



FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

Hydrogen for Sectoral Integration

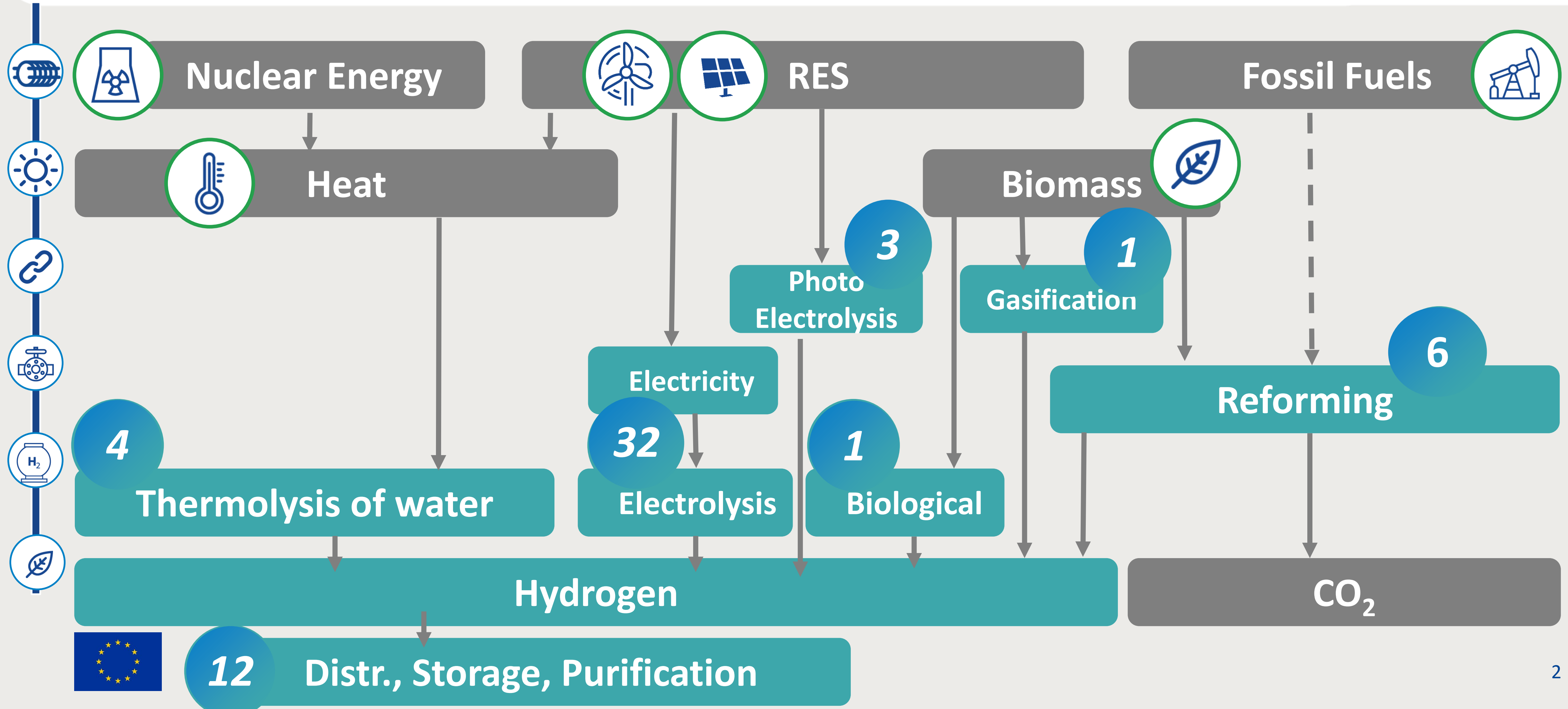
***Nikolaos
Lymperopoulos***

PRD 2019
19th November 2019



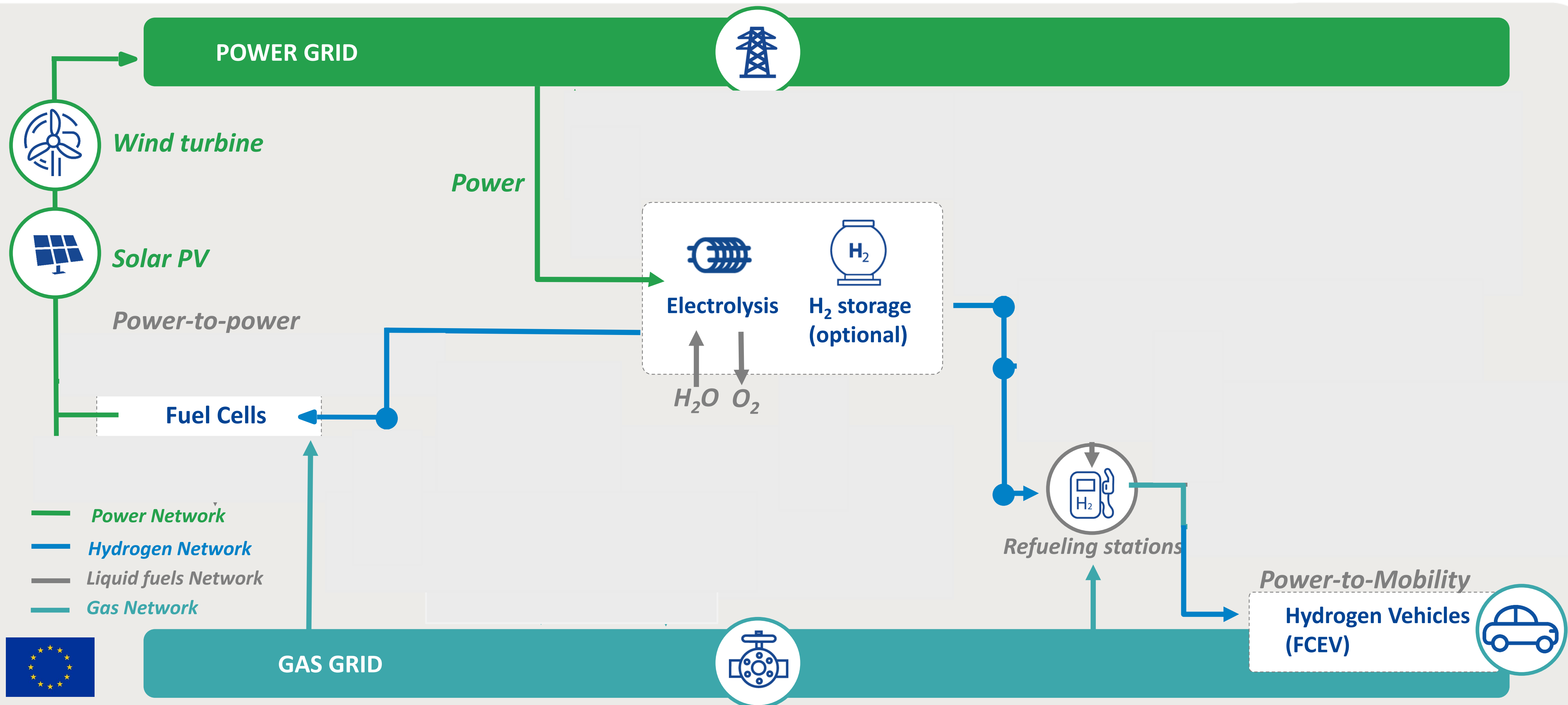
Hydrogen Production, Distribution & Storage Technical Coverage

95% of FCH JU support to green Hydrogen production



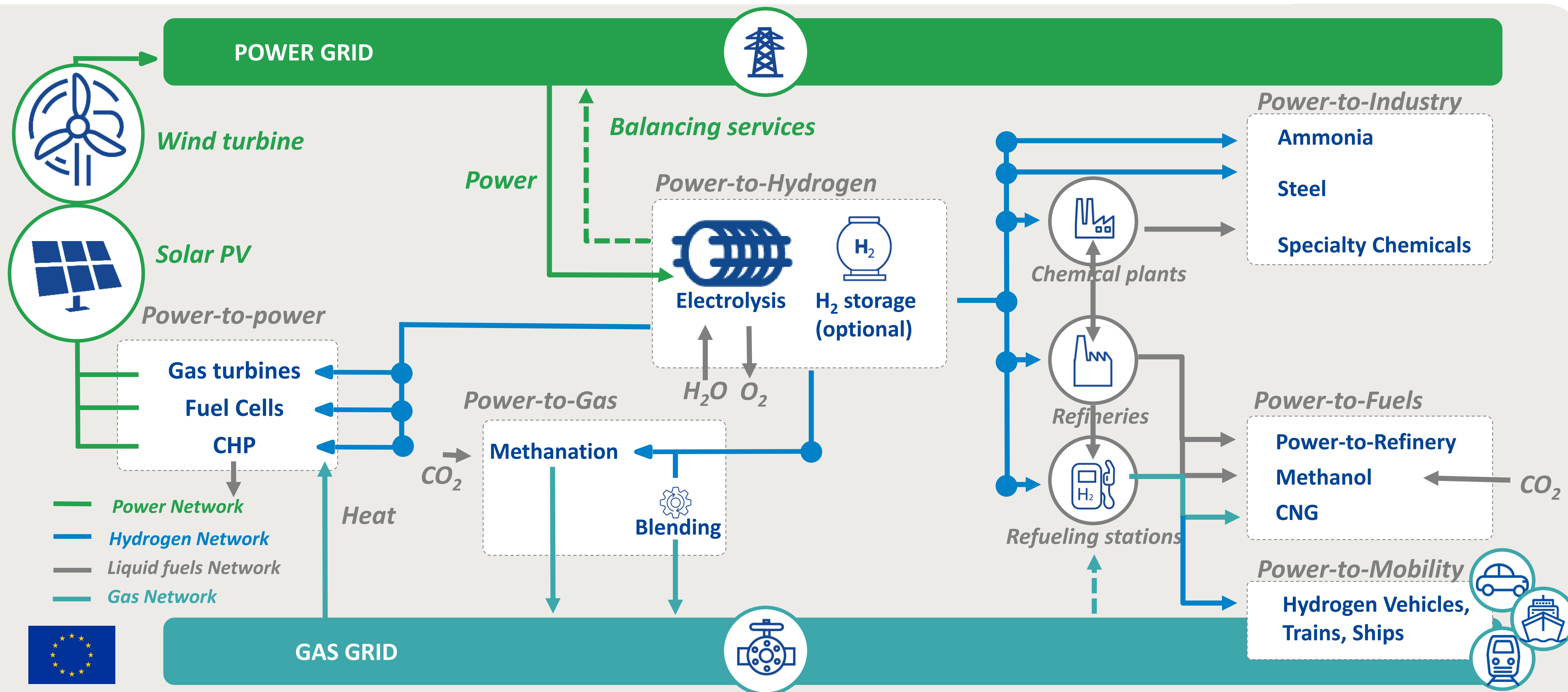
Early H₂ Production: a facilitator of FCs in Transport and Energy

P2P & FCEVs + “Where will the Hydrogen come from?”



Today's H₂ Production: enabler of Sectorial integration

H₂ is the best option for deep decarbonisation for a number of sectors

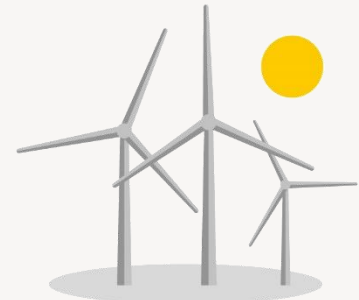


Hydrogen for Sectorial Integration

Well-positioned FCH JU objectives & budget

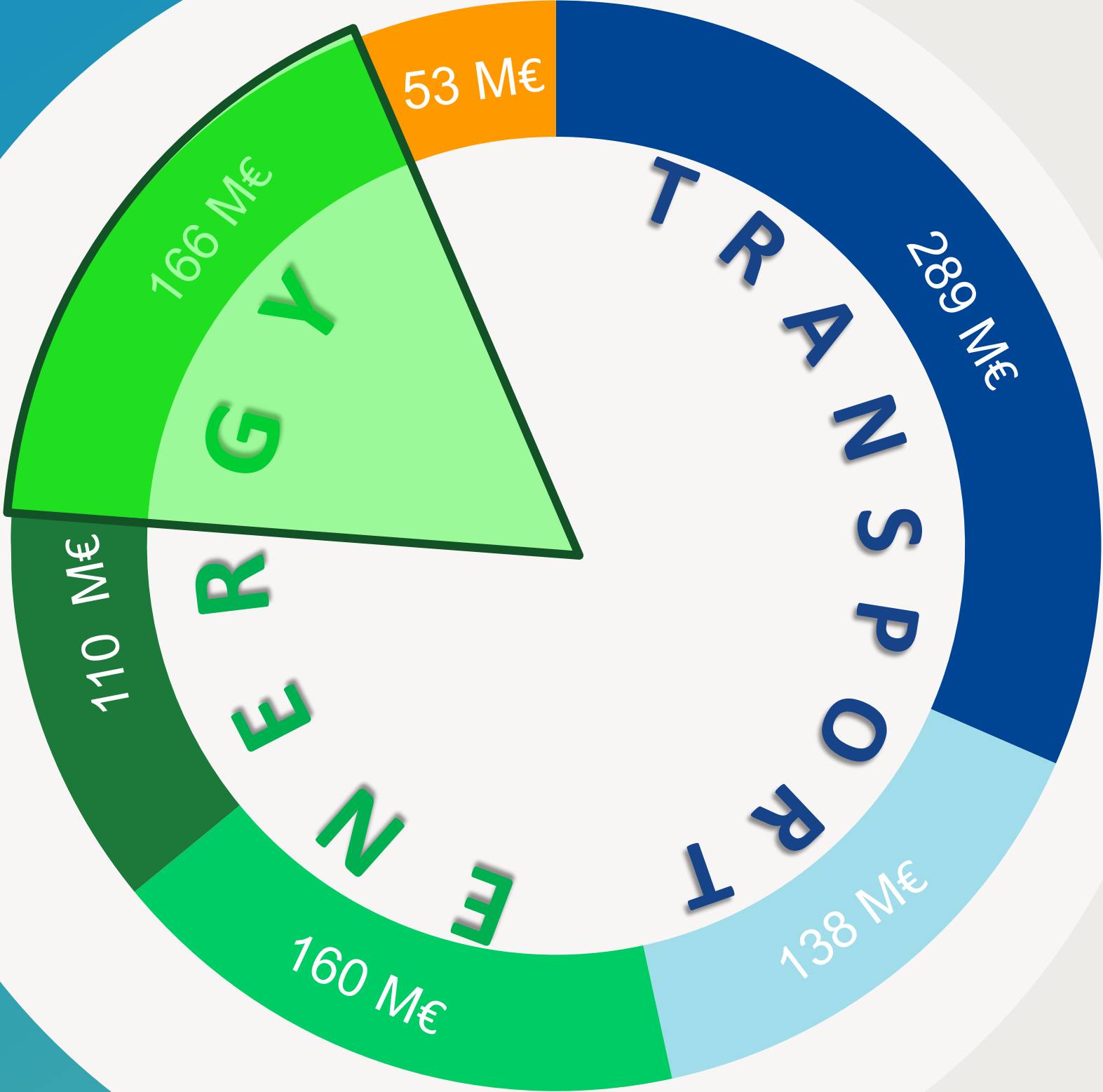


Related FCH JU Objectives

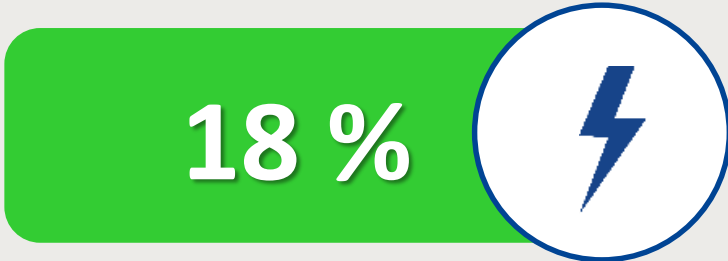


Increase efficiency and reduce costs of H₂ production, mainly from water electrolysis and renewables

Demonstrate on a large scale H₂'s capacity to harness power from renewables and support its integration into the energy system



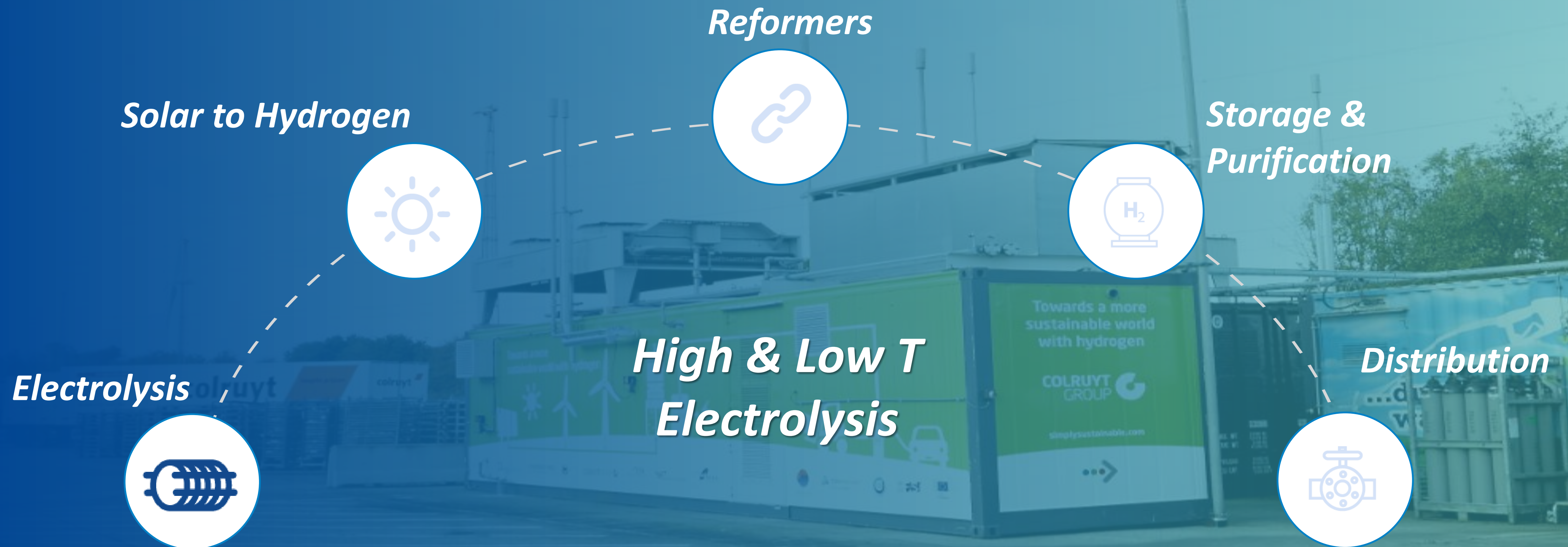
H₂ production, distribution & storage



166 M€

59 Projects





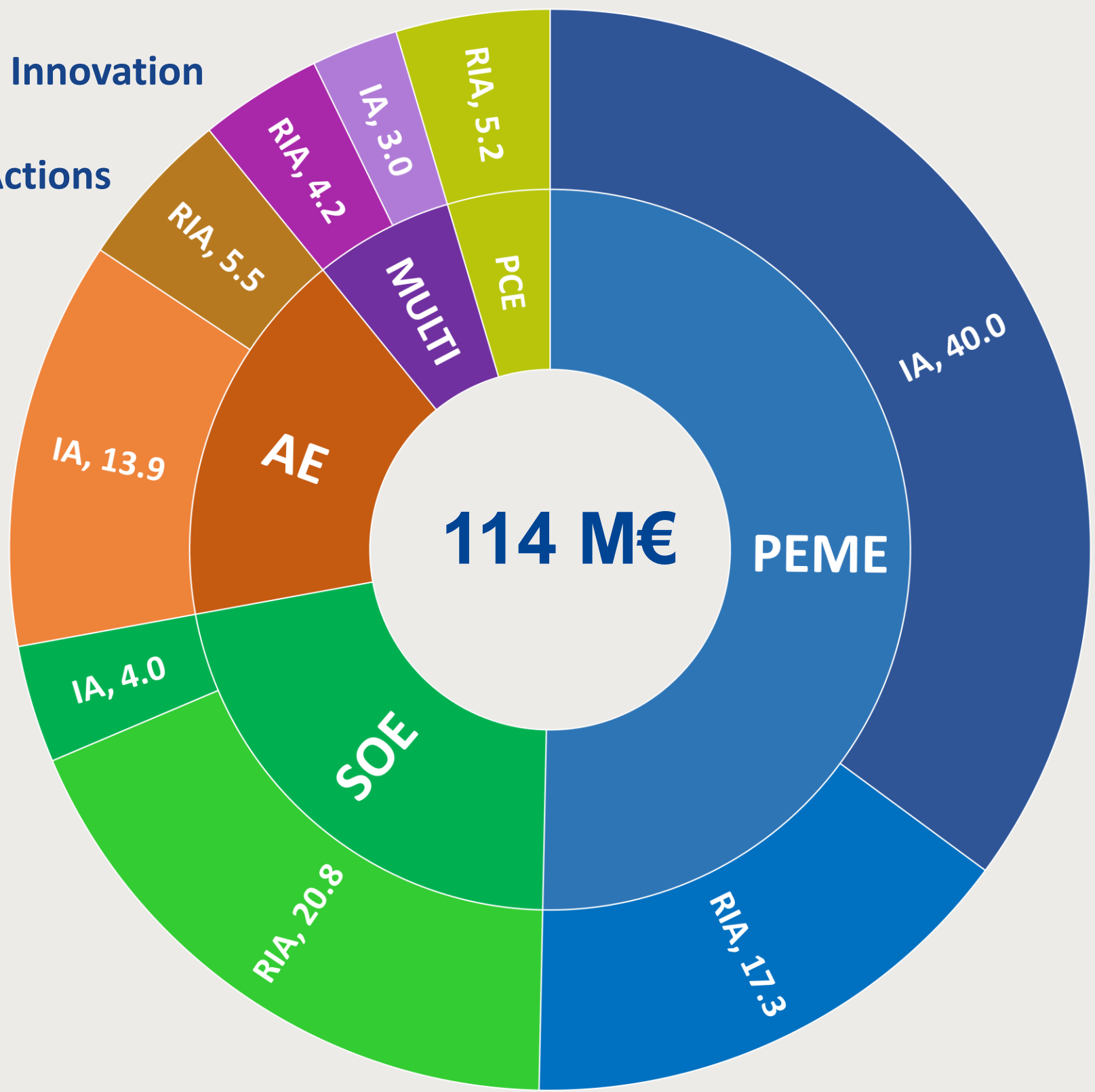
Electrolysis Research and Demonstration

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



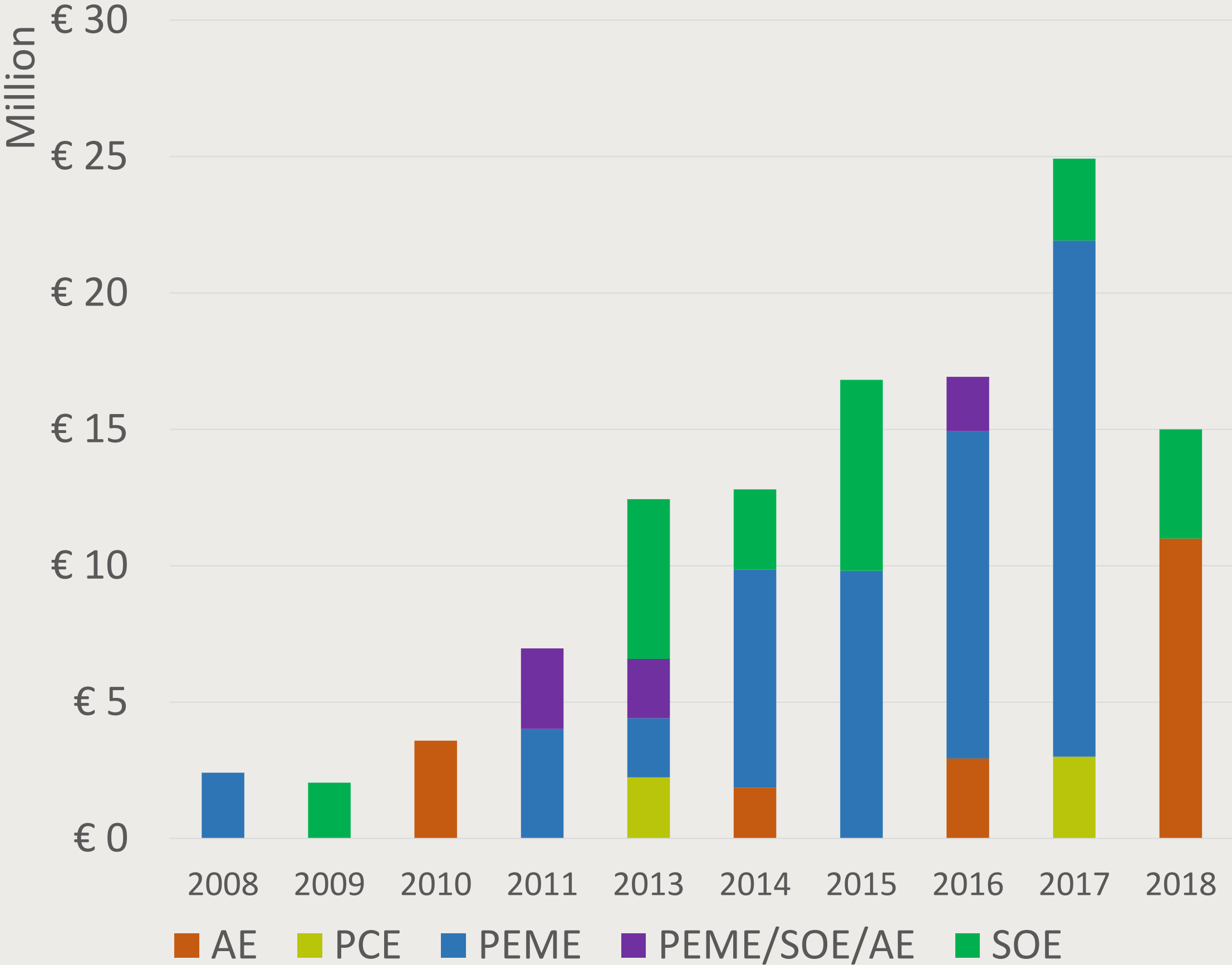
Electrolysers, M€ FCH JU support

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



32 Projects

FCH JU funding per technology



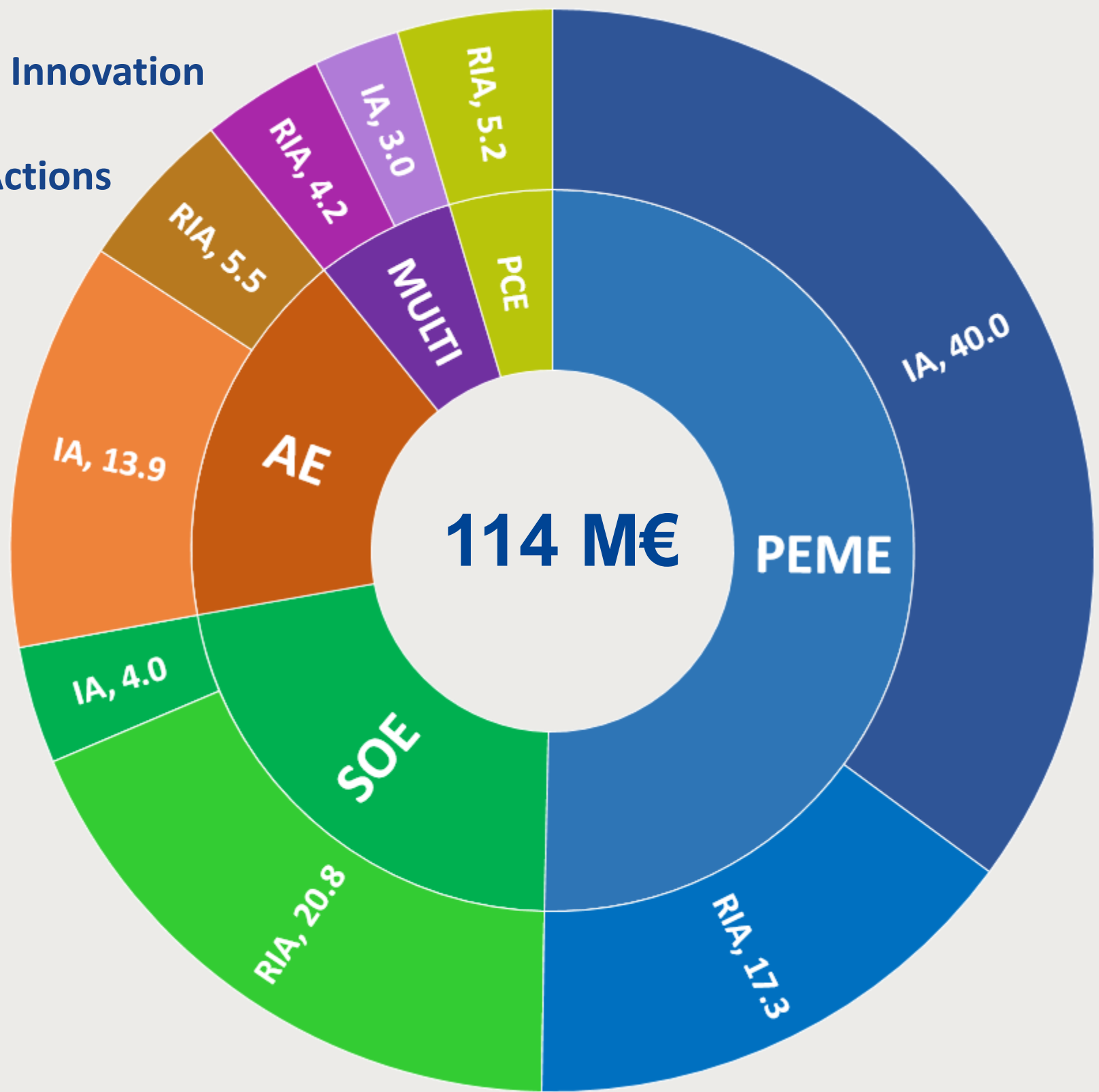
Electrolysis Research and Demonstration

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



Electrolysers, M€ FCH JU support

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



32 Projects



HRS



Steel industry

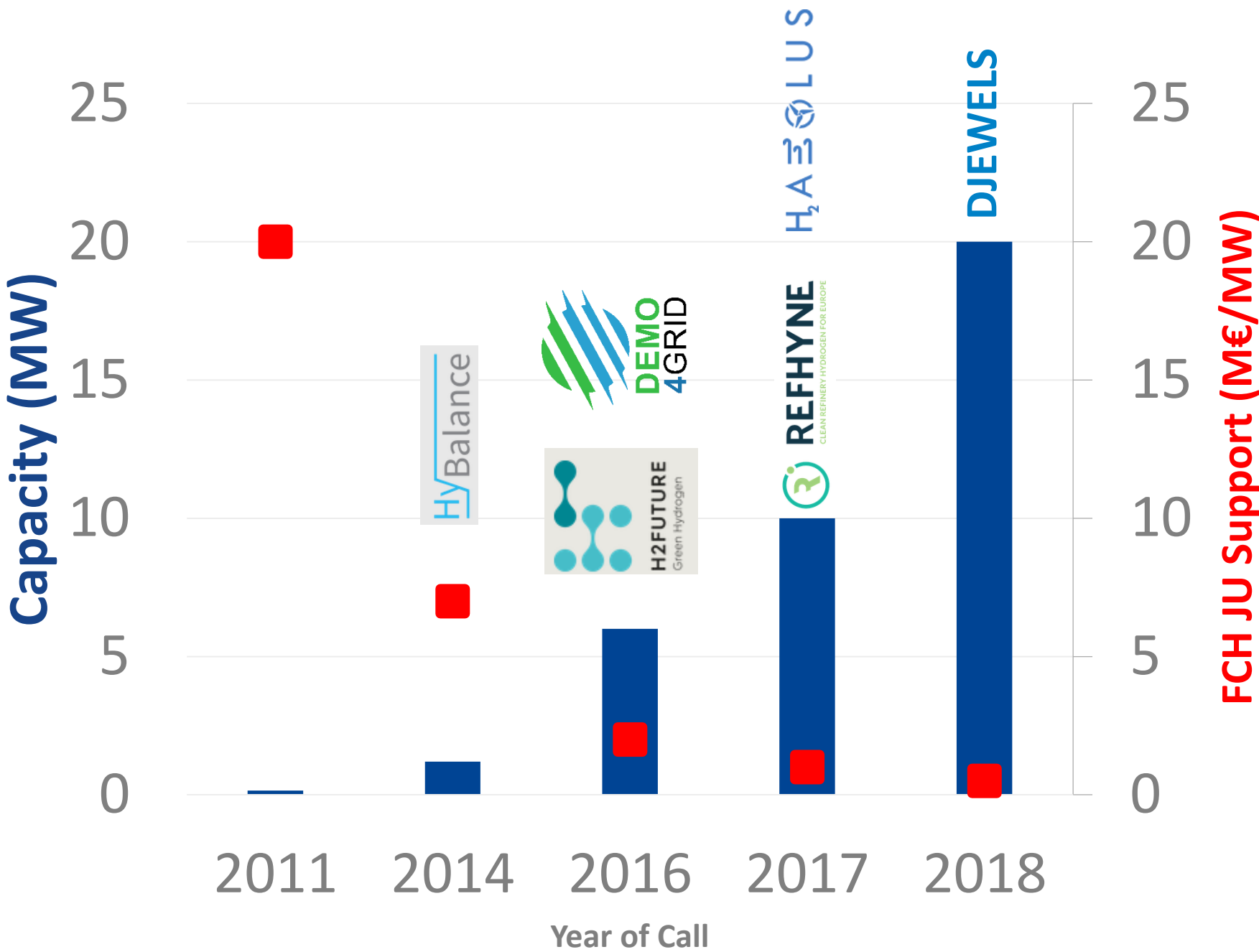


Refineries



Food
industry

Electrolyser Demo Projects

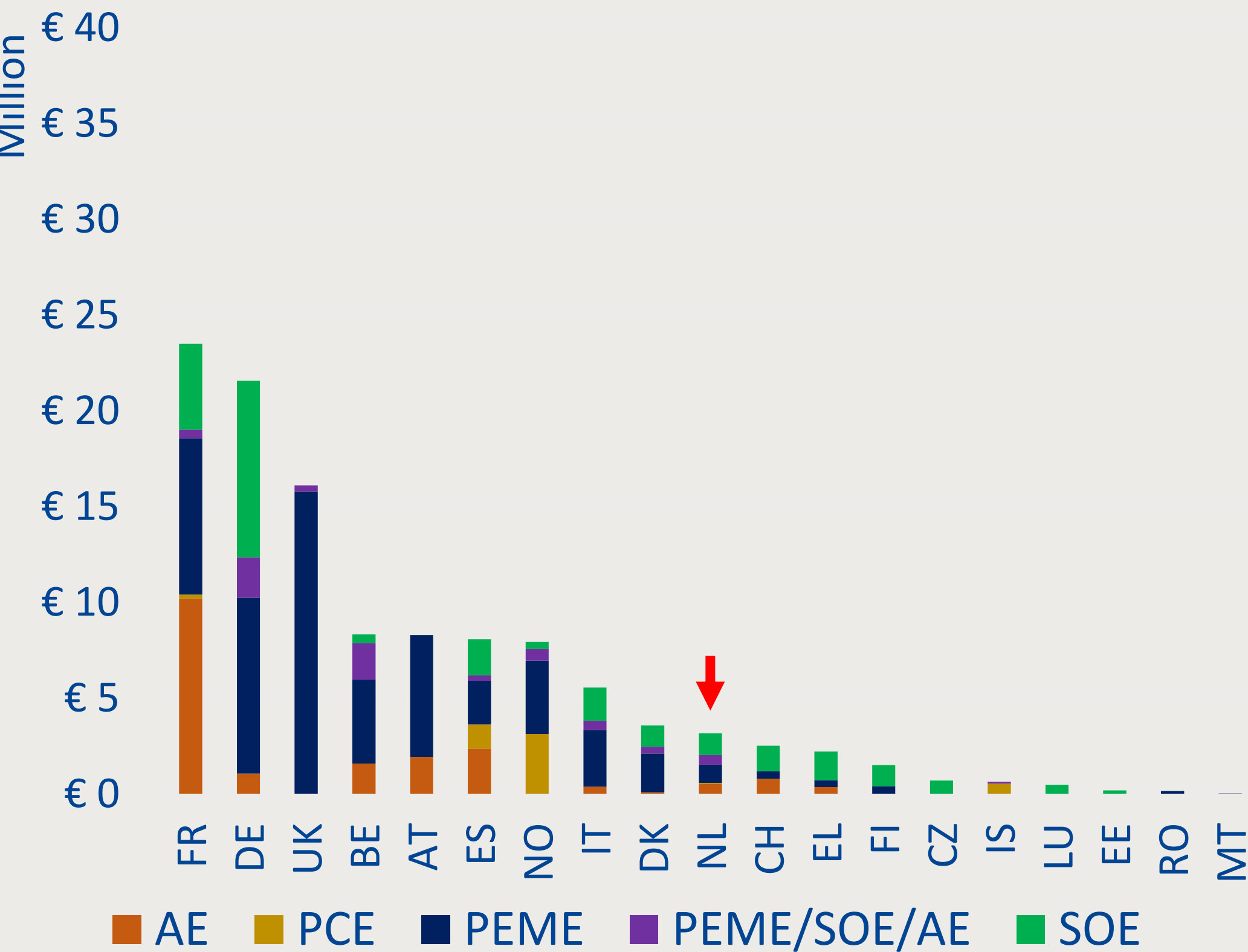


Electrolysis Research and Demonstration

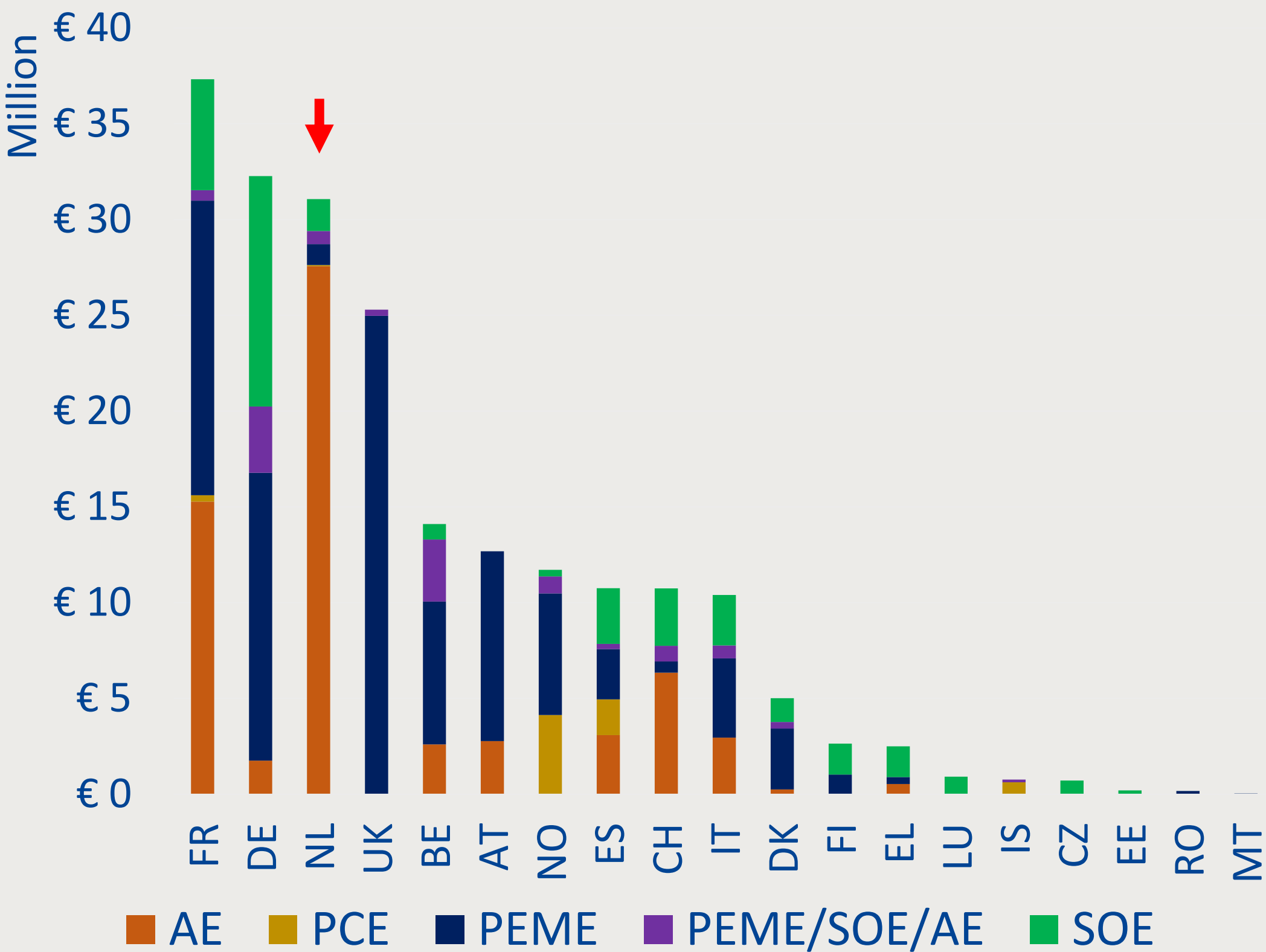
Support per country and type of beneficiary for electrolysis



FCH JU Funding by Beneficiary Country and Electrolyser Technology



Total Budget by Beneficiary Country and Electrolyser Technology



Safeguarding Europe's leading position in Low Temp electrolysis

Vibrant community of OEMs and R&D institutions

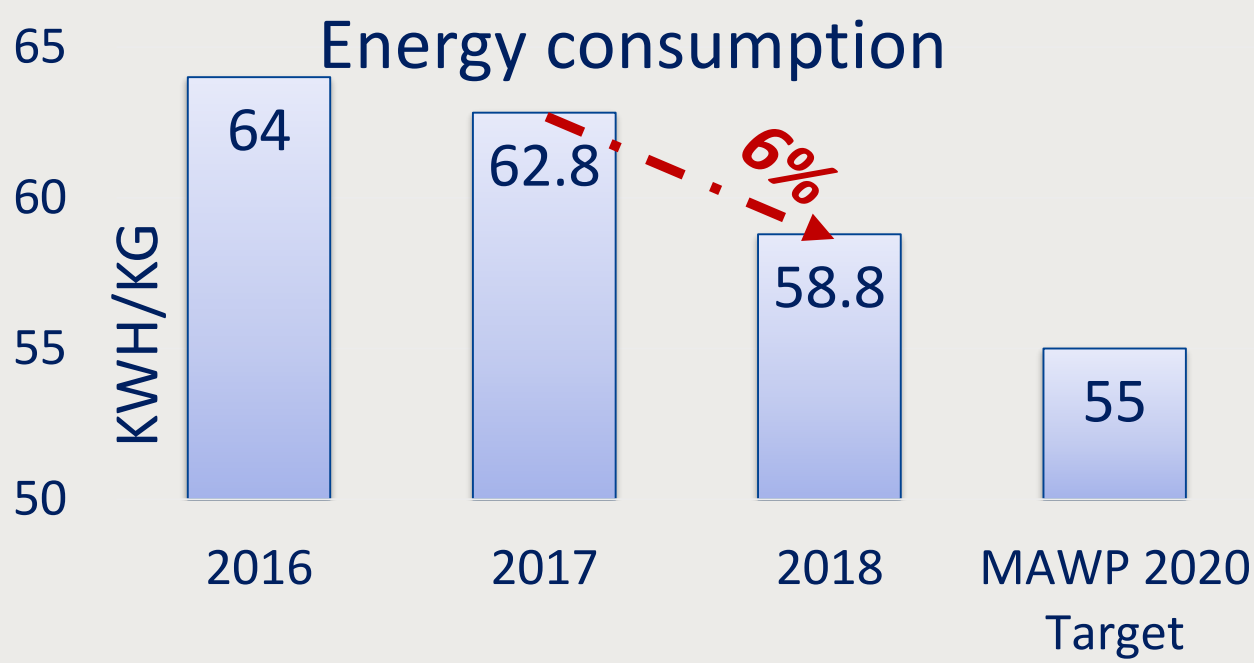
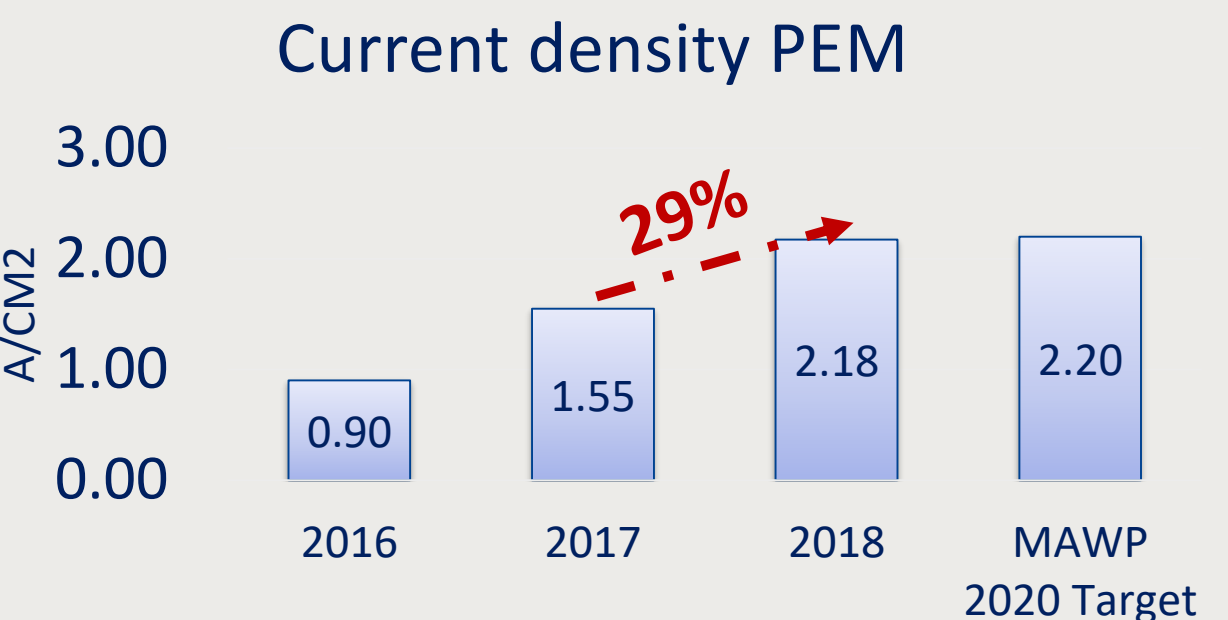


Capex targets for AE and PEME < 1.2 k€/kW

Current density > 3 A/cm²

Energy consumption @ system level < 55 kWh/kg

Dynamic op / Testing Harmo / Degradation / Diagnostics

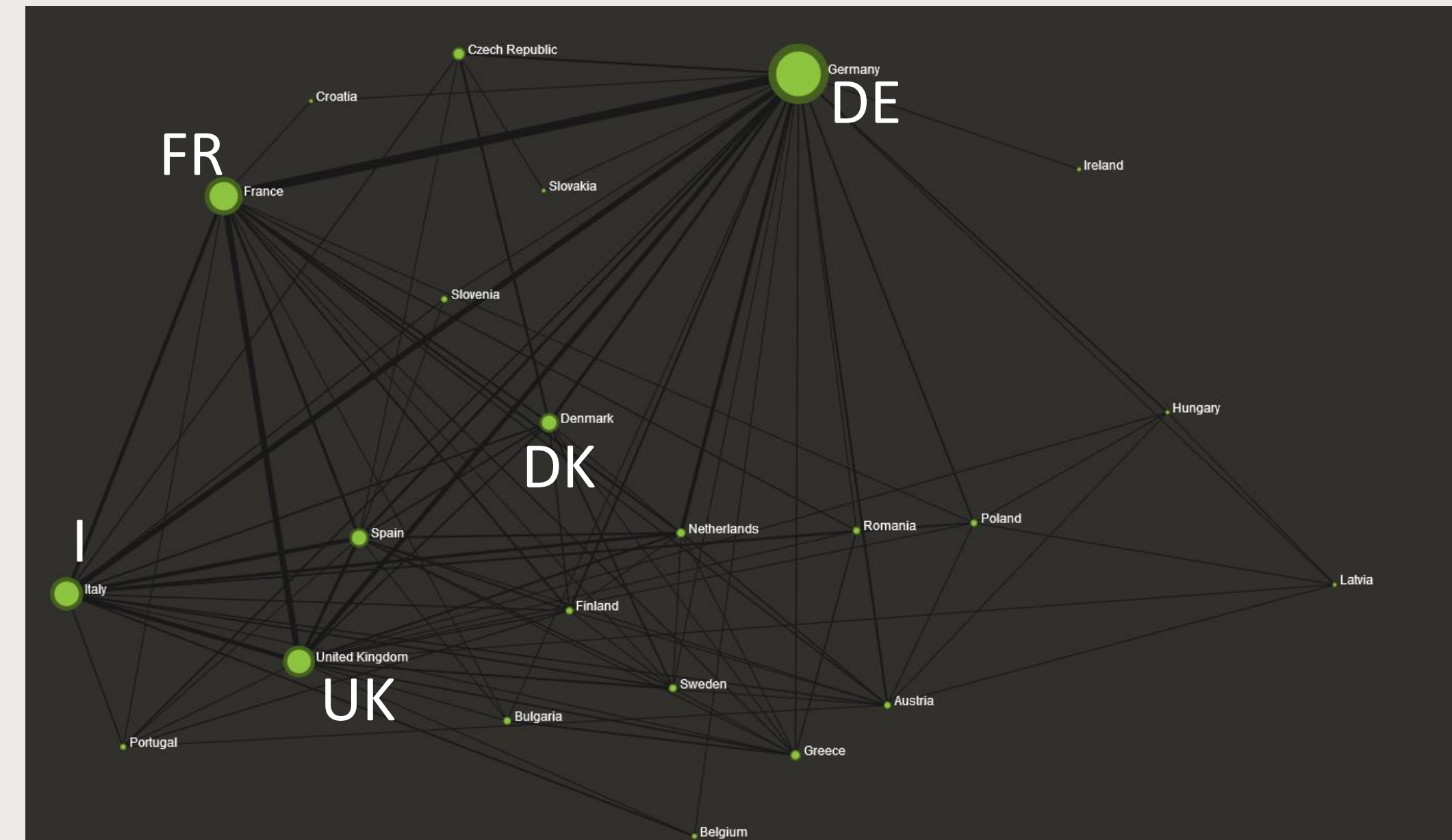


PEM electrolysis: Number of publications, patents, etc. 2004 - 2017

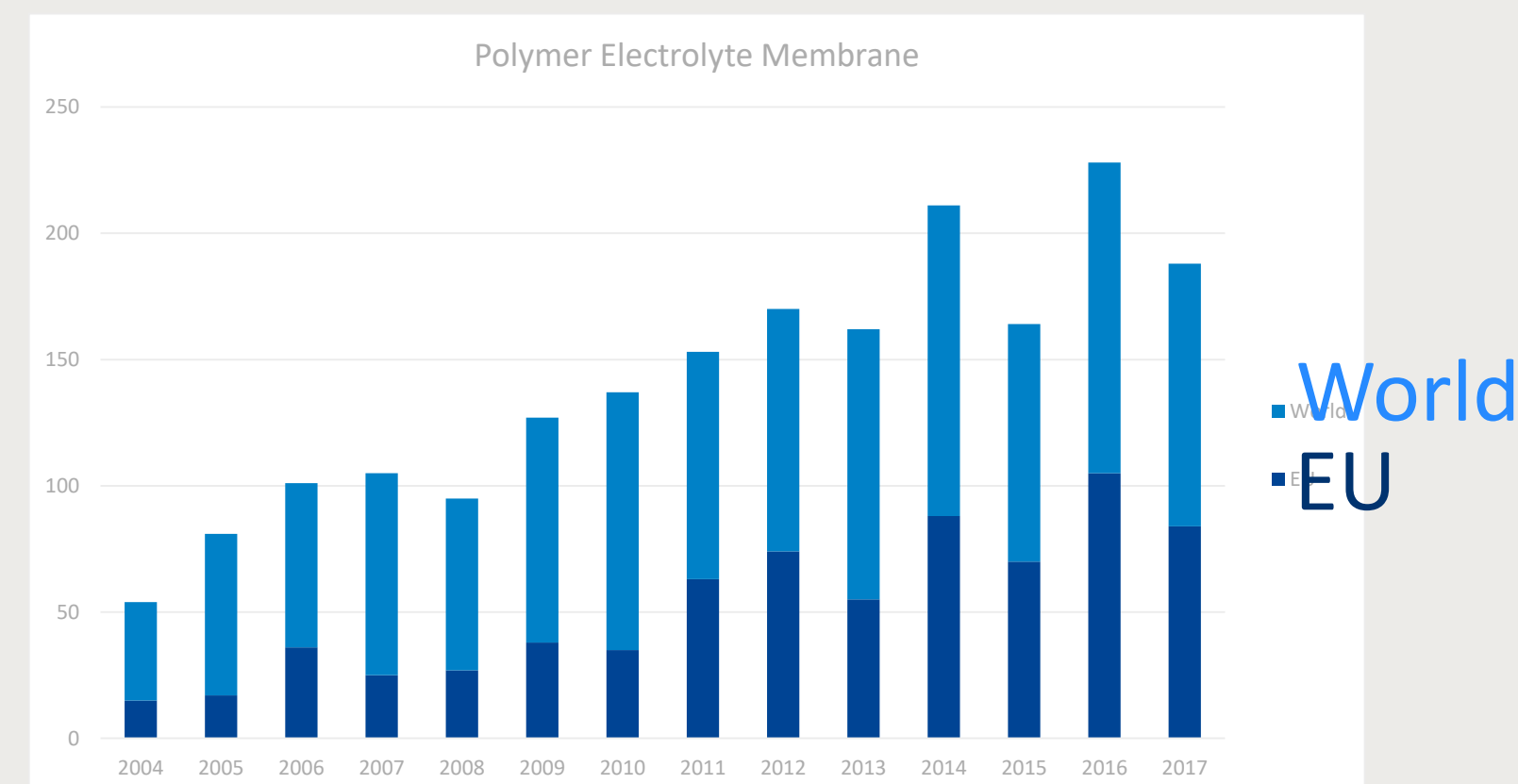
<https://fch.europa.eu/page/tools-innovation-monitoring-tim>



EU 823, US 430, China 270, JPN 193,
S. Korea 143



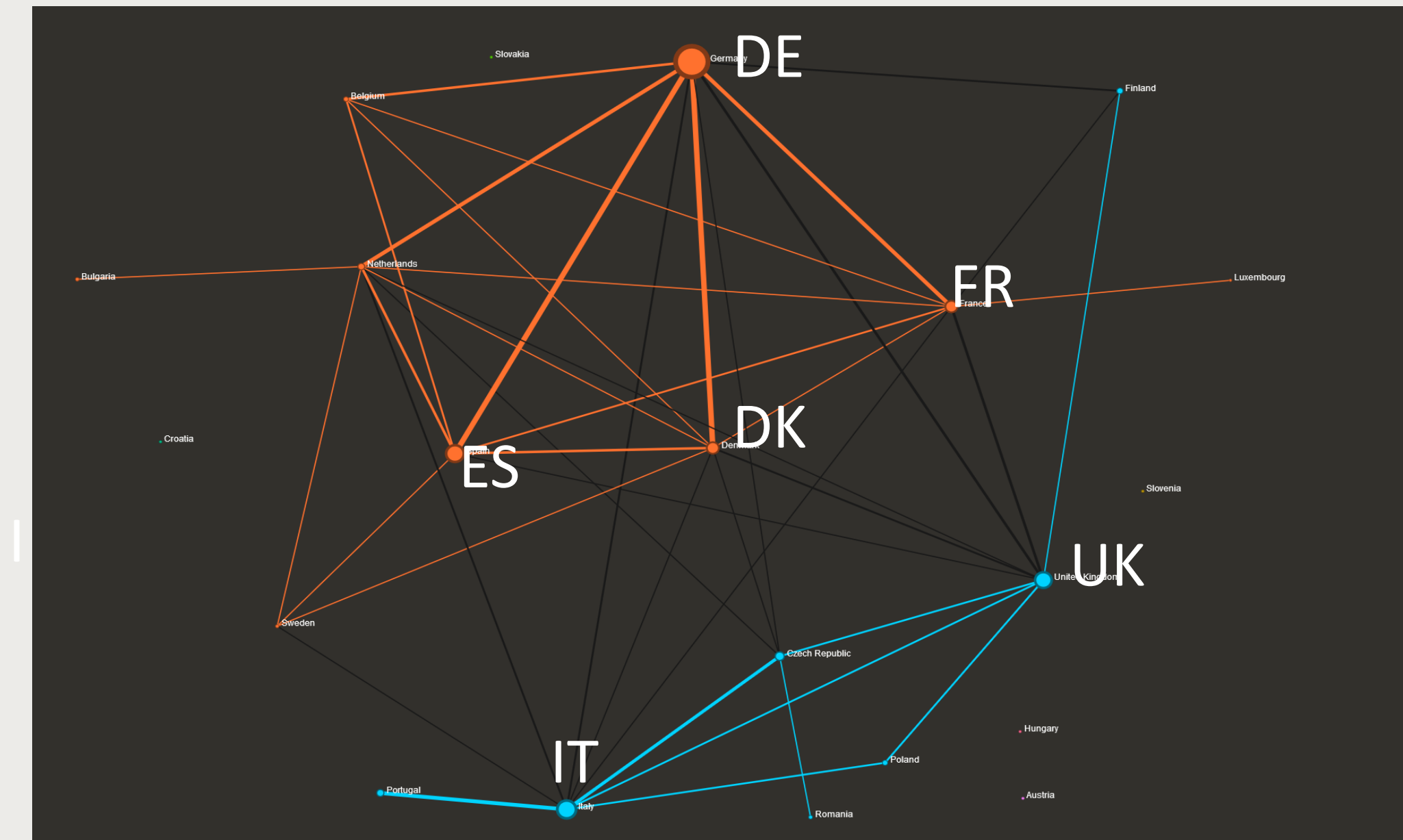
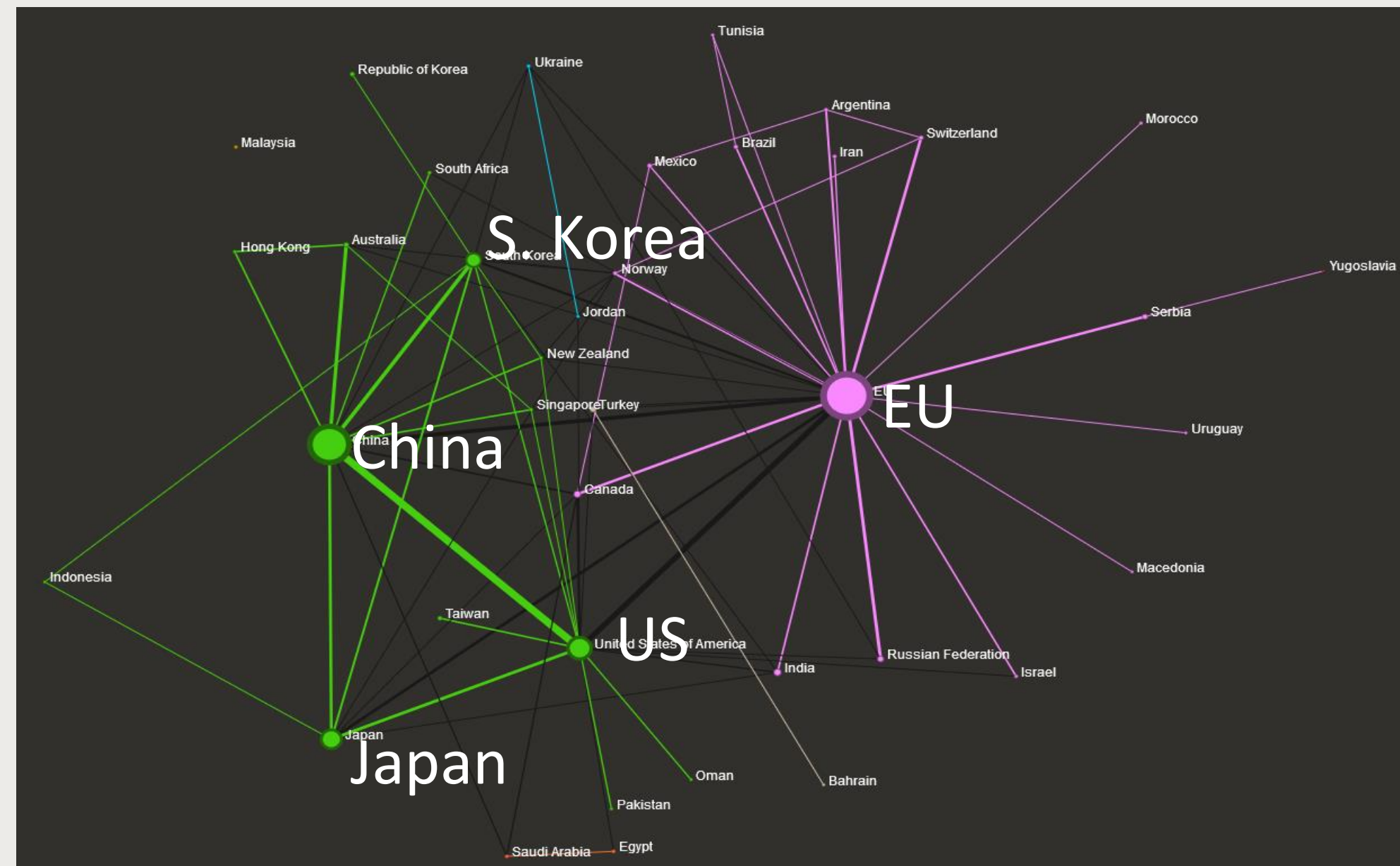
DE 224, FR 136, I 116, UK 111, DK 62



Alkaline electrolysis: Number of publications, patents, etc. 2004 - 2019

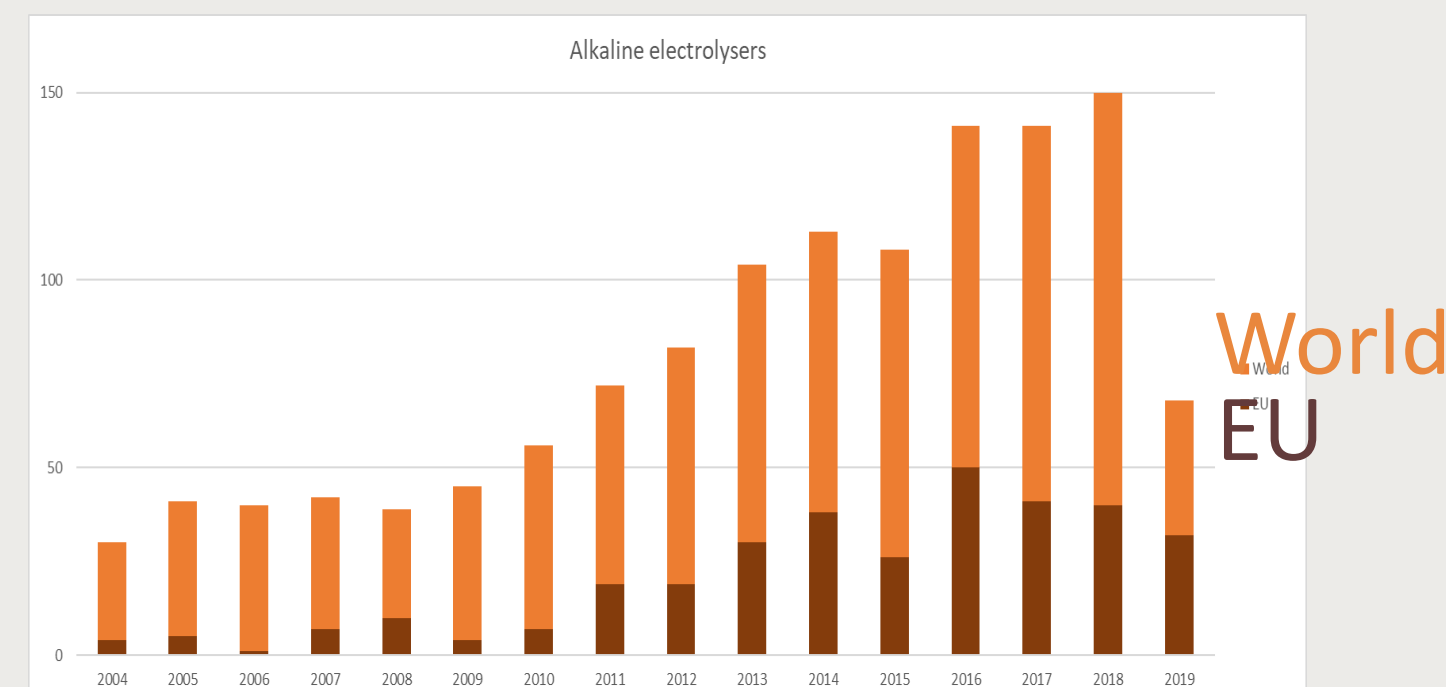


<https://fch.europa.eu/page/tools-innovation-monitoring-tim>



EU: 333, China: 277, USA: 155,
Japan: 131, South Korea: 90

DE: 84, IT: 46, ES: 43, UK : 40, FR 28,
DK :28, CZ : 19






European leadership in High Temp electrolyzers

Highest capacities & innovative concepts

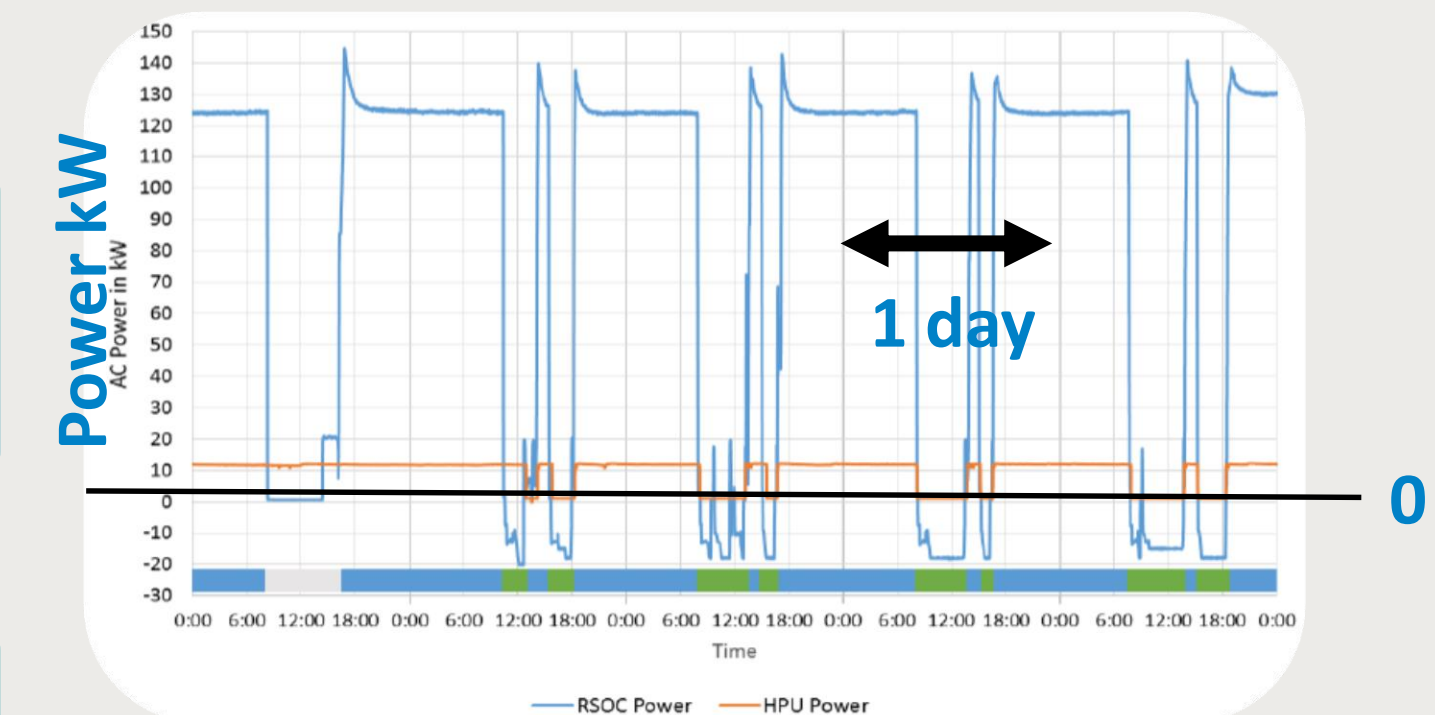


 Electricity consumption < 40 kWh/kg 

 Production loss rate < 1.9%/1000h 

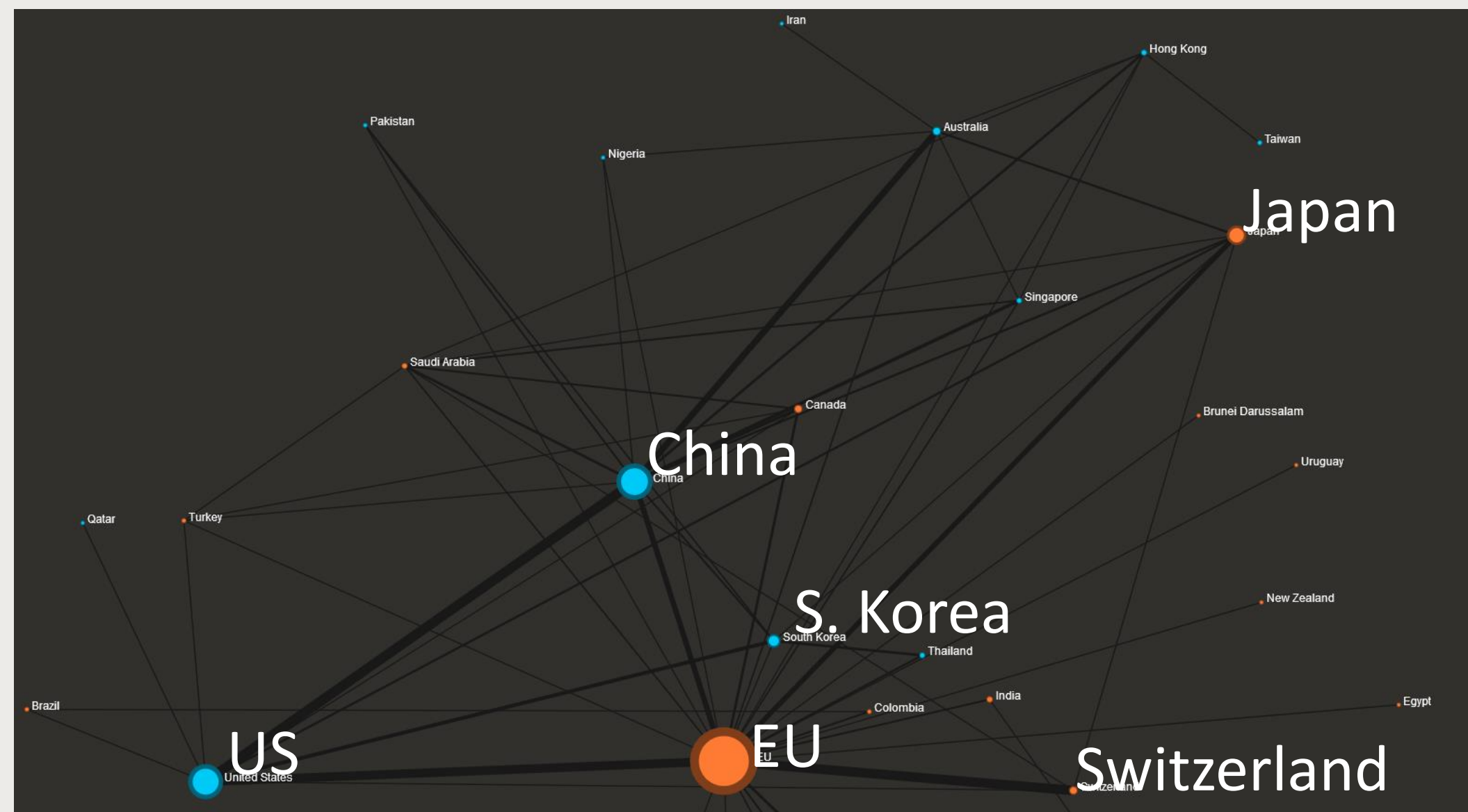
 Availability >95%, reversible FC efficiency 54% 

 Integrated methanation/ Co-electrolysis / 10 bar 

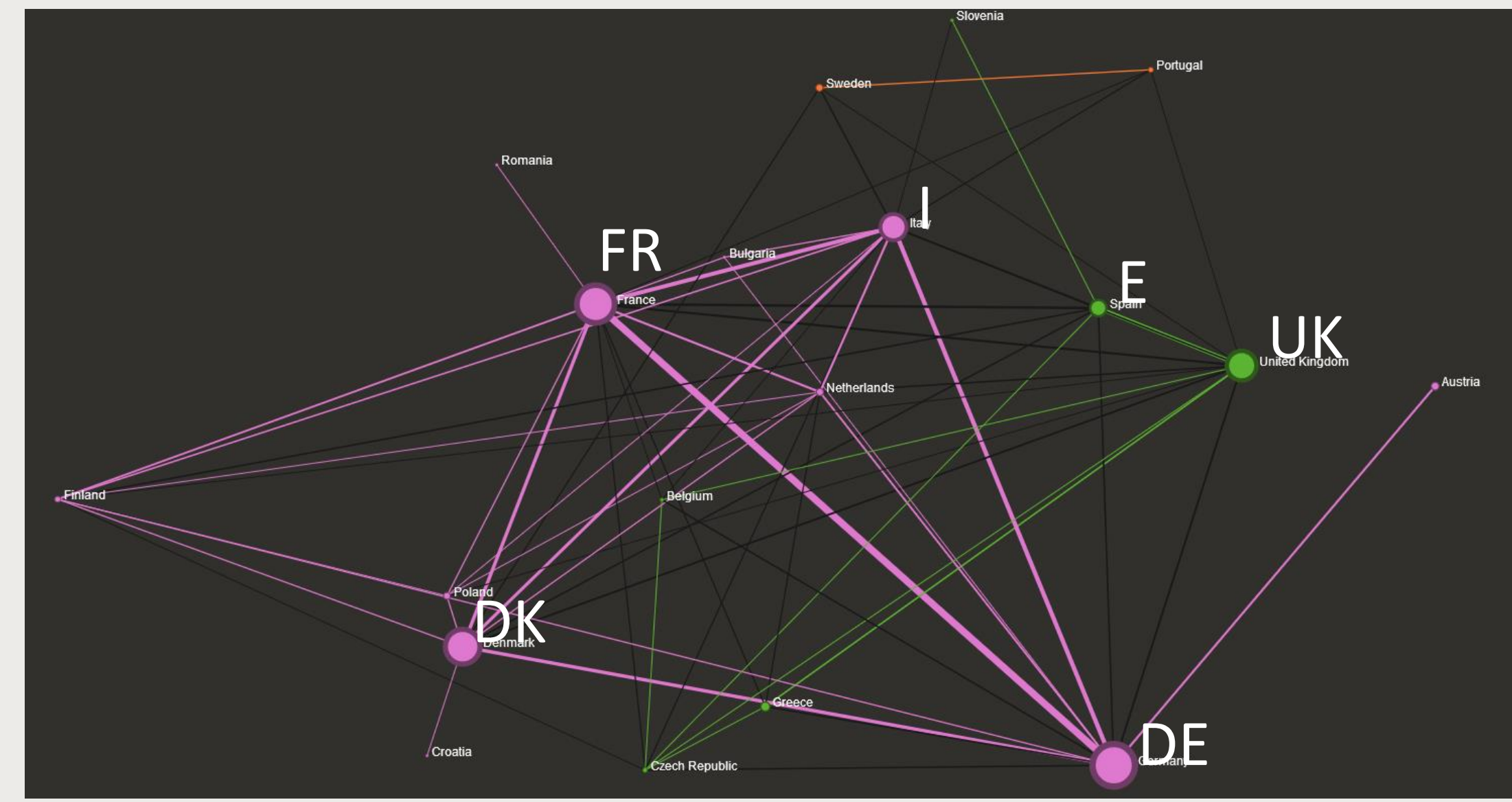


SOE electrolysis: Number of publications, patents, etc. 2004 - 2017

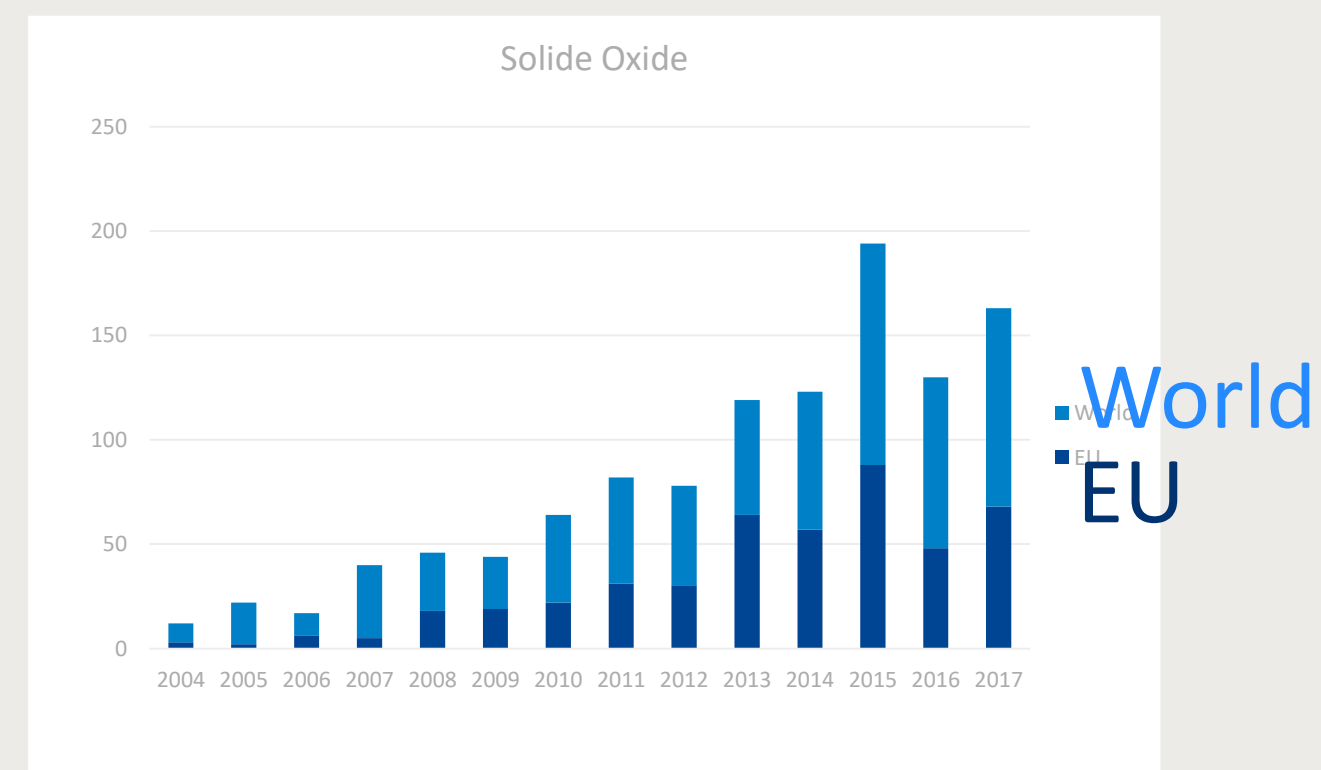
<https://fch.europa.eu/page/tools-innovation-monitoring-tim>



EU 508, China 255, US 246, JPN 121, S. Korea 74



DE 117, FR 103, DK 94, UK 79, I 69, E 40



Support to electrolyzers beyond projects

Actions facilitating the market entry of electrolyzers

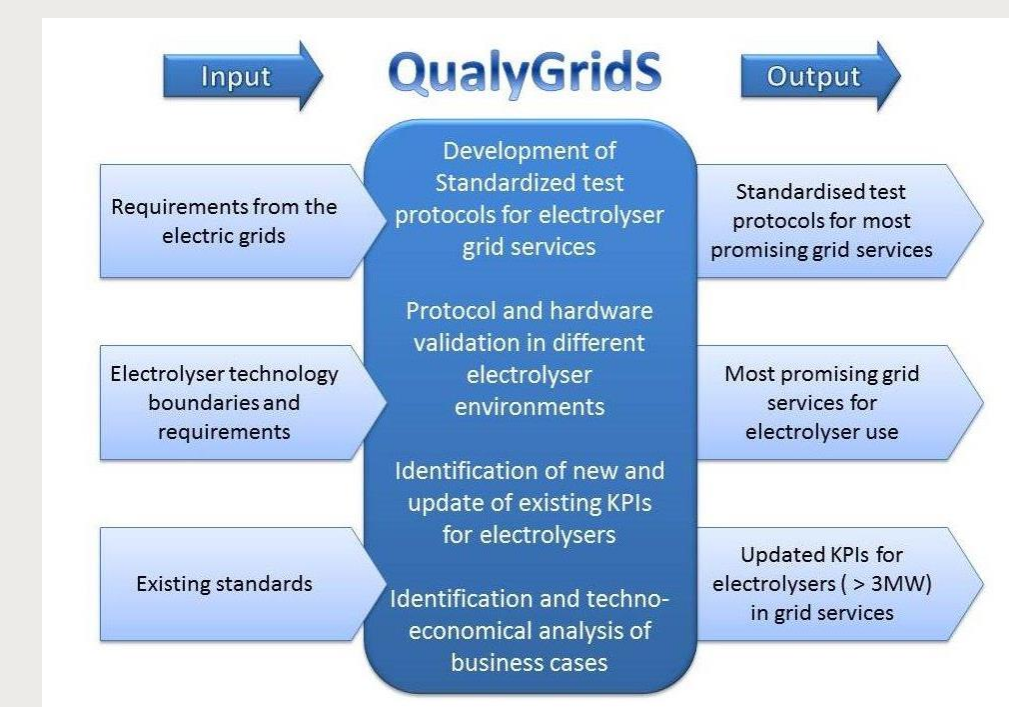
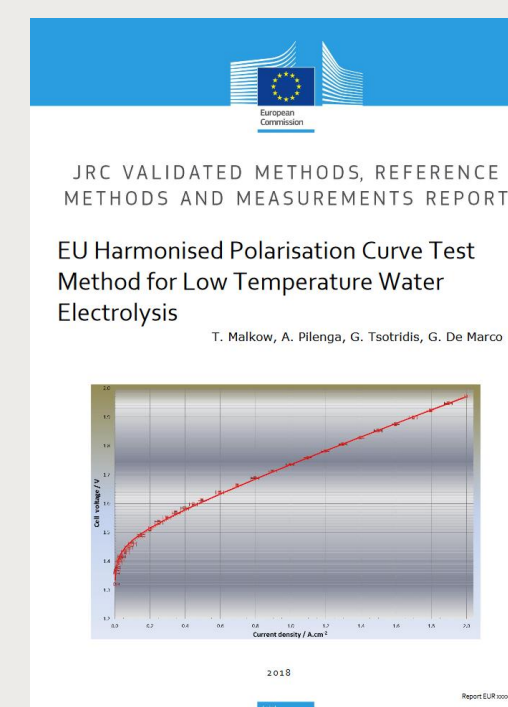
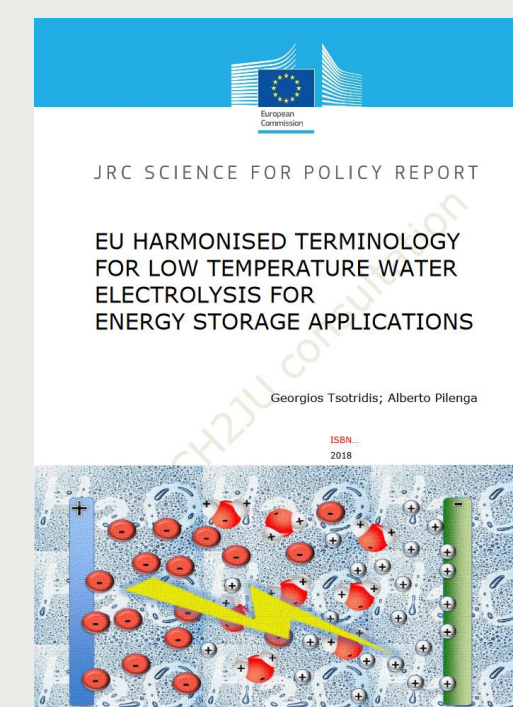


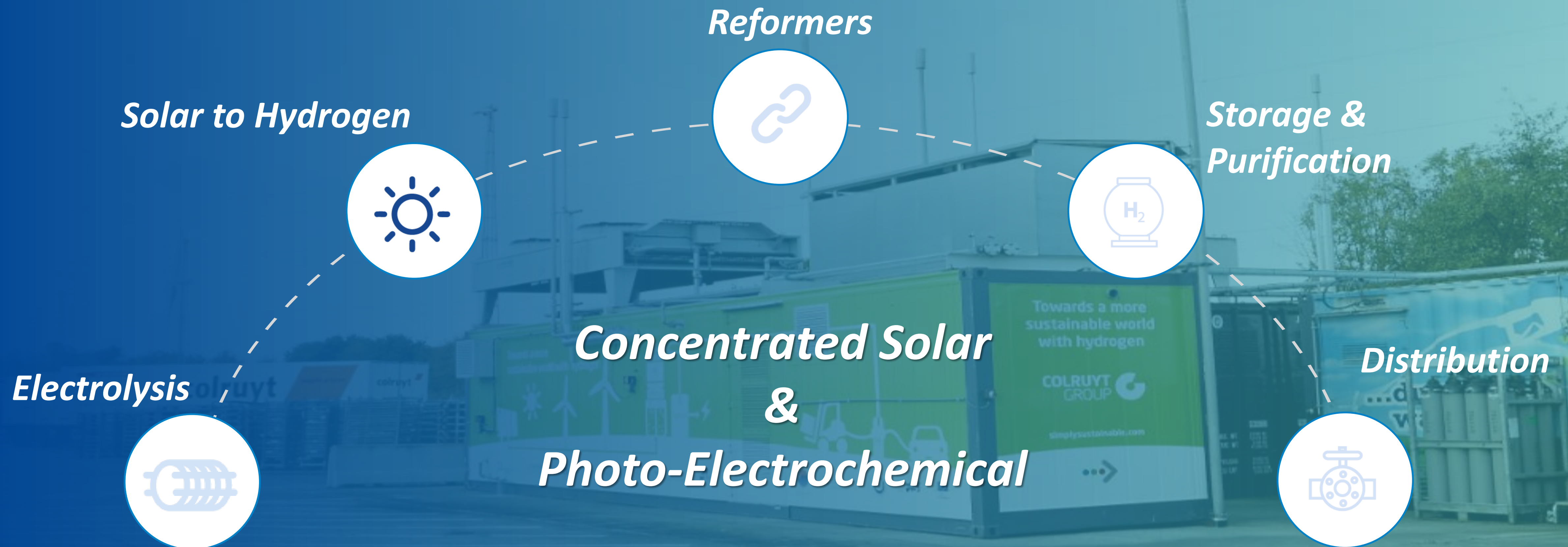
Studies, e.g. Opportunities arising from the inclusion of H₂ in NECPs

Developing an EU wide Guarantees of Origin Scheme for Hydrogen



Harmonisation of electrolyser Testing Protocols





Concentrated solar demonstrated in the field

Redox and HyS cycles supported



Solar Thermal capacity 0.75 MW



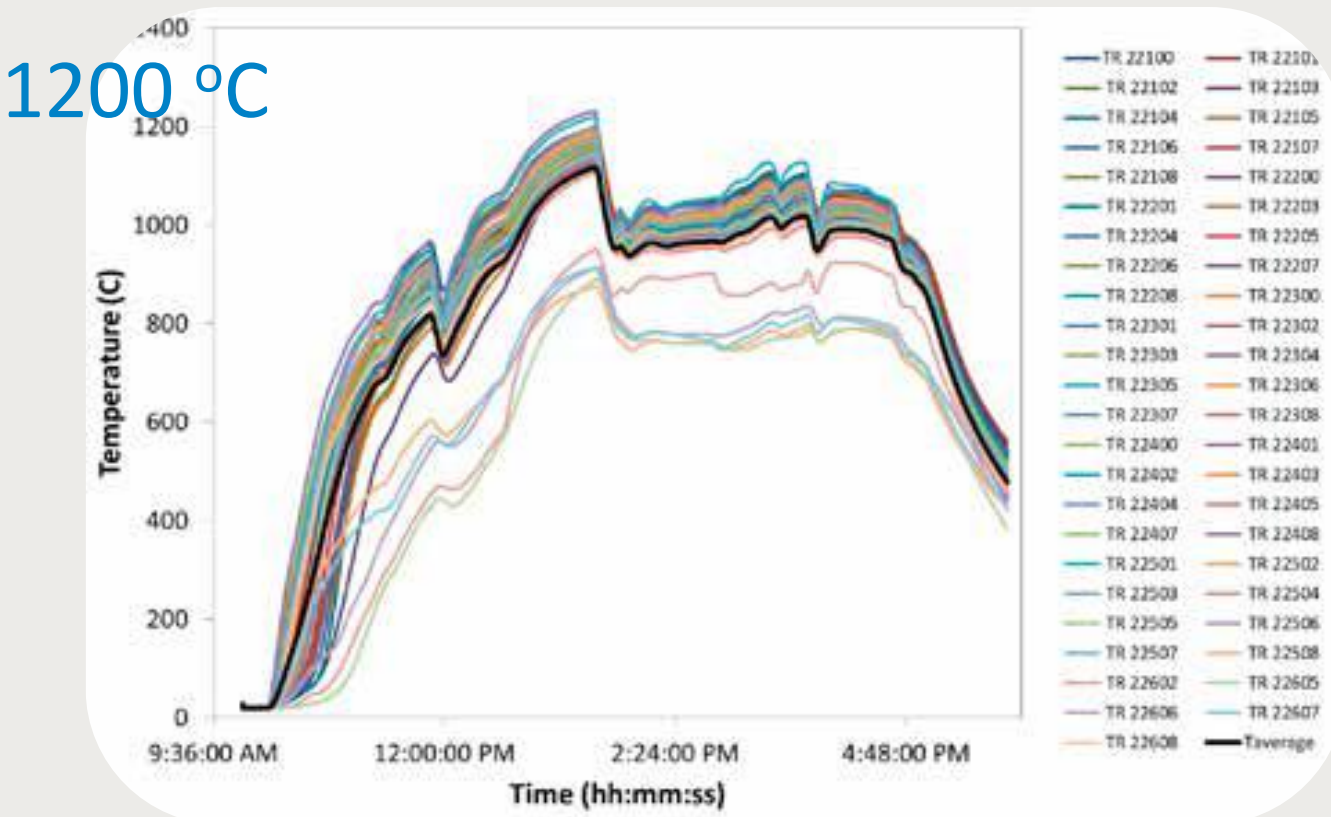
Material lifetime > 1,000 hr



H₂ production capacity < 3kg/week



Recovery of high temp heat, stability, cyclability





PhotoElectroChemical devices: moving to practical sizes

High efficiencies at specimen scale; challenges at scaling up and “under sun” operation



 Lab: 12.8% 

 Lab: 1,000 hours for Fe_2O_3 photo-anodes 

 4x50cm² done; working on 100 cm², aiming for 10m² 

 9 €/kg estimated for house system with η 8%





Compact reformers

Green hydrogen from raw biogas



Various biofuels, capacities 3 -300kg/day



Biogas without CO₂ prior removal



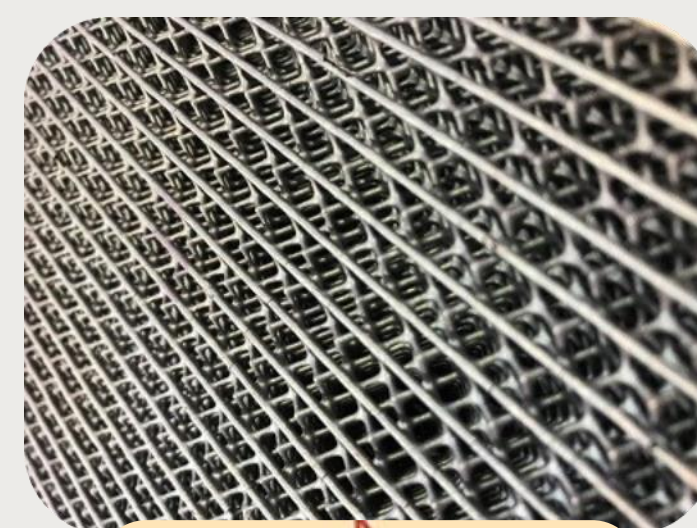
100kg/day H₂



conversion $\eta = 71.5\%$



4.8 €/kg demonstrated @ landfill site





Efficient separation / purification of H₂

Preparing for Hythane, underground storage, H₂ as byproduct



 Hydrogen recovery rate > 90% 

 H₂ recovery using Pd membranes < 5kWh/kgH₂ 

 Cost of purified H₂ < 1.5 €/kg 

 5-25 kg H₂/day, H₂ delivery @ 200 bar 



MEMPHYS

Efficient Distribution of H₂

Liquid Organic carriers



Hydrogen capacity of tube trailer >1,000kg



Cost of tube trailer < 350 €/kg



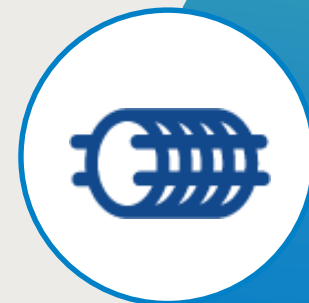
H₂ purity ISO 14687:2



Summary



Electrolysers: key enabler technology for Sectorial integration, Energy storage, Decarbonizing industry & the gas grid



Electrolysers: EU leadership but further work is required for cost reduction, improved efficiency, operation in specialised environments



Alternative routes for green H₂ production, H₂ storage and purification enjoying equivalent support



Green Hydrogen for sectoral integration expected to play a major role in the 2030 - 2050 Energy Strategy



FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

Nikolaos Lymperopoulos

Project Officer
Nikolaos.Lymperopoulos@fch.europa.eu

For further information

www.fch.europa.eu



@fch_ju



Fch-ju@fch.europa.eu



FCH JU