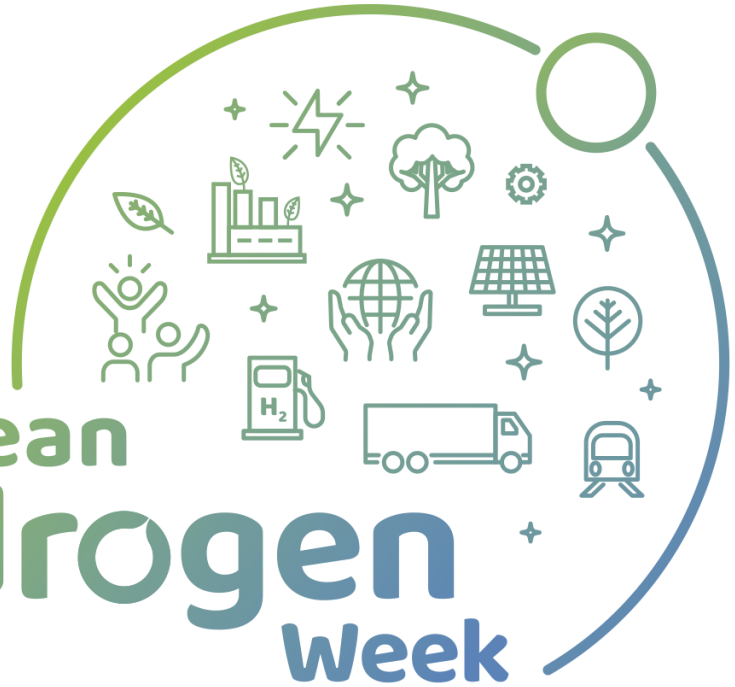
MULTIPLHY

Multi megawatt high-temperature electrolyser to generate green hydrogen for production of high-quality biofuels

MULTIPLHY



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Clean Hydrogen Partnership

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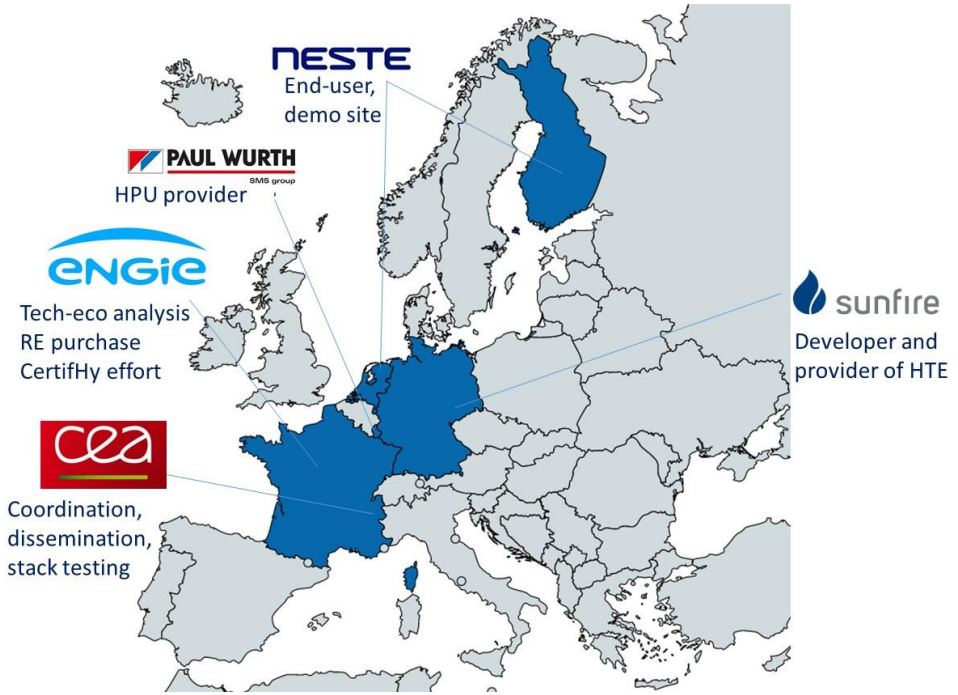
#EUResearchDays
#PRD2022
#CleanHydrogen

Project Overview

- Call year: 2019
- Call topic: FCH-02-2-2019: Multi megawatt high-temperature electrolyser for valorisation as energy vector in energy intensive industry
- Project dates: 01/01/2020-31/12/2024
- % stage of implementation 01/11/2022: 58%
- Total project budget: 9 751 722.50 €
- FCH JU max. contribution: 6 993 725.39 €
- Other financial contribution: 2 757 997.11 € (industrial partners)
- Partners: CEA (F), NESTE (FI, NL), SUNFIRE (D), PAUL WURTH (L), ENGIE (F)



Project Summary
Main objectives

Global positioning vs international SoA

World largest HTE unit (by factor >3)

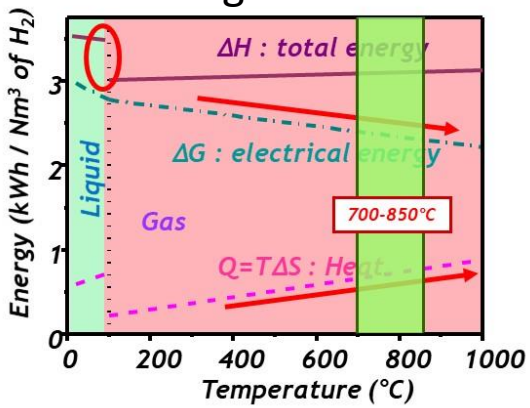
Goal:

- manufacturing, installation and integration of the world's first high-temperature electrolyser (HTE) system in multi-megawatt-scale, TRL8
- at a renewable products refinery located in Rotterdam / The Netherlands

1st HTE application for this market area

Benefits of HTE:

- High efficient technology



$H_2O\ (g) \rightarrow H_2\ (g) + ½\ O_2\ (g)$

$\Delta H = \Delta G + T\Delta S$ ~ constant

overall energy ΔH has to be provided **either as electric energy** or **as heat**

Low T: energy = 85% electricity / 15% heat
High T: energy = 70% electricity, 30% heat

- Technology with no expensive noble catalysts
- Modular technology

Project Summary
Main objectives

World largest HTE unit (by factor >3)

Key figures:

- electrical rated nominal power of ~ 2.6 $MW_{el,AC}$ (HTE and Hydrogen Processing Unit (HPU))
- Hydrogen production rate of ≥ 60 kg_{H2}/h (≥ 670 Nm^3/h)
- Operation period of 16,000 h

Longest demo phase

- leading to substantial GHG emission reductions

Best values in-field

Technical objectives:

- Electrolyzer electrical efficiency of up to 85%$_{el,LHV}$
- Electricity consumption @ nominal capacity: 39 kWh/kg_{H2}
- Availability: ≥ 98 %
- Production loss rate: ≤ 1.2% / 1000 h

Low degradation values measured at stack/system level for long periods

Global positioning vs international SoA

CAPEX and OPEX in agreement with MAWP targets

Economic objectives:

- Capital Cost: ≤ 2,400 € / (kgH2/d)
- Operations & Maintenance cost ≤ 120 €/(kgH2/d)/year
- Techno-Economic analysis of HTE utilisation in refineries
- Pave the way for further upscaling step to a 100 MW scale

Societal objectives:

- Increased awareness of HTE as viable solution within Energy Intensive Industries (EII)
- Procurement strategy for RE
- Certification of the green H2 according to CertifHy's methodology

1st H_2 certificates for HTE technology

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Project Progress/Actions -

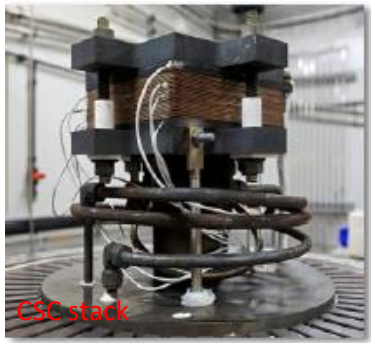
Stacks long term testing

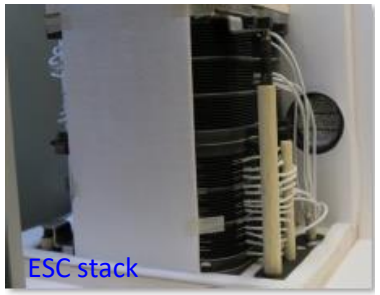
Achievement to-date

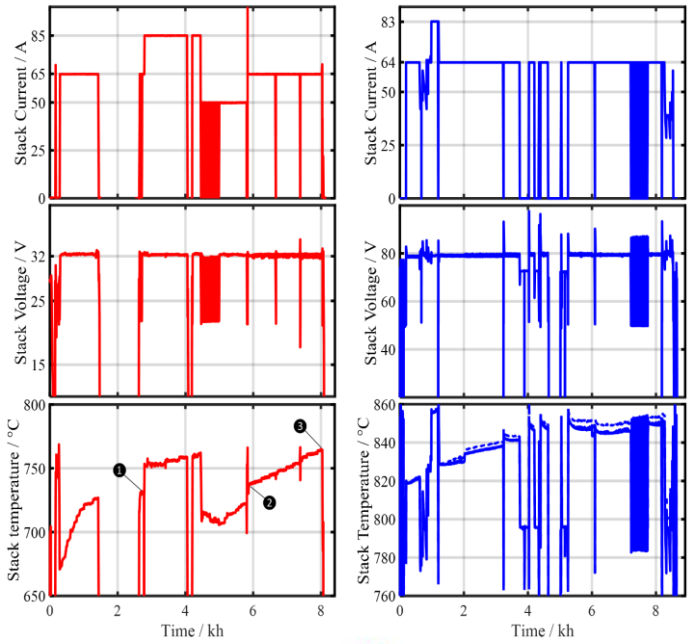
SRIA SoA 2020 Degradation at U_{TN} = 1.9%/1000h

No H2 production loss

25% 50% 75%







CSC stack ESC stack

- 2 stacks tested:
  - Cathode supported cells: 25 x 100 cm²
  - Electrolyte supported cells: 2 x 30 x 120 cm²
- Operating strategy:
  - Thermoneutral voltage U_{TN}
  - Fixed current density = fixed H_2 production
  - Increase of T to compensate potential degradation
- Status and results
  - Successful long-term test of both stacks:
    - 6800 and 8200 h respectively
  - No H2 production loss with the operation strategy adopted for the test durations performed

Project Progress/Actions -

Module manufacturing and installation

Achievement to-date

Gen1 133 kW – 36 stacks module

Gen2 230 kW - 60 stacks module

25% 50% 75%

sunfire | FAT-Protocol | Document No.: F-D&P-036-00
HyLink Modul Gen2.1.1 | Module no.: Module #01

Location	Dresden, Germany	Verifier	C. Lehmann
Variation	HyLink Modul	Type of test	Factory Acceptance Test
Generation	Gen2.1.1	Test according to	EN 60204:06-2019
Article no.	ASW-103732	Date	24.05. – 30.05.22
Revision status no.	A00	Test equipment	FAT-TS CD11
Serial number	SYS-100357	Test procedure	PS-PRO-056-00

Test result: PASS

Steps of procedure
1) Cold commissioning
2) Heat up
3) Leakage test (#1)
4) Rated load
5) Maximum load
6) Leakage test (#2)
7) Cool down

Comments

01.06.22	Claudia Lehmann	C. Lehmann
Date	Test carried out by	Signature
2022-06-28	Tim Meyer	
Date	Approved by	Signature

- HTE modules manufacturing
  - 12 modules of 60 stacks, 230 kW each manufactured for MultiPLHY Project
- Status and results
  - Successful FAT of 5 modules to date
  - 65.7 Nm^3/h H_2 production achieved per module
  - Very homogenous temperatures and voltages in stacks
  - 2 modules already installed in the refinery
  - Manufacturing of remaining MULTIPLHY modules in progress

Project Progress/Actions –

Hydrogen Processing Unit (HPU) manufacturing and installation

Achievement to-date

Grinhy 2.0 HPU
18 kg/h H2
12 bar, quality 3.8

25% 50% 75%

MULTIPLHY HPU
≥ 60 kg/h H_2,
30 bar, quality
at least 3.0

- HPU key components:
  - Hydrogen buffer tank
  - Hydrogen Compressor
  - Hydrogen Dryer
  - Air cooler
  - Chiller
  - Quality monitoring devise

- Status and results
  - All components manufactured
  - Successful FAT
  - Equipment delivered and installed in the refinery

Project Progress/Actions -

Site and demonstration preparation

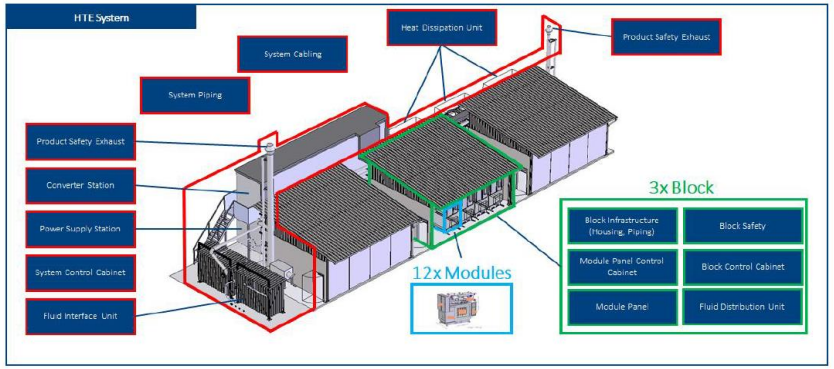
Achievement to-date

N/A

- Engineering and site preparation on-going for start-up in Q1/2023
- Service and maintenance concept defined
- Sourcing of renewable electricity is being planned
- Work on Guarantees of Origin (GO) for H_2 in relation with CERTIFHY and local Dutch system of GO
- Draft methodology for GHG avoidance adopted within CertifHy WG 2 (on production) & validation by WG1 expected end 2022

Risks, Challenges and Lessons Learned

		Measures taken
Risks	Delay due to longer than planned manufacturing duration + extended delivery times of components and material (COVID effect)	Contingency plan in place: manufacture, ship, install 2 modules at NESTE in Summer 2022. Installation and commission of the 10 other modules beginning of 2023.
	Implementation of a new technology in new scale leads to technology risk which needs to be mitigated	Detailed risk management in place, accurate planning of installation and commissioning phase to ensure smooth start-up.
Challenges	Procurement of a 3rd party stack for benchmark Contact with several potential suppliers, which unfortunately failed	Test of Sunfire new stack design in replacement



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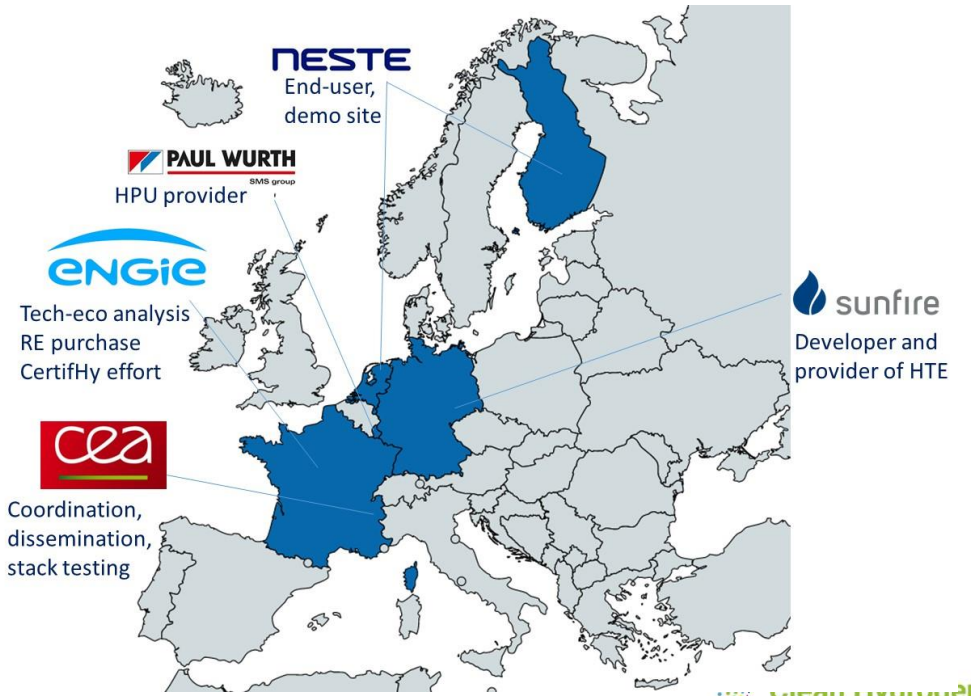
Exploitation Plan/Expected Impact

Exploitation

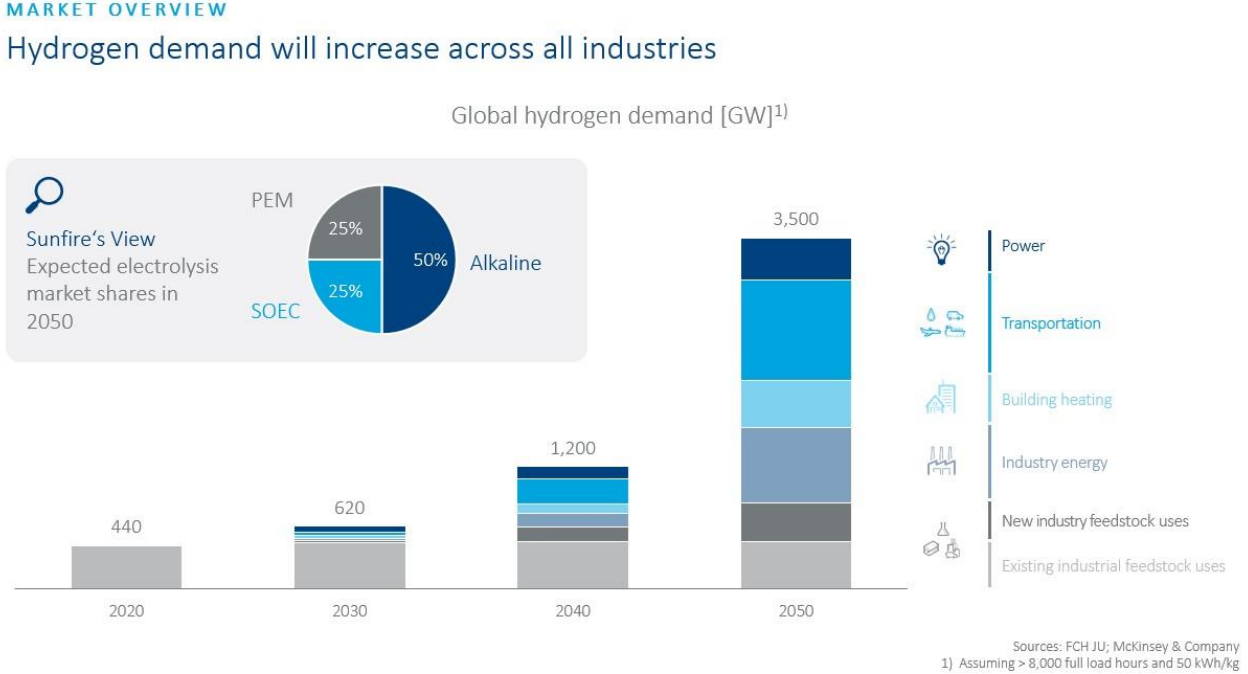
Projects partners on the whole value chain: each having its own stone



Impact

Preliminary market analysis performed

Sales forecast performed for each individual components



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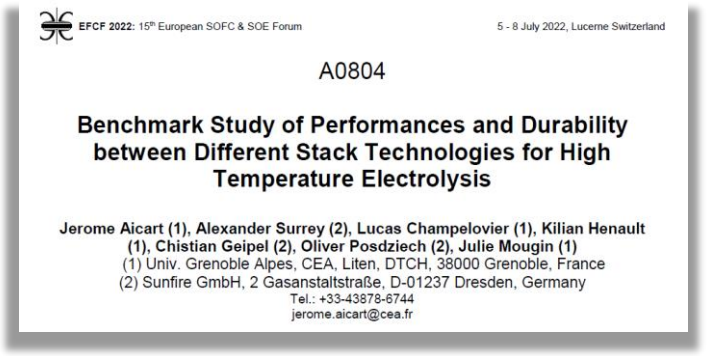
Dissemination/communication Activities

Website: https://multiplhy-project.eu
# of visitors: 19474 (10 Oct 2022)

Newsletters and leaflets

3D motion design to present MULTIPLHY concept

Presentations at workshops/conferences
Article in EFCF2022


EFCF 2022: 15th European SOFC & SOE Forum 5 - 8 July 2022, Lucerne Switzerland

A0804

Benchmark Study of Performances and Durability between Different Stack Technologies for High Temperature Electrolysis

Jerome Aicart (1), Alexander Surrey (2), Lucas Champelovier (1), Kilian Henault (1), Chistian Geipel (2), Oliver Posdziech (2), Julie Mougin (1)
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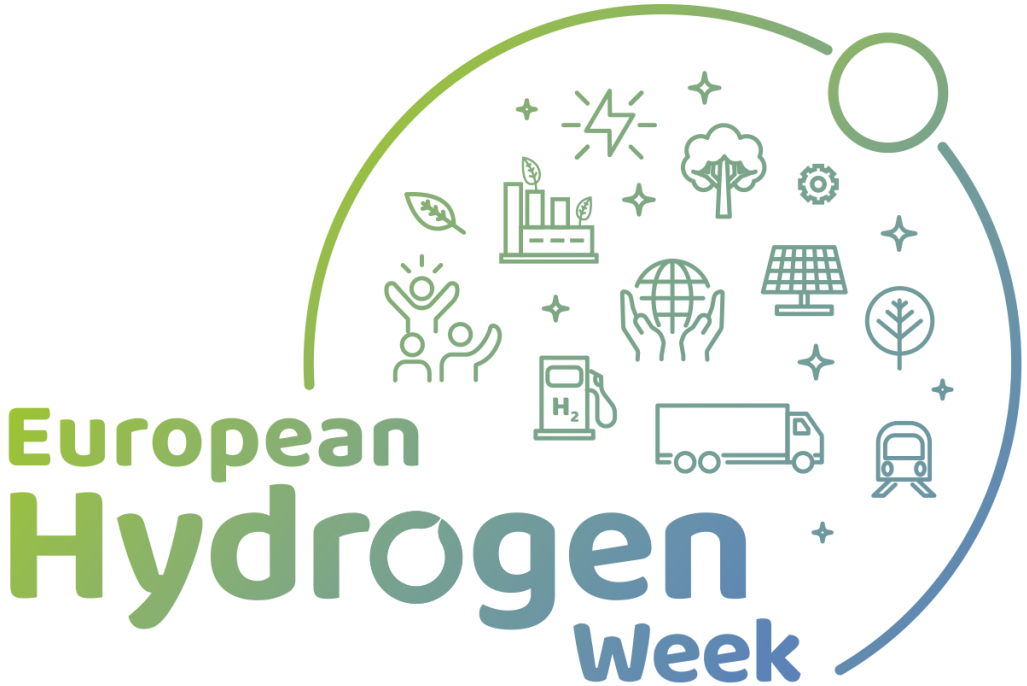

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