High temperature electrolysis: a 20-year journey from material developments to multi-MW electrolysers deployment

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Keywords: high temperature electrolysis, solid oxide electrolysis, SOEL, solid oxide cell, SOC, ceramic materials, performance, durability

Compared with other electrolysis technologies, Solid Oxide Electrolysis (SOEL) technology offers the highest efficiency on the market, as the high-temperature process significantly reduces electricity consumption, particularly when industrial waste heat is used to generate steam. Therefore, this technology has attracted a significant interest since the 1990s, taking advantage of the previous research activities performed on Solid Oxide Fuel Cells (SOFCs). Materials have been carefully selected or developed, concomitantly with the microstructures and interfaces, in order to reach high performances and adequate durability in the severe operating conditions implemented (high temperatures, > 650°C, and oxidizing environments (steam, oxygen)). Cells and stacks architectures have been optimized, in order to reach increasing levels of power. Modules and systems have been designed to maximize efficiency and decrease cost.
Compared to alkaline electrolysis and proton exchange membrane electrolysis, SOEL is still less mature. However extensive performance and durability studies have been performed at various relevant scales, and proof-of-concept demonstrations at increasing scale are now available. Recently SOEC systems have been deployed at multi-megawatt scale.
The presentation will provide an overview of the developments performed over the years, from materials developments and optimization to multi-MW electrolyzers deployment, through cell, stack and module development, characterization and industrialization. Latest field tests results obtained in an industrial environment will be presented. Figure 1 illustrates the SOEL related R&D activities performed at CEA over the last 25+ years.

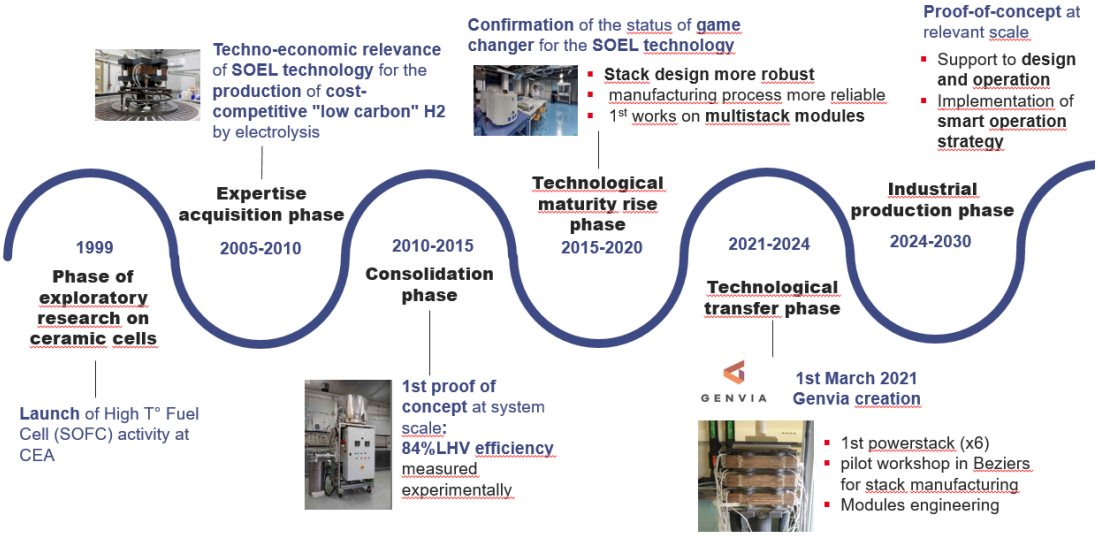

Figure 1: Illustration of the SOEL related R&D activities performed at CEA over the last 25+ years

Acknowledgements

Some activities and results presented in this article have been obtained, among others, in the frame of PEPR H2 CELCER-EHT project, MULTIPLHY project (Clean Hydrogen Partnership grant agreement No 875123), and in the frame of a collaboration between GENVIA and CEA.