Proton Produces "Green" Hydrogen

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Production of hydrogen from green sources has the potential to be a cost competitive alternative to steam methane reformation or coal gasification, while promising reduced emissions of greenhouse gases. The flexibility of electrolysis offers hydrogen production without greenhouse gas emission when coupled to electricity produced from renewable sources. This is especially conducive to distributed hydrogen generation options where the cost of transporting hydrogen can be prohibitive.

In the United States, 95% of hydrogen production comes from steam reformation of natural gas[1]. While electrolysis makes up a small fraction of hydrogen produced, it uses electrical energy produced by predominantly coal-fired power plants.

The growing concern over the volatility of the petroleum based fuel markets and environmental issues has accelerated the growth in renewable energy markets. Investment in renewable energy reached one-fifth of the approximately $150 billion invested in the conventional power sector globally in 2004[2]. The U.S. wind power fleet alone grew by more than 35%in 2005 for a total capacity of 9,000 MW of capacity[3]. The Global Wind Energy Council (GWEC) estimates are that by 2020 the U.S. wind generating capacity will be 100 GW[4].

In an effort to reduce U.S. dependence on oil from foreign sources, the Department of Energy's Hydrogen Fuel Initiative has focused on hydrogen powered fuel cell vehicles and the supporting infrastructure as a viable alternative by the year 2020. The most recent DOE distributed hydrogen model calls for an electrolyzer capable of 1500 kg of hydrogen per day[5]. With an efficiency of 75%, this electrolyzer would require nearly 79 MWh of electrical energy per day and power supply requirements of 3.3 MW. Currently, the largest wind turbines made are in the 3 to 5 MW range. Assuming a 25% capacity factor, a nominal 1500 kg/day electrolyzer would require about four 3.5 MW turbines to meet its annual energy requirements.

The intermittency and variability challenges associated with integrating wind energy systems with electrical grids can be addressed using electrolysis. An optimization of the size of the electrolyzer would need to address the relatively high cost of having underutilized hydrogen generation capacity. A target amount of electrical capacity can be split between a grid or micro-grid and an electrolyzer. The electrolyzer can absorb excess energy, up to its rated capacity, to generate hydrogen while helping to smooth out the effects of variability. This is facilitated by the fast response time of electrolysis.

Coupled with a hydrogen fuel cell or ICE generator, a renewable energy based electrolyzer system could achieve a level of dispatchable capacity.[6] Geographic dispersion of the wind turbines within the distributed generation area would help to offset the local lulls and peaks in wind energy while increasing the utilized hydrogen generator capacity[7]. In some instances, it may be practical to introduce a hybrid renewable energy system using solar generated electricity to offset fluctuations in wind energy. An electrolyzer may complement more traditional means to store excess wind energy such as a pumped hydro system or other proven methods with higher round-trip efficiencies but slower response times.

Why do it?

Production of hydrogen from renewable sources within the U.S. has been shown to have the potential to generously exceed the demands currently placed on petroleum by light duty vehicles[5]. As the cost of petroleum and electrical energy produced centrally continues to rise, so do the economic incentives for renewable energy. The escalating concern over pollution and greenhouse gas emissions has already given a boost to decentralized renewable energy sources. Because of the low cost (3 – 5 ¢/kWh) of wind energy, the competitiveness of hydrogen produced by electrolysis is beginning to be realized[8].

Proton Energy Company's PEM electrolysis systems have been sited in renewable based projects and surpassed expectations on performance and reliability for the hydrogen production that was required. The key to meeting future renewable based hydrogen production needs is the development of a larger electrolyzer capable of fully utilizing the megawatt scale input power from large wind turbines.

Notes:

[1] "Hydrogen Production", DOE Hydrogen Program, March 2006.

[2] "Renewables 2005 Global Status Report", REN21 Renewable Energy Policy Network. 2005. Washington, DC: Worldwatch Institute.

[3] "U.S. Wind Industry Ends Most Productive Year, Sustained Growth Expected For At Least Next Two Years", AWEA News Release, January 24, 2006.

[4] "A Blueprint to Achieve 12% of the World's Electricity from Wind Power by 2020", GWEC, WIND FORCE 12.

[5] "Solar and Wind Technologies for Hydrogen Production", Report to Congress, December 2005.

[6] W. Schroeder, "Hydrogen from Electrolysis" August 2003.

[7] "Variability of Wind Power and Other Renewables", International Energy Agency, June 2005.

[8] "An Analysis of Hydrogen Production from Renewable Electricity Sources", National Renewable Energy Laboratory, September 2005.