AN OVERVIEW OF FUEL CELLS

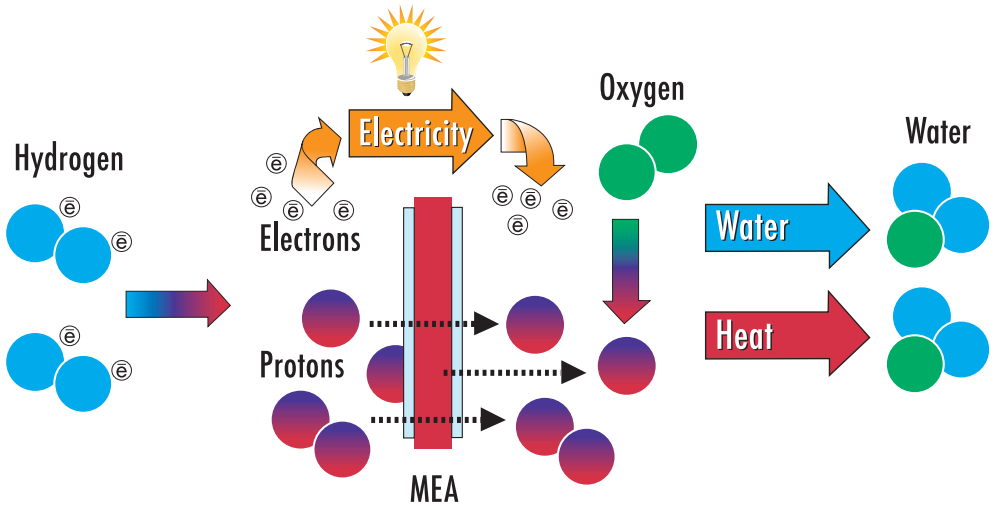
PRESENTED BY PLUG POWER INC.

plug power FUEL CELL SYSTEMS

A fuel cell is an electrochemical energy conversion device that combines hydrogen and oxygen from the air to produce electric power without combustion.

The Process of Creating Electricity with Proton Exchange Membrane (PEM) Fuel Cells

- **Step 1:** Natural gas (or any other hydrogen containing fuel such as propane, kerosene, etc) enters the fuel processor (reformer) where it is converted into a hydrogen rich gas called reformate. If hydrogen is used, this step is not necessary.
- **Step 2:** The hydrogen or reformate flows to the fuel cell stack where the hydrogen molecules are separated from each other in the presence of a catalyst on the anode side of an electrochemical cell. The protons pass through an impermeable non-conducting membrane to the cathode side of the cell. This membrane is known as a proton exchange membrane or a polymer electrolyte membrane. The electrons pass around the membrane through the electrical load to the cathode side. The hydrogen protons combine with the electrons and oxygen molecules from the air in the presence of the cathode catalyst to form water.
- **Step 3:** The DC power generated within the fuel cell is sent to the power conditioning module where it is converted into reliable, regulated DC or AC power.



History of the Fuel Cell

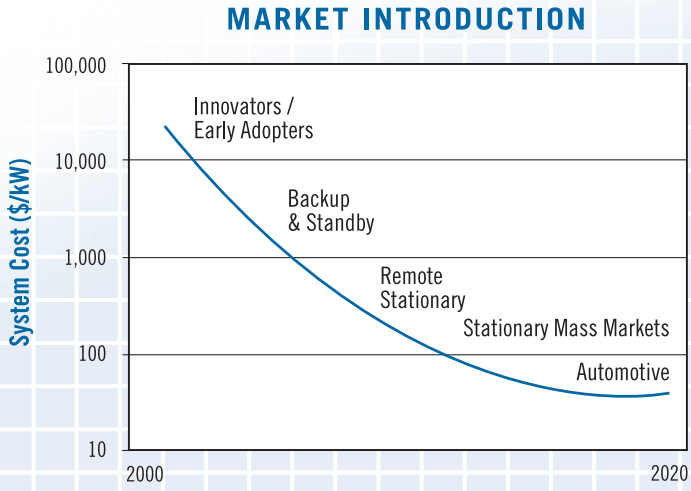
The first fuel cell experiments were completed in 1839 by Sir William Robert Grove. Grove was the first to produce electricity and water through the combination of hydrogen and oxygen. In the early 1950's, General Electric developed fuel cells for aerospace applications. In the 1960's, NASA adopted fuel cell technology to provide safe, reliable power for space missions. It wasn't until 1998, 159 years after the initial fuel cell experiments, that Plug Power became the first to successfully power a home with a fuel cell.

Types of Fuel Cells	Operating Temperature	Applications	Examples
Proton Exchange Membrane (PEM)	60°C – 160°C	Cyclical, Rapid Response, Load Following, High Turndown Cogeneration	Residential, Back-up, Light Commercial, Transportation
Phosphoric Acid Fuel Cells (PAFC)	175°C – 200°C	Baseload/Assured Power (Cogeneration), Medium-Large Commercial	Hospitals, Schools, Police Stations
Molten Carbonate Fuel Cells (MCFC)	600°C – 1000°C	Grid Support or Base Load, Industrial Applications	Factories
Solid Oxide Fuel Cells (SOFC)	700°C – 1000°C	Grid Support, Industrial Applications	Factories

Benefits

- Fuel cell energy is produced through a clean electrochemical reaction that releases only water when hydrogen is the fuel and practically no pollutant byproducts with other fuels.
- The waste heat that is produced during fuel cell power generation can be used to supplement thermal loads, making fuel cells one of the most efficient means of creating energy.
- The flexible operating ability of a fuel cell system allows it to function in parallel with the grid or as an independent energy source.
- Fuel cell systems can be deployed for on-site power generation, eliminating transmission losses over power lines and maximizing reliability.
- Fuel cell systems are capable of operating on multiple fuels and promote energy independence.

plug power GenSys 5C



Plug Power Inc. designs, manufactures and markets on-site electric power generation systems utilizing proton exchange membrane (PEM) fuel cells for stationary applications. Current product lines consist of prime power GenSys™ systems for residential and small commercial applications, and premium power GenCore™ systems for the telecommunications, cable broadband and outside plant uninterruptible power supply (UPS) industries. In 2002, Plug Power delivered 121 fuel cell systems to 30 customers in 19 U.S. states and 3 countries, affording its customers a greater degree of independence, comfort and security.