COMMITTEE ON
ENERGY & COMMERCE
CHAIRMAN FRANK PALLONE, JR.

MEMORANDUM

September 13, 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: Pathways to Net Zero Industrial Emissions"

On **Wednesday, September 18, 2019, at 10 a.m. in the John D. Dingell Room, 2123 of the Rayburn House Office Building**, the Subcommittee on Environment and Climate Change will hold a hearing entitled, "Building a 100 Percent Clean Economy: Pathways to Net Zero Industrial Emissions." The hearing will examine the challenges and opportunities associated with reducing greenhouse gas emissions from the U.S. industrial sector.

I. BACKGROUND

The wide-ranging industrial sector spans hundreds of subsectors, including energy-intensive ones such as refining and the production of iron and steel, cement, chemicals, glass, aluminum, food products, and paper products.[1] In 2016, the industrial sector contributed $3 trillion to GDP and employed almost 20 million Americans.[2]

The industrial sector is the third largest source of greenhouse gas (GHG) emissions in the United States, accounting for 22.2 percent of emissions in 2017.[3] That number increases to 29.7 percent of U.S. emissions when indirect emissions are counted.[4] Industrial sector GHG emissions include carbon dioxide (CO_2), methane, nitrous oxides, and fluorinated gases from either direct or indirect sources. Direct emissions occur at the industrial facility, resulting from either onsite fossil fuel combustion for heat or power, industrial processes, or the production and use of hydrofluorocarbons.[5] Indirect emissions, in contrast, occur offsite from the electricity production needed to power industrial facilities.[6]

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[1] U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks, Chapter 4: Industrial Processes and Product Use* (Apr. 11, 2019) (430-R-19-001).

[2] C2ES, *Decarbonizing U.S. Industry* (July 2018).

[3] U.S. Environmental Protection Agency, Sources of Greenhouse Gas Emissions (www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions) (Aug. 8, 2019).

[4] *Id*.

[5] *Id*.

[6] *Id*.

Industrial emissions have declined 11.8 percent since 1990,[7] due to energy efficiency improvements, fuel-switching, and a general shift within the U.S. economy away from energy-intensive manufacturing.[8] Yet, despite this trend, barriers to deep decarbonization remain.

The industrial sector currently accounts for nearly 33 percent of end-use energy consumption in the United States.[9] The U.S. Energy Information Administration projects that, in the coming decades, industrial energy use will grow faster than in any other sector, increasing 31 percent between 2018 and 2050.[10] The largest subsector sources of industrial emissions will continue to include refining, iron and steel, mining, food products, paper products, cement, and chemicals production, which is slated to increase more than any other subsector.[11]

II. CHALLENGES TO REDUCING INDUSTRIAL SECTOR EMISSIONS

In contrast to emissions from other sectors, industrial emissions come from a diverse mix of heat production, power generation, and chemical reactions – and that mix varies widely across individual subsectors and facilities.

Many industrial processes – such as steel, cement, copper, and aluminum production – require high-temperature heat sustained over long periods to convert raw materials into useful end products. In most cases, renewables are unable to provide the required high-temperature, long-duration heat. Certain renewable energy technologies, such as concentrating solar power, can generate both electricity and heat at high enough temperatures to support various industrial activities, but these technologies have not yet been deployed in industrial settings.[12]

GHG emissions are an inherent feature of many industrial processes, further complicating industrial decarbonization efforts. The chemical reactions required to create certain products naturally produce CO_2.[13] This challenge suggests that capturing emissions – rather than eliminating them altogether – will likely be necessary to decarbonize certain subsectors.

There are also accompanying challenges to the current suite of solutions for the industrial sector. High capital costs, technical complexity, and lack of internal familiarity with alternative technology at industrial facilities remain barriers to broader deployment of efficiency

[7] *Id*.

[8] *See* note 2.

[9] U.S. Energy Information Administration, Use of Energy Explained (www.eia.gov/energyexplained/use-of-energy) (Aug. 28, 2019).

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

[11] *See* note 2.

[12] Third Way, AFL-CIO, and Council on Competitiveness, *Industry Matters: Smarter Energy Use is Key for US Competitiveness, Jobs, and Climate Efforts* (Oct. 10, 2018).

[13] Intergovernmental Panel on Climate Change, *Climate Change 2014: Mitigation of Climate Change, Chapter 10: Industry* (2014).

improvements such as combined heat and power (CHP) systems.[14] Widespread fuel-switching across the industrial sector faces similar barriers, including the fact that onsite fossil fuel combustion tends to be more cost-effective than purchasing electricity from the grid.[15]

Industrial subsectors also compete in highly competitive global markets, and manufacturers may choose to relocate production overseas rather than invest in emissions mitigation technologies. Iron and steel, aluminum, chemicals, paper products, and other energy-intensive and trade-exposed (EITE) industries face steep barriers to deep decarbonization.[16]

III. REDUCING EMISSIONS FROM THE INDUSTRIAL SECTOR

Despite these challenges, pathways to industrial sector decarbonization exist. Due to the heterogeneous and complex nature of the sector, decarbonization will include a mix of industry- and process-specific solutions, as well as cross-cutting measures.[17] In some cases, technologies and process changes are already well-understood.[18] In others, where solutions are less developed, continued research, design, development, and demonstration (RDD&D) will be needed to lower costs and spur technological innovation.[19] The sections below outline a few possible pathways for emissions reductions.

A. Energy Efficiency and Process Improvements

Energy efficiency and industrial process improvements can dramatically reduce both energy consumption and GHG emissions. In 2015, the Department of Energy (DOE) estimated that adopting highly efficient technologies could reduce energy consumption in the industrial sector by as much as 32 percent by 2025. Such a reduction in consumption within the industrial sector could contribute to a decrease in overall U.S. energy consumption by up to 12 percent by 2025.[20]

Heating and motors – such as those found in pumps, fans, compressors, refrigerators, and air conditioners – account for 30 percent of industrial energy use, providing a prime opportunity for efficiency improvements.[21] Installing advanced motor systems, high-efficiency boilers, and

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[14] *See* note 2.

[15] *Id*.

[16] ACEEE, Energy-Intensive, Trade-Exposed Industries (www.aceee.org/topics/energy-intensive-trade-exposed-industries) (accessed Sept. 10, 2019).

[17] The White House, *United States Mid-Century Strategy for Deep Decarbonization* (Nov. 16, 2016).

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

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

[20] U.S. Department of Energy, *Barriers to Industrial Energy Efficiency* (Jun. 2015).

[21] *See* note 2.

"smart manufacturing" technologies can help reduce onsite energy consumption. Other process changes, such as intensification (i.e., using the same machine for multiple processes or running at higher process temperatures), can further improve the efficiency of industrial operations.[22] In addition, development of new materials and production methods, such as additive manufacturing or reuse of waste materials, can improve efficiency across subsectors.[23]

Combined heat and power (CHP) systems can also play an important role in reducing industrial emissions, especially for energy-intensive subsectors that require substantial amounts of heat.[24] These systems utilize the excess heat produced from power generation, rather than letting it go to waste. Onsite CHP can achieve efficiencies as high as 80 percent, whereas the efficiency of purchasing electricity from the grid and separately generating onsite heat is closer to 45 percent.[25] The energy savings from industrial CHP can be significant, since nearly 36 percent of the total energy used in industrial process heating is ultimately lost as waste heat.[26] CHP systems have already been commercialized and deployed across the United States, but the technology remains underutilized.[27]

B. <u>Switching to Low-Carbon Fuels and Feedstocks</u>

Given that onsite fossil fuel combustion is the largest source of direct industrial emissions,[28] shifting to low-carbon fuels and feedstocks can substantially reduce emissions. The barriers to fuel-switching are significant, however, since most industrial processes were designed to utilize energy-dense fossil fuels.[29]

Just one percent of industrial boilers and 10 percent of process heat applications have been electrified, while the remainder relies on fossil fuel combustion.[30] As the power sector decarbonizes, electrifying industrial processes could reduce both direct and indirect emissions. Well-developed technologies such as electric arc furnaces can be deployed in some subsectors.[31]

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[22] U.S. Department of Energy, *Quadrennial Technology Review, Chapter 6: Innovating Clean Energy Technologies in Advanced Manufacturing* (Sept. 2015).

[23] *Id*.

[24] *See* note 10.

[25] *See* note 2.

[26] *See* note 22.

[27] According to DOE, there are 154 gigawatts of potential CHP capacity at industrial facilities (for onsite use and export to the grid). *See* note 12.

[28] *See* note 3.

[29] *See* note 12.

[30] National Renewable Energy Laboratory, *Electrification & Decarbonization: Exploring U.S. Energy Use and Greenhouse Gas Emissions in Scenarios with Widespread Electrification and Power Sector Decarbonization* (Jul. 2017) (TP-6A20-68214).

[31] *See* note 18.

Electric arc furnaces use electricity, rather than direct fossil fuel combustion, for materials processing and production. Some steel producers have already switched to electric arc furnaces, and cement, chemical, and other industries may be well-positioned to deploy these systems.[32]

Certain subsectors can reduce emissions by switching to hydrogen or biomass as a fuel and/or feedstock.[33] Hydrogen can be produced via electrolysis (using low- or zero-carbon electricity) or steam methane reforming and used across various applications, namely in the chemicals and steel industries.[34] Biomass can also be used as both a fuel or feedstock.[35]

C. <u>Carbon Capture</u>

Carbon capture, utilization, and storage (CCUS) systems can also reduce emissions at industrial facilities, since various processes produce CO_2 as a natural and unavoidable byproduct of chemical reactions.[36] CCUS may be more cost-effective in some subsectors than others, such as ammonia production, where the concentration of CO_2 in process emissions can be as high as 85 percent.[37]

Captured carbon can be stored in geologic formations or used for producing construction materials, algae-based products, fuels, chemicals, and plastics.[38] Globally there are 17 operating industrial CCUS projects.[39] Deploying CCUS systems more broadly at industrial facilities will require continued RDD&D, further cost reductions, and policy support for private sector commercialization.

IV. WITNESSES

The following witnesses have been invited to testify:

Julio Friedmann, Ph.D.
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[32] *Id.*

[33] *Id.*

[34] International Energy Agency, *Industry: Tracking Clean Energy Progress* (www.iea.org/tcep/industry) (May 24, 2019).

[35] *See* note 18.

[36] *See* notes 17 and 22.

[37] *See* note 17.

[38] C2ES, *Carbon Utilization — A Vital and Effective Pathway for Decarbonization* (Aug. 2019).

[39] International Energy Agency, *CCUS in industry and transformation* (www.iea.org/tcep/industry/ccus) (Sept. 4, 2019).

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