Comparison of Biomass-Based Synthetic Natural Gas Production Scenarios: Cradle-to-Gate Life Cycle Assessment (LCA)

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Background

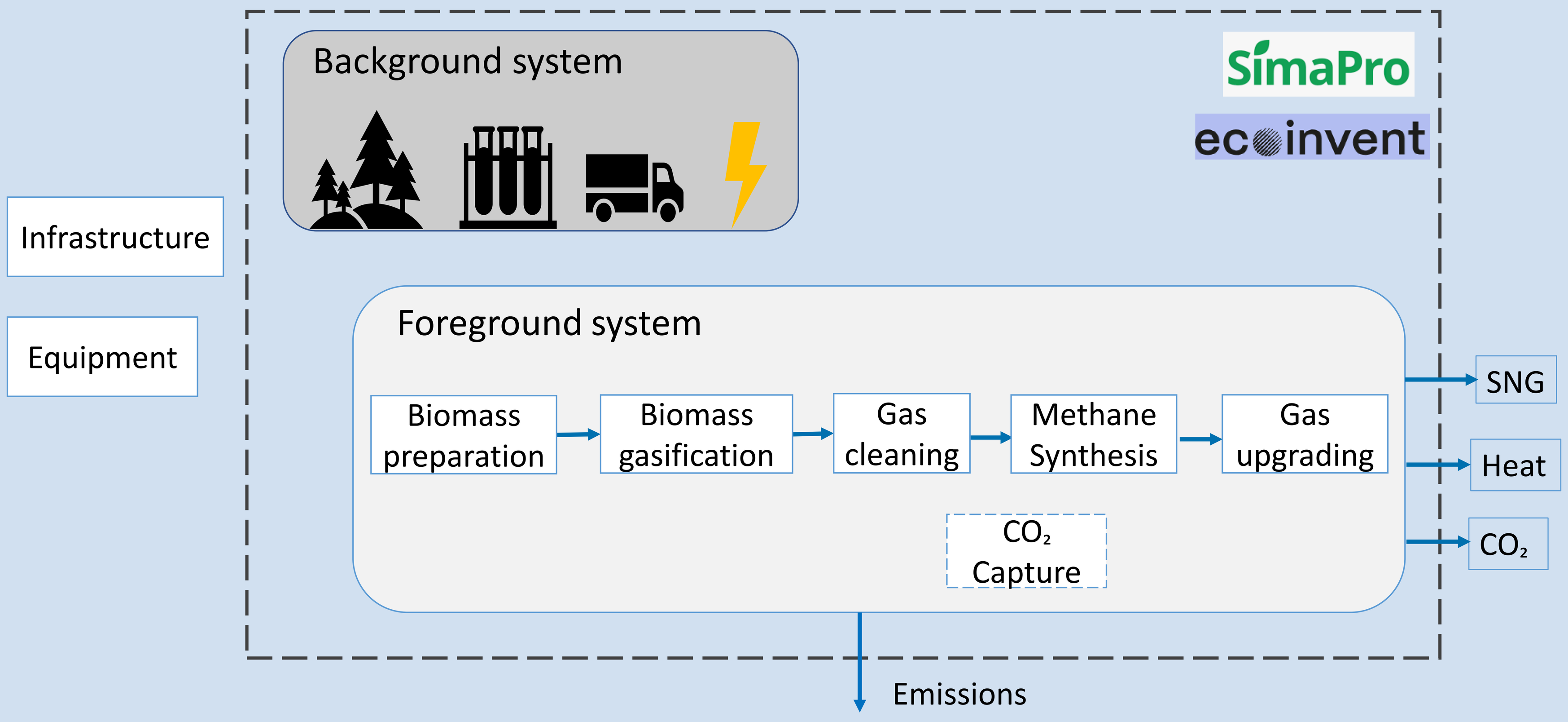
Biomass is a promising renewable resource for producing synthetic natural gas (SNG). The assessment of the environmental footprint usually focuses on comparing it to its fossil counterpart. Therefore, depending on the method, biogenic CO_2 emissions are usually excluded or assumed to be zero. This study includes these emissions and examines broader environmental impacts.

Goal & Scope

- Evaluate the environmental performance of Biomass-based Synthetic Natural Gas (Bio-SNG) process route
- Hotspot analysis and scenario analysis

Assumptions base case BioSNG:

Boundary:	Cradle-to-gate
Functional unit:	1 MWh BioSNG
Allocation:	Physical (energy)
Feedstock:	Wood chips
Location:	Austria
Database:	Ecoinvent 3.10.1



Results

Scenarios: ***BioSNG*** – base case (austrian electricity mix); ***BioSNG*W*** – wind electricity, ***BioSNG*CC*** – Capture of CO_2; ***BioSNG*H₂Ex*** – addition of hydrogen; ***BioSNG*H₂ExW*** – addition of renewable hydrogen & wind electricity.

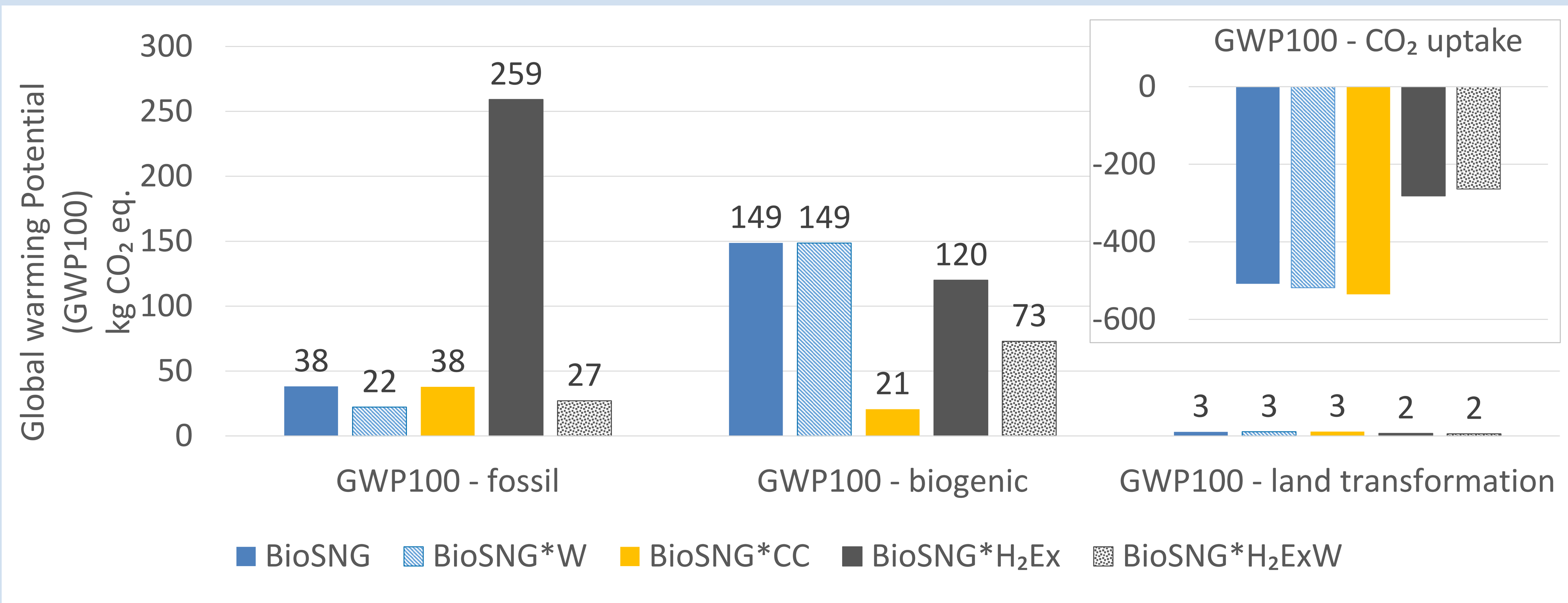


Fig. 1: Life cycle impact assessment results: climate change – method: IPCC 2021 GWP100 (incl. CO_2 uptake) V1.02.

Process contribution - Climate Change: BioSNG

- GWP100 fossil – electricity production and wood preparation (chipping/skidding)
- GWP100 biogenic – direct process emissions (combustion and/or methanation)
- GWP100 land transformation – Rapeseed methyl ester (RME) and wood chips
- GWP100 CO_2 uptake – wood chips

Process contribution – Additional impact categories: BioSNG

- **Acidification**: 90 % direct process emissions
- **Eutrophication**: 97 % direct process emissions (gas cleaning), 3 % wood chips
- **Water use**: 30 % wood chips, 30 % electricity, 40 % gas cleaning
- **Land use**: 98 % wood chips

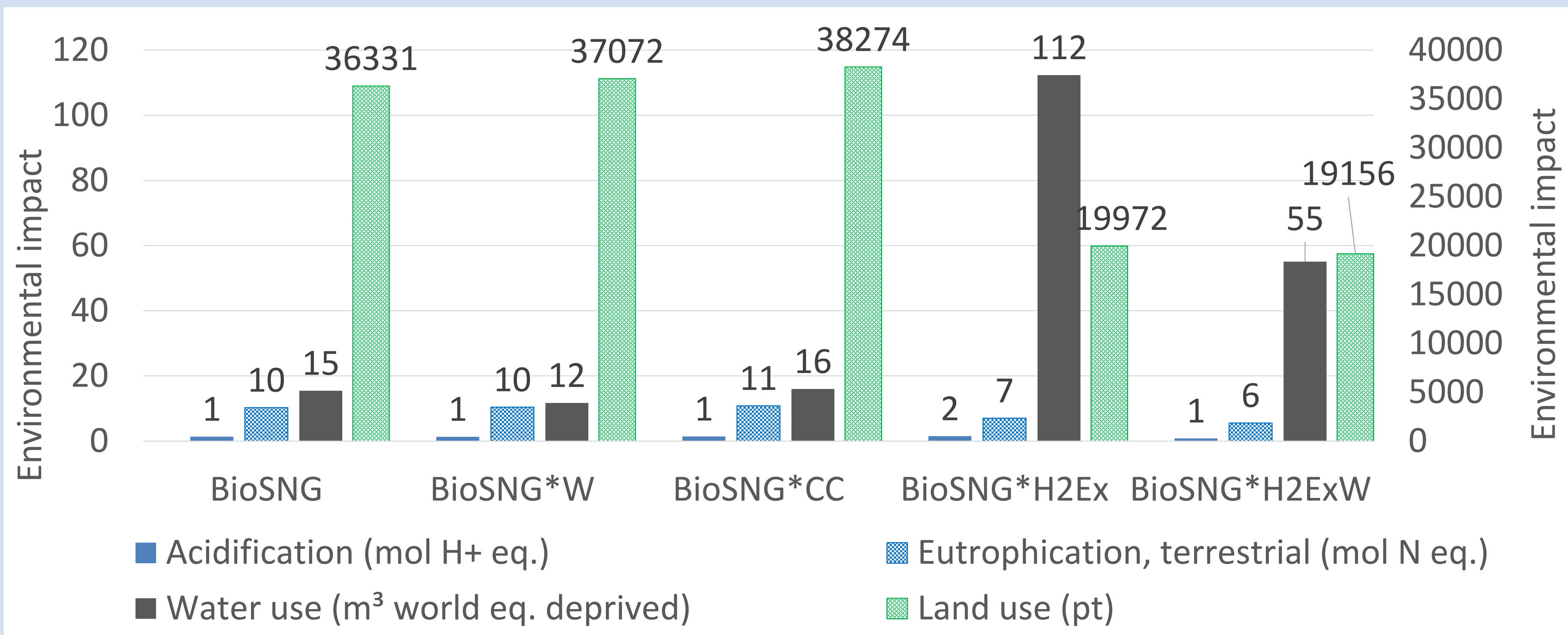


Fig. 2: Life cycle impact assessment results – method: Environmental Footprint 3.1.

Conclusion

- The electricity source plays an important role directly, through BioSNG process route, and indirectly, through the production of the feedstocks
- Illustrating the biogenic CO_2 emissions shows the carbon intensity of the different scenarios
- Addition of hydrogen from electrolysis only in regions where there is no water scarcity
- Optimisation of process route needed to include more feedstocks (waste and residues) to avoid competition for arable land and carbon sinks

Acknowledgements

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Reference

[1] Bartik Alexander. 2024. SNG from biogenic resources. Doctoral thesis. TU Wien, Vienna, Austria.