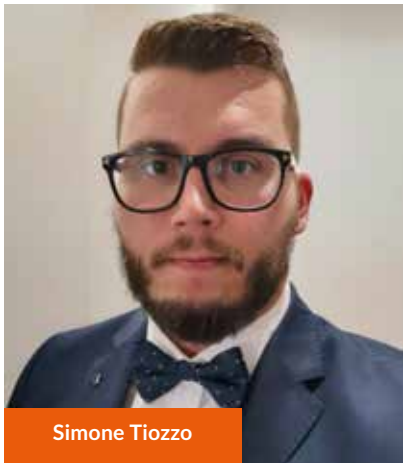
# Hydrogen milestones reached by the Horizon Europe H2GLASS Project



Simone Tiozzo

Within the framework of the Horizon Europe H2GLASS project, Stazione Sperimentale del Vetro has played a central role in the first industrial-scale hydrogen combustion trials conducted in oxy-fuel glass furnaces. These trials, carried out at Steklarna Hrastnik in Slovenia and at Owens Corning facilities in France, represent a significant step toward understanding how hydrogen can be integrated into existing glass manufacturing processes while maintaining product quality, process stability and environmental performance.

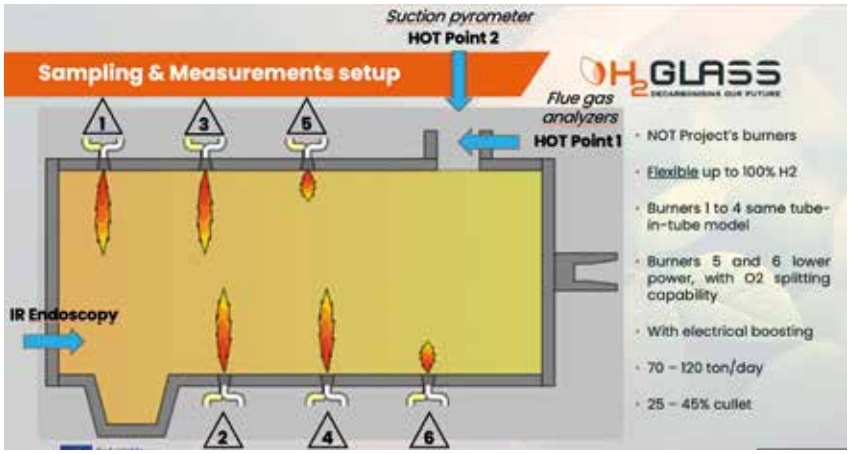
The H2GLASS project, running from January 2023 to June 2027, aims to develop and demonstrate hardware and software solutions that support the replacement of fossil fuels with hydrogen in the glass and aluminium sectors. The ultimate objective is to enable 100 percent hydrogen combustion while ensuring process safety and the required product quality. Within this context, the trials coordinated and analysed by Stazione Sperimentale del Vetro focused on validating hydrogen combustion under real industrial operating conditions.

## INDUSTRIAL HYDROGEN TRIALS AT STEKLARNA HRASTNIK

At Steklarna Hrastnik, two campaigns of grey hydrogen combustion trials were conducted in an oxy-fuel, high-quality flint soda-lime container glass melting furnace. The first campaign took place from 20 to 24 November 2023 and consisted of single-day discontinuous trials operated at a low pull rate. The second campaign followed from 27 November to 1 December 2023 and involved three consecutive days of continuous operation at a high pull rate.

Hydrogen was supplied by truck and fed through an $H_2$ skid with a maximum flow rate of 600 $Nm^3/h$, divided into two branches capable of supplying one left-side and one right-side burner at a time. The system allowed operation at a blending rate of up to 100 percent

**Hydrogen combustion trials performed at the industrial demonstrator sites of Steklarna Hrastnik and Owens Corning, and scientifically monitored on site by STAZIONE SPERIMENTALE DEL VETRO demonstrated that up to 100 percent hydrogen firing in oxy-fuel glass furnaces is feasible without compromising glass quality, production stability or energy efficiency – all whilst enabling substantial reductions in carbon dioxide emissions.**




hydrogen on selected burners (leaving the rest powered by natural gas), corresponding to a maximum of approximately 33 percent of the total energy input from hydrogen, equivalent to around 60 percent hydrogen by volume in the overall fuel feed.

The trials were conducted on an existing industrial furnace equipped with electrical boosting, processing between 70 and 120 tonnes of glass per day and operating with cullet levels ranging from 25 percent to 45 percent. Extensive sampling and measurement setups were installed, including suction pyrometers, flue-gas analysers and IR endoscopic cameras, enabling detailed monitoring of temperatures, combustion behaviour and emissions.

## COMBUSTION BEHAVIOUR AND OPERATIONAL STABILITY

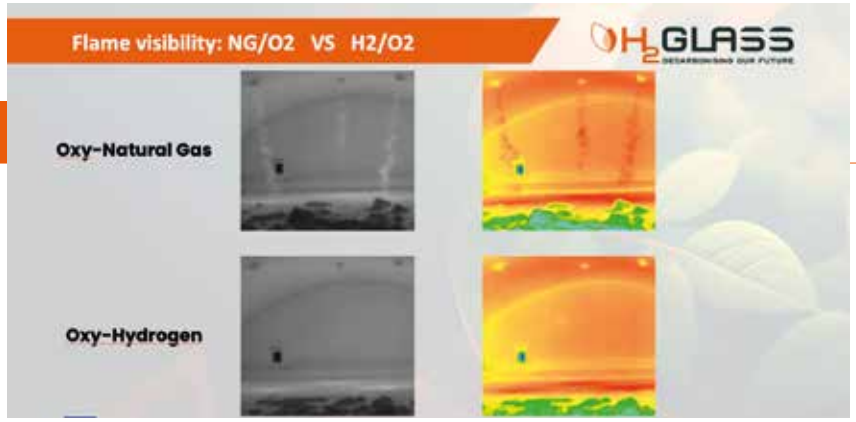
During the first week of trials, three single-day tests were designed to investigate the impact of hydrogen combustion on pairs of opposite burners positioned in different zones of the furnace. Despite initial hardware issues related to hydrogen flow meters, recalibration allowed tighter control of the combustion atmosphere. Once stable conditions were achieved, no adverse effects on energy consumption, production rate or glass quality were observed.

At a low pull rate, operation with 100 percent hydrogen on selected burners did not lead to flame formation problems. During the second week, the focus shifted to continuous 24/7 trials with increased pull rates, rising from 70 to 115 tonnes per day. Although flame lifting issues occurred on one burner at high power, operational adjustments allowed the trials to continue without any interruption or adverse impact upon glass production. Any impact on glass quality or colour was indistinguishable to the untrained eye.

## EMISSIONS ANALYSIS AND NORMALISATION

A key contribution of Stazione Sperimentale del Vetro was the rigorous acquisition, elaboration and normalisation of emissions data. Raw dry flue-gas concentrations were translated into pollutant mass flow rates and then into specific emissions expressed per tonne of molten glass. This approach enabled reliable comparisons between natural gas and hydrogen-blended combustion.

Under low pull rate conditions, nitrogen oxide emissions were found to be more strongly influenced by combustion ratio optimisation and residual oxygen levels than by fuel switching itself. When residual oxygen concentrations were comparable, no relevant differences were observed between natural gas and 60 percent hydro-




gen blends. At high pull rates, once combustion systems were properly tuned, nitrogen oxide specific emissions remained unchanged or even showed a slight decrease - approximately 5 to 6 percent - when switching from natural gas to hydrogen-blended fuel.

The trials demonstrated that a volume blending of up to 60 percent of hydrogen-blended fuel does not have a negative impact on nitrogen oxide emissions in oxy-combustion conditions, provided that burners, skids and combustion control systems are appropriately managed.

## VOLATILE ELEMENTS AND GLASS QUALITY

Discontinuous sampling of volatile metals, including selenium and antimony, showed that switching from natural gas to 60 percent volume of hydrogen-blended fuel did not produce a strong impact on evaporation or sublimation of these elements. Observed variations were more closely linked to pull rate and overall furnace temperature regimes than to fuel composition.

Analyses of produced glass articles confirmed these findings. The retention level of selenium in the glass bulk remained substantially constant throughout the hydrogen combustion trials. Colour measurements, viscosity, redox ratio and XRF analyses indicated that the glass properties remained essentially unchanged, with only very slight colour variations that were not appreciable to the untrained eye.

## INDUSTRIAL HYDROGEN TRIALS AT OWENS CORNING

Further industrial trials were conducted at Owens Corning facilities in France, with the objective of preparing for long-duration green hydrogen combustion. These trials involved oxy-fuel furnaces with electrical boosting and focused on boron-free continuous filament reinforcement glass fibre production.

Over two weeks of testing in November and December 2024, hydrogen substitution levels were progressively increased, reaching up to 100 percent hydrogen combustion for extended periods. Despite logistical challenges in hydrogen supply, stable furnace operation was achieved. At high hydrogen substitution levels, no negative impacts on furnace or glass temperatures were detected, while more than 95 percent reduction in carbon dioxide emissions was achieved, with residual $CO_2$ attributed to raw material impurities.

## TOWARD OPTIMISED HYDROGEN COMBUSTION IN GLASS FURNACES

Across both industrial sites, the trials coordinated and analysed by Stazione Sperimentale del Vetro demonstrated that hydrogen combustion can be integrated into existing oxy-fuel glass furnaces without compromising production stability, glass quality or energy efficiency. The results highlighted the critical importance of optimised burner design, precise combustion control and a well-engineered hydrogen supply ecosystem. These findings provide a robust technical foundation for future long-duration trials with green hydrogen and represent a concrete step toward decarbonising industrial glass manufacturing.



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# MARCH 03-05, 2027

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