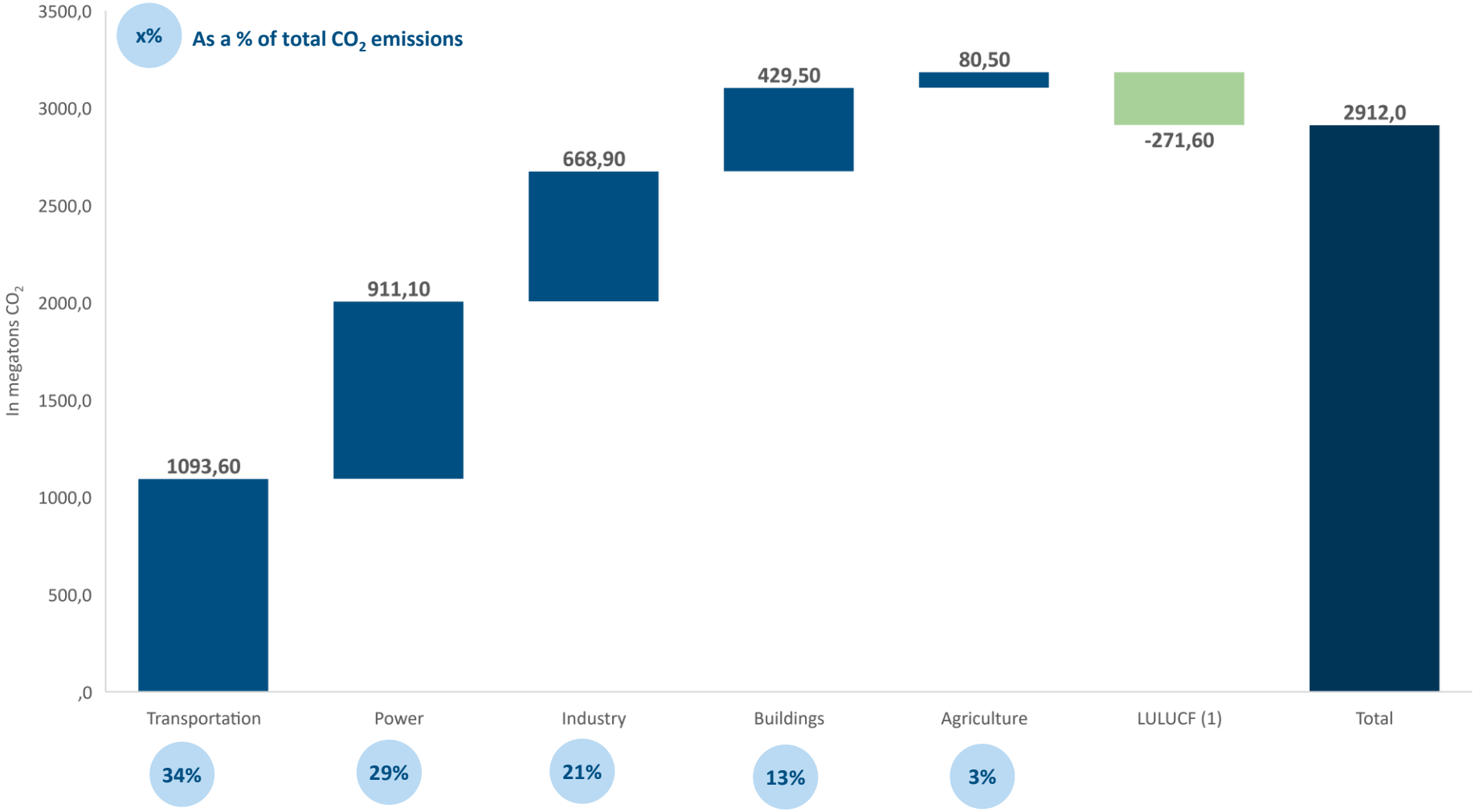
Cife
XIXe FORUM ANNUEL
HYDROGEN ET NUCLEAIRE

December 2, 2021

natureo FINANCE

EU Direct CO_2 emissions in 2019



(1) LULUCF is land use, land-use change and forestry. It absorbs CO2 and partly offsets emissions from other sectors

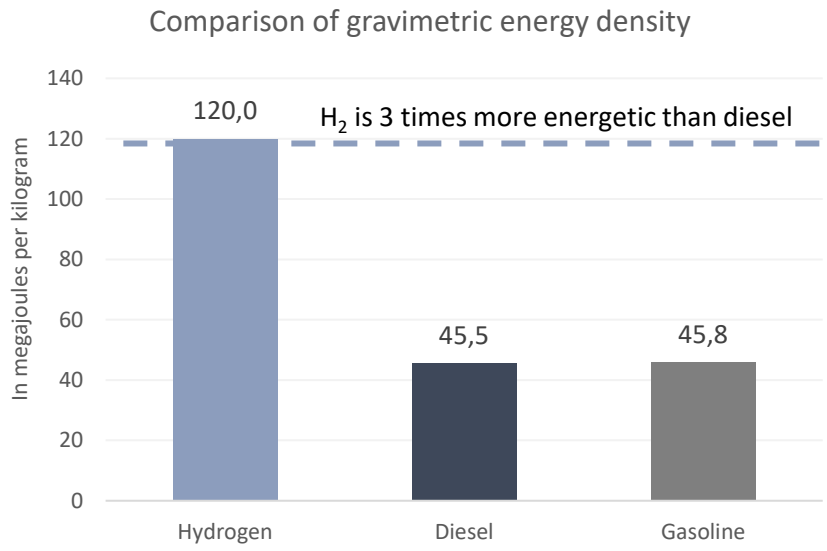
Sources: European Environment Agency

Hydrogen, a key element for the decarbonization of the economy

Hydrogen offers a response to intermittent renewable energies by storing excess energy produced. The resulting green hydrogen is an ideal energy carrier to decarbonize many industrial and transportation sectors

Hydrogen key features

- Most common atom in the universe
- Richest energy source for stars
- Low (gaseous) density (1/10 natural gas)
- Extremely energetic (120kJ/g)



Sources: Advanced Clean Tech News

Hydrogen key roles in the energy transition

Enable the renewable energy system

1 - Enable large-scale renewables integration and power

2 – Distribute energy across sectors and regions

3 – Act as a buffer to increase system resilience

Decarbonize end-uses

4 - Transportation

5 – Industry energy *(replacing fossil fuels used in energy-intensive industries)*

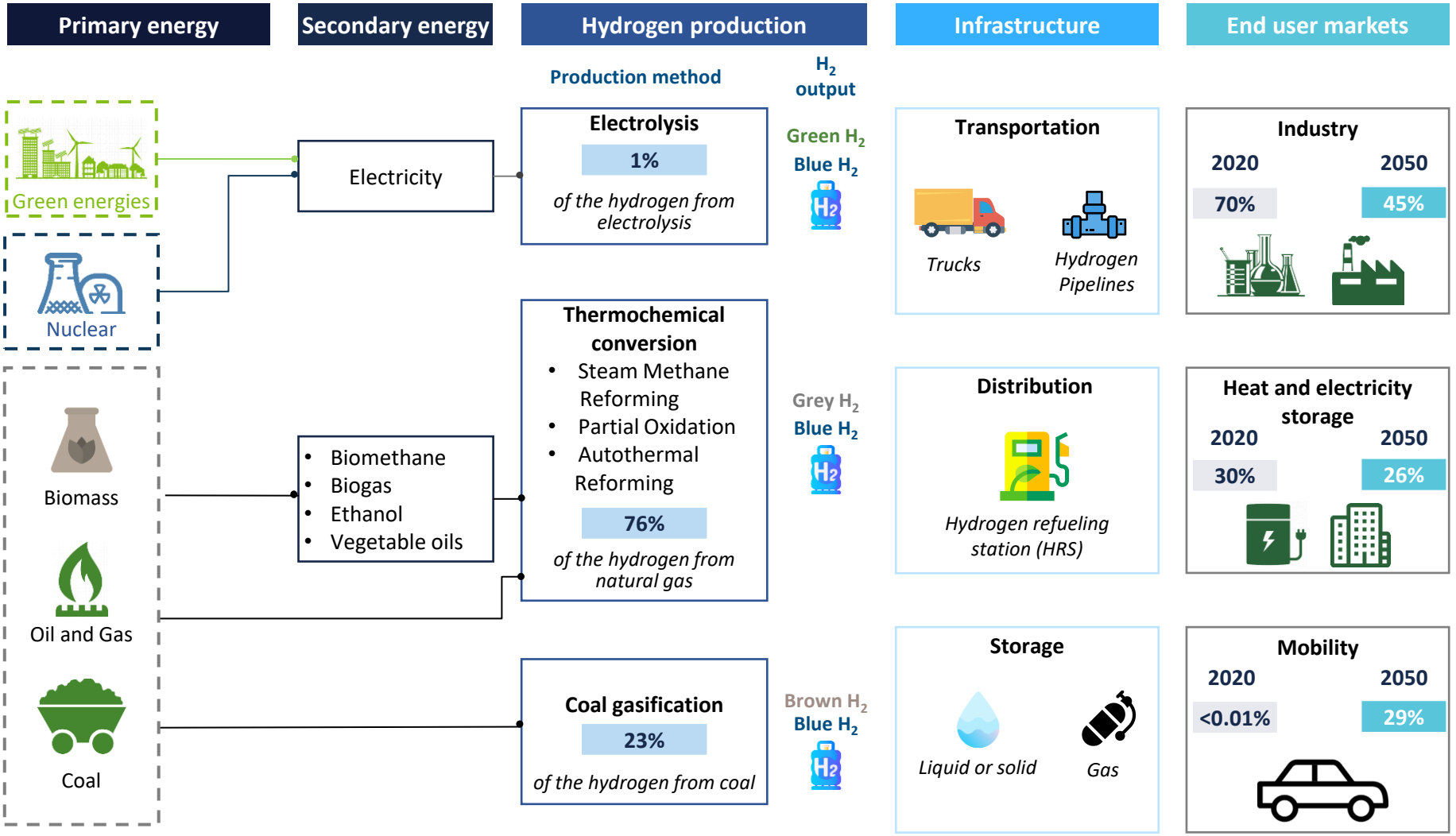
6 – Building heating & power

7 – Feedstock using green or blue H_2

Sources: Plastic Omnium – Hydrogen Conference (Oddo), Advanced Clean Tech News, L'UsineNouvelle, Air Liquide, Hydrogen Council, IEA 2019, CertifHy

H_2, a key energy carrier to implement transition to a low carbon economy

Green electrolysis development and carbon capture from fossil fuel hydrogen production are key elements for the transition to a low carbon economy



Source: "The Future of Hydrogen report" IEA, Air Liquide

Industry, currently the first hydrogen end-market mostly “grey”

Green hydrogen can lead industry in the broad sense to an eco-friendlier path. It is both a public concern and an obligation with governments setting “green” targets

Drivers for green hydrogen use in industry

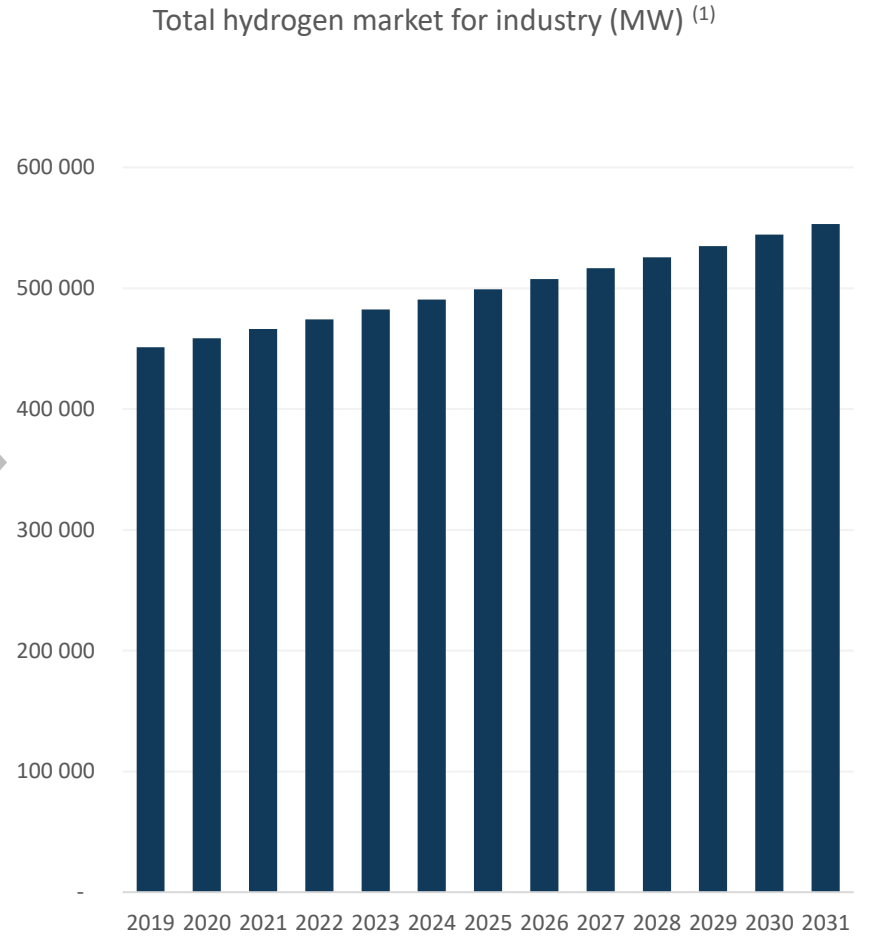
Impulse from European States aiming at decarbonizing hard-to-abate sectors

- Oil refinery
- Ammonia/ Methanol production
- Steel industry
- Cement industry
- Ceramics and glass

- **Few examples :**
  - Spain aims at replacing a quarter of the almost **500,000 tons** of fossil-based hydrogen consumed by industry every year with the renewably-sourced version
  - France targets **20-40%** decarbonized hydrogen in industry by 2028

Source: French national energy and climate plan (2020), Sia Partners 2020, Les Echos, lexology.com, energy.economictimes, Ministeries

Green hydrogen addressable market



Source: IEA 2019, AFHYPAC, Natureo Finance, (1) Equivalent electrolysis capacity required to produce total hydrogen market volumes

Many types of transportation means using hydrogen as of today

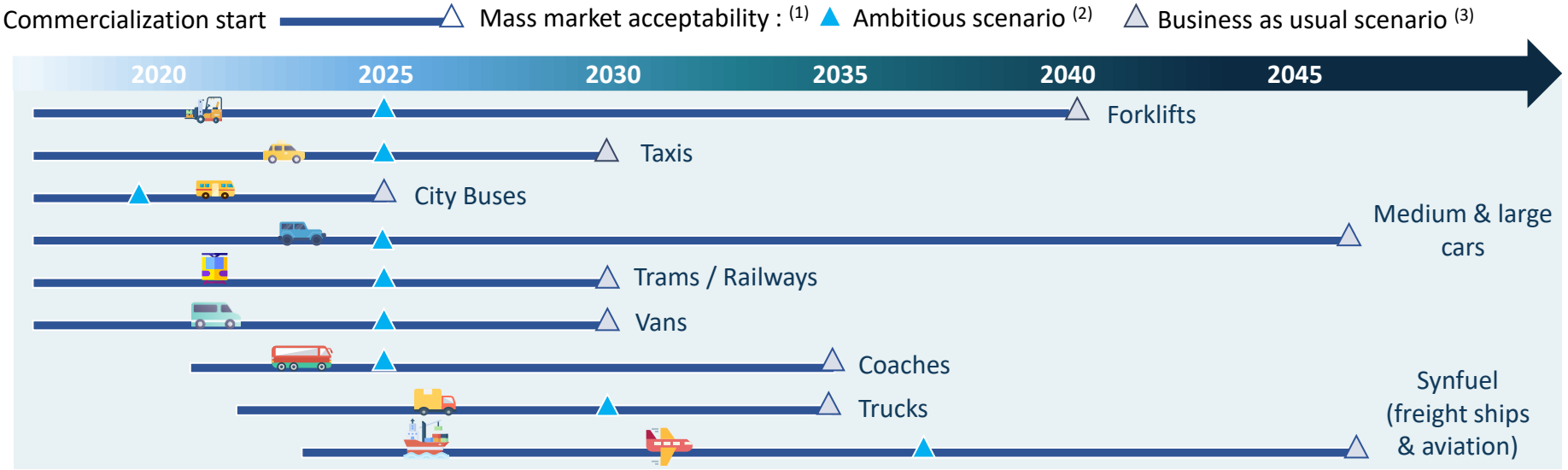
The adoption of H_2 in most transportation means has begun. A mass market deployment will require significant investments in H_2 production plants, distribution infrastructures, and production scale-up of vehicles

Transportation applications

Fuel cell that reverses hydrogen into electricity or hydrogen engine

- **Captive fleet** (buses, coaches) and **heavy transportation** (trucks) : hard to decarbonize with battery technology
- **Freight shipping** : hydrogen is used as a feedstock for synthetic fuel
- **Vehicles** : cars, taxis, vans, forklifts, etc.
- **Hydrogen trains** : non electrified train lines
- **Airplanes** : hydrogen is used as a fuel (in a liquid state) for short flights (1,850km)

Ramp-up of hydrogen vehicles in Europe from commercialization start to mass market acceptability per transportation means



(1) Annual sales of hydrogen vehicle exceed 1% within the segment (2) Scenario where there is a joint effort by investors, industries, and policymakers, a step-up of activities along hydrogen value chain, heavy investments in R&D, coordination of industry and regulators to push for the enforcement of long-term objectives for decarbonization in general and hydrogen in particular (3) Scenario where current policies and other measures stay in place and evolve only slowly, gradual investment in R&D with initial pilots but no scale up of investments and low efforts in hydrogen adoption

Sources: Sia Partners 2020, "Hydrogen Roadmap Europe" Fuell cells and hydrogen, connaissancedesenergies.org

Challenges needed to be tackled in order to widespread hydrogen uses

An ecosystem approach is required to ensure an efficient and a profitable deployment of hydrogen economy

Primary energy

- **Lower the cost** of renewable energies, ideally to 10 - 15 €/MWh for PV and 20 - 25 €/MWh for wind
- Renewable energy **production scale-up** (in order to achieve **70 GW of total installed electrolyzer capacity** by 2030) (1)

Hydrogen production

- **Increase the size** of electrolyzer stacks to reduce the cost of the balance of plant and **scale-up** electrolyzer manufacturing
- Improve **energy efficiency**
- **Capture CO_2 emissions** from hydrogen produced with fossil fuel
- **Build gigafactories of electrolyzer stacks** (economy of scale)

Infrastructure

- **Larger assets**
- **Higher pressure**
- **Increase load** of infrastructure
- Set up **hydrogen refueling stations close to end-consumers**
- Develop a wide network of hydrogen refueling stations

End user markets

- **Decarbonize** major industries
- **Manufacturing scale-up** for fuel-cell stacks and other components
- **A dense charging points' network** for transportation

2030 cost reduction potential

Hydrogen production cost	Hydrogen distribution cost	Component / equipment scale up
- (43-80)%	- 70%	- 45%

Source: Air Liquide, "The Future of Hydrogen report" IEA, BNEF, Kepler Chevreux, "Green Hydrogen investment and support Report" Hydrogen Europe, (1) Figure from "Path to hydrogen competitiveness" Hydrogen Council

Massive capital investments from private companies required for H_2

€ 430 bn are needed in Europe for the next 10 years : 1/3 coming from public money and 2/3 from private investors. Allocation of funds must go at the same time to production, infrastructure and end-markets

Hydrogen investment needs in Europe by 2030

	Necessary investments up to 2030	States required support (grants/subsidies) up to 2030
Hydrogen production : • Green H_2 production • Existing blue H_2 production (Gas SMR) • New blue H_2 (coal gasification)	**€ 220 bn** • € 187 bn • € 20 bn • € 12 bn	**€ 95 bn**
Hydrogen infrastructure & Storage : • Pipelines • refueling stations • Port facilities • Salt cavern storage	**€ 120 bn** • € 35 bn • € 10 bn • € 20 bn • € 55 bn	**€ 15 bn**
Hydrogen applications : • Mobility applications • Heating • Steel production • Electricity production • Synthetic fuels	**€ 90 bn** • € 40 bn • € 34 bn • € 8 bn • € 5 bn • € 3 bn	**€ 35 bn**
Total investments	**€ 430 bn**	**€ 145 bn**

Focus on small companies in France needing investments

Lhyfe, HYSILABS, SYMBIO, AD-VENTA, H2V, ERGOSUP, H2X, SEABUBBLES, atawey, HDF, Helion, ENERGY OBSERVER, H2SYS, hype, ZEROAVIA, Sylfen, bulane, Safra, Pragma industries, PowiDian

Sources: « Green Hydrogen investment and support Report » Hydrogen Europe

Contacts

Christophe Rouvière
Président
Natureo Finance
21 rue du Faubourg Montmartre
75009 Paris, France

Tel.: +33 (0) 1 43 12 79 01
Cell: +33 (0) 6 18 98 13 26
Email:
crouviere@natureofinance.com

Eric Missonnier-Rohart
Directeur Général
Natureo Finance
21 rue du Faubourg Montmartre
75009 Paris, France

Tel.: +33 (0) 1 43 12 79 03
Cell: +33 (0) 6 15 89 10 74
Email:
emissonnier@natureofinance.com

Natureo Finance

21 rue du Faubourg Montmartre

75009 Paris, France

Tel: +33 (0) 1 43 12 79 00

Web Site: http://www.natureofinance.com