United States House of Representatives
Select Committee on the Climate Crisis

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"Solving the Climate Crisis: Reducing Industrial Emissions Through U.S. Innovation"

Questions for the Record

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<u>The Honorable Kathy Castor</u>

1. **What is the biggest challenge to deploying renewable hydrogen for industrial processes? What single policy would be most effective at addressing this challenge?**

Today's biggest challenge is that industry does not use a lot of "renewable" hydrogen because there is not enough of it on the market for it to be cost-competitive. The existing market is predominantly supplied by hydrogen produced through steam methane reformation (SMR), without consideration of the carbon footprint of this process. And hydrogen producers don't want to take on the financial risk of ramping up production if they don't have a sure market to allow them to recover costs. To increase hydrogen supply and bring down the cost, regulations and/or financial incentives could be used to stimulate low-carbon hydrogen production, including that produced using zero-carbon electricity and also though SMR with associated carbon capture and storage (CCS).

2. **You mentioned government procurement of hydrogen as a potential policy solution. What considerations are important when designing procurement policy for hydrogen? How should the source of hydrogen play a role?**

Government demand for hydrogen, articulated through procurement policies focused on procuring more hydrogen as well as products produced using hydrogen fuel (such as steel), can play a key role in stimulating hydrogen production. Such policies should focus on sourcing low-carbon hydrogen, including that produced though zero-carbon electricity and also though steam methane reformation (SMR) with associated CCS. In addition, The long-term goal should be for all hydrogen to be produced using renewable electricity; in the near term, however, the goal should be to build the supply of hydrogen to bring down the price. Additionally, the government should continue to invest in Department of Energy (DOE) programs, such as H2@Scale, to continue to drive development of hydrogen pathways.

3. **Are there environmental, health, safety, or other risks and tradeoffs to pursuing the use of hydrogen? How can they be mitigated?**

Hydrogen has been safely produced and used in the American industrial sector for more than half a century. As with every fuel, safe handling practices are required, but hydrogen is non-toxic and does not pose a threat to human or environmental health if released. In addition, when used to generate power and for several other industrial applications (e.g., steelmaking), hydrogen produces only water as a byproduct, and does not release air pollutants or particulate matter. The environmental impact of hydrogen production depends on the production pathway. Hydrogen can be produced through electrolysis using any power source, the cleanest being renewable power. Hydrogen can also be produced through reforming of fossil fuels including natural gas; this process releases carbon dioxide that must be captured. In addition, one would need to account for the environmental impact associated with the production, transmission and distribution of the natural gas to the hydrogen production facility.

4. **You mentioned the similarities between hydrogen use and electric vehicles. Could you elaborate on how the Federal government can help the hydrogen market grow while simultaneously incentivizing lower-emission hydrogen production for this growing market?**

The similarity between growing the hydrogen market and in the EV market relates to the fuel sources used to create both markets. Right now, EVs are simply powered by the mix of power offered on the grid; widespread availability of power at a reasonable price has enabled the EV market to take off, while simultaneously the grid is becoming greener and a larger share of that power is being provided by renewable sources.

The development of the hydrogen market should follow that same dynamic. Right now, over 90% of the hydrogen produced in the US in produced through SMR, but the goal is to produce more hydrogen using electrolysis powered by low-carbon electricity. The focus now needs to be on building hydrogen supply so the price can come down, the demand can increase, and additional investments can be made in renewable hydrogen production. This will require applying CO_2-capture at existing SMR facilities, and also regulations and financial incentives, including renewable energy mandates, tax credits, loan guarantees, and feed-in-tariffs. On the demand side, clear regulations, direct investment, and loan guarantees for building additional transportation and distribution infrastructure can make hydrogen easier for industry to access. Financial incentives can be used to stimulate hydrogen use by large industrial facilities, and investment support programs can help reduce the costs associated with fuel-switching at these facilities.

5. **Are there ways that hydrogen can also help industrial facilities with reliability and resilience?**

Hydrogen has the potential to be used as stationary power (for buildings), backup power, storage of energy harvested through wind and solar processes, and as battery-like portable power (most commonly used in forklifts today). Energy stored in hydrogen fuel cells allows for the seamless transition of energy within the power grid in the event of a power station failure or a black-out situation. In addition, Power-to-Gas (P2G) is the only technology capable of providing storage at terawatt-hour scale without location limitations. Renewable electricity is used to create hydrogen, which then is stored in a storage system like tanks, caverns, or the natural gas grid. Using the natural gas grid would allow for very large amounts of renewable hydrogen to be stored very economically, as very little new infrastructure needs to be build. Effectively, this hydrogen reservoir could be used as back-up capacity for when there are production disruptions or shortages in the power grid.

6. **How do other countries view the use of hydrogen as a decarbonization strategy? What policies have they implemented and what can we learn from them?**

Many countries are planning to use hydrogen as a mechanism to decarbonize. The scale of these applications and the role they play in the economy varies quite substantially. Australia for instance has a number of highly developed pathways focusing on the production and export of hydrogen in addition to use in heavy transport applications. Japan, Korea, China, and Germany have announced ambitious goals for deployment of hydrogen fuel cell electric vehicles; China plans to have 1 million fuel cell electric vehicles on its roads by 2030. Some nations are setting targets for the type of hydrogen used in industry: in 2018, France announced a target of 20-40% low-carbon hydrogen use in industrial applications. In addition, there is a large effort in Europe through the European Commission's Fuel Cell and Hydrogen joint undertaking. This effort is a public private partnership to develop multiple hydrogen pathways, including using existing natural gas pipeline networks to transport hydrogen.

7. **You mentioned that government investment in hydrogen infrastructure for transportation and delivery will be needed to scale up hydrogen use in industry. Can you comment on how existing hydrogen infrastructure would need to be expanded? How would the footprints of hydrogen and carbon dioxide infrastructure overlap? Are there synergies we can take advantage of?**

Current hydrogen production is largely concentrated in areas where oil and gas refineries are located, and integrated with other (petro)chemical facilities that use the hydrogen as feedstock. This infrastructure will need to be expanded into additional geographies as hydrogen production expands across the US. However, there is promise in using existing the nation's extensive natural gas pipelines to carry hydrogen instead. Current research supports blending of 20% hydrogen into natural gas streams without changes to pipeline infrastructure. This percentage could be higher if natural gas pipeline is retrofitted to carry the smaller hydrogen molecules.

Hydrogen and carbon dioxide infrastructure could overlap as transportation and pipeline infrastructure is developed. Storage and utilization approaches for CCS could in some instances co-locate with hydrogen production technologies such as SMR, but the development of large-scale carbon dioxide storage, in geologic formations for example, will require the transportation of CO2 in the future. As such, planning for these infrastructure projects and indeed identification of storage capacity might offer potential for synergies in the development phases.

8. **You mentioned that biomass could be used to make hydrogen energy. Could you expand upon what issues need to be considered when determining whether sources of biomass are appropriate for hydrogen feedstocks to reduce greenhouse gas emissions? Taking into account land-use considerations and the multiple uses of biomass, what is a reasonable scale for using biomass for hydrogen?**

Biomass can be used to produce electricity that is then used to power via electrolysis; it can also be gasified to produce hydrogen, with appropriate controls to capture the resulting carbon monoxide and carbon dioxide byproducts produced. The production of hydrogen from biomass will likely be dependent on the relative cost of hydrogen production using this fuel source versus steam methane reforming. A more viable pathway for biomass in industrial applications may be to combust it directly and capture CO_2 emissions, rather than using the additional energy required to transform it into hydrogen before use.