COMMITTEE ON
ENERGY & COMMERCE
CHAIRMAN FRANK PALLONE, JR.

MEMORANDUM

October 19, 2019

To: Subcommittee on Environment and Climate Change Members and Staff

Fr: Committee on Energy and Commerce Staff

Re: Hearing on "Building a 100 Percent Clean Economy: Solutions for Planes, Trains and Everything Beyond Automobiles"

On **Wednesday, October 23, 2019, at 10:30 a.m. in room 2322 of the Rayburn House Office Building**, the Subcommittee on Environment and Climate Change will hold a hearing entitled, "Building a 100 Percent Clean Economy: Solutions for Planes, Trains and Everything Beyond Automobiles." The hearing will examine the challenges and opportunities associated with decarbonizing the U.S. transportation sector, with an emphasis on medium- and heavy-duty trucks, buses, ships, aircraft, and rail.

I. BACKGROUND

The transportation sector is the largest source of greenhouse gas (GHG) emissions in the United States, accounting for 29 percent of total emissions.[1] It includes light-duty vehicles (LDVs) (i.e., passenger cars, sport utility vehicles, pickup trucks, and minivans), medium- and heavy-duty trucks, buses, ships, aircraft, and rail.

This hearing will focus on decarbonization of non-LDV transportation. The Subcommittee on Environment and Climate Change previously examined solutions for LDVs at a hearing on June 20, 2019.

LDVs account for more than half of transportation sector emissions in the United States, followed by medium- and heavy-duty trucks (23 percent), aircraft (nine percent), ships and boats (three percent), rail (two percent), and other sources (four percent).[2] The vast majority of GHG emissions from this sector are carbon dioxide (CO_2), followed by smaller amounts of methane, nitrous oxide, and hydrofluorocarbons.[3] Combustion of fuels for transportation also contributes to various other environmental hazards, including ground-level ozone, particle pollution, and

[1] U.S. Environmental Protection Agency, Sources of Greenhouse Gas Emissions (epa.gov/ghgemissions/sources-greenhouse-gas-emissions) (Sept. 13, 2019).

[2] U.S. Environmental Protection Agency, Fast Facts on Transportation Greenhouse Gas Emissions (epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions) (Jul. 16, 2019).

[3] *See* note 1.

release of air toxics. Low-income communities and communities of color are disproportionately exposed to these local environmental impacts.[4]

CO_2 emissions from transportation (including LDVs) have increased 23 percent since 1990.[5] That increase has been driven by growing demand for travel resulting from low oil prices, population and economic growth, and urban sprawl.[6] Between 1990 and 2017, medium- and heavy-duty truck vehicle miles traveled (VMT) increased by 107 percent, resulting in an 88 percent increase in CO_2 emissions over that period.[7] Emissions from commercial aviation grew at a slower rate (17 percent) since 1990, but increased more than any other subsector in 2017.[8]

Petroleum-based fuels (including gasoline, diesel, jet fuel, and other liquids) supply nearly all energy consumed in the transportation sector.[9] Natural gas, electricity, biofuels, and hydrogen account for a small but growing share of the transportation energy supply.[10]

II. CHALLENGES TO REDUCING TRANSPORTATION SECTOR EMISSIONS

Growing demand for transportation is a primary barrier to decarbonization. According to the U.S. Energy Information Administration (EIA), VMT is expected to increase across nearly all modes of transportation through 2050.[11] EIA expects air travel to grow 77 percent by 2050, resulting in a 35 percent increase in jet fuel consumption. Travel via other modes will also increase significantly, including heavy-duty trucking by 52 percent, passenger rail by 31 percent, freight rail by 20 percent, and passenger buses by 11 percent.[12] By the late-2030s, increased demand for transportation will offset any projected energy efficiency improvements from existing policies, leading to an overall increase in energy consumption by 2050.[13]

---

[4] U.S. Environmental Protection Agency, How Mobile Source Pollution Affects Your Health (epa.gov/mobile-source-pollution/how-mobile-source-pollution-affects-your-health) (Dec. 15, 2016).

[5] U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks, Chapter 3: Energy* (Apr. 11, 2019) (430-R-19-001).

[6] *Id*. *See generally* Rhodium Group, Taking Stock 2019 (rhg.com/research/taking-stock-2019/) (Jul. 8, 2019).

[7] *See* note 5.

[8] U.S. Environmental Protection Agency, *Fast Facts: U.S. Transportation Sector Greenhouse Gas Emissions Office of Transportation and Air Quality 1990 –2017* (Jun. 2019) (EPA-420-F-19-047).

[9] *See* note 5.

[10] *See* note 5.

[11] U.S. Energy Information Administration, *Annual Energy Outlook 2019* (Jan. 24, 2019).

[12] *Id.*

[13] *Id.*

The slow turnover rate for fleets further complicates decarbonization of the transportation sector. Vehicles are long-lived assets; given their high capital costs, fleet owners typically only replace their vehicles at the end of their useful lifetime.[14] Slow turnover means there are fewer opportunities to replace existing vehicles with more fuel-efficient or zero-emission models, and thus new technologies take longer to deploy at scale.[15] Even when fleets do turn over, there still may be limited low-carbon alternatives.

Unlike LDVs, for instance, certain transportation modes are currently poorly suited for full electrification.[16] Factors such as physical space and weight constraints may preclude the use of large batteries in industries such as long-haul trucking, aviation, and marine shipping.[17] Accordingly, decarbonization of these modes will likely require widespread use of low- and zero-carbon fuels.

Moreover, the United States has made substantial investments in existing road and fuel-supply infrastructure. These road and transit systems can last between 50 to 100 years, leading to future infrastructure and carbon emissions "lock-in."[18] Decarbonizing transportation may, in some cases, require tailoring solutions to existing infrastructure constraints. Finally, transportation decarbonization faces unique barriers compared to other economic sectors. Unlike in the power and industrial sectors, for instance, CO_2 emissions from thousands of small, mobile sources cannot practically be captured and sequestered.[19]

III. OPPORTUNTIES TO DECARBONIZE THE TRANSPORTATION SECTOR

Overcoming these barriers will require a suite of solutions, including fuel-switching to low- and zero-carbon fuels and improving energy efficiency. Complementary measures, such as reducing demand and shifting to lower-emitting modes of transportation, may also play a role.[20]

---

[14] Transit buses typically operate for 14 years, aircraft for over 13 years, and heavy-duty trucks for almost eight years. *See*, *e.g.*, Union of Concerned Scientists, California Gets one Step Closer to Zero-Emission Transit Buses (blog.ucsusa.org/jimmy-odea/california-gets-one-step-closer-to-zero-emission-transit-buses) (Sept. 6, 2018); U.S Department of Transportation, Average Age of Aircraft (bts.gov/content/average-age-aircraft) (accessed Oct. 14, 2019); and FleetOwner, Trucking by the Numbers 2018 (fleetowner.com/trucking-numbers/trucking-numbers-2018-equipment-fleets-use) (Aug. 27, 2018).

[15] Intergovernmental Panel on Climate Change, *Climate Change 2014: Mitigation of Climate Change, Chapter 8: Transport* (2014).

[16] Energy Transitions Commission, *Mission Possible: Reaching Net-Zero Carbon Emissions from Harder-to-Abate Sectors by Mid-Century* (Nov. 2018).

[17] Steven J. Davis, et al., *Net-zero emissions energy systems*, Science (Jun. 29, 2018).

[18] *See* note 15.

[19] *See* note 16.

[20] U.S. Department of Energy, *Potential for Energy Efficiency Improvement Beyond the Light-Duty-Vehicle Sector* (Feb. 2013) (DOE/GO-102013-3706).

A. Fuel-Switching

Replacing petroleum-based fuels with low- and zero-carbon fuels is key to decarbonizing transportation.[21] Ethanol, natural gas, advanced biofuels, hydrogen, and electricity are already in use today, albeit at a relatively small scale. The climate benefits of using these fuels will depend on whether they are produced using zero-carbon sources and processes.[22] In the case of electrification, for example, transportation decarbonization will require net-zero emissions from the power sector.[23]

Electrification is better suited to certain modes of transportation, such as buses and select trucking applications, as well as short-distance air and boat travel.[24] Bloomberg New Energy Finance estimates that battery-electric buses will account for nearly 70 percent of the global bus fleet by 2040.[25] In contrast, medium- and heavy-duty trucks may be slower to electrify.[26] In cases where battery electrification is infeasible, hydrogen fuel cells may be a viable alternative. Most hydrogen used in fuel cells today is derived from natural gas, but it can also be produced from water via hydrolysis.[27] Widespread electrification using either batteries or fuel cells will ultimately require steep reductions in the costs of onboard storage and performance improvements, as well as expanded battery charging and hydrogen refueling infrastructure.[28]

Some modes of transportation, namely aviation and marine shipping, will be difficult to electrify. Fuel-switching to zero-carbon biofuels will accordingly play an important role in

---

[21] Center for Climate and Energy Solutions (C2ES), *Decarbonizing U.S. Transportation* (Jul. 2018).

[22] *Id.*

[23] Energy Transitions Commission, *Mission Possible: Reaching Net-Zero Carbon Emissions from Harder-to-Abate Sectors by Mid-Century, Sectoral Focus: Heavy Road Transport* (Nov. 2018).

[24] In the near term, long-haul freight trucks face physical and operational barriers to electrification, namely that the weight and volume needed for onboard battery storage would reduce freight capacity. However, technological advances – driven by growing interest and investment in electric trucks – may increase the viability of long-haul electric trucking. *See, e.g.*, National Renewable Energy Laboratory, *Electrification Futures Study: End-Use Electric Technology Cost and Performance Projections through 2050* (2017) (NREL/TP-6A20-70485).

[25] Bloomberg New Energy Finance, *Electric Vehicle Outlook 2019* (May 2019).

[26] According to Bloomberg, battery-electric medium- and heavy-duty trucks will account for 20 and ten percent of their respective global fleets by 2040. National Renewable Energy Laboratory, *Electrification Futures Study: Scenarios of Electric Technology Adoption and Power Consumption for the United States* (2018) (NREL/TP-6A20-71500).

[27] *See* note 21.

[28] White House, *United States Mid-Century Strategy for Deep Decarbonization* (Nov. 2016).

decarbonizing those subsectors.[29] Aircraft and ships can use “drop-in” alternative fuels (such as biofuels or synthetic fuels), which require only relatively minor modifications to existing engines.[30] However, as previously stated, the climate impact of fuel-switching to alternative liquids will depend on the carbon-intensity of production.[31]

Liquified or compressed natural gas may also play a role in fuel-switching. However, the climate benefits of switching to natural gas are significantly lower in heavy-duty transportation than in other industries, such as from coal to natural gas for electricity generation.[32]

B. Improved Fuel Efficiency and System Efficiency

Energy efficiency is critical to decarbonizing all modes of transportation – especially those that are most difficult to electrify.[33] According to the American Council for an Energy-Efficient Economy (ACEEE) improving the efficiency of trucks, buses, ships, and aircraft can reduce total energy use in the United States by eight percent and CO_2 emissions by more than 13 percent by 2050.[34] Realizing that potential will require policy support, as well as both public and private investment in research, development, and deployment.

Increasing engine and motor efficiency using lighter materials and making design improvements (i.e., optimizing vehicle size and shape) can substantially reduce transportation energy consumption.[35] According to the U.S. Department of Energy, technology and efficiency improvements can reduce the energy intensity of trucks by 50 percent, aircraft by 65 percent, ships by 75 percent, and rail by 35 percent by 2050.[36] In the near term, the National Academies of Sciences found that existing fuel economy standards for medium- and heavy-duty vehicles can reduce fuel consumption by 12 to 19 percent by 2030; stronger standards could reduce fuel consumption by as much as 30 percent by that year.[37]

System-level efficiency can also reduce emissions from transportation. Coordinated planning at ports, for example, can allow for more seamless freight transitions between ships, aircraft, rail, and on-road vehicles.[38] Improved supply chain management, collaborative shipping

---

[29] Center for American Progress, *A 100 Percent Clean Future* (Oct. 2019).

[30] *See* note 16. *See generally* U.S. Department of Energy, *Alternative Aviation Fuels: Overview of Challenges, Opportunities, and Next Steps* (Mar. 2017).

[31] *See* note 21.

[32] *See* note 16.

[33] *See* note 28.

[34] American Council for an Energy-Efficient Economy, *Halfway There: Energy Efficiency Can Cut Energy Use and Greenhouse Gas Emissions in Half by 2050* (Sept. 18, 2019).

[35] *See* note 21.

[36] *See* note 20.

[37] National Academies of Sciences, *Reducing Fuel Consumption and Greenhouse Gas Emissions of Medium- and Heavy-Duty Vehicles, Phase Two: Final Report* (Oct. 4, 2019).

[38] *See* note 34.

arrangements, and truck platooning (i.e., linking trucks through connective technologies or autonomous operation) can also increase freight transportation efficiency.[39]

System-level approaches are particularly important in sectors such as marine shipping, given the expected growth in trade over the coming decades.[40] The International Transport Forum estimates that global CO_2 emissions from marine shipping can be cut by up to 95 percent by 2035 through a combination of new ship designs, greater efficiency, fuel-switching, and operational improvements such as lower operating speeds and less idling at ports.[41]

IV. WITNESSES

The following witnesses have been invited to testify:

Jeremy Baines
President
Neste US, Inc.

Emily Wimberger
Climate Economist
Rhodium Group

Wayne Eckerle
Vice President, Research and Technology
Cummins, Inc.

Adrian Martinez
Staff Attorney
Earthjustice

Fred Felleman
Commissioner
Port of Seattle and the Northwest Seaport Alliance

Timothy A. Blubaugh
Executive Vice President
Truck & Engine Manufacturers Association

J.P. Fjeld-Hansen
Managing Director and Vice President
Musket Corporation
On behalf of National Association of Truckstop Operators

[39] *See* note 34.

[40] *See* note 20.

[41] International Transport Forum, *Decarbonising Maritime Transport Pathways to Zero-Carbon Shipping by 2035* (Mar. 27, 2018).