• Air Liquide

Energy Gases in Transition

Air Liquide Europe - EMN for Energy Gases Workshop - IPQ, Portugal - 21 & 22 March 2023

Introduction, Snapshot on Hydrogen and Carbon Capture and Storage (CCS) at Air Liquide







Air Liquide Profile video

PATIENTS

Air Liquide

Air Liquide in brief

Air Liquide is a world leader in gases, technologies and services for Industry and Health



Our ambition is to be a leader in our industry, to deliver long term performance and to contribute to a more sustainable world.

Our scientific territory: Essential small molecules

Oxygen, nitrogen and hydrogen are essential small molecules. They embody Air Liquide's scientific territory and have been at the core of the company's activities since its creation in 1902.

Separating the components of **air** to take advantage of their properties



Producing molecules from the **natural resources** of the planet





Hydrogen

On the move

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Seven roles for hydrogen in the Energy Transition





Hydrogen as a Cornerstone of the ET..... and a Tremendous Growth Potential



Our ENGAGEMENT

Decarbonize our **production assets** to develop a competitive low-carbon H_2 offering at large scale.

Creating value by **decarbonizing** our **customer's processes**, leveraging our long-term relationships.

Be a **key enabler** of the **Hydrogen society** thanks to our assets, technology and expertise.

Becancour Electrolyzer LH2 storage

VirLiquide

Definition of H2 and typical Carbon Footprints



Natural Gas + CCUS

Low Carbon, Decarbonized, Blue Hydrogen

- Fossil-based H2 with CCS
- H2 produced by electrolysis using electricity with significantly reduced carbon footprint



Renewable or Green Hydrogen

H2 produced by electrolysis with electricity produced by renewable sources (including biomethane)

Hydrogen Product Routes	CO2 Footprint kgCO _{2eq} /kgH ₂
Natural gas without CCS	+11
Natural gas with CCS	+3
Biomethane without CCS	+2
Biomethane with CCS	-5
Mix France 2020	3.6
Wind offshore France	0.9
Nuclear France	0.4
Solar France continental	3.3
Mix Germany	27.7
Mix EU27	25.2

2 routes: renewable & decarbonized hydrogen supply modes



Biomethane capabilities for renewable hydrogen







- Air Liquide **produces biomethane** in the UK, FR, Hungary, Denmark (500 GWh/y)
- AL has an integrated biomethane management from biomethane producing to use in industrial operations
- Biomethane usage does not require technical adaption of the SMR unit
- Benefit: reduction of EU ETS cost



Electrolysis as Integrated Solution for green hydrogen







CCS (Carbon Capture Storage) Emerging CO₂ value chain

..... 65 CCUS projects in Europe

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Industrial setting for CSS

CCS is considered an important lever to reach CO₂ reduction objectives.

- It allows for a **fast decarbonization** of industries.
- It has a potential to **deliver negative emissions** (bio energy with CCS).
- It is a potential **long term solution** for hard to abbate sectors.



CCS is quickly becoming a priority for the industry to meet decarbonization targets.



CCS - Air Liquide ambition

2050

- **Carbon neutrality in 2050**, with an important milestones:
 - To start reducing its absolute CO2 emissions around 2025
 - To reach a 33% decrease CO2 emissions by 2035 compared to 2020
 - Commitment to working with its customers towards a low carbon, sustainable industry
- CCS is for Air liquide an important lever to reach these CO₂ reduction objectives.
 - CO2 Hub, there where there is a potential for aggregation of CO2.
 - In selected basins, examples: Rotterdam, Anvers, Dunkerque, Normandie, Duisburg, Gdansk, Fos



CCS - Air Liquide Expertise in CO2 Management



Air Liquide expertise:

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

Key project examples:

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



CO₂

CH2ANGE WITH HYDROGEN





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General Concept of CO2 hub



