Abstract TEMPEL

Temperature enhanced electrolysis, full cSBO with a proposed starting date on 1 January 2022 and a proposed duration of 36 months, with partners VITO, IMEC, UAntwerpen, UGent and KU Leuven.

Context

The future energy system is based on renewable sources for the supply of electricity, heat or fuels and will require an interconnected system of H_2-based energy carriers and adequate technologies, capable of converting energy vectors in the most efficient way. Green H_2 production is key in transition path 3 of the VLAIO/Deloitte study[1], i.e. its supply needs to triple by 2050, while the Hydrogen Council even estimates a 10-fold increase[2]. TEMPEL aims at producing electrolytic H_2 assisted by heat delivered at 150 to 400 °C, increasing the system's electrical efficiency. The process temperature affects the electrolysis' entropy contribution (TΔS) by turning heat almost equivalent to electric energy (fig.1). This is a very attractive value proposition, since such utilization can be more CO_2-friendly than converting heat to electricity (e.g. via ORC) or recover residual heat for process heating.

Innovation goals

High-temperature electrolysis (HTE) is setting its first steps into (subsidized) commercialization, operating from 600 to 850°C, but faces serious material and design challenges, causing its lifetime (<10 khrs) to be much lower than of LTE (>40 khrs), inherent to this high-temperature operation.

TEMPEL develops medium-temperature electrolysis (MTE) that already offers thermodynamic efficiency gains, suppressing OPEX significantly, and bypasses the material degradation intrinsic to HTE.

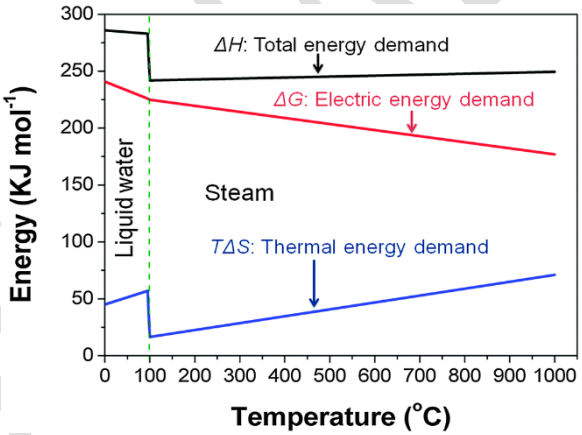

Figure 1: Decrease of electric energy required (red) with increasing operational temperature for steam electrolysis.

The major hurdle to tackle is that **no electrolyte materials with sufficient conductivity exist** in this temperature range. TEMPEL seeks to develop key enabling material here and answer integration challenges with advanced synthesis processes. MTE provides opportunities within different sustainability strategies in the process industry, such as residual heat valorization (potential of 180 TWh at 200 – 500 °C in EU), green heat conversion from CST and exothermic heat upgrading from CO_2 hydrogenations, in the context of Power-to-X.

For substantive questions about this project proposal, please contact MOT4 representative Jeroen van Walsem (jvanwalsem@catalisti.be; +32 497 731 175).

[1] Naar een koolstofcirculaire en CO2-arme Vlaamse industrie, Deloitte (2020)
[2] 'Hydrogen scaling up', https://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-scaling-up-Hydrogen-Council.pdf (2017)