H2GLASS

DECARBONISING OUR FUTURE

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Agenda

- Overview
- Trials
- Combustion technologies
- Other research and development areas

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WHY

The Glass Decarbonization Challenge

Glass and Aluminium play a central role in sustainable/circular economy and new low-carbon and energy-efficient applications

In EU the Glass and Aluminium industries employ >400.000 people, generate > 3.5B€ and emit ca.21.5 Mt CO2e

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WHAT

H2GLASS aims to **develop the solutions** that glass manufacturers need to meet **climate targets** and make their sector **sustainable** by replacing fossil fuels with **100% hydrogen,** ensuring the required **product quality** and manage this **safely**.

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WHO

23 partners
4 years
33M€ budget
24M€ EU fund
Project started Jan'23

HOW

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Key industrial players pushing forward the State of The Art

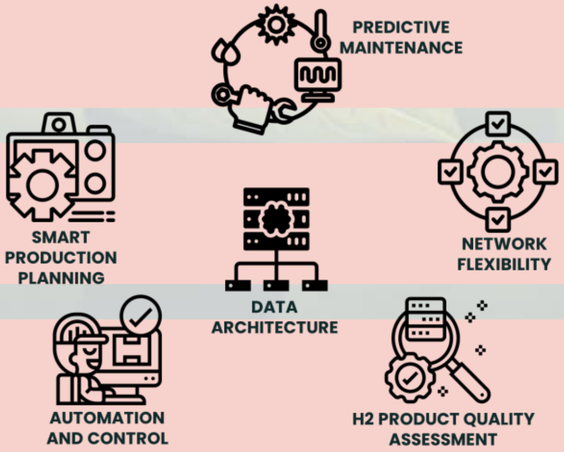
Technology replicability and **EU Industrial Associations** for impact

Retrofit solutions business model

2.5MW electrolyser for trials at scale

Digital Twin technologies for smart production

Safety and **Risk Management** focus



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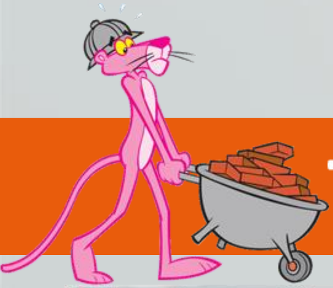

Trials in Owens Corning, France

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Safety and regulation skid H2

H2 decompression platform
300 bars => 10 bars

H2 piping @ 10 bars length ~500m

O2 and H2 drops
+ O2/H2 burners (crown)

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H_2Glass - Burners

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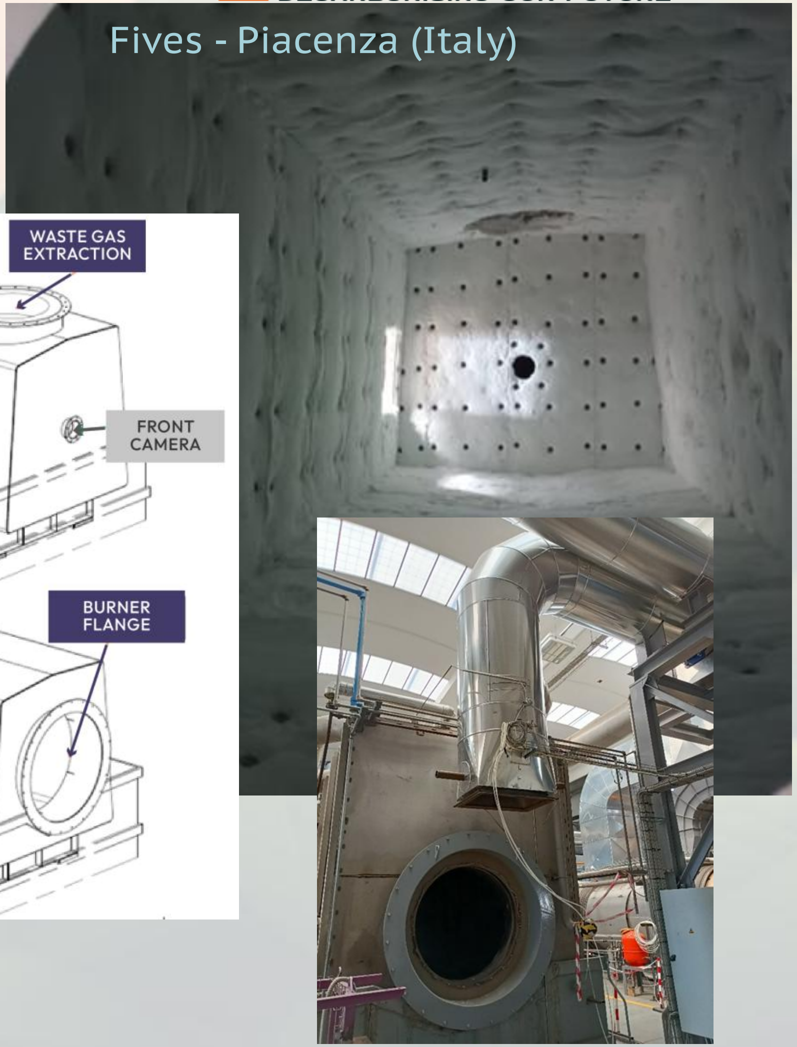
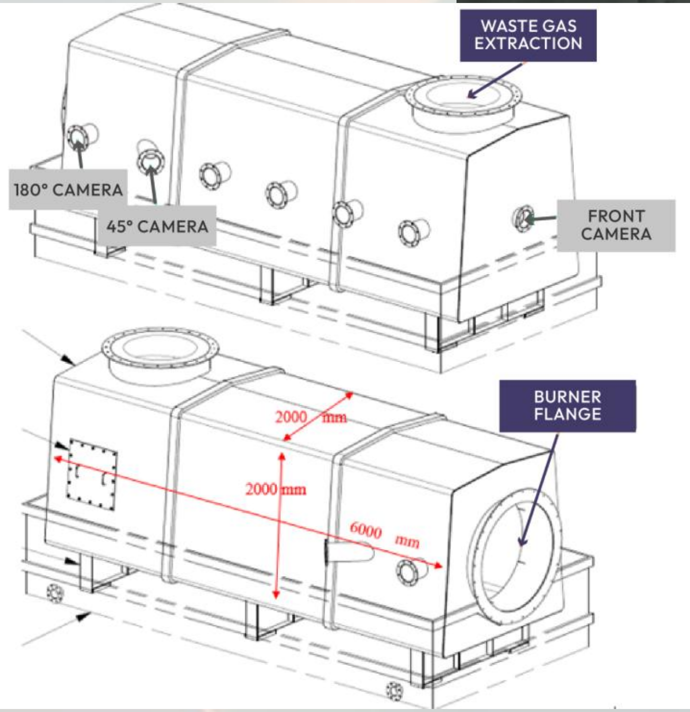
Stara Glass: any CH4/H2 0-100% mix; oxy side, regenerative end-port

- The small scaled prototypical version of both (metal and refractory parts) have been:
  - Designed according to Stara Glass / Stara Tech experience and existing H2 safety regulation
  - Verified and implemented with CFD analysis
  - Built and tested in the Piacenza (Italy) FIVES combustion laboratory (images of this slide)
- The full scaled version of the two solutions will be:
  - Finalized and built
  - Undergo an open flame test
  - Installed in the project IDs furnaces (at least in Vetrobalsamo and Zignago, one for type)
  - Operated in a real environment





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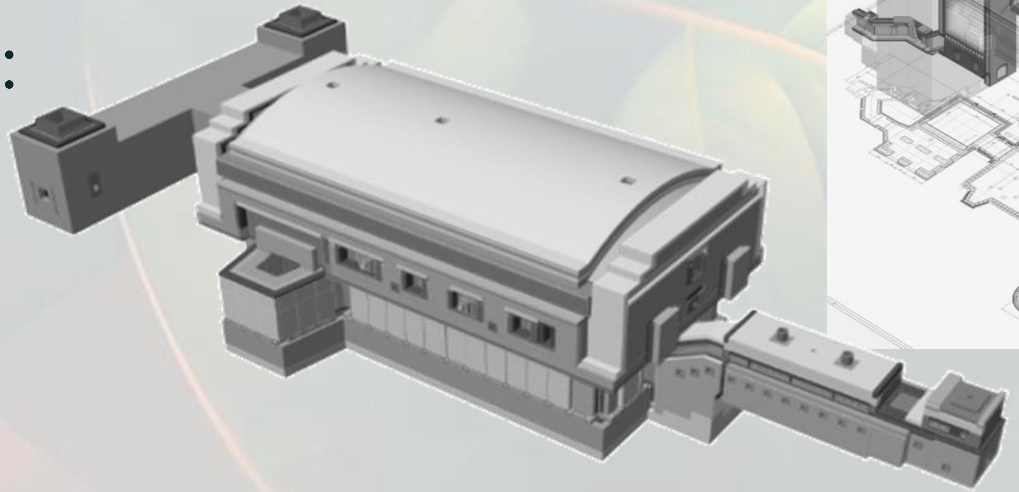
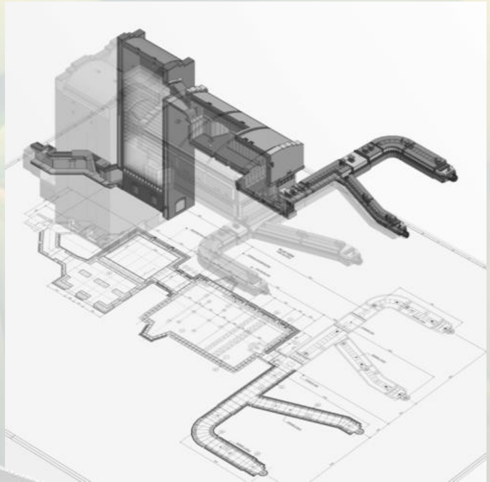
H_2Glass - Furnaces

- Among the goals of the project, the partnership is meant to define the characteristics of the future hydrogen powered glass furnaces, focusing on the upgrades in comparison with the state of the art. The two most typical furnace types are under analysis:
  - Regenerative
  - Oxy-fired
- The main areas of study include:
  - Furnace materials and insulation
  - Furnace geometry
  - Combustion geometry
  - Burners
  - Additional safety





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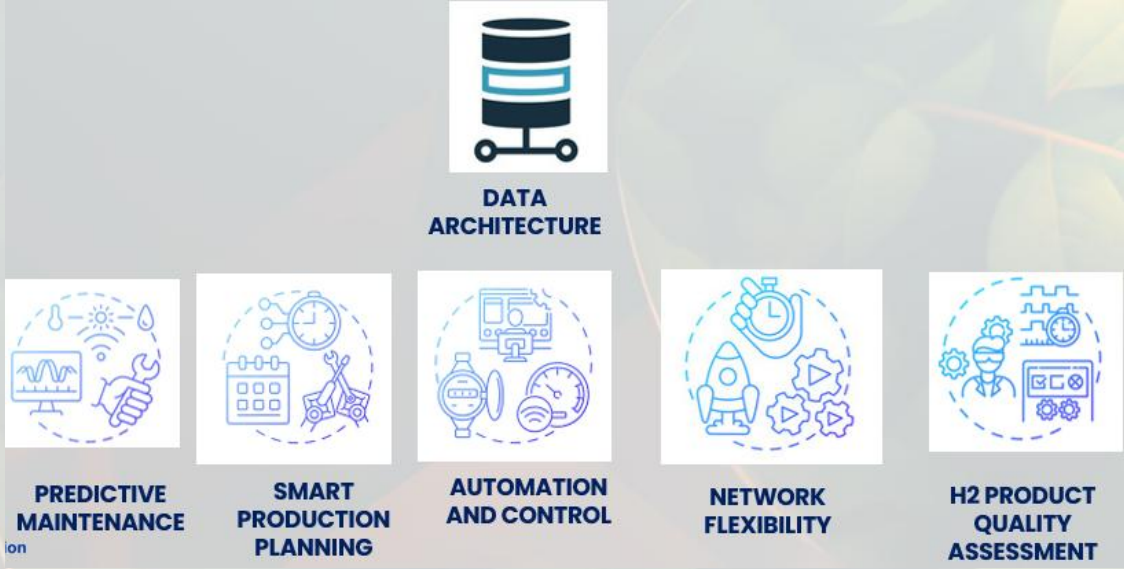
Digital Transition: overview and objectives

I. Creating a data architecture for the collection, storage and remote access to data and metadata produced on-site
II. Creating Digital Twins (DT) to characterise the behaviour of the selected processes/components, to enable preventive action and optimization of the maintenance frequency and duration
III. Developing a DT to optimize the production, the costs and the energy efficiency of the system
IV. Improving the automation level of the furnace system
V. Providing flexibility services towards internal manufacturing processes and/or external to network operators
VI. Assessing the quality of the final product in relation to the use of hydrogen



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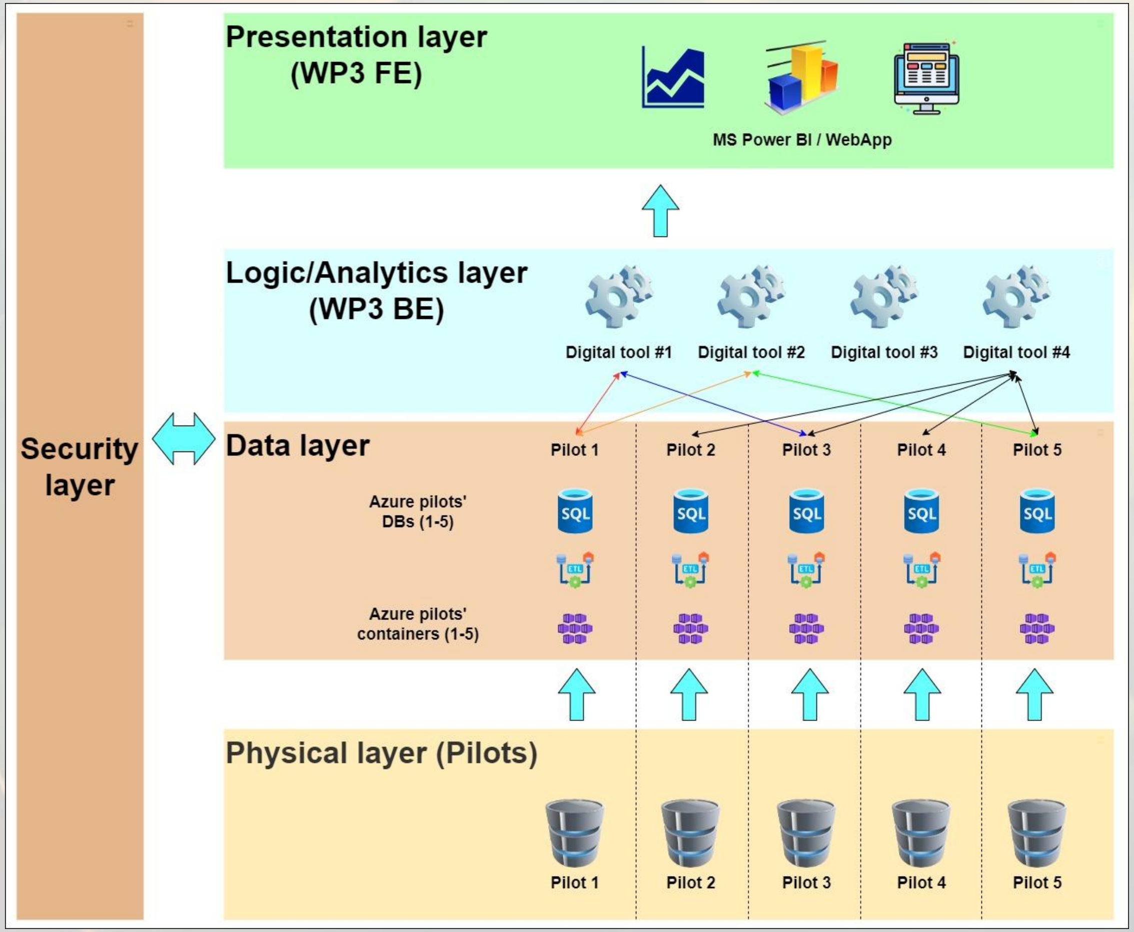
Creation of data architecture and big-data infrastructure

Design, develop, and deploy **the digital infrastructure** for a **common solution for gathering, storage and remote access to data** and metadata **produced on-site**, implementing and using public cloud-based technologies.

Operational objectives:

- analysis of the project's use-cases
- design of the innovation concept and creation of data infrastructure
- identification of infrastructure requirements and specifications
- definition of the Standards and protocols to access, manage, and exchange Data (i.e., HTTP, FTP; TCP/IP, SSL)
- on-site data acquisition and cloud communication
- collection of pre-existing industrial data and collection of new data related to innovative H2 technology through instrumentations/sensors

Data flow through the IT infrastructure is done in a way to assure the safety and confidentiality of the data moving between the data providers and data users (WP3 applications in represented in the Logic / Presentation layers).



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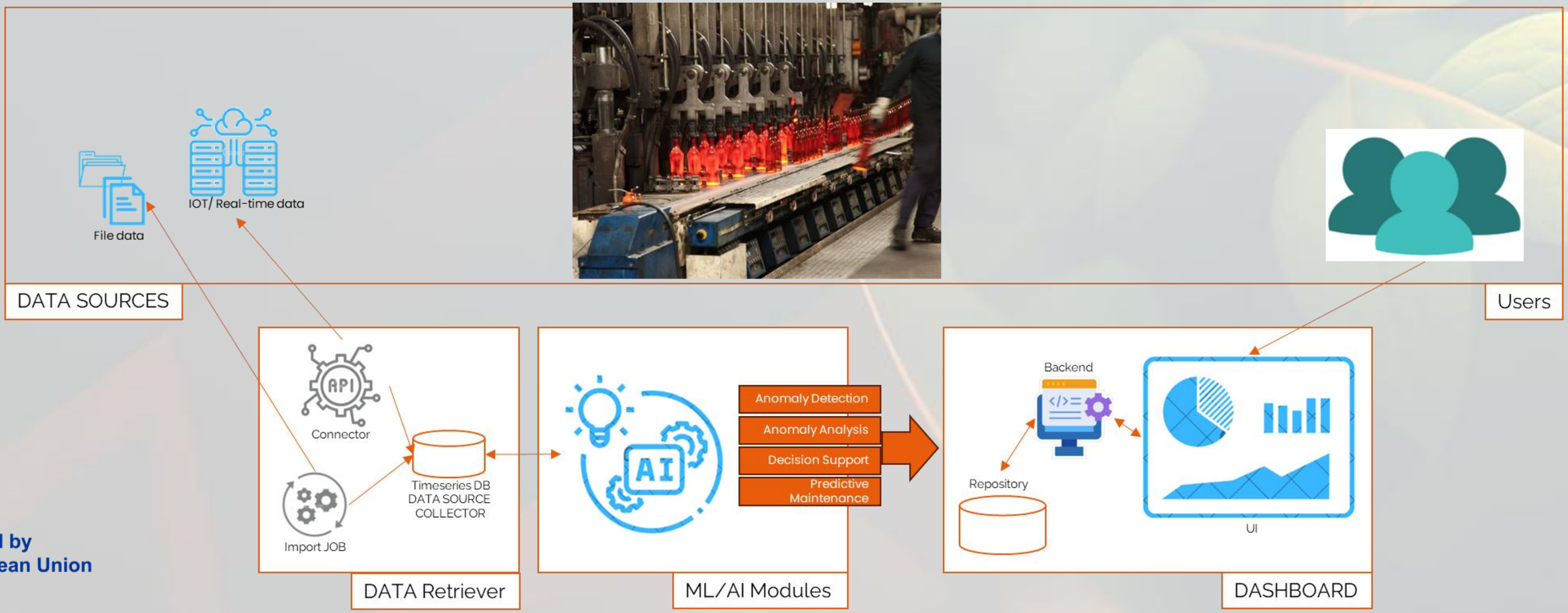
Process analysis for Digital Twin development

Deliver models and tools that will enable the Digital Twins to access and exploit the process data.

- Performing an in-depth assessment of target processes and components:.
- Definition of a reference architecture for data manipulation
- Developing data-related services to make data smoothly available for the Digital Twin modules



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Development of Digital Twins for predictive maintenance operations and scheduling

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Define and develop the predictive models that will characterize the behaviour of the process components, to enable preventive action and optimization of the maintenance frequency and duration.

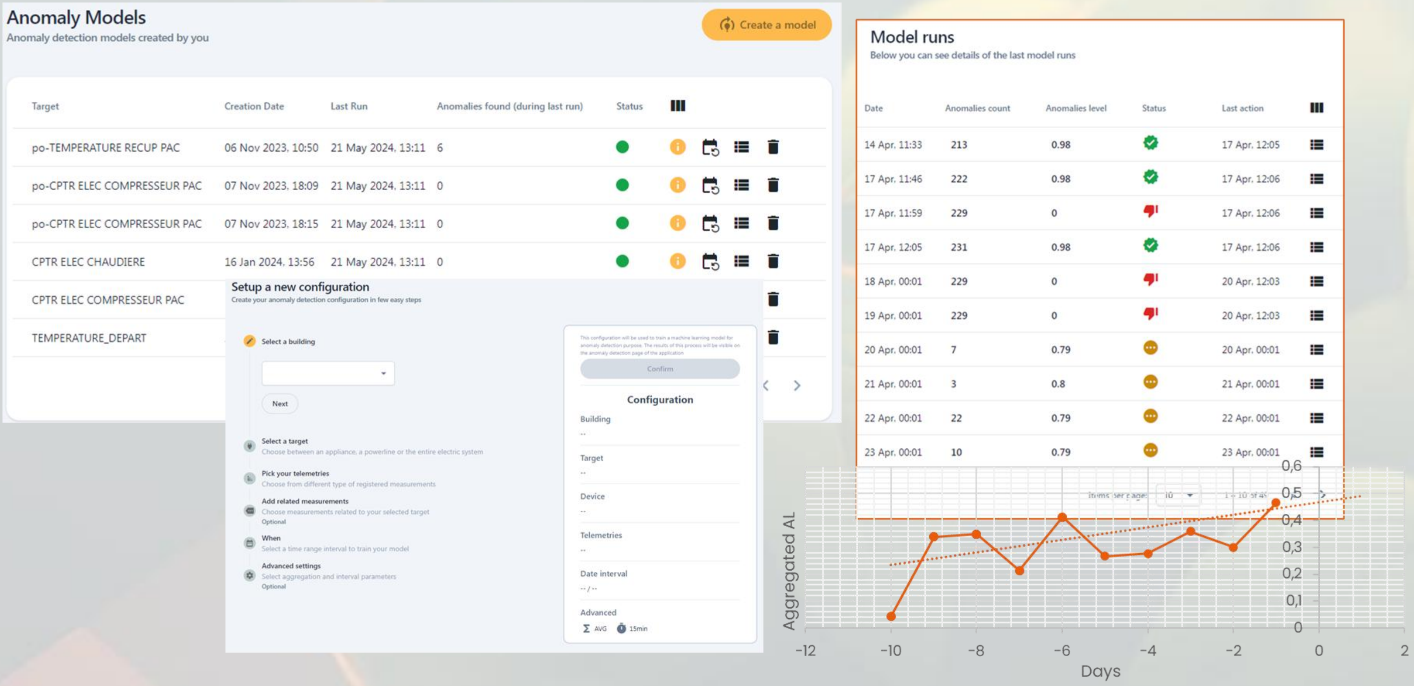
Demonstrator Data → **Model #1** → Label: Critical/No Critical → **Model #2** → Predicted action

Model #1: Classification Model

Objective: Develop a model based on historical data to classify new data rows as critical or non-critical.

Model #2: Natural Language Based Model

Objective: Develop a model to suggest solutions for critical situations using operator knowledge.



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Digital Twin based Smart Production Planning and Control

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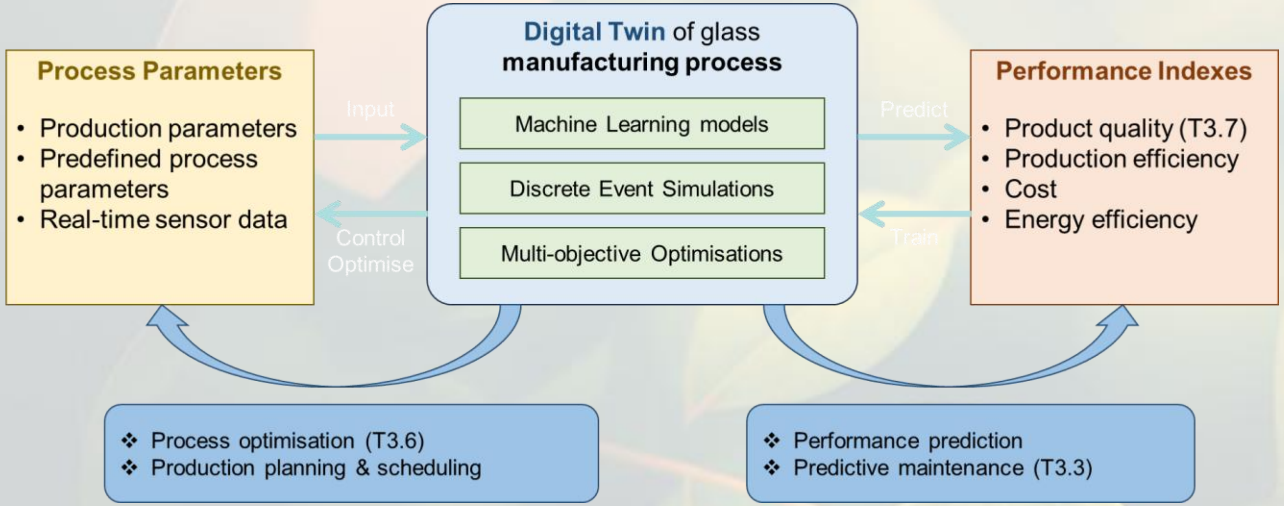
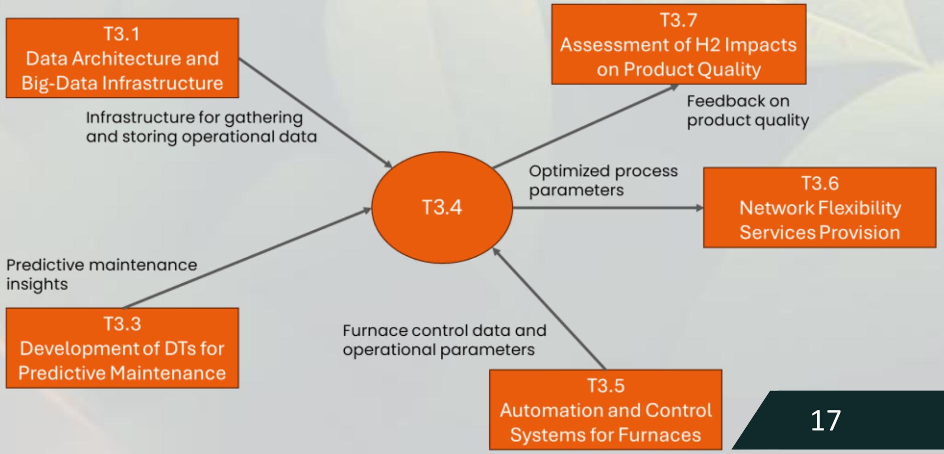
- The **key process parameters** in each forming step will be investigated, and their impact on the process outputs and **performance indexes**, including resulting product quality, production efficiency, cost, and energy efficiency.
- **Simulation-based digital twin models** of the manufacturing systems will be developed to predict the performance indexes.
- **Multi-objectives optimisation** will be conducted to seek optimised process parameters for achieving best overall performance, i.e., trade-off between all the process performances indexes.





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Automation and Control Systems for Furnaces

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Deepen and improve the existing glass production automation, to optimize quality from the furnace and during production changes, minimise energy waste, and reduce the presence of personnel in the control room, particularly in the hottest factory's areas. SG glass furnace design and simulation software has been implemented to produce an empirical formula able to estimate furnace consumption, depending on:

- Pull [t/day]
- O2 excess at the port [%]
- Boosting [kW]
- Glass temperature at the throat [°C]
- Furnace waste gas outlet temperature [°C]
- Cullet %
- Mix humidity %
- Preheated air temperature [°C]
- Heat loss / aging

Example
End-port

Main data	
Pull [t/day]	**200**
Melting area [m2]	**75**
Boosting [kW]	**0**
Cullet %	**25**
Specific pull [t/m2day]	2,66
Preheated air temperature [°C]	1300

Glass temperature at the throat [°C]	1390
Furnace waste gas outlet temperature [°C]	1540
O2 excess at the port [%]	1,5
Room air temperature [°C]	20
Mix humidity %	3

Fuel: CH4 = 1 ; Dense oil = 2 ; CH4-Oxy = 3	1
NCV [kcal/Sm3]	8200

Heat balance

Input heat	kcal/kg	GJ/ton	Gcal/h	%
Fuel	1060	4,436	8,829	99,2
Electrical power	0	0,000	0,000	0,0
Air	8	0,034	0,069	0,8
Total input heat	**1068**	**4,470**	**8,898**	**100,0**
Output heat				
Glass	443	1,856	3,695	41,3
Chemical reactions	103	0,432	0,860	9,6
H2O evaporation	21	0,086	0,171	1,9
Waste gas and leakage	331	1,385	2,757	30,8
Holes and air leakage	10	0,041	0,082	0,9
Thermal loss	167	0,699	1,391	15,5
Total output heat	**1075**	**4,500**	**8,957**	**100,0**

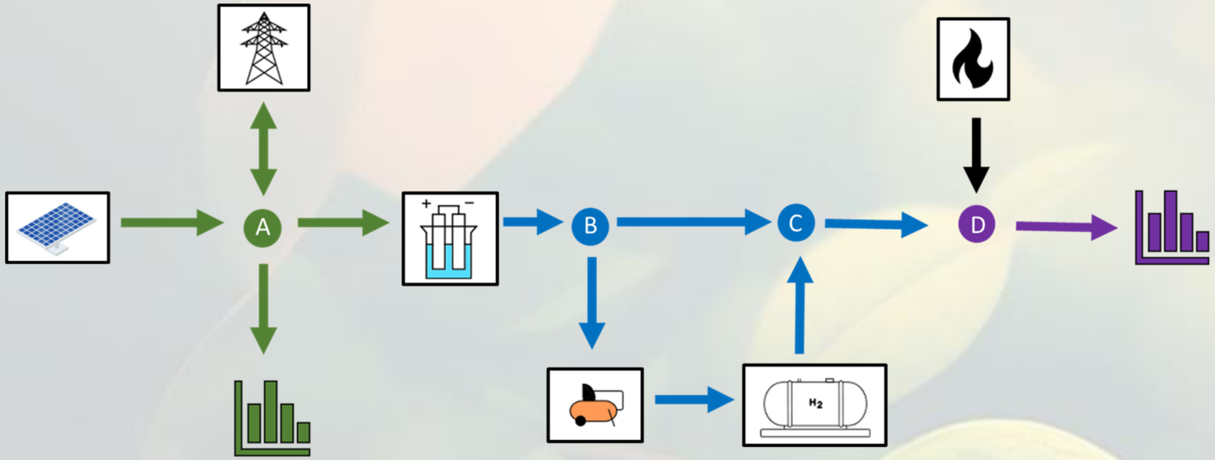
Fuel [Sm3/h]	**1076,7**	± 5%
[Nm3/h]	**1020,7**	± 5%
Specific consumption [kcal/kg]	**1060**	± 5%
Specific consumption [GJ/ton]	**4,436**	± 5%
Specific useful heat [Mcal/m2h]	71,5	± 5%

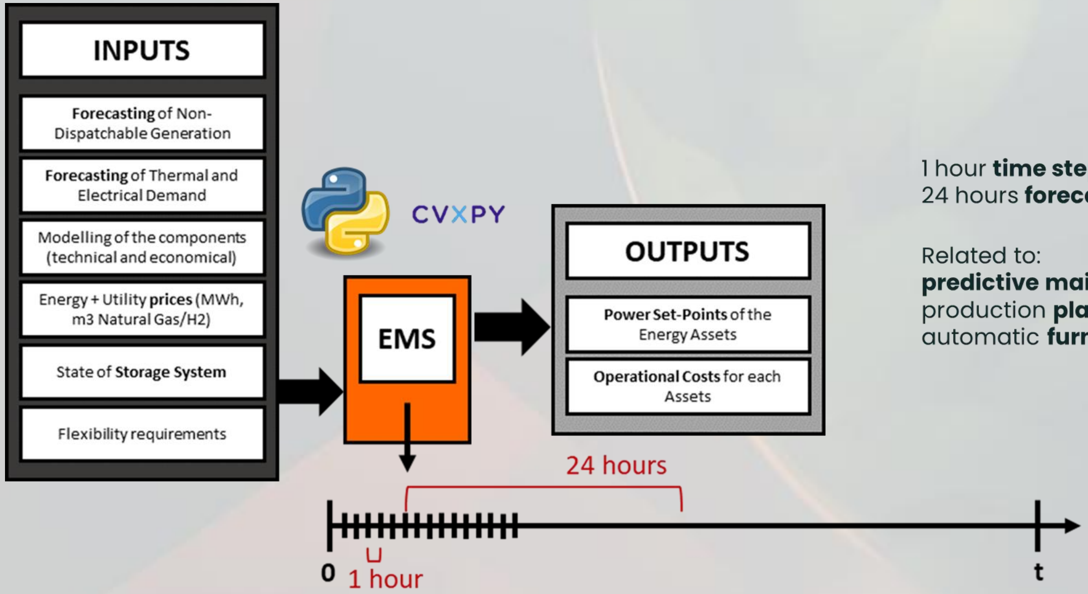
STARA GLASS

Network flexibility services provision

➔optimize the **schedule of energy assets**
➔minimize the **costs** and **emissions**
➔optimize the **production** of **hydrogen**
➔provide **services** to the **system operator**

The system needs to be in **balance**, coping with **uncertainty** and **variability** in both demand and supply sides





1 hour **time step**
24 hours **forecast horizon**

Related to:
predictive maintenance (T3.3),
production **planning and control** (T3.4),
automatic **furnace control** (T3.5)

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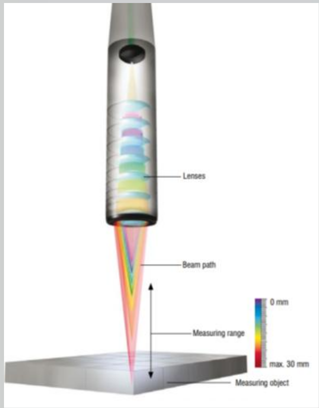
Assessment of H2 impacts on product quality

Evaluation of the impacts of H2 technologies and integration of H2 within the glass manufacturing sector

Hot side

- Optical monitoring of excited H_2O within premixed hydrogen-oxygen to determine flame temperature and shape
- Potential for this to be used for H2 and natural gas flames in hybrid tests for direct comparison of improvement.



- Adapt UNOTT confocal system to 3D image microscale defects in glass – offline assessment of defect volume/count possible in glass sample
- Assess glass quality on available sample from partial-H2 burn test, use data to develop prediction methods for glass quality under conditions beyond test dataset

Cold side

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Q&A

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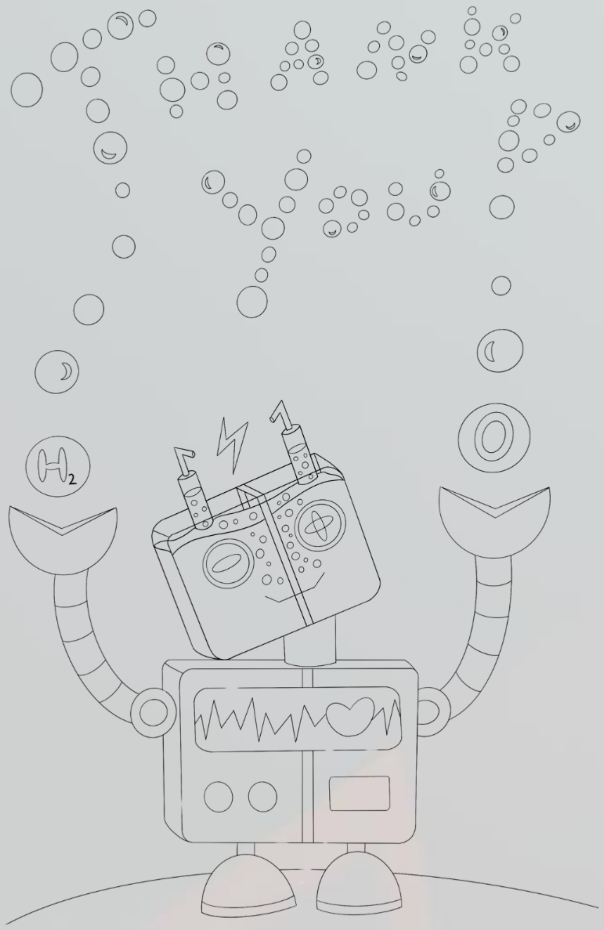

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