B EXTERNAL FORCES AND POLICIES EXPLORATION: PEER GROUP DISCUSSION

TABLE OF CONTENTS

INTRODUCTION 2
- TABLE 1. TOPIC AREAS 3

EXTERNAL FORCES 5
- CONNECTED AND AUTONOMOUS VEHICLES (CAV) 5
- E-BIKE ADOPTION 7
- ELECTRIC VEHICLE ADOPTION 9
- FREIGHT DISRUPTIONS 11
- HIGH-TECH TRANSIT SYSTEMS 13
- INTERNET SHOPPING 15
- INTER-REGIONAL HIGH-SPEED TRANSIT 17
- NEW MICRO-MOBILITY ADOPTION 18
- ON-DEMAND TRAVEL AND SHARING SERVICES (Transportation Network Companies-TNC) 20
- PASSENGER DRONES/DRONE TAXIS 22
- TELECOMMUTING 24

POTENTIAL POLICY RESPONSES 26
- APP DEVELOPMENT 26
- CONGESTION PRICING 28
- CURBSIDE MANAGEMENT 29
- FARE-FREE TRANSIT 30
- LOCAL STREET DESIGN MODIFICATIONS 31
- MANAGED LANES 33
- MICROTRANSIT 34
- MODERNIZATION OF PARKING REGULATION 35
- ROAD USAGE CHARGE 37
- STREET CONNECTIVITY 38
- SUBSIDIZED E-BIKE PURCHASES 39

PEER GROUP MEETING RESULTS 41

INTRODUCTION

It's coming...it's coming...it's coming. The future. It's coming. And what will it bring with it? How will COVID-19 affect communities and transportation after recovery? Will the potential of micro-mobility be realized? Will each trip be taken by the suitability of each mode or device? Will your most important utility be your internet connection as online shopping and teleworking proliferate? Will the act of "driving" be a thing talked about in history museums? What will happen to where and how people live, work, and play? And how will these changes affect communities economically and physically? Will the future shape us or will we shape the future? The Wasatch Front Regional Council (WFRC), in collaboration with regional and state transportation agencies in Utah, is looking to you to help inform the answers to these (and many more) questions.

WFRC is beginning the 2023-2050 Regional Transportation Plan (RTP) process with a focus on exploring and understanding external forces (market shifts, transportation technologies, and policy approaches) that would impact our transportation, land use, and economic development decisions. The intent of this approach is to elevate the discussion of these planning uncertainties and understand these changes as a Region. WFRC has gathered initial research and literature on over 20 topic areas of external forces and policies which will be discussed in peer groups. The purpose of the peer groups is to hold space for meaningful dialogue on the identified influences and policies, develop consensus on which of these external forces is important to address, approximate the range of impacts from these forces, and determine whether these influences and policies should be tested through simulated scenarios. Scenarios would gauge the long-term effectiveness of the policies and prospective transportation projects by simulating how well they perform in the context of these external forces. Overall, this is an opportunity for communities, transportation agencies, and other stakeholders to come together to discuss how the Region should move forward, address future uncertainty, and become more resilient in the face of change.

There are four peer groups which are grouped in the following areas: active transportation, local communities, road, and transit and on-demand travel. Each group will focus on several influences and policies and their significance and impacts to each group. Table 1 shows the topic areas which will be covered.

This guidebook is laid out by category and respective topic areas; is meant to be a tool and living document that serves the purpose of aiding peer group discussions on the influences and policies; and is meant to provide a high-level description of the influences/policies so peer group members participate with the same understanding of the influence/policy. WFRC staff recognizes that these descriptions and findings may change depending on the peer group's desired direction. WFRC also recognizes that agency partners, counties, and cities may have ongoing studies that relate to the topic areas.

As the designated Metropolitan Planning Organization (MPO) for Davis, Salt Lake, Weber, and southern Box Elder Counties, WFRC is responsible for coordinating the Wasatch Choice 2050 Regional Vision and the regional transportation planning process that is updated and adopted every four years. The planning process looks out several decades into the future to anticipate needed transportation investments. The current four-year planning cycle began in 2019 and will be completed in 2023, leading to the adoption of the 2023-2050 RTP.

Recent four-year planning cycles have increasingly recognized the relationship between transportation, land use, and economic development. Holistic planning of these three elements in concert has led to the adoption of the Wasatch Choice Regional Vision, our communities' shared vision for transportation investments, development patterns, and economic opportunities that will enhance the Region's quality of life. The RTP informs, and is the transportation element of, the Wasatch Choice Regional Vision. Several partners are involved in the development of the RTP and the Regional Vision, including the Mountainland Association of Governments (MAG), the Utah Department of Transportation (UDOT), the Utah Transit Authority (UTA), and county and city governments, along with other agencies, stakeholders, and the public.

WFRC works with the Cache MPO, Dixie MPO, MAG, UDOT, and UTA on Utah's Unified Transportation Plan. The exploration of external forces and policies will inform this Unified Transportation Plan in addition to being addressed in the WFRC planning process.

TABLE 1. TOPIC AREAS

External Forces *Each topic area is linked to its section in the document*	Connected/Autonomous Vehicles (CAV)	Autonomous vehicles (AVs) are vehicles that are capable of driving without human intervention (also called self-driving or driverless vehicles). A connected vehicle is one that communicates with other vehicles (V2V), infrastructure (V2I), and other road users (V2X) via wireless technology.
	E-Bike Adoption	Rate of adoption for electric-assisted bicycles.
	Electric Vehicle Adoption	Rate of adoption for battery electric vehicles.
	Freight Disruptions	Freight disruptions refer to a series of changes that are occurring in freight distribution and delivery of goods. These include, but are not limited to, truck automation and platooning, change in distribution methods, and last-mile delivery.
	High-Tech Transit Systems	High-tech transit systems utilize technology within their fleet and/or on the roadway systems they operate. The scope of an Intelligent Transportation System (ITS) covers traffic and mobility management, managing movement of vehicles and assisting drivers, enhancing transport infrastructure, and providing improved interfaces for transport systems.
	Internet Shopping	Internet shopping and e-commerce are the ability to purchase goods and services through the internet.
	Inter-Regional High-Speed Transit	Transportation of passengers and/or freight through multiple states or MPO areas, usually being trips between 100 to 500 miles.
	New Micro-Mobility Adoption	Rate of adoption for micro-mobility devices including bikeshare and electric scooter share.
	On-Demand Travel and Sharing Services (TNC)	The use of technology in the form of a mobile application that enables users to call/secure individual and carpool rides.
	Passenger Drone/Drone Taxi (Drones)	Reviews the emergence of passenger drone taxis, also known as vertical take off and landing (VTOL) aircraft, and popularly known as "flying cars" or "passenger drones."
	Telecommuting	A work arrangement in which an employee works outside the office, often working from home or a remote location.

Policies *Each topic area is linked to its section in the document*	App Development	A tech service on smart phones that allows users to plot out, order, share, and pay for a wide variety of transit/transportation options.
	Congestion Pricing	Tolling to enter a cordoned area with an area. Does not include traditional toll lanes and roads.
	Curbside Management	Policies and practices that allocate curb space to different uses, potentially at different times, including transit, freight, passenger pick-up and drop-off, vehicle parking, micro-mobility device parking, and public space.
	Fare-Free Transit	Fare-free transit is a policy decision to remove the barrier of paying for transit services. This can be done system wide or within designated zones.
	Local Street Design Modifications	Policies that improve the suitability of roads through design and speed modifications for a variety of transportation modes. These could be implemented within Centers identified in the Wasatch Choice Regional Vision.
	Managed Lanes	Smart freeways that prevent congestion by continuously monitoring traffic flows and controlling freeway access using state-of-the-art technologies including coordinated ramp signaling, variable speed limit and variable message signs, as well as lane use management. They optimize the efficiency of freeways and major arterial roads.
	Microtransit	Microtransit is a privately or publicly operated, technology-enabled transit service that typically uses multi-passenger/pooled shuttles and vans to provide on-demand and fixed-schedule services with either dynamic or fixed routing.
	Modernization of Parking Regulation	Policies and practices that consider changes to parking policies such as elimination of parking minimums, adoption of paid parking, unbundled parking costs, and impact of autonomous vehicles.
	Road Usage Charge	A road usage charge is a usage-based fee based on a certain rate per mile traveled, replacing the per gallon purchased at the pump fee (gas tax).
	Street Connectivity	Connectivity can be defined as multiple routes and connections serving the same origins and destinations. Relative to external forces, a connected network helps amplify the potential benefits of micro-mobility -- technologies that solve the first-/last-mile problem which would in turn help reduce single occupant vehicle (SOV) usage in those locations.
	Subsidized E-Bike Purchases	Subsidized or discounted programs and trial use programs aimed at accelerating the adoption and purchase of electric-assisted bicycles.

EXTERNAL FORCES

External forces are transportation technologies and shifts in market and consumer demand that may impact transportation, land use, and economic development decisions. WFRC identified 12 initial topic areas that fall under this categorization. However, this is not an exhaustive list and is open for more discussion of other potential external forces.

CONNECTED AND AUTONOMOUS VEHICLES (CAV)

Description	Autonomous vehicles (AVs) are capable of driving without human intervention (also called self-driving or driverless vehicles). A connected vehicle is one that communicates with other vehicles (V2V), infrastructure (V2I), and other road users (V2X) via wireless technology. This includes a range in the levels of automation ability depending on the technology. Connected and autonomous vehicles (CAV) can be passenger, public transport, and freight vehicles. CAV requires the use of sensors, cameras, light detection and ranging (LIDAR), GPS, and other on-board technology to operate with reduced, limited, and/or no human interaction. The "connected" aspect of CAV also operates via dedicated short-range communications (DSRC) that are omnidirectional or potentially through cellular, wireless, or satellite connections. According to USDOT, as of June 2019, more than 1,400 CAVs are being tested in the U.S. by more than 80 companies in 36 states. Companies include Tesla, Alphabet, Nuro, and many other original equipment manufacturers (OEMs) including Audi, BMW, and Bosch.
Key Findings	CAV has wide implications to safety, roadway design, freight, parking, land use, transit options, and traffic markings and signaling. In general, most research indicates improved safety benefits of CAV by reducing driver error and connecting vehicles to other vehicles, infrastructure, and road users. CAV has the potential to reduce crashes, congestion, and headways on narrower lane widths. CAV also has the potential for increased vehicle miles of travel (VMT) with zero-occupancy driving and reduced potential for trip chaining if CAV technology functions at full automation. CAV expands mobility for those currently unable to drive and may improve first-/last-mile connections with transit. However, CAVs may also shift mode choice and affect transit dependent populations by offering opportunities for mobility for certain populations (young and older populations, persons with disabilities, and/or underserved populations). CAVs may also impact demand and location of parking facilities. Full-scale commercial introduction of AVs are predicted to occur within five to 20 years. A large range of uncertainties exist between predictions of the usage of a variety of CAV features in the years 2030-2050. Although many researchers,

	OEMs, and industry experts have different timelines for AV market penetration and full adoption, the majority predict NHTSA Level 4 AVs around 2030. A USDOT Congressional Research Service report estimates that 20 percent of intersections may be V2I capable in 2025 and 80 percent will be V2I capable by 2040. V2I deployments will likely be located at highest-volume signalized intersections first.
Key Considerations	Major factors that contribute to advancement of CAV include the following: - Innovation - Vehicle infrastructure - Workforce Training - Government law and regulations encouraging development and testing - Level of Consumer acceptance Another consideration is that standards for traffic control devices are not adopted uniformly across the U.S. The Federal Highway Administration develops the Manual of Uniform Traffic Control Devices, but state adoption is not uniform, and laws are different between states, creating a challenge for AV manufacturers. There are technological implications for highway infrastructure on which AVs operate as AV technology relies on clear pavement markings and legible signage to navigate through traffic. Cost of driving and travel time delays would be reduced if individuals are able to do other in-vehicle activities. However, this would impact land use with people more willing to accept a longer commute in order to live in a more affordable home, which may incentivize more sprawl. Facilitation of CAV travel may include the designation of special highway corridors that would include all V2X systems necessary for safe autonomous operation.
What We Know with Higher Certainty	Because AVs promise to make transportation more convenient, it will eliminate one of the biggest transportation costs - the value of time - by giving people the opportunity to engage in other activities while traveling. People will have fewer incentives to minimize or optimize travel, thus potentially increasing vehicle travel. By reducing the cost of driving time, AVs will encourage greater travel and increased VMT, which could lead to more congestion. Utah Department of Transportation (UDOT) and Panasonic launched a partnership in 2019 to further expand V2X technology in the State. Although almost 30 states, including Utah, have adopted legislation surrounding autonomous vehicles, there is no federal law surrounding self-driving vehicles. Major barrier is conflicting state laws throughout 50 states - manufacturers face challenges in the lack of uniformity of infrastructure for CAV.
What We Know with Lower Certainty	We know with lower certainty how the introduction of CAV will take place in the shared economy (to operate as a TNC) and how likely it is for private vehicle ownership to be reduced due to CAV. It's known with lower certainty if there are Accessibility and mobility benefits of CAV for persons with limited access to vehicular travel is also known with lower certainty. However, most studies indicate this will likely occur when CAV is fully commercially adopted.
COVID-19 Resiliency	AVs are ferrying COVID-19 tests from drive-thru clinics to a processing lab within

	the Mayo Clinic Florida Campus in Jacksonville, Florida. Jacksonville Transportation Authority is testing the AV's ability to travel through the campus.
Sources	Anderson, Kalra, et al. "Autonomous Vehicle Technology: A Guide for Policymakers". Rand Corporation. 2016. https://www.rand.org/content/dam/rand/pubs/research_reports/RR400/RR443-2/RAND_RR443-2.pdf Canis, Bill. "Issues in Autonomous Vehicle Testing and Deployment". Congressional Research Service. February 11, 2020. https://crsreports.congress.gov/product/pdf/R/R45985 GCN Staff. "Autonomous Vehicles Deliver COVID-19 Tests to Lab". April 8, 2020. https://gcn.com/articles/2020/04/08/avs-covid-tests-mayo-clinic-campus.aspx Litman, Todd. "Autonomous Vehicle Implementation Predictions: Implications for Transport Planning". Victoria Transport Policy Institute. March 24, 2020. https://www.vtpi.org/avip.pdf Public Sector Consultants and Center for Automotive Research."Planning for Connected and Automated Vehicles". March 2017. https://www.cargroup.org/wp-content/uploads/2017/03/Planning-for-Connected-and-Automated-Vehicles-Report.pdf Remarks Prepared for Delivery by U.S. Secretary of Transportation Elaine L. Chao at Uber Elevate Symposium. June 11, 2019. https://www.transportation.gov/briefing-room/uber-elevate-symposium Shladover and Greenblatt. "Connected and Autonomous Vehicle Concept Dimensions and Examples." U.S. Department of Energy Vehicle Technologies Office. 2018. https://eta-publications.lbl.gov/sites/default/files/lbnl-2001086_new.pdf Teigen, Ann and Ben Husch. "Regulating Autonomous Vehicles." NCSL Vol. 25, No. 13. April 2017. https://www.ncsl.org/research/transportation/regulating-autonomous-vehicles.aspx UDOT. "Impact of Shared Autonomous Vehicles on Vehicles on Vehicle Miles Traveled in Utah." 2019. https://www.udot.utah.gov/main/uconowner.gf?n=7127517546170418

E-BIKE ADOPTION

Description	Electric bicycles (e-bikes) make cycling longer distances and utilitarian trips more attainable for those who regularly ride a bicycle and for those who do not. E-bikes can offer a cheaper transportation alternative to the car, increase physical fitness levels, improve air quality, and decrease noise in cities.
Key Findings	E-bikes will increase the use of bicycling for commuting and purposeful transportation by increasing trip distances by bike and by removing many physical limitations of bicycling use. Older adults and people less physically fit use e-bikes for recreation; others use e-bikes for commuting and utilitarian purposes. E-bikes have the potential to increase the number of women cyclists. Some e-bike trips will replace transit and other active transportation trips, but up to nearly 68 percent of utilitarian e-bike

	trips replace a car trip. E-bike trips are farther than traditional bike trips, but take a similar amount of time. Health benefits still accrue when using an e-bike. In 2018, the U.S. saw a 73 percent increase in e-bike sales compared to the previous year. Unlike electric vehicles, e-bikes do not require a special power network to recharge the battery.
Key Considerations	Equity: E-bike purchase costs are high. Safe infrastructure, separated from both vehicles and pedestrians, will affect e-bike adoption rates. Secure bicycle parking will also affect adoption rates. Speed differences between standard bicycles and e-bicycles can be a concern, depending on rider skill level and confidence.
What We Know with Higher Certainty	E-bikes allow further travel with less effort than a regular bicycle, which allows more of the population to use such a bicycle for both recreation and non-recreation trips, especially for trips up to five miles. The market is still relatively untapped and is growing. Also, utilitarian bike models such as different cargo and commuter bikes, are more realistically able to replace the function of a car with the assistance of an electric motor.
What We Know with Lower Certainty	Will construction of safe bicycle infrastructure accelerate the adoption of e-bikes, or will the adoption of e-bikes accelerate the construction of safe infrastructure? Will e-bike adoption reach the potential of shifting trips from cars? How quickly the price of e-bikes, and their associated motors and batteries, will decrease as technology and manufacturing processes improve? Will the e-bike market serve vulnerable populations?
COVID-19 Resiliency	During pandemic social distancing measures, bicycle riding has increased as people have looked for recreational pursuits as well as transit trip replacements.
Sources	Arkenberg, Chris, Mark Casey, Paul Lee, Jeff Loucks, David Jarvis, Paul Sallomi, Duncan Stewart, Craig Wigginton. 2020. Technology, Media, and Telecommunications Predictions 2020. https://www2.deloitte.com/content/dam/insights/us/articles/722835_tmt-predictions-2020/DI_TMT-Prediction-2020.pdf Cherry, Christopher R., Michael Harpool, John MacArthur, Daniel Scheppke. 2018. A North American Survey of Electric Bicycle Owners. https://ppms.trec.pdx.edu/media/project_files/NITC_RR_1041_North_American_Survey_Electric_Bicycle_Accessible.pdf Cherry, Christopher, John MacArthur, Michael McQueen. 2019. The E-Bike Potential: Estimating the Effect of E-Bikes on Person Miles Travelled and Greenhouse Gas Emissions. https://wsd-pfb-sparkinfluence.s3.amazonaws.com/uploads/2019/05/E-bike-Potential-Paper-05_15_19-Final.pdf Dill, Jennifer, Geoffrey Rose. 2011. E-bikes and Transportation Policy: Insights from Early Adopters. 91st Annual Meeting of the Transportation Research Board. https://nacto.org/wp-content/uploads/2012/02/E-bikes-and-Transportation-Policy-Insights-from-Early-Adopters-Dill-et-al-12-4621.pdf People for Bikes. n.d. “Research + Stats.” Accessed April 22, 2020.

https://peopleforbikes.org/our-work/e-bikes/research-and-stats/
Plazier, Paul A., Agnes E. Van Den Berg, Gerd Weitkamp. 2018. Exploring the Adoption of E-Bikes by Different User Groups. https://www.frontiersin.org/articles/10.3389/fbuil.2018.00047/full
National Park Service. 2020. "Electric Bicycles (e-bikes) in National Parks." Last modified April 8, 2020. Accessed April, 22, 2020. https://www.nps.gov/subjects/biking/e-bikes.htm
Smith, Goran, Helena K. Stromberg, Pontus Wallgren. 2017. Electric Bicycle Adoption: Opportunities and Requirements. https://www.researchgate.net/publication/320611992_Electric_Bicycle_Adoption_Opportunities_and_Requirements
Wild, Kirsty, Alistair Woodward. 2018. Electric City: E-bikes and the Future of Cycling in New Zealand. https://cpb-ap-se2.wpmucdn.com/blogs.auckland.ac.nz/dist/c/520/files/2018/08/Electric-City-Ebikes-and-the-Future-of-Cycling-in-NZ-1rihn5y.pdf

ELECTRIC VEHICLE ADOPTION

Description	Rate of adoption for battery electric vehicles in Utah.
Key Findings	Approximately two percent, or 52,000, of the 2.6 million vehicles registered in Utah are fully electric, plug-in electric, or hybrid gas/electric. Multiple cities and counties across Utah have already expanded, begun implementation, or have plans to install electric vehicle charging areas in their communities. There are now over 100 charging stations along the Wasatch Front, including direct current (DC) "fast charge" stations that can fully charge a vehicle in 30 minutes.
Key Considerations	A major hurdle to overcome with electric vehicle adoption is addressing consumer fears regarding running out of power, perception in the lack of available infrastructure, and initial vehicle cost. The fear of inadequate charging infrastructure is a top concern according to one study, with 61 percent of respondents saying that more charging stations would increase their likelihood of going electric. Variety in the vehicle models available is also a factor. Currently, most electric vehicles are small, midsize, or compact so consumers interested in SUVs or pickup trucks have minimal options. While there are more passenger vehicles on the road, medium and heavy -duty truck emissions still account for approximately one-third of pollution along the Wasatch Front, in which these vehicles currently are not replacing.
What We Know with Higher Certainty	H.B. 396 passed during the 2020 legislative session and would help advance the deployment of a statewide DC fast-charger network. The State of Utah is working with Rocky Mountain Power (RMP) to invest $50 million on electric charging stations throughout Utah along interstate highways and businesses. In Utah, sales of electric vehicles increased from under one percent in 2017 to 1.6 percent in 2018 of total Utah market share. Sales jumped from 1,135 vehicles sold in 2016 to 2,295 in 2018. Utah State University (USU) is currently developing an electric vehicle adoption model for Utah in partnership with RMP. It is recommended to work with USU and RMP to learn more about the model and potentially incorporate it in regional

	transportation planning models.
What We Know with Lower Certainty	Consumers may be less interested in switching to EV at a time when gasoline prices are relatively cheap. Additionally, consumers may be interested when there is more variety in vehicle types for EVs. In 2019, SUVs and pickups comprised a record 70 percent of vehicle sales in the United States. Ford, for example, has spent $11 billion in 40 electrified models which will be out by 2022. More vehicle types in electric SUVs and trucks in addition to more economical prices may increase the likelihood for consumers to purchase an electric vehicle.
COVID-19 Resiliency	With large sections of the country under stay-at-home orders, sales for vehicles have plummeted, down 27 percent in March compared to a month earlier. Many potential buyers are suffering economic setbacks due to closed businesses. Automakers and suppliers have also been forced to close factories with 95 percent of auto plants in North America and Europe shutting down operations, according to research firm GlobalData. However, this could merely be a temporary setback. In China, during the peak of the pandemic, vehicle sales were down as much as 96 percent, yet by March when lockdowns were lifted, sales for electric vehicles jumped. There were a reported total of 47,000 EVs sold in March, with Tesla sales jumping from 3,900 cars in February to more than 10,000 EVs old in March - the best results in a single month. It's likely that once stay-at-home orders are lifted, gains may also be seen in the United States.
Sources	GlobalData. "Auto Sector Faces biggest existential crisis since 2007-09". March 13, 2020. https://www.globaldata.com/auto-sector-faces-biggest-existential-crisis-since-2007-09-says-globaldata/ Kane, Mark "China: Plug In EV Car Sales in February 2020 Down by 65%" https://insideevs.com/news/405693/china-plugin-car-sales-february-2020/ Pierce, Kelly. "Utah Getting Hundreds of Electric Vehicle Charging Stations". February 24, 2020. https://kslnewsradio.com/1919993/utah-getting-hundreds-of-electric-vehicle-charging-stations/ Rocky Mountain Power. "Utah Legislation to Greatly Expand EV Charging Network". February 24, 2020. https://www.rockymountainpower.net/about/newsroom/news-releases/utah-expands-ev-charging. html State of Utah. "Electric Vehicle Master Plan". 2018. https://energy.utah.gov/wp-content/uploads/2019/07/State-of-Utah-EV-MasterL.pdf Stomsta, Karl-Erik. "Electric Vehicle Sales Set to Crash in 2020 Amid Coronavirus and Oil Price Shocks" Green Tech Media. April 8, 2020. https://www.greentechmedia.com/articles/read/electric-vehicle-sales-set-to-crash-in-2020-as-coronavirus-bites-and-oil-stays-cheap Ulrich, Lawrence. "SUV vs. Sedan, and Detroit vs. the World, in a Fight for the Future". New York Times. September 12, 2019. https://www.nytimes.com/2019/09/12/business/suv-sedan-detroit-fight.htm Utah Foundation. "Driving Toward a Cleaner Future: Alternative Fuel Vehicles In Utah." November 2019. http://www.utahfoundation.org/uploads/rr772.pdf

FREIGHT DISRUPTIONS

Description	Freight disruptions refer to a series of changes that are occurring in freight distribution and delivery of goods. These include, but are not limited to, truck automation and platooning, change in distribution methods, and last-mile delivery.
Key Findings	For truck automation and platooning to work, connected technology and automated driving support systems (V2V) is required. These vehicles automatically maintain a set, close distance between each other when they are connected for certain parts of a journey, for instance on motorways. Studies indicate truck platooning has the potential to reduce fuel consumption by ten percent, while improving safety on the roadway. Cost savings with phasing out truck drivers and the ability for trucks to operate 24 hours per day. A test was conducted by CR England in 2013 outside of Salt Lake City with the North American Council for Freight Efficiency using the Peloton platooning system. This test platooned two identical trucks. These vehicles, outfitted with test fuel tanks to accurately measure fuel use, were operated at a constant 64 miles per hour (mph) at a following distance of 36 feet. This configuration resulted in an average fuel consumption savings of 4.5% for the lead truck and 10% for the following truck (overall "team" savings were an estimated 7.25%). The first fully autonomous truck was able to complete a cross-country delivery from Pennsylvania to California with no disengagements in December 2019. There is change in demand for distribution methods and land use. Demand for distribution centers and industrial land has increased throughout the United States as people have changed the way they shop, which has reshaped distribution networks, retailers, and logistics providers. In order to have faster delivery and distribution in urban areas, companies also are adapting existing buildings such as empty malls to warehousing, while more retailers are using their stores as fulfillment centers for online customers. Last-mile delivery is the movement of goods from a transportation hub to the final delivery destination. With the advent of e-commerce, last-mile delivery and logistics has become a popular area of interest for retailers due to the growing demand for fully integrated omnichannel retailing. A variety of solutions have been brought up to address last mile delivery abilities in urban areas including e-cargo bikes, drones, and third-party delivery services that operate like TNCs, but for goods instead of passengers. In Utah, amendments to H.B. 277 on personal delivery devices were made in 2020 to allow autonomous personal delivery devices (not a motor vehicle) to use pedestrian areas to deliver cargo and goods at a maximum speed of 10 mph. Microhubs are consolidation centers for last-mile deliveries in dense urban districts, which include small neighborhood lockers that can reduce the time a delivery person spends in a building, and consequently reduces the time that curb space is utilized for active deliveries. Communities are experiencing higher volumes of freight delivery on local streets. Incompatibilities between delivery vehicles and community form (such as

	neighborhood streets) are generally growing.
Key Considerations	Demand for smaller warehouses is soaring with e-commerce and faster delivery in urbanized areas. Rents for warehouses in between 70,000 and 120,000 square feet rose more than 33.7 percent in five years across the United States. Businesses have been adding smaller fulfillment and distribution center locations that put inventory closer to customers to have items delivered in two days or less. Regarding innovative truck technology such as platooning, like CAV, there are a series of hurdles to overcome before it may be fully adopted in places. According to the American Transportation Research, one of the largest barriers to innovative trucking technology in the United States is the patchwork of truck self driving laws among states. The Federal Autonomous Vehicle Policy USDOT has developed includes no rules or regulations - only guidance for states.
What We Know with Higher Certainty	Truck Automation and Platooning - Commercial Level 1 truck platooning (longitudinal control only where a driver steers the truck) is approved in 27 states, including Utah. Change in Distribution methods - Already occurring, see above on impacts to land use. Last Mile/Delivery Concerns - Bikes/Drones/3rd Party/Micro-Hubs - 3rd party delivery is already occurring, bike delivery is already occurring in some parts of the country. Micro-hubs or micro depots occurring in many places: 1. The City of Chicago converted a floor of a downtown municipal parking garage into a fulfillment center allowing for deliveries to be accomplished by bicycle and foot. 2. Singapore and several European cities have established Delivery Micro-Hubs which are consolidation centers with a smaller footprint where goods are delivered from warehouses and distribution centers via truck and picked up by the customer or delivered by cargo bike or bicycle to their destination. 3. City Council of Paris, France invited developers to create central city logistics centers (five of which are operational) and mandated that 50 percent of final-kilometer deliveries be carried out by non-diesel vehicles by 2017, followed by the total phase-out of diesel-fueled deliveries by 2020.
What We Know with Lower Certainty	Truck Automation and Platooning - Most truck operators and fleet managers feel that platooning technology is highly developed, but it will still take time to implement into real-world operation. Technological improvements needed include on-board technologies such as LIDAR and on-board human machine systems. Large fleet managers do not predict widespread adoption before 2028–2030. Ongoing studies surrounding how other road users would respond to a "wall of trucks" on freeways, spacing of trucks, and regular vehicles merging in between, ahead of, or behind platoon trucks. Last Mile/Delivery Concerns - Bikes/Drones/3rd Party/Micro-Hub Less certainty exists on how much TNCs and contractors play in the role of last mile distribution and freight delivery. Many companies hire out for this.

COVID-19 Resiliency	The Cybersecurity and Infrastructure Security Agency identified transportation and logistics workers as essential during the coronavirus crisis. Demand for freight has increased during the pandemic, even spotlighted the importance of trucking and freight movement during this time frame.
Sources	Marshall, Aarian. "As Covid-19 Spreads, Truckers Need to Keep Trucking" Wired Magazine. March 20, 2020. https://www.wired.com/story/covid-19-spreads-truckers-keep-trucking/ American Trucking Association. https://www.trucking.org/COVID19 New York State Department of Transportation. "Truck Platooning Policy Barriers Study". 2018. https://www.dot.ny.gov/divisions/engineering/technical-services/trans-r-and-d-repository/C-15-10%2520Final%2520Report_7-2018.pdf Dopart, Kevin. "USDOT Research in Truck Platooning." Transportation Research Board Session 1468. January 15, 2019. https://www.its.dot.gov/presentations/trb_2019/Session_1468_dopart_public.pdf

HIGH-TECH TRANSIT SYSTEMS

Description	High-tech transit systems utilize technology within their fleet and/or on the roadway systems they operate. The scope of an Intelligent Transportation System (ITS) covers traffic and mobility management, managing movement of vehicles and assisting drivers, enhancing transport infrastructure, and providing improved interfaces for transport systems.
Key Findings	Signal priority research has shown that this strategy optimizes schedule adherence, and therefore waiting time. Passenger counters allow for real-time crowdedness on transit. Evaluating Transit Signal Priority (TSP) implementation for bus along major arterials found that travel time was reduced more than 40 percent in some cases - which can be translated into faster arrival time, lower transit delay, and more reliable transit service. Studies have found that TSP has minimal effect on the general traffic. Travel Advisory Systems (TAS) is used to inform transportation updates to the traveling user. The system has the capabilities to deliver real-time information like travel time, travel speed, delay, accidents on roads, change in route, diversions, workzone condition, etc. This provides safety and comfort to citizens and easy maintenance and surveillance for city administration. Positive Train Control (PTC) improves safety by preventing any train to train collisions, speeding derailments, and trains routed the wrong way on tracks due to switches being left in the wrong position. This technology offers back office systems and communication alongside onboard hardware equipment that is associated with the PTC system in place. Autonomous shuttles/buses are beneficial in providing more frequent and regular services, provide first/last mile solutions, optimization of paratransit services, reduction in operating costs and human error, and could help aid driver shortages

	to increase reliability. Autonomous shuttles/buses can impact walking and biking due to the changes in infrastructure.
Key Considerations	Software system security, especially for self-driving systems should be considered when implementing autonomous shuttles/buses to ensure hacking issues are mitigated to keep passengers safe. It will be important to consider barriers for the visually impaired and those who need assistance boarding and exiting an autonomous transit vehicle. Important to consider how high-tech transit is influenced by ever evolving transportation apps. When deploying an autonomous fleet, it will be important to consider the impacts to walking and biking infrastructure.
What We Know with Higher Certainty	ITS systems are developing and becoming more commonplace. Autonomous shuttles/buses technology is emerging rapidly and it is something to anticipate integrating within our transportation systems.These systems are already being implemented in projects throughout the Wasatch Front region.
What We Know with Lower Certainty	User trust of autonomous shuttles/buses for future use. General trend so far states that people are willing to use autonomous buses, but the majority of that population has been younger.
COVID-19 Resiliency	Passenger counters providing real-time crowdedness on transit vehicles has the potential to ease riders anxieties when transitioning back to riding public transit.
Sources	Botello, Bryan, et al. "Planning for Walking and Cycling in an Autonomous-Vehicle Future." 2019. https://www.sciencedirect.com/science/article/pii/S2590198219300120#s0020 FTA. "Transit Bus Automation FTA Quarterly Update." 2019. https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/148191/transit-bus-automation-update-december-2019_0.pdf FTA. "Signal Priority." 2015. https://www.transit.dot.gov/research-innovation/signal-priority FTA, USDOT. "Transit Signal Priority Research Tools." 2008. https://nacto.org/docs/usdg/transit_signal_priority_research_tools_caltrans.pdf Quarles, Neil, et all. "Costs and Benefits of Electrifying and Automating U.S. Bus Fleets." 2020. https://www.caee.utexas.edu/prof/kockelman/public_html/TRB18AeBus.pdf Shaaban, Khaled, et al. "Evaluation of Transit Signal Priority Implementation for Bus Transit along a Major Arterial Using Microsimulation." 2018. https://www.sciencedirect.com/science/article/pii/S187705091830365X USDOT. "How ITS has Improved our Quality of Life." https://www.its.dot.gov/resources/fastfacts.htm Wang, Yinhai, et all. "Comprehensive Evaluation of Transit Signal Priority System Impacts Using Field Observed Traffic Data." 2008. https://www.wsdot.wa.gov/research/reports/fullreports/699.1.pdf

INTERNET SHOPPING

Description	Internet shopping and e-commerce is the ability to purchase goods and services through the internet.
Key Findings	Internet shopping and e-commerce represents a growing share of the retail market and most commonly associated with online shopping of retail products - including clothing, consumer electronics/technology, furniture, computer equipment and beauty products. In addition, delivery of groceries and other food items via e-commerce are growing. According to a Gallup study, just 11.0 percent of consumers said they buy groceries online—for pickup or home delivery—at least once per month, up from 9.0 percent in 2017. In 2019, 4.0 percent of consumers say they buy groceries online at least once per week, unchanged from 2017. Consumer expectations for how fast shipments are delivered have changed drastically with the advent of free shipping. According to the US Census Bureau, total e-commerce sales for 2019 were estimated at $601.7 billion, an increase of approximately 14.9 percent from 2018. E-commerce sales in 2019 accounted for 11.0 percent of total retail sales.
Key Considerations	Communities should consider the implications for land use regulation. Communities and the state also need to further assess implications for local revenue and taxation as well as infrastructure funding. Average mall vacancy rate has reached an eight-year high at 9.4 percent. Retailers in 2019 closed nearly 7,300 stores. Regional malls are doing worse compared to strip-style centers as traditional department stores which have anchored larger malls have closed down in the last few years. However, non-traditional tenants, like online-first companies, gyms, churches, and entertainment centers are finding homes in large mall space. Demand for smaller warehouses is soaring with e-commerce and faster delivery in urbanized areas. Rents for warehouses in between 70,000 and 120,000 square feet rose more than 33.7 percent in five years. Businesses have been adding smaller fulfillment and distribution center locations to place inventory closer to customers so items can be delivered in two days or less. This external force is closely linked to the growth of freight. Connected and autonomous vehicles may fuel further growth of e-commerce.
What We Know with Higher Certainty	Online shopping is already a large and growing portion of all U.S. retail sales, which is changing the real-estate footprint and creating less demand for conventional retail. Half of mall-based department stores are projected to close in the next five years. Online shopping has also increased demand for warehousing and distribution footprint in cities. Distribution centers tend to favor suburban and exurban locations. These distribution/fulfillment centers require larger workforces than traditional warehouses would, creating more trips by employees coming from areas with limited transit service options and working multiple shifts.There is

	also a trend in seeing stores shift to operate more like showrooms, small warehouses, and pickup locations (also known as omni-stores). For transportation, e-commerce has and will further result in a significant shift of trips toward freight. For land use, this shift away from retail will reduce demand for brick and mortar shopping and increase demands for warehousing.
What We Know with Lower Certainty	There is less certainty on how much transportation network companies (TNCs) and contractors play in the role of last mile distribution and freight delivery. New operations are changing the way we regulate freight, i.e., hiring contractors, they are not required to be registered as motor carriers (transporting cargo for hire) and consequently, avoid a number of safety and operational requirements and are unlikely able to account for this in travel models.
COVID-19 Resiliency	Internet shopping activity has increased with people placed under stay-at-home directives. According to the Utah Sales Tax Commission report for March, non-store retail (internet) are up 76 percent in the state. Online shopping and telemedicine are helping avoid in-person contact. Additionally, many brick and mortar shops, if they haven't already done so, are rapidly moving their business online to continue serving clients. However, this increase in internet sales does not make up for much of the losses in industries in the state. In North America, the number of online orders for web-only online retailers were up 52 percent year over year in the United States and Canada for the 2 weeks of March 22 through April 4, according to an online tracker. More people are also ordering from grocery stores online as a result of the pandemic. Downloads of Instacart, Walmart's grocery app, and Shipt increased 218 percent, 160 percent, and 124 percent respectively on March 15 compared to the year prior. According to the Utah Department of Workforce Services, the entertainment, food services, and retail trade sectors were among the hardest hit by Coronavirus. Coronavirus has caused a shock to physical retail that will likely continue. There may be fewer brick and mortar retail, and increased pressure for retail to evolve to more automation, less use of cash, and more options for curbside pickup and fast delivery.
Sources	City of Portland. Freight Master Plan Update: E-Commerce and Emerging Technologies Research Report. December 2019. https://www.portlandoregon.gov/tRANSPORTATION/article/751002 Hatte, Julian. KUTV Channel 2 News. "Utah Legislature passes requirement for online sales tax" July 19, 2018. https://kutv.com/news/local/utah-legislature-passes-requirement-for-online-sales-tax Howland, Daphne. "Mall Vacancy Rate at 8-year High". October 3, 2019. https://www.retaildive.com/news/mall-vacancy-rate-at-8-year-high/564296/ Melton, James. "Online Buying Soars as Coronavirus Spreads WorldWide". April 8, 2020. https://www.digitalcommerce360.com/article/coronavirus-impact-online-retail/ Nielsen Group. "Concerns About Covid-19 Push US E-Commerce Boundaries". April 7, 2020. https://www.nielsen.com/us/en/insights/article/2020/concerns-about-covid-1

9-push-u-s-e-commerce-boundaries/
Smith, Jennifer. Wall Street Journal. “E-Commerce Driving Bigger Demand for Smaller Warehouses, CBRE Says”. October 10, 2019. https://www.wsj.com/articles/e-commerce-driving-bigger-demand-for-smaller-warehouses-cbre-says-11570701600
Thomspon, Alyse. “How Consumers are Shopping Online During the COVID-19 Pandemic”. April 8, 2020.
https://www.candyindustry.com/blogs/14-candy-industry-blog/post/89068-how-consumers-are-shopping-online-during-the-covid-19-pandemic
Transportation Policy Research Center. "How will E-Commerce Growth Impact Our Transportation Network?" Texas A&M Transportation Institute. 2017. https://static.tti.tamu.edu/tti.tamu.edu/documents/PRC-17-79-F.pdf
US Census Bureau. Quarterly Retail E-Commerce Sales, 2019. https://www.census.gov/retail/mrts/www/data/pdf/ec_current.pdf
Young, Jessica. “US E-Commerce Grows by 14.9 percent in 2019”. February 19, 2020. https://www.digitalcommerce360.com/article/us-ecommerce-sales/

INTER-REGIONAL HIGH-SPEED TRANSIT

Description	Defined broadly as the transportation of passengers and/or freight through multiple states or MPO areas, usually being trips between 100 to 500 miles, reaching speeds up to 220mph.
Key Findings	Has the capability to create major connections to different regions, contribute to economic development, and create jobs. Majority of findings concluded that it is fast, reliable, and a comfortable means of transporting large numbers of travelers; stimulated the economy in the short term by creating construction jobs and helping drive demand for construction materials. Japan’s high-speed rail system was implemented in 1964. They have a network of nine high-speed rail lines. This service carries more than 420,000 passengers on an average weekday. These trains travel up to 200mph. Europe implemented high-speed transit in France in 1981. From there it dispersed across Europe, with many lines cross-border with international links. Many of the European rail lines were built to match those in France with speeds up to 220mph. China has had high-speed rail develop rapidly and extensively in the past 17 years. China’s trains are able to travel up to 217mph. China has found that high-speed transit has the capability to stimulate the economy, facilitate cross-city economic integration, and provides fast, reliable, and comfortable means of transportation. Cost of infrastructure was found to be quite significant.
Key Considerations	Has a high ability to move people and goods. Due to size and complexity that comes with high-speed inter-regional travel, planning will have to begin years, if not decades, before implementation. Cities along the eastern coast of the U.S.

	and large metro areas on the west coast would most likely see high-speed inter-regional rail before Utah and the Wasatch Front. Longer distance railways in the United States are majorly owned by freight companies, which forces the passenger rail lines to yield priority to freight trains, impacting travel times for passengers.
What We Know with Higher Certainty	The United States is lacking with high speed rail infrastructure, which can be attributed to a few points of note. One being lower population density compared to that of Europe and Asia, which decreases the economic viability.
What We Know with Lower Certainty	When this will become a viable option for Utah. What ridership demand is there for passenger high-speed transit to move inter-regionally.
COVID-19 Resiliency	Transit in general is largely being impacted by COVID19. There are anxieties in the short term that come from gathering in places with large volumes of people. Inter-regional travel has slowed due to Stay Safe Stay Home orders.
Sources	Caltrans. "Interregional Transportation Strategic Plan - Status Update." 2013. https://www.fresno.gov/publicworks/wp-content/uploads/sites/17/2017/10/14-CA-DOT-Interregional-Transportation-Strategic-Plan.pdf EESI. "Fact Sheet: High Speed Rail Development Worldwide." 2018. https://www.eesi.org/papers/view/fact-sheet-high-speed-rail-development-worldwide Menzies, Thomas R. "Interregional Travel - A New Perspective for Policy Making." 2016. http://onlinepubs.trb.org/Onlinepubs/trnews/trnews303sr320.pdf Rasmussen, Ben, et al. "ACtional Strategy paper" Inter-Regional Transportation Planning." 2009. https://www.cmap.illinois.gov/documents/10180/57301/Inter-Regional.pdf/ba3ed67f-b9c5-4acf-bbf1-db9b0f0e6569

NEW MICRO-MOBILITY ADOPTION

Description	Micro-mobility trips continue to increase across both docked and dockless systems, especially with improving electric motor technology for bikes and scooters. Increased use has potential for congestion easing, pollution reductions, repurposing of parking.
Key Findings	E-scooters gained 3.6 percent market share in 2018 alone. In shared bike systems, e-bikes are used three times more than traditional pedal bikes. Potential to replace car trips under five miles. Energy use for charging 5 million e-scooters is 80 to 90 percent less than energy used by equivalent cars. In 2018, e-scooter trips were 38.5 million, and 36.5 million bikeshare trips. One study predicts an 8 to 15 percent market take for trips under five miles. Reports show 23 to 40 percent of micro-mobility trips are replacing vehicle trips.
Key Considerations	Cities need improved regulatory framework and improved infrastructure to encourage trips. Also, there may need to be some type of public subsidy to make private company services a permanent part of a city's mobility landscape. Which

	service providers will come out on top of the pack? Curb management is a crucial component to success of micro-mobility. Safety of e-bike and e-scooter use is a concern to many. Just like with pedestrian infrastructure, maintenance of micro-mobility infrastructure for things like snow removal and gravel sweeping, needs to be invested in.
What We Know with Higher Certainty	Huge potential of devices to provide a first/last mile connection to transit and replace vehicle trips under five miles; leads to reduced parking demand. Dense urban cores are best served. Existing trips are replacing some vehicle trips, but not all. Bikeshare trips tend to be during commute peak hours while e-scooter trips peak on weekends. Potential to service vulnerable communities. Increase in micro-mobility use lessens the need for private vehicle parking.
What We Know with Lower Certainty	Which companies will be around in the next five years and what cities will they be operating in? Will access to these devices reduce car ownership? Short time frame of these devices being in the market with huge influxes of private investment doesn't tell us if the scooter industry will ever be profitable. How will municipal regulation impact use of micro-mobility? Will cities invest in more protected infrastructure?
COVID-19 Resiliency	Many micro-mobility companies have shut down during the pandemic. bikeshare is an exception in larger cities like Chicago and New York. These systems have offered free one-month memberships to health care workers as an option to avoid social distancing struggles on transit. Bike services have been deemed essential services in many cities and e-scooters in some. Renewed emphasis on deep cleaning of devices will probably be a focus for months after the pandemic has slowed. Biking trips are up during the pandemic. One opinion article believes that e-scooter companies will need loosened fees from cities and possibly even subsidies, like bikeshare, to come out of the pandemic. Micro-mobility can plan a role in filling transit gaps due to decreased service and capped ridership.
Sources	DuPuis, Nicole, Jason Greiss, Connor Klein. 2019. "Micromobility in Cities: A History and Policy Overview." https://www.nlc.org/sites/default/files/2019-04/CSAR_MicromobilityReport_FINAL.pdf Fong, James, Maria Lucchi, Paul McDermott. 2019. "Micro-Mobility, E-scooters, and Implications for Higher Education." https://upcea.edu/wp-content/uploads/2019/05/UPCEA_Micro_Mobility-White-Paper-May-2019.pdf Heineke, Kersten, Benedict Kloss, Darius Scurtu, Forian Weig. 2019. "Micromobililty's 15,000 mile checkup." https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/micromobilitys-15000-mile-checkup Kelman, Ben, Derek M. Pankratz, Rasheq Zarif. 2019. "Small is Beautiful: Making micro-mobility work for citizens, cities, and service providers." *Deloitte Insights*, April 15, 2019. https://www2.deloitte.com/us/en/insights/focus/future-of-mobility/micro-mobility-is-the-future-of-urban-transportation.html?id=us:2ps:3gl:confidence:eng:

cons:42319:nonem:na:nhRV7UOl:1149484916:344865936403:b:Future_of_Mobility:Micromobility_BMM:nb
Lime. 2019. "Year-End Report 2018." https://www.li.me/hubfs/Lime_Year-End%20Report_2018.pdf
MIT Energy Initiative. 2019. "Insights into Future Mobility." Cambridge, MA: MIT Energy Initiative. http://energy.mit.edu/insightsintofuturemobility
National Association of City Transportation Officials. 2019. "Shared Micromobility in the U.S.: 2018." https://nacto.org/wp-content/uploads/2019/04/NACTO_Shared-Micromobility-in-2018_Web.pdf
Populus Research. 2018. "The Micromobility Revolution: The introduction and adoption of electric scooters in the United States" https://research.populus.ai/reports/Populus_MicroMobility_2018_Jul.pdf
Westervelt, Marla, David Zipper. 2020. "Anyone Feel Like Saving Electric Scooters?" https://www.citylab.com/perspective/2020/04/electric-scooters-coronavirus-bird-lime-bikesharing/610060/

ON-DEMAND TRAVEL AND SHARING SERVICES (TNC)

Description	The use of technology in the form of a mobile application that enables users to call/secure individual and carpool rides.
Key Findings	Currently there are about 400 cities with carsharing, 400 cities with bike sharing, and 600 cities with TNCs. Mobility as a service allows users to order, track, travel, and pay for transportation. Some studies have found a decrease in parking demand. One study found that Uber was a compliment for the average transit agency, increasing ridership by five percent after two years. Another study conducted using a longitudinal analysis using monthly transit ridership data from the National Transit Database for 22 transit agencies and four modes (commuter rail, heavy rail, light rail, and motor bus) found that bikeshares introduced into cities was associated with increased light and heavy rail ridership, but with a 1.8 percent decrease in bus ridership. New York City found that for each additional 1000 bikeshare docks proximate to a bus route are associated with a 1.7 to 2.4 percent decrease in bus ridership. Each year after TNCs enter a market, heavy rail ridership can be expected to decrease 1.3 percent and bus ridership can be expected to decrease by 1.7 percent. A 2017 report found that completely private TNC's have the potential to induce more trips, greater vehicle miles traveled, and less use of public transit. Another 2017 report found that TNC's generated net increases of 31 million trips and 52 million passengers since 2013 in New York City, and that TNCs accounted for an increase in VMT of 600 million miles in three years. "Supersharers" are people who use shared modes to complete trips routinely. They have been found to save the most money and have also been found to own half as many cars as people who rely solely on public transit.
Key Considerations	Integrating carsharing, bikesharing, and ridesourcing with transit will provide the most mobility options to users. Furthermore, having all of these options aggregated on one app eases user experience frustrations.

	While on-demand and TNCs have been found to decrease public transit ridership, other cases have been found to compliment it. It seems to depend on what current transportation systems are in place, and what accessibility looks like in certain areas. Where and how will on demand travel affect automobile ownership. Automobile ownership may determine the extent to which carsharing, bikesharing, and transit complement TNCs (lack of auto ownership is anticipated to increase the use of a variety of on-demand modes/resources). Utah specifically - Uber and Lyft now command 70 percent of SLC airport commercial rides. Uber and Lyft will have 510 feet of curb space at the new airport, compared to just 90 feet for taxi stands, 360 feet for resort shuttles and limo companies for pick and drop offs. This has impacts on curbside management. TNC regulations vary from state to state.
What We Know with Higher Certainty	These technologies are here and they are impacting transportation and transportation mode choices.
What We Know with Lower Certainty	Uber/Lyft current stats in Utah and how these companies are impacting other mode choices. Long-term feasibility and how long these services will be able to stick around due to heavy venture capital subsidies.
COVID-19 Resiliency	Ridership in Ubers/Lyfts has fallen since COVID19, with some cities seeing a decrease of 70 percent in rides requested.
Sources	APTA. "Shared Mobility and the Transportation of Public Transit." 2016. https://www.eesi.org/files/APTA-Shared-Mobility.pdf Alonso-More, Javier, et al. "On-Demand High-Capacity Ride-Sharing via Dynamic Trip-Vehicle Assignment." 2017. https://www.pnas.org/content/114/3/462 Davidson, Lee, Salt Lake Tribune. "Uber and Lyft now command 70% of SLC airport commercial rides. The new airport will reflect their dominance." 2019. https://www.sltrib.com/news/politics/2020/02/19/uber-lyft-now-command/ D. Hall, Jonathan. "Is Uber a Substitute or Complement for Public Transit?" 2018. https://www.sciencedirect.com/science/article/abs/pii/S0094119018300731 Graehler, Michael Jr. "Understanding the Recent Transit Ridership Decline in Major US Cities: Service Cuts or Emerging Modes?" 2018. https://usa.streetsblog.org/wp-content/uploads/sites/5/2019/01/19-04931-Transit-Trends.pdf Gururaja, Prashanth. "MOD Sandbox Workshop: Discoverability of On-Demand Services in Trip-Planning Apps." 2018 https://sharedusemobilitycenter.org/mod-sandbox-workshop-discoverability-of-on-demand-services-in-trip-planning-apps/ Henao, Alejandro. "Impacts of Ridesourcing - Lyft and Uber - On Transportation Including VMT, Mode Replacement, Parking, and Travel Behavior.'" 2017. http://digital.auraria.edu/content/AA/00/00/60/55/00001/Henao_ucdenver_0765D_10823.pdf Li, Ziru. "An Empirical Analysis of On-Demand Ride-Sharing and Traffic Congestion." 2017. https://scholarspace.manoa.hawaii.edu/bitstream/10125/41152/1/paper0003

.pdf
Qian, Xinwu, et al. "Impact of Transportation Network Companies on Urban Congestion: Evidence from Large Scale Trajectory Data." 2020 https://reader.elsevier.com/reader/sd/pii/S2210670720300408?token=513ED35FE745AE6321741FB424AE17C4CB472FE19C5F41F3DDB3D9CCA8F8A4E6EFBE6412AE6A4CD6B002912664FABF55
Schaller Consulting. "The New Automobility: Lyft, Uber, and the Future of American Cities." 2018 http://www.schallerconsult.com/rideservices/automobility.pdf
Shared-Use Mobility Center. "When Uber Replaces the Bus: Learning from the Pinellas SUncoast Transit Authority's Direct Connect Pilot." https://learn.sharedusemobilitycenter.org/overview/direct-connect-what-the-first-transit-tnc-partnership-can-teach-us-pinellas-county-fl-2019/
Shared-Use Mobility Center. "Four Steps Towards Mobility Integration for Public Agencies."https://sharedusemobilitycenter.org/wp-content/uploads/2019/06/05.08.19_PolicyPaper_SUMC.pdf
Shared-Use Mobility Center. "Twin Cities Shared Mobility Action Plan." 2017. https://sharedusemobilitycenter.org/wp-content/uploads/2017/10/SUMC_TWINCITIES_Web_Final.pdf

PASSENGER DRONES/DRONE TAXIS

Description	Reviews the emergence of passenger drone taxis, also known as vertical take off and landing (VTOL) aircraft, and popularly known as "flying cars" or "passenger drones". Passenger drones are autonomous passenger air vehicles (UAV, PAV) or Vertical Take Off and Landing (VTOL) aircraft. Unmanned Aircraft Mobility (UAM) primarily looks at the use of drones to move people. UAM is being enabled by more than 70 manufacturers worldwide including Boeing, Airbus, and Bell. Boeing just did its first flight test in January 2019 of an eVTOL. UAMs would seat one to five people in an aircraft. Cruise at altitudes between 500 feet and 5000 feet. Although UAM Drones are still in development, smaller drones are widely used for many purposes including gathering information or supplying essentials for disaster management, thermal sensors for search and rescue operations, geographic mapping of inaccessible terrain and locations, and law enforcement activities. At the end of May 2019, there were more than 1.39 million registered drones in the U.S. of which 372,000 are registered as commercial drones. There are more than 136,000 certified drone pilots, triple the number in 2017.
Key Findings	5-seat piloted eVTOL will cost $6.25 per mile for passengers. However, higher operational efficiency, autonomy, and technological improvements over time may decrease cost by 60 percent. One fare study indicated for VTOL aircraft to be competitive with automobile technologies, fare must be kept between $1 and $1.25. However, many barriers exist for VTOLs, including psychological barriers related to flying in an unmanned aircraft, regulations for pilotless vehicles, airworthiness certifications, need for a pilot's license, safety concerns, infrastructure including building takeoff and landing zones, parking lots, charging stations, and

	vertifports. Weather also poses significant challenges to UAM operations with low visibility, strong winds, and storms being challenges.
Key Considerations	Sustainability implications and potential benefits of flying cars. One study looked at traveling 100 km (point-to-point) with one pilot in a VTOL resulted in greenhouse gas (GHG) emissions that are 35 percent lower than a one-occupant internal combustion engine vehicle (ICEV) and 28 percent higher than battery electric vehicle (BEV), respectively. When comparing fully loaded VTOLs (three passengers) with ground-based cars with an average occupancy of 1.54 passengers, VTOL GHG emissions per passenger-kilometer are 52 percent lower than internal combustion engine vehicles and six percent lower than electric vehicles.
What We Know with Higher Certainty	Use of passenger drones and drone taxis are likely to appear sooner in more dense urban areas which are mega-regions and where individuals may opt to use passenger drones for more direct travel and to avoid traffic and congestion on roads. The west remains lightly populated except for clearly defined urban regions.
What We Know with Lower Certainty	Lots of safety and regulatory hurdles before VTOLs have any commercial viability. Gaps in path to certification of VTOLs - new standards need to be made and developed for VTOLs. Major barriers include psychological and technical barriers, designing and implementing the required ground infrastructure, drone storage, safety, affordability, and lack of existing policies. Currently, national and local regulatory authorities are addressing regulations related to smaller drones. Widespread use of passenger drones and flying cars is likely decades away. As of 2020 FAA currently has a proposed rule available for public comment that would establish requirements for the remote identification of aircraft systems.
COVID-19 Resiliency	Not VTOLs but drones are being used by police departments and local governments to enforce social distancing by capturing film and playing messages to remind people to adhere to social distancing. Drones are also being used during the pandemic to help spray disinfectant in public areas. Drones and robots are also being used for deliveries to reduce cross-infection by implementing home delivery of drugs and meals via robot. The existing use of drones now in addition to CAV may shape public acceptance and use of VTOLs.
Sources	Deloitte Insights "Elevating the Future and Mobility: Passenger Drones and Flying Cars". https://www2.deloitte.com/content/dam/Deloitte/nl/Documents/consumer-business/deloitte-nl-cip-elevating-the-future-of-mobility.pdf Kasliwal, Ashkat et al. Nature Communications."The Role of Flying Cars in Sustainable Mobility". 2019. https://www.nature.com/articles/s41467-019-09426-0 Marr, Bernard. “Robots and Drones are Now Used to Fight COVID-19”. Forbes Magazine. March 18, 2030.

	https://www.forbes.com/sites/bernardmarr/2020/03/18/how-robots-and-drones-are-helping-to-fight-coronavirus/#56f2d79c2a12 Remarks Prepared for Delivery by U.S. Secretary of Transportation Elaine L. Chao at Uber Elevate Symposium. June 11, 2019. https://www.transportation.gov/briefing-room/uber-elevate-symposium NASA Briefing. "Urban Air Mobility (UAM) Market Study." October 5, 2020. https://www.nasa.gov/sites/default/files/atoms/files/bah_uam_executive_briefing_181005_tagged.pdf Raymond, Adam K. "Social Distancing Enforcement Drones Arrive in the U.S." New York Magazine. April 8, 2020. https://nymag.com/intelligencer/2020/04/social-distancing-enforcement-drones-arrive-in-the-u-s.html Yedavalli, Pavan and Jessie Mooseberry. "An Assessment of Public Perception of Urban Air Mobility (UAM)." Airbus UTM. 2019. https://www.semanticscholar.org/paper/An-Assessment-of-Public-Perception-of-Urban-Air-Yedavalli/f4641304ae7082a61d9cd82905917ce694a120c4

TELECOMMUTING

Description	Telecommuters partially or entirely replace their out-of-home work activities by working at home or at locations close to home, thus reducing the potential for network congestion and vehicular emissions, specifically during rush hours.
Key Findings	There is a significant opportunity during the COVID19 recovery to affect long-term adoption of telecommuting. Although telecommuting is heralded for its ability to reduce VMT and congestion, the literature shows modest benefits to VMT of essentially no change to a two percent reduction in VMT. This could be due to employees moving farther away from their workplaces because they have the ability to part-time telecommuting, resulting in an increase in weekly commute VMT and/or it could be attributed to teleworkers making more off-peak trips. However, telecommuting as a travel-demand management (TDM) technique has lower costs and a shorter implementation timeline than many other TDM approaches. Employment areas with higher concentrations of employees tend to have higher rates of telecommuting than employment areas with fewer employees.
Key Considerations	Types of telecommuting - full-term vs. non-daily; adoption differences by socio-economic status, job sector; effects of telecommuting on land use patterns and housing affordability.
What We Know with Higher Certainty	Before COVID19, telecommuting was slowly increasing throughout the nation. However, the U.S. is undergoing an unparalleled experiment in telecommuting in the midst of COVID19, the long-term effects of which are unknown. For telecommuting to be a realistic option for employees, high-speed telecom infrastructure systems may need to be more available and affordable.
What We Know with Lower Certainty	The actual extent to which telecommuting can improve congestion and emissions. Many researchers have shown a rebound effect of telecommuters - they make more trips than they would if they commuted to the workplace. In addition, there is

	evidence that shows teleworking may increase the willingness to accept a longer commute, and may induce urban sprawl. Telecommuting adoption rates differ by job sectors and it is unclear how this might evolve over the long-term. Added to these uncertainties is how recent events will influence long-term telecommuting adoption. The impacts of telecommuting on both travel demand and network operation are still inconclusive and there is substantial need for more empirical evidence on this issue. It can be difficult to quantify how many employees are actually working from home as Census data related to work-from-home includes both telecommuters and home-based businesses and the Census generally asks about typical work commutes, missing those who telecommute only one or two days a week.
COVID-19 Resiliency	Global Workplace Analytics forecasts that 25 to 30 percent of the workforce may work at home on multiple-days-a-week basis within the next two years, accelerated by the coronavirus pandemic. Companies and individuals have been forced to overcome telework challenges and are more comfortable with it and employees will demand more opportunities to work remotely.
Sources	Choo, Sangho, Patricia L Mokhtarian, and Ilan Salomon. "Does Telecommuting Reduce Vehicle-Miles Traveled? An Aggregate Time Series Analysis for the US." Transportation 32 (1), 2005, 37–64. De Vos, Duco and Evert Meijers. "Working from Home and Commuting: Heterogeneity over Time, Space, adn Occupations." IZA Institute of Labor Economics, Discussion Paper Series, No. 12578, August 2019. Flex Jobs and Global Analytics. "2017 State of Telecommuting in the U.S. Employee Workforce." https://globalworkplaceanalytics.com/telecommuting-statistics Global Analytics. "Work-At-Home After Covid-19 - Our Forecast." Accessed April 19, 2020. https://globalworkplaceanalytics.com/work-at-home-after-covid-19-our-forecast Lachapelle, Ugo, Georges Tanguay,; and Lea Neumark-Gaudet. "Telecommuting and sustainable travel: Reduction of overall travel time, increases in non-motorised travel and congestion relief?" Urban Studies, Urban Studies Journal Limited, vol. 55(10), pages 2226-2244, August. Levinson, David, Jason Cao, Yingling Fan, Michael Iacono, and Greg Lindsey. "Travel Behavior Over Time." Report Number MnDOT 2015-23, June 2015. http://www.cts.umn.edu/Publications/ResearchReports/reportdetail.html?id=2460 Maciag, Michael. "What Does Telecommuting's Rise Mean for Traffic and Transit?" https://www.governing.com/topics/transportation-infrastructure/gov-telecommuting-impact-transportation.html. Published October 30, 2017. Ravalet, Emmanuel and Patrick Rerat. "Teleworking: Decreasing Mobility or Increasing Tolerance of Commuting Distances?" Built Environment 45(4):582-602. November 2019. Shabanpour, R., Golshani, N., Tayarani, M., Auld, J., & Mohammadian, A.. Analysis of Telecommuting and Impacts on Travel Demand and the Environment. Transportation Research Part D: Transport and Environment, 62, 563-576. 2018. Utah Foundation. "Work Away from Work: The Challenges and Promise of Teleworking." 2020. http://www.utahfoundation.org/reports/work-away-from-work-the-challenges-and-promise-of-teleworking/?mc_cid=533ac5f8dd&mc_eid=e18605838f

POTENTIAL POLICY RESPONSES

APP DEVELOPMENT

Description	A tech service on smart phones that allows users to plot out, order, share, and pay for a wide variety of transit/transportation options.
Key Findings	Research generally found that the use of multi-modal apps yielded travel that was less energy intensive and more supportive of public transportation by offering real time information. From survey respondents from case studies, one survey found 56% reported users increasing their bus use, 43% increasing their rail use, and improved customer experience from the ability to pay on the app and create quick and easy boarding of service. Another case study survey reported that nearly 40% of users were driving less as a direct result of these applications. The smartphone and multimodal aggregators allow for entire trip planning from start to finish, which helps aid first/last mile considerations. Real time bus sharing technology on apps was found to increase weekday ridership in Chicago. Bikeshare users reported a 40% decrease in driving, reduced driving miles, and even some instances of reported selling of personal vehicles due to options provided by apps. Transportation apps began by operating with only their system, as time has gone on and technology has evolved, these transportation apps are integrating with one another to provide options to users. Currently, the Transit app has real-time crowding information available in certain cities that have passenger count technologies in their fleets. This allows users to see if a bus is empty, has standing room only, or the bus is full.
Key Considerations	Use of these transportation apps has the potential to reduce travel time, cost, and vehicle emissions. Transportation apps impact travel by providing options to people, letting them know the most efficient route. Digital ticketing/payment expedites the boarding processes and reduces the need to have exact cash on hand. It will be important for transportation agencies to consider how they can integrate their transit networks into these applications, utilizing them as a tool. How can transportation agencies in Utah plan for and work with emerging transportation applications? Not everyone has access to a smart phone with these application technologies. How can we bridge the gap in equity?
Pros/Cons	*Pros:* Users have a multitude of transportation options at the palm of their hand. Users can order, track, share, and pay for a variety of modes to complete their trip. Has the ability to reduce driving trips.

	Cons: Not everyone has access to a phone. Currently, not all transportation modes are aggregated in one app, which can cause confusion for users.
Barriers to Implementation	Potential barriers can include challenges with open source data sharing, access to a phone with application capabilities, integration of different mode applications into one.
Applicability to External Forces	App development can be applied as a potential response to growing alternate mobility options like on-demand and sharing services (TNC) and shared micro-mobility. There is the potential for app development to connect to parking modernization and freight delivery.
Sources	Dutzik, TOny, et al. "A New Way to Go - The Transportation Apps and Vehicle-Sharing Tools that are Giving More Americans the Freedom to Drive Less." 2013. https://uspirg.org/sites/pirg/files/reports/A%20New%20Way%20to%20Go%20vUS1.pdf Regional Transportation District. "Uber Collaboration." https://www.rtd-denver.com/projects/uber-collaboration USDOT, "Smartphone Applications to Influence Travel Choices: Practices and Policies," https://ops.fhwa.dot.gov/publications/fhwahop16023/ch4.htm Shaheen, Susan, et al. "A Review of Smartphone Apps and a Study of User Response to Multimodal Traveler Information." 2016. http://innovativemobility.org/wp-content/uploads/MobileApps_UCCONNECT.pdf Siuhi, Saidi, et al. "Opportunities and Challenges of Smart Mobile Applications in Transportation." 2016. https://reader.elsevier.com/reader/sd/pii/S2095756416302690?token=85DBEA271404ABFB0C04758E52F9D2091F0A2355FEC46FBFC0D9A0DE9D2052BCE72D543F4A4A783FEC5D7E622A090244

CONGESTION PRICING

Description	Tolling to enter a cordoned area within a city. Does not include traditional toll lanes and roads.
Key Findings	Congestion pricing based on time of day could reduce peak-hour travel time by as much as 25%.
Key Considerations	To address the potential unfairness of pricing auto travel without alternative options, robust transit and active transportation networks should be in place to offer travel options. In general, the public tends to be largely against congestion pricing before they are implemented, but a majority of the public are supportive of efforts after congestion pricing schemes are implemented. Congestion pricing could be paired with a road usage charge system to reduce the amount of capital investment but easily collect congestion tolling.
Pros/Cons	Congestion pricing is effective at reducing traffic congestion and increasing auto

	throughput. It can also increase transit ridership. Reduced congestion tends to dramatically improve safety, and reduce emissions. Congestion pricing implementation should be supported with a robust transit network. Support of congestion pricing tends to increase after programs begin because the value of saved time and the reliability of travel outweigh the direct prices paid.
Barriers to Implementation	There has yet to be a congestion pricing program implemented in the U.S. (New York City's starts in 2021), so it is unknown if the successes of programs abroad will be seen in the U.S. Further, it is unknown if American cities outside of NYC have the political will to adopt congestion pricing policies. Other factors needing more attention include how to set an appropriate congestion price and what level of investment in transit is needed to support these programs.
Applicability to External Forces	COVID19, by disrupting normal activities, can provide an opportunity for experimentation of pricing strategies. Changes to mobility like CAV may require or benefit from changes to infrastructure. At the same time those changes are put in place it presents an opening to simultaneously introduce pricing mechanisms.
Sources	Croci, Edorado. "Urban road pricing: a comparative study on the experiences of London, Stockholm and Milan." Transportation Research Procedia 14 (2016) 253–262. Domonoske, Camila. "City Dwellers Don't Like the Idea of Congestion Pricing - but They Get Over It." National Public Radio, All Things Considered. May 7, 2019. Accessed online: https://www.npr.org/2019/05/07/720805841/city-dwellers-dont-like-the-idea-of-congestion-pricing-but-they-get-over-it Macdonald, Gregor. "How a Highway Widening In This City Could Lead to Congestion Pricing." Route Fifty. April 3, 2019. Accessed online: https://www.routefifty.com/infrastructure/2019/04/interstate-widening-congestion-pricing-portland/156034/ United States Government Accountability Office. "Traffic Congestion: Road Pricing Can Help Reduce Congestion, but Equity Concerns May Grow." Report to the Subcommittee on Transportation, Housing, and Urban Development and Related Agencies, Committee on Appropriations, House of Representatives. January 2010. Accessed online: https://www.gao.gov/assets/590/587833.pdf

CURBSIDE MANAGEMENT

Description	Demand for curb space, especially in dense urban cores, is increasing. The rise of transportation network companies, micro-mobility devices and stations, and personal delivery services are joining existing demand for space by pedestrians, drivers, bicycle infrastructure, transit service, etc. Managing curbsides differently will be crucial due to burgeoning demand. Curbside management may be used to help local governments affect mode decisions and obtain revenue that helps address street maintenance and operations.
Key Findings	It is becoming increasingly untenable to allocate the majority of curb space to the parking of private vehicles. To bring value to occupants of a city, the curb has to be managed dynamically, re-allocating space depending on demand throughout the day. Better curb management has the potential to reduce illegal

	parking that increases congestion and delay, as well as the potential to increase transit reliability and accessibility. Failure to better regulate the curb will result in more congestion, delay, and safety concerns among users.
Key Considerations	Revenue loss from parking fees and tickets, options for replacing revenue loss through curb-side management techniques; data gathering and management, aka "curb coding"; real-time information sharing; political desire for change; enforcement; and infrastructure costs. Coordination between multiple city departments, transit agencies, private mobility/delivery companies, and adjacent land uses/owners is essential.
Pros/Cons	*Pros:* Demand for curb space will continue to increase as new mobility options and private package delivery services increase their offerings. This demand will mostly be in dense, urban cores. Proper curb management increases efficiency of space compared to only having private automobile parking, can decrease congestion, and increase safety for all users. *Cons:* New fee structures will require digital infrastructure, data standards, regulatory language, and compliance regimes that are not yet developed. As people transition to new mobility options and demand for curb space increases, there will most likely be increased congestion until cities develop modern regulatory frameworks.
Barriers to Implementation	Knowledge of existing curb space allocation is poor in cities; no managed databases; and city departments lack coordination. City parking revenues may decrease as curb space is reallocated. Curbside property owners need to be educated on immediate and broader benefits of curbside management.
Applicability to External Forces	Curbside management recognizes changing demand on curb usage from private vehicle parking to freight (internet shopping), micro-mobility parking and lanes, transportation network companies pick-up and drop-off, in addition to business space (cafes, restaurants), and public space (seating, art, utilities).
Sources	Goffman, Ethan. 2018. "How to manage the chaotic 21st century curb." https://mobilitylab.org/2018/06/08/managing-the-chaos-of-the-21st-century-curb/. International Transport Forum. 2018. "The Shared Use City: Managing the Curb." https://www.itf-oecd.org/sites/default/files/docs/shared-use-city-managing-curb_3.pdf. Kite-Powell, Jennifer. 2019. "Are Curbs the Next Frontier in Urban Mobility?" https://www.forbes.com/sites/jenniferhicks/2019/04/29/are-curbs-the-next-frontier-in-urban-mobility/#541657e23339. National Association of City Transportation Officials. 2017. "Curb Appeal: Curbside Management Strategies for Improving Transit Reliability." https://nacto.org/wp-content/uploads/2017/11/NACTO-Curb-Appeal-Curbside-Management.pdf. National Center for Mobility Management. 2018. "Peer Exchange Summary: The Rise of the Curb: Expanding Mobility While Protecting Space (Nashville, TN)." https://www.apta.com/wp-content/uploads/Nashville-September2018-NCMM_Brief.pdf.

FARE-FREE TRANSIT

Description	Fare-free transit is a policy decision to remove the barrier of paying for transit services. This may be done system wide or within designated zones.
Key Findings	Majority of fare-free transit systems found an increase in ridership. Benefits from that increased ridership were reflected in eased traffic congestion, reduced air pollution, and in some cases, revitalization of downtown areas. Small transit systems operated well with fare-free systems, while larger transit systems had more to juggle in terms of crowdedness, repair/maintenance, operating costs, and expansion pressures. Fare-free transit systems remove the payment barrier that has the ability to deter riders, but some studies have shown that riders tend to care more about reliability and frequency of service in the long run. Many case studies saw a significant increase in vandalism of buses and overcrowded systems, which led to a decline in positive user experiences.
Key Considerations	Majority of fare-free transit systems saw an increase in ridership, how can transit agencies hold on to that increase in ridership? Increase in ridership can lessen congestion on roadways improving air quality and travel times. Increased ridership lead to vandalism on buses and overcrowdedness in some cases which led to a decline in ridership experience. How can transit systems absorb an increase in ridership while maintaining user experience, especially for long time users? How can transit agencies absorb loss in farebox revenue?
Pros/Cons	*Pros:* Eliminates the barrier of payment for public transit creating equal access for all. Makes boarding quicker and more efficient. People are more likely to pop on and off transit systems to try them out when they are free. *Cons:* Majority of research found an increase in vandalism and rowdiness, which declined long-term rider experience. Loss of farebox collection revenue.
Barriers to Implementation	Funding - a transit agency may need to absorb loss of fare revenue or have this loss of revenue subsidized from state or local funding sources.
Applicability to External Forces	There is potential for transportation network companies to complement transit with the fare-free system in place.
Sources	S. Perone, Jennifer. "Advantages and Disadvantages of Fare-Free Transit Policy." 2002. https://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=1216&context=cutr_nctr Thoegersen, John. "Breaking Car Use Habits: The Effectiveness of a Free One-Month Travelcard." 2008. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1124483 Transportation Research Board. "Implementation and OUtcomes of Fare-Free Transit Systems." 2012 https://cvtdbus.org/wp-content/uploads/2018/09/2012-07-TCRP-fare-free-report.pdf

LOCAL STREET DESIGN MODIFICATIONS

Description	Local street design impacts travel speeds, safety, and travel mode share. Policies such as design and speed modifications can improve the suitability of roads for all modes of travel, especially as new technologies such as connected and autonomous vehicles and micro-mobility continue to evolve. Such policies could be implemented within Centers identified in the Wasatch Choice Regional Vision. By enabling all modes, there could be a reduction in single occupancy vehicle use and a reduction of parking demand.
Key Findings	As connected and autonomous vehicle technology improves, street design elements will provide feedback to these vehicles regarding speed and surrounding activities. Such elements can also be used now to inform human drivers about appropriate speed and surrounding activities. Design that is inviting, safe, and comfortable is also important for increased micro-mobility adoption. There are several approaches to improving roads in identified Centers today - traffic calming measures, road diet policies, and right-sizing streets. Many benefits for implementing these measures through Centers, including added safety for pedestrians and bicyclists and encourages walking, biking, and transit use. Evidence on the safety effect suggests, for example, that road diet conversions of arterial streets in urban areas achieve a 19 percent reduction in crashes. Rightsizing streets also foster centers that support businesses and the local economy. Road diets often are conversions of four-lane, undivided roads into three lanes with a center turn lane. The fourth lane could be converted to a bicycle lane, sidewalk, and/or on-street parking.
Key Considerations	Solutions are not a one-size-fits all and need to be specific to the context of the modifications and community. Streets should be designed based upon an appropriate target speed. Target speeds on Complete Streets are generally between 10 and 35 mph. The ideal target speed in urban environments is 25 mph or less. Design speeds should match a target speed. On some streets, implementing traffic calming and speed mitigation may be necessary to achieve a higher level of compliance with lower speed limits. Technology infrastructure integrated into the design and redesign of streets needs to be considered as part of the transition to connected and autonomous fleets.
Pros/Cons	*Pro:* Local street design modifications would improve overall safety for all users, especially pedestrians, bicyclists, and micro-mobility users. There is also an opportunity for more efficient vehicular parking. *Con:* There may be fewer travel lanes, and it could be difficult for drivers to access middle turning lanes if through-traffic volumes are high, especially during peak times. Difficult to anticipate infrastructure needs for connected and autonomous vehicles now.
Barriers to Implementation	Rightsizing and road diets are already occurring in many communities. Major barriers in application can be project context, where it fits in the surrounding land

	uses and transportation options, in addition to lack of local support. However, in the age of the pandemic, cities across the country have acted quickly to modify streets by limiting vehicles, slowing traffic, removing lanes, and adjusting signal timing to facilitate safer travel for bikes and pedestrians. With these steps widely accepted during the pandemic, it may lead to more opportunities for future long-term implementation of local street design modifications that would support mobility and use of external forces technologies such as micro-mobility and e-bikes.
Applicability to External Forces	This policy relates to physical modifications to streets that are bundled with many of the external forces, including Freight Disruptions, On Demand Travel and Sharing Services (TNCs), and Connected and Autonomous Vehicles. In addition, street modifications can significantly affect the likelihood that individuals will utilize e-bikes and new micro-mobility devices by affecting the safety and comfort of their use.
Sources	Urbanism Next Center. “Emerging Technologies: Micromobility”. Jan. 2020. https://assets-global.website-files.com/5d9f83b8b237fa6c07d5d69d/5e3f32df00dbcd76b3560bc8_FS_Micromobility.pdf National Highway Cooperative Research Program. "Right-Sizing Transportation Investments: A Guidebook for Planning and Programming". 2019. https://drive.google.com/file/d/1kEXsgjsYidrekKDDneQ2NhnbCfnd5JFA/view FHWA. Road Diet Reference Handbook. https://safety.fhwa.dot.gov/road_diets/desk_ref/sa_15_046.pdf FHWA - Road Diet Policies. https://safety.fhwa.dot.gov/road_diets/resources/fhwasa16072/ Association of Pedestrian and Bicycle Professionals. “Policy Statement: Complete Streets.” 2019. https://apbp.memberclicks.net/assets/docs/APBP_Complete_Streets_Policy.pdf

MANAGED LANES

Description	Managed lanes optimizes the efficiency of freeways and major arterial roads by providing a comprehensive package of strategies to fully control freeway access and manage demand. This includes state of the art technologies with coordinated ramp signaling, variable speed limit and message signing, as well as lane use management.
Key Findings	Managed lanes increase mainline throughput, network productivity, and overall travel time reliability. One study reviewed the benefits of smart motorways in 96 project case studies and the travel time savings is the largest benefit to smart motorways (69 percent of the total benefit).
Key Considerations	This process requires a comprehensive, holistic approach to optimizing existing road systems. Coordinated ramp metering is the key element of managed lanes and implementing system-wide controlled access - it is essential to control all entry and exit points to and from the freeway.
Pros/Cons	*Pros:* Managed Lanes increases traffic flow, reduces expenditures on capacity

	and new lanes. Managed Lanes is also included in the 2019-2050 RTP.
Barriers to Implementation	UDOT has undertaken initial assessments and reviewing a variety of methods in a Managed Lanes Study. General acceptance for use among road users may be a barrier to implementation, especially when shoulders on certain smart motorways are used only during peak times or sudden speed limit changes on variable speed limit signage.
Applicability to External Forces	As CAV comes online, managed lane implementation could be bundled with exclusive CAV lanes and speed limits, automated freight lanes, and possibly bypasses or special on-ramps for electric vehicles, CAVs, freight, etc. If fiber lines are being installed along travel corridors for ramp metering and variable message sign purposes, the backbone communications network is in place for CAV communication devices and technology.
Sources	Arcadis. "Smart Motorways". 2016. https://www.arcadis.com/media/F/B/F/%7BFBFBE568-064D-4341-9A0D-23780E0898AD%7DSmart%20Motorways.pdf Federal Highway Administration. "Managed Lanes, a Primer." August 2008 https://ops.fhwa.dot.gov/publications/managelanes_primer/managed_lanes_primer.pdf Katharine Boddington, Dr Ian Espada and David Nash. Austroads. 2016. "Guide to Smart Motorways" https://austroads.com.au/publications/traffic-management/agsm/media/AGSM-16-Guide_to_Smart_Motorways.pdf Texas Department of Transportation. "Managed Lanes: What They are and Why We Need Them". https://www.txdot.gov/driver/travel/managed-lanes.html Wang, Gorlic, et. al. Economic benefits of Smart Motorway applications. 39th Australasian Transport Research Forum (ATRF 2017), Auckland, 27-29 November 2017https://trid.trb.org/view/1596719

MICROTRANSIT

Description	Microtransit is a privately or publicly operated, technology-enabled transit service that typically uses multi-passenger/pooled shuttles and vans to provide on-demand and fixed-schedule services with either dynamic or fixed routing.
Key Findings	Significantly aids in providing first/last mile connections to and from transit, allowing riders to utilize other higher-capacity transit networks near them. The flexibility of microtransit provides a unique opportunity to meet other service demands like paratransit, or respond to late-night service as a response to high event demand. West Sacramento case study found surveyed users and found that people riding the most were - younger riders (under 21), older riders (50+), members of lower-income households, and women. This survey also found that 49 percent replaced Uber/Lyft with the microtransit service, 34 percent of respondents replaced driving alone, and 34 percent of respondents replaced getting a ride with a family member, and 14percent of respondents saying that before the microtransit, they would have have taken a trip at all.

	From the same survey, 66 percent of respondents felt safer, 41percent of respondents reported enjoying improved access to health foods and medical care, and 77 percent feeling more satisfied with the city's transportation system.
Key Considerations	Consider the ratio of passengers to drivers. Microtransit is a low capacity service, only carrying small numbers of people at a time. Impacts to surrounding transit ridership and vehicular traffic. Does it have the capabilities to replace a fixed route bus?
Pros/Cons	*Pros:* Provide first/last mile solutions. Improved feeling of safety. Flexible capabilities. Potential for vehicle ownership needs to decrease due to greater transit accessibility. *Cons:* It is a bit of gamble knowing if a micro-transit pilot will be successful.
Barriers to Implementation	Funding and long-term feasibility. Because micro-transit is a lower capacity service, it costs more per rider.
Applicability to External Forces	Micro transit often utilizes transportation apps for ride hailing. UTA has partnered with VIA and has the micro transit pilot on their app based service. It coincides with on-demand travel and sharing because most micro transit vehicles aim to pick up multiple passengers on one trip, and they utilize the ride hailing service much like Uber/Lyft.
Sources	Angie Schmitt. Streets Blog. "The Most Successful "Micro Transit" Pilots are Performing like Decent Dial-a-Ride Services." 2018. https://usa.streetsblog.org/2018/07/03/the-most-successful-micro-transit-pilots-are-performing-like-decent-dial-a-ride-services/ APTA. "Microtransit." 2020. https://www.apta.com/research-technical-resources/mobility-innovation-hub/microtransit/ Coleman, John. Smart Growth. "reBlog: Microtransit: Right-Sizing Transportation to Improve Community Mobility." 2019. https://smartgrowth.org/reblog-microtransit-right-sizing-transportation-to-improve-community-mobility/ Eno Center for Transportation. "Uprouted: Exploring Microtransit in the United States." 2018. https://www.enotrans.org/eno-resources/uprouted-exploring-microtransit-united-states/ MaRS. "Microtransit: An Assessment of POtential to Drive Greenhouse Gas Reductions." 2016. https://www.marsdd.com/wp-content/uploads/2016/12/Microtransit-report-2016.pdf Metropolitan Washington Council of Government's. "Demand Response Transit Microtransit: A Guide for Implementing Flexible Transportation Services." https://www.mwcog.org/assets/1/6/Arlington_County_Guide_-_Final_6.4.19.pdf Share-Use Mobility Center. "Four Ways Microtransit Can Influence the Future of Public Transportation." 2015. https://sharedusemobilitycenter.org/four-ways-microtransit-can-influence-the-future-of-public-transportation/ UTA. "Utah Transit Authority Quarterly Microtransit Pilot Project Evaluation."

	2020. https://www.rideuta.com/-/media/Files/Services/Via/Final_UTA_microtransit_pilot_Q1_report.ashx?la=en

MODERNIZATION OF PARKING REGULATION

Description	Parking demands are and will be affected by telecommuting, growth of TNCs, and the spread of first/last mile solutions including micro-mobility. Parking regulations should be modernized or liberalized, especially in locations where TNC and micro-mobility usage rates are or will be high. Doing so would enable repurposing of land for development or open space which improves destination accessibility, affects propensity for transit, walk and bike, and improves fiscal sustainability of urban form.
Key Findings	Parking maximums are an effective way of reducing car use. Parking availability significantly affects the probability of choosing a car. Priced parking impacts mode choice. Parking arrangements at the place of work significantly impact mode choice to work. Evidence is growing that residential parking might be just as important as work parking.
Key Considerations	A Utah Parking Modernization Study is underway and will have case studies from South Salt Lake City and Ogden that will further inform this research at a local level.
Pros/Cons	*Pros:* Parking regulation modernization could lead to more efficient land use, both in urban and other settings. This can lead to higher revenue for local governments, higher land values and rents for property owners, less waste spent on construction of unnecessary parking facilities, and decreased congestion, among other things. However, not all communities will be impacted in the same way when it comes to freight, TNCs, micro-mobility, etc. *Cons:* A comprehensive modern parking regulation program will use technology to inform real-time parking availability and prices; this can be expensive to deploy and implement. A comprehensive public awareness campaign to educate the public on system-wide changes requires a big resources lift. Also, many cities rely on parking fees and tickets as revenue; any changes to the parking regulation will have to take changes of revenue into account.
Barriers to Implementation	Impact of AVs on parking demand, could lessen demand, more efficient parking lots, and decreased parking revenues. Impacts of parking maximums on transit ridership and reduced vehicle congestion. However, the importance of residential parking for transport mode choice, trip frequency and car ownership must still be regarded as under-researched. Very limited research has been done on the effects of parking availability at home and work ends in tandem - this is important to study car ownership.
Applicability to External Forces	Many claim that parking is over built now, but with the advent of transportation network companies (Uber/Lyft), micro-mobility (shared bikes and scooters), and mobile apps that display real-time travel options and times, private vehicular parking needs may drop considerably.

Sources	Chicago Metropolitan Agency for Planning. "Impacts of Parking Strategies." Accessed online: https://www.cmap.illinois.gov/about/2040/supporting-materials/process-archive/strategy-papers/parking/impacts-of-parking-strategies. Published date: September 2013. Christiansen, Petter, Oystein Engebretsen, Nils Fearnley, and Jan Usterud Hanssen. "Parking facilities and the built environment: Impacts on travel behaviour." Transportation Research Part A 95 (2017) 198-206. Hess, Daniel Baldwin. "The Effects of Free Parking on Commuter Mode Choice: Evidence from Travel Diary Data." UCLA Working Paper Series #34. 2001. Sherman, Alyssa. "The Effects of Residential Off-Street Parking Availability on Travel Behavior in San Francisco." Master's Degree Dissertation, San Jose State University. May 2010. Shoup, Donald. "Cutting the Cost of Parking Requirements." Access Magazine (48), Spring 2016. Wu, Xinyi, Frank Douma, and Jason Cao. "Challenges and opportunities of autonomous vehicles to urban planning: Investigation into transit and parking." Center for Transportation Studies, University of Minnesota, CTS 19-30, October 2019.

ROAD USAGE CHARGE

Description	A road usage charge is a usage-based fee based on a certain rate per mile traveled, replacing the per gallon purchased at the pump fee (gas tax).
Key Findings	Interest in road usage charges is gaining around the nation as a replacement for gas taxes as vehicles become more efficient and as fuel tax purchasing power declines. Some estimate that it will take ten to 25 years to fully transition from a gas tax to a road use charge system. There has been significant discussion about the impacts to rural drivers, but there has been no evidence that rural drivers would be impacted disproportionately, with studies showing rural drivers would pay less compared to their urban counterparts..
Key Considerations	There is significant concern from the public about the privacy of their information. Many other typical considerations in implementing a road usage charge are being refined through UDOT's road usage charge pilot program, which is currently underway. Other remaining considerations include addressing out-of-state drivers.
Pros/Cons	*Pros:* RUC effectively matches the size of user impacts to the fees users pay. Oregon's road usage charge program has been shown to reduce VMT. Similar programs in Germany have resulted in declines in empty freight vehicles, purchase of more energy efficiency trucks, and a shift from moving freight by trucks to by trains. *Cons:* Gathering of road usage data may be seen as intrusive by some. The visibility of paying on a per-mile basis may be difficult for many to accept and may be challenging to discuss with the public and policy-makers.
Barriers to	Utah-specific impacts as UDOT's pilot program has just begun. Nationally, there

Implementation	is concern that implementing a road usage charge only on fuel-efficient vehicles would negatively impact purchases of fuel efficient vehicles, but this is not well studied.
Initial Recommendation	Include this strategy in all scenarios as the State has already passed Legislation for UDOT to enroll all vehicles registered in the state in the RUC program by 2031.
Applicability to External Forces	Electric Vehicle Adoption, CAV, Freight Disruptions: Autonomous Trucking/Truck Platooning.
Sources	Information Technology & Innovation Foundation. A Policy Maker's Guide to Road User Charge." April 22, 2019. Accessed online: https://itif.org/publications/2019/04/22/policymakers-guide-road-user-charges Kergaye, Cameron. "Utah Road Usage Charge Program." Presentation at the Road User Charging Conference. March 2019. National Association of Regional Councils. "State and Regions are Exploring the Transition from Gas Taxes to Per-Mile Charges." March 20, 2020. Accessed online: https://regionslead.org/states-and-regions-are-exploring-the-transition-from-gas-taxes-to-per-mile-charges/ RUC West. Accessed online: https://www.rucwest.org/ Washington State Transportation Commission. "Washington State Road Usage Charge Assessment Final Report." January 2020. Accessed online: https://waroadusagecharge.org/wp-content/uploads/2020/01/WSTC-Final-Report-Vol-1-WEB-2020_01.pdf

STREET CONNECTIVITY

Description	Connectivity can be defined as multiple routes and connections serving the same origins and destinations. Connectivity has long been known as providing multiple benefits. Relative to external forces, a connected network helps amplify the potential benefits of micro-mobility - technologies that solve the first/last mile problem which would in turn help reduce SOV usage in those locations.
Key Findings	Street connectivity, with its short blocks and high intersection density, shorten travel distances, reducing vehicle miles travelled (VMT) and increasing transit access. Better connectivity results in a more balanced distribution of traffic flows within the roadway network, reducing travel times and delays throughout the system. The greatest benefits of increasing street connectivity occurs between low and moderate connectivity, with diminishing returns between moderate and high connectivity. The association between street connectivity and active transportation are modest, but indicate that greater connectivity leads to an increase in walking.
Key Considerations	The effect of connectivity on walkability and safety. Regarding walkability, while some studies have indicated positive associations between connectivity and active transportation, other studies have indicated these relationships are weak, even when statistically significant. Regarding safety, limited research has shown

	that low intersection density networks had the highest risks of fatal and severe crashes.
Pros/Cons	*Pros:* Street connectivity is associated with reduced VMT, overall reductions in vehicle hours of delay, and reduced average trip length. These benefits are highest between low and moderate connectivity and diminish between moderate and high connectivity. With an increase in connectivity, some traffic will divert onto the local street network, but these impacts can generally be mitigated. *Cons:* Street connectivity can increase the linear feet of roads per acre which may increase costs. These cost increases may be offset by changes to street width (enabled by a more efficient street system derived by connectivity) or increases in development intensity.
Barriers to Implementation	Increased volumes on local roads; public perception about the benefits of discontinuous street patterns such as extensive cul-de-sacs; and perception that street connectivity is more costly and reduces development potential in neighborhoods compared to contemporary design.
Applicability to External Forces	Street connectivity can affect the route-directness of modes of travel that are sensitive to distance including micro-mobility devices. It thereby affects those devices.
Sources	Berrigan, David; Linda Pickle; Jennifer Dill. "Associations between street connectivity and active transportation." International Journal of Health Geography, 2010; 9: 20. Ewing, Reid and Robert Cervero. "Travel and the Built Environment." Journal of the American Planning Association, 2010, 76 (3). Portland Metro. "Street Connectivity: An Evaluation of Case Studies in the Portland Region." June 2004. Wasatch Front Regional Council. "Utah Street Connectivity Study Literature Review." Accessed online: https://wfrc.org/Studies/UtahStreetConnectivityGuide-FINALAndAppendix.pdf Zlatkovic, Milan; Sara Zlatkovic; Tim Sullivan; Julie Bjornstad; Seyed Kiavash Fayyaz Shahandashti. "Assessment of effects of street connectivity on traffic performance and sustainability within communities and neighborhoods through traffic simulation." Sustainable Cities and Society 46, 2019.

SUBSIDIZED E-BIKE PURCHASES

Description	Subsidized or discounted purchase programs and trial use programs aimed at accelerating the adoption and purchase of electric assisted bicycles. E-bikes can offer a cheaper transportation alternative to the car, increase physical fitness levels, improve air quality, and decrease noise in cities. These costs may include the secure storage of e-bikes or expansion of bikeshare programs to include e-bikes region wide.
Key Findings	Experience-based education is an important tool to increase participation. Strategic partnerships can provide advantages for program leaders, participants, and vendors. Pre-approved preferred vendors can provide participants with a

	trusted resource and a quality product, ensuring a positive experience throughout the lifetime of the e-bike. Lastly, inventive sources of funding such as new toll-road revenue can reduce the burden on local governments to fund such programs. Most programs developed have used a partial purchase subsidy. The ability to use and e-bike for an extended period of time prior to purchase is critical to behavior change. Approximately 15 to 17 percent of long-term trial users purchased e-bikes without a financial incentive. Many different organizations can conduct an e-bike purchase incentive program, from cities, energy departments, universities, and nonprofits to private retailers. No program researched ever had unexpended funds.
Key Considerations	Programs need to be designed around goals of agency. When mixed with other incentive programs for solar or EVs, a target for purchases of e-bikes should be stated to determine program effectiveness. Ongoing programs, rather than one-time appropriations, may be more effective at increasing e-bike adoption. Subsidies as small as $200 can be effective.
Pros/Cons	*Pros*: Off-set of carbon emissions comes at a much lower price than subsidies for electric vehicles; similar health benefits to conventional cycling; an e-bike costs about eight percent of the price of an electric car. *Cons*: Cost of e-bikes even with subsidy is often beyond the reach of the financially insecure; no guarantee that purchasers of e-bike with subsidy would be replacing car trips. Equity is not often considered in programs. Additional efforts that allow users to experience e-bikes for extended periods appear necessary to change travel behavior.
Barriers to Implementation	With vendor only incentives, vendors may lose the motivation to continue offering such discounts once sales reach a certain threshold. Revenue source for partial subsidy purchases needs to be identified. Need to expose people to e-bikes as a legitimate form of transportation.
Applicability to External Forces	E-bikes are a disruptive force and their use has huge potential to shift mode share for trips five miles or less. Programs designed to speed up adoption of e-bikes for utilitarian trips will allow benefits of e-bike use to be realized more quickly than otherwise.
Sources	Active SGV. n.d. "E-Bike, SGV Rebate Program." Accessed April 23, 2020. https://www.activesgv.org/bicycleeducationcenter-633258.html Boulder County. 2018. "Final Discount Electric Bike Purchase Program Now Available." https://www.bouldercounty.org/news/final-discount-electric-bike-purchase-program-now-available/ Burlington Electric Department. n.d. "E-bikes." Accessed April 23, 2020. https://burlingtonelectric.com/ebike California Bicycle Association. 2018. "Summary of E-Bike Rebate Programs Throughout the World." https://www.calbike.org/wp-content/uploads/2019/02/Summary-of-E-bike-rebates-around-the-world.pdf Cherry, Christopher, John MacArthur, Michael McQueen. 2019. How E-bike

Incentive Programs are Used to Expand the Market. https://wsd-pfb-sparkinfluence.s3.amazonaws.com/uploads/2019/05/E-bike-Incentives-Paper-05_15_19-Final.pdf

Haubold, Holger. 2016. Electromobility for All: Financial Incentives for E-cycling. European Cyclists' Federation. https://ecf.com/sites/ecf.com/files/FINAL%20for%20web%20170216%20ECF%20Report_E%20FOR%20ALL-%20FINANCIAL%20INCENTIVES%20FOR%20E-CYCLING.pdf

Sloman, Lynn, Carey Newson. 2019. The Case for a UK Incentive for E-bikes. https://www.bicycleassociation.org.uk/wp-content/uploads/2019/07/The-Case-for-a-UK-Incentive-for-E-bikes-FINAL.pdf

Weiss, Eben. 2019. "Want to Save the Environment? Subsidize E-Bikes." *Outside Magazine*, July 17, 2019. https://www.outsideonline.com/2399731/to-save-environment-subsidize-e-bikes