Clean Hydrogen in Industry (glass)

Tilen Sever

HRASTNIK1860

Outline

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2 Background

3 Hydrogen pilot system

4 Hydrogen combustion

5 Carbon-free glass melting & LCA

6 H2GLASS

About The Company

Hrastnik1860 is developing and manufacturing world-class engineered glass products, distinguished by some of the clearest glass in the world.

Hrastnik1860 is based in Slovenia and offers wide range of products that include **premium and super premium glass containers,** primarily dedicated to the spirit, perfumery and cosmetics market.

It focuses on flexible and excellent service, short time to the market and innovative tailor-made solutions.

1. **285 t** daily production capacity
2. **600** employees
3. export to more then **50** countries worldwide
4. **full service** solution
5. **160 years** of tradition

HRASTNIK1860

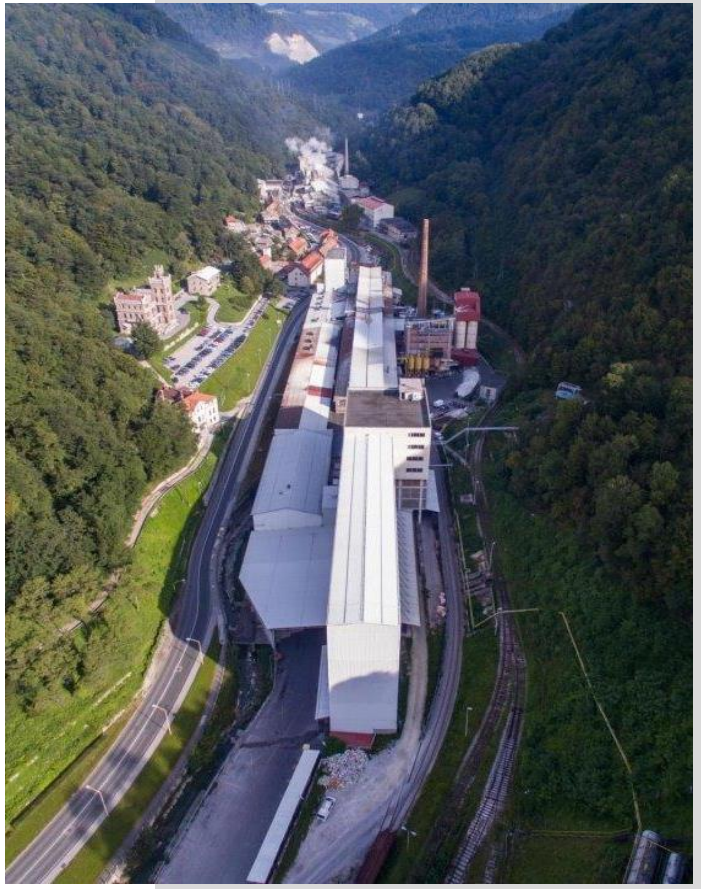
What we do

SPIRIT GLASS
PACKAGING

PREMIUM WATER
GLASS PACKAGING

PERFUMERY AND
COSMETICS
FLACONS

Two Business Units



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VISION

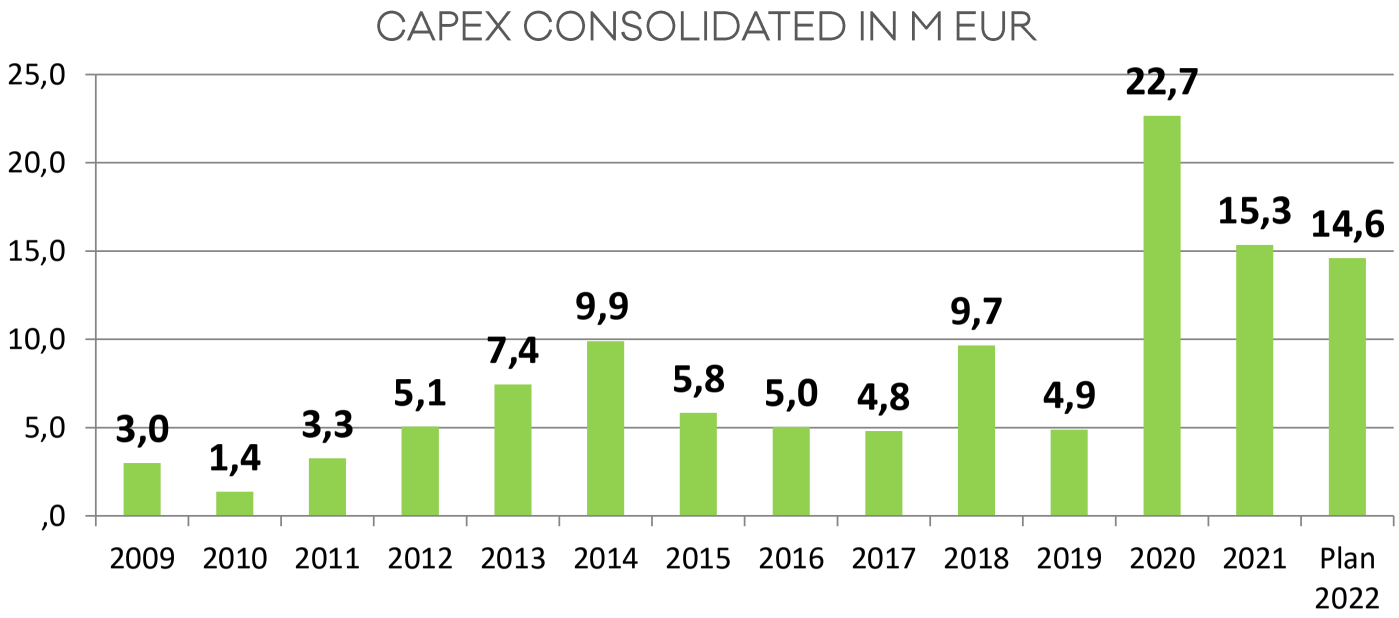
To be the **most inspiring** and **most sustainable glass packaging** company on the planet.


Challenge
Neutrality by 2050
CHANGE
Dramatically improved technologies needed
Innovations are of key importance

INVESTMENTS

TECHNOLOGY
INNOVATION
SUSTAINABILITY

2009-2021: 98 mio EUR

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GREEN
TRANSFORMATION
Use of renewable energy sources
Improving energy efficiency
Electrification
Renewable fuels
Green innovation

1 Background

CHALLENGE

- ✓ THE EUROPEAN GREEN DEAL REQUIRES THE TIGHTENING OF GHG EMISSION REDUCTION TARGETS BY **AT LEAST -50%** FOR THE PERIOD **1990/2030**. THE PROPOSED EUROPEAN CLIMATE LAW, HOWEVER, DICTATES **CLIMATE NEUTRALITY BY 2050**.

- ✓ **GHG EMISSIONS** ARE THUS ONE OF THE KEY CHALLENGES OF THE ENERGY-INTENSIVE INDUSTRY. THE **GLASS INDUSTRY WILL HAVE TO DECARBONIZE** COMPLETELY OVER THE NEXT 30 YEARS.

- ✓ IN ORDER TO ACHIEVE THESE REDUCTION LEVELS, CURRENT PRODUCTION TECHNOLOGIES NEED TO BE **DRAMATICALLY IMPROVED**, AND NEW TECHNOLOGIES NEED TO BE DEVELOPED AT THE **INDUSTRIAL LEVEL**.

- ✓ THE AVERAGE LIFE SPAN OF THE **GLASS FURNACE**, WHERE **90% OF ALL GHG EMISSIONS ARE PRODUCED**, IS 8-10 YEARS. IT IS, THEREFORE, THE PRESSING NEED TO **START INNOVATING** AND TO TRANSIT TO **NEW TECHNOLOGIES** AS 2050 IS ONLY A FEW FURNACES AWAY.

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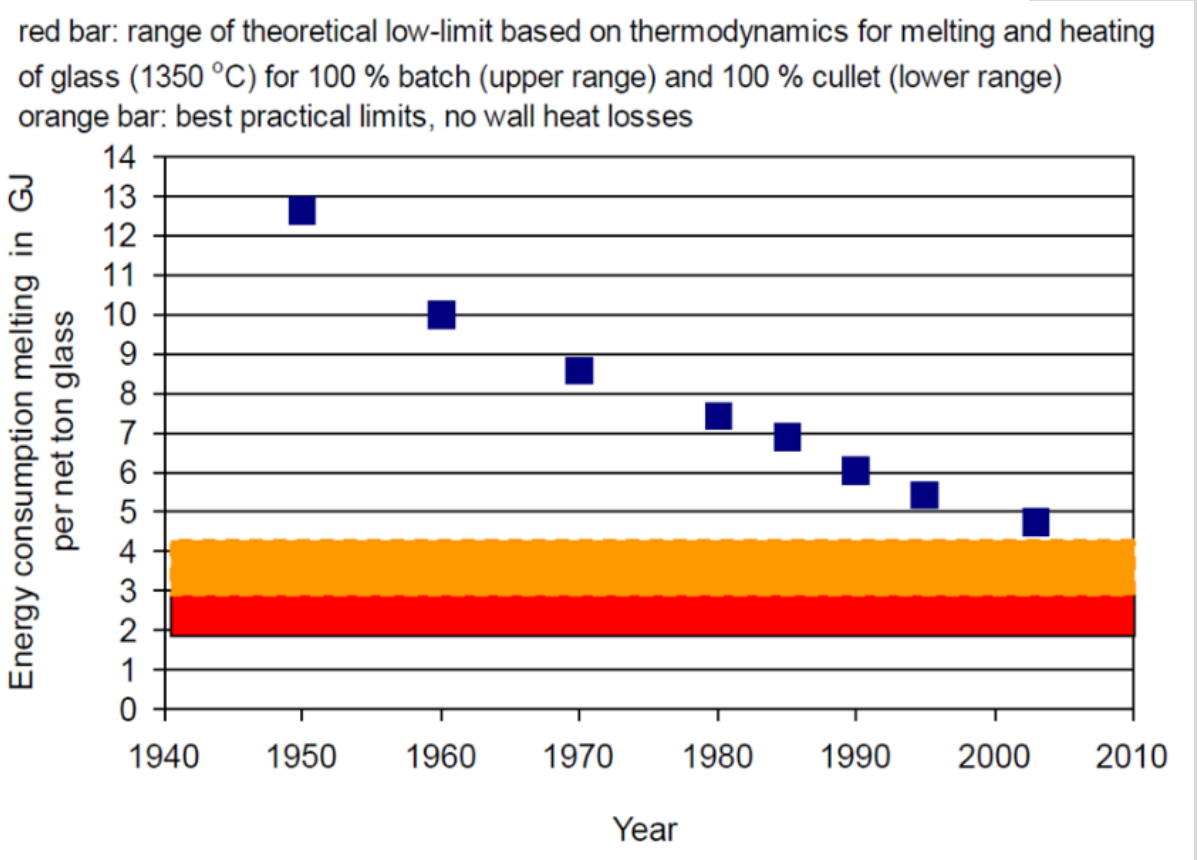
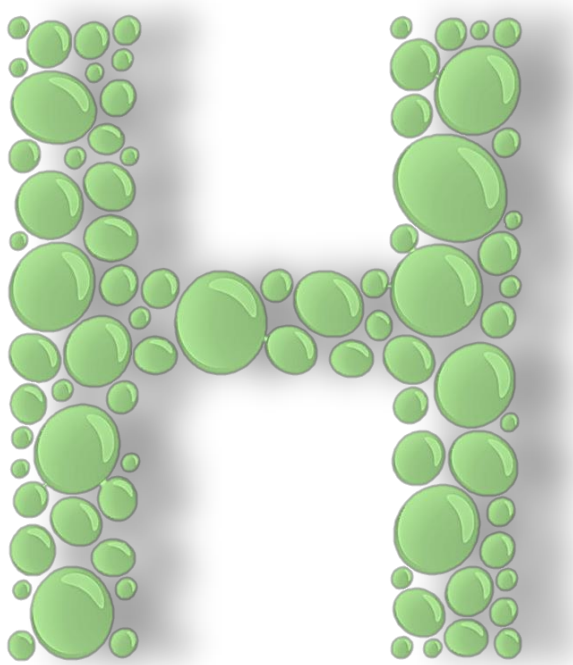
THE “PLATEAU OF DIMINISHING RETURNS”

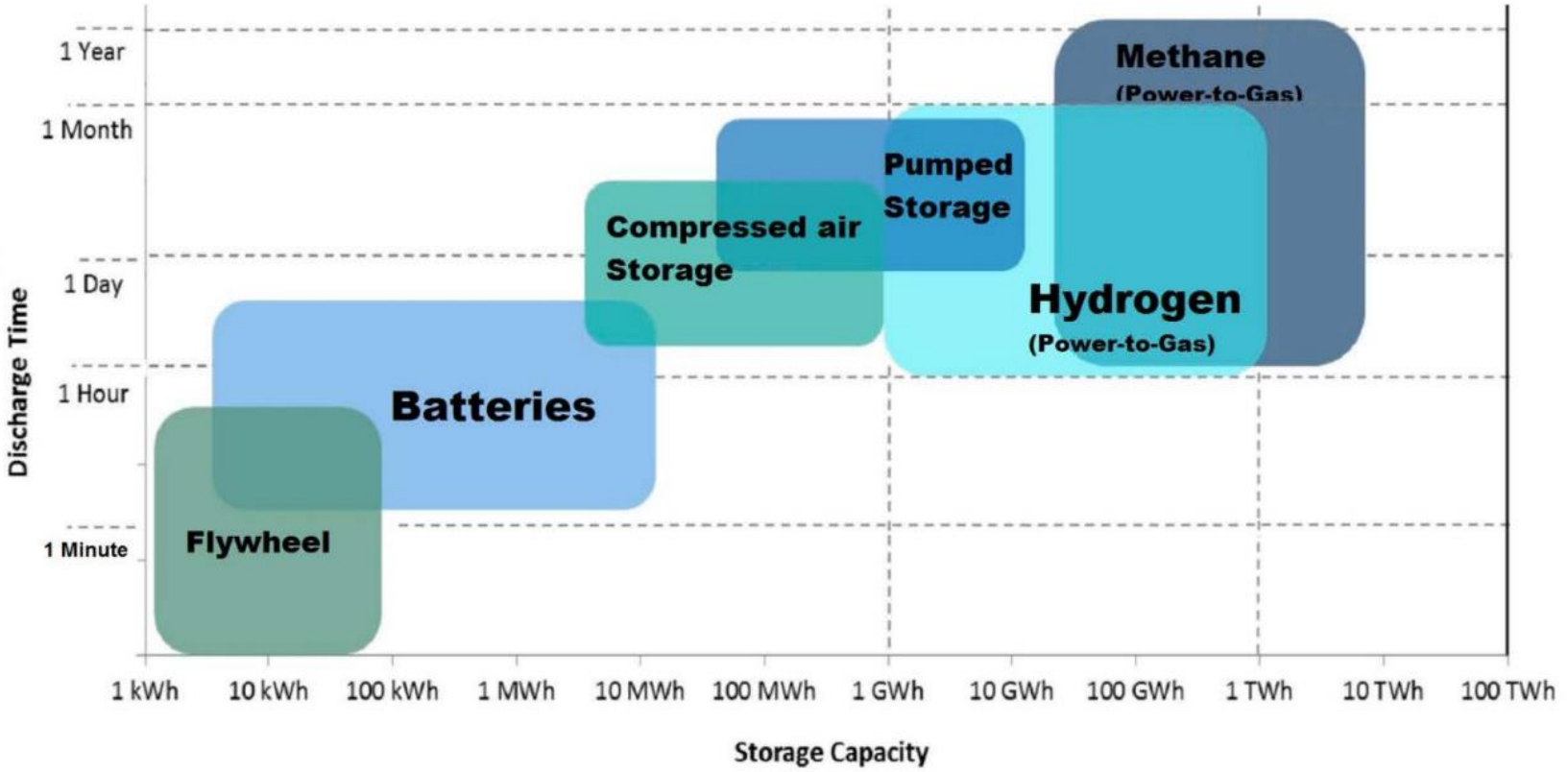


Why hydrogen?

- ✓ **HYDROGEN** FROM RENEWABLE POWER IS TECHNICALLY VIABLE TODAY AND IS QUICKLY APPROACHING **ECONOMIC COMPETITIVENESS**
- ✓ **HYDROGEN** AS RENEWABLE FUEL CAN BE RELATIVELY EASILY APPLIED TO EXISTING FURNACES THAT USE NATURAL GAS AS PRIMARY FUEL
- ✓ **HYDROGEN COMBUSTION** DOESN'T AFFECT FURNACE LIFESPAN TO A LARGE EXTENT
- ✓ HYDROGEN CAN ENABLE OUTSTANDING ENERGY FLEXIBILITY BETWEEN NATURAL GAS AND ELECTRICITY
- ✓ HYDROGEN CAN OFFER FURTHER REDUCTION OF FOSSIL FUEL CONSUMPTION ONCE 80% ELECTRICITY IS DEMONSTRATED TO REALIZE **ZERO GHG EMISSION MELTING**.
- ✓ HYDROGEN IS COMPLEMENTAL TO **HYBRID MELTING**, AND IS IMPORTANT FOR **CCUS** AND **POWER-2-X SOLUTIONS**

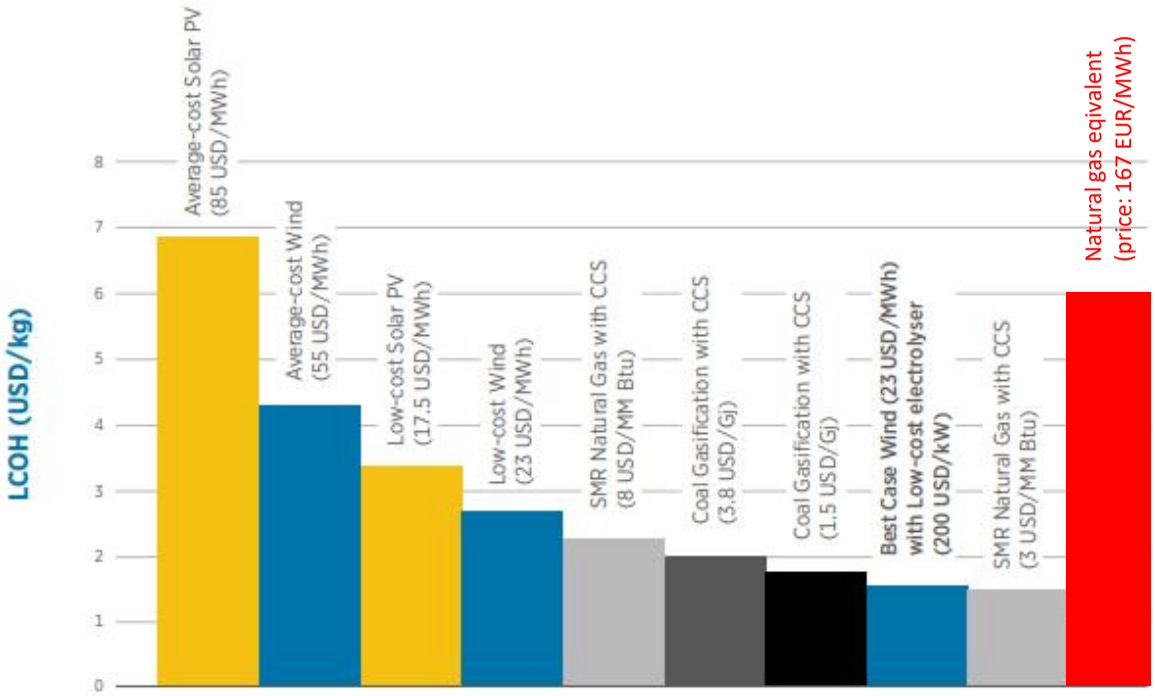


Hydrogen for RE storage



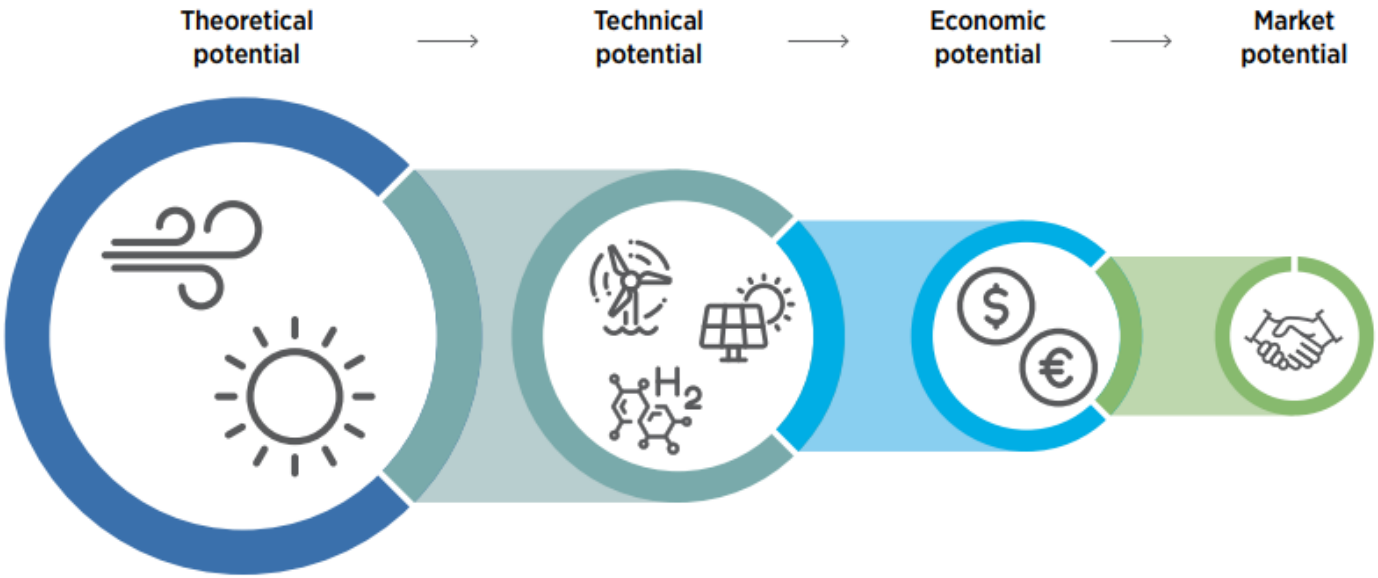
Source: School of Engineering, RMIT University (2015)

Competitiveness of renewable hydrogen today



Notes: Electrolyser capex: USD 840/kW; Efficiency: 65%; Electrolyser load factor equals to either solar or wind referencence capacity factors. For sake of simplicity, all reference capacity factors are set at 48% for wind farms and 26% for solar PV PV systems.
Source: IRENA analysis

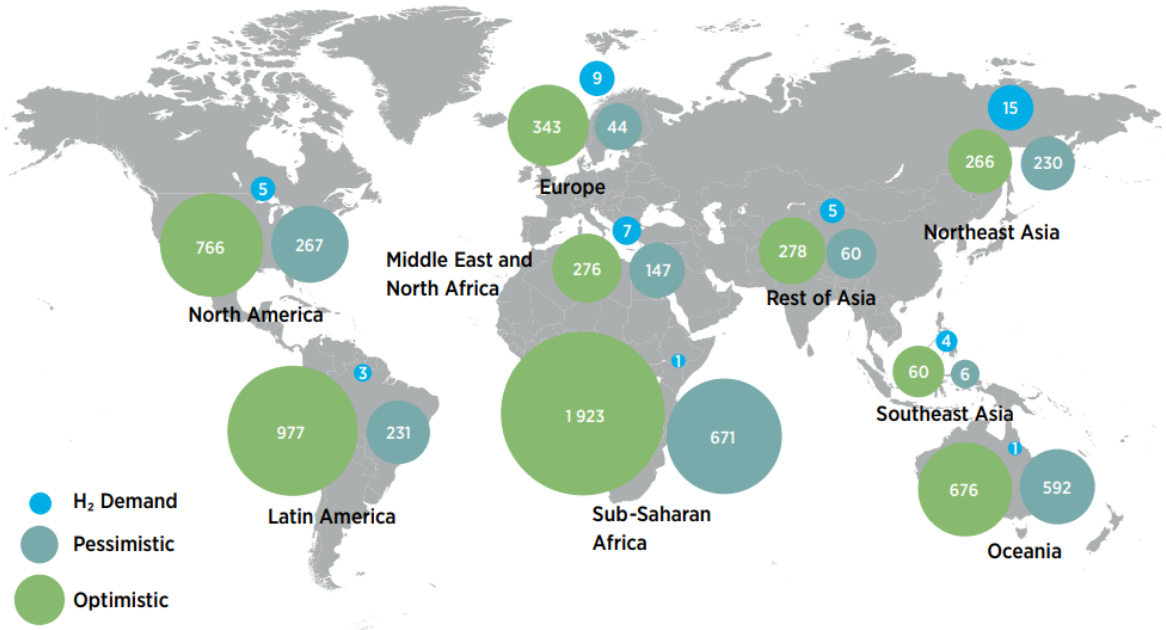
But?



- Energy content of all wind and solar resources which could theoretically be transformed into green hydrogen.
- Solar and wind energy that can be effectively harvested through wind parks and utility-scale PV.
- Theoretical potential reduced by technology characteristics and land eligibility constraints.
- Not all hydrogen technical potential production may present competitive LCOH.
- Dictated by the presence of green hydrogen offtakers.
- Competition between direct sale of clean energy and sale of green hydrogen produced with that energy.

Source: IRENA Global Hydrogen Trade Costs 2022

Potential of green hydrogen supply below and forecasted hydrogen demand



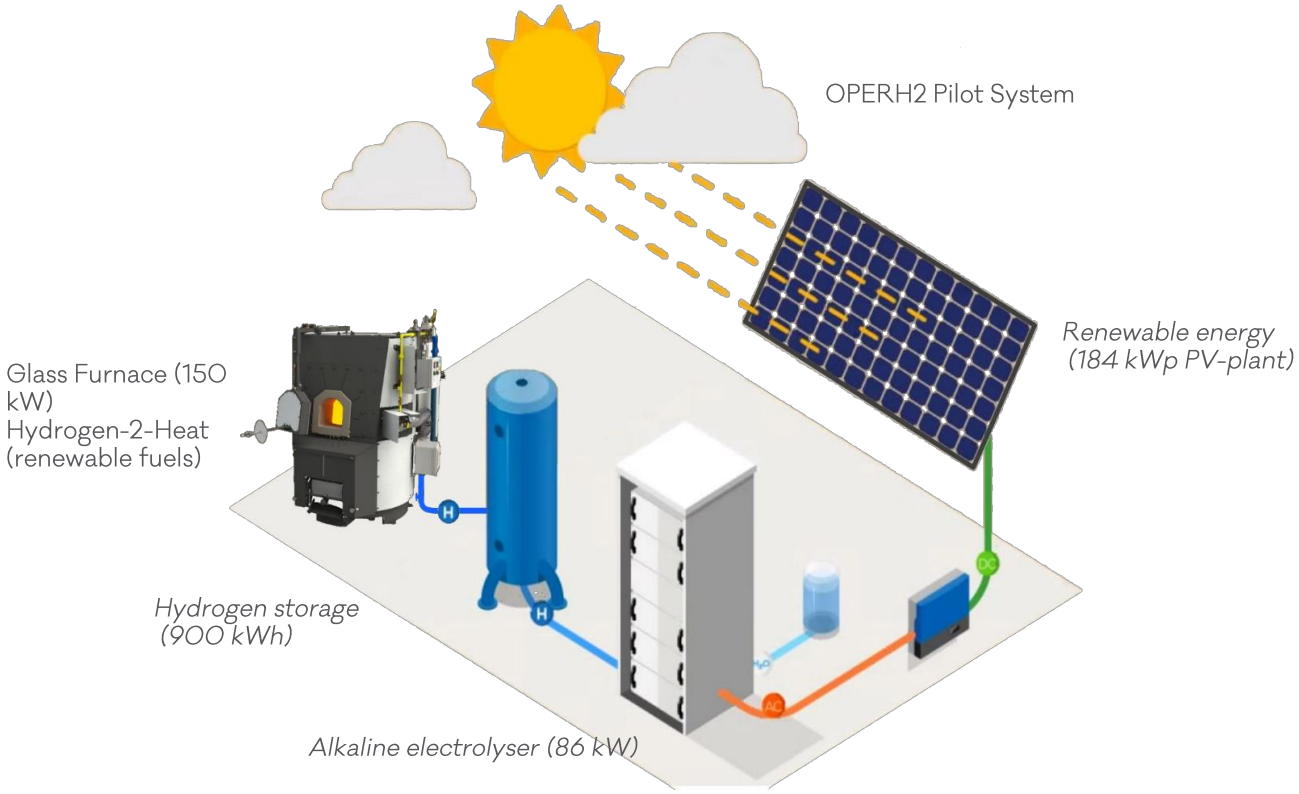
Notes: Assumptions for CAPEX 2050 are as follows: optimistic, PV: USD 225/kW to USD 455/kW; onshore wind: USD 700/kW to USD 1070/kW; offshore wind: USD 1275/kW to USD 1745/kW. Pessimistic, PV: USD 271/kW to USD 551/kW; onshore wind: USD 775/kW to USD 1191/kW; offshore wind: USD 1317/kW to USD 1799/kW. WACC: optimistic, per 2020 values without technology risks across regions. Pessimistic, per 2020 values with technology risks across regions. Technical potential has been calculated based on land availability considering several exclusion zones (protected areas, forests, permanent wetlands, croplands, urban areas, slope of 5% [PV] and 20% [onshore wind], population density and water stress). Total hydrogen demand, not including power sector (24 EJ/year), is equal to 50 EJ/year.

Source: IRENA Global Hydrogen Trade Costs 2022

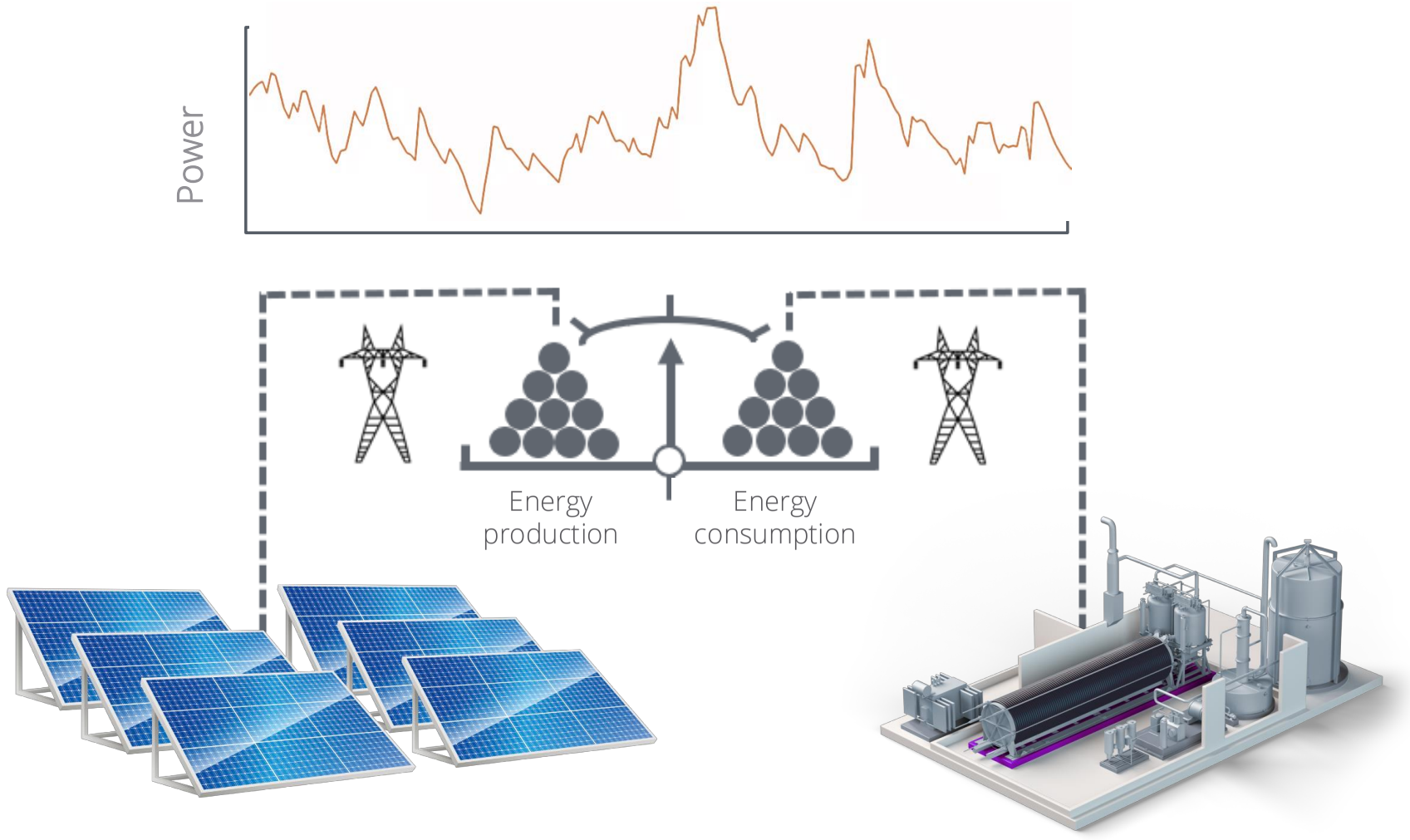
2 Hydrogen pilot system

OPERH2 Project pilot

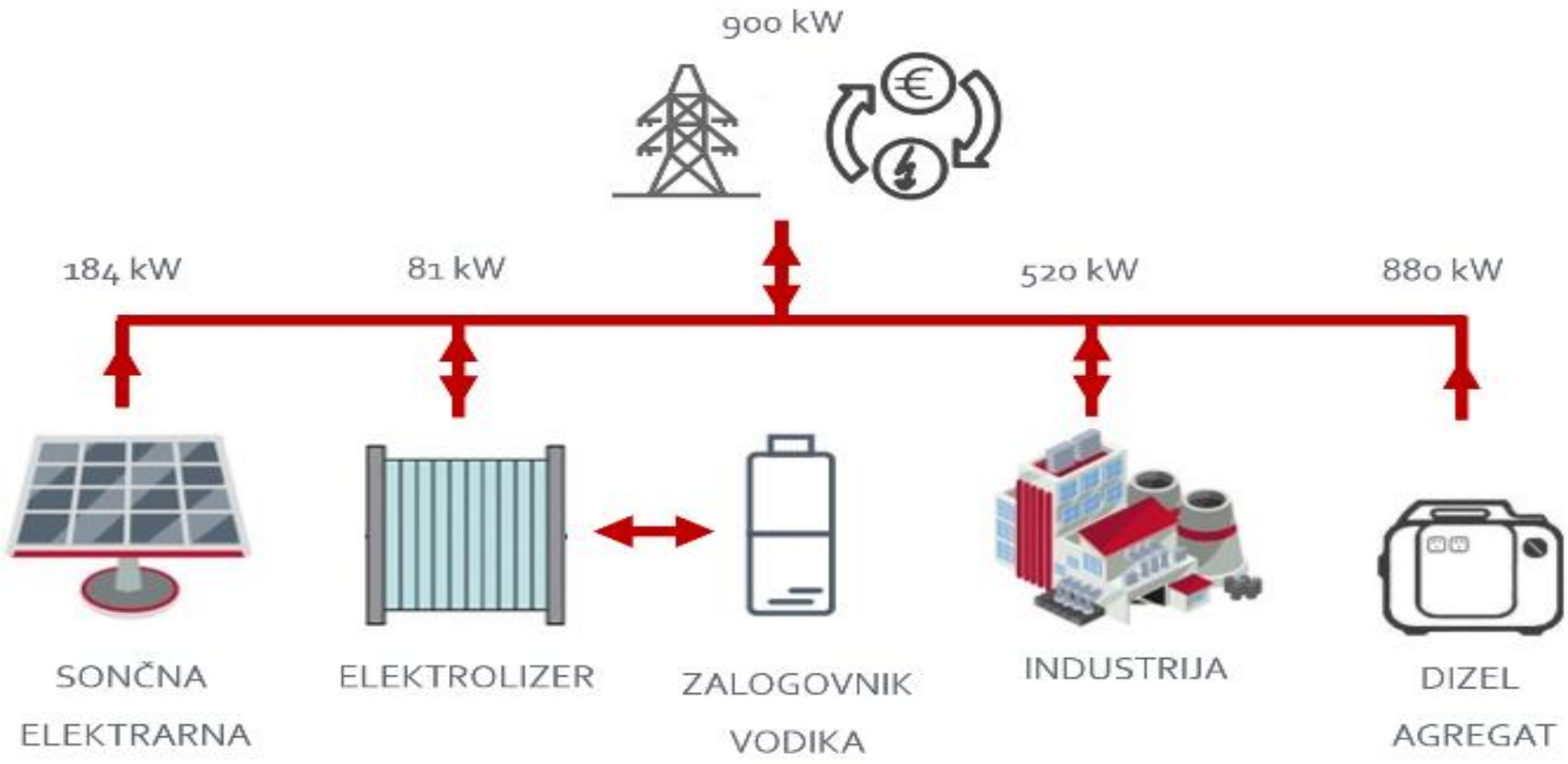
Optimization of energy conversion to replace the share of fossil fuels used for industrial glass melting with hydrogen.



PV coupled with WE



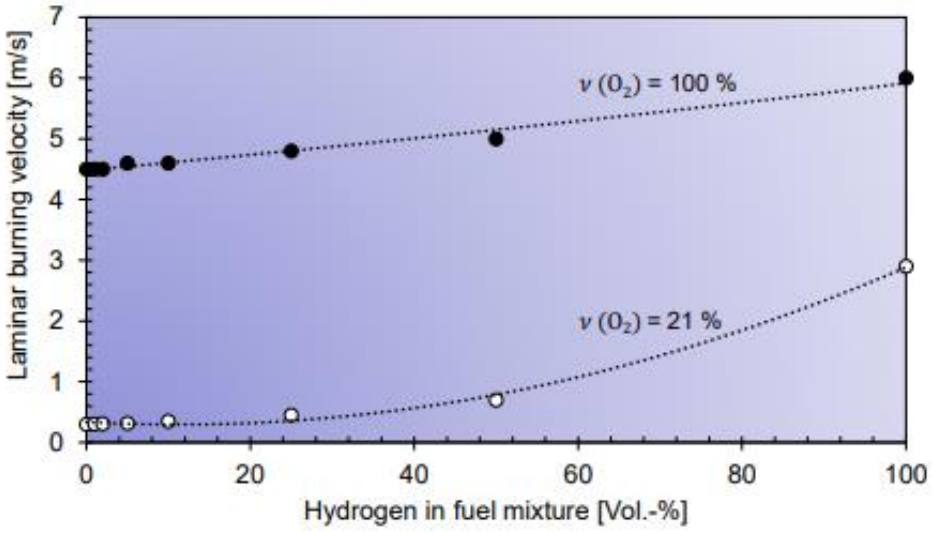
Energy Management System

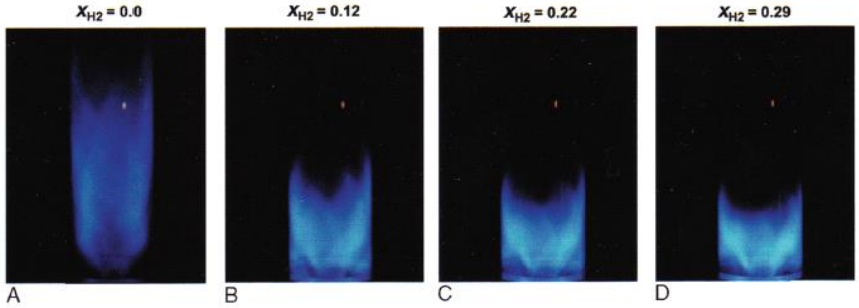


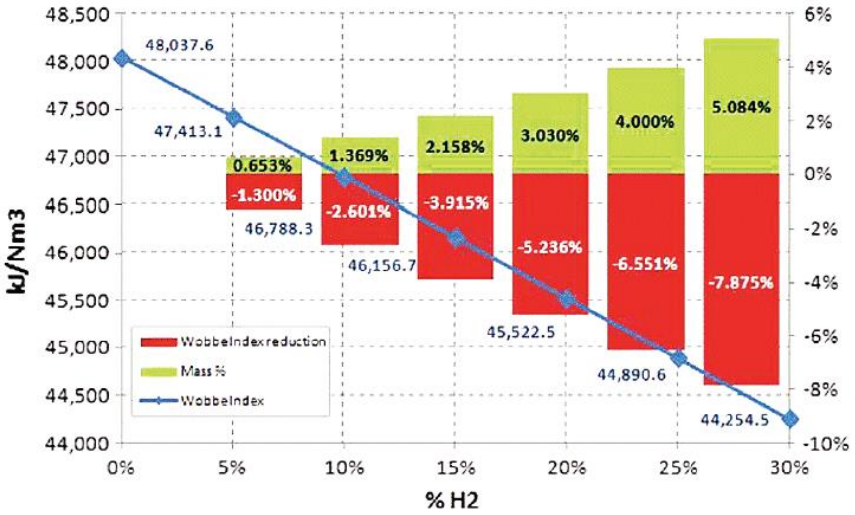
3 Hydrogen combustion

Hydrogen combustion

- Laminar burning velocity 10x higher with H2
- Lower Wobbe index







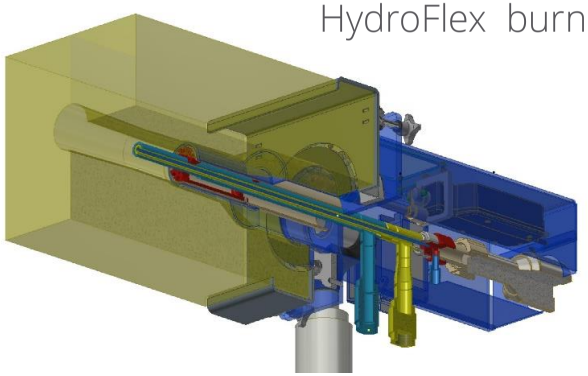
Source: L. Santoli et al.

HydroFlex combustion system

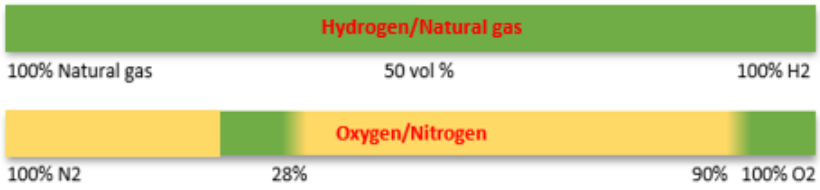
- High exit velocity burners
- Mixure of natural gas and hydrogen in every ratio possible, and mixture of air and oxygen in every ratio

Skid for H2, NG, O2, Air

HydroFlex burner

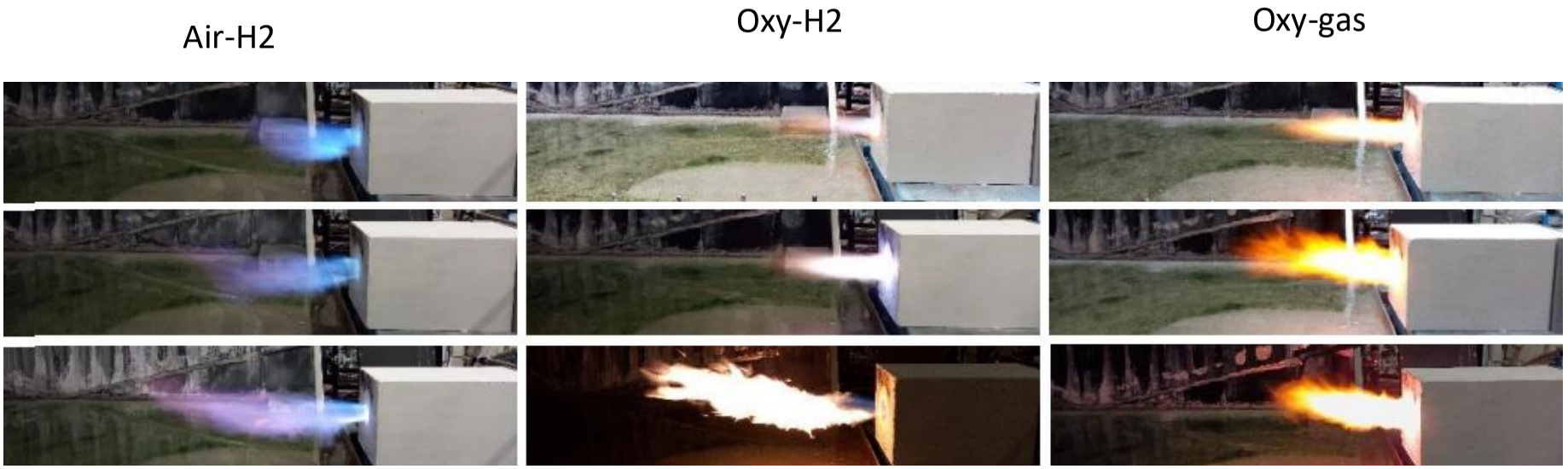


Fuel/oxidiser mixtures flexibility range visualisation:



Open flame testing

- Similar flame length and temperature distribution for Air-hydrogen, Oxy-hydrogen and Oxy-gas combustion



4 Carbon-free glass melting and LCA

Pilot demonstration

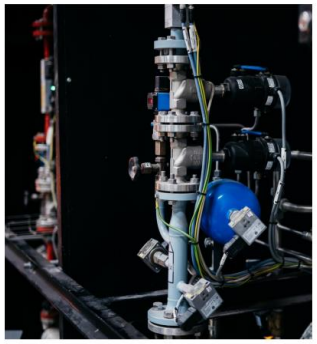
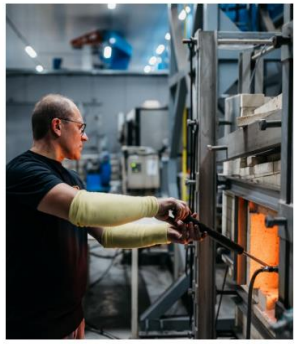
- Melting of glass with 100% hydrogen and 100% PCR cullet









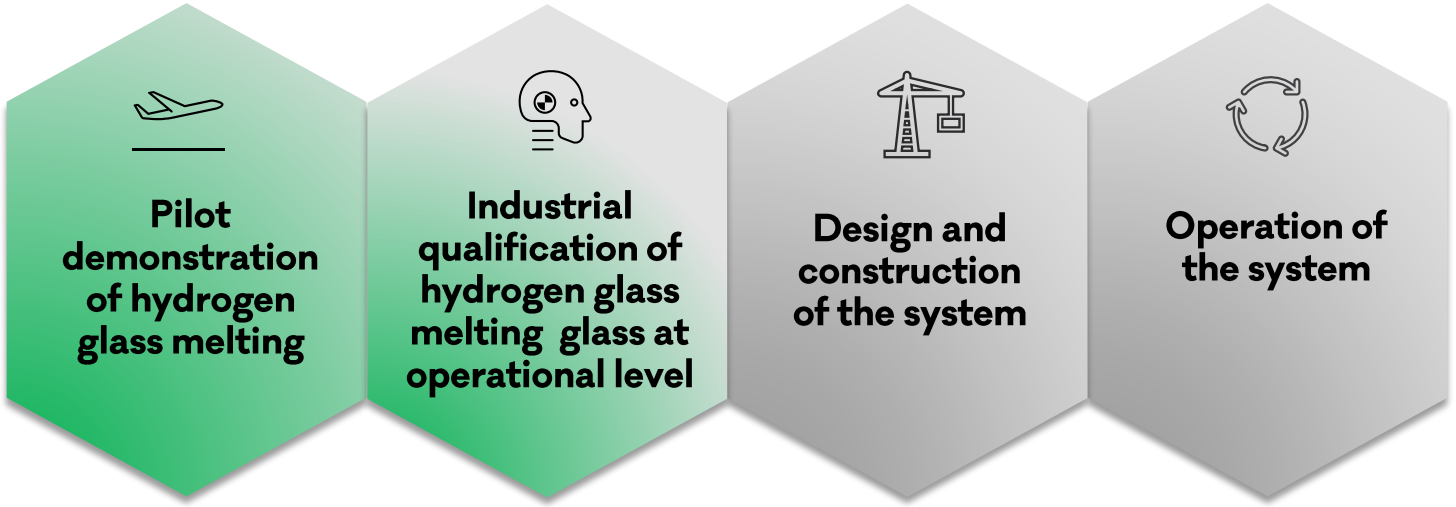
Our most sustainable glass bottle

5 Industrial demonstration (H2GLASS)

Project roadmap

H2GLASS

TRL6



TRL9

1 PHASE

2 PHASE

3 PHASE

4 PHASE

H2GLASS Consortium

- 23 partners
- 4 years
- 33 M€ budget
- 24 M€ EU fund
- Launch in Jan 23

List of participants

Participant no.	Participant organisation name	Country
1 (coordinator)	SINTEF ER AS	Norway
2	SINTEF AS	Norway
3	SINTEF MANUFACTURING AS	Norway
4	STAM	Italy
5	STEINBEIS INNOVATION GGMBH	Germany
6	WE PLUS SPA	Italy
7	NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU	Norway
8	THE UNIVERSITY OF NOTTINGHAM	United Kingdom
9	Stara Glass S.p.a.	Italy
10	Steklarna Hrastnik d.o.o.	Slovenia
11	KEMIJSKI INSTITUT	Slovenia
12	FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV	Germany
13	ASTON UNIVERSITY	United Kingdom
14	UNIVERSITAT POLITECNICA DE CATALUNYA	Spain
15	EUROPEAN ALUMINIUM	Belgium
16	STAZIONE SPERIMENTALE DEL VETRO S.c.p.A.	Italy
17	Vetrobalsamo S.p.A.	Italy
18	OCV CHAMBERY INTERNATIONAL	France
19	ZIGNAGO VETRO SPA	Italy
20	SENER INGENIERIA Y SISTEMAS SA	Spain
21	CIB UNIGAS	Italy
22	HYDRO HAVRAND	Norway
23	PTML PILKINGTON	UK

H2GLASS Concept

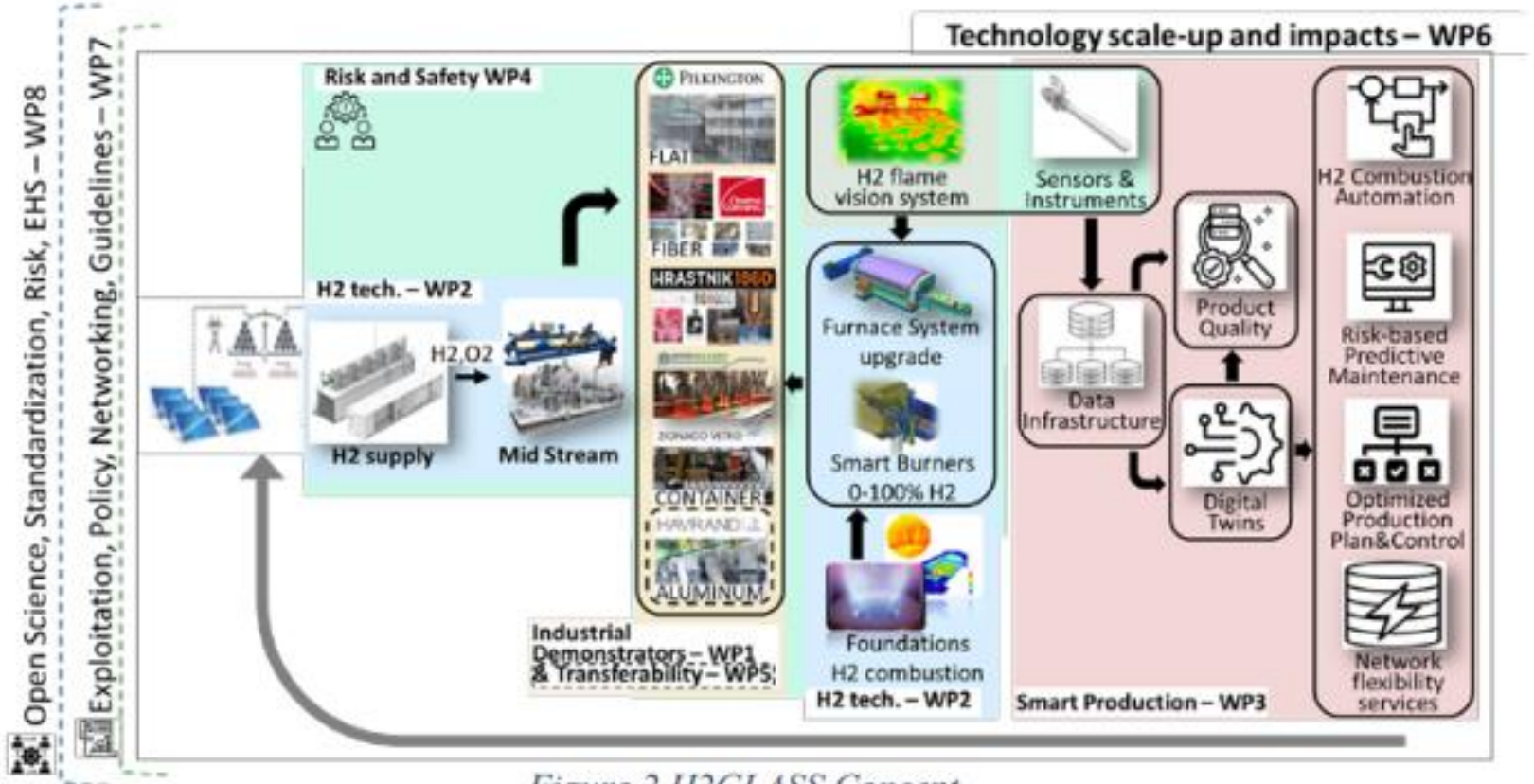
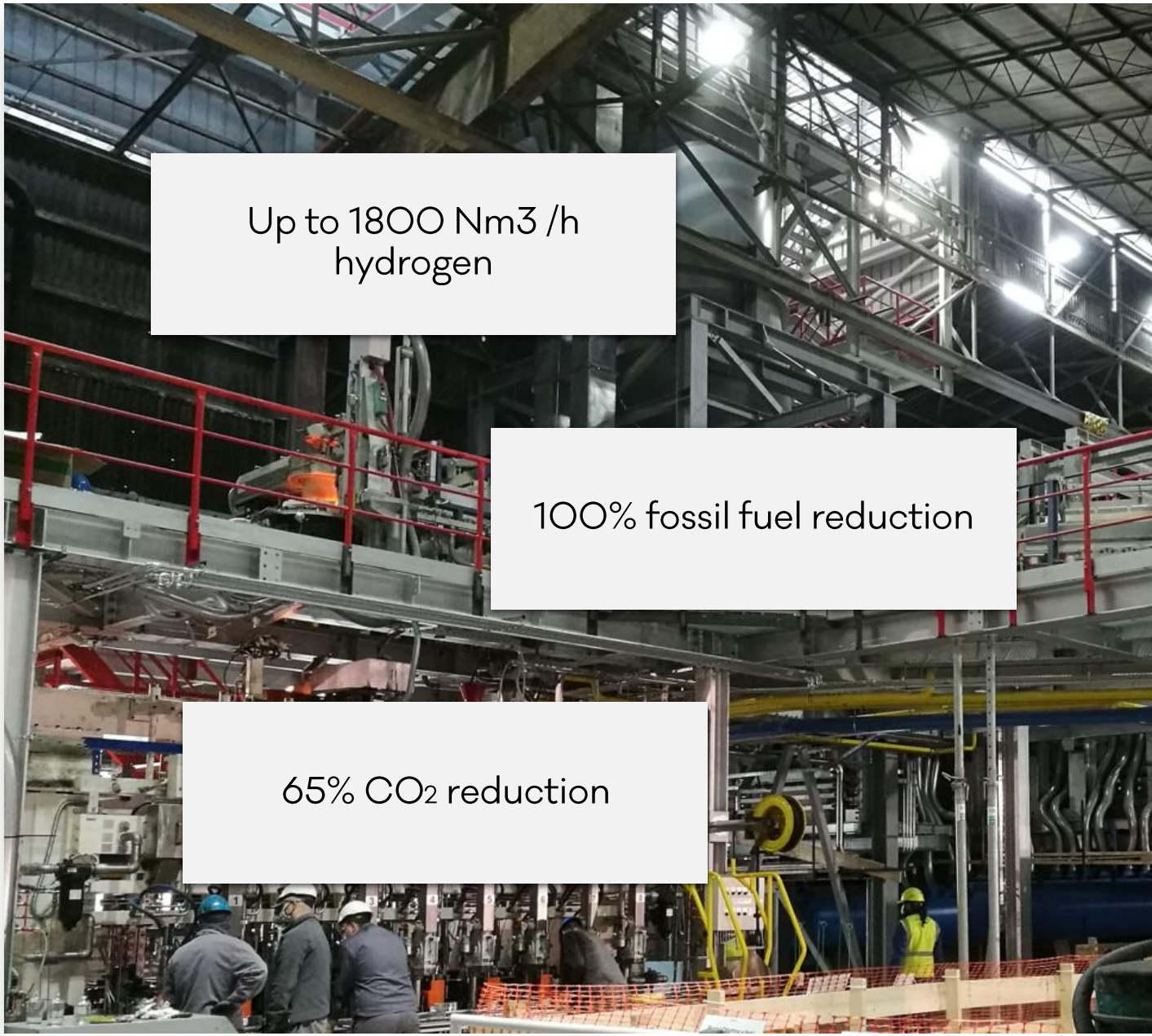


Figure 2 H2GLASS Concept

Glass production decarbonisation utilizing Hydrogen

Large-scale
(120 t/day)



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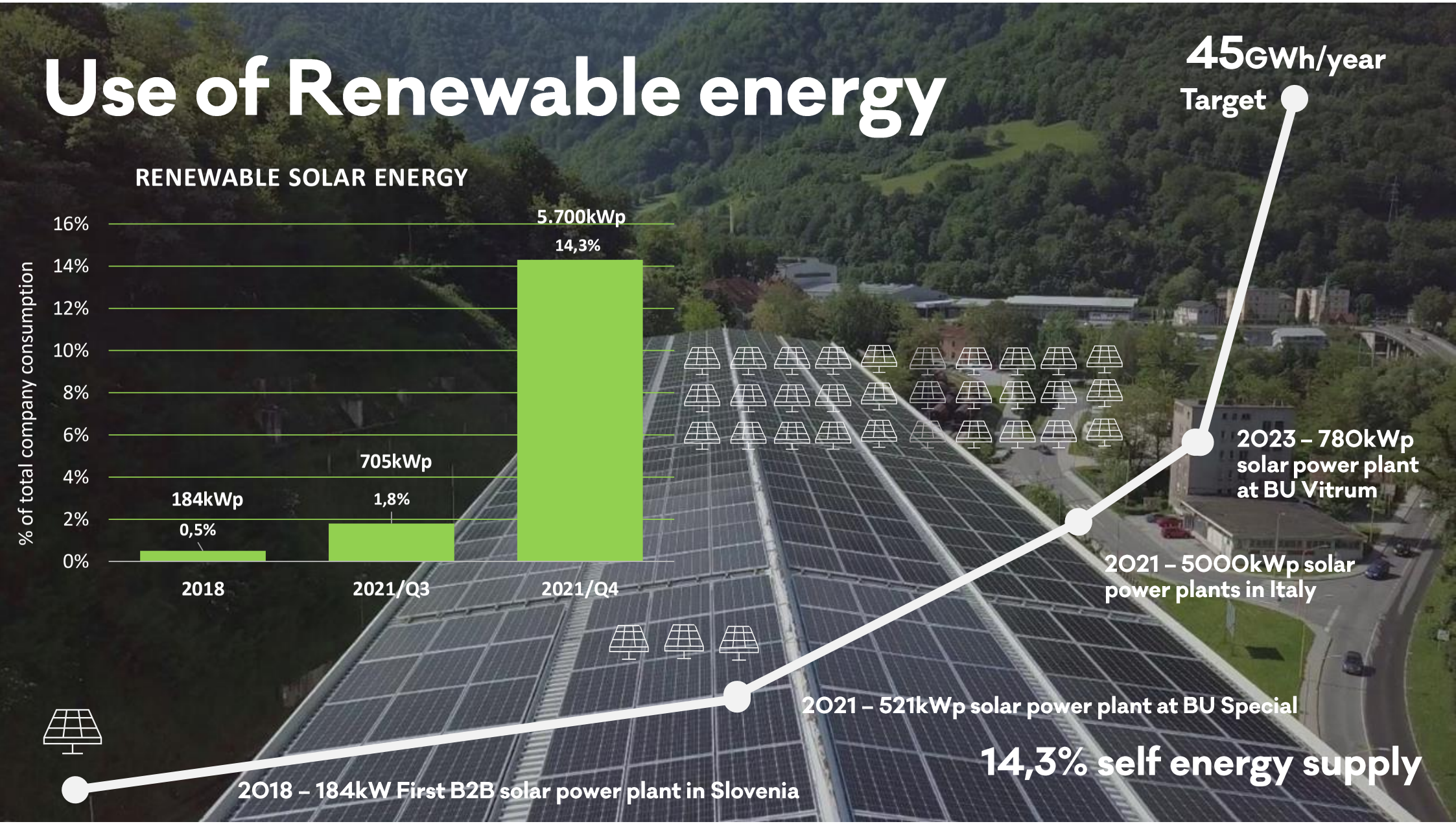
Use of Renewable energy



Electrification

HYBRID REGENARATIVE FURNACE 2023

-40% CO2

First in the world.

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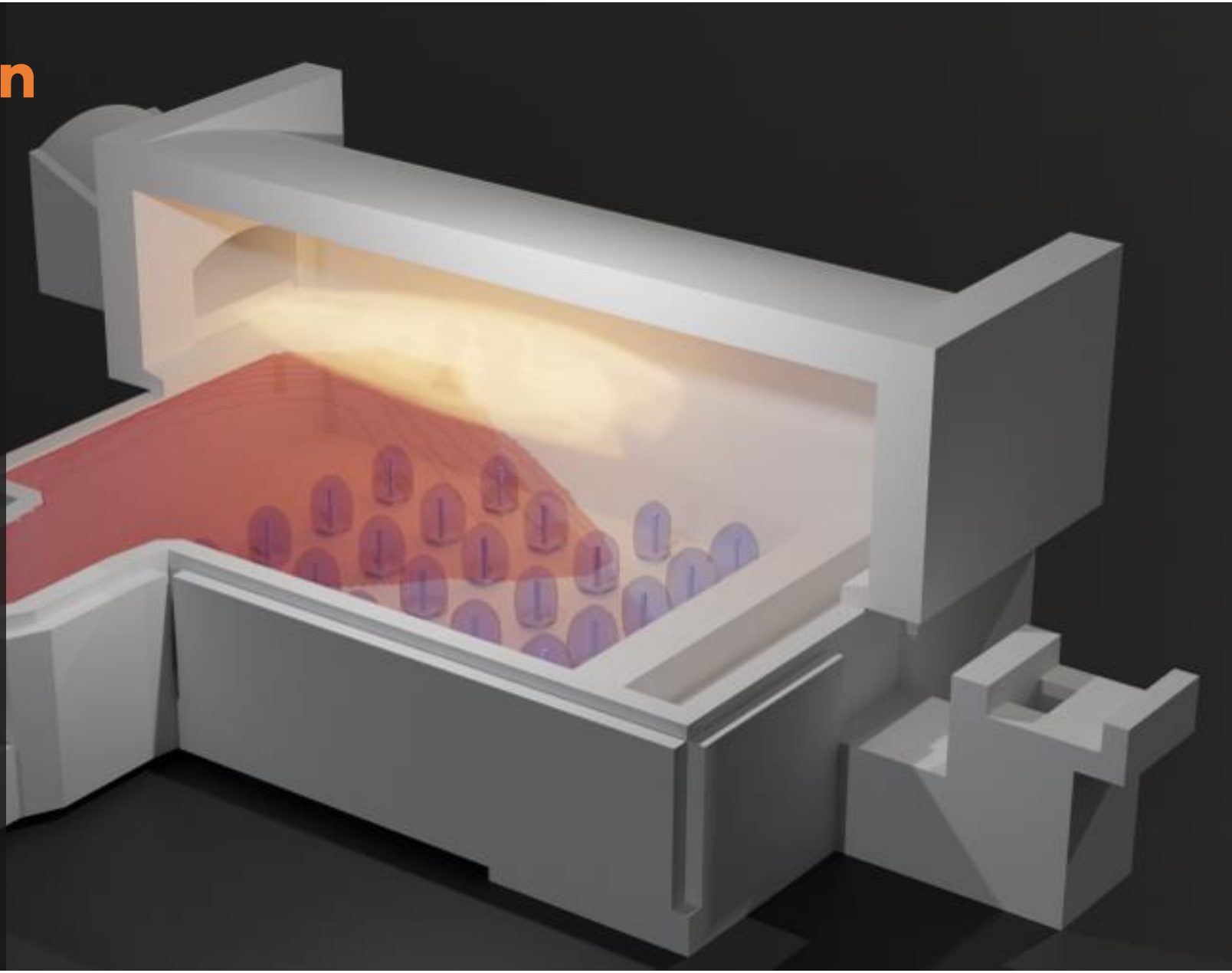

New Sustainable Green-field factory

HRASTNIK 1860

New Furnace X

HRASTNIK1860

Q & A