Simulation of Hydrogen - RE Systems Using Hybrid2

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A decentralized Renewable Energy (RE) system can meet the electric needs of a home while reducing the user's dependence on fossil fuels. However, wind and solar power, two commonly utilized RE components, are both intermittent energy producers. Hydrogen, produced through electrolysis during periods of high wind and solar power production, can be used in a fuel cell as a buffer during periods of low wind velocities and low solar insolation rates.

Hybrid2 is a software package that simulates an integrated energy system using wind, PV, and diesel generators. To avoid the use of fossil fuels in the system, a post-processing program was assembled that models a fuel cell in place of the diesel generators and an electrolyzer as a dump load for power that exceeds the demand. Figure 1 illustrates a possible configuration of a hydrogen based hybrid system. Using site-specific wind, solar, and user load data, a hydrogen-based hybrid system can then be tested and optimized. One major advantage of utilizing a simulation package is that multiple scenarios can be examined before settling with specific component sizes.

Approach:

The performance of a fuel cell system was modeled after a 1kW fuel cell presented by researchers at NTT Building and Facilities, Inc. [1]. The electrolyzer is modeled after the results from Lehman et al. [2]. The behavior of the electrolyzer is such that it will not produce hydrogen proportional to the power consumption if the power available to the electrolyzer is below a critical level. In the post-processing program no hydrogen is produced if the power available is less than a critical percentage of the electrolyzer's rated power. The probabilistic method of simulating the electrolyzer performance in the post-processing program follows the methods outlined in the Hybrid2 theory manual [3].

A preliminary chart of hydrogen storage for a simulated system, over a time period of 2000 hours, that included a 12kW wind turbine, 2.4kW$_p$ of solar panels, a synthesized diurnal load based on a 1kW average, a 5 kW fuel cell, and a 10kW electrolyzer is shown in Figure 2.

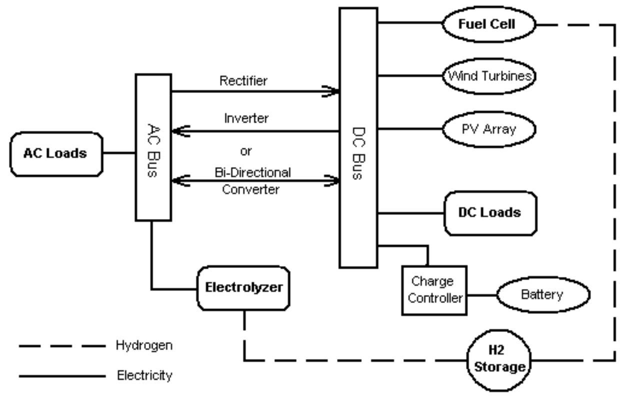

Figure 1 – Hydrogen-based hybrid system layout

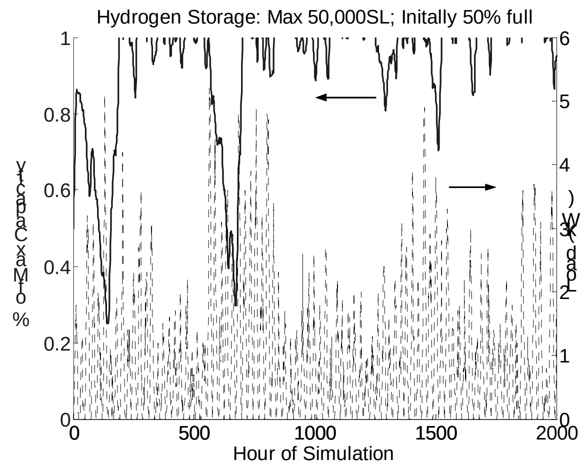

Figure 2 –System simulation: Hydrogen storage

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References:

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