

Decarbonisation acceleration with TOPSOE Power-to-X technology

As glass manufacturers pursue deep emissions reductions, TOPSOE is expanding its role through solid oxide electrolysis cell technology that enables efficient production of low-carbon hydrogen from renewable electricity - building upon decades of catalytic emissions-control collaboration and supporting fuel-switching pathways for hard-to-electrify high-temperature glass furnaces worldwide.



For more than 80 years, Topsoe has been built on science, innovation and applied chemistry. Today, the company is expanding its contribution to glass decarbonisation through its solid oxide electrolysis cell (SOEC) technology - a key component of its Power-to-X portfolio that enables the production of low-carbon hydrogen from renewable electricity.

This step builds on more than two decades of collaboration with glass manufacturers, during which Topsoe has delivered -and continues to provide- catalytic filtration technologies that reduce industrial emissions. These solutions support advanced De-NOx processes, ammonia control, CO and VOC removal, and the destruction of dioxins (PCDD/F).

Headquartered in Kongens Lyngby, Denmark, and operating globally across Europe, Asia and the Americas, Topsoe aligns its technologies, catalysts and services around a single ambition: enabling the energy transition for energy-intensive industries.

This scientific heritage underpins the company's approach to some of the world's most complex industrial decarbonisation challenges. Glass manufacturing represents one of these challenges, as it belongs to the

category of hard-to-electrify industries that account for approximately 30 percent of global greenhouse-gas emissions, where continuous high-temperature processes make full electrification difficult to achieve.

In glass production, fuel switching away from fossil energy sources offers the largest single opportunity for CO₂ reduction. However, this transition must be achieved without compromising furnace performance, product quality or plant economics.

EFFICIENCY

Topsoe's solid oxide electrolysis cell (SOEC) technology is positioned as a key enabler in this transition. Operating at temperatures of around 700-750°C, SOEC performs high-temperature steam electrolysis with higher electrical efficiency than conventional alkaline or PEM electrolysis technologies.

Efficiency increases further when additional heat or steam from industrial processes is integrated, improving overall energy utilisation and reducing the electricity required for hydrogen production.

This characteristic makes SOEC particularly attractive for industries such as glass manufacturing, where large volumes of high-grade waste heat are already present. By integrating steam from existing processes, electrolysis efficiency can increase

significantly while reducing overall electricity demand.

ECONOMICS

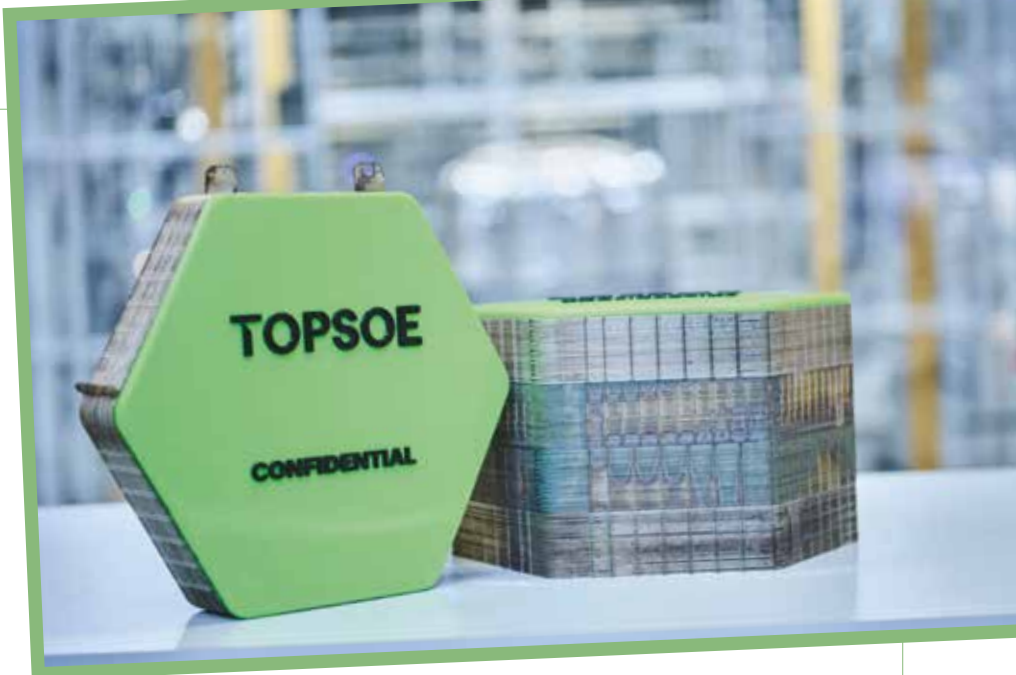
Higher efficiency directly improves project economics. With steam integration, SOEC can deliver up to 20 percent more hydrogen per megawatt of electricity input, enabling higher hydrogen output for a given electricity input.

Over long operating periods, this translates into higher hydrogen yields and improved project economics compared with conventional electrolysis technologies. In markets facing volatile electricity prices and tightening emissions constraints, these characteristics can strengthen the economic case for hydrogen-based fuel switching in glass furnaces, particularly where low-carbon electricity and supportive policy frameworks are available.

INTEGRATION

Decarbonising glass production requires more than hydrogen supply alone. Hydrogen combustion introduces new technical requirements, including burner redesign, refractory and insulation adjustments, potential oxygen integration, and dedicated hydrogen storage and handling systems.

Topsoe therefore collaborates with technology partners across the glass value chain to enable the integration of hydrogen into industrial



NET ZERO

furnace operations. This includes collaboration with OEMs and glass manufacturers on hydrogen-compatible burner concepts, oxygen system integration and plant-level hydrogen supply configurations.

In parallel, Topsoe supports feasibility studies, business case development and public funding applications to help overcome the high capital costs and long investment cycles associated with industrial decarbonisation.

Hydrogen utilisation in glass furnaces has already been demonstrated in collaborative initiatives led by Stazione Sperimentale del Vetro and its industrial partners, where hydrogen-based combustion has been tested in glass manufacturing processes. Results from these demonstrations confirm the technical feasibility of integrating hydrogen into glass furnace operations and provide valuable insights for future large-scale deployment.

TOWARDS A NET-ZERO GLASS INDUSTRY

Looking ahead to 2050, studies indicate that full decarbon-



isation of the glass sector will require a portfolio of solutions. While hydrogen is expected to contribute a meaningful share of the future fuel mix, the majority of emissions reductions will likely come from electrification, increased cullet use, alternative raw materials and, where necessary, carbon capture technologies.

Within this multifaceted pathway, SOEC-based Power-to-X solutions can serve as a critical bridge between renewable electricity and the operational realities of industrial glassmaking, enabling the production of low-carbon hydrogen and synthetic fuels that support deep emissions reductions in high-temperature industrial processes.

By combining decades of catalytic expertise with next-generation electrolysis technologies, Topsoe continues to expand its role in supporting glass manufacturers as they move from incremental efficiency improvements towards credible Net-Zero glass production pathways. ■

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