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"The Next Mile: Technology Pathways to Accelerate Sustainability within the Transportation Sector"

Chairman Lamb, Ranking Member Weber, and distinguished members of the Subcommittee: Thank you for the opportunity to appear before you today. My name is Claus Daniel. I am director of the Sustainable Transportation Program at the U.S. Department of Energy's Oak Ridge National Laboratory in Oak Ridge, Tennessee. I am also founding director of the DOE Battery Manufacturing Facility at ORNL, and I am a materials scientist by education and training, focused on characterization, processing, and manufacturing development for automotive systems. In my career, I have also worked in private industry at companies such as Bosch and Saint Gobain. It is an honor to present this testimony on the important role of the scientific capabilities and expertise of DOE's national laboratories in accelerating innovations for an efficient, secure, and sustainable national transportation system.

INTRODUCTION

Efficient, safe, and sustainable transportation drives our economy and improves our quality of life. It underpins our commerce, enables our work, allows us to access essentials such as food and health care, and enhances our leisure time. In 2018, the U.S. transportation sector accounted for about 28 percent of the nation's total energy use and 69 percent of its petroleum use.[1] The average U.S. household spent roughly 16 percent of its annual expenditures on transportation in 2017, second only to housing expenditures.[2]

At the same time, rapidly advancing technology, increased urbanization, and increasing calls from both the industrial sector and the average consumer for on-demand transport are changing

[1] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Vehicle Technologies Office, *Transportation Energy Data Book: Edition 37.2*. Oak Ridge, Tennessee: Oak Ridge National Laboratory, August 2019. https://tedb.ornl.gov/.
[2] U.S Department of Labor, Bureau of Labor Statistics, *Consumer Expenditures—2017.* Washington, D.C., September 2018. https://www.bls.gov/news.release/cesan.nr0.htm.

transportation in fundamental ways. Coupled with growing traffic congestion, rising costs, pollution concerns, and roadway fatalities that have persisted at a rate of some 40,000 for each of the last three years, transportation sector challenges are complex and their resolution is vital.

In a year in which the nation marked the 50th anniversary of the moon landing, it is appropriate to examine how the same spirit of innovation that enabled our space program infuses our country's transportation research today.

We work closely in our transportation-related activities with the DOE Vehicle Technologies Office, whose mission is to enable research, development, and deployment of efficient and sustainable transportation technologies that will improve energy efficiency and fuel economy, with the goal of increasing the nation's energy security, economic vitality, and quality of life.

At Oak Ridge National Laboratory, I am privileged to co-manage one of the largest portfolios of transportation research at DOE's 17 laboratories. From nanoscale materials science for advanced batteries and lightweighting of vehicles and aircraft, to the development and testing of new gaseous fuels and blendstocks, including biofuels, for ultra-clean and efficient combustion engines, to a bi-directional wireless charging system for electric vehicles, to the data behind the decision-making tools at fueleconomy.gov, Oak Ridge touches on nearly every area of transportation science.

For more than 30 years, experts at ORNL have accelerated the pace of research and development for new materials and fuels for next-generation mobility systems, provided decision-making tools for sustainable transportation, and created economic opportunity by improving the energy efficiency of vehicles to support a robust transportation system for people and commerce.

Oak Ridge is DOE's largest science and energy laboratory, with an R&D portfolio that spans the spectrum from fundamental science to demonstration and deployment of breakthrough technologies for clean energy and national security. Our mission includes both scientific discovery and innovation, so we place a high value on translational R&D—the coordination of our basic research and applied technology programs to accelerate the deployment of solutions that will shape our nation's future. Our ability to mobilize multidisciplinary teams and to form partnerships with universities, industry, and other national laboratories is essential to this work.

Our facilities include:

- DOE's largest materials R&D program, which supports three scientific user facilities focused on understanding, developing, and exploiting materials—-the **Spallation Neutron Source** (SNS), the **High Flux Isotope Reactor**, and the **Center for Nanophase Materials Sciences** (CNMS);
- The **Oak Ridge Leadership Computing Facility** (OLCF), which hosts the world's most powerful supercomputer, Summit, as well as growing capabilities in artificial intelligence and machine learning. Training artificial intelligence algorithms requires processors that can handle a massive number of mathematical calculations. Summit links more than 27,000 NVIDIA Volta graphics processing units (GPUs) with more than 9,000 IBM

Power9 CPUs. Each of Summit's 4,608 nodes contains six deep-learning–optimized GPUs packed with more than 21 billion transistors;

- The **National Transportation Research Center** (NTRC), the nation's only transportation-focused user facility with core capabilities in advanced energy storage and electric drive systems, including fast wireless charging, lightweight materials and multi-material structures for harsh environments, advanced combustion engines and biofuels, data science and analysis, and vehicle cybersecurity, vehicle systems integration, and intelligent mobility systems;
- The **Battery Manufacturing Facility** (BMF), the nation's largest open-access battery manufacturing R&D center for studying materials from the atomic level up to 7 Ah pouch cells;
- The **Manufacturing Demonstration Facility** (MDF), the nation's only designated user facility focused on early-stage R&D to improve the energy and materials efficiency, productivity and competitiveness of U.S. manufacturers;
- The **Carbon Fiber Technology Facility** (CFTF), DOE's only designated user facility for carbon fiber innovation to support economic U.S. production of this material of tomorrow for clean energy applications; and
- The **Center for Bioenergy Innovation** (CBI), one of four multi-institutional DOE Bioenergy Research Centers created to lay the scientific groundwork for a new bio-based economy, with a focus on developing sustainable biomass feedstocks, processes to break down and convert plants to specialty biofuels, and valuable bioproducts made from lignin residue.

ACCELERATING INNOVATION WITH BIG SCIENCE CAPABILITIES

The DOE laboratory complex occupies a distinctive position in the national innovation ecosystem. We bring together experts in multiple disciplines and equip them with state-of-the-art capabilities to solve some of the biggest challenges facing our society today.

Following are recent examples of how ORNL has leveraged its science tools and expertise to resolve challenges in the transportation sector.

Next-generation materials:

Simulations for a new high-temperature alloy. Working with Fiat-Chrysler (FCA US LLC) and casting manufacturer Nemak, ORNL scientists accelerated the development of a new aluminum-copper alloy ideal for use in advanced, super-efficient engines that operate at high temperatures. The researchers used a quantum mechanics code on Oak Ridge supercomputers to simulate the thermodynamics of alloy materials and determine the best design. Atomic-level characterization tools at the CNMS were used to analyze the new material's function. The alloy was developed in less than four years using these advanced scientific resources, compared with traditional alloy development time of a decade or more. The new ORNL superalloy, known as

ACMZ (aluminum-copper-manganese-zirconium), can withstand temperatures nearly 100 degrees Celsius higher than traditional alloys and is easier to cast than other high-temperature alloys. At Chrysler, an engine made with ACMZ has met or surpassed all expectations in repeated tests.

Accelerating a novel engine design. California-based Pinnacle Engines used the high-performance computing resources at the OLCF to accelerate the design work for its unique internal combustion engine. Pinnacle's opposed-piston engine provides the flexibility needed to optimize energy performance under a wide range of operating conditions. To find the right efficiency and emissions profile among so many variables, the company turned to ORNL's supercomputing resources, simulating key design options for a multi-cylinder gasoline engine for light-duty vehicles. Pinnacle estimated that it would have taken eight times as long to design the engine in-house without using our supercomputers.

The ageless aluminum revolution. Finding an application for cerium, which currently is a waste product when mining the rare earth element neodymium, would enable more economical and secure access to rare earth elements needed for permanent magnets for electric vehicles and other applications. Through DOE's Critical Materials Institute, Oak Ridge scientists worked with Eck Industries, Ames Laboratory and Lawrence Livermore National Laboratory on a unique high-temperature-tolerant alloy that is corrosion-resistant, easier to cast, and does not require expensive heat treatment. To test this aluminum-cerium alloy's performance, ORNL researchers performed a first-of-its-kind experiment on an engine cast with the Al-Ce material—using neutrons at the SNS to investigate the material's performance while the engine was running. The Al-Ce alloy remains stable at temperatures 300 degrees Celsius higher than leading commercial alloys and can withstand 30 percent more load before deforming. By removing the need for energy-intensive heat treatments, scientists estimate that using the new alloy could reduce manufacturing costs as much as 50 to 60 percent. The Al-Ce alloy has been licensed to Eck.

Cobalt-free cathode development and testing. Reducing the use of cobalt in lithium-ion batteries is key to lower costs and less reliance on critical materials. ORNL scientists have developed a nickel-rich cathode using 50 percent less cobalt and tested a water-based manufacturing process at scale. The project achieved 1,000 charging/discharging cycles with pilot pouch cells comprising a nickel-manganese-cobalt, or NMC 811, water-engineered cathode with excellent capacity retention. The results demonstrated that aqueous processing is feasible for nickel-rich cathode materials, which will enable higher energy densities at lower cost and eliminate the need for hazardous solvents in the manufacturing process. The work made use of ORNL's advanced characterization tools as well as the Battery Manufacturing Facility. Oak Ridge is continuing its work in this area, exploring the development of new materials to completely eliminate cobalt in a new type of cathode.

Advancing solid-state batteries. Solid-state batteries that use solid electrolytes have the potential for much higher energy density and safety, but they have traditionally had low ion conductivity and are too expensive for most commercial applications. State-of-the-art microscopy at the CNMS helped identify a feature in a solid electrolyte that is important to increasing the speedy transport of ions. In a similar project, ORNL scientists used scanning transmission electron microscopy and computer simulations to reveal how a two-dimensional ceramic-based material cannibalized itself to form new stable structures ideal for ionic transport such as in solid-state batteries.

Carbon fiber composites for strong, lightweight structures. Building on ORNL's rich history in materials science, the Carbon Fiber Technology Facility is producing technology solutions for low-cost, domestic carbon fiber production. Our scientists developed a process to replace costly traditional precursors with a textile-grade precursor—typically used to make clothing and carpets—that can produce carbon fiber at roughly half the cost, and we're exploring the use of bioderived precursors such as lignin. ORNL has also developed less expensive methods to join carbon fiber composites with other materials on vehicles, including the use of lasers to prepare surfaces for bonding, which improves the performance of joints and provides a path toward high-volume automation.

Additive manufacturing for transportation. Additive manufacturing (AM) is the ability to deposit materials layer by layer to fabricate complex components directly from computer-aided design models. AM technologies give engineers the ability to exploit new materials with custom designs for specific applications, such as lightweighting electric vehicles. Using its Big Area Additive Manufacturing machine at the MDF, ORNL researchers 3D printed a replica of a Shelby Cobra sportscar in 2015 and worked with NTRC to create a "plug-and-play" laboratory on wheels, designed to allow research and development of integrated components to be tested and enhanced in real time, with the goal of improving the use of sustainable, digital manufacturing solutions in the automotive industry. The MDF at ORNL is also being used to help advance the development of novel biomaterials for printing, which in turn supports a healthy bioeconomy that also delivers domestic biofuels.

Safe, Impact-Resistant Electrolyte (SAFIRE). ORNL and collaborators at the University of Rochester developed an electrolyte additive that improves battery safety, transforming liquid electrolyte to a solid upon impact. It blocks contact between electrodes, preventing short circuiting and reducing fire hazards. The SAFIRE electrolyte performs as well as conventional electrolytes while trimming vehicle weight and increasing travel distance. The project leveraged small-angle neutron scattering measurements performed at SNS to characterize materials.

Fuel cell characterization. In support of DOE's fuel cells and hydrogen research, ORNL conducts characterization of fuel cell materials through advanced microscopy, including at the CNMS, to gauge the durability and performance of new technologies. The research has focused on new materials to advance the design and manufacture of catalysts and catalyst supports for hydrogen transportation applications.

DOE lithium-ion battery recycling center. ORNL is participating in the new DOE ReCell Center led by Argonne National Laboratory. Oak Ridge scientists will use state-of-the-art tools at the Battery Manufacturing Facility to develop new methods for separating and reclaiming valuable materials from spent EV batteries. ORNL's role in the ReCell Center will focus on the design of cells to optimize recyclability, including working on the separation of active powders from their collector foils and developing a new method to rejuvenate cathode powers using ionic liquids.

Supercomputing for smarter mobility:

Chattanooga regional mobility project. ORNL is working with several collaborators, including the National Renewable Energy Laboratory (NREL), to improve regional transportation networks, using Chattanooga, Tennessee, as a testbed. Chattanooga, located along one of the nation's busiest traffic corridors, is an ideal testbed since it is a Smart City, equipped with numerous radar detectors on its roadways, cameras to monitor traffic flow, and instrumented intersections with additional sensors. ORNL researchers are working with the city to develop a digital twin, or living model, of the area's transportation network using AI on ORNL supercomputing resources, to enable solutions for smoother traffic patterns and more efficient freight transport. The multi-year project has the potential to reduce energy usage by 20 percent or more in the region.

AI for enhanced autonomous driving agents. Oak Ridge is also teaming with NREL to explore the use of custom machine learning algorithms to enhance the perception and control of autonomous driving agents, including the potential use of ORNL's MENNDL deep learning algorithm. When run on a supercomputer such as Summit, MENNDL can generate a custom neural network very quickly, in a matter of hours as opposed to the months needed to build a conventional artificial intelligence network.

Modeling CAV impact on fuel use, traffic. To study the potential benefits of connected and automated vehicles (CAVs) on roadways, ORNL researchers developed a simulation framework to analyze the impact of partial market penetration of CAVs on fuel consumption, travel time and traffic flow in a merging on-ramp scenario under varying traffic volumes. Research demonstrated that an increased number of CAVs communicating and coordinating driving activity stabilizes traffic flow and, depending on the traffic volume, can reduce fuel use by more than 40 percent.

Machine learning + smart traffic signals for better commuting. ORNL teamed with Knoxville technology firm GRIDSMART to test the use of machine learning algorithms for smoother traffic flow and fuel economy. ORNL scientists developed machine learning algorithms that allowed smart cameras at intersections to recognize various vehicle types in their field of vision and to send signals to traffic lights that decreased the amount of fuel lost to idling and allowed better flow of vehicles through intersections. The project was the first supported by DOE's HPC4Mobility program, which facilitates access to national lab supercomputers and expertise for companies who want to explore energy-efficiency mobility solutions.

Quantum Computing. In the transportation sector, quantum technologies can be leveraged for improved autonomous driving systems, for energy-efficient technologies and for computing at the edge, in which more calculations that enhance automated driving and other mobility solutions are decentralized and still performed in time for proper decision making on board. ORNL scientists are engaged in a lab-wide collaboration that promotes the use of theory, computation, and experiment in the research and development of quantum information technologies. We leverage ORNL capabilities in material fabrication and characterization, high-performance computing, and electrical systems and sensors to develop the ideas and platforms needed for beyond CMOS technologies. The work fosters collaborations between ORNL staff scientists and with external research partners to accelerate development and more quickly realize the benefits from quantum computing.

Fuels, electrification, simulations for next-gen mobility:

Co-Optimizing new fuels, engines for ultimate efficiency. The DOE Co-Optimization of Fuels & Engines Initiative (Co-Optima) led by ORNL is the first program of its kind, leveraging the expertise and resources of eight other national labs and 13 universities to simultaneously tackle fuel and engine R&D for maximized fuel economy and performance. The program leverages high-performance computing facilities at ORNL, NREL, and Argonne, and its researchers have developed algorithms and other computational tools to enable rigorous analysis of potential solutions. Co-Optima recently announced that after three years of research, it has identified 10 blendstocks from four chemical families with the greatest potential to increase boosted spark-ignition engines and to be commercialized for real-world use. These blendstocks can be added to existing fuel to dramatically improve fuel properties and co-optimize performance with engines. Researchers also broadly characterized the fuel properties and engine parameters needed to deliver a path towards 10 percent boost in fuel economy for light-duty vehicles and enhanced engines.

High-powered wireless charging for electric vehicles. Oak Ridge was the first lab to demonstrate a 20-kilowatt bi-directional wireless charging system for passenger electric vehicles (EVs). Just last fall, we demonstrated a 120-kilowatt charging system over a six-inch air gap with 97 percent efficiency, which approaches the convenience of a gas station fill-up. Our next goal is at least 200-kilowatt wireless power transfer for in-motion/dynamic charging and 300 kilowatts for stationary wireless charging. Dynamic wireless charging would allow vehicles to recharge while being driven over roadways equipped with special charging systems. The lab is currently designing and installing a 20-kilowatt bidirectional wireless charging system on a commercial delivery truck with United Parcel Service.

E-fuels: Enabling net-zero carbon fuels while balancing the power grid. Building on our success in such projects as developing new efficient catalysts to convert carbon dioxide to ethanol, ORNL is envisioning how we can leverage supercomputing and materials characterization capabilities for solutions that advance the production of synthetic liquid fuels relying on renewable energy sources. These domestic "e-fuels" would diversify the nation's fuel mix while supporting a more stable and profitable power grid. Liquid fuels production would give a new market to renewable energy generation and help balance the grid, enabling large amounts of energy to be stored, in essence, in the form of synfuels using existing fuels infrastructure. We estimate that the U.S. power grid capacity factor would increase from 44 percent to 96 percent as a result, increasing the grid's profitability and advancing solutions for net-zero carbon transportation fuels.

SuperTruck I and II. DOE's SuperTruck initiatives aim to develop and demonstrate technologies to more than double the freight efficiency of Class 8 trucks, commonly known as 18-wheelers. In our work with Cummins, we are designing a more efficient engine and drivetrain and vehicle technologies. We also used novel diagnostics to enable fuel-efficient engine modeling and design, resulting in 86 percent higher freight efficiency and a 75 percent increase in fuel efficiency. With Daimler, we are making use of leadership capabilities for engine and vehicle simulation, engine and powertrain-in-the-loop experiments, and advanced combustion strategies to improve efficiency and emissions, and emissions characterization and control. The team demonstrated dual-fuel, low-temperature combustion with natural gas and diesel fuel and a 115 percent higher freight efficiency. This doubled the truck's miles per gallon. In our work with Volvo, we helped develop emissions control strategy for the company's advanced engine concepts.

Biofuels: A domestic fuel resource

By supporting biofuels research and development, DOE seeks to advance a domestic, sustainable fuel resource for a modern transportation system that also has the potential to support rural economies. ORNL advances this goal through several initiatives, including:

Center for Bioenergy Innovation. The CBI, which is headquartered at ORNL, engages scientists from across the country who are working to enable viable biofuels and other bioproducts. CBI focuses on developing non-food feedstock crops using genomics and engineering; creating advanced processes to simultaneously break down and convert plants into specialty fuels; and accelerating bioproducts such as chemical feedstocks from lignin residue. CBI scientists are leveraging high-performance computing, high-throughput chemistry, and specialized microscopy to help identify promising microbes and to analyze plant genomes and related traits to advance breakthroughs.

Conversions for biofuels. ORNL researchers are leading a multi-lab consortium developing computational tools and methods to convert biomass into biofuels. These computational models, which extend from the atomic scale all the way to the bioreactor scale, are able to simulate biomass conversion and predict reactor performance. These tools allow the bioreactor to be operated more efficiently, providing lower-cost fuels and greater understanding of how these systems operate in real-world conditions. ORNL also continues to advance new catalysts that can produce bioproducts at lower cost.

Biofuel-to-hydrocarbon technology and scaleup. ORNL invented new catalysts that are able to convert ethanol into different hydrocarbon blendstreams that can be blended with gasoline or jet fuel. The technology is a good means to introduce more renewable fuel into the bioeconomy. This invention offers the advantage of high conversion rates, moderate operating conditions and requires no external hydrogen. The technology was licensed to Vertimass Corporation.

Materials compatibility testing. Our bioproducts program includes compatibility and degradation testing of new biofuels on vehicle technologies and refueling systems, and research examining how biomass conversion technologies may affect biorefinery infrastructure. Our ability to understand materials degradation (such as wear and corrosion) under laboratory conditions allows us to mitigate this damage in the field and is highly valued by our industry stakeholders.

Data for fuel savings:

Fueleconomy.gov. The fueleconomy.gov website, the official U.S. government's source for fuel economy information, is hosted, managed and maintained by ORNL researchers on the Transportation Analysis team at NTRC. The website is DOE's most-visited and provides everything from the latest government fuel economy guides to side-by-side comparisons of cars, trip calculators, and resources to find the cheapest gas by region.

Transportation Data Book. The Transportation Data Book is a comprehensive desktop reference containing detailed data on transportation with an emphasis on energy. It is prepared by ORNL's Transportation Analysis team for DOE's Vehicle Technologies Office. The data book was first published in 1976 and is on its 37th edition.

Freight Analysis Framework. The Freight Analysis Framework, produced by the ORNL Transportation Analysis team through a partnership with the Federal Highway Administration, integrates data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation.

NEW CAPABILITIES TO SUPPORT SUSTAINABLE TRANSPORTATION

The global race to develop and deploy the most advanced scientific resources is relentless, with the recognition that these facilities give a distinct advantage in the competition to innovate across a broad range of fields from materials science to chemistry to complex transportation systems.

A new generation of scientific capabilities is being prepared across the DOE lab complex, including deployment of the world's first exascale computing systems. These tools have the potential to revolutionize our ability to meet emerging demands in the transportation sector. On ORNL's campus, these new capabilities include:

- The **Frontier exascale computing system**, with anticipated delivery in 2021. Frontier's compute power will exceed 1.5 exaflops—solving calculations up to 50 times faster than today's top supercomputers, exceeding a quintillion calculations per second—and enabling ever-more complex simulations.

Using an exascale system, we can take what we learn in the Chattanooga mobility project, for instance, and **develop regional and even nationwide traffic simulations**. We can include more vehicles and more realistic scenarios with greater complexity, creating a model that can guide us to solutions for congestion and fuel efficiency on a national scale.

Exascale computing can also significantly enhance our **development of new materials**, **fuels and engines** for better energy efficiency and lower emissions. With an exascale system, we can, for example, perform simulations of a full combustion chamber over a realistic engine duty cycle.

- A **Second Target Station** (STS) under development at the **Spallation Neutron Source** will deliver transformative new capabilities for understanding and developing new materials. The STS will deliver cold (long-wavelength) neutrons of unprecedented peak brightness.

The proposed STS will give scientists the ability to simultaneously probe the structure and function of **new, complex materials** across broader time and length scales—all to better investigate atomic structures, vibrations, and magnetic properties.

Studies at the STS will support the development of **quantum materials**, for instance, whose novel and exotic magnetic properties could revolutionize high-density storage devices. The STS will enable researchers to observe the structure and behavior of **complex items such as batteries, engines, and aerospace parts like turbine blades** in real time at a faster pace without damaging materials. The STS will enable detailed studies of the response of structural materials to manufacturing and extreme conditions.

We are already developing a neutronic engine to use at the SNS that will allow us to measure strain and temperature in a running engine to provide critical insights and important data for simulation. We will for the first time be able to **image inside the cylinder of a running engine** and **analyze injector and spray development in a firing engine**.

VITAL PARTNERSHIPS TO ACCELERATE DEPLOYMENT

The user facilities established by DOE are shared resources, representing large-scale capabilities that private industry and universities cannot afford to build and maintain on their own, but that are essential to maintain U.S. economic competitiveness. The national labs actively seek out collaborators among private industry and academia to ensure our work is targeted and impactful.

ORNL's remarkable capabilities are a nexus for our nearly 4,900 staff. During fiscal year 2018, we also welcomed 3,289 facility users and 1,533 visiting scientists. At the National Transportation Research Center alone, ORNL has partnerships with 137 private companies and

32 universities, and it works with eight other national laboratories on technology solutions with real-world applications.

By leveraging the assets of the national lab system through a variety of agreements, private industry can de-risk their investments in innovation and accelerate commercialization. The Cooperative Research and Development Agreements, Strategic Partnership Projects, User Agreements and other vehicles for partnerships allow companies to participate in or directly sponsor research across the laboratory system. The results have been significant: At ORNL alone, more than 20 startups have been formed based on lab-developed technologies over the past five years.

CLOSING REMARKS

America's national laboratories and their scientific facilities are powerhouses of science, technology, and engineering. The DOE labs offer one-of-a-kind capabilities with unparalleled scientific capabilities that have real-world results. In collaboration with industry and academic institutions, the labs are advancing projects that will keep the U.S. transportation system at the forefront of innovation.

At ORNL and across the DOE laboratory system, we are open for business: We actively seek and develop partnerships that increase the lab's economic impact, accelerate deployment of lab-developed technologies, and strengthen innovation ecosystems across the nation.

Just as the Apollo program brought together scientists and engineers from multiple institutions to enable successful space missions, the DOE laboratories are eager to collaborate and continue providing early-stage research and development for greater mobility both for commerce and everyday life. We look forward to continuing our scientific pursuits in support of a safer, more efficient, and sustainable transportation system for the nation's prosperity and security.

Thank you again for the opportunity to testify today. I welcome your questions on this important topic.