Innovation and Technologies Enabling Energy Transition to deliver the ADVANCE strategic plan

May 31, 2023
Innovation and Technologies Enabling Energy Transition

Emilie Mouren-Renouard - Vice President, Innovation and Development
ADVANCE

Financial performance
And beyond,
Decarbonizing the planet
Unlocking progress via technologies
Acting for all
Decarbonizing Air Liquide Assets, Commitment to Carbon Neutrality

Air Liquide Commitments

CO₂ emissions start decreasing in absolute value

-30%
Carbon intensity in kg CO₂/€ EBITDA\(^{(a)}\) vs 2015

\(\sim 2025\)

2035

2050

Reach Carbon Neutrality by 2050

Decrease scope 1 & 2 CO₂eq emissions in absolute value by -33\(^{(b)}\)

(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)
Decarbonizing Customers, Air Liquide Solutions Along the Low-Carbon Chain

1. Low-carbon Industrial Gas Supply

2. Low-carbon process transformation
   - Carbon Capture as a service

3. Low-carbon Products & Fuels

Customers:
- Energy / Refining
- Chemicals
- Steel
- Cement

Geographies:
- Europe
- Americas
- Middle East
- Asia
Leveraging our Technologies, Focus on Solutions for Energy Transition

Technos

- Renewable Electricity intermittency management - ALive™
- Ultra low energy ASU
- Oxycombustion

Innovative Air Gases Solutions

- ATR* / POX* with Carbon Capture for large H₂ volumes
- H₂ Liquefaction
- Other E&C technologies such as NH₃ cracking

Low-carbon H₂

Carbon Capture

- The most complete Carbon Capture offer

- Absorption
- Cryogenic
- Membranes
- Adsorption

Electrolysis

- PEM* partnership with SIEMENS energy
- Active innovation in all technologies

Combined with

Digital - AI

Smart Innovative Operations - Integrated Bulk Operations

- Technical and innovation experts
- Skilled operational teams

4,000 TCL(1)
3,000 inventors

Human expertise

(1) Technical Community Leaders
Leading in Innovation to Support Business and Operations

Climate solutions

- ~33%

Others (industrial security, air gases...)

- ~22%

Advanced Materials

- ~11%

Digital

- ~15%

Healthcare

- ~19%

#1 applicant of new patents in Industrial Gases

€308m in 2022

(1) Innovation expenses
Innovation Contributing to Short Term Profitable Growth While Preparing the Group’s Future
E&C Capabilities Enabling Innovation Delivery

7 Main Engineering Centers worldwide

3 Manufacturing centers

>€1bn Order Intake

~50% of Group’s patents filed

Proprietary core business technologies
- Air gases, low-C $\text{H}_2$, $\text{H}_2$ liquefaction, carbon capture

References in large projects

Closeness to plant operations
- operated by LI, EL, IM

Allowing continuous operational feedback, creating a virtuous circle for fast continuous improvement

➢ Key differentiating factors enabling innovation DELIVERY
Air Liquide Global Markets & Technologies

Emilie Mouren-Renouard – Vice President, Innovation and Development
Support the Deployment of Sustainable Solutions, Invent the Future

Delivering **solutions** Technologies, Molecules, Equipment, Services for
- **Energy Transition**
- **Deep Tech**

Through 3 activities:
- **Technologies**
- **Biomethane Solutions**
- **Maritime**

- Acting to **decarbonize** industry
- Promoting **progress** through **technological innovation**
- **Acting for all** of our stakeholders
Strong Growth Dynamic, Disruptive & Entrepreneurial Mindset

2022 third party sales\(^{(1)}\)

- Technologies
  - Space
  - Big Science & Fusion
  - Hydrogen technologies
  - Membranes
  - Cryogenic equipment

- Biomethane solutions
  - Production & purification

- Maritime
  - Global sourcing of molecules (helium, rare gases) to IM & EL

GM&T solutions provider to the Group

- Technologies: Equipment for EL & IM

- Maritime
  - \(\sim \€900m\)

+19% \(5 \text{ years CAGR}\)^{(2)}

\(^{(1)}\) Consolidated revenue \(^{(2)}\) 2017-2022
A Unique Technology Campus within the Innovation Network

- Created in **1962**
- Around **1,400** employees
- **14 hectares** including a **test center** of 3 hectares
- ~**20,000 m²** of production workshops
- **Low environmental impact** tertiary buildings
More than 60 Years of Innovation

- Creation of the Cryogenic Studies Centre
- World's first automatic helium liquefier
- Herschel and Planck satellites with our cryogenic equipment
- 1st Test for hydrogen-electric aircraft
- 1st Biogas upgrading unit
- 1st Hydrogen developments for mobility
- 1st Ariane tanks
- 1st Turbo-Brayton offshore
An Exceptional Local Ecosystem with Strong International Reputation

- **30,000 jobs in research**
  - Within a radius of 20km

- **#1 in France for concentration of R&D jobs (7.6%)**
  - (ex: glass, steel)

- **670 Startups launched since 2000**

- **High concentration of research organisations and industry leaders**

- **5th most inventive city in the world**

- **40% of people in the industry sector employed by a foreign entity**

(1) Forbes magazine
Acting for All: Highly Integrated into Local Ecosystem

With research-oriented ecosystem

**SOLAR IMPULSE FOUNDATION**
Supporting the **ecological transition** of the territory and businesses

April 25th: Climate & Solutions Day

**CNRS**
Common **research** for **cryogenics & quantum computing**

Common **laboratory** for **space cryogenics and refrigeration for big science**

With local authorities and public services

**FONDATION Université Grenoble Alpes**
Promotion of **scientific culture** through projects of public interest

**PACTE ÉCONOMIQUE LOCAL**
Making commitments for **economic resilience**

**CEA**
**Common research** for **cryogenics & quantum computing**

**Sport Dans La Ville**
**Professional insertion & mixity in technological industries**

**Elles Bougent**

**CITIZENCAMPUS**
**Unique training program** on “Science & Society” debates
Dynamic Electronics Activity in the Basin

Huge presence at customer sites, delivering carrier gases, specialty materials and equipment for semiconductors and flat panels display manufacturing.

Stunning rise of electronic activities in the 2023-2025 period:
- ~+9,000m² new clean rooms
- ~+15,000m² new fabs

Capacity to deliver in less than 18 months. Planned until 2025:
- 4 new N₂ generators
- 2 new PEM electrolysers
- >375 gas cabinets and >180 chemical distribution systems
Key Takeaways

Emilie Mouren-Renouard – Vice President, Innovation and Development
Innovation and Technologies, First Enablers of the Energy Transition

Act as a leader in Energy Transition

- Decarbonize our assets
- Decarbonize the assets of our customers

Innovation as a differentiating factor

- Large portfolio of proprietary technologies
- Key partnerships
  - Unique position: ability to innovate, develop, invest, operate

There will be no Energy Transition without Innovation and Technologies
Early Player in Biomethane

- Proprietary technologies
- Build, own and operate on a **long term** basis
- **De-risking sourcing of waste** by incentivizing feedstock providers & promoting **circular economy** schemes
- Starting in transportation, now positioning on **high value niche markets** upstream for **industry**:
  - Decarbonizing industrial customers’ processes, leveraging Air Liquide portfolio
  - Partly decarbonizing Large Industries SMRs
  - Offering **renewable H₂** and **CO** to Large Industries customers
  - Supplying **biogenic CO₂** to Industrial Merchant
- **Dynamic** market growth
Innovating in Cryogenics for Growth and Efficiency

- Unique cryogenic expertise
- Turbomachines at the core of gas liquefaction and refrigeration units, key for Energy Transition
- To reach cryogenic temperature (-150°C, 120K)
  Gas flows through compressor, heat exchanger, expander
- High expertise in Turboexpander machines
  - High-speed rotating machines
  - The site produced:
    - >800 turbo expanders over the last 50 years
    - >400 turbo compressors for Turbo Braytons over the last 6 years
  - Unique test bench in cryogenic conditions
- Recognized performance of AL expanders associated with cryogenic knowledge
  - ITER nuclear fusion project
  - Major He liquefaction units in Qatar
Leveraging Turbo Brayton for Liquid $\text{H}_2$

- Several steps of development over 20 years
  - Space $\rightarrow$ Superconductivity $\rightarrow$ Maritime LNG & Biomethane liquefaction $\rightarrow$ **Hydrogen liquefaction**

- Highly competitive in Capex & Opex
  - Improved **reliability, efficiency & flexibility**
  - Compact & modular system for **easy manufacturing, logistics & installation**
  - Adapted to intermittent renewable energy source

- One of the key techno bricks for the liquefaction of $\text{H}_2$
Liquid Hydrogen, a Key Differentiator for H₂ Mobility Markets

- **H₂ distribution in**
  - **Gaseous** form @300 bar in GH₂ tube trailers
  - **Liquid** form in LH₂ trailers
  - 1 LH₂ trailer replaces 6 GH₂ tube trailers

- **AL global Leader in H₂ (and He) liquefaction**
  - Unique test platform with unique cryogenics capabilities
    - LH₂ @-253°C, LHe @-269°C

- **HRS⁽¹⁾, a key enabler for H₂ mobility markets**
  - From GH₂ storage to GH₂ (from 300 to 700 bar; >200 HRS delivered) -> mature technology
  - From LH₂ storage to GH₂ (@700 bar, test of the pump) -> less energy intensive, cheaper LH₂ supply chain
  - From LH₂ storage to LH₂ into planes, ships, trucks -> developed for Ariane rockets, to be adapted to new markets

⁽¹⁾ HRS: Hydrogen Refueling Stations
Air Liquide Unique Competencies enabling H₂ Emergence for Aviation

- H₂ central for the decarbonation of aviation with 3 usages:
  - Electricity produced onboard with **fuel cells**
  - H₂ **burned** into a turbine
  - efuels (H₂ + CO₂)
- Medium-haul aircrafts prime segment for LH₂
  <2000 kms, <200 passengers
- Leveraging on unique competencies to:
  - Master the H₂ **supply chain**
  - Contribute to the **airport H₂ infrastructure development**
- Working with partners to move fast
Taking a Strong Position in Electrolysis

- Secure **access to the most competitive technology** in Capex and Opex
- Ensure **safe, reliable and efficient operations**
- **Leveraging** project execution & industrial operation
  - from **PEM**\(^{(1)}\) **20MW electrolyzer in Becancour** since 2021
- **Managing all technologies**
  - **PEM** Joint Venture
    - Gigafactory and R&D agreement
  - On-going development on **Alkaline**
  - Promising **AEM**\(^{(2)}\) - R&D program started with bench tests

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\(^{(1)}\) Proton Exchange Membrane  \(^{(2)}\) Anion Exchange Membrane
Well Positioned to Capture Growth in the Energy Transition

Growing Customer Needs

Air Liquide offer

- Low Carbon Industrial Gas Supply
- Low Carbon Process Transformation
- Carbon Capture As A Service
- New Products & Manufacturing Support

Value creation

Innovation
Partnerships
Resources
Customer Relationship
Basin Footprint

Value creation offer
Growing Customer Needs
From Technology to Business Projects

Pascal Vinet, Senior Vice President in charge of Europe Industries and AMEI
Chris Clark, Large Industries Vice President
Dynamic Development of Electrolyser Projects in Europe

- **ELYgator** - Terneuzen
  - 200 MW
  - Customers: O&G, Mobility

- **Dunkirk ELY** - Dunkirk
  - 420 MW
  - Customers: Steel

- **Normand’Hy** - Port-Jérôme
  - 200 MW
  - Customers: O&G, Chemicals, Mobility

- **Curt’Hyli** - Rotterdam
  - 200 MW
  - Customers: O&G, Mobility

- **Trailblazer** - Oberhausen
  - 20 MW
  - Customers: Steel, Chemicals, Mobility

- **Green Motion Steel** - Duisburg
  - 120 MW
  - Customers: Steel, Mobility

**Electrolyser capacity**: >1 GW

**Public funding**, **Ren. energy sourcing**, **Awarded / secured**
Connecting Electrolyzer and Existing H₂ Pipeline Network

**20MW PEM**(1) electrolyzer

- **Air Liquide** + **SIEMENS energy** 1st cooperation project
- Startup in Q4 2023
- In the **most industrialized basin in Germany**
- Diverse customers: **Steel, Chemicals, Refineries** & mobility
- Supplying **new DRI project**
- Synergies: **high purity renewable O₂** to local premium markets
- Secured **PPA**, wind + solar

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**Trailblazer Oberhausen**

(1) Proton Exchange Membrane
Trailblazer Project: Startup in Q4 2023

Pictures taken on site, May 5th, 2023

Visit of German President May 2nd, 2023
Carbon Capture, a New Business for Large Industries

A favourable ecosystem
- Leveraging major industrial & transportation hubs
- Strong national & EU support for emissions reduction
- Driven by the hard-to-abate sector

Complete portfolio of Proprietary technologies

Involved in flagship projects in European key basins

<table>
<thead>
<tr>
<th>Basin</th>
<th>Projects</th>
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<tr>
<td>Belgium-Netherlands</td>
<td>▪ Porthos [Rotterdam]</td>
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<td>▪ Kairos@C [Antwerp]</td>
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<td>Normandy</td>
<td>▪ CCU/CCS for</td>
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<td>▪ Grandpuits SMR &amp; CC</td>
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Cryocap XLL: for large scale CO₂ liquefaction; Cryocap Oxy: for flue gas from oxycombustion; Cryocap H₂: for H₂ production; Cryocap FG: for low CO₂ concentration flue gas; Cryocap Steel: for steel production
Accelerating Opportunities in the US

Canada and US Midwest

A favourable ecosystem
- Accelerating opportunities in the battery market
- new $O_2/H_2$ opportunities from Low Carbon Steel Making

Key project drivers
- Advancing decarbonization projects of key chemical and oil/gas facilities to meet sustainability objectives
- IRA legislation and relatively low energy cost underpinning US gulf coast competitiveness for energy export markets (eg low carbon ammonia for northeast Asia)

Infrastructure legislation:
providing subsidies for $H_2$ Hubs across the US (industry and mobility)
Delivering ADVANCE Strategic Plan

Jérôme Pelletan, Group Chief Financial Officer
Innovation and Technologies at the Heart of the Group’s Strategy

ADVANCE

Financial performance
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Technologies as a Key Differentiator, Supporting Investments

Industrial Investment Decisions above €5m

- Large Industries
- Energy Transition
- Electronics
- Others thereof ~1/2 IM

Total investment decisions €16bn (1) 2022-2025

(1) Cumulated industrial and financial investments decisions over 4 years 2022-2025
To Deliver **ADVANCE** Performance Objectives

Sales growth
+5-6% CAGR\(^{(1)}\)

ROCE
>10% by 2023 and forward

\(\text{CO}_2\) emissions inflection around 2025

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\(^{(1)}\) Group comparable sales growth 2021-2025 CAGR