Test Line 3

Showcase #3 - Steam Methane Reformer (e-SMR)

Showcase #3 of the H2SHIFT project focuses on an electrified **Steam Methane Reformer (e-SMR)** designed for the production of low-carbon hydrogen from biogas and biomethane. Led by **Politecnico di Milano** (POLIMI), this showcase puts into practice advanced concepts of electrification and system intensification for hydrogen production, involving Test Line 3 led by SNAM and test line 9 led by CDI.

This technology is a compact, **high-efficiency reactor** developed by the Energy Department's Group LCCP at POLIMI and composed of resistive heating elements embedded in porous copper-based materials, packed with highly active catalytic pellets. The combination of the catalyst and an efficient heat transfer allows to thermal efficiency above 90% in conditions relevant for biogas reforming. The system is designed to be pseudo-isothermal and compact, operating at 800°C with a power density above 5 MW/m³.

Compared to traditional SMR systems, this electrified reforming technology **reduces direct CO_2 emissions (approx. 7 $kgCO_2/kgH_2$ vs. 11–13 gCO_2/gH_2)** and using biogas as a feedstock lowers the overall carbon footprint, making the hydrogen production process more sustainable. The power demand of this system is about 17 kWh/kg H2 – a value remarkably lower than 44-55 kWh/kg of state of the art electrolyzers.

The core testing activities will take place at **Test Line 3**, managed by SNAM, and include a series of phases to evaluate both the lab-scale and pilot-scale prototypes of the e-SMR.

First, an **upscaled prototype will be realized through a collaboration between POLIMI and SNAM**, followed by laboratory testing to validate its thermal performance and hydrogen production efficiency. A dedicated containerized test facility is being designed and constructed to host the system and replicate real industrial operating conditions, including the use of biogas produced by Bioenerys.

The test line will allow the e-SMR reactor to be operated continuously for up to 200 hours, during which energy input, and thermal stability will be closely monitored. A gas chromatograph will be used to assess output gases, while internal sensors (thermocouples) will measure actual versus predicted temperature profiles—helping to refine POLIMI's in-house mathematical model.

Test Line 9

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Alongside the technical validation, **Test Line 9** will contribute additional services:

- A techno-economic analysis to calculate the Levelized Cost of Hydrogen (LCOH)
- A regulatory compliance check to determine feasibility for market deployment
- An optional Life Cycle Assessment to quantify the environmental footprint of bio-hydrogen from e-SMR