

Hydrogen Research & Innovation Days

24-25 November 2025





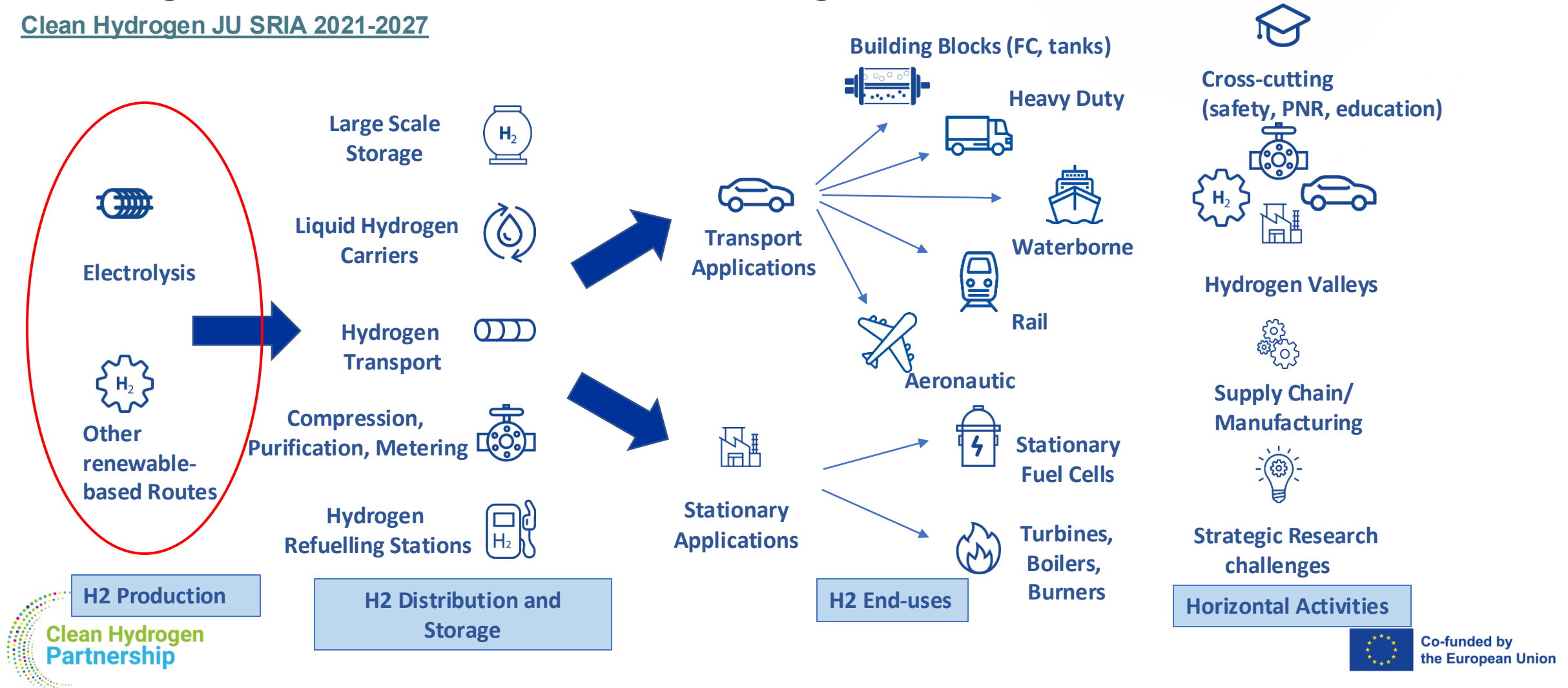
Hydrogen Production

Eleni Kontonasiou - Project Officer, Clean Hydrogen Partnership



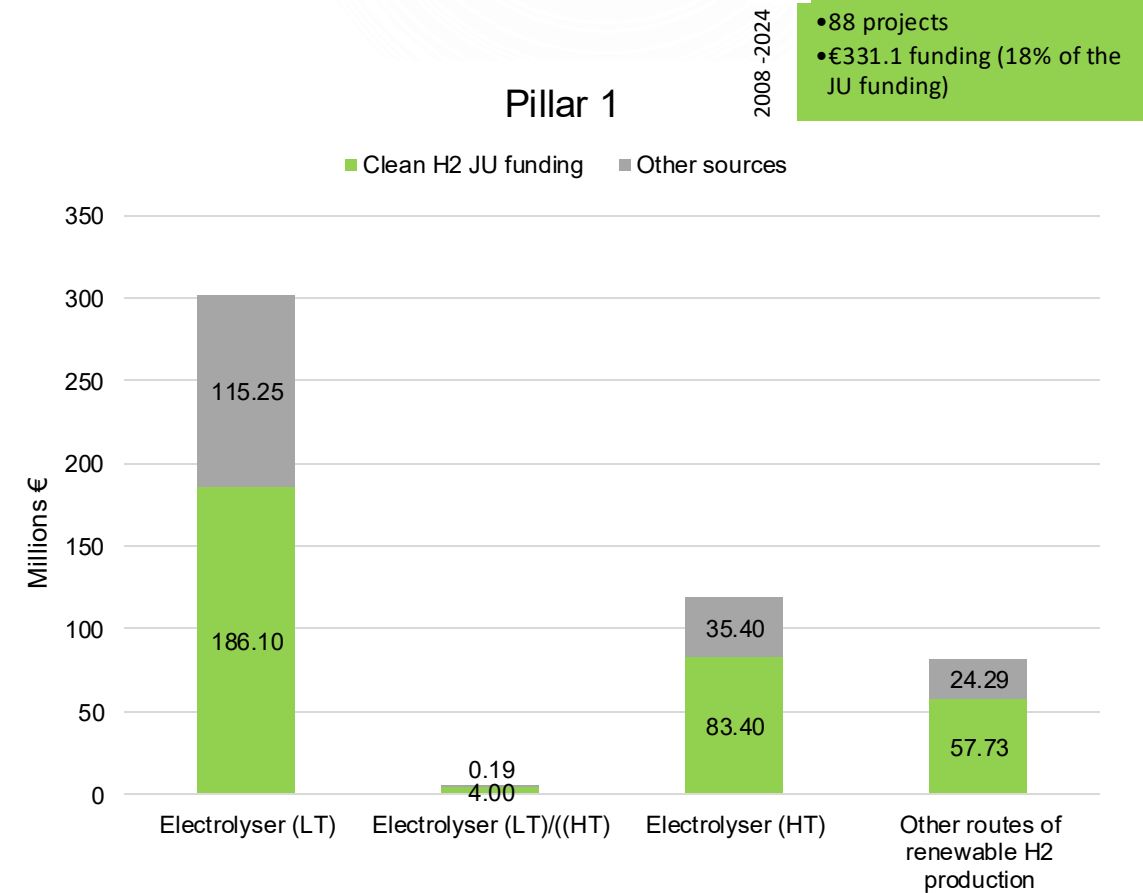
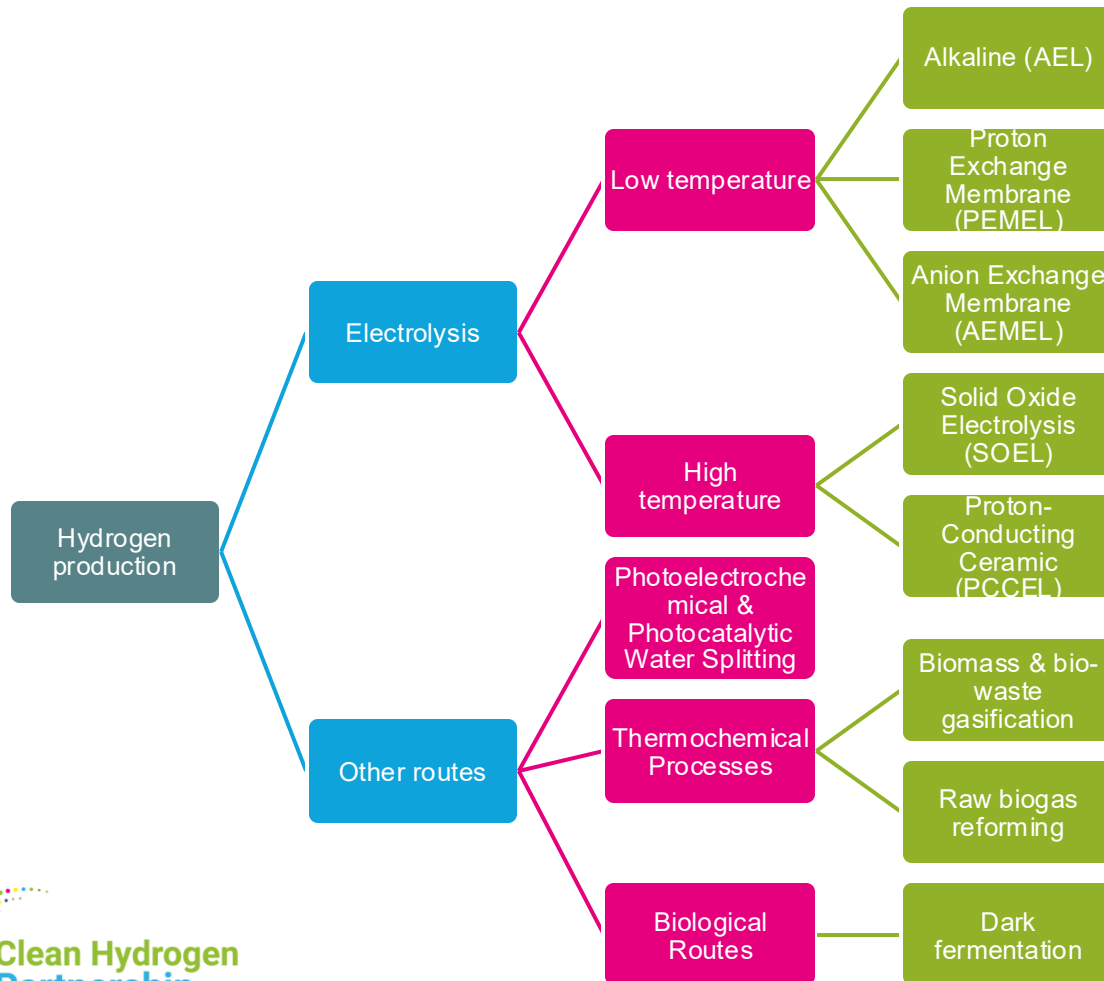
Strategic Research & Innovation Agenda

Clean Hydrogen JU SRIA 2021-2027





Renewable Hydrogen Production

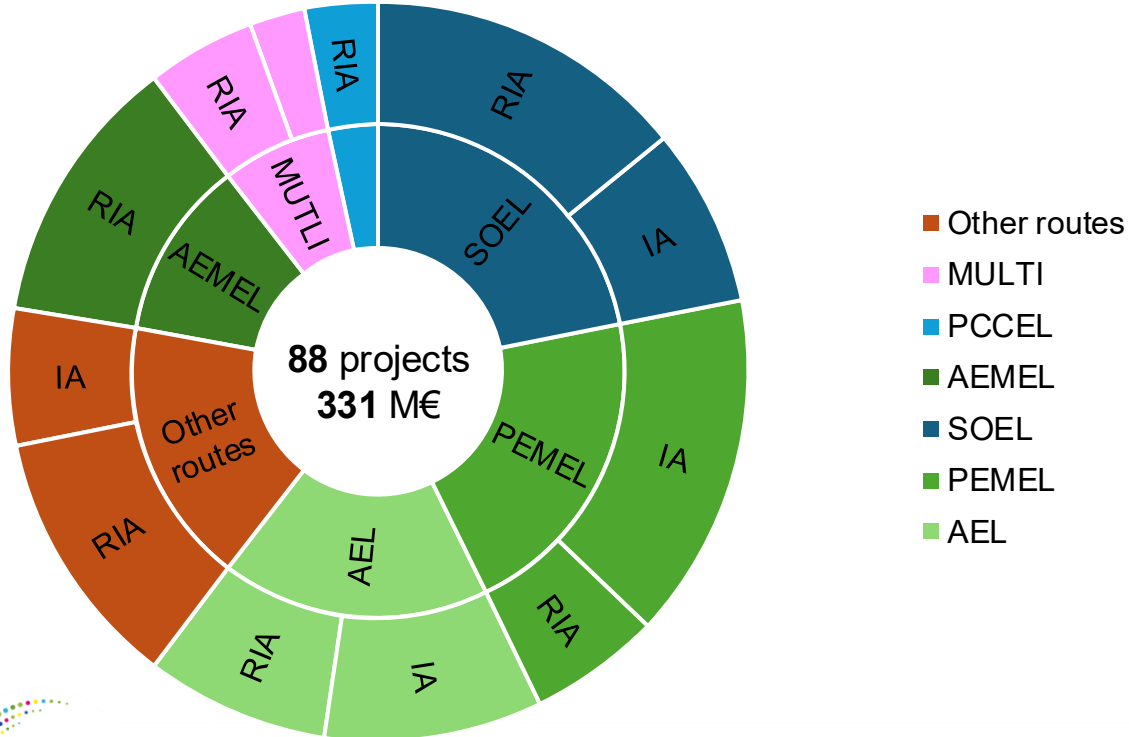




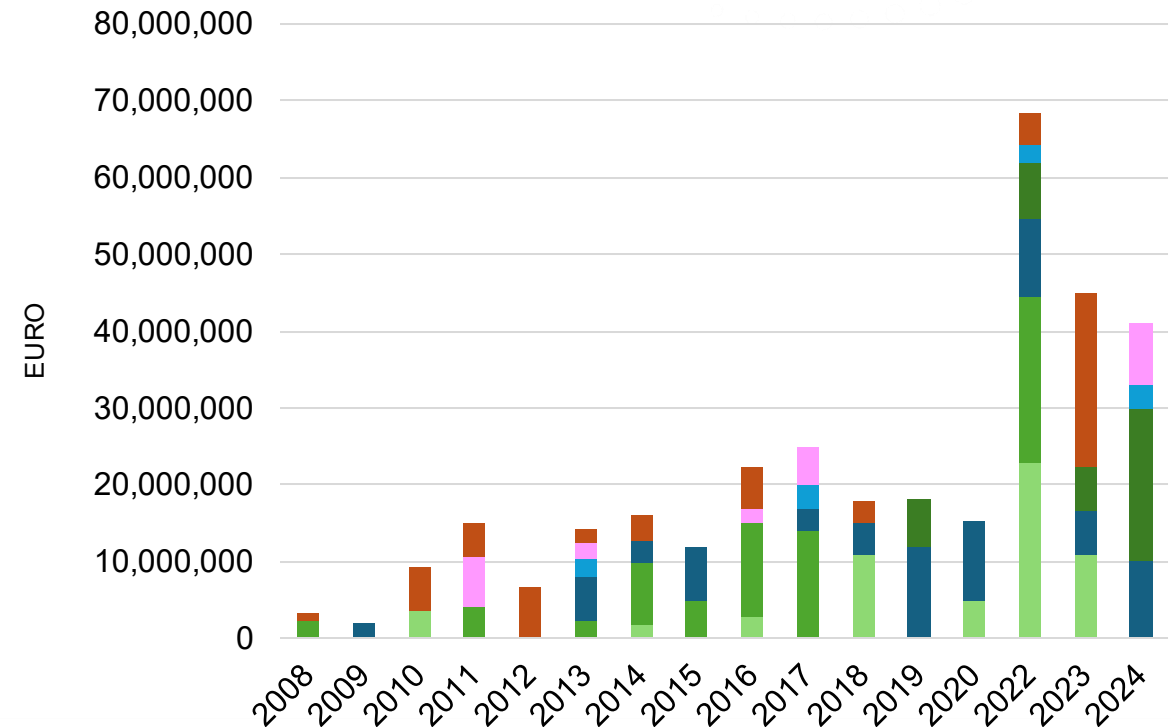
H₂ production Research & Demonstration

50% of the H₂ production JU funding is allocated to LT technologies, 25% to HT

H₂ production M€ Clean H₂ JU support



JU funding per H₂ production type per year

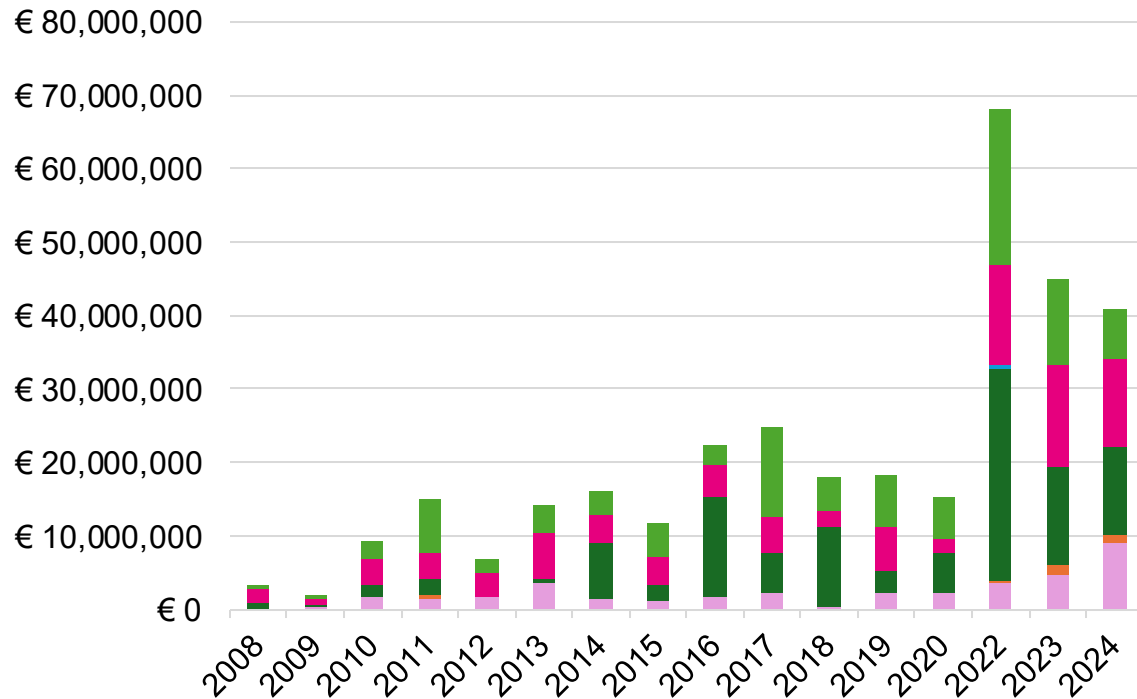




H₂ production Research & Demonstration

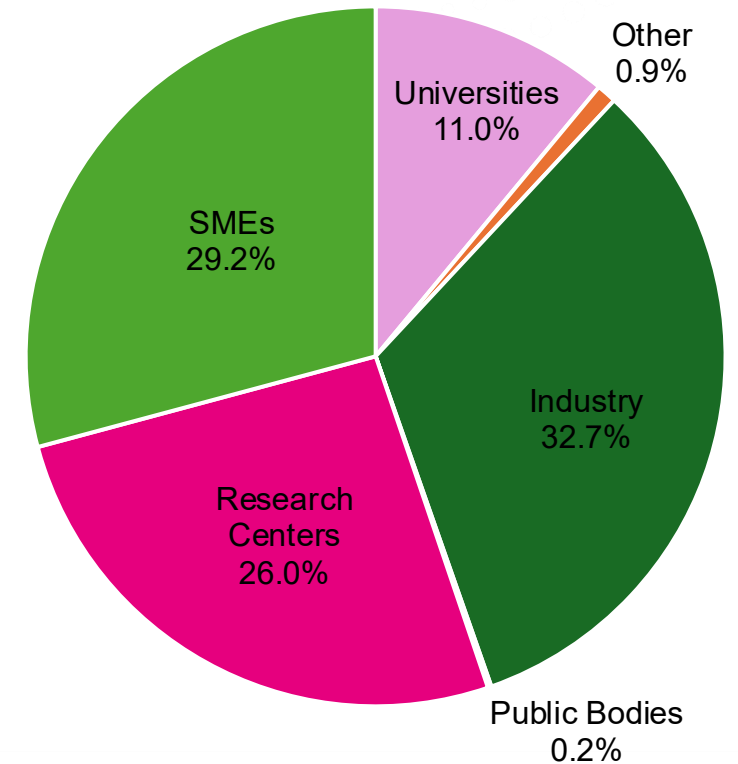
Balanced support to industry, SMEs, R&D actors

JU funding per type of beneficiary



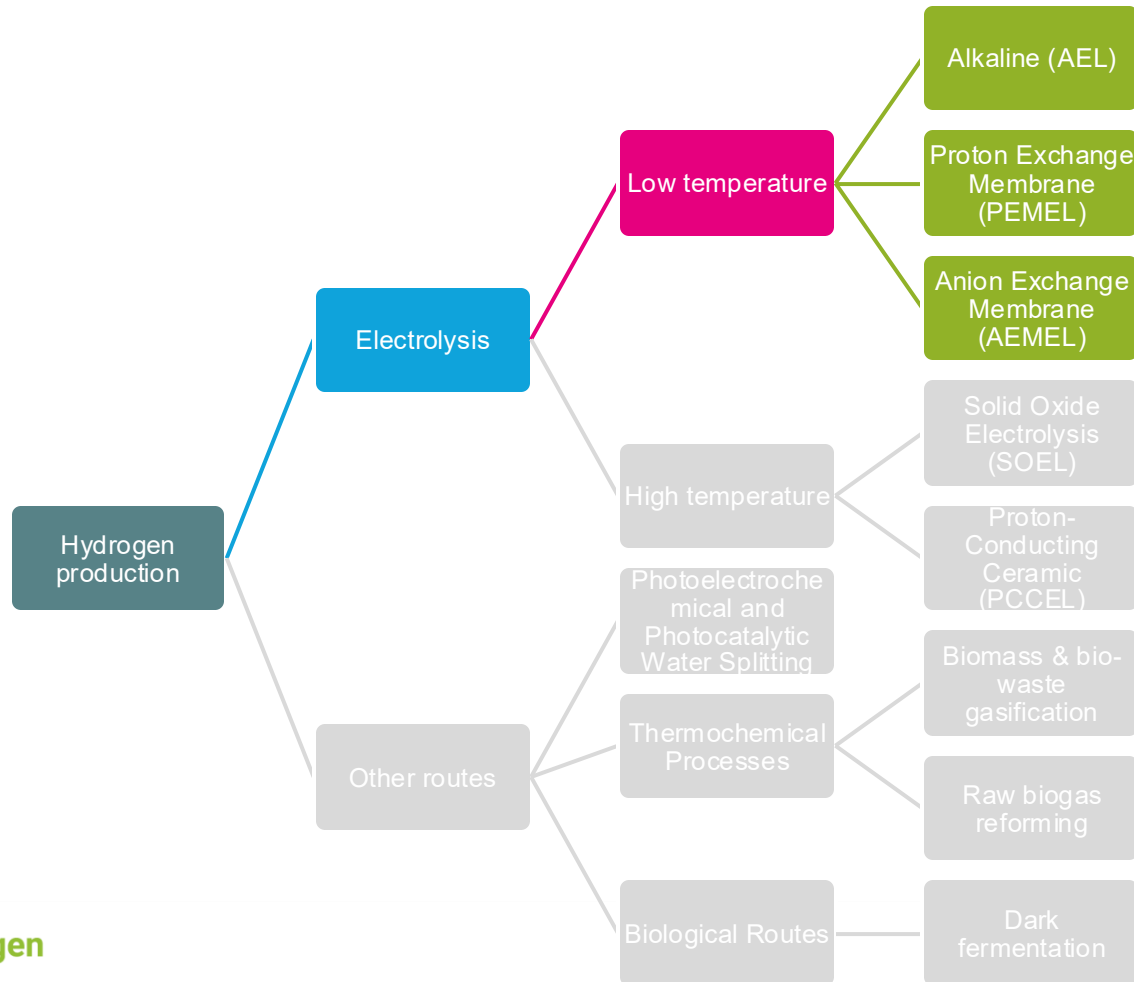
UNI: Higher Education Institutions
OTH: Other Participants
IND: Private Sector
PUB: Public Bodies
REC: Research Centres
SME: Small Medium Enterprises

JU Funding per type of beneficiary





Low Temperature Electrolysis



Low Temperature Electrolysis Demonstration projects

In 12 years electrolyser capacity increased x200 and funding per MW installed reduced x100

All facilities continue to operate after the project completion

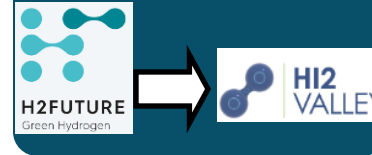
Project: **Don Quichote**
Place: Belgium
Date: **2011**
Electrolyser: Hydrogenics
Funding: 5.0 M€



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



Project: **H2future**
Place: Austria
Date: **2018**
Electrolyser: Siemens
Funding: 12 M€



Project: **Djewels**
Place: The Netherlands
Date: **2018**
Electrolyser: Tbc
Funding: 11 M€



0.15 MW

1.2 MW

2.5 MW

3.2 MW

6.0 MW

10 MW

20 MW

30 MW

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



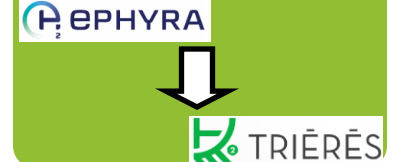
Project: **Demo4grid**
Place: Austria
Date: **2016**
Electrolyser: IHT
Funding: 2.9 M€



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



Project: **EPHYRA**
Place: Greece
Date: **2023**
Electrolyser: Tbc
Funding: 17.7 M€



PEMEL

AEL

Stacks: PEMEL 0.5-1.25 MW; AEL 1-3MW

Low Temperature Electrolysis Demonstration projects

Projects success supported EU H₂ policies

2017 - 2021



$\eta=83\%_{\text{HHV}}$, purity 99.9%

Operating range 15-150%

Balancing services

H₂ prod. Costs <25-50%

6MW PEM, Steel plant,
AT

Expansion plans (storage tanks, compression and purification systems)

2018 - 2024



52.63 kWh/kg @ 2.2 A/cm²

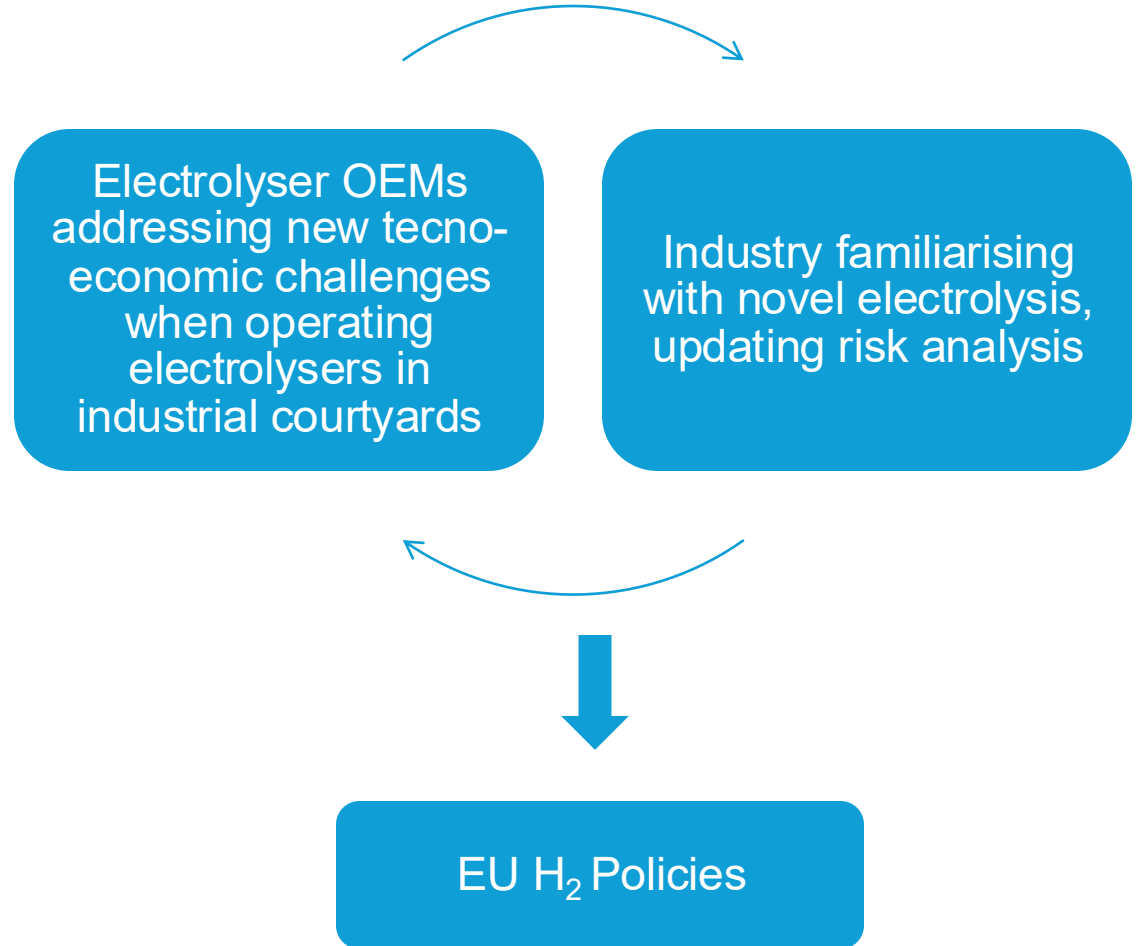
Lack of suitable BoP

Close cooperation of industry with SMEs

EU added-value & competitiveness

10MW PEM, Refinery,
DE

Predecessor of REFHYNE II 100MW



Low Temperature Electrolysis R&I

...and the work continues: funding complementary approaches

Call
2022

Low temperature water electrolyzers
for highly pressurised H₂ production



Call
2023

Innovative cells



Advances in alkaline electrolysis



Advanced AEMEL



Call
2024

Direct seawater electrolysis



Low Temperature Electrolysis R&I

Anion Exchange Membrane Projects: Creating and Sharing Knowledge





2019

➔

2022

New materials and components validated in 2 kW stacks

58% efficiency

< 57kWh/kg H₂ energy consumption

No CRMs

AEMEL testing protocols

AEM-HUB for information sharing

Commercialisation of membranes, electrodes and stacks

2022

Further improvements & scaling up



- Cost-effective stack architecture
- Advanced automated sequential manufacturing processes for 25kW AEMEL (500 cm² cells, 50 bar, 1A/cm²)

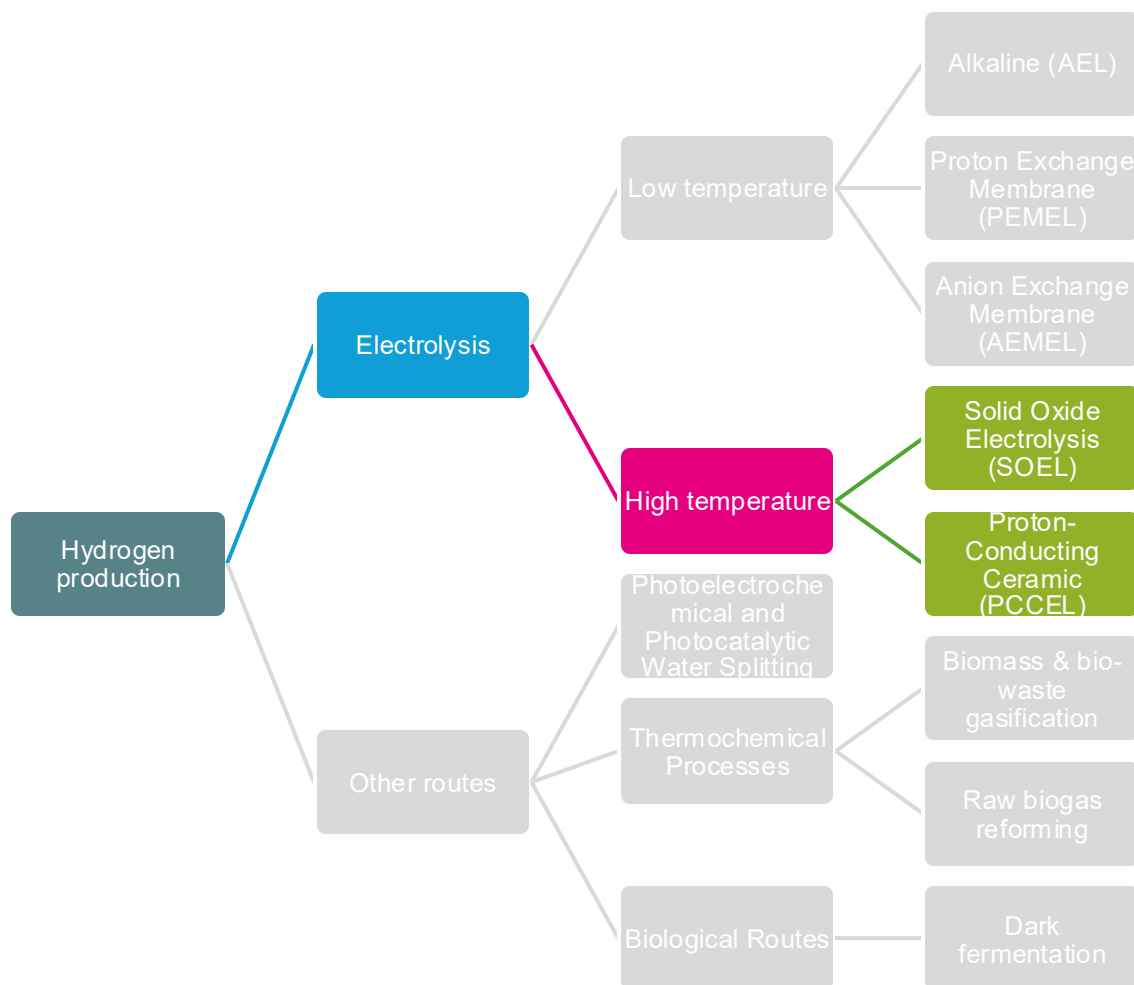


- Material efficiency
- Large prototype: 100kW AEMEL – 400 cm² cells, 15 bar, 2A/cm²





High Temperature Electrolysis



High Temperature Electrolysis Demonstration Projects

Scaling up innovation: An incubator for Europe's electrolyser industry

2019 - 2022

PAUL WURTH BECOMES NEW
LEAD INVESTOR AND
TECHNOLOGY PARTNER OF
SUNFIRE



GrInHy2.0
Green Industrial Hydrogen

Salzgitter Iron and Steel Works
720kW – 200 Nm³/h – η 84.6%
Availability 84%
Valuable open access data
JU funding: €4.0M

2016 - 2019



GrInHy
Green Industrial Hydrogen

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

2020 -
2025



NESTE INVESTS
IN SUNFIRE

MULTIPLHY

Rotterdam Neste Biorefinery
2.4MW in operation
JU funding: €7.0M

2025 -
2029



Europe's
largest SOEC

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

High Temperature Electrolysis Demonstration Projects

Turning promising technologies into bankable industrial solutions

Achievements

Demonstration across diverse industrial settings: steel (GrinHy2.0: >8,000hrs of op.), refinery

Advances in key technological KPIs: GrinHy2.0: Ef. 84.6%, availability: >95%

Growth and scale-up of participating companies



Impacts

Strengthening Europe's industrial leadership

Mobilising significant private investment

Advancing industrial decarbonization

Building a robust and resilient supply chain



High Temperature Electrolysis R&I

...and the work continues: exploring different pathways & manufacturing and scaling up

Call
2022

Pressurised HT stacks (SOEL & PCCEL)

Stack in pressurised vessel: 30 bar, 1A/cm²; 3D-printed cells for compressed H₂ for P2G and HRS - 0.90A/cm², 850°C, 5+ bar



Scaling up SOEL

Cells with areas up to 900 cm²



Scalable manufacturing

Reduced CRM, waste recycling, automation in stack assembly



Call
2023

SOEL for intermediate temp. H₂ production

<700 °C, low CRM, flexible operation, 1.2 A/cm², degradation <0.75% /1000h



Call
2024

PCCEL for intermediate temp. H₂ production

<600 °C for industrial waste heat integration, ≥ 90% faradaic efficiency, ≥ 0.75 A/cm²





Conclusions

AEL, PEMEL technologies are maturing rapidly

- Many SRIA targets (almost) achieved e.g. on efficiency and current density
- Further focus: CRM use, CAPEX, improving lifetime and flexibility, and exploiting AI, standardised tests and shared data

SOEL technology is reaching industrial scale with strong efficiency potential

- MW-scale systems close to SRIA targets for electrical consumption and current density, especially with waste-heat integration
- Further focus: degradation, CRM use, upscaling, manufacturing processes, demonstration actions

Emerging technologies (AEMEL, PCCEL) are promising but early-stage

- Require continued, targeted support to validate performance, durability and cost at system level

Cross-cutting enablers are essential for impact

- Robust data sharing, common standards and protocols, improved risk and permitting frameworks, with enhanced attention to sustainability, circularity and safety, to move from successful projects to large-scale deployment



Thank you for your attention!