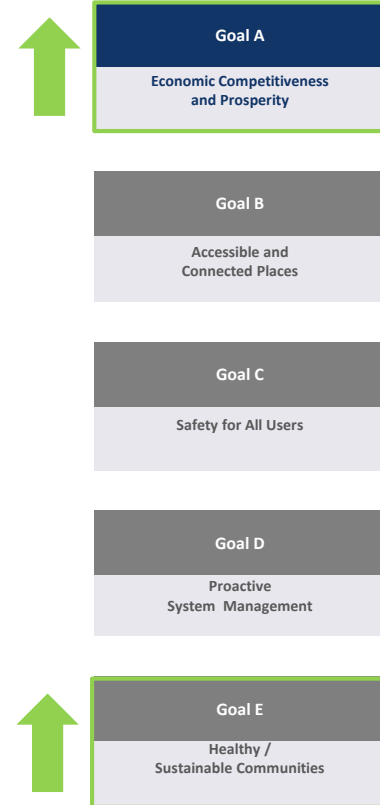
Source: Virginia Energy Policy Simulator (EPS) is a free and open-source computer model created by [Energy Innovation LLC](https://energyinnovation.com) and [Rocky Mountain Institute](https://rockymountaininstitute.com). It is adapted from software originally created by Energy Innovation LLC. <https://virginia.energypolicy.solutions/scenarios/home>

TREND # 6: ELECTRIC VEHICLES | KEY TAKEAWAYS

- **Public sector can play a meaningful role in this space to achieve more desirable outcomes**
- **Projected Transportation Consequences**
 - **Air quality** benefits expected however, maximizing these benefits requires appropriate incentives and infrastructure.
 - However, lower cost per mile of operation is projected to increase VMT.

	2020 Costs per mile	Level 4 AV 2030-2035 Costs per mile
Privately owned internal combustion engine vehicle	\$0.86	\$0.62
Privately owned hybrid electric vehicle	\$0.89	\$0.61
Private owned plug-in hybrid with 40-mile all-electric range	\$0.94	\$0.62
Private battery electric vehicle with 200 mile range	\$1.02	\$0.60
Private battery electric vehicle with 300 mile range	\$1.15	\$0.66
Ridesource (TNC) internal combustion engine vehicle	\$2.35	\$0.42
Ridesource (TNC) hybrid electric vehicle	\$2.34	\$0.39
Ridesource (TNC) battery electric vehicle with 300 mile range	\$2.35	\$0.36

Compostella, Junia. "Near- (2020) and Long-Term (2030-2035) Costs of Automated, Electrified, and Shared Mobility in the United States." Transport Policy, 2020, 14.
 Dong, Jing, Diane Davidson, Frank Southworth, and Tim Reuscher. "Analysis of Automobile Travel Demand Elasticities with Respect to Travel Cost." Oak Ridge National Laboratory, 2012. <https://www.fhwa.dot.gov/policyinformation/pubs/hpl-15-014/TCElasticities.pdf>





Trend # 7: Mobility-as-a-Service (MaaS)

TREND # 7: MAAS I DEFINITION AND STATUS

- **This macrotrend focuses on Mobility-as-a-service (MaaS) or, more specifically, Ridesourcing.**
 - Other forms of MaaS are important and we continue our research to identify their potential projected impact on CTB's Goals.
- **Current:**
 - Mode share of Ridesource vehicles is estimated at around 2% (2018)
 - Per-mile costs of Ridesource vehicles (based on small SUV) estimated at around three times those of an equivalent personal vehicle, mostly due to costs of driver and service fees

	Mode Cost (\$/VMT)		Mode Share	
	2018	2045	2018	2045
Driving or Carpooling	\$0.92	\$0.86	97.8%	85.3%
Ridesource	\$2.31	\$1.51	2.2%	14.7%

Society of Automotive Engineers (SAE)
Taxonomy and Definitions in SAE J3163

SHARED MOBILITY is the shared use of a vehicle, motorcycle, scooter, bicycle, or other travel mode; it provides users with short-term access to a travel mode on an as-needed basis

BIKESHARING provides users with on-demand access to bicycles at a variety of pick-up and drop-off locations for one-way (point-to-point) or roundtrip travel. Bikesharing fleets are commonly deployed in a network within a metropolitan region, city, neighborhood, employment center, and/or university campus.

CARSHARING offers members access to vehicles by joining an organization that provides and maintains a fleet of cars and/or light trucks. These vehicles may be located within neighborhoods, public transit stations, employment centers, universities, etc. The carsharing organization typically provides insurance, gasoline, parking, and maintenance. Members who join a carsharing organization typically pay a fee each time they use a vehicle.

MICROTRANSIT is a privately or publicly operated, technology-enabled transit service that typically uses multi-passenger/pooled shuttles or vans to provide on-demand or fixed-schedule services with either dynamic or fixed routing.

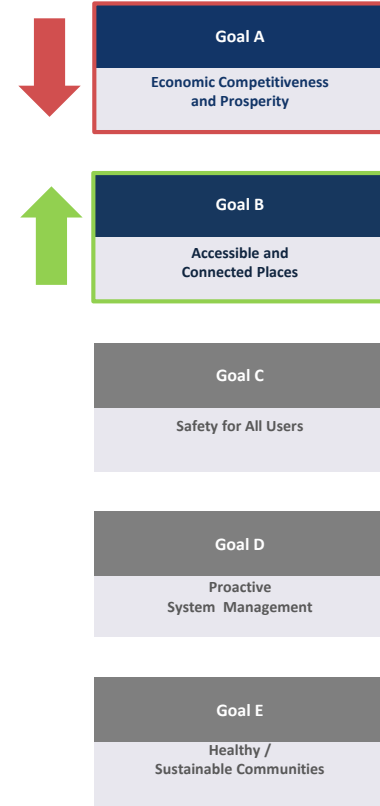
RIDESHARING (also known as carpooling and vanpooling) is defined as the formal or informal sharing of rides between drivers and passengers with similar origin-destination pairings. Ridesharing includes vanpooling, which consists of 7 to 15 passengers who share the cost of a van and operating expenses, and may share driving responsibility.

RIDESOURCING services are prearranged and on-demand transportation services for compensation in which drivers and passengers connect via digital applications. Digital applications are typically used for booking, electronic payment, and ratings.

SCOOTER SHARING allows individuals access to scooters by joining an organization that maintains a fleet of scooters at various locations. Scooter sharing models can include a variety of motorized and non-motorized scooter types. The scooter service provider typically provides gasoline or charge (in the case of motorized scooters), maintenance, and may include parking as part of the service. Users typically pay a fee each time they use a scooter. Trips can be roundtrip or one way.

TREND # 7: MAAS | KEY TAKEAWAYS

- **MaaS proliferation is closely linked with the proliferation CAVs as electrification and automation vehicle technologies are increasingly becoming more connected**
- **Currently, one of the major barriers for Ridesourcing is the relatively high cost-per-mile compared to those of private vehicles**
- **CAVs and EVs are projected to reduce cost-per-mile which will make Ridesourcing services less expensive leading to proliferation**
- **Projected Transportation Consequences**
 - Socio-demographic and employment impacts are expected which will impact transportation factors.
 - This macrotrend impacts trip generation rates as well as "trip assignment" or where and how a trip is conducted.

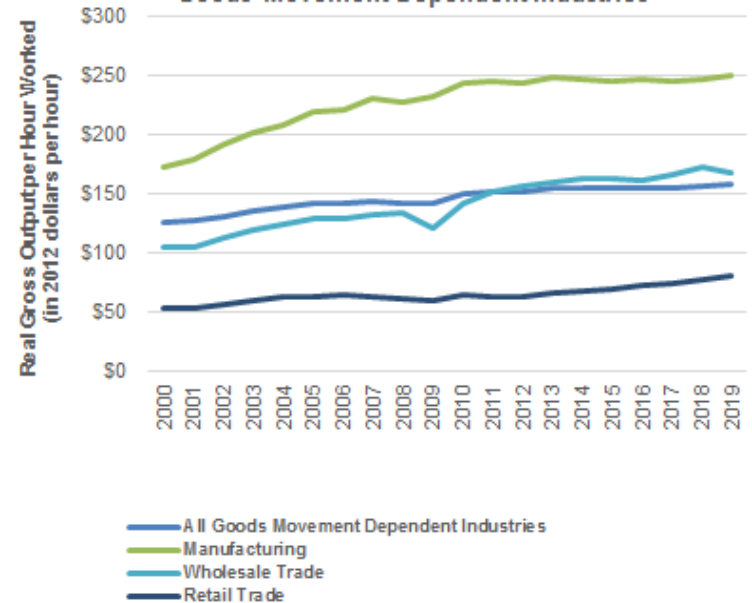




Trend # 8: Greater Production Automation

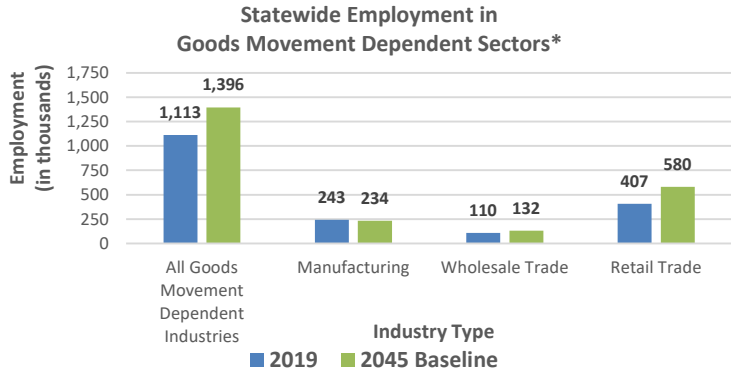
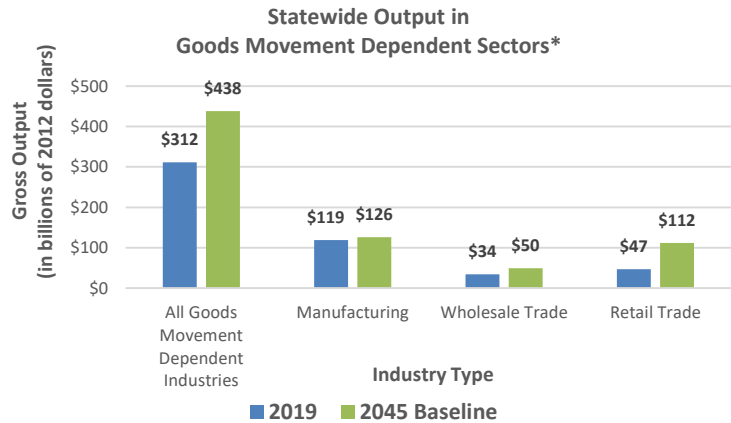
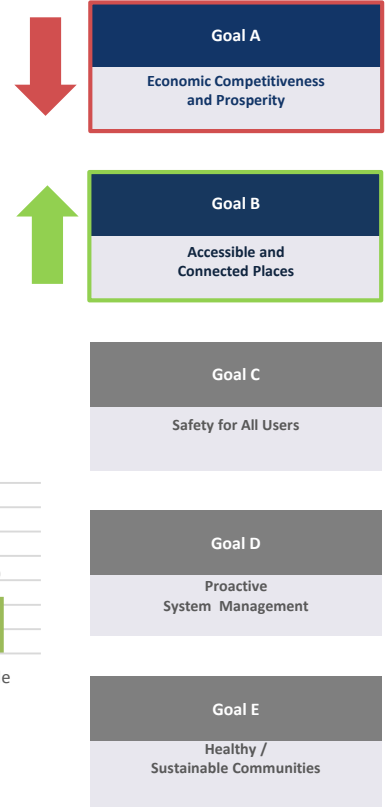
TREND # 8: PRODUCTION AUTOMATION I DEFINITION AND STATUS

- **This macrotrend focuses on** greater automation in production or digitalization of goods production and distribution systems.
 - Demand for faster “time to market” (agile/lean) goods production
 - Growth in high-ceiling and high level of automation fulfillment centers
- **Importance**
 - Increased productivity may affect industry-level employment
 - May shift costs between transportation and other industry needs
- **Current:**
 - Between 2000 and 2019, productivity increase by 45% for manufacturing, and 51% for retail trade
- **Projected (2045)**
 - 10% gain for manufacturing and 66% gain for retail trade to 2045



TREND # 8: PRODUCTION AUTOMATION I KEY TAKEAWAYS

- **This job productivity analysis considered increases in automation but without other emerging trends (e.g., 3D Printing, E-Commerce, electrification, autonomous vehicles, etc.)**
 - Despite productivity gains, automation could impact statewide employment by as much as 4% by 2045.
 - However, employment in other goods movement-dependent sectors will increase.
- **Transportation Consequences**
 - This macrotrend impacts trip generation rates as well as "trip assignment" or where and how a trip is conducted.



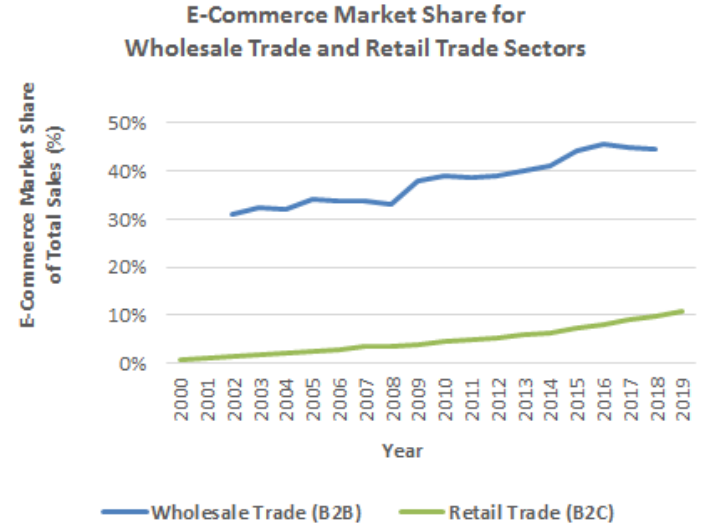


Trend # 9: E-Commerce

TREND # 9: E-COMMERCE | DEFINITION AND STATUS

- **This macrotrend focuses on two types of online sales:**
 - B2C: Business-to-consumers, or retail trade
 - B2B: Business-to-business, or wholesale trade
- **Importance**
 - Affects consumer travel patterns
 - Affects freight travel patterns (distribution/delivery)
 - Competition drives innovative practices
- **Current Marketshare**
 - B2C: ~8% market share (2019)
 - B2B: ~42% market share (2018)
- **Projected (2045) Market Share**
 - Low B2C: 14%
 - Medium B2C: 22%
 - High B2C: 31%

 - Low B2B: 42%
 - Medium B2B: 48%
 - High B2B: 58%



TREND # 9: E-COMMERCE | KEY TAKEAWAYS

- **This macrotrend, similar to Trend # 8, will result in different type of employment which will impact growth in transportation demand.**
- **Transportation Consequences**
 - This macrotrend has the potential for reduced VMT. Our initial projections indicate that reduction in consumer travel (386k - 1.1m VMT) will far outweigh the increased freight travel required for deliveries.
 - Job growth due to E-Commerce is projected to be unevenly distributed throughout the state and will have localized impact on transportation demand/VMT.
 - o Example: B2C related job growth is projected to vary between 75% to over 200%.
 - This macrotrend impacts trip generation rates as well as "trip assignment" or where and how a trip is conducted.





Trend # 10: E-Commerce Delivery (Drones)

TREND # 10: DELIVERY METHODS I DEFINITION AND STATUS

- **This macrotrend focuses on Unmanned Aerial Vehicles (Drones) with the ability to delivery small, lightweight goods over short distances**
 - Delivery methods such as low-speed automated vehicles are also projected to have an impact. However, projections are not available for this webinar
- **Importance**
 - Drone delivery provides an alternative to roadway-based delivery of goods
 - It is a more attractive delivery method in rural areas where last-mile delivery services are limited and/or expensive
 - There are policy options/questions as to how, where and when they should be deployed
- **Current Status**
 - In US, 484,000 commercial drones have been registered and 188,395 remote pilots certified as of early August 2020. Another 1.2 million recreational drones have been registered.
 - Amazon’s Prime Air and Wing’s drones can deliver less than 5 pounds packages over 10-15 miles distance range at an average speed between 50-70 mph. They both recently received FAA approval as "air carriers" but have yet to start commercial service.
- **Projected (2045) Market Share**

	Existing	Projected (2045)		
	2019	Low	Medium	High
Short-Range Drone	0.0%	5.0%	13.0%	25.0%
Long-Range Drone (Mostly within 500 miles)	0.6%	0.6%	4.6%	4.6%

TREND # 10: DELIVERY METHODS | KEY TAKEAWAYS

- **This macrotrend, similar to Trend # 8, will result in different type of employment which will impact growth in transportation demand.**
- **Transportation Consequences**
 - This delivery method is projected to become a meaningful mode for delivery of goods purchased online (5-15%) as it provides cost savings compared to short-range delivery trucks.
 - This macrotrend impacts trip generation rates as well as "trip assignment" or where and how a trip is conducted.





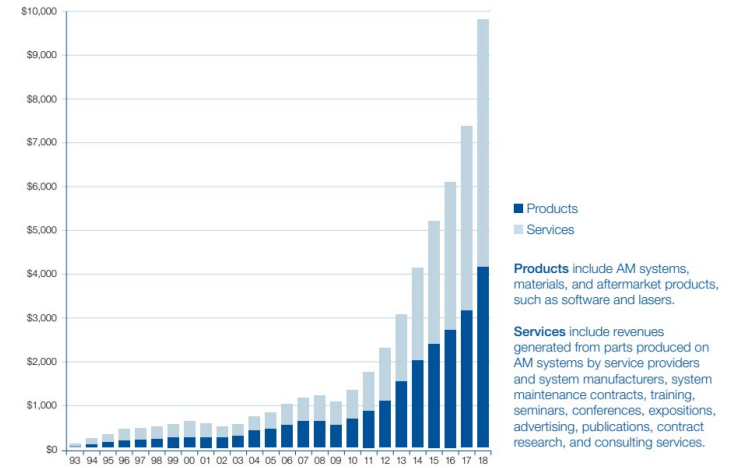
Trend # 11: 3D Printing

TREND # 11: 3D PRINTING | DEFINITION AND STATUS

- **This macrotrend focuses on 3D Printing or Additive Manufacturing are alternate manufacturing technologies that create objects through sequential layering**
 - In contrast, traditional manufacturing involves subtractive or forming processes
- **Importance**
 - Ability to manufacture goods closer to market and in reaction to demand
- **Current Status**
 - ~ 300 jobs estimated in VA
- **Projected (2045) Market Share**

	Existing	Projected (2045)		
	2019	Low	Medium	High
3D Printing Jobs in VA (in thousands)	0.3	2.1	16.6	29.7
3D Printing Market Penetration in VA	0.1%	0.9%	7.1%	12.7%
3D Printing Output in VA (\$B of 2012)	\$0.1	\$1.2	\$8.9	\$16.0

Figure 3: Global GDP revenues (in million \$)



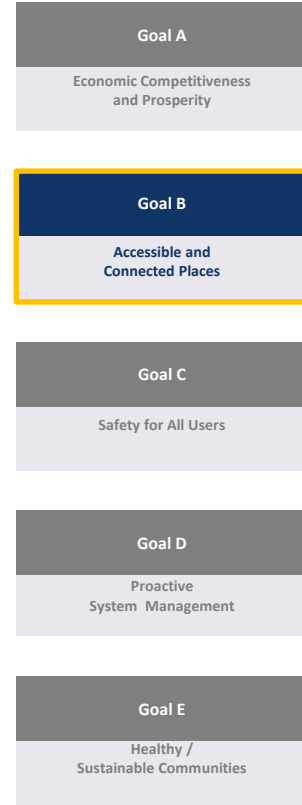
Source: Wohlers Associates, 2019

Sources:

1. 3D Hubs, 3D Printing Trends 2020 - Industry highlights and market trends, 2020.
2. <https://www2.deloitte.com/us/en/insights/industry/technology/technology-media-and-telecom-predictions/3d-printing-market.html>
3. HP and AT Kearney, 3D Printing: Ensuring Manufacturing Leadership in the 21st Century, 2017.
4. World Economic Forum (WEF), 3D Printing: A Guide for Decision-Makers – White Paper, In collaboration with Mitsubishi Chemical Holdings Corporation, January 2020.

TREND # 11: 3D PRINTING | KEY TAKEAWAYS

- **This macrotrend, similar to Trend # 8, will result in different type of employment which will impact growth in transportation demand.**
- **Transportation Consequences**
 - Potential to become a significant mode for delivery of goods purchased online (5-15%)
 - Potential for cost savings compared to short-range delivery trucks
 - Ability to manufacture goods closer to market and in reaction to demand can reduce truck VMT and operating costs, but not much (less than 1% in our scenarios)



NEXT STEPS

- **This is first of three Long-term Needs related webinars that focus on different trends, drivers, and associated needs**
 - **April 2021:** [VTrans Economic and Technology Trends](#)
 - **May 2021:** [VTrans Vulnerability Assessment](#)
 - **June/July 2021:** [VTrans Long-term Needs](#)
- **Subscribe to [VTrans Newsletter](#) for future updates.**
- **Please share any comments, questions, or contact us for more details.**

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Questions?