

Written Statement of Vicki Arroyo
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Good morning, Chairman Barrasso, Ranking Member Carper, and members of the Committee. Thank you for inviting me today to discuss the upcoming federal transportation reauthorization bill and opportunities to address the critical threat of climate change.

I'm Vicki Arroyo and I serve as Executive Director of Georgetown Climate Center, which is based at Georgetown University Law Center. I am also a member of the full-time faculty, serving as a Professor from Practice and as Assistant Dean for Centers and Institutes.

The nonpartisan Georgetown Climate Center was established over ten years ago to serve as a resource to states on issues relating to climate change policy and to inform the federal dialogue with the lessons of the states.¹ We work with state and city officials on a bipartisan basis to support their transitions to cleaner energy sources in major sectors, including the power sector and transportation, and to prepare for the impacts of a changing climate.

I am also currently Chair of the Executive Committee of the Transportation Research Board of the National Academy of Sciences,² and recently chaired TRB's Task Force on Resilience and Sustainability, which made recommendations regarding how TRB might incorporate considerations of a changing climate and the role of transportation – and impacts to transportation infrastructure – into its important work, and served on national studies regarding the future of the interstate highway system, reducing greenhouse gas emissions from transportation, and improving the resilience of the transportation sector.

While I am proud of these roles and affiliations, my comments today are my own.

I am here as someone who has worked on climate change for decades and who requests you incorporate climate change considerations in the transportation reauthorization bill. Since my initial introduction to global climate change as a staffer representing Governor Buddy Roemer

¹ *About Us*, GEORGETOWN CLIMATE CENTER, <https://www.georgetownclimate.org/about-us/index.html> (last visited Feb. 19, 2019).

² *TRB Executive Committee*, NATIONAL ACADEMIES OF SCIENCES, ENGINEERING, MEDICINE (2019), <http://www.trb.org/CommitteeandPanels/ExecutiveCommitteeOverview.aspx>.

of Louisiana on a National Governors' Task Force thirty years ago,³ the science underlying our understanding of the causes and impacts of climate change has only become more clear, and our need for action more urgent.

The Fourth National Climate Assessment, released in November 2018, described the serious impacts of climate change already being felt throughout the U.S., and made clear that the risks to communities all across the country are growing rapidly.⁴

These findings, along with those in the 2018 Intergovernmental Panel on Climate Change (IPCC) report should serve as an immediate call to action. Even if we manage to limit planetary warming to just 2 degrees Celsius, the world will still face increased chances of economic and social upheaval from more severe flooding, droughts, heatwaves, and other climate impacts as well as devastating environmental consequences, the IPCC report warns.⁵

The consensus from leading scientific research academies within the United States and internationally is clear: multiple lines of evidence indicate, and have indicated for years, that our atmosphere is warming, sea levels are rising, the magnitude and frequency of certain extreme weather events is increasing, and that human activity is the primary driver of climate change.⁶ As described in the IPCC Special Report, the consensus is that countries around the

³ See, 1990 NGA Annual Meeting report at <https://classic.nga.org/cms/home/about/nga-annual--winter-meetings/page-nga-annual-meetings/col1-content/main-content-list/1990-nga-annual-meeting.html> and policy recommendation “urging that the U.S. join in the international agreement to protect the earth's atmosphere, that U.S. emissions of carbon dioxide be stabilized, that production and recycling of CFCs [chlorofluorocarbons] be stopped, that alternative energy systems be developed and commercialized, that forestry programs be promoted, that planning efforts begin for adapting to a changing climate, and that more aggressive research be conducted to determine what more states could do to control global climate change...”

⁴ *Climate Assessment, Volume II: Impacts, Risks, and Adaptation in the United States—Summary Findings*, NATIONAL CLIMATE ASSESSMENT (2018), <https://nca2018.globalchange.gov/>

⁵ *Global Warming of 1.5 °C*, IPCC (2018), <https://www.ipcc.ch/sr15/>.

⁶ NATIONAL ACADEMIES OF SCIENCE, ENGINEERING, AND MEDICINE, *National Academies Presidents Affirm the Scientific Evidence of Climate Change* (June 18, 2019), <http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=06182019>; ACADEMIA BRASILEIRA DE CIÊNCIAS (Brazil), ROYAL SOCIETY OF CANADA (Canada), CHINESE ACADEMY OF SCIENCES (China); ACADEMIE DES SCIENCES (France), DEUTSCHE AKADEMIE DER NATURFORSCHER LEOPOLDINA (Germany), INDIAN NATIONAL SCIENCE ACADEMY (India), ACCADEMIA NAZIONALE DEI LINCEI (Italy), SCIENCE COUNCIL OF JAPAN (Japan), RUSSIAN ACADEMY OF SCIENCES (Russia), ROYAL SOCIETY (United Kingdom), NATIONAL ACADEMY OF SCIENCES (USA), *Joint science academies' statement: Global response to climate change* (2005), available at <http://nationalacademies.org/onpi/06072005.pdf>; ACADEMIA BRASILEIRA DE CIÊNCIAS (Brazil), ROYAL SOCIETY OF CANADA (Canada), CHINESE ACADEMY OF SCIENCES (China); ACADEMIE DES SCIENCES (France), DEUTSCHE AKADEMIE DER NATURFORSCHER LEOPOLDINA (Germany), INDIAN NATIONAL SCIENCE ACADEMY (India), ACCADEMIA NAZIONALE DEI LINCEI (Italy), SCIENCE COUNCIL OF JAPAN (Japan), ACADEMIA MEXICANA DE CIENCIAS (Mexico), RUSSIAN ACADEMY OF SCIENCES (Russia), ACADEMY OF SCIENCE OF SOUTH AFRICA (South Africa), ROYAL SOCIETY (United Kingdom), NATIONAL ACADEMY OF SCIENCES (USA), *Joint science academies' statement: Climate Change Adaptation and the Transition to a Low Carbon Society* (2008), available at https://sites.nationalacademies.org/cs/groups/international/site/documents/webpage/international_080858.pdf.

world must rapidly decarbonize their economies, cutting greenhouse gas emissions in half by 2030 and to near zero by 2050.⁷ The U.S. Department of Defense, and leaders within the defense and national security communities, have also recognized climate change as a “national security issue” that requires adapting military operations and planning to ensure readiness.⁸

Despite our understanding of the consequences we will face and the urgency to act, U.S. GHG emissions from fossil fuel combustion **increased** by 2.7 percent in 2018, according to the Rhodium Group.⁹ Clearly more action is needed.

While we all recognize the importance of transportation in our daily lives and for our economy, it is also important to recognize that the transportation sector is the largest contributor of GHG emissions in the United States,¹⁰ and is already facing significant impacts from climate change.

There is an urgent need, therefore, to transition to a low-carbon and more resilient transportation system. Such a transition would not only reduce emissions and fight climate change, it also would bring additional important benefits, including protecting public health by reducing conventional air pollution, providing more mobility options, and driving innovation and economic growth through policy action and through public and private investment.

Transportation and Climate Initiative

Across the United States and on a bipartisan basis, states are seizing the opportunity to invest in low-carbon transportation solutions to reduce carbon pollution, improve air quality, and stimulate economic growth.

The Northeast and Mid-Atlantic States launched the Transportation and Climate Initiative (“TCI”) in 2010 to work as a region to develop the clean energy economy, improve transportation, and reduce carbon emissions in the transportation sector. This collaboration of energy, environment, and transportation agencies from twelve states and the District of Columbia is facilitated by our Georgetown Climate Center.

⁷ *Id.*; *Climate Assessment, Volume II*, *supra* note 4.

⁸⁸ See *Report on Effects of a Changing Climate to the Department of Defense*, U.S. DEPARTMENT OF DEFENSE (January 2019), <https://media.defense.gov/2019/Jan/29/2002084200/-1/-1/1/CLIMATE-CHANGE-REPORT-2019.PDF>; DoD Directive 4715.21: Climate Change Adaptation and Resilience, U.S. DEPARTMENT OF DEFENSE (January 14, 2016), <https://dod.defense.gov/Portals/1/Documents/pubs/471521p.pdf>; UPDATE: Chronology of U.S. Military Statements and Actions on Climate Change and Security: 2017-2019, THE CENTER FOR CLIMATE AND SECURITY, <https://climateandsecurity.org/2019/02/16/update-chronology-of-u-s-military-statements-and-actions-on-climate-change-and-security-2017-2019/>.

⁹ *Final US Emissions Estimates for 2018*, RHODIUM GROUP (May 30, 2019), <https://rhg.com/research/final-us-emissions-estimates-for-2018/>

¹⁰ *Sources of Greenhouse Gas Emissions*, EPA, <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions> (last visited Feb. 19, 2019).

The states have collaborated through TCI over the years on projects including eliminating barriers to the use of cleaner transportation fuels and technologies; sharing best practices in promoting smart growth; and understanding freight flows into and through the region to consider ways to enhance efficiency and reduce congestion and air pollution.

Since 2012, TCI jurisdictions have explored potential regional policy solutions with analysis that demonstrated the economic benefits of moving to cleaner transportation alternatives. In 2015, the TCI jurisdictions announced plans¹¹ to work together on potential market-based policies and in 2017¹² began to conduct extensive public outreach, which included six regional listening sessions in 2018 that engaged diverse stakeholders—including from businesses, local governments, community groups, and NGOs,¹³ along with extensive outreach by many states.¹⁴

Those efforts led to a landmark announcement on December 18th, 2018, by nine states plus DC to work together on a bipartisan basis to design a regional low-carbon transportation policy proposal. The proposed plan would cap and reduce carbon emissions from the combustion of transportation fuels and allow each TCI jurisdiction to invest the proceeds in low-carbon and more resilient transportation infrastructure.¹⁵

For the past six months, the states participating in TCI have been diligently working to design a policy that will accelerate the transition to a low-carbon transportation future and deliver a better, more resilient transportation system that benefits all our communities, particularly those underserved by current transportation options and disproportionately burdened by pollution.

This policy design process has included extensive engagement with stakeholders and communities through regional workshops to discuss program design options and opportunities to advance equitable outcomes for communities in the region. In addition, TCI states have conducted individual outreach to diverse stakeholders. In addition to this public engagement, TCI states are conducting modeling and analysis to inform policy design so that the proposed

¹¹ *Five Northeast States and DC Announce They Will Work Together to Develop Potential Market-Based Policies to Cut Carbon Emissions from Transportation*, TRANSPORTATION & CLIMATE INITIATIVE (Nov. 24, 2015), <https://www.transportationandclimate.org/main-menu/five-northeast-states-and-dc-announce-they-will-work-together-develop-potential-market>.

¹² *Northeast and Mid-Atlantic States Seek Public Input As They Move Toward a Cleaner Transportation Future*, TRANSPORTATION & CLIMATE INITIATIVE (Nov. 13, 2017), <https://www.transportationandclimate.org/northeast-and-mid-atlantic-states-seek-public-input-they-move-toward-cleaner-transportation-future>.

¹³ *Listening Session Summary Report*, TRANSPORTATION & CLIMATE INITIATIVE (Nov. 13, 2018), <https://www.transportationandclimate.org/tci-news-and-updates>.

¹⁴ Massachusetts, New York, and Rhode Island held state listening sessions.

¹⁵ *Nine States and D.C. to Design Regional Approach to Cap Greenhouse Gas Pollution from Transportation*, TRANSPORTATION & CLIMATE INITIATIVE (Dec. 18, 2018), <https://www.transportationandclimate.org/nine-states-and-dc-design-regional-approach-cap-greenhouse-gas-pollution-transportation>.

policy will reduce GHG emissions from transportation while improving transportation systems and creating economic and public health benefits in the region.

Recently, a diverse coalition of business, environmental, and taxpayer groups in Massachusetts came together to support the opportunity presented by the Transportation and Climate Initiative. The Massachusetts Business Roundtable, the Associated Industries of Massachusetts, the Environmental League of Massachusetts, Ceres, and the Massachusetts Taxpayers Foundation sent a letter to Massachusetts Governor Baker commending his leadership on TCI and recognizing the unique opportunity for the TCI regional policy to meet the goals of reducing GHG emissions, alleviating congestion, and generating proceeds for investments in transit.

We believe that the TCI effort could provide significant benefits to the region and are proud to support the bipartisan group of states undertaking this important initiative, yet we—and the states we serve—realize that federal action and support are vital. Threatened rollbacks of federal policies, including vehicle air pollution and fuel economy standards make this work even more important and more challenging.

Opportunities for Federal Leadership on Climate Change and Transportation

The states working through the Transportation and Climate Initiative have recognized the opportunity to modernize our transportation system while reducing air pollution and greenhouse gas emissions. While this state leadership is critically important, the federal government has an indispensable role in solving these challenges.

In the listening sessions we have held with the TCI states, businesses and community members across the region shared the challenges they face with the transportation system: congestion that is diminishing the efficiency of our economy; severe air pollution affecting those with asthma and other serious health problems—impacts that are often concentrated in communities of color and low-income communities; lack of access to transportation services, both for citizens in urban areas without access to transit, as well as in rural communities where lack of access to basic services like healthcare and jobs is harming wellbeing; and finally, the greenhouse gas emissions from burning fossil fuels that will cause billions of dollars in economic damage and loss of life in more severe storms and fires.

In the upcoming transportation reauthorization, Congress has an opportunity to address these problems by expanding on initiatives underway in the states, funding innovative programs that expand access to transportation, and supporting new technologies that offer great promise for emissions reduction and economic growth. When asked what investments were needed to bring about a more reliable, affordable, fair, safe and clean transportation system, diverse stakeholders who participated in the TCI listening sessions offered many strategies, including, electrification of transportation, smart growth and transit-oriented development, supporting

other alternative fuels, improving ports and other freight facilities, and multi-modal investments to provide greater transportation alternatives.

Similarly, the recent future of the Interstate Highway System study encouraged consideration of our “transportation system” as a whole, recognizing the importance of providing alternative options including support for “complete streets” and transit to address the congestion of the interstate system, especially in urban and suburban areas.¹⁶ The report committee heard about the lack of investment in our system and the need to invest in maintaining it to meet current and future demands, including the challenges of a changing climate that I discuss later in this testimony. These investments will require a strong federal partnership.

Investments to Modernize and Decarbonize Our Transportation System

“Fix-it-First” Investment and Transportation System Management

Transportation infrastructure in the United States requires significant investment to achieve a state of good repair (in the American Society of Civil Engineers 2017 Infrastructure ‘Report Card’, our on-road transportation system received a ‘D’ grade). However, some studies show that significant federal and state funding is going to road expansion rather than maintaining and improving our existing system.¹⁷ The Committee has an opportunity to reevaluate ways in which federal transportation funding can prioritize fixing and maintaining our existing network.

While congestion is a major challenge, analyses have found that road capacity expansion projects will induce additional vehicle demand and have a limited impact on congestion, while increasing greenhouse gas emissions (a recent example in California showed that pre-existing levels of service and congestion returned five years after completion of a \$1.1 billion road widening investment¹⁸).¹⁹ The future of the Interstate Highway System study recognized that highway congestion mitigation, particularly in fast-growing urban and suburban areas, could be pursued through a combination of measures, including managing demand through road and

¹⁶ National Academies of Sciences, Engineering, and Medicine 2019. Renewing the National Commitment to the Interstate Highway System: A Foundation for the Future, 61-63. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25334>.

¹⁷ Smart Growth America’s 2014 Repair Priorities report shows nearly equal investment between road maintenance and new road construction in the United States from 2009 to 2014. This report uses data from the Federal Highway Administration Highway Statistics Series: <https://www.fhwa.dot.gov/policyinformation/statistics.cfm> .

¹⁸ Eric Sundquist, State Smart Transportation Initiative, “Yet more evidence: ‘If you build it they will drive’” (May 2019), <https://www.ssti.us/2019/05/yet-more-evidence-if-you-build-it-they-will-drive/>

¹⁹ Susan Handy, University of California, Davis, and Marlon G. Boarnet, University of Southern California, “Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions,” Policy Brief for California Air Resources Board (September 2014), https://ww3.arb.ca.gov/cc/sb375/policies/hwycapacity/highway_capacity_brief.pdf

congestion pricing, high-occupancy vehicle lanes, parallel transit services, and other transportation system management strategies.²⁰

“Complete Streets” with Bicycle and Pedestrian Transportation

The proportion of traffic fatalities involving pedestrians and bicyclists is increasing in the United States.²¹ These forms of active transportation provide significant societal benefits by reducing congestion and air pollution and limiting wear and tear on our roadways. Better street design, including developing “complete streets” that allow for safe and efficient movement of pedestrians and bicyclists in addition to vehicles, can provide significant safety benefits as well as emission reductions. Federal funding programs, including the Capital Investment Grant program, the Transportation Alternatives Program, and the Surface Transportation Block Grant, provide critical support to state, local, and regional governments to enable investments in bicycle and pedestrian transportation infrastructure.

Port Electrification

The United States’ port facilities are a critical part of our national transportation system and are vital to a strong economy. For example, the Port of New York and New Jersey handled nearly \$200 billion in cargo containers in 2017.²² However, these port facilities are often some of the worst sources of air pollution, particularly for communities located near the ports and major transportation corridors. Port authorities across the country are taking steps to reduce emissions through deploying alternative fuels and new technologies, including electrification of port facilities. For example, in the neighborhoods surrounding the Port of Long Beach and the Port of Los Angeles, port-related diesel particulate emissions decreased by 87 percent from 2005 to 2017, due to state and local regulations and the port authorities’ Clean Air Action Plan investments.²³ However, the communities near these ports still suffer higher rates of childhood asthma and exposure to cancer-causing pollution, and more action is needed.²⁴ Federal funding for scaling up pilots and investing in new technology will be critical to accelerating the deployment of zero- and near-zero emission technologies, including for drayage truck and cargo handling equipment.²⁵

²⁰ Renewing the National Commitment to the Interstate Highway System: A Foundation for the Future, 61-66.

²¹ U.S. National Highway Traffic Safety Administration, 2017 Fatal Motor Vehicle Crashes: Overview (October 2018), <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812603>

²² Port of New York and New Jersey, About Port of New York and New Jersey, <http://www.panynj.gov/port/about-port.html>

²³ San Pedro Bay Ports, Clean Air Action Plan 2017 (November 2017), <http://www.cleanairactionplan.org/documents/final-2017-clean-air-action-plan-update.pdf/>

²⁴ San Pedro Bay Ports, Clean Air Action Plan 2017.

²⁵ See, e.g., Port of Long Beach, Officials Launch Zero-Emissions Port Project, <http://www.polb.com/news/displaynews.asp?NewsID=1716>

Public Transportation and Transit Oriented Development

While I recognize that federal investments in transit systems are outside the jurisdiction of this committee, I do want to express the importance of transit investments to our national surface transportation system. Investment in public transit, including light rail systems, bus rapid transit, traditional bus routes, and new mobility applications such as dynamic-routing micro-transit, provide additional transportation choices while reducing emissions. Cities and states throughout the U.S. are pioneering innovative ways of making transit more convenient and accessible, while harnessing the benefits of transit for community development and economic growth. We should explore ways to improve multi-modal connections and better integrate vehicle travel with our transit services. This improved access to transit can spur economic growth and development. For example, Arlington, Virginia, where I live, has successfully decoupled strong economic growth from greenhouse gas emissions by implementing transit-oriented development, in which mixed use developments are clustered near Metro stations.²⁶

Funding a Low-Carbon National Highway System

The United States Interstate Highway System is one of our great public works projects and is a striking example of how ambitious federal investment leads to job creation and economic growth. While the Interstate Highway System and our national highways are operated and managed through important state/federal cooperation, this national system of roadways relies on federal investment to continue connecting communities and supporting commerce.

Committee members on the Future of the Interstate Highway System Study recognized that we should avoid the sins of our past in our design and expansion of the system, which often cut through cities and disrupted communities, disproportionately impacting low-income communities, often communities of color. Efforts to mitigate those impacts are underway in many cities, including projects where stretches of highway bisecting communities are being taken down or are being “capped”—something that is occurring just blocks away here in the District of Columbia.²⁷

Similarly, the unintended consequences of our expansive highway system on air pollution and climate change should be a focus of this committee given your broad jurisdiction over air pollution and public works projects. Federal leadership is critical as we make the investments necessary to create a low-carbon national highway system. One effective strategy for reducing emissions from the transportation sector is to transition our vehicle fleet to electric vehicles. Electric cars are more efficient and reduce GHG emissions even when emissions from power

²⁶ *Arlington's Framework for Prosperity: Economic Development Strategic Plan*, ARLINGTON ECONOMIC DEVELOPMENT, <https://www.arlingtoneconomicdevelopment.com/index.cfm?LinkServID=0DDC0123-EC51-4DED-8EBB576881FA52F8&showMeta=0> (last visited Feb. 25, 2019).

²⁷ *Renewing the National Commitment to the Interstate Highway System: A Foundation for the Future*, 41-42.

plants that generate the electricity for the electric vehicles are included.²⁸ And the opportunities for emissions reductions from adopting electric vehicles will improve throughout the country as the electricity grid further decarbonizes.²⁹

A robust network of highway corridor fast charging is critical to grow the market for electric vehicles. People need to know that they can charge their vehicles, such as my 2018 Chevy Bolt, Bluebell, before they will use the vehicles for long distance trips.

Because electric vehicles are a new technology with limited penetration in the vehicle market, there are very few viable business cases for investment in DC fast charging—particularly along highway corridors—in the absence of some public sector funding to support early investment. However, once a minimum level of EV fast charging coverage is in place and EV sales increase, increased demand for charging will drive private investments.³⁰ In order to jump-start this critical transition to transportation electrification, targeted public funding is needed.

Countries around the world are making the investment in EV fast charging needed to provide the minimum level of coverage necessary for the market to mature. For example, China has made significant investments in fast charging to support charging corridors between its major metropolitan areas. As of January 2018, China had installed over 66,000 DC fast charging plugs, compared to just over 7,500 in the US at that time³¹ (there are 11,079 fast charging plugs in the United States as of July 2019³²).

²⁸ For example, in Oregon, a recent analysis showed that an electric vehicle in 2018 would be the equivalent of a gas car with 96 MPG rating [David Reichmuth, *New Data Show Electric Vehicles Continue to Get Cleaner*, UNION OF CONCERNED SCIENTISTS (2018), https://blog.ucsusa.org/dave-reichmuth/new-data-show-electric-vehicles-continue-to-get-cleaner?_ga=2.65610987.430581647.1520949632-566757794.1516988670]. Even in Wyoming, where (as of 2015 data) coal power makes up more than 85 percent of electricity generation, [State Energy Analysis Tool, GEORGETOWN CLIMATE CENTER, <https://www.georgetownclimate.org/clean-energy/sea.html>] an electric vehicle would be equivalent to a 46 miles per gallon gas vehicle.

²⁹ As the grid becomes cleaner, an electric vehicle sold this year will effectively become lower- and lower-emitting throughout its life. Decarbonization of the electricity sector is happening due to fuel switching and the falling prices of wind and solar power. See, e.g., Robert Walton, *Xcel Solicitation Returns 'Incredible' Renewable Energy, Storage Bids*, UTILITY DIVE (Jan. 8, 2018), <https://www.utilitydive.com/news/xcel-solicitation-returns-incredible-renewable-energy-storage-bids/514287/>; Press Release, *New Solar-Plus-Storage Projects Set Low-Price Benchmark For Renewable Energy in Hawaii*, HAWAIIAN ELECTRIC COMPANY (Jan. 3, 2019), <https://www.hawaiianelectric.com/new-solar-plus-storage-projects-set-low-price-benchmark-for-renewable-energy-in-hawaii>.

³⁰ Eric Wood, *New EVSE Analytical Tools/Models: Electric Vehicle Infrastructure Projection Tool (EVI-Pro)*, NATIONAL RENEWABLE ENERGY LABORATORY (Jan. 24, 2018), <https://www.nrel.gov/docs/fy18osti/70831.pdf>.

³¹ Michael Nicholas and Dale Hall, The International Council on Clean Transportation, *Lessons Learned on Early Electric Vehicle Fast-Charging Deployments* (July 2018), https://theicct.org/sites/default/files/publications/ZEV_fast_charging_white_paper_final.pdf

³² U.S. Department of Energy, Alternative Fuels Data Center, <https://afdc.energy.gov/stations/#/find/nearest> (Filtered for Fast Charging for electric vehicles)

The largest source of current investment in EV fast charging in the U.S. is an investment of \$2 billion over ten years by Electrify America, a subsidiary of Volkswagen Group that was created as part of the settlement agreement with the U.S. Environmental Protection Agency following the diesel emissions scandal. To demonstrate the total scope of EV fast charging investments needed in the United States, Electrify America staff have estimated that its \$2 billion investment will likely meet only 10 – 15 percent of the charging infrastructure needs in the United States at the end of the company’s mandated investment commitment.³³

Federal Investment in Alternative Fuel Corridors

The Fixing America’s Surface Transportation Act (FAST Act) instructed the U.S. Federal Highway Administration to designate corridors for alternative fuels (including electric vehicles) but did not provide any direct funding for infrastructure investment to support the build-out of designated or pending corridors.³⁴

Potential federal investment could expand on corridor planning efforts underway in states and regional partnerships to ensure that federal funding is strategically invested to grow the market for EVs while spurring economic development and improving transportation. For example, several states, including California, Washington, and New York, have undertaken modeling and analysis to better understand which highway corridors have been developed by the private market and which are the highest priorities for public funding to support a comprehensive network of EV charging.³⁵

One strategy that this Committee might consider is targeting investment in EV charging in rural and remote corridor locations which are currently underserved by the private market, as a business and economic development opportunity for those locations that would also provide access to EVs to a wider range of communities.

Building on Existing Regional Partnerships

The importance of long-distance fast charger corridor planning is reflected in how states are working together to plan for EV corridors in regions around the country.

The Pacific Coast states have collaborated since 2011 to develop the West Coast Electric Highway, a network of DC fast charging stations along Interstate 5 and other major roadways.³⁶ This project was first funded as part of the American Recovery and Reinvestment Act. Since the initial wave of funding, Washington, Oregon, and California have used public-private partnerships and state grant funding to build out EV charging infrastructure along corridors.

³³ From discussions with Electrify America staff.

³⁴ 23 U.S.C. § 151 (2015).

³⁵ *Electric Vehicle Charging Infrastructure*, WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (2019), <http://www.wsdot.wa.gov/funding/partners/evib>.

³⁶ *West Coast Electric Highway*, IDAHO NATIONAL LABORATORY: ADVANCED VEHICLES, <https://avt.inl.gov/project-type/west-coast-electric-highway> (last visited Feb. 19, 2019).

The West Coast Electric Highway effort is notable for its focus on expanding consumer awareness of EV charging through outreach and branding. The states have shared their lessons with other regions, including states participating in the Transportation and Climate Initiative in this region.

TCI states have worked to develop EV charging infrastructure since the start of the regional partnership, and have collaborated since 2016 on regional interstate corridor planning. The focused effort on corridor planning has included engagement with the Federal Alternative Fuel Corridors Program, including a regional nomination resulting in over 2,500 miles of EV corridors designated by U.S. Federal Highway Administration (FHWA) in the first round of designations.³⁷

The Transportation and Climate Initiative has been a valuable forum for electric vehicle corridor planning, due to the leadership of state departments of transportation and given the inherent need to collaborate across state lines to allow residents to travel seamlessly and conveniently between cities, for work, and to tourism destinations. The TCI states have worked together to share best practices, engage with EV charging businesses and electric utilities, and apply together for grant funding programs.

The TCI states have also worked together to conduct a regional analysis to identify priority locations for additional EV charging infrastructure investment. The technical analysis—launched in 2018—includes an Excel-based tool that can be used to identify which highway exits may be good candidates for additional charging infrastructure investment, as well as an interactive GIS map that displays fast charging infrastructure along corridors in the region and priority investment locations.³⁸ This corridor analysis was developed by the Georgetown Climate Center and M.J. Bradley & Associates to support the TCI states.

In the inter-mountain west states, another bipartisan coalition of governors from eight states launched the Regional Electric Vehicle Plan for the West, or “REV West,” with governors signing an MOU with the goal to promote a network of EV corridors.³⁹

A federal corridor funding program would benefit from harnessing the important partnerships between state officials that have been created through these regional collaborations.

³⁷ U.S. Department of Transportation Designates Electric Vehicles Corridors in the Transportation and Climate Initiative Region, TRANSPORTATION & CLIMATE INITIATIVE (Nov. 3, 2016), <https://www.transportationandclimate.org/us-department-transportation-designates-electric-vehicles-corridors-transportation-and-climate>.

³⁸ The regional EV corridor analysis is publicly available at no cost from Georgetown Climate Center. *EV Corridor Analysis Tool for Northeast and Mid-Atlantic States*, GEORGETOWN CLIMATE CENTER (July 26, 2018), <https://www.georgetownclimate.org/articles/ev-corridor-analysis-tool-for-northeast-and-mid-atlantic-states.html>.

³⁹ *Regional Electric Vehicle (REV) West Program*, U.S. DEPARTMENT OF ENERGY: ENERGY EFFICIENCY & RENEWABLE ENERGY, <https://afdc.energy.gov/laws/11874> (last visited Feb. 29, 2019).

Strategic Investment to Avoid Stranded Assets

Federal technical and financial support could also help states and metropolitan planning organizations better identify gaps in EV charging infrastructure. This could include expansion of existing tools; for example the corridor analysis tool built to inform northeast and mid-Atlantic states⁴⁰ or the Electric Vehicle Infrastructure Projection (EVI-Pro) tool built by the California Energy Commission and National Renewable Energy Laboratory to assess charging infrastructure needs.⁴¹ The federal government could support a study (using EVI-Pro or other methodology) of specific charging infrastructure needs to support long-distance trips on a national level. This analysis has already been conducted for California, Colorado, and Columbus, Ohio, through existing programs or partnerships.⁴²

One opportunity for federal investments is to require that charging stations funded by federal grants use charging station hardware, software, and network services that are inter-operable. Interoperability of hardware and software creates a more flexible business market that allows for innovation within the industry and avoids stranded assets. I encourage Congress to engage with states and U.S. national laboratories considering these issues when developing potential infrastructure funding programs.

Using Federal Funds to Create a Convenient Driver Experience

In addition to strategically targeting geographic locations, a federal funding program could also provide additional public benefits by including requirements or incentives that ensure driver convenience and a robust private market for charging stations. There is an opportunity for such a federal program to incorporate lessons learned and policies developed through ongoing state efforts. States participating in the multi-state ZEV Task Force have worked to identify policy outcomes that can be achieved through requirements for EV charging stations installed with public funding.⁴³ For example, states are exploring open payment requirements, to ensure that drivers know how much they will pay for a charge, can easily use a credit card to pay for charging, and are not required to have a charging station network membership. We've all gotten used to driving up to a gas station and knowing that we can pay with a credit card (for example), without the requirement of becoming a member of a fuel provider like Exxon or

⁴⁰ *EV Corridor Analysis Tool for Northeast and Mid-Atlantic States*, *supra* note 38.

⁴¹ *CEC EV Infrastructure Projection (California)*, NATIONAL RENEWABLE ENERGY LABORATORY, <https://maps.nrel.gov/cec/?aL=0&bL=cdark&cE=0&IR=0&mC=36.8708321556463%2C-116.34521484375001&zL=6> (last visited Feb. 19, 2019).

⁴² Eric Wood, *New EVSE Analytical Tools/Models: Electric Vehicle Infrastructure Projection Tool (EVI-Pro)*.

⁴³ See Kathy Kinsey, Elaine O'Grady, and Jesse Way, *Northeast States For Coordinated Air Use Management, Building Reliable EV Charging Networks: Model State Grant and Procurement Contract Provisions for Public EV Charging* (May 2019), <https://www.nescaum.org/>

Shell. But that is not always the case with EV charging, which can create inconvenience and confusion.

Providing Clear and Convenient Signs for Drivers

Currently the federal Manual on Uniform Traffic Control Devices does not allow state DOTs to easily add an EV charging station logo to specific service (food/fuel/lodging) signs. The current manual is somewhat unclear on this subject, which has been vexing to many state agencies looking to develop EV charging signage guidance.⁴⁴ One potential solution would be to create a new category of highway logo (specific service) signs for EV charging. This would improve EV driver convenience and provide a significant consumer awareness benefit. California has already taken this approach, modifying its state manual to create a new category for EV charging station logos, and other states are interested in this issue as well. It is important at a minimum that the federal manual maintain flexibility for states to experiment with the best ways to provide logo signs for electric vehicles as we develop an appropriate federal standard.⁴⁵

Supporting Innovative Technology Deployment

The upcoming transportation reauthorization bill may also provide an opportunity to remove barriers to innovative technology deployments like solar power installations along highways. Roadside solar is an exciting idea that is being pursued by state departments of transportation around the country.⁴⁶ Roadside solar is an opportunity for clean energy investment and might even provide a supplemental source of highway funding moving forward. However, roadside solar projects are being bogged down in significant bureaucracy related to the lack of clarity around the statutory ban on commercial activity in the interstate right of way. State departments of transportation and independent organizations innovating with roadside solar projects—like The Ray in Georgia—have identified these administrative barriers as a major impediment to project development. These restrictions have been identified as a barrier in reports, including the recent Transportation Research Board Report to Congress on the Future of the Interstate Highway report.⁴⁷ The Senate should consider modernizing this statutory provision to provide greater clarity that innovative projects, such as the Ray, can explore opportunities to better leverage our highway system, generate revenue, and bring low-cost, clean energy to the grid without displacing farmland or forests.

⁴⁴ “To qualify for a GAS logo sign panel, a business should have: (1) Vehicle services including gas and/or alternative fuels, oil, and water; (2) Continuous operation at least 16 hours per day, 7 days per week for freeways and expressways, and continuous operation at least 12 hours per day, 7 days per week for conventional roads; (3) Modern sanitary facilities and drinking water; and (4) Public telephone.” U.S. DEP’T OF TRANSP., MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES § 2J.01.10 (Dec. 2009).

⁴⁵ CAL. DEP’T OF TRANSP., MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES § 2J.01 (Nov. 2014).

⁴⁶ See, e.g., The Ray, <https://theray.org/>; Massachusetts Department of Transportation, MassDOT Solar Energy Program, <https://www.mass.gov/massdot-solar-energy-program>

⁴⁷ *Renewing the National Commitment to the Interstate Highway System: A Foundation for the Future*, Transportation Research Board (Feb. 6, 2019), <http://www.trb.org/Main/Blurbs/178485.aspx>.

Opportunities for Research and Development

While there are many exciting developments underway that are helping to expand the uses of EVs and other low-carbon transportation options, there are still technical and logistical barriers where federal support of pilot programs, research, or public-private partnerships might be helpful.

As we scale up the use of new transportation fuels and technologies over time, research and pilot deployments can help ensure that federal funds are invested efficiently in projects and technologies that reduce emissions, provide energy security, and stimulate economic growth. Additionally, research programs can effectively identify issues that might arise in the future. For example, the federal government could support additional research into questions on how the different zero-emission or alternative fueling and charging infrastructures complement or interact with one another at individual sites or throughout the transportation system. There is significant investment in hydrogen fueling infrastructure in California and other states, due to the significant opportunity for hydrogen to serve as a fast-refueling, zero-tailpipe emission fuel source for vehicles.⁴⁸

For electric vehicle charging, key questions include the opportunities for managed EV fast charging (e.g., providing options for drivers where the cost and speed of charging vary based on electric grid capacity). A related topic for additional research is the interaction of EV charging with on-site storage to minimize distribution grid impacts. Electrify America and Tesla are making major investments in on-site storage co-located with DC fast charging facilities. This is an area where transportation system research—in conjunction with battery storage research underway at the U.S. Department of Energy and U.S. national laboratories—could prove valuable.

Decarbonizing Medium- and Heavy-Duty Trucks

As the movement of goods on our country's highway corridors continues to increase with the growth of e-commerce, decarbonizing truck transport will be critical to meeting state and national climate commitments. For both long-haul and local delivery by heavy-duty and medium-duty vehicles, a number of low- or zero-emission vehicle and fuel types may serve different use cases.

For reducing emissions of criteria pollutants, natural gas- and propane-fueled vehicles offer a promising and potentially low-cost alternative. For reducing GHG emissions, the federal government could play a key role in enabling the deployment of battery electric and hydrogen fuel cell vehicles.

Many vehicle and engine manufacturers have announced plans to release battery electric trucks over the coming years, and hydrogen truck technology offers a promising alternative. The U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, has

⁴⁸ *California's Hydrogen Transportation Initiatives*, CALIFORNIA AIR RESOURCES BOARD, <https://www.arb.ca.gov/msprog/zevprog/hydrogen/hydrogen.htm> (last visited Feb. 20, 2019).

supported significant research and development efforts for hydrogen and fuel cell technologies, including through partnerships with U.S. national laboratories and private sector businesses, and has set ambitious goals for reducing the price of hydrogen fuel cells.⁴⁹ This investment in hydrogen as a transportation fuel is as part of a broader role for hydrogen fuel in a decarbonized United States energy system.

One critical challenge for both of these zero-emission technology types is the development of sufficient charging or fueling infrastructure along highway corridors. Similar to passenger vehicles, a minimum level of infrastructure coverage needs to be in place in order for the market to grow to the scale necessary to support private investment and unsubsidized growth.

Heavy duty battery-electric trucks provide unique charging infrastructure and electric grid challenges. For example, the electric semi-truck specifications suggested by Tesla might require over 1 MW capacity charging per plug—equivalent to a Walmart Supercenter. A truck stop depot with 10 of these chargers could have a peak electrical load similar to an industrial facility, but will often be located in a rural area far from available electrical power capacity.

The federal government could play a critical role expanding research and pilot programs to determine the most cost effective and efficient means of providing this type of vehicle charging, including the role of stationary storage batteries and co-location of renewable power generation. This work could incorporate the freight corridor planning underway in many states through the FHWA Alternative Fuel Corridor program, and could engage key stakeholders, including electric utilities, the National Association of Truck Stop Operators, and vehicle manufacturers.

Creating a More Resilient Transportation System

Beyond needing to innovate and reduce emissions from the transportation sector and shift to cleaner sources of electricity, we need to ensure that our transportation infrastructure and systems are prepared for storms, floods and other climate change impacts, which are already being observed.

There are numerous examples of the toll that more frequent extreme weather events, sea-level rise, and warming temperatures are taking on communities across states, including those represented by members of this committee. For example, in the first six months of 2019 we have seen a record-setting numbers of declared flood disasters, which have affected many states represented by senators serving on this committee, including Iowa, North Dakota, Oklahoma, Arkansas, Vermont, and South Dakota (where 63 of the state's 66 counties have

⁴⁹ *Fuel Cell Technologies Office Accomplishments and Progress*, OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, <https://www.energy.gov/eere/fuelcells/fuel-cell-technologies-office-accomplishments-and-progress> (last visited Feb. 19, 2019).

declared flood disasters in 2019).⁵⁰ These flood events are straining federal funding and personnel resources, which is only likely to become more of a challenge as hurricane season gets underway. Meanwhile, coastal villages in Alaska are losing in some cases dozens of feet of land each year as they are less protected by sea ice and vulnerable to storms that cause erosion; and this is causing these communities to face difficult decisions about the need to relocate entirely.⁵¹ And we all can recall the consequences of the Chicago heat wave of 1995, which caused over 700 deaths and highlighted the need to focus on fostering resilience and preparedness to extreme heat within communities and infrastructure.⁵² We are increasingly seeing record-setting heatwaves, including the one hitting Europe this summer, which is creating health emergencies, melting roads and buckling railways, and even causing German authorities to limit speeds on the Autobahn.⁵³

However, it is not just the increasing and changing extreme weather events that challenge our states and communities, but also the “slow-moving” and chronic stressors of climate change, including increasing average temperatures and incidence of drought, and sea-level rise and related stressors like rising groundwater levels. These changes are requiring communities within your states to plan long-term for increasingly exposed coastal areas, effects on natural resources and agriculture, and changing economic drivers. For example, increasing temperatures and higher incidence of drought will affect many areas of the United States with a strong agricultural economy, as these impacts can cause crops to fail, reduce livestock productivity, and change or increase the types of pests and diseases that affect crops.⁵⁴ In recent years there are several examples of major heat waves and droughts that amounted to “billion-dollar disasters” where significant portions of the costs resulted from agricultural losses.⁵⁵ And in coastal states like Maryland and Delaware, nuisance flooding happening on

⁵⁰ Thomas Frank, E&E NEWS, Record number of flood disasters strains Trump admin (July 2, 2019), <https://www.eenews.net/climatewire/2019/07/02/stories/1060683093>.

⁵¹ Andrea Thompson, SCIENTIFIC AMERICAN, Alaska's Coast Is Vanishing, 1 Storm at a Time (November 30, 2017), <https://www.scientificamerican.com/article/alaskas-coast-is-vanishing-1-storm-at-a-time/>.

⁵² Bonnie M. Rubin & Jeremy Gerner, CHICAGO TRIBUNE, Fatal heat wave 20 years ago changed Chicago's emergency response (July 15, 2015), <https://www.chicagotribune.com/news/ct-chicago-heat-wave-20-years-later-met-20150715-story.html>.

⁵³ Patrick Sawyer & Victoria Ward, THE TELEGRAPH, UK weather: Rails overheat and roads melt as temperatures soar across Britain on hottest day of the year (June 29, 2019), <https://www.telegraph.co.uk/news/2019/06/29/rails-buckle-roads-melt-temperatures-soar-across-britain/>; (Ivana Kottasova, CNN, France endures its hottest day ever as Europe swelters in heat wave (June 28, 2019), <https://www.cnn.com/2019/06/28/europe/france-record-temperature-heatwave-intl/index.html>; William Wilkes & Brian Parkin, BLOOMBERG NEWS, Blazing Heatwave Forces Germany to Limit Autobahn Speeds (June 25, 2019), <https://www.bloomberg.com/news/articles/2019-06-26/blazing-heatwave-forces-germany-to-lower-autobahn-speed-limit>

⁵⁴ See *Climate Assessment, Volume II: Impacts, Risks, and Adaptation in the United States—Agriculture*, NATIONAL CLIMATE ASSESSMENT (2018), <https://nca2018.globalchange.gov/chapter/10/>.

⁵⁵ For example, the 2012 drought and heat wave conditions affected more than half of the U.S. and caused an estimated \$33.6 billion in damages, including widespread crop failure for corn, sorghum, and soybean. Billion-

even sunny days is affecting the ability of residents and visitors to travel, with consequences for their way of life and their local economies.⁵⁶

In the transportation sector, aging roads, bridges, railroads, and other assets are increasingly threatened by extreme heat, sea-level rise and coastal storms, more intense downpours and riverine flooding, changing freeze-thaw cycles and thawing permafrost, among other effects of climate change. We have seen how these changes directly affect our transportation infrastructure and networks, with cascading consequences for regional economies and human health as movement of goods and people and access to services are disrupted. For example, as a result of the 2008 floods in central Iowa, which were caused by extreme precipitation in late May and early June and record-breaking river levels, over 450 miles of the primary highway system was closed and over 300 bridges, 1500 road miles, and railroad track and signal infrastructure needed repairs or reconstruction.⁵⁷ In 2011, Vermont experienced an estimated \$250-300 million in infrastructure damage resulting from Tropical Storm Irene, which washed out numerous roads and culverts.⁵⁸ And the many transportation and related effects within New York and New Jersey from Hurricane Sandy in 2012 are well-documented, and include flooding of New York City tunnels, electrical substations, transit stations, airport runways, and rail yards, causing billions in damage to multimodal systems and assets.⁵⁹ Federal, state, and local infrastructure agencies have learned from such events in preparing, responding, and recovering from these and other disasters, but continue to be challenged by growing risks, policy constraints, and limited budgets.

Transportation Agencies Responding to Climate Change

In the transportation sector specifically, decisionmakers are working to understand the implications of climate change for their systems, to plan and prepare assets, and to modify operations and maintenance practices accordingly; and these agencies are doing so on very

Dollar Weather and Climate Disasters: Table of Events, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, <https://www.ncdc.noaa.gov/billions/events/US/2004-2018>.

⁵⁶ See, e.g., Thomas Frank, E&E NEWS, Annapolis parking lot foreshadows future flood losses (March 26, 2019), <https://www.eenews.net/climatewire/stories/1060128369>.

⁵⁷ *Local Office Service Assessment: Central Iowa Floods of 2008*, NATIONAL WEATHER SERVICE (May 2009), https://www.weather.gov/media/dmx/SigEvents/2008_Central_Iowa_Floods.pdf.

⁵⁸ Vermont's challenges of rebuilding culverts more resiliently during the recovery period, due to barriers at the time in federal law and disaster recovery programs, is explored in the report. *Lessons Learned from Irene: Climate Change, Federal Disaster Relief, and Barriers to Adaptive Reconstruction*, GEORGETOWN CLIMATE CENTER (Dec. 20, 2013), <https://www.georgetownclimate.org/reports/lessons-learned-from-irene-climate-change-federal-disaster-relief-and-barriers-to-adaptive-reconstruction.html>.

⁵⁹ See Sarah Kaufman, et al., *Transportation During and After Hurricane Sandy*, RUDIN CENTER FOR TRANSPORTATION: NYU WAGNER GRADUATE SCHOOL OF PUBLIC SERVICE (Nov. 2012), <https://wagner.nyu.edu/files/faculty/publications/sandytransportation.pdf>.

limited budgets. Many of the transportation departments and other state agencies, legislatures, and local agencies within your own states have been leaders in these efforts.

For example, as part of a pilot project, the Maryland State Highway Administration has led efforts in Maryland to map vulnerabilities of the road network⁶⁰ and is now working to integrate those findings into their transportation asset management program.⁶¹ Many other states represented by the members of this committee have similarly worked to understand and prepare for effects of current and future extreme weather events and other climate impacts on their transportation systems, including Alaska, Delaware, Illinois, Iowa, Massachusetts, Mississippi, New Jersey, New York, and Oregon.⁶²

Aside from the technical assistance and other support provided through these pilot programs, states and local governments are taking actions to reduce risks from climate change and extreme weather both within and outside the transportation context. For example, New York State established formal statewide sea-level rise projections by regulation in early 2018,⁶³ implementing an important aspect of the state's Community Risk and Resiliency Act (2014), which is designed to integrate considerations of climate change impacts to proposed projects in certain funding and permitting processes overseen by state agencies.⁶⁴ Maryland expanded its "Coast Smart" program in 2018, now requiring that state-funded local projects (in addition to state capital projects) be sited and designed according to the state's "Coast Smart" criteria, and requiring certain local jurisdictions to develop plans to address nuisance flooding.⁶⁵ Rhode Island passed legislation requiring local planning board members to be trained on sea-level rise

⁶⁰ Maryland State Highway Administration's first pilot project focused on assessing vulnerabilities of bridges and roads in two counties. FHWA Climate Resilience Pilot Program: Maryland State Highway Administration, FHWA-HEP-15-046, FEDERAL HIGHWAY ADMINISTRATION, https://www.fhwa.dot.gov/environment/sustainability/resilience/pilots/2013-2015_pilots/maryland/index.cfm. Using the same process, SHA later expanded the analysis to other counties statewide and to additional types of transportation assets.

⁶¹ Asset Management, Extreme Weather, and Proxy Indicators Pilot Program (2017-2019), FEDERAL HIGHWAY ADMINISTRATION, <https://www.fhwa.dot.gov/asset/resources/pilot.pdf>

⁶² See Resilience Pilots, FEDERAL HIGHWAY ADMINISTRATION, <https://www.fhwa.dot.gov/environment/sustainability/resilience/pilots/>.

⁶³ NY ENVTL. CONSERV. LAW § 490 (2018).

⁶⁴ New York Community Risk and Resiliency Act (S06617B), GEORGETOWN CLIMATE CENTER: ADAPTATION CLEARINGHOUSE (Sept. 22, 2014), <https://www.adaptationclearinghouse.org/resources/new-york-community-risk-and-resiliency-act-s06617b.html>.

⁶⁵ For more information, see Maryland HB 1350/ SB 1006 - Sea Level Rise Inundation and Coastal Flooding - Construction, Adaptation, and Mitigation, GEORGETOWN CLIMATE CENTER: ADAPTATION CLEARINGHOUSE (Apr. 5, 2018), <https://www.adaptationclearinghouse.org/resources/maryland-hb-1350-sb-1006-sea-level-rise-inundation-and-coastal-flooding-construction-adaptation-and-mitigation.html>.

and floodplain development impacts.⁶⁶ And the City of Minot, North Dakota won a grant through the National Disaster Resilience Competition, administered by HUD, to prepare the community for future flood events following the city's 2011 flood disaster.⁶⁷

Our Center's Transportation Resilience Case Studies, which are featured in our Adaptation Clearinghouse database, highlight some of the additional infrastructure-related resilience efforts going on within your states and across the country. These include examples from Oregon like the Pringle Creek community's green streets initiative, which utilized porous pavements and has proven highly successful in mitigating stormwater runoff from rainfall events compared to surrounding communities,⁶⁸ and the Necanicum River flood mitigation project, which has reduced seasonal flooding of portions of Highway 101 by removing a levee and restoring the natural floodplain.⁶⁹ In Alaska, the state DOT has increased monitoring of temperatures,⁷⁰ and has explored the use of insulation materials to improve the thermal stability (and therefore structural integrity) of roads as warming increases the thawing of underlying permafrost.⁷¹ And in Massachusetts, the Port Authority, which oversees critical facilities like Logan International Airport, initiated a resiliency program and developed floodproofing design guidelines to help ensure resilience of new and existing assets to future flooding.⁷²

Support for state and local efforts to prepare for extreme weather and sea-level rise is needed and there are many ways the federal government can and should help.

⁶⁶ STATE OF RHODE ISLAND GENERAL ASSEMBLY, [New law creates flooding and sea rise training requirement for planning boards](http://www.rilin.state.ri.us/pressrelease/_layouts/RIL.PressRelease.ListStructure/Forms/DisplayForm.aspx?List=c8baae31-3c10-431c-8dcd-9dbbe21ce3e9&ID=13236), Press Release (Oct. 6, 2017), http://www.rilin.state.ri.us/pressrelease/_layouts/RIL.PressRelease.ListStructure/Forms/DisplayForm.aspx?List=c8baae31-3c10-431c-8dcd-9dbbe21ce3e9&ID=13236

⁶⁷ HUD AWARDS \$1 BILLION THROUGH NATIONAL DISASTER RESILIENCE COMPETITION: 13 states/communities to receive funding for resilient infrastructure and housing projects, News Release (January 21, 2016), <https://archives.hud.gov/news/2016/pr16-006.cfm>.

⁶⁸ Pringle Creek (Salem, Oregon) Green Streets Initiative, GEORGETOWN CLIMATE CENTER: ADAPTATION CLEARINGHOUSE, <https://www.adaptationclearinghouse.org/resources/pringle-creek-salem-oregon-green-streets-initiative.html>.

⁶⁹ Necanicum River – Highway 101 Flood Mitigation, GEORGETOWN CLIMATE CENTER: ADAPTATION CLEARINGHOUSE, <https://www.adaptationclearinghouse.org/resources/necanicum-river-highway-101-flood-mitigation.html>

⁷⁰ Elizabeth Jenkins, KTOO PUBLIC MEDIA, As the climate changes, Alaska's DOT works to keep up (Nov. 13, 2018), <https://www.ktoo.org/2018/11/13/as-the-climate-changes-alaskas-dot-works-to-keep-up/>

⁷¹ Alaska Repaving Roads Using Polystyrene Insulation, GEORGETOWN CLIMATE CENTER: ADAPTATION CLEARINGHOUSE, <https://www.adaptationclearinghouse.org/resources/alaska-repaving-roads-using-polystyrene-insulation.html>

⁷² Massachusetts Port Authority Resiliency Program and Floodproofing Design Guide, GEORGETOWN CLIMATE CENTER: ADAPTATION CLEARINGHOUSE, <https://www.adaptationclearinghouse.org/resources/massachusetts-port-authority-resiliency-program-and-floodproofing-design-guide.html>

Federal Opportunities

As the reality of climate change becomes more evident with each catastrophic hurricane, flood, drought, wildfire, or heat wave that strikes, it is more important than ever that our states and communities have the funding and resources they need to prepare.

Investing in Resilience Before Disaster Strikes

The value of hazard mitigation is clear and has been demonstrated for years; the most recent *Natural Hazard Mitigation Saves* report from the National Institute of Building Sciences found that federal hazard mitigation grants (analyzed from FEMA, HUD, and EDA) save \$6 for every \$1 spent, and infrastructure investments analyzed (from utility and transportation case studies) indicated a savings of \$4 for every \$1 spent, while meeting international building code (I-Code) standards can save \$11 nationally for every \$1 spent.⁷³ Meanwhile, our infrastructure systems are failing: the American Society of Civil Engineers' 2017 Infrastructure Report Card assessed the overall grade of infrastructure in the United States a D+, with roads receiving a D, transit a D-, bridges a C+, and levees a D, among other sector grades.⁷⁴ Furthermore, the exposure of the federal government to economic losses from extreme weather has caused the U.S. Government Accountability Office to feature climate change on its High Risk List. In its most recent list published in March 2019 of this year, GAO indicates that “[s]ince 2005, federal funding for disaster assistance is approaching half a trillion dollars (about \$430 billion),”⁷⁵ which amounts to about \$1,300 per person based on current population estimates.⁷⁶ The GAO notes that one of the areas requiring federal action to reduce fiscal exposure to climate impacts is in the federal government's role as owner and operator of infrastructure systems, like transportation infrastructure.⁷⁷ Clearly, significant investments are needed to bring our infrastructure back to a state of good repair, and to ensure that it stays that way and functions as intended into the future despite anticipated impacts of climate change. This will not be cheap or easy, but it's necessary to avoid even greater costs and hardship to our states and communities.

This committee can play an important role in ensuring not only that adequate funding is authorized for infrastructure investments but also that funding is spent wisely on projects, programs, and planning that will result in more resilient assets and systems. Fortunately, there is already a strong foundation to build on, with changes made through MAP-21 and the FAST

⁷³ *Natural Hazard Mitigation Saves: 2018 Interim Report -- Summary Report*, NATIONAL INSTITUTE OF BUILDING SCIENCES, https://cdn.ymaws.com/www.nibs.org/resource/resmgr/docs/NIBS_MitigationSaves2018-Sum.pdf.

⁷⁴ 2017 Infrastructure Report Card, AMERICAN SOCIETY OF CIVIL ENGINEERS, <https://www.infrastructurereportcard.org/americas-grades/>.

⁷⁵ U.S. GOVERNMENT ACCOUNTABILITY OFFICE, *HIGH RISK SERIES: Substantial Efforts Needed to Achieve Greater Progress on High Risk Areas*, at 110 (March 2019), <https://www.gao.gov/assets/700/697245.pdf>.

⁷⁶ <https://www.census.gov/popclock/>.

⁷⁷ *Supra* note 76 at 116-118.

Act including the transition towards a performance-based and risk management approach to surface transportation planning and programming and resilience planning requirements.⁷⁸ Further, in recognition that investments in hazard mitigation can save substantial taxpayer dollars in costs avoided, the Disaster Recovery Reform Act was an important step towards shifting the focus towards proactive adaptation rather than reactive recovery, when it can be avoided.⁷⁹

Providing Dedicated and Flexible Funding for Resilience

In its recent report, the Committee for the Study of the Future Interstate Highway System highlighted the importance of preparing the Interstate Highway System and other roads and bridges for the impacts of climate change and more intense weather events.⁸⁰ Congress should ensure that major federal infrastructure investments, including but not limited to the Interstate Highway System, are built to withstand flooding, increased heat, and other climate change impacts. To ensure fiscal responsibility, recipients of federal funding should be considering how climate change will affect their infrastructure systems and assets in the future, and ensure that their investments are designed accordingly to withstand future conditions. However, while some existing sources of federal funding may already be used for planning and preparing infrastructure for climate change, many state and local agencies nevertheless find it difficult to do so. Even though the upfront costs to plan and adapt will save money further “down the road,” state and local agency budgets are often already stretched too thin with normal repair, and mounting operations and maintenance costs. States and local agencies could therefore benefit from dedicated funding for resilience planning and implementation of resilient infrastructure projects. They could also benefit greatly from having a broad degree of flexibility in how they can use funds dedicated for resilience, particularly for projects and planning that cross multiple sectors, as planning for future extremes and changed landscapes requires more holistic conversations and solutions (e.g., regarding land use and when and where to make investments). For example, allowing federal funding to capitalize State Infrastructure Banks would be one way to better enable multi-modal, cross-sectoral projects with numerous

⁷⁸ Moving Ahead for Progress in the 21st Century (MAP-21) Act, P.L. 112-141, Div. A., Tit. I, Subtit. B (2012); Fixing America’s Surface Transportation (FAST) Act, P.L. 114-94, secs. 1201-1202 (2015).

⁷⁹ Federal Aviation Administration Reauthorization Act of 2018, H.R. 302, Div. D, 115th Cong. (2018). For example, the DRRRA also clarifies that pre-disaster hazard mitigation funds may be used to establish and implement the latest hazard-resistant designs and criteria (modifying 42 USC 5133(e)), and it adds new evaluation criteria for pre-disaster hazard mitigation assistance awards, including the extent to which potential grantees have adopted the latest hazard-resistant designs and codes, and “the extent to which the assistance will fund activities that increase the level of resiliency” (modifying 42 USC 5133(g)). It also clarifies that Public Assistance funds can reimburse costs of rebuilding facilities according to “the latest published editions of relevant consensus-based codes, specifications, and standards...” or “in a manner that allows the facility to meet the definition of resilient” (which is to be developed by FEMA rulemaking) (modifying 42 USC 5172(e)).

⁸⁰ *Supra* note 46.

co-benefits.⁸¹ Additionally, as federal funding program requirements can be burdensome for state and local agencies, steps should be taken to ensure that federal infrastructure agencies work together to coordinate across program requirements and definitions whenever possible, such as with defining “resilient infrastructure” and cost-benefit evaluations.⁸²

Providing Technical Assistance, Tools, and Resources

To adequately prepare, states and infrastructure agencies must be provided with the tools, information, and technical assistance they need to adequately integrate these considerations into capital decision-making processes, and given strong incentives to engage in resilience planning and to modify codes and standards ahead of disasters to facilitate resilient rebuilding when funds are available.⁸³ They also need real-world examples and best practices that demonstrate those innovative approaches that are at the forefront of planning and designing for a new normal of extremes. Resources like our Center’s [Adaptation Clearinghouse](#) and [transportation resilience case studies](#) are often used by state and local government practitioners to identify examples from similarly situated jurisdictions or areas challenged by the same climate stressors. Some federal tools and resources (including case studies, technical guidance, frameworks, and more) provide in-depth information and best practices to help agencies integrate resilience considerations into their decisionmaking processes, from assessing vulnerabilities all the way to design and making modifications to operational and maintenance practices. More is needed. Federal infrastructure funding should continue to support not only the states’ infrastructure investments directly, but the production of these kinds of tools and resources that help states and infrastructure agencies find relevant examples and identify where to start and how to get through each step of this process of planning and building more resiliently.

⁸¹ For example, the Rhode Island Infrastructure Bank blends funding from multiple sources to finance infrastructure projects, and the state provides technical assistance to help project proponents address climate impacts in project design and construction. See Rhode Island Infrastructure Bank, Who We Are, <https://www.riib.org/who-we-are>.

⁸² For example, FEMA and USDOT could be encouraged to work together as FEMA develops the new “Building Resilient Infrastructure and Communities” program (implementing changes made by the Disaster Recovery Reform Act, at H.R. 302, secs. 1234, 1235(d) (2018)) and agency guidance and definitions for “resilient” and “resiliency,” and identify opportunities for coordinating with USDOT programs.

⁸³ Standards-setting organizations like the American Society of Civil Engineers have been engaging for several years in discussions about how to modify infrastructure design to account for changing risk profiles as a result of climate change. ASCE’s Committee on Adaptation to a Changing Climate recently published a new Manual of Practice with guidance for engineers and others involved in infrastructure decisionmaking to assist with integrating adaptive design and minimizing lifecycle costs given a changing climate. Climate-Resilient Infrastructure: Adaptive Design and Risk Management, COMMITTEE ON ADAPTATION TO A CHANGING CLIMATE (2018), <https://ascelibrary.org/doi/book/10.1061/9780784415191>.

Emphasizing Emergency Preparedness

In addition to infrastructure, we should understand that resilience to impacts depends on people as well and developing strategies to evacuate safely. In Katrina, when my hometown of New Orleans was flooded and much of my family lost their homes, more than 1800 people who stayed behind died. Some didn't leave because of the difficulty in evacuating the year before during Ivan, when my own father, Sidney Arroyo died during a stressful evacuation. Others who chose not to leave before Katrina did not have affordable options for transportation or shelter. Still others didn't want to leave their pets behind after discovering that public transport and shelter options prohibited animals. Because of those hard lessons, Congress passed the Pet Evacuation and Transportation Standards Act—"PETS"—which no doubt has saved lives of countless pets and people in more recent storms.

New programs like "Evacuteers" in New Orleans have sprung up to make sure people (and pets) can get out of harm's way, and portions of the I-10 twin spans, after sections were knocked out in Katrina, have been elevated.

We learn hard lessons from each major storm and fire, but there is more to be done to translate those lessons into action on the ground where the disaster hit, as well as to other communities to help them be better prepared. There is much more to be done to prepare our communities for the changes we're experiencing now that will only accelerate and worsen over time. It is important to people across the country affected by these disasters. It's also important to ensure that federal dollars are spent wisely towards investments that will last under future extreme conditions and that will deliver the economic, health, and environmental benefits of transitioning to a low-carbon future.

Thank you for the opportunity to share this testimony and for this Committee's important work.