Self-sustainable Hydrogen Fueling Station

OVERVIEW

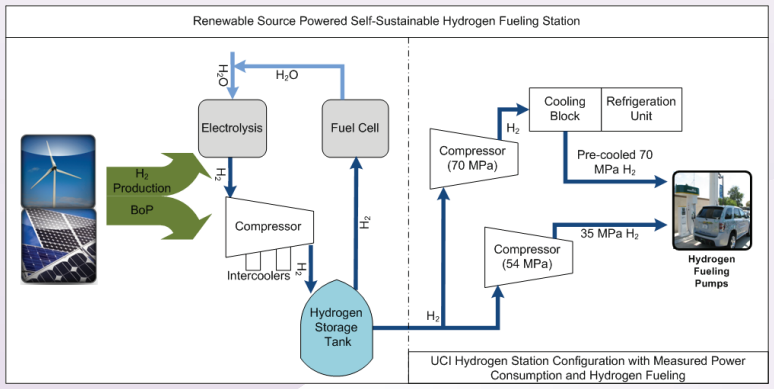
To evaluate the dynamic operation and feasibility of designing and operating a self-sustainable hydrogen fueling station using renewable energy sources, hybrid system models for a hydrogen fueling station using a proton exchange membrane (PEM) electrolyzer and fuel cell have been developed.

GOALS

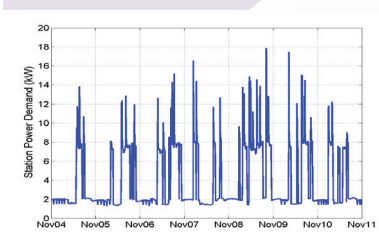
A self-sustainable hydrogen fueling station could provide better interconnections to the existing 'cluster' station approach. This work expands upon current understanding of various wind/solar-hydrogen systems and analyses the dynamics associated with both renewable sources and hydrogen dispatching/fueling operations. This work also addresses design and evaluation of control strategies used to size and operate the renewable hydrogen fueling station as well as providing renewable hydrogen fuel cost estimates.

APPROACH

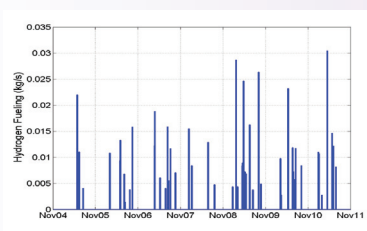
A schematic of the self-sustainable hydrogen fueling station concept using renewable sources that is modeled is presented below. In the self-sustainable hydrogen fueling station, renewable energy from the wind turbine or solar PV is directed to the PEM electrolyzer that electrochemically split water into hydrogen and oxygen gases. The hydrogen is compressed and stored in the storage tank for fueling or supplying power to the station. When power is required to meet the station load demand dynamics, either the stored hydrogen is converted back to electrical energy in a PEM fuel cell, or the renewable power is utilized directly, depending upon renewable power availability and the control strategy implemented.



Schematic of a self-sustainable hydrogen fueling station



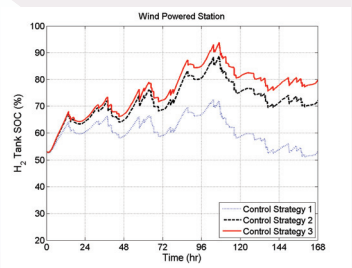
UCI hydrogen station electric load over a week



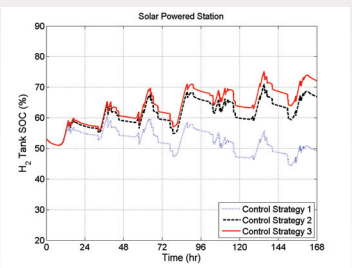
UCI hydrogen station hydrogen dispensed over a week

RESULTS

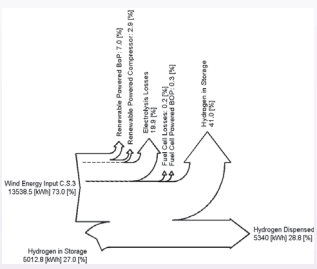
Using fueling and power demand data from an existing public hydrogen station in Irvine, California, dynamic analyses of the self-sustainable station have been carried out. Various control strategies are evaluated and renewable capacity factors, efficiency and other performance characteristics of the station are determined. The simulation results suggest that with careful sizing and system design, a self-sustainable hydrogen fueling station that relies completely upon renewable sources for hydrogen production, storage and dispensing is feasible. Moreover, a cost and sensitivity analysis is carried out to evaluate the levelized hydrogen cost for various station designs.

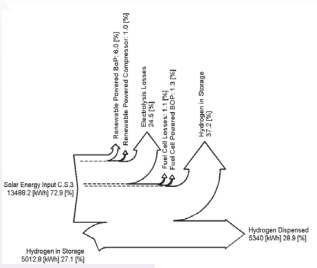


State of charge of the hydrogen storage tank for one week operation, station powered by wind

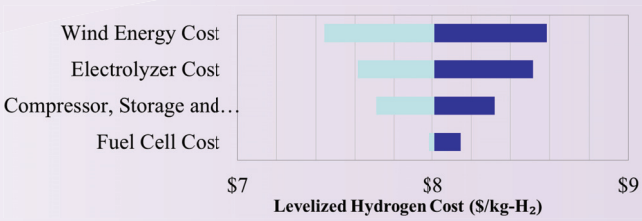


State of charge of the hydrogen storage tank for one week operation, station powered by PV

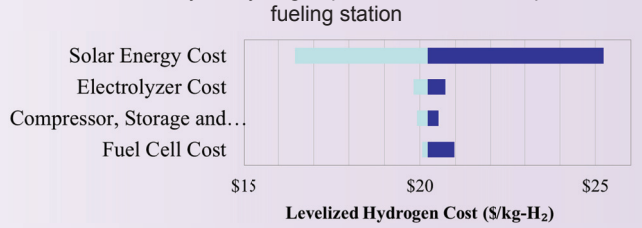




Sankey diagrams of energy fluxes for wind and solar PV powered stations using control strategy 3.



Cost sensitivity for hydrogen produced in the wind powered fueling station



Cost sensitivity for hydrogen produced in the solar PV powered fueling station

PERSONNEL

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