Air Liquide

Hydrogen

At the heart of the energy transition

David Hasse

Sustainable Energy Economy - Research & Development of Nuclear Light Water Reactors and Hydrogen Hybrids January 14, 2020

Hydrogen’s roles in the energy transition

Hydrogen has a positive effect on limiting global warming and reducing carbon emissions:

Enable the growth of intermittent renewable energy

By supporting the development of renewable energy sources, and the energy storage and transportation across the globe

Lower the carbon emissions of end uses

- Energy for **industry**
- Heating and **power**
- **Transportation**
- **Carbon-free** raw material

Hydrogen by 2050:
a quantified vision of its key role in the energy transition

18%
of final energy demand

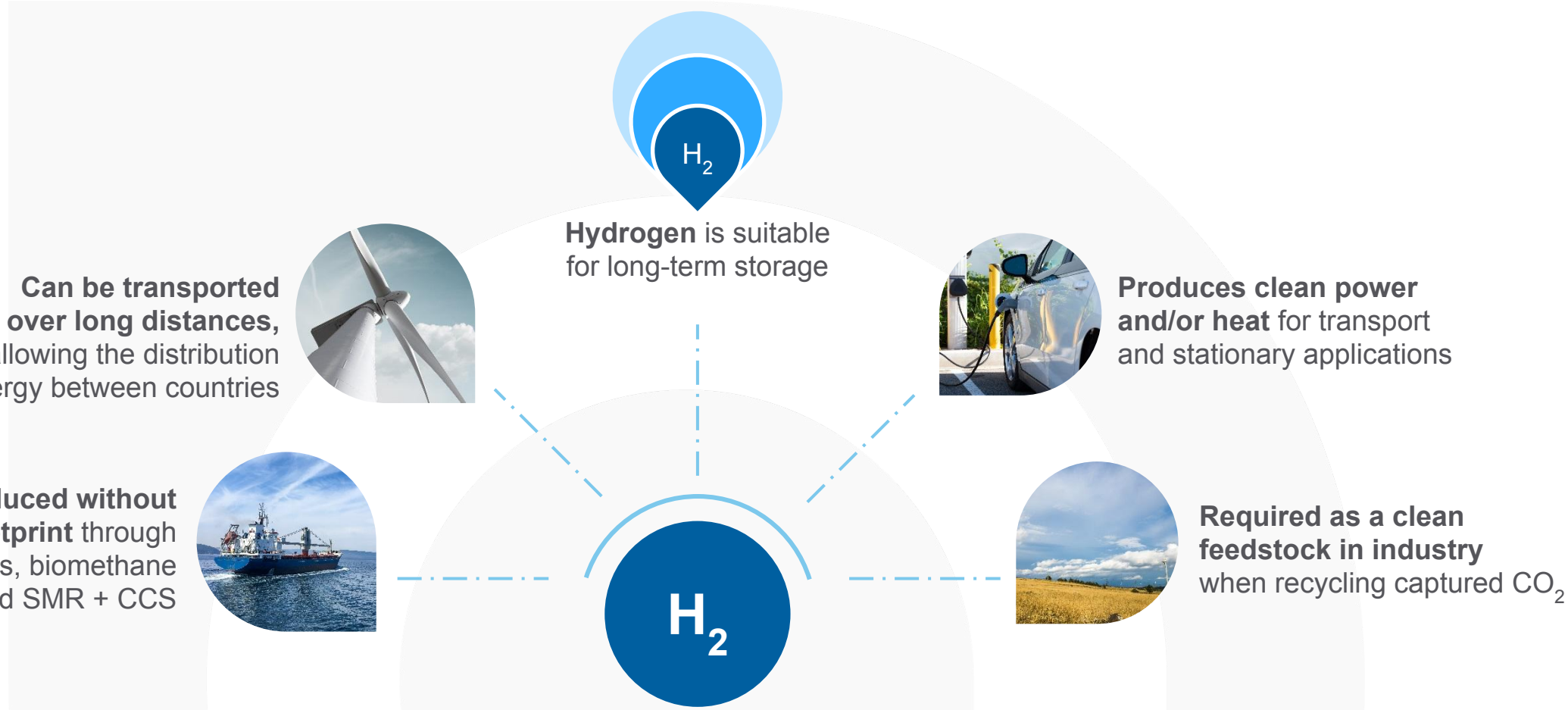
30 million
jobs created

6 Gt
annual CO_2 abatement

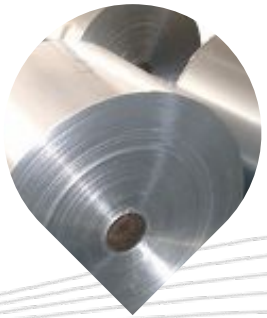
$2 500 Bn
annual sales
(hydrogen & equipment)

Source: McKinsey & Hydrogen Council 2017

Hydrogen is a clean,
safe and versatile energy carrier

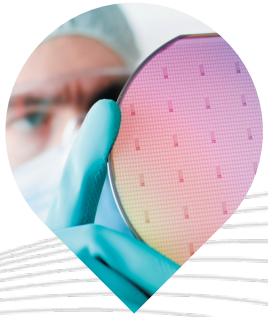


Hydrogen, many existing applications…



Heat Treatment

Glass



H_2 Ultra pure <1 ppb

Chemicals &
Petroleum refining

Rockets

Fuel cell vehicle

Hydrogen for industry

H_2

Existing industrial usages of H_2

Refining

Ammonia

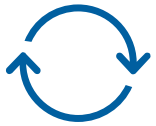
High grade heat

Objective:
Shift to low carbon H_2

New H_2 markets

Steel production

Chemical products



Recovered CO_2

Objective:
Develop new usages for H_2 to replace fossil fuels

Low carbon hydrogen pathways

Biomethane

Electrolysis
low carbon electricity

Natural Gas +
Carbon Capture
and Storage (CCUS)

BLUE HYDROGEN
Clean energy solutions

Technology leveraged at every step in the chain

Air Liquide is mastering the whole hydrogen value chain

Production

Storage

Delivery

Application

Efficient
Sustainable
Safe
Reliable

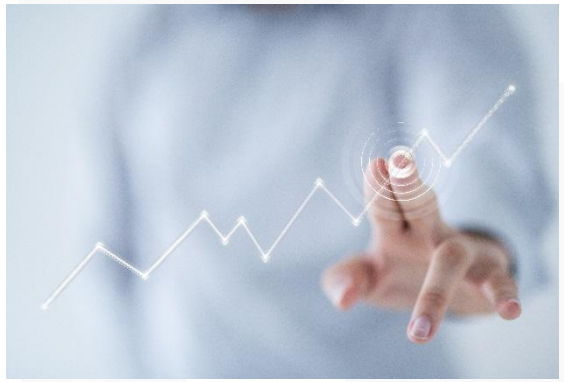
Our ambitions:

Lead **activation of H_2 Energy Markets with strategic partners,** in particular H_2 Mobility and Industry

Maintain leadership across the full value chain from H_2 production to delivery at the point of use

CUSTOMER EXPERIENCE

TECHNOLOGY



INVESTMENT

Everything
in place for scale up

- Early markets starting up
- Initiated effort to align for deployment
- Existing supporting policies
- A systemic need
- Strong technology potential
- Early signs of societal acceptance

Air Liquide's presence and place

Air Liquide already started to invest *(decisions to date)*

Mobility for Professionals
US+EUROPE
9 HRS

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

Mobility for Consumers
California
4 HRS

Mobility for Consumers
Japan
6 HRS

Mobility for Consumers
Dubai HRS
1 HRS

Mobility for Consumers
Korea
1 HRS

Power to Gas
Denmark
5 HRS
+ 1 Electrolyzer

Mobility for Consumers
Germany
12 HRS

Mobility for Consumers
Paris, Brussels and Rotterdam
5 HRS

14 bn m^3/yr

1,850 km H_2 pipelines

46 large H_2/CO plants

40 electrolyzers in operation

2 bn € sales

100 Hydrogen recharging stations (HRS) installed by Air Liquide in the world in which 40 directly invested and operated by Air Liquide

Air Liquide invests in the world's largest membrane-based electrolyzer to develop its carbon-free hydrogen production

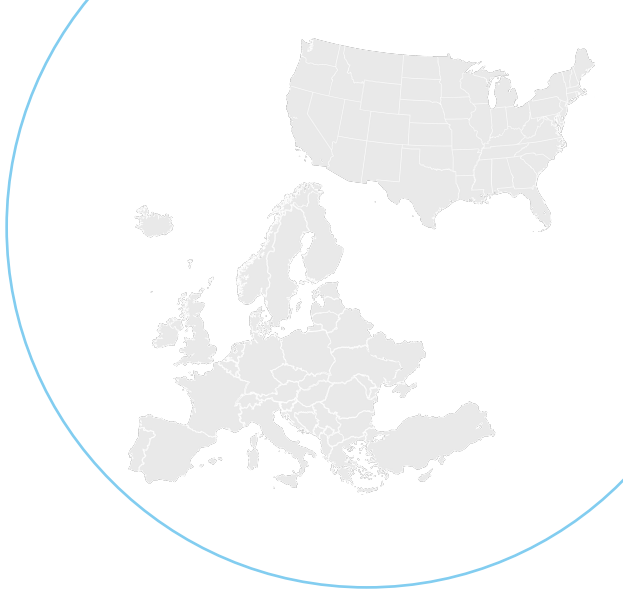
February 25, 2019 link

Air Liquide announces the construction in Canada of the largest PEM electrolyzer in the world with a 20 MW capacity for the production of carbon-free hydrogen.

This investment allows the Group to reaffirm its long-term commitment to the hydrogen energy markets and its ambition to be a major player in the supply of carbon-free hydrogen.

Mobility for Professionals
USA+EUROPE

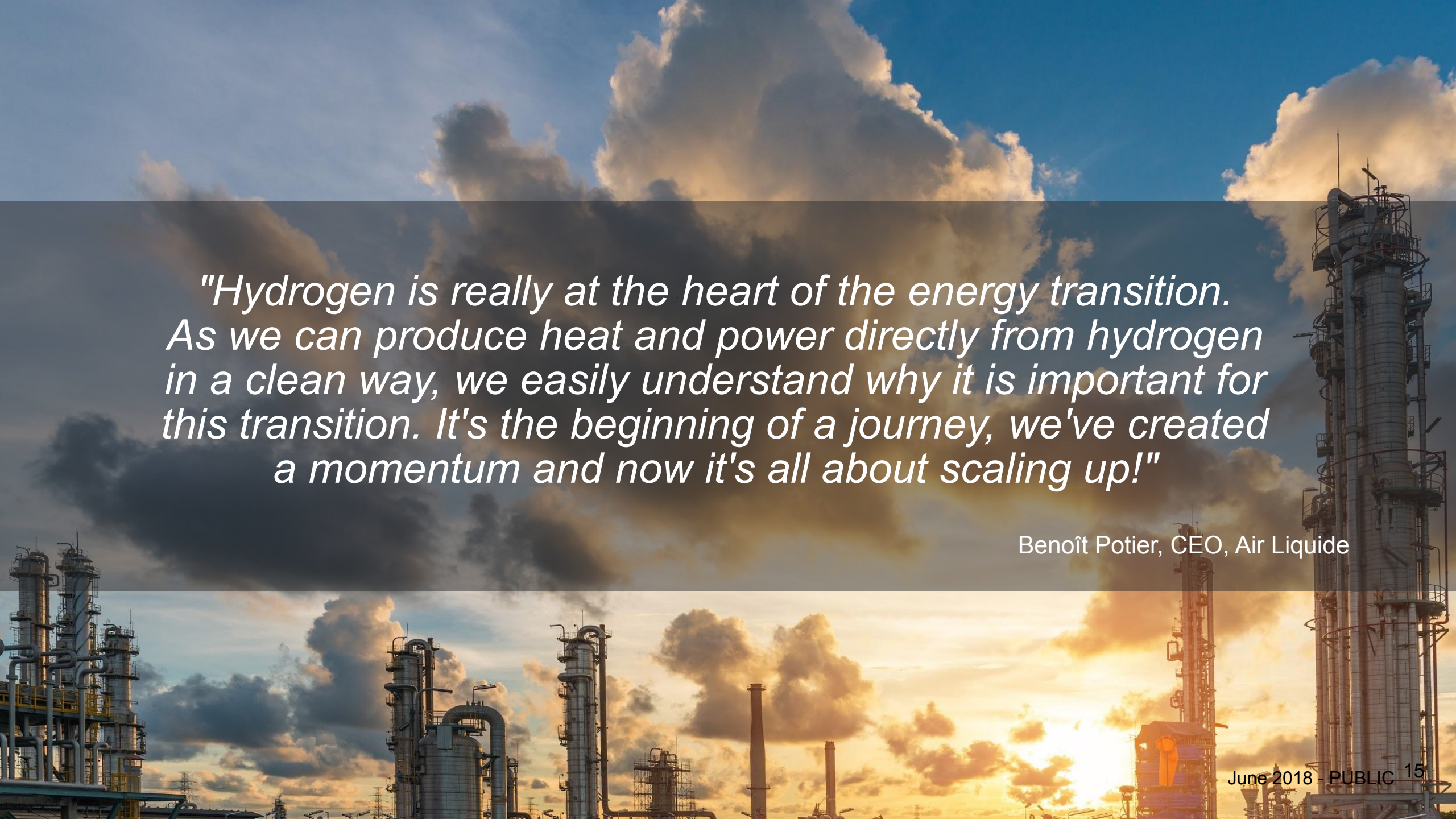
Hydrogen station for forklift trucks in Prelocentre logistic warehouse in Orléans, France



Hydrogen for forklifts

To date, there are 20,000 hydrogen-powered forklift trucks deployed on the North American market. The potential development of this market in Europe could be around 10,000 units by 2020.

> Air Liquide designed hydrogen station for forklifts trucks
> 11 stations installed in North America and Europe
> 270 forklifts powered by Air Liquide H_2 stations in France (HAWL and Hylift projects)
> Providing hydrogen to Walmart (Canada) and Coca-cola (in California)



"Hydrogen is really at the heart of the energy transition. As we can produce heat and power directly from hydrogen in a clean way, we easily understand why it is important for this transition. It's the beginning of a journey, we've created a momentum and now it's all about scaling up!"

Benoît Potier, CEO, Air Liquide