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

www.so-free.eu

# Newsletter

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

## Welcome to the SO-FREE project

It has been a while that we updated you on the progress of the SO-FREE project. Pandemics, inflation and supply chain issues intervened heavily in the activities of all innovation in Europe, and so also in SO-FREE. With a change in approach and an extension of the project to September 2025, nevertheless we maintain the intended purpose of delivering and demonstrating two 5-kWe SOFC-CHP systems capable of running on H2 and CH4 at any ratio.

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## Short stack characterization tests

The performance results obtained by ENEA and IEN, each on two short stacks manufactured by Elcogen and IKTS respectively, are in! The tests covered a gas grid transition scenario (from 100% natural gas to blends to 100% hydrogen). SO-FREE aims to demonstrate a fully fuel-flexible CHP system that can run on all these compositions

The stacks were initially tested under reference conditions to ensure alignment with manufacturer benchmarks before evaluating performance under real gas compositions. The experimental campaign aimed to assess the performance of both stacks under three gas grid fuel scenarios: 100% natural gas, a blend with significant hydrogen admixture (67% hydrogen + natural gas, leading to 40% CO2 emission reduction), and 100% hydrogen. Tests varied load conditions, fuel utilization factor, and working temperature. By using identical furnaces (developed by IEN) the measurements show an uncertainty below 2% between partners, confirming the validity and replicability of the performance data.

PROJECT COORDINATOR

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Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile

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# Short stack characterization test results

The performance maps for both the the E350 (Elcogen) and the the MK35x (IKTS) short stacks indicate that the highest output power is achieved with 100% hydrogen composition compared to reformate compositions (derived respectively from pre-reforming 67%H2+NG and 100%NG). At nominal conditions (30 A-660°C for E350, 35 A-835°C for MK35x), power outputs are slightly higher for the 100%H2 scenario compared to the reformate compositions

The experimental results show that while 100% hydrogen yields the highest voltage/power at stack level, whereas reformate scenarios offer better energy efficiency at system level due to higher chemical energy content. Detailed analyses at stack and system levels are required to assess the performance of operating SOFC systems indistinctly with natural gas, blends, or hydrogen. This evaluation should consider various system design choices and operating strategies, including off-gas recirculation, fuel utilization, and temperature levels.

The Short-stack test results offer tangible evidence of SOFC fuel flexibility at a manageable scale. The performance maps generated by IEN and ENEA at the stack level will inform system-level models based on experimental findings and contribute to refining model calibration data within WP3.

IKTS short stack

ELCOGEN short stack

IKTS stack test rig

ENEA stack test rig

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