



Hydrogen
Europe

Hydrogen opportunities – best practices and projects

Jorgo Chatzimarkakis, Secretary General

06/11/2018, Brussels

Coal Regions in Transition Platform



Fuel Cell & Hydrogen 2 Joint Undertaking

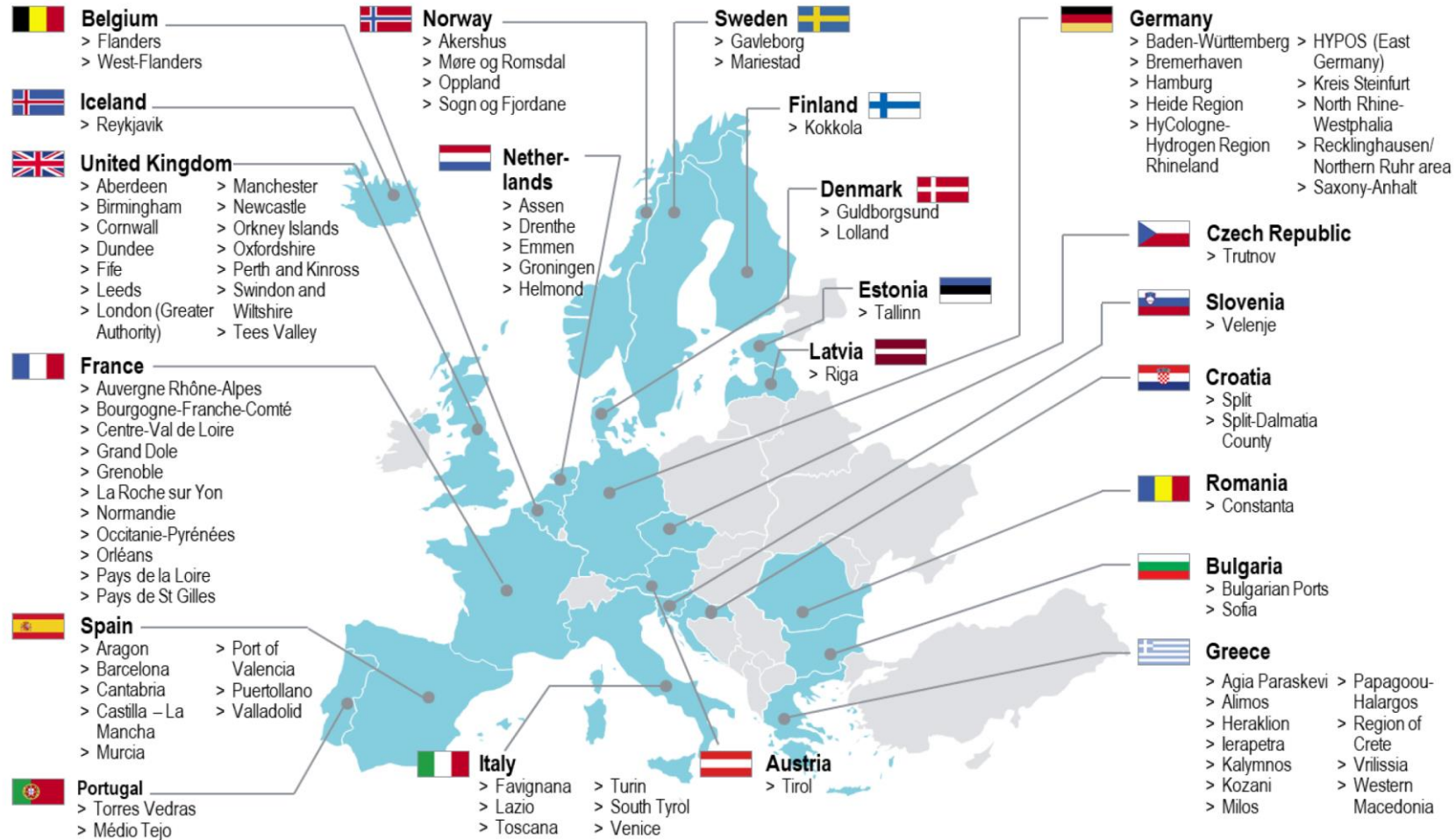


European Union represented by the European Commission

A portfolio of clean, efficient and competitive solutions based on fuel cells and hydrogen technologies in energy and transport



Fuel Cells and Hydrogen for Green Energy in European Cities and Regions

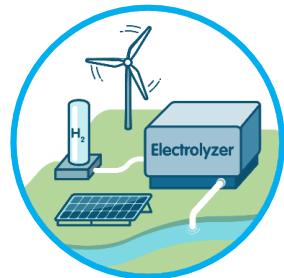


Legend: Map shows all regions and cities which have signed the Memorandum of Understanding (MoU)

Hydrogen Production & Markets

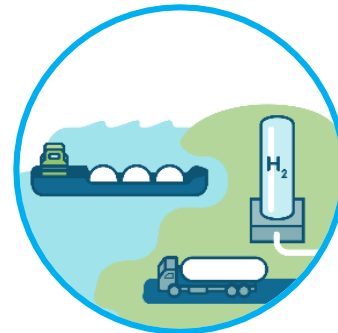


Steam methane reformer (~48%)
Crude oil cracking (~30%)
Coal gasification (~18%)
Industrial by-product (~3%)

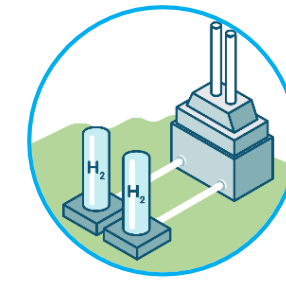


Water electrolysis (~1%)

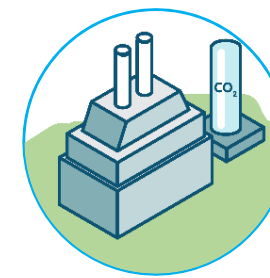
Annual global market size:
55Mtons ↔ \$130bn
= 611 bcm (in H2 energy terms)



Pipelines
Trucks



Fertilisers (~50%)
Refineries (~43%)
Other industry (~6%)
(Float glass, metallurgy, semi-conductors)



Mobility, cooling agent, food industry (~1%)

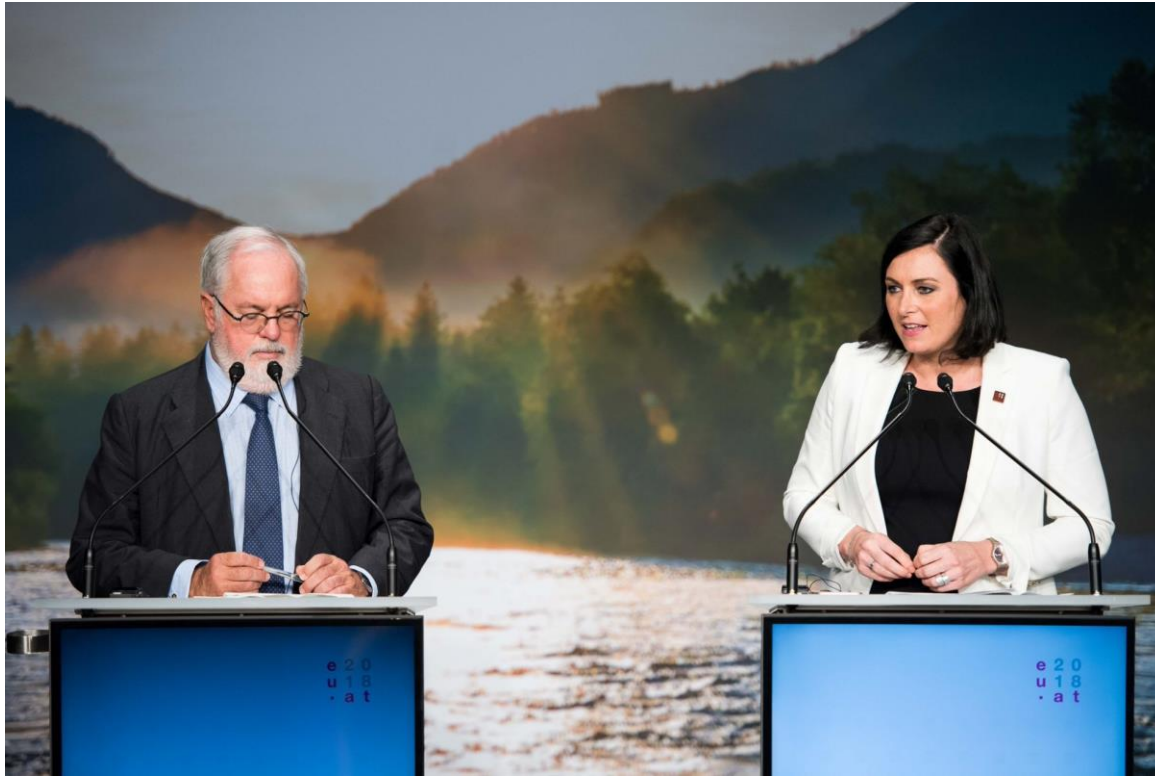


Production

Transport

End-users

The Hydrogen Initiative: Energy Ministers open new chapter



We, the signatories of this initiative, gathered in Linz, Austria, on the 17th and 18th of September 2018, collectively aim to maximise the great potentials of sustainable hydrogen technology for the decarbonisation of multiple sectors, the energy system and for the long-term energy security of the EU.

Linz, Austria
18 September 2018

Hydrogen: Suddenly in the news all over the globe

World premiere: Alstom's hydrogen trains enter passenger service in Lower Saxony



"This is a revolution for Alstom and for the Future of Mobility. The world's first hydrogen fuel cell train is entering passenger service and is ready for serial production"

Henri Poupart-Lafarge
Chairman & CEO of Alstom

16 September 2018

EU CLIMATE AND ENERGY FRAMEWORK

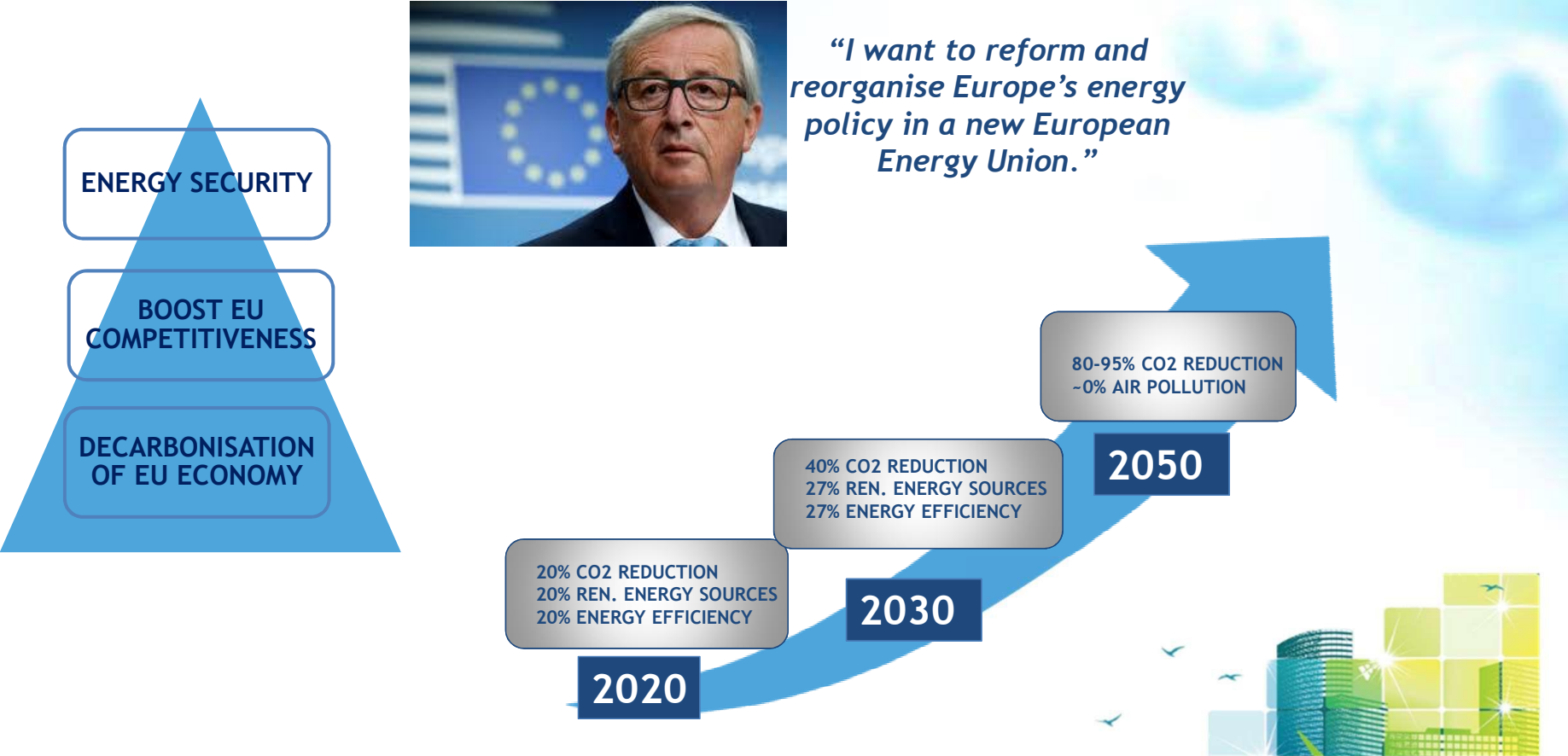
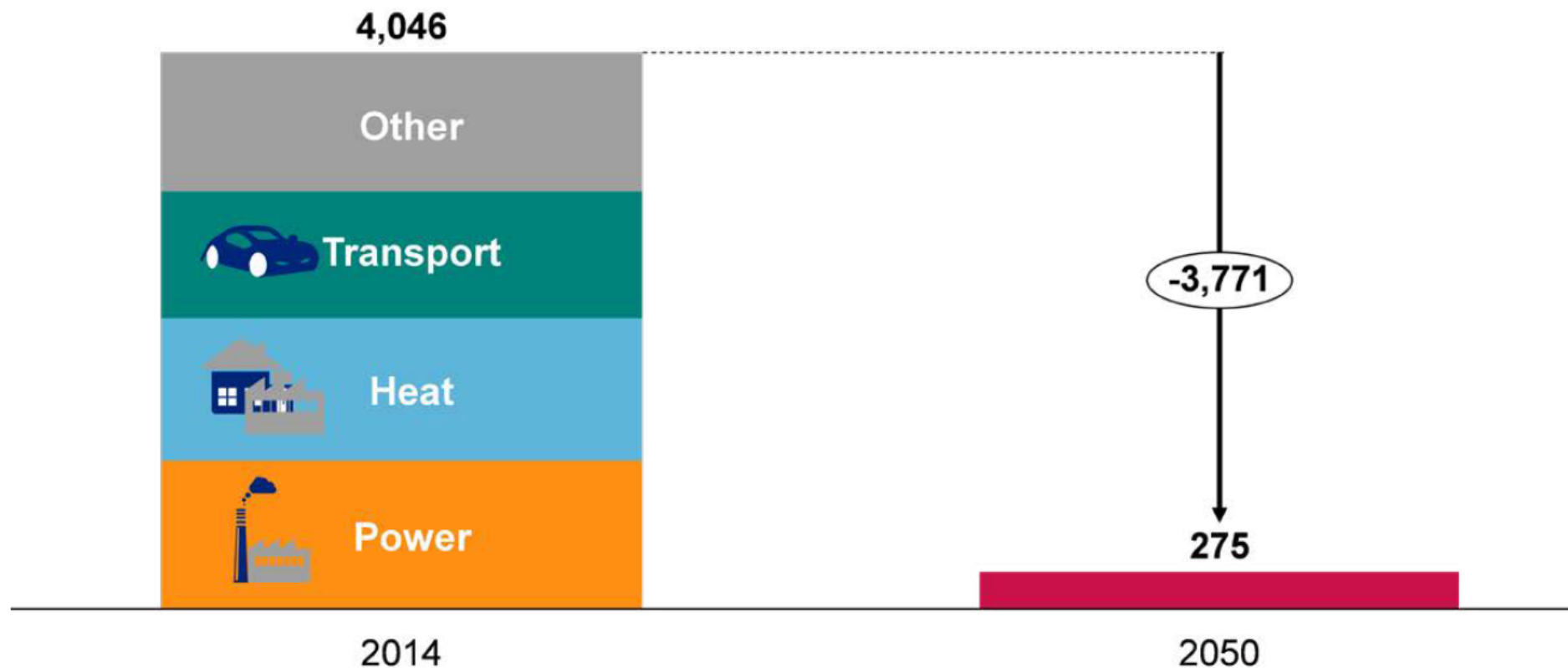


FIGURE 1 – THE SCALE OF EUROPE’S DECARBONISATION PROBLEM (MtCO₂e)



Source: 2016 National Inventory Submissions (Common Reporting Format) for EU, Norway and Switzerland.

The Solution

Enable the renewable energy system → Decarbonize end uses

Enable **large-scale renewables integration** and **power generation**



Distribute energy across sectors and regions



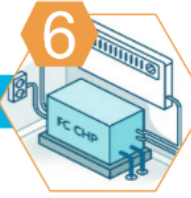
Act as a **buffer** to increase system resilience



Help decarbonize **transportation**



Help decarbonize **industrial energy use**



Help decarbonize **building heat and power**



Serve as **renewable feedstock**

The Solution

Enable the

H2 supply chains:

- Conditioning
- Transport (P/L, ships, trucks)
- GH2/LH2

Enable **large-scale renewables integration** and **power generation**

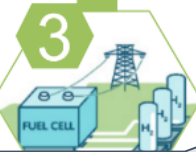


Clean H2 production:

- Electrolysis
- Carbon Capture & storage

Power production: H2-Turbine
REN integration: Stationary Fuel Cells

Distribute energy across sectors and regions



H2 storage

- Cyclic operations of H2 caverns

Act as a **buffer** to increase resilience

Decarbonize **transport**

Transport:

- Refueling (GH2/LH2)
- LDV/HDV FC & H2 storage components and integration



Help decarbonize **transport**

Industry energy:

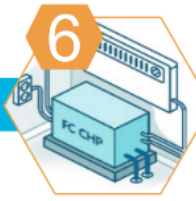
Adapted boilers/furnaces



Help decarbonize **industrial energy**

Residential

Distribution/Injection



Help decarbonize **building heating power**

Domestic appliances
micro-CHP

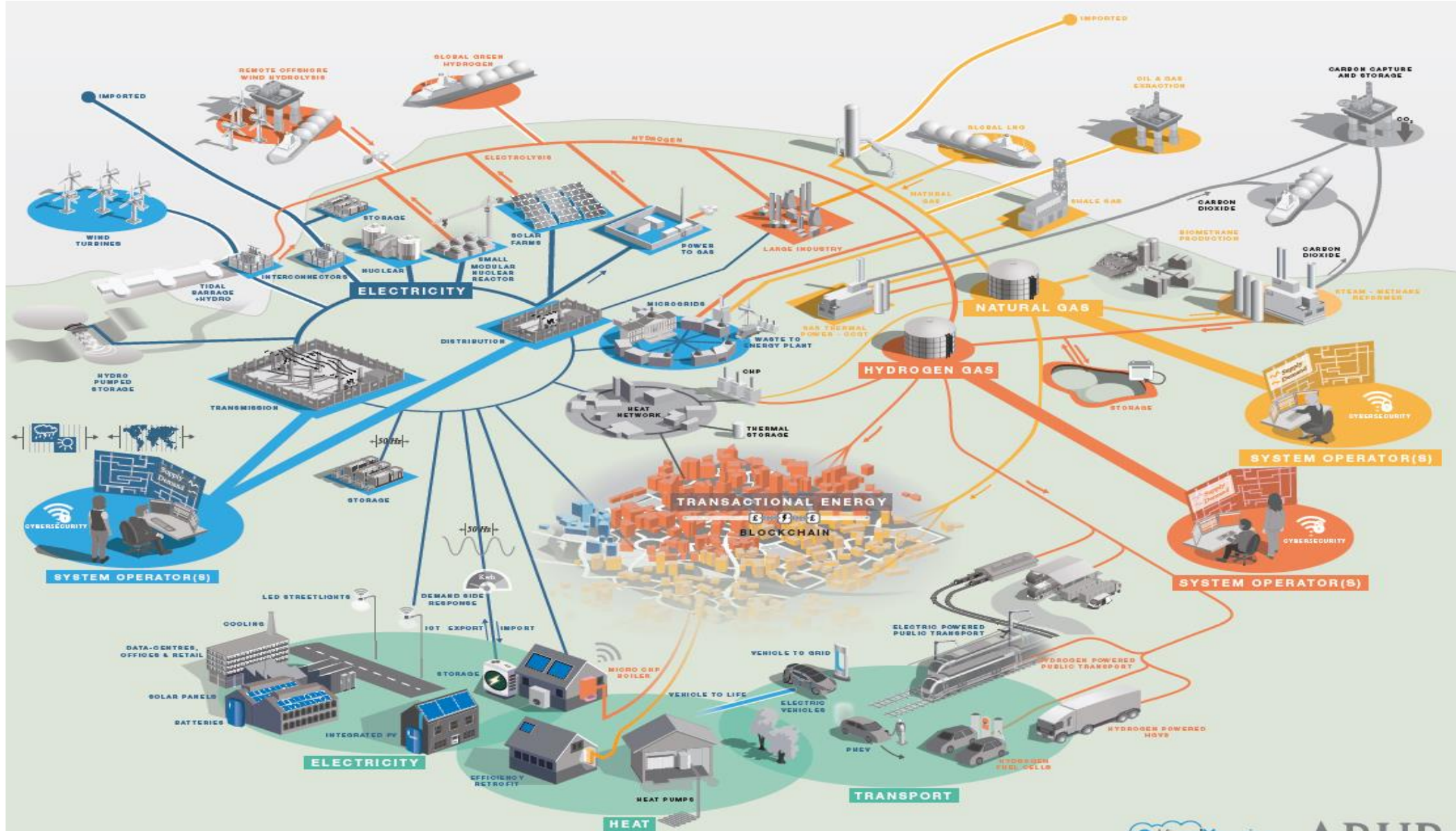


Serve as renewable **feedstock**

Industry feedstock:

Existing process => new clean production pathways
New processes => steel, carbon re-utilization

Sector coupling & sectoral integration

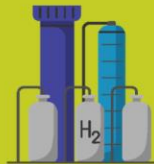


How can coal regions act? Example: Silesia

Hydrogen separation



Coke plant



Hydrogen

Zero-emission urban transport



JSW coking coal mine

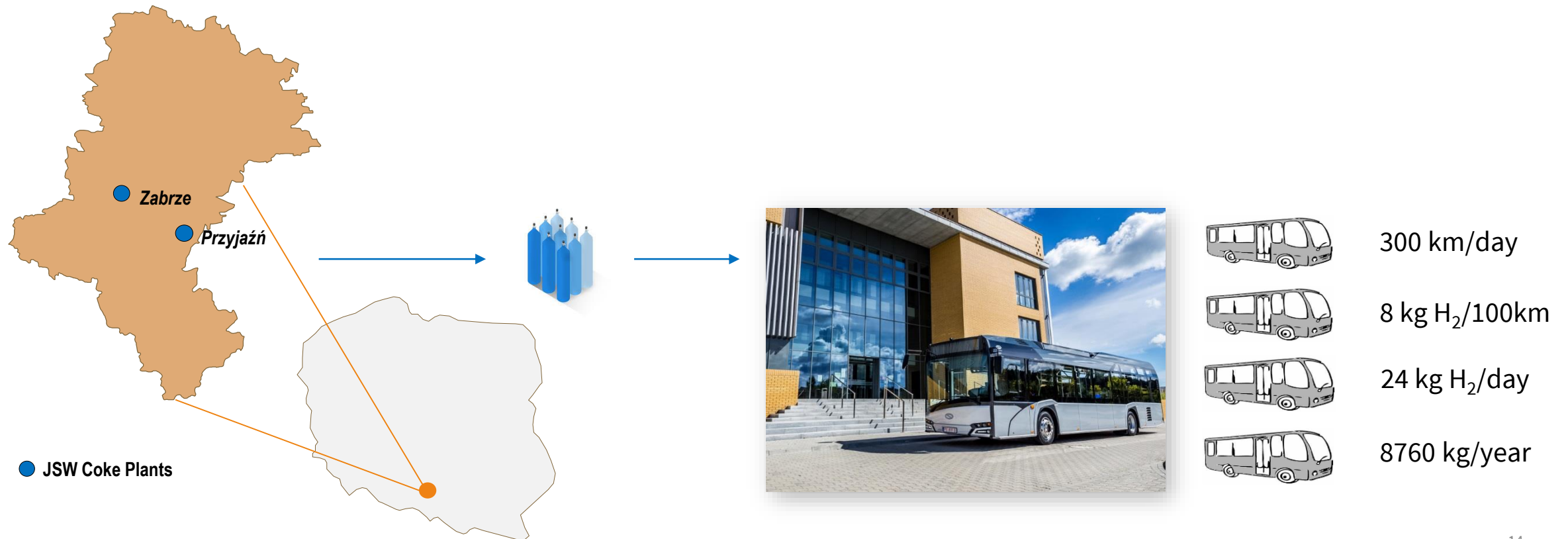
- JSW S.A. and JSW Innowacje S.A. are planning to build the installation for hydrogen separation from coke-oven gas in one of JSW Group coking plants in tested PSA (Pressure Swing Adsorption) technology.
- The installation would enable the production of **8000 tonnes of hydrogen per year**.
- Obtained HYDROGEN 5.0 with high level of purity (99,999%) will secure needs of Silesia for implementation and development of zero-emission urban transport based on fuel cell technology.

How can coal regions act? Example: Silesia

Upper Silesia = >2,5M citizens.

Modernisation of the existing bus fleet with **600 new zero-emission vehicles.**

JSW = main supplier of hydrogen



How can coal regions act? Example: H2Bus Europe

600 FC busses spread across major cities in 2023

3 Clusters (central electrolysers) in Europe (DK, UK, LV)

15-20 H2Stations (dispensars)

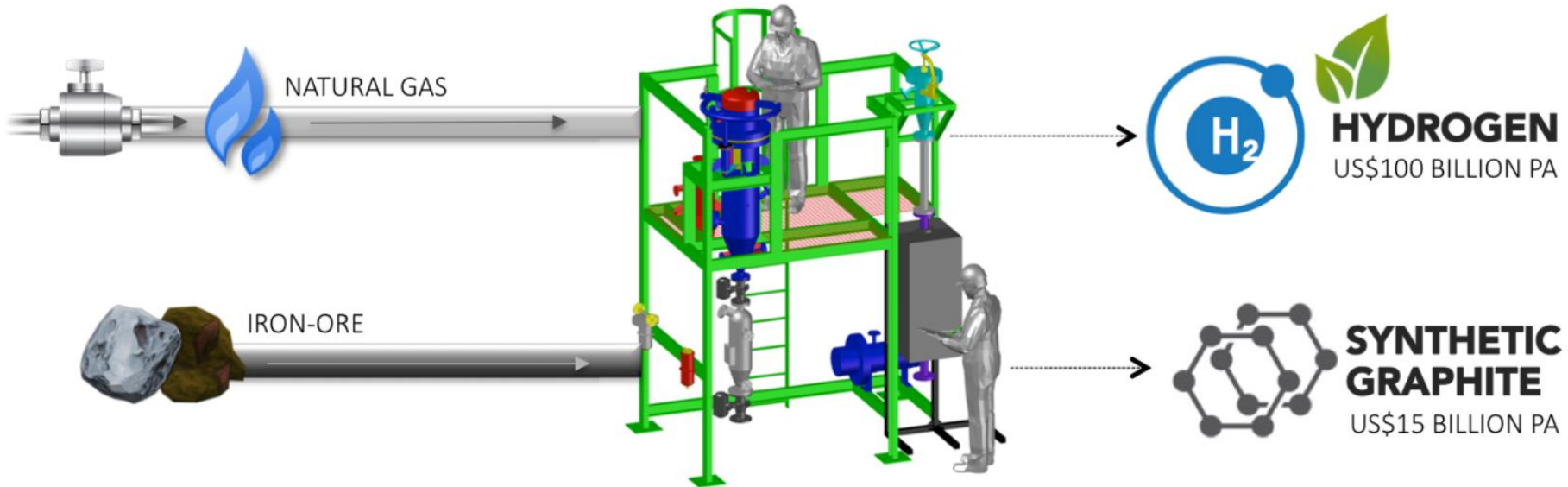
20-40 35MPa Hydrogen trailer

Moving hydrogen buses to a commercial level

40M€ Support from CEF



How can coal regions act? Example: Hazer/Australia



THE HAZER® PROCESS

Other Coal regions' switch to hydrogen

The Canberra Times

EXCLUSIVE POLITICS FEDERAL ENERGY

Australia's top scientist calls for hydrogen revolution to replace fossil fuels

By Nicole Hasham

10 October 2018 – 12:01am



The federal government's top scientist Alan Finkel says Australia could slash global carbon emissions and create a multi-billion dollar export industry by developing hydrogen as an everyday energy source to replace fossil fuels used in vehicles, homes and industry.

A major climate report on Monday identified hydrogen, which can be produced with virtually no emissions, as among fuel options that must be developed if the planet is to stay below the critical 1.5 degrees warming threshold and avoid the worst climate change disasters.

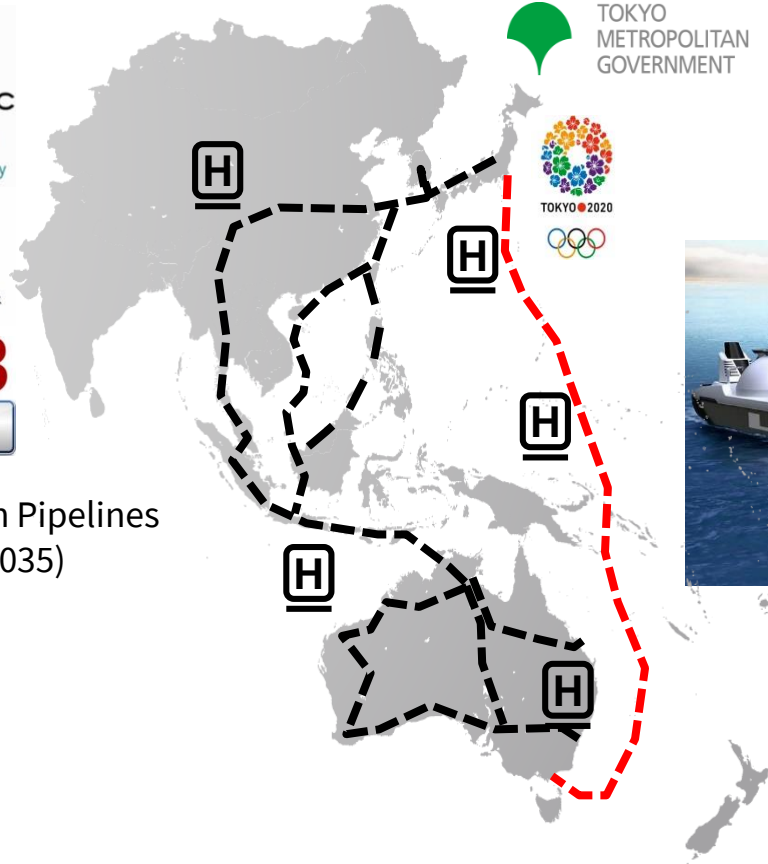
The report by the UN's climate science body, the Intergovernmental Panel on Climate Change, called for a coal phase-out by 2050 and predicted a substantial decline in the use of natural gas – two export industries upon which Australia is heavily reliant.



Tokyo Olympic Games 2020



Hydrogen Pipelines (~2035)



Hydrogen Shipping (~2025)



Development Target of China's Hydrogen Infrastructure



- Both hydrogen FCVs and electricity generation shall be put into operation in large scale;
- Hydrogen becomes an important choice in energy consumption area.

- 1 million fuel cell vehicles shall be put into market.
- Over 1000 hydrogen refueling stations will be built and operated.

- 1000-5000 FCVs will be manufactured as demonstrations.
- Over 100 hydrogen refueling stations are built and operated.

Starting the transformation
in 2018-2020

Small scale
demonstrations

2020-2030

Large scale
commercialization

2030-2050

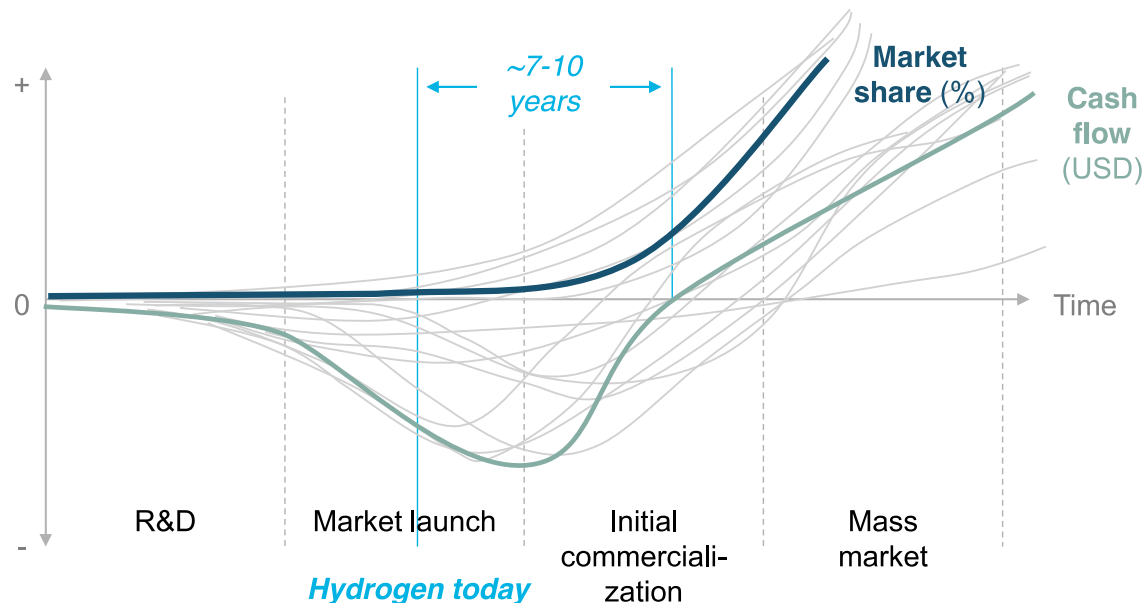
Hydrogen
becomes an
important
component in
energy mix

How to enhance market development?

In order to reach this target investments are needed now

PRELIMINARY
ILLUSTRATIVE

Hydrogen technologies are ready to be launched and scaled up...



...requiring significant investments in manufacturing facilities and infrastructure

USD billion, 2018-2030

- 240 bn** Infrastructure investments (project finance, corporate debt..)

Hydrogen production, hydrogen refueling stations, distribution (liquefaction plants, shipping, trucks, pipelines)

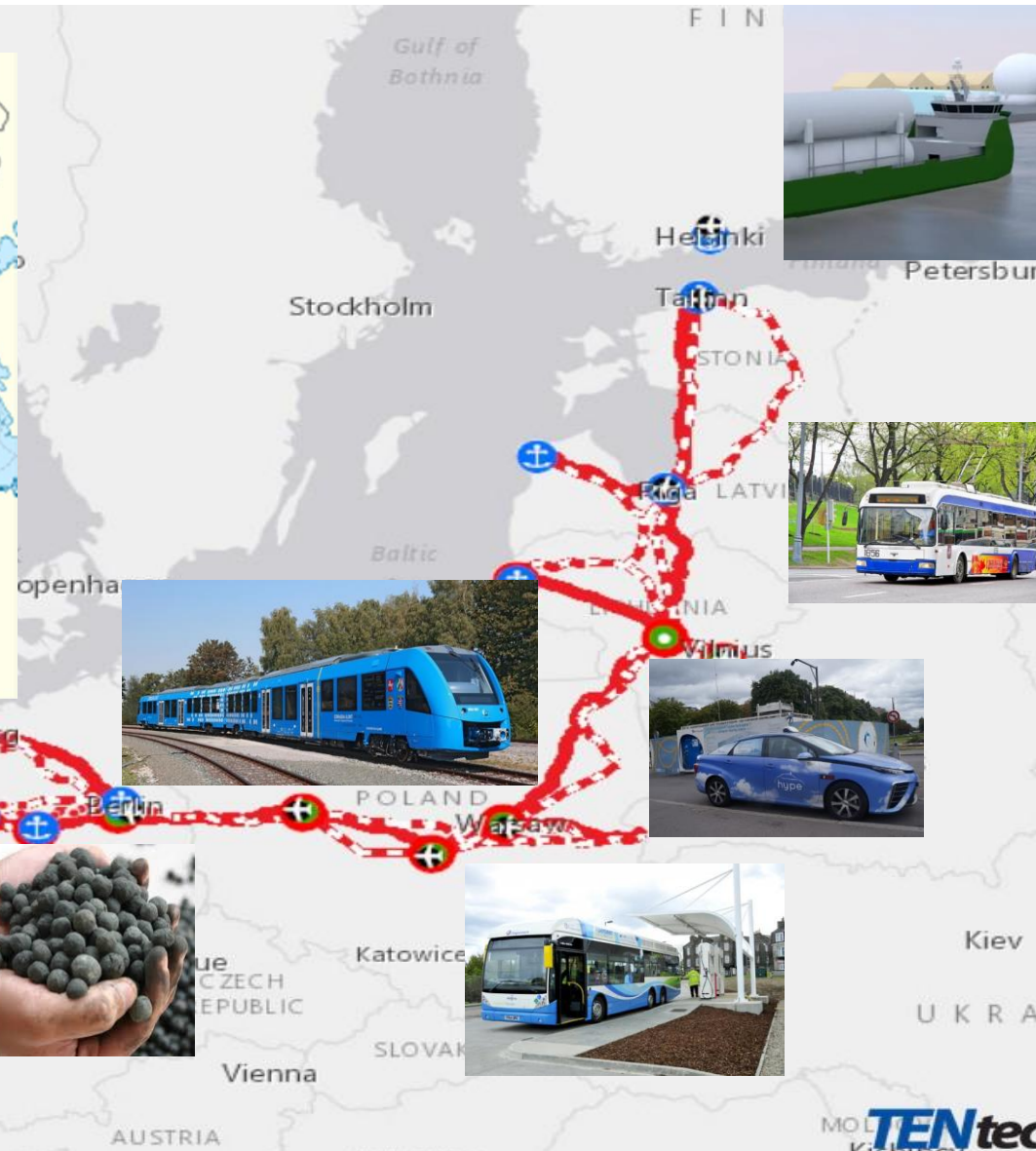
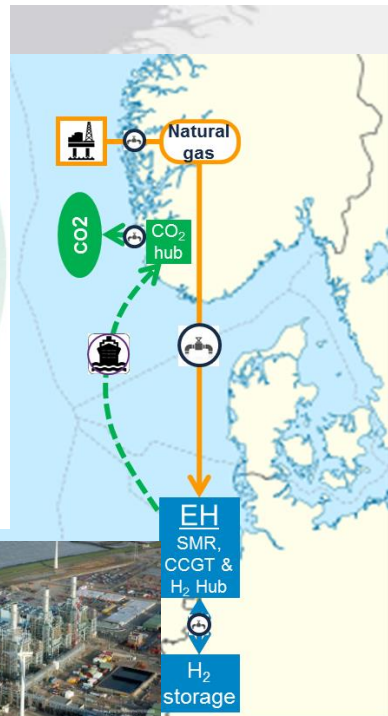
- 215 bn** Scaling up manufacturing (corporate debt..)

Scaling up manufacturing for fuel cell and components, new R&D for components and new models

- 20+ bn** New business (venture capital/equity)

Investments in end-use applications, e.g., FCEV taxi and truck fleets, financing of CHPs in buildings, ...

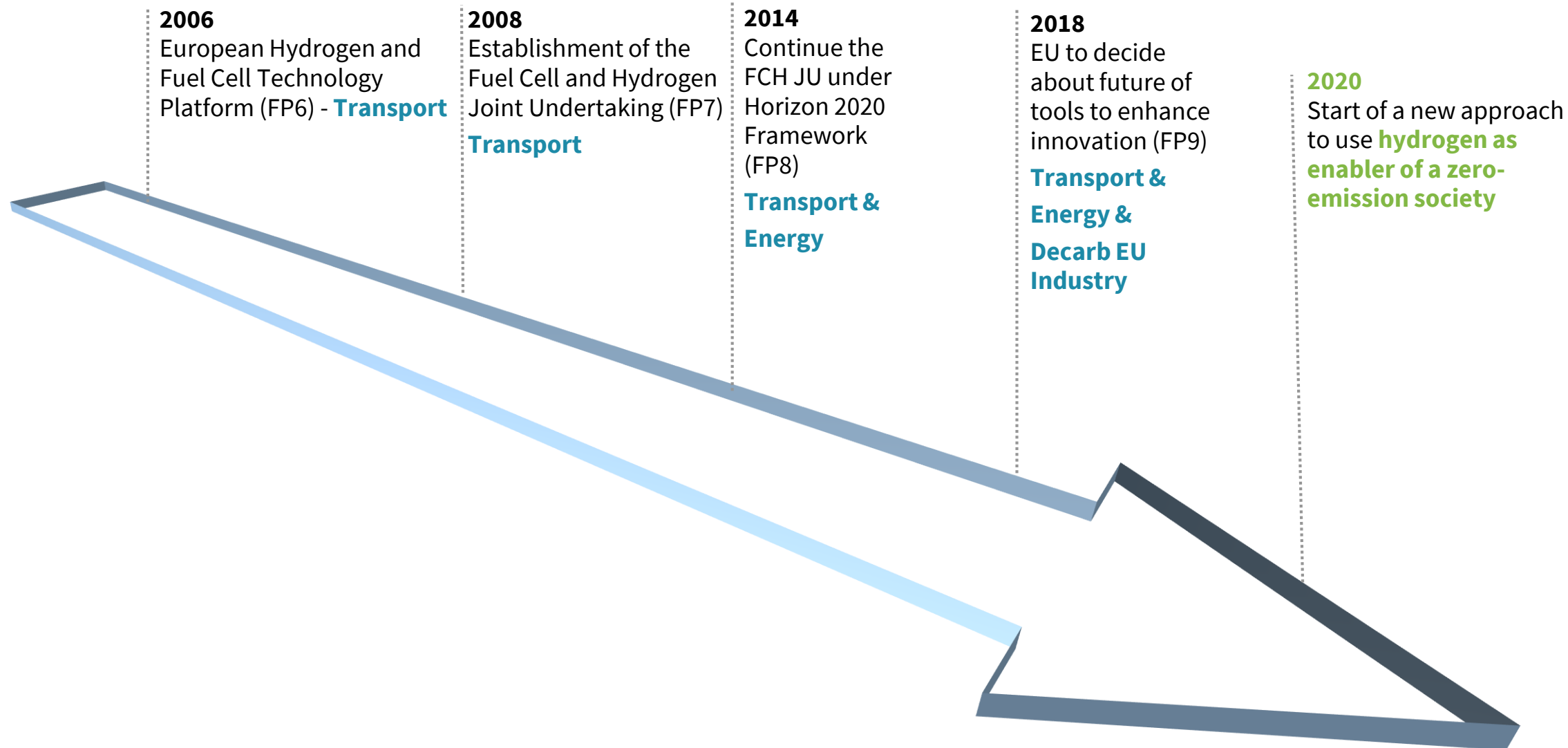
Market through Projects of Common Interest (IPCEI)



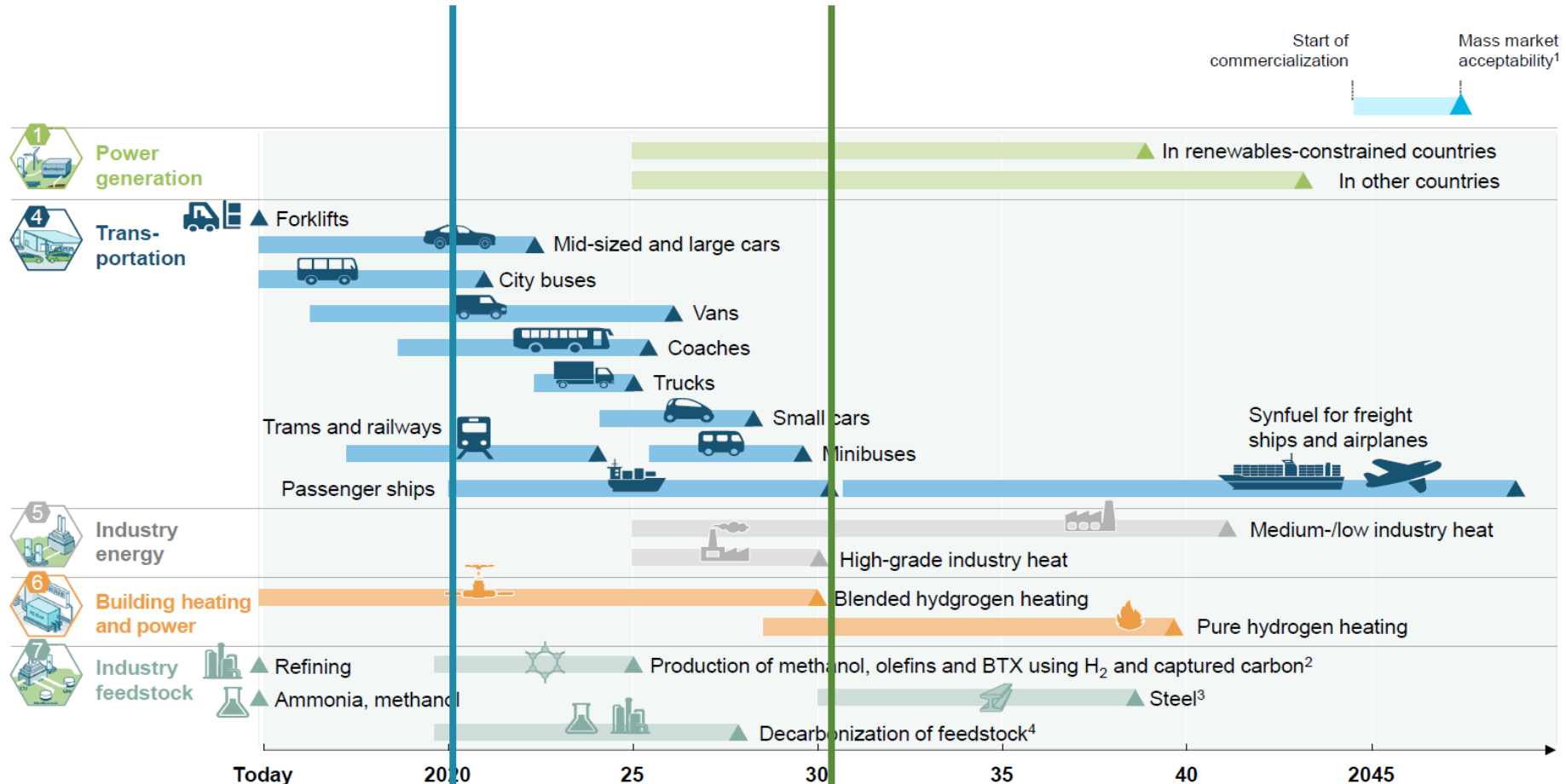
Market through Financial Engineering



Why we need to continue R&D



Why we need to continue R&D



1 Mass market acceptability defined as sales >1% within segment in priority markets
 3 DRI with green H₂, iron reduction in blast furnaces and other low-carbon steel making processes using H₂

2 Market share refers to the amount of production that uses hydrogen and captured carbon to replace feedstock
 4 Market share refers to the amount of feedstock that is produced from low-carbon sources

Achievements of
FCH 2

Ambitions for
Horizon Europe

IC#8

Renewable and Clean Hydrogen Challenge

MISSION INNOVATION
Accelerating the Clean Energy Revolution

Our objective

To accelerate the development of a global hydrogen market by identifying and overcoming key technology barriers to the production, distribution, storage, and use of hydrogen at gigawatt scale.

- Launched in May 2018
- 14 countries
- 3 years to make a difference

Co-lead: Australia, European Commission, Germany



Join us at the ZEB!



2018 EUROPEAN ZERO EMISSION BUS CONFERENCE

Cologne • November 27th & 28th

Organised under the patronage of



Technology and policy experts will lead a two-day conference to drive forward the realisation of zero emission public transport for Europe.

Agenda overview

- Technological readiness
- Zero emission bus deployment
- Lessons learned
- New business and financing models
- Scaling up – going from small bus fleets to complete zero emission bus fleets

DETAILS & REGISTRATION: zebconference.com/eu



elementenergy



In partnership with EnergieAgentur.NRW & ElektroMobilität NRW

@EUZEBconference #ZEB2018

- Discuss the most pressing legal and administrative barriers which hinder the deployment of hydrogen technologies across the EU
- Brings together EU policy makers, industry players and the Hylaw team of researchers and analysts

When: 06.11.2018, from 10:00 until 16:00

Where: White Atrium, Avenue de la Toison d'Or 56-60, BE-1060 Brussels



The poster features the title 'HyLAW EU Workshop' in large blue font. Below it, the dates 'Brussels 06.12.2018' are displayed. To the right is a map of Europe with 23 countries highlighted in blue, representing the HyLAW partners. A small HyLAW logo is in the top right corner of the poster, and the European Union flag and a circular logo are in the bottom right corner.

HyLAW EU
Workshop

Brussels
06.12.2018

23 HyLaw partners from:

United Kingdom, Norway, Sweden, Finland, Denmark, Latvia, The Netherlands, Poland, Germany, France, Italy, Hungary, Romania, Bulgaria, Portugal, Spain

HyLAW

European Union flag and circular logo

DETAILS & REGISTRATION: <https://www.hylaw.eu/events>

Shift happens!

Hydrogen enables you.



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