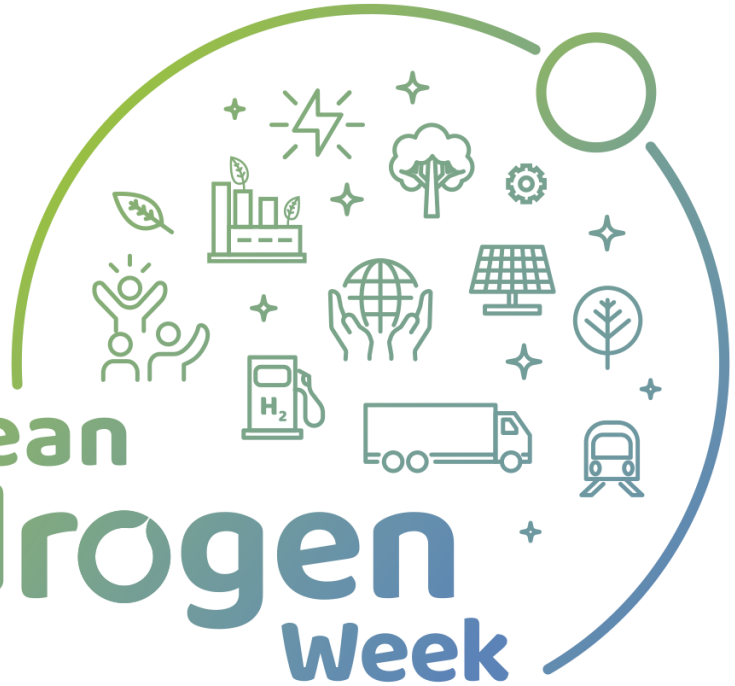
MULTIPLHY
Multimegawatt high-temperature electrolyser to generate green hydrogen for production of high-quality biofuels

MULTIPLHY



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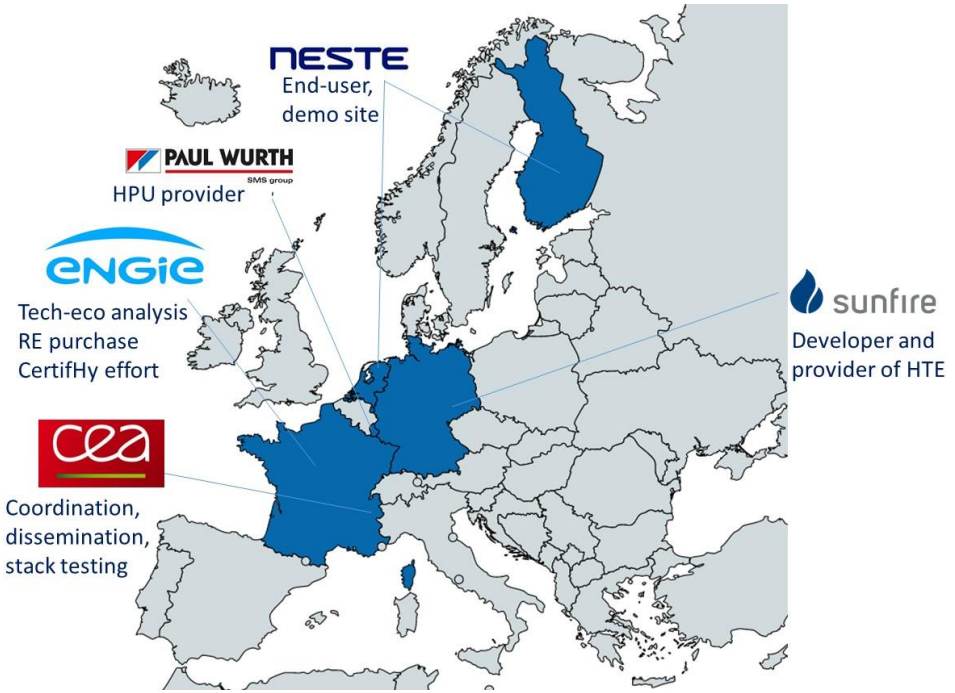
Project Overview

- 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 01/11/2021: 36%
- 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)

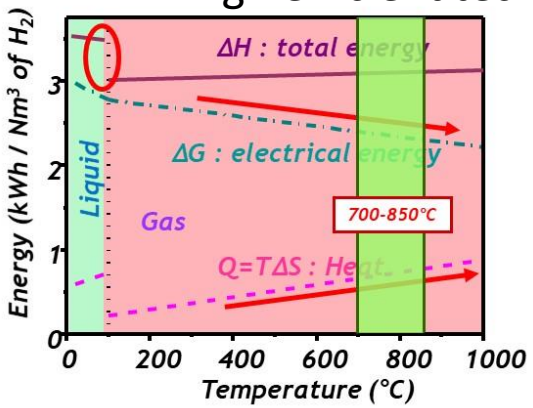
Goal:

- 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



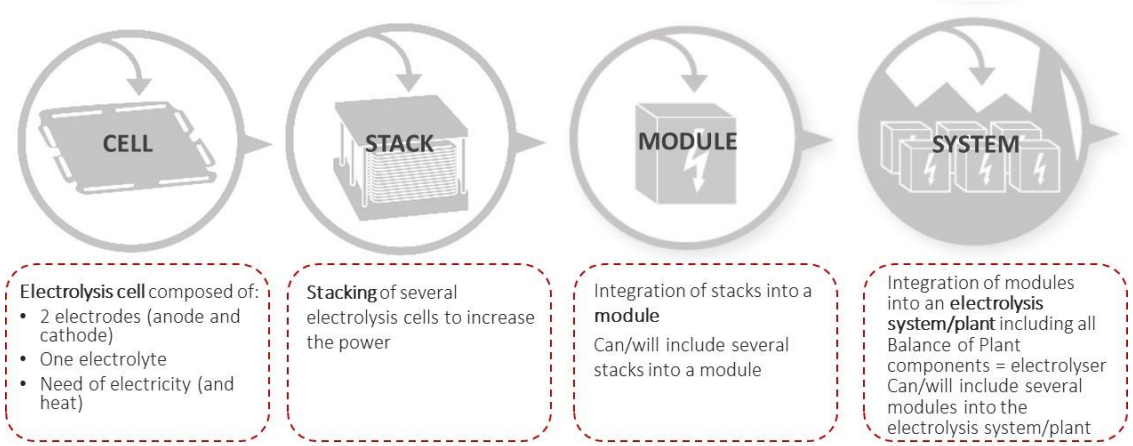
$H_2O\ (g) \rightarrow H_2\ (g) + ½\ O_2\ (g)$

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



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Project Summary
Main objectives

Global positioning vs international SoA

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

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 EII
- Procurement strategy for RE
- Certification of the green H2 according to CertifHy

1st H_2 certificates for HTE technology

Project Progress/Actions -

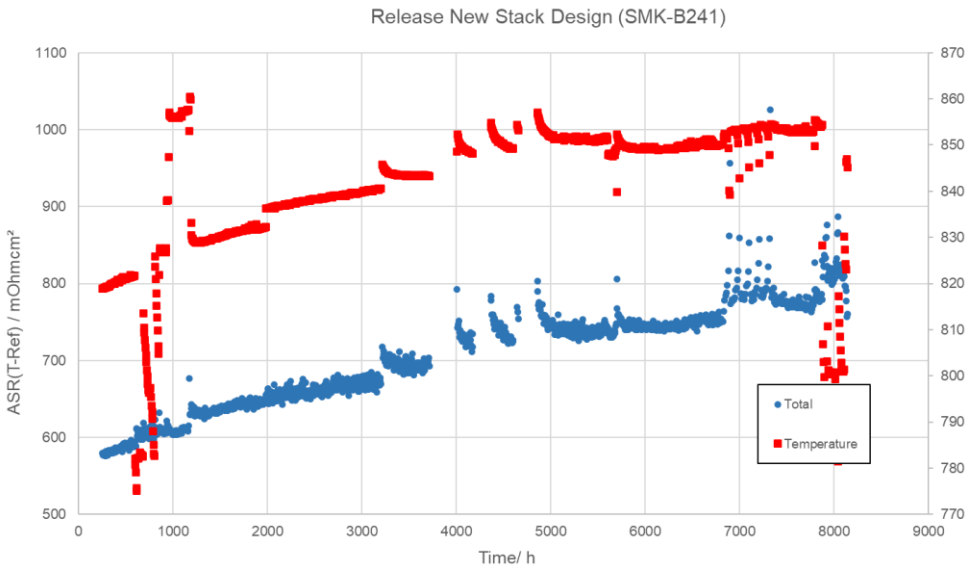
Stack performance and durability

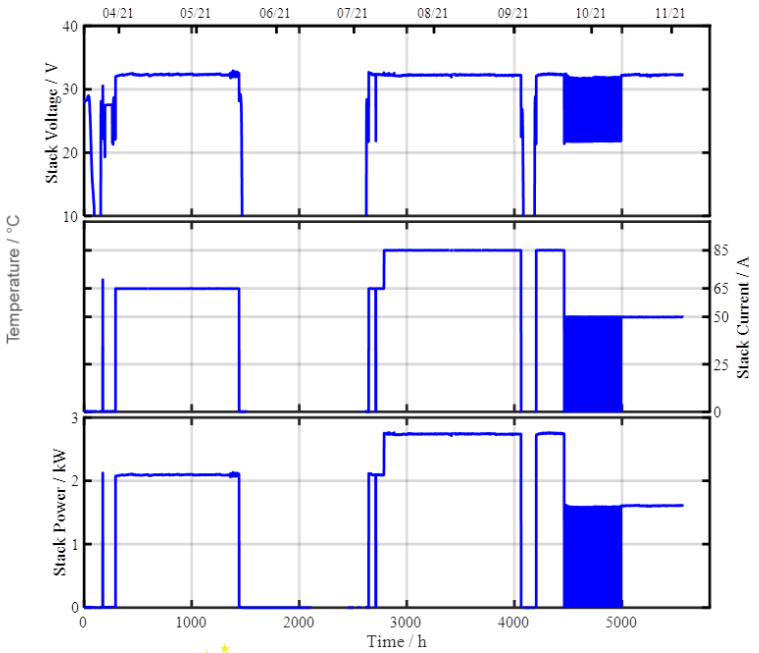
Achievement to-date

H_2 production loss ~ 2-4%/1000h

H_2 production loss ≤ 1.2% / 1000 h

25% 50% 75%





- Testing protocol defined (public): Initial performance map, durability steps > 2000h, 500 h of on-off load cycles, thermal cycles, final performance map
- 2 stacks tested: Sunfire 30-ESC cells (3.3 kW at 820°C), CEA 25-CSC cells (2.6 kW at 700°C)
- Longest test at full stack scale for both technologies, at current densities in the range 0.5 to 0.85 A/cm² and at high steam conversion (70-80%)

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Project Progress/Actions –

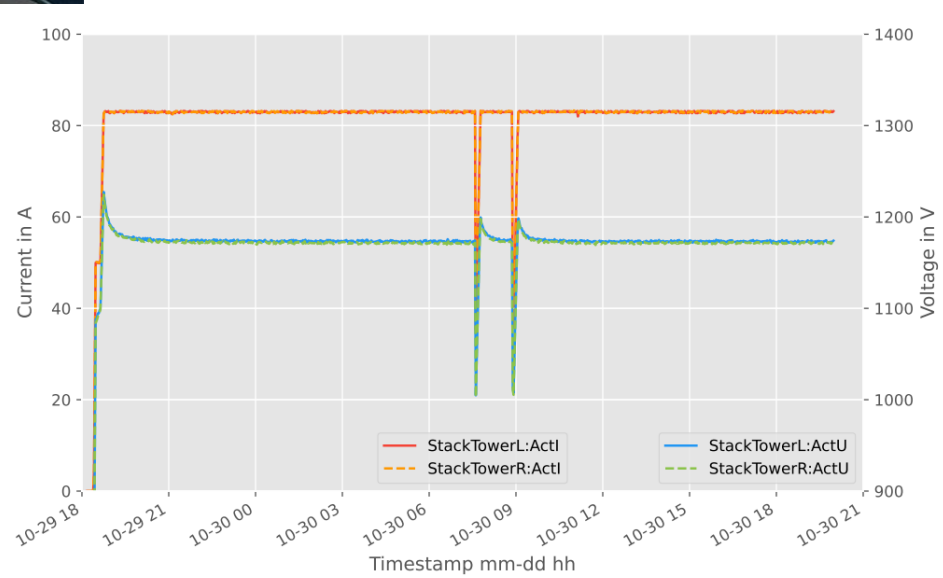
Module development and validation

Achievement to-date

Gen1 133 kW – 36 stacks module

25% 50% 75%

Gen2 230 kW - 60 stacks module



- HTE system engineering and optimization
  - Testing of Gen. 2.1.0 ‘Prototype’ Module carried out
  - Evaluation of manufacturing durations and release of design for MultiPLHY Project

Status and results

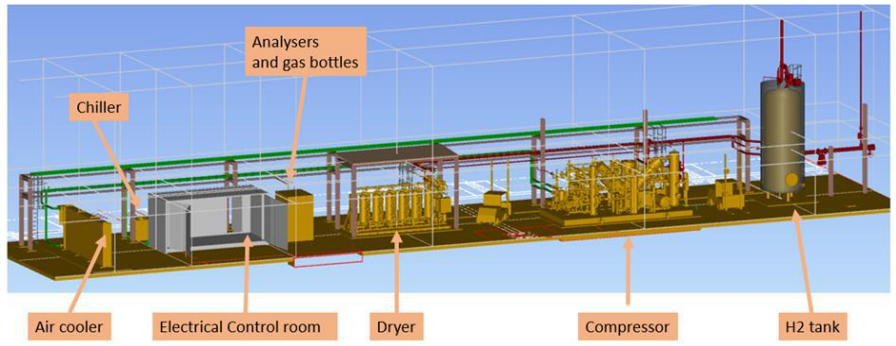
- Successful design freeze of hot- and coldbox
- 65.7 Nm^3/h H_2 production achieved
- Very homogenous temperatures and voltages in stacks
- Manufacturing of MULTIPLHY units in progress

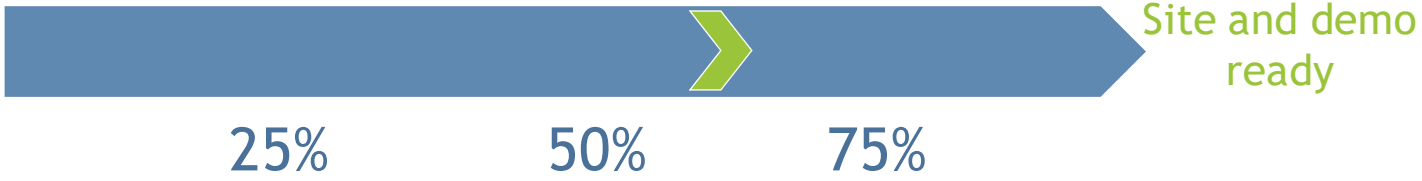
Project Progress/Actions –

Site and demonstration preparation

Achievement to-date

N/A

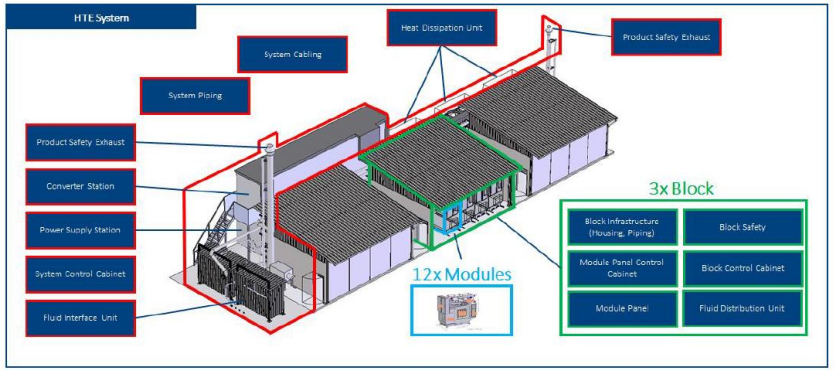




- Engineering and site preparation on-going for start-up in H2/2022
- Design, manufacturing and commissioning of auxiliary unit on track (dryer, compressor, buffer tank)
- Service and maintenance concept under definition
- Sourcing of renewable electricity is being planned
- Work on Garanties of Origin (GO) for H_2 in relation with CERTIFHY and local Dutch policy
  - analysis of the draft RED2 implementation's impact in The Netherlands GO
- Draft methodology for GHG avoidance under discussion within CertifHy WG 2 (on production)

Risks, Challenges and Lessons Learned

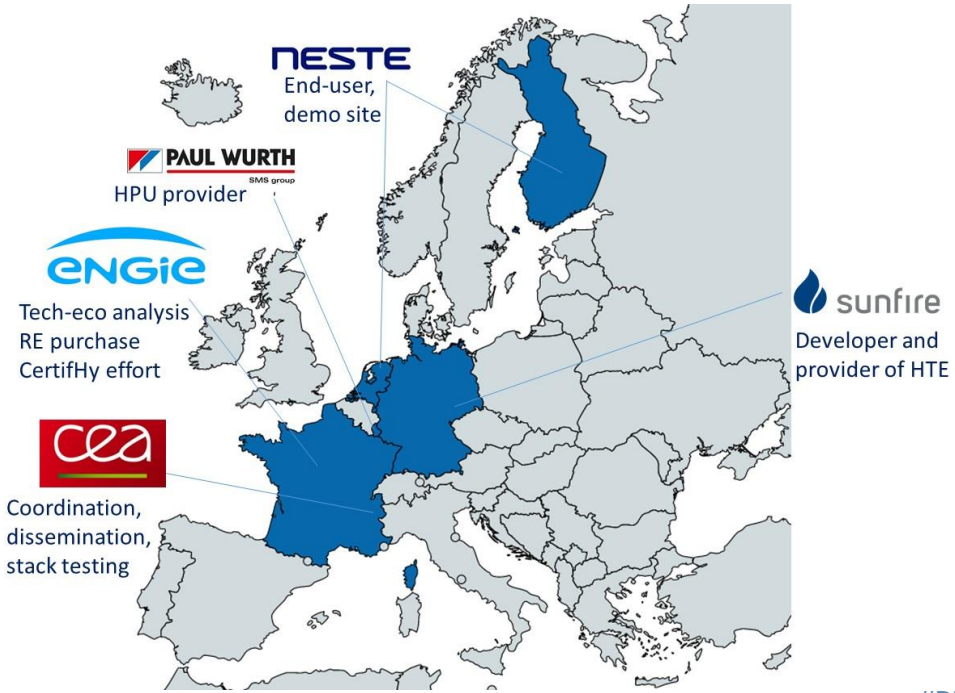
		Measures taken
Risks	Delay due to longer than planned manufacturing duration + extended delivery times of components and material (COVID effect)	Contingency plan in place: manufacture, ship, install, commission and start 6 modules (50% capacity) at NESTE H2/2022. Installation and commission of the last 6 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



Exploitation Plan/Expected Impact

Exploitation

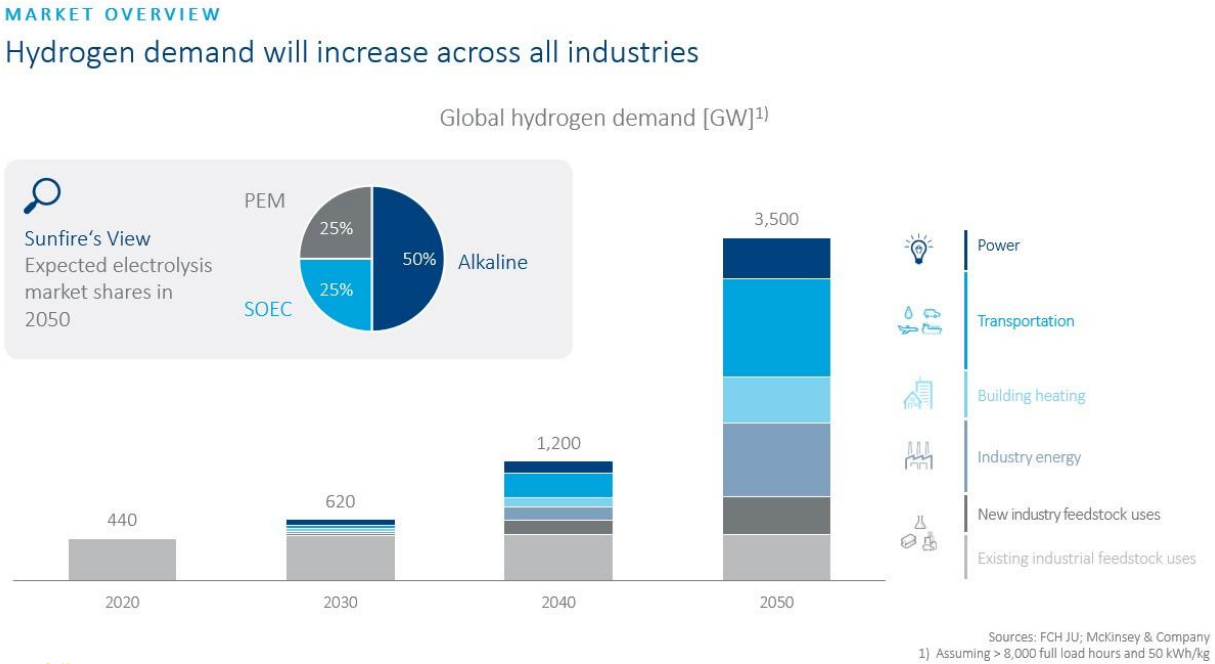
Projects partners on the whole value chain: each having its own stone



Impact

Preliminary market analysis performed

Sales forecast performed for each individual components



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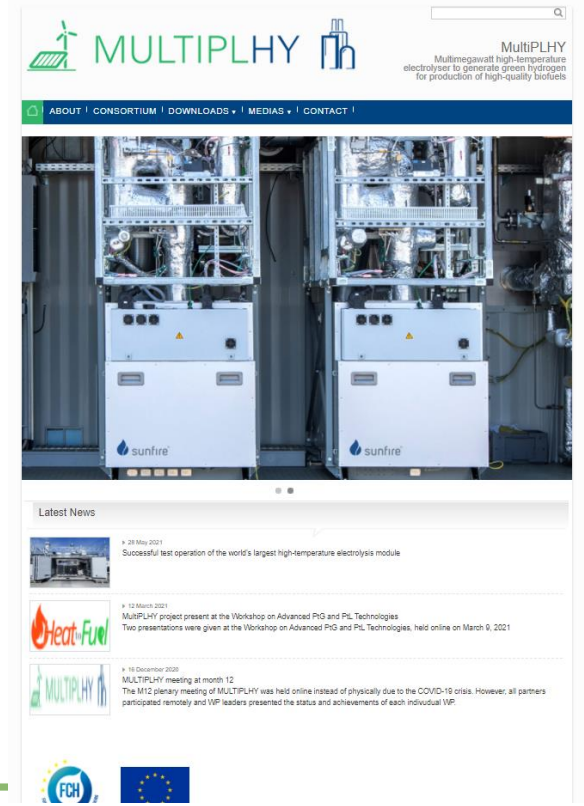
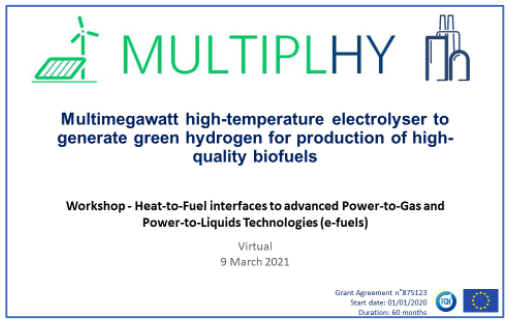
Dissemination/communication Activities

Website: https://multiplhy-project.eu
# of visitors: 8232 (8 Nov 2021)



Newletters and leaflets

Presentations at workshops/conferences



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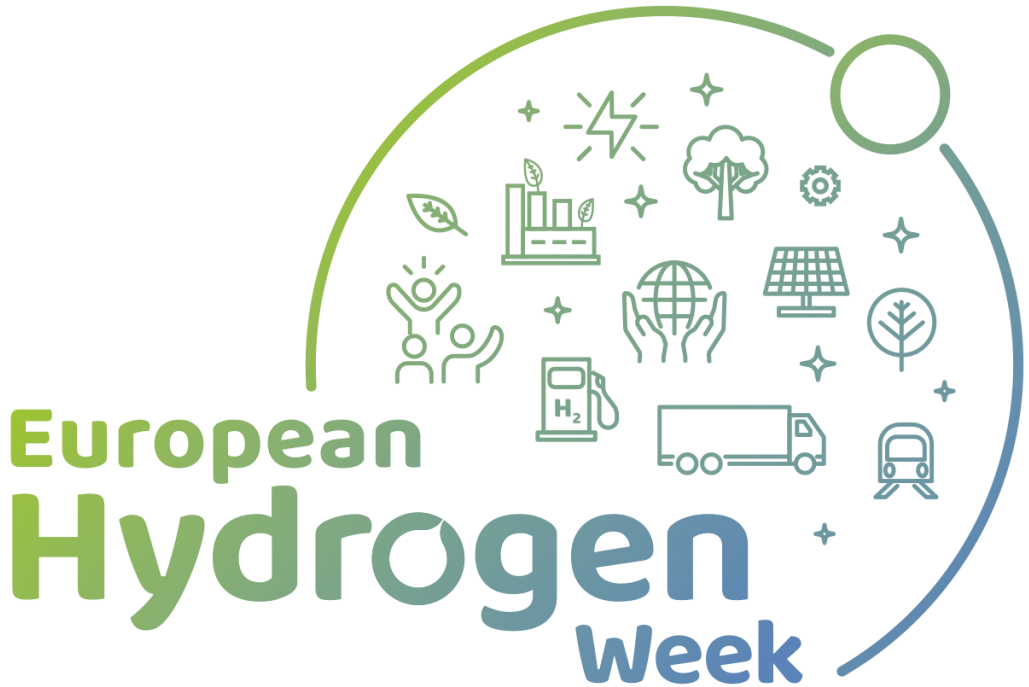
Check of actions realised as compared to plans

Target groups	Indicators for measuring the effectiveness of the approach	Min target value	Planned before M30	Achieved M1-M12	Feedbacks expected
Customers *Industrial companies from different sectors; Local authorities*	Customer request for other project deployments	50	20	> 20	-Discussions on industrial and commercial fairs (mainly Hannover Fair) -Request for specific features in order to address specific needs of various sectors - Improved understanding on business cases, installation requirements and operation schemes
	Interest of industrial customers on Technology Exploitation via partnerships and/or licence agreements	15	5	> 5	
Research community *H_2 & FC researchers & industries*	Publications at international conferences (M24 onwards)	6	1	2 (EFCF2020)	-Disseminate the latest results towards H_2 & FC actors -Designing new collaborative proposals for demonstrations. -MoUs[1] concluded between research & industrial partners.
	Publications in international journals (M24 onwards)	6	1	0	
	Participation with presentation of results at international events with industry	6	2	7 (presentation of objectives rather)	
Industry associations, *Chemicals, Refining, Energy Intensive Industry related Think tanks*	Presentation of results at association events	3	1		-Attract attention and generate interests from industry associations and get their support in the political decision-making process
General public *Public and Private*	Non-scientific publications (articles, press releases); Participation in national events promoting	10	3	2, one article, one press release; many other posts, see section 6.4 for details	-Attract attention and generate interests for an optimal exploitation of the project's results for further exploitation and deployment of the technology

[1] Memoranda of Understanding



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