Latest in H2 blending
WGMSC 2024
Salt Lake City

PAVING
THE WAY TO
HYDROGEN

Paving the way to Renewables

Accelerating new energy value chains in the gas infrastructure of tomorrow

Green Value Chains

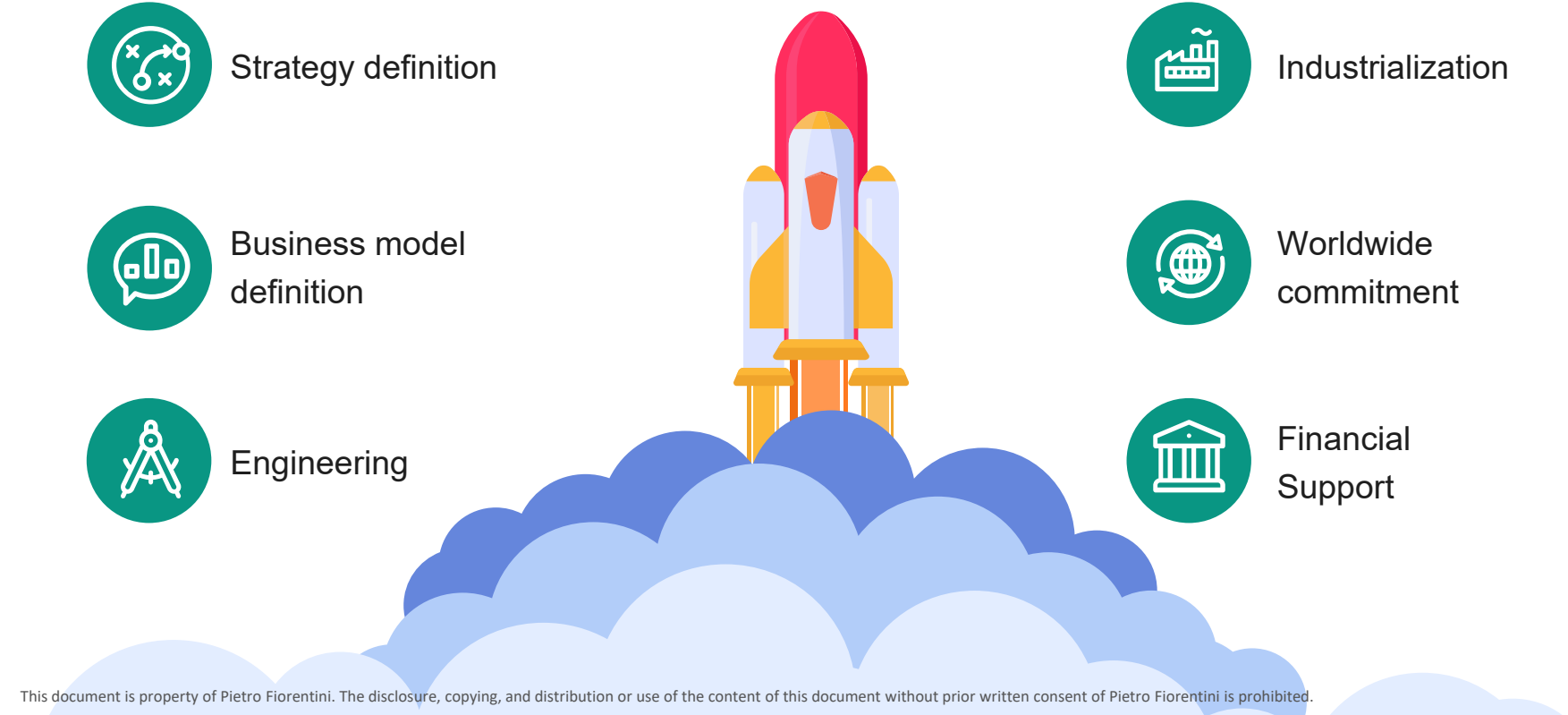
1. Green Molecules Production
2. Power2X
3. Carbon Capturing Usage & Storage

Green Gas Networks

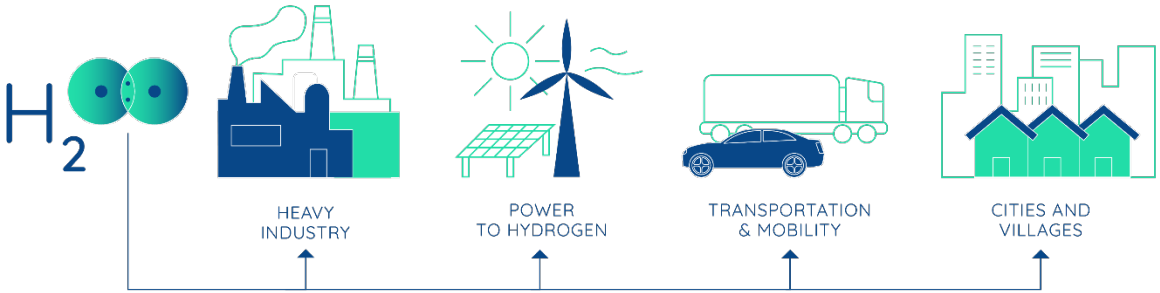
4. Systems for Gas Grid acceptance
5. Grid readiness to Green Gases
6. Gas Grid Efficiency

Ways to accelerate

- Strategy definition
- Business model definition
- Engineering
- Industrialization
- Worldwide commitment
- Financial Support



Hydrogen final use

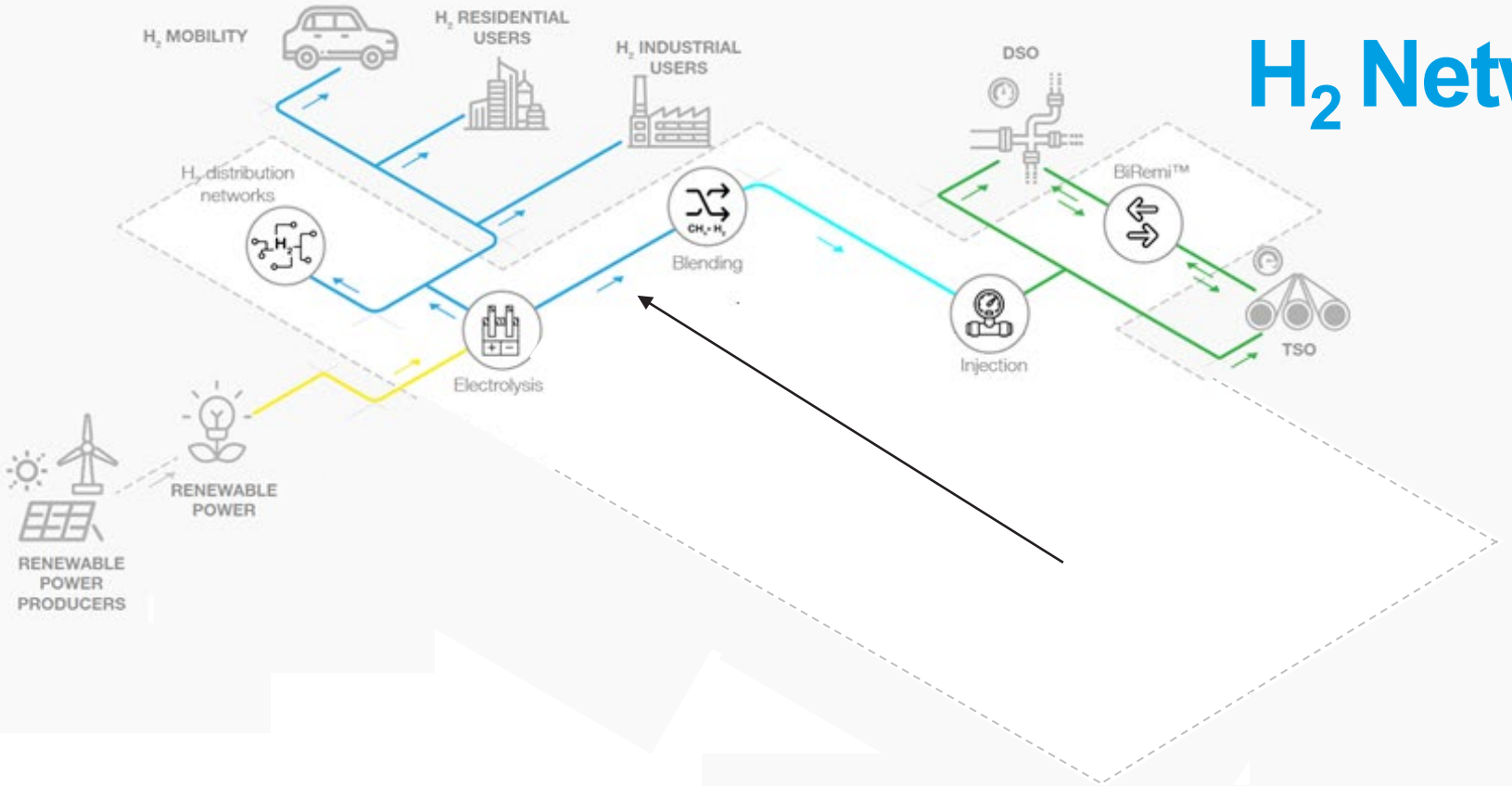


	HEATING	MOLECULES	PRODUCTION	FLEXIBILITY	REFUELLING	ENERGY
BIG	• Steel mills • Pottery • Food	• Ammonia • Refineries • Chemical industry	• Syngas methanation • Biogas methanation • Carbon utilization / circular economy • Gas Grid Hydrogenization	• Dispatching service / Grid balancing • Capacity payment for industry using H2 produced	• Light Vehicles • Heavy Vehicles (trucks) • Trains & Ships • Material Handling	• Heating • UPS / micro UPS • Broadcasting / Base stations • Energy Islands & Energy communities
SMALL	• Weldings	• Pharma • Nitrogen • Alternators cooling • Electronics		• Make predictable renewables • Minimize curtailments • Energy trasport w/o grid		

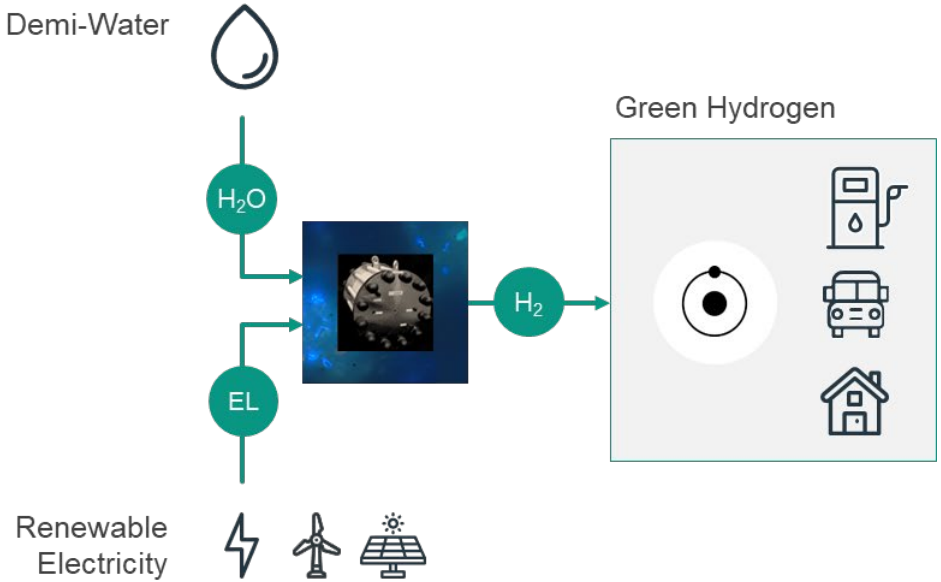
GRID

BEHIND THE METER

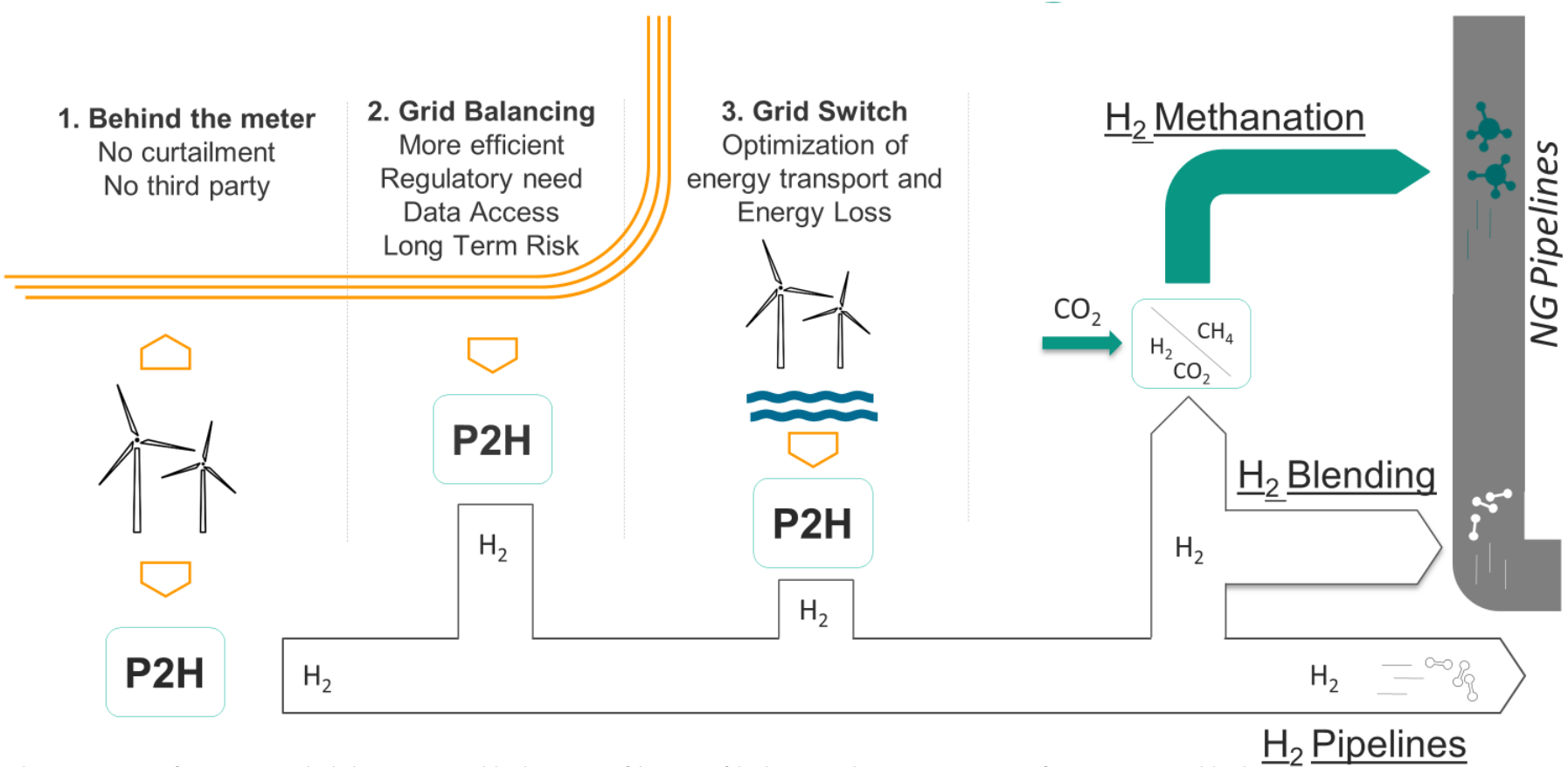
H_2 Networks



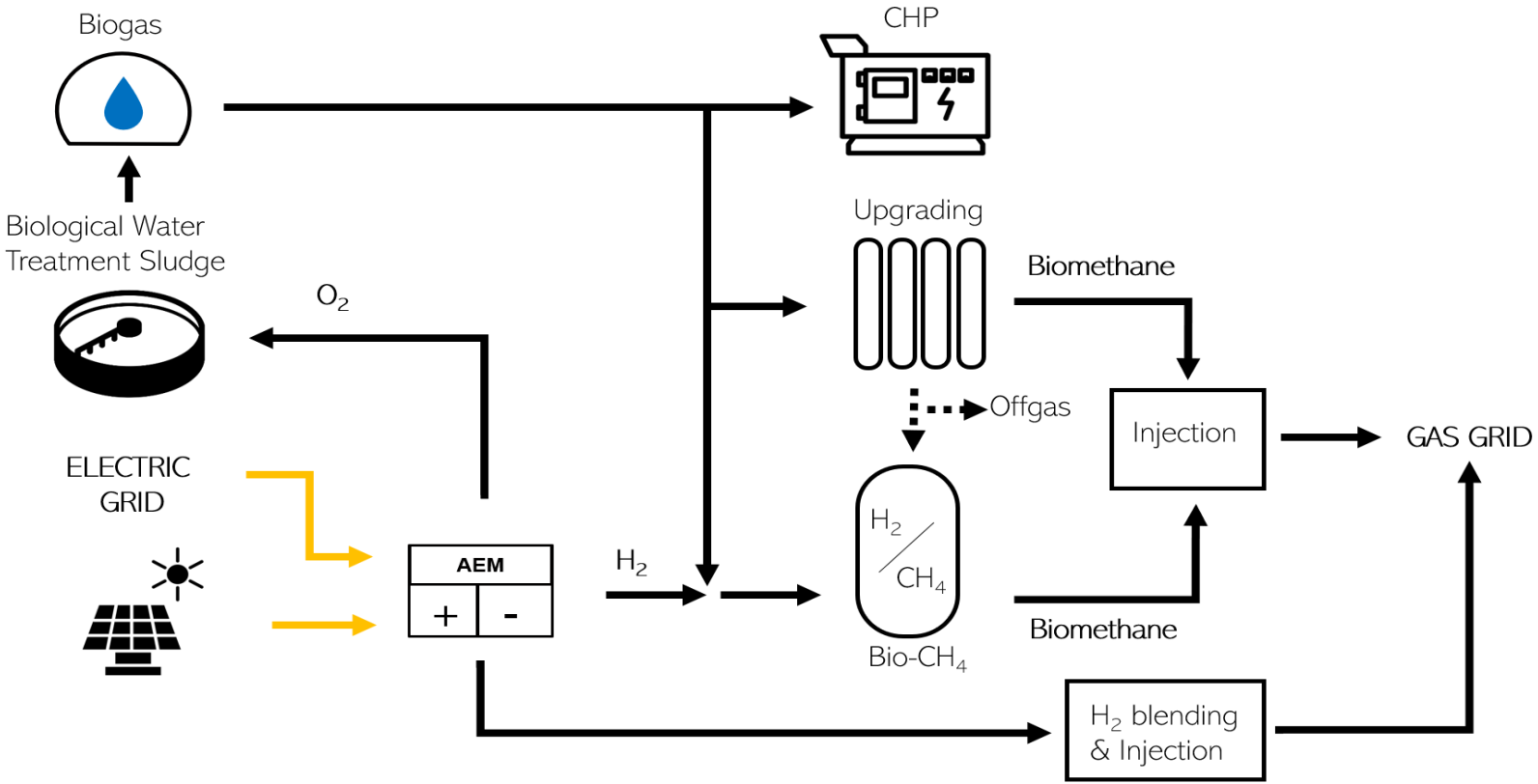
How it works – AEMWE



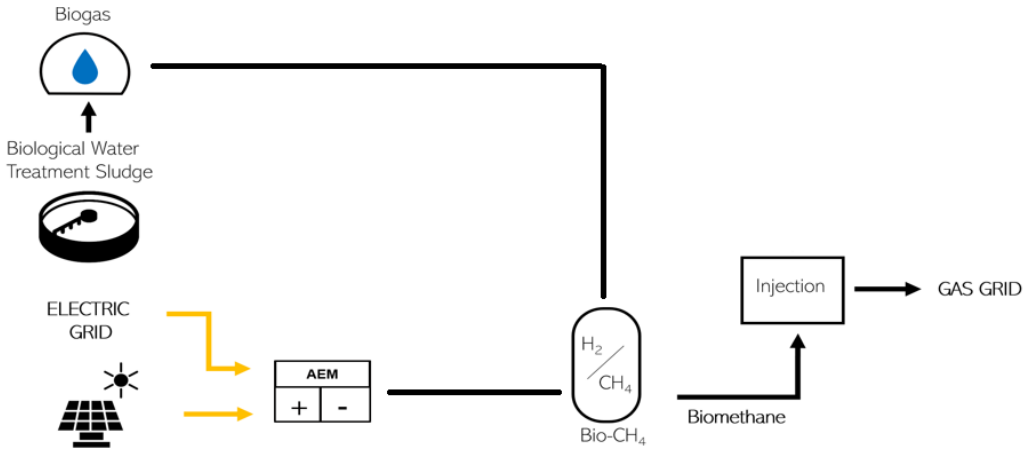
P2G: new value chains



Solutions for P2G



BIOFARM Straubing - Germany

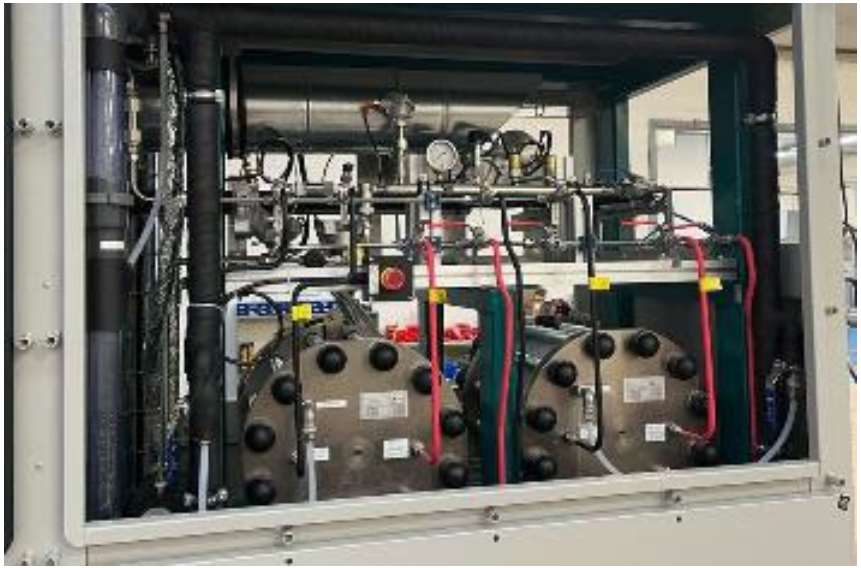


H_2 Production

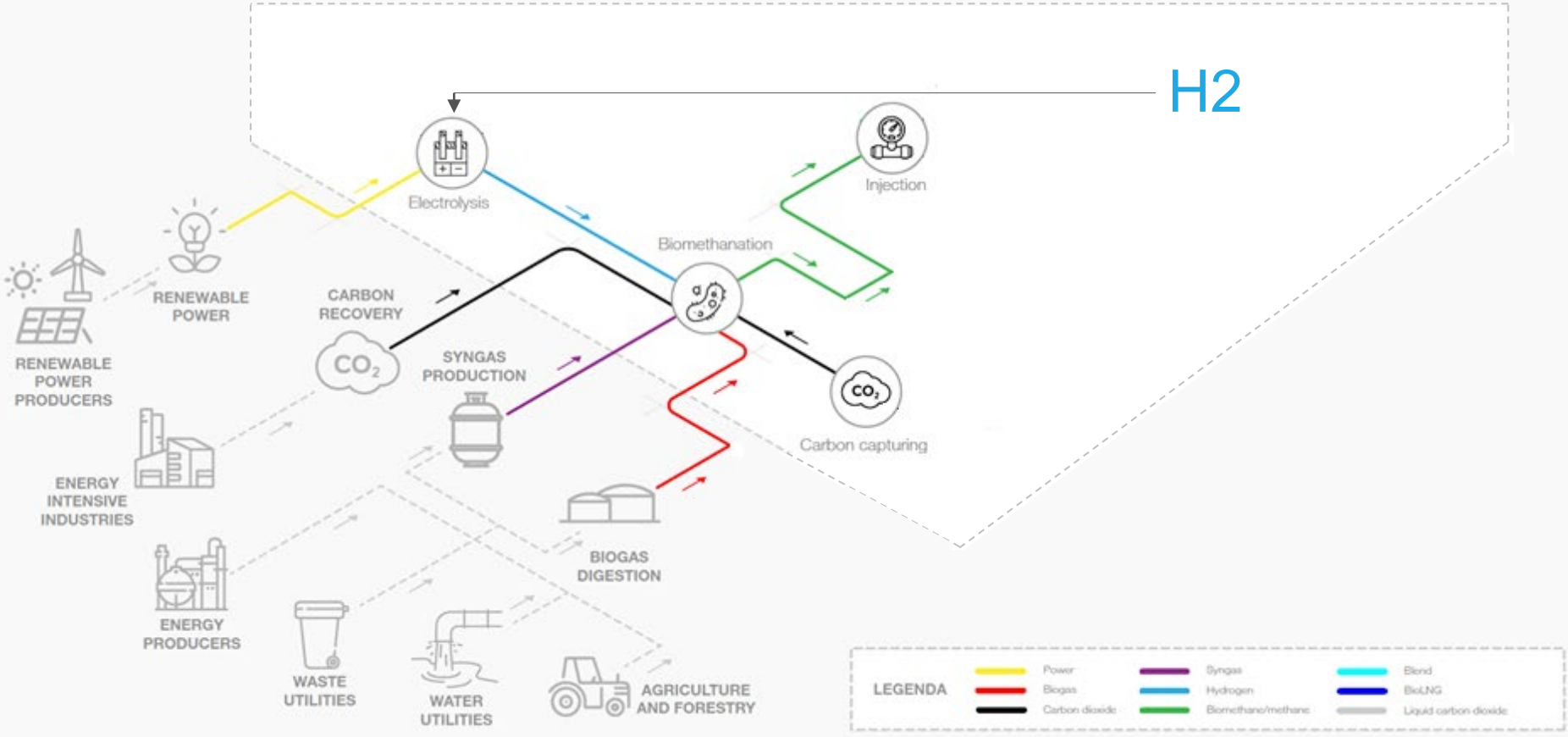
A fully dedicated 40 kW AEMWE electrolyzer is installed to fully replicate a P2G system.

Technical Data

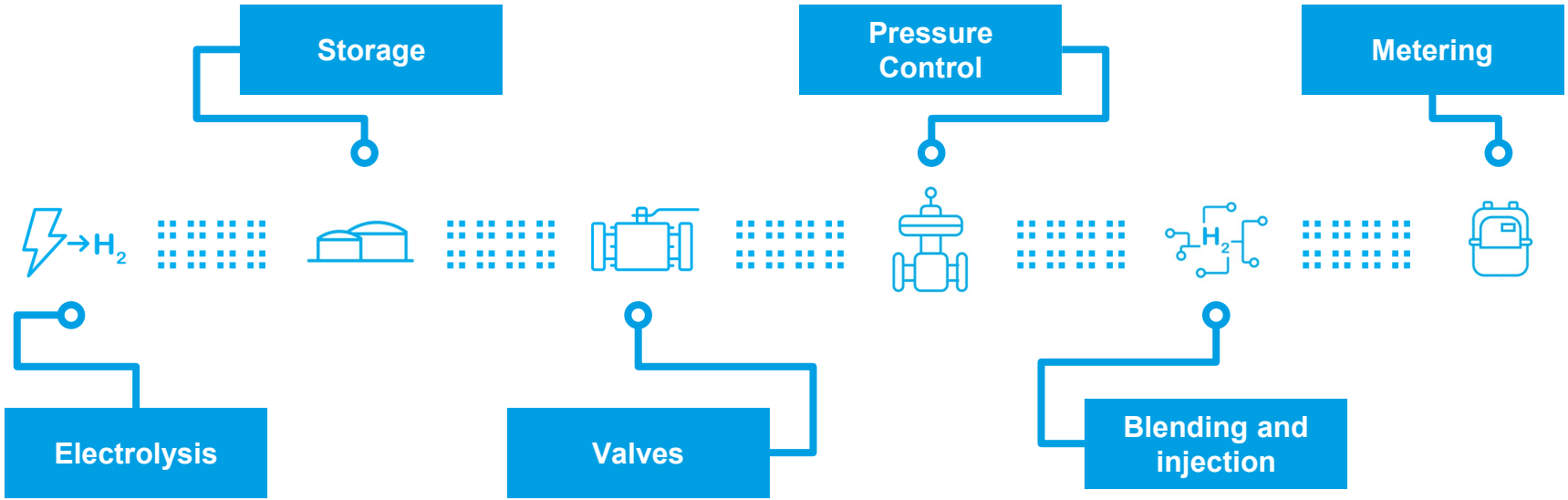
- **40 kW** electrolyzer, with room for another 40 kW stack
- **400 liter** bioreactor volume
- **300 SCFH** H_2 production and consumption
- **70 SCFH** CH_4 production
- **90 – 145 Psi** operational pressure range
- **212°C** max operational temperature
- **>96%** product CH_4 purity
- **CO_2, CO, H_2, CH_4** cylinder for syngas simulations



New green molecules

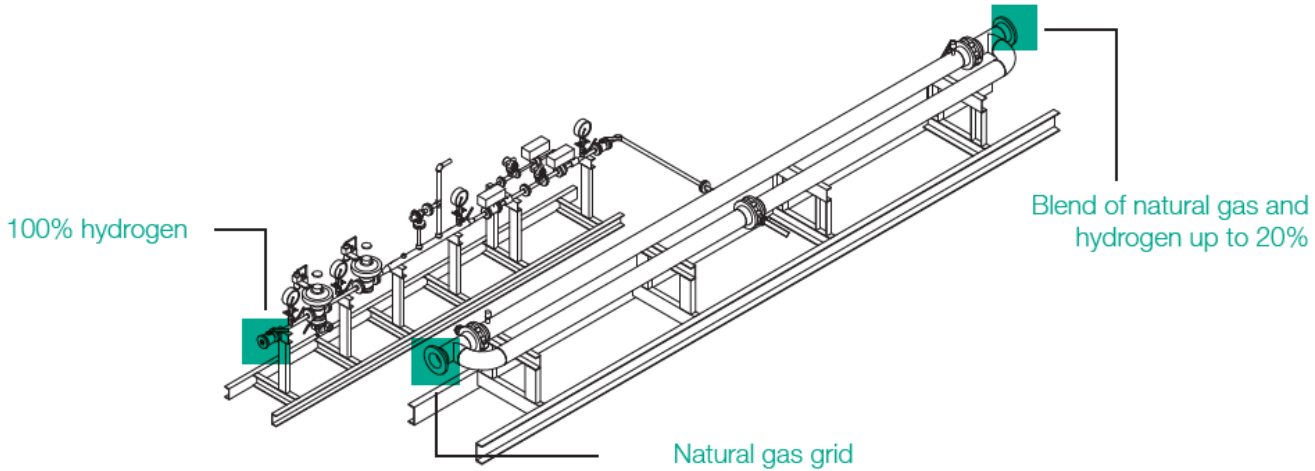


The Hydrogen Package Concept

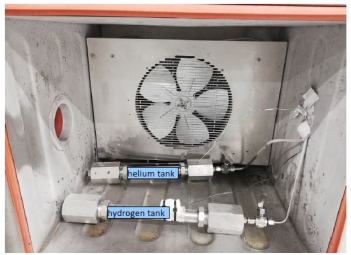


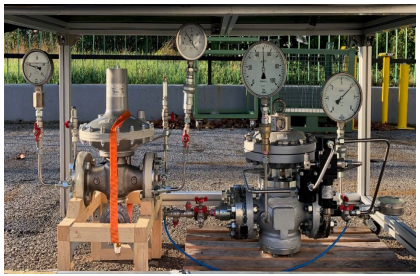
Blending equipment consideration:

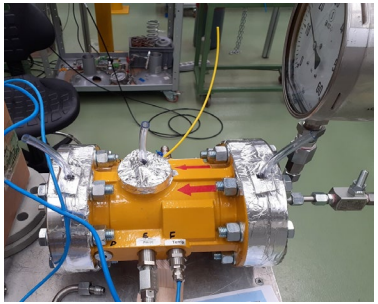
- Metal materials characteristics
- Elastomeric materials characteristics
- Auxiliaries materials characteristics
- Tightness of external devices
- Tightness of internal devices
- Equipment performances



H_2 gas networks readiness







Material selection

- Rubbers behaviours (aging, permeability)
- Metals (hydrogen embrittlement)
- Plastics
- Lubricants

Performance

- HHV vs. Flow Rate
- Technology readiness
- Metrology
- Accuracy
- Tightness

Certifications

- ATEX classification for different hydrogen blends (NG IIB -> 100% H2 IIC)
- Production approval (tightness test and approval process)

Field operators safety training & certifications

- Field installation
- Commissioning
- Maintenance
- De-commissioning

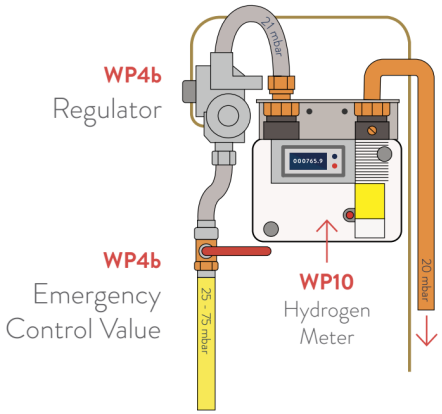
Hydrogen Innovation Labs

H_2 New Hydrogen Products

Hy4Heat Project Target: Establish if it is technically possible, safe and convenient to replace natural gas with 100% hydrogen in residential and commercial buildings and gas appliances.

WP4b : Domestic appliance development

Pressure Regulator, Emergency Control Valve, Excess Flow Valve and Flexible hose and fittings suitable for 100% hydrogen



WP10 : Residential solid state meter

Measures natural gas & up to 100% hydrogen

Ultrasonic flow sensor able to cover large flow range span

West Macedonia project by DESFA

Hellenic Gas Transmission System Operator S.A.

First high-pressure transmission gas pipeline in Greece, certified to transport up to **100% hydrogen**.

It is part of the **European Hydrogen Backbone**, the hydrogen infrastructure needed to achieve EU climate and energy objectives

Hydrogen Blending & Injection Unit

Operating conditions:

- Hydrogen blending steps: **5-10-15-20%**
- NG pressure: **4 bar**
- Hydrogen pressure: **40 bar**
- NG flowrate: **500 Nm^3/h**

Solution features:

- **Control panel** for remote monitoring & control
- **PLC based**
- Minimum flow-rate managed: **0,25 Nm^3/h**

Grid Injection Unit – Blended gas

Rentable solution to connect tube trailers for
temporary injection of hydrogen blending up to 20%

Solution features:

- Pressure control from **250bar to 20mbar**
- Gas Quality Analyzer
- Measuring section
- Smart Gas Unit with Wi-Fi remote control

H_2 Pressure Reduction Station

Pressure Reduction Station for 100% H2 properly working

Operating conditions:

- Inlet Pressure: **90 barg**
- Outlet Pressure: **7 barg**
- Max Flow rate: **4.000 Sm3/hr**

H_2 Pressure Reduction Station

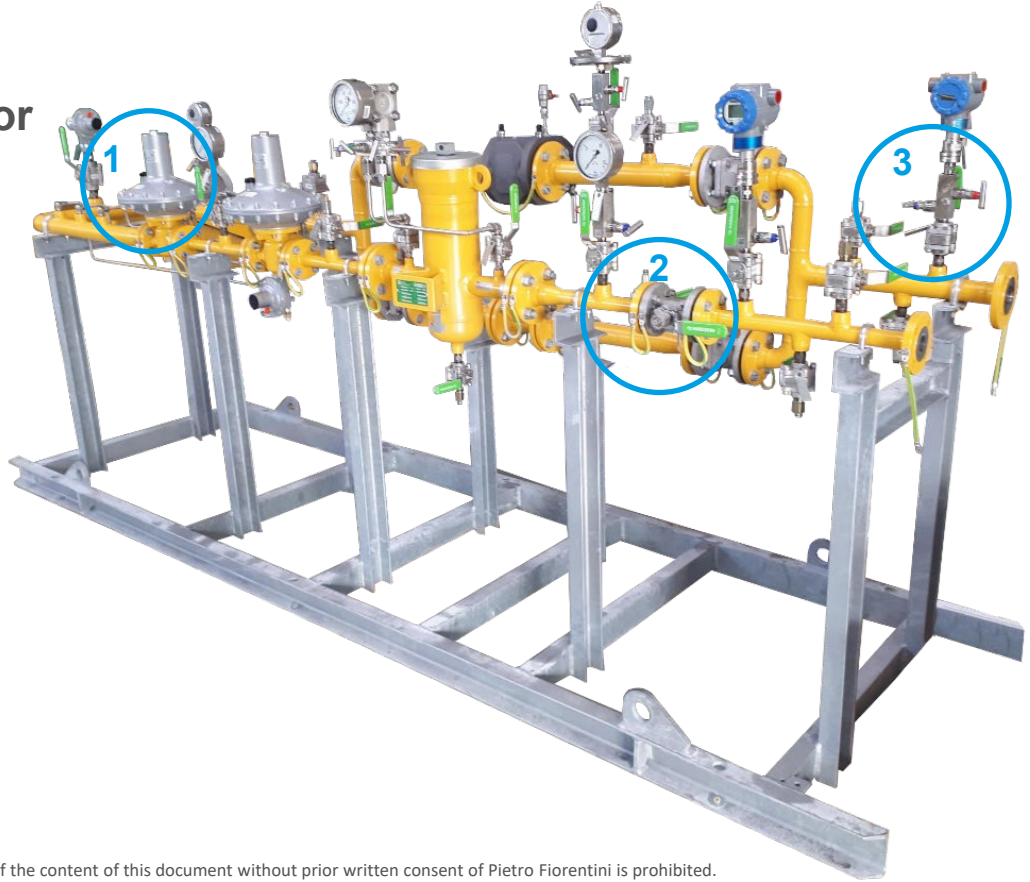
Pressure Reduction Station for 100% H_2 for a Laboratory in UK

Operating conditions:

- Inlet Pressure: **7 barg**
- Outlet Pressure: **75 mbarg**
- Max Flow rate: **150 Nm^3/hr**

PF H2 products and engineering:

1. Direct operated gas pressure regulators,
2. Slamshut valves,
3. Filters
4. Piping



European Market Trends

Mismatch between H2 production and demand targets affecting market development

Production targets (global): 27-35 Mt vs Use targets (global): 14 Mt

Only 4% announced production projects have taken FID

European Hydrogen Bank: 800 M€ for the pilot auction to be launched on November 23rd

Fixed premium up to 4.50€/kg of RFNBO for 10 years

Minimum electrolyzer capacity: 5 MW

Focus France → 4 B€ to support hydrogen production with "contracts for difference"

Calls for tenders to allocate 1,000 MW production capacity

Mismatch between H2 production and demand targets affecting market development

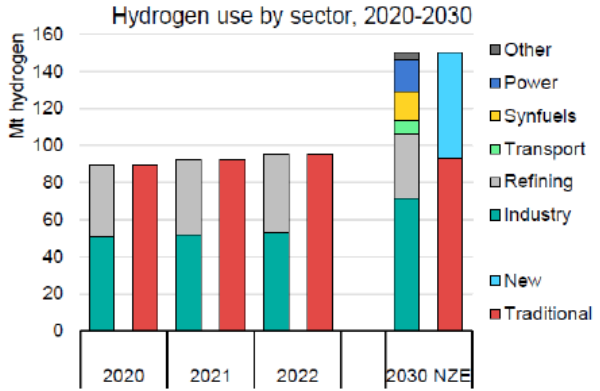
Measures to stimulate low-emission hydrogen use are still not sufficient to meet global climate ambitions

Government action has been focused on supporting low-emission hydrogen production, with less attention to the demand side. The sum of all government **targets** for low-emission **hydrogen production** accounts for **27-35 Mt** today, but **targets for creating demand** account for just **14 Mt**, **less than half of which is focused on existing hydrogen uses, which by contrast are the main sectors for demand.** Without robust demand, producers of low-emission hydrogen will not secure sufficient off-takers to underpin large-scale investments, jeopardising the viability of the entire low-emission hydrogen industry.

So, despite the efforts on supporting production, the **lack of measures to boost hydrogen use reflects negatively on production projects implementation**. Indeed, even if global announced projects for low-emission hydrogen could lead to an annual production of 38 Mt in 2030, **only 4%** of the announced projects, in terms of production, are currently **under construction or have taken a final investment decision (FID).**

Hydrogen demand: 95 Mt in 2022, but still concentrated in traditional applications

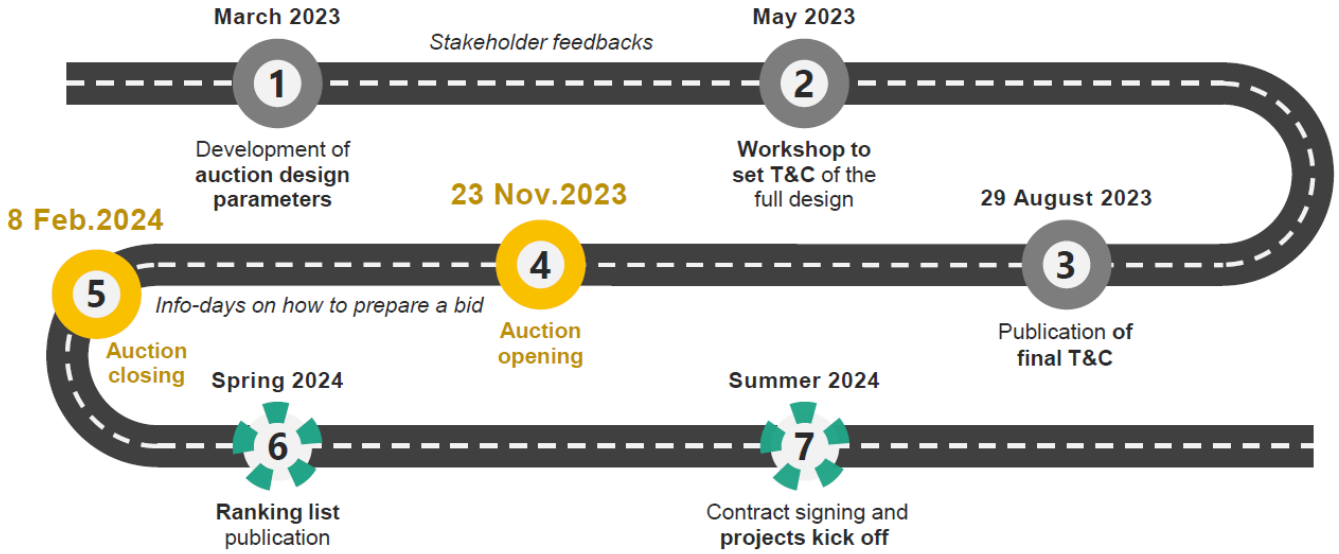
As of 2022, demand remains concentrated in industry and refining, with less than **0.1% coming from new applications** in heavy industry, transport or power generation.



European Hydrogen Bank

European Hydrogen Bank wants to connect H2 supply and demand, reducing the cost gap and enabling price discovery to finally ensure a fast roll-out of H2 market.

Financing mechanism: H2 producers will be rewarded with a fixed premium (€/kg) for 10 years covering the gap between the LCOH and revenues.



Focus France

On August 29, the French Minister for Energy Transition, Agnès Pannier-Runacher, announced the signing of a decree to launch a mechanism to support **low-carbon hydrogen** production. **4 B€ will be allocated between 2024 and 2026** through a system of **contracts-for-difference** (CfDs) for a duration of **15 years** with the aim of **covering the cost gap between green and grey H2**. In detail, calls for tenders will be launched in 2024, 2025 and 2026 to allocate production capacity, in the form of tranches of **150, 250** and **600 MW** respectively, for a total of 1,000 MW.

Mechanism and evaluation of projects:

- **"calls for projects"** consisting in a dual evaluation criteria:
  - **70%** of the assessment comes from **price considerations (based on a ratio of €/ton of carbon avoided)**
  - **30%** of the assessment comes from **non-price variables** (not yet communicated)
- **Bonuses** will be paid **to projects that can curtail production in order to redirect renewable electricity to the grid when demand is high**
- **Extra incentives** will be awarded **to plants where 50% of the power input comes from newly built renewables** (suggesting that the **French criteria for "low-carbon" H2 does not match completely with the EU's delegated acts definition of RFNBO**, where newly built renewables are mandatory).

Focus: French loopholes to RED targets and Delegated Acts

RED target	Exemption	Nuclear contribution for France
42.5% of **RFNBO-hydrogen** in industry by 2030, rising to 60% in 2035.	**20% discount** on this target as long as Member States can prove that their national contribution to the overall EU renewables target meets their expected contribution, and if the **share of hydrogen from fossil fuels** consumed in the country is **not more than 23% in 2030** and 20% in 2035.	Producing some of the **hydrogen for industrial use from nuclear reactors will make France fall under the exemption** concerning RFNBO-hydrogen to be used in industry
Delegated Acts: Additionality	**Exemption**	**Nuclear contribution for France**
Use of renewable electricity coming from newly installed and dedicated renewable generation for RFNBO-hydrogen production	**Electricity to be taken off the grid without new renewables being built** as long as the **bidding zone's carbon intensity is less than 18 grams of CO2-equivalent per megajoule** (64.8CO2e/kWh) — although a renewable PPA is required, and time matching rules will still apply.	France's **nuclear-dominated power mix may allow it to bypass the requirement** for additionality

European Power and Gas systems with METIS

Level-1

Adopted without major technical or regulatory interventions at the transmission and distribution level.

Table 1. Admixture threshold levels

	% vol	% HHV
Level-1 (Early)	2-5	0.6-1.6
Level-2 (Mid)	15-20	5.1-7.1
Level-3 (Advanced)	50	23.4

Level-2

Possible without major adaptation of the existing gas infrastructure . However the impact of H2 on the Wobbe Index (and other gas quality parameters) may require modifications of end-use appliances on certain types of consumers, most notably transformation assets in power generation and sensitive industrial end-users.

Level-3

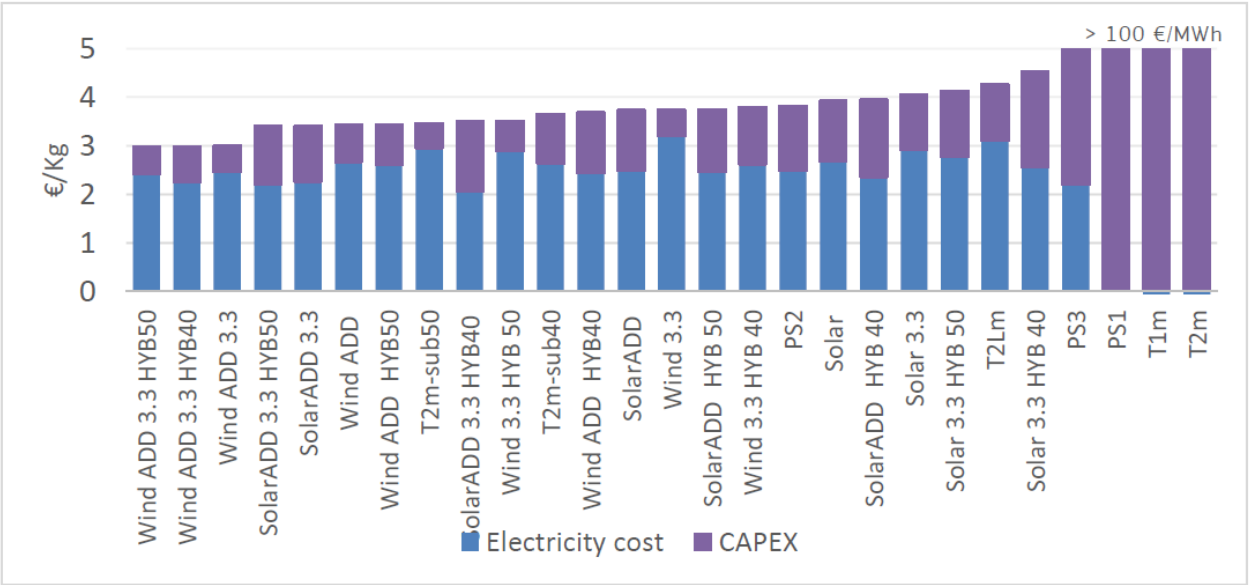
A final interim step towards a hydrogen grid. It is likely that this level of hydrogen concentration would not be equally feasible for all types of networks/end uses. The present analysis has not looked into hydrogen content at the level-3 thresholds since it focuses on 2030, by which time hydrogen production capacity is unlikely to have scaled up to the level required to support such concentration levels.

European Power and Gas systems with METIS

Without a price support scheme hydrogen would not (yet) be dispatched on pure economic terms in the gas market as another source of gas.

Renewable and low-carbon hydrogen today could be produced at a cost ranging between 2.5 and 5.5 €/kg (2) (63-140 €/MWh - HHV), and although costs are expected to fall sharply, it's highly unlikely that it will compete by 2030 with natural gas on the spot market.

European Power and Gas systems with METIS



- The addition of renewable capacity in the power system.
- Linkage to wind.
- Application of a hybrid RES-market configuration.
- Linkage of electrolysers to renewable capacity that is a multiple of their own installed capacity

Hydrogen Future

Blending up to 20%:

- Opportunities → Industrial processes
  Gas Networks ?

- Power generation surplus

100% Hydrogen

- Mobility
- Industial applications
- New constructions
- Small networks

7% GN Reduction

Thank you

Technologies and solutions for a digital and sustainable world