Clean Hydrogen Partnership

Clean Hydrogen JU support to Hydrogen Production

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Former Project Officer

HYDROGEN FOR A CLEAN FUTURE: PATHWAYS FOR CYPRUS & BEYOND

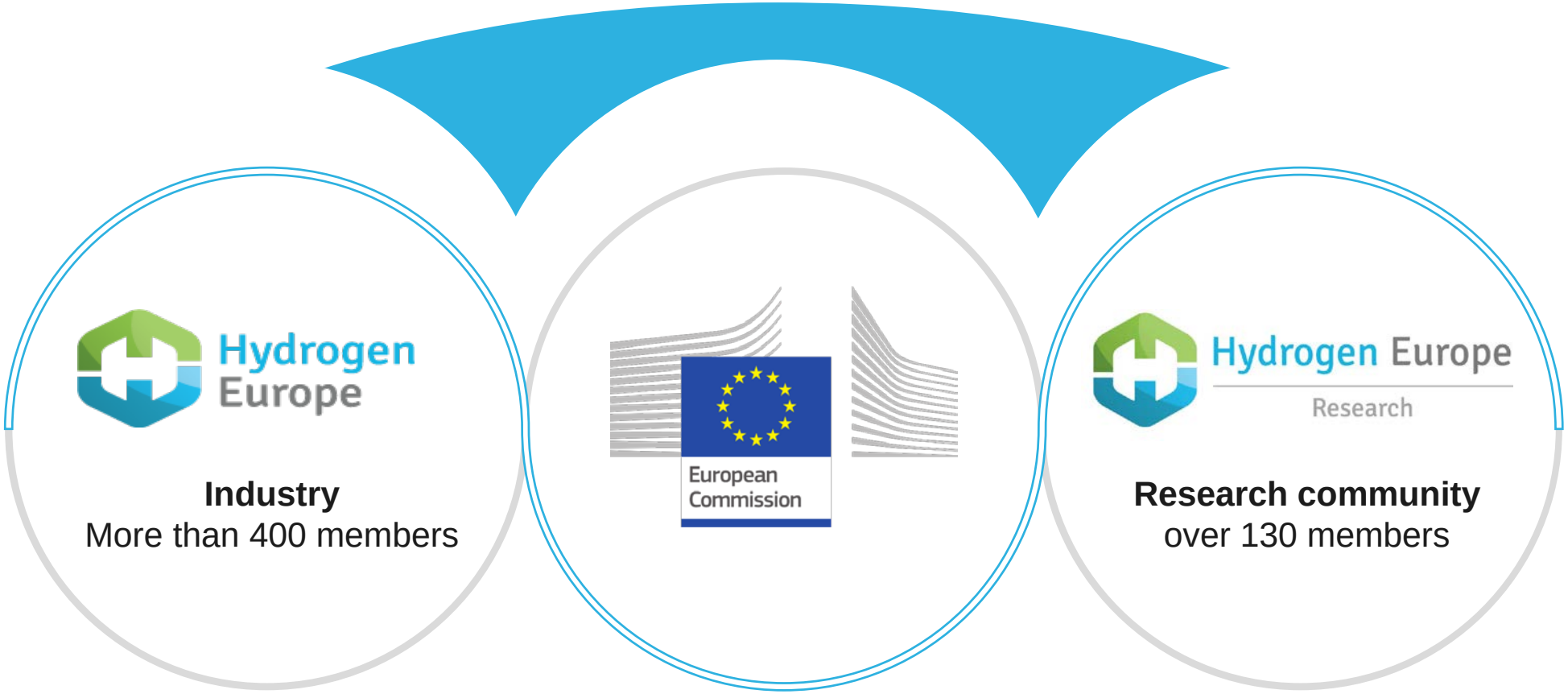
Nikosia, 14 November 2025

EUROPEAN PARTNERSHIP

Co-funded by the European Union

Clean Hydrogen Joint Undertaking

EU Institutional Public-Private Partnership (IPPP) **2021-2027**



1 billion EURO from Horizon Europe* to implement R&I activities and facilitate the transition to a greener EU society through the development of hydrogen technologies

**** additional 200 million EURO for Hydrogen valleys (under RePowerEU)***

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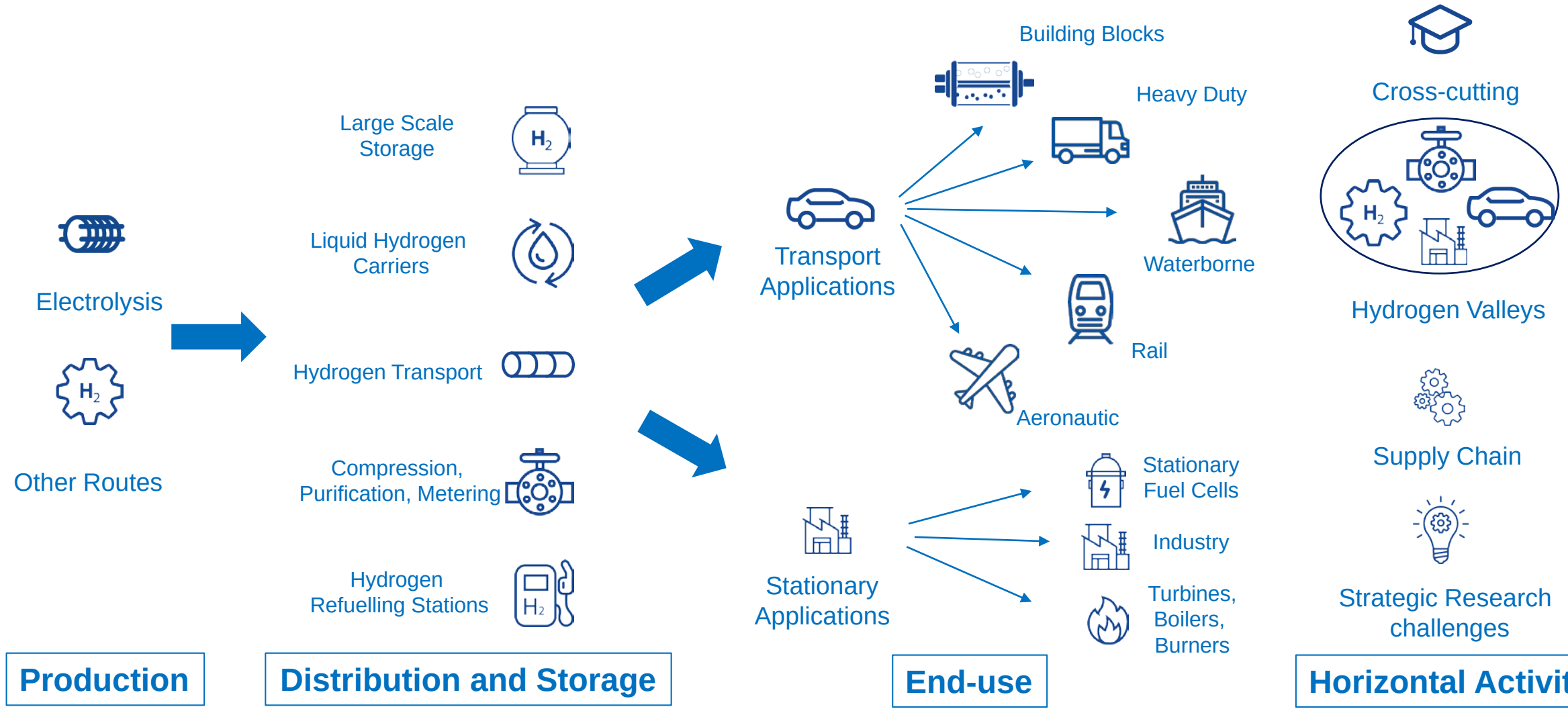
Clean Hydrogen JU Strategic Research and Innovation Agenda 2021 – 2027



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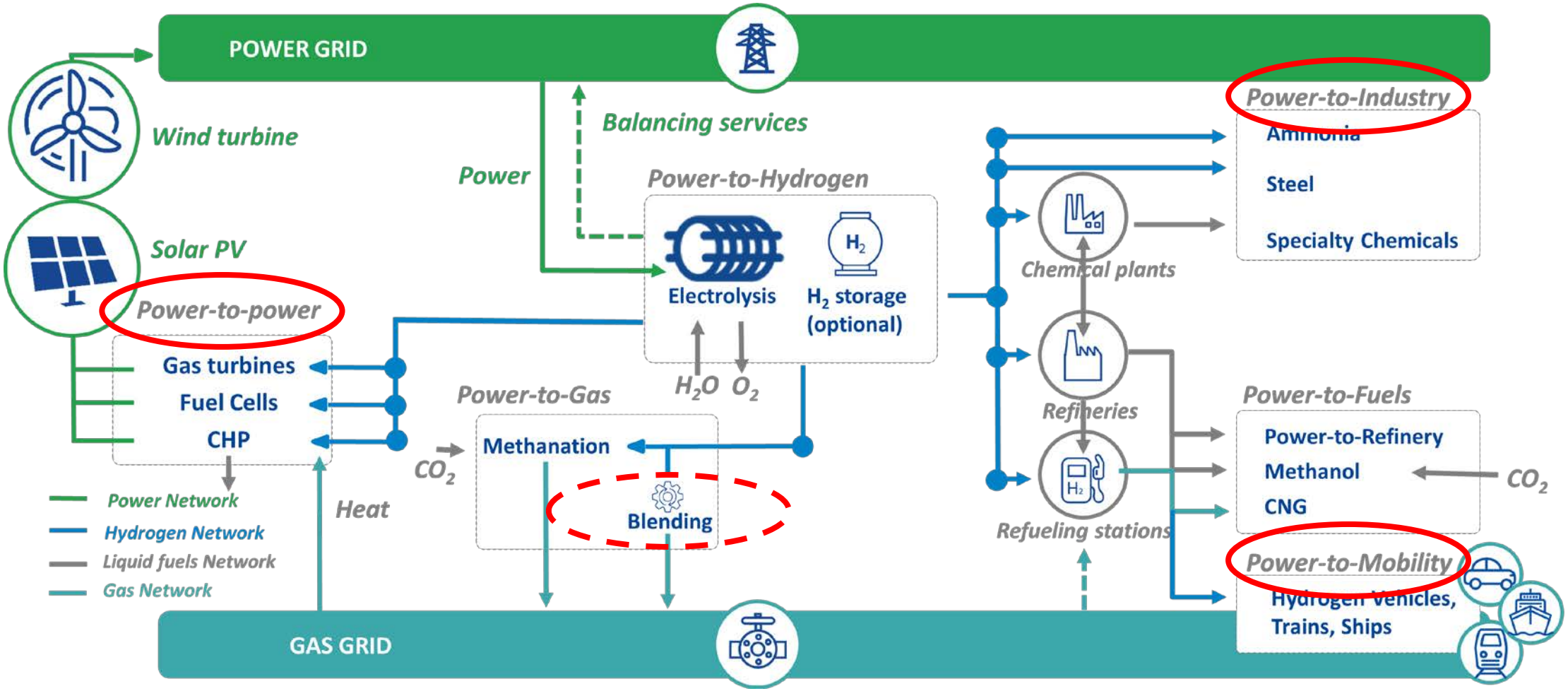
Power2Hydrogen2X: Indirect electrification of hard-to-abate sectors through Hydrogen

For a sustainable future we will need green electrons and green molecules



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Clean Hydrogen JU Programme (2008-2024)

Clean Hydrogen Partnership

H_2 Valleys

21 Projects

€ 253.4 million

H_2 End Use: Clean Heat and Power

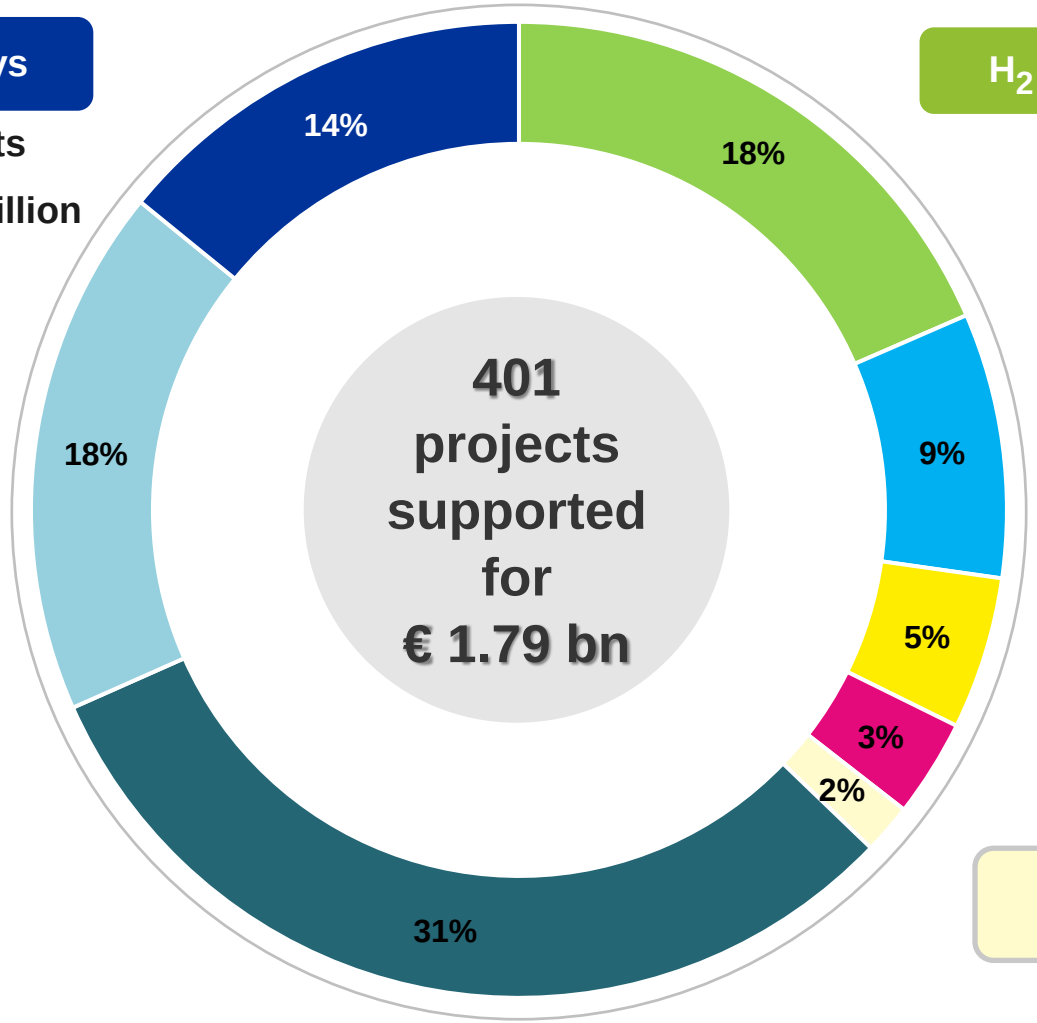
90 Projects

€ 314 million

H_2 End Use: Transport

82 Projects

€ 559.1 million



H_2 Production

Electrolysis & Other routes

88 Projects

€ 331.2 million

H_2 Storage & Distribution

41 Projects

€ 157.3 million

Cross-cutting

58 Projects

€ 90.6 million

Supply Chain

18 Projects

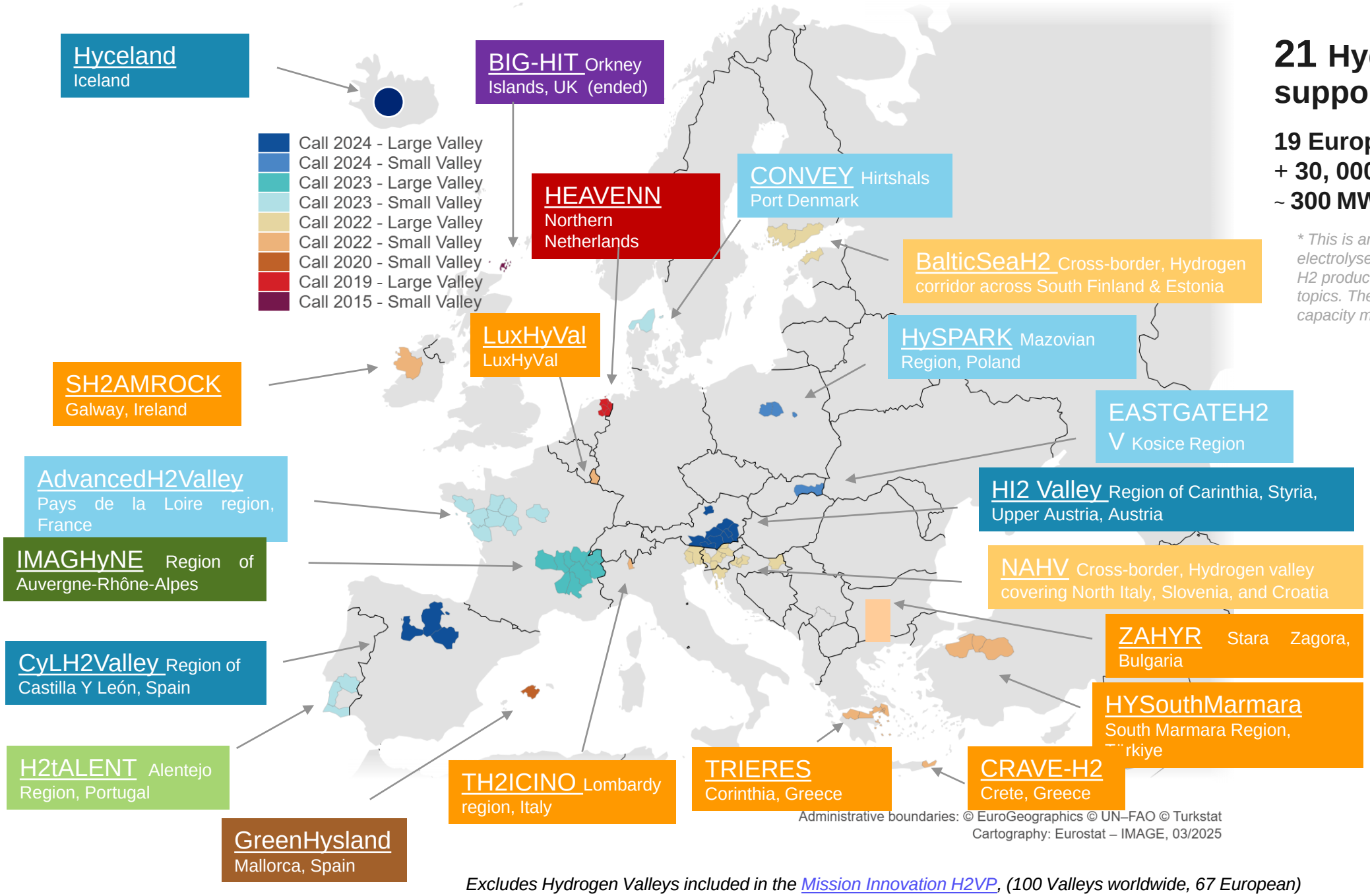
€ 58 million

Strategic Research Challenge

3 Projects

€ 29.6 million

Co-funded by the European Union



21 Hydrogen Valleys supported to date

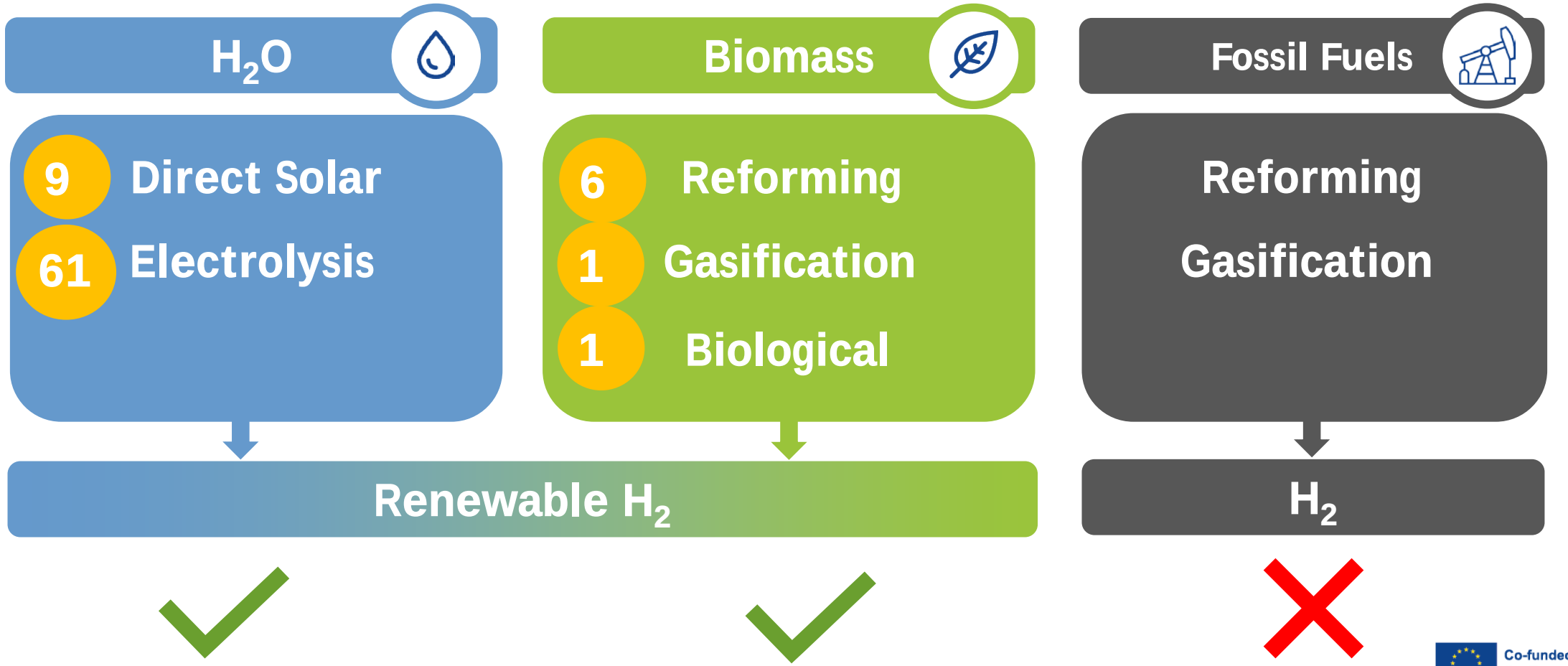
19 European countries
+ 30, 000 tons H2 / year
~ 300 MW equiv*. Electrolyser capacity

** This is an estimated equivalent electrolyser capacity calculated using the H2 production requirements of the Call topics. The actual "to be installed" capacity may differ*

Excludes Hydrogen Valleys included in the Mission Innovation H2VP, (100 Valleys worldwide, 67 European)

Hydrogen Production Technical Coverage

79 projects, 290 M Euro 18% of Clean H_2 JU support. Only renewable H_2



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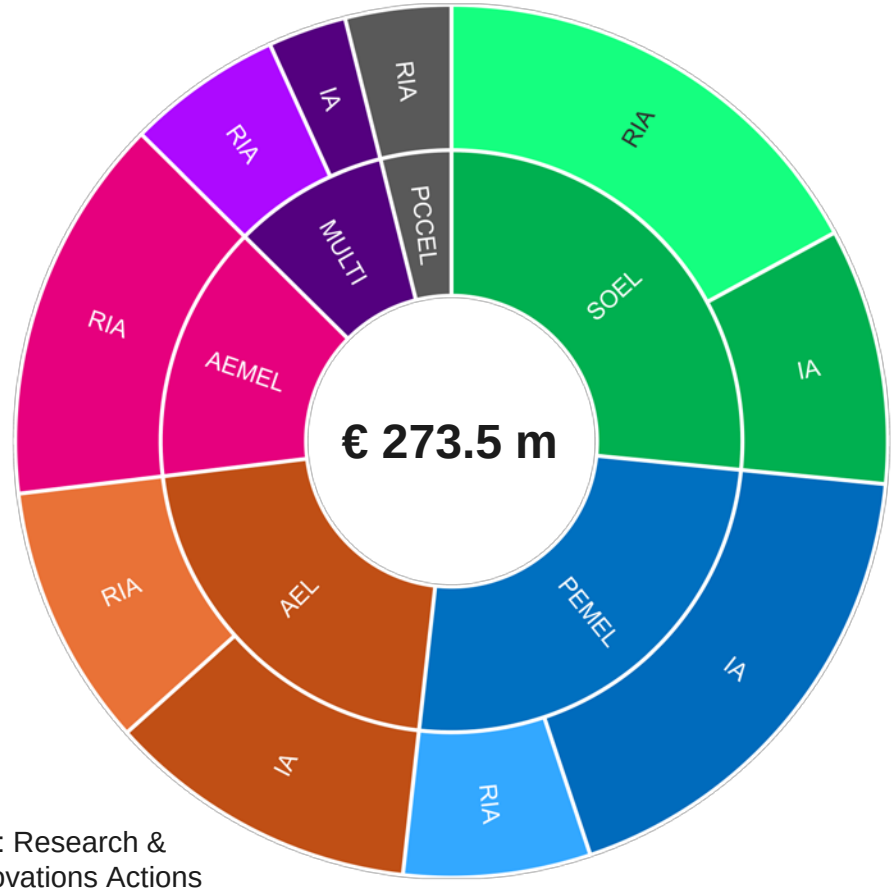
Electrolysis Research and Demonstration

The potential of Hydrogen for the greening of industry has led to fast capacity increase and cost reduction

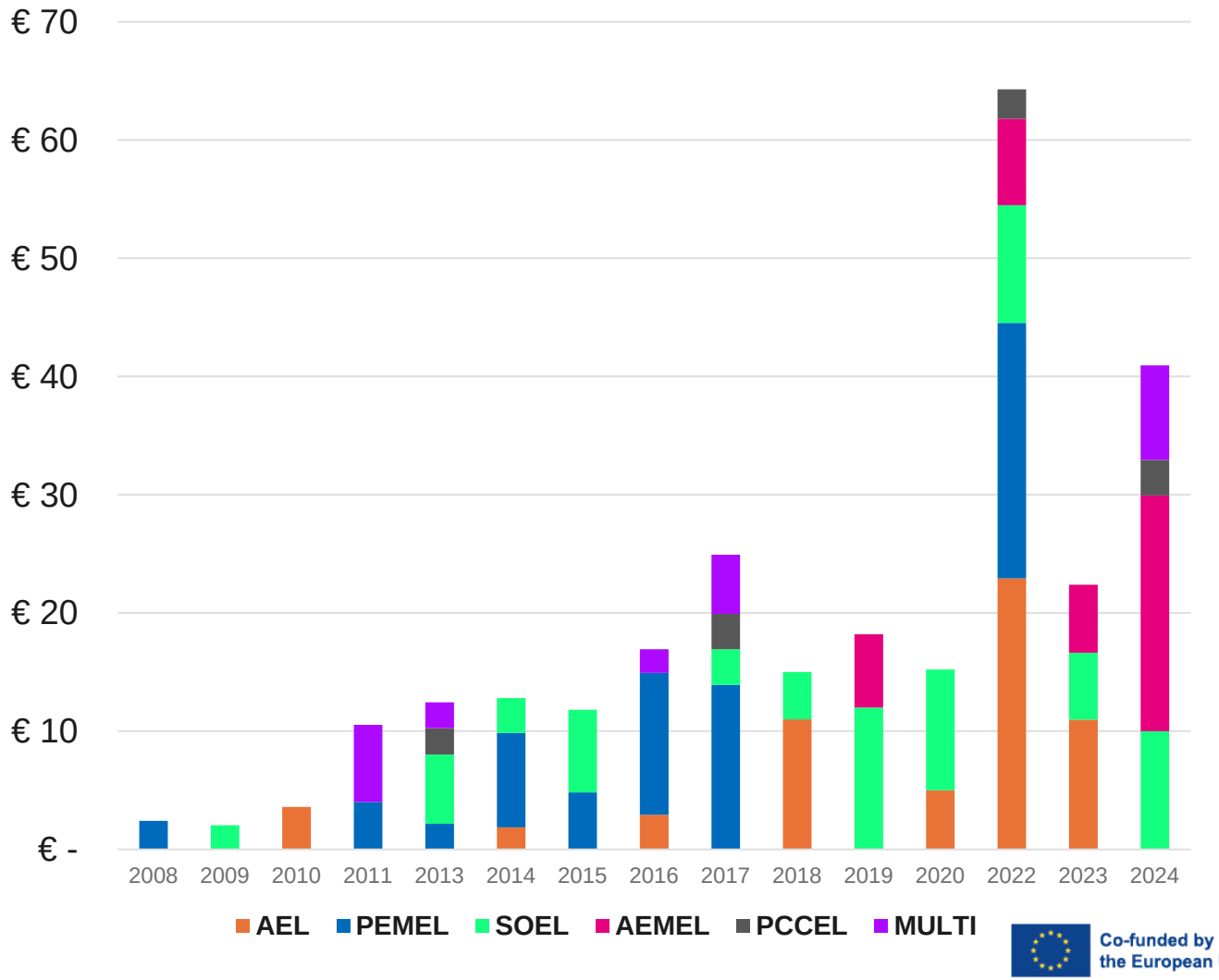
Electrolysers, M€ Clean H_2 JU support



RIA: Research & Innovations Actions (RTD)
IA: Innovation Actions (Demo)

70 Projects

JU funding per electrolyser type



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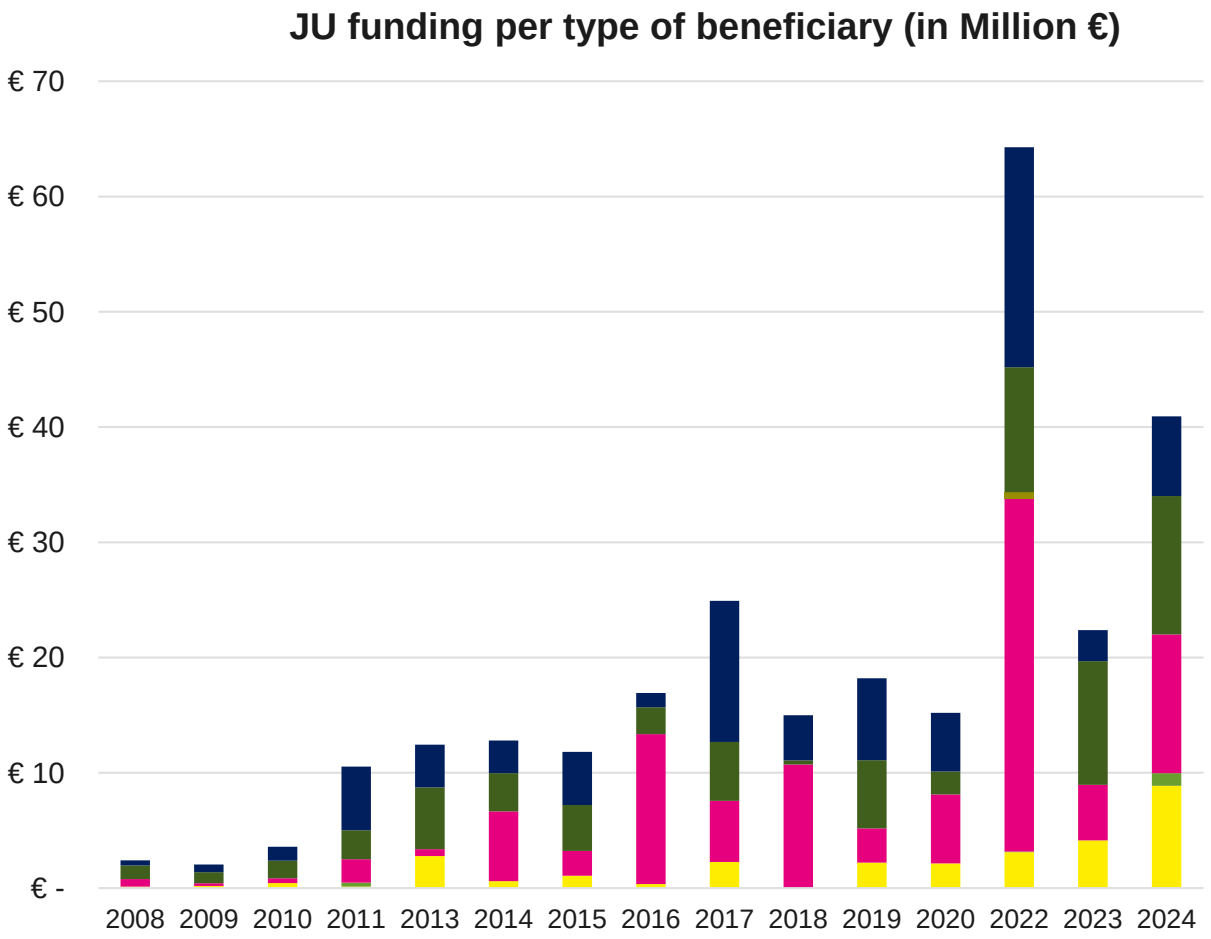
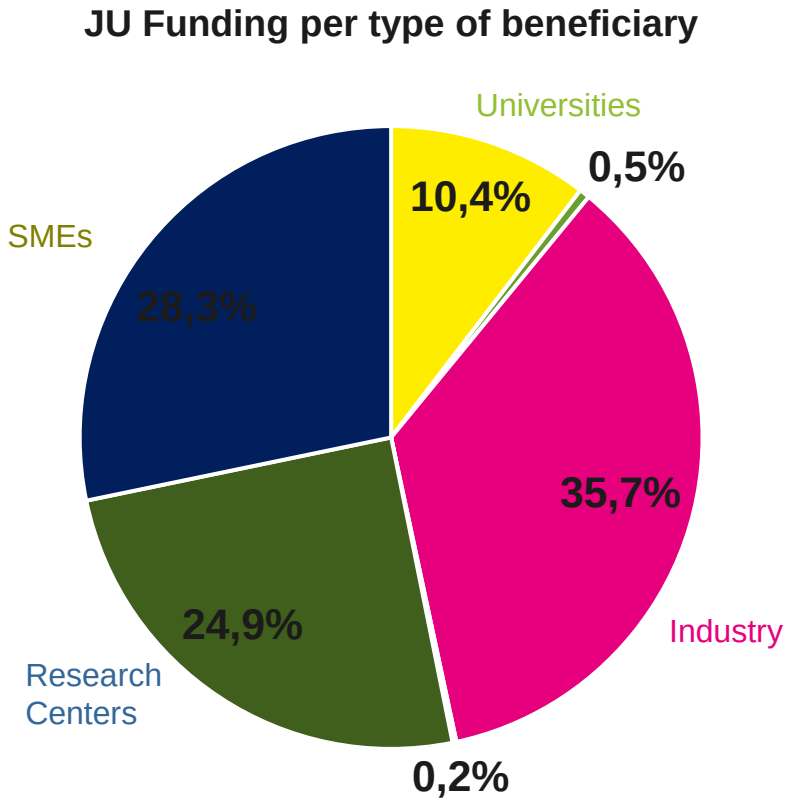
Electrolysis Research & Demonstration

Balanced support to industry, SMEs, R&D actors





UNI: Higher Education Institutions
OTH: Other Participants
IND: Private Sector
PUB: Public Bodies
REC: Research Centres
SME: Small Medium Enterprises

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Low Temp Electrolysis Demonstration projects

In 12 years electrolyser capacity increased 200× and funding per MW installed reduced 100×

All facilities continue to operate after completion of each project

Project: **Don Quichote**
Place: Belgium
Date: **2011**
Electrolyser: Hydrogenics
Funding: 5.0 m€

0.15 MW

Project: **Hybalance**
Place: Denmark
Date: 2014
Electrolyser: Hydrogenics
Funding: 8.0 m€

1.2 MW

Project: **Haeolus**
Place: Norway
Date: **2017**
Electrolyser: Hydrogenics
Funding: 5.0 m€

2.5 MW

Project: **Demo4grid**
Place: Austria
Date: **2016**
Electrolyser: IHT
Funding: 2.9 m€

3.2 MW

Project: **H2future**
Place: Austria
Date: **2016**
Electrolyser: Siemens
Funding: 12 m€

6.0 MW

Project: **Refhyne**
Place: Germany
Date: **2017**
Electrolyser: ITM
Funding: 10 m€

10 MW

Project: **Djewels**
Place: The Netherlands
Date: **2018**
Electrolyser: McPhy
Funding: 11 m€

20 MW

Project: **EPHYRA**
Place: Greece
Date: **2023**
Electrolyser: TBA
Funding: 17.7 m€

30 MW

PEMEL

AEL

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Low Temp Electrolysis Demonstration projects

EU Electrolyser industry ready to support EU H_2 policies

2016

H2FUTURE
Green Hydrogen

η=83%$_{HHV}$, purity 99.9%

Operating range 15-150%

Balancing services
H_2 prod costs < 25-50%

6MW, Steel plant, AU

2017

REFHYNE
CLEAN REFINERY HYDROGEN FOR EUROPE

In commissioning

Close cooperation of industry with SMEs

10MW Refinery, DE

Lack of suitable BoP

2018

Djewels

Degradation @ 0.9 A/cm^2

Real world market issues

20MW Biomethanol, NL

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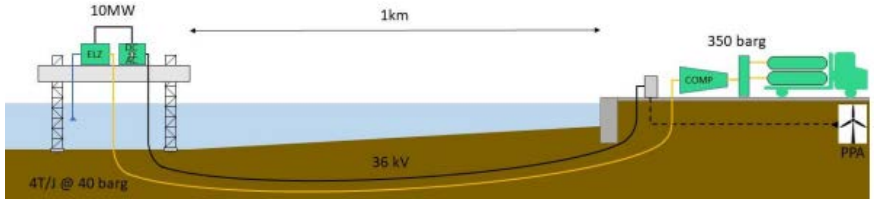
LT Electrolysis projects – Going off-shore

New electrolyser OEMs / players to JU frameworks

2020: OYSTER project

- Marinisation of 3MW AEL - Stiesdal (DK)
- Near-shore operation
- Zeeland (NL)
- Integrated desalination

2022: HOPE project



- Marinisation of 10MW PEMEL - Frames Energy / Plug (NL)
- Off-shore operation
- Oostende (B)
- Recycled barge

Call 2024 includes topic on direct seawater electrolysis

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Low Temperature Electrolysis R&I

Latest projects

- Low temperature water electrolysers for highly pressurised hydrogen production
- Innovative cells
- Advances in alkaline electrolysis
- Advanced AEMEL
- Direct seawater electrolysis

HYPRAEL
PEACE
Advancepem
X-SeeD
EXSOTHyC
Aemelia
Green Hydrogen for the future
SEALHYDROGEN
REDHy
ENDURE
HyPrAEM
ENDURION
ASTERISK
SWEETHY
HySEas
Sea4Volt

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HT Electrolysis Demonstration projects

HTEs finding their place in the industrial courtyard, facilitating strategic partnerships

2016

Salzgitter Iron and Steel Works
150kW
JU funding: €4.5M

2019

PAUL WURTH BECOMES NEW LEAD INVESTOR AND TECHNOLOGY PARTNER OF SUNFIRE

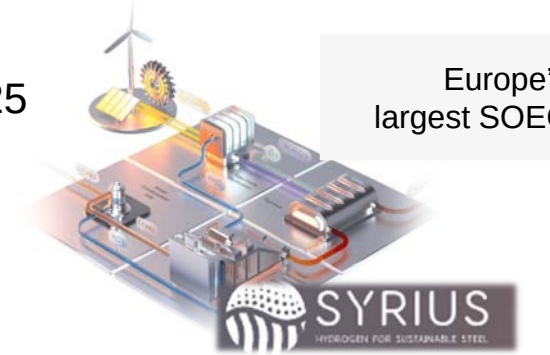
Salzgitter Iron and Steel Works
720kW – 200 Nm³/h – η 84.6%
Availability 84%
Valuable open access data

2020

NESTE INVESTS IN SUNFIRE

Rotterdam Neste Biorefinery
2.4MW in commissioning

2025



Europe's largest SOEC

Steel plant in Terni
4.2 MW
JU funding: €10M

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HT Electrolysis R&I projects

Exploring different pathways of research and development

Pressurised operation

HYP3D

- 5 bar; 0.85 A/cm^2
- Electrolyte-supported SOECs based on 3D-printed 3YSZ and 8YSZ with non-flat geometry.

PRESHYOUS

- One lab-scale 30-bar/20 kWe stack in a pressurised vessel
- And a 10-bar pressurised stack operated without needing a pressure vessel.

Intermediate Temperatures

NOAH$_2$

Targets

- Increase current density to 1.2 A/cm2
- Operation at 550- 700°C
- Degradation rate of 0.75%/1000hr
- Reducing the use of critical raw materials

Hy-SPIRE

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Electrolyser current R&I emphasis

- Seawater electrolysis
- Improvements in materials, components, BoP, control (Digital Twin)
- Removing PFAS
- Manufacturing & Recycling
- Improved/direct Coupling with renewables
- EU competitiveness – electrolyser design for safety

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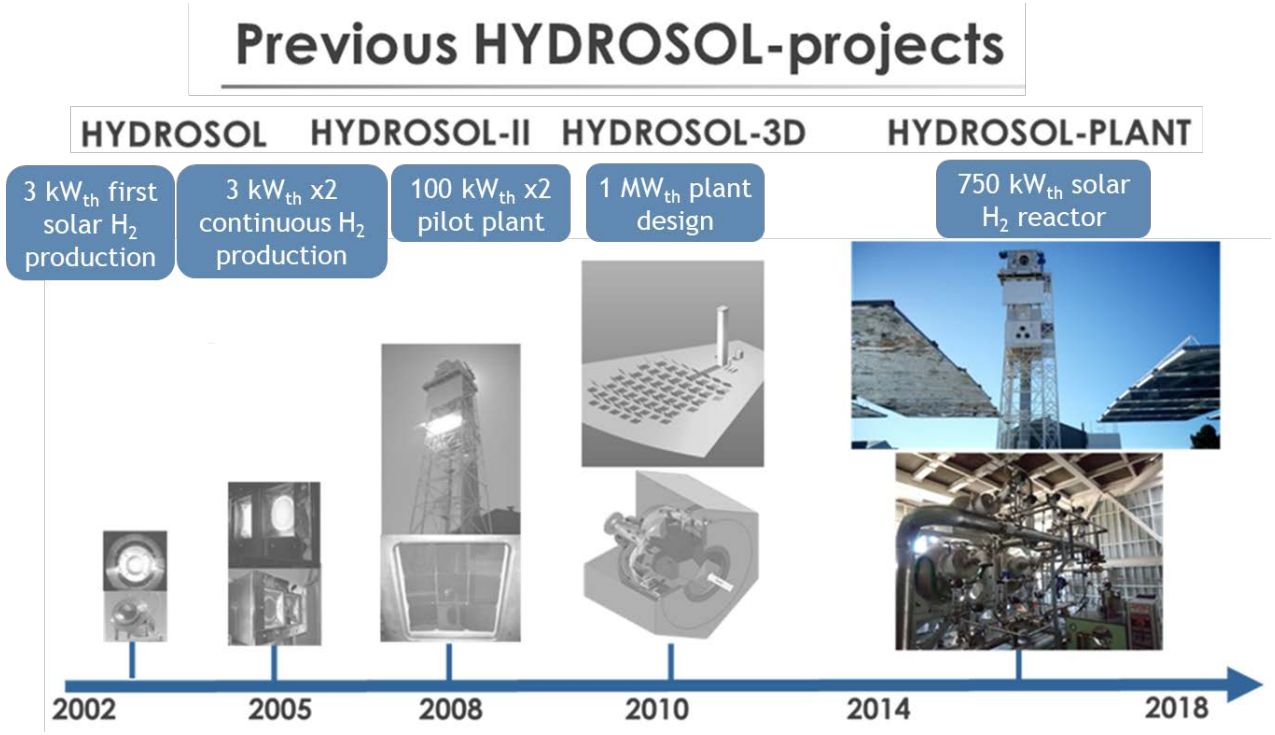
High Temp Direct production of H_2 from sunlight

Thermal dissociation of water using concentrated solar-thermal power and redox thermochemical cycles



- Production of stable NiFe2O4 lattice structures - 150 cycles
- Heat recovery of high temp heat >60% Scaling up & Stability of reactor
- Demonstration of efficiency >5% in the field tests of the 750 kW$_{th}$ plant

hydrosol beyond

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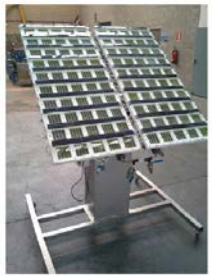
Low Temp Direct production of H2 from sunlight

Scale-up and outdoor demonstration of a photo-electrochemical (PEC) system @ 10 m² and a photo-catalytic system @ 0.5 m²

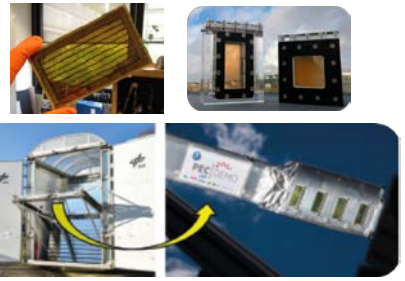
Artiphyction

- 1.6 m^2 irradiated surface (η=3 % STH)



PEC DEMO

- Hybrid PEC-EV
- η =9 % STH
- 4x50 cm^2



PECSYS

- PV-electrolyser concept
- 10 m^2 prototype
- η =9 % STH
- LCOH = 4 - 10 €/kg

2011 — 2013 — 2016 — 2022

- Demonstration of 10 m^2 direct coupled PV-EC*1 device
- Efficiency record of 14 % for SHJ*2 PV-PEM electrolyser
- 6 €/kg achievable with integrated PV-EC approach
- Constraints in scaling-up an integrated PV-EC device

2023

Photo-catalytic project in GAP

- STH % > 5%
- >500 h
- 500 cm^2

*1 PV-electrochemical
*2 Silicon Hetero junction

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Biomass gasifiers & reactors; Biogas reformers

Singular projects on biomass; Recent emphasis on raw biogas compact reformers

Dry biomass: H_2 <5 €/kg from biomass gasification

2012

UnifHy 1MW_{th} plant – 500kg/d

2023

Hyield Project
- **Waste-to-hydrogen gasifier**
- **400t to cement factory**
- **LCOH <2.2€/kg**

Biogas without CO_2 prior removal

100kg/day H_2 Conversion η = 71.5%

2015

BIONICO

2017

BioRobur plus

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2020 FCH JU Study: Opportunities from the inclusion of Hydrogen in NECPs

The existing framework

CYPRUS

- Cyprus is not explicitly considering hydrogen deployment in its NECP for the period from 2021 to 2030 nor in the Alternative Fuels Directive
- Cyprus has no natural gas network but plans to diversify its energy sources by importing liquified natural gas
- Cyprus has a large technical renewable electricity generation potential, exceeding considerably its expected overall electricity demand in 2030
- This potential could be better exploited if renewables were coupled with hydrogen, improving the flexibility of the isolated energy system and helping reduce imported fuels

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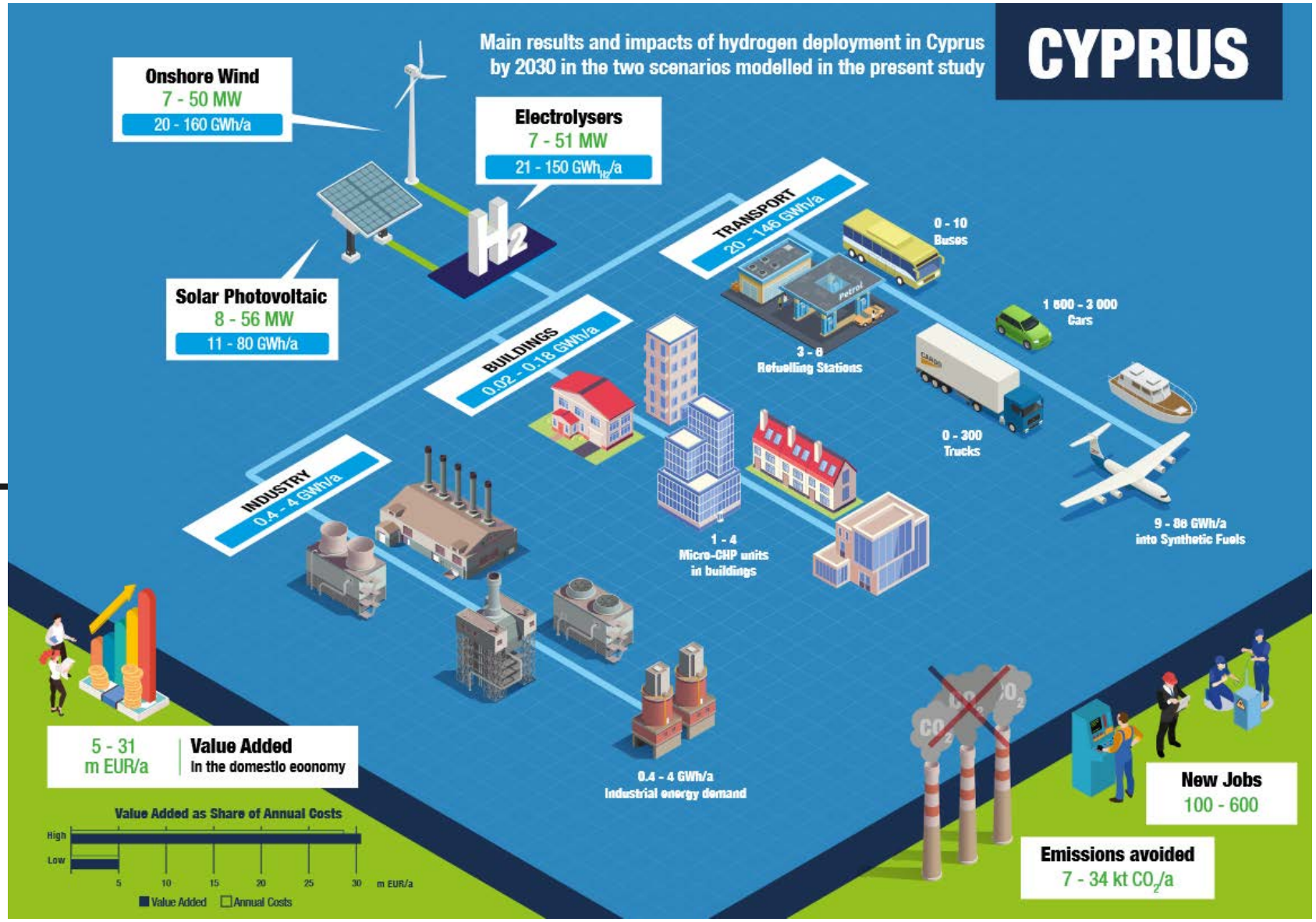
Low and High scenario for Hydrogen deployment in Cyprus

CYPRUS



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Thank you for your attention!

Acknowledgement: all information shown was provided by the Clean Hydrogen JU

For further information
https://www.clean-hydrogen.europa.eu/

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