FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

FCH JU
Support to Electrolysis in view of 2050 Decarbonisation Targets

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ETIP Wind Workshop

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Strong public-private partnership with a focused objective

EU Institutional Public-Private Partnership (IPPP)

Fuel Cells & Hydrogen Joint Undertaking (FCH 2 JU)

To implement an *optimal research and innovation programme* to bring FCH technologies to the point of market readiness by 2020

FCH JU programme implementation

Energy

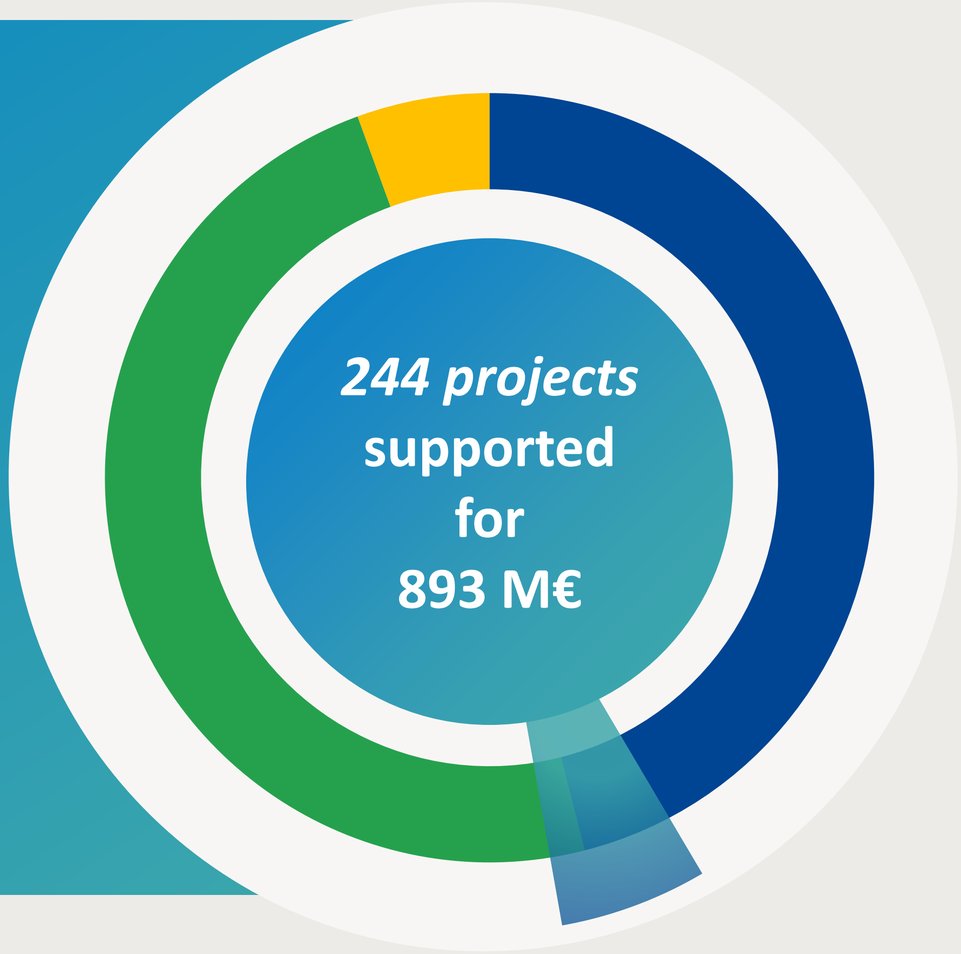
- Hydrogen production and distribution
- Hydrogen storage for renewable energy integration
- Fuel cells for power & combined heat & power generation

Transport

- Road vehicles
- Non-road vehicles and machinery
- Refuelling infrastructure
- Maritime rail and aviation applications

Cross-cutting

- E.g. standards, safety, education, consumer awareness …



47 %

418 million euro

135 projects

42 %

376 million euro

65 projects

6 %

53 million euro

40 projects

5 %

46 million euros

4 projects

Similar leverage of other sources of funding: 892 M€

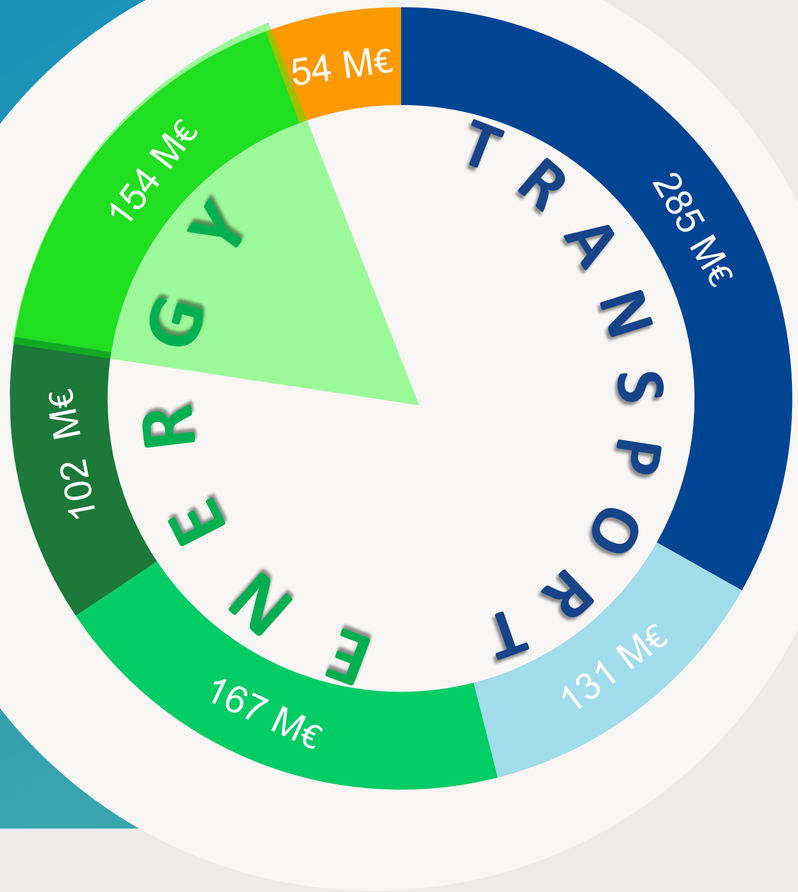
Hydrogen for Sectorial Integration

Well-positioned FCH JU objectives & budget

Related FCH JU Objectives

Increase efficiency and reduce costs of H_2 production, mainly from water electrolysis and renewables

Demonstrate on a large scale H_2's capacity to harness power from renewables and support its integration into the energy system



H_2 production, distribution & storage

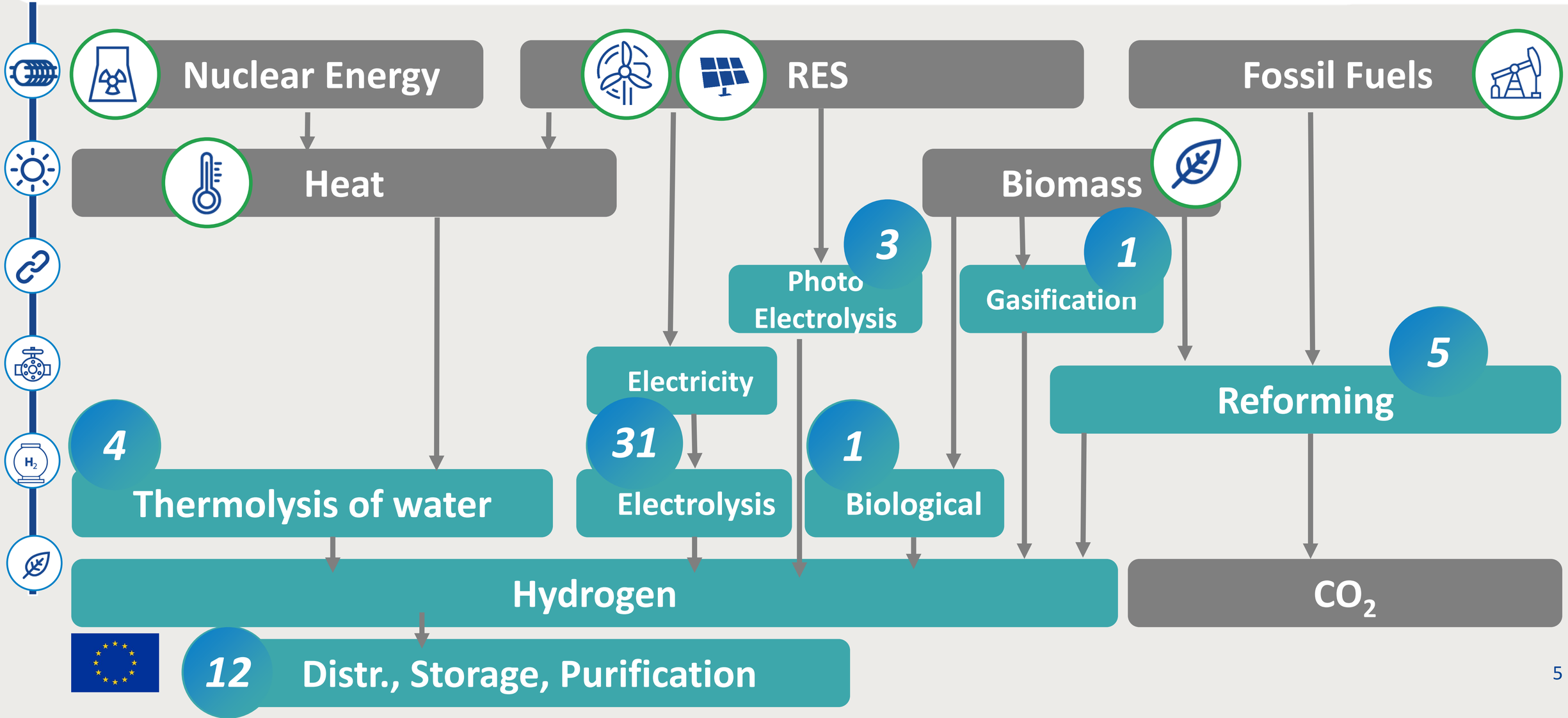
17.2%

154 M€

57 Projects

Hydrogen Production Technical Coverage

95% of FCH JU support to green Hydrogen production

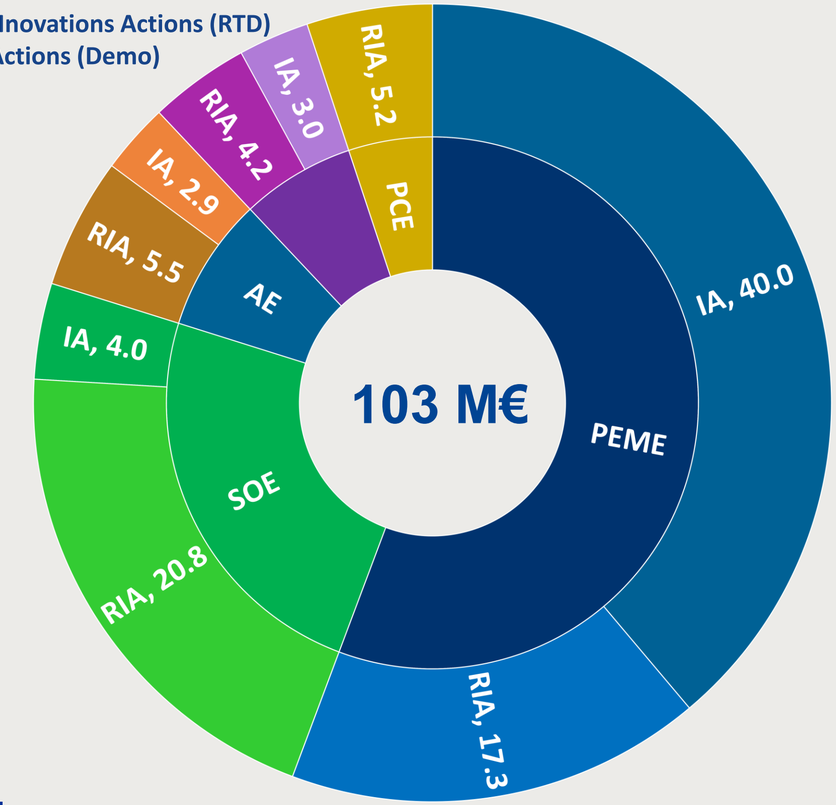


Electrolysis Research and Demonstration

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

Electrolysers, M€ FCH JU support

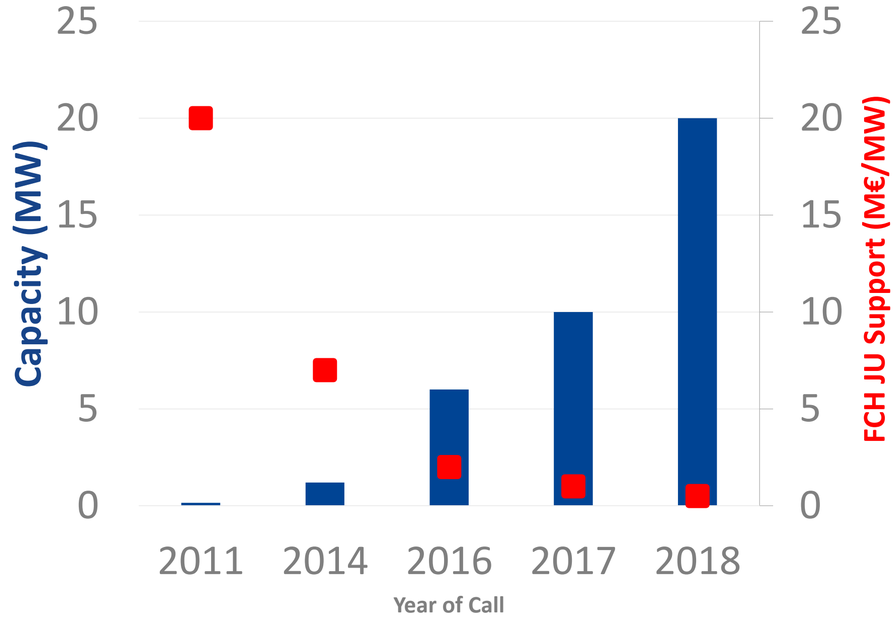
RIA: Research & Inovations Actions (RTD)
IA: Innovations Actions (Demo)



31 Projects

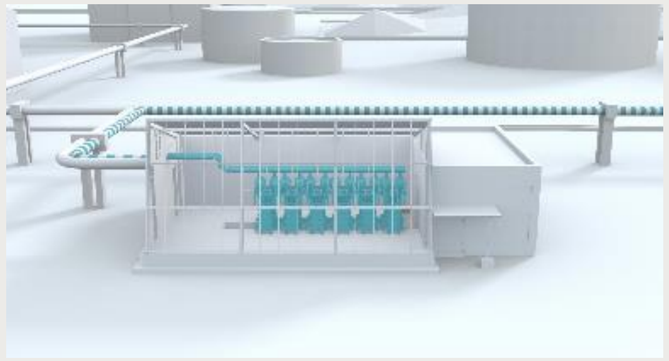
HRS *Steel industry* *Refineries* *Food industry*

Electrolyser Demo Projects



2016: Greening the Steel Industry

The H2Future Project: Producing green H_2 from hydro power, Injecting in steel industry, providing grid services



Co-ordinated by Verbund (electricity company of Austria)

6MW PEM atmospheric electrolyser by Siemens

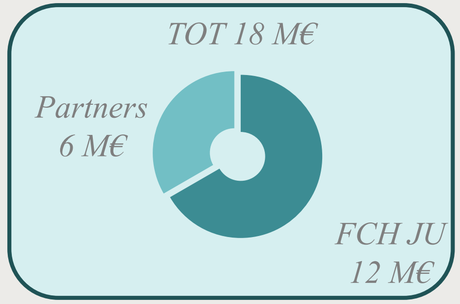
Installed in voestalpine (steel industry) in Linz

H_2 injected in coke oven gas. Long term view is **direct iron ore reduction through H2**

Favourable electricity tariffs in Austria for electrolysers

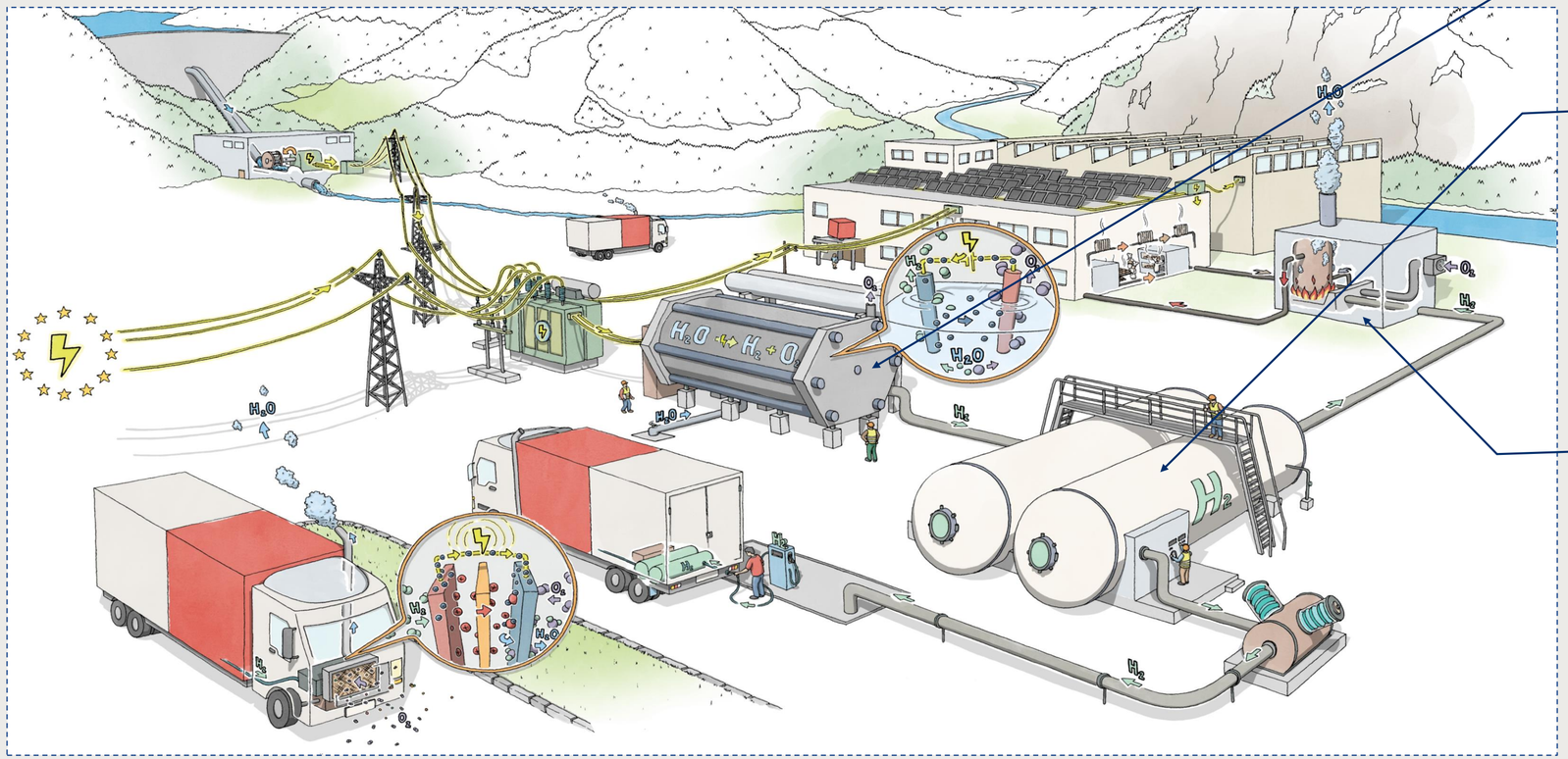
Steel industry a great proponent of green H_2 at Commission level

H2FUTURE
Green Hydrogen



2016: Greening the Food Industry

The Demo4Grid Project: Producing green H2 from hydro power, combustion in boiler of food industry

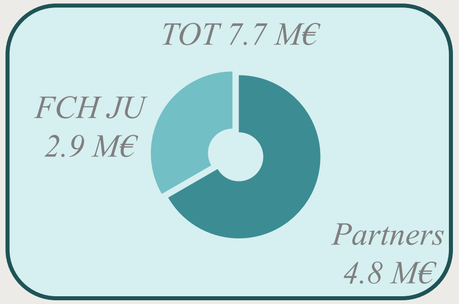


Pressurized ALK (approx. 4 MW power intake; 1.840 kg H_2/day @30 bar)

Buffer storage @ 30 bar, 300 m³

Thermal usage of H_2 in bakery/production plant (H_2-burner, 2MW)
Efficiency >95% ELY thermal energy production is utilized

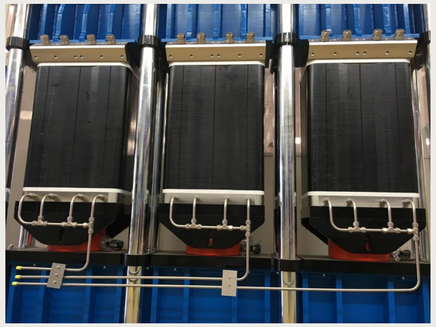
Hosted by Mpreis (food industry, Tirol)
4MW alkaline electrolyser by IHT
H_2 4 Heat, H2 4 Transport
TRL 6-8

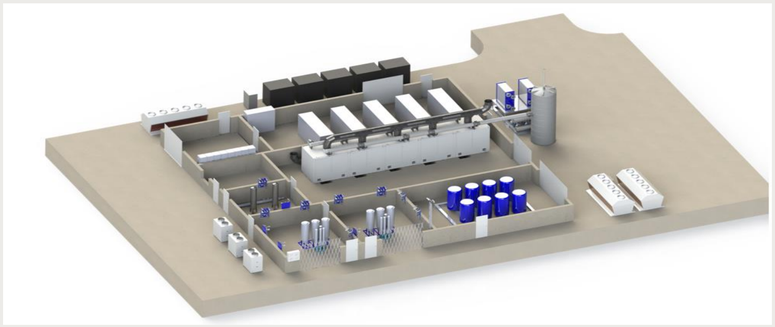


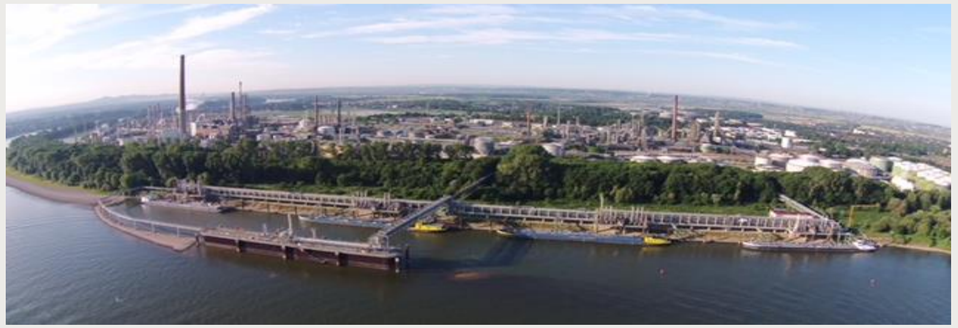
2017: Greening the Refining Industry

The Refhyne Project: Producing green H_2 from renewables, displacing grey SMR hydrogen

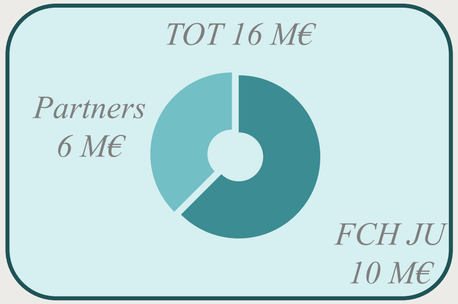
REFHYNE
CLEAN REFINERY HYDROGEN FOR EUROPE





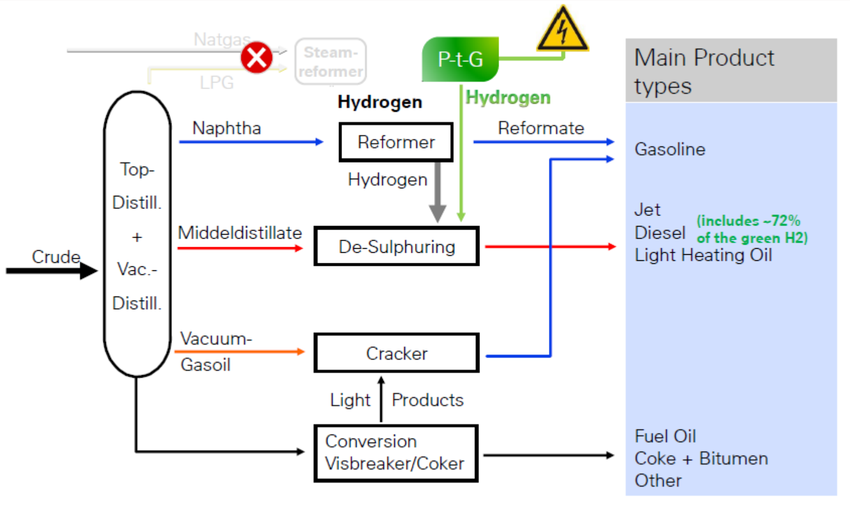


- 10MW PEM electrolyser by ITM Power installed in Shell refinery in Wesseling, Germany
- 3 A/cm^2, 30bar
- H_2 fed to existing pipeline – grid and load balancing services
- Displacing 1% of 180,000 tons annual consumption



Greening the Refining Industry

Green H_2 attractive for refineries in terms of CO2 avoidance costs



Why?
... alternatives to H_2 even more expensive!

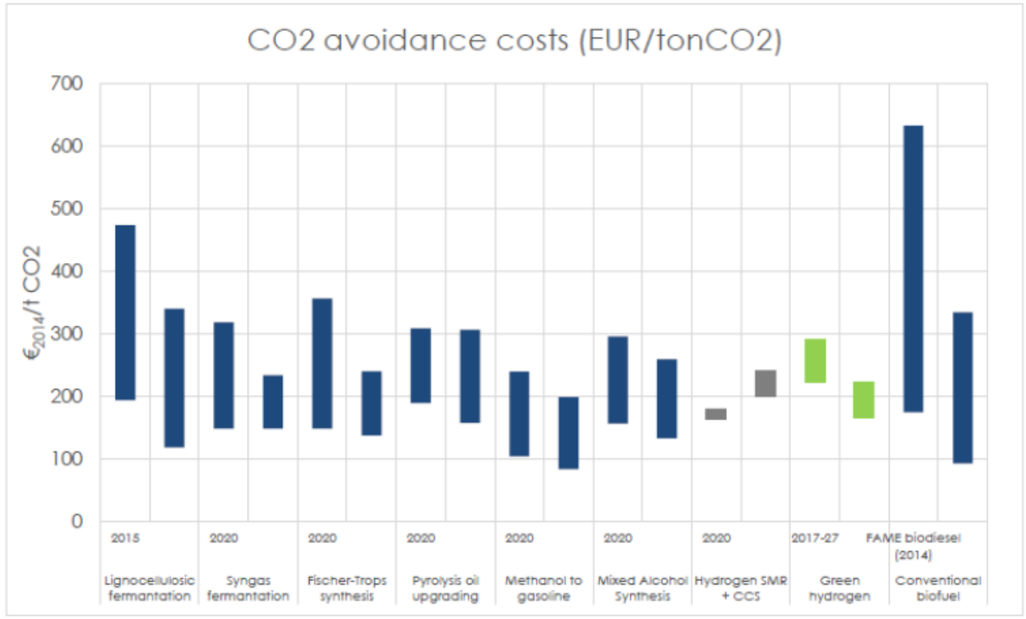


FIGURE 5.7- CO_2 ABATEMENT COSTS BIOFUELS, GREEN HYDROGEN ADVANCED BIOFUELS (€/T CO_2)

BP Europa SE *11*

Ref: Enno Harks, BP Europa SE

Hydrogen Roadmap Europe

Developed with an industry coalition – Available @ www.fch.Europa.eu

- Study by the FCH JU, supported by Hydrogen Europe and 17 companies and organizations along the whole value chain of hydrogen
- First comprehensive quantified European perspective for deployment of hydrogen and fuel cells in two scenarios
  - Ambitious, yet realistic two-degree scenario and business-as-usual scenario
  - Long-term potential
  - Roadmap with intermediate milestones
  - Recommendations to kickstart

Hydrogen Roadmap Europe

Managing variable renewables requires H_2

Challenge

Hydrogen is the only option to enable the transition of the energy system – managing quadrupling renewables requires...

Managing variable renewables

Hydrogen Roadmap Europe

H_2 and FCs meet customer preferences

Challenge

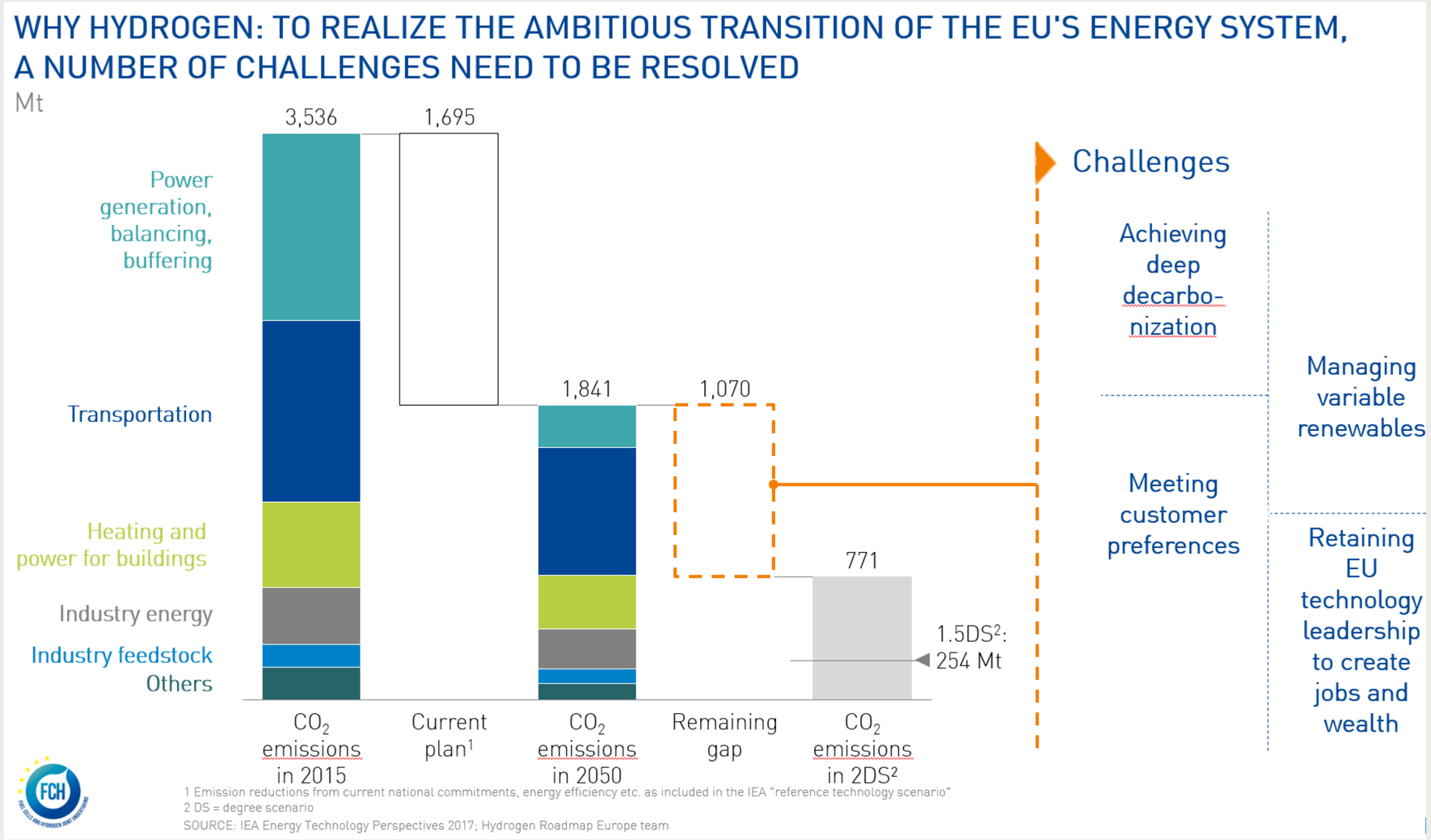
Hydrogen and fuel cells are compatible with current usage patterns and convenience due to...

Meeting customer preferences

- SUPERIOR RANGE AND REFUELING TIME OF FCEVs
- NO OR FEW CONSTRUCTION CHANGES REQUIRED FOR HEATING WITH H_2
- POTENTIAL FOR LOWER ENERGY COSTS IN THE LONG TERM

Hydrogen Roadmap Europe

Hydrogen is the best or only choice for at-scale decarbonization of key segments

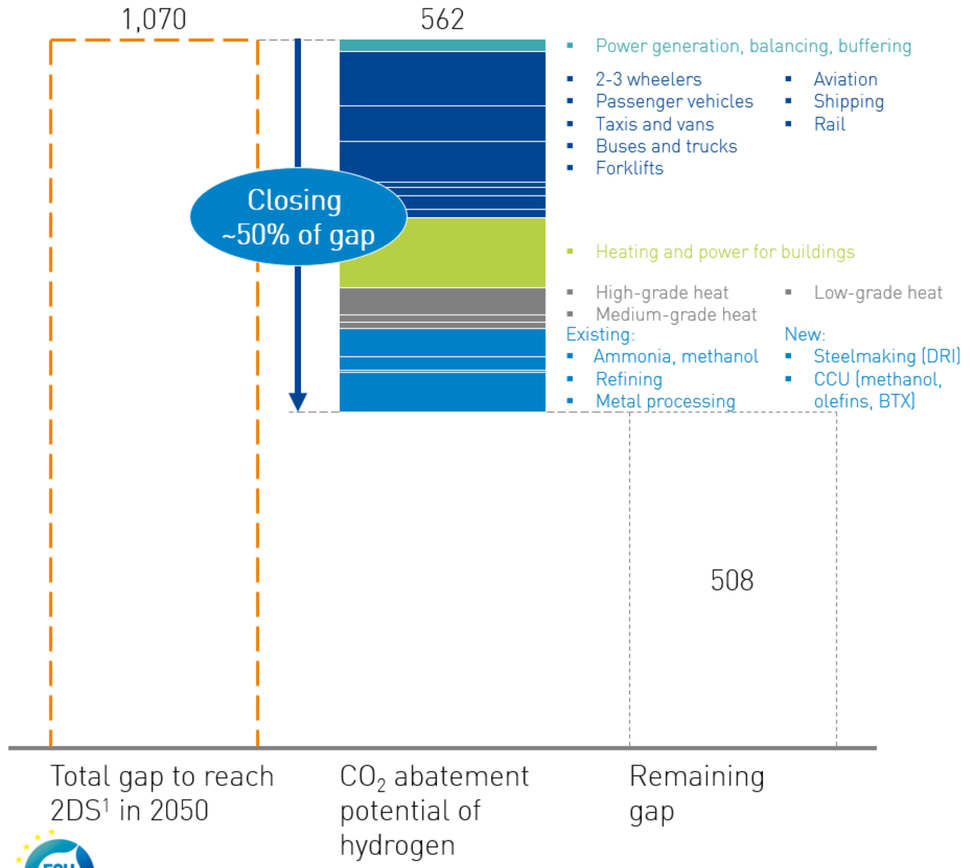


Hydrogen Roadmap Europe

Hydrogen can close half of the gap towards 2DS

ACROSS APPLICATIONS HYDROGEN CAN CLOSE HALF OF THE GAP TOWARDS THE 2DS

Carbon emissions gap to reach 2DS[1] in 2050, Mt



Segments

- Power generation, balancing, buffering
- 2-3 wheelers
- Passenger vehicles
- Taxis and vans
- Buses and trucks
- Forklifts
- Aviation
- Shipping
- Rail
- Heating and power for buildings
- High-grade heat
- Medium-grade heat
- Low-grade heat

Existing:
- Ammonia, methanol
- Refining
- Metal processing

New:
- Steelmaking (DRI)
- CCU (methanol, olefins, BTX)

Hydrogen decarbonization levers

Power generation	Integration of renewables into the power sector[2] Power generation from renewable resources
Transportation	Replacement of combustion engines with FCEVs, in particular in buses and trucks, taxis and vans as well as larger passenger vehicles Decarbonization of aviation fuel through synthetic fuels based on hydrogen Replacement of diesel-powered trains and oil-powered ships with hydrogen fuel-cell-powered units
Heating and power for buildings	Decarbonization of natural gas grid through blending Upgrade of natural gas to pure hydrogen grid
Industry heat	Replacement of natural gas for process heat
Industry feedstock	Switch from blast furnace to DRI steel Replacement of natural gas as feedstock in combination with CCU

1 2-degree scenario 2 Please see the chapter on renewables and power for information on the role of hydrogen as enabler of a renewable power system. The "enabled" carbon abatement from renewables is not included here and is an additional benefit of hydrogen for decarbonization

SOURCE: IEA Energy Technology Perspectives 2017; Hydrogen Roadmap Europe team

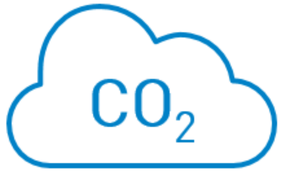
Hydrogen Roadmap Europe

Besides CO_2 abatement, deployment of H_2 also cuts local emissions, creates new markets and secures sustainable employment in Europe

2050 hydrogen vision

~24%

of final energy demand[1]



~560 Mt

annual CO_2 abatement[2]

~EUR 820bn

annual revenue (hydrogen and equipment)

~15%

reduction of local emissions (NO_x) relative to road transport

~5.4m

jobs (hydrogen, equipment, supplier industries)[3]

1 Including feedstock 2 Compared to the reference technology scenario 3 Excluding indirect effects

SOURCE: Hydrogen Roadmap Europe team

Summary

- Sectorial integration, Energy storage, Decarbonizing industry & the Gas grid: mainstream energy policy terms
- H_2: important component for deep decarbonisation – Electrolyser: key technology
- FCH JU: continuous support of Industry and Researchers in moving electrolysers from kW to MW, improving performance & reducing costs
- 

A recent H_2 roadmap concludes that by 2050 H_2 techs can cover 24% of the total energy demand, reducing CO_2 by 560Mtn/a and creating 5.4M jobs in the EU

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