

**Testimony of Tim Cortes,  
Vice President, Hydrogen Energy Systems**

**on behalf of  
Plug Power Inc.**

**before the  
United States House of Representatives  
Committee on Science, Space, and Technology  
Subcommittee on Energy**

**Hearing entitled  
“The Next Mile: Technology Pathways to Accelerate Sustainability  
within the Transportation Sector”**

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Good afternoon. Thank you to Chairman Lamb, Ranking Member Weber, and the entire Subcommittee for inviting me to testify before you today regarding Sustainable Transportation and the work that is going on in the U.S. Department of Energy’s Fuel Cell Technologies Office. I am excited to discuss the role that hydrogen fuel cell technology is playing in sustainable transportation and share my perspective on how Congress and the federal government can enable even greater progress through this pathway.

**Background and Introduction:**

My name is Tim Cortes. I am the Vice President for Hydrogen Energy Systems at Plug Power, Inc. I have been with the company since early 2015 and I am responsible for overseeing our hydrogen business. I was hired to build a world class hydrogen business and I am proud to say that since I started, we have developed an excellent management team focused on installation, engineering and service of Plug Power’s GenFuel hydrogen fueling systems. As I will discuss more later, we have developed, installed and are operating over 80 hydrogen fueling systems across the United States.

Prior to joining Plug Power, I served as the Chief Technology Officer and Vice President of Engineering at Smiths Power. My professional background has been spent in the development of critical power infrastructures in both the data center and telecommunications markets including positions with AT&T Bell Laboratories, GNB/Exide Technologies and Power Distribution Incorporated.

**About Plug Power:**

Plug Power is the leading manufacturer of hydrogen fuel cell engines and fueling stations serving the broader logistics and transportation market. We have deployed over 28,000 fuel cell systems, many in your congressional districts and states and have unmatched field experience on our technology platform with over 270M hours of customer operation.

Plug Power was founded in 1997 and went public in 1999. We are headquartered in Latham, New York, Congressman Tonko's district, and have facilities in Spokane, Washington, Rochester, NY, Dayton, OH, Romeoville, IL, and Montreal, Canada. We manufacture all of our systems and many of our critical components in Latham, NY and Spokane, WA,

In our core technology platform, Plug Power replaces lead acid batteries to power electric industrial vehicles, such as the lift trucks customers use in their distribution centers and warehouses. We have unmatched field experience, with over 270M hours of customer operation – that's the equivalent to more than 8 billion automotive miles driven. We have installed over 80 hydrogen fueling stations in more than 30 states across the United States. Our customers have completed more than 22 million fills using our hydrogen dispensers. Long-standing relationships with material handling industry leaders forged the path for the company's key accounts, including Walmart, Amazon, Home Depot, Kroger, Wegmans, Honda, BMW, Mercedes Benz and many more.

Plug Power is extending its reach into the on-road electric vehicle market and providing hydrogen solutions for customers. In fact, Plug Power is the only company today that can service the entire logistics and transportation market with our modular hydrogen fuel cell engines and fueling stations as a single-sourced vendor. Earlier this year, we announced our first major on-road customer win. In the second quarter, Plug Power closed a deal with electric vehicle manufacturer StreetScooter, a subsidiary of DHL, the world's largest logistics and mail communications service. With this partnership, StreetScooter will initially deliver 100 hydrogen fuel cell-powered trucks for on-road use to Deutsche Post DHL, starting in 2020. This marks the world's first commercial scale fuel cell engine deployment for the on-road logistics application.

From our leading position as the largest buyer of liquid hydrogen, Plug Power is evaluating strategic priorities for the growing hydrogen business. Our interest is twofold: 1) to provide increasing comfort of hydrogen price and supply stability to our end customers, and 2) to improve margins in our business. Operationally, we remain focused on continuously reducing our product cost, enhancing our technology platform, and increasing overall reliability. These collective activities allow Plug Power to expand the addressable market and continue overall margin improvement.

Plug Power's CEO, Andy Marsh, is the Chairman of the Fuel Cell and Hydrogen Energy Association (FCHEA.) FCHEA represents the leading companies and organizations that are advancing innovative, clean, safe, and reliable energy technologies. Their member organizations represent the full global supply chain for hydrogen and fuel cells, including automakers; material, component, stack and system manufacturers; hydrogen producers and energy companies; trade associations; utilities; and end users. Andy is also a member of the Hydrogen and Fuel Cell Technical Advisory Committee (HTAC), which was established in the Energy Policy Act of 2005 to provide technical and programmatic advice to the Energy Secretary on DOE's hydrogen research, development, and demonstration efforts.

Plug Power also participates on the Hydrogen Council, which is a global initiative of 60 leading energy, transport and industry companies with a united vision and long-term ambition for

hydrogen to foster the energy transition. The council estimates that by 2050 hydrogen can help cut global CO2 emissions by as much as 20%, with substantial reductions coming from the transportation sector.<sup>1</sup> In September 2018, the Council adopted a goal to completely decarbonize the production process for hydrogen transportation fuel by 2030.<sup>2</sup> Plug Power looks forward to working with its industry partners and leveraging support from the public sector to achieve this goal.

Plug Power has been a platinum member of the California Business Council for the last several years. The California Hydrogen Business Council (CHBC) is the leading advocate for the hydrogen and fuel cell industry in Sacramento, California. Its vision is to reinforce California's position as the most advanced clean energy state in the nation, expanding the sustainable use of its precious natural and renewable resources and providing clean air to its citizens, by adopting hydrogen and fuel cell technologies in transportation, power and goods movement markets.

Plug Power sits on the Board of Directors for the Ohio Fuel Cell Coalition. The Coalition was established to ensure Ohio's presence both regionally and nationally in current fuel cell discussions and works to advance the integration of a coordinated, robust fuel cell infrastructure and supply chain, promote public awareness of fuel cell technology, and increase the number of economic opportunities available to Ohio organizations and residents.

### **About Fuel Cells:**

A hydrogen fuel cell (HFC) is an electrochemical power generator that combines hydrogen and oxygen to produce electricity, with water and heat as by-products. Simply put, hydrogen fuel cells form energy that can be used to power anything from commercial vehicles to drones.

HFC technology offers a clean and reliable alternative energy source to customers in a growing number of applications – electric vehicles including forklifts, delivery vans and cars, primary and backup power for a variety of commercial, industrial and residential buildings, and more futuristic-sounding applications like drones and mobile phone recharging.

How does a fuel cell work? A fuel cell is composed of three main components: an anode, a cathode, and an electrolyte membrane. The “magic” of the PEM fuel cell is its proton exchange membrane, which looks like a piece of construction paper. It works by passing hydrogen through the anode side and oxygen through the cathode side. At the anode site, the hydrogen molecules are split into electrons and protons. The protons pass through the electrolyte membrane, while the electrons are forced through a circuit, generating an electric current and excess heat. At the cathode, the protons, electrons, and oxygen combine to produce water molecules.

Fuel cells are very clean, with their only by-products being electricity, a little heat, and water. Additionally, as HFCs do not have any moving parts, they operate very quietly.

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<sup>1</sup> Hydrogen Council, *Hydrogen: scaling up*, November 2017, <http://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-scaling-up-Hydrogen-Council.pdf>.

<sup>2</sup> “Our Goal: 100% Decarbonized Hydrogen Fuel in Transport by 2030,” *Hydrogen Council*, September 14, 2018, <http://hydrogencouncil.com/our-2030-goal/>

## **Advantages & Benefits – 5 things you should know about fuel cells:**

1. **Zero Emission Power.** HFCs produce no harmful emissions, eliminating the costs associated with handling and storing toxic materials like battery acid or diesel fuel. In fact, when fueled with pure hydrogen, the only by-products are heat and water, making this a zero-emission sustainable power source. HFCs are a part of many well-planned corporate sustainability programs. Hydrogen fuel cell products utilize environmentally-benign hydrogen as a fuel source, which eliminates the environmental impact of fuel spillage, leaks or air pollution and results in simplified zoning requirements.
2. **Robust Reliability.** HFCs have proven themselves against tough conditions including cold environments as low as -40 degrees F/C, weather environments like hurricanes, deserts and winter storms, and even the hard-working business environments of material handling warehouses.
3. **Improved Efficiency.** According to the U.S. Department of Energy, HFCs are generally between 40–60% energy efficient. This is higher than some other systems for energy generation. For example, the typical internal combustion engine of a car is about 25% energy efficient. In combined heat and power (CHP) systems, the heat produced by the HFC is captured and put to use, increasing the efficiency of the system to up to 85–90%. HFC efficiency is put to work to improve warehouse productivity by up to 15% using fuel cell forklifts; to extend the mileage range for electric vehicles like package delivery vans; and to provide electricity and hot water for hotels and businesses.
4. **Scalability.** The advantages of using a modular product are profound: greater reliability, easier serviceability. But the most important benefit may be scalability – and the savings that feature provides when purchasing and using a fuel cell. These products may be engineered precisely to meet a variety of customer power needs – whether for material handling, stationary power or on-road electric vehicles. Paying for only what you need just makes good business sense.
5. **Lower Operational Costs.** Compared to batteries and internal combustion generators, fuel cells save money. They eliminate the need to change, charge and manage batteries – saving both labor/time and space normally allocated to a battery room. The units run longer than lead-acid batteries and can be fueled in as little as two minutes, substantially reducing vehicle and personnel downtime. Fueling the HFC is as simple as fueling a car. Eliminating a battery charging infrastructure also significantly reduces the peak power demand of a commercial operation. Additionally, simple maintenance and fewer site visits mean up to 84% lower operational costs when compared to combustion generators for stationary power. Robust reliability eliminates the need for quarterly site maintenance visits, keeping site personnel focused on their critical tasks.

## **United States Leadership in Fuel Cells:**

When the Apollo 11 mission put a man on the Moon in 1969, the Command Module's primary source of electricity and drinking water was from a set of three hydrogen fuel cells. In the ensuing decades, American scientific and industrial ingenuity ensured that our country became the global leader in hydrogen and fuel cell technologies. This could not have been accomplished

without the support and dedication of the United States Government – including from this Committee.

Today, this support primarily comes from the Fuel Cell Technologies Office (FCTO,) housed within the Department of Energy’s Office of Energy Efficiency and Renewable Energy. FCTO leverages the resources of our National Laboratories and partnerships with the private sector, (EERE) including Plug Power, to research, develop, and demonstrate innovative, efficient solutions for advancing fuel cell systems and hydrogen energy.

The results speak for themselves, with the United States leading the world in deployments of zero-emission hydrogen fuel cell forklifts and light-duty cars. There are also more than 550 MW of installed stationary fuel cell capacity nationwide, providing efficient, clean, and resilient energy to power office buildings, data centers, hospitals, universities, manufacturing and logistics facilities, and other stationary end users. Finally, the American hydrogen and fuel cell industry continues to push forward with novel applications for these technologies, such as heavy-duty trucking, maritime vessels, port vehicles, drones, military equipment, municipal and industrial microgrids, energy storage systems, and more.

### **Working with the Department of Energy (DOE):**

Plug Power has been working with the Department of Energy since the company’s inception to advance our innovative fuel cell solutions. This started with basic research and development projects in the late 1990s and early 2000s, which led to proving the feasibility and utility of powering material handling equipment with hydrogen fuel cells and stationary systems for prime backup power. Once these first-generation systems were ready for deployment, DOE’s Market Transformation activities accelerated cost reductions and promoted consumer acceptance for this new, alternative energy technology.

Thanks to these efforts, Plug Power was able to establish initial relationships with customers, help the company significantly expand, and create an entire new market for hydrogen fuel cell systems. Today, Plug Power continues to work with DOE to further improve the efficiency of these systems, scale up the production of hydrogen fuel, bring advanced manufacturing processes for our technologies from the laboratory to the factory, and introduce hydrogen fuel cells to new markets and applications. For example, through DOE we have conducted a series of successful pilot projects with FedEx to demonstrate the feasibility of our hydrogen fuel cell engines in delivery vans and ground support equipment at the Albany International and Memphis International airports.

Put simply, Plug Power’s relationship with DOE is a prime example of “government working right.” The company would not have gotten to where it is today without this partnership, and we hope to see its success replicated with other players in the hydrogen fuel cell industry and beyond to accelerate sustainability in the transportation sector.

According to the Department of Energy’s website, the mission of its Hydrogen and Fuel Cells Program is to reduce petroleum use, greenhouse gas (GHG) emissions, and air pollution and to contribute to a more diverse and efficient energy infrastructure by enabling the widespread commercialization of hydrogen and fuel cell technologies. The Program’s key goals are to advance these technologies—through research, development, and validation efforts—to be

competitive with current technologies in cost and performance, and to reduce the institutional and market barriers to their commercialization.

We are pleased to have been part of, what we believe, some of its most successful activities. For example, the American Recovery and Reinvestment Act of 2009 (Recovery Act) was an unprecedented effort by the DOE to jumpstart our economy, create or save millions of jobs, and put a down payment on addressing long-neglected challenges so our country can thrive in the twenty-first century. On April 15, 2009, the Energy Department announced \$41.6 million in Recovery Act funding to accelerate the commercialization and deployment of fuel cells; and to build a robust fuel cell manufacturing industry in the United States, with accompanying jobs in fuel cell manufacturing, installation, maintenance, and support services. By the end of December 2011, more than 450 fuel cells for material handling were operational, at customer sites including Sysco Houston, Coca Cola, Kimberly Clark, Sysco Philadelphia, Wegmans and Whole Foods. It was a classic example of how a government program should work. It was a public-private partnership aligning government with industry needs at the exact right time. It allowed customers to demonstrate the technology, “kick the tires,” understand technology, validate and get comfortable with hydrogen infrastructure. In the subsequent years, nearly all of these customers have continued or expanded their fuel cell programs, and they provided the basis for many of the expanded list of customers we have today.

Plug Power is very appreciative of DOE’s H2@Scale concept. This program explores the potential for wide-scale hydrogen production and utilization in the United States by leveraging resources from the Department, National Labs, and array of diverse domestic industries that can produce and utilize hydrogen fuel. Unfortunately Plug Power is not currently an active participant in H2@Scale, but we are hopeful DOE will embrace our priorities since we are the leading user of liquid hydrogen in the United States. We hope that Congress can maintain support for the concept in future policy authorizations and encourage DOE to work with industry to facilitate partnerships that will be beneficial to all in the industry. For example, we think the program can be utilized to help the fuel cell transportation sector transition to fully decarbonized hydrogen fuel production in the coming years, with the proper policies in place.

Plug Power also appreciates FCTO’s continued work on safety, codes, and standards for the fuel cell and hydrogen industry, especially by coordinating with international bodies to ensure the development of one set of global regulations.

A good example of the current, or recently completed, programs Plug Power is working on with DOE that are synergistic with the goals of this committee: **Ground Support Equipment (GSE)**: The GSE program began at the FedEx Hub at the Memphis International Airport in 2015. A total of 15 Charlotte CT5E baggage tractors equipped with Plug Power hydrogen fuel cells were deployed along with an on-site hydrogen delivery system. The initial 2 phases of the program were completed in Memphis At the start of 2019, [phase 3 of the program was launched at the Albany International Airport](#). This phase again supported the freight operation of FedEx, albeit on a different scale than in Memphis.

At the end of June, a decision was made to continue to operate the hydrogen-powered baggage tractors at the Albany Airport to move freight and packages. FedEx and Plug Power will continue to cooperate and support the model established during this program for the foreseeable future.

**FedEx Delivery Van Program:** Plug Power delivered the first ProGen-powered delivery van to FedEx at the start of 2018 – the vehicle has now delivered packages over more than 18,000 miles in varying weather conditions including ice, snow, rain, and extreme heat. Why is this important? Well, it has proven that the Plug Power design is able to withstand harsh elements with above-average reliability and dependability. The ProGen-powered electric delivery van is one of the first of its kind to operate in a standard commercial environment and deployed on a standard delivery route for FedEx.

The addition of Plug Power's ProGen fuel cell enables the vehicle range to exceed 160 miles per delivery cycle, a 166% increase over standard battery power alone. This is an elite van, operating 11 hours per day (60-100 miles each day) almost immediately upon its deployment. And, since it's delivering Plug Power fuel cell equipment, this truck is carrying some of FedEx's heaviest loads in comparison to its typically delivery van loads.

The FedEx drivers report the vehicle is more responsive with quicker acceleration than the incumbent vehicle. It is also quiet and does not release any diesel odor – since there is no diesel onboard. Pair this with less maintenance from the FedEx crew and we are seeing acceptance from all sides. This project is proving that with hydrogen fuel cells, electric vehicles can be used on all commercial routes as a highly-efficient, highly-sustainable mobility solution.

**WSU Program:** Plug Power has been working with Washington State University's Hydrogen Properties for Energy Research (HYPER) Labs. This project will result in the implementation of an innovative technology, Heisenberg Vortex Tube (HVT), which will provide more liquid hydrogen to be delivered at scale and allow hydrogen fuel cells to be used in more on-road applications. This partnership focuses on one of the largest logistical issues of delivering hydrogen at scale: efficient transportation. Optimizing the HVT to operate with supercritical hydrogen has the potential to reduce the cost and efficiency of small, distributed hydrogen liquefaction systems as well as aid in low boil-off and heat mitigation challenges relevant to Plug Power and its customers.

The proposed sub-cooling technology will enable improvements to the transportation and storage of liquid hydrogen to fueling stations. It will allow Plug Power's fleet vehicle customers, including material handling lift truck fleets, to achieve lower fuel costs due to lower back-end costs of transportation and storage. In the future, this innovation will improve the operational efficiency of GenFuel liquid hydrogen architecture, which is critical for the high-volume hydrogen fueling needed to support the burgeoning on-road fuel cell electric vehicle market.

### **Expanding Markets:**

As previously mentioned, Plug Power is committed to reducing emissions in the transportation sector by advancing zero-emission hydrogen fuel cell solutions for a variety of mobility applications. We see our technology as complementary to other vehicle electrification technologies, such as batteries. As the United States continues to invest in and scale up deployment of sustainable transportation options, we urge Congress to recognize the unique role hydrogen fuel cells can play in helping to decarbonizing this sector.

For example, according to the Environmental Protection Agency, light-duty vehicles (LDVs) contributed to 59% of transportation GHG emissions in the United States in 2017.<sup>3</sup> The remaining 41% of these emissions came from medium and heavy duty vehicles (23%), aircraft (9%), ships and boats (3%), rail (2%), and other sources such as material handling equipment (4%). While both battery electric and hydrogen fuel cell technologies are important solutions in decarbonizing light-duty transportation, the advantages that the fuel cells provide in range, efficiency, cargo capacity, and refueling times make them a worthwhile option for decarbonizing these other mobility sectors too.

Going forward, Plug Power sees commercial class 5 to class 8 trucks as the next phase in hydrogen fuel cell transportation. We hope that Congress and the federal government can provide the necessary policy and incentive support to get these technologies on the road and start decarbonizing *all* transportation applications. This should include further reducing the cost and increasing the availability of hydrogen fuel production, storage, and distribution.

### **Recommendations:**

With today's urgent focus on mitigating climate change, industrialized countries are recognizing the crucial role that hydrogen energy and fuel cells can play in decarbonization policies across all sectors. In just the past few years, China, Germany, Japan, the United Kingdom, France, South Korea, Canada, Australia, and other developed nations have put forth implementation and funding plans worth billions of dollars to accelerate the deployment of these technologies, especially in the transportation sector. To ensure that the United States does not fall behind on global leadership in hydrogen and fuel cell technologies, Congress and the Executive Branch must make sure policies and incentives are available to American industry to accelerate further deployment. America's approach to sustainable mobility on the international community's and incorporate hydrogen fuel and fuel cell systems into our strategy.

Recently FCHEA, with Plug Power's leadership, submitted comments to the House Energy and Commerce Committee on their recently announced plan to achieve a 100% clean economy by 2050. Plug Power supports these recommendations and supports creating policies for scaling up the infrastructure necessary to facilitate the widespread adoption of innovative clean energy technologies, such as fuel cells and hydrogen energy. Ideally, this would include, but not be limited to, updated authorization for the Department of Energy's (DOE) Hydrogen and Fuel Cell Technologies program that focus on:

1. Supporting the development of hydrogen refueling infrastructure nationwide to accelerate the adoption of zero-emission fuel cell transportation.
2. Reducing the cost of hydrogen fuel production, storage, and distribution through the H2@Scale initiative, with an emphasis on obtaining hydrogen from renewable sources.
3. Scaling-up innovative applications of hydrogen fuel cell technology, including medium and heavy-duty transportation, maritime vehicles, port and drayage equipment, microgrids and distributed energy resources, unmanned aerial vehicles, and public safety/resiliency.

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<sup>3</sup> "Fast Facts on Transportation Greenhouse Gas Emissions," *United States Environmental Protection Agency*, June 2019, <https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions>.



4. Late-state research, development, and technology acceleration programs to further reduce the cost of fuel cell components and systems. This includes mid and late-stage RD&D into fuel cell components such as balance of plant, membrane electrode assemblies, compressors, catalysts, sensors, and storage tanks.
5. Late stage R&D on reducing input costs and improving the performance of light-duty fuel cell vehicles.
6. Promote interagency cooperation between DOE and other federal stakeholders in hydrogen and fuel cell technologies, such as the Department of Transportation, the Department of Defense, the Department of Agriculture, and NASA.
7. Renewed support for DOE's Hydrogen and Fuel Cells Market Acceleration activities that can help deploy novel applications for hydrogen and fuel cell systems, such as in energy storage technologies, steel production, maritime transportation, aviation, and others. The fuel cell industry's early successes today stem from similar activities that were included in the 2009 American Recovery and Reinvestment Act, and as industry develops new approaches to utilizing these technologies, similar initiatives could help the United States scale-up its "hydrogen economy."
8. Including hydrogen fuel cell technologies in any provisions to incentivize the adoption of clean energy solutions across the federal government.
9. Workforce development and training programs to ensure that fuel cell manufacturers and hydrogen fuel suppliers can recruit the talent needed to help the industry thrive.
10. Ensure the policies that govern pipelines for fuel address the needs of transporting gaseous and liquid hydrogen.
11. Renew authorizations for DOE's safety, codes, and standards work to ensure the continued safety and training procedures for utilizing hydrogen fuel.
12. Authorize the EPA to classify hydrogen transportation fuel as an Approved Pathway for its Renewable Fuel Standard and assign Renewable Identification Numbers.

### **Funding:**

We are thankful to Congress for maintaining robust appropriations for DOE's Hydrogen and Fuel Cell Technologies program in recent years. Plug Power is extremely pleased with the funding levels and report language included in the House and Senate Energy and Water Appropriations for FY 2020, which both direct DOE to maintain a diverse set of early, mid, and late-stage research, development, demonstration, and deployment activities. With continued emphasis of Congressional intent in these reports, we hope DOE will fully align their Hydrogen and Fuel Cell Technologies program with what the industry needs to succeed today including the technology acceleration and H2@Scale programs. Furthermore, while we appreciate EERE's focus on funding the National Labs and research universities, we are hopeful to create more partnerships that will allow for industry to engage on needed priorities. Our goal is to make sure the important research labs and universities are doing is being utilized to create markets and get clean energy technologies in the hands of American tax payers.

Thank you for the opportunity to participate in this hearing and giving us the opportunity to talk about sustainable transportation and fuel cells and hydrogen technologies in a global marketplace, and I look forward to answering your questions.