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Power-to-Gas plant in Falkenhagen, Germany

Image courtesy of Hydrogenics

Power-to-Gas Energy Storage and Transportation

In the latest edition of our newsletter, LRI interviewed Mark Kammerer and Denis Thomas, Sales Director and International Business Development Manager Power-to-Gas respectively, from Hydrogenics, a leading designer, manufacturer builder and installer of hydrogen systems and pioneer of “Power-to-Gas”. “Power-to-Gas” is an innovative way to store and transport energy using electrolysis and is likely to play an important role in maximising energy return from renewable energy investments.

Hydrogenics

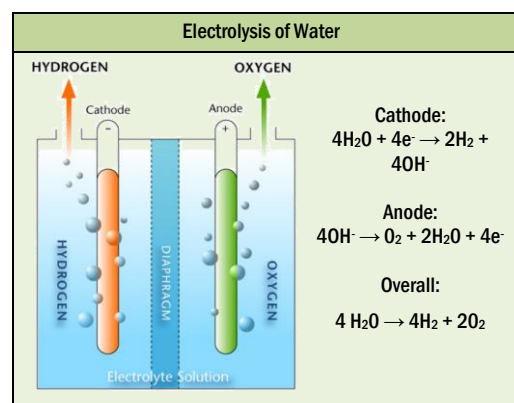
The Electrolyzer Corporation started the construction and commercialization of atmospheric electrolyzers in 1948 and after various mergers and acquisitions (Stuart Energy, Vandenberg Hydrogen Systems), Hydrogenics established itself in 2005 as the world leader in hydrogen technologies. With over 160 full time employees and a number of key projects internationally, Hydrogenics now has offices in North America, Europe and Asia.

Hydrogenics develops, manufactures and installs electrolyzers and hydrogen fuel cells for a range of applications and is one of the few companies worldwide producing both technologies under one roof. They produce electrolyzers for hydrogen generation for industrial processes and hydrogen refuelling stations. They also have fuel cell technology for both mobile and stationary applications, including electric vehicles, freestanding electrical power plants and uninterruptible power supply systems. In recent years Hydrogenics has emerged as a pioneer of an innovative energy conversion and storage solution using water electrolysis known as ‘Power-to-Gas’.

Power-to-Gas

Hydrogen gas can be produced from the electrolysis of water. Current electrolyser technology converts energy at 70-80% efficiency (based on the Higher Heating Value of Hydrogen) and the hydrogen produced has purity of up to 99.999. The only by-product is oxygen. In more practical terms this means:

- 1 kg of H₂ can be produced by approximately 57 kWh of electrical energy.
- 1 kg of H₂ will allow you to drive fuel cell powered electric vehicle approximately 100km.
- 1kg of H₂ has the equivalent energy content of 3.77 L of petrol.



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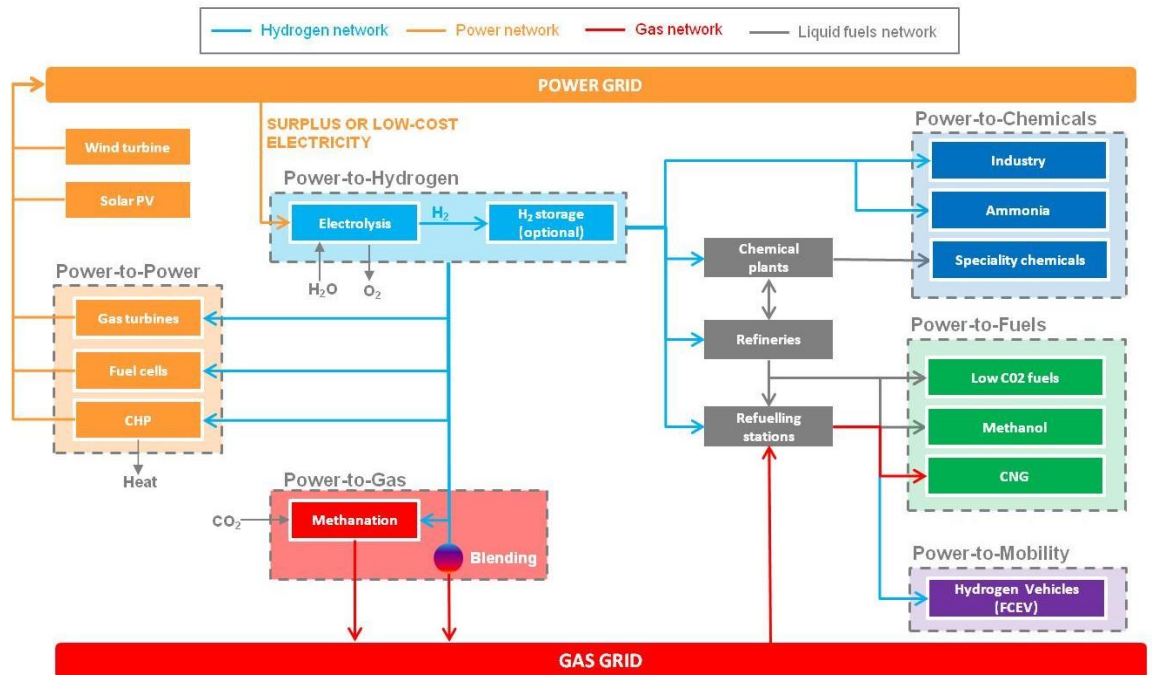
The Tidal and Wave Energy Outlook: Opportunities and Challenges

LRI London Research International

The Tidal and Wave Energy Outlook
Opportunities and Challenges



A comprehensive industry analysis with company case studies and commercial and investment outlook. This invaluable resource features the most up to date information available for investors, developers and those interested in the Marine energy sector.



Power-to-Gas Schematic Overview

Image courtesy of

Hydrogen gas produced from electrolysis is used in numerous industrial applications. An outline of hydrogen production and storage is shown on the schematic above. One such application is storage and transportation of energy in the natural gas grid for later use, so called power-to-gas.

In some countries, it is possible today to inject directly a limited quantity of hydrogen (<10% percentage by volume) in the natural gas grid. Alternatively the gas can first undergo methanation process, combining with carbon dioxide to produce methane before being fed into the natural gas grid. This additional methanation step enables simple and very large storage in the existing natural gas infrastructure.

Market

In today's market, creating value from converting purchased electrical energy into hydrogen gas and reselling on the natural gas grid market is complex and not yet economical given the existing regulatory framework in most countries. Exceptions can occur when electricity costs become close to zero; electricity costs usually make up approximately 70% of total production costs, including the grid fees and levies. One of the greatest market opportunities exists in collaborations with power generators and the storage of surplus electricity sourced directly from renewable power installations.

Power production from intermittent renewable power sources demands constant management and at times of low demands there is potential for a surplus of electricity to be produced. Rather than being a burden on the power grid, the surplus electricity is stored and can be reused in its hydrogen form. Given the growing amount of renewable electricity production around the world, the ability to store this electricity is becoming an important factor in maximising return on investment.

Injecting hydrogen into the natural gas grid takes advantage of existing infrastructure and provides very large storage and long distance transportation capabilities. Subsequently it can be reused in applications such as space heating, industrial processes, mobility, and even power generation. The ancillary equipment required for hydrogen production and injection is also well established within process industries.

Current Applications

Among others, Hydrogenics is currently running power-to-gas projects across Europe; in Germany, Belgium, Denmark and Italy.

In Focus

Falkenhagen, Germany: A 2MW power-to-gas plant has been built and is operated by E.ON, with Hydrogenics alkaline electrolyser technology. The Falkenhagen unit uses renewable-source electricity to power electrolysis, producing hydrogen which is injected into the natural gas transmission system. The two megawatt capacity enables the production of 360 cubic meters of hydrogen per hour. E.ON delivers some of Falkenhagen's hydrogen output its project partner, Swissgas AG, and makes some available to its residential customers through a product called "E.ON WindGas".

Falkenhagen Specifications	
Electrolysers	6 X HySTAT® 60 (Alkaline)
Capacity	2 MW
H ₂ Production	360 Nm ³ /h (780 kg/day)
H ₂ Supply Pressure	55 bar

Hamburg, Germany: A 1MW power-to-gas plant is currently in development in partnership with E.ON and completion is expected in the first quarter of 2015. This system uses a single PEM electrolyser stack which represents the world first 1MW singular stack within PEM technology. Hydrogenics hopes that this project will serve to validate this technology in a real environment (with fluctuating input from wind energy) and serve as a building block for future, larger systems expected in the range of 10-100MW.

PEM Electrolyser Technology

Hydrogenics uses two types of electrolysis to produce hydrogen; Alkaline electrolysis, which is a mature technology, and Polymer Electrolyte Membrane (PEM) electrolysis, where notable developments are taking place.

Hydrogenics has developed single stack PEM electrolysers which have improved efficiencies over their alkaline counterparts and are significantly smaller in size. The smaller size of the systems will improve accessibility, particularly with use in fuelling stations in mind. It also means less materials and ancillary equipment is required, leading to lower costs for large projects.

Alternative Uses for Produced Hydrogen

Utilising the hydrogen directly, as opposed to storage and transportation in the natural gas grid, limits additional capital expenditure and reduces losses from further energy conversions.

There is steady demand for hydrogen from traditional hydrogen consuming industries such as the glass, metallurgical and petrochemical industries. Demand from the mobility market is very small, though large growth is expected in coming years.

Hydrogenics is also involved in a flexible green methanol production project called "MefCO₂", funded by EU Horizon 2020 to produce synthetic methanol from hydrogen gas and carbon dioxide. Production is planned for 2016-2017.

Market Outlook

Hydrogenics is well established in the industrial hydrogen market. Their participation in power-to-gas is viewed as a supplementary to core business and this enables flexibility in their approach to the developing market.

There are high hopes for the hydrogen economy and big changes expected in the next 2-5 years. Well respected names, like Siemens, have hastened their movement into the market and are helping to give power-to-gas credibility.

The main barrier presently is regulation; appropriate regulation for the hydrogen industry is currently lacking. However, this is changing at an ever increasing rate and industry standards are being currently being developed.

There is currently no certification mechanism in place for green hydrogen or biomethanol produced from hydrogen. Certification and the support for hydrogen based fuels such as a biomethane and biomethanol from green hydrogen production could attract premium to such products and increase hydrogen production demand. Hydrogenics feels as though a certification mechanism would be needed for hydrogen in Europe.

In the medium term, the demand in the mobility market is expected to increase. High profile developments such as the hydrogen fuel cell powered vehicles, Hyundai ix35, Honda FCX Clarity and Toyota Mirai, will increase demand for hydrogen. Hydrogenics is involved in a number of hydrogen refuelling station projects in the EU.

In the field of hydrogen production, other companies will continue to offer stiff competition to Hydrogenics. However, Hydrogenics feel that their single stack PEM technology gives them a competitive advantage, particularly because of the technology's modularity and potential for application in very large hydrogen production systems. Given the potential for large scale growth in the hydrogen economy, opportunities for start-ups and smaller businesses to find market penetration in a more mature marketplace are certain.

Summary

- Hydrogenics are a leading provider of hydrogen energy solutions.
- Power-to-Gas offers energy storage and transportation solution for intermittent energy sources.
- Collaboration with leading utilities across Europe has already begun.
- World first 1MW single stack PEM electrolyser is an important step towards affordable renewable hydrogen.

For More Information on Hydrogenics

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