Robert Tichler

MACROECONOMIC EFFECTS OF THE ENERGY STORAGE SYSTEM POWER-TO-GAS

Dr: Robert Tichler, Energieinstitut an der Johannes Kepler Universität Linz;
Altenberger Straße 69, 4040 Linz, Austria
tel. +43 70 2468 5659; e-mail: tichler@energieinstitut-linz.at;

Overview

The paper focuses on the macroeconomic dimension of the relatively new energy storage system 'power-to-gas'. Power-to-gas means primarily an energy storage system, where volatile electricity production is stored by converting water to hydrogen within a dynamic electrolyzer. In addition, hydrogen can be converted with an addition of carbon dioxide to methane – this is also called 'power-to-gas'. The economic dimension can be defined as quite complex due to the fact that power-to-gas offers significant benefits to the whole energy system in excess to the storage role. An economic analysis of power-to-gas requires not only business analysis but also comprehensive macroeconomic and systemic analysis. Only the combination of those two approaches offers an all-embracing method for statements on economic characteristics of power-to-gas. As a consequence, the paper shows the systemic and macro-economic impacts of the new flexible energy storage power-to-gas with special focus on the context of new possibilities for energy transport, of a greening of vehicle fuels, of carbon capture and utilization and of the storage usage itself.

The environmental and energy objectives of increased integration of renewable energy into the present energy sector - and in particular in the production of electricity - generates new challenges to economies, especially in providing a high level of supply security. This challenge results in particular from strong fluctuations in the supply of renewable energy from volatile sources as wind and solar power. In consequence, as the share of these energies increases, a balance between power surpluses during periods of high levels of generation and periods of shortfalls is necessary. Energy storage systems will play a key role providing an integration of renewable energy sources with volatile production structures in addition to optimized power management. The power-to-gas technology will be an important part in future storage portfolios, because long term storage as well as shifts in capacity between energy networks (from power grid to gas grid) can be realized, which offer new possibilities in energy transmission.

Furthermore, power-to-gas systems can solve additional energy and environmental policy challenges presented by the enlargement of the percentage of alternative fuels in the mobility sector. In the long term power-to-gas technology can provide a significant shifting in the use of produced energy out of volatile sources from conventional power usage to dependable usage in the form of methane and hydrogen. The spread reconversion of gas for electricity supply is excluded in this context, due to energetic reasons, because of the related loss of efficiency and increase in costs.

Method

As a matter of fact, technologic developments and characteristics determine the economic characteristics but also vice versa. This is quite more important in cases where the shape of the focused system offers significant space for additional improvements - like in the case of power-to-gas. This gives additional necessity to economic analysis. The paper includes a macroeconomic and systemic analysis of the new and flexible energy storage system power-to-gas. It is illustrated that the power-to-gas system generates a set of parameters that have a benefit for the energy system and for this reason also for the European economy. Power-to-gas plants imply - far in access of direct economic benefits for companies - positive superior effects for the whole energy system and for the national economies. These indirect effects of the implementation of the power-to-gas-plants are analyzed and quantified. The author uses therefore the macroeconometric simulation model "MOVE" for national and for regional applications to detect macroeconomic and energetic effects simultaneously with all secondary effects within the economy.

Results

It can be determined that current issue of the economic viability of the power to gas operation is significantly overshadowed by the unique positive system benefits of the technology. For economic and welfare benefits to be realized power to gas has to be pursued and supported from the public sector. Overall, single economic analysis show that currently a power to gas plant (H2 and CH4) is economically far from being competitive without including indirect effects in terms of systemic and macroeconomic advantages. The power-to-gas technology and systems are at the moment at the beginning of their development (single pilot and demonstration plants have been designed or realized in different sizes). The timing of the development stage of the technology may involve no financial rate of return also due to the economic theory. Because of learning curve effects and economies of scale, the cost of production of new technologies is generally decreasing.

Highly innovative products and services - such as new forms of energy storage – should be adequately provided, with which the many new requirements such as the improved integration of energy from renewable sources can be met. So from a macroeconomic point of view, overall positive effects of certain power-to-gas plants on the indicators GDP, employment, investment and energetic consumption can be detected with specific negative side-effects of higher energy prices. It has to be stated that the realization and operation of power to gas plants leads to a higher gross domestic product as well as higher levels of employment. The greatest pronounced influence on a positive macro-economic result is the substitution of imported energy through domestic energy production, thereby resulting in significant value-added profit and a significant increase in net exports. This is fundamentally supported by the positive investment impulses, of which construction, manufacturing and service companies benefit. As a consequence, the assessment of the macroeconomic impacts of the construction and operation of power to gas plants in Europe shows that triggered multi-round effects are generally positive, although the financial burden has also multiple partially negative effects on earnings.

Conclusions

As a result, a macroeconomic and systemic analysis for the new energy storage system is presented, leading to an approximate evaluation of the future changes of success among a broad range of new technologies. It can be shown, that a macroeconomic and systemic analysis is essential for assessing power-to-gas. The positive macroeconomic effects compete in the short run with high investment costs. As a matter of fact, regulation and public support should be done for a realization of the systemic benefits of power-to-gas.

References

Lehner M., Tichler R., Steinmüller H., Koppe M. (2014) Power-to-Gas: Technology and Business Models, SpringerBriefs in Energy, ISBN 978-3-319-03994-7. *Forthcoming.*

Mueller-Syring G, Köppel W, Mlaker H, Sterner M, Höcher T. Entwicklung von modularen Konzepten zur Erzeugung, Speicherung und Einspeisung von Wasserstoff und Methan ins Erdgasnetz. DVGW-Bericht G 1-07-10, S.124f. Bonn, 2013.

Steinmüller H., Tichler R., Reiter G. et al. (2014) Power to Gas – A systems analysis, Project report for the Austrian Federal Ministry of Science, Research and Economy. (*report only available in German language)*

Tichler R., Lindorfer, J., Reiter G., Friedl, C., Steinmüller H. (2014) Technology research & innovation roadmap Power-to-Gas for Austria, Project report for the Austrian Ministry for Transport, Innovation and Technology. *(report only available in German language)*