Power-to-Gas: A framework for companies to support investment decisions

Roland Maximilian Happach: Institute for Diversity Studies in Engineering, University of Stuttgart,
Pfaffenwaldring 9, 70569 Stuttgart, Germany
Phone:+49 (0)711 685 60702, e-mail: maximilian.happach@ids.uni-stuttgart.de
Meike Tilebein: Institute for Diversity Studies in Engineering, University of Stuttgart,
Pfaffenwaldring 9, 70569 Stuttgart, Germany
Phone:+49 (0)711 685 60700, e-mail: meike.tilebein@ids.uni-stuttgart.de

Overview

Having a large share of renewable energy generation might bear some risks to economies. The oscillation resulting from the volatile energy generation challenges a stable and reliable energy supply which is crucial for an economy with its different industries and companies. The power system therefore needs to balance generation excess supply and shortages. This challenge has led to an ongoing discussion about the security of supply in renewable energy generation scenarios. One of the insights from this discussion is that storage technologies play a key role regarding stable energy supply (e.g. Wassermann, Reeg and Nienhaus 2015; Schill 2014).

Generally, energy concepts, technologies and policies are field of and subject to governmental decisions and therefore take a holistic perspective. The German Energiewende is a prime example how legislature supported the diffusion of certain technologies like photovoltaics. Yet, such global governmental decisions about energy aspects have also impact on the more local levels of private households and companies. For companies, not only legislation, but also technology readiness and availability influence decisions on their specific energy strategy. In the past, for example, companies that are highly dependent on energy invested into energy technology like combined heat and power (CHP) plants, especially in energy-intensive industries like automotive industry, chemical industry, paper and steel producers and refinieries (van Oostvoorn 2003).

Power-to-Gas is a storage technology using electricity for hydrogen and methane production. It is a large-scale long-term storage using the natural gas network. Advocates claim power-to-gas to be a promising technology for secure energy supply and autarchy (Brunner, Michaelis and Möst 2015; Lehner et al. 2014). Its low efficiency and the high investment cost, in contrary, seem to hinder the diffusion of the technology (Brunner, Michaelis and Möst 2015; Michaelis and Genoese 2015). Previous analysis showed that power-to-gas might play an important role without discussing actors that become active in using the technology. However, there are first pilot projects by companies who might adopt this technology for their specific energy strategy. With ongoing scientific discussion, scholars identify more and more influencing factors that support or hinder a diffusion of the power-to-gas technology.

The paper has two primary goals:

1. Assessing the capability of P2G together with identifying other drivers and obstacles to the adoption of P2G technology in a company's external environments
2. Elaborating a framework to identify key factors for evaluation for the investment decision into power-to-gas for companies in Germany combining a company's external and internal perspectives

This paper provides a first step towards identifying companies that might invest in power-to-gas as a technology for energy storage on company level.

Methods

The analysis is based on a comprehensive literature review and structures the external analysis according to the PESTLE-framework that is commonly applied in companies' strategy processes. This categorization presents a company's external view onto the technology and summarizes the static key factors influencing the development and diffusion of power-to-gas technology, thus influencing a company's investment decision. In a second step, the external perspective is complemented by a company's internal perspective. By applying the strategic approach of the resource-based view on companies, like e.g. energy-extensive companies, energy producers, transmission system operators etc., the framework identifies tangible and intangible resources influencing the investment decision. The combination of external and internal decision factors lead to the description of company profiles that are more likely to invest in the P2G technology based on the factors analysed (in the German market). The paper concludes with a discussion about interdependencies of the decision factors.

Results

The framework presented in this paper provides a first step towards an indepth investment analysis for companies considering the integration of P2G technology in their individual energy strategy. Yet, we conclude that the framework should be developed further in different aspects: First, no quantitative analysis was conducted. Second, the framework does not capture causal relations between the identified factors as well as the strength of the interdependencies and respective dynamics. We argue for example that reaching the German government's goal of 50% renewable energy sources as a legal factor might lead to lower/no subsidies into renewable energy production. This, in turn, may decrease the pace of diffusion of renewable energy production technologies and therefore lower the need for storage technologies, even though the oscillations within the energy supply might not have been fully discovered because of production delays. Furthermore, energy storage technologies compete with each other – the marginal benefit of each unit of capacity decreases by every further installed unit of capacity. This effects needs quantification in order to identify sensitive factors. Nevertheless, the framework presented in this paper provides a easy-to-use starting point for companies in order to decide whether or not the P2G technology provides a benefit for the company's activities.

Conclusions

This paper provides a first step towards a systematic decision support for companies planning to invest into the power-to-gas technology. The framework is easy-to-use and presents a holistic approach for information gathering. It identifiys key factors that influence the attractiveness of the power-to-gas technology. However, it does not include investment calculations since interdependencies between the factors are not quantified. Capital budgeting and investment decisions will need more quantitative analysis. However, the framework presents the first step towards such quantitative analysis with simulation and delivers the groundwork for indepth scenario-based investment decisions for companies in Germany.

References

Brunner, C., Michaelis, J., Möst, D. (2015): Competitiveness of Different Operational Concepts for Power-to-Gas in Future Energy Systems, in: Zeitschrift für Energiewirtschaft Vol. 39, pp. 275-293.

Lehner, M., Tichler, R., Steinmüller, H., Koppe, M. (2014): Power-to-Gas: Technology and Business Models, Springer: Heidelberg.

Michaelis, J., Genoese, F. (2015): Power-to-Gas, in: Wietschel, M., Ullrich, S., Markewitz, P., Schulte, F., Genoese, F. (eds.) (2015): Energietechnologien der Zukunft: Erzeugung, Speicherung, Effizienz und Netze. Springer Vieweg: Wiesbaden, pp. 229-244.

Schill, W.-P. (2014): Residual load, renewable surplus generation and storage requirements in Germany, in: Energy Policy Vol. 73 pp. 65-79.

Van Oostvoorn, F., (2003): CHP statistics and impacts of the gas directive on the future development of CHP in Europe. Petten, Energy research Centre of the Netherlands.

Wassermann, S., Reeg, M., Nienhaus, K. (2015): Current challenges of Germany's energy transition project and competing strategies of challengers and incumbents: The case of direct marketing of electricity from renewable energy sources, in: Energy Policy Vol. 76, pp. 66-75.