

UC Irvine Hydrogen Station

OVERVIEW

Reliable hydrogen fueling stations will be required for the successful commercialization of fuel cell vehicles. An evolving hydrogen fueling station has been in operation in Irvine, California since 2003, with nearly five years of operation in its current form. The usage of the station has increased from just 1000 kg dispensed in 2007 to over 8000 kg dispensed in 2011 due to greater numbers of fuel cell vehicles in the area. The station regularly operates beyond its design capacity of 25 kg/day and enables fuel cell vehicles to exceed future carbon reduction goals today. Current limitations include a cost of hydrogen of \$15 per kg, net electrical consumption of 5 kWh per kg dispensed, and a need for faster back-to-back vehicle refueling.



UC Irvine Hydrogen Station

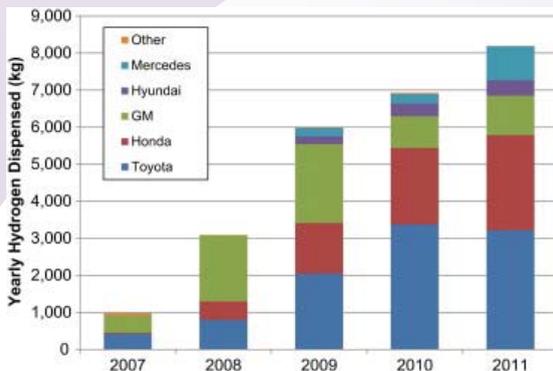
HIGHLIGHTS

- The UC Irvine Hydrogen Station has robustly and safely dispensed 25,000 kg of fuel over the course of 5 years.
- Usage has increased each year as automakers place more hydrogen powered vehicles on southern California roads.
- Average consumption is 0.7 kg/car/day.
- Net station electric use is 5.18 kWh/kg.
- Net cost is \$14.95 per kg of hydrogen.

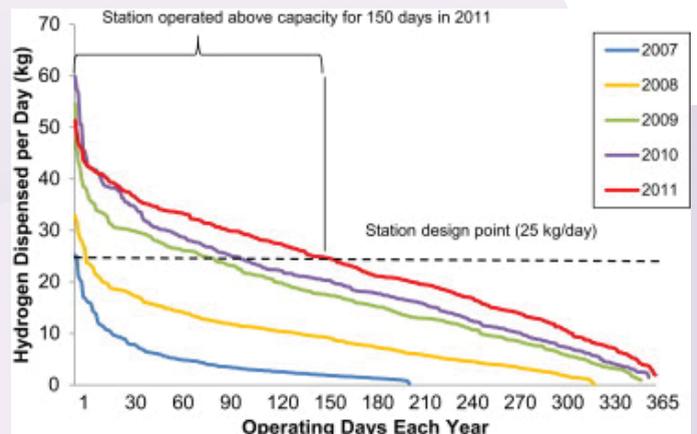
RESULTS

Throughout 2009, 2010 and 2011, the UCI Hydrogen Station experienced heavy use and multiple car back-ups as users waited for fuel. The usage nearly tripled from 2007 to 2008, and doubled from 2008 to 2009. However, the quantity of hydrogen dispensed increase by only 15.5% in 2009, and 18.2% in 2010 because the station has been operating above the design capacity. There has not been a single safety incident in any of the 8976 refuelings performed at the UCI station. Hydrogen is delivered to the UCI station as a liquid and is stored onsite as a liquid in a 1500 gallon (385 kg) insulated vessel. As needed, the liquid is vaporized and compressed by the main compressor to 54 MPa and stored in three equally sized storage tubes capable of holding a combined 52 kg of hydrogen at 54 MPa. Hydrogen vehicles are equipped with onboard storage tanks pressurized to either 35 MPa or 70 MPa, depending on the vintage and the manufacturer. When a 35 MPa vehicle refuels, hydrogen is cascaded directly from the 54 MPa storage tubes to the vehicle's tank.

Two additional steps are required to fill a 70 MPa vehicle. The stored 54 MPa hydrogen is further compressed with a reciprocating piston compressor up to a final pressure of nearly 80 MPa. However, the extra compression and high pressure require that the fuel be cooled substantially in order to accomplish quick vehicle refueling without overheating the vehicle tank. The high pressure hydrogen therefore passes through a heat exchanger (cooling block) which cools the gas just before it enters the vehicle. The cooling block is cooled by an onsite refrigeration unit. The load duration curve below shows the mass of hydrogen dispensed at the station each day for five years, in descending order. As shown, the station was only used 209 days in 2007 compared to 324, 353, 358, and 362 days for 2008, 2009, 2010, and 2011, respectively. 83% of fill times for 35 MPa fueling range between 50 and 100 s per kg, and 63% of 700 bar fill times require between 75 and 100 s per kg.



Hydrogen Dispensed Annually for Each Manufacturer



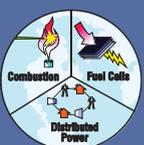
UCI Hydrogen Station Load duration Curve

RECENT PUBLICATIONS/PAPERS

Brown, T., Stephens-Romero, S., & Scott Samuelsen, G. (2012). Quantitative analysis of a successful public hydrogen station. *International Journal of Hydrogen Energy*, 37(17), 12731–12740.

PERSONNEL

Staff: Brendan Shaffer
Principal Investigator: Scott Samuelsen



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