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California Energy Commission
Dockets Office, MS-4
Re: Docket No. 10-ALT-1
1516 Ninth Street
Sacramento, CA 95814-5512

Subject: the docket number 10-ALT-1 and indicate Advisory Committee - Pairing electrolysis facilities with distributed renewable electricity generation a business case for grid stabilization and fuel

Enclosed for review is an assessment of wind-hydrogen systems for light duty vehicles conducted by International Association for Hydrogen Energy, published by Elsevier Ltd.

Abstract reads as follows; a hydrogen system based on wind-generated electricity is presented as a viable component in a hydrogen transition strategy. The strengths of a wind-hydrogen system are exhibited in its modular design, exploitation of existing technology, and utilization of a renewable resource. Specifically, a state level assessment of wind power was conducted in order to determine the ability of individual states to meet light-duty vehicle hydrogen fueling demands while utilizing the proposed system. Additionally, analysis related to existing hydrogen resources is presented in order to form a transition scenario.

Under section 3.4 Regional and state level results, Fig. 4 provides a representation of the individual state's ability to meet internal demand for four scenarios based upon the percentage of theoretical maximum wind-hydrogen generation used for transportation. States within the inner most circle would require only 10% of the theoretical maximum wind-hydrogen generation capability in order to support a complete conversion of the internal LDV fleet. As stated, California is not able to fully (85% internally met) support its vehicle fleet based solely on terrestrial wind; it has vast offshore wind resources and solar resources. In addition, the neighboring states of Oregon, Nevada, and Arizona have excess capability totaling approximately five times the amount of hydrogen California would need to fully meet demands based on 2005 vehicle registrations.

3.5 Economic Analysis Section

Fig. 5 compares the total costs including generation, transportation (if needed) and station costs for three scenarios. Scenario 1 generates 1500kg of hydrogen per day using on site electrolysis and storage and electricity at $0.055/kWh. This scenario is indicative of a standard rural commercial fueling station. Scenario 2 generates 52,300 kg of hydrogen per day using a bank of electrolyzers deployed in a centralized fashion with on site buffer storage and electricity at $0.055/kWh with hydrogen transmission and distribution taking place using a pipeline. The central production size was selected to be indicative of a regional production facility. Scenario 3 is identical to scenario 2; however the electricity price has been changed to $0.022/kWh. The availability of lower priced electricity represents a case for instance where the grid could not accept power generated from a wind farm and in order to maintain a high capacity factor the electricity is utilized to generate hydrogen at the wind farm and then transported via pipeline. The comparison of scenarios 1 and 2 demonstrate that onsite electrolysis is more cost effective for all distances than utilizing a centralized production method and transporting the generated hydrogen via pipelines when the cost of electricity is the same. However, when the cost of electricity is reduced, as in case 3, there exists a range of distances where centralized production with pipeline production is more economical. Based on Fig. 5, it appears that the generation and distribution of hydrogen on a regional basis utilizing excess wind energy provide an interesting concept. The centralized system addresses many current issues such as grid balancing and the buildup of regional networks while addressing environment concerns. Scenario three poses the possibility of seeing clusters of hydrogen fueling stations constructed within an approximate 300km radius of wind farms. Further, if the wind farm and hydrogen station were owned by the same entity the reduced electricity generation profit would be offset by the sale of the generated hydrogen.

Discussion section of report states, combining hydrogen and wind power creates an almost totally renewable non polluting pathway that addresses the perceived drawback of most renewables in general: the fluctuating nature of power generation. In the past, utilities have been reluctant to introduce wind into the generation mix not only due to cost per kilowatt hour, but also because of the additional strain due to the variable generation. In a wind-hydrogen system, electricity can be generated and either fed into the power grid to be used at a distant demand or used to generate hydrogen near the wind farm, from which it could be transported to local fueling stations.

Entire report enclosed for review.

In Europe today, power industry utility companies, in particular those producing electrical power with coal are considering refurbishing their value chain by investing in large capacity electrolyzers for H2 and O2 production.

These utilities are producing electricity and heat mainly from sources such as: lignite & hard coal, nuclear power, gas and hydropower. They see the benefits of increasing the use of renewable power. But as mentioned in the report above, they also see a potential threat to transmission network due to inherent fluctuations in the production capacity of renewable power. It is therefore of interest to them to investigate different routes of how to stabilize the grid and balance electricity supply and demand.

One of the scenarios involves large scale electrolysis. Electrolysers would be used in a centralized location and electric power would be transmitted to them from the wind parks. Electrolysers could also be utilized for production of hydrogen and oxygen from the excess power of coal plants in the periods of low demand.

Resulting hydrogen would be used in the most economic way: Resource in Carbon Capture and Usage (CCU) – conversion of CO2 from coal power plants to syngas (CO + H2 – which can be used as raw stock for synthesis of higher hydrocarbons via Fisher-Tropsch), methane or methanol. Feedstock for chemical processes: hydrogenation. Conversion to electric power in the peak periods, energy storage and then sold on the market.

The oxygen could be used as oxy fuel. Oxy-fuel refers to technology that burns oxygen with gaseous fuel. As compared to air, which contains 20.95% oxygen, higher temperatures can be reached using pure oxygen. Approximately the same total energy is produced when burning a fuel with oxygen as compared to with air; the difference is the lack of temperature diluting inert gases. The most common fuel burned in a torch with oxygen is acetylene; even though it presents special handling problems, it has the greatest heat output. The process has also been proposed as a method of capturing carbon dioxide from coal-fired electric power plants because the output flue gases from combustion in oxygen as opposed to air have a higher carbon dioxide content fraction.

A combination of different approaches above could make an interesting business case and enable commercialization of various by-products including H2 for fuel. Utility providers using predominantly coal, beginning to invest in renewables, who are under pressure because of CO2, and ideally are close to chemical plants using H2 would be a good target.

Hydrogen Technologies is a world-leading supplier of water electrolysis equipment and complete hydrogen generation units for industrial applications, hydrogen fueling stations and distributed energy systems. Hydrogen Technologies is a subsidiary of Statoil, a Norwegian Oil & Energy company with some 29.500 employees in 40 countries worldwide.

Enclosures

An assessment of wind-hydrogen systems for light duty vehicles, 2009 International Association for Hydrogen Energy.

The Economics of Wind Energy, Clipper.

Hydrogen Technologies Brochure

Best regards,

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