Lehrstuhl für Wirtschaftliche Staatswissenschaften, insbesondere Energiewirtschaftslehre

Bachelor Thesis

White hydrogen – A potential natural source for clean energy?

Natural (or "white") hydrogen is generated in the subsurface by geological processes such as serpentinization of ultramafic rocks and radiolysis of water and is increasingly discussed as a low-carbon energy carrier that could, if found in commercial accumulations, partly replace oil and gas (Jackson et al., 2024; Mao et al., 2025). Recent assessments suggest that natural hydrogen may have significantly lower production costs than green hydrogen: techno-economic modelling for an Australian case study reports a levelized cost of about USD2/kg under favourable reservoir conditions (Musa et al., 2024), while broader reviews cite cost estimates around USD1/kg and, in some scenarios, as low as USD0.5/kg (Mao et al., 2025).

This bachelor thesis should analyze the potential, costs and challenges of white hydrogen. It should focus on the main geological generation mechanisms (serpentinization, radiolysis), resource and accumulation potential and uncertainties in hydrogen generation rates and reservoir renewability (Jackson et al., 2024; Mao et al., 2025). In addition, the work will examine techno-economic aspects such as production costs, required surface and subsurface infrastructure and the technological maturity of exploration, extraction, transport and storage options, in order to critically assess the future role of natural hydrogen in European and/or global energy markets (Musa et al., 2024; Mao et al., 2025). The influencing factors on the production costs should be identified and reviewed systematically. The production cost data and influencing factors should be benchmarked against costs of other types of hydrogen (EWI, 2025). Based on the gained understanding of white hydrogen production and acquired techno-economic and resource data, a case study for white hydrogen production in Europe should be conducted quantifying the levelized cost of hydrogen (LCOH) and the cost impact of the main influencing factors in a sensitivity analysis.

Key tasks and objectives of the thesis

- Conduct a literature review on the current state of white hydrogen exploration and production
- Investigate the technological maturity of exploration, extraction, transport and storage options
- Examine techno-economic aspects, such as production cost and potentials and systematically review the influencing factors on the production cost
- Benchmark production costs of natural hydrogen against other types of hydrogen, e.g. blue and green hydrogen
- Conduct a case study for Europe, quantifying the LCOH under different scenarios

Your profile

- Student of economics, ideally with focus on energy
- Interest in techno-economic topics, energy markets and green transition

Literature

- **Jackson, O., Lawrence, S.R., Hutchinson, I.P., Stocks, A.E., Barnicoat, A.C. and Powney, M. (2024)**: Natural hydrogen: sources, systems and exploration plays. In: *Geoenergy*, 2(1), geoenergy2024-002. https://doi.org/10.1144/geoenergy2024-002
- **Mao, S., Yu, S., Xu, J., Chen, H., Zhao, W., Blunt, M.J., Kang, Q., Gross, M., Chen, B., Van Wijk, J., Yuan, Q., Gao, K., Kazi, S.R. and Mehana, M. (2025)**: Geologic hydrogen: A review of resource potential, subsurface processes and exploration strategies. In: *Energy & Environmental Science*, 18, pp. 9991–10035. https://doi.org/10.1039/D5EE02910D
- **Musa, M., Hosseini, T., Sander, R., Frery, E., Sayyafzadeh, M., Haque, N. and Kinaev, N. (2024)**: Techno-economic assessment of natural hydrogen produced from subsurface geologic accumulations. In: *International Journal of Hydrogen Energy*, 93, pp. 1283–1294. https://doi.org/10.1016/j.ijhydene.2024.11.009
- **EWI**. (2025): EWI Global PtX Cost Tool V2.1: https://www.ewi.uni-koeln.de/en/publications/ewi-global-ptx-cost-tool-v2-1/

Contact

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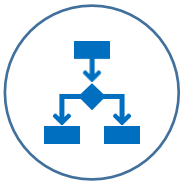
Topics

- White hydrogen
- Market potential of energy carriers
- Green transition

Methods



- Literature review
- Techno-economic analysis
- Levelized cost of hydrogen