EDITO

Hydrogen Storage: a pathway for leveraging infrastructure development

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To date, we have heard a great deal about hydrogen as a fuel and an energy carrier. Soon, we will be hearing more about hydrogen as an energy storage medium. Hydrogen is, in fact, a flexible way to store energy - short term and long term - for transport and stationary applications, on-grid and off-grid. Use of hydrogen as energy storage not only offers potential as a discreet market (with kW, MW, GW and GW size segments), it also offers value added as a pathway for leveraging infrastructure development, notably in the mass transportation market.

How might this scenario evolve? The answer begins with the global proliferation of installed capacity in renewable energy, especially wind energy, a fluctuating resource. The wind energy installed capacity has grown from 6,600 MW in 1996 (GWEC) to 200,457 GW in 2010 (IEA Wind and GWEC), and strong continued growth is forecast. When electricity demand is low, wind energy (and other renewable energy resources, such as photovoltaics) can be stored as hydrogen. When grid congestion decreases and demand resumes or increases, or when there is a need for peak shaving or load balancing, the stored hydrogen can be converted to electricity to meet demand. Thus, the renewable resource is not lost by curtailing generation; neither is the return on investment diminished or stranded by a lower capacity factor. Storing energy as hydrogen turns renewable energy resources into dispatchable reserves that can be turned on and off by the grid operator, enhancing return on investment. Value-added could also flow from a market for use of stored hydrogen as a fuel, rather than reconverted electricity. Hydrogen storage thus becomes a means for optimizing the harvest of renewable energy.

What system components/configurations could convert and store hydrogen? Electrolysers convert electricity into hydrogen. Fuel cells, internal combustion engines (ICE) and turbines reconvert the hydrogen into electricity. At small-medium scale, hydrogen can be stored as a compressed gas or in metal hydrides. Large scale geologic storage and pipeline storage are also possible.

Where might one install a system that stores hydrogen? There are many locations in both the developed and developing world where storing hydrogen could make eminent sense given the resources available for renewable energy production. Further, there are different type systems that could integrate hydrogen storage: on grid distributed energy systems of various sizes; large central systems; and off grid systems.
The International Energy Agency Hydrogen Implementing Agreement (IEA HIA) Task 29 - Distributed and Community Hydrogen [DISCO H2] is working to develop replicable models and roadmaps for distributed hydrogen systems (<500 KW) that serve urban communities, island and remote areas, and industrial applications on and off-grid).
Distributed systems often exist in low population density areas where investment in large scale central distribution and transmission is constrained by economics. Scotland provides a cogent example of a renewable energy rich environment that is already producing a substantial amount of wind energy to distributed systems for low density (including island!) communities whose demand exceeds supply. Scotland's renewable energy electricity target is100% by 2020. Given these conditions, stored hydrogen could play an important near-term role not only as electricity but also as heat, combined heat and power, and fuel for transport.

While distributed and off-grid systems are important for development of hydrogen storage market, the requirements of large-scale central grids would take the hydrogen storage market to a whole new level. For example, in Denmark (with its 2050 fossil energy free goal) and Germany, large scale use of wind energy could require a TW of stored hydrogen in each case to assure stable electricity supply. Excess wind energy stored as hydrogen could find a market as transportation fuel. The German Ministries of Environment, Transport and Economy have recently initiated a new 200 M Euro R&D program to explore storage opportunities.

The optimization of renewable energy resources and the clean electricity supply offers a compelling argument for hydrogen storage. A revitalized electric grid - (popularly referred to as the "smart grid") should be structured wherever feasible to integrate the complementary energy carrier hydrogen. It could be called the "smart hydrogen-electric grid." One happy day in the future we may well look back and clearly see the important role that hydrogen storage played in the evolution of hydrogen infrastructure.

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