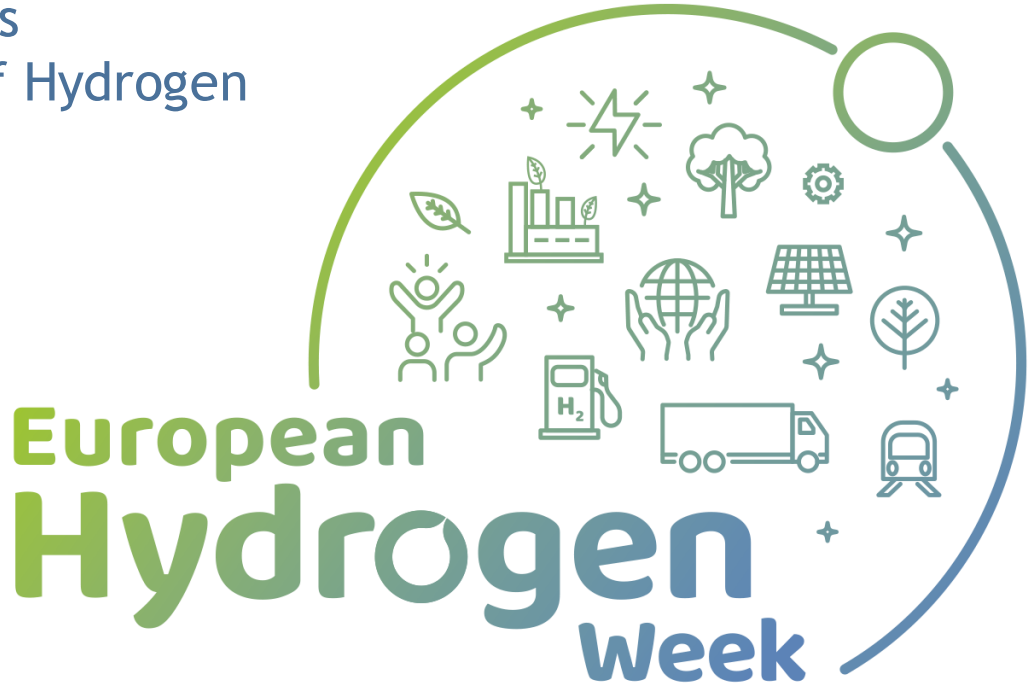
SWITCH

Smart Ways for In-Situ Totally Integrated and Continuous Multisource Generation of Hydrogen

SWITCH



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FCH

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Project Overview

- Call year: 2019
- Call topic: FCH-02-3-2019: Continuous supply of green or low carbon H2 and CHP via Solid Oxide Cell based Polygeneration
- Project dates: 1 Jan 2020 – 31 Dec 2022
- % stage of implementation 01/11/2021: 50 %
- Total project budget: 3 746 753,75 €
- FCH JU max. contribution: 2 992 521 €
- Other financial contribution: -
- Partners: FBK, SOLIDPower, EPFL, HyGEAR, SHELL, DRL, SWECO Polska

Project Summary

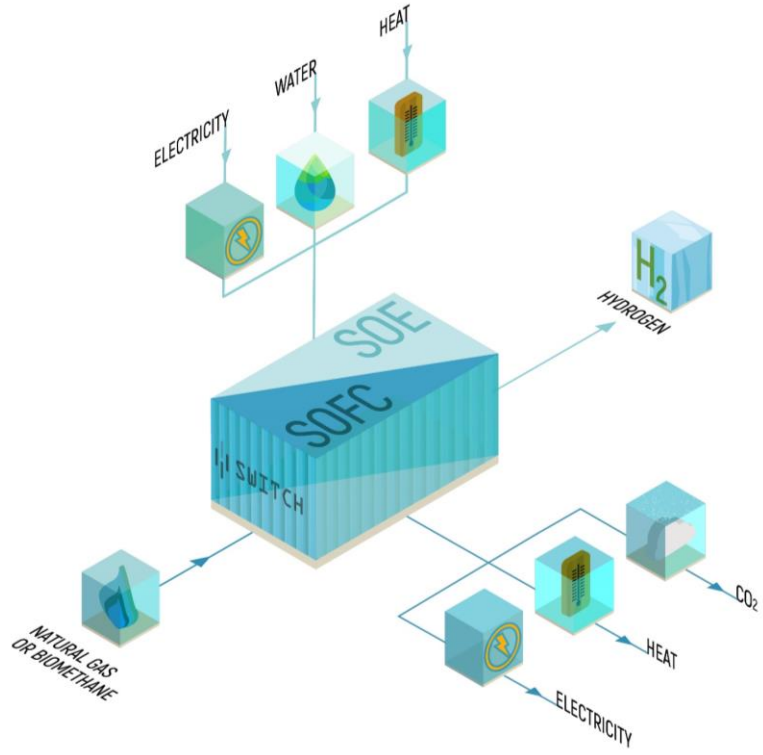
SWITCH aims to design, build and validate a novel prototype of an hydrogen poly-generation system producing “mostly green and always secured” hydrogen.

The core of the system will be a reversible Solid Oxide Cell (SOC) operating in two modes:

1 electrolysis - SOE mode: using **renewable electricity**, water and heat to produce green hydrogen.

2 fuel cell - SOFC mode using **methane rich mixtures** to produce grey or green hydrogen, electricity and heat when renewable electricity will not be available.

SWITCH will be tested at STCA in Amsterdam.



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Project Summary

By offering economic and continuous supply of hydrogen at HRSs, SWITCH aims to become a key technology for the transition to a zero-carbon mobility in Europe. To this end, the project targets the following goals for H_2 production:

Security

by demonstrating the capability of supplying green or low carbon hydrogen in all operating and demand conditions

Efficiency

by using multisource hydrogen generation that optimizes green H_2 production capacity whilst minimizing electricity costs

Sustainability

by targeting a 65% reduction of CO_2 emissions in H_2 production with respect to conventional steam methane reforming

Cost reduction

by targeting an hydrogen cost of 5.00 €/kg H_2 for 40 tons of hydrogen produced per day (SOE/SOFC operations)

Flexibility

by relying on multiple input sources and "switching" between the two operation modes

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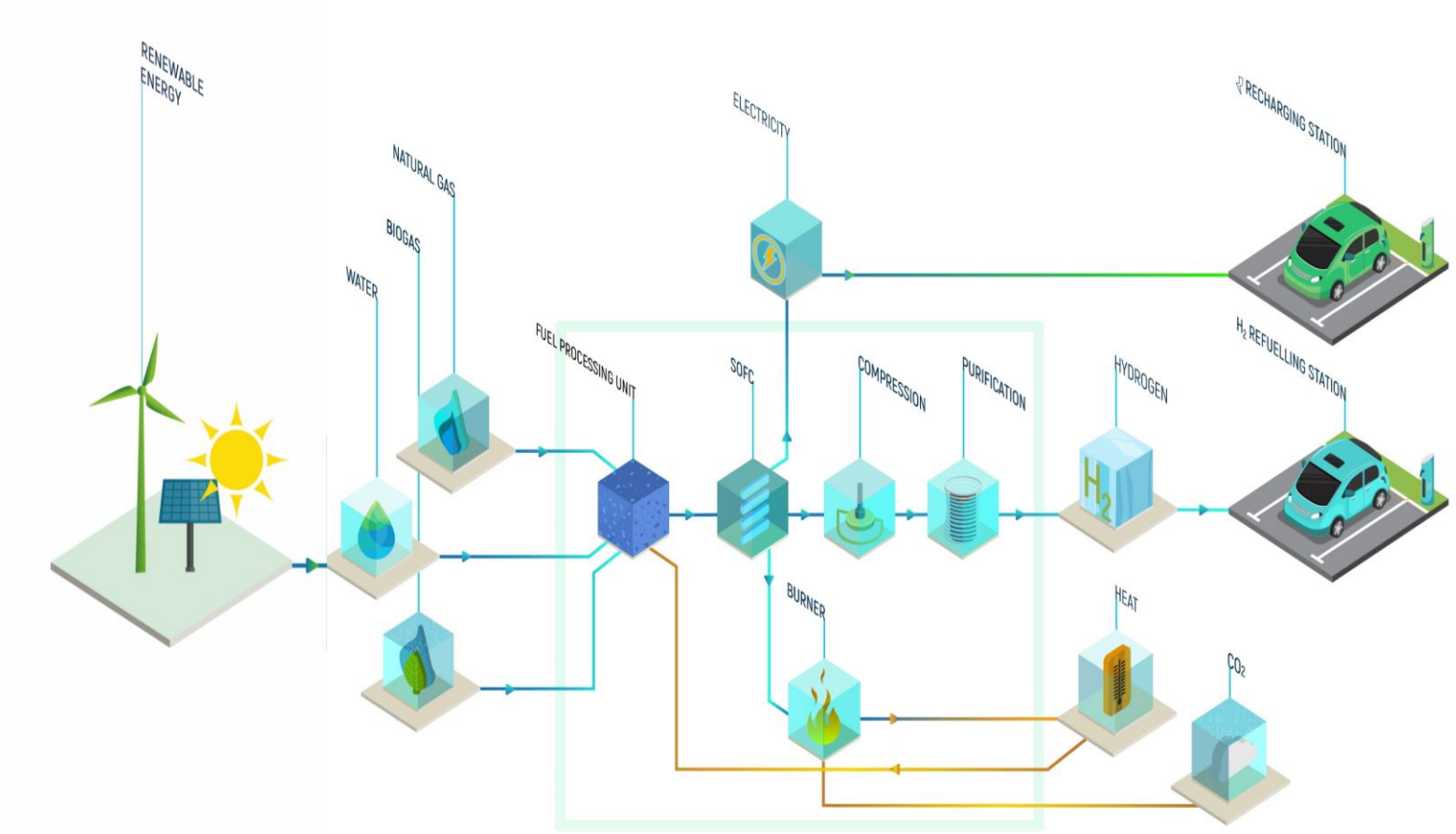
Project Summary

The SWITCH system uses either renewable energy or methane rich mixtures to produce hydrogen in all conditions.

The system integrates the cold section for fuel processing, desiccation, and purification, with the hot section for the heat up and operation of the large stack module.

The innovativeness of the system lays in the high integration of modular components.



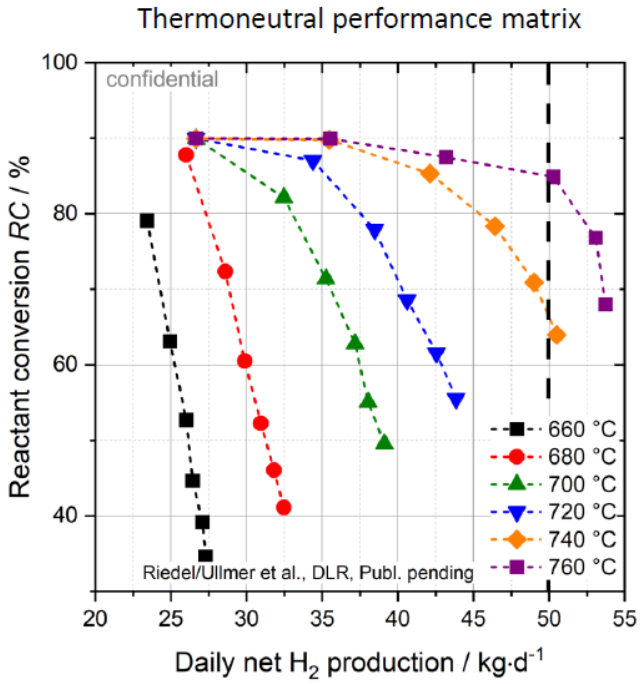
Project Progress – System size

53.1 kgH2/day demonstrated

Achievement to-date 20 kgH2/day 25 kW → 100 kgH2/day 50 kW/150 kW

25% 50% 75%

- The final SWITCH prototype comprising two Solid Oxide Large Stack Modules (LSM) will be a **50kW (SOFC)/150kW(SOE)** system producing up to **100 kg/day of hydrogen**. The prototype will be operated in a relevant industrial environment for at least **5000 hours** until full validation.
- The call asks for demonstration at system level hydrogen production by electrolysis greater than 20 kg/day.
- LSM testing at DLR: More than **250 hr of testing** (317 hr EC/FC operation within 2293 h of hot test rig operation, 105 days) >53 kg H2/day production successfully demonstrated



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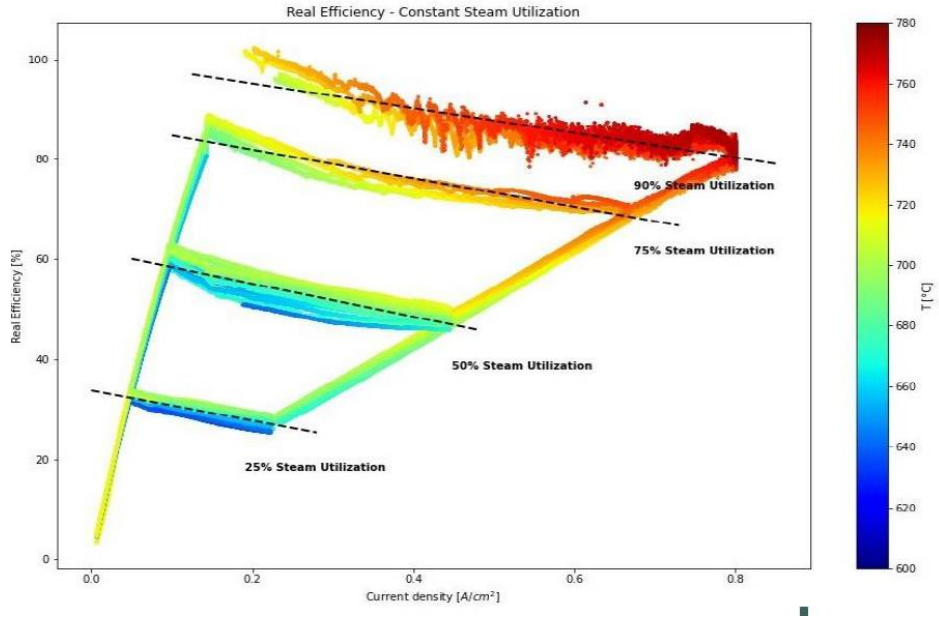
Project Progress – System efficiency

Achievement to-date

0% — 25% — 50% — 75% — 75%

- The call asks for high efficiency of the conversion process through thermal energy integration. SWITCH will realize an integrated gas treatment unit that pre-reforms fuel, recovers heat, generate steam and produce hydrogen, thus increasing the overall efficiency:
- LHV-based efficiency in steam electrolysis mode:
  - the LSM demonstrated 97% LHV efficiency (electrical steam generation not accounted)
  - at system level, efficiencies of up to 70% LHV are expected (including electrical steam generation)
- LHV-based cogeneration efficiency in fuel cell mode:
  - >75% accounting produced H_2 LHV, electricity and useful heat,
  - 60-65% accounting only produced H_2 LHV and electricity

Efficiency Map in SOE mode for constant and variable Steam Utilization



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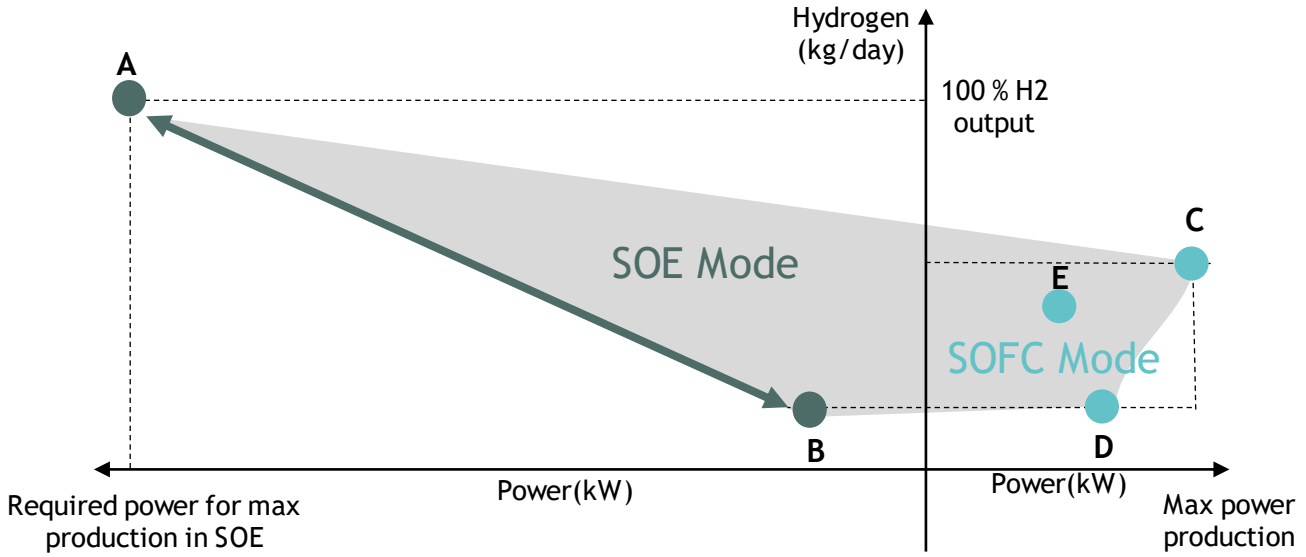
Project Progress – Partial load capability

Achievement to-date

0% — 25% — 50% — 75% — 30%- 100%

- The call asks for partial load operation capability as low as 30% for hydrogen production.
- SWITCH will be fully dynamic between 30 and 100% of hydrogen and electric power production.
- Each Solid Oxide Large Stack Module (LSM) can operate in 5 different modes: the overall operating envelop can be cover by selecting the proper operating mode per each LSM.

Operating mode	Description
Operating mode A	SOE @ full load
Operating mode B	SOE @ 50% load
Operating mode C	SOFC @ full load
Operating mode D	SOFC @ 50% load
Operating mode E	SOFC @ 100% Power /40% H_2



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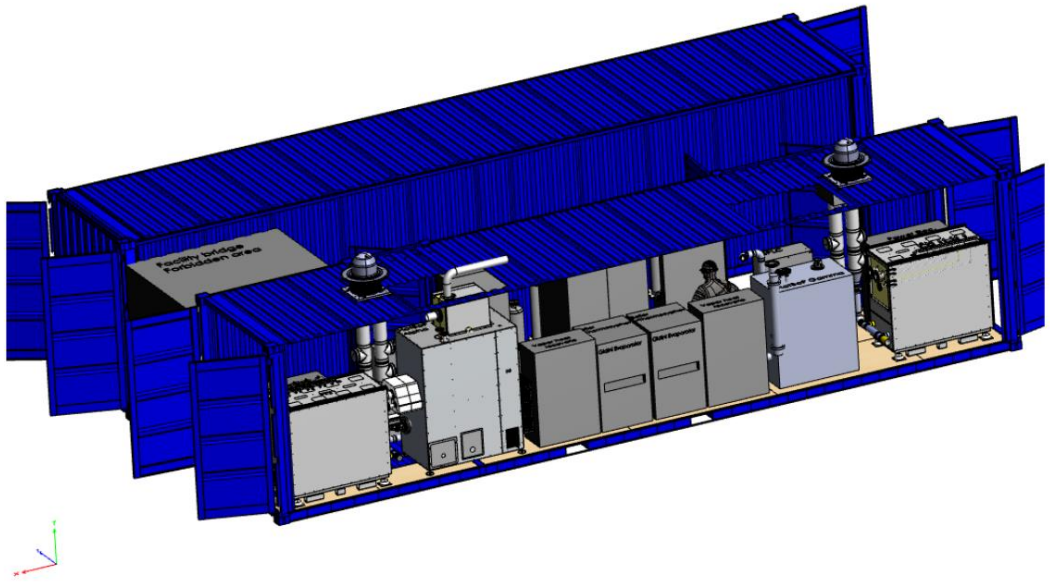
Risks, Challenges and Lessons Learned

The SWITCH system integrates a complex technology.
The sequential operations and the integration of components might undermine the project both in terms of schedule and results.

To mitigate this risk, the Consortium:

- relies on the previous experience and testing results of the CH2P project;
- anticipates final testing with in-lab testing and validation of single key components.



Exploitation Plan

Exploitation

Four Key Exploitable Results(KERs) expected

KER	Type of KER	Exploitation route
1) SWITCH system	Multimodal reversible H2 production technology (new product)	Direct commercialization by HyGear
2) Large Stack Module	New technology Reversible platform of Solid Power	Direct commercialization by SOLIDPower
3) Flexible PSA	Customised technology for hydrogen purification	Direct commercializaion by HyGear
4) Flexible HOTBOP	Customized HOT Balance-of-Plant for all FC modes and Electrolysis mode operation	Licencing, direct commerc. by SOLIDPower, to be defined later

Expected Impact

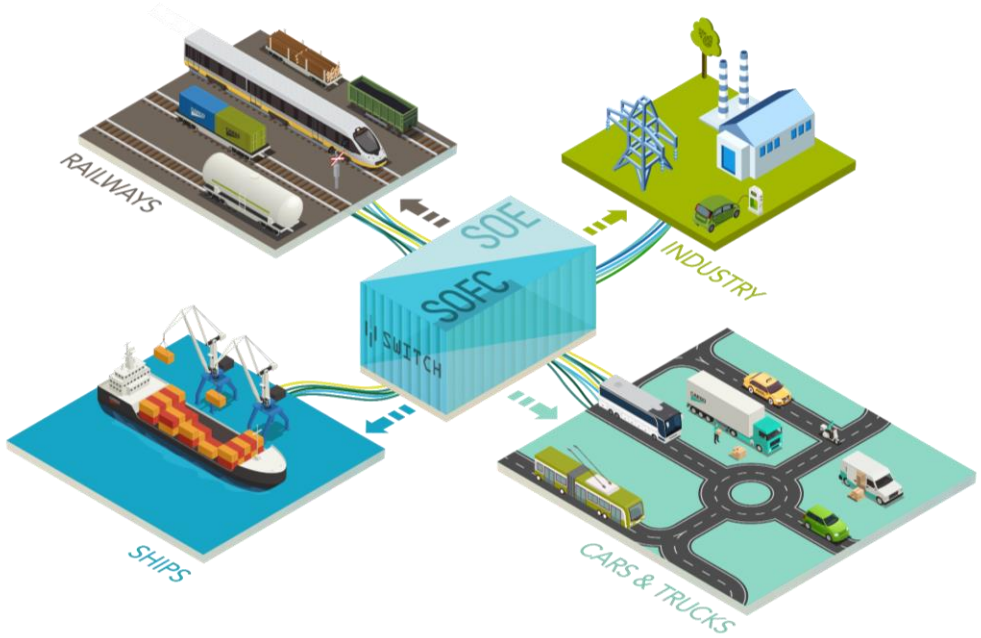
Impact

Supply continued, secured and green H_2 at HRS.

The SWITCH system is designed for integration at hydrogen refueling stations (HRS).

The goal is to target multiple use cases by considering different demand profiles to supply hydrogen and power for electric vehicles (hydrogen and battery).

The ambition of the project is to address future applications in the mobility sector (railway, heavy transport, ships) and in multiple industrial sectors that are in search of new ways for decarbonization (chemical, energy, fertilizer, and residential sectors).

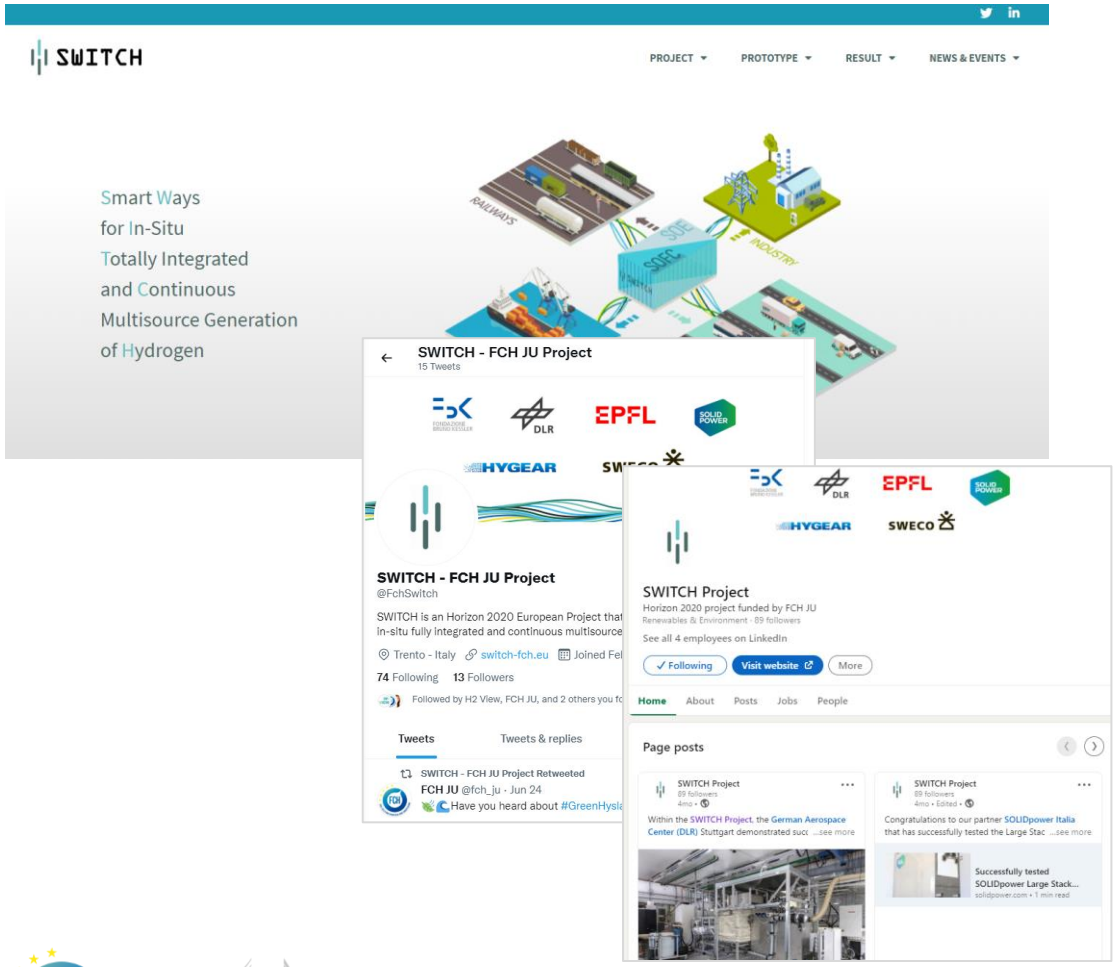


Communications Activities

The Dissemination and Communication Plan of the project identify the strategy, tools and plan for making aware and engage stakeholders in the project.

All the dissemination and communication materials are available at:

www.switch-fch.eu/



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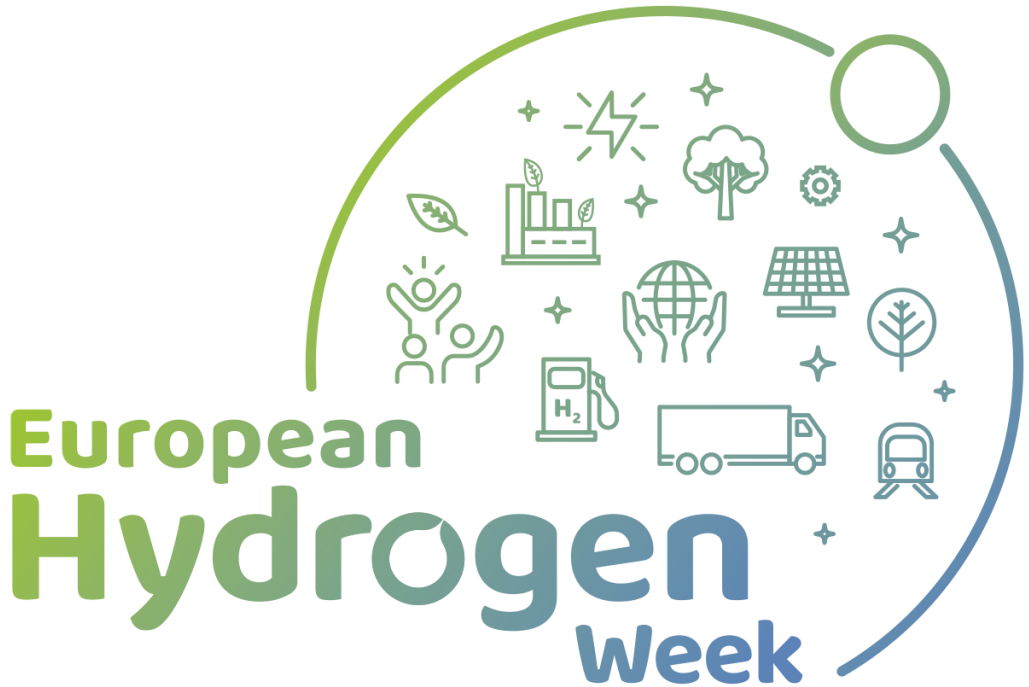

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