

Role of H₂ in Decarbonizing Industry

Priya Ravindranath
Senior Manager, Marketing
Air Liquide Large Industries World Business Line
priya.ravindranath@airliquide.com



Air Liquide Group 2022 Key Figures



~67,100
EMPLOYEES



PRESENT IN
73 COUNTRIES



MORE THAN
3.9 MILLION
CUSTOMERS &
PATIENTS



REVENUE
€29.9bn



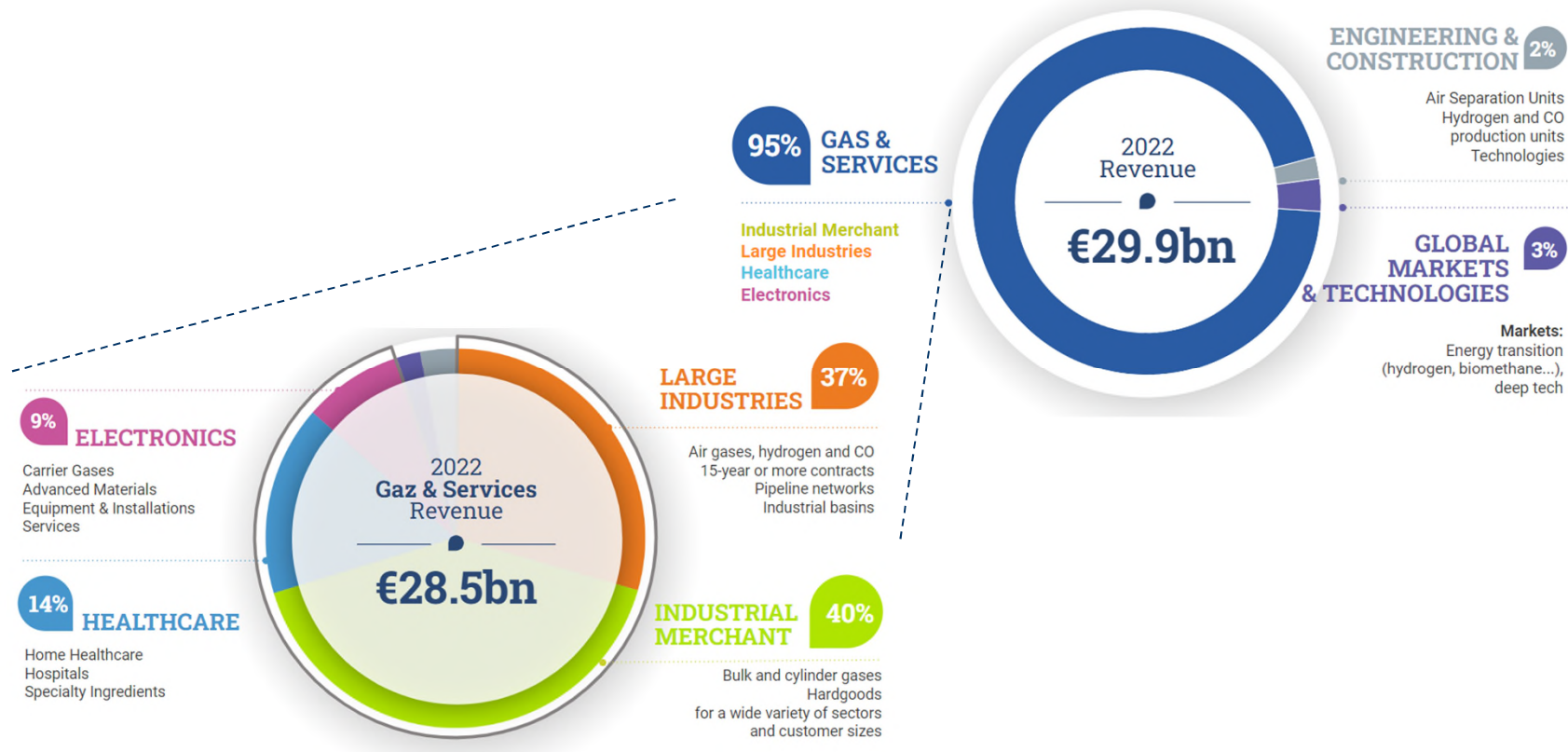
NET PROFIT
(GROUP SHARE)
€2.7bn



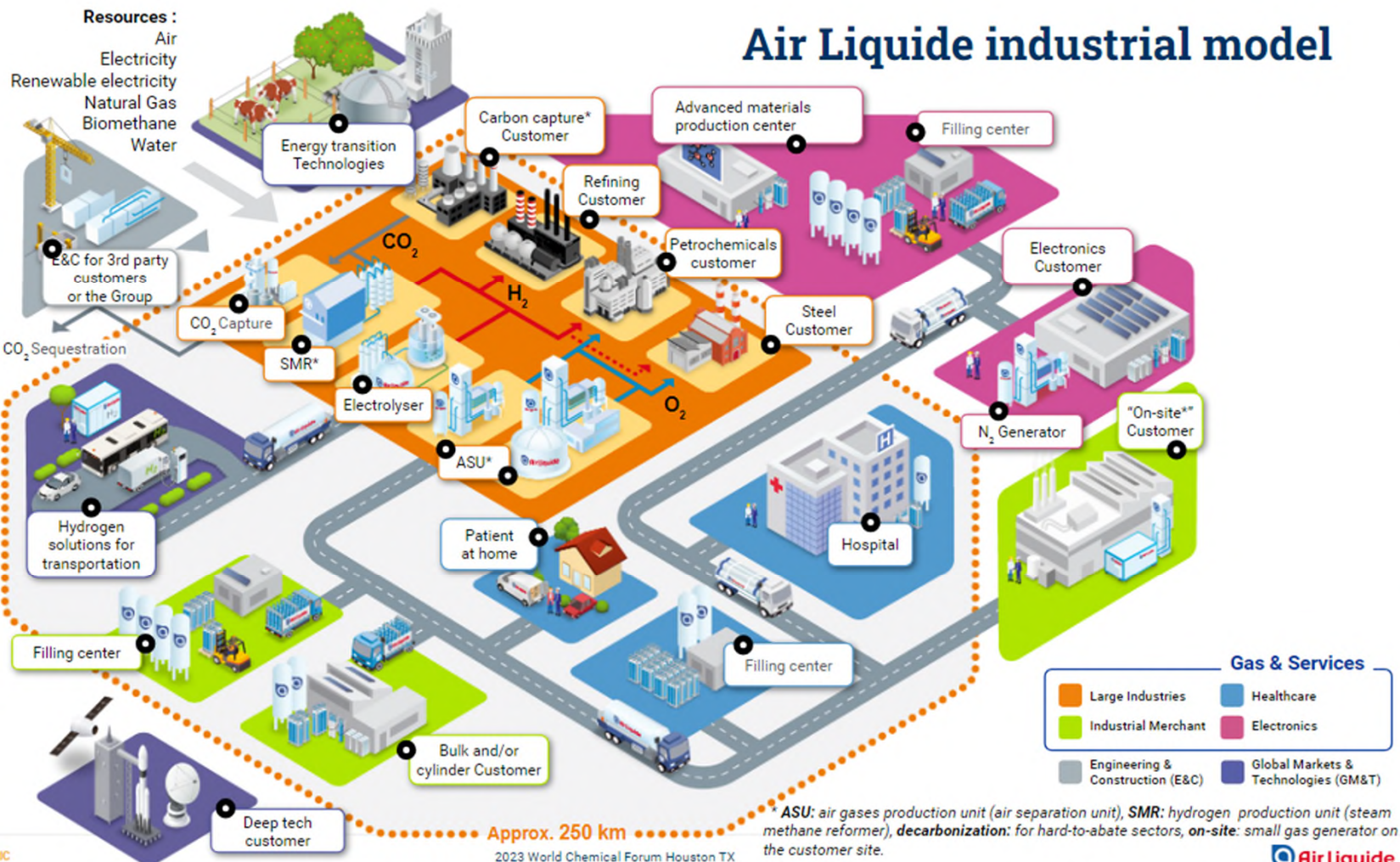
INVESTMENT
DECISIONS
~€4bn

Air Liquide Group Overview

2022 figures



Air Liquide industrial model



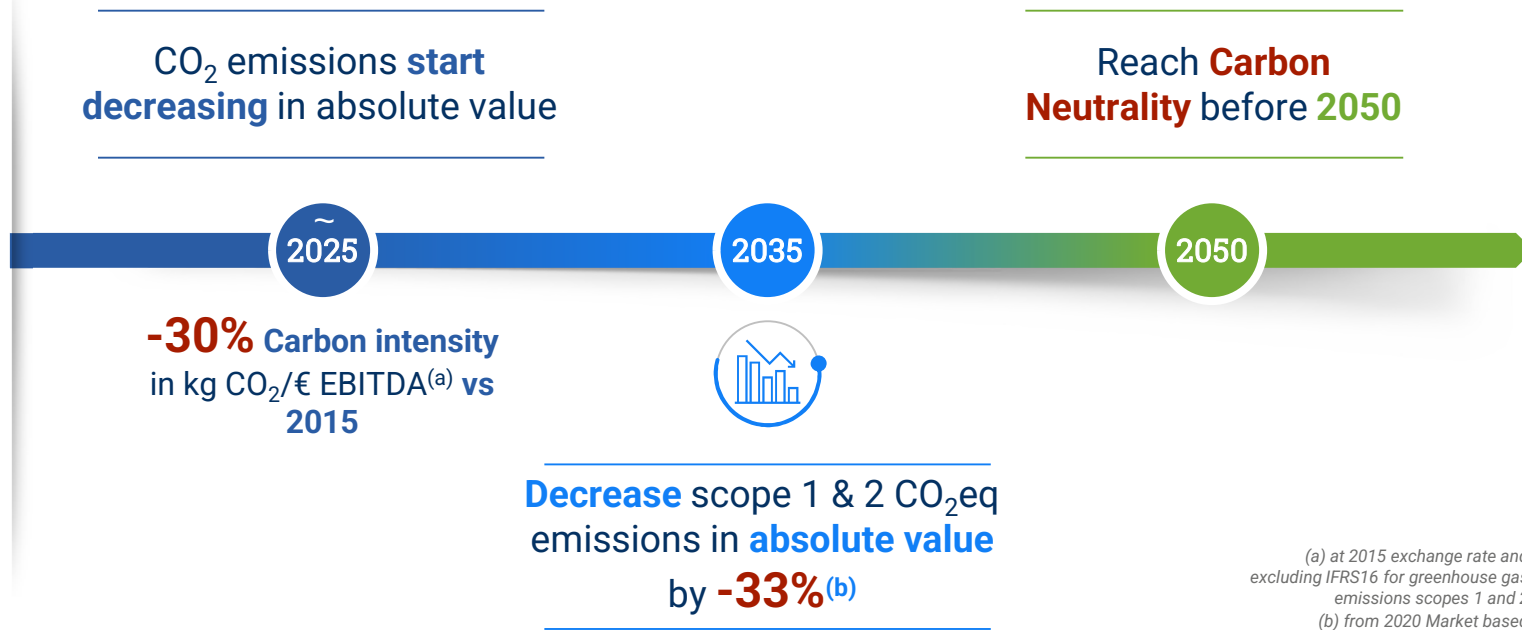
ABATEMENT OF CO₂ :

Setting a trajectory to reach Carbon Neutrality

Air Liquide Commitments



Reach **Carbon Neutrality** before **2050**

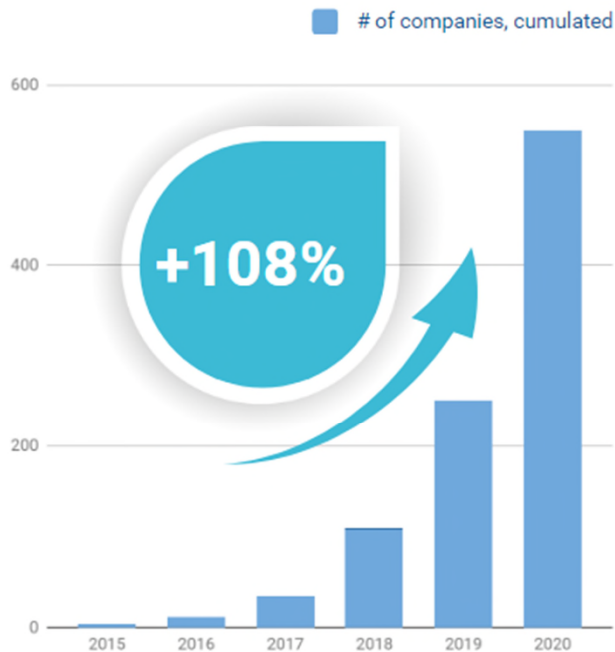


(a) at 2015 exchange rate and excluding IFRS16 for greenhouse gas emissions scopes 1 and 2

(b) from 2020 Market based emissions of 32.5 million tonnes CO₂eq (Scope 1+2)

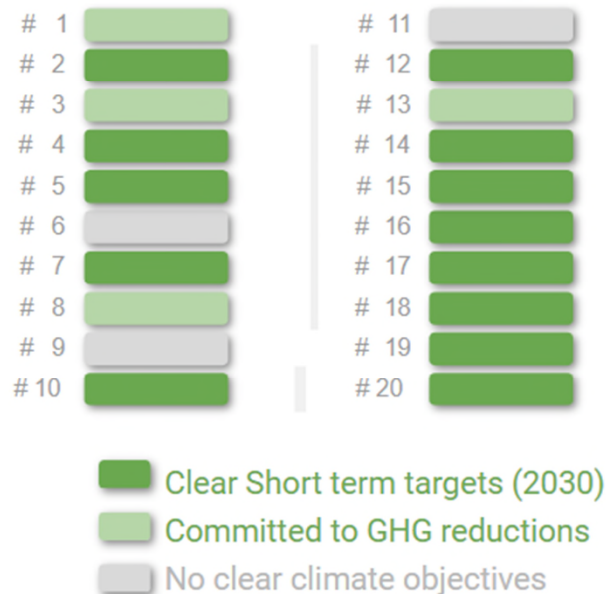
Our Industrial Customers also embrace Energy Transition

Industrial Companies Taking actions



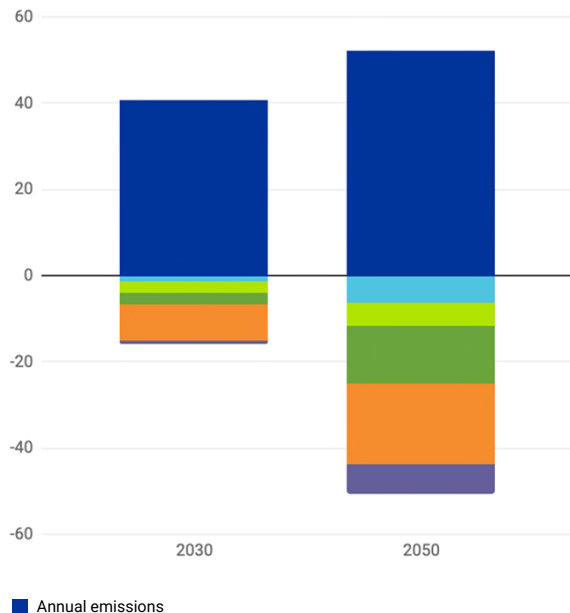
+108%: refers to 2020 vs 2019, source SBTi

Air Liquide's Top 20 Customers



Five major levers are needed to enable the energy transition

in Gt of CO₂/year



1. **Behaviour and avoided demand**



2. **Increasing energy efficiency**
to limit the rise of energy consumption



3. **Switch to low-carbon energy carriers**
(electricity, hydrogen, etc.)



4. **Renewables**
to replace fossil fuels

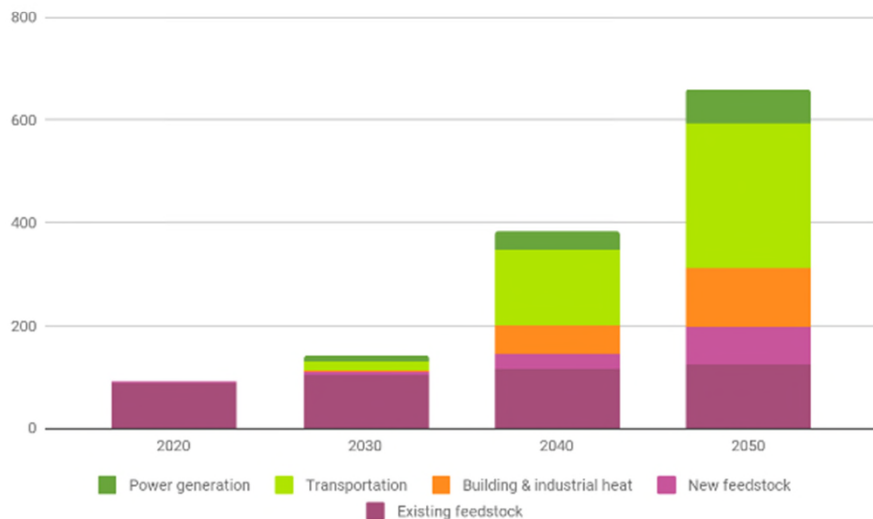


5. **CCS/U**
to decarbonize the use of fossil fuels

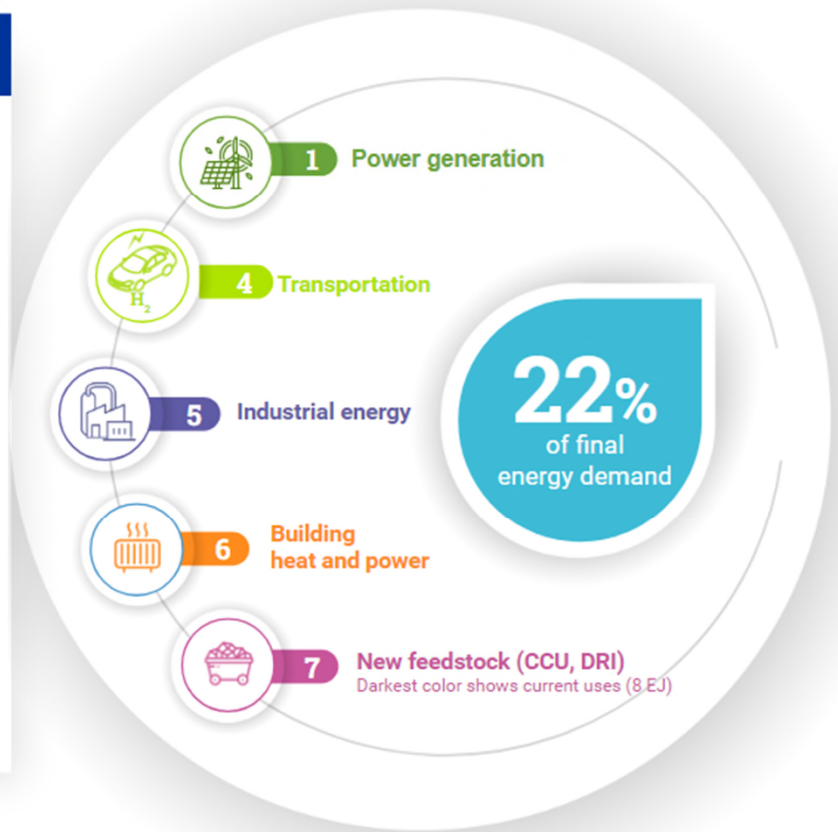
Source: Hydrogen Council, 2017 ; [IPCC AR6](#)

In a 1.5-degree-world, hydrogen could contribute to ~22% of demand

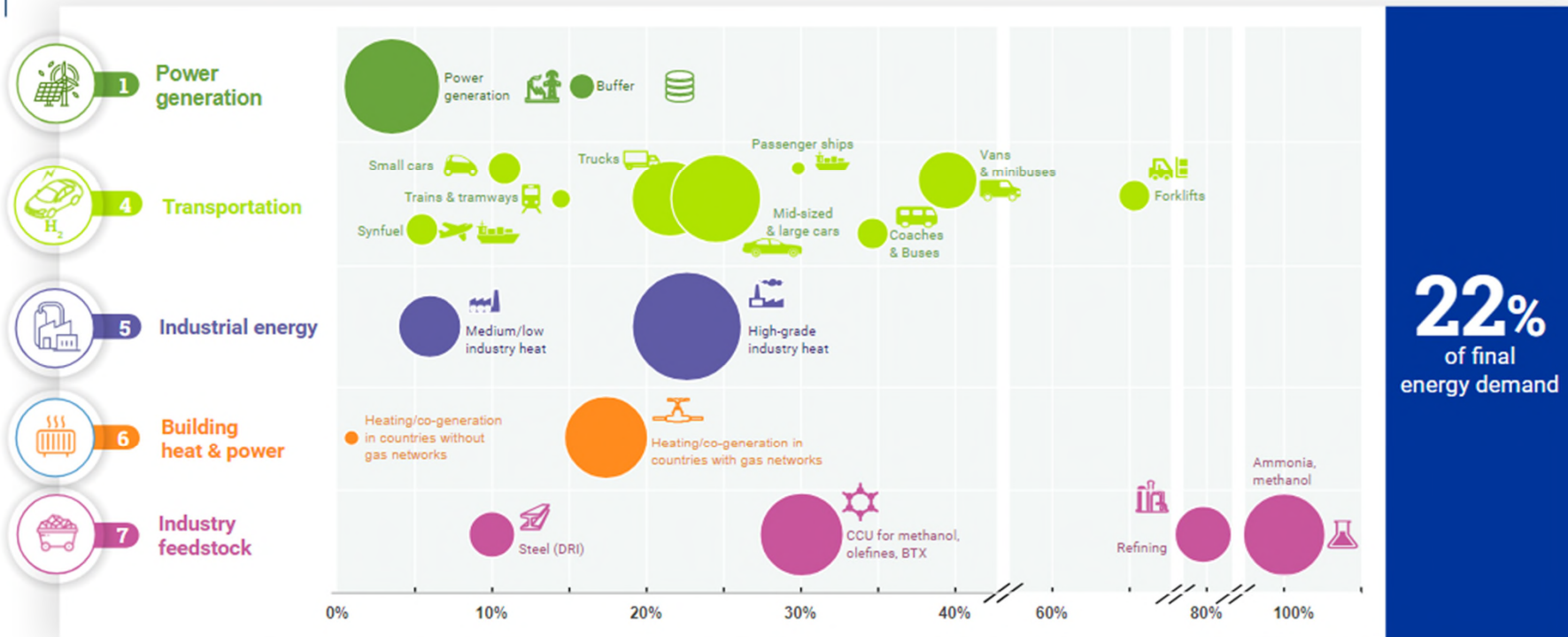
Global hydrogen demand, Million tonnes per year (Mtpy)



Source: Hydrogen for Net Zero, Hydrogen Council, 2021



Hydrogen has significant potential across all applications



22%
of final
energy demand

○ Bubble size indicates hydrogen potential in 2050 in EJ (1 EJ); 1 EJ = 948X10⁶ MMBtu

Relative importance by 2050
Potential market share in the segment

Source: McKinsey & Hydrogen Council 2017

Deployment of hydrogen growing across the value chain

500_{MW}

ELECTROLYSIS DEPLOYED

+80% VS 2020



50,000

VEHICLES

65% increase in 2021 vs 2022

3.5_{GW}

OF ANNUAL ELECTROLYZER
CAPACITY INSTALLED IN 2021

x2 planned in 2022



700

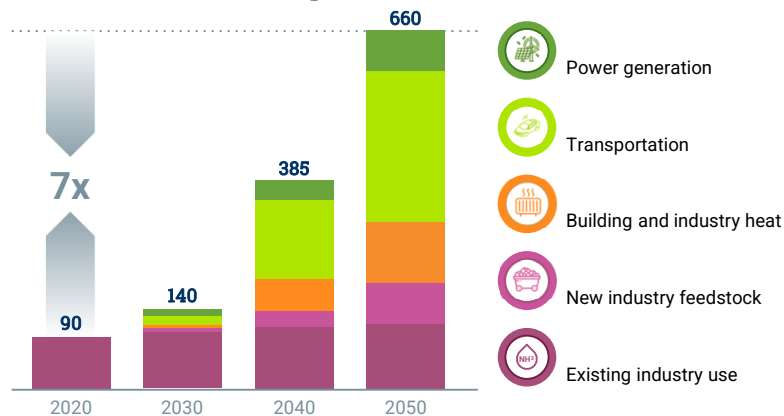
H₂ STATIONS

x2 since 2019

Transportation, heat and feedstock will be
the biggest uses for hydrogen

Demand required to meet Net-Zero, as projected previously in the
Hydrogen for Net-Zero report

SCALE-UP BY SEGMENT, MT H₂ PER YEAR



New energy geopolitics

30+ countries have a hydrogen strategy

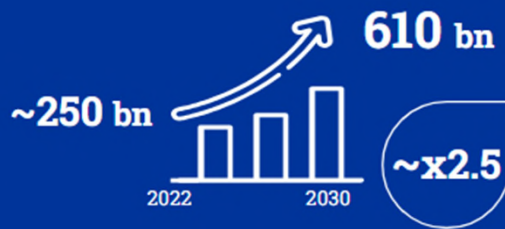


Source: Wec, Bloomberg (2021)

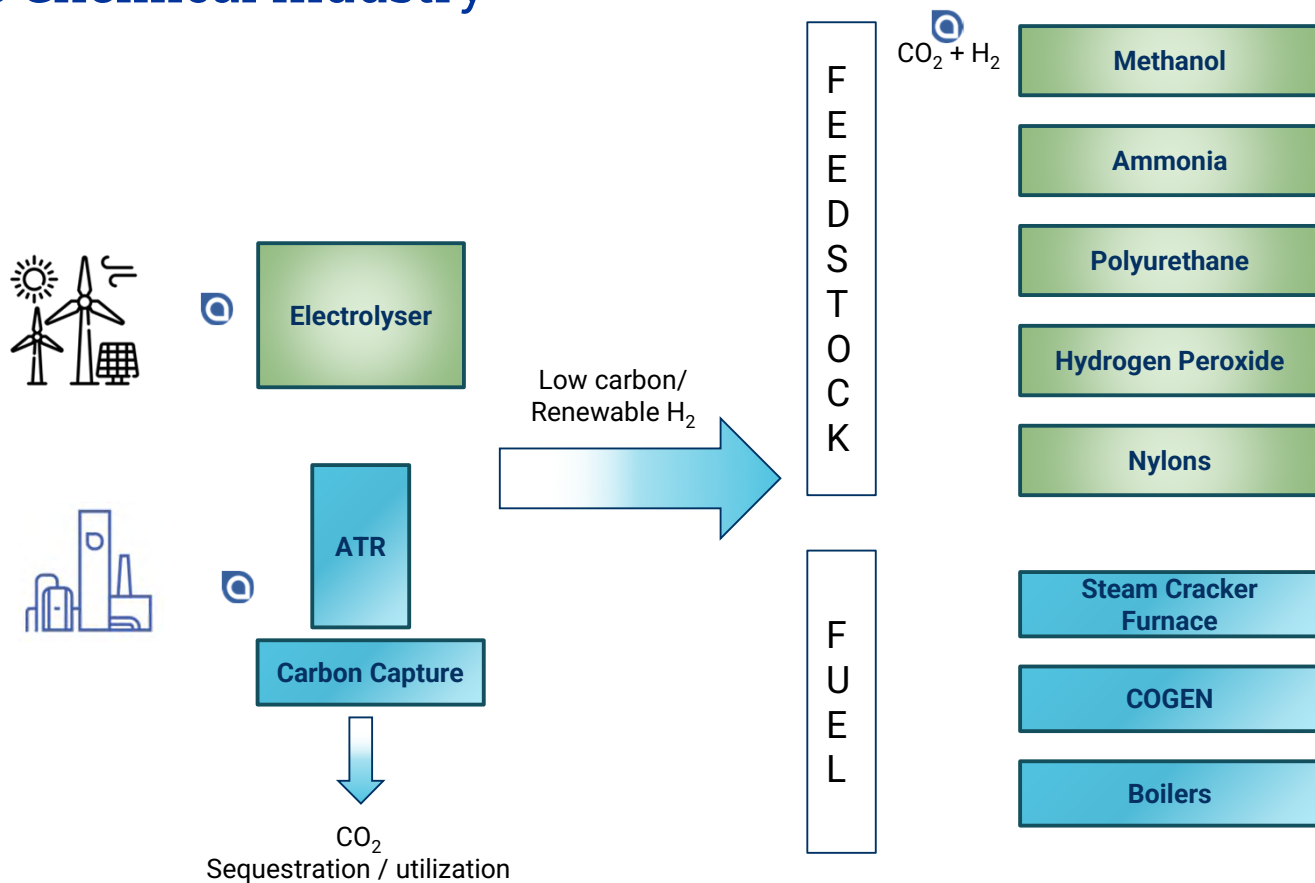


Hydrogen is revolutionizing the energy globalization

- Producing hydrogen is accessible to all countries (no need for a hydrogen field)
- The end of oil hegemony
- Export/import strategies: localized logistics as a cornerstone



Low carbon/ Renewable Hydrogen - Decarbonized Feedstock & Fuel for the Chemical Industry



Hydrogen: Air Liquide's unique expertise and experience

60

YEARS OF EXPERTISE

>1,000

EMPLOYEES IN HYDROGEN

€2.2bn

ANNUAL SALES

1.2 Mt

ANNUAL PRODUCTION

~200

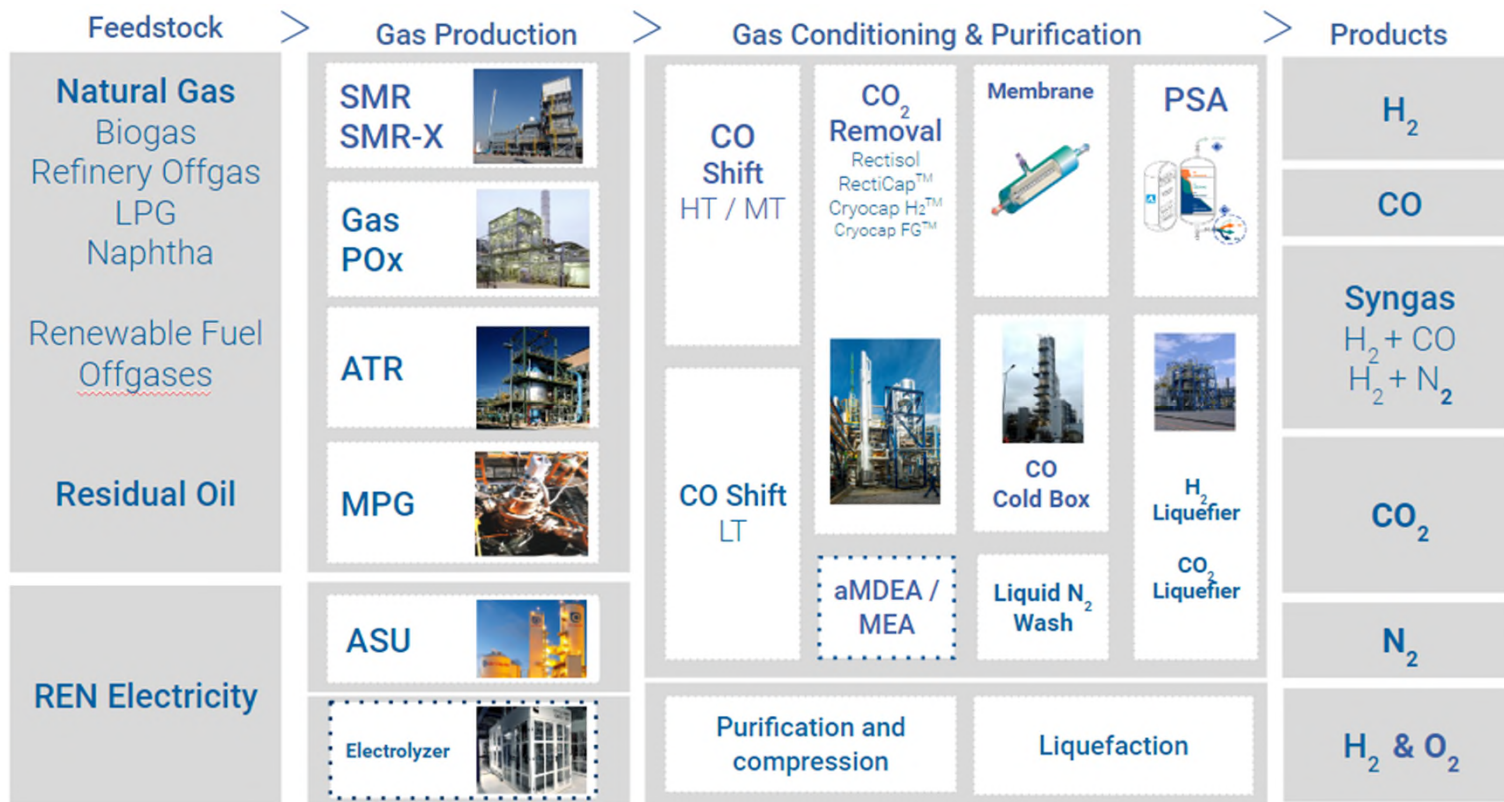
STATIONS DELIVERED

~2,000

KM OF PIPELINES



Air Liquide's Technology Portfolio - Supporting Industry Decarbonization



Third party techno - Operational and Integrator expertise

Ammonia - The H₂ Carrier

Ammonia is an excellent hydrogen carrier

Compressed gaseous hydrogen at 700 bar

42 kg_{H₂} / m³

LHV content: 1.4 MWh/m³

Liquid, cryogenic hydrogen

70 kg_{H₂} / m³

LHV content: 2.3 MWh/m³

Liquid Ammonia

119 kg_{H₂} / m³

LHV content: 3.5 MWh/m³

Strong similarity between Steam Reforming, a technology mastered by Air Liquide, and Ammonia Cracking!

Steam Reforming

Natural Gas + Energy + Steam -> **Hydrogen** + Carbon Dioxide

Ammonia Cracking

Ammonia + Energy -> **Hydrogen** + Nitrogen

Hydrogen from ammonia can be produced without emitting a single CO₂ molecule.

Air Liquide Ammonia Cracking Pilot Plant in industrial scale

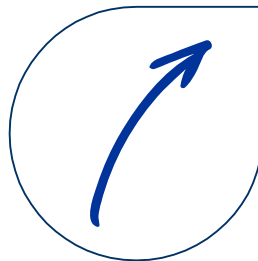


Demonstration of

- Ammonia Cracking
- Ammonia Firing

in industrial, full scale next-generation reactor tubes

Startup: Q2 2024



Scale-up!

The pilot plant and **operational experience** thereof enables Air Liquide to **scale-up** to a **commercial size**

Hydrogen- Contributing to Decarbonization of the Industry



Hydrogen could contribute to
~22% of global energy demand

Technologies for H_2 production and
deployment exist

H_2 will continue to be a key feedstock and will
find applications as a fuel as the chemical
industry transitions towards lower emissions

**Air Liquide brings more than 60 years of H_2 expertise in
operations and technology**



Thank you