MINIMAL-COST MULTI-GAS NETWORK REPURPOSING

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ABSTRACT

The EU and Norway have high ambitions about the role of hydrogen in the future energy system. At the same time, natural gas will gradually play a smaller role, and its unabated usage is unlikely after 2050. Additionally, we can expect an increasing need to transport carbon dioxide from capture locations to storage locations. Repurposing natural gas pipelines and storages for hydrogen and carbon transport and hydrogen storage can significantly reduce cost of integrating hydrogen in the energy system.

We present and apply a new optimization model to find a minimal cost solution to meet transport and storage demand for natural gas, hydrogen and carbon dioxide between 2025 and 2050. The model considers supply potentials and capacities, and demand projections, at a detailed NUTS2 level for various gases (natural gas, hydrogen and carbon dioxide). It decides which pipelines to repurpose (retrofit) and/or make bidirectional, and which additional pipelines are needed.

The starting point is the existing networks for gases (natural gas, H2, and CO2). For different energy transition scenarios, the aim is to minimize investment and operational costs for the period 2025-2050, considering a representation of hourly supply, demand, and flows. The model applies mixed integer linear programming, to account for yes-no decisions and fixed costs in investment decisions.

As at the NUTS2 level there are many more connections between countries, we find that more pipelines are repurposed or made bidirectional compared to analyses at the country level. The model can often find corridors to repurpose pipelines rather than building new, especially in scenarios where entire NUTS2 level regions quickly phase out natural gas consumption. Relative costs determine the tradeoffs between repurposing and new investment in pipelines and storage.

Future work may include the prioritization of industry clusters to phase in hydrogen and to phase out natural gas consumption, and an explicit representation of ammonia.

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