



# At the heart of the energy transition

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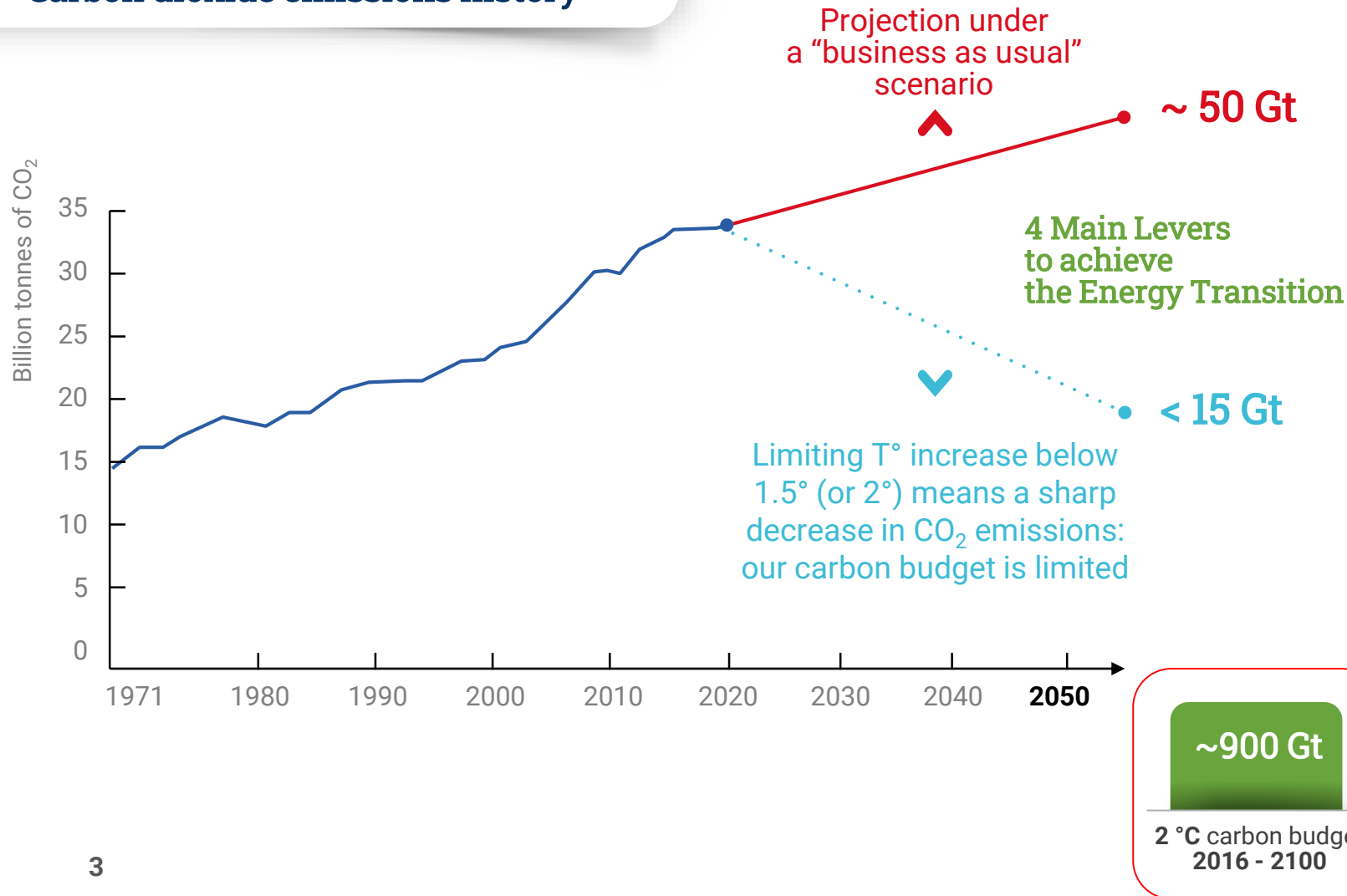
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## Energy Transition: What's at stake ?

 Air Liquide

# CO2 Emissions can no longer follow the historical curve

## Carbon dioxide emissions history



1. Energy Efficiency



2. Carbon Capture Sequestration/Usage (CCS/CCU)



3. Low-carbon emission carriers (electricity & hydrogen)



4. Renewables

# The regulatory environment is evolving to get there

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- **Carbon Pricing:** from 25 to up to 200 USD/tCO<sub>2</sub> for specific applications and geographies
- **Caps on emissions** as a requirement to operate
- **Bans on Diesel / Gasoline** use in transportation announced in several cities
- **Sulfur limits** on bunker fuels (IMO 2020)
- **Renewable content obligations** in alternative fuels and electricity

Actions to fight climate change are evolving from “voluntary” to “enforced”.

“Cleaner” is differentiating and its value keeps increasing.



CLEAN  
MOBILITY  
by Air Liquide

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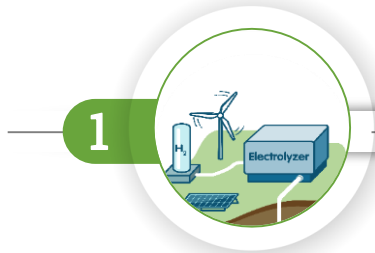
Hydrogen

Air Liquide

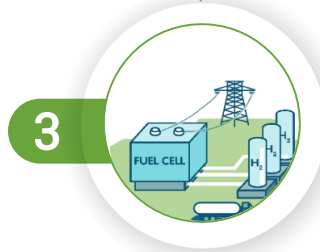
# The 7 roles of hydrogen in the energy transition

## Enable the renewable energy system

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



**Distribute** energy across sectors and regions



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

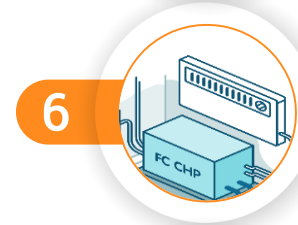
## Decarbonize end-uses



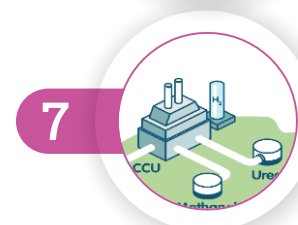
Decarbonize **transportation**



Decarbonize **industry energy use**



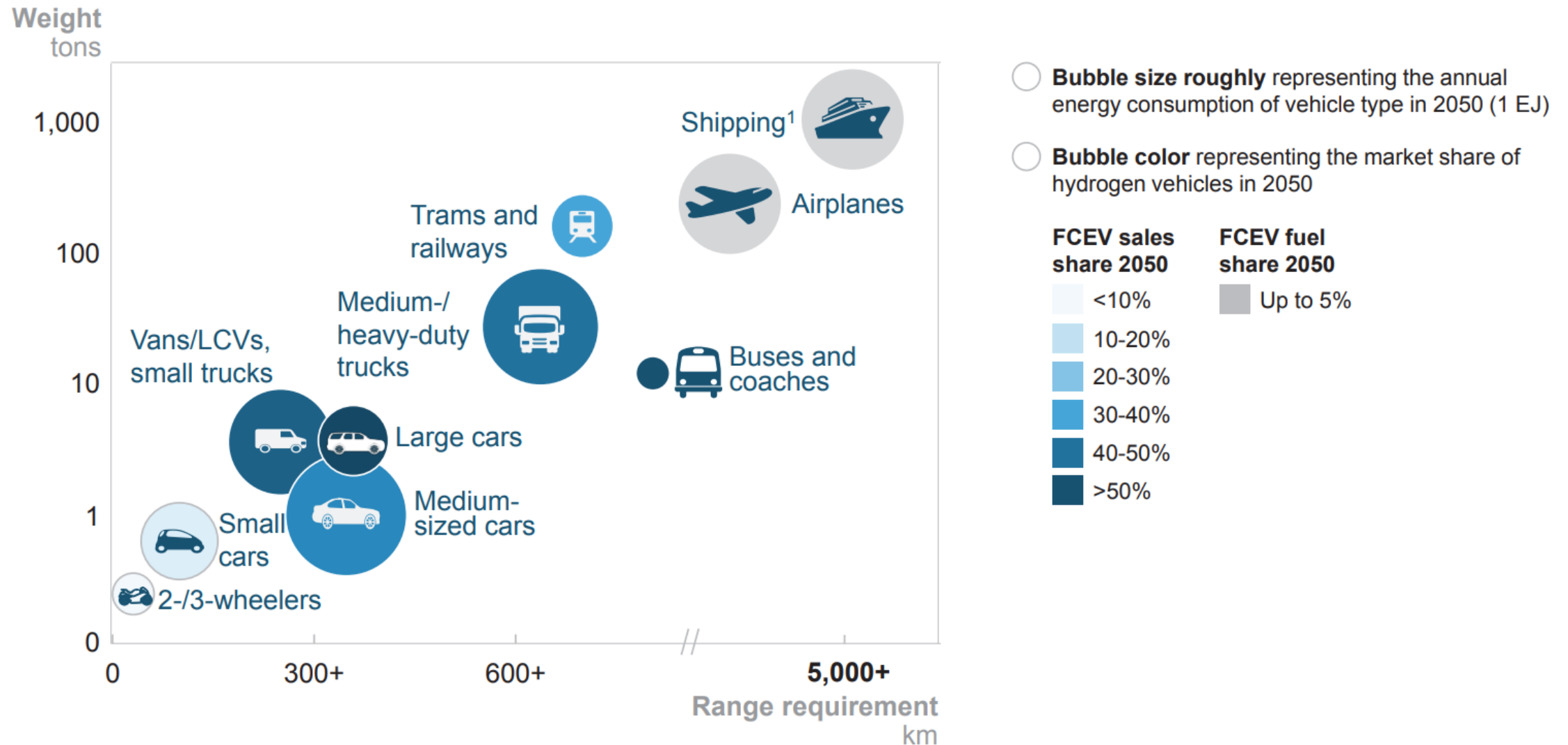
Help decarbonize **building heating and power**



Serve as **feedstock**, using captured carbon

Source: McKinsey & Hydrogen Council 2017

# H2 is critical in many transportation segments




# Several major industrial sectors move on with first use of hydrogen to replace their carbon based processes or energy needs



**thyssenkrupp**

Hydrogen injection  
in blast furnace



Announced power-to-hydrogen  
solutions in Shell   
& other refineries



CO2 recycling  
in petrochemicals

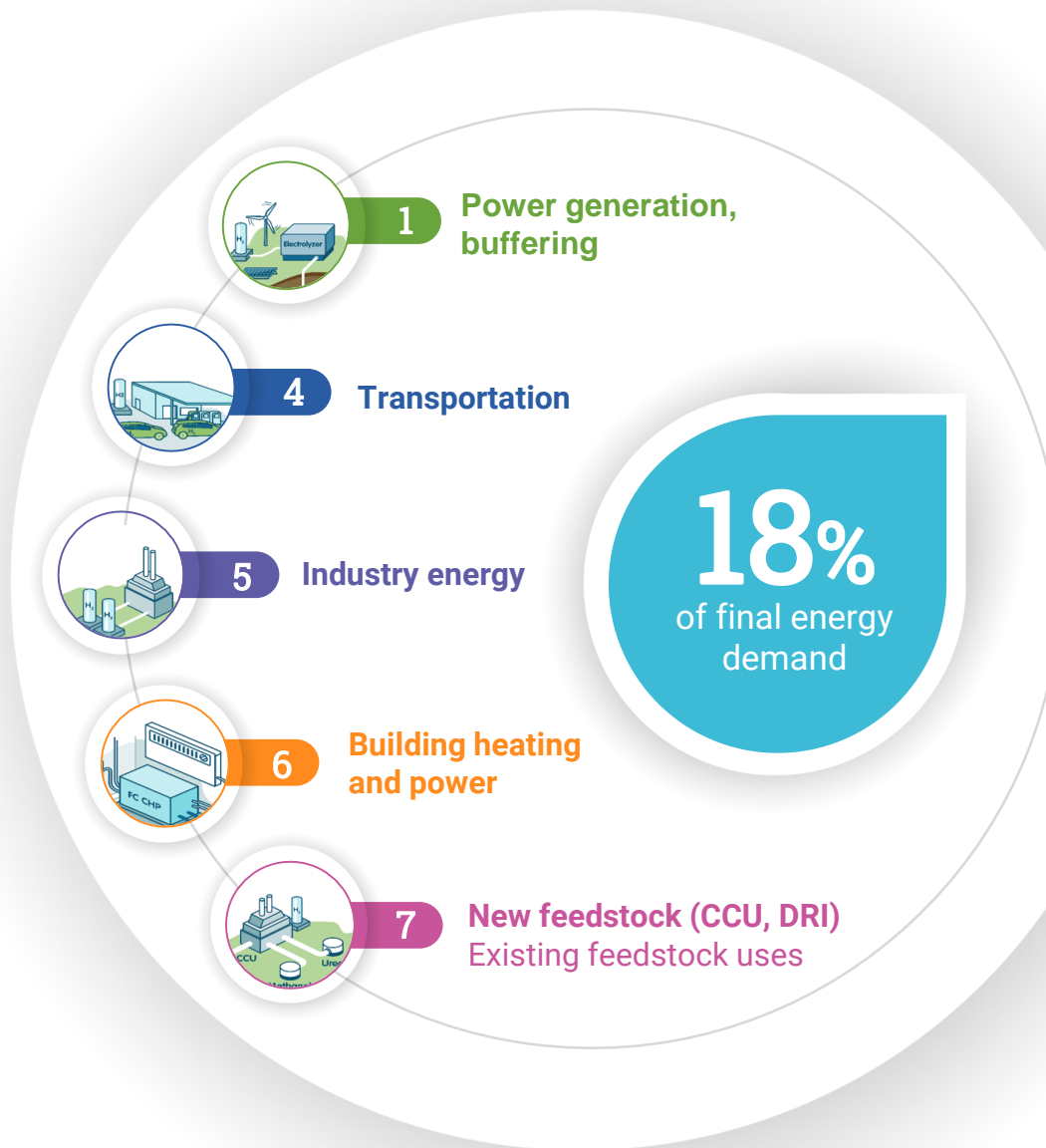
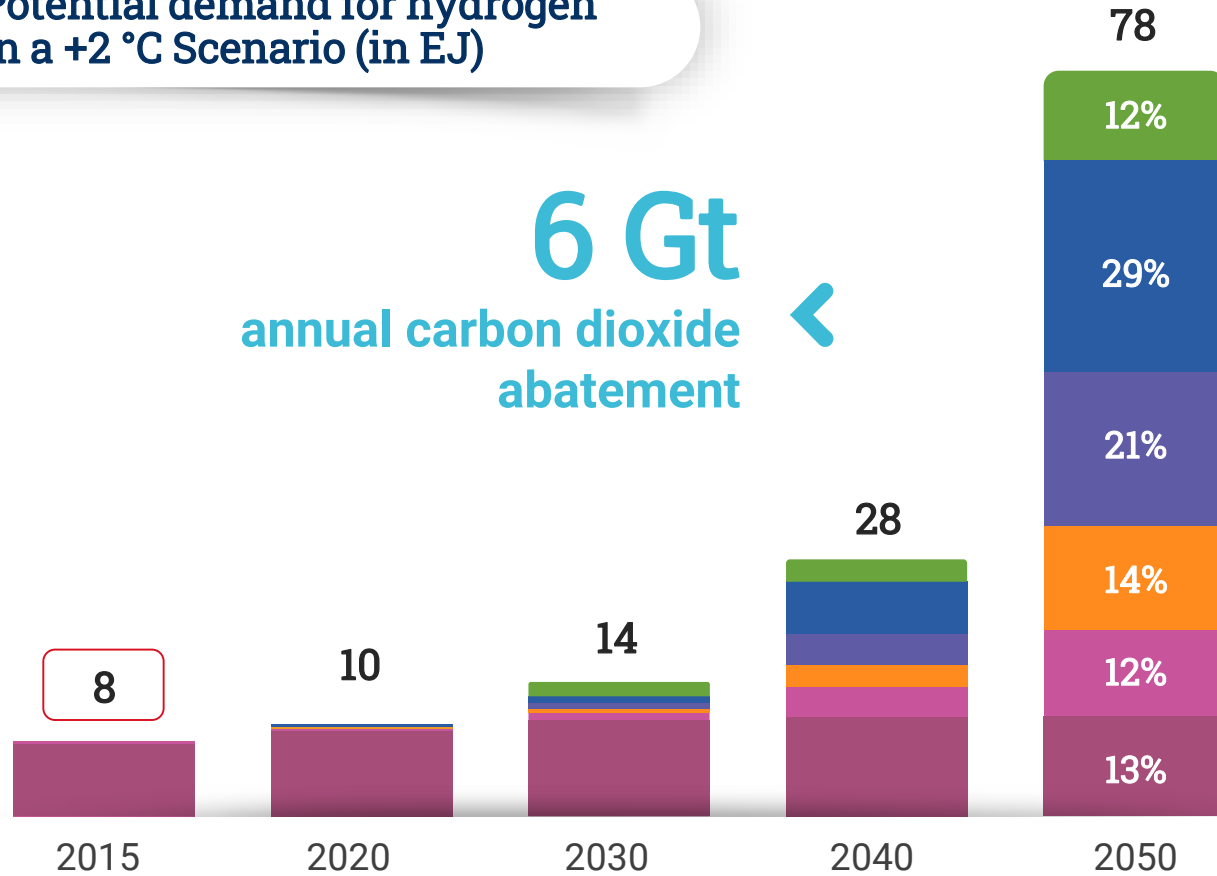


Growing demand  
for low-carbon  
hydrogen solutions  
from AL customers



# 2050 Hydrogen demand in a +2°C Scenario

Potential demand for hydrogen in a +2 °C Scenario (in EJ)



> **30 M**  
jobs created

> **\$2,500 Bn**  
annual sales

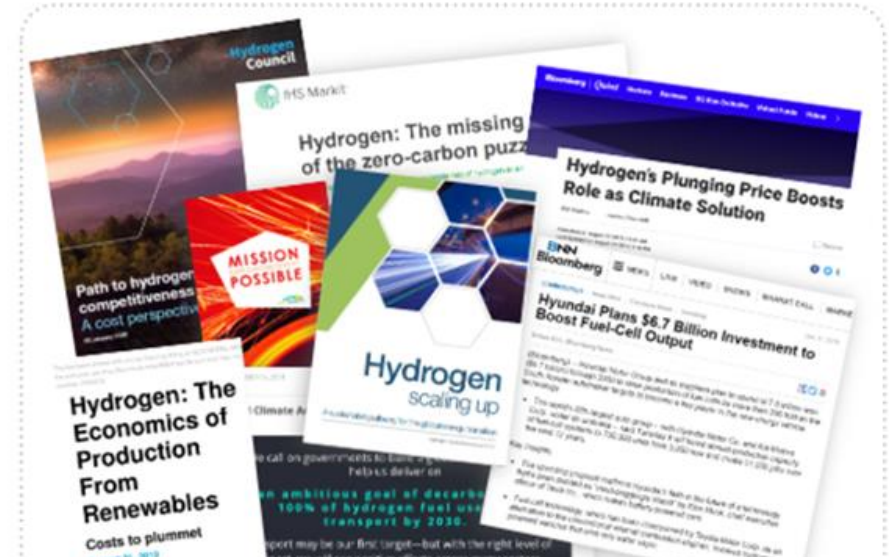
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Unlocking the full potential of Hydrogen



# The Hydrogen Energy World today: a widely shared view

## Hydrogen Council



# The Hydrogen Energy World in 2019

Promising market developments in many areas, going beyond mobility



% in delta vs 2018  
CHP = Combined Heat & Power

# H2 competitiveness potential by 2030



Source: Hydrogen Council

# Scale-up to drive cost down across the value chain

2030 Cost reduction potential

Hydrogen  
Production Cost

**-60%**

Scale-up Electrolyzer  
manufacturing  
&  
Larger plants

Hydrogen  
Distribution cost

**-70%**

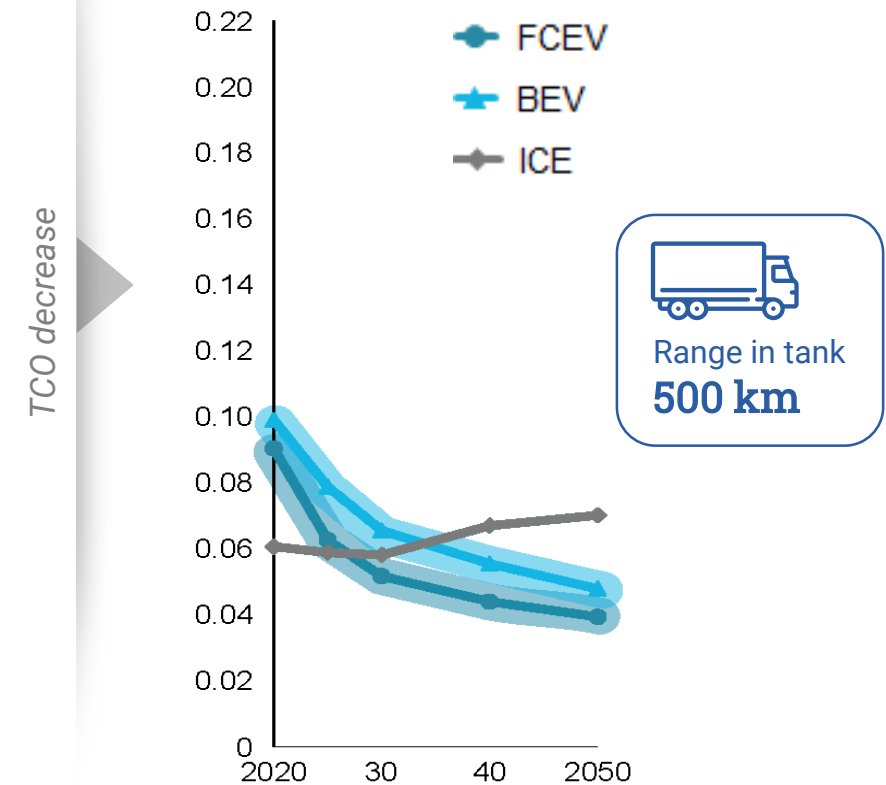
Larger assets  
High Pressure and  
Liquid H2 Supply chain  
Increased load of  
infrastructure

Component /  
Equipment scale up

**-45%**

Manufacturing scale-up  
for Fuel-Cell stacks  
&  
other components

MDT for regional transportation





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## Air Liquide in Hydrogen

 Air Liquide

 Air Liquide

# Air Liquide has nearly 50 years of hydrogen development for industries

## Production & Supply chain

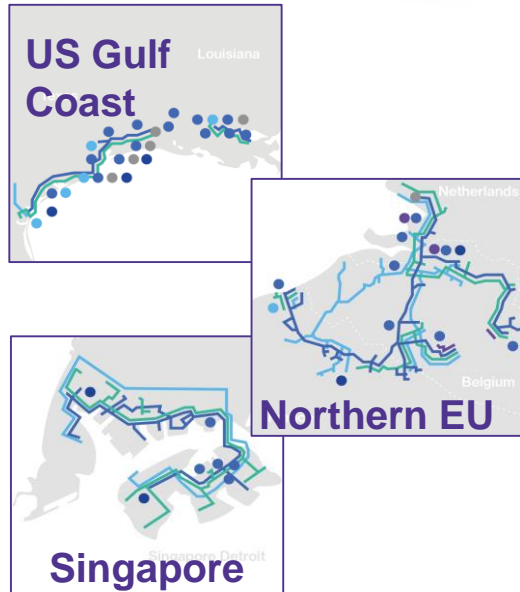
### Production



### Supply chain



## Distribution Networks



- Hydrogen
- Oxygen
- Nitrogen
- Synthetic gas
- Hydrogen and/or carbon monoxide facility and hydrogen source
- Oxygen and nitrogen facility
- Cogeneration facility
- Synthetic gas facility

## Markets Segments

### Process industries

Oil & Gas



Steel, Glass



Electronics



### Transportation

Space



## Key Figures

14 Bm<sup>3</sup>/yr

1,850 km H<sub>2</sub> pipeline

46 large H<sub>2</sub>/CO plants

40 electrolyzers in operation

2 B€ sales



# Air Liquide's strategic positioning as pioneer on new H2 applications, worldwide



**Power to Gas**  
Denmark  
1 Electrolyzer



**Mobility for Consumers**  
Paris, Brussels and Rotterdam  
6 HRS



**Mobility for Consumers**  
Japan  
10 HRS



**Mobility for Consumers**  
China  
4 HRS



**Mobility for Consumers**  
Germany  
31 HRS



**Mobility for Professionals**  
US+EUROPE  
9 HRS



**Mobility for Consumers**  
US North-East  
12 HRS  
+ Supply chain



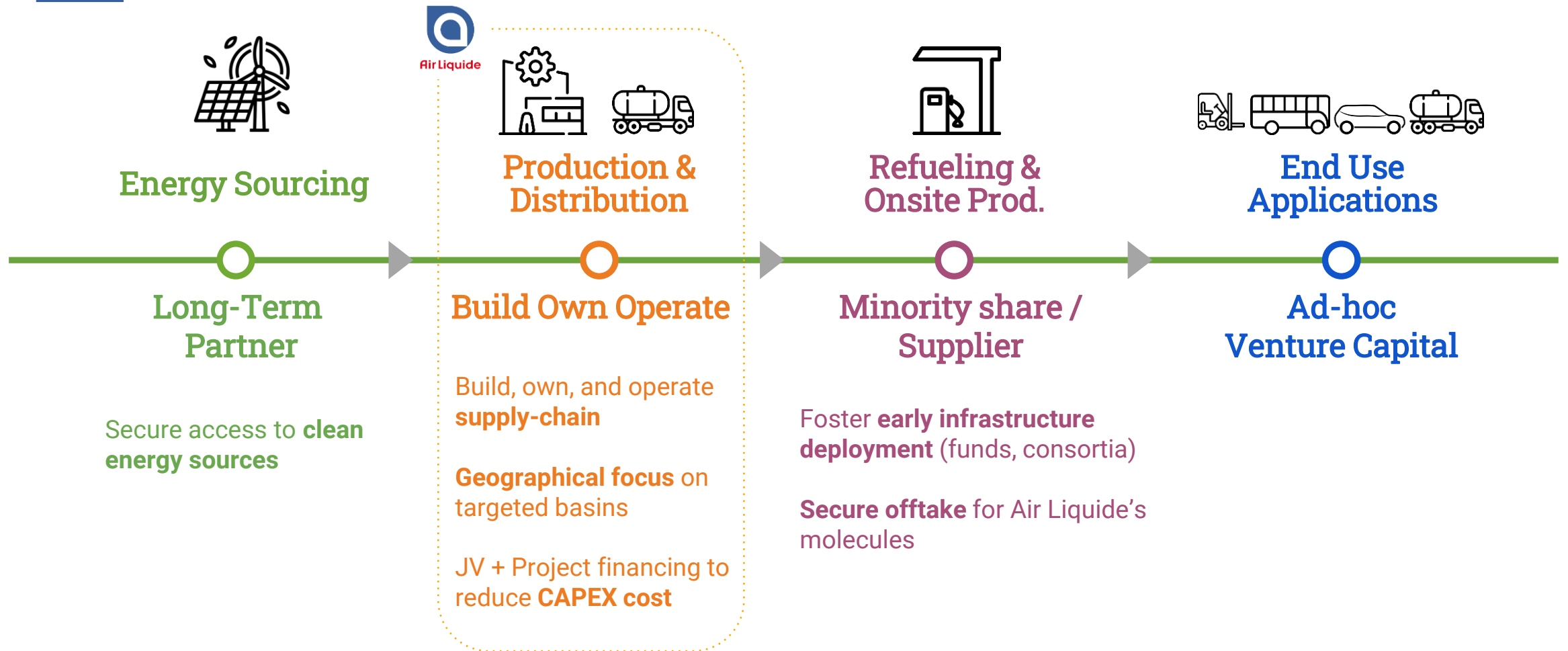
**Mobility for Consumers**  
California  
4 HRS



More than 120 Hydrogen Refueling Stations (HRS) installed by Air Liquide in the world, in which more than 50 are directly invested and operated by Air Liquide

ALIAD: 12 M€ invested in 5 start-ups

# In H2E Value Chain, Air Liquide focuses on Production and Distribution





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**Air Liquide in the  
Energy Transition**



# Air Liquide's offering to a low-carbon society and industry is broader than hydrogen....

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A global approach

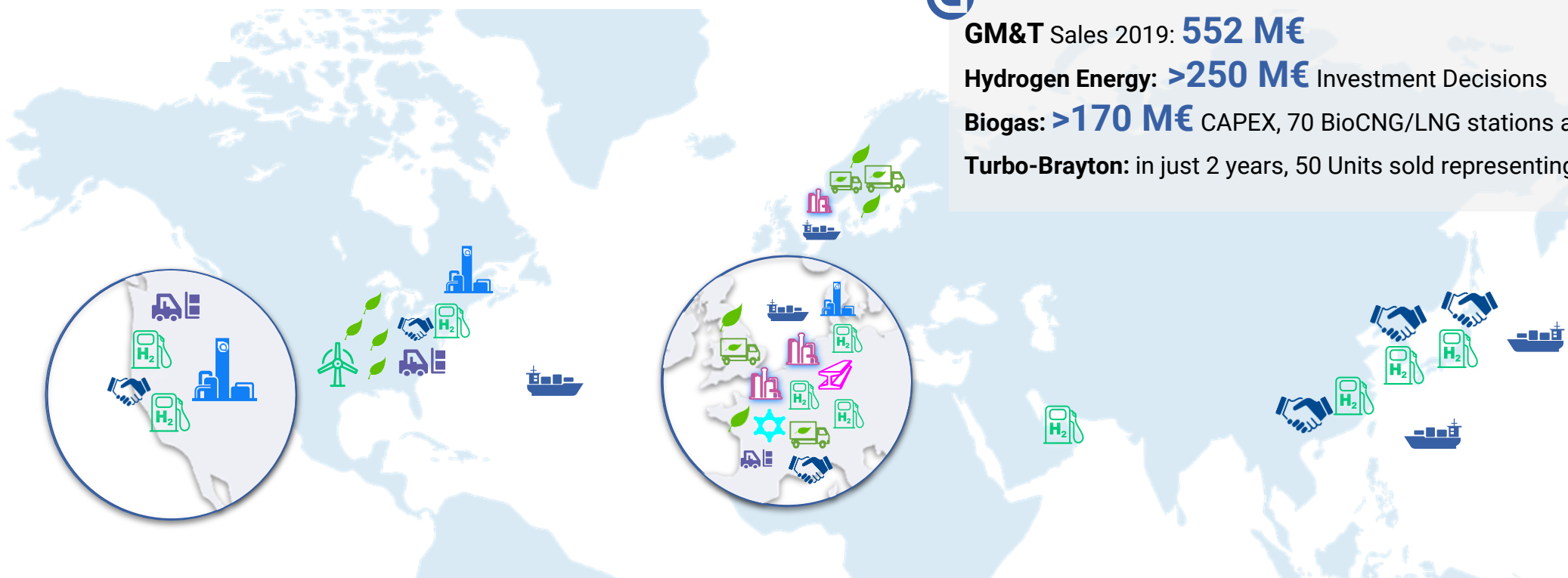


- A Assets**  
Reduce our carbon intensity in 2025 vs. 2015 by **-30%**
- C Customers**  
Act for clean industry by developing low-carbon solutions
- E Ecosystems**  
Contribute to a new low-carbon society












# Air Liquide at the forefront of the Energy Transition across the globe



**GM&T Sales 2019: 552 M€**  
**Hydrogen Energy: >250 M€** Investment Decisions  
**Biogas: >170 M€** CAPEX, 70 BioCNG/LNG stations and > 1TWh/year production  
**Turbo-Brayton:** in just 2 years, 50 Units sold representing **180 M€** in orders



## Air Liquide's global footprint in enabling and accelerating the Energy Transition

-  CCS/U Projects
-  Biogas production (Renewable Nat. Gas)
-  H2 Stations
-  Renewable Electricity PPA
-  Low CO2 Steelmaking
-  BioCNG/LNG for transportation
-  H2 FCEV Forklifts
-  Major partnership for H2E Development
-  LNG Boil-off Reliquefaction Turbo-Brayton
-  Clean Refrigerated Trucks (Blueeze™)
-  H2 Energy Production Facility

A close-up photograph of several black fuel nozzles at a gas station. The nozzles are arranged in a row, with the one in the foreground being the most prominent. The background is slightly blurred, showing the metallic surfaces of the gas pumps and the side of a dark-colored car. The lighting is bright, suggesting a sunny day.

**End**

