Renewable Gases -
A System-Update for the Energy Transition

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Management Summary

This study aims at creating a more complete image of Germany's energy system in 2050. This system is supposed to ensure cost-efficient greenhouse gas neutrality and, thus, a sustainable and environmentally sound energy supply. To this end, the development in the fields of energy supply, usage and transformation is analysed, focusing on where and to what extent renewable gases must be used merely out of technical necessities or should be used because they are economically advantageous. In this study, biomethane and synthetically produced gases from renewable electricity as hydrogen or methane are considered renewable gases.

Two scenarios that achieve greenhouse gas neutrality in 2050 by different means are analysed. The scenario *Maximum Electrification* (see Fig. 1) reflects political ideas as to completely align the energy market with the electricity market and electrify all sectors of consumption to the highest degree possible.

In contrast, the scenario *Optimised System* (see Fig. 2) allows other energy sources in the field of consumption, thus being technologically more open.

Sources that account for more than 90 per cent of Germany's greenhouse gas emissions are analysed in this study. This includes sectors of consumption such as heating, transport, electricity and industrial feedstock. Agriculture, accounting for about 8 per cent of Germany's emissions, has not been included, however.

An analysis of the industrial feedstock, meaning the material usage of energy carriers in the industrial field, shows that this sector can only be decarbonised using synthetically produced hydrocarbon. A direct comparison of power to liquid and power to gas technologies suggests that the most cost-efficient option is using renewable gases. An energy system that achieves greenhouse gas neutrality by 2050 will therefore need about 280 terawatt hours of renewable gases per annum independent from the respective scenario.

The transport sector shows more ambiguous results. Leaving aside soft factors such as vehicle range or length of loading operations, the study finds that the decarbonisation of individual automotive transportation will be achieved by electric vehicles alone. Especially in the field of air transport, renewable energy that is transformed by power to liquid technologies will be necessary though; as using renewable electricity in this sector currently proves technically infeasible. Maritime transportation does not allow for a mere electrification either; however, in this sector renewable gases could be used leading to a more cost-efficient path to decarbonisation than using power to liquid. The study therefore finds that about 140 terawatt hours of renewable gases per annum will be used in the transport sector by 2050.

The heating sector accounts for almost 50 per cent of final energy consumption in 2050. Generally, technologies exist that allow the decarbonization of consumption by replacing existing fossil-fueled heating systems through electrical-powered systems. These are primarily electric heaters and heat pumps. However, the study suggests that a maximised electrification of the heating market is not efficient. To optimise the system and thereby reduce economic costs, about 400 terawatt hours of renewable gases should be used in the heating market. The scenario *Optimised System* indicates that between 2017 and 2050 the use of gas-fueled heating systems instead of electrical-powered systems allows for a cost reduction of 70 billion Euros at the end-consumer level.

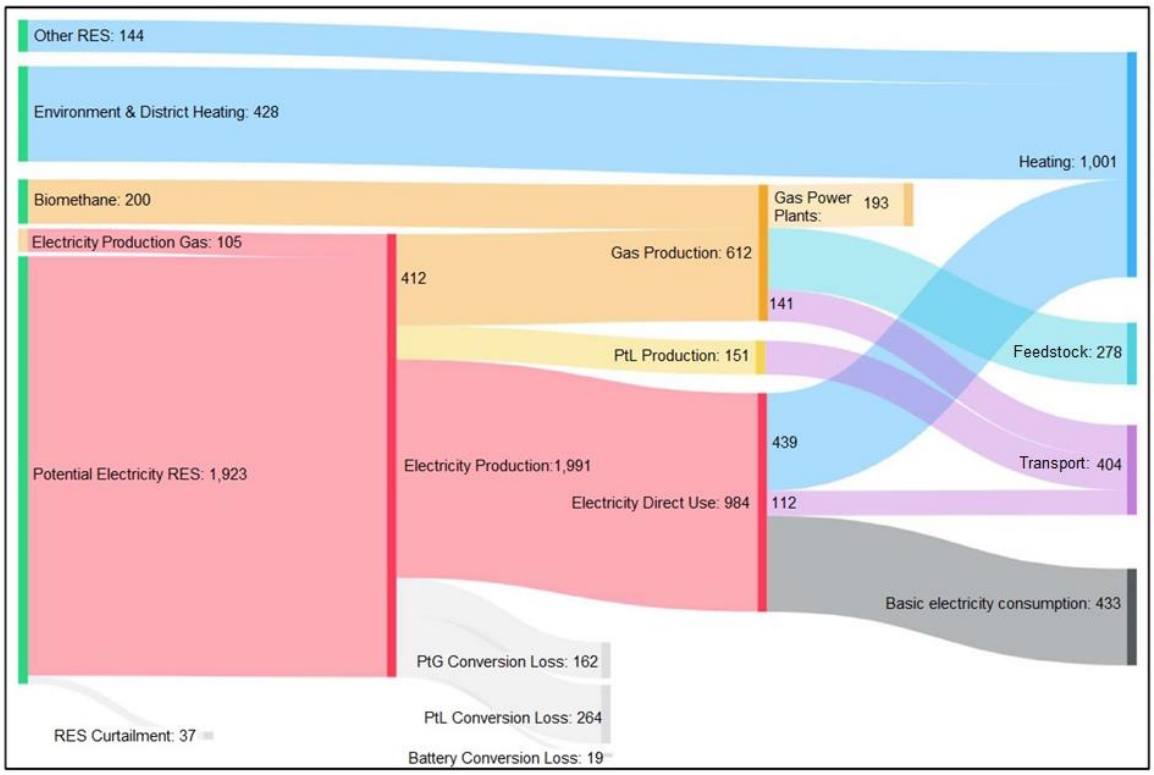

Fig. 1 – Energy Supply and Usage in 2050 – Scenario Maximum Electrification[1]

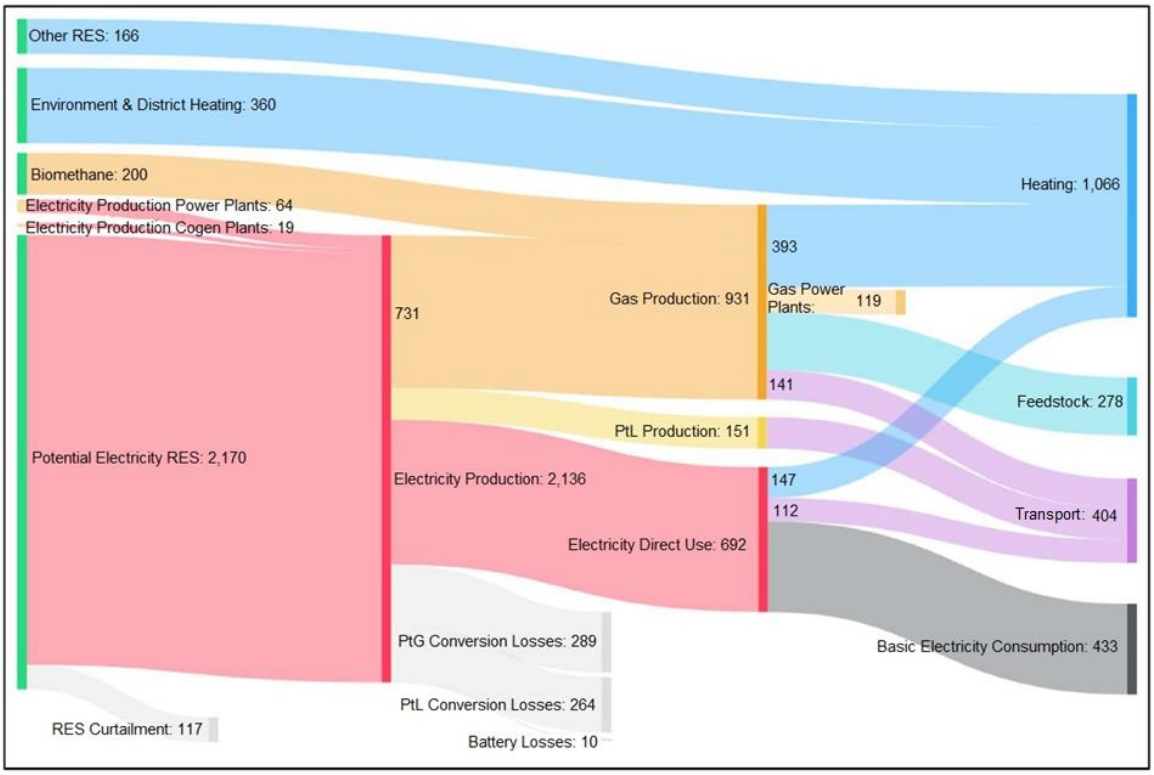

Fig. 2 - Energy Supply and Usage in 2050 – Scenario Optimised System[2]

[1] H_o

[2] H_o

Looking at the energy system in total, the study finds that the battery storage capacity that is necessary to provide flexibility for electricity-based systems will be reduced by 150 gigawatts under the assumptions of the scenario *Optimised System.* Using gas-fueled heating systems leads to a cost cut of about 80 billion Euros until 2050. In addition to that, the need for gas-fired power plants to bridge times where wind and solar power cannot provide sufficient amounts of electricity will decrease by more than 50 per cent as a higher heating demand in winter does not need to be covered by the electricity market only. Instead of 110 gigawatts of installed capacity from gas-fired power plants only 50 gigawatts will be necessary. As renewable gases move flexibility demand from the electricity to the gas sector where storage facilities provide considerable capacity for this demand, another cost cut of around 100 billion Euros will be achieved by 2050.

The biggest advantage of a pathway that ensures openness to all technologies, however, lies in the cost reduction achieved by reduced needs for upgrading the electricity transmission system. Using electrical-powered instead of gas-fueled heating systems increases the need for upgrading the transmission system by the factor three. Using gas storage facilities and networks to transport renewable gases therefore generates a further cost reduction of about 160 billion Euros until 2050. It is worth noting that the projected cost reduction will likely be increased even further on the assumption that the existing gas infrastructure is also used to relieve electricity distribution systems, though this was not part of this study.

The analysis suggests that following the scenario *Optimised System* 2,170 terawatt hours of renewable electricity need to be produced by 2050 to reach greenhouse gas neutrality. For this purpose, about two per cent of the country's land will be used by RES installations. Comparing this result to the scenario *Maximum Electrification* the production of electricity from renewable sources is about 13 per cent (247 terawatt hours) higher, mainly due to higher conversion needs using the power to gas technology. Construction of additional power to gas facilities to produce the necessary amounts of renewable gases as well as the expansion of land to be used by RES, especially PV, leads to higher costs of about 410 billion Euros in an *Optimised System* scenario.

Analysing all segments from energy production to transportation and usage it is shown that the goal of greenhouse gas neutrality by 2050 can be achieved more cost-efficiently if renewable gases are used to complement electricity-dominated technologies instead of merely following an all-electric vision. The cost advantage of the *Optimised System* is calculated at about 19 billion Euros until 2050.

In general, a renewable energy system that achieves greenhouse gas neutrality by 2050 will see significant amounts of residual load and seasonal (heat) demand. Gas storage facilities will play an important role in ensuring that the necessary amounts of energy can be shifted from summer to winter months. Even in a system that follows the *Maximum Electrification* scenario, 200 terawatt hours of renewable gases are shifted between seasons. This task cannot be fulfilled by current electricity storage technologies (battery and pumped storage).

Acknowledging the results of this study with regard to the areas that renewable gases can be used in, it is obvious that the energy system will only achieve greenhouse gas neutrality by 2050 if renewable gases are used to a significant degree (*Optimised System*: about 930 terawatt hours). Renewable gases can therefore be called a system update for the energy transition.

The complete study (only available in German) can be downloaded at:
www.erdgasspeicher.de/files/20171212_studie_erneuerbare_gase.pdf.