

Hydrogen Research & Innovation Days

24-25 November 2025





HYDROGEN FOR CLEAN HEAT AND POWER

Portfolio Analysis

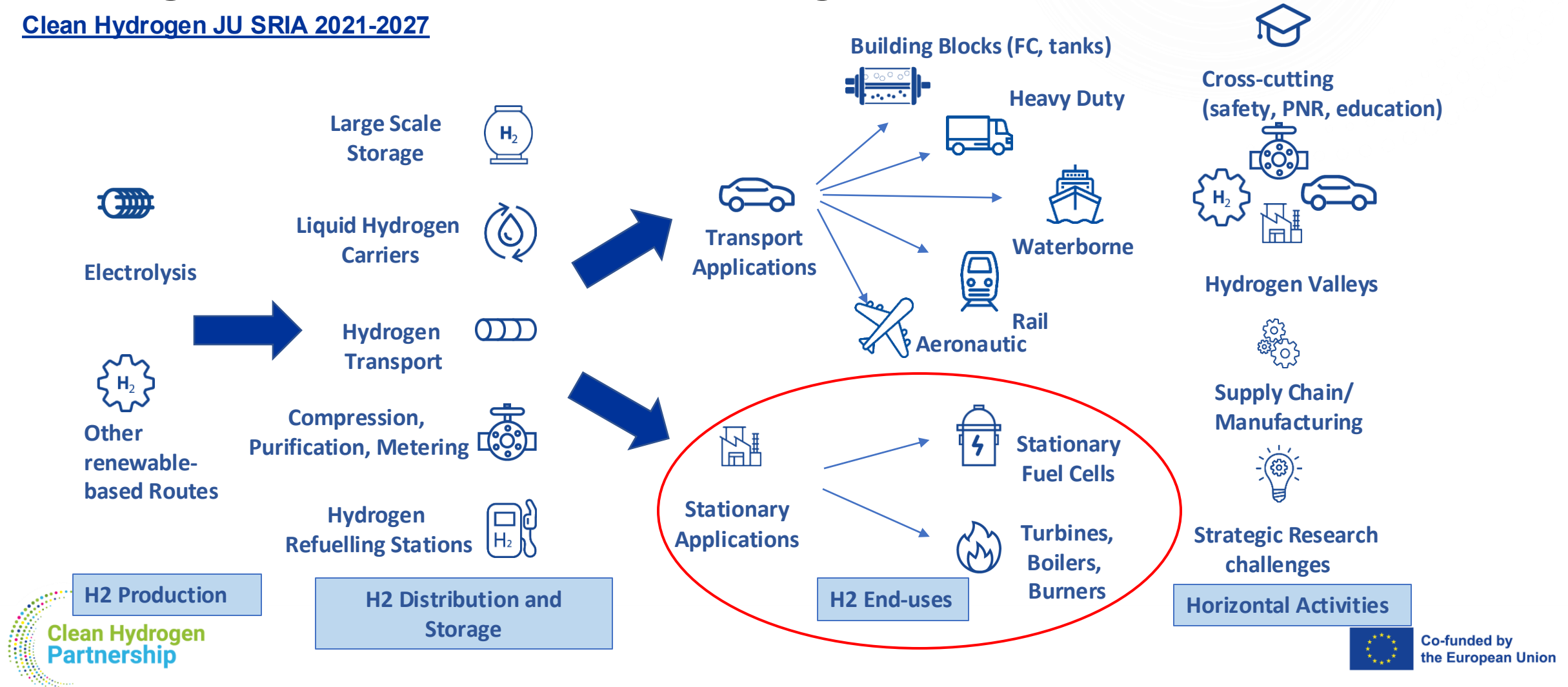
Luca Feola

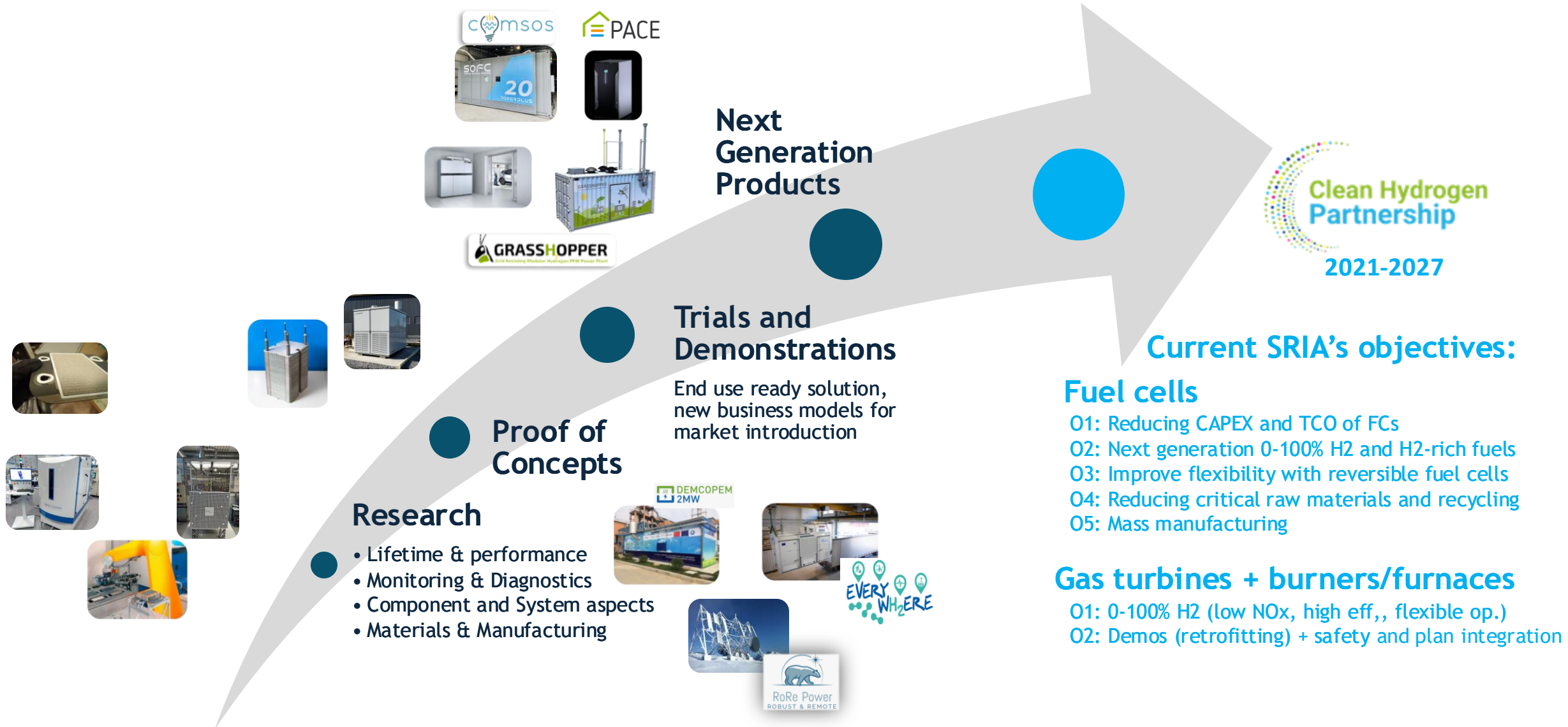
Project Officer, Clean Hydrogen Partnership



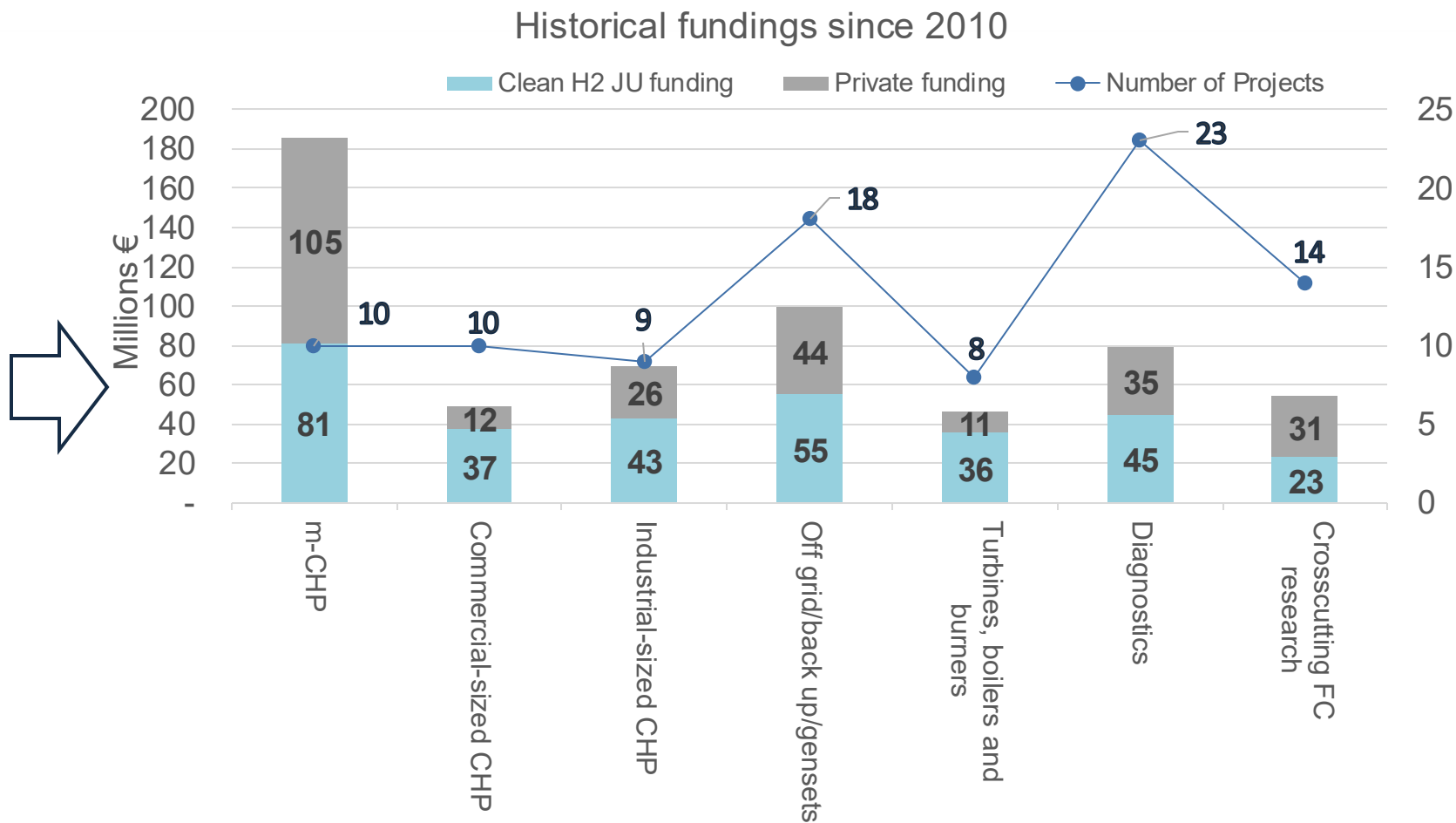
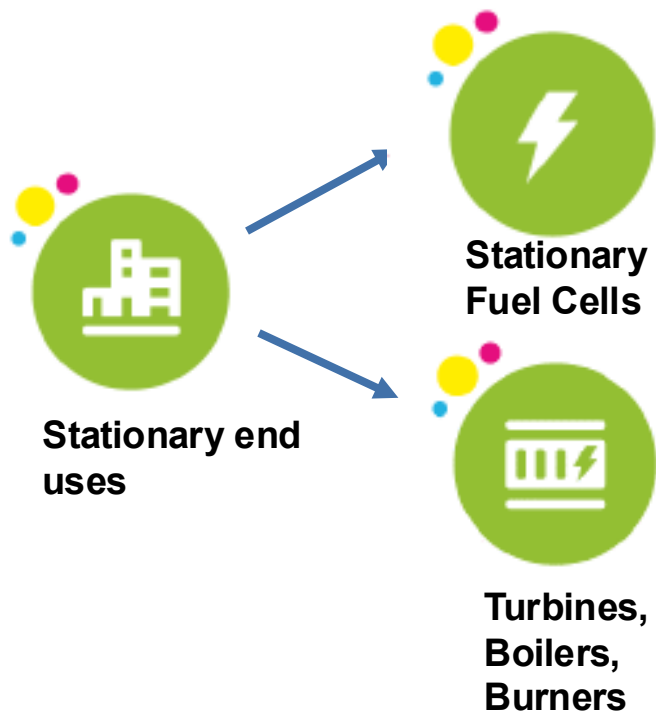
Strategic Research & Innovation Agenda

Clean Hydrogen JU SRIA 2021-2027





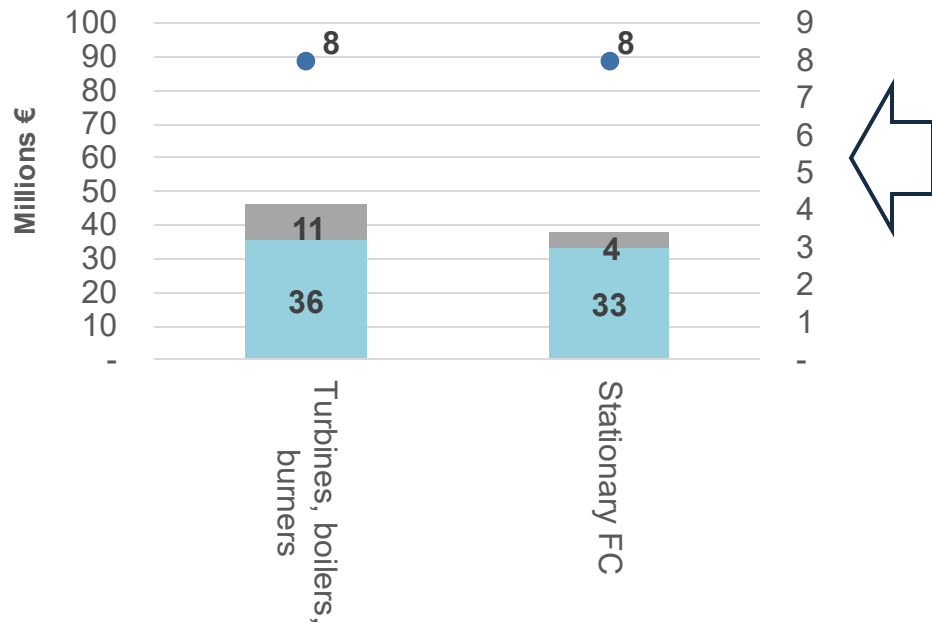
Clean Heat and Power Portfolio Historical fundings



92 projects since 2010
320 million EUR JU funding
263 million EUR private funding

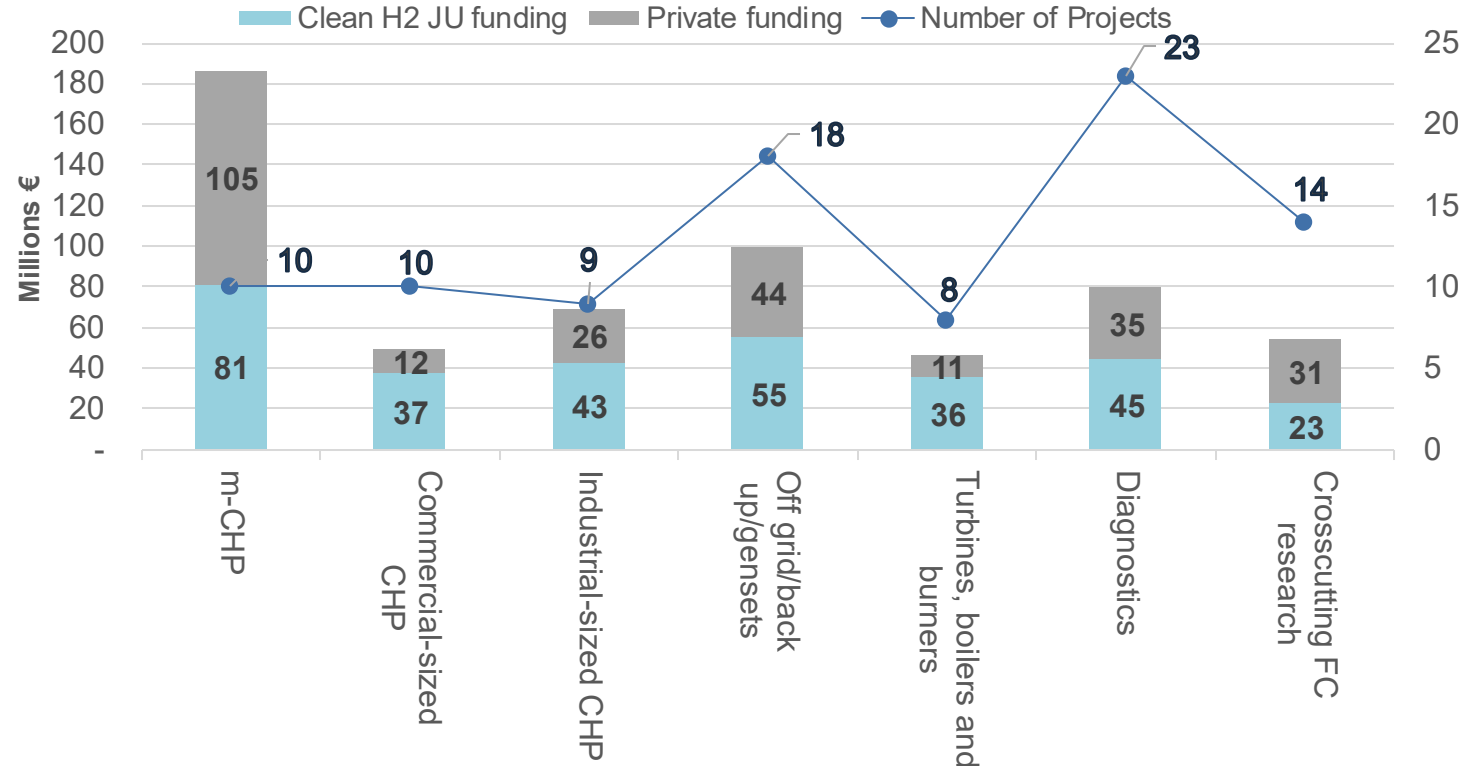
Ongoing projects

■ Clean H2 JU funding ■ Private funding ● Number of Projects



16 ongoing projects
Equally split between FC and H2 combustion applications

Historical fundings since 2010



92 projects since 2010
320 million EUR JU funding
263 million EUR private funding

Flexibility of fuels

- **Mixture** of natural gas, **biogas** and **hydrogen**.



- Commissioned **2 5kW_e** demonstrators (TRL6 and 7) 

- **8 kW_e** stack.
- **100% ammonia** power.
- Target **70% efficiency**.



Use cases:
Residential CHP, Port operation

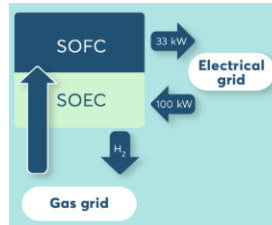
Reversibility and grid integration

- Continuation of activities:



- Develop a **33/100 kW** scale rSOC power balancing plant. 

- Demonstrate compatibility the electricity & gas grid.



Use cases:
Electricity/gas grid integration

Demo projects

- Proof of Concept of module that provides **2x45kW** SOFC systems.



- Seamless servicing by partial replacement of modules in case of failure.



- **Availability: 99.999%** (key feature for data centers). 

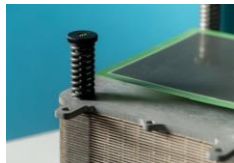
Use cases:
Prime power for data centers

Innovative manufacturing

- High-speed **laser welding & stack components handling** with alignment fixture and camera. 

- Target **manufacturing cost of <800 €/kW_e** at production volume of **100 MW/year**. 

- **Exploitation** potential by SOFC manufacturers.



Users:
FC manufacturers makers

High power and impurity tolerant FC

- **>100 kW** PEM fuel-cell co-generation system.
- Suitable for industrial H_2 with purity of **~ 98%**.
- **> 5000h testing** at industrial quality hydrogen.
- **Reduce TCO** through lower cost materials, modelling and increasing efficiency.



Use cases:

Ports and airport equipment

Backup power systems

- Portable and flexible container type rescue system.
- **50-100kW**, powered by methanol or hydrogen (dual fuel operation).
- **High Temperature Fuel Cells**.
- 50% fuel to efficiency targeted.



Use cases:

Portable power for civil emergencies

Diagnostics - SOFC and PEM

- Innovative monitoring and control systems for fuel cell.
- Based on **Onboard EIS** (Electrochemical Impedance Spectroscopy).
- Legacy of projects:



- **EIS data analysis tool publicly available**



Use cases:

Cross-applications

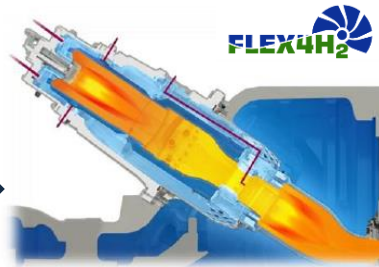
Combustors operating at 100% H₂

Intermediate results:

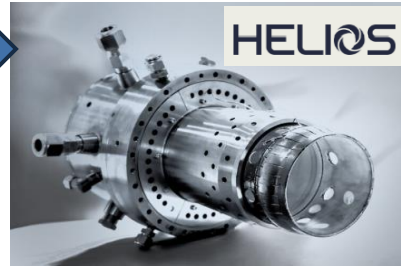
- 100% H₂ combustion achieved (both projects).



- Different technologies:
Sequential combustion →



Flame sheet® →

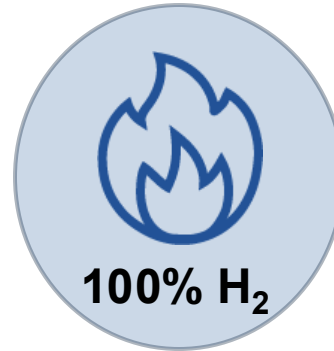


Next challenges:

- **Stable combustion at 100% H₂** (no flashback, no thermodynamic instabilities).
- Further understand effect of high pressure.

InsigH₂t

ACCEPT



Retrofit Gas Turbines for Cogeneration

Target:

- 100% H₂ combustion in gas turbines.

HyPowerGT HyCOFlex

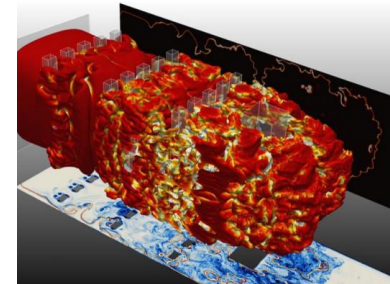
Intermediate results:

- (HyPowerGt) Finalized burner design.



- Full-scale combustor with 39 burners in assembly phase.

- **Study of turbulent burning rate** empirical data analysis ongoing.



Next activities :

- Full rig tests with newly developed combustors.
- Full retrofit into gas turbines and test.



Retrofit burners in furnaces

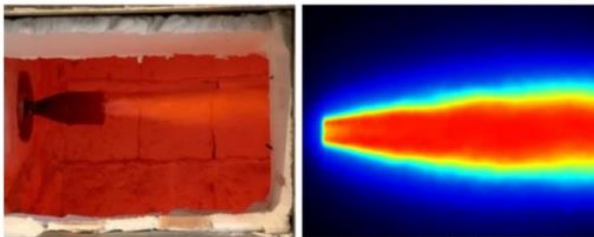
Retrofitting of:

- 2 Redesigned **oxyfuel burners** at 100% H₂ and NG/H₂ blends.
- **New refractory materials.**
- sensors **for monitoring oxyfuel combustion.**



Flame image

OH* chemiluminescence

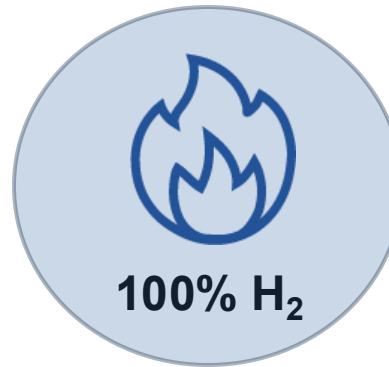


Achievements:

- Design of burners and sensors completed.
- Test of refractory material completed.
- **Retrofit and 100h testing within 2027.**



Use case:
Heat for aluminum industry



H₂ combustion phenomena (including ammonia)



- Understanding **instability mechanisms** (effects of pressure up to 10 bar).
- Use of **advanced numerical simulations** and **optical measurements.**
- Study **unconventional H₂ blends, including ammonia** (swirl stabilized, Hot Jet Coflow).

First results as of 2026.



International cooperation



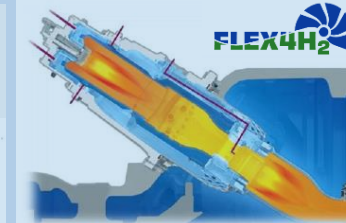
Hydrogen combustion: cooperation with NEDO (JP)

- Workshop held in Japan March 2025: **Low TRL research as strategic cooperation area.**
- Collaboration **encouraged** in AWP 2026.
- Positive synergies also within Europe through **OEM network within our projects (InsigH2t, HyPowerGT, Flex4H2)**



H₂ and NG blends

Low Purity H₂



H₂ and alternative fuels



~10kW

30-150kW

300kW to 1MW

>10 MW scale

- Clean Heat and Power technologies are flexible in terms of fuels and power ranges.
- Fuel Cells solutions to reach MW scale.



Clean Heat and Power Portfolio – Key takeaways

- Development in FC technology continues with focus on reversibility and fuel flexibility.
- Research on Innovative Manufacturing and diagnostics techniques contribute to lower TCO.
- Achieving MW scales for FC and study degradation mechanisms in reversible mode remains is a key achievable challenge.
- Hydrogen combustion technology successful at high TRL.
- Next research area: achieving stability across different operative conditions.
- Fuel Cells and hydrogen combustion technologies jointly show high degree of flexibility in terms of power requirements and type of fuels.

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Thank you for your attention