Supporting green gases with renewable energy policies

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Outline

- Introduction of the paper
- Positioning in the academic literature
- Methodology
- Results
- Conclusions

Relevance of paper

- International treaty – Paris Agreement
- European Union’s Green Deal – European Climate Law
- Member States – National energy and climate plans

- Greenhouse gas emissions (- externality) & knowledge spillovers / technology learning by doing (+ externality)
  - EU Emissions Trading System (ETS)
  - Renewable Energy policies (RES-Electricity, support schemes)

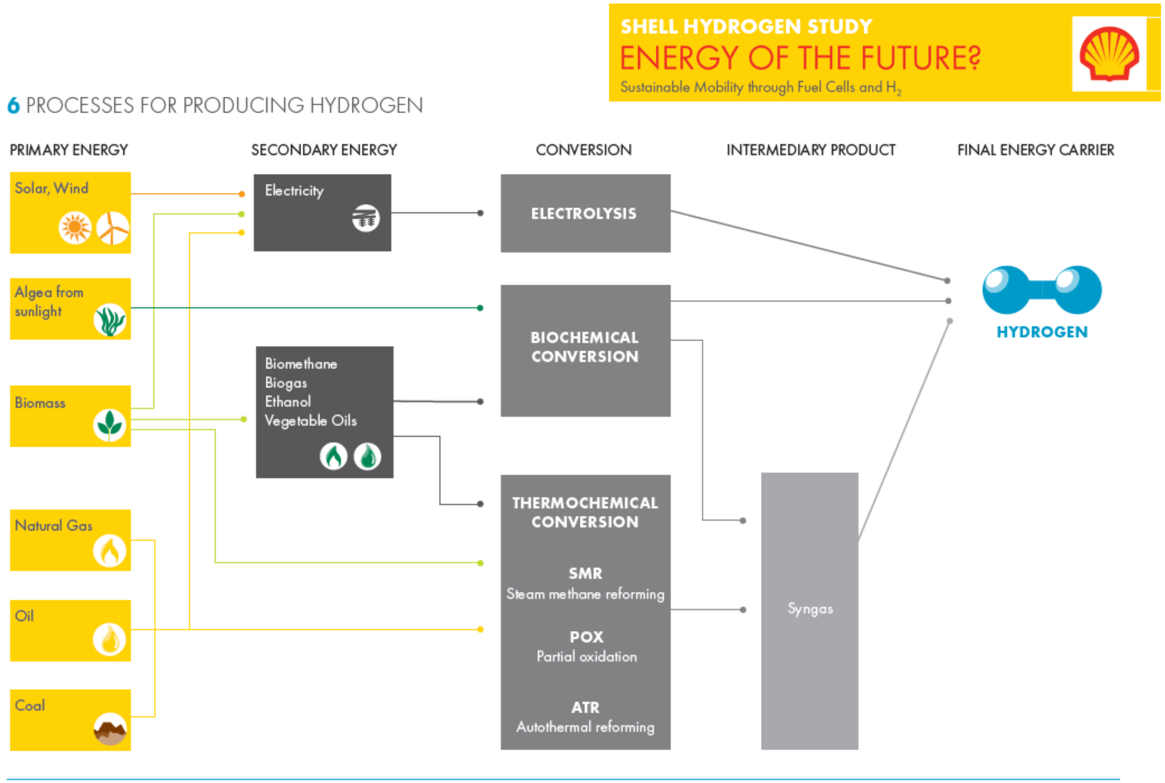
- Green gases can play a key role in decarbonizing parts of the gas sector on the 2050 horizon, but these technologies are immature or not cost-competitive enough today.

- Show the impact of some of the possible tools the European Commission is considering to support green gases.
  - RES-Gas target with direct market-based support

- Anticipate interactions between gas and electricity targets, and CO_2 pricing

What are green gases?

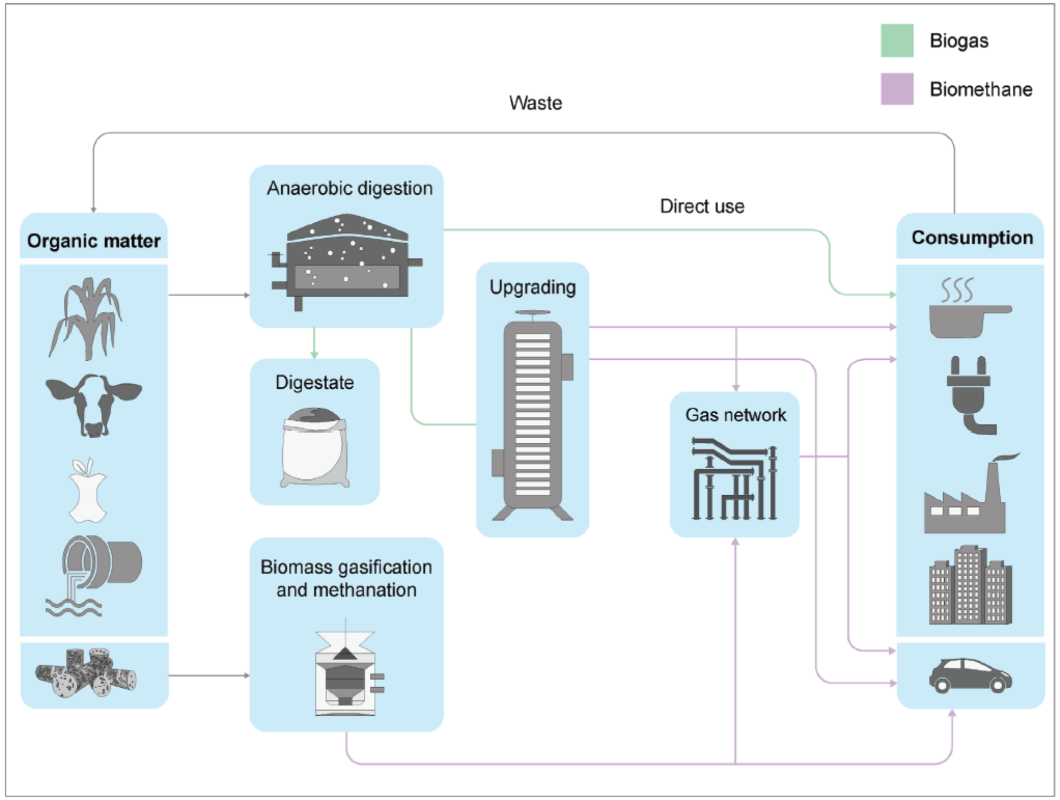
Green Hydrogen



Biomethane

Outlook for biogas and biomethane

Prospects for organic growth



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Economic rationale for policy mix and interaction effects

- Economic rationale for directly supporting environmentally beneficial technologies. (Jaffe et al., 2005)
- the rejection of RES-E support schemes rests on a narrow set of assumptions that climate change mitigation is the only public policy objective and the negative externalities from CO2 emissions is the only market distortion where government intervention is required. (Lehmann and Gawel, 2013)
- Main concern about RES-E support schemes is interaction effects between instruments (Lehmann and Gawel, 2013) :
  - They do not contribute to CO2 emissions reductions in the EU ETS (waterbed effect)
  - They impair the cost-effectiveness of the EU ETS.
- **Policy mixes inherently lead to interactions between the different instruments**, either in the form of conflicts or synergies. Potential negative interactions between renewable energy deployment and the EU ETS can be alleviated through coordination or design of policy instruments. (del Rio, 2017)

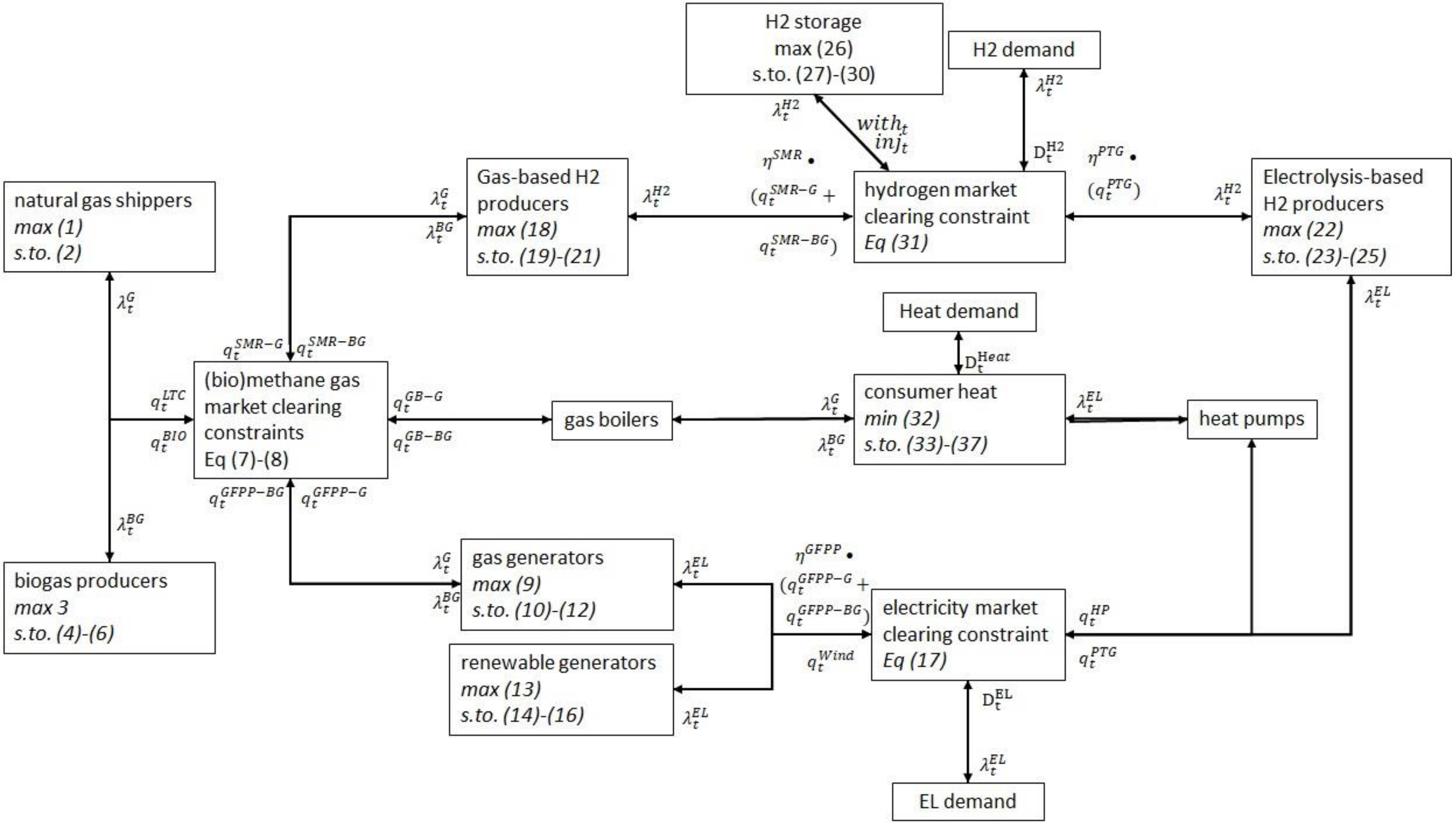
Gap and contribution

- Is a RES-G target and support schemes necessary to replicate the renewables deployment success of the electricity sector in the gas sector? To what extent do existing policies, RES-E target or carbon market, support green gases?
- Are interaction effects between a RES-E and RES-G target relevant in a multi-sector energy market setting?

- Debate about interaction effects between policies focused on RES-E policy and EU ETS. We investigate interaction effects between RES policies.
- Multi-sector model with endogenous investments and support of a range of green gases.

Model overview

Our modelling approach: Non-cooperative game, Nash Equilibrium solution concept, Mixed Complementarity Problem Reformulation, Solve in GAMS using PATH



Policy	No policy	RES-Electricity	RES-Electricity & RES-Gas	
Feed-in premium (€/MWh)		ς^E	ς^E	ς^G
Renewable Generators		X	X	
Biomethane producers		X		X
Electrolysis-based H2 producers				X
Heat pumps				

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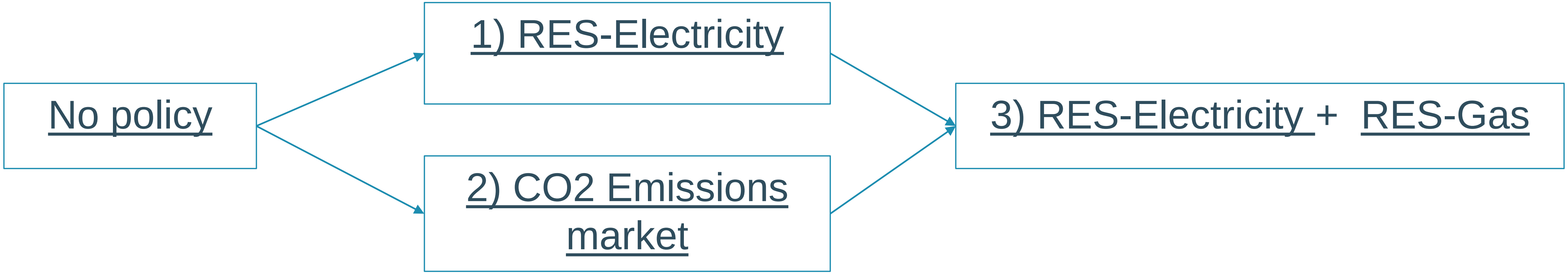
Stylized approach

- Agents are perfectly competitive and have complete information. Single shot model – investment and generation decisions simultaneously.
- 4 representative days, 24 hours each, 96 time periods in total
- Representative technology for each agent using Danish Energy Agency technology data to compute equivalent annualized costs :
  - Biogas plant, basic configuration + biogas upgrading; Large offshore wind; Alkaline Electrolyser; Heat pump, air-to-water, existing one family house
  - Gas turbine, combined cycle; Natural gas boiler, existing one family house; Steam Methane Reformer
- Assume shippers have access to natural gas at fixed variable costs of 20 €/MWh and biogas producers have a feedstock costs of 42 €/MWh (Gas.be report)
- The heat demand and the coefficient of performance of an air-source heat pump in Belgium is extracted and scaled from the time series dataset created by Ruhnau et al. (2019).
- The RES targets are modelled as renewable energy certificate (REC) markets, but policy costs are not allocated to agents.
- Formulated and solved as a mixed complementarity problem (Gabriel et al., 2013)

3 Policies under analysis



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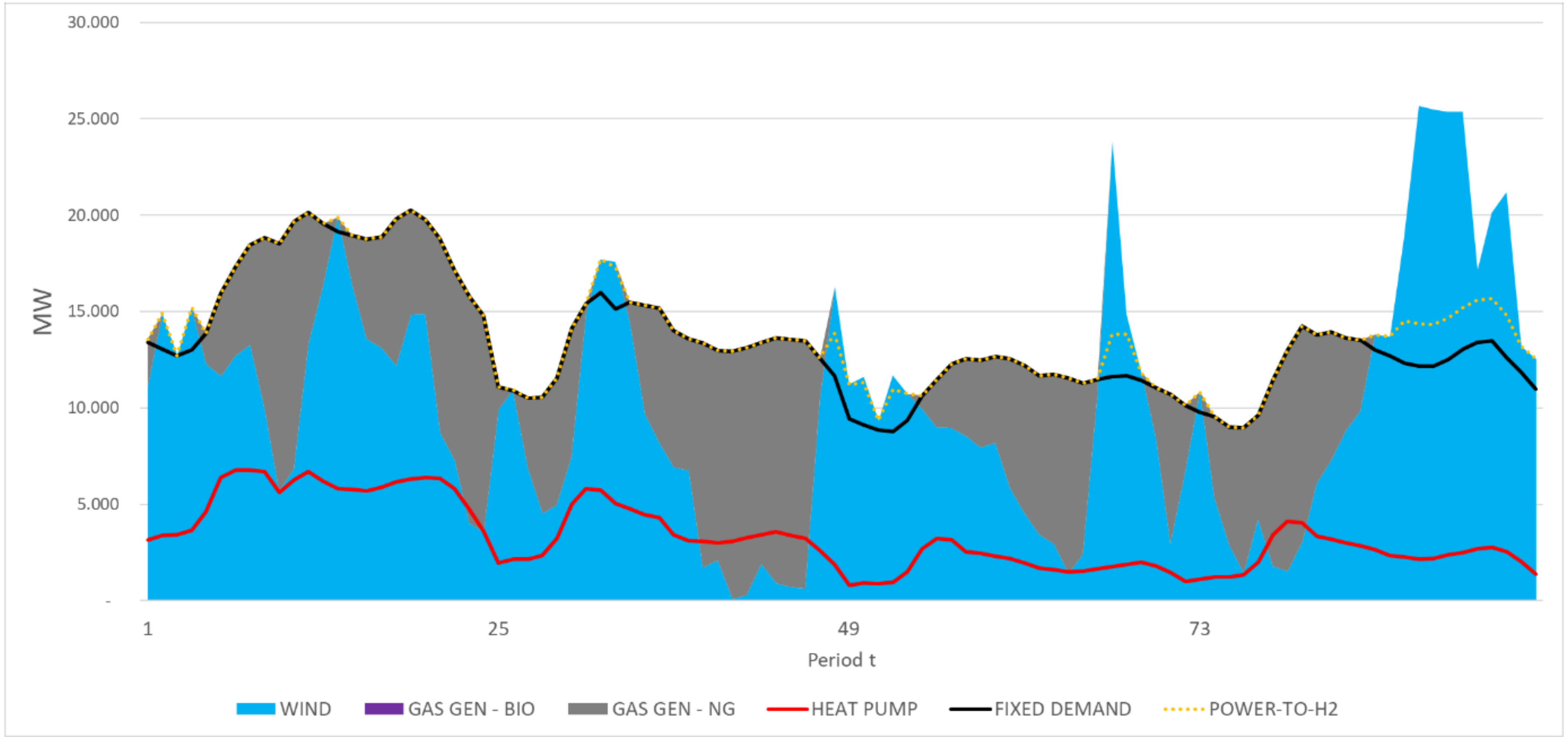
Overview of findings

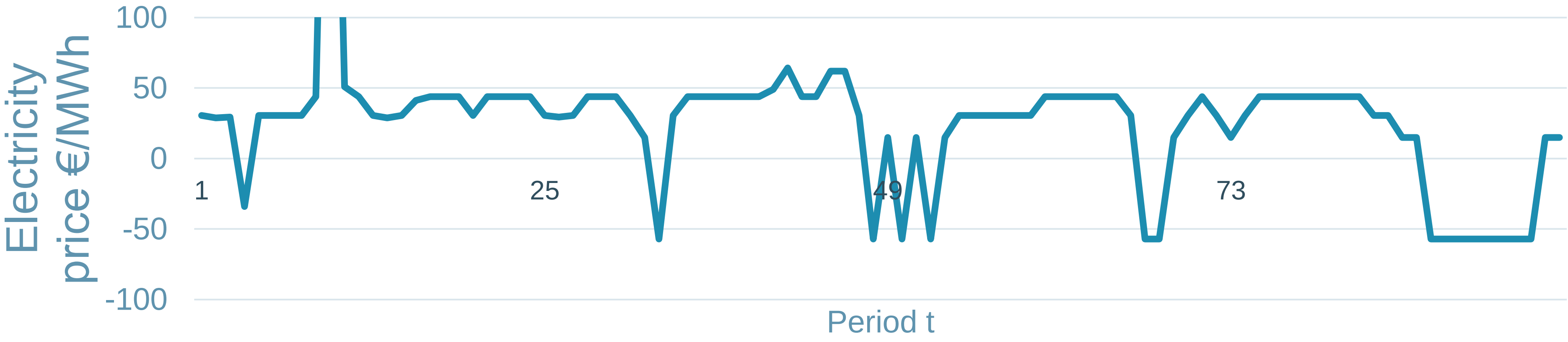
- **In the RES-Electricity target policy scenarios:**
  - **Wind is the least cost technology to meet the electricity target, but causes spillage at and above a 40% target.**
  - **In a high RES-E ambition scenario of 65%, both biomethane and power-to-hydrogen are indirectly supported by negative electricity prices.**

- **In the CO2 emissions market policy scenarios:**
  - **In setting a CO2 emissions target equivalent to the CO2 emissions output of the 65% RES-E target, nearly all the emissions reductions are achieved by wind and heat pumps.**
  - **More stringent emissions reductions can eventually increase the CO2 price and support green gases.**

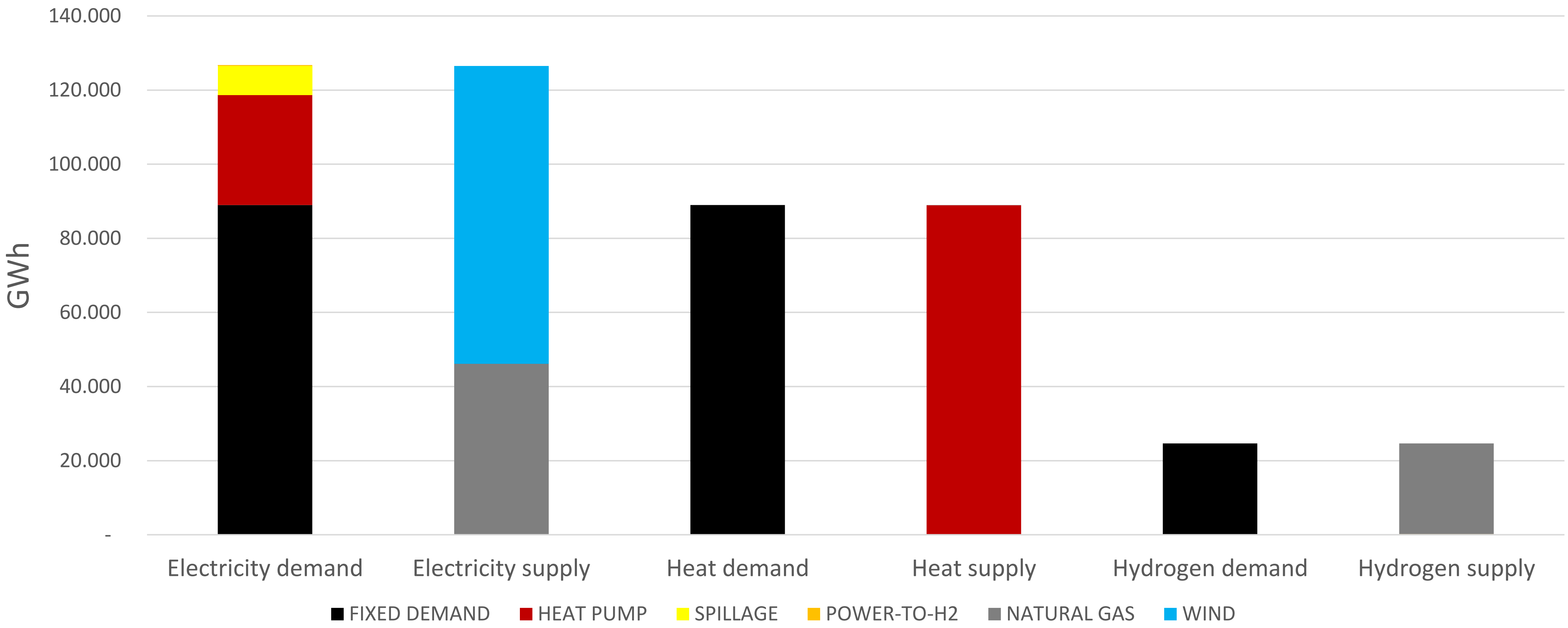
- In the dual RES-Electricity and RES-Gas scenarios:

RES-Electricity target 65 % scenario– hourly profile of generation and demand





CO2 emissions target equivalent to 65% RES-E target



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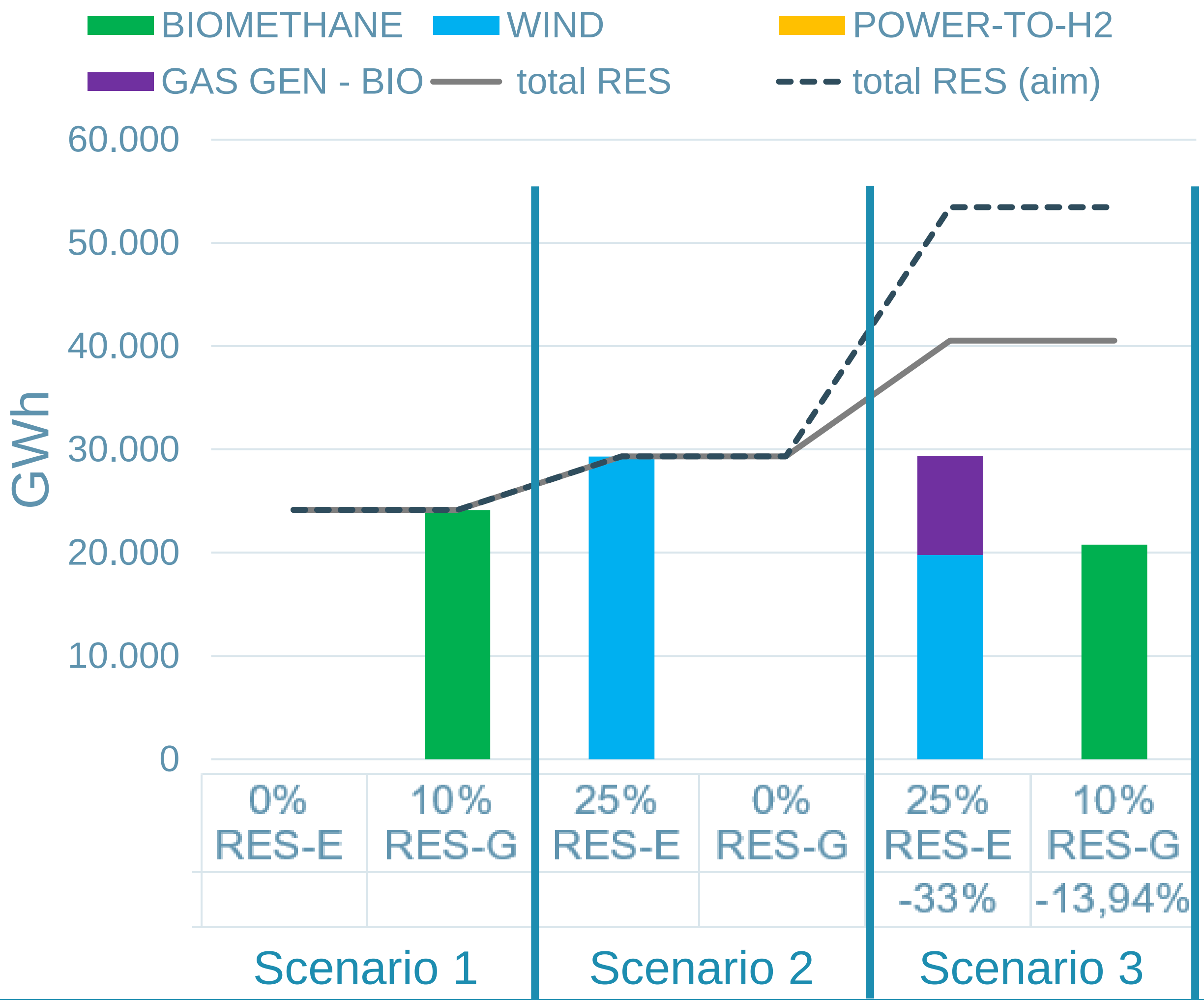
Overview of findings

- In the RES-Electricity target policy scenarios:
- In the carbon emissions market policy scenarios:
- **In the dual RES-Electricity and RES-Gas scenarios:**
  - **Clear interactions exist, a RES-E target can contribute to a RES-G target and vice versa.**
  - **However, these interactions are substitutive, meaning progress in one may crowd-out investment in the other.**
  - **The deployment of power-to-hydrogen appears to depend more on the RES-E target than RES-G target, if defined in technology-neutral terms.**

Substitutive interaction effects of dual RES-E and RES-G target



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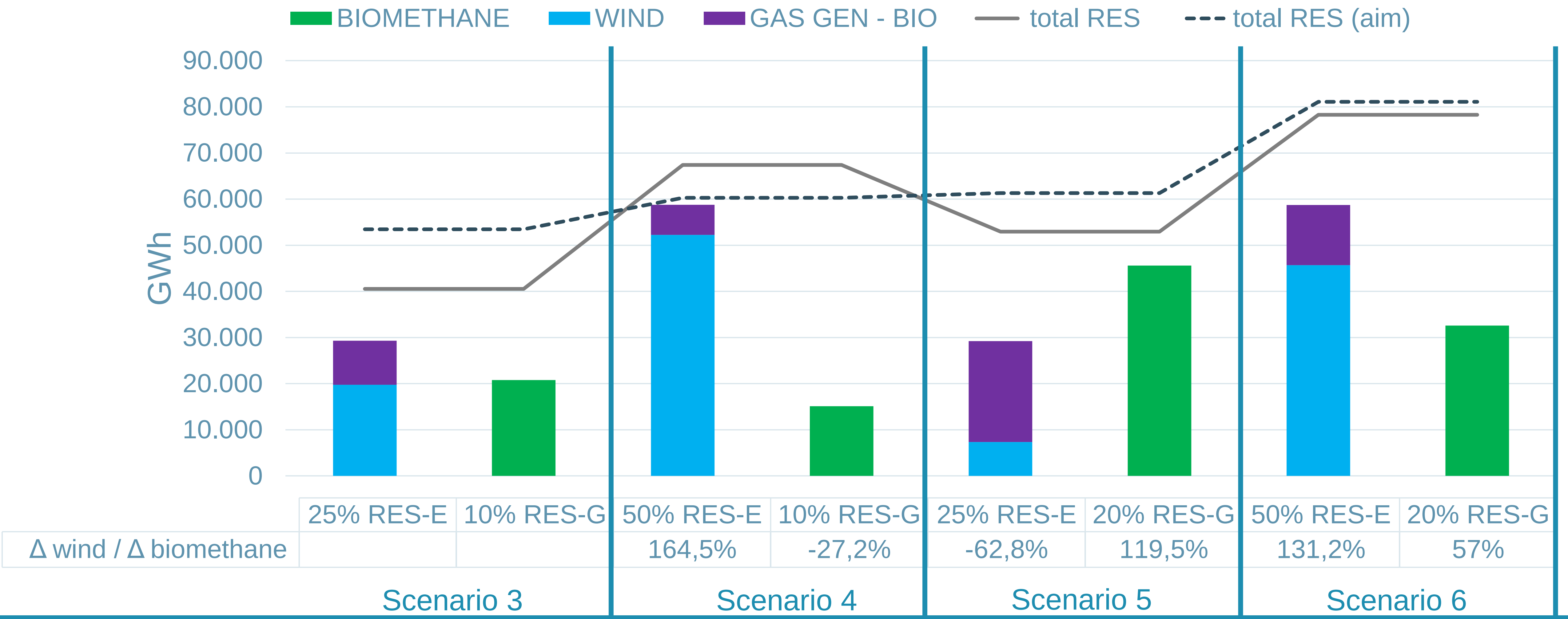
Substitutive interaction effects of dual RES-E and RES-G target



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In progress

Conclusions and next steps

- Can we replicate the success in deploying renewables in the electricity sector also in the gas sector?
  - If immature and emerging green gas technologies are not directly supported by current policies (RES-E or emissions market) and face a technology-related market failure, then the motivation for a RES-G target with direct market-based support could be justified.
  - However, if it is not clear which green gas will become most efficient in the long run (uncertainty about technology learning curves), then a policy could encourage a range of green gases, which may not be achieved with a technology-neutral RES-G target.

- Are there potential interaction effects between dual RES-E and RES-G targets and what does this imply for the design or implementation of a RES-G target?
  - Clear synergies are observed such that a RES-E target can contribute to meeting a RES-G target, and vice versa. However, this also means that substitutive interaction effects ultimately modify the final output of renewable energy from the electricity and gas sector. Therefore, to reach the desire goal of green gas deployment, these targets should be coordinated.

Q&A

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Model Assumptions

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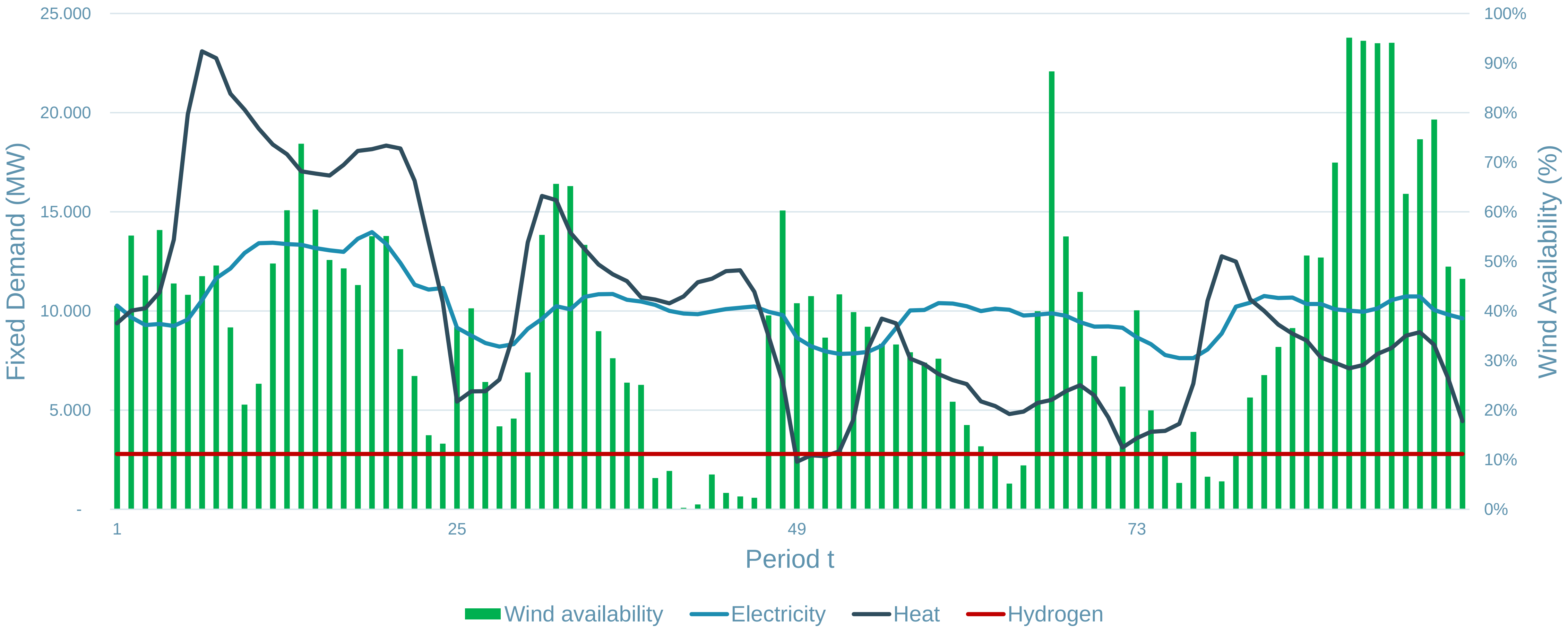
Input data



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