EPHYRA

ESTABLISHING EUROPEAN PRODUCTION OF HYDROGEN FROM RENEWABLE ENERGY AND INTEGRATION INTO AN INDUSTRIAL ENVIRONMENT

Project ID	101112220
PRR 2025	Pillar 1 - H_2 Production
Call Topic	HORIZON-JTI-CLEANH$_2$-2022-01-08
Project Total Costs	24 705 752.39
Clean H_2 JU Max. Contribution	17 757 002.50
Project Period	01-06-2023 - 31-05-2028
Coordinator Beneficiary	MOTOR OIL (HELLAS) DIILISTIRIA KORINTHOU A.E., EL
Beneficiaries	ENVIROMETRICS TECHNIKOI SYMVOULOI ETAIREIA PERIORISMENIS EFTHYNIS, INSTITUTO TECNOLOGICO DE ARAGON, SOLUFORCE B.V., STICHTING NEW ENERGY COALITION, ENVIROMETRICS TECHNIKOI SYMVOULOI ANONYMI ETAIREIA, ENERTIME SA, SIEMENS PROCESS SYSTEMS ENGINEERING LIMITED, ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS, RINA CONSULTING SPA, DEUTSCHES ZENTRUM FUR LUFT - UND RAUMFAHRT EV

https://ephyraproject.eu/

PROJECT AND GENERAL OBJECTIVES

EPHYRA will demonstrate the integration of a first-of-its-kind renewable hydrogen production facility at an industrial scale in South-eastern Europe by employing an improved electrolysis technology, at a 30 MW scale. The large-scale electrolysis will be integrated with industrial operations within Motor Oil Hellas's Corinth Refinery, one of the top refineries in Europe and the largest privately-owned industrial complex in Greece. It will be operated for at least two years under commercial conditions and will supply renewable hydrogen to the refinery's processes and external end-users.

The industrially integrated renewable hydrogen production will be developed around a circular economy, industrial symbiotic approach, as the electrolyser will be coupled with (i) renewable electricity production, (ii) an innovative waste heat harvesting technology, (iii) water use environmental optimisation, (iv) valorisation of produced oxygen in current Motor Oil Hellas's refinery operations, (v) a digital twin and (vi) a dedicated energy management system. EPHYRA will contribute to all electrolysis technology key performance indicators as detailed in the Clean Hydrogen Partnership strategic research and innovation agenda objectives. Therefore, EPHYRA will demonstrate the technology's reliability for green hydrogen production at the lowest possible cost thus enabling the EU renewable hydrogen economy, industry decarbonisation and uptake of zero-emission fuels.

NON-QUANTITATIVE OBJECTIVES

- Develop a detailed technology and integration concept for an enhanced electrolysis system.
- Optimise synergies among H_2 production, utilisation, complementary supply, and the valorisation of waste streams (waste heat, oxygen, water), within a circular economy framework.
- Develop a digital twin, controls and automation of the H_2 plant and its (symbiotic) environment.
- Set up and operate the integrated H_2 production plant and complementary supply and valorisation streams (local circular H_2 economy), including standardisation and safety aspects.
- Assess the techno-economic, environmental and societal sustainability of the H_2 production plant and the local circular H_2 economy.
- Achieve sustainable impact by stakeholder engagement, social acceptance and industrial replication (incl. business modelling and development).

PROGRESS, MAIN ACHIEVEMENTS AND RESULTS

- Major milestones such as electrolyser procurement, technical validation, and integration planning have successfully been completed.
- A tender process for the procurement of the electrolyser has been launched.
- A comprehensive evaluation of the suggested solutions was conducted, which concluded with METACON AB as the selected vendor.
- A purchase order has subsequently been placed and a solar Power Purchase Agreement (PPA) has been secured.
- A feasibility study has been conducted for integrating an Organic Rankine Cycle (ORC) system with the most cost-efficient scenario identified involving installing ORC in other refinery units rather than directly with the electrolyser by ENERTIME and MOH in providing data for evaluation.
- An economic feasibility of utilising oxygen in the refinery claus unit and a desktop study for the use of oxygen in the FCC unit were also performed. The findings of these studies are critical in guiding investment decisions and ensuring the project's alignment with the overall business strategy.
- Significant activities on digital twin design include the development of a mathematical model of the electrolyser-separator block in gPROMS, the realisation of two configurations of the electrolyser-separator block and the integrated system model, while sensitivity analysis was performed on the steady-state model to identify key performance variables affecting system performance.
- Additional models for optimisation of hydrogen production system configuration to minimise cost, the ORC for waste heat management, as well as renewable energy supply are under development.
- A comprehensive market assessment for large-scale renewable hydrogen production,

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especially in refineries, has been conducted where the significant replication potential in industries such as steel and chemicals was identified. The assessment also emphasised integrating green hydrogen into existing operations for decarbonisation.

- A comprehensive suite of communication and dissemination tools was developed to enhance project outreach and engagement.
- A dedicated project website was launched, serving as a central hub for project-related information and updates.
- Standardised document templates were created to ensure consistency and professionalism in project communications. A LinkedIn project account was established to facilitate networking with industry professionals and policymakers.

FUTURE STEPS AND PLANS

- Completion of the FEED study for the electrolyser, followed by detailed engineering for the integrated industrial green hydrogen production unit in order to precisely define all the technical specifications of the system as well as its operational requirements.
- Conduction of environmental study for the permitting process, as well as the necessary safety studies (HAZID, HAZOP etc) culminating in the final version of the draft safety plan.
- The GO/NO-GO decision is expected in tandem with the selection of the EPC contractor, followed by site preparation and the beginning of the construction phase, leading to the equipment's arrival.
- Conduction of basic and detailed engineering and procurement for the ORC system.
- Refinement of the models developed for the digital twin and the simulation of the auxiliary functions and the energy management system will proceed as planned.
- Further work towards techno-economic, environmental and societal sustainability of the project includes the development of a techno-economic framework and sustainability assessment and a preliminary business plan to assess the project's theoretical feasibility and long-term sustainability.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Target achieved?
Project's own objectives	O_2 production - Base Case	tons/year	19 322	
	Operating hours per year - Base Case	hours/year	3 945	
	O_2 production - Full Load	tons/year	39 184	
	CO_2 savings for project duration - Base Case	ktons/year	52.6	
	Availability - Full Load	%	91	
	H_2 production - Full Load	tons/year	4 898	
	H_2 production - Base Case	tons/year	2 415	
	CO_2 savings for project duration - Full Load	ktons/year	108.1	
	LCOH targeted - Full Load	€/kg H_2	2.6	
	LCOH targeted - Base Case	€/kg H_2	3.3	
	Availability - Base Case	%	45	
	Operating hours per year - Full Load	hours/year	8 000	
	Degradation	%/1 000h	≤0.11	
	Use of critical raw materials as catalysts	mg/W	< 0.6	
	Hot idle ramp time	sec	≤30	
	Cold start ramp time	sec	≤900	
	CAPEX	€/kW	≤ 480 ±10%	
	Current density	A/cm^2	> 0.6	
	O&M cost	€/(kg/d)/y	≤ 43±10%	
	Electricity consumption @ nominal capacity	kWh/kg	≤49	

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