



GLASSMAN, ISTANBUL - MAY 2025

# The future of glass furnaces: revolution or optimization? Both!

Ernesto Cattaneo – STARA GLASS

Glass industry  
is emitting about 5%  
of the total European  
industrial CO<sub>2</sub>

What can we do?





# The four pillars of decarbonization





# Active Innovation Project

## SUGAR Project

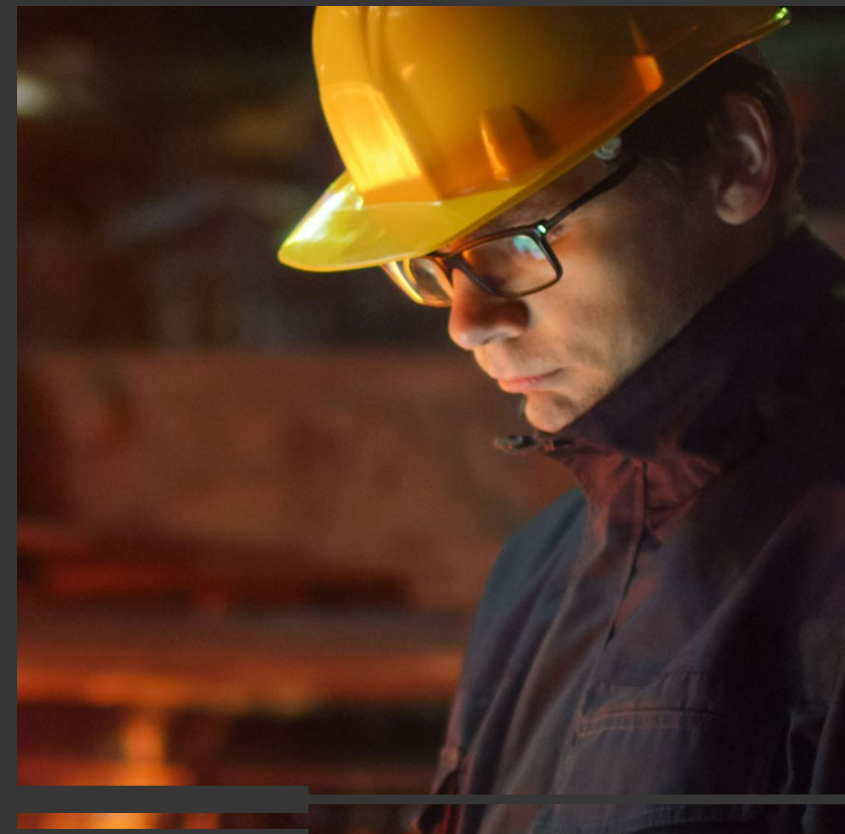
SUustainable Glass: Architecture of a furnace heat recovery system including a steam Reformer

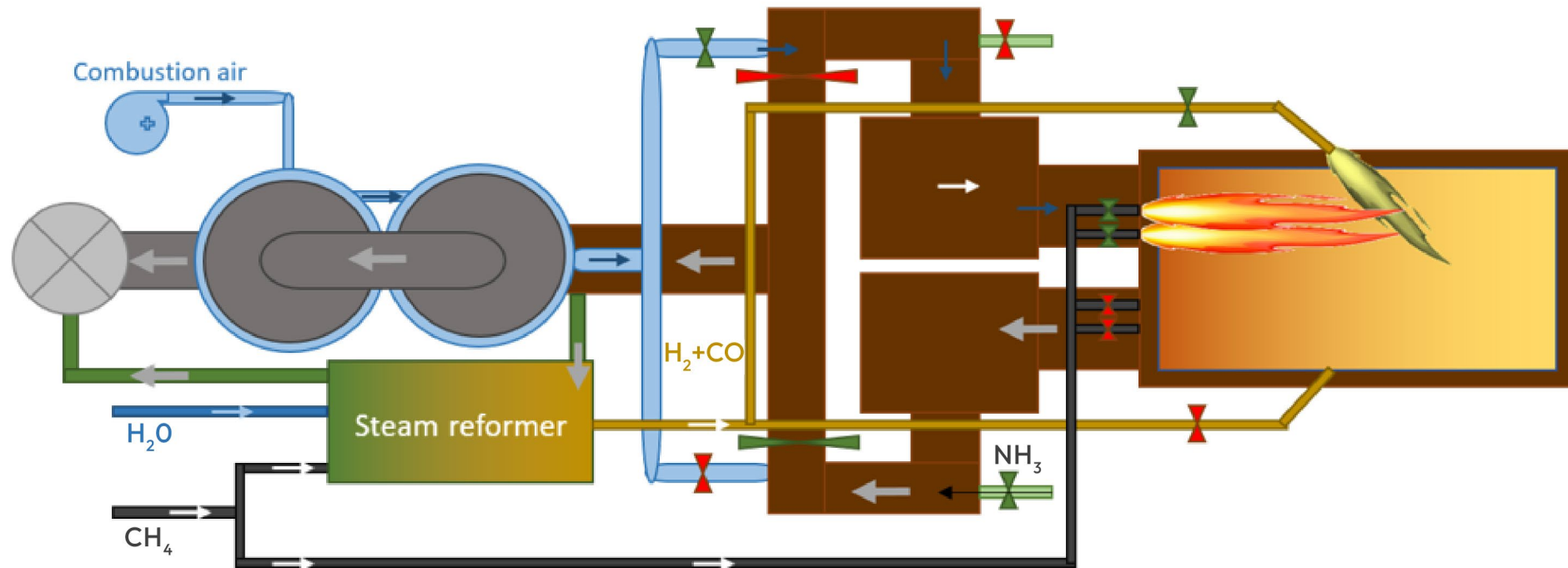
Regenerative furnaces release waste gas at approximately 500 °C, containing significant energy potential. While this heat can be partially reused within the melting process, methods like batch and fuel heating often prove insufficient for fully recovering the available energy due to technical limitations.

We leveraged the unique design of Centauro to use this thermal energy for steam reforming, converting methane into hydrogen. This approach transforms the chemical reaction into an energy vector, enabling a fully optimized furnace that can reduce energy consumption by about 15% compared to standard regenerative technology.



[Discover more](#)



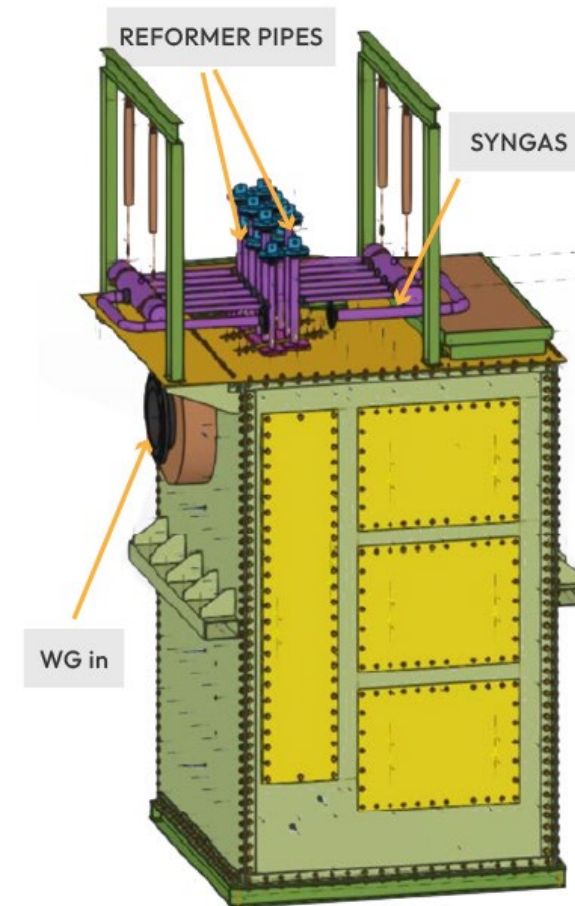


## Progress:

- The technology has been validated at the laboratory scale.
- A suitable catalyst has been selected.
- In May 2025, a pilot -scale component will be installed at the Vetrerie Meridionali (O-I) facility in Castellana Grotte, Italy.
- The development of the application for oxy -fuel furnaces is ongoing.

## Target:

Technology market -ready by 2026.

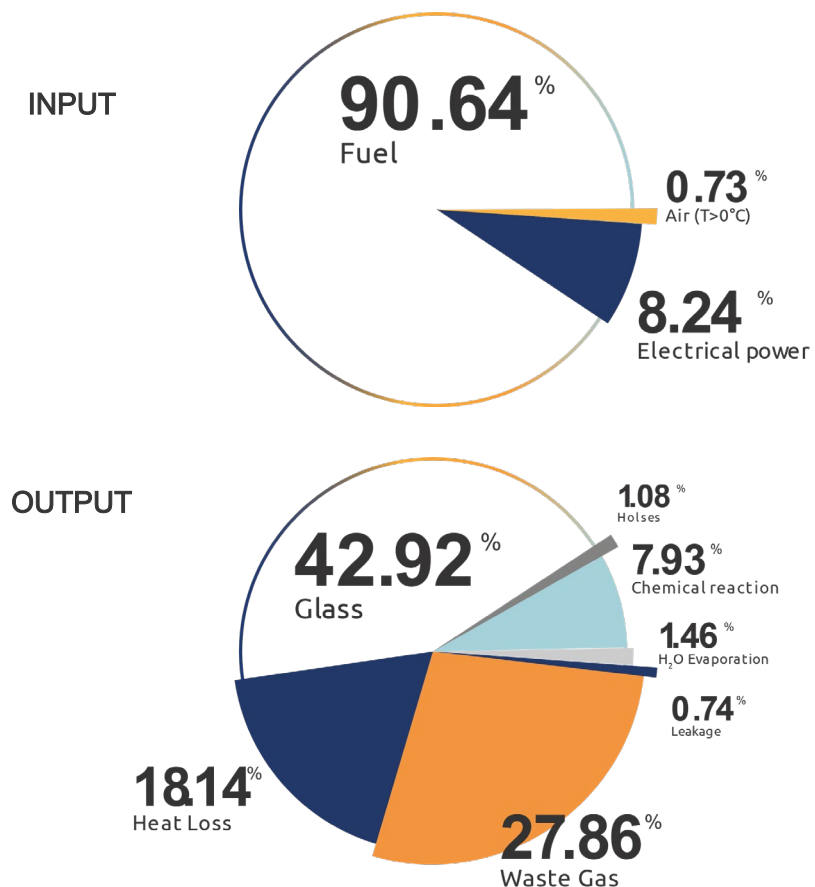


Heat balance is a 3-5 days campaign of measurements, performed by 3-6 specialists, that is able to provide the “as is” of the furnace in terms of the thermodynamics involved.

Our experts, while performing the activity, are often able to provide the Customer with useful suggestions regarding furnace optimization. Once all data are collected, the Customer receives a report that accurately describes the working condition and suggests the strategies to optimize operation.

This activity allows for:

- ① Check general plant conditions.
- ① Maximizing performance, in terms of consumption and quality.
- ① Understand the strengths and weaknesses of the furnace, in order to address issues and optimize the following campaign design.
- ① Verify the precision of all the measuring equipment installed on the plant.



The FurnaceMaster© software by Stara Glass is designed to assess structure costs during the design phase, enabling price and performance comparisons while balancing **OpEx** (operating costs) and **CapEx** (capital expenditure).

Solutions the designer can adopt:

- Efficient heat recovery system
- High-quality insulation
- Thermal-economic optimization

Glass manufacturers often request furnaces with specific dimensions, productivity, boosting power, and cullet percentage while aiming to reduce consumption, pollution, and investment costs.

**FurnaceMaster** - Regenerative furnace

Author: Ernesto Cattaneo

Item	Value
Company	Furnace
Furnace	250
Full [t/day]	75
Melting area [m <sup>2</sup> ]	1.5
CO <sub>2</sub> access at the port [%]	600
Boosting [kW]	1370
Glass temperature at the throat [°C]	20
Room air temperature [°C]	1540
Furnace waste gas outlet temperature [°C]	0
CO <sub>2</sub> flow [Sm <sup>3</sup> /h] (CO <sub>2</sub> = 93%)	3
Fuel: CH <sub>4</sub> = 1, Dense oil = 2, CH <sub>4</sub> -Oxy = 3	50
Chamber couples number	1
Cullett [%]	3
Mix humidity [%]	3.00
Initial fuel flow [Sm <sup>3</sup> /h]	350
Preheated air temperature [°C]	1310

Item	Value
Air port leakage [Sm <sup>3</sup> /h]	100
Waste gas port infiltration [Sm <sup>3</sup> /h]	150
Furnace infiltration [Sm <sup>3</sup> /h]	300
Waste gas chamber infiltration [Sm <sup>3</sup> /h]	200

Item	Value
Air port leakage [Sm <sup>3</sup> /h]	50
Waste gas port infiltration [Sm <sup>3</sup> /h]	150
Furnace infiltration [Sm <sup>3</sup> /h]	300
Waste gas chamber infiltration [Sm <sup>3</sup> /h]	200

Holes	T [°C]	Flow [Sm <sup>3</sup> /h]	Radiation heat [kcal/h]	Total heat [kcal/h]
Hole 1	1400	150	0	76571
Hole 2	1400	0	10000	0
Hole 3	0	0	0	0
Hole 4	0	0	0	0
<b>Total</b>	<b>2800</b>	<b>150</b>	<b>10000</b>	<b>76571</b>

Item	Value
Specific consumption [kcal/kg]	905
Fuel flow [Sm <sup>3</sup> /h]	1097
Specific useful heat [kcal/m <sup>2</sup> h]	1040
Fuel cost [€/Sm <sup>3</sup> ]	0.42
Electric energy cost [€/kWh]	0.125
CO <sub>2</sub> cost [€/Sm <sup>3</sup> ]	0.11
CO <sub>2</sub> [€/ton]	80

Item	Value
Regenerative furnace	1155000
Tank [kcal/h]	50338
Waste gas port [kcal/h]	43961
Air port [kcal/h]	111023
Waste gas chamber [kcal/h]	87983
Air chamber [kcal/h]	1443206
<b>Total</b>	<b>1443206</b>

Item	Value
Tank [kcal/h]	1150 / 1444
Waste gas port [kcal/h]	50 / 51
Air port [kcal/h]	43 / 45
Waste gas chamber [kcal/h]	111 / 116
Air chamber [kcal/h]	87 / 93
<b>Total</b>	<b>1448 / 1781</b>

Item	Value
Heat % on top chamber	50
Dust hypothesis [mg/Sm <sup>3</sup> ]	220
Air infl. from reversal valve [Sm <sup>3</sup> /h]	500

Item	Value
Calculated leak/holes/infiltration	86571
Tank	736
<b>Total</b>	<b>87307</b>

Item	Value
Port radiation [kcal/h]	10000
Check radiation [kcal/h]	10000
<b>Computed Port radiation [kcal/h]</b>	<b>171749</b>

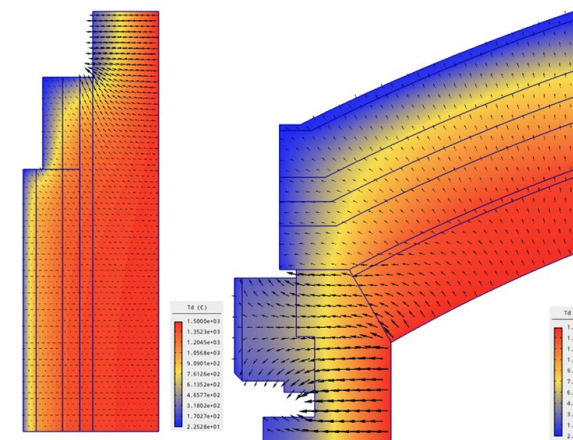
Item	Value
Top Port radiation [kcal/h]	10000
Top Check radiation [kcal/h]	10000
<b>Commissa</b>	<b>100000</b>

Item	Value
Temperature	25
Air port leakage [°C]	30
Waste gas port infiltration [°C]	30
Furnace infiltration [°C]	30
Waste gas chamber infiltration [°C]	30
Pressure	0.5
Chamber top waste gas pressure [mmH <sub>2</sub> O]	-7
Chamber bottom waste gas pressure [mmH <sub>2</sub> O]	2.8
Chamber top air pressure [mmH <sub>2</sub> O]	-5
Chamber bottom air pressure [mmH <sub>2</sub> O]	8
Chamber height [m]	8

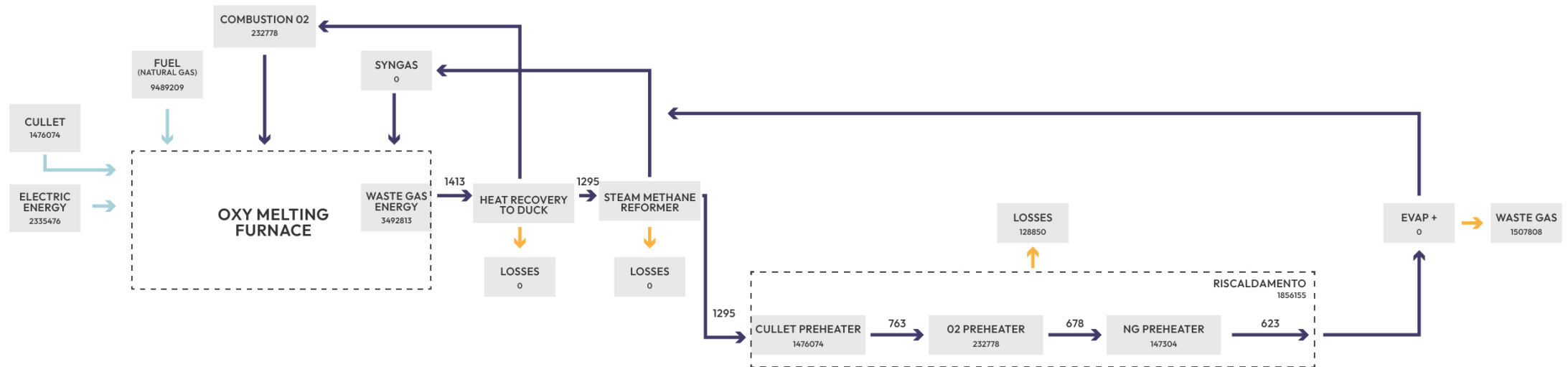
  

Item	Value
NCV [kcal/Sm <sup>3</sup> ]	3200



Stara Glass computing environment is optimized to help evaluating within and outside the glass production process heat recovery opportunities, like additional heat exchangers, cullet pre-heating, oxygen and gas preheating, steam reforming components (see our LIFE SUGAR project), and more.

It is our precise goal to help customers containing their carbon footprint in any possible way.



In this example/indicative scheme  
 Values in the boxes: [kcal/h]  
 Values above the lines: [°C]

## H<sub>2</sub>-GLASS

Stara Glass is dedicated to advancing hydrogen combustion in glass production and has joined the Horizon H<sub>2</sub>-GLASS project with the goals of:

- Testing full hydrogen combustion in a range of operational furnaces.
- Developing and implementing hydrogen burners for both regenerative and oxy-fuel technologies in real-world applications.



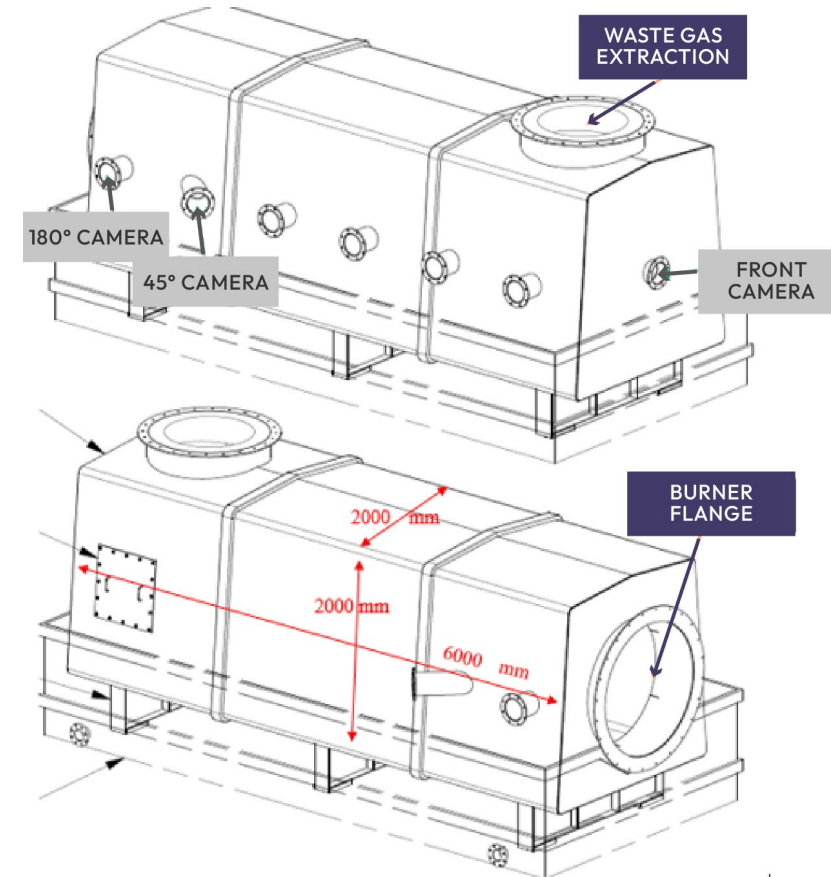
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The prototype burners have been successfully tested in the **FIVES lab**. The activity paved the way for the development of the full -scale burners that are going to be designed, built and **open-flame** tested during **2025**.

The test results are still under analysis in the following slides, there are some information about the tests

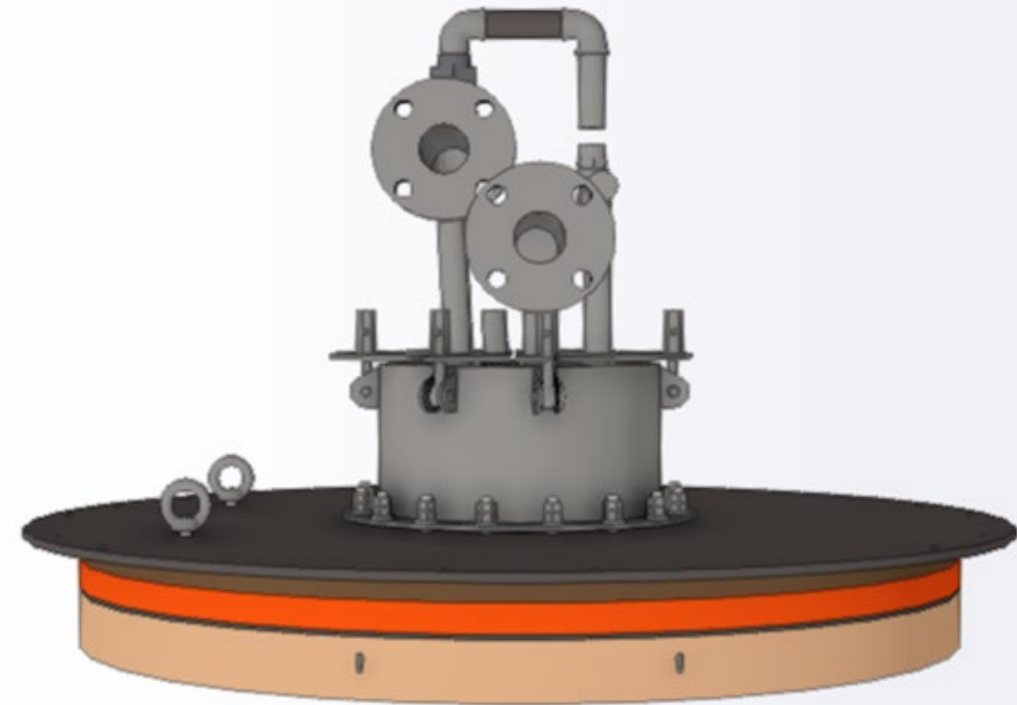


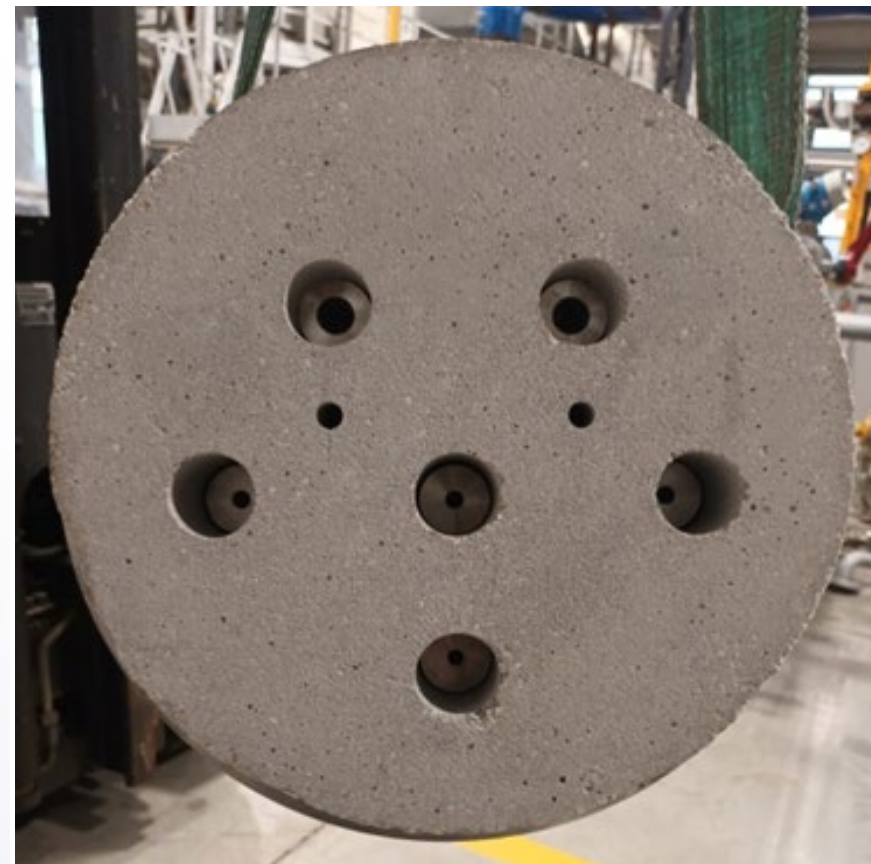
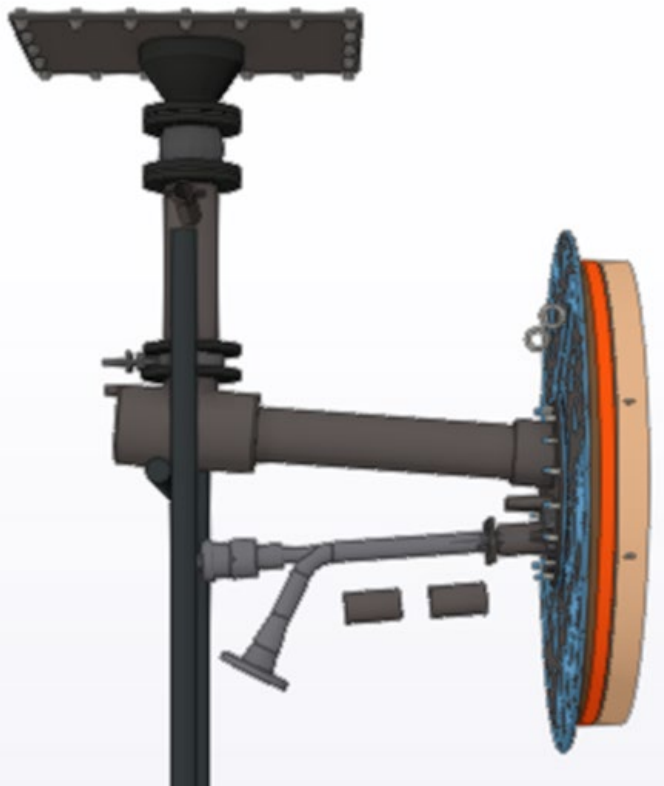


Fives - Piacenza (Italy)

## Test Setup Specifications

<b>Boilers:</b>	Water Tube Boiler (WTB) with a maximum capacity of 9 MW
<b>Burner Specifications:</b>	Burner Rating: 300 kW Natural Gas Flow Rate: 30 Nm <sup>3</sup> /h Hydrogen Flow Rate: 100 Nm <sup>3</sup> /h Oxygen Flow Rate (Oxy-Gas Mode): 40 Nm <sup>3</sup> /h
<b>Furnace Dimensions:</b>	Width: 2000 mm Height: 2000 mm Length: 6000 mm
<b>Testing Approach</b>	Each test varied the fuel ratios from 100% CH <sub>4</sub> to 100% H <sub>2</sub> . Both air-gas and oxy-gas configurations were evaluated under different fuel flow rates to measure: Emissions, Flame stability, Efficiency. To maintain chamber temperatures of up to 1100°C, internal surfaces were insulated with 100 mm thick fiber sheets (applied as two 50 mm layers).

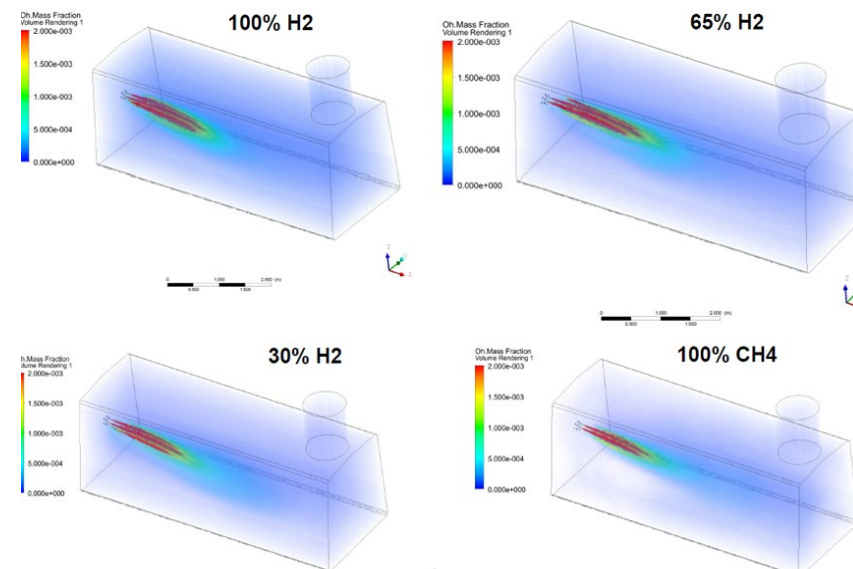
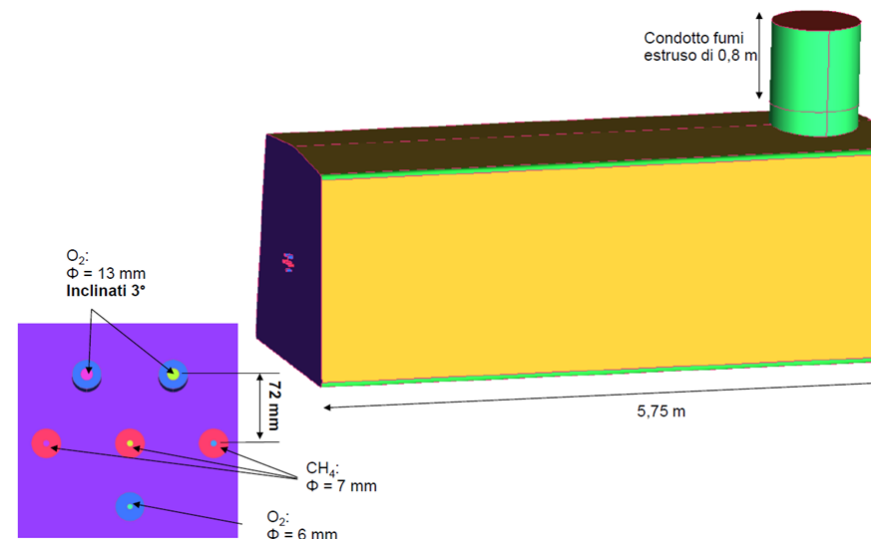




Two geometric configurations were examined, selecting a lower incidence angle between the fluids to move the flame formation away from the refractory area and prevent an undesired downward tilt.

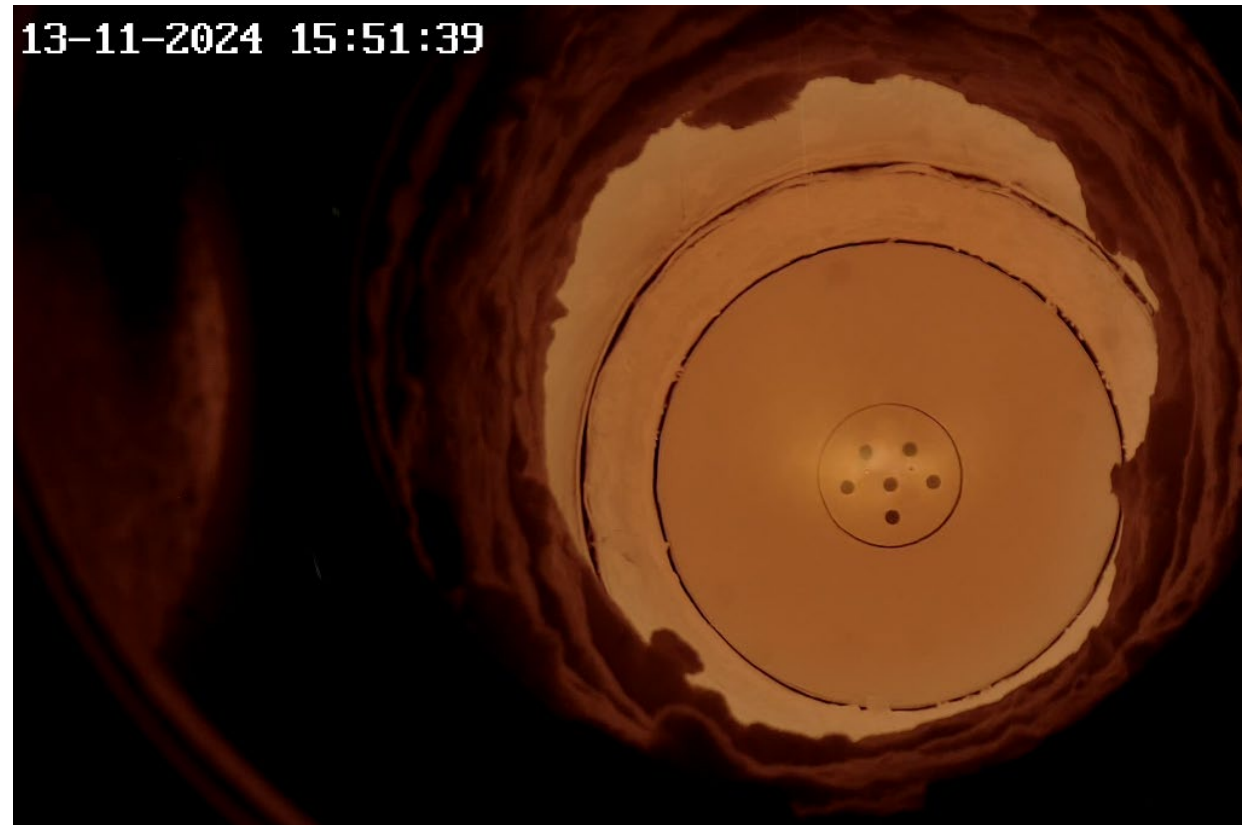
## Effects of the H<sub>2</sub>/NG Mixture:

- Increasing the hydrogen fraction results in a longer flame. Although H<sub>2</sub> is more reactive, its flow velocity—about three times higher than in the 100% CH<sub>4</sub> case—hinders mixing with the oxidant, mechanically extending the jet.
- A slight widening of the flame is also observed with 100% H<sub>2</sub>, although less pronounced than the increase in length.
- When burning 100% H<sub>2</sub>, the core flame temperature rises by 80-100°C compared to natural gas due to hydrogen's higher adiabatic flame temperature. This increase may lead to higher NO<sub>x</sub> formation.
- The flame angle slightly decreases with 100% H<sub>2</sub>, as the jet's kinetic energy counteracts the downward force exerted by the O<sub>2</sub> flow.
- A particularly significant effect is the shift in the flame root position relative to the refractory: with 100% H<sub>2</sub>, it directly attaches to the refractory surface.



### Results:

Two geometric configurations were examined, selecting a lower incidence angle between the fluids to move the flame formation away from the refractory area and prevent an undesired downward tilt.



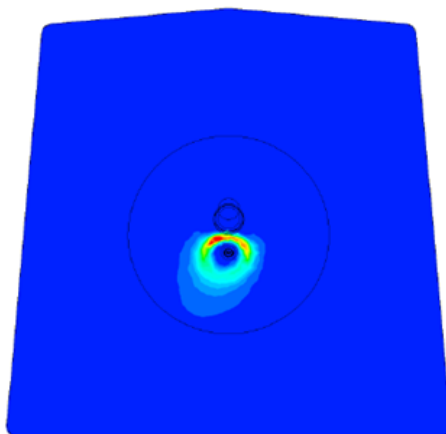
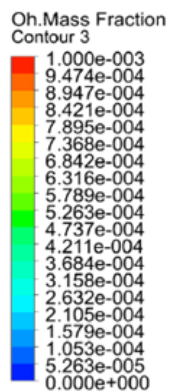
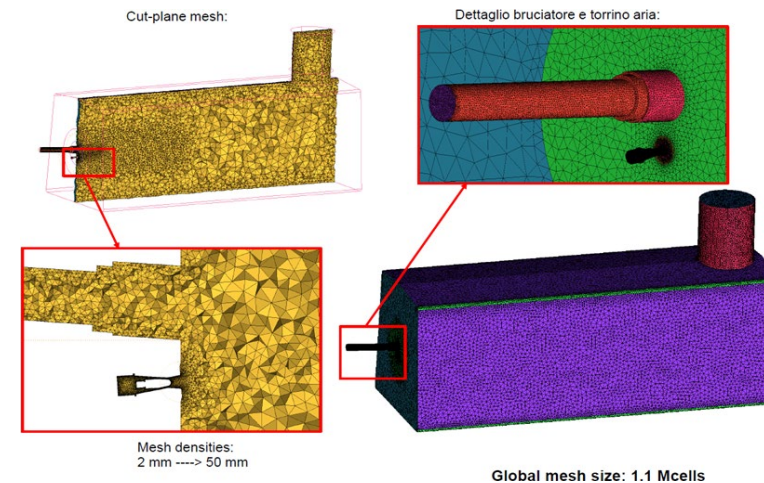


# H<sub>2</sub>Glass - Prototype test: EP burner

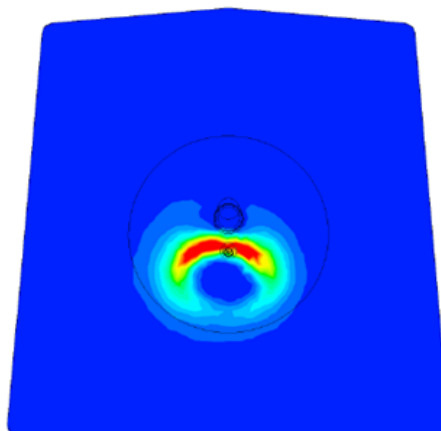
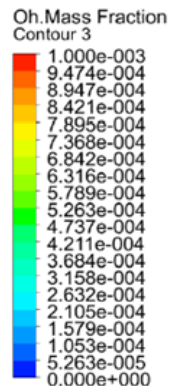


The flame length is significantly greater (approximately 2.3 m compared to 1.5 m in the OXY case). This is primarily due to the presence of inerts (N<sub>2</sub>) in the oxidant, which hinder the mixing between oxygen and fuel.

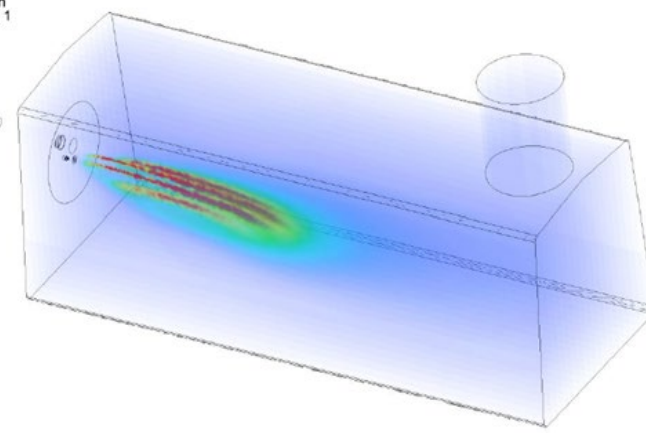
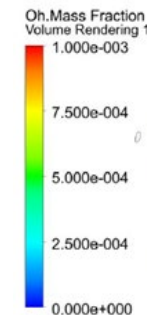
For the same reason, the flame is more detached from the refractory (11 cm compared to approximately 5 cm in the OXY case).



Piano a 0,3 m

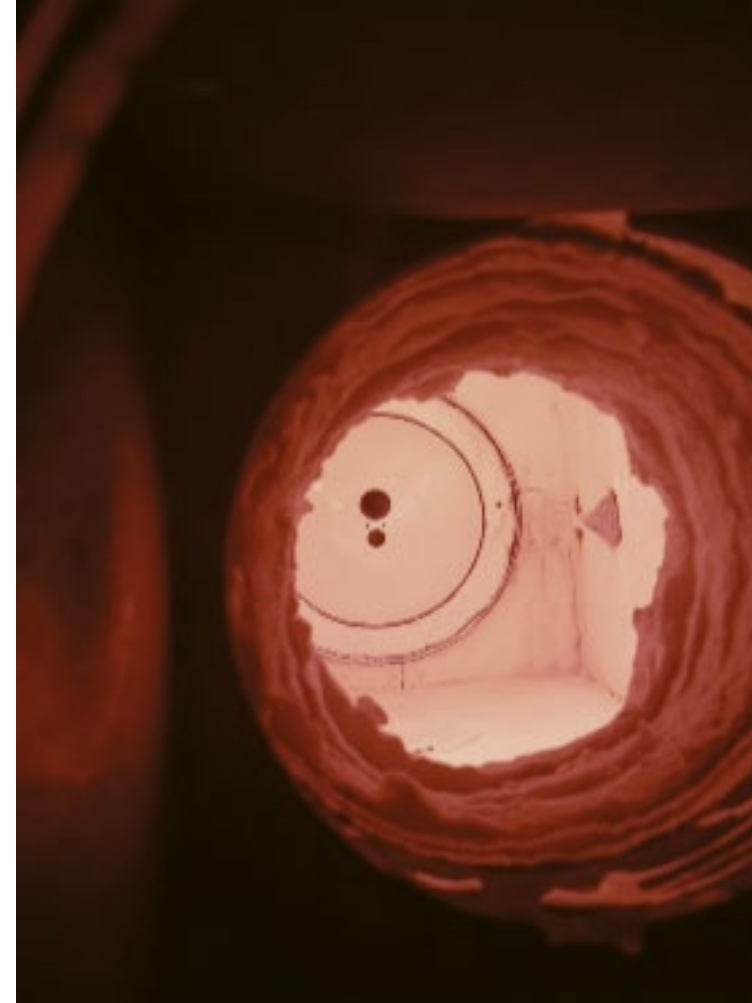


Piano a 1 m



### Results:

Two geometries have been analyzed. A lower incidence angle between the fluids was selected to distance the flame formation from the reactor.





# Active Innovation Project

## COREu

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Stara Glass is in the team of the Horizon COREu(CO<sub>2</sub> Routes across Europe) project, that started in January 2024.

This ambitious project aims to explore the potential of carbon capture (CC) technology by identifying technical solutions and optimal strategies for European glassmakers to effectively capture CO<sub>2</sub> emissions.

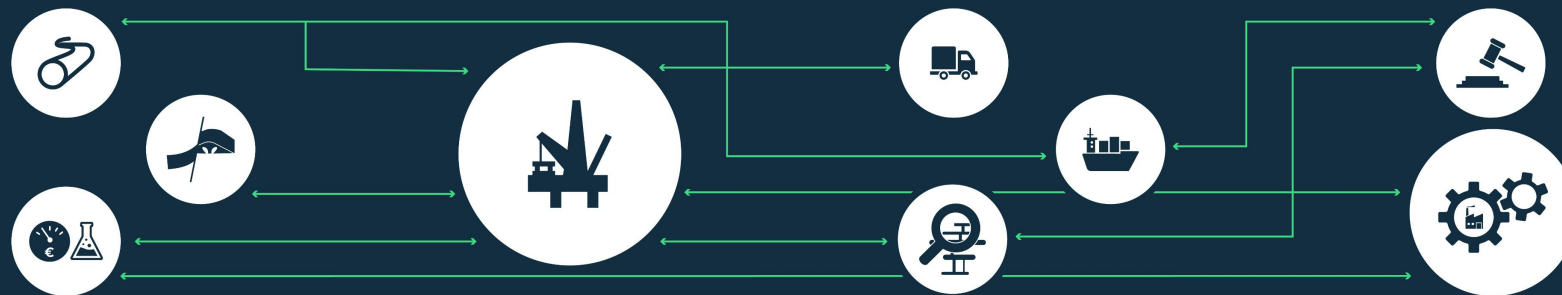


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## Expert Advisory Board

### WP6 | Exploitation, Communication and Dissemination



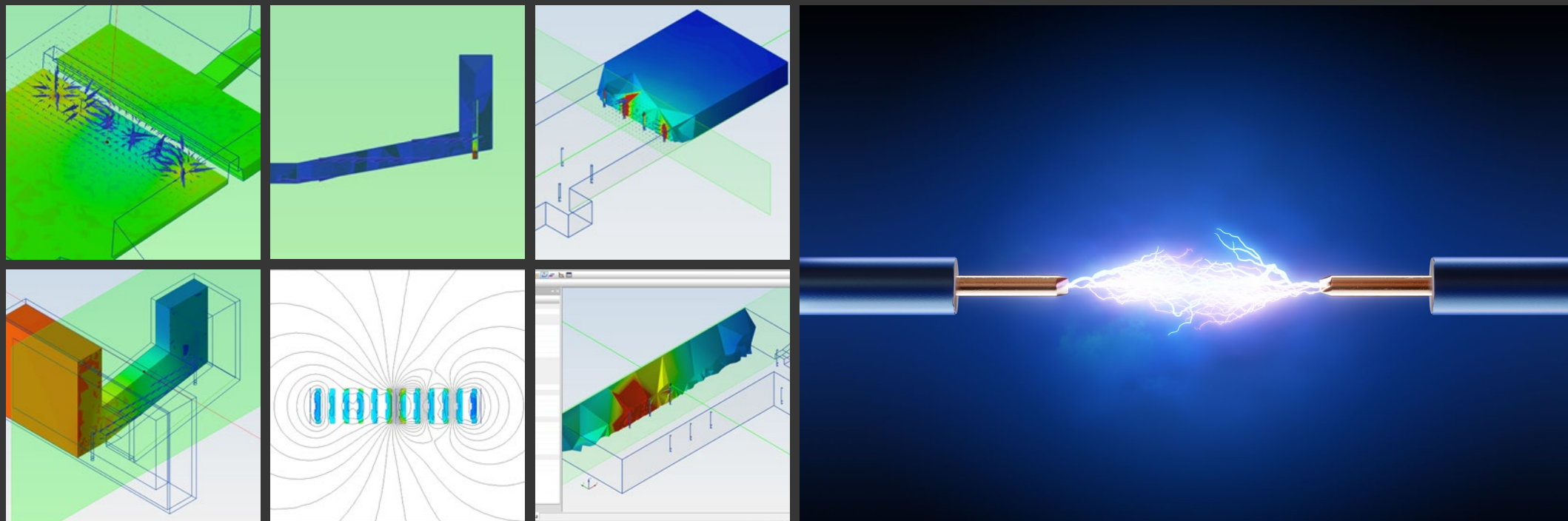
### WP1 Project Management



# Innovation projects: hybrid furnaces (Hybrid / Electric)

Stara Glass aims to be at the forefront of hybrid and electric glass furnace design.

Nowadays, we are ready to design hybrid furnaces up to **50% electricity**, and we are spending a considerable effort to move towards higher boosting percentages and cold -top / hot -top electrical solutions.





# Conclusions

There is not one single simple technological solution that will eliminate the carbon footprint of glass industry. But there are several important lines of development, and every glass production plant needs to identify what are its best available opportunities.

**The first immediate action that can be taken is the maximization of the efficiency of the current situation,** by an accurate analysis of the furnace operation and the implementation of in-process or extra-process heat recovery systems.

After this, glassmakers need to figure out if their plant is more suitable for the implementation of **hydrogen combustion, carbon capture, or renewable electrification.**

Thank you! - Teşekkür ederim!



Stara Glass SpA



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