Europe's independence from Russian natural gas – Effects of a complete import stop on energy system development

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Motivation and research question

With the disruption of Russian natural gas imports due to Russia's war on Ukraine, Europe's energy reliance on Russia is more apparent than ever. Before the COVID-19 pandemic, natural gas imports from Russia covered about 23.7% of Europe's energy supply [1]. Even after one year of war, 8% of natural gas is still imported from Russia [2]. To tackle the resulting challenges of limited gas supply from Russia, short and long-term effects need to be investigated. High energy prices and the fear of gas shortages in winters stimulate the discussion whether Europe can manage without any natural gas imports from Russia. How such a European energy system could look like and whether it can function using alternative technologies and trade shall be examined in this paper.

Methodology

The Global Energy System Model (GENeSYS-MOD) is used to represent the future European energy system for this paper. GENeSYS-MOD is a linear, cost-optimizing, techno-economic energy system model, publicly available with code and data. The sectors electricity, heat, transport and their interdependencies are considered to model a sector-coupled energy system towards deep decarbonization. Figure 1 shows a stylized illustration of the model's structure.

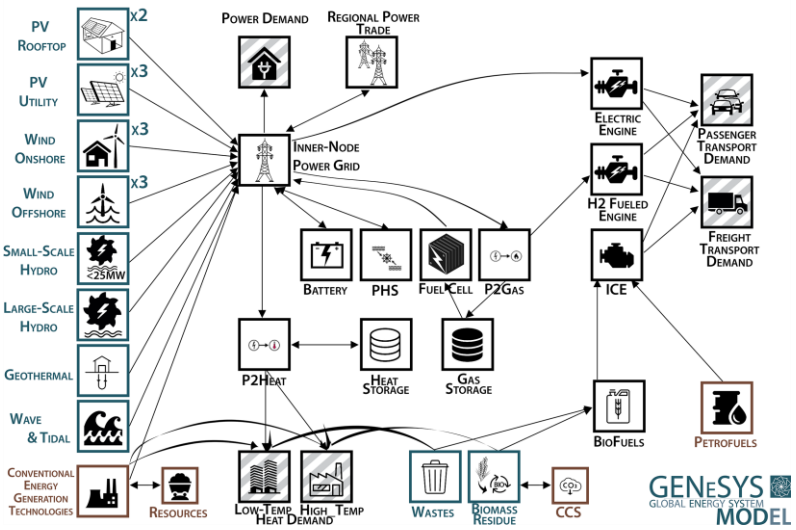

Figure 1: Stylized illustration of GENeSYS-MOD's structure

The European model version 3.1, developed in the H2020 project openENTRANCE [3] serves as the basis for this study. With the help of international partners, comprehensive country-level data was collected within the project, serving as a baseline. Additionally, this study improves the modeling of international gas infrastructure within Europe. Improvements to the representation of hydrogen technologies strengthen the model's possibility to substitute Russian natural gas. These changes include e.g., retrofitting of natural gas pipelines to also carry hydrogen. This could be especially important considering renewable hydrogen as a viable short- to medium-term alternative. In order to investigate an independence from Russian natural gas, three gas supply scenarios with varying amounts of available natural gas from Russia are compared. Based on the given data and model formulations, the model then decides what the cost-optimal energy system looks like and what alternatives to invest in.

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Results and conclusion

This paper intends to display possibilities of a European energy system without natural gas imports from Russia. Overall, it will show in which time period the model invests in which alternatives to identify the cost-optimal energy system until 2050. LNG imports from Turkey and outside Europe will play an important role, especially in view of the scarce natural gas resources within the continent. Especially in the heating sector, natural gas is difficult to replace in the short term. Therefore, it is assumed that the import of LNG will be the first alternative, before switching to other technologies such as heat pumps. In the electricity sector, natural gas can be more easily substituted. Although coal-fired power generation would potentially need to increase in the short term, the transformation towards 100% renewables could be accelerated, especially in the long run. In addition to alternative technologies, trade within Europe is another important factor that can contribute to the phase-out of Russian natural gas. Since especially Eastern European countries have only limited access to LNG, trade through continental measures is necessary. It is assumed that this will further lead to an increased trade across Europe in order to ensure an optimal energy system.

Literature

[1] Franziska Holz, Claudia Kemfert, Hella Engerer, Robin Sogalla, "Europa kann die Abhängigkeit von Russlands Gaslieferungen durch Diversifikation und Energiesparen senken", 1. April 2022. https://www.diw.de/documents/publikationen/73/diw_01.c.838364.de/diw_aktuell_81.pdf (zugegriffen 09. November 2022).

[2] Ben McWilliams, Giovanni Sgaravatti, Georg Zachmann, "European natural gas imports", Bruegel Datasets, 09 November 2022. https://www.bruegel.org/publications/datasets/european-natural-gas-imports/ (accessed 09. November 2022).

[3] H. Auer et al., „Quantitative Scenarios for Low Carbon Futures of the European Energy System on Country, Region and Local Level“, Deliverable 3.2, May 2022. Accessed: 18. Oktober 2022. [Online]. Available at: https://openentrance.eu/wp-content/uploads/openENTRANCE-D3.1.pdf