



Decentralized Hydrogen Production from Woody Biomass via Fixed-Bed Gasification

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Introduction



Sustainable fuels, including solid, liquid, and gaseous bioenergy, hydrogen (H₂), and hydrogen-based fuels, are required to reduce greenhouse gas emissions [1]. In the Hydrogen Strategy for Austria [2], water electrolysis and biomass gasification are pointed out as "especially relevant" pathways for the commercial production of renewable H_2 .

A 100 kW_{H2} demonstration plant (BioH₂Modul) has been built to provide high-purity hydrogen from wood chips for a proton exchange membrane fuel cell tractor (FCTRAC).



Concept & Methodology

- > Decentralized production of 100 kW high-purity H₂ in \ge 3.7 quality (ISO 14687:2019) from wood chips by the BioH₂Modul
- > Process chain BioH₂Modul: fixed-bed gasifier (1), water-gas shift unit (2), rapeseed methyl ester scrubber (3), activated carbon adsorption (4), compression unit (5), pressure swing adsorption (6), and hydrogen refueling station (7) > Fueling of the FCTRAC with 700 bar H₂ by the H₂ refueling station

Isometric view of BioH₂Modul (back)

CHP plant		
Parameter	Unit	Value
Biomass input	kW _{th}	218
Electric power	kW _{el}	50
Thermal power	kW _{th}	110
BioH ₂ Modul		
Parameter	Unit	Value

arameter	Unit	Value
l ₂ output	kg h⁻¹	3
	kW _{th}	100

FCTRAC

Parameter	Unit	Value
H ₂ storage capacity	kg	12.4
Net electric output	k\\/	100



> Integration of the BioH₂Modul into an existing energy center of Glock Ecoenergy in Carinthia (Austria)

- Heat & power can be produced by combined heat & power (CHP) plants by coupling the gasifier with the internal combustion engine (ICE) in months with high heat demand
- High-purity H₂ can be produced by coupling the gasifier with the BioH₂Modul in months with low heat demand

Results & Conclusion

- > Accompanying test runs in pilot-scale proved the technical feasibility of high-purity H₂ production from woody biomass
- Achieved H₂ purity was found to be higher than 99.97 vol.-% on pilot-scale
- **Cold commissioning** of the **BioH**₂**Modul** has already been **completed**
- \succ Techno-economic analysis showed that flexible H₂, electricity and heat production within a multi-product plant is economically conceivable with current Austrian H₂ selling prices [4]

FCTRAC

Outlook

- > **Demonstration** of a **whole value chain** for decentralized H₂ production and utilization will be carried out in mid-2024
- > Optimization objectives may be
 - aiming for **below-zero emission H**₂ production by deploying CO₂ removal technologies
 - flexible H₂, electricity and heat production



[1] IEA, World Energy Outlook 2022, IEA, Paris (2022). https://www.iea.org/reports/world-energy-outlook-2022 [accessed 9 August 2023].

[2] Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, Hydrogen Strategy for Austria - Executive Summary, Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, Vienna (2022). https://www.bmk.gv.at/themen/energie/energie/energieversorgung/wasserstoff/strategie.html [accessed 14 August 2023]. [3] DBI, Broschüre Gasanwendung, DBI (2019). https://www.dbi-gruppe.de/files/PDFs/Flyer_Broschuere/81_Gasanwendung_FY_Monitoring_2014.pdf [accessed 25 November 2019] [4] V. Gubin, F. Benedikt, F. Thelen, M. Hammerschmid, T. Popov, S. Müller, H. Hofbauer, Hydrogen Production from Woody Biomass Gasification: A Techno-Economic Analysis, In: Biofuels, Bioproducts & Biorefining [accepted for publication on 17 May 2024].

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