# ECO-DESIGN AND ENVIRONMENTAL PERFORMANCE OF SOLID OXIDE TECHNOLOGY

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## ABSTRACT

Solid oxide cells (SOCs) are a group of electrochemical devices within FCH (fuel cells and hydrogen) technologies able to operate reversibly for power generation as solid oxide fuel cells (SOFCs) and for hydrogen production as solid oxide electrolysis cells (SOECs). SOCs operate at very high temperatures, typically between 650-850°C, and reach high energy efficiency by heat utilization. Solid oxide technology is still not widely commercialized. Despite the significant improvements in the last two decades, some major challenges are still unmet and must be addressed to achieve their market breakthrough. When addressing the sustainability of SOC technology, environmental, social, and economic parameters must be addressed. One desirable option refers to the implementation of actions based on the eco-design strategy wheel throughout the life cycle of the technology. Within the EU-funded project eGHOST, eco-design actions addressing all axes of the eco-design strategy wheel were assessed. Two product concepts were defined for SOEC: (i) enhanced realistic, and (ii) optimistic concept, with the goal of improving the sustainability of the SOC technology. Actions within axis 1 (selection of low-impact materials) and axis 7 (optimization of end-of-life, EoL) are further linked to the recycling industry-oriented EU-funded BEST4Hy project, which deals with recycling technologies of SOFCs. Namely, yttria-stabilized zirconia (YSZ) and nickel oxide (NiO) on the anode, and lanthanum (La) and cobalt (Co) on the cathode side. These are materials that generally have high environmental impacts in the manufacturing phase, and most of them are on the list of EU critical materials.

The results presented in this paper are therefore a combination of two EU-funded projects: i) results of the SOEC eco-design approach within eGHOST, and ii) EoL strategies for recycling the main materials within the SOC technology from BEST4Hy. The environmental profile of both aforementioned SOEC product concepts is evaluated and compared with the base case defined in the eGHOST project, using the life cycle assessment (LCA) methodology. Improving the environmental profile of the SOEC, by using recovered target materials (YSZ, NiO, La, Co), is the focus of the evaluated actions of the eco-design wheel (based on the eGHOST project) and the considered multi-stage EoL recovery process (based on BEST4Hy findings), which is checked in this work.

***Keywords:*** Solid oxide technology, eco-design, recycling, criticality, life cycle assessment, hydrogen economy

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