323

# Techno-economic targets for solar redox reactors: How solar methanol competes with electricity-based pathways

Jonas Martin[1], Matthias Loevenich[2], Enric Prats Salvado[1], Nathalie Monnerie[1], Christian Sattler[1]

[1]German Aerospace Center (DLR), Institute of Future Fuels, Cologne, Germany. [2]German Aerospace Center (DLR), Institute of Solar Research, Cologne, Germany

**Extended Abstract**

Download file

**Abstract Summary**

The study investigates solar thermochemical methanol production as a potential pathway to decarbonize hard-to-abate transport sectors. While biofuels offer a short-term solution, their long-term scalability is limited. Electricity-based fuels (e-fuels) are promising but depend on large-scale renewable power infrastructure. As an alternative, this research explores solar redox thermochemical processes, which can operate largely independent of the electricity grid.

The proposed system uses concentrated solar radiation to generate high-temperature heat (up to 1,700 °C) to drive a redox reactor that splits water into hydrogen and oxygen. This hydrogen is then combined with $CO_2$ captured from the air to produce methanol. The system is modeled and optimized using DLR's YACOP tool to minimize the levelized cost of methanol, accounting for uncertainties in future technology development.

The analysis focuses on two critical parameters of the solar redox reactor: efficiency and capital expenditure (CAPEX). A Monte Carlo approach is used to evaluate how variations in these parameters affect overall system costs. The results identify target corridors required for solar methanol to remain competitive with e-methanol.

The findings suggest that solar redox thermochemical processes are a promising solution for sustainable fuel production, especially in regions with abundant solar resources. However, achieving cost competitiveness will require significant improvements in reactor efficiency and reductions in CAPEX, alongside continued technological innovation and investment.

**Presenting Author Biography**

Jonas Martin works at the German Aerospace Center in the Institute of Future Fuels, where he conducts techno-economic analyses in the Department for Evaluation of Solar Production Processes. In addition to his work on process simulation and cost optimization, he leads a major DLR project on solar fuel production across several institutes. He holds a PhD in Industrial Economics and Technology Management from the Norwegian University of Science and Technology.