Fuel cells explained

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Plug has a long, celebrated history in fuel cell technology -- crafting innovative solutions across the energy value supply chain as global businesses work to decarbonize their operations.

As green hydrogen fuel cells become both increasingly viable and vital as an energy choice in the age of climate change, those in sectors ranging from automobile, retail, electric utilities, and agriculture -- among others -- have all shown increased efforts to green their portfolios and play a part in catapulting climate solutions.

With recent U.S. Congressional action accelerating tax incentives for fuel cell applications, and multiple countries aiming to emulate an energy strategy backing fuel cells" growth, fuel cells remain top-of-mind for many business leaders and policymakers.

What is a fuel cell anyway? How does a fuel cell work in a car and other power applications? Further, what are the various fuel cell types? And what"s the difference between a battery and a fuel cell?

These questions and their answers speak directly to the core of Plug"s business model and customer offerings in the fuel cells space. Further, they touch upon the inherent advantages in our proton exchange membrane (PEM) fuel cells technology, offering us a sector-wide advantage due to their wide utility in both stationary and mobility power generation.

A fuel cell is an electrochemical power generator. Fuel cells combine hydrogen and oxygen to produce electricity with water and heat generated as byproducts. Fuel cells, like a battery, create energy via an electrochemical process and not combustion. But like an internal combustion engine, fuel cells also intake fuel sources and generate a chemical reaction to produce power, yielding energy in an array of use cases. That fuel resource, in Plug"s case, is hydrogen.

Fuel cells, summed up, consist of three main components: An anode, a cathode, and an electrolyte membrane, working akin to batteries in that they don"t need charging. Instead, operating continuously provided fuel is supplied into the mechanism. Those three components interact, in turn, intaking and through putting energy.

Plug"s PEM fuel cells function by passing hydrogen through the anode side of the mechanism mentioned above. Oxygen, from the air around us, is passed through the cathode side. Hydrogen molecules then split into electrons and protons on the anode side. Protons next pass through an electrolyte membrane (hence PEM). From there, electrons move through a circuit, generating current and excess heat. At the cathode side, the protons, electrons, and oxygen combine to produce water.

In a 2017 report titled “The Business Case for Fuel Cells,” the Argonne National Laboratory

concluded that fuel cells can provide "power to retail stores, data centers, production sites and other company facilities, greatly reducing emissions and doing so at a cost that can be competitive with the local electric grid in some states."

At large, Plug has deployed several tens of thousands of fuel cell systems, and the number grows every month, as countries around the world cash in on plans to increase business efficiency and curtail greenhouse gas budgets.

PEM fuel cells require a low operational temperature, making them the most sensible for vehicles needing short periods of time between ignition and start-up. A PEM fuel cell generally operates at a temperature of 80?C (176?F). This low temperature, the U.S. Department of Energy notes, also "results in less wear on system components, resulting in better durability."

Hydrogen fuel cell vehicles, known as FCEVs or fuel cell electric vehicles, utilize hydrogen within a PEM fuel cell stack webbed into electric vehicles, supplanting standard internal combustion engines or the aforementioned battery-powered engines currently powering electric vehicles. Unlike the internal combustion engine and analogous with electric vehicles, hydrogen fuel cell vehicles do not emit pollutants or greenhouse gasses into the atmosphere and instead only emit water vapor and heat, making them beneficial for combating climate change.