

# Hydrogen

**A French-Norwegian approach to  
decarbonisation of the industry**



# A solid base of 50 years of experience in H<sub>2</sub> supply

## Production

Large portfolio of technologies

Recuperation of H<sub>2</sub> from Offgas



Steam Methane Reformer + CO<sub>2</sub> Removal



Chlor-Alkali electrolysis  
Water electrolysis (planned)



Natural Gas



Feedstock from Industrial Process

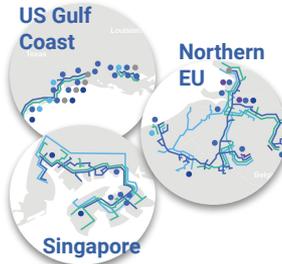


Biomethane



Low-carbon electricity

## Supply Chain



Supply modes:

- Onsite
- Pipeline
- Trucking

## Markets



Existing Industrial Usages Shifting to **Low-carbon Hydrogen**



**New Growth Opportunities**  
New usages for Hydrogen to replace fossil fuels

## Key Figures

1.2 Mt/y

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

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

40 electrolyzers in operation

2B€ sales

# Definition of H<sub>2</sub> and typical Carbon Footprints



Natural Gas + CCUS

## Low Carbon, Decarbonized, Blue Hydrogen

Fossil-based H<sub>2</sub> with CCS and H<sub>2</sub> produced by electrolysis using electricity with significantly reduced carbon footprint

## Renewable or Green Hydrogen

H<sub>2</sub> produced by electrolysis with electricity produced by renewable sources (including biomethane).



Low-carbon electricity & Biomethane

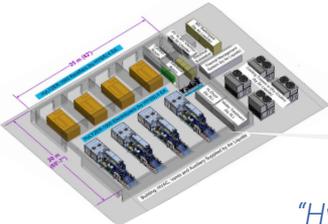
Energy source	CO <sub>2</sub> Footprint kgCO <sub>2eq</sub> /kgH <sub>2</sub>
<b>Steam Methane Reforming</b>	
Natural gas without CCS	+11
Natural gas with CCS	+3
Biomethane without CCS	+2
Biomethane with CCS	-5
<b>Water electrolysis</b>	
Mix France 2020/Quebec 2020	3.6/1.5
Wind offshore France	0.9
Nuclear France	0.4
Solar France continental	3.3
Mix Germany	27.7
Mix EU27	25.2

# H2 Production & AL Electrolyzers Operating Expertise

**ON SITE** More than 40 electrolyzers in operation worldwide  
Usual range: 50 - 100 Nm<sup>3</sup>/h H<sub>2</sub>  
Mainly Alkaline technology

Air Liquide  
Equity  
20%

**HYDROGENICS**  
SHIFT POWER | ENERGIZE YOUR WORLD



2018



"Hybalance" **DENMARK) 1.25 MW**  
PEM  
H2 balancing plant

2019



PEM Electrolysis Bécancour,  
**Canada/Quebec 20 MW** hydropower,  
competitive vs. SMR  
Stacks from 1.7MW to  
5MW under development (2020)

2020

Commercial offers: Electrolyzers

- 100MW (GER),
- 100 MW (FR)
- 65 MW (FR)

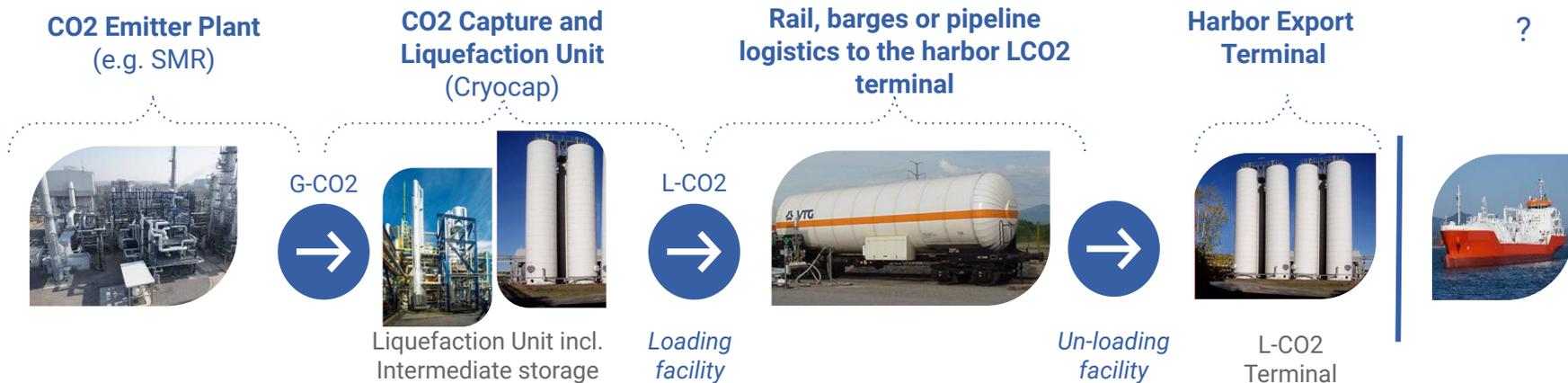
**SIEMENS**  
energy

AL & Siemens Energy decided to develop a large scale electrolyzer partnership for sustainable hydrogen production.

# C02 Management - AL expertise



Air Liquide



## Air Liquide expertise:

- Various CO2 capture technologies (Cryocap FG/Oxy, Amine wash, Rectisol) for different flue gas compositions
- CO2 compression, liquefaction and storage expertise
- CO2 pipeline experience

## Lighthouse projects:

- ▣ **CRYOCAP™**, Port-Jérôme, Carbon Capture
- ▣ **Antwerp@C**, Antwerpen, CO2 infrastructure
- ▣ **Northern Lights**, CO2 infrastructure,



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## Moving Industry forward for a better future

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As good citizens of industry

we help industry move towards carbon  
neutrality

Our world is changing; climate challenge  
requires a profound adaptation of the way we  
live, and the way products are made.

Our customers' products touch our lives daily  
and we use our experience and knowledge to  
help them **solve some of their greatest  
production challenges.**

We are striving to support our industrial  
customers **to produce cleaner products safely,  
responsibly and more efficiently.**