



Sustainable Financing Framework

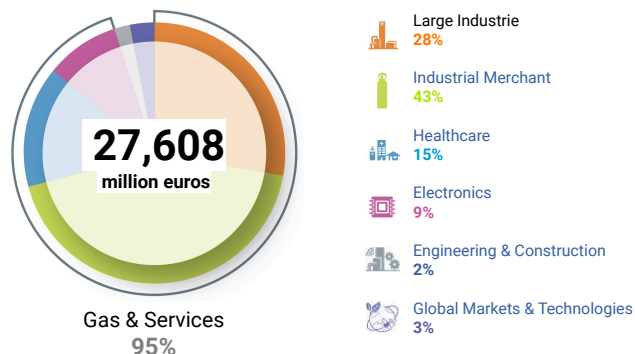
May 2024

1. The Air Liquide Group

A world leader in gases, technologies and services for Industry and Health, Air Liquide (or “the Group”) is **present in 72 countries with approximately 67,800 employees and serves more than 4 million customers and patients.** Air Liquide has been providing oxygen, nitrogen and hydrogen, essential small molecules for life, matter and energy, since 1902.¹

¹ <https://www.airliquide.com/>

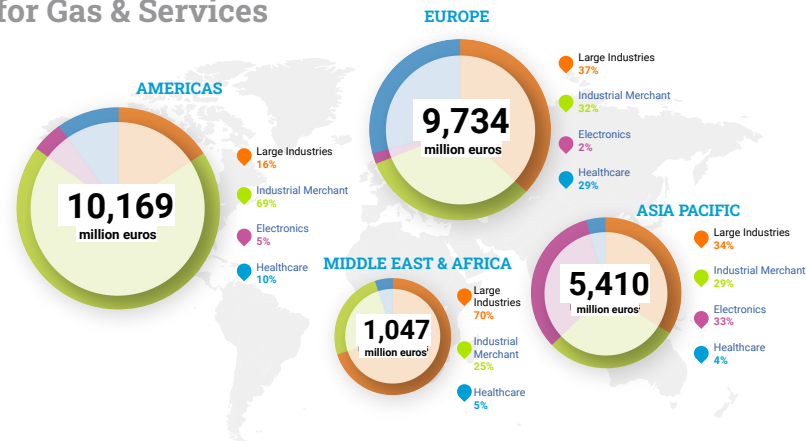
2023 Group revenue by activity



The Group serves industrial gases and classifies its activities as follows:

- Gas & Services (Large Industries, Industrial Merchant, Healthcare and Electronics) – **95%** of Revenue in 2023
- Global Markets & Technologies – **3%** of Revenue in 2023
- Engineering & Construction – **2%** of Revenue in 2023

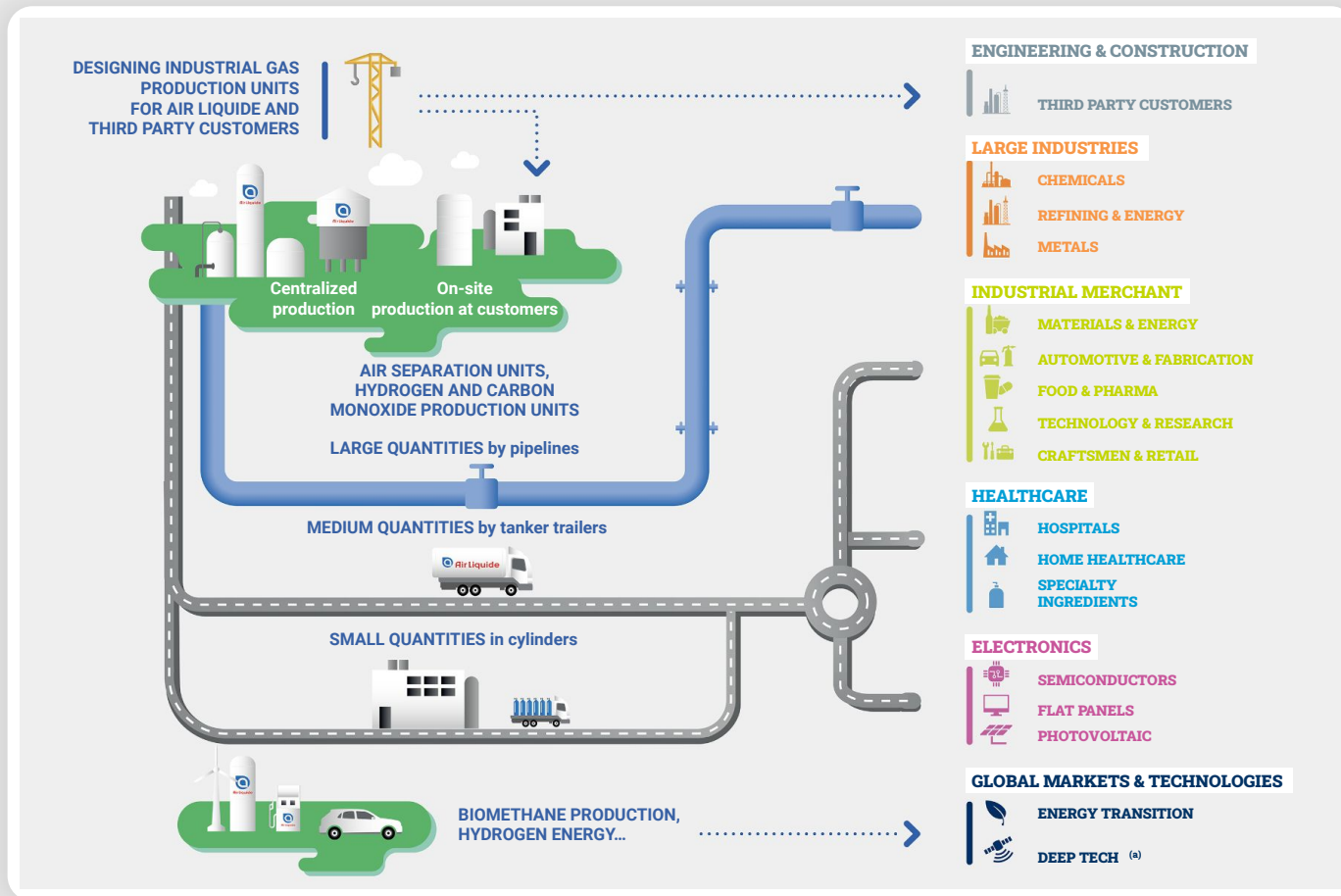
2023 Group revenue by region and by activity, for Gas & Services



1.1. Gas & Services

The Gas & Services businesses include four World Business Lines to better support changes and meet the needs of the various markets: Large Industries, Industrial Merchant, Healthcare, and Electronics. The Gases supplied by Air Liquide's Business Lines include: Oxygen, Nitrogen, Argon, Hydrogen, Carbon Monoxide, Carbon Dioxide, Steam, Biomethane and other Rare Gases.

Air Liquide gas production units are located throughout the world to support local demand and can supply many types of customers and industries with the relevant volumes and services required. Air Liquide's structure is made up of a base, in Paris, and four hubs: Americas, Europe, Asia Pacific and Middle East & Africa.



(a) Disruptive technologies based on scientific breakthroughs of such a nature as to change the modes of design and production.

Large Industries

supplies industrial gases by operating major production units. It serves customers in the metals, chemicals, refining and energy sectors where high gas volumes call for a dedicated plant or the development of a pipeline network. Large Industries also supplies the Group's other business lines with gases which are then packaged and delivered to their respective customers. The Large Industries are at the heart of the energy transition, through the supply of low-carbon gases as well as new modes of process and solutions for the Group's customers' CO2 emissions reduction.

Industrial Merchant

supplies a wide range of different gases, application equipment and associated services. It serves industries (including automotive, materials, energy, food, pharmaceutical, retail, technology and research) where professionals that require smaller quantities than Large Industries' customers. Gas can be distributed in bulk, in liquid form, or in cylinders, in gaseous form, for smaller quantities. Finally, small production units can be installed locally for customers with larger gas needs, or in remote areas. Strong operational discipline is applied across the value chain (supply, packaging, distribution) and when coupled with new digital tools including the IBO ("Integrated Bulk Operations"), this allows the Group to optimize the use of its resources to improve the competitiveness of its products and services for customers and reduce its CO2 emissions.

Healthcare

supplies medical gases, equipment and services to hospitals and also directly to patients in their homes. It also produces and distributes healthcare specialty ingredients for the cosmetics, pharmaceutical, vaccine and nutrition markets. Air Liquide Healthcare has a unique position in that it is present along the continuum of care and is connected to all stakeholders in the healthcare ecosystem (patients, healthcare professionals, hospitals, health authorities, payers) for the treatment of acute diseases (with the supply of medical gases and services in hospitals and other places of care), the treatment of chronic diseases (with Home Healthcare) and in prevention and well-being of patients with Specialty ingredients.

Electronics

supplies gases, materials (complex molecules) used in manufacturing processes, as well as equipment and services mainly used for the production of semiconductors, but also flat screens and photovoltaic panels. The Electronics business line works on reducing greenhouse gas emissions associated with electricity consumption for the production of carrier gases and by providing customers with low environmental impact materials which are able to replace some of the more polluting materials currently in use.

1.2. Engineering & Construction

The Engineering & Construction (E&C) World Business Unit designs and constructs gas production units, from the feasibility study stage through to the delivery of the complete installation, for its own use or for sale to customers who prefer to insource their gas requirements. Engineering & Construction develops solutions for **industrial gas, energy conversion, gas purification and CO2 capture technologies**, as well as **renewable and low-carbon hydrogen**, enabling customers to optimize the use of natural resources.

In particular, Engineering & Construction teams are already offering the customers, particularly in hard-to-abate sectors, a full range of carbon capture proprietary technologies that enable them to decarbonize their operations.

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In hydrogen, Air Liquide covers the entire supply chain, from production to storage, to distribution and the development of applications for industrial markets and heavy-duty mobility. ”

1.3. Global Markets & Technologies

The Global Markets & Technologies (GM&T) World Business Unit delivers technological solutions – molecules, equipment and services – to support the dynamic markets of energy transition and deep tech.

The GM&T World Business Unit invests in and operates biomethane production units to recover agricultural, household or industrial waste as part of a **circular economy approach**. Biomethane can be used to replace natural gas of fossil origin: in grids for domestic use, for heavy mobility (trucks, buses, ships, etc.) or for various industrial applications, in particular the **production of low-carbon hydrogen**.

In hydrogen, Air Liquide covers the entire supply chain, from production to storage, to distribution and the development of applications for industrial markets and heavy-duty mobility. The Group thus contributes to the wider use of hydrogen as an energy vector. GM&T designs **hydrogen refuelling stations** to support the mobility, and the Group is developing technologies and infrastructure required for the use of liquid hydrogen.

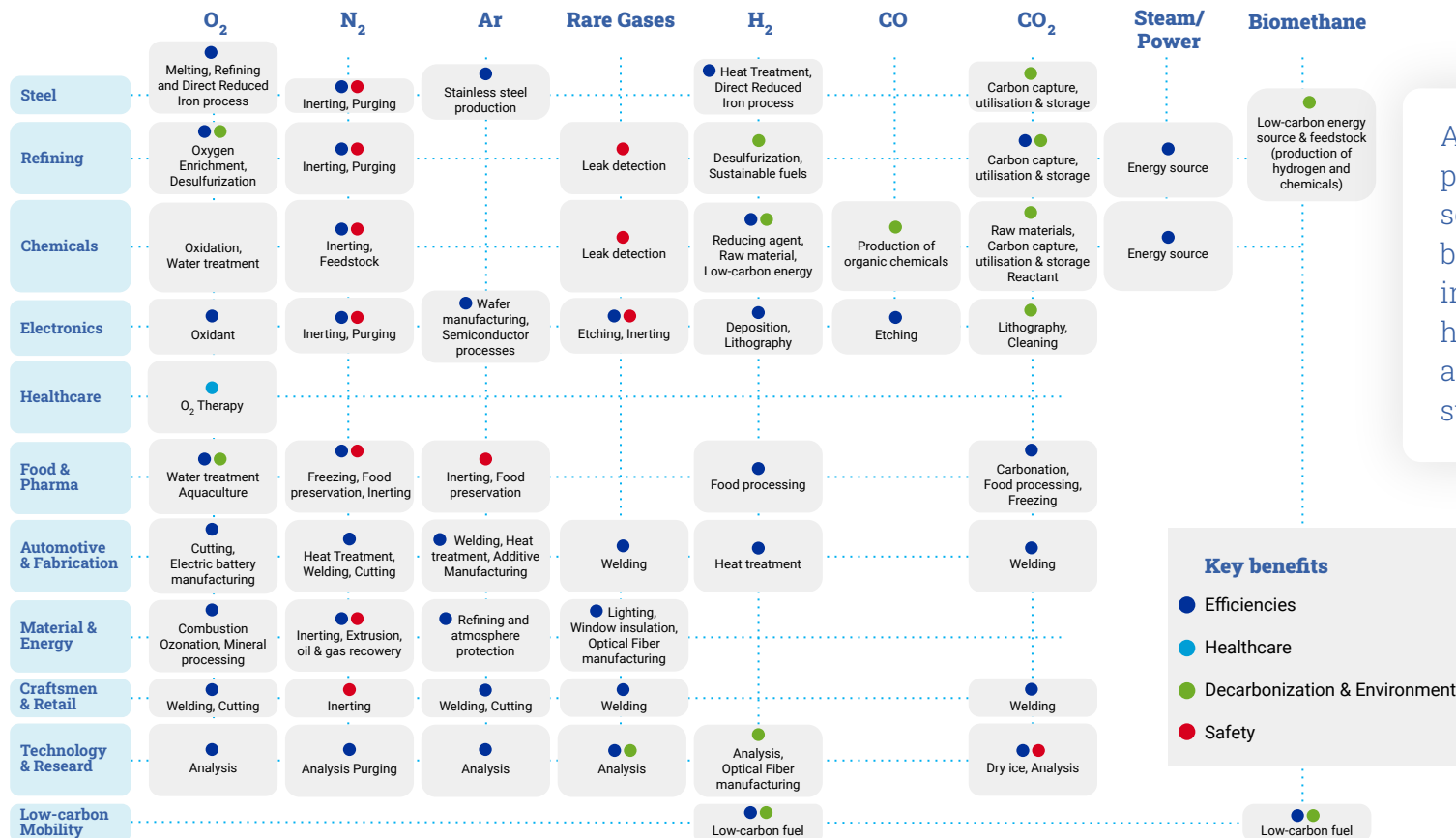
For the **maritime industry**, GM&T develops multimodal and sustainable solutions to supply a comprehensive range of gases (air gases, carbon dioxide, helium, hydrogen, krypton, xenon, etc.) and support its customers to decarbonize their operations.

To support **deep tech**, GM&T designs and develops, with its customers and ecosystems, disruptive technologies notably for the launchers, satellites, international research projects and the quantum computing.

2.

Air Liquide's Sustainable Development Strategy: Advancing for a Sustainable Future

Air Liquide is deeply committed to creating a positive impact on both the environment and society. The Group's strategy and actions are designed to address crucial challenges the world faces today, where Air Liquide can make an impact and thus invent a sustainable future.



Air Liquide products* and solutions contribute both directly and indirectly to a healthier society, and a more sustainable planet.

Key benefits

- Efficiencies
- Healthcare
- Decarbonization & Environment
- Safety

* Only major products are shown here

With its strategic plan ADVANCE, Air Liquide positioned its extra-financial and financial performance as equally important. It is with these convictions that Air Liquide has made commitments for the environment, for health, and for all.

Advancing for the Environment

Contribute to a low-carbon society and the environment as a whole:

- **Reducing our CO2 emissions**
 - by 2035, a -33% reduction in absolute Scopes 1 & 2 emissions, with an inflection point around 2025² (compared to 2020)
 - by 2025, -30% reduction in carbon intensity (compared to 2015)³
 - by 2050, reach carbon neutrality across the entire value chain
- **Water management**
 - Implement a water management plan by 2025 for high water use sites in high water stress areas
 - Define a Group standard for all operations related to the quality of discharged water
- **Biodiversity preservation**
 - Reinforce biodiversity assessment criteria in the investment process in 2024
 - Implement an aggregated biodiversity indicator in 2025

Advancing for Health

Improve the quality of life of patients and access to medical oxygen:

- **Improving the quality of life of patients with chronic diseases at home in mature economies**
- **Facilitating access to medical oxygen in low- and middle-income countries**

Advancing for All

Strive to act as a trusted partner with all Air Liquide's stakeholders:

- **Engaging with our employees: creating a safer, more collaborative and inclusive work environment**
 - by 2025, 35% women among Managers and Professional population
 - by 2025, 100% of employees to have common basis of care coverage
 - by 2025, 100% of employees to have access to volunteering opportunities through the Citizen at Work program
- **Building a best-in-class governance to create close relationships with stakeholders**

² Validated by the Science Based Targets initiative (SBTi) in May 2022 as compliant with a well below 2C scenario

³ In kg CO2-equivalent/euro of Operating income recurring before depreciation and amortization at 2015 exchange rates and excluding IFRS 16 for greenhouse gas emissions Scopes 1 and 2 reported using the "market-based" methodology

2.1. Decarbonizing the planet

With ADVANCE, Air Liquide confirms its leadership in the decarbonization of various industries and in the emergence of a low-carbon society in which hydrogen and carbon capture play a decisive part.

Air Liquide intends to contribute to carbon neutrality by addressing its entire value chain, covering direct emissions (Scope 1), indirect emissions related to the procurement of electricity and steam (Scope 2), as well as emissions of Scope 3, where other indirect emissions are reported.

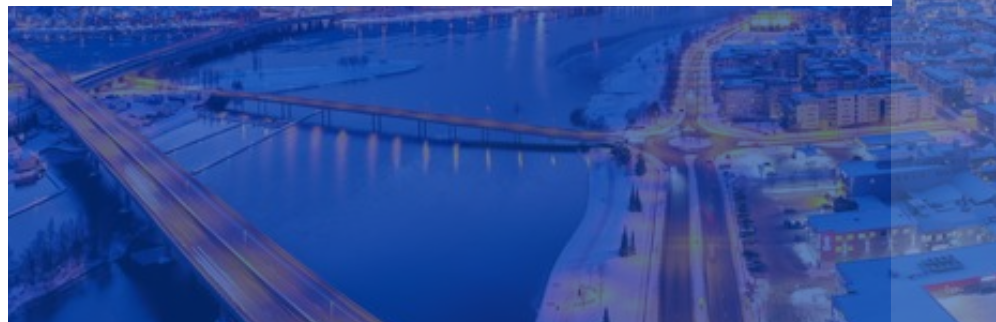
Two major intermediate milestones support this long-term objective: the start of reduction of absolute CO₂ emissions around 2025, followed by a -33% reduction in Scope 1 and Scope 2 emissions in 2035 compared with a 2020 baseline in "market-based" methodology. Moreover, the Group has maintained the objective set in 2018 to reduce its carbon intensity by -30% by 2025 compared with 2015. The Group's trajectory was validated by the Science Based Targets initiative (SBTi) in May 2022 and has been determined to be consistent with a scenario well below 2°C compared with pre-industrial levels.

The reduction of CO₂ emissions is a major challenge for large industrial players and for heavy duty mobility. This represents a pool of opportunities for Air Liquide. Hence, the Group has a large portfolio of technological solutions and services to accompany its Large Industries customers across the world in their path to decarbonization. Notably, this includes the supply of low-carbon industrial gases, the transformation of its customers' industrial processes and CO₂ management.

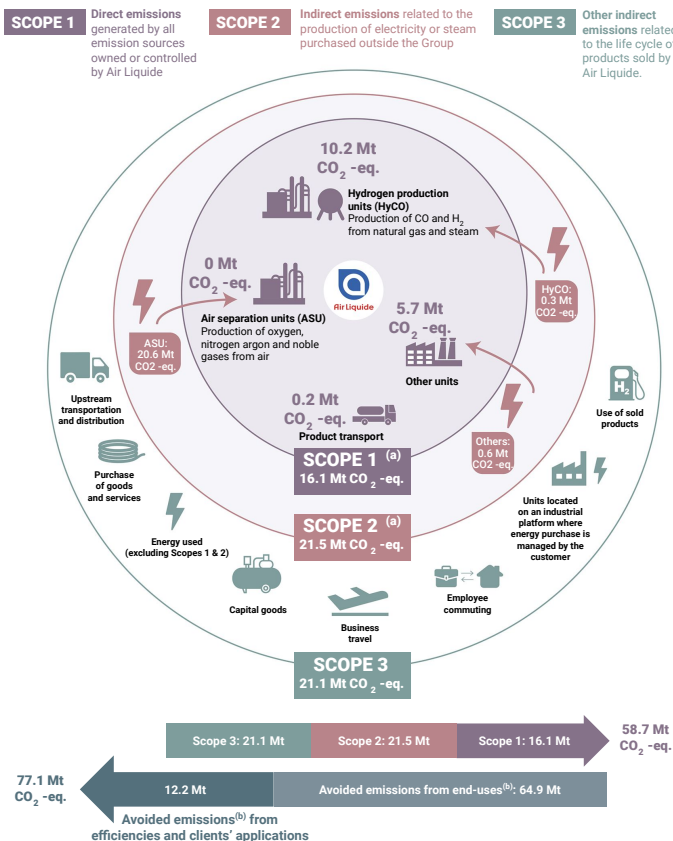
Furthermore, Air Liquide, through its activities, helps to avoid greenhouse gas emissions via three main levers:

- via its intrinsically efficient business model : efficiencies are generated by pooling several customers' requirements in the same basin enabling Air Liquide to invest and operate units which are larger in capacity
- via the direct use of the Group's products and services, enabling customers to reduce their emissions for the same level of production (e.g. using O₂ in blast furnaces instead of smoking coal to cut emissions at steel mills)
- via the impact of the Group's products on the greenhouse gas balance of customers' downstream value chains (e.g. using hydrogen to desulfurize road fuels thereby reducing black coal emissions down the value chain)

In 2023, Air Liquide calculated 77.1 Mt CO₂-eq of avoided emissions from efficiencies, clients' applications and end uses.



2023 Group revenue by activity



Air Liquide's decarbonization approach integrates the Group's activities through three complementary axes:

- taking action on **assets** by committing to reduce the carbon impact of production, distribution and service activities;
- taking action with **customers** by innovating for a cleaner industry;
- taking action for **ecosystems** by contributing to the emergence of a low-carbon society.

2.1.1. Reducing the carbon impact of Air Liquide's production, distribution and service activities

The following levers identified by the Group in order to reduce the carbon footprint of its assets are based on Air Liquide's technological and operational expertise. They also rely on the implementation of public policies and regulatory frameworks allowing, in particular, the rapid and massive development of decarbonized energies, which determine the speed at which these levers can be mobilized.

Scope 1 and 2 carbon emissions

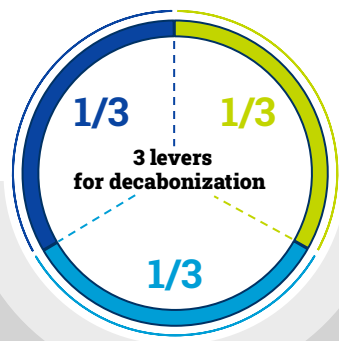
► Sourcing low-carbon energy

Air Liquide's ambition to achieving carbon neutrality associated with its assets is usually supported by the sourcing of low-carbon electricity to power the Air Separation Units. Hydrogen production units using methane reforming can be adapted to operate on renewable natural gas.

To reduce its indirect emissions related to energy purchases (Scope 2 emissions), Air Liquide adopts a proactive approach to purchase renewable and low-carbon electricity using several approaches depending on local conditions allowing access to renewable energy. The main one is the conclusion of long-term Power Purchase Agreements (PPA).

► Improving the efficiency of assets

Air Liquide constantly improves the design of its production units and modernizes them thanks to the innovation efforts of Research & Development and Engineering & Construction teams, in order to improve their energy efficiency and reduce their energy consumption. The Group continues to roll out the Smart and Innovative Operations (SIO) program which optimizes energy consumption and procurement through centralized operation centers. For example, Air Liquide uses a large fleet of trucks for the supply of industrial gases to its customers. Air Liquide therefore takes targeted actions to reduce logistics-related emissions by leveraging digital resources to optimize deliveries, and by progressively converting its fleet to alternate fuels.



► Rolling-out innovative technologies

Producing low-carbon hydrogen on an industrial scale and in a sustainable manner is a core development area for Air Liquide. The electrolysis of water is one of the key solutions to produce hydrogen with a minimal carbon footprint, when powered by low-carbon electricity. Air Liquide has also developed a portfolio of proprietary technologies such as Cryocap™, which allow CO2 to be captured and reused or stored on hydrogen production units using methane reforming units for the production of hydrogen. Capture for CO2 valorization and storage is thus set to play a major role in reducing direct emissions from hydrogen production.

Upstream Scope 3 carbon emissions

► Engaging with suppliers to reduce Scope 3 emissions from the supply chain

Procurement has a key role to play in supporting the Group's carbon neutrality objective throughout the supply chain by supporting its suppliers in the decarbonisation of the goods and services purchased, reducing Group emissions and contributing to the development of low-carbon solutions offered to its customers.

To address Air Liquide's supply chain GHG emissions, the Group Procurement Department has developed a climate roadmap in 2021, titled "Procure to Neutrality"⁴, which is based on four pillars: Measure, Engage, Leverage and Reduce. Additionally, the Group is including sustainability criteria in its supplier selection process via its TCO2 tool, which integrates Air Liquide's CO2 reduction objectives into three supplier selection criteria: the total cost of ownership, the risk assessment and the total CO2 emissions.

⁴ Procure to Neutrality, the Procurement climate roadmap

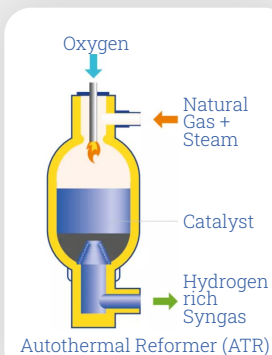
2.1.2. Innovative technologies to decarbonize customers' industries for a cleaner industry

The importance of the relationship with its customers has led the Group to pledge to have 75% of its 50 largest customers committed to carbon neutrality by 2050 in 2025 and 100% in 2035.

To achieve this ambition, addressing Air Liquide's Scope 3 and avoided emissions, three levers have been identified.

► Reducing Air Liquide products' carbon footprint

Air Liquide relies on its expertise to offer its customers innovative solutions to support them by outsourcing their needs to pool production assets and thus aim for greater energy efficiency. Air Liquide installs units directly on its customers' sites in order to save on transportation or to provide a new generation of lighter cylinders, and thus reduce transport-related CO2 emissions. Key solutions include:



- **ATR-based low-carbon ammonia and hydrogen technologies:** Competitively producing low-carbon hydrogen and ammonia at scale is key to decarbonize the economy. Therefore, among the Group's portfolio of technologies, Air Liquide can leverage seven decades of experience with its proprietary Autothermal Reforming Technology (ATR) that represents an area of interest for many industrial partners.

► Co-developing innovative processes with customers

The Group provides technical innovations to reduce the CO2 emissions associated with the conventional processes used in the industrial sectors such as metallurgy and chemicals by employing new production processes, such as oxy-combustion for cement coupled with CO2 capture, direct reduced iron (DRI unit) combined with submerged arc furnace for steel production, or new uses of materials such as hydrogen.

► Developing innovative carbon capture technologies⁶

Air Liquide's presence in major industrial basins, combined with its expertise in carbon capture and liquefaction technologies allows the Group to contribute to major global initiatives aimed at aggregating large streams of CO2 in order to capture them for valorization or storage.

- **Low carbon air gases⁵** Many sectors of industry use industrial gases such as oxygen, nitrogen, argon or carbon dioxide in their manufacturing processes. Air Liquide offers low-carbon gas solutions through its ECO ORIGIN™ offer produced using renewable feedstock and energy.

⁵ Additional details on the contribution of air gases to the decarbonization of industries can be found in appendix 1

⁶ More details on Carbon Capture can be found in the use of proceeds section of the Framework as well as in Appendix 2

2.1.3. Contributing to ecosystems for the emergence of a low-carbon society

► Promoting hydrogen (H2) for energy transition

Air Liquide is a founding member of the Hydrogen Council⁷, a unique global initiative that brings together nearly 150 companies in 2023 and aims to define a common ambition for hydrogen as an accelerator for the energy transition. Around 8 billion euros will be invested by the Group in the low-carbon hydrogen value chain by 2035. Hydrogen sales are expected to triple to 6 billion euros by 2035. Deeply convinced that hydrogen will play a major role in the energy transition, the Group intends to be a key player in the emergence of a hydrogen society thanks to its assets, its technologies and its expertise.

► Contributing to the development of clean mobility

Around 25% of Europe's total CO2 emissions originate on its roads, with heavy duty vehicles accounting for a major share. Air Liquide is investing in the production of low-carbon hydrogen from the electrolysis of water, as well as in hydrogen mobility distribution networks. The Group is also developing the biomethane chain from production to filling stations.

► Contributing to the circular economy through the development and diversification of biomethane

According to the International Energy Agency, biogas production is set to quadruple by 2030⁸. Naturally emitted by the decomposition of organic waste, biogas is composed of biogenic CO2 and biomethane. This biomethane can be used as a substitute for natural gas in industrial processes such as hydrogen production, or as an energy source or renewable raw material for industries such as chemicals, thereby reducing CO2 emissions by up to 80%⁹. Air Liquide supplies and purifies biogas for the production of biomethane (which can be directly injected into the gas network) for distribution to customers.

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Air Liquide is investing in the production of low-carbon hydrogen from the electrolysis of water, as well as in hydrogen mobility distribution networks. The Group is also developing the biomethane chain from production to filling stations. ”

⁷ <https://hydrogencouncil.com/en/>

⁸ <https://www.iea.org/reports/renewables-2023/special-section-biogas-and-biomethane>

⁹ Source: Carbone 4

2.2. Advancing for Health

Healthcare systems face different dynamics as a result of socio-economic heterogeneity. In mature economies they are challenged by demographics and rising costs, while developing economies are looking for long lasting, tailored solutions to find their own sustainable model.

Both at the hospital and at home, in person or remotely, in large cities or in medical deserts, Air Liquide works to improve patient outcomes by being there at every step of the care pathway.

In 35 countries, Air Liquide's 16,500 employees in the Healthcare business units – nurses, researchers, technicians, engineers, doctors, data scientists – support two million chronic patients and provide medical gases and related services to 20,000 hospitals and new care facilities, as well as 140,000 healthcare professionals.

► Providing medical gases and making them more accessible

Medical gases are essential to care for people and save lives, whether in the operating theatre, intensive care, in an ambulance or at a patient's bedside. Every day, Air Liquide guarantees the availability, reliability and safety of the supply of medical gases and associated services in hospitals and care facilities.

One gas in particular, oxygen, saves lives - yet half of the world's population has no access to medical oxygen. As a major player in the healthcare sector worldwide for 60 years, Air Liquide has leveraged its long-term expertise in medical oxygen supply to create a social impact program – Access Oxygen™ – to make medical oxygen available in rural areas in low- and middle-income countries. Since the launch of the program, 2 million people in Senegal, South Africa and Kenya have gained access to oxygen.

Air Liquide's goal is to expand access to oxygen in low- and middle-income countries, focusing today on Africa, Asia and Latin America.

► Providing more personalized care

In home healthcare, Air Liquide aims at providing everyday personalized support for people living with chronic diseases, with the objective to make it easier for them to achieve their therapy goals and improve their quality of life. Air Liquide believes in the combination of the most suitable treatment and the most adapted support, which are both key components in supporting chronic diseases. Air Liquide is convinced that it can contribute to better outcomes through a focus on personalization of care.

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2.3. Advancing for all

Acting as a socially responsible company and increasing Air Liquide's positive impact on society means first creating a safe, ethical and engaging environment for all employees. Air Liquide also strives to foster a more inclusive society and support the local ecosystems wherever the Group operates. The Group recognizes that the transition to a carbon-neutral economy may have significant social and societal implications. This must take all stakeholders into consideration, such as workers, customers, suppliers, and local communities to ensure a Just Transition that mitigates negative impacts while amplifying positive ones.



► Air Liquide's way to protect people

Air Liquide promotes well-being in a safe and ethical working environment. Everything starts with safety. It is a fundamental value and governs everything Air Liquide does. The Group is committed to remove or minimize professional and industrial risks for all employees and stakeholders, as well as to the well being of employees outside the workplace. As a global company present in more than 70 countries, 78% of Air Liquide's employees are already covered by the Group's common basis of care coverage, on track to achieve 100% by 2025.

► Being diverse and inclusive

Within the organization, Air Liquide seeks to reflect the world it serves, and welcomes people from all walks of life, backgrounds and life experiences. This rich and diverse culture is a source of motivation, performance and innovation. Inclusion means that everyone has the same opportunities, and the Group particularly seeks to enhance this for women in areas such as engineering and science, where they are still under-represented. Science sits at the heart of innovation and has never been more important to tackle the challenges the world faces now. Innovation is in Air Liquide's DNA, and women in science and technology play a key role in the Group's technical stewardship.

► Making an impact

Air Liquide is determined to use its expertise as a force of good in society and has a dedicated organisation, the Air Liquide Foundation. The Foundation supports scientific and developmental projects, suggested by the Group's employees, across three missions of focus: environmental and medical research, job integration and solidarity. In addition, Air Liquide is making an impact on society through multiple actions such as the Citizen at Work program, which enables employees to support their local communities through volunteering. Air Liquide strives for best in class governance, and that includes aligning the interests of its business with those of employees, stakeholders and the needs of society.

3.

Sustainability fully
embedded in strong
governance and
process

Sustainability topics comes
under the direct management
of the Executive Committee up
to the Board of Directors.

Board of directors:**Environment and Society Committee****Audit and Account Committee****Supervisory
bodies****Executive committee:****Ethics and Compliance Committee****Risk Committee****Control
bodies****Human rights**

- Human Resources Steering Committee
- Digital Security Committee

**Health & Safety/
Security**

- Industrial and Safety Committee

Environment

- E-Enrisk Committee
- Sustainable Development Committee

Suppliers

- Procurement steering Committee

**Operational
Steering
bodies****Deployment:****Awareness:**

Network of volunteer ambassadors

**Development
of local
decarbonization
plans****Operational
monitoring and
control of CO₂
trajectory****CO₂ trajectory in
investment
process****Example for
CO₂ Trajectory
Management:**
Deployment of trajectory
and monitoring

A CEO-chaired committee reviews all strategic sustainability activities, ensuring the implementation of a sustainability focused strategy across the Group. Sustainability objectives are also integrated in Air Liquide's variable compensation, mobilizing the organization to deliver on the commitments.

4.

Sustainable Financing Framework

Air Liquide's refreshed Sustainable Financing Framework echoes to its new strategic plan, **ADVANCE**, to finance/refinance sustainable projects intended to **have a clear benefit to environment and society**.

Air Liquide's refreshed Sustainable Financing Framework echoes to its new strategic plan: ADVANCE¹⁰, which **places sustainable development at the heart of the Group's strategy**. Sustainable Financing Instruments are an effective tool to channel investments to projects that have a clear benefit to the environment and society, as well as contributing to the achievement of the United Nations Sustainable Development Goals (UN SDGs).

By committing to issue Sustainable Financing Instruments, Air Liquide plans to support the continued growth and development of the sustainable finance market, taking into consideration the evolutions in ESG regulations and market expectations.

Air Liquide aims to strengthen its relationship with existing investors, maximise transparency of disclosure to the market regarding the Group's ESG narrative, and diversify its investor base to access new pools of ESG capital.

As Air Liquide continues to develop pioneering technologies and solutions which are key for energy transition, Sustainable Finance is also an opportunity to foster the dialogue with the market on these.

¹⁰ <https://www.airliquide.com/group/strategy>



Air Liquide has established this Sustainable Financing Framework (the “Framework”) to cover the following instruments to finance/refinance sustainable projects intended to have a clear benefit to environment and society:

- **Green, Social and/or Sustainability Bonds** including public and private format (the “Bonds”)
- **Green, Social and/or Sustainability Loans** (the “Loans”)
- Any other instrument aiming at financing/refinancing Eligible Projects as defined in the “Use of Proceeds” section (such as but not limited to corporate trade instruments)

Together known as “Green, Social and Sustainability financing”.

This Framework is aligned with the Green Loan Principles 2023¹¹ and the Social Loan Principles 2021¹² overseen by the Loan Market Association (LMA) and with the Green Bond Principles 2021¹³ (GBP), the Social Bond Principles 2023 (SBP)¹⁴ and the Sustainability Bond Guidelines 2021 (SBG)¹⁵ overseen by the International Capital Markets Association (ICMA).

Any Green, Social and Sustainable Financing transaction will be aligned to the most recent version of the Framework published at the time of issue or entry into of such Green, Social and Sustainable Financing transaction. Any transaction issued or entered into prior to the publication of this Framework and expressed to be aligned to the Air Liquide Sustainable Financing Framework (May 2021) will continue to be reported on in accordance with the Air Liquide Sustainable Financing Framework (May 2021).

4.1. Use of Proceeds

The Use of Proceeds of any Green, Social and Sustainability financing under this Framework will be subject to the following eligibility criteria, to be applied to new or existing projects. The financing/refinancing of such projects is expected to create substantial environmental or social benefits by significantly reducing GHG emissions or improving the living conditions of target populations.

Green Eligible Projects and Social Eligible Projects are “Eligible Projects” and constitute the Eligible Project Portfolio.

Green Eligible Projects

Green Eligible Projects will primarily include capital expenditures. They may also include maintenance costs related to Green Eligible Projects, as well as direct investments in companies and investment in dedicated funds (excluding equity participations in publicly listed companies¹⁶), both specialized in any of the below Green Eligible Projects categories¹⁷.

Green Eligible Projects may also include R&D and innovation expenses, as well as equity shares of companies (excluding equity participations in publicly listed companies), related to developing, or acquiring, technology bricks and processes for below eligible projects.

¹¹ <https://www.lma.eu.com/sustainable-lending/documents#green-loan-principles139>

¹² <https://www.lma.eu.com/sustainable-lending/documents#social-loan-principles-158>

¹³ <https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/green-bond-principles-gbp/>

¹⁴ <https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/social-bond-principles-sbp/>

¹⁵ <https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/sustainability-bond-guidelines-sbg/>

¹⁶ Private equity investments will remain eligible in the event that an investee company transitions to a publicly traded company, but Air Liquide will exclude any newly originated public equity participations in listed companies

¹⁷ A company will be considered eligible if it derives 90% or more of its revenues from activities falling in

1. Air Gases

Air separation units to deliver the industrial gases that Air Liquide's customers need is at the heart of the Group's business and is a fundamental part of its history.

Air Liquide has extensive experience in the design, construction and operations of Air Separation Units (ASUs), that serve well-established markets in sectors including metals production, chemicals, glass, pulp and paper to name just a few.

Air gases are necessary solutions to decarbonize our economy, playing an enabling role for several industrial processes value chains which are instrumental to the energy transition and long-term net zero and transition plans (see Appendix 1).

As a result these units support the decarbonisation of Air Liquide customers' existing processes around the world, as well as supporting the development of the new value chains (such as the battery for EVs value chain). Additionally, as Air Liquide has been increasing its sourcing of renewable energy, this allows the ASUs be powered with an increasing share of decarbonised electricity.

The Group is also supporting the energy transition by developing ASUs which enable energy storage, helping to manage the grid intermittency that results from increased renewable power generation while delivering in a safe, efficient and reliable manner Air Liquide's products to its customers.



This category includes the following Green Eligible Projects:

► **Production of air gases for the decarbonization of industries involved in the energy transition and as necessary component in green activity value chain:**

→ Manufacture of O2 and N2 through energy efficient¹⁸ Air Separation Units (ASUs) contributing to:

- The decarbonisation of the following industries, necessary in net-zero scenarios and medium to long-term transition plans: cement, construction materials, chemicals, steel, maritime
- The value chain of industrial processes related to the following green activities: electric vehicles, low-carbon hydrogen, carbon capture, renewables

► **Production of air gases for the integration of variable renewables through Demand-Side Management (DSM):**

→ New process for Air Gases production specifically designed to ensure a smooth integration on power grids featuring a high share of intermittent renewable sources

Mapping to the ICMA GBP Green Project Categories

Energy efficiency

Contribution to the UN SDGs

9.4: Upgrade infrastructure and retrofit industries to make them sustainable



¹⁸ ASUs financed under the Framework are more efficient than the top quartile of Air Liquide's existing ASUs and/or > 75% sourced from renewable or nuclear power

2. Hydrogen

Low carbon and renewable hydrogen will play a major role in the energy transition and Air Liquide is deeply committed to be a developer of this technology on a global scale. Air Liquide is focused on delivering low carbon and renewable hydrogen enhancing reliable and safe processes via multiple technologies such as electrolysis, capture of CO₂ and hydrogen liquefaction. Hydrogen is a solution to decarbonize industry, power and mobility sectors, according to the IEA and the IRENA as well as the Hydrogen Council, which account for hydrogen to be between 10 and 20% of the energy mix by 2050¹⁹. Air Liquide's hydrogen business comprises of the whole value chain for industry and mobility which includes the sourcing of low-carbon energies and renewables, the production of hydrogen, packaging by compression and liquefaction, delivery by truck and pipelines along with storage and distribution to the end customers.



Mapping to the ICMA GBP Green Project Categories

Renewable Energy,
Pollution Prevention
and Control

Contribution to the UN SDGs

7.2: By 2030, increase substantially the share of renewable energy in the global energy mix



This category includes the following Green Eligible Projects:

► Hydrogen production:

- Development, construction, installation, upgrade, transmission, distribution and maintenance²⁰ of hydrogen production capacity with related lifecycle GHG emissions that comply with the Renewable Energy Directive (EU) 2023/2413 (RED II)²¹ threshold of 3.38tCO₂e/tH₂ ("the Hydrogen Production threshold")
- Development, construction, and upgrade of conditioning process such as liquefaction of hydrogen to enable its transport, when hydrogen meets the Hydrogen Production Threshold
- Acquisition and manufacturing of equipment for the production, conditioning and use of hydrogen, when hydrogen meets the Hydrogen Production Threshold

► Storage of hydrogen:

- Construction of storage facilities dedicated to hydrogen, including trailers and containers when hydrogen meets the Hydrogen Production Threshold
- Operation of hydrogen storage facilities where the hydrogen stored in the facility meets the Hydrogen Production Threshold
- Conversion of existing underground gas storage facilities into hydrogen storage facilities

► Hydrogen mobility:

- Infrastructure for hydrogen refueling installations for road and off-road transportation, such as passenger cars, public transportation, road freight, waterborne transport and aircrafts

¹⁹ Sources: International Energy Agency, International Renewable Energy Agency, the Hydrogen Council

²⁰ Including conversion of existing networks into hydrogen transmission and distribution networks. Freight / trucks eligible will comply to the technical criteria zero emission heavy duty vehicles or less than half of the reference CO₂ emissions of all vehicles in the vehicle sub-group to which the heavy-duty vehicle belongs

²¹ The European Renewable Energy Directive mandates the usage of hydrogen with a carbon footprint of less than 3.38tCO₂e/tH₂. To achieve compliance, Member States are setting up incentives in the hydrogen value chains (industry and mobility) for hydrogen meeting this production threshold. Low carbon and renewable hydrogen project developments are driven by those incentives, whereby the RED production threshold becomes the reference for the decarbonisation value of hydrogen.





3. Carbon Capture as a Service

To face the climate emergency, industries are mobilizing to limit and avoid CO₂ emissions generated by their activities. With over 20%²² of CO₂ emissions generated by industry, CCS is seen as a crucial solution to avoid CO₂ emissions in the short term, particularly in sectors whose emissions are difficult to reduce, such as the chemical, steel or cement industries. CO₂ is captured directly at the factory gate, as a by-product of fossil fuel combustion fumes and various production processes. Large scale CCS projects are underway across the world, particularly in Europe and the United States for more mature projects, but also starting in other geographies. Leveraging its long standing experience with producing, purifying and delivering this molecule, Air Liquide runs a comprehensive portfolio of carbon capture solutions, based on different technologies. Carbon capture can be used to decarbonize the Group's hydrogen production units as well as develop carbon capture as a service. In order to foster the scale-up of this value chain and associated services, Air Liquide is also involved in transport when relevant²³.



Mapping to the ICMA GBP Green Project Categories

Pollution Prevention
and Control

Contribution to the UN SDGs

9.4: Upgrade infrastructure
and retrofit industries
to make them sustainable



This category includes the following Green Eligible Projects:

► Capture of CO₂:

→ Design, development and installation of carbon capture units for the purpose of decarbonizing hard-to-abate sectors, with a designed carbon capture rate above 90% and associated infrastructure for the transport (pipelines, vehicles, and vessels) and intermediate storage of captured CO₂.

Exclusions:

To the extent possible²⁴ in its sustainable finance instruments, Air Liquide will prevent carbon lock-in²⁵. Air Liquide seeks to align its Eligible Green Projects end-uses and applications with the ones featured in net zero scenario, by developing technologies and solutions necessary for its client sectors to genuinely decarbonize and/or instrumental for the development of net zero emission activities (see Appendix 2). Hydrogen and CCS investments applied to the O&G upstream (exploration and production) and fossil fuel based power generation sectors, as well as for Greenfield Refineries will be excluded from the scope of Eligible projects.

²² Source: International Energy Agency

²³ For instance Air Liquide has partnered with Sogestran to develop shipping solutions for CO₂ (see <https://www.oceos-shipping.com/>)

²⁴ As a supplier to industrial customers in many supply chains, some of which may be very long and imply many steps, Air Liquide may not have sufficient information on the final products from value chain it is supplying

²⁵ According to the OECD, carbon lock-in occurs when fossil fuel infrastructure or assets (existing or new) continue to be used, despite the possibility of substituting them with low-emission alternatives, delaying or preventing the transition to near-zero or zero-emission alternative.

Social Eligible Projects

In line with the Social Loan Principles (SLP) and the Social Bond Principles (SBP), Social Eligible Projects aim at providing access to essential services (e.g. health).

Social Eligible Projects will include capital expenditures, maintenance costs related to social eligible projects, as well as direct investments in companies (excluding equity participations in publicly listed companies) specialized in the below Social Eligible Project category²⁶.

Social Eligible Projects may also include R&D and innovation expenses, as well as equity shares of companies (excluding equity participations in publicly listed companies), related to developing, or acquiring, technology bricks and processes for below eligible projects.

This category includes the following Social Eligible Projects:

► **Development of home healthcare services and of proximity / community care services that fall under a public health subsidy program for long-term follow-up care related services, for chronic or complex patients**

→ **Target population:** each and every person in need of medical care, including the most vulnerable. It includes patients suffering from chronic diseases such as chronic obstructive pulmonary disease, obstructive sleep apnea, chronic respiratory insufficiency, diabetes, pulmonary arterial hypertension, Parkinson's disease, and other pathologies treated by infusion

4. Home healthcare and proximity /community care services

As a leader in home healthcare in Europe, Air Liquide provides care at home for people with chronic diseases. The Group provides respiratory and perfusion assistance solutions (e.g. for diabetes or Parkinson's). Thanks to its expert multi-disciplined teams, Air Liquide aims to increase patients' autonomy and quality of life, improve their treatment compliance and lower their risk of relapse or re-hospitalization.



The Home Healthcare business is one of the responses to the shift to outpatient care and sits at the heart of the healthcare system between the patient, hospital or other healthcare facilities, doctors, nurses, health insurance organizations, pharmacists and others. Air Liquide supplies the services, products and/or medical equipment necessary to start treatment at the patient's home, following the medical prescription, and trains patients and their families in the proper use of devices.

Air Liquide's Home Healthcare business strives to meet public health challenges as well as the growing constraints on health spending in advanced economies, by reducing hospitalization and developing a home care offer. In developing economies, Home Healthcare is growing in areas where health systems reimburse treatments of chronic diseases at home.

Mapping to the ICMA GBP Green Project Categories

Access to
essential services

Contribution to the UN SDGs

3.8



²⁶ A company will be considered eligible if it derives 90% or more of its revenues from activities falling in any of the Social Eligible Project categories

4.2. Process for Project Evaluation and Selection

Air Liquide Sustainable Financing working group, established in 2021, evaluates and selects the Eligible Projects. This working group meets at least once a year plus once at the upstream of each new bond issuance. It is chaired by the Group CFO with representatives from

- Treasury department
- Group Operation Controls department
- Sustainability department (including representatives from the family of each eligible project)

The working group together with Business teams identify Green Eligible Projects and Social Eligible Projects, to be funded from the Use of Proceeds of the Green, Social and Sustainability Financings. Air Liquide systematically and proactively identifies assets which are likely to be allocated to a Green, Social or Sustainability Financing issuance either at present or in the foreseeable future. The working group uses the group investments decisions base.

The Sustainable Financing working group checks the compliance of the selected pool of eligible projects with the eligibility criteria defined in this Framework and is responsible for approving allocations of net proceeds on an annual basis.

The working group monitors the Eligible Projects Portfolio on an on-going basis, in particular, to identify any Eligible Projects that would exit Air Liquide's portfolio or to remove any Eligible Project that would no longer meet the eligibility criteria, or that would be subject to a material controversy.

The Sustainable Financing working group will manage any future updates to Section 4 "Sustainable Financing Framework" of this Framework. Such updates of this Framework will only apply to Green, Social, and Sustainability financings that are launched after the issuance of a new Second-Party Opinion.

ESG policies applicable to all Air Liquide Eligible Projects

Management of environmental risks

► Climate

A Climate Policy published in the BlueBook²⁷ in 2022 aims to consolidate the principles governing Climate risk management within the Group, as well as across the entire value chain.

Physical risks (water availability, frequency of extreme events, etc.) are appraised during the review of investment requests, in the same way as financial criteria, to ensure that the associated risk management measures are adapted, for example in the design of equipment.

In addition, Group operations that are regularly exposed to the acute risks described above have risk management systems in place aimed at adopting suitable preventive operational measures and managing these crises by, first and foremost, protecting individuals and the production facilities in close cooperation with customers. These systems are regularly updated and improved.

Chronic risks are taken into account, particularly in the design of production units, in the same way, and to the same extent as their energy efficiency and carbon footprint.

Physical risks and the risks of greenhouse gas emissions are also taken into account in the preparation of the financial statements.

²⁷ The BlueBook is Air Liquide's Global Reference Manual, which gathers the Group's codes, policies and procedures and forms the basis for the Group's internal control and risk management system

► Water

To manage the risks associated with water withdrawal and use, a water management policy has been published in the BlueBook in 2021.

This policy identifies the impact of Air Liquide's activities on water availability. The policy defines the principles of risk management based on a specific assessment of the situation at each site. Finally, it describes the actions to be implemented to ensure appropriate water management.

Management of social risks

► Discrimination

The Group's Principles of Action and the Code of Conduct reaffirm the Group's values and, more specifically, a culture based on diversity, openness, transparency, respect for others and the rejection of all forms of discrimination. These values are also included in the Human Resources policy and must be promoted by all Group employees, with the support of Human Resources, through awareness-raising, training and alert tools and the monitoring of progress indicators.

Moreover, for several years, Air Liquide has been a signatory of the United Nations Global Compact, for which one of the principles aims to contribute to the elimination of all forms of discrimination in respect of employment and occupation.

► Suppliers and subcontractors

Air Liquide rolls out all elements of the Sustainable Procurement procedure, including in particular the following prevention measures:

- application of the Procurement Code of Conduct, which is available in 11 languages, is expected from all Group employees engaged in Procurement activities;
- the Supplier's Code of Conduct, aims to promote and ensure that all suppliers respect notably human rights, ethics, environmental protection and safety. It is based on the Group's Code of Conduct. The adherence of suppliers to the principles inscribed in the Supplier's Code of Conduct is a prerequisite to all commercial relation for the supply of Air Liquide. The revision aims to align it with new regulatory expectations and changes in practices. In particular, it includes additional articles on conflict minerals and the whistleblowing system. This Code of Conduct is available on the Air Liquide website;
- a sustainability contractual clause (covering compliance with the Supplier's Code of Conduct, safety, and the environment) is included in the contract templates with suppliers, including those for framework agreements.



Management of risks related to governance and overall business conduct

► Whistleblowing system

Air Liquide's Whistleblowing Policy, defines the various channels that the whistleblower can use to report a possible violation of the Group's ethics commitments and rules and the process for handling alerts by Air Liquide. Available for all employees in the BlueBook, it is accessible on the Group's website for external stakeholders. This policy is progressively being cascaded down through local entities in the Group's entities.



4.3. Management of Proceeds

The net proceeds of any Green, Social, and Sustainability financing will be managed on a portfolio basis by the Group Treasury Department

An amount equivalent to each financing net proceeds will be used to finance Eligible Projects which are part of Eligible Project Portfolio.

- Only Green Eligible Projects can be allocated to Green financings,
- Only Social Eligible Projects can be allocated to Social financings.

The Treasury Department has established a Sustainable Register, that is reviewed annually by the Sustainable Financing working group. It contains information of the use of proceeds of each Green, Social and Sustainability financing, including the amount of allocation per Eligible Projects Category.

For Bond issuances:

- In case of refinancing, Air Liquide could include disbursements related to Eligible Projects made in the 2 calendar years²⁸ prior to the issuance
- Air Liquide commits on a best effort basis to reach full allocation within 2 calendar years following each Bond issuance.

Pending full allocation, unallocated proceeds may temporarily be invested in accordance with Air Liquide's investment guidelines in cash, deposits and money market instruments. Air Liquide commits, on a best effort basis, to temporarily invest 50% of unallocated proceeds on deposits and money markets instruments with ESG criteria²⁹.

²⁸ Calendar Year means 1st January – 31st December

²⁹ Including but not limited to Article 8 funds and Green Deposits

4.4 Reporting

After entering into a Green, Social, or Sustainability financing, Air Liquide commits to publish annually a Sustainable Financing Report, which will provide an allocation report and an impact report, as detailed below. The allocation and the impact report will be provided until full allocation, and thereafter in case of material changes.

The full reporting document, (the "Sustainable Financing Report") will be made available on Air Liquide's website.

Allocation report

Air Liquide's allocation report will provide information on the following:

1

The list of
outstanding
**Green, Social
and
Sustainability**
financings

2

The total
amount
of proceeds
allocated **per**
Eligible Project
category

3

The total
amount
of proceeds
allocated
per geography

4

The share
of **financing**
and
refinancing

5

The amount of
unallocated
proceeds and
nature of
temporary
placements
(if any)

6

The share
of **Green**
financing
which is
EU Taxonomy
aligned



Impact report

Air Liquide will provide an impact report to support the allocation report described above. Environmental impact indicators per Green Eligible Project Category will include impact and output indicators.

- The impact indicator of estimated expected GHG emissions avoided (tCO₂e/year) will be provided, when feasible, per Green Eligible Projects categories.
- Output indicators for Green Eligible Projects categories may include the following:

Eligible Projects	Description of eligible projects	Possible Output and Impact Indicators
Air Gases	Production of air gases for the decarbonization of industries involved in the energy transition and as necessary component in green activity value chain	<ul style="list-style-type: none"> • Energy saving of the ASU • Information on industrial pilot units when relevant
	Production of air gases for the integration of variable renewables through Demand-Side Management (DSM)	
Hydrogen	Hydrogen Production	<ul style="list-style-type: none"> • Annual Hydrogen production (tH₂ or m³) • Annual Hydrogen transported (tH₂ or m³)
	Storage of Hydrogen	<ul style="list-style-type: none"> • Annual Hydrogen stored (tH₂ or m³) • Energy storage capacity (MW)
	Hydrogen mobility	<ul style="list-style-type: none"> • Number of HRS installed or HRS refueling station capacity (H₂ kg per day)
Carbon Capture as a Service	Capture of CO₂	<ul style="list-style-type: none"> • Annual amount of CO₂ captured (tCO₂ or m³) • Annual amount of CO₂ transported (tCO₂ or m³)

- Impact indicators for the Social Eligible Project category may include the following:

Social Eligible Projects	Description of eligible projects	Possible Impact Indicators
Home healthcare & proximity / community care services	Development of home healthcare services and of proximity / community care services that fall under a public health subsidy program for long-term follow-up care related services, for chronic or complex patients	<ul style="list-style-type: none"> • Estimated number of beneficiaries

The impact reporting will include information on the methodology and assumptions used to evaluate the Eligible Projects impacts.



4.5 External Review

Second Party Opinion

Moody's Investors Service has issued a Second-Party Opinion of the Framework, to confirm the alignment of the Framework to the ICMA's Green Bond Principles, Social Bond Principles and Sustainability Bond Guidelines and to the Green Loan Principles and Social Loan Principles issued by the LMA.

The Second Party Opinion document will be made available on Air Liquide website.

Post issuance external verification

An external verification on the Sustainable Financing Report will be provided by an independent external auditor, on an annual basis and until the complete allocation of proceeds, and thereafter in case of material changes.

The external auditor will verify that the proceeds of the bonds are either allocated to Eligible Projects or invested in approved financial instruments. This will be published on Air Liquide website.

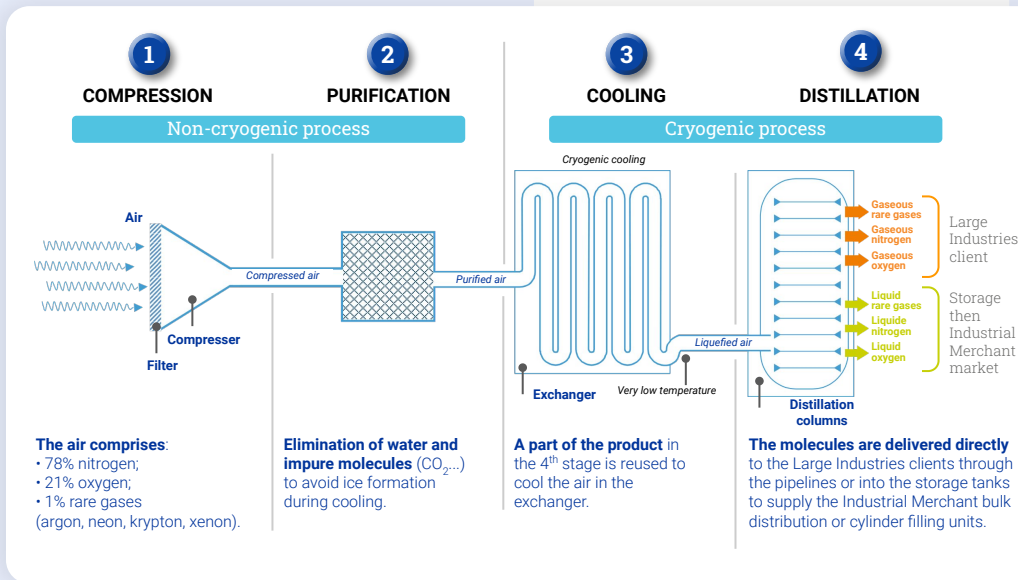
5.

Glossary

► **Air Separation Unit:** Unit separating air into its primary components, mostly dinitrogen and dioxygen.

Air Liquide Low-Carbon Air Separation Unit:

SIMPLIFIED DIAGRAM OF AN AIR SEPARATION UNIT'S OPERATION



Used in a wide variety of fields, large air separation units (ASU) produce high purity oxygen, nitrogen, argon and rare gases through a combination of adsorption purification, cryogenic distillation and internal compression of high pressure product

An Air Separation Unit (ASU) compresses, liquefies and distills air in order to separate it into its different components: 78% nitrogen, 21% oxygen, 1% argon and noble gases (neon, krypton and xenon). Only certain large ASUs can produce noble gases. The ASUs do not emit directly CO₂ but electricity consumption is significant.

► **Carbon Capture and Storage:** Process of capturing CO₂ from human activities and transporting it to a storage site to prevent its entry into the atmosphere.

► **Carbon Capture and Utilization:** Process of capturing CO₂ from human activities to use it later.

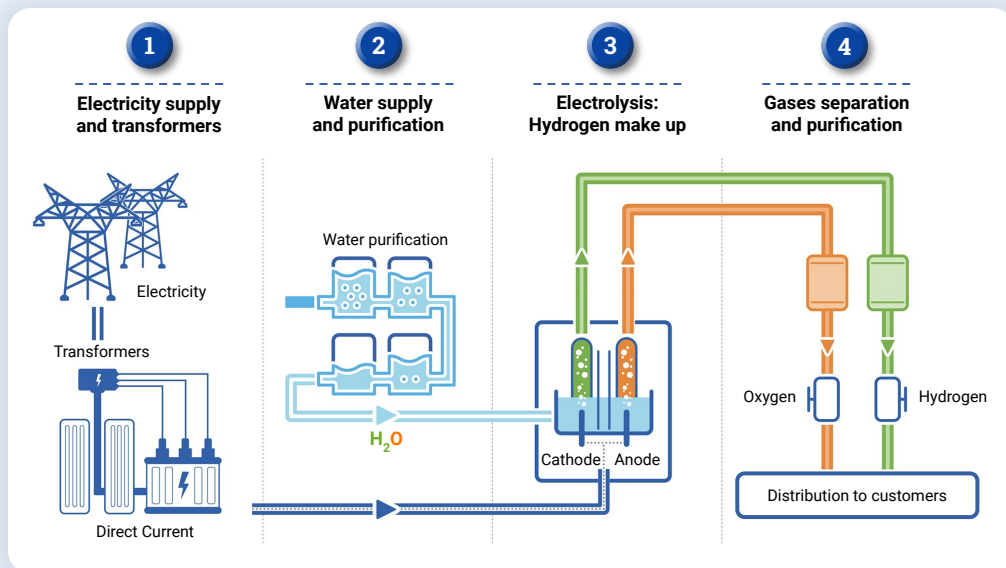
► **Dihydrogen:** Molecule formed with two hydrogen atoms, referred to simply as hydrogen.

► **Dinitrogen:** Molecule formed with two nitrogen atoms, referred to simply as nitrogen.

► **Dioxygen:** Molecule formed with two oxygen atoms, referred to simply as oxygen.

► **Electrolysers:** Unit using electric current to drive a chemical reaction such as the separation of water molecule between dioxygen and dihydrogen.

Air Liquide Hydrogen production through electrolysis:



Hydrogen production through electrolysis is based on the dissociation of water molecules (H_2O) using electricity, to extract hydrogen and oxygen molecules. This process produces hydrogen without using or emitting carbon-based molecules. It can be used to produce carbon-free hydrogen for industry and mobility, as well as for electricity storage.

► **Oxy-combustion:** Process of burning a fuel using pure oxygen or gases with high-oxygen content instead of air.

► Oxy-combustion allowing carbon capture of CO_2 :

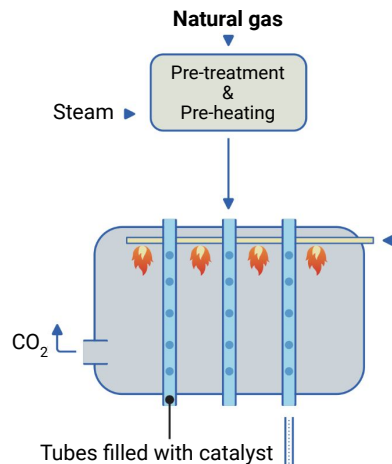
The oxy-combustion process being deployed incorporates a CO_2 purification process to produce a stream of CO_2 suitable for direct capture and storage. The process helps reduce greenhouse gases from industrial activities that use carbon-based fossil fuels.

► Steam Methane Reformer:

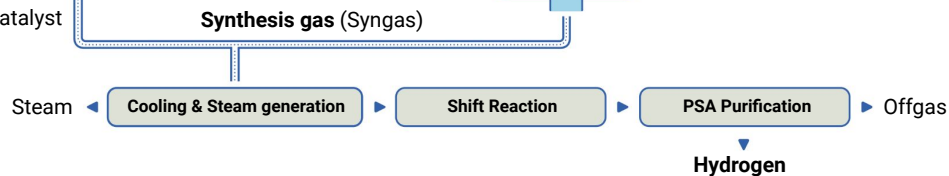
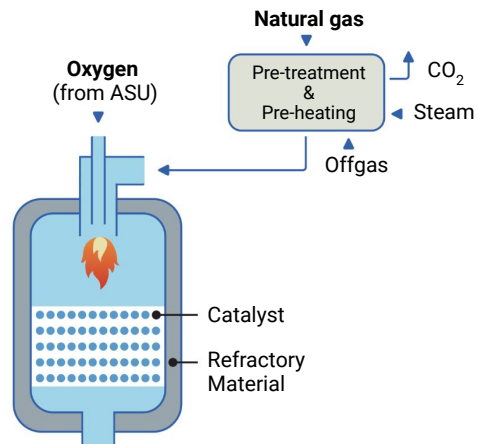
By steam reforming natural gas, an SMR produces hydrogen and carbon monoxide. The most significant raw material is natural gas; electricity and water consumption is modest. Air Liquide has developed a portfolio of CO_2 capture solutions adapted to SMR, allowing to very significantly reduce their greenhouse gas emissions.

The two main processes for the production of hydrogen by methane reforming are:

Steam Methane Reformer



Auto Thermal Reformer



Appendix 1:

Air Gases contribution to decarbonisation of industries and necessary component in green activity value chain

Air gases, and in particular oxygen, are essential molecules for decarbonisation pathways to several sectors and technologies, and when deployed at scale, will help to achieve carbon neutrality by mid-century. Some relevant industries include steel manufacturing, petrochemicals, materials such as cement and lime, or emerging manufacturing activities for the energy transition. Air Separation Units (ASUs) represent a significant share of wider investments in projects from the aforementioned industries. Air Liquide's production of air gases contributes both to new applications for existing clients' decarbonization strategies, and to the development of new clients/markets. This highlights Air Liquide's role as an "enabler" of low-carbon industry with Air Liquide's air gases offering and ASUs are considered to be a major and essential part of the overall decarbonisation or projects via reducing overall emissions.

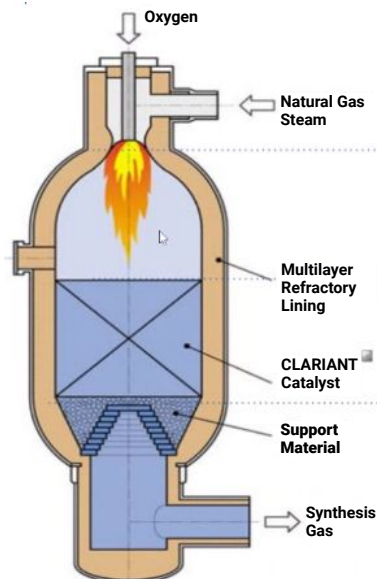
Main illustrative use cases are listed below:

- In the **steel market**, on top of growing needs for H₂, the transition to net zero requires a shift from unabated blast furnaces, where oxygen is already increasingly in use to improve the energy and carbon efficiency of the process, to mostly two main processes: (1) electric arc furnaces and (2) direct reduced iron (DRI) units. Both processes require large amounts of oxygen, and therefore an area of Air Liquide projects business growth.

- In the **petrochemicals**, many units such as crackers are often relying on the combustion of off-gases to generate the heat and power required by the chemical reactions. In this process, the carbon that does not end up in the chemical products, is emitted into the atmosphere. Converting these off-gases into low carbon hydrogen with CO₂ capture for underground storage, and then utilising this low carbon hydrogen for combustion will fulfill the heat and power, is a major avenue for decarbonizing such petrochemical units. In parallel, the hydrogen could be used for the development of fully electrified units (noting that this will first require demonstrations and build out of renewable assets). Conversion of gases into hydrogen with subsequent CO₂ capture is efficiently done at a large scale, in Auto-Thermal Reformers (ATR) equipped with CO₂ capture. Such ATR units require large investment in oxygen production. In addition, air gases like nitrogen are also needed to enable the decarbonization of ammonia, wherein, green/ renewable ammonia produced from hydrogen from electrolysis will require nitrogen to produce ammonia.
- In the **material** markets such as cement and lime, oxygen is used in process furnaces to concentrate CO₂ in the output gas streams, enabling the CO₂ capture. In some cases, investment in the ASU may be part of the CO₂ capture plant itself.
- In the **battery value chain**, oxygen and nitrogen are essential to the operation of the Cathode Active Material plant - the firing of materials in the two sintering furnaces takes place in the presence of pure oxygen in the case of high nickel cathode chemistries, whereas nitrogen is required for other chemistries such as lithium iron phosphate (LFP) CAM production. The purity of these gases has an impact on final characteristics of the battery in terms of performance.

Example: Oxygen consumption in auto-thermal reforming processes:

ATR (or without catalyst: POX)



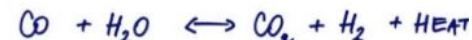
Reactor head incl. Media cooled burner
Medium Cooled Burner

~25-60 barg and 450-650°C

Upper Reactor Zone
Partial Combustion and Syngas
recirculation



Catalytic Reforming Zone
ATR reactor volume sized to ensure
4+ years of continuous operation



Catalyst Support and Reactor Outlet

950 - 1050°C

Refractory lined bottom and transfer
Line to Process Gas Boiler

Example: Oxygen consumption in low-carbon cement and lime production

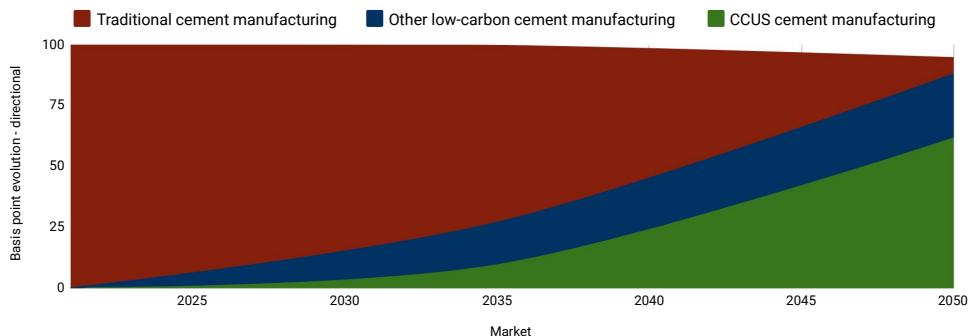
Unique portfolio of two solutions

- Postcombustion (preferred for revamp)
→ Cryocap FG only no steam sol^o on the market
- Oxy-combustion (preferred for new plant) - Intrinsically
Most efficient solution for future cement plant

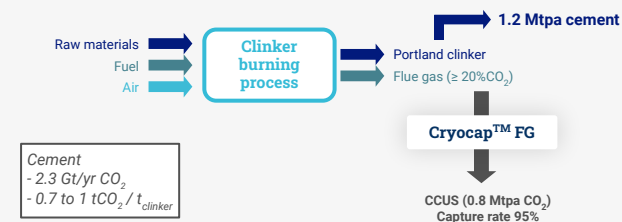
Key AL differentiations

- No steam solution (almost no heat available in plant)
- Impurities management (NOx...)
- Solutions to reduce air ingress
- Synergies with oxy-boosting
- Combined capture & liquefaction

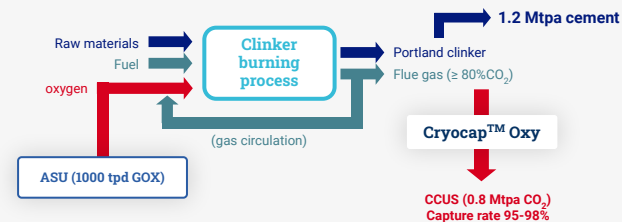
Cement manufacturing in a 1.5°C pathway



POST COMBUSTION CAPTURE



OXY-COMBUSTION CAPTURE



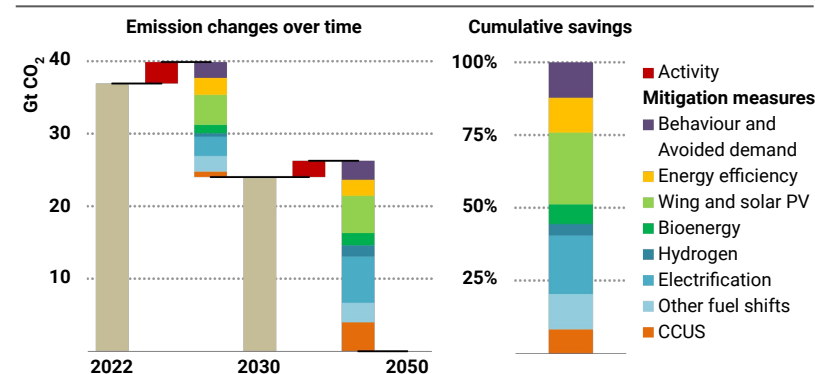
Appendix 2:

Role of carbon capture and low carbon hydrogen in Net Zero Emission Scenario

According to IEA in their last report *Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach - 2023 Update*, the NZE Scenario is a normative scenario that shows a pathway for the global energy sector to achieve net zero CO₂ emissions by 2050, with advanced economies reaching net zero emissions in advance of others. All countries will need to contribute to deliver the desired outcomes; advanced economies take the lead and reach net zero emissions earlier in the NZE Scenario than emerging market and developing economies.

According to IEA, emerging technologies such as hydrogen and carbon capture, utilisation and storage (CCUS) cut emissions mainly after 2030. If all announced projects for hydrogen electrolysis capacity are realised, they would provide around 70% of what is required in the NZE Scenario by 2030. **In the 2023 NZE Scenario, IEA estimates that those two technologies will account one-fifth of all emissions reductions between 2030 and 2050, across all sectors.**

Figure 2.5 ▶ CO₂ emissions reductions by mitigation measure in the NZE Scenario, 2022-2050



IEA. CC BY 4.0.

Expansion of solar PV, wind and other renewables, energy intensity improvements and direct electrification of end-uses combined contribute 80% of emission reductions by 2030

Notes: Activity = energy services demand changes from economic and population growth. CCUS includes BECCS and DACS

Source: Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach - 2023 Update, IEA

Low carbon hydrogen in the IEA Net Zero scenario

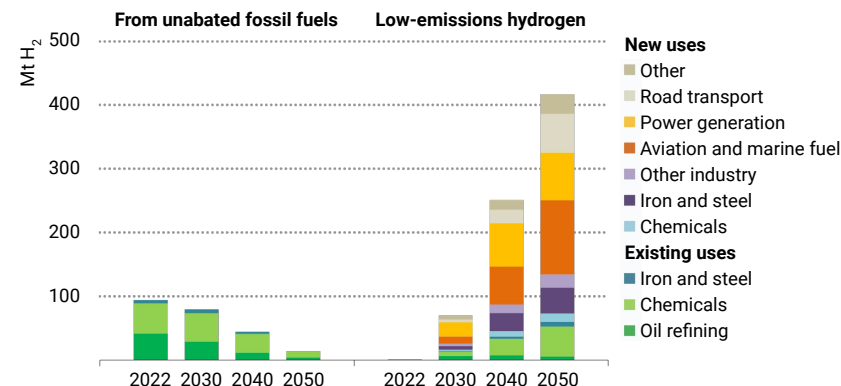
According to IEA, the NZE Scenario sees global hydrogen demand scaled up first in existing applications where large quantities of low-carbon hydrogen can be integrated with minimal plant modifications and little need for new infrastructure. This builds on recent experience: to date, most of the world's largest financed projects for hydrogen production from electrolysis or with carbon capture have been designed to serve existing uses.

Besides, more than 4 Mt of low-emission hydrogen are produced and used in refineries by 2030 in the IEA NZE Scenario, with around two-thirds produced from electrolysis and low-emission electricity, and one-third from fossil fuels-based hydrogen equipped with carbon capture.

But the level of demand for low-emissions hydrogen in existing applications is insufficient to reach the level called for by 2030 in the NZE Scenario due to needed new uses. **New applications represent more than four-fifths of low-emissions global hydrogen demand in 2030 in the NZE Scenario.** These are at early stages of development or deployment today yet are targeted by the expanding pipeline of announced projects.

In the industry sector, iron and steel production represents one of the important sources of low-emissions hydrogen demand despite there being no such plants in operation today. In the NZE Scenario, hydrogen-based direct reduction of iron (DRI) – a means of processing iron ore without fossil fuels – leads to just over 4 Mt of low-emissions hydrogen demand by 2030.

Figure 3.21 ▶ Global hydrogen demand in the NZE Scenario, 2022-2050



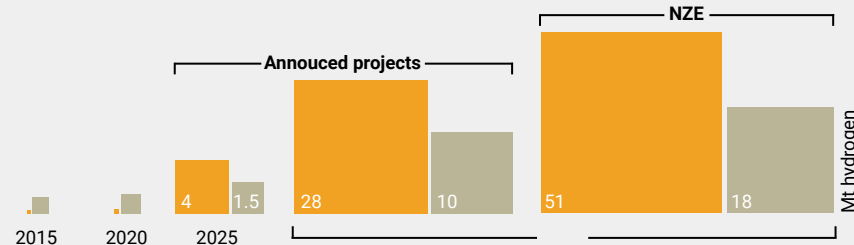
IEA, CC BY 4.0.

Use of low-emissions hydrogen rises significantly to 70 Mt by 2030 and extends to new applications such as in aviation and shipping

Notes: Mt H₂ = million tonnes of hydrogen. Unabated fossil fuels include hydrogen produced with CO₂ capture for utilisation without storage, such as in urea synthesis. Demand for aviation and marine fuel and power generation includes hydrogen that is converted to make low-emissions hydrogen-base fuels.

Source: Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach - 2023 Update, IEA

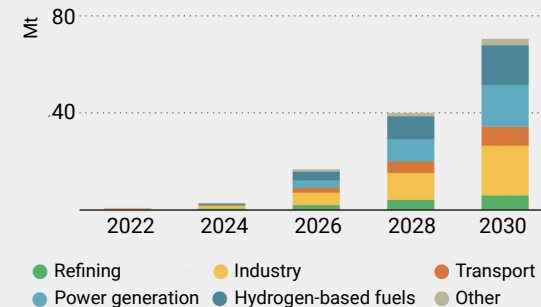
Low-emissions hydrogen production



Milestones	2022	2030	2035	2050
Total hydrogen demand	95	150	215	430
Refining (Mt H ₂)	42	35	26	10
Industry (Mt H ₂)	53	71	92	139
Transport (Mt H ₂ -eq. Including hydrogen-based fuels)	0	16	40	193
Power generation (Mt H ₂ -eq. Including hydrogen-based fuels)	0	22	48	74
Other (Mt H ₂)	0	6	10	14
Share of total electricity generation	0%	1%	1%	1%
Low-emissions hydrogen production (Mt H₂)	1	70	150	420
From low-emissions electricity	0	51	116	327
From fossil fuels with CCUS	1	18	34	89
Cumulative installed electrolysis capacity (GW electric input)	1	590	1 340	3 300
Cumulative CO₂ storage for hydrogen production (Mt CO₂)	11	215	410	1 050
Hydrogen pipelines (km)	5 000	19 000	44 000	209 000
Underground hydrogen storage capacity (TWh)	0.5	70	240	1 200

Source: Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach - 2023 Update, IEA

Demand for low-emissions hydrogen grows quickly in the NZE, particularly in heavy industry, transport and the production of hydrogen-based fuels



Source: Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach - 2023 Update, IEA

Carbon capture in the IEA net scenario

CCUS is an important technology because it can reduce or eliminate emissions in areas where other options are limited, for example in the production of cement or synthetic kerosene and in the removal of CO₂ from the atmosphere. In IEA's 2023 NZE scenario, carbon capture will be instrumental in removing CO₂ emissions and will have to reach 6 Gt of CO₂/y by 2050 (ie 16% of 2022 annual emissions), accounting for **12%** of the cumulative emissions reduction by 2050.



According to IEA, the NZE Scenario sees global hydrogen demand scaled up first in existing applications where large quantities of low-carbon hydrogen can be integrated with minimal plant modifications and little need for new infrastructure. This builds on recent experience: to date, most of the world's largest financed projects for hydrogen production from electrolysis or with carbon capture have been designed to serve existing uses.

Besides, more than 4 Mt of low-emission hydrogen are produced and used in refineries by 2030 in the IEA NZE Scenario, with around two-thirds produced from electrolysis and low-emission electricity, and one-third from fossil fuels-based hydrogen equipped with carbon capture.

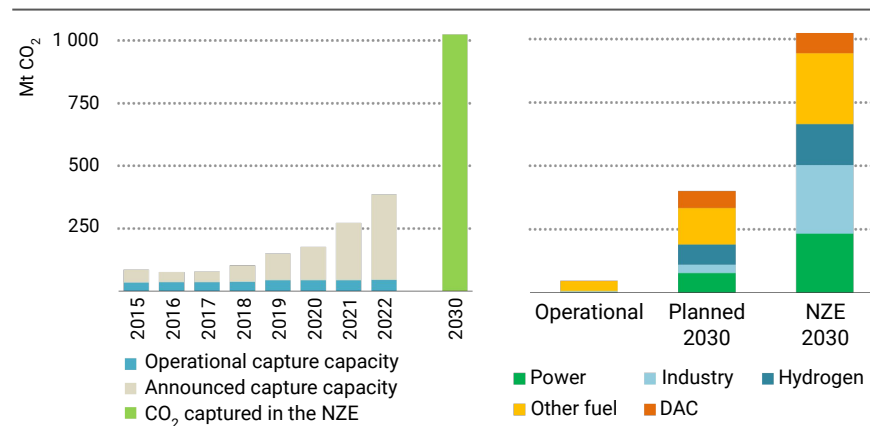
But the level of demand for low-emissions hydrogen in existing applications is insufficient to reach the level called for by 2030 in the NZE Scenario due to needed new uses. **New applications represent more than four-fifths of low-emissions global hydrogen demand in 2030 in the NZE Scenario.** These are at early stages of development or deployment today yet are targeted by the expanding pipeline of announced projects.

In the industry sector, iron and steel production represents one of the important sources of low-emissions hydrogen demand despite there being no such plants in operation today. In the NZE Scenario, hydrogen-based direct reduction of iron (DRI) – a means of processing iron ore without fossil fuels – leads to just over 4 Mt of low-emissions hydrogen demand by 2030.

Carbon capture in the IEA net scenario

CCUS is an important technology because it can reduce or eliminate emissions in areas where other options are limited, for example in the production of cement or synthetic kerosene and in the removal of CO₂ from the atmosphere. In IEA's 2023 NZE scenario, carbon capture will be instrumental in removing CO₂ emissions and will have to reach 6 Gt of CO₂/y by 2050 (ie 16% of 2022 annual emissions), accounting for **12%** of the cumulative emissions reduction by 2050.

Figure 3.18 ▶ Global annual CO₂ capture capacity by status and sector in the NZE Scenario, 2015-2030



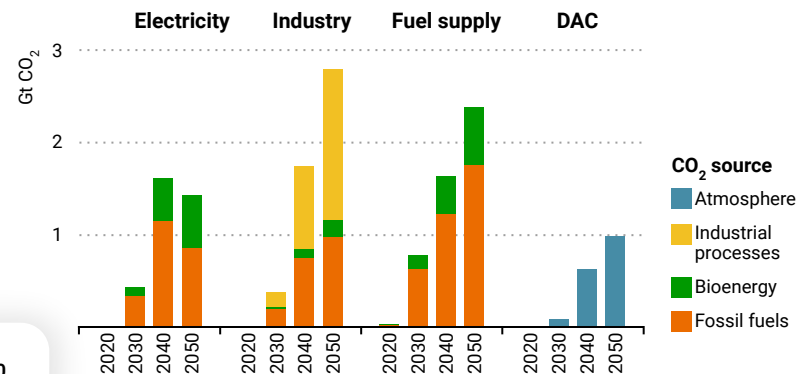
Planned CCUS projects, if brought to fruition, would increase capacity over eightfold, about one-third of needed requirements by 2030

Notes: Mt CO₂ = million tonnes of carbon dioxide; DAC = direct air capture. Includes all facilities with a capacity larger than 0.1 Mt CO₂ per year. Planned capacity for 2030 only includes projects with an announced operation date by 2030. Hydrogen includes low-emissions hydrogen production at dedicated facilities, including for use in ammonia manufacture. Captive low-emissions hydrogen production onsite at refineries and industrial plants are included in other fuel and industry categories.

Source: IEA CCUS Projects Database, (IEA, 2023h).

According to this figure, more than 75% of CO₂ capture capacity in NZE 2030 scenario is dedicated to decarbonize industry, hydrogen and other fuel sectors as well as direct air capture (DAC), highlighting the need for scale up of carbon capture technologies.

Energy-related and process persisting CO₂ emissions in industry processes will account for almost 40% of the CO₂ captured in 2050. The industry sector represents one of the most important sources of CO₂ capture demand, in particular for industrial processes decarbonation. In the NZE Scenario, industry leads to over 270Mt of CO₂ capture demand by 2030 (i.e. 26% of total demand).



Source: Energy technology perspective, IEA

Milestones

	2022	2030	2035	2050
Total CO ₂ captured (Mt CO ₂)	45	1 024	2 421	6 040
CO ₂ capture from fossil fuels and industrial processes	44	759	1 712	3 736
Power	1	188	568	811
Industry	4	247	769	2 152
Merchant hydrogen	0	161	285	756
Other fuel transformation	38	163	90	17
CO ₂ capture from bioenergy	1	185	506	1 263
Power	0	44	204	438
Industry	0	23	77	232
Biofuels production	1	114	213	474
Other fuel transformation	0	5	13	121
Direct air capture	0	80	203	1 041

Source: Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach - 2023 Update, IEA

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