

SO FREE-Solid oxide fuel cell combined heat and power: Future-ready Energy

Topic: FCH 02 4 2020 : Flexi fuel stationary SOFC

Grant Agreement number : 101006667

Viviana Cigolotti

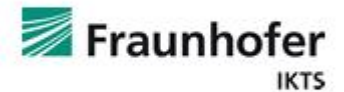
Head of Division Technologies and Vectors for Decarbonization: Storage, Hydrogen,
Mobility, CCUS, and End Uses, ENEA

Innovations for Maritime & Stationary Use
20th January 2026

Project overview

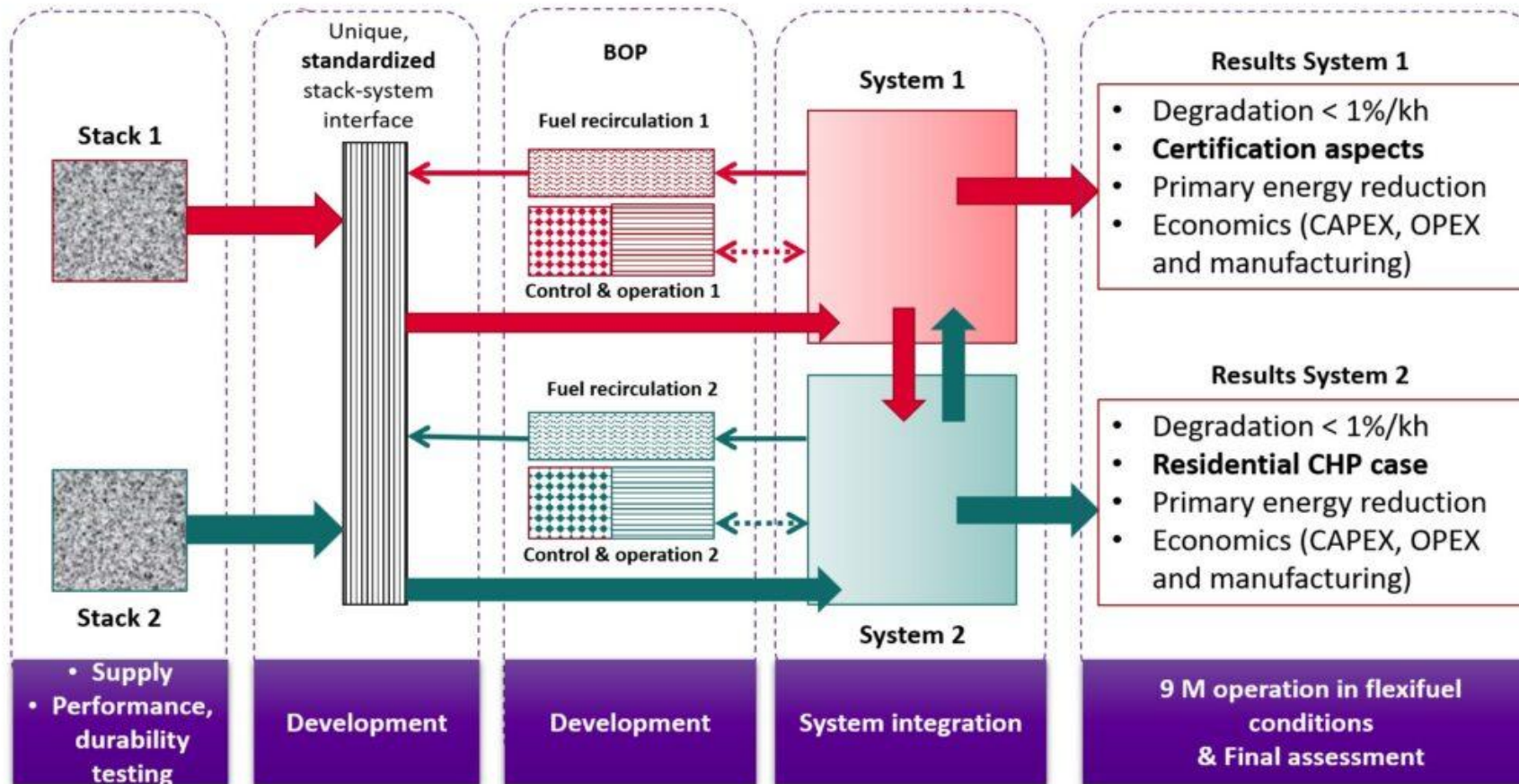
SO-FREE aims to develop a **future-ready SOFC-CHP system** enabling **fuel-flexible, low-emission** and **modular** power and heat generation.

- Demonstration of a fully fuel-flexible, 5 kW CHP system
- Start: 1 January 2021- End: September 2026
- Budget: 2.7M€
- **Stack suppliers:** Elcogen (ASC, 650°C), Fraunhofer IKTS (ESC, 850°C)
- **CHP System developers:** ICI
- **Stacktest labs:** ENEA, IEN
- **Demosites:** KIWA, IEN (>6000 h)
- **Pre-certification & market assessment:** SOFC-CHP NL, IT, PL, UK
markets: PGE, KIWA, USGM, ENEA



This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under grant agreement No 101006667. This Partnership receives support from the European Union's Horizon Europe Research and Innovation programme, Hydrogen Europe and Hydrogen Europe Research.

SO-FREE concept: decoupling stack and system development



Project Objectives

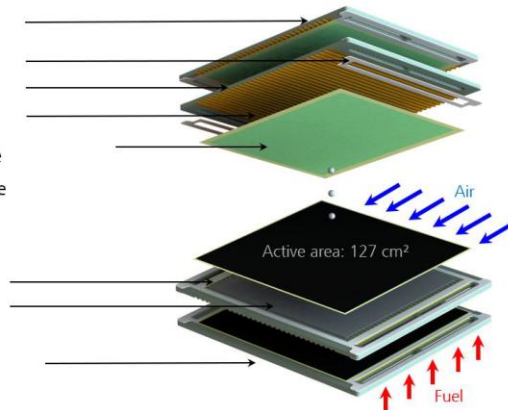
- Study the effects of **fuel mixtures** (natural gas, biogas, hydrogen) on **AS and ES SOFC stacks** integrated in a **5 kWe-class CHP system**
- Optimise **system architecture** and **BoP compatibility** for **fuel- and stack-flexible systems**
- Enable **standardised stack-module interfaces** for **full interchangeability**
- Demonstrate **long-term prototype operation (>6000 h)**
- Support **pre-certification** according to **EU and international directives**

Experimental testing and cross-lab validation

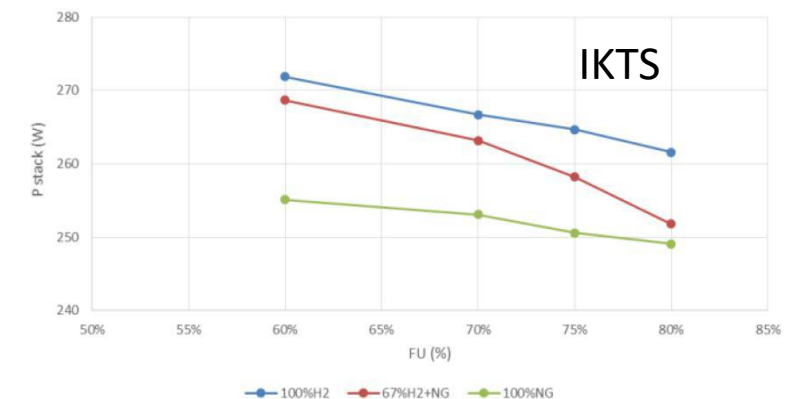
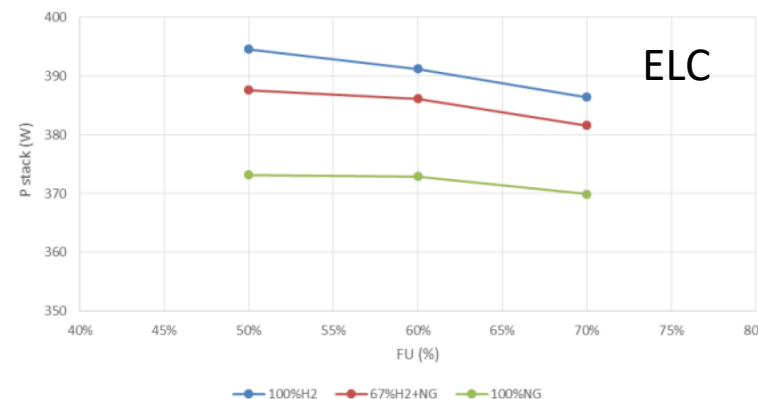


- Developed a unique testing interface for validation in 2 labs
- Testing under 100% H₂, 100% CH₄ & 67% H₂ – 33% CH₄
- IV curves, Fuel utilization curves, Temperature sensitivity
- $\pm 0,88\%$ average difference between 2 test labs on all measurements (and difference always < 4%)

End plate BiP
Glass step
Bipolar plate
Protection layer
Cell with 10ScSZ Electrolyte
and contact layer on air side



Glass frame
Nickel mesh
Bottom plate BiP



This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under grant agreement No 101006667. This Partnership receives support from the European Union's Horizon Europe Research and Innovation programme, Hydrogen Europe and Hydrogen Europe Research.

From stack validation to system integration

- **Validated stack performance as system input**

Stack operating envelopes translated into system-level requirements

- **Scaling from stack to stack module**

Short-stack results extrapolated to full-scale modules under CHP conditions

- **Standardized stack module–system interface**

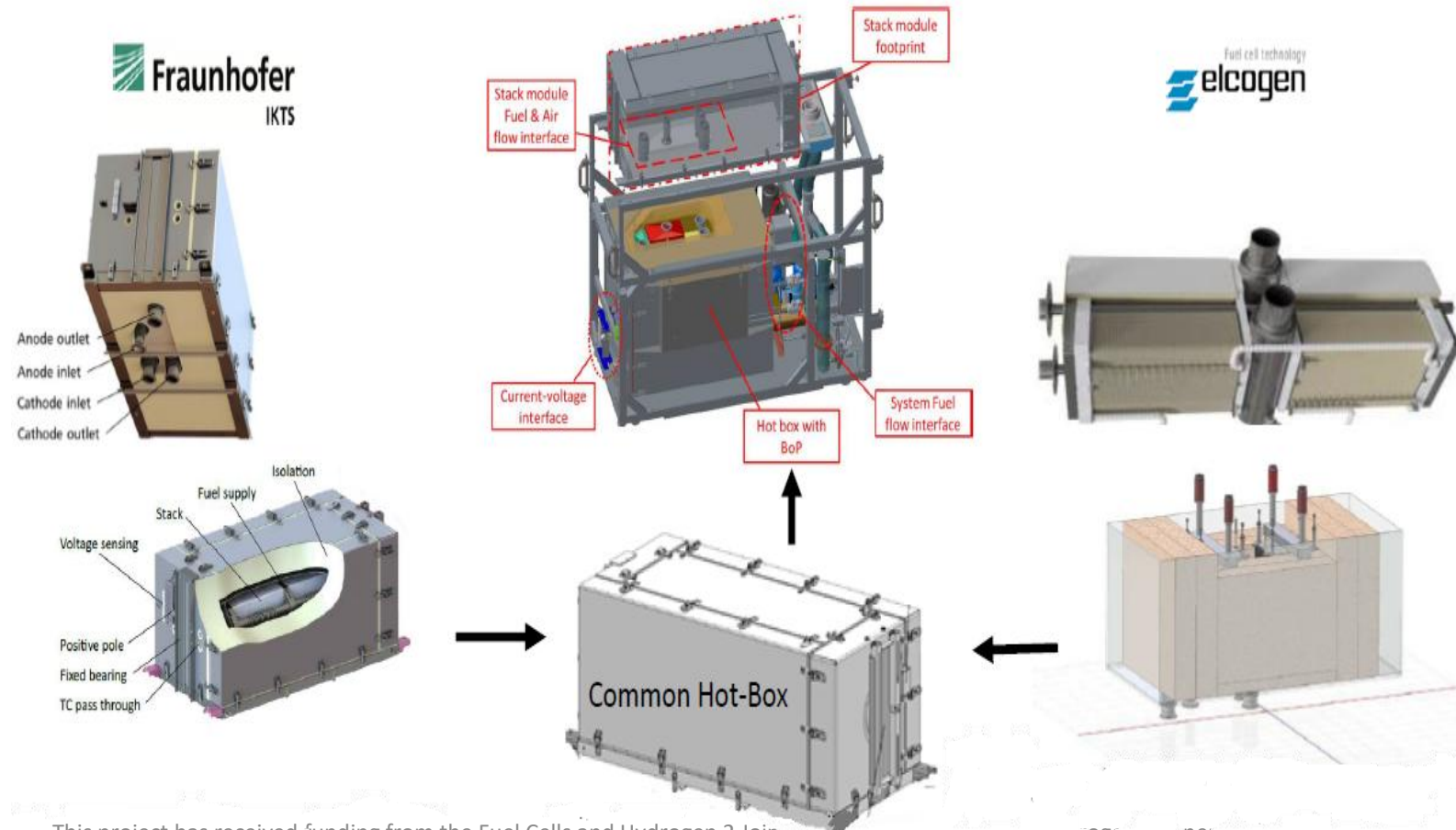
Mechanical, thermal, electrical and fluidic decoupling

- **Interchangeability of different SOFC technologies**

ASC and ESC stacks integrated within the same CHP architecture

- **Basis for prototype manufacturing and pre-**

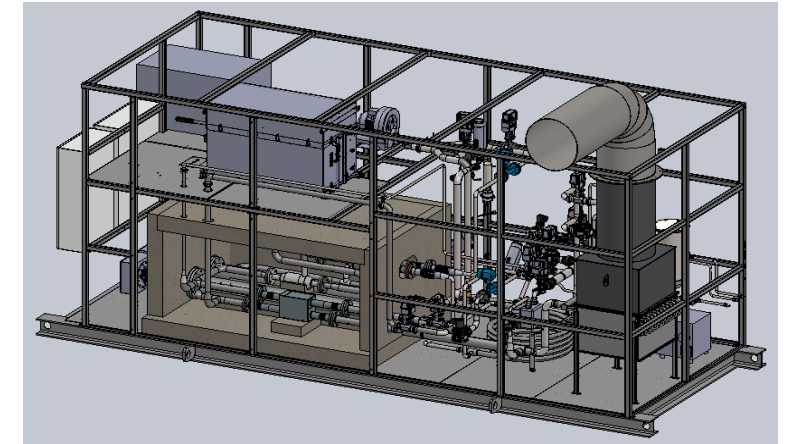
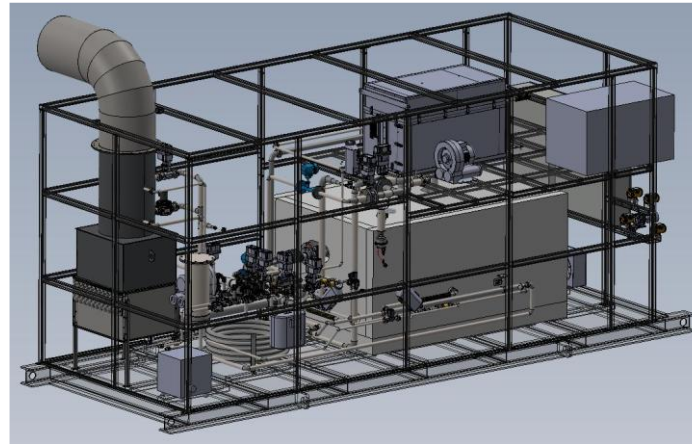
certification Design freeze enabling demonstration and long-term operation



This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under the European Union's Horizon Europe Research and Innovation programme, Hydrogen Europe and Hydrogen Europe Research.

Next step : and cross-lab validation

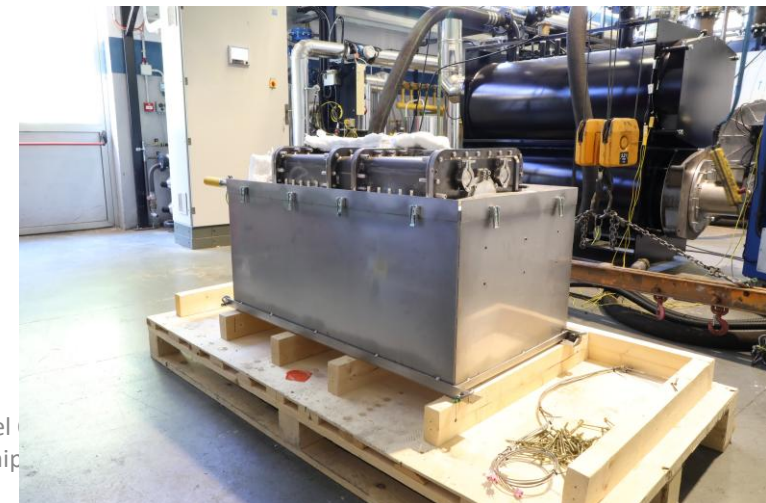
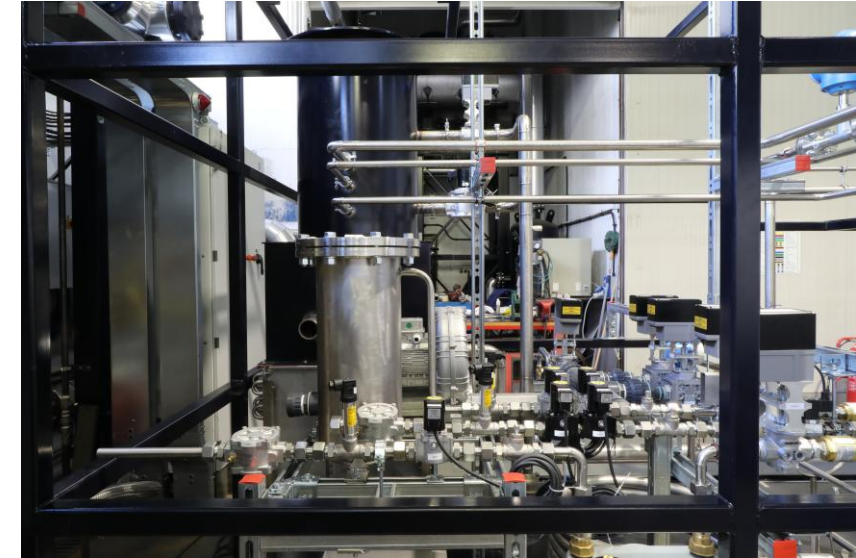
- **One 5 kWe-class SOFC-CHP systems deployed**
Prototypes integrating standardized stack modules and flexible BoP architecture
- **Demonstration in relevant operational environments**
Long-term operation at two independent demo sites
- **>6000 hours of operation under flexi-fuel conditions**
Natural gas, H₂/NG blends and hydrogen-ready operation



- **Performance, durability and availability assessment**
Validation of efficiency, degradation rate and system reliability
- **Input to pre-certification and market readiness**
Demonstration results supporting CE pathway and exploitation strategy

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under grant agreement No 101006667. This Partnership receives support from the European Union's Horizon Europe Research and Innovation programme, Hydrogen Europe and Hydrogen Europe Research.

Final prototype @ICI Caldaie



This project has received funding from the Fuel Cell Partnership under grant agreement No 101006667. This Partnership is part of the Clean Hydrogen Partnership, which is co-funded by the European Union.

ship) under grant
ch and Innovation
Europe Research.

Thank you for your attention!!

Viviana Cigolotti
E-mail: viviana.cigolotti@enea.it

www.so-free.eu