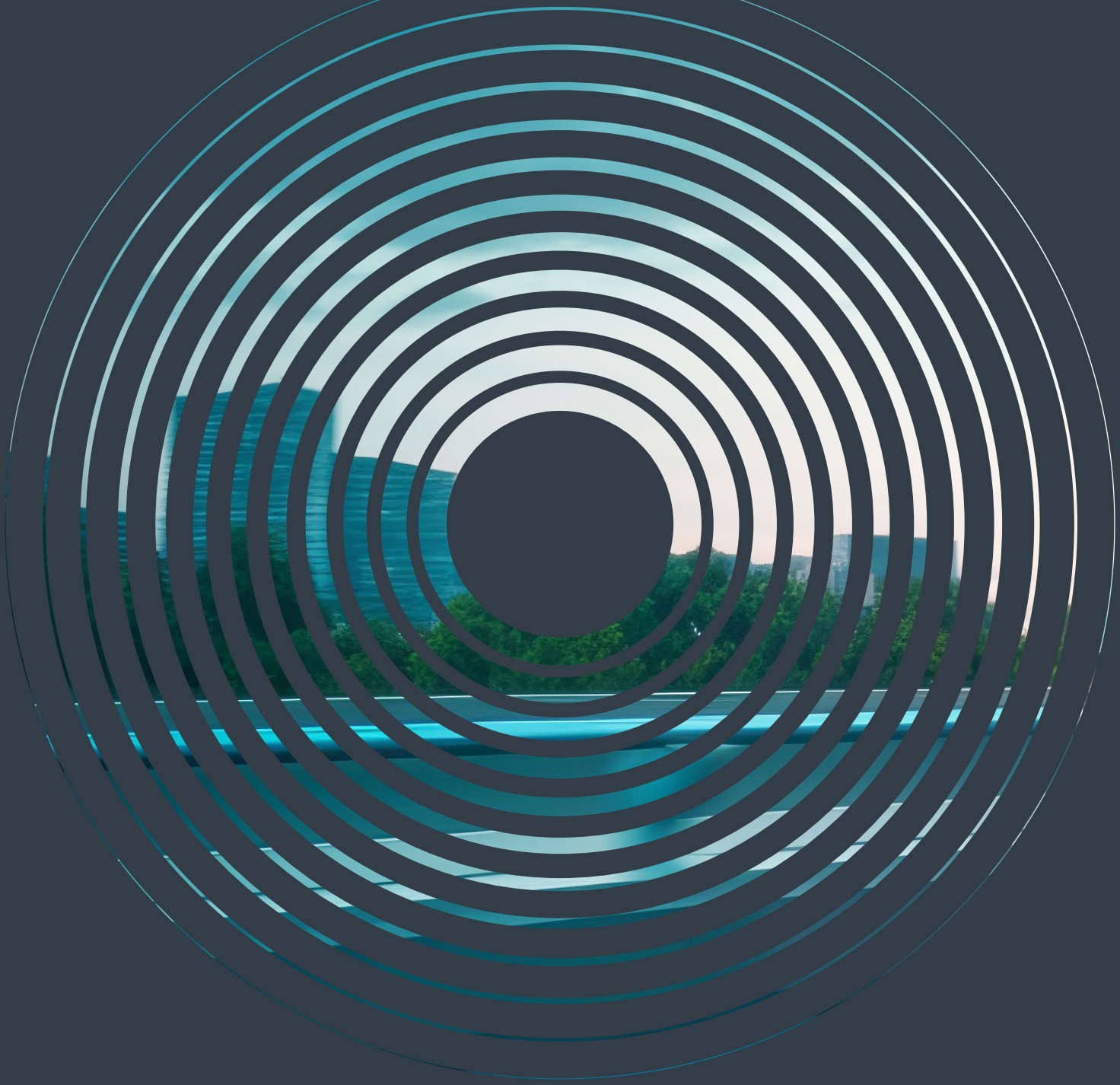
New Mobility
NOW 2.0

Assessing progress and incorporating innovations into transportation



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Connect with WSP experts in New Mobility

If you are interested in learning more about New Mobility in your region, WSP offers valuable insights into different markets around the world that go beyond the information included here. We would be delighted to share more of these insights with you; please do get in touch with our team via *NewMobility@wsp.com* or contact the team members noted at the end of the whitepaper.

Foreword

In 2017, WSP set out to describe a vision for how 21st-century innovations in systems, technologies and communications could be applied to 20th-century infrastructure to meet future needs. The vision imagined a future transportation system that transforms the way all people move around and interact with each other.

WSP presented this vision in the document titled *New Mobility Now*. Leveraging the minds of representatives from over fifty global municipalities, agencies, manufacturers, operators and community organizations, *New Mobility Now* shared our thinking about how to make sense of emerging technologies, across a range of contexts, and yield clear actions that any interested party could apply to advance the use of these systems and achieve the vision we are all seeking for our communities.

A lot has changed since the publication of *New Mobility Now*. We were all greatly affected by the COVID-19 pandemic, which stressed countless systems of society and governance, let alone the human toll the pandemic exacted upon us. The catastrophic effects of climate change, as revealed in severe habitat loss, wildfires, typhoons, drought, floods and other disasters, have become impossible to ignore over the past few years.

Through it all, human ingenuity has provided opportunities for hope. The pandemic gave rise to bespoke, rapid development of vaccines and, by necessity, new ways of living and working with closer attention to how transportation can better support people's shifting needs. Social equity and related accessibility issues became drivers of positive change and key points of investment for new infrastructure. Fears of the worst outcomes of climate change have yielded meaningful advancements in cost-effective, affordable and renewable sources of energy, which reduce the production of greenhouse gases as sectors seek ways to decarbonize toward net zero. Within the transportation sector, the pandemic accelerated a reassessment of how emerging New Mobility business models could better support people's changing attitudes and expectations and advance the development of sustainable cities—economically, socially and environmentally.

WSP is driven by the desire to solve the challenges facing the built environment brought forth by these global factors. Informed by the sharing of our global experiences and knowledge gained through and following COVID-19, we have revisited the foundational guidance and advice from *New Mobility Now* and developed *New Mobility Now 2.0*.

New Mobility Now 2.0 presents lessons learned by ongoing global practice and provides the transportation industry with guidance for a renewed way forward. We couple the lessons learned with a look-ahead for the coming years, entitled *New Mobility Next*. (See the link at the end of this whitepaper.) Whereas *New Mobility Now 2.0* details the developments since the publication of *New Mobility Now* in 2017, *New Mobility Next* shares our knowledge and evolving view informed by global insights and learning—and further expands the dialogue with consideration of new realities—to deliver lasting benefits. Both papers complement the spirit of WSP's Future Ready®[1] ethos that seeks to bring clarity and vision to the complex challenges ahead.

We hope that you find *New Mobility Now 2.0* informative and helpful, and we look forward to continuing our discussions with you—to build upon the developments and lessons learned explored in this whitepaper.

Eric Peissel
Global Director, Transport and Infrastructure

1 Future Ready® is WSPs global innovation program that seeks to better understand the key trends in climate change, society, technology, and resources and how they are impacting our world, locally and globally. Future Ready® is a registered trademark of WSP Global Inc. in Canada and New Zealand. WSP Future Ready (logo)® is a registered trademark of WSP Global Inc. in Europe, Australia and in the United Kingdom.

Introduction

In the face of far-reaching changes throughout global society, agencies, manufacturers and operators have continued to advance New Mobility concepts. The evolution of mobility raises numerous questions. Below, we pose some core questions, offering associated understanding and useful action.

What components of New Mobility have been effectively mainstreamed in the past few years as revealed through standardization or procedural consolidation? Formal actions such as regulations will be accompanied by informal mainstreaming events, such as a manufacturer embedding New Mobility capabilities that set an industry standard. It is important to recognize how evolution occurs and be able to leverage New Mobility aspects at the right time.

By comparison, what aspects have yielded progress but remain in a developmental status? The transportation industry continues to develop pilots and evaluations of New Mobility aspects to test viability toward progressing to deployment.

Finally, what are emerging concepts that will likely impact and advance New Mobility? Technology continues to advance, requiring the capability to anticipate and adapt to changes.

WSP presents *New Mobility Now 2.0* to identify mainstreamed New Mobility concepts, those concepts still in development, and possibilities by which we anticipate changes in the near future. We have structured our approach upon the same four distinct aspects of New Mobility as presented in the original report but with an updated understanding of them based on developments since 2017:

-Automated
-Connected
- Electric
- Shared Use

These four New Mobility aspects continue to take our transport networks, systems and modes of mobility to a future of potential benefits to be shared throughout society. With guidance and market shaping, we can build this New Mobility future upon a foundation of equitable and sustainable policies, actions and strategies.

We recognize that business models continue to evolve in this space, showing a stronger emphasis on needs of the user and changing approaches to ownership and finance. Innovation and technology must be considered alongside the commercial perspective, which remains critical in building the case for investment and sustained viable operation. These ideas are expanded upon in WSP's companion whitepaper *New Mobility Next*, which explores in greater detail how to deliver change through innovation and technology from the customer viewpoint, rather than through the historical single lens of technology-readiness.

Automated

What it is

Vehicle automation has gained traction as both private and public entities utilize technology to enhance accessibility, improve safety and introduce new methods for moving goods and people. The industry often utilizes the terms "automated," "autonomous," "self-driving," and "driverless" in place of vehicle automation.

Automated vehicles (AV) perform the primary driving functions of vehicles (steering, acceleration, and braking) with varying degrees of decreased human intervention. The automated driving system (ADS) includes sensing, communicating, monitoring, navigating and decision-making, depending on the level of automation.

The Society of Automotive Engineers (SAE) Standard J3016 standardizes six automation levels,[2] ranging from no automation (level 0) to full automation (level 5). Levels 1 and 2 are widely available on the market today, assisting drivers with some functions while requiring them to maintain the primary responsibility of operating the vehicle. Levels 3 and 4 require less direct human interaction as the vehicle performs all of the dynamic driving tasks under specific conditions. These vehicles are being actively piloted and tested but are not yet available for commercial use. Level 5 vehicles are fully autonomous (requiring no human backup) but are still distant from deployment.

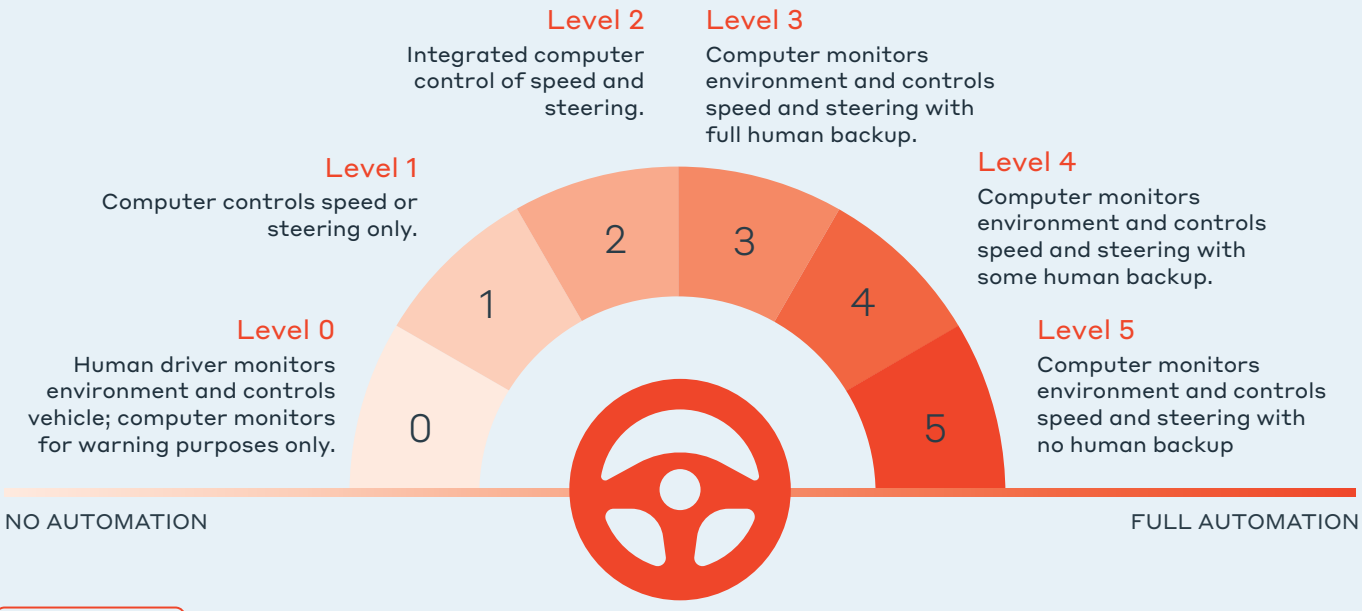

FIGURE 1

The spectrum of automated driving

Adapted from "SAE international standard J3016 levels of driving automation"

2 Society of Automotive Engineers. *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles*, SAE J3016, current revision 2021-04-30.

The SAE J3016 standard has evolved over time, keeping pace with development and requirements identified by road operators and system developers. There is now a deeper understanding of environmental characteristics forming the operational design domain (ODD) for automated vehicles. To examine the impact of automation on the market, it is essential to understand how, why and at which rates key market share levels could be reached.

Predicting market trends in automation requires examining specific modes under the umbrella of AV (automated vehicle), for specific levels of automation, and within certain ODDs. If we consider mode, these include freight, transit, ride hailing services, and personal vehicles. Each of these modes will experience independent rates of adoption depending upon what becomes safely possible while addressing market needs.

AVs have the potential to revolutionize various aspects of transportation, offering numerous use cases across different sectors such as freight, transit, ride-hailing services and personal vehicles.

Freight	Transit	Ridehailing Services	Personal Vehicles
			
One of the first L4+ AV use cases is likely to be the movement of goods using a variety of vehicle types and incorporating different objectives such as long-haul, short-haul, and even last mile personal delivery devices. With autonomous trucks and delivery vehicles, the transportation of goods can be made more efficient, reliable, and cost-effective	Another early L4+ AV use case is likely to be the movement of people by public agencies, using a variety of vehicle types such as full-size buses, specialty on-demand vehicles, and even low-speed shuttles. AVs can enhance public transportation systems by providing safe and convenient options for commuters, reducing congestion, and optimizing routes	This L4+ AV use case, which complements the shared mobility services described later in this paper, includes vehicles that are fleet-owned and purpose-built to serve either as a supplement or replacement to public transportation, or can be single-occupant, on-demand services. AVs can transform the way we travel, offering on-demand transportation without the need for human drivers.	One of the last L4+ AV use cases likely to be adopted is the traditional model of a private automobile that a person purchases or leases from their local car dealer and utilizes for personal commutes or other travel. AV technology holds the promise of safer and more comfortable journeys, with self-driving cars taking the wheel and providing increased mobility for individuals.
Near term to market	**Near/mid term to market**	**Near/mid term to market**	**Long term to market**
			

Why it matters

Beyond the basic definition of vehicle automation, one must understand the high-level opportunities that AV technology has to offer. Automation has the potential to improve the following:

- **Efficiency.** Fully deployed and connected AVs hold the potential to increase freeway throughput, reduce congestion, reduce vehicular greenhouse gas (GHG) emissions, and improve air quality in the long term.[3]

- **Safety.** Automation has the capacity to mitigate accidents caused by human error and save lives on a scale well beyond other safety countermeasures.[4]

- **Mobility**. AVs increase access to essential services for populations who are unable to drive, like the young, aging, underserved, disabled, or medically ill.

- **Economic vitality.** AVs ease the movement of people, goods and services. They also provide opportunities for job creation and new public-private partnerships in a growing industry. AVs can also reduce the burden on haulage companies, with the potential to lower the need for drivers' input at some stages of a journey.

Why we're still talking about it

Vehicle automation, like most disruptive technologies, has proven difficult to predict, challenging to plan and problematic to execute. In 2016, AVs appeared to be on the precipice of changing the industry. At the time, Ford's Chief Executive Officer (CEO) stated, "The next decade will be defined by automation of the automobile, and we see autonomous vehicles as having as significant an impact on society as Ford's moving assembly line did 100 years ago." [5] *New Mobility Now* expressed similar optimism stating that "we can expect continued and rapid change."

Six years later, this change has proved discontinuous. As Ford's current CEO stated in October of 2022, "We're optimistic about a future for level 4 ADS, but profitable, fully autonomous vehicles at scale are a long way off and we won't necessarily have to create that technology ourselves." [6] What does the last decade imply about the future of automation? At WSP, we continue to see the promise in automated vehicles, but perhaps at a slower, more deliberate pace than originally envisioned.

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3 Heaslip, K.; Goodall, N.; Bumsik, K.; and Abi Aad, M. *Assessment of Capacity Changes Due to Automated Vehicles on Interstate Corridors*, Virginia Transportation Research Council, Final Report VTRC 21-R1, July 2020.

4 National Highway Traffic Safety Administration. *Automated Vehicles for Safety*, US Department of Transportation, 2022.

5 Ford Motor Company. *Ford targets fully autonomous vehicle for ride sharing in 2021; invests in new tech companies, doubles Silicon Valley team*, August 16, 2016.

6 Ford Motor Company. *Ford fulfills earning guidance, has strong cash flow in Q3; will accelerate development of L2+/L3 ADAS technology*, October 26, 2022.

CASE STUDY

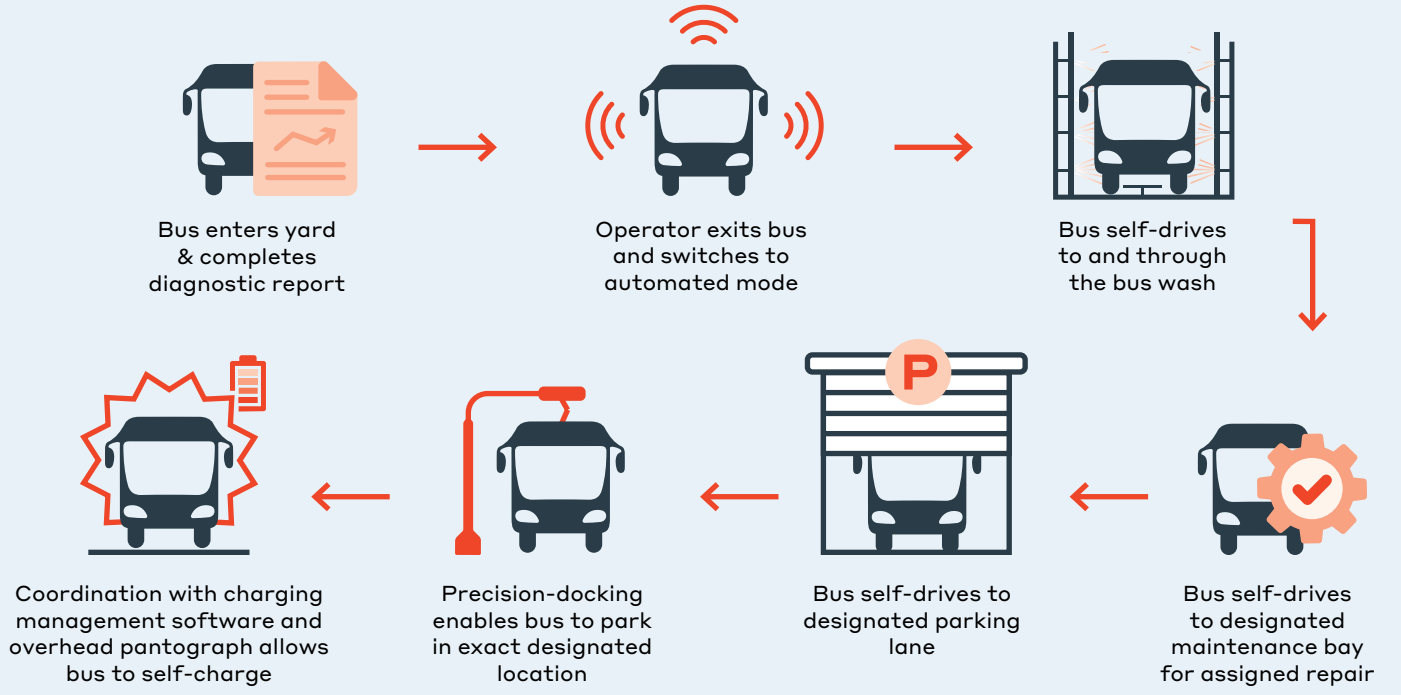
Full-Size Bus Automation

Low-speed shared AV shuttles provide a natural complement to larger public transportation/public transit vehicles by closing the gap between first and last mile; however, automated full-size vehicles equipped with advanced driver assistance systems (ADAS) would radically shift the paradigm of public transit. Automated buses could be utilized to help facilitate driver assistance and safety benefits on the road. ADAS technologies can provide services like adaptive cruise control (speed and headway management), forward-collision warning, emergency electronic brake lights, lane keeping/departure warning, precision docking and curve-speed warning. In denser settings, ADAS applications could additionally provide warnings about vehicles turning in front of buses, pedestrians in signalized crosswalks or other vulnerable road users.

Additionally, ADAS equipment could be utilized to safely operate within the bus yard, providing a valuable bridge to full automation. The yard represents a well-defined operational design domain with several hazards within a confined space, making it an ideal environment for testing. ADAS technology in the form of new bus orders or retrofitting could enable operations such as parking and recall, bus wash, precision docking, and battery-electric charging.

The WSP USA team has done a significant amount of analysis and produced a report that highlights the potential benefits of an Automated Bus Yard.[7] The research indicates the following key benefits:

- **Pull-in and pull-out time** requirements may be substantially reduced if the bus is able to self-drive to a designated area to form a queue for operators.
- **Space saving** becomes possible as buses can park closer together. The programmable nature of the buses will allow operations staff to get more creative for where buses are stored overnight.
- **Battery-electric buses** could be queued to charge overnight without the need for individual operators. Immediately upon reaching a full state-of-charge, one bus proceeds toward a designated parking area while the queued bus takes its place to be charged.
- **Collision avoidance** and automatic braking features included in ADS sensors can result in a reduction of rear-end collisions and reduce in-yard collisions.



7 *Bus Automation: Cost-Effective Solutions for Transit Operators*, WSP. January 19, 2023.

CASE STUDY

Smart Columbus

The winner of the U.S. Department of Transportation's (USDOT's) 2016 Smart City Challenge, the City of Columbus, Ohio stood ready to harness the power and potential of data, technology, and creativity to reimagine how people and goods move throughout the city, reshaping its transportation system to become a fully integrated city.

As part of the Smart Columbus consultant team, WSP led the systems engineering, design, procurement support, and test activities for both the autonomous vehicle (AV) and connected vehicle (CV) projects within the city. The city's plan for AV deployment included fully automated, CV-enabled electric vehicles, operating on public roadways and coordinated with the local transit agency to solve first/last mile challenges. WSP supported Smart Columbus by developing the Request for Proposal (RFP) for two separate pilot projects along with the standard operating procedures and operational concept, building on multiple route-planning exercises and coordination with stakeholders.

Lessons learned include:

- **Flexibility is key** – When it was determined that the routes included in the Smart City Challenge application were too ambitious given the current technology capabilities, the City of Columbus went back to the drawing board to identify how it could feasibly deliver the project. The result was two deployments that served different purposes for the program. The Smart Circuit linked downtown visitors with cultural attractions and learning experiences while educating the project team and partners on the capabilities of the technology and how to procure the services. The Linden LEAP served as a first/last mile transit connection until passenger service was permanently suspended due to the pandemic and its mission transitioned from moving people to goods to moving goods to people.
- **Data needs must be communicated with partners early on** – For the first procurement, the project team thought the requirements related to data were clear in the procurement documents. However, not all of the data expected was produced and a lesson learned was that the data requirements could have been better defined to ensure the appropriate data was received, including defining the method and frequency of transmission. This lesson was applied successfully in the second procurement with a data table and transmission requirements included in the RFP.

CASE STUDY

UTA Innovative Mobility

The Utah Transit Authority (UTA) is seeking to improve access through engagement with innovative mobility. WSP worked with UTA to create an innovative mobility strategic plan to align the agency's vision and goals with internal and external opportunities. In addition, WSP supported a pilot Mobility as a Service program, as well as the launch of an automated shuttle demonstration project in partnership with the Utah Department of Transportation (UDOT).

The automated shuttle hit the roads in April 2019 and was demonstrated at 8 different deployment sites across the state throughout the 17-month pilot period. During this project, WSP had direct, hands-on experience supporting the implementation of an automated shuttle demonstration project. This included the ability to consider the needs of various stakeholders to develop a plan for execution that strives to mitigate any potential safety concerns, is responsive to local needs and procedures, and is carefully documented and reviewed.

Lessons learned include:

- **Piloting an automated vehicle can provide valuable firsthand experience** – The variety of experiences provided by rotating the shuttle across multiple locations in Utah helped reveal the best types of environments and routes for a longer-term temporary or permanent deployment of an automated shuttle. It also maximized exposure of this technology to a broad cross-section of the public. The project team experienced eleven deployments at eight unique sites and are therefore very familiar with what is required to set up a deployment, lessons which can be carried forward to future projects.

- **Public engagement can build on enthusiasm and help address any concerns** – Based on the responses to rider surveys, the public overwhelmingly felt comfortable with the shuttle and those who didn't ride it indicated that they were still excited for autonomy to become part of the transportation network. Site owners were uniformly excited and cooperative about this technology. This overwhelmingly positive response exceeded the expectations of the project team.

CASE STUDY

Armidale Regional Driverless Initiative (ARDi)

In response to Transport for New South Wales Regional Automated Vehicle Trials Expression of Interest, Armidale Regional Council brought together a range of partners to trial highly automated transport for the region. Spanning between February 2019 to February 2020, the Australian first ARDi trial helped cement Armidale's reputation as a smart, technologically advanced and progressive city. WSP provided support throughout the safety assurance process, advice regarding infrastructure and road safety and collation of key learning for the project partners.

The trial's EasyMile EZ10 Automated Shuttle is known as ARDi, a battery-powered, 12-person autonomous electric shuttle. ARDi is a last-mile solution optimized for relatively low-speed travel (15 to 30 kph) in diverse environments.

The trial was delivered in two phases:

1. Phase 1 took place on University of New England's campus to the north-east of Armidale's central business district from February to June 2019. This on-campus trial covered up to 4.8 km distance (per round trip) and provided an alternative form of public transport for staff and students in and around the campus from 10am to 2pm and 5.30pm to 9.30pm. The phase 1 route gave the trial a strong user focus, addressing the University's desires to improve transport links between residences and campus faculties, and safety for students/staff (including at night). From a technical perspective, the speed of the vehicle and distance between stops on this route were important factors.

2. Phase 2 saw ARDi deployed to Armidale's central business district between October 2019 and February 2020, providing a dedicated route around and through the region's central commerce and entertainment precinct. Following a circular route of 822 meters. ARDi ran 6 days per week (Monday – Saturday) between 9am and 3pm (Monday - Friday) and 9am to 12pm on Saturdays. This phase focused on testing the technology behind ARDi and was the most advanced deployment of a CAV shuttle in Australia, with ARDi travelling in a busy, mixed-traffic environment and navigating complex obstacles such as roundabouts and a range of road users.

Lessons learned include:

- Phase 1 saw ARDi provide students and staff at the University of New England with a viable alternative transport option for last-mile travel around campus. The route saw ARDi tackle new challenges from unlikely sources (leaves), helping to develop and test newly optimized features in a real-world environment.

- Over Phase 2, ARDi completed the most advanced deployment of CAV technology on Australian roads, providing a service to residents and tourists around the central business district. ARDi successfully navigated roundabouts, bus stops and public perception to provide a useful service to the community.

- Building up CAV's acceptable speed on public roads safely is key to the acceptance of the technology by both passengers and other drivers. ARDi has taught us that the mapping process—particularly speed during the process—can have a negative impact on public perception. However, this can be negated with careful planning and appreciation of the local operational environment. Strong community engagement was found to be key to managing public perception and was found to directly impact driver behavior (positively).

What you can do now, and what you can start planning for

Improve today's infrastructure for tomorrow's technology

Simple infrastructure maintenance, such as good lane striping (road pavement markings), clear, well-positioned signage and the availability and use of prior maps of the environment is the best way to support AVs today. [8] AV-exclusive lanes provide an interim solution towards demonstrating the effectiveness of connected infrastructure and automated vehicle capabilities, while also providing an opportunity to start a conversation between agencies and the AV industry. Lanes would be built and maintained to a certain standard in a controlled environment to provide reliability and operational benefits to AV-users.

Support the development of regulations and standards

Acknowledge and support advancement of existing national or international regulations (i.e., United Nations Economic Commission for Europe AV regulations; SAE standards.) Encourage and support the development of national or international regulations where they don't exist (i.e., in the U.S., there are efforts for the USDOT and other federal regulatory bodies to establish AV regulations rather than each state/locality establishing their own, creating a patchwork of regulation.)

Prepare public agencies

Because the operation of AVs has broad implications for a wide variety of stakeholders, information about AVs must be communicated to the public in a comprehensive, transparent and equitable way. Additionally, facilitating conversation among the public, legislators and government agencies will enable lessons to be shared.

Agencies must remain nimble to accommodate shifts in technology while understanding what policy and institutional changes are needed to safely deploy AVs. To do this, agencies should have a transparent response that embraces new ideas and partners while challenging assumptions. Diverse, public groups and community partners should be brought into the process to help the authorities understand the varying needs of the technology from different perspectives.

Create strategic plans, preparation roadmaps, and collaborative working groups, as WSP has done for organizations including MetroPlan Orlando,[9] the Maryland CAV Program,[10] and Washington AV Work Group.[11]

Pilot AV technology

Locality and organization-specific AV pilots must be conducted to test the different rules of the road in each geography. Establish use cases for AV pilot projects that further the state of the practice. Consider an equitable distribution of AV pilot projects within the region to the extent possible. Partner with private automakers and AV developers to learn more about AV technologies and to further pilot activities. Partner with local interest groups to gain insight into user input on AV testing. Engage your communities through user focus groups and meeting forums. Incorporate feedback and evaluation into AV pilots that engage the general public.

Learn from real-world experience and metrics

Spend more energy and resources toward developing metrics and monitoring them for opportunities to garner relevant data. This makes it easier to understand how automation and other vehicle technologies are impacting the transportation network—and, above all, ensure that data is collected to monitor and confirm safe operation for the vehicles, occupants and all other road users. In addition, there is an opportunity to further improve safety and operation of the wider road network with insight from vehicle interaction with their environment.

Continue outreach and public engagement

Play a greater role in workforce development initiatives as a tool for workforce retraining, economic development and workforce readiness for AVs. Ensure AV pilot projects are accessible to users with varying abilities, ages, socioeconomics and demographics, and travellers across different modes, including motorcyclists, pedestrians and bicyclists. This will help identify needs, gaps and opportunities to expand AV access and protect equity.

Educate

Individual practitioners need to know what automation is and where their organization sits within that space, in both the present and future, to gain support for AV in cases in which it is the right and feasible solution. Interested champions can reach out to stakeholders, legislators, industry and government agencies to widen support and build a more educated community that is ready to integrate enhancements into the transportation system.

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8 Queensland Department of Transport and Main Roads. *How Automated Vehicles Will Interact with Road Infrastructure Now and in the Future*. 2020.

9 Metroplan Orlando. *CAV Readiness Study*. 2020.

10 Maryland Department of Transportation. *Connected and Automated Vehicle Strategic Framework*. 2020.

11 Washington State Transportation Commission. *Washington State Autonomous Vehicle Work Group*. 2022.

Connected

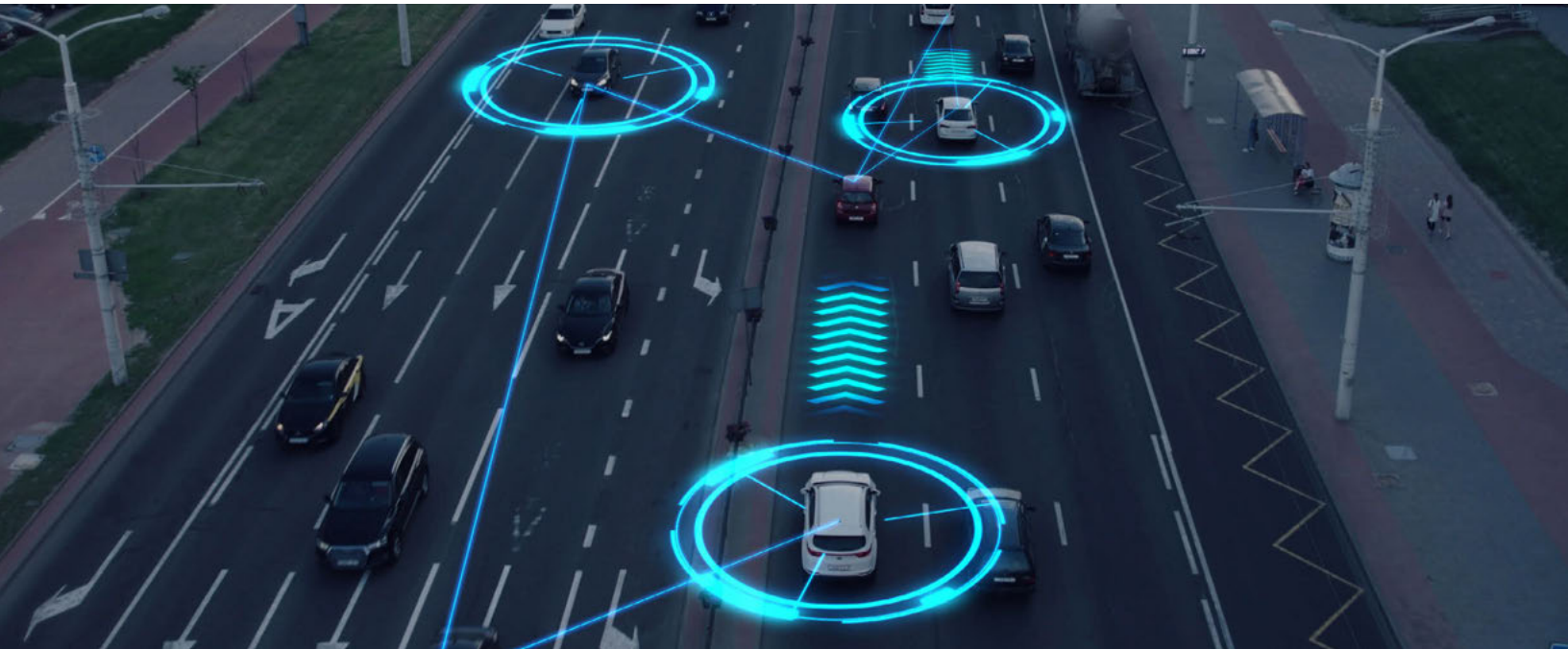
What it is

The future of connected mobility is already around us, with many of us already travelling in connected cars or public transportation. In fact, any new vehicle purchased today is likely to come with some level of connectivity. Additionally, any driver using a smart phone to access the best route advice is already connected, as applications are both receiving this information and transmitting data back to inform live road conditions for other users. Most of the connectivity today still relies on and leverages cellular communications. As an example, cell phone data from users is aggregated by service providers and road network operators to create a near-real-time understanding of vehicle movements and performance of the road network.

Despite a heavy reliance on cellular communications, several new technologies are emerging to globally advance connectivity through Connected or Cooperative Intelligent Transport Systems (C-ITS) encompassing vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) connectivity. These solutions are both inexpensive and impactful. The technology is based on CV systems comprised of roadside units (RSU), installed at strategic locations on roadways, and vehicle-based on-board units (OBU). In certain regions, such as Europe and Australia, there is more of a focus on the term "cooperative intelligent transport systems" or C-ITS, which is a form of CV. The cooperative and collaborative need aspect is critical given the need for CVs to connect between vehicle systems and roadside infrastructure and a wide range of data users and providers.

The purpose of CV technology is to provide real-time trusted data to enhance road safety, traffic efficiency and sustainability. CV technology can also augment AV technology (discussed earlier) as an additional trusted source of information. Standardized packets of data (including metrics such as position, speed, and direction) are used in numerous on-board applications to enhance situational awareness. The same data can be used in further applications that are not directly related to safety—to smooth traffic flow, reduce energy use and reduce emissions.

The industry will continue to build upon CV applications and pilots to better connect vehicles to each other, to roadside infrastructure, and to other devices, expanding information available to network providers and users. A connected network enables vehicles travelling in it to become sophisticated mobile sensors, while simultaneously benefiting from information received from other connected vehicles.



Why it matters

Technology continues to evolve to promote connectivity among both physical and logistical resources. Mobility is following a similar trajectory as it becomes increasingly connected to vehicles and infrastructure. Connectivity among global technology and mobility enables transportation networks to improve quality of life, communities and economic vitality.

- **Safety** – improved safety features and alerts, reduced crashes and fatalities, reduced congestion related crash events
- **Efficiency** – reduced travel delays for goods movement, better network and fleet management, better planning for workforce management, automated reporting for any mandated activities (e.g., freight oversize permits or fuel tax payments)
- **Productivity** – data-driven decision-making, accurate and precise information and analysis, detection and action sequencing to increase productivity
- **Comfort** – informed trip planning, travel times, congestion alerts and rerouting, road weather alerts

Why we're still talking about it

Multiple trials undertaken globally continue to validate the expected benefits from the take-up of CV technology. Multiple industry organizations are actively working to standardize CV technology and systems to ease adoption across the globe. For example, the Institute of Transportation Engineers (ITE) published the Connected Intersection Implementation Guide in June 2022.[12] It provided infrastructure owner operator guidance for deploying CV infrastructure that supported the vehicle-based Red-Light Violation Warning application.

The Society of Automotive Engineers (SAE) formed the Connected Transportation Interoperability Committee to specifically build upon this ITE work. Additionally, a global non-profit alliance of automakers and suppliers has formed the Connected Vehicle Systems Alliance (COVESA), working to standardize connected vehicle communication. Despite industry's attempts to standardize connected vehicles, there is still a general lack of agreement on this front. This lack of CV standards will make it difficult for owners, operators, service providers and vendors to plan for long-lasting CV deployment solutions.

The European Telecommunications Standards Institute (ETSI) has developed a set of standards for C-ITS in Europe. These standards provide a framework for enabling bi-directional and secure communication of messages between vehicles, infrastructure, and other stakeholders. These have and continue to provide a solid foundation for the implementation and deployment of co-operative communication technologies, whereby European Member States are working together under the C-Roads initiative, building upon these standards, by developing a set of specifications that enable interoperability and harmonization across local, regional and national borders, which can be applied over both short-range and long-range communication technologies.

Interoperability, trust and security, and reliable data exchange, have brought proven benefits including enhanced road safety, improved traffic efficiency, reduced congestion and a more connected transport network, all of which can bring wider socio-economic benefits. Such benefits are already being realized across Europe through existing market implementations, including VW and Volvo, which are using short range communications (ITS-G5) coupled with road operators equipping their motorways with compatible infrastructure including Austria and Germany. In addition, operators including those in the Netherlands and Nordic countries are providing "'Day 1" services over existing 4G cellular communication networks. Industry forums such as the 5G Automotive Association (5GAA) are investigating how

12 Institute of Transportation Engineers. *Connected Intersections*. July 2022.

emerging cellular technologies can be leveraged to deliver long range, real-time C-ITS services and use cases that require low latency using the Cellular-Vehicle-to-Everything (C-V2X) specification developed by the 3G Private Public Partnership (3GPP).

Today in Europe, over half a million vehicles are equipped with C-ITS technologies covering over 120,000 km of road coverage, and the advent of these co-operative technologies act as potential enablers to the future successful roll-out of Connected Co-operative and Automated Mobility, especially CAVs.

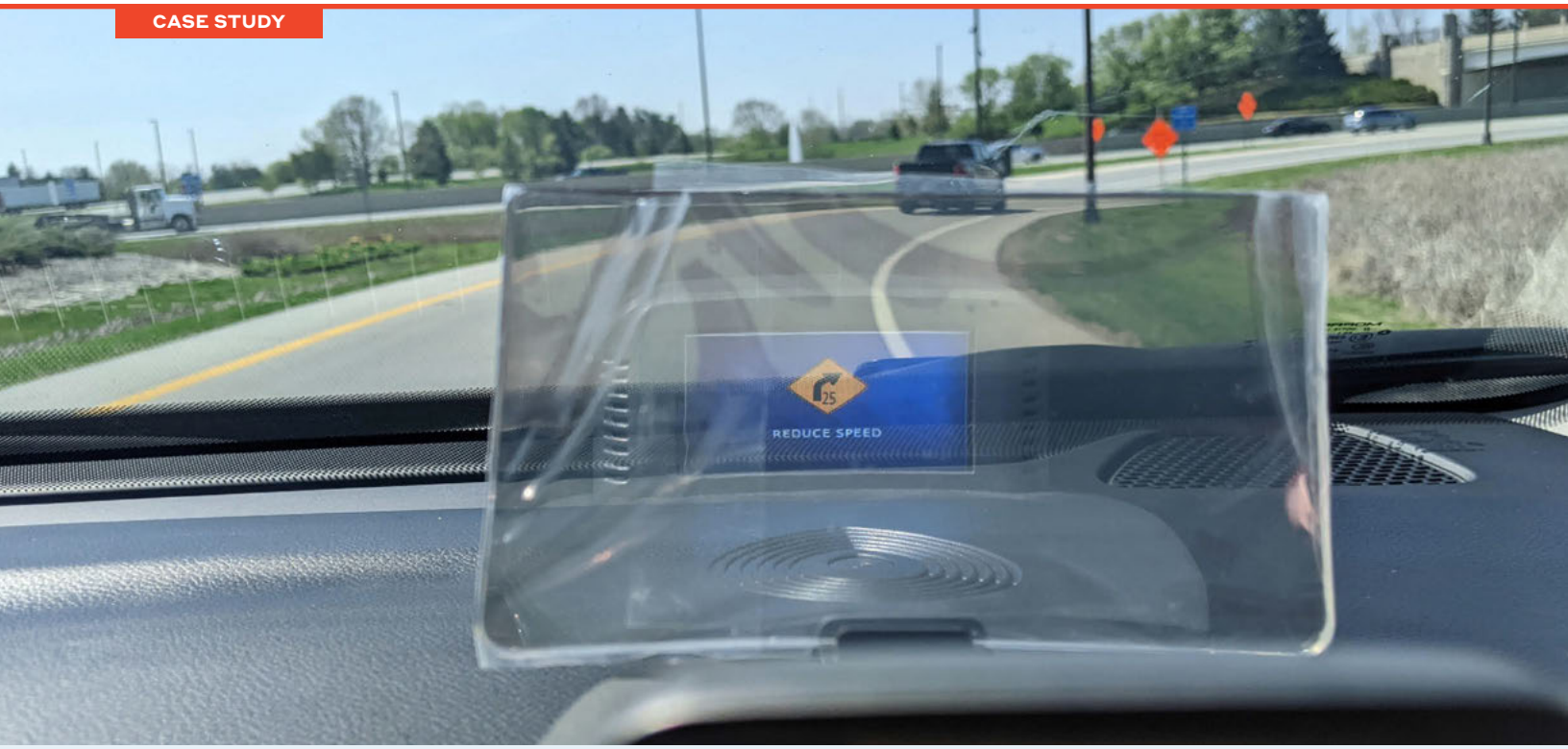
Along with other national and international standards, Australia aligns its vehicle standards with the United Nations Economic Commission for Europe (UNECE) regulations. These regulations cover various aspects of vehicle safety, including crashworthiness, emissions, and vehicle components.

Australia has just published a draft set of principles for C-ITS deployment and ecosystem continues to evolve. There is strong ongoing support for research and development and a shift toward deployment in some Australian states.

Framing CV technology around specific applications helps to identify realistic opportunities and actions that agencies, manufacturers and providers can take to both prepare for and advance connected technologies. This is a central focus that can be discussed and developed in a collaborative manner globally regardless of the specific technical standards and technologies applied.

Application	Examples of how Connected Technologies can enable the Application	
 Safety	**Red light violation warning:** Alert drivers to slow down as they are approaching a red light.	**School zone alerts:** Alert drivers to an active reduced speed School Zone
	Work zone alerts: Alert drivers to an active reduced work speed zone and/or lane closure/shifts.	**Curve speed warning:** Alert drivers to a reduced speed curve or other significant changes in roadway geometry.
 Mobility	**Transit Signal Priority:** Automatically request signal priority if a transit vehicle meets certain conditions, such as being behind schedule by a pre-determined amount of time.	**Freight-specific Dynamic Travel Planning:** Provide route planning for freight vehicles based on current traffic conditions
	Emergency Vehicle Signal Preemption: Automatically request signal preemption when emergency vehicle is responding to a call.	**Road Pricing:** Collect transportation fees based on distance, corridor access, routes driven, time of day, etc.
 Environmental	**Eco-Signalized Intersection Approach/ Departure:** Reduce emissions by managing powertrain operation as vehicles approach and depart an intersection.	**Eco-Speed Harmonization:** Lower speeds upstream of a heavily congested area to reduce the stop-and-go traffic that contributes to driver frustration and crashes.
	Eco-Lanes Management: Reserve lanes for low emission, high occupancy, freight, transit, and alternative fuel vehicles to take advantage of eco-friendly applications.	**Connected Eco-Driving:** Reduce fuel consumption and emissions by providing customized real-time driving advice to drivers.

CASE STUDY



DriveOhio US 33 Smart Mobility Corridor – Reduced Speed / Lane Closure Warnings

The SAE J2735[13] Traveler Information Message (TIM) can support numerous applications including a reduced speed warning, school zone warning, work zone warning, lane shift/closure warnings, and countless others. The desired outcome is that CVs equipped with OBUs approaching a CV-equipped work zone respond with reduced speed and shifting between lanes.

In 2016, the USDOT awarded the NW 33 Innovation Corridor Council of Governments (COG) an Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) grant for the 33 Smart Mobility Corridor (33 SMC). The COG was formed by the City of Marysville, the City of Dublin, Union County, and the Marysville-Union County Port Authority to coordinate multi-agency needs and efforts.

The project involved installing CV OBUs in up to 200 Marysville and Dublin city fleet and first responder vehicles, as well as some RSUs. The OBUs collect and send safety data to RSUs. The 33 SMC demonstrates how smaller cities can leverage innovative technologies, such as CV applications, to improve operations, safety, and mobility.

WSP is providing Systems Engineering activities, including updating the 33 SMC System Design Document and Test Plan, developing application specific test procedures, and conducting OBU testing.

Lessons learned include:

- Define desired OBU application driver alert behavior in OBU procurement documents so as to establish expectations early to deliver preferred outcomes.
- Identify the tools needed to generate appropriate traveler information messages to evaluate and meet pre-defined objectives and success measures.
- Engage roadway operation and maintenance stakeholders early in the project to garner input into planning and gather feedback and insights throughout the effort.

13 Society of Automotive Engineers. *V2X Communications Message Set Dictionary*, SAE J2735, current revision 2022-11-14.

CASE STUDY

Australian Integrated Multimodal Ecosystem (AIMES)

This project, a collaboration between WSP, the Victorian Government and the University of Melbourne's School of Engineering and other 25 leading industry partners from around the globe is the world's first multimodal connected transport laboratory. The laboratory is capable of testing and implementing emerging technologies at a large scale in complex urban environments.

Since 2016, WSP's ITS team has been working closely with partners to develop the test bed, to integrate emerging technologies that help to reduce congestion, improve livability and deliver more sustainable transport outcomes for the local community.

The partnership is focusing on the development of a National Connected Multimodal Transport (NCMT) test bed. This focuses on multimodal transportation systems consisting of connected vehicles, connected roadways, connected city logistics, connected public transportation and connected pedestrians and cyclists.

The test area includes a six square kilometer grid of streets across Melbourne's inner North – a living laboratory – complete with all the realistic complexities, obstacles and rules that come with urban travel, providing the project with connected data from vehicles, cyclists, pedestrians and infrastructure. Thousands of sensors and wireless units fitted to roads, traffic signals and vehicles are generating connected data.

The trial aimed to enable faster cooperative and automated vehicle (CAV) response times to impending events and effectively assess threats to vulnerable road users (VRUs) as well as CAVs. From a broader perspective, the trial confirmed the benefits of the AIMES test bed as an effective test environment enabling rapid, highly collaborative trial deployment.

The test bed is an excellent opportunity to obtain empirical impacts of disruptive technologies for carefully staged pilots and trials which a range of technology partners. WSP assists by providing a key coordinating role alongside VicRoads and University of Melbourne.

Lessons learned include:

- It was demonstrated that by investing in smarter connected infrastructure (such as devices based at intersections) we can realize the safety benefits of Connected and Automated Vehicles sooner, rather than wait for vehicles to be rolled out en masse.
- We can tackle traffic congestion by leveraging machine learning techniques to analyze huge amounts of data and recommend appropriate solutions.

CASE STUDY

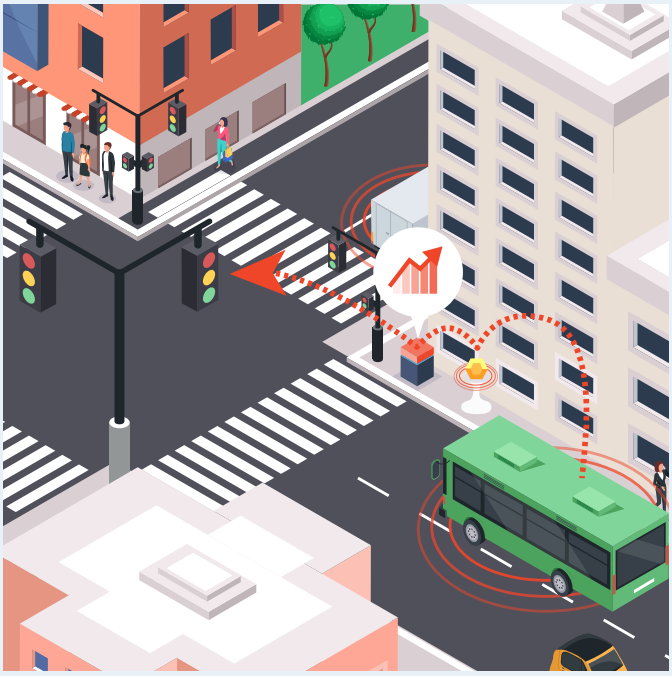
Smart Columbus Connected Vehicle Environment, Transit Signal Priority

If a CV-equipped transit vehicle with an on-board unit is behind schedule or has a specified passenger capacity, it can request signal priority at a CV-equipped intersection. This will ultimately allow transit vehicles to get back on schedule by reducing the amount of time the transit vehicle sits at red lights.

In 2016, the USDOT awarded USD 40 million (~ CAD 54 million) to the City of Columbus, Ohio, as the winner of the Smart City Challenge. Columbus used this funding to integrate an ecosystem of innovative technologies to bridge Columbus's most pressing community-centric transportation problems—the sociotechnical gap. The Connected Vehicle Environment project focused on enabling technologies by integrating smart traveler applications and deploying CV infrastructure.

WSP USA developed the concept of operations, system requirements, system design document, test plan, and test procedures systems engineering documents for the connected vehicle environment. WSP also oversaw the integration of roadside units with traffic signal controllers, and on-board units into transit vehicles. WSP conducted testing to verify transit signal priority, emergency vehicle preemption, and various other CV applications.

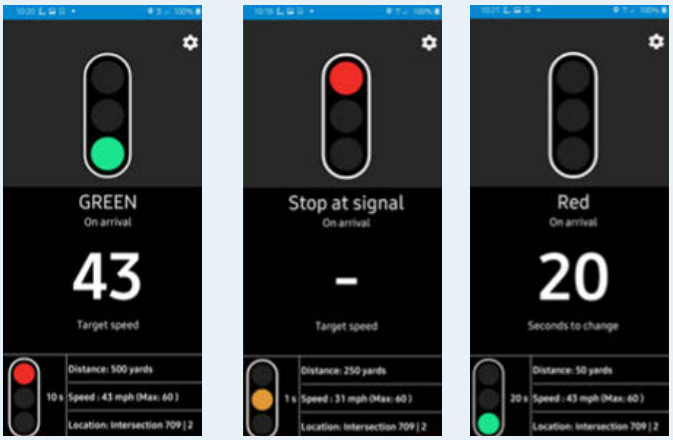
For transit signal priority, the SAE J2735 Signal Request Message (SRM) and Signal Status Message (SSM) standards were used. The transit vehicle on-board unit broadcasts a SRM to request priority. Roadside units receive and either process these SRMs directly or forward them to traffic signal controllers or other roadside devices. The traffic signal controller makes the determination if signal priority can be given and sends an SSM, or data to be contained in an SSM, to the roadside unit for broadcast in response to an SRM.



Lessons learned include:

- Defining potential maintenance and upgrade cycles for technologies used in a project and building them in the project schedule and budget reduces potential unexpected changes down the road, especially when working with emerging mobility technologies early in their evolution.
- Identifying transit partners early on helps set the appropriate level of engagement and communications expectations with the industry, creating a partnership approach.

CASE STUDY



Green Light Optimized Speed Advisory Graphic Example

United Kingdom Green Light Optimized Speed Advisory

Connected eco-driving utilizes vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) data to provide customized real-time driving advice to drivers. This includes recommended driving speeds and optimal acceleration/deceleration profiles, so that drivers can adjust their driving behavior to save fuel and reduce emissions.

Avoiding traffic queues and congestion is a key driver in the uptake of public transportation. Green Light Optimized Speed Advisory (GLOSA) is being trialed in the United Kingdom to support the prioritization of public transportation.

GLOSA provides visual and / or audio guidance on when traffic signals are expected to change so drivers can slow their speed before a traffic signal to avoid harsh stopping, ultimately reducing emissions.

This project specifically focuses on traffic signal infrastructure and its interaction with cloud and in-vehicle systems. It supports efficient use of existing transportation systems. Read more about this and other WSP environmental-related projects in the whitepaper *Intelligent Transport Systems Enable the Decarbonization of Road Transportation*.

Lessons learned include:

- The most successful trials to date include those involving Heavy Goods Vehicles (HGVs) and commercially owned cars. There are now plans to trial GLOSA at scale with privately owned cars.
- Successful trials demonstrate fuel efficiencies of 3-27% depending upon how advice is given.
- Access to accurate signal timing data from traffic signal controllers is key and can be achieved via connection to existing back-office systems.
- Latency in communications to individual roadside units can impact upon the accuracy of advice.
- The UK traffic signal industry is not yet geared up to provide access to the signal timing data even though existing European standards are defined for timing and location data;– therefore, more work is required.
- Highly adaptive forms of signal control, where large changes in timing between stages can occur, currently require a prediction engine.
- GLOSA where signals employ adaptive control is unproven.
- A central database for signal timing data will be required to implement GLOSA at scale.

What you can do now, and what you can start planning for

Define and Advance Connected Data Needs

- Continue to refine and improve use cases. Ensure there is widespread engagement with all road users and across government, academia and industry to cover all needs and importantly prioritize development and deployment, one step at a time.

- Identify the connected data needs of both the public and private sector in your region. Develop data governance, security, privacy and management policies and plans. Understand what can be done, where there are gaps and what you should do now in preparation for future connectivity data needs.

Define and Advance Connected Vehicle Infrastructure

- Evaluate existing ICT infrastructure and its ability to support connected data (data storage size, computing power, latency, security protocols, etc.), identify gaps and develop an IT infrastructure upgrade deployment strategy.

- Define current and future physical connectivity needs, such as broadband, fiber and wireless communications. Research ways to partner with the public and private sectors to enhance the communications and connectivity network collaboratively and collectively (e.g., installing dark fiber lines when completing roadway reconstruction projects for future use).

Understand Funding Opportunities

Grant and other funding opportunities are available for deployment of connected technologies across the V2V, V2I and V2X landscapes.

- USDOT Strengthening Mobility and Revolutionizing Transportation (SMART) Grant[14]

- USDOT Advanced Transportation Technologies & Innovative Mobility Deployment (ATTIMD) Grant[15]

- Australian funding is currently state based and needs to be strongly aligned with road safety and congestion strategies and outcomes.

- Transport Canada - Program to Advance Connectivity and Automation in the Transportation System (ACATS)[16]

Incorporate Connectivity into your Strategic Planning

Include connected technology strategies in project selection, planning, and scoping. (e.g., Are there planned infrastructure improvement projects that could include the addition of connectivity for added benefits with minimal additional scope or impact?) This may include incorporating connectivity as an evaluation criterion for project selections, adding as value-adds / desired attributes for upcoming procurements and including CV subject matter experts in key strategy discussions and committees or other activities to integrate the connected discussion throughout your organization.

Difference in Global Direction

There are different approaches to standards and deployment globally but strong recognition of the importance of global compatibility in the long term.

For the European Union (EU) and the United Kingdom, a continued focus on C-Roads will provide the building blocks for connected services and facilitate interoperability between service providers. Network coverage, particularly in rural areas continues to pose challenges to ubiquitous connectivity.

Greater emphasis on the Safe System approach[17] can lead to a greater reliance on connected vehicles and understanding how to capitalize on the safety benefits that connectivity can provide. The EU ITS Directive requires data for road safety traffic information to be provided free of charge, where possible; however, continued work is required to create interoperable data exchange. In the EU, it has been compulsory since 2018 for new vehicles to be equipped with eCall. Clarity around the value chain and unearthing where support may be needed to create the business case for providing connected services.

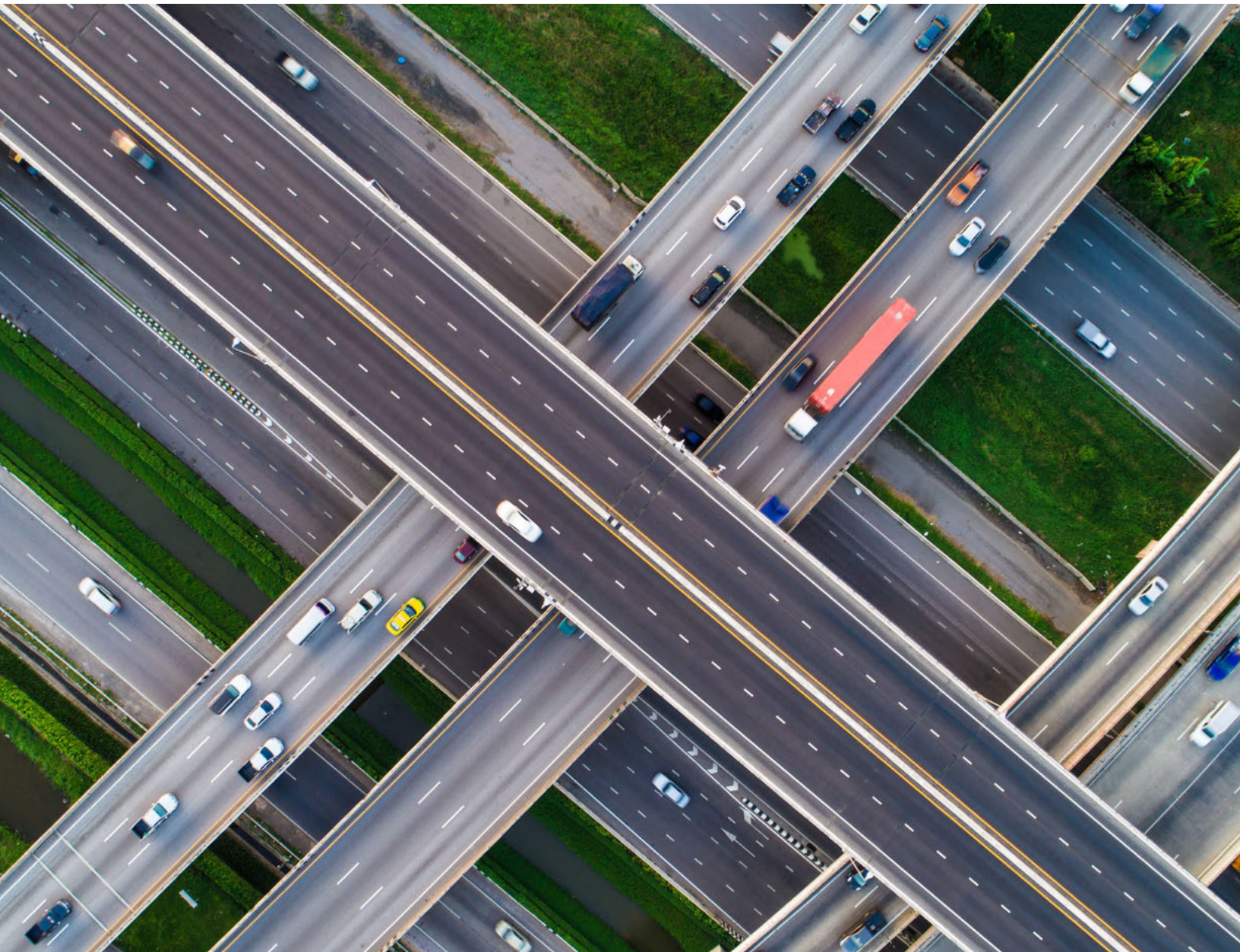
Challenges around data privacy and ownership will need to be resolved if the full benefits of connected services are to be realized; a conservative approach is taken at the moment: "If in doubt, don't share" (data). The Data for Road Safety Group (DFRS) will continue to grow and develop the range of connected services available in vehicles, with an emphasis on assuring the quality of data shared. DFRS has proven the benefits of, and need for, collaboration between original equipment manufacturers, systems providers and road network operators.

14 *Federal Register*, The Daily Journal of the United States Government.
15 Federal Highway Administration, U.S. Department of Transportation.
16 Program to Advance Connectivity and Automation in the Transportation System, Government of Canada.
17 WSP Vision Zero Brochure

For Australia, alignment with UNECE is critical and means Australia will be likely to continue to align with the EU approach to standards and deployment.

There are a range of different approaches to deployment globally, including another set of standards for motorways in Japan.

It is important that countries focus on proof of value of these technologies and standards in meeting their ultimate needs and act when there is a clear return on investment. While there may be some differences in standards globally, these differences are only a small part of the overall ecosystem and preparation to improve connectivity and provide better information to end users. Broad consideration as part of strategic planning should help ensure further no-regrets development in connected vehicles. However, it is critical that within any jurisdiction there is a clear direction for deployment discussed with industry to ensure all vehicles, infrastructure and systems are aligned to get the outcomes sought.



Electric

What it is

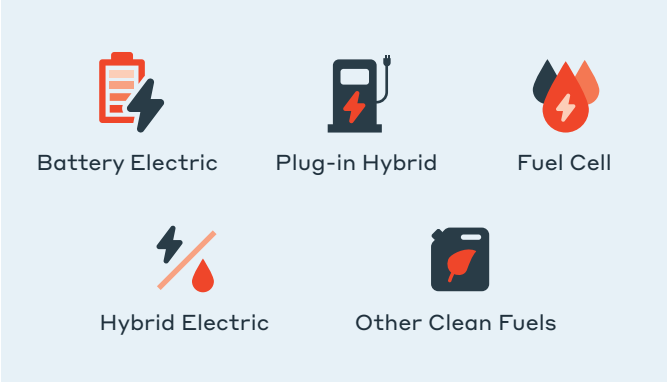
Electric vehicles (EV) refer to vehicle types beyond those whose primary source of propulsion is an electric motor and includes zero-emissions vehicles (ZEV) that do not emit exhaust or other pollutants from their sources of propulsion, including battery-electric vehicles (BEV) and fuel-cell electric vehicles (FCEV).

Although governments worldwide are by nature focused on the transit industry, embracing a transition to ZEVs as part of concerted efforts to meet broader climate change mitigation targets, this focus now extends well beyond public transport fleets. The mature adoption of EV's in the passenger and transit vehicle space has now been accompanied by investments in commercial fleets as well as maritime and aviation sectors. EVs are not just for person movement.

This wider focus requires coordination and collaboration between numerous stakeholders, including regulatory agencies, governments, utilities, manufacturers, service providers, and climate activists, with each stakeholder facing a broad range of new challenges in the increasingly cooperative quest to plan, manage and finance a large-scale transition to electrified modes of transport.

Millions of ZEVs, both battery-electric and fuel-cell vehicles, are already in service in cities around the world, transporting millions of passengers and tons of freight on a daily basis. Lessons learned from those early adopters go a long way to helping advance the state-of-the-art, which continues to evolve at a rapid pace. The emergence of new and more affordable technologies, refined business models, clearly defined policies and legislation, and flexible financing options together contribute to a set of more comprehensive and implementable options for addressing the many challenges of large-scale EV technology adoption.

On the other hand, ZEVs present significant implications for the development of a robust infrastructure network. Access considerations will vary greatly for different customers of these vehicles, ranging from larger fleets with dedicated charging infrastructure to shared-use charging that is strategically installed along major travel corridors, key destinations, and medium / high density urban areas which may not have off-street parking facilities with charging infrastructure.



Additionally, ZEVs require fleet operators, policymakers, regulators, manufacturers and planners to completely rethink mobility best practices. For example, ZEVs require different workforce considerations with a new set of training requirements. They also require increased resilience considerations to ensure that EVs can operate during blackouts or other grid events. Lastly, they require constant monitoring of technological improvements, such as increased vehicle range and service requirements.

Historically, vehicle range for both fleet and personal use has posed real and increasingly perceived challenges as vehicle range has improved. Additionally, post-pandemic supply chain disruptions have caused a backlog of electric vehicles and supporting charging infrastructure due to a shortage of raw materials. This is further aggravated by an influx of orders for both private and public customers in the wake of tax incentives, rebates and policy targets.

Readily available charging infrastructure is a key component to the adoption of ZEVs. New EV drivers, especially those with access to only one vehicle, must be able to reliably travel to the same locations as with their previous vehicles. Additionally, access to EV chargers needs to be available to drivers beyond socioeconomic and locational restrictions. All these considerations will become especially important as policy continues to require the implementation of ZEVs.

Why it matters

In response to new environmental policies and regulations, countries, cities, car manufacturers and fleet operators are now seriously considering and actively adopting ZEV propulsion options. The result is a shift from petrol- and diesel-fuelled combustion engines toward a focused strategy for the electrification of vehicle fleets.

One reason for this shift is the clear benefits of EVs. Given the current technology readiness, rate of adoption and market acceptance, of all four aspects of New Mobility, the immediate benefits of an electric fleet are most widely recognized across government entities and the private sector and by consumers.

The extent of benefits will depend on local circumstances, but there is a consensus that the key opportunities include:

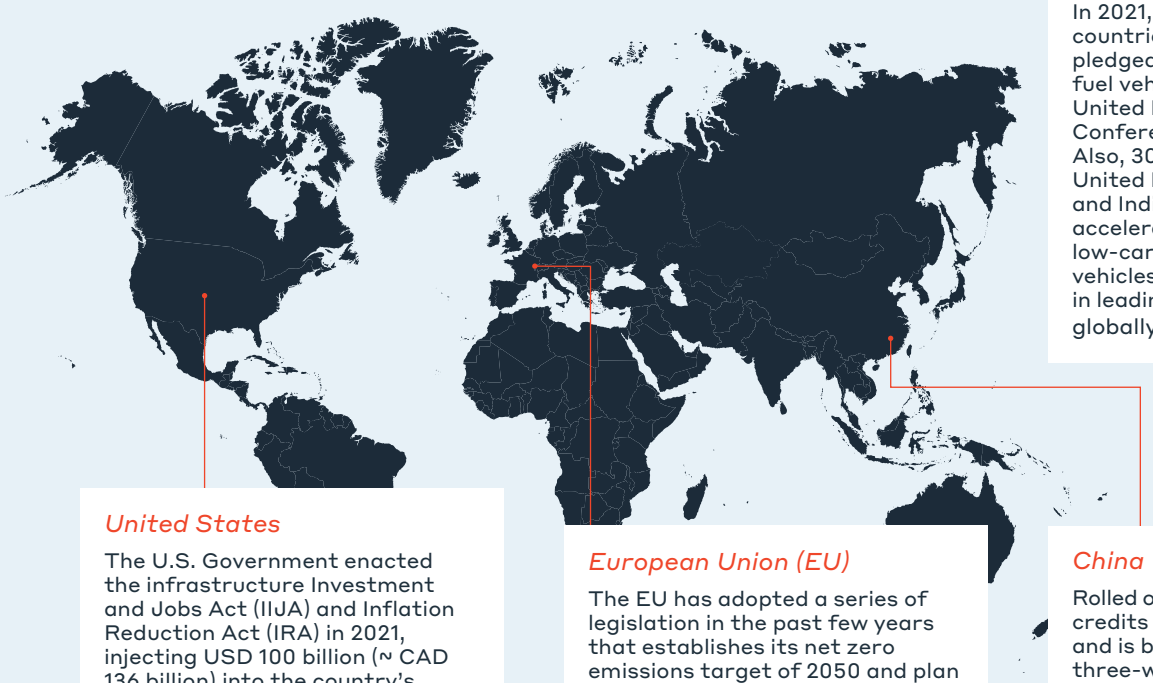
- Reduced CO_2 emissions from the burning of fossil fuels, which will help address global and country specific emissions reduction targets to tackle climate change.
- Better air quality and heathy communities particularly in urban centers, due to reduced local emissions.
- Reduced costs for users, expected to increase as developments in battery technology continue.
- Better vehicle reliability relative to petrol and diesel models, due to simpler systems within the vehicle.

ZEVs present an opportunity to excite a new generation of the transit workforce about cutting-edge technology. This, combined with both private- and public-sector funding, could lead to a major shift toward greener transportation infrastructure.

Why we're still talking about it

Since the development of *New Mobility Now*, EVs have gained significant public confidence and popularity and governments have created targets and in some cases mandates to reduce or stop ICE production. The shift to electrification has developed buy-in from both the public and private sectors, propelling the market forward with a clear upward trajectory. This differs significantly from automation and connectivity, which have hit speed bumps over the past few years with limited opportunity for public engagement with these solutions.

Government commitments



Globally

In 2021, a group of hundreds of countries, cities and companies pledged to end the sale of fossil fuel vehicles by 2040 at the United Nations Climate Change Conference in Glasgow, Scotland. Also, 30 countries including the United Kingdom, Canada, Mexico and India pledged to rapidly accelerate the transition to low-carbon and zero-emission vehicles, achieving 100 percent in leading markets by 2035 and globally by 2040.

United States

The U.S. Government enacted the infrastructure Investment and Jobs Act (IIJA) and Inflation Reduction Act (IRA) in 2021, injecting USD 100 billion (~ CAD 136 billion) into the country's economy for investment into the electric vehicle industry.

European Union (EU)

The EU has adopted a series of legislation in the past few years that establishes its net zero emissions target of 2050 and plan to end ICE vehicle sales by 2035.

China

Rolled out New Energy Vehicle (NEV) credits in 2017, updated in 2021, and is banning ICE versions of two/three-wheelers in multiple cities.

Private sector commitments

- **Tesla:** fully electric fleet today
- **GM:** Plans to stop selling gasoline and diesel vehicles by 2035
- **Ford:** Investing USD 22B (~ CAD 30B) to delivery battery EVs and plans tobe carbon neutral by 2050
- **Honda:** Will only sell EVs and hybrids in Europe starting 2023; by 2030, phase out all gasoline cars by 2040
- **Bentley:** Fully-electric fleet by 2030
- **Volkswagen:** 70% of European sales will be EVs by 2030; 50% full-electric vehicle sales by 2030 in U.S. and China
- **Volvo:** All-electric vehicle sales by 2030
- **Mitsubishi:** 50% of its global sales plan to be EV by 2030
- **Hyundai:** Carbon-neutral by 2045, new vehicles all-electric by 2025, 100% zero-emissions brand by 2030
- **Mercedes:** All new vehicle platforms will be EV-only by 2025

EV sales have been growing rapidly with the support of both government entities and vehicle manufacturers. Whereas annual EV market share was around 1 percent globally when *New Mobility Now* was published in 2017, contemporary EV market share was 8 percent in 2021 and 13 percent in 2022. EVs are increasingly becoming a normalized mode of transportation. Despite the good news on EV sales as it pertains to emissions and GHG reduction objectives, EV charging infrastructure needs to better support this growth, especially during grid anomalies.

During Winter Storm Uri in 2021, multiple regions within the United States, especially Texas, were hard hit.[18] The severe ice storm highlighted the deficiency of the electrical grid as it tried to support power outages, generators, electric vehicle charging, and other energy needs that overstressed and overpowered Texas's energy grid. Interestingly, EVs may be part of the solution—directing current from charged EV batteries into home appliances and other essentials during grid disruptions.

Charging infrastructure needs to rapidly improve as increased regulations and policies drive the adoption of EVs. Select examples from across the globe include:

- California has adopted Executive Order N-79-20 in 2020.[19] It mandates that by 2035 all in-state sales of new passenger vehicles must be ZEVs.

- Washington state adopted state mandate ESSB 5974, calling for a reduction in GHG emission of 45 percent by 2035.

- The Canadian federal government has announced proposed regulation (Dec 2022) requiring new light duty vehicles to be a minimum 20% ZEV in 2026 and increasing to 100% by 2035.[20]

- In October 2021, 15 nations signed a global Memorandum of Understanding for zero-emission medium and heavy-duty trucks, targeting 30% of new vehicle sales by 2030 and 100% by 2040. This pact now extends to 27 nations in 2023.[21]

Altogether, these mandates for EV adoption require a concurrent increase in the capacity and availability of EV chargers.

18 Rocky Mountain Institute (RMI). *Are We Ready for Another Uri?* February 15, 2022.
19 State of California. *Executive Order N-79-20, 2020-09-23*.
20 Proposed regulated sales targets for zero-emission vehicles, Government of Canada
21 Global Memorandum of Understanding on Zero-Emission and Medium- and Heavy-Drive Vehicles, Drive to Zero.

CASE STUDY

BlueIndy Electric Vehicle Charging Infrastructure

BlueIndy Infrastructure Reuse Feasibility Assessment

Converting underutilized properties or programs (e.g., park-and-ride lots, City Carshare systems, etc.) into EV charging locations represents a method to increasing charging networks.

Between July 21st and August 31st, 2020, WSP USA supported the City of Indianapolis in conducting a technical analysis of the former BlueIndy Carshare System. The study was done in conjunction with a request for information (RFI) made public by the City to gather ideas for site reuse and decision-making on infrastructure development. Using the information gained by studying the system, WSP conducted a critical analysis of the 17 RFI responses that the City received.

This project included three major components: 1) studying the existing infrastructure, technology, and operating system; 2) defining the value and costs associated with the system; and 3) determining the feasibility of upgrading existing infrastructure and the power supply. The system consisted of 89 individual charging sites, each with four or five Level 2, 208 V/16 A chargers.

Throughout the project, information was gained through data provided by the City, meetings with City representatives, meetings with the Indianapolis Power & Light Company (IPL), multiple field visits to BlueIndy and BlueLA sites, and the team's local knowledge of Indianapolis and its environs. The result of WSP's technical analysis was provided to the City in the form of two draft technical memos and two final technical memos.

Lessons learned include:

- Gathering the wealth of information necessary to effectively develop the project can pose challenges, such as tracking down manufacturer details, hearing from former users, or coordinating with utilities organizations.
- Building appropriate time into project schedules can provide the appropriate amount of time needed to properly engage stakeholders to gather holistic information.

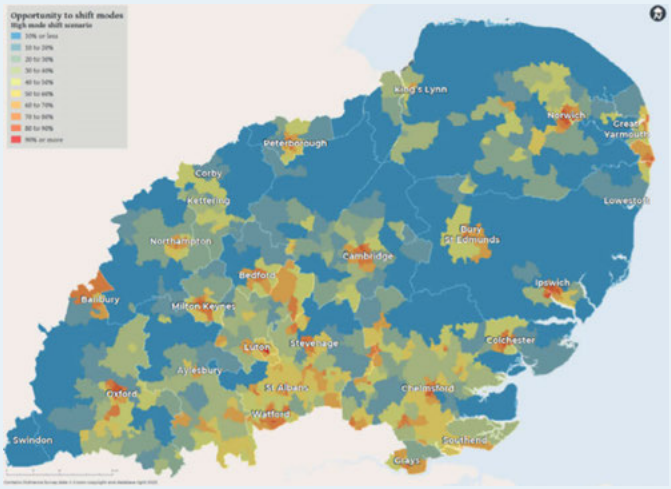
CASE STUDY

Transport East/EEH EV Insights

WSP UK utilized *EV:Ready*, an electric vehicle (EV) uptake forecasting and modelling tool, to support Transport East (TE) and England's Economic Heartland (EEH), two of England's seven Sub-national Transport Bodies (STBs). The tool helps identify the infrastructure needs, constraints and opportunities that support and enable a transition to EVs as part of the wider decarbonization of transport to net zero 2050. Work included an assessment of which existing car trips could switch to sustainable modes across the two STB regions, forecasting EV uptake and electric vehicle charge point (EVCP) requirements, and evaluating the involvement of local authorities in supporting the most effective distribution of deployment.

A key aspect of electrification is the region-specific adoption of ZEVs. Evaluation of mode shift opportunities, baseline analysis including grid capacity and energy supply, ZEV sales trends, and scenario development can help paint the picture of EV uptake, charging demand and supply, and needs of government and planning organizations.

This project is part of a joint venture between Transport East and England's Economic Heartland due to the similarities of the two regions geography and transport approaches. The team forecasted the scope of publicly funded EVCP by performing a gap analysis that identified where the private sector is less likely to meet EVCP requirements. Partnering with TE and EEH enabled WSP to develop a customized analysis to develop their ZEV uptake strategies. In addition to being used to support Sub-national Transport Bodies (STBs), *EV:Ready* has helped several local transport and planning authorities with the development of their EV strategies, and will continue to play a part in supporting the UK reach its net zero ambitions.



Insights and Outcomes

- EV forecasting and modelling tools such as *EV:Ready* can help government and local authorities identify existing charging infrastructure, develop strategies for deploying new charging infrastructure, and understand how deployments can leverage better business cases.
- EVs may play a vital role for short trips in rural areas, where less than 20% have viability for a shift to sustainable modes. EV uptake can also be significant for longer trips (over 8 km) in both urban and rural contexts, where only 14% of trips show the opportunity to shift to public transport when considering a high mode shift scenario. Transitioning these trips to electric vehicles can contribute to reducing end-user tailpipe emissions across the STB regions and help deliver strategic priorities of decarbonizing transport.
- Transitioning to electric vehicles could present a significant strain on energy networks and grid capacity, promoting the need to engage with grid network operators to better understand how to overcome constraints. As demonstrated through the TE/EEH project, the EV:Ready tool can help identify locations most susceptible to capacity constraints to better inform this engagement.
- Using the bespoke *EV:Ready* tool, Sub-national Transport Bodies and their partners can access a personalized analysis that outlines the present baseline situation and trends in their region, providing forecasts to support the development of effective EV strategies. The analysis enables STBs to work collaboratively with local authority and business partners to help prepare and deploy vital infrastructure supporting the uptake of electric vehicles.

CASE STUDY

City of Toronto Economic Impact Analysis – Taxicabs, Limousine and Private Transportation Companies

In December 2018, WSP was contracted by the City of Toronto to evaluate and reflect on the economic impacts of private transportation companies including UBER, which had then been operating in the city for several years. The study consisted of three primary components: 1) data gathering and research focusing on the past and current industry landscapes in Toronto and comparable jurisdictions in North America 2) review of economic and social changes affecting residents, consumers and the City in terms of quality of life, consumer choice, access, tourism, and environmental changes in the city. 3) Consultation with drivers and industry to understand perceptions of regulations, industry accessibility and to collect data on ridership and revenue. The full report is available on the City of Toronto website.[22]

Lessons learned include:

- Data is at the centre of economic mobility studies and people are sometimes at the centre of key datasets. When designing survey questionnaires, it is important to balance the level of detail with ease of use and simplicity to optimize data quality.
- Drilling down into seemingly limited datasets obtained can reveal insights that mitigate the risk of biased outcomes.

22 *Economic Impact Analysis of Toronto's Taxicab, Limousine, and Private Transportation Companies*, City of Toronto, May 17, 2019.

CASE STUDY

Public Transit and Municipal Fleet Low Carbon Migration Strategy, Saint John, NB

An example which illustrates the geographic diversity and breadth of the commitment to electrification in North America is the City of Saint John, New Brunswick. In August 2021 the City of Saint John commissioned WSP to identify and assess technologies, infrastructure and supporting policies to decarbonize the City of Saint John's public transit and municipal fleets.

The project included two main phases; the first phase included reviewing the baseline and forecast GHG emissions and operational characteristics for the fleet, and the development and appraisal of potential technology and policy decarbonization measures tailored to align with best practice, the City's strategic plans and fiscal parameters. A detailed technical and financial roadmap was then developed for the transit and corporate fleet transition processes covering vehicles, municipal facility modifications required for electrification, charging infrastructure requirements, power needs assessments and resilience assessments. The study aligns with the City Climate Change action plan to achieve net zero by 2040. The project was completed in March 2022.

Lessons learned include:

- Early-stage site surveys proved invaluable to design efficiency.
- To mitigate the risk of implementation delays caused by long lead times and supply chain issues related to procurement of EV charging equipment and associated components, it is important to identify a diversified supplier base, appropriately leverage industry connections and secure alternative sources of equipment.
- Temporary charging infrastructure measures can also enable short-term relief to longer-term procurement and supply-chain issues.

What you can do now, and what you can start planning for

Align organizational, local, regional and national electric mobility strategies and objectives.

Getting alignment and agreement across organizations, sectors, and jurisdictions in your region can enable collaborative partnerships and initiatives to advance electric mobility goals.

- Incorporate electric capacity, availability, opportunity and efficiency in project planning and scoping. This should go beyond electric vehicles and consider electric mobility, more broadly including development of electric or low-emission buses and public transport systems and support for active transport modes, i.e., cycling (including e-bikes and scooters) and pedestrians.
- Integrate health and equity into planning and scoping processes to identify where high- emissions areas may be impacting communities, air quality, etc. These could be priority areas for electrification of vehicle fleets.
- Evaluate and pursue available funding opportunities (e.g., Infrastructure Investment and Jobs Act (IIJA) for US) to help fund initiatives, and where applicable, make grants available to localities, non-profits, and the private sector to provide support with their own investments for partnerships.
- Take advantage of logical business models, such as focusing on infrastructure with routes likely to be electrified or benefit near-term from electrification (e.g., short haul/loop routes).
- Support innovative electric vehicle and charging solutions, through partnerships and collaborative initiatives with public, private and non-profit partners.

Establish electric mobility and charging implementation strategies.

Reliable, available charging infrastructure is key to electric mobility strategies long-term. Without a sufficient density of charge points, drivers may suffer from range anxiety, ultimately impacting adoption rates.

- Consider ways to encourage the use of electric vehicles on the network, such as by providing information on charge points.
- Support the build-out of EV-charging infrastructure by partnering with the private sector to provide design guidelines and prioritize certain routes and locations.
- Identify existing charging infrastructure, opportunities for deploying charging infrastructure and how deployments can be integrated with other initiatives.
- Identify upcoming construction, maintenance or development projects on or near roadways, parking lots, etc. that could incorporate installing EV charging infrastructure within an existing project to reduce costs and maximize benefits.
- Establish comprehensive policy standards for electric charging provision by location and land use.
- Expand the availability of rapid charging stations across the on-street network and review parking policies to support the use of shared electric vehicles.
- Prioritize convenient locations of electric vehicle parking bays over traditional parking bays.
- Provide electric charging infrastructure at new developments, considering a range of charging types to accommodate needs of shared, freight and personal vehicles for short-term and long-term charging demands.
- Consider electrification of fleets, such as public vehicle fleets of maintenance vehicles. Include deployment of EV charging infrastructure where those vehicles are stored.

Shared

What it is

Shared mobility refers to any transportation service that is utilized by multiple users, including all forms of public transportation, as well as some individual modes of transport. Sharing can take many forms. It can be multiple individuals simultaneously within the same mode (i.e., ridesharing), it can be a consecutive sharing of vehicles from one individual to another (i.e., bike sharing), or it can extend to multiple applications within one trip (i.e., using a shared scooter at a transit hub).

Shared mobility has experienced rapid change over recent years, diversifying as digital information and app-based tools have evolved. Specifically, taxi and ride-sharing services have experienced substantial changel due to the emergence of new sharing platforms (i.e., apps with multimodal options and integration with transit ticketing systems) and new modes of transport (i.e., electric scooters). Despite the changing landscape of shared mobility, the basic premise has remained the same: sharing allows for a more efficient transit network at a fraction of the cost of private car ownership.

Mobility as a Service (MaaS) expands on shared mobility by commercializing it for personal travel or the shipment of goods. A particular trip can take advantage of one or more forms of shared mobility to produce a seamless journey. A wide range of shared mobility services are currently offered based on location, origin and destination. Trips are typically booked through digital apps with costs that are either pay-as-you-go or bundled. MaaS models work best where there is already a wide range of transport modes, open data access and third-party ticket sales.

Smartphone availability is driving the adoption of MaaS and new mobility alike. It has transformed the commercial marketplace for personal shared mobility, enabling the emergence of Uber, Lyft, Didi, Ola, Gojek and many similar pay-as-you-go services. Contactless payment cards are also accelerating access to shared mobility by allowing users to bypass the need for specialist ticketing or travelcard systems in public transit systems.

Traditional public transportation services, such as buses and trains

Vanpools, carpools, shuttles, transport network companies (TNCs) and rideshare pools

Carsharing, bikesharing, scooter sharing in all its forms

Flexible goods movement and courier network services (CNS)

In parallel to public transportation, bike sharing has become greatly utilized in the last two decades. With the initial concept in 1965, to 75 schemes in 2005, the global total now stands at over 10 times that amount.[23] Car sharing is slated to experience a similar trajectory. Car clubs, peer-to-peer sharing models, and fractional ownership models are promoted by manufacturers to accelerate sales.

While operation across modes vary, they all share a reliance on data and analytics to manage vehicles and user booking and a significantly improved user experience. This increasing seamlessness of shared mobility, combined with the high cost of living in urban centers, public interest in sustainable lifestyles, and emergence of smartphone-based mobility apps have caused a proliferation in new shared-mobility options.

23 European Cyclists Federation. Bike Share Schemes.

Why it matters

Shared mobility has the potential to serve areas that are often overlooked or underserved by existing transit options. Better service information is supporting the transition by helping users understand the range of shared-mobility options offered. This increases equitable access to both public and private services.

Shared mobility is blurring the line between public and private transportation. This presents a challenge for transport regulators and operators in the context of everyday network management. It also offers an opportunity for better collaboration between public authorities and the private sector—namely, infilling routes that have proven difficult to support individually. It could additionally allow for first- and last-mile feeders to support higher-capacity transit. Governments across the world must assess the societal good in any arrangements between private and public providers. Agencies must avoid the privatization of routes and trip types that are oriented toward high profitability by private operators, not for maximizing mobility and accessibility.

The general ability to increase network efficiency will reduce congestion, vehicle distance travelled, and emissions. It also allows for more cost-effective transportation solutions that rely on shared mobility solutions over hard infrastructure.

Shared mobility in the freight sector prioritizes the reduction of "empty running" through freight brokerage platforms. This mainly occurs via shared and consolidated deliveries and through a more efficient means of last-mile logistics.

Why we're still talking about it

Implementing and advancing shared mobility remains a priority for most jurisdictions; however, many are currently uncertain how to maximize its benefits. The COVID-19 global pandemic highlighted a few challenges that slowed the rate of implementation across countless communities. The introduction of social distancing and heightened standards of cleanliness caused long-lasting shifts in transportation. Many people were and continue to be significantly less comfortable sharing space with others, which impacts mode use ranging from public transit to on-demand rideshare. In response, many pilots were cancelled and are experiencing issues restarting.

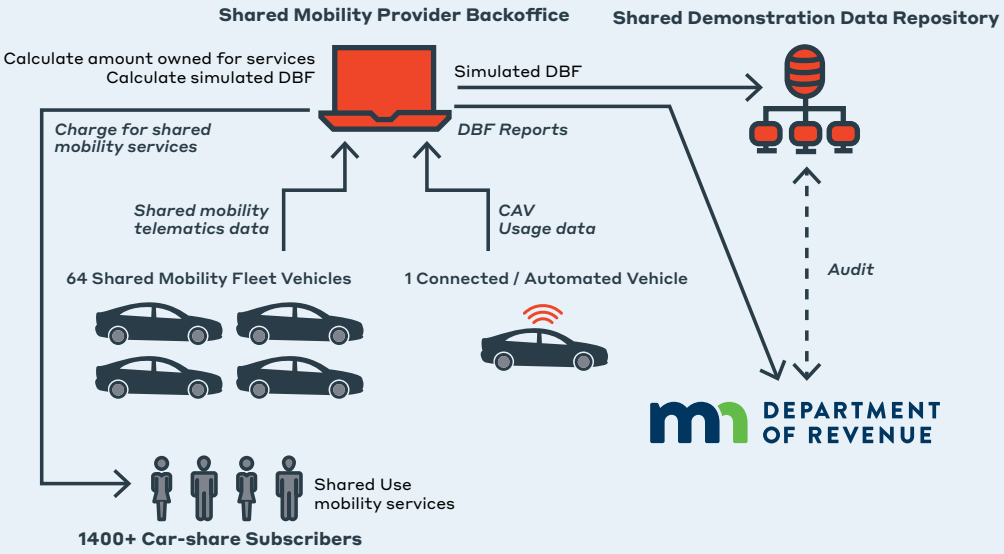
On the other hand, COVID-19 has accelerated the penetration of shared goods and services. Populations that previously experienced difficulty accessing certain commodities are able to obtain food and groceries despite location or situation. COVID-19 expanded the take-up of some shared mobility services—for example, ebike and escooter schemes in Detroit, Michigan in the United States.

Shared mobility raises questions beyond the scope of COVID-19. An increase in shared mobility will cause a reduction in both vehicle miles travelled and the number of vehicles on roadways. While this reduces wear and tear on transportation networks, it also causes a decrease in revenue to fund maintenance and improvements. The interaction between shared mobility and transportation funding is an important consideration that needs continued evaluation.

CASE STUDY

Project Highlight

The Demonstration ran from April 2020 through March 2021, right in the heart of the global pandemic. Although ridesharing and transit saw a steep usage drop, carsharing only had a minimal usage dip, with usage back to normal in just a few months. Carsharing enables shared mobility objective while offering consumers more comfort in their usage (rides are not shared; cleaning between users) and allowed many in urban areas to reduce or do away with personal car ownership (especially with the uptick in telecommuting wich reduced personal travel needs).



MnDOT Distance-Based Fee Demonstration Data Flow Diagram

Minnesota Distance-Based Fee Demonstration Integration of MaaS, CAV, and Road Usage Charging

WSP USA led the development, deployment, and operation of a 12-month demonstration for carsharing and connected automated vehicles for the Minnesota Department of Transportation (MnDOT). In collaboration with MnDOT and the Minnesota Department of Revenue, WSP developed policy guidance, design and implementation materials, systems evaluation and testing, (simulated) revenue collection, and tax reconciliation and auditing.

Minnesota hoped to understand how the state could both advance shared mobility while simultaneously ensuring sustainable funding. WSP and MnDOT examined the application of a distance-based fee on shared mobility fleets through carsharing provider partners. The goal was to understand the technical feasibility, ease of use and reporting for the providers, and obstacles and opportunities available for private-public collaboration. MnDOT held sessions with carsharing partners to understand how a distance-based fee program may impact their day-to-day operations. MnDOT wanted to additionally understand how to develop a streamlined fee structure and reporting and how to continue advancing shared mobility while ensuring a sustainable source of funding.

Lessons learned include:

- Shared mobility providers are generally supportive of exploring sustainable transportation funding to ensure that transportation networks continue to be improved upon for shared goals, such as better air quality, network efficiency and travel predictability.
- Shared fleets can enable an ease of data collection and reporting for other initiatives, such as distance-based fees.
- Assessing fees at the provider level (in this case, the carshare provider) removes the need for government entities to collect personally identifiable information; needed information for fee assessment can be aggregated and anonymized.
- Proper planning and collaboration with partners can support project success, even in the midst of a global pandemic.

What you can do now, and what you can start planning for

Develop a strategy to leverage shared mobility to support goals and objectives

Goals and objectives for shared mobility would seek to improve network efficiency, enable better place-making, and apply land use to alternative uses.

- Each local context will require unique solutions, including land use, demographic, cultural, and regulatory aspects. Additionally, the existing urban fabric of a city will play a part in determining its suitability for different shared solutions, eventually affecting uptake.

- Evaluate potential opportunities for shared mobility hubs, such as repurposing underutilized Park-n-Ride lots.

- Explore new uses for other infrastructure that may be underutilized due to changes in commute patterns. As some workers continue to work from home, it could be beneficial to expand off-peak transit service, enable people to rent their car out on an hourly basis, and promote slow streets near bikeshare hubs as well as other ways to encourage active transportation where traffic volumes are low.

Evaluate and revise policy to address benefits of shared mobility and remove obstacles to adoption

- Conduct policy analysis to support shared mobility goals. For example, identifying outdated regulations that inhibit new development, create new policies to support smart land use development and zoning ordinances, and ensure that the policy framework supports a strong, sustainable and flexible suite of mobility and travel options.

- Develop policy and quality targets for the range of sharing mobility models. These could relate to reliability, cleanliness, and affordability service indicators to ultimately achieve specific modal shares and reduction in personally owned car usage.

- Consider policy incentives for shared mobility options such as preferential parking/drop-off locations, high occupancy lanes or signal prioritization.

- Better understand the needs of the public sector to support the growth of commercial shared mobility services across a greater proportion of the population.

- Build upon existing visions and policies within local and regional comprehensive plans, and identify districts and corridors that can be transitioned to become successful multimodal, mixed-use, and CAV-friendly areas. These may include nodes around existing major transit centers, corridors connecting major nodes and districts around existing airports. Land use is important to ensuring that sharing is effective and successful.

Evaluate shared mobility availability, accessibility and appetite

- Evaluate transit availability and accessibility to identify gaps and potential solutions. For example, added transit capacity, supplemental transit (non-profit, private, or publicly funded), potential low-speed automated shuttle opportunities for fixed routes, and active transport modes (scooters, bikes, ped walkways). Not every option will work for every traveller, but with a suite of options, the system will cover a greater breadth of needs.

- Better understand the needs of the public sector to support the growth of commercial shared mobility services across a greater proportion of the population.

- Identify, build and foster strong public- and private-sector partnerships and collaboration channels to increase accessibility and operational efficiency, increase data sharing, blur cross-ownership boundaries and establish reciprocal arrangements to maximize investments and benefits for all involved.

Explore new uses for other infrastructure that may be underutilized

Underutilization may be due to changes in commute patterns due to the increase in hybrid work since the pandemic. It could be beneficial to expand off-peak transit service, enable people to rent their car out on an hourly basis and promote slow streets near bikeshare hubs as well as other ways to encourage active transportation where traffic volumes are low.

Toward *New Mobility Next*

As the past few years have shown, our global society is changing. Communities are becoming more dispersed, and a once urban-centric workforce has migrated to more distanced, community-focused workplaces. Technological advancements in areas such as data science, broadband connectivity and renewable energy sources are also creating a focus on resilience. As transportation professionals, it is incumbent upon us to determine how these advancements can help strengthen communities for future generations.

The COVID-19 global pandemic has shifted how transportation agencies across the world are approaching the various aspects of mobility. Now emerging into a post-pandemic economy, WSP is re-evaluating the functional role of communities, how they serve their residents, workers, and visitors—with a particular emphasis on how people move within them and between communities. Long gone are the days of simply providing residents with a means to travel from their homes to urban centers and other destinations. Moving forward, to be resilient, communities must expand their mobility offerings to provide for additional options, focusing on solutions that improve safety, reliability, flexibility and ease of use for all members regardless of where they live, how they commute or their socioeconomic position.

Our companion whitepaper *New Mobility Next* builds upon the aspects of New Mobility revisited in this publication by considering key themes shaping mobility landscapes and communities around the world. To devise sustainable mobility solutions, social equity is recognized as an essential part of a paradigm shift to focus on the needs of all people and places—rather than effecting change through technology-readiness thinking.

As an industry, we tend to celebrate technological achievements and breakthroughs without considering the social-psychological impact of those technological achievements. Whenever setbacks occur with those technologies, the lack of preparedness for anticipating societal reactions can lead to policies and regulations which restrict the market's investment in necessary improvements and enhancements to deliver on the promise of New Mobility. To avoid these outcomes, transportation agencies need to communicate effectively and frequently the current practice in New Mobility: what is possible, what are the near-term benefits and what are the reasonable risks in the application. Global citizens need to know the limitations of mobility as they exist today, but also be provided the opportunity to voice ideas and recommendations on how to improve.

This report describes several key innovations that can improve the safety, reliability, resilience, and flexibility of a community's mobility capabilities. Each of these innovations should be evaluated and prioritized by transportation agencies' leaders for the benefits brought to residents, the costs for deploying and maintaining each solution, the risks associated with each innovation across various timescales, and how each solution may best benefit the overall community across flexibility, equity, and resilience. Once prioritized, these initiatives should become part of agencies' strategic plans, with detailed steps for funding, procuring, and deploying the highest-prioritized solutions. The text box below provides some practical steps for transportation agencies to consider as they begin to incorporate these New Mobility concepts into their plans and priorities.

Practical Steps for Agencies to Leverage New Mobility

1. **Improve today's infrastructure for tomorrow's technology.**

   As community leaders develop infrastructure improvement projects, considerations should be made for supporting future technologies. *New Mobility Next* explores how to **deliver change through innovation and technology from the customer viewpoint, rather than through the historical single lens of technology-readiness thinking**.

2. **Support standardization and streamlining of regulations.**

   Public and private organizations with a vested stake in new mobility options should work with standards entities to identify the need for new standards, create proposals for new standards, and even become members of standards committees and subcommittees.

3. **Prepare and organize for innovation.**

   Creating a more nimble, responsive, and innovative workforce will not only help improve the acceptance of new technology, but also help make existing workers more well-rounded and ready to meet innovations head on.

4. **Build on and expand engagement with decision-makers and stakeholders.**

   Active community participation through every facet of an innovative project including planning, design, and implementation help gain public and political acceptance, build trust, and set the stage for more public acceptance as new innovations unfold.

5. **Identify and pursue funding opportunities**

   Agencies should look into governmental grants for research and exploration, commercial grants, private-sector investments, charitable non-profit grants, and even the issue of long-term debt, all of which can help fund innovative programs and deliver them within our communities.

6. **Identify where to invest for unique circumstances, scenarios, or opportunities.**

   When exploring innovation and potential applications, organizations should find ways to not only maximize the benefit of their solutions, but also explore ways they can become an example for other organizations to follow.

7. **Leverage innovations throughout the world and seek partnerships.**

   Organizations should explore international relationships, such as peer exchanges and "sister city" initiatives where knowledge can be transferred, best practices can be shared, and perhaps investments can be spread across multiple sources as opposed to having one organization burden the entire cost of an initiative.

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