Fuel Cell & Hydrogen Energy Association

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Fuel Cells and Wind

Fuel cells generate electricity using an electrochemical reaction, not combustion, so there are no polluting emissions, only water and heat as by-products. Many fuel cells are fueled with hydrogen, which can be derived from a wide range of sources, both traditional and renewable. This includes wind-powered electrolysis, the process of running electricity through water to generate hydrogen and oxygen. Since a fuel cell produces water as a by-product, it can become a sustainable closed-loop system.

The variable nature of wind lowers the efficiency of wind turbines, but fuel cells can provide base-load power that ensures a facility stays powered during times of low or no wind.

In areas with abundant wind, hydrogen and fuel cells are becoming a viable energy storage option. Power-to-Gas (P2G) projects, where the excess electrical energy can be used to produce hydrogen, are on the rise in Europe, mainly Germany, and many incorporate wind turbines. The hydrogen produced via wind electrolysis can then be injected into existing natural gas pipeline infrastructure, or stored and used at a later time to generate electricity in a stationary fuel cell or used to fuel up fuel cell electric vehicles (FCEVs).

Examples of Wind/Fuel Cell Projects

Several wind-to-hydrogen FCEV refueling stations have been demonstrated over the years, including one in Hempstead, New York. There are currently many of wind-to-hydrogen projects, P2G, and co-located wind and fuel cell installations operating around world, opening up new opportunities for the wind industry.

Adobe Systems - At its corporate headquarters in San Jose, California, Adobe combined 1.2 megawatts (MW) of fuel cells with 24 MW of wind turbines to provide about 30% of the electricity needed to power the site's three office towers and more than 90,000 m^2 of office space. The fuel cells are installed on the 5th floor patio of the West Tower. Adobe purchases renewable biogas from a Pennsylvania landfill to offset the natural gas the fuel cells use, making the system virtually carbon neutral.

National Renewable Energy Laboratory (NREL) - NREL, and partner Xcel Energy, oversees a wind-to-hydrogen (Wind2H2) demonstration project in Boulder, Colorado, that links wind turbines and photovoltaic (PV) arrays to electrolyzer stacks, to electrolyze water. The resulting hydrogen is stored for later use at the site's hydrogen fueling station to fuel FCEVs or converted back to electricity via a hydrogen internal combustion engine or fuel cell and fed to the utility grid during peak-demand hours.

Wind-to-hydrogen facility at NREL

Southern California Gas - The first P2G project in the United States also launched in April 2015, involving Southern California Gas Company (SoCalGas) testing two electrolyzers to generate hydrogen from a local PV source. The produced hydrogen will then be injected into a simulated natural gas pipeline system at the National Fuel Cell Research Center at the University of California, Irvine.

Japan Wind-to-Hydrogen - In Japan, a wind-to-hydrogen project began in April 2015, near Kabashima Island in Nagasaki Prefecture. Using large wind turbines, the offshore power plant has an output of 2 MW of electricity. The plant transmits wind-generated electricity through a cable running along the seabed to the island, with the surplus electricity used to generate hydrogen for storage, converted into electricity during peak times, or shipped to remote islands to provide continuous, reliable power.

Global P2G Projects - Germany is aggressively pursuing P2G using wind as part of its Energiewende (energy transition) strategy, and other countries and consortiums are following suit.

There are currently P2G demonstrations featuring wind-to-hydrogen in:

Canada - A micro-grid energy storage project in Ontario is replacing a diesel generation system with an electrolyzer to generate hydrogen from surplus wind and a fuel cell for storage.

Denmark - The Power-to-Gas Biological Catalysis (BioCat) Project will use hydrogen made from excess wind power to convert biogas from sewage sludge into cleaner methane gas. A 1 MW water electrolysis plant will be installed at Spildevandscenter Avedøre, one of Denmark's largest wastewater treatment facilities, located in Hvidovre. The hydrogen will be injected into a nearby gas distribution system and the by-products – oxygen and heat – will be recycled onsite in the wastewater treatment process.

P2G project in Grapzow, Germany

Germany -

- City of Herten, consists of an electrolyzer, a hydrogen storage mechanism, and a 50-kW fuel cell power system;
- Mmunicipality of Grapzow, which features a 140 MW (28 turbine) wind farm and a 1 MW electrolysis system;
- City of Falkenhagen, began operation in August 2013. The 2 MW plant uses wind power and an electrolyzer to convert water into hydrogen, which is then injected into the existing regional natural gas transmission system; and
- City of Hamburg, a 1 MW system will use excess wind and solar to generate hydrogen.

Singapore - Installed at Raffles Lighthouse, the system will store renewable energy generated from solar and wind turbine electrolysis from rainwater.

South Yorkshire, UK – The Hydrogen Mini Grid project consists of a 225 kW wind turbine coupled directly to an electrolyzer, 200 kg of hydrogen storage, a hydrogen dispensing unit and a 30 kW fuel cell system. The system is designed so that energy from the wind turbine is used to provide power for some nearby with excess energy being used by the electrolyzer to generate hydrogen gas which is compressed, stored and can be used to fuel FCEVs.