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Hydrogen: the state of art

At present, the European Union has an annual hydrogen consumption of 9.7 million tonnes. Unfortunately, 95% of this hydrogen is produced from natural gas and oil, resulting in the co-production of CO_2, a significant greenhouse gas [1]. The remaining 5% of hydrogen is generated through electrolysis [2], although the majority of this production relies on non-renewable sources. Hydrogen finds its primary use in the chemical industry, particularly for the production of ammonia and methanol, as well as in oil refining, metal treatment, semiconductor production, and other applications.

Moreover, hydrogen possesses immense potential as a large-scale energy storage medium for renewable electricity sources. Given the intermittent nature of most renewable electricity generation, **surplus electricity can be effectively stored as hydrogen to prevent energy wastage**. For that, electrolysis can be used. There are several types of electrolyzer (EL) available, including Alkaline Electrolyzer (AEL), Polymer Electrolyte Membrane Electrolyzer (PEMEL), and Solid Oxide Electrolyzer (SOE). The efficiencies of AEL, PEMEL, and SOE are approximately 60%, 70%, and 85%, respectively [3].

Intensive research is currently being conducted on the SOE, owing to its high efficiency, which has garnered considerable interest. SOE systems typically operate within a temperature range of 700°C to 850°C. One significant advantage of these systems is their ability to operate in reversible modes (SOFC/SOEC). This allows for the continuous generation of electricity and/or hydrogen, along with the concurrent production of heat. This feature can be advantageously used in a wide range of waste heat valorization applications, including integration with a steam cycle.

Electrolysis

A way forward for clean fuel production

H_2

References

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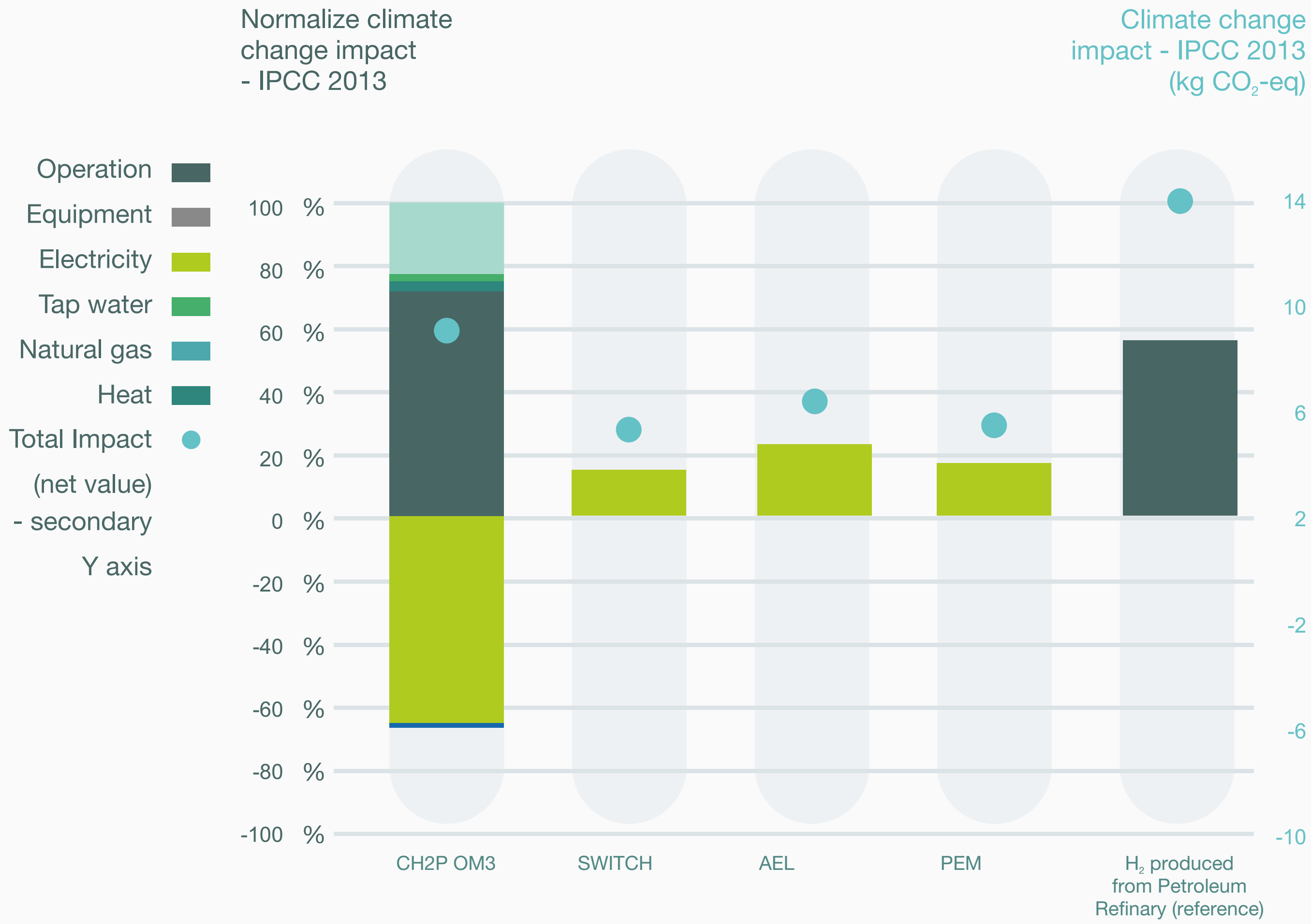
H_2 production technologies comparison on climate change impact



Environmental Impact Assessment: *SWITCH vs. Other Hydrogen Production Technologies*

In the SWITCH project, which can be considered an extension of the CH2P project, the primary focus lies on the reversible mode operation of SOC. This mode is utilized to generate hydrogen (H_2) when there is surplus renewable electricity available (clean H_2).

The environmental assessment of the SWITCH mode, developed within the project, is primarily analyzed using the life cycle thinking approach, following the guidelines set by ISO 14040, ISO 14044, and FC-HyGuide. The functional unit for comparison in future applications is defined as 1 kg of H_2 produced in the SWITCH system. The system expansion method is employed to address the multifunctionality of the system. Four technologies have been selected for comparison: CH2P OM3, SWITCH, AEL, PEM, and H_2 produced from traditional steam methane reforming.

The chart depicts the effects of climate change, indicating favorable outcomes for the SWITCH system when employing SOEC. The CO_2 emissions are comparable to those produced by PEM electrolyzers. Moreover, the SWITCH project showcases a notable reduction of more than 30% in CO_2 emissions compared to the AEL technology.

Clean Hydrogen Partnership

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