FONDAZIONE BRUNO KESSLER

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Hydrogen to support the decarbonization process

Hydrogen generation is looking to support the growth of clean and low carbon energy systems and their spread to have a fully decarbonized society.
The European Green Deal focuses "*on three key principles for the clean energy transition:*

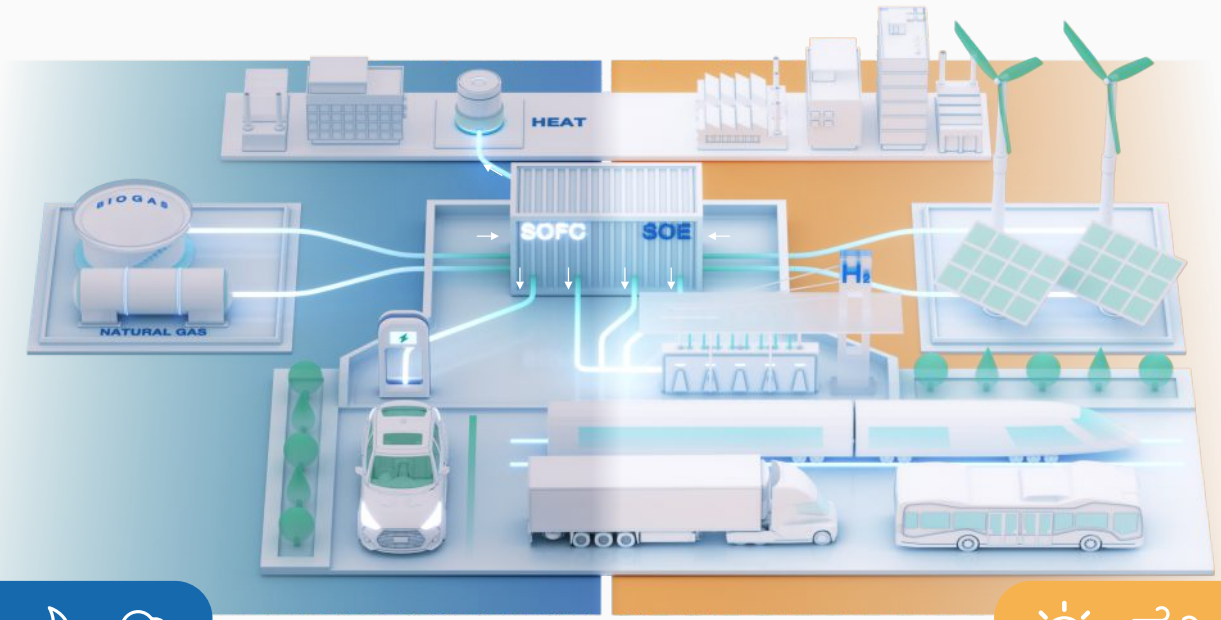
1. *Ensuring a secure and affordable EU energy supply*
2. *Developing a fully integrated, interconnected, and digitalised EU energy market*
3. *Prioritising energy efficiency, improving the energy performance of our buildings and developing a power sector based largely on renewable sources"* [1]

Continuous
energy supply

Flexible and Interconnected
energy systems

The SWITCH technology is fully aligned with all these principles as it provides a continuous energy supply and builds a flexible and interconnected energy systems grid to support renewable energy sources.

The novelty of the SWITCH concept is the continuous supply of on-site hydrogen via electrolysis fed by renewable electricity or from low carbon sources where it generates simultaneously hydrogen, electricity, and heat. In this way, the generation of hydrogen is mostly green, but always secured.



SOFC Natural gas Bio gas

SOE Renewable energy

References

1 *European Commission (2019). Clean Energy, factsheet: https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6723*

The intermittency of renewable energy is accommodated by being able to rapidly switch from the electrolysis operation mode to the fuel cell mode of operating the system. The core of the SWITCH system is a SOFC/SOE unit that allow the switch among the two mentioned operating modes maintaining high efficiency and performances.

The flexibility of the system is a big added value: the possibility to use distinct energy carriers, the connections to the grid as it ranges from the production to the consumption of energy and has the focus on mobility due to its reversibility.

Objectives

The SWITCH project aims at demonstrating the core building block module for an efficient technology solution supporting a reliable way to a zero-carbon hydrogen fed by renewables complemented by a secured continuous supply and production of hydrogen and power by an integrated low carbon back-up.

Technical

- Electrolysis output > 50 kg/day.
- LHV-based efficiency in electrolysis mode > 75%.
- LHV-based efficiency in fuel cell mode > 75% accounting H_2 lower heating value (LHV), electricity and useful heat or 70% accounting H_2 LHV and electricity.
- Partial load operation capability as low as 30% for hydrogen production.
- Transient operation capability and reverse cycle time of less than one hour for reversible Solid Oxide Cell (rSOC) unit.

Socio - Environmental

- Low carbon energy is fully converted into hydrogen and power.
- Smooth energy transition for Small Medium Enterprises (SMEs), whose productivity and competitivity depends on permanent availability of hydrogen for their processes.
- Reduction of > 60% in CO_2 emission per kg of produced hydrogen via electrolysis and steam internal reforming in the SOFC module. Internal steam reforming in the SOFC module is more efficient since part or the total heat required for the steam reforming reaction comes from the heat dissipated by the fuel cell when producing electricity.
- The manufacturing of an integrated and innovative system like SWITCH creates manufacturing jobs in Europe.
- Reduction of using critical raw materials as the SWITCH system is based on the combination of a small reformer and a SOE/SOFC stack, which do not use precious materials as platinum, Iridium or Ruthenium catalysts.

Economical

The following economic impacts will be reached according to the available industrial capacity and by production sites of significant dimensions (minimum manufacturing capacity of 100 MW/year):

- Compact solution with a single CAPEX investment: a single conversion unit operating on an integrated multisource mode.
- Provision of economic and continuous hydrogen.
- Production of by-products that might have industrial uses.
- Reduction of the specific CAPEX (i.e., CAPEX per kg of H_2 or kWh electricity) to < 5,000 €/(kg H_2/day) at an annual system manufacturing volume corresponding to 40,000 kg/day.
- Cost effectiveness with targets of 3.50 €/kg H_2 (@40 €/MWh_{el}) and 5.00 €/kg (@80 €/MWh_{el}).
- No need for expensive back-up system for hydrogen supply when renewable energy sources are not available.

Clean Hydrogen Partnership

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