COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY
U.S. HOUSE OF REPRESENTATIVES
HEARING CHARTER

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

Wednesday, September 18, 2019
2:00 PM EST
2318 Rayburn House Office Building, Washington, D.C. 20015

PURPOSE

The purpose of the hearing is to examine the range of research, development, and demonstration (RD&D) activities necessary to advance a new era of sustainable transportation. Improvements in vehicle and fuel technologies are largely responsible for the progress that has been made in reducing various forms of air pollution, and emerging technologies have the potential to significantly reduce greenhouse gas (GHG) emissions from the transportation sector in the years ahead. The desire to further improve energy efficiency and reduce GHG emissions is motivating a transition to new-generation vehicle and advanced fuel technologies, including drop-in biofuels and a broad range of electric vehicles, including plug-in hybrids, battery-, fuel cell-, and roadway-powered vehicles. The hearing will serve to inform the development of legislation that will guide the Department of Energy's (DOE) activities in these and other areas.

WITNESSES

- ***Ms. Ann M. Schlenker****, Director, Center for Transportation Research, Argonne National Laboratory*

  Argonne's Center for Transportation Research (CTR) focuses on solutions to challenges involving fuel efficiency, emissions, durability, safety, design and operating efficiency, petroleum dependence, interoperability, compatibility, and codes/standards compliance and harmonization.[1]

[1] https://www.anl.gov/es/center-for-transportation-research

- ***Mr. James Chen**, Vice President of Public Policy, Rivian Automotive LLC*

  Founded in 2009, Rivian is an American automaker and automotive technology company that develops vehicles, products, and services related to sustainable transportation, and specializes in electric sport utility vehicle (SUV) and pickup trucks.[2]

- ***Mr. Brooke Coleman**, Executive Director, Advanced Biofuels Business Council*

  The Advanced Biofuels Business Council (ABBC) supports efforts to develop and commercialize next generation, advanced biofuels and bio-based products. ABBC members include companies in the advanced biofuel production and technology sectors making low carbon fuels and other bio-based products from feedstocks such as agricultural by-products and sustainable energy crops, municipal and agricultural waste, and algae.[3]

- ***Dr. Claus Daniel**, Director, Sustainable Transportation Program, Oak Ridge National Laboratory*

  ORNL's sustainable transportation researchers identify capabilities for next-generation systems in electrification, engines, and emissions controls; develop new materials for future systems and automated vehicle technologies; provide decision-making tools and intelligent technologies for secure, efficient movement of passengers and freight; and support the development of technologies to improve the energy efficiency of light-, medium-, and heavy-duty vehicles.[4]

- ***Mr. Tim Cortes**, Vice President of Hydrogen Energy Systems, Plug Power Inc.*

  Plug Power is engaged in the design and manufacturing of hydrogen fuel cell systems.[5] The company has delivered hydrogen engines for use in fuel cell-powered electric delivery vans and cargo tuggers used by FedEx at the Albany International Airport[6].

OVERARCHING ISSUES

[2] https://rivian.com/
[3] https://advancedbiofuels.org
[4] https://www.ornl.gov/transportation
[5] https://www.plugpower.com/
[6] https://www.greencarcongress.com/2019/04/20190429-pp.html

- New and expected future transportation advancements, such as on-demand mobility and vehicle automation, and how these may affect net GHG emissions.
- Electric vehicles cost and GHG emission reduction potential for different applications (two, four wheelers, trucks, etc.)
- The role of hydrogen relative to electrification, its relative costs and benefits, and applications where it will have the largest impact
- The role of advanced biofuels for light and heavy-duty transportation, considering costs, availability, and net environmental impacts
- The potential for the various alternative low-carbon technology and fuels in trucking, shipping, rail, and aviation

BACKGROUND

The transportation sector is one of the primary contributors to anthropogenic GHG emissions in the United States. According to the Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990–2017 (the Inventory), the transportation sector accounted for the largest portion (29%) of total U.S. GHG emissions in 2017. Within the sector, light-duty vehicles (including passenger cars and light-duty trucks, i.e. sport utility vehicles, pickup trucks, and minivans) accounted for the largest category, with 59% of GHG emissions, while medium- and heavy-duty trucks made up the second largest category, with 23% of emissions.[7] The Inventory also showed GHG emissions in the transportation sector increased more in absolute terms than any other sector over the same time period (i.e. electricity generation, industry, agriculture, residential, commercial), due in large part to increased demand for travel.[8]

Petroleum supplies more than 90 percent of the transportation sector's energy, and principally all of the sector's GHG emissions come from the combustion of gasoline, diesel, jet fuel, or other petroleum liquids. Other energy sources like natural gas, ethanol, biofuels, hydrogen, and electricity comprise small fractions of today's transportation energy supply.[9] The majority of GHG emissions from the sector are carbon dioxide (CO_2) emissions resulting from the combustion of petroleum-based products in internal combustion engines. According to the Environmental Protection Agency, "[t]he buildup of CO_2 and other greenhouse gases like methane, nitrous oxide, and hydrofluorocarbons

[7] Fast Facts, U.S. Transportation Sector Greenhouse Gas Emissions, 1990-2017 https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100WUHR.pdf
[8] https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks
[9] https://www.c2es.org/document/decarbonizing-u-s-transportation/

is causing the Earth's atmosphere to warm, resulting in changes to the climate we are already starting to see today."[10]

There is growing demand for sustainability within the transportation sector due to rising prices of traditional energy sources and expanding mobile connectivity, increasing populations and urbanization, as well as concerns about the environment and global warming. However, adopting sustainable energy technologies, practices, and policies to reduce petroleum consumption and GHG emissions is challenging as rising car ownership, freight movement, and air travel patterns will continue to increase emissions without continued federal R&D direction.[11]

Understanding the most promising technology options at both the micro and macro scale will be necessary to address these challenges. Potential emissions abatement and cost reductions from decreases in vehicle travel, shifts to lower carbon transportation options, and new technology and fuel options require further examination and development. And on a larger scale, a better understanding of the relative roles of these options and how they may interact is also needed. Zero-emission technologies are now coming to the entire transportation sector, and R&D will help determine their various rates of progress.

Light-duty vehicles

Given its large contribution to the transportation sector's GHG emissions (59%), the light-duty vehicle fleet is expected to undergo substantial technological changes in the coming decades. According to a 2015 report by the National Academies entitled *Cost, Effectiveness, and Deployment of Fuel Economy Technologies for Light-Duty Vehicles*, new powertrain designs, alternative fuels, advanced materials and significant changes to the vehicle body are being driven by increasingly stringent fuel economy and GHG emission standards.[12] Through continued research, development, and deployment of advanced technologies, new vehicles are projected to be more fuel efficient, lighter, safer, cleaner, but likely more expensive to purchase relative to current vehicles in the near term. Given their increased efficiency, however, these vehicles are also expected to be less expensive to fuel than current conventional vehicles.

The National Academies report noted above projects that though the gasoline-fueled spark ignition engine will continue to be the dominant powertrain configuration through 2030, such vehicles will be equipped with advanced technologies, materials, electronics

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[10] EPA, Transportation and Climate Change https://www.epa.gov/transportation-air-pollution-and-climate-change/carbon-pollution-transportation

[11] https://www.nap.edu/read/18805/chapter/2

[12] https://www.nap.edu/catalog/21744/cost-effectiveness-and-deployment-of-fuel-economy-technologies-for-light-duty-vehicles

and controls, and aerodynamics. And by 2030, the deployment of alternative methods to propel and fuel vehicles and alternative modes of transportation, including autonomous vehicles, will have advanced to greater commercialization.[13]

Mid-Heavy-duty vehicles

Medium- and heavy-duty vehicles account for only 5 percent of vehicles on the road but contribute 20 percent of U.S. transportation emissions.[14] This subsector experienced a 95 percent increase in vehicle miles traveled (VMT) between 1990 and 2015, leading to a 78 percent increase in CO2 emissions.

This category includes tractor-trailers, large pickups and vans, delivery trucks, buses, and garbage trucks. While technological advancements are currently foreseeable for the majority of the vehicles listed, albeit still facing limitation (i.e. electric buses[15,16] and hydrogen medium-duty delivery trucks/vans), emission improvements to heavy duty freight remains stagnant. Barriers to the growth of electric and hydrogen fuel cell heavy-duty commercial freight trucks include limited technology availability, limited economies of scale, long-distance travel requirements, payload mass and volume constraints, and a lack of refueling and recharging infrastructure.

However, as demand for freight transport grows, transitioning the global fleet of on-road freight vehicles to both cleaner and more fuel-efficient will steadily increase in importance to meet emission standards. Most heavy-duty vehicles are powered by diesel engines that, particularly in older models, can emit high levels of particulates, nitrogen oxides, and other pollutants that cause both chronic disease and premature death, especially in urban areas and among the most vulnerable populations. And heavy-duty vehicles are responsible for an increasing proportion of total carbon emissions from the transportation sector, as light-duty vehicles become more fuel efficient. Achieving a cleaner freight transport system will depend not only on a similarly farsighted approach to regulating vehicle emissions and efficiency, but also on developing an effective model for systemic change that includes measures to shift freight to the most sustainable options and optimize supply chain activity.[17]

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[13] https://www.nap.edu/catalog/21744/cost-effectiveness-and-deployment-of-fuel-economy-technologies-for-light-duty-vehicles

[14] https://www.c2es.org/content/regulating-transportation-sector-carbon-emissions/

[15] https://www.wired.com/story/electric-buses-havent-taken-over-world/

[16] https://www.citylab.com/transportation/2019/01/electric-bus-battery-recharge-new-flyer-byd-proterra-beb/577954/

[17] https://theicct.org/heavy-duty-vehicles

travel requirements, payload mass and volume constraints, and a lack of refueling and recharging infrastructure.

Non-road vehicles

Whereas road vehicles are the largest sources of emissions and have received the most attention, one-fourth of transport CO_2 emissions (2.2 gigatonnes) are attributable to non-road transport—maritime, aviation, and rail—a share projected to grow in the coming decades. Maritime and aviation emissions are projected to rise through 2030 as a result of increasing demand and slower efficiency improvements.[18]

Non-road transportation category CO_2 emissions from domestic aviation increased by 8 percent over the same period, while emissions from international flights leaving the U.S. increased by 88.8 percent. By contrast, CO_2 emissions from international shipping from the U.S. have decreased 40.6 percent since 1990.

In addition, non-road vehicles such as agricultural and construction equipment, account for almost three quarters of the fine particulate matter ($PM_{2.5}$) and one quarter of the nitrogen oxides (NO_X) emitted from mobile sources.[19]

The Department of Energy's Sustainable Transportation Programs

DOE's Office of Energy Efficiency and Renewable Energy (EERE) supports U.S. researchers and other partners in efforts to make transportation cleaner and more efficient through its Vehicle, Bioenergy, and Fuel Cell Technologies Offices.

FY 2019 Enacted:	$ 690 million
FY 2020 Budget Request:	$ 157.4 million
FY 2020 House Passed:	$ 770 million
FY 2020 Senate Report:	$ 815 million

Vehicle Technologies Office

DOE's Vehicle Technologies Office supports research and development (R&D) of transportation technologies to improve energy efficiency, fuel economy, and decrease dependency on petroleum. Technology focus areas include advanced batteries and electric drive systems, lightweight materials, advanced combustion engines, alternative fuels, and energy efficient mobility systems.

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[18] https://theicct.org/sites/default/files/publications/Beyond_Road_ZEV_Working_Paper_20180718.pdf
[19] https://theicct.org/publications/managing-emissions-non-road-vehicles

FY 2019 Enacted:	$ 344 million
FY 2020 Budget Request:	$ 73.4 million
FY 2020 House Passed:	$ 370 million
FY 2020 Senate Report:	$ 410 million

Bioenergy Technologies Office

DOE's Bioenergy Technologies Office focuses on research and development to advance bioenergy technologies that are capable of producing price-competitive biofuels, biopower, and bioproducts from various sources of biomass.

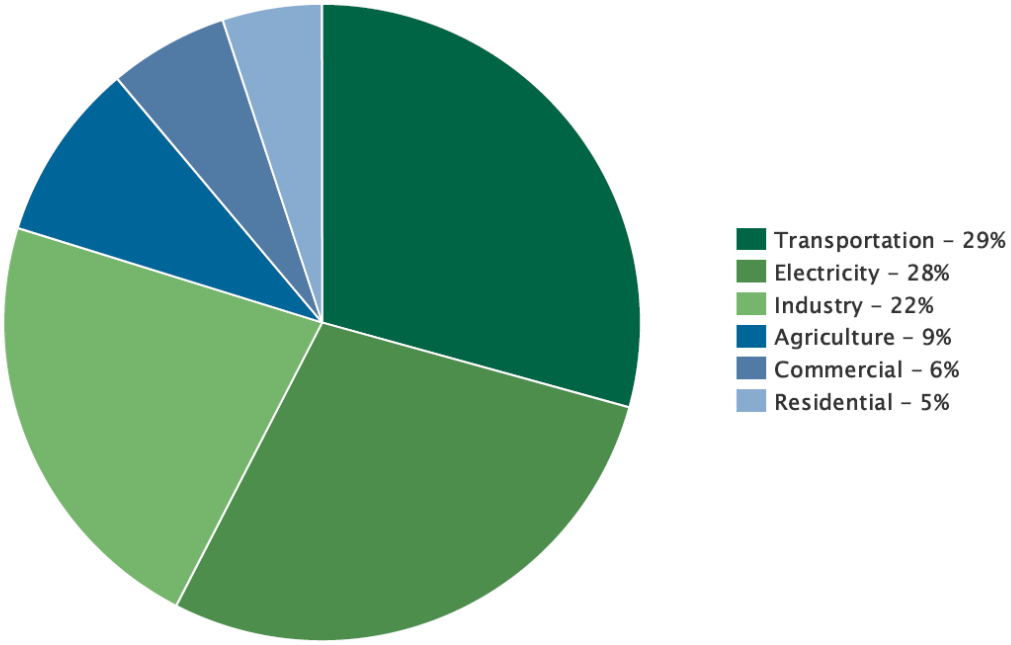
FY 2019 Enacted:	$ 226 million
FY 2020 Budget Request:	$ 40 million
FY 2020 House Passed:	$ 256 million
FY 2020 Senate Report:	$ 245 million

Fuel Cell Technologies Office

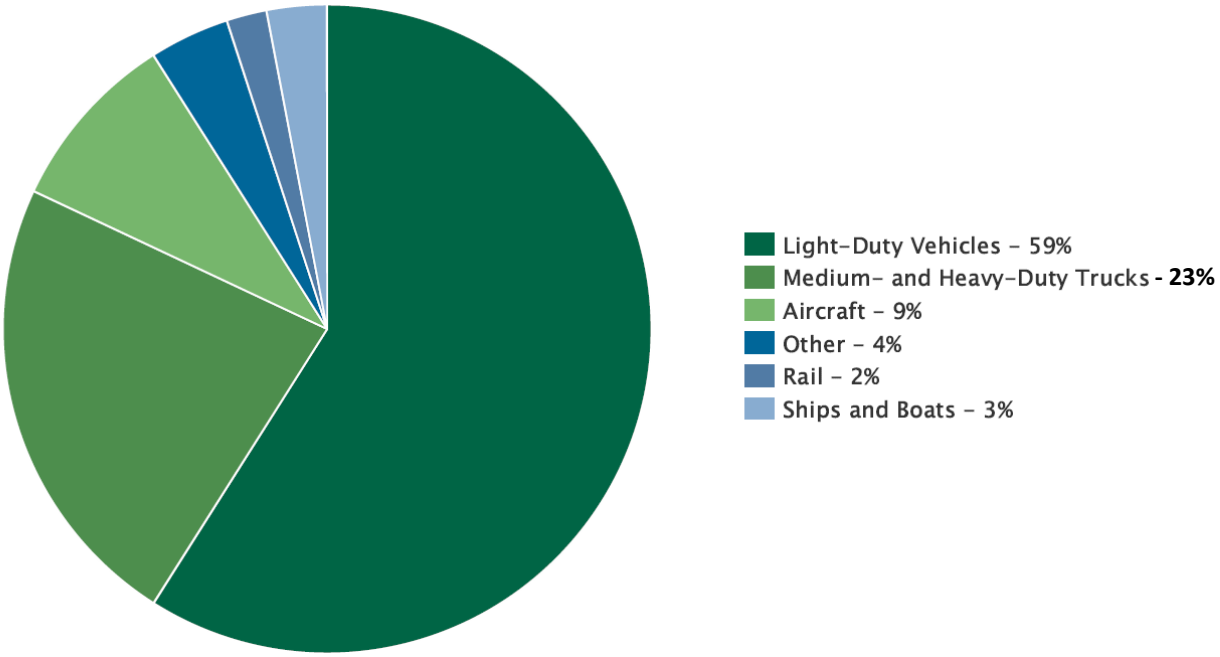
The Fuel Cell Technologies Office supports research to overcome the technological, economic, and institutional barriers to the development and use of hydrogen and fuel cells.

FY 2019 Enacted:	$ 120 million
FY 2020 Budget Request:	$ 44 million
FY 2020 House Passed:	$ 144 million
FY 2020 Senate Report:	$ 160 million

2017 U.S. GHG Emissions by Sector



2017 U.S. Transportation Sector GHG Emissions by Source



Note: Totals may not add to 100% due to rounding. Transportation emissions do not include emissions from non-transportation mobile sources such as agriculture and construction equipment. “Other” sources include buses, motorcycles, pipelines and lubricants.

U.S. Environmental Protection Agency (2019).
Inventory of U.S. Greenhouse Gas Emissions and Sinks; 1990-2017