

Transportation Resiliency Roundtable Summary

August 2023

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ABOUT THE WASHINGTON STATE ACADEMY OF SCIENCES

The Washington State Academy of Sciences (WSAS) is an independent, nonprofit organization of more than 375 elected members who are nationally recognized for their scientific and technical expertise. All members of the National Academies of Sciences, Engineering and Medicine who reside in Washington State are invited to join; others are elected in recognition of their scientific and technical contributions to our nation and their desire to contribute their expertise to inform issues in Washington State. As a working academy, not an honorary society, WSAS mobilizes the expertise of its members, plus a network of partners, to provide independent, non-advocate scientific and engineering assessments on issues that impact the citizens, governments and businesses of Washington State.

WSAS was established by the legislature in 2005 at the request of Governor Christine Gregoire to improve public policies and programs through the integration of informed, independent scientific analysis and communication with policymakers.

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Introduction

Research indicates that the effects of global climate change threaten to drastically alter most aspects of human life within the next few decades. Some incidents stemming from climate changes that are likely to increase in both frequency and intensity include severe drought, fires, flooding events, precipitation, sea level rise, and other localized severe weather events. These events can have devastating impacts on key infrastructure systems. However, plans are being developed to improve the resiliency of key systems throughout the United States. One such key infrastructure is the transportation system.

The Washington State Academy of Sciences (WSAS) convened a roundtable discussion on April 4, 2023, in collaboration with the University of Washington's Mobility Innovation Center, with the goal of hearing from researchers and public and private stakeholders committed to ensuring a resilient transportation system (Appendix A – Agenda). Co-chairs of the Roundtable on Transportation Resilience were François Baneyx, PhD, Vice Provost for Innovation at the University of Washington and the Director of CoMotion, and Paula Hammond, Senior Vice President of WSP USA (Appendix B – Bios).

For this event, we adopted the Federal Highway Administration's definition of *transportation* resiliency as ***the ability to anticipate, prepare for, adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions***. With transportation system and infrastructure resiliency, anticipating, preparing for, and adapting to changing conditions requires a holistic understanding of the risks to the transportation system and the gaps in our current knowledge base.

The afternoon-long roundtable discussion focused on the following topics:

1. Resilience in the transportation system in the face of the energy transition that is underway due to the decarbonization of energy sources in the face of global climate change
2. Research and knowledge sources stakeholders currently rely on to plan and make decisions about transportation systems
3. Areas where more research and knowledge are needed to do better planning at local and state levels in the near and long term.

The Roundtable brought together 20 researchers and stakeholders for an afternoon of presentations and discussions. Roundtable co-chair Paula Hammond, former Washington Secretary of Transportation, kicked off the event with introductory remarks that described the general state of transportation practices as they prepare for the transition to a zero emissions future, and the major threats to key components of the transportation system that need to be resilient. Discussions then followed focused on three areas: 1) key challenges and threats to transportation resiliency related to the energy transition underway; 2) key components of the transportation system that need to be resilient; and 3) key questions for the research community. Throughout the Roundtable event, the participants exhibited enthusiasm at the opportunity to work together as a group to meet these challenges. Several participants noted throughout the event that there was a lack of formal opportunities for cross-agency

collaboration and collaboration between policymakers, agency representatives, scientists, and non-profits, and that this event provided a space for such interactions and discussions to occur.

One outcome of the roundtable is this summary, which captures the main issues discussed during the afternoon. It is organized around key challenges that participants identified related to science and technology, environmental justice, the workforce, and community engagement, followed by key opportunities for new partnerships, building community-based resilience, and engaging in scenario building activities. (Appendix C – Background Reading).

In keeping with its mission to serve Washington State, the WSAS will explore additional opportunities to continue this cross-sector discussion about transportation resilience, and with special attention to helping to increase understanding of how the state's transportation system can become more resilient in the face of the imminent transportation transition in response to climate change.

Key Challenges

The TRR discussion identified several key challenges both to the resilience of the transportation system and to the transition of the transportation system to clean energy. These challenges are divided broadly into four sections: Science and Technology, Environmental Justice, the Workforce, and Community Engagement. In each section, several key questions serve to focus the conversation and provide actionable items for policymakers and stakeholders to address.

Science and Technology

Carbon emissions, particularly carbon dioxide, drive global climate change. To address the effects of climate change, discussions of the role of science and technology must focus on efforts to decarbonize key transportation systems. However, questions remain to achieve this outcome. What scientific and technological challenges arise from decarbonization of the transportation system? Can the system remain resilient through the transition and beyond?

Key Question: Is electrification the answer to decarbonizing transportation infrastructure?

The TRR participants identified several issues with electrification as a panacea to decarbonization. The popularity and availability of electric vehicles (EVs) has increased dramatically in the past several years.² As more EVs come on the market, the strain on the electric grid will similarly increase. Moreover, the electrical grid continues to rely broadly on the use of fossil fuels to provide electrical power. If the source of the power is not changed, decarbonization goals will be difficult, if not impossible, to meet.

The TRR participants noted that with the steady increase of demand for EVs, the increase in demand on the electric grid could cause rolling blackouts or a complete loss of electrical power to consumers for extended periods of time. These blackouts could be predictable, as many consumers will need to charge EVs in the evenings to prepare for the standard workday. However, they may not be, as the increase in demand on the electrical system from the less predictable effects of climate change (drought, heat waves, strong storms) could couple with the increased demand from EV usage to cripple the entire grid more erratically.

Thus, the TRR participants raised several questions about the viability of electrification to decarbonize the transportation system. For electrification to be possible, the threats to the energy system of Washington must be considered. Additionally, several participants noted the potential promise of other sources of energy to meet the transportation system's needs. For example, hydrogen power is a potentially potent carbon free source of energy that could be used to decarbonize the transportation system. These other energy sources, while promising, would require additional resources and infrastructure to make viable.

Key Question: How can electrification scale to meet decarbonization goals and remain resilient throughout the process?

If electrification is the process by which Washington elects to decarbonize the transportation system, several issues must be considered. How can the electric system be scaled to meet demand? This issue is twofold: the total *capacity* of the electrical grid must be increased to meet demand, and the *source* of the energy must be altered to provide a decarbonized electric grid. Particularly with EVs, several TRR participants noted the severe lack of grid infrastructure to meet the capacity of a deluge of new EV users – especially given that EV charging can cause up to four times the amount of power usage that a normal home would draw. Any scaling of the electrification of transportation systems must consider how to avoid overdrawing the electric grid. This issue is compounded with the development and implementation of commercialized EV fleets (e.g. long-haul trucking). With these changes, the transportation infrastructure will be reliant on the development of new EV charging substations to meet the need of commercial EVs.

The source of energy must also be considered with electrification. Which energy sources are prioritized to decarbonize? Washington specifically stands poised to meet decarbonization with hydropower. What other sources of energy could be used symbiotically to decarbonize the energy grid? Are those sources of energy developed well enough to meet the demand, and if not, what technological advances are needed for them to be made ready quickly?

Finally, during the change from carbon energy sources to decarbonized sources, the resilience of the entire system must be considered. Nature-made impacts during a transition from fossil fuel energy to electric energy could potentially cause more significant effects than if only one source of energy were being used for transportation. This is acutely important if the changing system is working from multiple systems at one time. Resilient transportation will take these issues into consideration and prepare for potential disruption in which different sources of energy are not enough to meet transportation needs.

Key Question: How does technology in general scale to manage a decarbonized and resilient transportation system?

Several avenues exist to help technology scale to meet the needs of a resilient transportation and energy system. Currently, the TRR noted that there is a lack of flexibility in the grid. For instance, the energy grid is unable to store energy well when energy usage is low to accommodate for other more taxing times for the grid. Technological scaling to meet the needs of decarbonized energy and transportation systems then needs to focus on – among other issues – the problem of energy storage.

Furthermore, many technological solutions to energy issues are in pilot programs. These programs are typically small, are cost-intensive, and are run by private entities that are more able to gamble on a project that fails than a public agency. TRR participants noted that public agencies are often more reluctant to take the similar risks, leading to a focus on narrower solutions. Thus, is the role of funding or scaling new technologies the role of public agencies or private entities? Which entities can better take the risks needed to make transportation systems resilient with energy changes?

Key Question: Which fixes need to be made to make the system more resilient?

When considering a resilient transportation system, what changes should be made to increase overall resiliency? For example – can older buildings be retrofitted to include carbon-neutral infrastructure like solar panels or other green energy sources? Are there certain infrastructure changes that will allow for a more resilient transition over others?

Important to consider with this challenge is a cost-benefit analysis of the types and impacts of the fixes to be made. For example, if one technological change may bring about greater decarbonization but creates greater risks to resiliency in implementation, how are those risks assessed? Are other technologies better prepared to meet the needs of a decarbonized transportation system?

Environmental Justice

Key Question: When moving towards a decarbonized transportation system/infrastructure, which communities benefit the most?

Throughout the TRR, participants consistently questioned how environmental justice consideration would factor into any decarbonization or resiliency decisions. For example, one TRR participant noted that up to a quarter of Washingtonians do not drive as their method of transportation. If decarbonizing the transportation system focuses on personal EVs and other changes to affect the resilience of EV transport, a whole demographic could be left behind in the push towards a decarbonized society.

Inherent in this question are discussions about who gets to decide about which communities get the benefit. The Infrastructure Investment and Jobs Act of 2021 (IIJA) and the Inflation Reduction Act of 2022 (IRA) provide significant monetary opportunities and other grants to help the transition to clean energy. However, with these opportunities, who gets to decide which communities benefit from federal dollars spent in their communities? How can the distribution of these federal dollars in Washington be made equitable?

In the transition to a resilient and decarbonized transportation system, an equitable distribution of resources is paramount. Public agencies and private sector businesses should consider which communities are poised to bear a disproportionate burden of climate change (e.g., coastal communities, communities who rely on certain transportation systems for daily life, communities that will be left behind in a clean energy transition). Stakeholders should ensure that plans for a clean energy future consider these groups of people and are sensitive to their needs.

Key Question: Which communities are underserved? Which communities need energy resilience the most?

How are climate- and transportation-vulnerable communities identified? Answering this question requires input from a host of groups from policymakers to stakeholders and community advocates. To ensure that historically marginalized communities are adequately addressed, one TRR participant noted that it is important that these communities see *themselves in the solution* to decarbonization and transportation resilience. Thus, disadvantaged communities need to be prioritized and included in any resiliency discussions.

In addition to historically marginalized communities, communities who need energy resiliency measures the most should be prioritized. For instance, the Washington State Ferry system in 2022 served over 17 million people.³ In the face of sea level rise from global climate change, the state ferry system will face many challenges to overall systemic resilience. In aviation, furthermore, many large airports may have access to funds and infrastructure needed to improve resiliency. However, many small airports need significant assistance to build infrastructure to address decarbonized aviation systems and overall transportation resilience. These are compounded by issues related to land use. Outstanding questions that remain for how can the land be used effectively and lead to resilient transportation systems, and how can land use be better addressed through the lens of equitable transformations of the energy system?

When making decisions to promote better transportation resiliency, these factors must be addressed, and specific communities will need to have specific energy and mobility solutions tailored to their individual needs to ensure equitable distribution of resources.

The Workforce

Key Question: How does Washington build a new workforce capable of leading the transition to a decarbonized energy system?

Currently, the workforce is focused on a fossil fuel economy. Several TRR participants consistently noted that to properly transition away from fossil fuels to a decarbonized energy system and transportation system, broad workforce changes are needed. These changes include the need for automation of routine jobs to build up the specialized workforce needed to address the problems of resiliency in the transportation system.

For example, communities need to be engaged with policymakers and other stakeholders to ensure that adequate resources are allocated to build up workforce needed. If communities are engaged with the concept of resiliency, they are more likely to train and maintain a workforce capable of addressing energy and resiliency concerns.

Overall, several TRR participants noted that the workforce needs more specialized trade workers (e.g., engineers, electricians, maintenance workers, construction workers) who are trained with a resiliency mindset to meet the needs of a decarbonized energy sector. Additionally, with the need for more specialized workers comes the need to incentivize those workers to enter such careers. Who pays for training the new generation of specialized

workers? What incentives can stakeholders use to bring in the new generation of workers? Finally, how does Washington state or other private industries attract new workers or reeducate previous workers to build and maintain a resilient transportation system?

Community Engagement

Key Question: How can trust be built between communities and public/private entities?

Trust between the public and government is at an all-time low.⁴ Given this, strong governmental interventions to build a resilient transportation system might engender strong negative responses from communities who lack fundamental trust in governmental agencies to implement the best or most equitable solution for those communities. Key to engendering this trust is to trust and allow that communities know what changes they need the most and how best to implement those changes throughout the community.

These issues often arise in tandem with issues of environmental justice. Excluded and overburdened communities have not traditionally seen themselves in the solution to resiliency discussions. These communities additionally have not always had a seat at the table to address issues specific to their community. Also, they can be unfamiliar with funding structures of the state and federal governments and do not have enough grant money to make those changes within the communities.

Community engagement, then, is vital to creating an equitable and resilient transportation system. Through engagement, communities can build trust between localities and public/private entities that will encourage growth and progress toward a resilient transportation system.

Key Opportunities

The TRR discussion identified several opportunities that policymakers and stakeholders can address to bolster resilience in the transportation system in the face of climate change. Some of these opportunities address the Key Challenges of the previous section, while others provide opportunities to develop a resiliency mindset to find gaps in our knowledge and to build toward a resilient future.

Partnerships

With an issue as multifaceted as decarbonization and resiliency of the transportation system in the face of global climate change, cooperation between stakeholders is vital. Several distinct partnerships need to be maintained for an effective transition to decarbonization of the transportation system.

Among Governmental Agencies

Several TRR participants noted that governmental agencies tend to take a siloed approach to policy issues and work within the confines of their agency to solve problems. Decarbonization

of the transportation system, however, is not a single-agency problem. The issues are not limited to the Department of Transportation. Solving the decarbonization problem will require efficient communication between the Department of Transportation, Department of Energy, Department of Commerce, and the Office of the Insurance Commissioner, to name a few. This does not include the need for communication between these agencies and legislators to help address the various issues at stake. A more streamlined method of communication is necessary among governmental agencies to ensure that all issues are being addressed and that resources are being used adequately to combat the issue.

Additionally, participants supported the opportunity for pilot projects both within and across agencies. While often these pilot projects have been shouldered by private entities, the participants noted that there was an opportunity for governmental agencies to partner with each other and with private entities agencies to help alleviate or distribute some of the risk associated with these pilot projects.

Among Private Entities and Governmental Agencies

Often, private entities are more willing to take on projects with higher risk (but often with greater potential reward) than governmental agencies are. Yet, cooperation between public agencies and private entities is crucial for developing energy solutions and resiliency within the transportation system. How can the collaboration between public and private groups be best managed so that private industry can shoulder some of the risk of innovative technologies and their development that government cannot?

One tool in increase collaborations are public-private partnership arrangements. These coalitions between government and industry allow for maximum collaboration on an issue. A combined approach with public and private groups can engender cross-sector engagement and buy-in, leading to a more streamlined approach for innovation and collaborative problem solving.

Among Communities and Public/Private Organizations

Building trust between *all* stakeholder groups is key to progressing towards decarbonization and ensuring that resources are distributed equitably. Given that trust between communities and governmental agencies is low, this trust building is extremely important. In this way, cross-sector involvement could help bridge the gap between communities and the government by adding another layer of accountability and helping to rebuild trust. Community outreach from public and private entities is also crucial to ensure that progress happens both *quickly* and *equitably*. This outreach will be addressed further in the following section.

Community-Based Resilience

To address the Key Challenges of Environmental Justice, communities must have a place at the table to communicate with other entities about problems and solutions in the transition to decarbonized energy sources. Here, basing resilience *in the community* allows for each

community to have more of a say about which problems or solutions are important to them. Community outreach is crucial to progress.

Community liaisons are necessary and will play a vital role throughout these transitions. These liaisons can help to build trust between governmental agencies and the community. The liaisons ideally would be from the community they are representing so that they can better advocate for their needs. Liaisons would additionally help to advocate for funding and move to establish what state or federal dollars should be spent and how they would be best utilized.

Fundamentally, historically excluded communities need to see themselves as the solution to decarbonized energy resilient transportation systems. It is important to let these communities lead the way. They should be represented to share what they need to combat the issue and be given tools to solve it. Thus, money and educational resources must be made available to empower these communities to take the solutions into their hands.

Scenario Building

An important concrete exercise to help address resiliency are “Red Team” or “Table-Top” scenarios. These are real-life scenarios that test how an agency or organization would respond to certain paradigm shifting events. Governmental agencies use these scenarios to address evaluate their ability to respond to certain events and understand where the gaps in their systems are.

In the energy transition with the transportation system, such scenarios can play a critical role in demonstrating what the strengths and weaknesses of interconnected transportation and energy systems may be. They can also highlight technical or practical gaps in our systems that could lead to more severe or compounding impacts. These scenarios allow for the assessment of potential consequences of energy crises or other impacts to the system. They also help agencies create plans of action to respond to certain events or crises.

In a table-top scenario, who should participate? Given the large variety of stakeholders involved in the transition to clean energy and resilient transportation, the scenario-building exercises must not be limited to intragovernmental or private agencies. At a minimum, governmental agencies, private stakeholders, community officials and liaisons should be involved. What other groups should be prioritized? How can disparaged communities be ensured a seat at the table for these events?

Finally, how should these scenario outcomes be disseminated to the public? How do they create actionable items for government agencies, communities, and private industries? If they show knowledge or technical gaps, how are these communicated to the correct groups so that they can be addressed? It is crucially important to consider these questions when summarizing scenario outcomes so that the exercises remain a useful tool for both policymakers and communities to address the challenges of climate change on energy and transportation resilience.

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Appendix A: Agenda

WSAS Roundtable Discussion on Transportation Resilience

Tuesday, April 4, 2023, Noon – 5 PM

The Rainier Club

820 Fourth Avenue, Seattle, WA 98104

Purpose: The Washington State Academy of Sciences (WSAS) is convening a roundtable discussion in collaboration with the UW's Mobility Innovation Center, with the goal of hearing from key public and private stakeholders working on and concerned about transportation resilience with a focus on:

1. Resilience in the transportation system in the face of the energy transition that is underway
2. Research and knowledge sources stakeholders currently rely on to plan and make decisions
3. Areas where more research and knowledge are needed to do better planning in the near and long term.

During the discussion we will use the following definition of transportation resilience related to the energy transition.

To anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions.

Federal Highway Administration Order 5520

Noon – 1 PM

Informal discussion. Buffet lunch provided.

1:00 Welcome and Introductions

Donna Gerardi Riordan, WSAS Executive Director

1:05– 1:20 PM

Introductory remarks:

Roundtable Co-chair Paula Hammond will frame the discussion by providing a high-level overview of 1) the general state of the transportation practices as they prepare for the transition to a net-zero transportation future, and 2) the threats to key components of the transportation system that need to be resilient.

1:20 – 2:20 PM

Session 1: Key Challenges and Threats to Transportation Resilience Related to the Energy Transition Underway

Moderator: Paula Hammond

Each participant (Casey Sixkiller (EPA), Roger Millar (WA DOT), Michael Furze (WA DOC), Jessyn Ferrell (City of Seattle), De'Sean Quinn (King County), Ryan Calkins (Port of Seattle), Jay Bruns (Office of the WA Insurance Commissioner), Shari Call (WA Trucking Association), and TBD rep from the PUDs, whose professional responsibilities include working on transportation issues is asked to reflect on some key issues being worked on today their agency or organization. Some guiding questions focused on the needs in Washington State include:

1. Key components of the transportation system that need to be resilient as we transition to new energy systems to support decarbonization goals.
2. Threats and risks inherent in that transition.
3. What we need to know more about to prepare, to adapt, and to ensure that the new future is resilient, whatever the new energy source may be.
4. What we need to do to know or communicate better about transmission, storage, and types of fuel and energy needed for the transportation system.
5. Related to this issue, what keeps you up at night?

2:20 – 3:15 PM

Session 2: Key Components of the Transportation System that Need to be Resilient

Moderator: WSAS Member Anjan Bose (WSU)

Each researcher participant (Anjan Bose, WSU; Cynthia Chen, UW; Michael Kintner-Meyer, PNNL; Don MacKenzie, UW; Roger Myers, consultant; and Dan Schwartz, UW) is asked to describe research activities focused on the needs of Washington State that address the questions posed above, characterized by 1) the research going on now in various sectors (e.g., fuels, aviation, ferries, rail, cars and trucks); 2) emerging research in those areas; and 3) the demands for new research that could lead to solutions for problems that exist.

3:15 – 3:30 PM

Break

3:30 – 4:30 PM

Session 3: Key Questions for the Research Community

Co-chair and Moderator: François Baneyx

Discussion of important questions raised in the two prior sessions that, if answered, could help WA State's transportation system become more resilient in the face of the imminent energy transition.

4:30 – 4:45 PM

Wrap-up and Next Steps

Co-chairs and WSAS Executive Director: Paula Hammond, François Baneyx, Donna Gerardi Riordan

Appendix B: Transportation Resiliency Roundtable Discussion Participants

Co-Chairs

Paula Hammond

[Paula Hammond](#) is Senior Vice President of WSP USA and chair of the American Road and Transportation Builders Association (ARTBA). Hammond previously served almost 35 years at Washington State's Department of Transportation (WSDOT), serving as its first female transportation secretary from 2007 to 2013.

François Baneyx, University of Washington

[François Baneyx](#) is the Director of the University of Washington's CoMotion, Vice Provost for Innovation, the Director of the Center for the Science of Synthesis Across Scales, Adjunct Professor of Bioengineering, and Charles W.H. Matthaei Professor of Chemical Engineering at the University of Washington. Dr. Baneyx's research focuses on the intersection of synthetic biology, nanotechnology, molecular engineering, and materials science.

Researchers

Anjan Bose, Washington State University

[Anjan Bose](#) is Regents Professor, Distinguished Professor in Power Engineering, and Site Director of the NSF-sponsored Power System Engineering Research Center at Washington State University. Dr. Bose additionally served as Senior Advisor to the Federal Energy Regulatory Commission in Washington, D.C. and is a founding member of the Washington State Academy of Sciences. He is a member of the National Academy of Engineering.

Cynthia Chen, University of Washington

[Cynthia Chen](#) is the Interim Chair of Industrial and Systems Engineering, Professor of Civil and Environmental Engineering, and Professor of Industrial and Systems Engineering at the University of Washington. Dr. Chen directs the THINK (Transportation-Human Interaction and Network Knowledge) lab at the University of Washington.

Michael Kintner-Meyer, Pacific Northwest National Laboratory

[Michael Kintner-Meyer](#) is a research engineer and systems analyst with more than 25 years in the area of energy/economy and multi-sector simulation and analysis for national and international clients. Dr. Kintner-Meyer's research projects focus on the modernization of the nation's power grid.

Don MacKenzie, University of Washington

[Don MacKenzie](#) is an Associate Professor of Civil & Environmental Engineering at the University of Washington and leads the Sustainable Transportation Lab. Dr. MacKenzie is a member of the Transportation Research Board's Standing Committee on Transportation Energy and an editorial board member for Transportation Research Part D: Transport and Environment.

Roger Myers, Consultant

[Roger Myers](#) is a consultant for Space Systems and Technology, Strategy, Mission Architecture, and Business and Program Management. He is the former General Manager of Aerojet Rocketdyne (*Retired*). Dr. Myers served as chair of the Washington State Joint Center for Aerospace Technology Innovation (JCATI), as President of the Electric Rocket Propulsion Society (ERPS), and is a Fellow of the American Institute of Aeronautics and Astronautics (AIAA). He is a member of the National Academy of Engineering.

Feng Pan, Pacific Northwest National Laboratory

[Feng Pan](#) is a research scientist at Pacific Northwest National Laboratory, where he currently works in the Optimization and Control Group in the Energy and Environmental Directorate. Dr. Pan's research focuses on the application of operations research techniques to solve energy and national security applications.

Dan Schwartz, University of Washington

[Dan Schwartz](#) is the Boeing-Sutter Professor of Chemical Engineering and the founding director of the UW Clean Energy Institute (CEI). Dr. Schwartz served on the Technical Advisory Board for Washington's Energy Strategy in 2012 and is a board and executive committee member of the Washington CleanTech Alliance.

Transportation and Energy Leaders

Roger Millar, Secretary, Washington Department of Transportation

[Roger Millar](#) was appointed Secretary of Transportation in August 2016. He is the President of the American Association of State Highway and Transportation Officials (AASHTO), Chair of the Intelligent Transportation Society of America Board of Directors, President of the ASCE Transportation and Development Institute, and a member of the National Operations Center of Excellence Strategic Advisory Council and the National Complete Streets Coalition Steering Committee.

Casey Sixkiller, EPA Region 10

[Casey Sixkiller](#) was appointed Regional Administrator, Region 10, of the Environmental Protection Agency by President Joe Biden in May 2022. As regional administrator, Sixkiller oversees the EPA's work to protect human health and the environment across the states of Washington, Oregon, Idaho, and Alaska, and 271 tribal nations. Sixkiller is leading the EPA's efforts locally to implement both the Bipartisan Infrastructural Law and Inflation Reduction Act, which together are making generational investments in water infrastructure, helping to address the impacts of climate change, and scaling the deployment and adoption of solutions necessary to achieving our nation's green energy future — all centered on President Biden's and EPA Administrator Michael Regan's commitment to environmental justice and equity. Prior to joining EPA, Sixkiller served as Deputy Mayor of the City of Seattle and Chief Operating Officer of King County.

Michael Furze, Washington Department of Commerce

[Michael Furze](#) is an assistant director at the Department of Commerce, where he heads the State Energy Office. Furze also serves on the Board of the National Association of State Energy Officials.

Jessyn Farrell, City of Seattle

[Jessyn Farrell](#) is the director of the Office of Sustainability and Environment for the City of Seattle. Farrell previously was a member of the Washington House of Representatives from 2013 to 2017, representing District 46-Position 2.

De'Sean Quinn, King County Metro

[De'Sean Quinn](#) is Assistant General Manager for Strategy and Partnerships at King County Metro. Quinn has also served as city council member for Tukwila since 2008, and previously served as the Community Relations Manager for King County Executive Ron Sims and became the Executive's Council Relations Director.

Ryan Calkins, Port of Seattle

[Ryan Calkins](#) was elected to the Port of Seattle Commission in 2017 and re-elected in 2021. Ryan is the Executive Director of the Edge Cluster, a non-profit dedicated to statewide economic development through emerging technologies.

Jay Bruns, Washington Office of the Insurance Commissioner

[Jay Bruns](#) is Senior Climate Policy Advisor at the Washington State Office of the Insurance Commissioner. Bruns previously served as senior advisor for private sector engagement at the United Nations Environment Program, and was vice president at The Hartford, where he led the company's environmental stewardship efforts.

Sheri Call, Washington Trucking Association

[Sheri Call](#) is the President and CEO of the Washington Trucking Association. Call is also a current Board Member of the Washington Highway Users Federation and NORPASS. Sheri represents freight in Washington State on the Community Advisory Group for the Interstate Bridge Replacement Project and serves on the Workers Comp Advisory Committee.

Stephanie Formas, Vice President of Challenge Seattle

[Stephanie Formas](#) serves as the Vice President of Challenge Seattle, an alliance of CEOs from 22 of the region's largest employers tackling the region's most pressing civic challenges through public-private partnerships. She previously served as the Chief of Staff for Seattle Mayor Jenny Durkan leading a series of major initiatives including the COVID-19 response, record-breaking heat wave, downtown revitalization, and COVID-19 vaccine distribution. She has also worked for three presidential campaigns and in the U.S. House of Representatives.

Other Attendees

WSAS

Donna Gerardi Riordan, Executive Director
Joe Conry, Finance Manager
Josh Frost, NSPN Scholar
Tristan Fehr, Associate Program Officer

UW CoMotion

Bart Treece, Director, Mobility Innovation Center, CoMotion

EPA

Abby Hook, Senior Advisor to the Regional Administrator

Danielle (Dani) Shannon, Member of Region 10's Mobile Sources Team and the West Coast Collaborative whose purpose is to reduce diesel emissions and advance clean technologies throughout the western United States.

UW

Rishi Verma, PhD Student, Industrial Engineering

Appendix C: Resilience: Background Reading and Further Information

Introduction: In the face of global change, building resilient systems to adapt to and overcome these changes has become increasingly important. The Federal Highway Administration defines resilience as the ability “to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions” (see § III-9). Additionally, the White House defines resilience broadly as “the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents” (see § IV-3). This library aims to provide a primer on resilience efforts, particularly as they relate to global change and the transition to clean energy in the transportation sphere.

I: Electric Grid Resilience:

Section I provides resources and information on the resiliency of the nation’s electric grid, particularly in the face of changing energy technology. Additionally, they discuss the development and implementation of new energy and the changes that this research and development may bring.

1: [The Future of Electric Power in the United States - 2021](#)

- “Electric power is essential for the lives and livelihoods of all Americans, and the need for electricity that is safe, clean, affordable, and reliable will only grow in the decades to come. At the request of Congress and the Department of Energy, the National Academies convened a committee of experts to undertake a *comprehensive evaluation of the U.S. grid and how it might evolve in response to advances in new energy technologies, changes in demand, and future innovation.*”

2: [Enhancing the Resilience of the Nation's Electricity System - 2017](#)

- “Enhancing the Resilience of the Nation's Electricity System focuses on identifying, developing, and implementing strategies to increase the power system's resilience in the face of events that can cause large-area, long-duration outages: blackouts that extend over multiple service areas and last several days or longer. Resilience is not just about lessening the likelihood that these outages will occur. It is also about limiting the scope and impact of outages when they do occur, restoring power rapidly afterwards, and learning from these experiences to better deal with events in the future.”

3: [The Power of Change: Innovation for Development and Deployment of Increasingly Clean Electric Power Technologies - 2016](#)

- “The Power of Change: Innovation for Development and Deployment of Increasingly Clean Energy Technologies considers how to speed up innovations that would dramatically improve the performance and lower the cost of currently available technologies while also developing new advanced cleaner energy technologies...This study focuses on five paths to accelerate the market adoption of increasing clean energy and efficiency technologies: (1) expanding the portfolio of cleaner energy technology options; (2) leveraging the advantages of energy

efficiency; (3) facilitating the development of increasing clean technologies, including renewables, nuclear, and cleaner fossil; (4) improving the existing technologies, systems, and infrastructure; and (5) leveling the playing field for cleaner energy technologies.”

II: Electric Vehicles (EVs):

Section II provides information on electric vehicles and the unique challenges they present both to the electric grid and the transportation system in general. Additionally, they cover specific considerations for the equitable distribution of EVs throughout Washington state and beyond. A link to more resources regarding EVs and the electric grid is provided at the end of this section.

1: [Planning Considerations for Electric Vehicles in Washington](#)

- “DOE Resources and Technical Assistance options to inform the *smart, equitable, and grid-aware planning of Electric Vehicle infrastructure.*”

2: [Using Mapping Tools to Prioritize Electric Vehicle Charger Benefits to Underserved Communities - 2022](#)

- “This report provides examples of how to *apply mapping tools to identify priority locations for installing EV chargers that may benefit [energy and environmental justice] underserved communities* through four EV charger planning approaches: corridor charging, community charging, fleet electrification, and diversity in STEM and workforce development. It also explores various methodologies for calculating low-public [electric vehicle supply equipment] density.”

3: [Guidebook for Deploying Zero-Emission Transit Buses - 2021](#)

- “The zero-emission bus (ZEB) market, including Battery Electric Buses and Fuel Cell Electric Buses, has seen significant growth in recent years. ZEBs do not rely on fossil fuels for operation and have zero harmful tailpipe emissions, improving local air quality. The increase in market interest has also helped decrease product pricing. The TRB Transit Cooperative Research Program's TCRP Research Report 219: Guidebook for Deploying Zero-Emission Transit Buses is designed to *provide transit agencies with information on current best practices for ZEB deployments and lessons learned from previous deployments, industry experts, and available industry resources.*”

4: [An EV Future: Navigating the Transition, A Voices of Experience Initiative – 2021](#)

- “The report compiles ideas, advice, and approaches from various stakeholder perspectives about the transition to EVs. The topics include residential charging, long-haul transportation, public transit, infrastructure deployment, regulatory policy, and new market entrants. The report also includes a broader, more informal collection of experiences and observations and explores successful approaches, as well as not-so-successful ones, to uncover unanticipated challenges or barriers.”

More resources for EVs can be found at [EVGrid Assist](#).

III: Climate Change Resilience:

Section III provides resources on the resilience of infrastructure (particularly transportation infrastructure) in the face of global climate change. Additionally, these resources provide an assessment of the state of research in transportation resiliency with respect to global change and offer some case studies on transportation resilience.

1: [AASHTO Case Study: Integration of Resilience and Context Sensitivity on a Mountain Corridor: Interstate 70 Floyd Hill to Veterans Memorial Tunnels Project, Colorado – March 23, 2022](#)

- "...examines a transportation project that uses the Context Sensitive Solutions (CSS) and Design (CSD) processes to *integrate resilience to existing hazards* through project design."

2: [Video: Infrastructure Resilience and Innovation – February 25, 2022](#)

- "The effects of natural hazards with respect to infrastructure resilience are reviewed with examples related to earthquakes, hurricanes, and fire. Infrastructure resilience with respect to natural hazards vs climate change is discussed. Innovation with respect to increasing the resilience of pipelines and tunnels is examined. A case history of the restoration of the Canarsie Tunnel, which was flooded by Hurricane Sandy, is given. The agents of change that lead to improved policies and approaches are explored, including the technical, institutional, and social challenges of introducing new technologies and engaging community support." *Speaker: Tom O'Rourke, Thomas R. Briggs Professor of Engineering Emeritus in the School of Civil and Environmental Engineering at Cornell University*

3: [Investing in Transportation Resilience: A Framework for Informed Choices - 2021](#)

- "TRB's Special Report 340: Investing in Transportation Resilience: A Framework for Informed Choices *reviews current practices by transportation agencies* for evaluating resilience and conducting investment analysis for the purpose of restoring and adding resilience."

4: [Transportation System Resilience: Research Roadmap and White Papers - 2021](#)

- "The TRB National Cooperative Highway Research Program's NCHRP Research Report 975: Transportation System Resilience: Research Roadmap and White Papers *highlights significant knowledge gaps* within AASHTO and state departments of transportation, *presents a 5-year research plan* that addresses these gaps, and *discusses critical resilience-related issues* facing senior transportation leaders today."

5: [Resilience Primer for Transportation Executives - 2021](#)

- "The TRB National Cooperative Highway Research Program's NCHRP Research Report 976: Resilience Primer for Transportation Executives provides a quick grounding in resilience benefits, the CEO's role in resilience, and *approaches taken in various states to increase the resilience of their transportation system*. It also offers concepts and tools to lead agencies toward greater resilience."

6: [Resilience in transportation systems: a systematic review and future directions - 2018](#)

- "This paper presents a *systematic review on transportation resilience with emphasis on its definitions, characteristics, and research methods* applied in different transportation systems/contexts. It aims to figure out what transportation resilience is and what kind of essential characters it usually has. More importantly, *research challenges are analysed* and a future research agenda on the resilience of transportation systems is proposed." Particular focus given here on the Belt and Road initiative in Asia.

7: Improving the Resilience of Transit Systems Threatened by Natural Disasters

- "TRB's Transit Cooperative Research Program (TCRP) Web Only Document 70: Improving the Resilience of Transit Systems Threatened by Natural Disasters, Volume 1: A Guide *offers practices for transit systems of all sizes to absorb the impacts of disaster, recover quickly, and*

return rapidly to providing the services that customers rely on to meet their travel needs. The report shows how to *identify and implement appropriate resilience strategies* to strengthen operations and infrastructure throughout an agency. It explores ways that agencies can become more resilient through incremental adjustments in planning and small changes in what they do every day. The guide also shows *how to identify critical transit-related interdependencies* and engage in broader regional resilience efforts.

- o A: [Volume 1: A Guide](#)
- o B: [Volume 2: Research Overview](#)
- o C: [Volume 3: Literature Review and Case Studies](#)

8: [Transportation Resilience: Adaption to Climate Change](#)

- Transportation Resilience: Adaptation to Climate Change and Extreme Weather Events summarizes a symposium held June 16–17, 2016 in Brussels, Belgium. The fourth annual symposium promotes *common understanding, efficiencies, and trans-Atlantic cooperation within the international transportation research community* while accelerating transport-sector innovation in the European Union (EU) and the United States.

9: [Federal Highway Administration Order 5520 - 2014](#)

- Purpose: “The purpose of this directive is to *establish the Federal Highway Administration (FHWA) policy on preparedness and resilience* to climate change and extreme weather events.”

10: [Airport Climate Adaptation and Resilience](#)

- TRB’s Airport Cooperative Research Program (ACRP) Synthesis 33: Airport Climate Adaptation and Resilience reviews the range of risks to airports from projected climate change and the emerging approaches for handling them.

11: [Towards enhanced collaboration and information sharing for critical infrastructure resilience: current barriers and emerging capabilities – September 11, 2012](#)

- “This work presents a review of *general issues and barriers to information sharing and collaboration during a critical infrastructure crisis response*. An overview of the emerging concepts and capabilities that are promising for making an improvement in the field is also presented and discussed.”

12: [Disaster Resilience: A National Imperative - 2012](#)

- “Disaster Resilience confronts the topic of *how to increase the nation's resilience to disasters* through a vision of the characteristics of a resilient nation in the year 2030.”

13: [Critical Infrastructure, Interdependencies, and Resilience – March 1, 2007](#)

- “Thinking about critical infrastructure through the subset of lifelines helps clarify features that are common to essential support systems and *provides insights into the engineering challenges* to improving the performance of large networks.”

IV: Further Information – Human-Made Threats, General Resources:

Section IV provides additional resources for further reading, including resources on human-made threats to transportation resiliency and other general resources.

1: [Cybersecurity in Transit Systems - 2022](#)

- “The TRB Transit Cooperative Research Program's TCRP Synthesis 158: Cybersecurity in Transit Systems identifies and documents emerging cybersecurity trends related to teleworking/remote worker offices, contactless customer services, real-time information services, *transit-on-demand services*, and *cyber resilience affecting transit agencies now and in the near future* as a consequence of the digital acceleration stimulated by the global pandemic of 2020–2021.”

2: [Communications, Cyber Resilience, and the Future of the U.S. Electric Power System - 2020](#)

- “On November 1, 2019, the National Academies of Sciences, Engineering, and Medicine convened a workshop to gather diverse perspectives on current and future threats to the electric power system, activities that the subsector is pursuing to defend itself, and how this work may evolve over the coming decades. This publication summarizes the presentations and discussions from the workshop.”

3: [Presidential Policy Directive – Critical Infrastructure Security and Resilience - 2013](#)

- The Presidential Policy Directive (PPD) on Critical Infrastructure Security and Resilience advances a national unity of effort to strengthen and maintain secure, functioning, and resilient critical infrastructure.