ECONOMIC AND ENVIRONMENTAL ASSESSMENT OF CO_2 UTILIZATION FROM BIOMETHANE PRODUCTION

18. Symposium Energieinnovation

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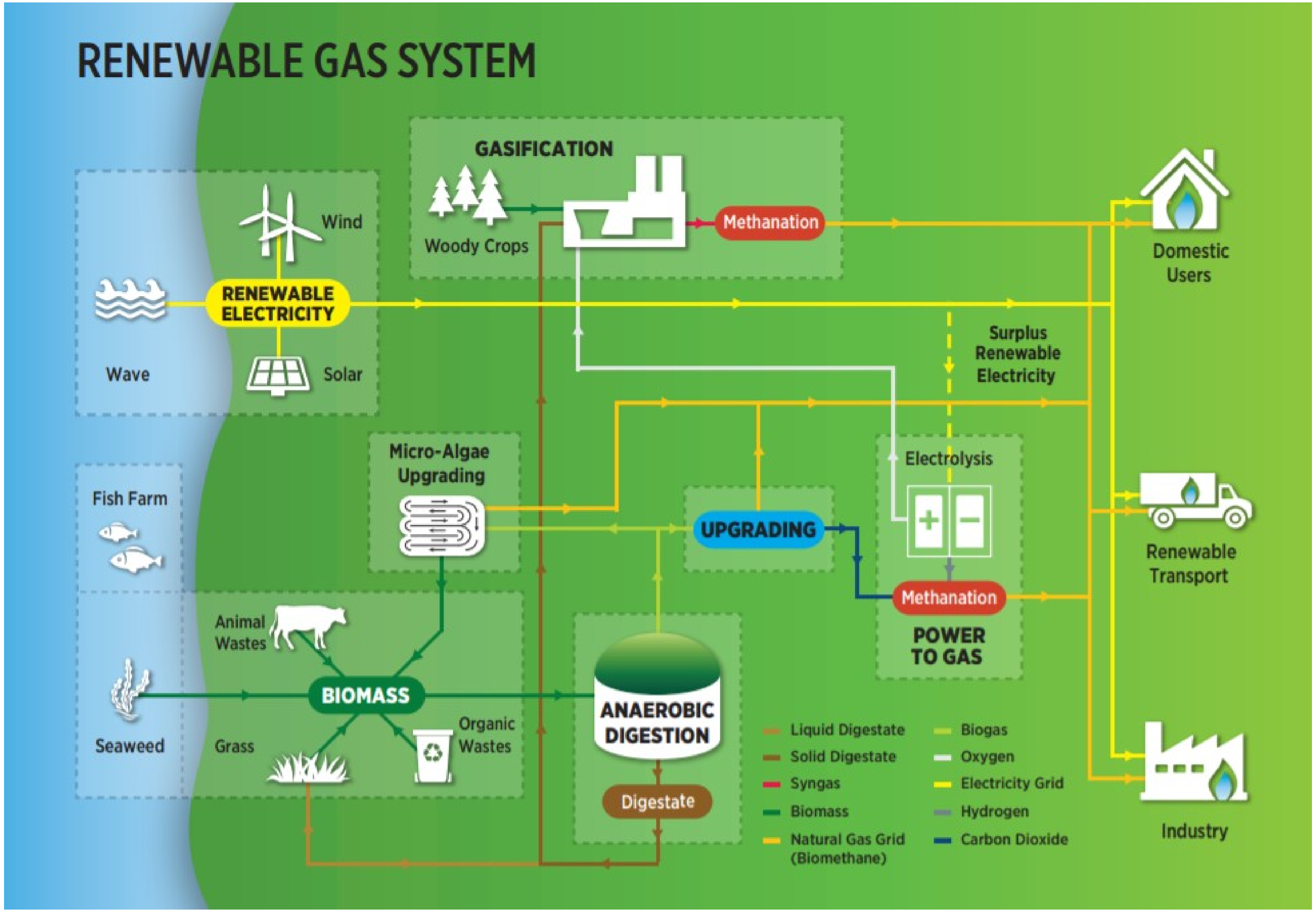
Motivation

- EU depends on imports of natural gas: 80% imports
- Share of LNG increased from 20% in 2021 to 42% in 2023
- LNG leads to at least 15% higher emissions than conventional natural gas (Deutscher Bundestag 2023)
- Green gases are substitutes for natural gas (flexibility)
- Contribution to emission reduction
  - Industry
  - Transport



Source: Green Gas Brochure, www.MaREI.ie

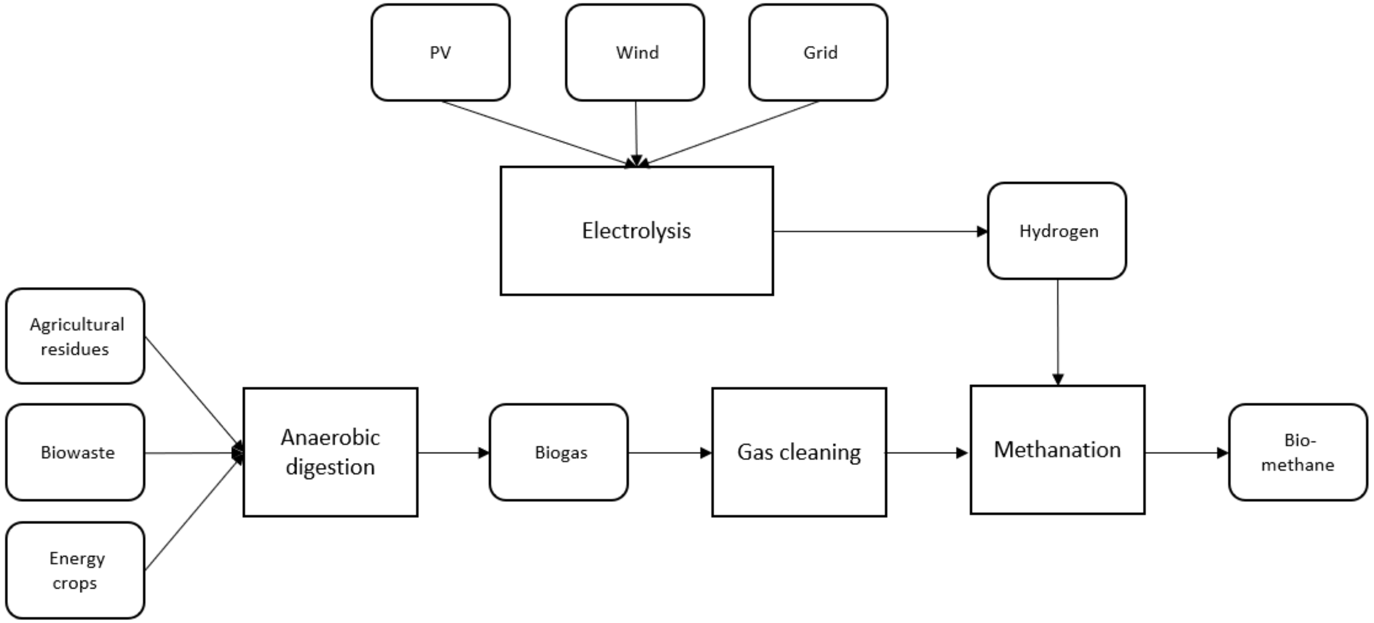
Research aims

- Economic assessment
  - Production costs and cost reductions
  - Sensitivity analysis
- Environmental assessment
  - CO_2 mitigation potential in 2050

Methods

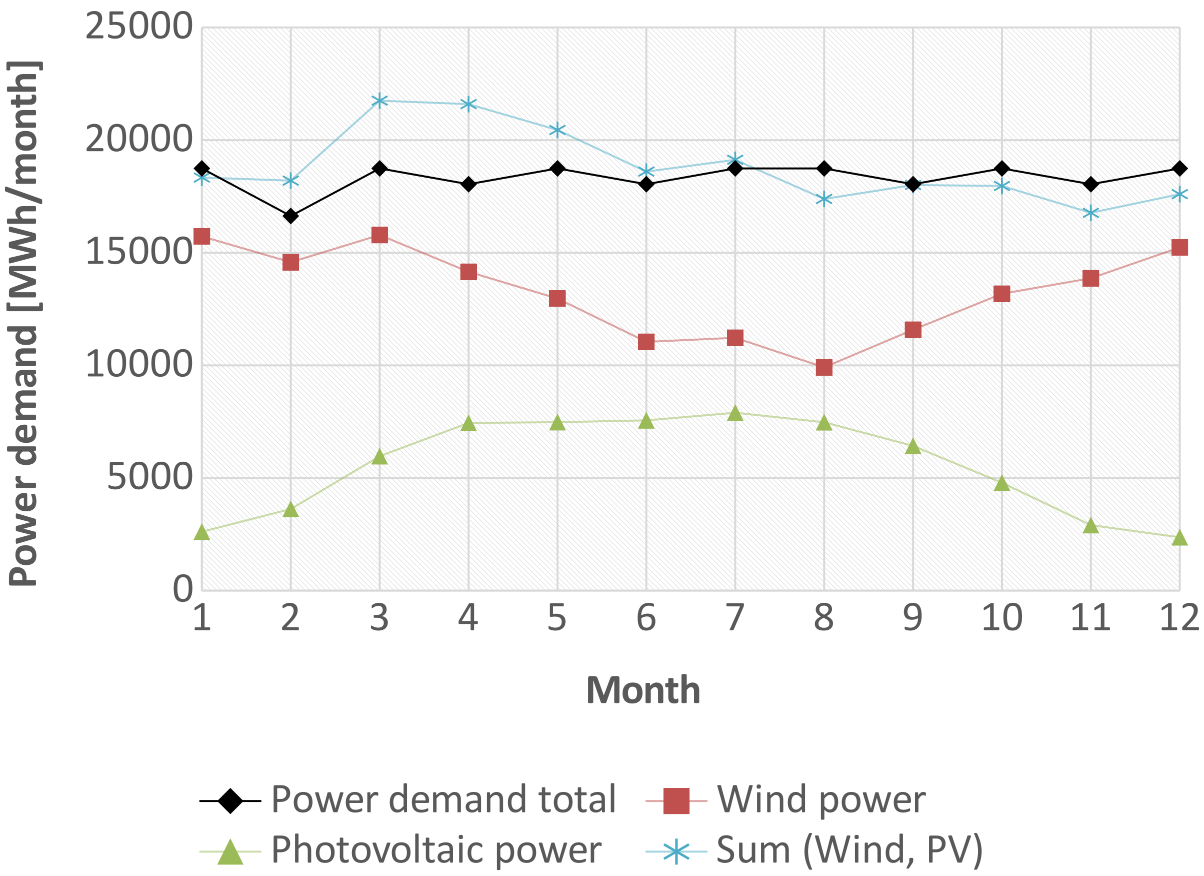
Methodology

- Direct methanation of biogas
- Costs for CO_2 separation can be omitted
- Investment costs increase



Scenarios

- Biomethane production at 2 MW and 5MW scales
  - Energy maize
  - Manure
  - Biowaste
- Enhanced biomethane production with hydrogen
  - Grid electricity
  - Hybrid energy model



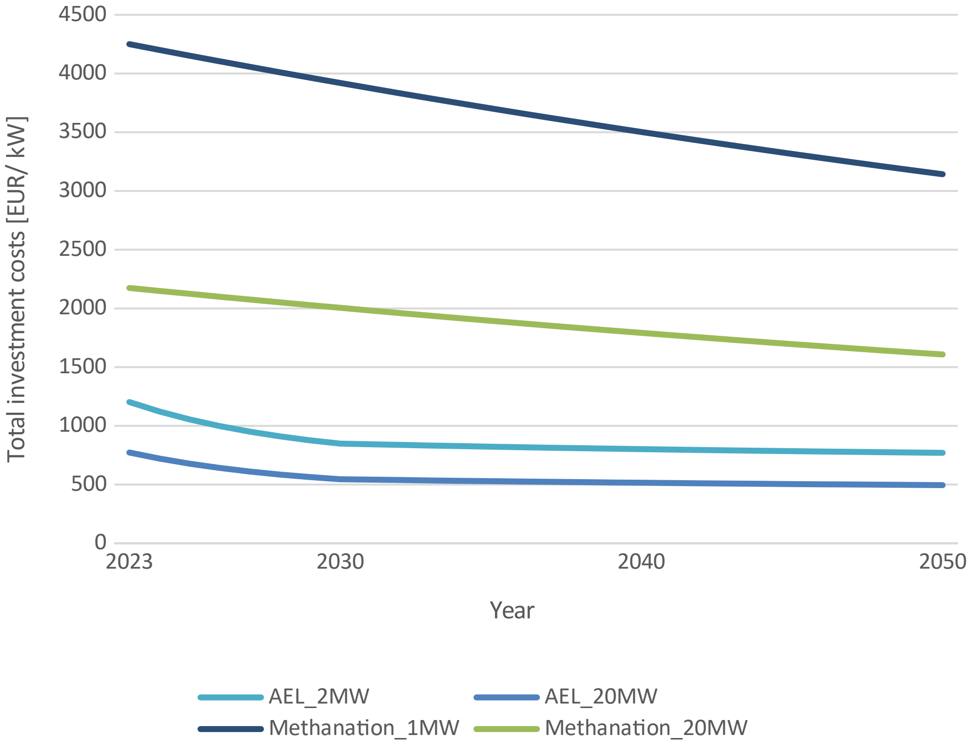
adapted from Pratschner et al. 2023

Economic assessment

- Production costs

= production costs, = capital recovery factor, = fixed operating cost [€/ kW], = other capacity related cost, = biomass price, = lower heating value, = energy efficiency, = variable cost [€/ kWh], = reference price for scale 0, = base scale, = scaling factor

Cost reductions



Radosits et al. 2024

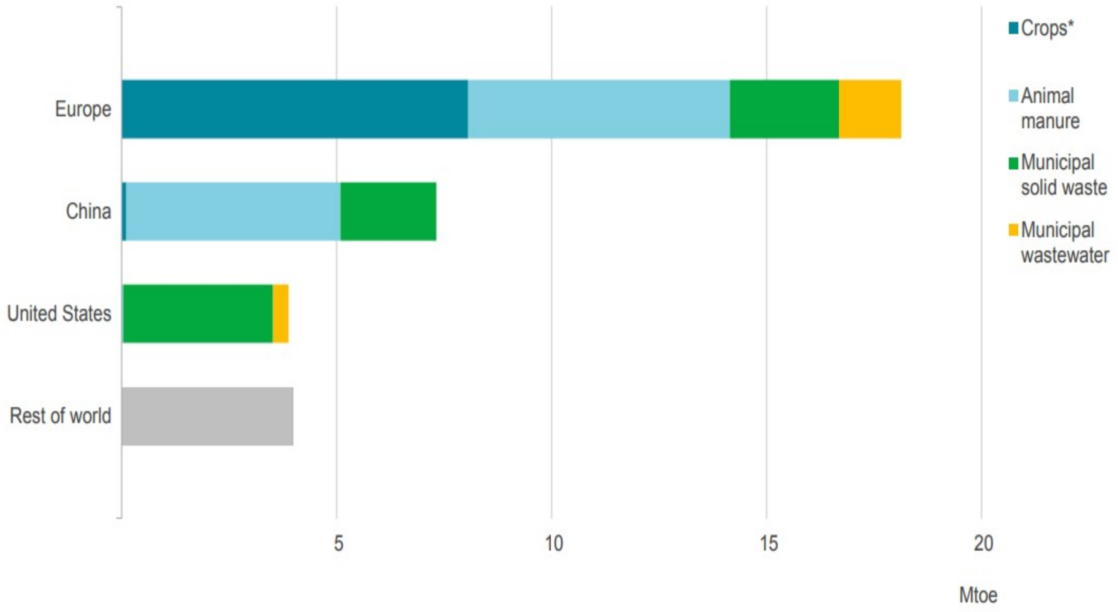
= investment costs of new components, = investment costs of conventional components, = investment costs of a unit at time t, = installed capacity at time t, = learning rate, *b*= parameter for the extent of learning measured

Environmental assessment

- CO_2 mitigation potential of biomethane production in the EU
- Data from the ProBas database

Scenarios EU 2050

- Optimistic scenario: 91 bcm biomethane
- Medium scenario: 60 bcm biomethane
- Pessimistic scenario: 35 bcm biomethane

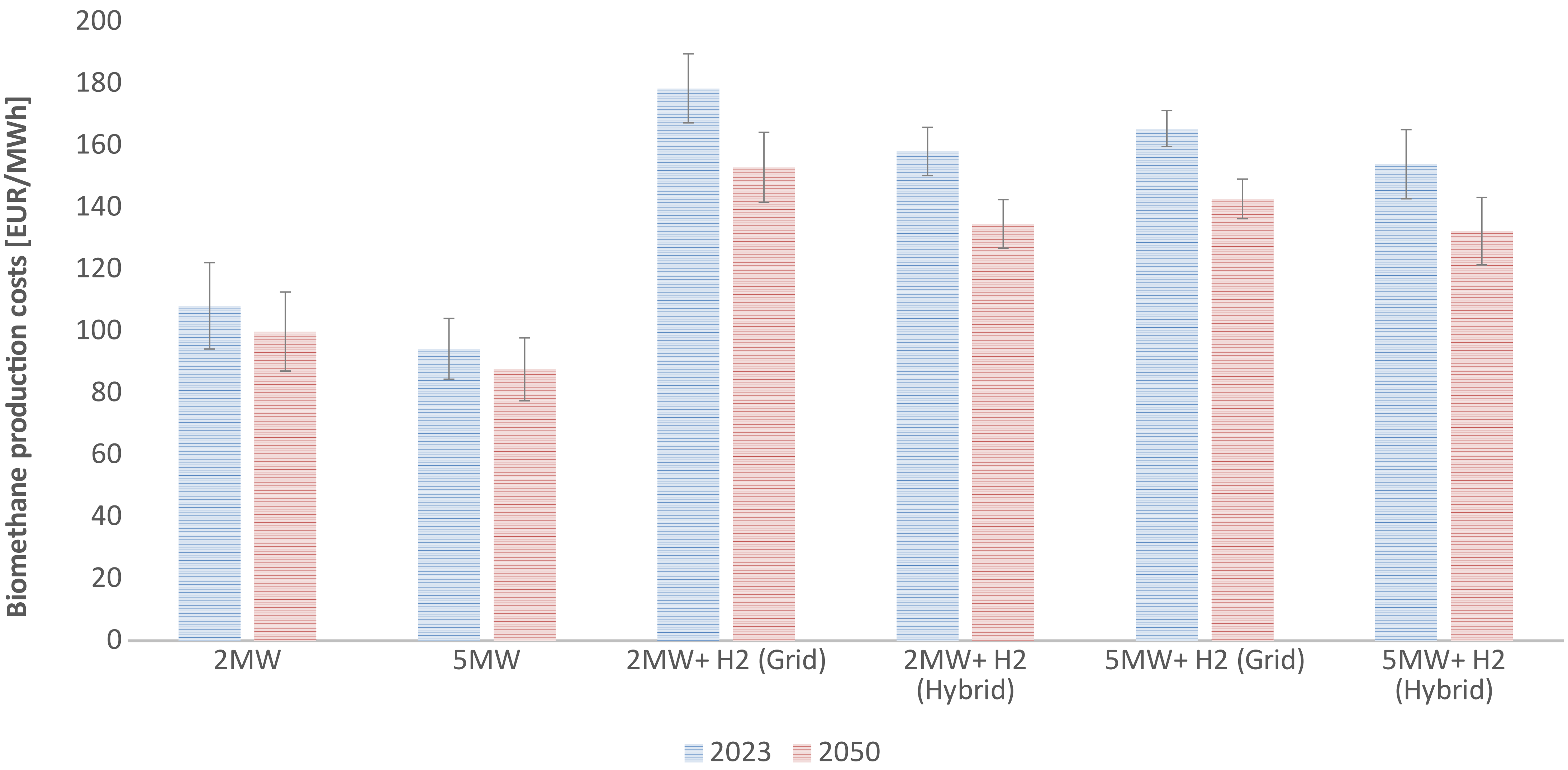


* Crops include energy crops, crop residues and sequential crops.
Note: 1 Mtoe = 11.63 terawatt-hours (TWh) = 41.9 petajoules (PJ).

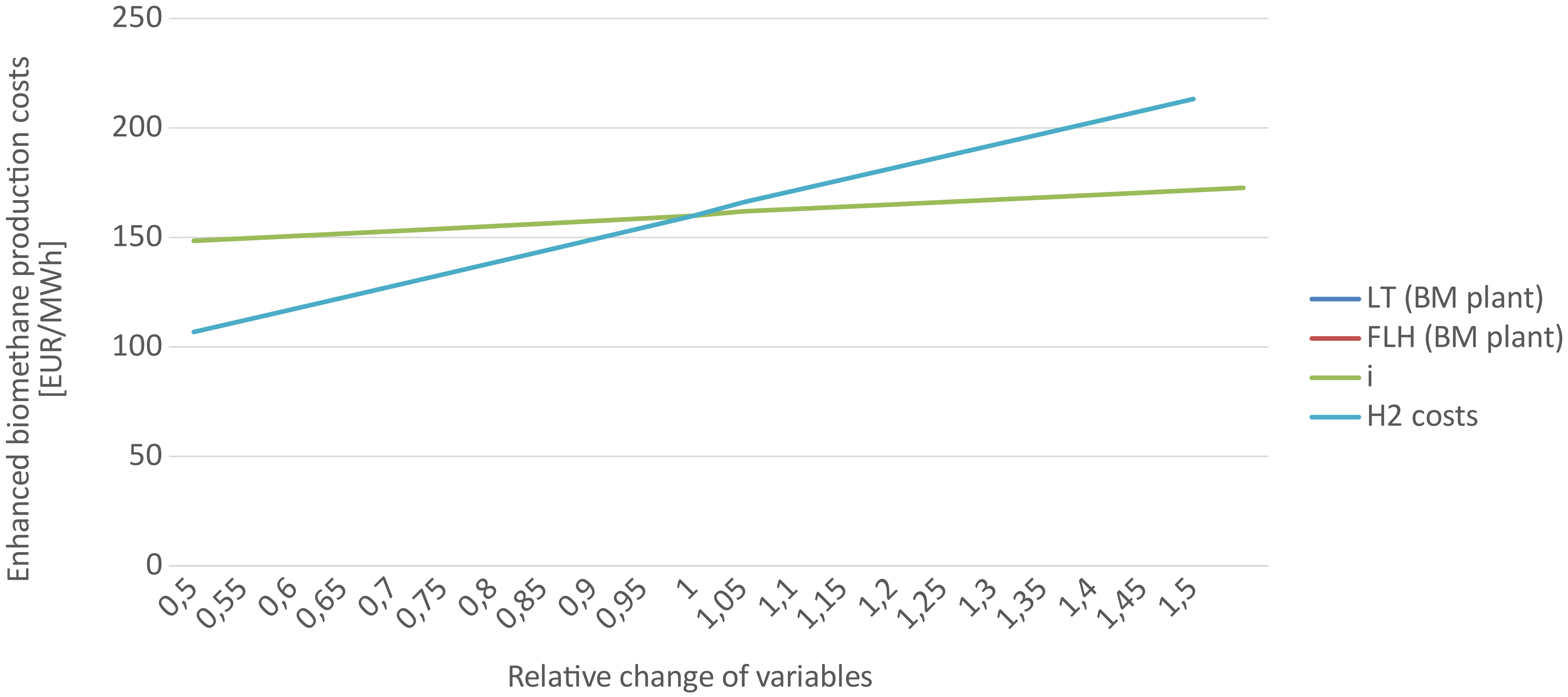
IEA 2020

Results

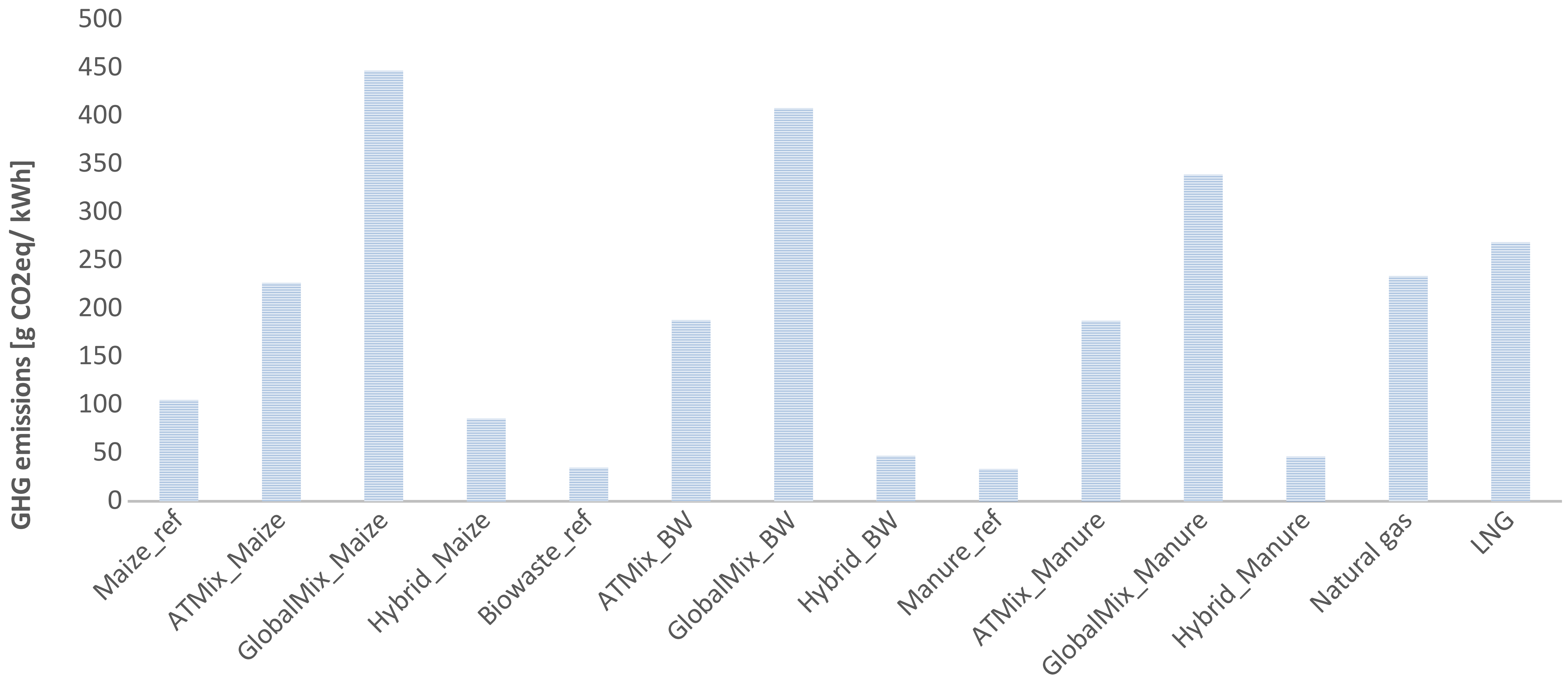
Production costs



Sensitivity analysis

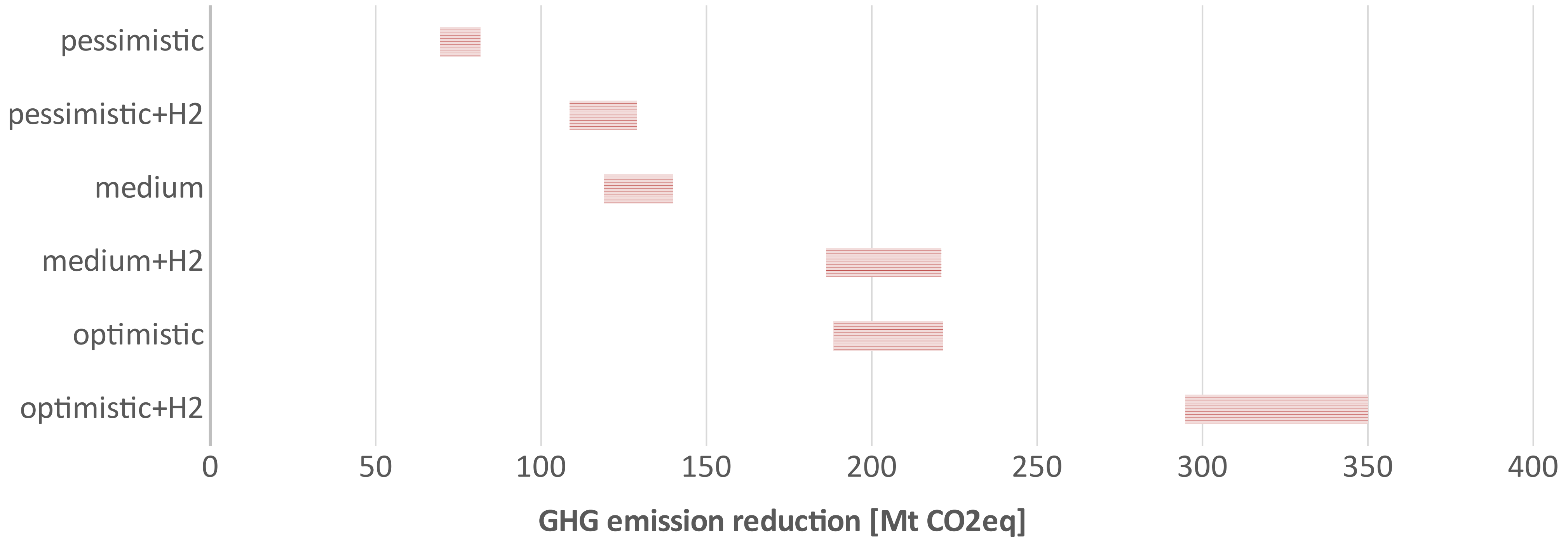


Environmental analysis



BW=Biowaste, ATMix = Austrian electricity mix, LNG=Liquefied natural gas

CO_2 mitigation potential



Conclusions

- Hydrogen-enhanced biomethane production is an effective way of CO_2 utilization
- Production costs increased for the enhanced biomethane production
- Biomethane usage reduces the reliability on fossil fuel imports such as LNG and contributes to emission reduction
- The CO_2 mitigation potential can be increased compared to the reference

- Limitations
  - Uncertainties: Feedstock costs, developments in the transport sector, investment costs, etc.

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