POWER-TO-GAS IS INEVITABLE FOR FURTHER GROWTH IN RENEWABLE ENERGY: THE BUSINESS CASE STILL A CHALLENGE

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The pan-European energy system is faced with the enormous challenge of lowering carbon emissions from electricity supply to nearly zero by 2050. Renewable energy sources (RES) supply, mainly from wind and solar power, are on a rise to meet these goals. The variable nature of renewable energy sources makes it however increasingly difficult to match electricity production and demand. There is an increasing need for providing local flexibility on time-basis between milliseconds to seasons to ensure balance in the power system. This causes stress on grids from growing production capacity and fluctuating supply. In addition, geographical between renewable electricity resources (e.g. offshore wind fields) and demand put an additional strain to the electric grid.

Previously, it was easier to predict times of peak load on the system; whereas now it is becoming ever harder to manage the load. Unlike other technologies, Power-to-Gas can provide that flexibility by managing peak supply and long distance, massive transfer of energy and may therefore be considered as inevitable for further growth in renewable energy.

Power-to-Gas is a compelling concept that entails the conversion of renewable electricity into hydrogen via electrolysis. The gaseous products of Power-to-Gas are to enhance decarbonisation of the gas sector, mobility sector and chemical industry. Power-to-gas is technologically ready for commercial exploitation, however the economical exploitability is not always sufficient.

The business case challenge

The economical exploitability for Power-to-Gas depends both on the market conditions for the different applications of power-to-gas products, as well as on costs associated for power-to-gas in comparison to other flexibility-providing solutions. Depending on the local circumstances and market conditions, Power-to-Gas may be bankable today. Nevertheless, for many of the functionalities of Power-to-Gas there is not yet a positive business case. Significant cost reductions and efficiency improvements are required to benefit the rentability and enable its deployment on commercial scale. Alternatively, the optimal use of local available revenue streams is required.

In general, for a business case assessment both detailed cost and revenue assessment is required. The Power-to-Gas is influenced by many factors and have a high complexity level, due to the sector coupling character of the concept. For Power-to-gas, a positive business case may summarize as follows:

$$\text{Power price} + \text{CAPEX} + \text{OPEX} < \text{products value}$$

Or more precise:

$$PP + EL + EQ + O\&M + PF < PMV + GS + HT + OX$$

In this formula, the costs generating factors are: Power price (PP) including the electricity price and grid tariff, Electrolyser costs (EL), Equipment costs (EQ), Operations & Maintenance costs (O&M) and Project Financing costs (PF). The revenue generating factors include: product market value of hydrogen/methane (PMV), provided flexibility or grid services (GS), heat benefits (HT) and oxygen benefits (OX).

After DNV GL's Macro-Economic Business Cases Assessment for Power-to-Gas Applications (2014), the following (figure 1) generic outcomes can be obtained for Power-to-Hydrogen costs for a 100 MW power level, 1600 annual operating hours, a power price of 30 EUR/MW and a depreciation period of 12 years. In figure 1, 70% of the costs are operational costs and related to the electricity price. In each Power-to-Gas project it should be considered to identify and access the best technologies for the business case and its purpose to ensure the lowest CAPEX. However, this CAPEX is less than half of the costs of the business case.

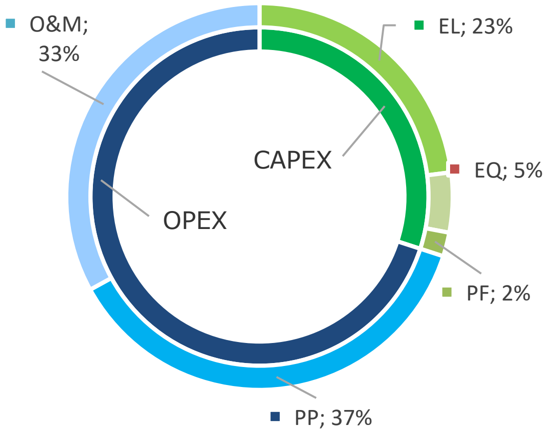

Figure 1: Costs generating factors for Power-to-Hydrogen business case

Following the Business Cases Assessment scenarios, the highest revenues may be obtained from various grid flexibility services. In addition to the production of hydrogen, additional revenues may be obtained from heat and oxygen.

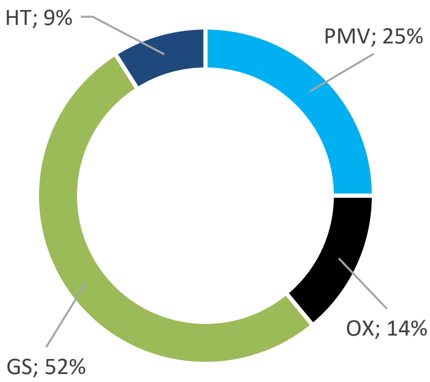

Figure 2: Revenue generating factors for Power-to-Hydrogen business case

The business case for Power-to-Gas, however given some general number in abovementioned figures, might strongly be affected by the local market conditions, the availability to infrastructures and the (country-specific) regulatory framework conditions. By these means, IEA (2018) expects electricity prices remain flat in the period towards 2050, with falling generation costs offset by increasing transmission (24%) and distribution costs (25%) reflecting the need to replace aging infrastructure and upgrade the grid to accommodate changing reliability standards. Therefore, the pace of the energy transition has a large impact on electricity price developments, since the pace of infrastructure development is key factor in this. Stability and long-term perspective in the regulatory framework for stimulating investments in Power-to-Gas is therefore an absolute requirement.

Example project:

Eoly (Colruyt Group Energy), Fluxys, and Parkwind, have announced late April 2018 to join forces to explore an industrial-scale power-to-gas installation. The power-to-gas installation will convert green electricity into green hydrogen that can be transported and stored in the existing natural gas infrastructure.

Unlike demonstration projects elsewhere in Europe, Eoly, Parkwind and Fluxys consider to realize one of the first industrial-scale power-to-gas facilities in Belgium of around 25 MW.

Comparative technologies

The economics of Power-to-Gas in comparison to other electricity storage technologies is only relevant when considering the amount of cycles that the technology can last in relation to the amount of cycles needed, because this determines its specific costs (e.g. €/MWh's) and its lifetime. Case specific analysis should determine the amount of cycles requested and the suitable technologies in that case. Solely focusing on investment costs, Power-to-Gas has many cheaper alternatives, however these are either applicable in small power ranges (e.g. batteries) or bound to geographical or location specific circumstances (e.g. pumped hydro storages). There is however no 100% alternative solution for providing long-term seasonal storage, as PtG delivers.

Electrolysers cost reduction potential

The capital costs for Power-to-Gas are mostly based on the costs of the electrolyser.

Cost reductions of electrolyser may be achieved by a higher market uptake, economy of scale and the associated improvement of the supply chain. This allows product standardization and optimization.

As special feature, the developments in hydrogen application in fuel cells stimulates the development in electrolysis, since synergies in the technology and in logistics apply.

Example project

MicrobEnergy GmbH, a member of the Viessmann Group, operates a fully automated Power-to-Gas with biological methanation demonstration site in Allendorf, Germany, since 2015. The site is successfully certified and is ready for upscaling.

Mitigating financial investment risks

Implementation of new technology introduces uncertainties that imply a risk for its developers, manufacturers, vendors, operators and end-users. Concepts with well-known and proven technologies are often preferred over solutions with elements of non-proven technology, even if the latter provides significant operational improvement or cost-efficiency. With the current status of Power-to-Gas technologies, investors take a risk that their investment might not return within the envisioned period. In order to abate investors' and policy-makers' uncertainties in adopting power-to-gas as an energy transition enabler, testing and demonstration of grid-integrated full-scale Power-to-Gas systems in operational real life environments is the first next step that needs to be taken. Since 2012 there has been a steep increase in the number of pilot plants. Currently over 45 Power-to-Gas plants have been realized or are about to be commissioned in Europe, all having a strong research and pilot character.

Increasing need for PtG demonstrations

Technology demonstration enables the further upgrade of technology maturity, needed to facilitate the implementation of power-to-gas and improved profitability. Technology demonstration gives investors and potential operators reliable information about the technology and helps them mitigating investment and technology-related risks. This, subsequently, enables Power-to-Gas projects to well-accepted standards and accelerates realization of market developments.

Harvesting the technology's potential

The European Power to Gas Platform acknowledges that technology demonstration is crucial for further improvement of Power-to-Gas on the technology maturity, for managing investor's risk and thus for harvesting the technology's potential to enhance the energy transition and realize EU's RES ambitions.

About The Platform

Established in 2012, the European Power to Gas Platform is a joint body, based on an integrated network of stakeholders, which aims to explore the viability of power-to-gas in European countries. The Platform takes an independent position when pursuing its objective: the Platform aims to present unbiased data and views, and does not for instance promote technologies. The Platform actively involves their stakeholders in exploring the possibilities for power-to-gas to line them up for supporting R&D and demonstration projects.

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