Power-to-Gas
Balancing the energy system with green fuel

European Engine Power Plants Association EUGINE

Due to the ongoing energy transition, increasing shares of variable renewable energy sources (V-RES) only producing electricity when the sun is shining or the wind is blowing are being introduced into the energy mix. This variability generates an increasing challenge: how to balance tomorrow's energy system in a secure, cost-efficient and sustainable way. Power-to-Gas in combination with flexible engine power plants can be the answer to this question. While overproduction is balanced by generating green gas, supply gaps are covered by fast starting gas-engines burning the green gas when needed.

1. What is Power-to-Gas?

Excess electricity generated by variable renewable energy sources (wind & solar) is used to split water (H_2O) into hydrogen (H_2) and oxygen (O_2). This proven chemical process known as 'electrolysis' has been used for more than two centuries. This renewable hydrogen can be used directly for various applications (power generation, mobility, industry) or can be fed in existing gas grids where it is mixed with natural gas.

Via 'methanation', a chemical process combining the hydrogen (H_2) with carbon monoxide (CO), synthetic natural gas (SNG) (CH_4), a gas very similar to the traditional natural gas, can be generated.

2. A game changer?

Power-to-Gas could become a game changer, as it represents a very promising systemic solution to integrate V-RES and sustainably balance the energy system:

- V-RES overproduction
  Excess electricity from V-RES is not anymore curtailed but transformed into gas and stored into existing gas grids
- Energy storage
  It is much easier to store gas than electricity: duration and geographical constraints are removed and long-term & large-scale energy storage becomes feasible. Furthermore the existing gas infrastructure can be used as a large storage system.
- V-RES underproduction
  Green gases, be it hydrogen (carbon-free) or SNG (carbon-neutral), may be burnt in gas-fired power plants to produce the electricity (and heat) needed.

The energy system becomes much more efficient, sustainable, connected, flexible and innovative.

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- Power-to-Gas is the transformation (by electrolysis) of electricity into renewable gas
- Hydrogen may be further transformed (by methanation) into synthetic natural gas
- Both hydrogen and synthetic natural gas can be used in gas-fired engine power plants to produce electricity and heat
- Power-to-Gas in combination with gas engines solves the challenges related to both over- and under-production of electricity by variable renewables

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EUGINE is the centre of knowledge for engine power plant technology and electricity market design. Its members are the leading European manufacturers of engine power plants and their key components. EUGINE works with EU and national institutions in order to help the European electricity system to meet the challenges of today and tomorrow.

3. Case studies

A number of recent projects show a strong commitment from economic players to developing Power-to-Gas.

3.1. BioCatProject (DK)

The 'P2G-BioCat' project (1 MW electrolyser) is running from 2014 to the end of 2016, at the wastewater treatment plant Avedøre, south of Copenhagen, in Denmark. This Power-to-Gas plant transforms excess electricity from renewables into hydrogen and mixes it with carbon dioxide from an adjacent biogas plant to create SNG. This carbon-neutral gas is finally injected and stored in the local gas distribution grid. This plant usually starts drawing power from the electricity grid and producing green gas when power prices are low (i.e. case of power/demand imbalance). It is able to provide 'tertiary reserve' and thus to balance the grid.

3.2. Haßfurt (DE)

A brand-new Power-to-Gas plant (1,25 MW electrolyser) was inaugurated on 21 October 2016 in Haßfurt, in Germany, by 'Greenpeace Energy eG'.

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The green energy provider is committed to showcasing advantages of Power-to-Gas: its plant is contributing to balancing the electricity grid by transforming excess wind and solar energy into hydrogen which is directly fed into:

- on one side, the gas grid (5% to 10% hydrogen, 90% to 95% natural gas)
- on the other side, an engine power plant (10% hydrogen, 90% natural gas) located in a nearby malthouse.

3.3. Jupiter1000 (FR)

As from 2018, a Power-to-Gas plant (1 MW electrolysers) located in the harbor of Marseille, in France, will transform electricity into synthetic natural gas. Unlike the BioCat project, the Jupiter1000 project will use carbon dioxide from a nearby steel factory and feed the SNG directly into the gas transmission grid.

4. Outlook

According to recent studies[*)], the roll-out of the Power-to-Gas technology will be key to making the energy transition a success while keeping costs under control.

The green gases generated by this promising technology may be used in different types of gas-fired power plants, including engine power plants. Being a flexible technology, engines can run on various types of gaseous fuels, including hydrogen and SNG, and transform them very efficiently into electricity and heat.

However, while SNG can easily replace natural gas as a fuel for power generation, hydrogen is a more complex gas. It has to either be blended with natural gas (with a cap) or to be burnt in engines which were specifically designed to run on hydrogen.

Engine power plants are anyway ready to team-up with green gases from Power-to-Gas installations to balance the energy system, in a secure, cost-efficient and sustainable way.

[*)] Energy Brainpool, OTH, FENES: Bedeutung und Notwendigkeit von Windgas für die Energiewende in Deutschland, im Auftrag von Greenpeace Energy eG, August 2015
Energy Brainpool: Minimaler Bedarf an langfristiger Flexibilität im Stromsystem bis 2050, im Auftrag von Greenpeace Energy eG, 24 Februar 2016

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