



# Discovering the molecule of the future

## Session 2: Hydrogen Applications

Online Briefing Session specially prepared for MEPs and Political Groups Advisers  
in cooperation with the EEF Associate Members



Our event will start soon

 [@EEF\\_EnergyForum](#) [#EEFdebates](#)

Please keep the Chatham House rule in mind when tweeting, thank you!



## IN-HOUSE RULES

**Chatham House Rule:** one can mention what is said, but not quote anyone. Please keep it in mind when tweeting (@EEF\_EnergyForum)

**Mute mode:** all participants are on mute mode and not visible during panellists' initial interventions

**Debate time:** all participants are encouraged to ask for the floor to visibly provide their insights or ask their questions. To do so :

- ❖ Use the «Raise Hand» function at the bottom of the participants tab
- ❖ When given the floor, you will be unmuted and have the option to turn on your camera
- ❖ Please introduce yourself and be brief
- ❖ The use of camera while asking a question is advised for a better, livelier interaction
- ❖ We will take 3 questions at a time



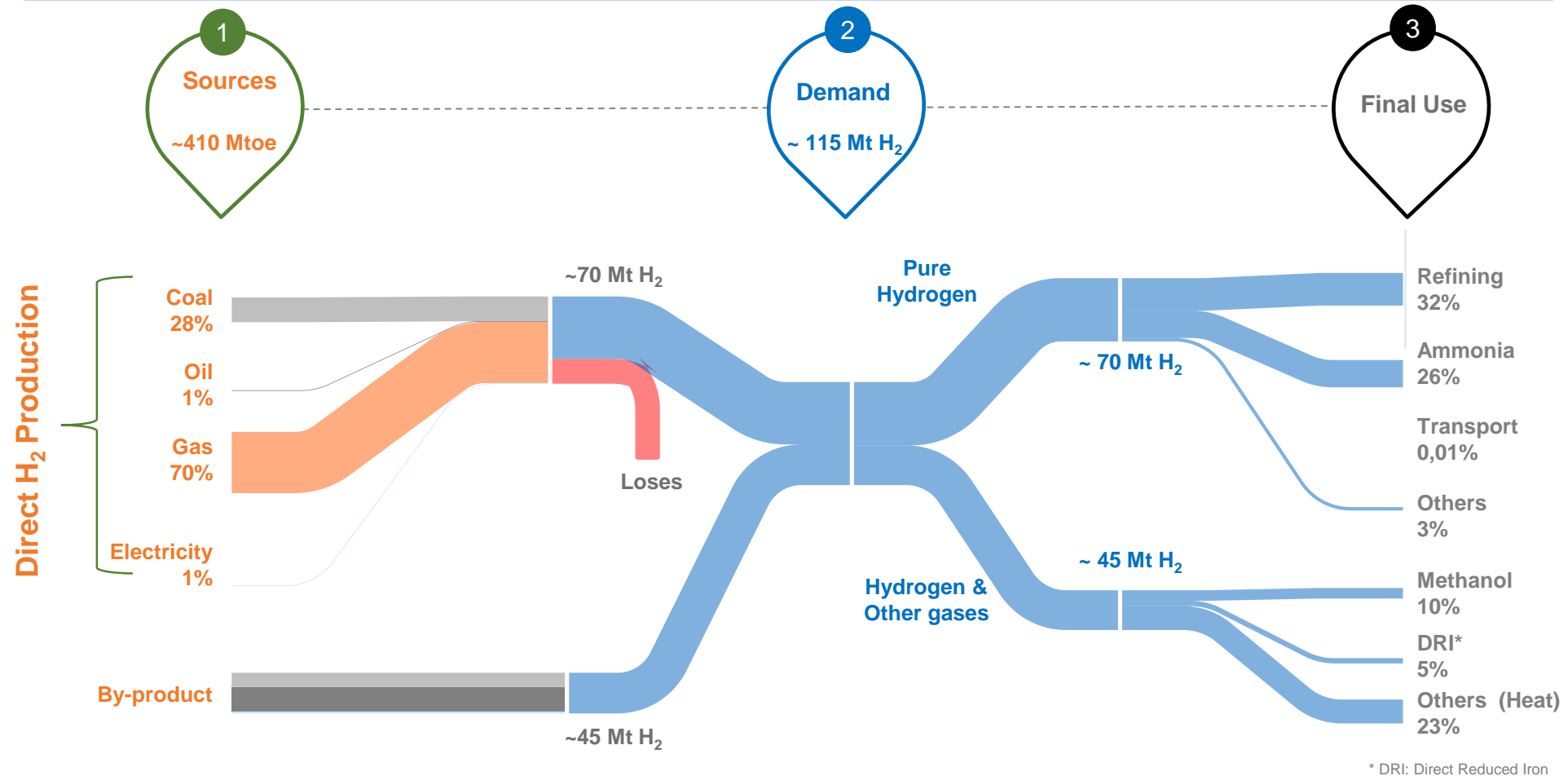
# Hydrogen uses today – an overview

*Presented by*

Miguel Garagorri, European Affairs Manager, IBERDROLA



## Where is H<sub>2</sub> used today?



**Current H<sub>2</sub> production mainly devoted to produce fertilisers from ammonia, to processes within the refining industry, and to the chemical industry**



# Hydrogen-based power generation

*Presented by*

**Ralf Wezel**, Secretary General of **EUTurbines** (European Association of Gas and Steam Turbine Manufacturers) & **EUGINE** (European Engine Power Plants Association)



# Power generation with gases – Gas turbines and engines

## Why different technologies?

- Differences in typical size
- Efficiency in certain use cases
- Operational flexibility
- Fuel flexibility
- Costs

### Gas engines



#### Typical gas engine applications:

- Size: from a few kW to >100MW (combined modules)
- Fuels: natural gas, biogases, hydrogen, synthetic fuels
- Local or decentral cogeneration
- Biogas plants
- Flexible & back-up power (very short start-up and ramp-up times)
- Industrial cogeneration

### Gas turbines





#### Typical gas turbine applications:

- Size: from a few MW to 600MW
- Fuels: natural gas, hydrogen, industrial waste gases
- Central power generation (high efficiency in steady operation)
- Larger district heating networks
- Cogeneration in energy-intensive industries


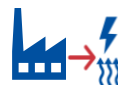


# Why power generation with hydrogen?


## Gas Power Generation & Cogeneration Today

-  Flexible reliable power whenever needed
-  Using natural gas is not compatible with climate targets

## Why will we need it in the future ?

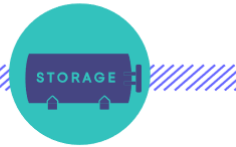
-  Flexible reliable power generation to complement batteries and demand response, especially for seasonal peaks
-  H<sub>2</sub>-cogeneration (large to micro) contributes to decarbonising heating and process heat demand of industry

## Reaching ambitious 2030 targets

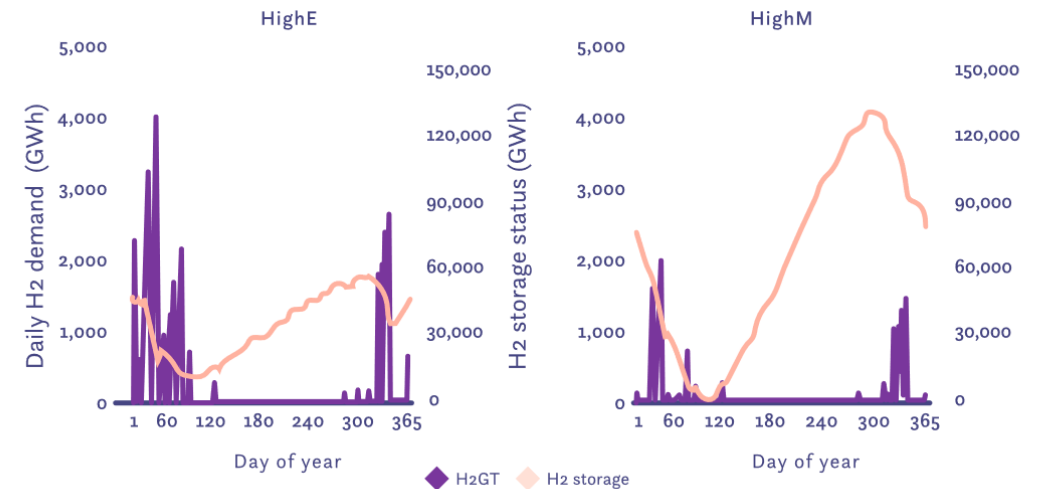
- 1 Replace coal plants by gas plants
  - 2 Switch gas plant from natural gas to carbon-neutral and renewable gas
- 
- Future-Proof

## THREE PILLARS OF ZERO-CARBON ENERGY SYSTEMS

- Green hydrogen is used for generating winter peak electricity in H2GT's
- Major increase in electrolyser capacity across Europe



### 3. SEASONAL STORAGE



Source: European Climate Foundation  
"Towards fossil-free energy in 2050"



# Hydrogen in power plants – Replacing natural gas



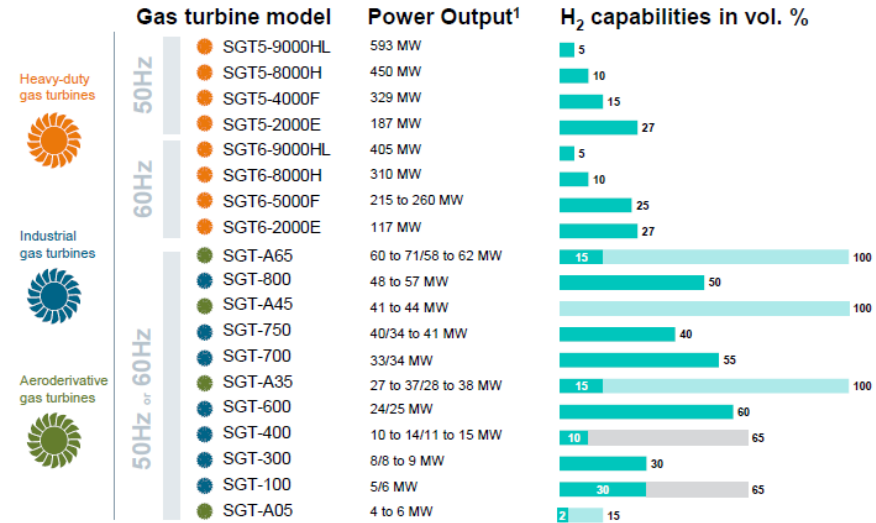
Use of climate-neutral and renewable gas in existing technology (H<sub>2</sub> but also biogas/biomethane or other fuels derived from hydrogen)

## Technological challenges of hydrogen:

- Burns at higher temperature -> impacts other emissions like NO<sub>x</sub>
- Higher explosiveness -> extended safety requirements
- Lower volumetric-energy density -> adaptation of volumes



## Siemens Hydrogen Gas Turbines for our sustainable future – The mission is to burn 100% hydrogen



**SIEMENS**  
Ingenuity for life

Values shown are indicative for new unit applications and depend on local conditions and requirements. Some operating restrictions/special hardware and package modifications may apply. Any project >25% requires dedicated engineering for package certification.

**Higher H<sub>2</sub> contents to be discussed on a project specific basis**



Source: Siemens Energy

! Depending on product used, already today considerable shares of H<sub>2</sub>-blending are possible





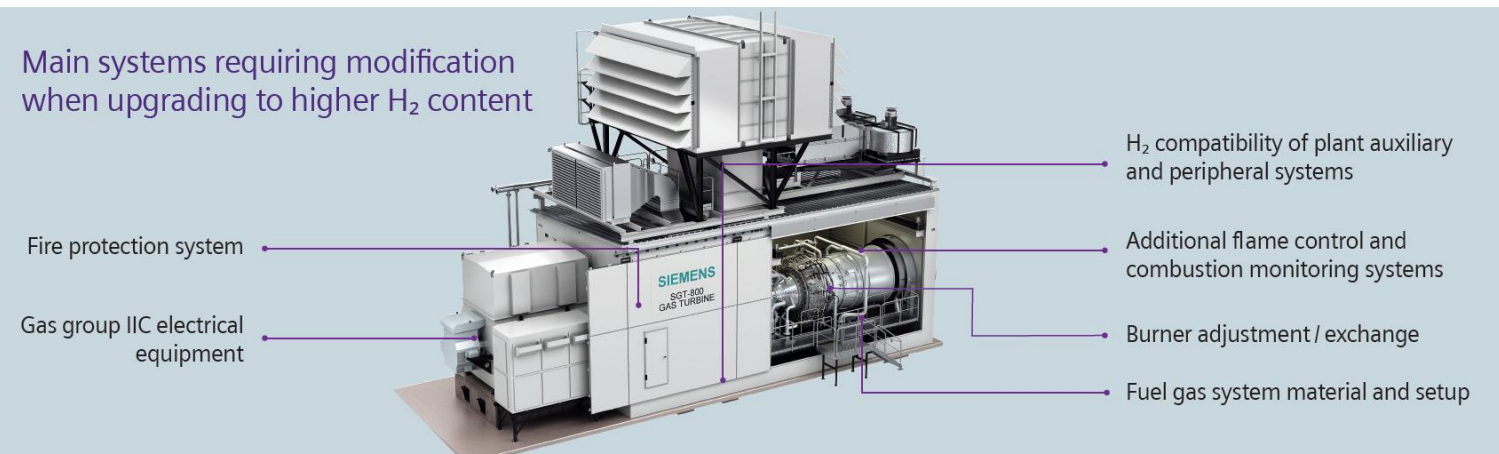
# Upgrading of existing power plants

- **H<sub>2</sub>-ready capability today:**  
Many engines & turbines are already capable of handling high H<sub>2</sub>-shares in the gas grid
- **Why still R&I is needed?**  
Different combustion technologies have different existing capabilities
- **Important to know:**  
Which way to go: 100%H<sub>2</sub> or H<sub>2</sub>-blending
- **How much effort is it?**  
Limited modifications necessary
- **No carbon lock-in!**  
Gas power plants can be upgraded to be future-proof

## OUR HYDROGEN GT DEVELOPMENT

Combustor type	Hydrogen level	Status
Diffusion	100 % with water injection	READY ✓
Premix Dry Low NOx	30 %	READY ✓
Multicluster Dry Low NOx	100 %	To be completed by 2025

Source: Ansaldo Energia



Source: Siemens Energy



## Some hydrogen power plant projects



### Combination power-to-gas & cogeneration plant

H<sub>2</sub> engine connected to Greenpeace Energy wind park & electrolyser

Ready for hydrogen  
Vattenfall replaces in  
Berlin coal plant for  
district heating by a  
240MW cogeneration  
turbine plant with gas



Retrofit of large gas  
turbine power plant  
for H<sub>2</sub>  
in the Netherlands  
(Magnum Project)



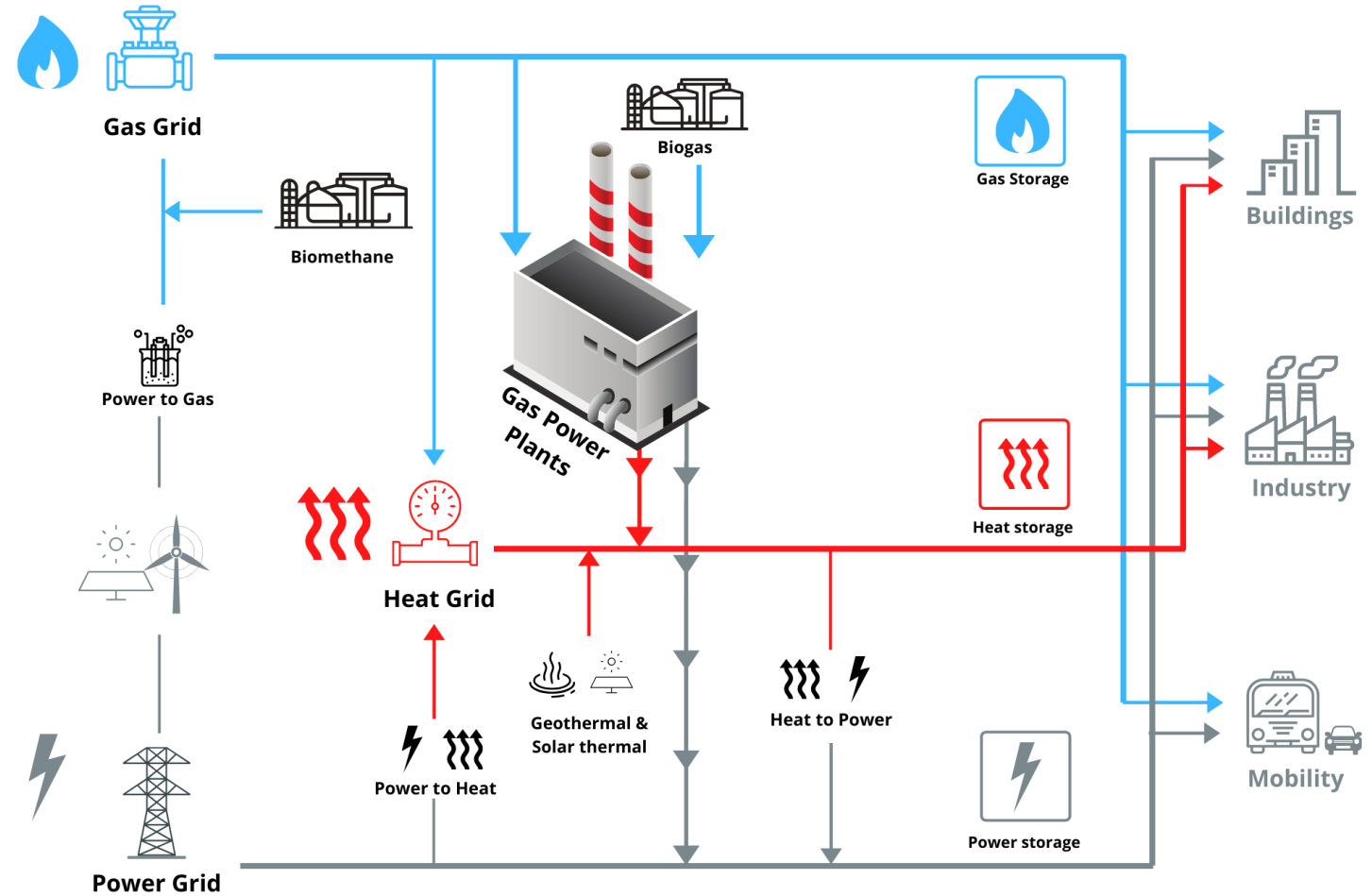
H<sub>2</sub> retrofit of a gas  
cogeneration engine  
for a Hamburg district  
heating network



# What is needed to make it happen

- Recognition of the **value of hydrogen power plants for an energy system** with a high share of variable renewable electricity
- A **transition strategy that looks also at the 2030 climate targets**, not only the final climate-neutrality in 2050
- An **energy system integration approach** that gives consumers a choice for their optimised decarbonisation strategy
- **Clear pathway** for the development of H<sub>2</sub> production and distribution
- Financial support for **demonstration projects and investments** in the transformation

.... and of course sufficient electricity from renewables, fast scaling-up of clean or low-carbon H<sub>2</sub> production, a suitable carbon price, incentives for creating a functioning H<sub>2</sub> market, an adequate infrastructure, ....





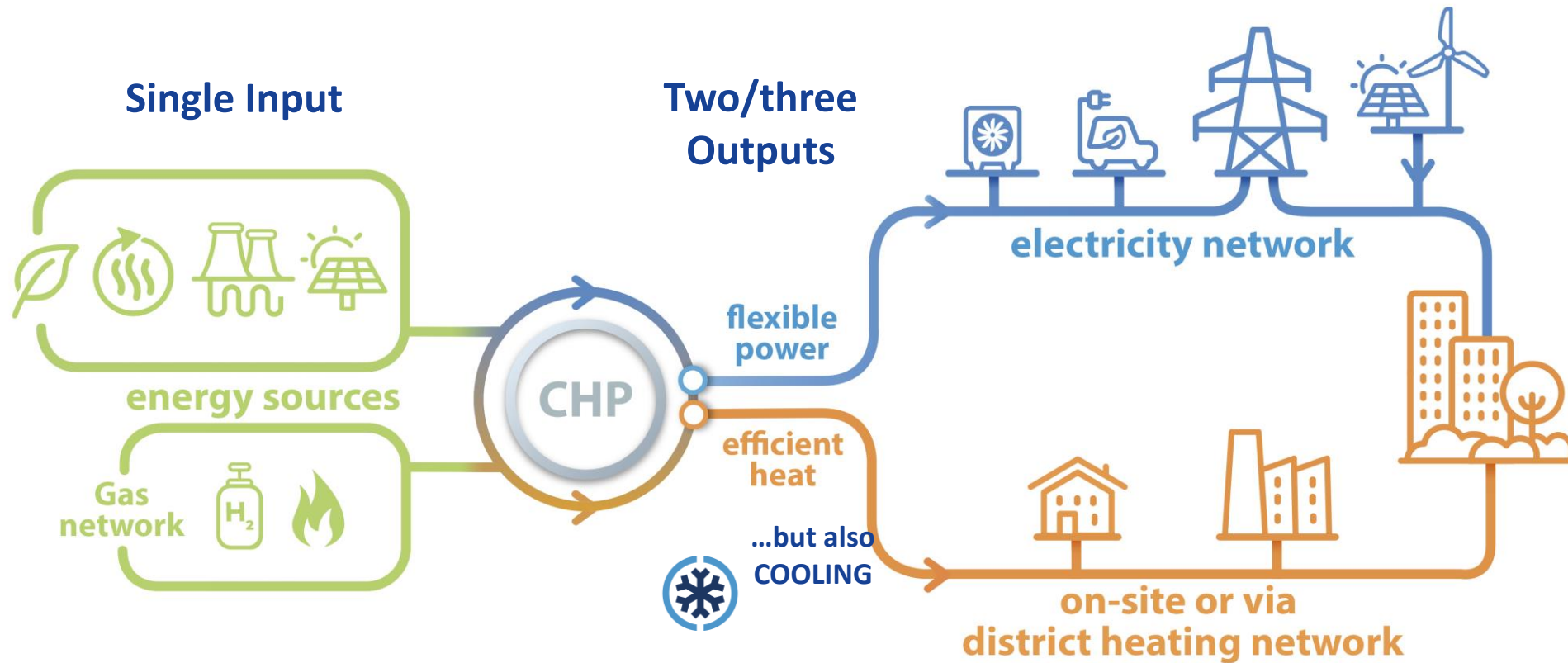
# Hydrogen-based cogeneration

*Presented by*

François Paquet, Public Affairs Manager, **COGEN Europe** (The European Association for the Promotion of Cogeneration)



# What is cogeneration?



Cogeneration transforms **90%** of the energy into useful heat & power for factories, offices, public buildings and homes.





Bundestag (Berlin)



European Commission (Brussels)



European households



All use cogeneration

...and even the  
European Parliament



Hospital



70% of District Heating in Europe



European industry





# Why Hydrogen in Cogeneration: The benefits of energy efficiency



## Do more with less

- Up to 40% energy saved for producing electricity + heat + cooling
- Cut carbon emissions
- Reduce energy bills
- Integrate heat, gas and electricity infrastructure
- Reduce need for energy infrastructure
- Close the hydrogen loop in the most efficient way, avoiding its waste

**For these benefits, cogeneration is promoted in EU legislation**





# Hydrogen-based cogeneration: already a reality - 1

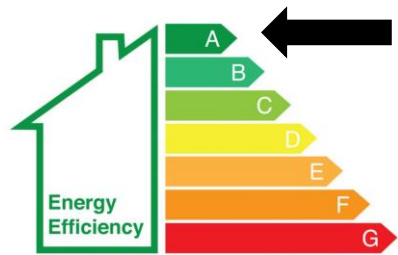
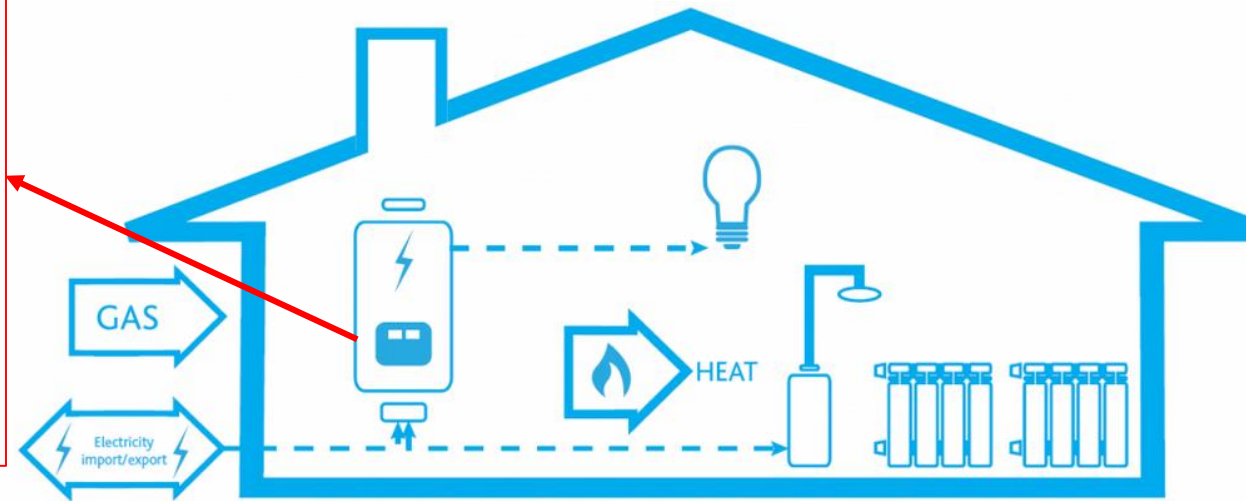
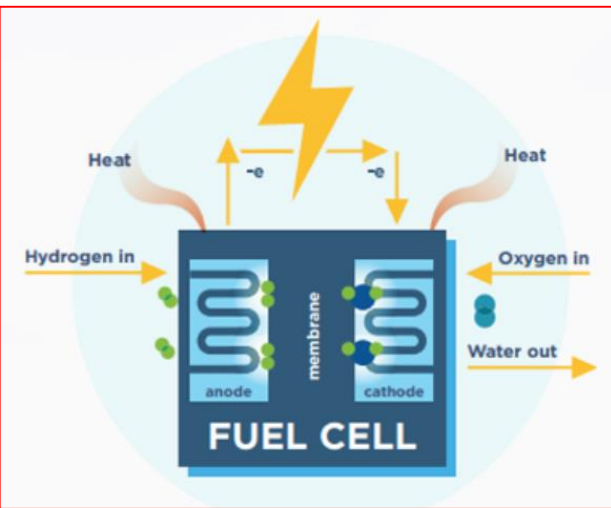
**Buildings entering the Hydrogen economy with Fuel Cell micro-cogeneration**

**90M EUR**

EU funded project



Pathway to a Competitive European Fuel Cell micro-CHP Market



**95% System efficiency**  
**60% Electrical Efficiency**

$H_2$   
Green Gas and Hydrogen ready

$NO_x$   $SO_x$   
Improved air and life quality:  
no particles,  
no noise

Can avoid  
**€62bn**  
in grid reinforcement  
and is a  
Smart Grid  
solution

ECO  
**30%**  
Energy savings

**~10,000**  
**units**  
**installed**  
**across Europe**  
**to date**

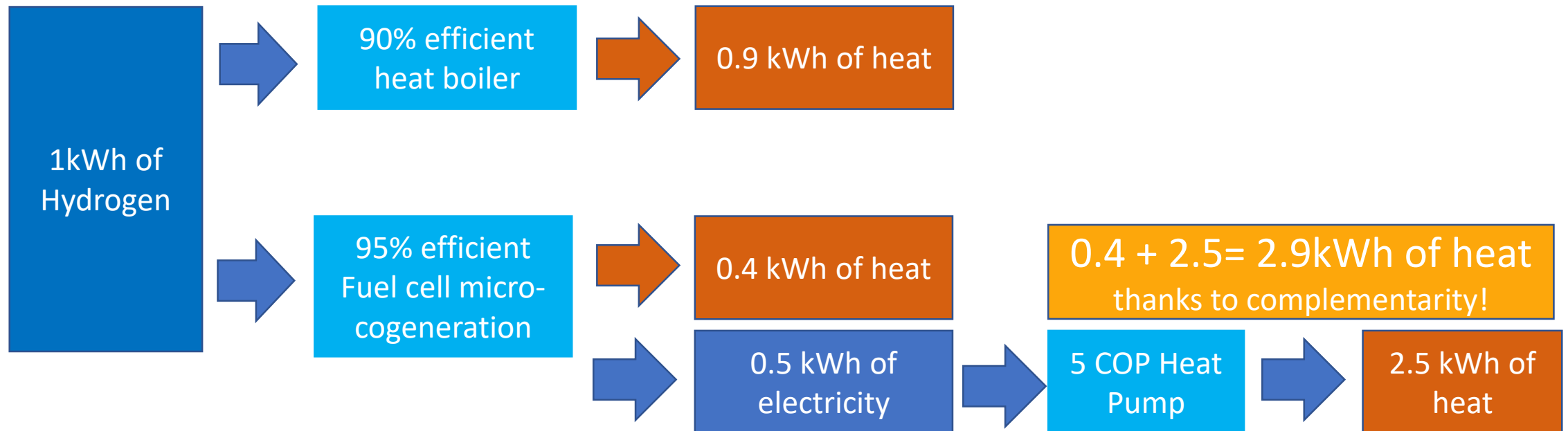




## Hydrogen-based cogeneration: already a reality - 2

### Buildings entering the Hydrogen economy with Fuel Cell micro-cogeneration

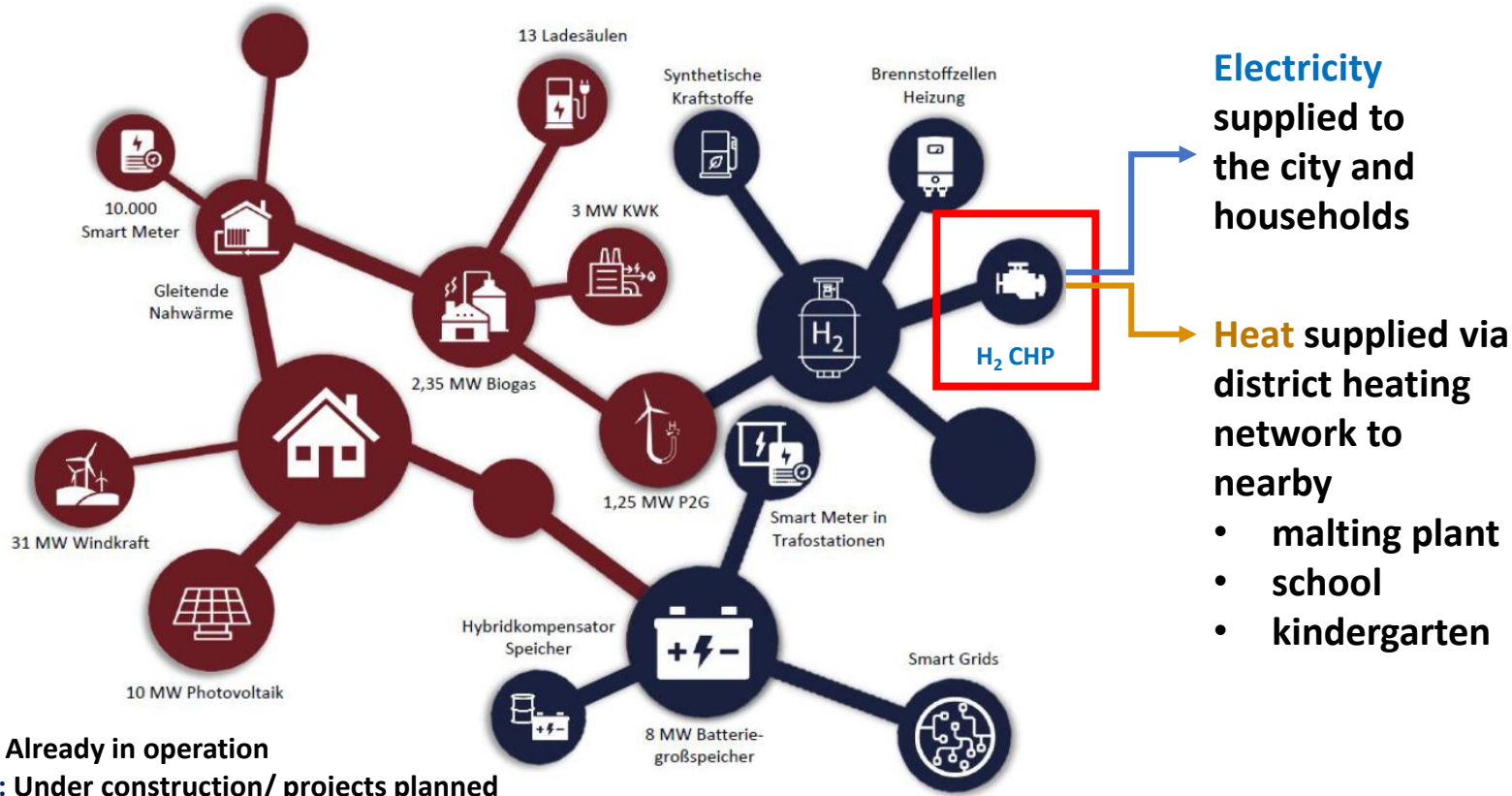
- Complementarity of solutions
- Closing the loop of hydrogen in buildings in the most efficient way





# Hydrogen-based cogeneration: already a reality - 3

## Haßfurt city: a fully integrated energy system at local level



- Haßfurt: 10.000 inhabitants
- Budget : €2.5M funded by Greenpeace energy incl.
  - Cogeneration unit: € 0.5M
- CO<sub>2</sub> avoided: up to 23,000 tons/y
- Savings:
  - Up to 40% energy saved compared to separate heat and power
  - ~ € 150,000 not spent in separate heating systems for the 3 users
  - ~€ 35.000/y saved on gas for separate heating systems
  - Electricity generated supplies the electrolyzer
- Can be replicated in other cities and for other applications (sport centres, Food& Drink companies, ...)

Red: Already in operation  
Blue: Under construction/ projects planned

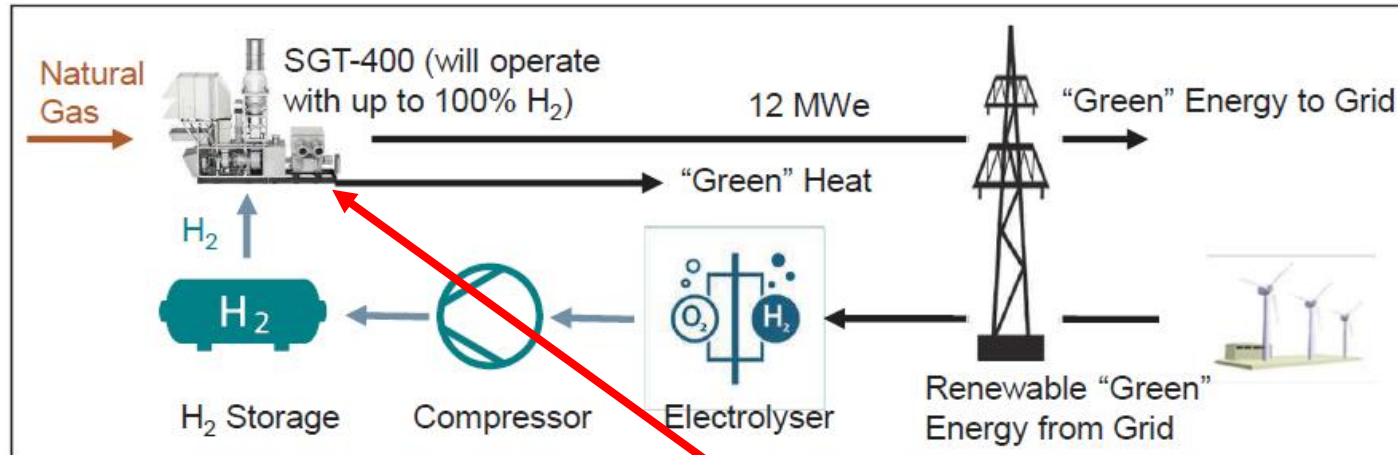
Source: 2G



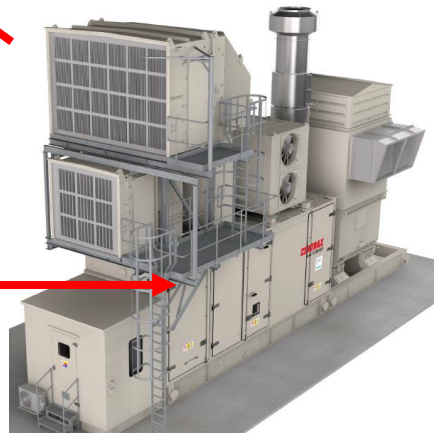
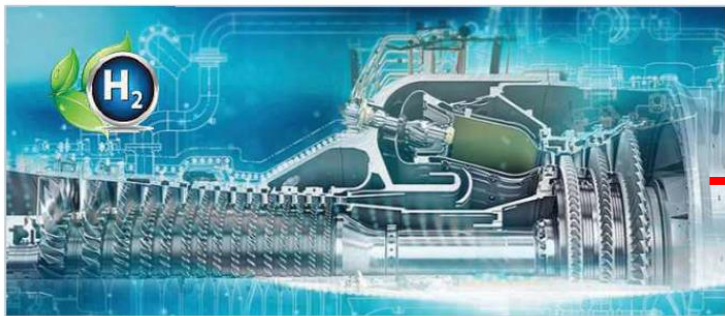
# Hydrogen-based cogeneration: already a reality – 4

## CO<sub>2</sub>-Free Energy in Industry with Hydrogen Turbine Cogeneration

Smurfit Kappa plant in Saillat-sur-Vienne - France



### GT for H<sub>2</sub> re-electrification



**Project duration: 2020-2022**

**12 MWe combined heat and power plant 80% efficient**

**Budget: €15.2M (€10.5M from EU H2020)**

**Smurfit Kappa: 350 plants in 35 countries**

**Solution is technically feasible**

- but requires public funding for business case
- EU Call Horizon 2020: LC-SC3-NZE-4-2019



# Hydrogen for the decarbonisation of industry & transport

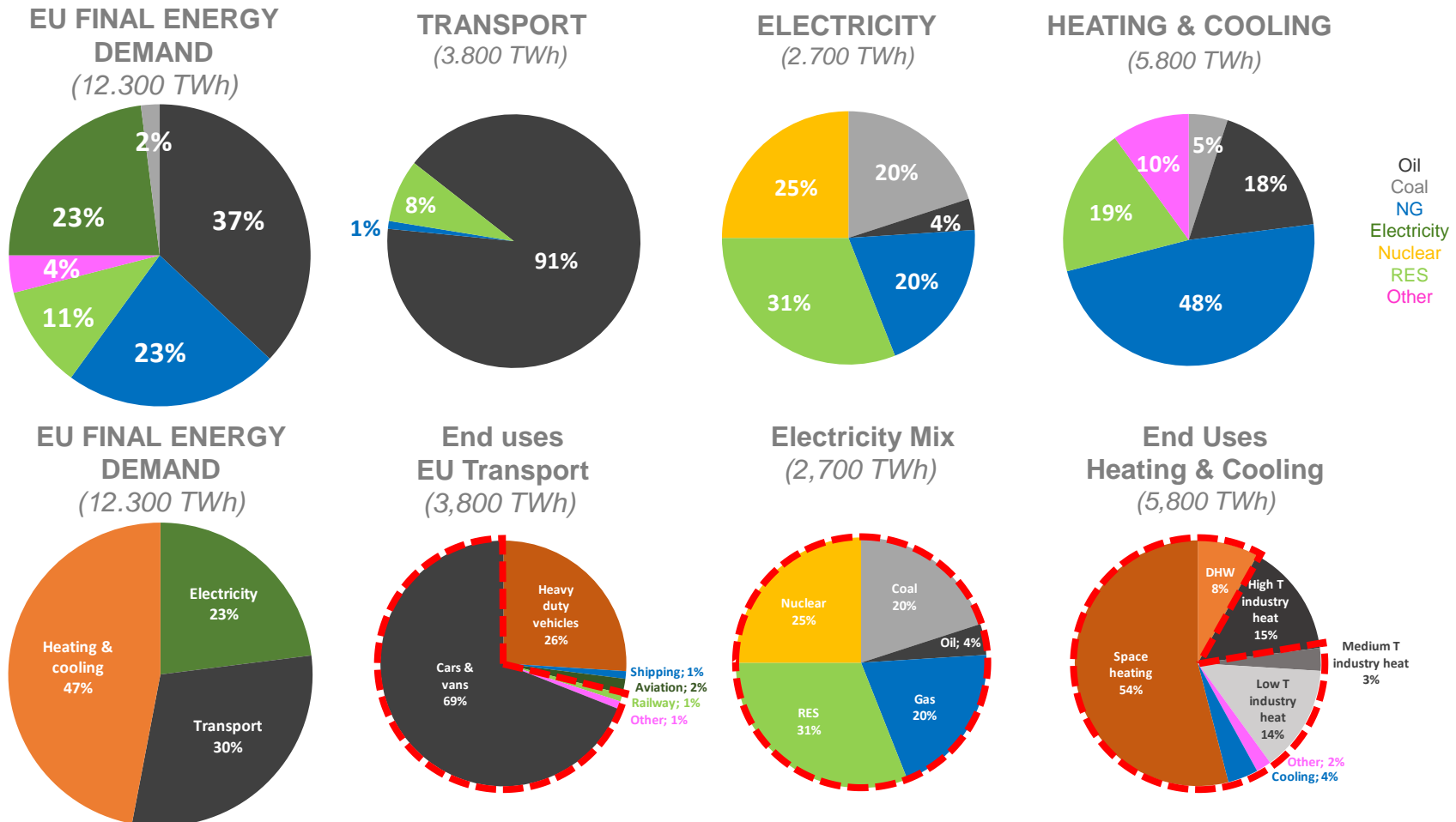
*Presented by*

Ane Landaluze Solaun, European Regulation Manager, IBERDROLA

Marion Labatut, Deputy director European Affairs and Head of the Brussels office, EDF Group



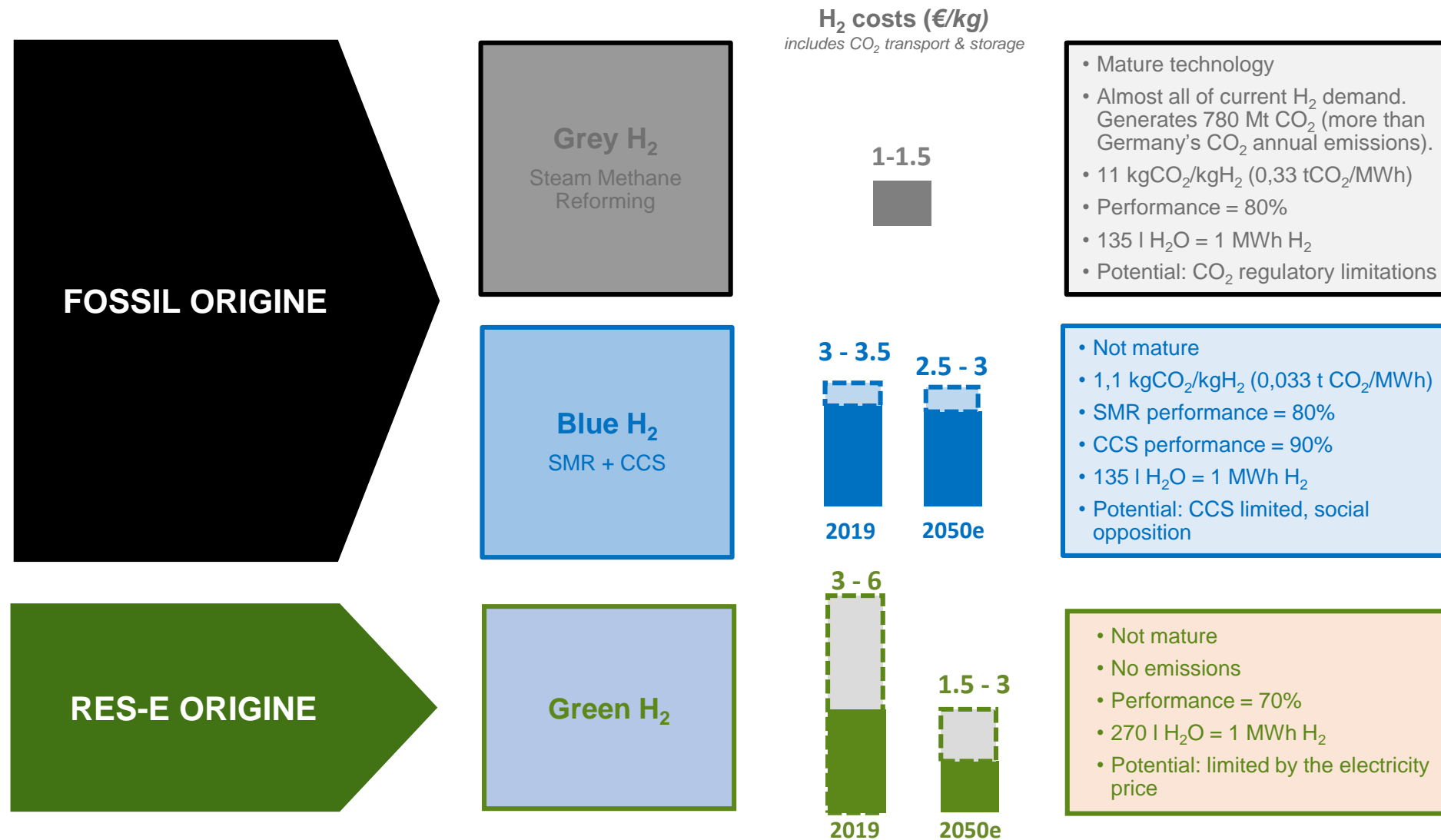
## Where could H<sub>2</sub> be used in the decarbonised future?



H<sub>2</sub> will be an alternative to decarbonise those niche sectors hard to electrify



## But not all types of H<sub>2</sub> are carbon neutral alternatives



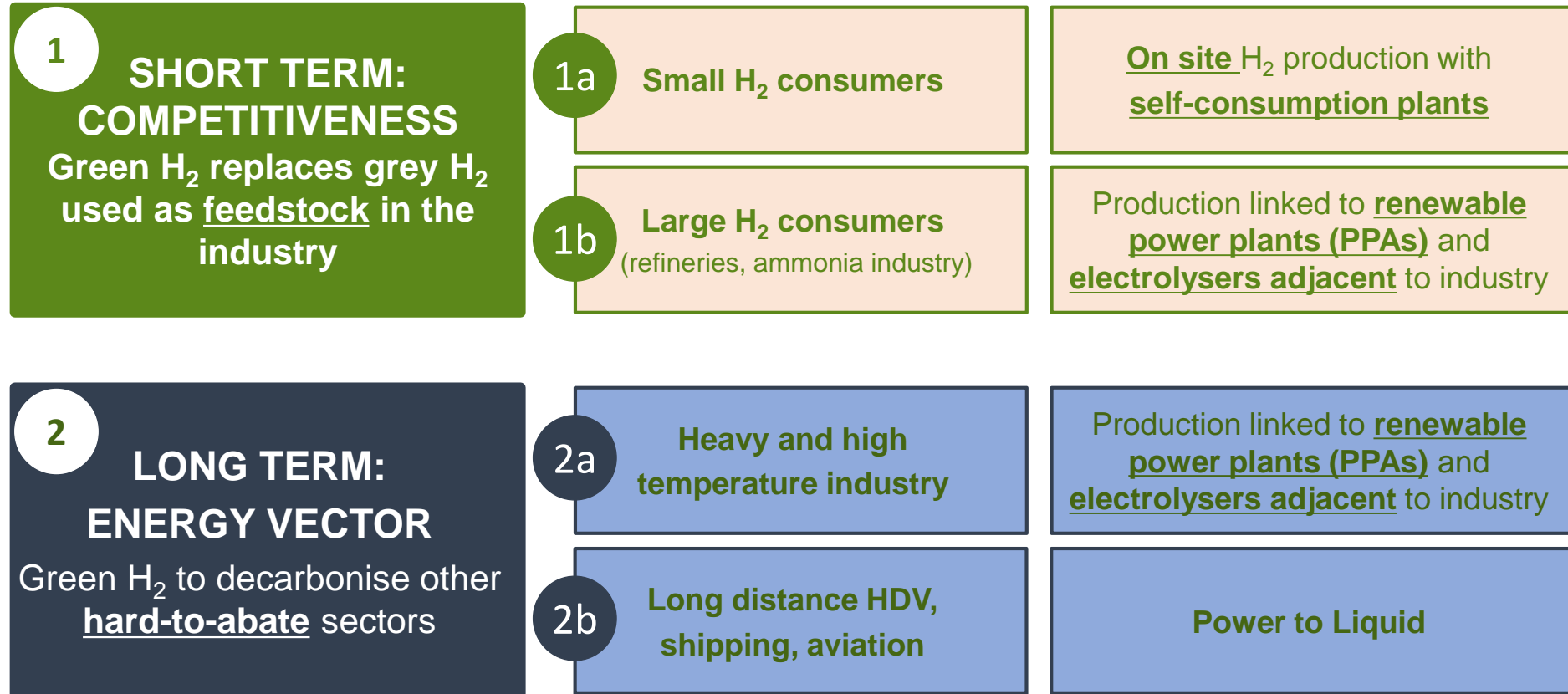
Slide provided by IBERDROLA

Natural Gas ≈ 13 €/MWh  
CO<sub>2</sub>: 100 €/ton  
1\$ = 0,92€





## A targeted approach to develop green H<sub>2</sub> in the industry: R&D on feedstock before deployment on hard-to abate



Technology leadership, impact on local employment & investments



# Clean H<sub>2</sub> proposal for the industrial area: [Puertollano Project](#)

## Industrial-scale pilot project for green H<sub>2</sub> production

### Main parameters:

- **30 MW** PV (AC)
- **5MW / 20 MWh** Battery
- **20 MW** PEM Electrolyser
- **8 km** direct electric line
- **2 sites** Iberdrola- Fertiberia

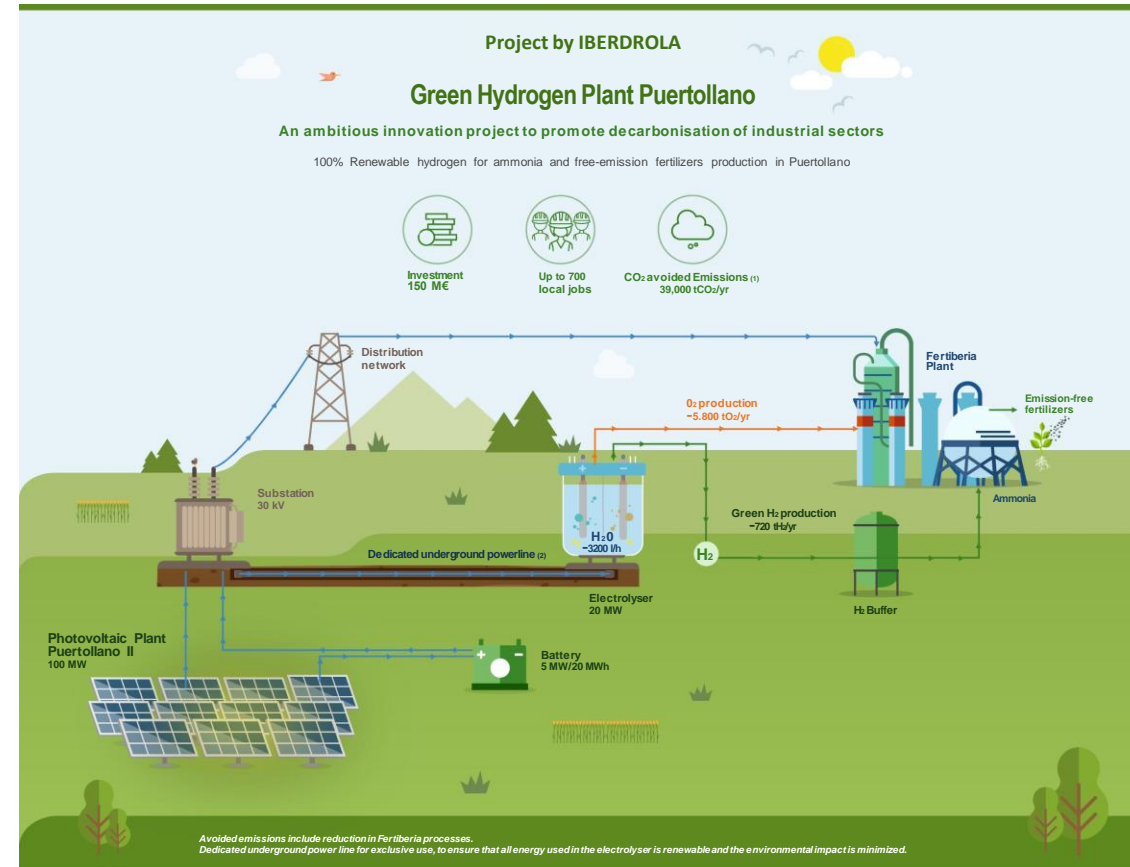
<b>Production H<sub>2</sub></b>	720 tH <sub>2</sub> /yr
<b>Production O<sub>2</sub></b>	5.800 tO <sub>2</sub> /yr
<b>Annual load factor</b>	2000 h (23%)
<b>Avoided CO<sub>2</sub> Emissions</b>	7000 tCO <sub>2</sub> /yr

### Initial investment Budget\* ~34 M€

- **Evacuation:** direct electric line ~3,4 M€
- **Electrolyser 20 MW:** ~28-31 M€

**Green H<sub>2</sub> produced at >5€/kg**  
**Grey H<sub>2</sub> production <1,5€/kg**

\* Under development by thermal generation eng. dept



**Today it's still not feasible without important subsidies**

Slide provided by IBERDROLA





Project by IBERDROLA

# Green Hydrogen Plant Puertollano

An ambitious innovation project to promote decarbonisation of industrial sectors

100% Renewable hydrogen for ammonia and free-emission fertilizers production in Puertollano



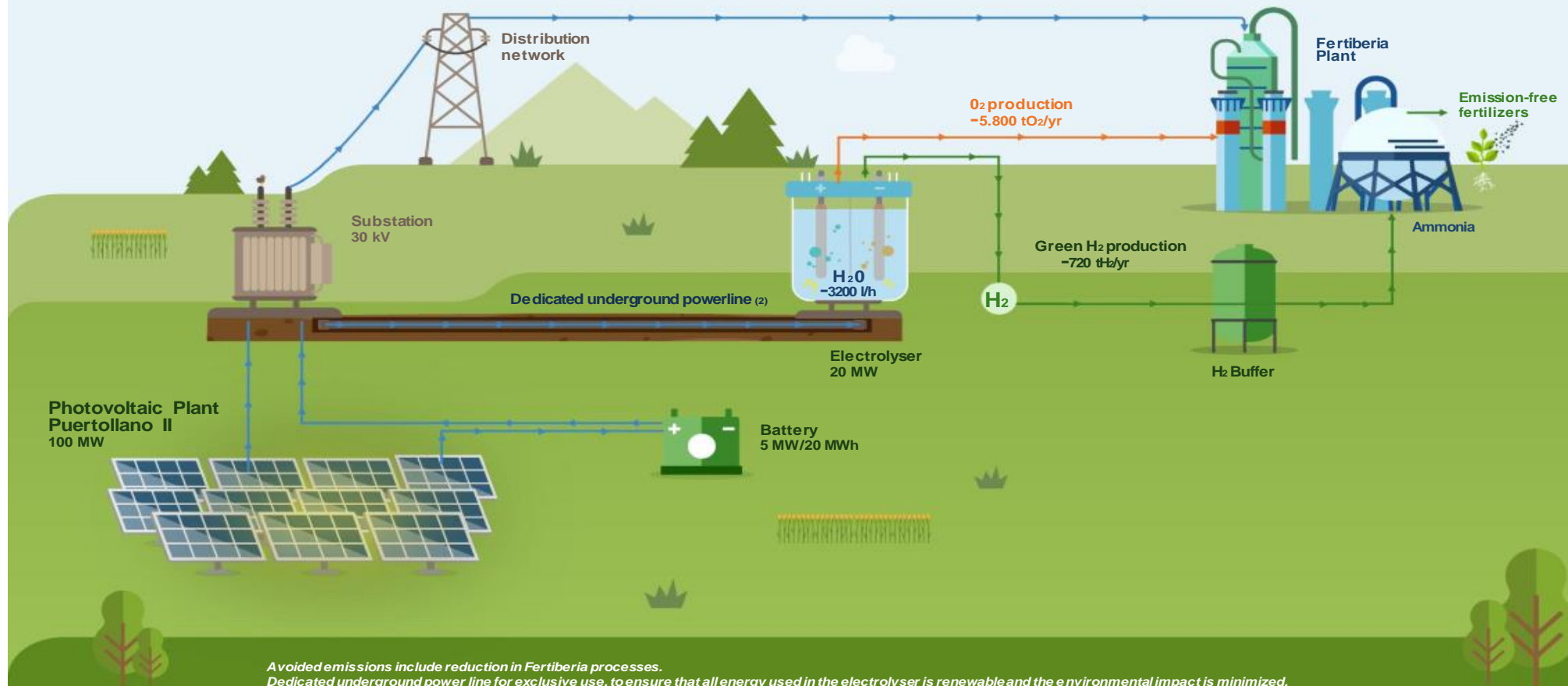
Investment  
150 M€



Up to 700  
local jobs



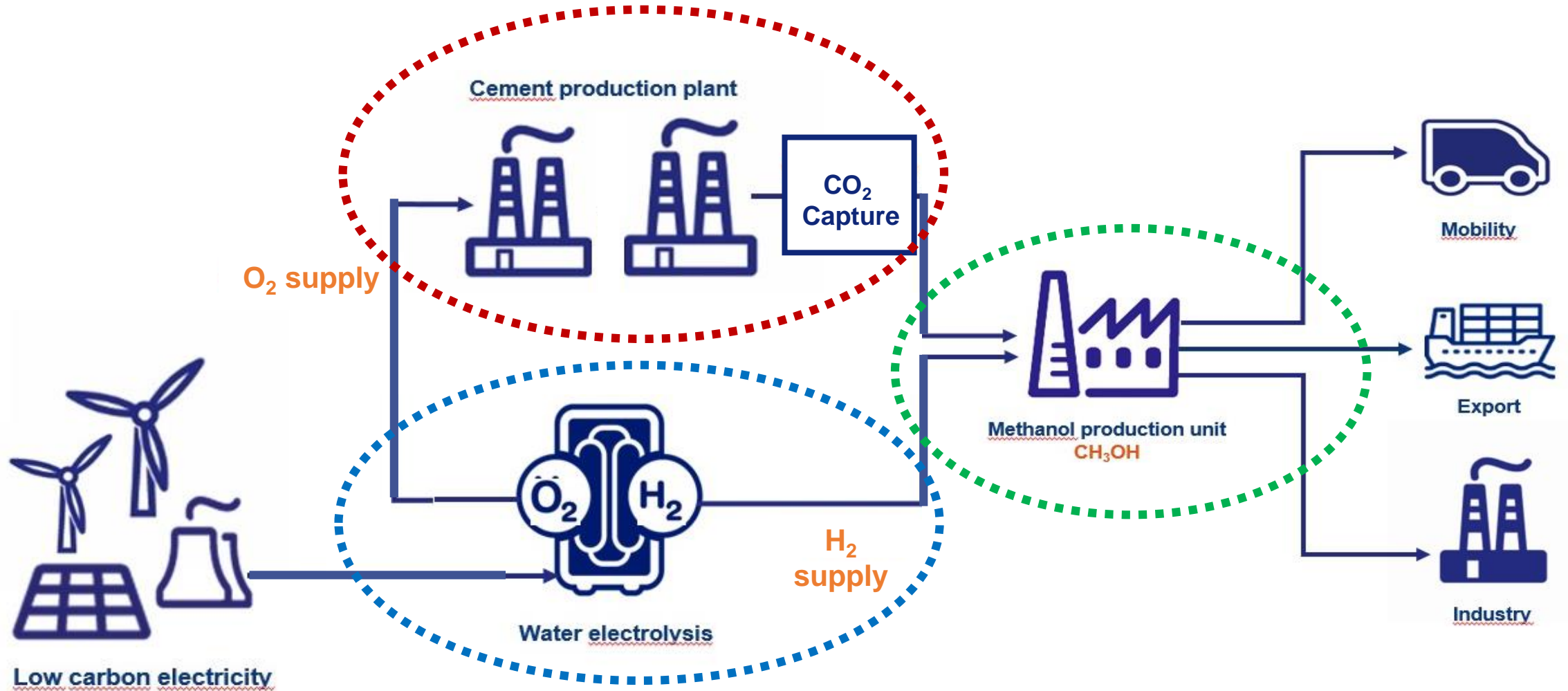
CO<sub>2</sub> avoided Emissions <sup>(1)</sup>  
39,000 tCO<sub>2</sub>/yr





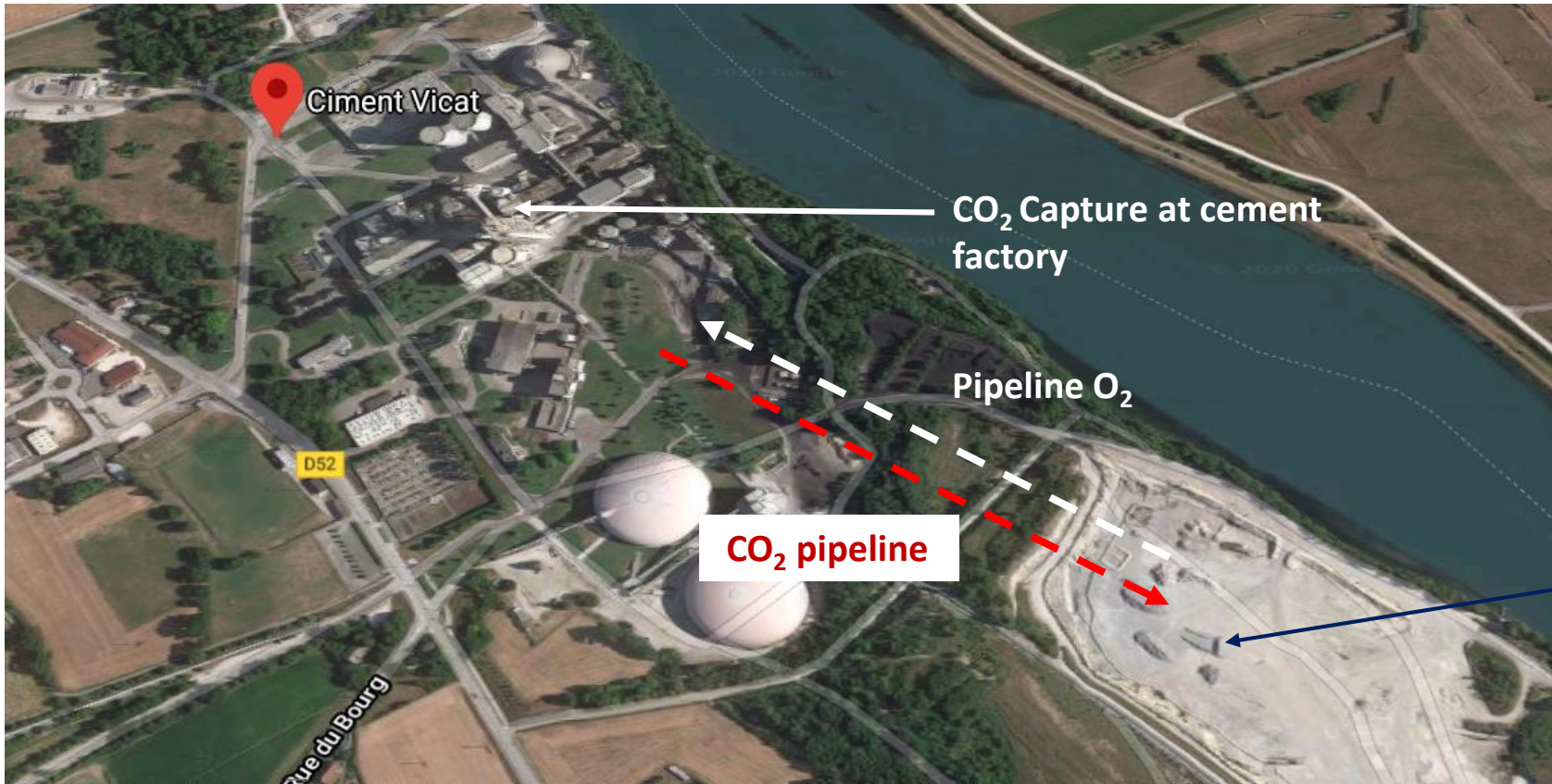
# DECARBONISING CEMENT PRODUCTION AND PRODUCING METHANOL WITH HYDROGEN - 1

## An integrated industrial process





## DECARBONISING CEMENT PRODUCTION AND PRODUCING METHANOL WITH HYDROGEN – 2



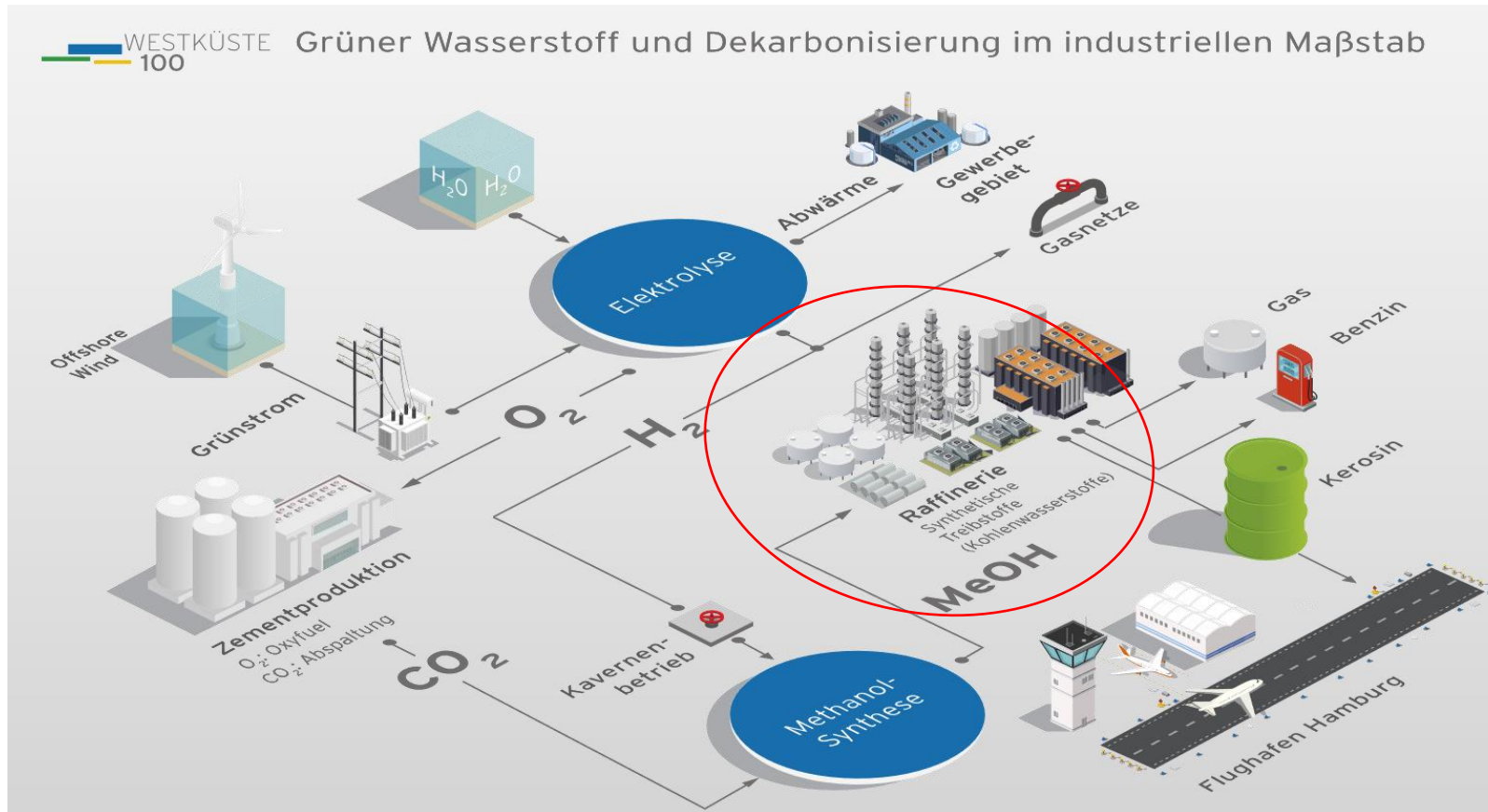
**Production of H<sub>2</sub> : construction of a 350 MW electrolyser connected to the grid**  
+  
**Purification of CO<sub>2</sub>**  
+  
**Production of Methanol (CH<sub>3</sub> OH)**

### Key facts and figures:

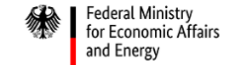
- 2,6 TWh/year electricity consumption: one of the biggest electricity consumers in France
- 1.1 Mt CO<sub>2</sub> emissions avoided/year
- Total investment: 528 M€ - OPEX: 310M€/year
- Support is required and the business case depends on the value of the CO<sub>2</sub> captured



# DECARBONISING FUEL PRODUCTION: REALLABOR PROJECT WITH THE HEIDE REFINERY



Supported by:



on the basis of a decision  
by the German Bundestag

- **Phase 1:** A 30MW electrolyser to produce H<sub>2</sub>, used to refine petroleum, replacing fossil H<sub>2</sub> in the process. German ministry BMWi already agreed to subsidize this project, which is already started together with the feasibility study of Phase 2
- **Phase 2:** A 700MW electrolyser with full speed production and industrial processes by 2030

## Added value of the project

- **Accelerating the learning curve:** knowledge and feedback on environmental, technical and economical aspects related to safety rules, technologies, control and O&M, as well as the integration of the electrolysis plants into a broad industrial process and energy system
- **Decreasing costs:** scaling-up to multi MW, then multi-100s of MW, industrializing manufacturing, design, planning, build and operation.
- **Finding the right business model:** a support scheme bringing the level of risk at an acceptable level



# DECARBONISING TRANSPORT: HYDROGEN REFUELLING STATION AND USE CASES



## Examples on the basis of buses or trucks driving 200km/day

### Consumption of 1 bus/day:

⇒ 10 kg H<sub>2</sub>/100 km

⇒ 20 kg H<sub>2</sub>/day

### Consumption of 1 truck/day:

⇒ 20kg H<sub>2</sub>/ 100km

⇒ 40 kg H<sub>2</sub>/day

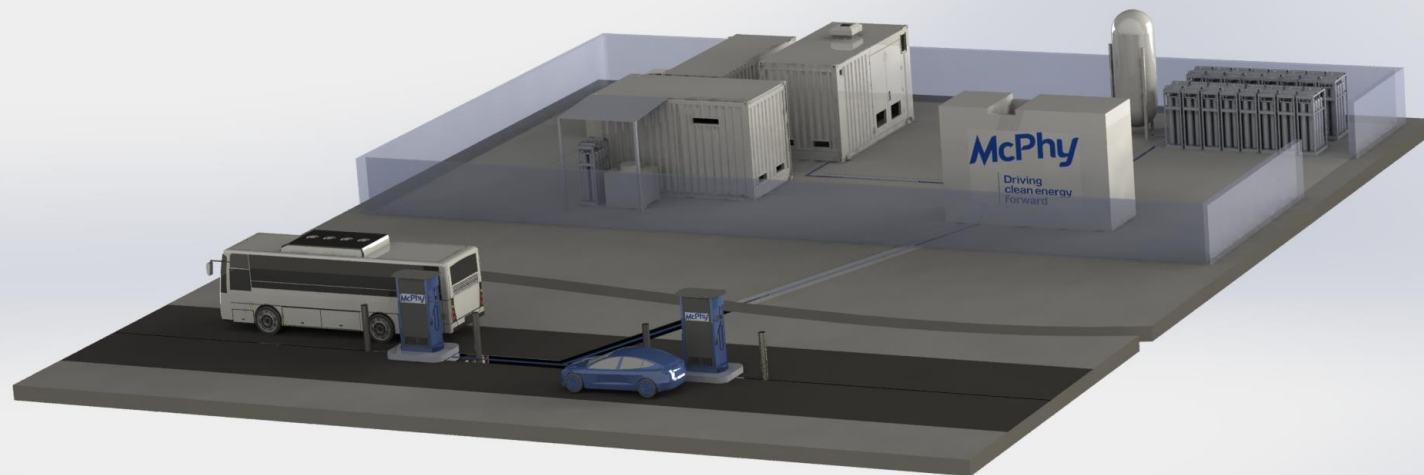
1 MW electrolyser produces 400 kg H<sub>2</sub>/day

⇒ 1MW electrolyser can power 20 buses max, or 10 trucks max.

⇒ CAPEX of a 1 MW H<sub>2</sub> station: : 5-6 M€

⇒ CAPEX of a 2 MW H<sub>2</sub> station : 7-8 M€

Recharging time: 3 to 5 minutes



A modular approach: possibility to recharge a wide range of vehicles at the same stations



# Intervention by the European Commission

*Tudor Constantinescu, Principal Adviser to the Direct-General for Energy,  
DG ENER, European Commission*