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BIOGENIC CO_2 FROM BIOMETHANE:

The Key to Europe's Carbon Strategy

Successfully Integrating bioCCUS through Technical, Economic, and Policy Solutions in Europe.

EBA
European Biogas Association

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ABOUT EBA

Founded in 2009, the association is committed to the expansion of sustainable biogas production and its use across the continent. EBA counts on a well-established network of over 350 members including national associations, research institutes and companies representing the whole biogas and biomethane value chain throughout Europe and further afield.

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EXECUTIVE SUMMARY

This white paper examines the current status and future outlook of biogenic CO_2 carbon capture, utilisation and storage (CCUS) from both the technical and economic perspectives, as well as providing market intelligence on trends shaping bioCO_2 capture. The report details the sector's fast-growing capture capacities, the expanding range of applications for renewable CO_2 and the policy frameworks guiding its scale-up.

Biogenic CO_2 from biogas presents an immediate and scalable solution to Europe's growing climate and circularity ambitions. The current conventional CO_2 demand in Europe in 2024 stands at 13.9 Mt/year, with the merchant market accounting for 56% of this total. However, the European Commission's Impact Assessment for the Climate Target projects that emerging markets (primarily e-fuels and storage) will require a dramatic increase to 344 Mt of CO_2 by 2040 to support a 90% net reduction in GHGs. E-fuels alone are likely to require over thirteen times today's merchant CO_2 volumes within just 15 years, demonstrating an urgent need to scale up sustainable, non-fossil CO_2 sources.

Derived from biogas upgrading, biogenic CO_2 directly contributes to these targets by both displacing fossil-derived CO_2 and utilising the closed natural carbon cycle. ***By 2040, the technical potential of biogenic CO_2 from anaerobic digestion in the EU-27 is estimated to reach 89 Mt annually, which is sufficient to cover more than 25% of the necessary carbon capture to meet the Climate Law objective.*** Capture of biogenic CO_2 is already underway in the biogases sector, primarily through biomethane production, ***with 125 plants currently capturing 1.17 Mt CO_2. This is set to grow to more than 2 Mt CO_2 by 2027***, with additional potential from gasification, biohydrogen production and flue gas capture. Beyond the biogas sector, further sources include bioethanol production and biomass combustion, while Direct Air Capture can also provide sustainable CO_2. Compared with other sustainable CO_2 production routes, the biogas sector offers one of the most effective, cost-efficient and scalable solutions for CO_2 capture.

To fully unlock the potential of biogenic CO_2, Europe must tackle policy and infrastructure barriers, prioritising bioCO_2 as a premium resource for net-zero and negative emissions pathways. There is a strong need for targeted incentives, integrated CO_2 infrastructure, harmonised certification and traceability schemes, and the expansion of support measures that reflect bioCO_2's superior sustainability value. To deliver climate, circularity and competitiveness benefits for Europe, biogenic CO_2 from the biomethane sector must be the cornerstone of Europe's energy transition.

ABBREVIATIONS

AD	Anaerobic Digestion
bioCCS	Biogenic Carbon Capture and Storage
bioCCU	Biogenic Carbon Capture and Utilisation
bioCO_2	Biogenic CO_2
CAPEX	Capital Expenditure
CCS	Carbon Capture and Storage
CCU	Carbon Capture and Utilisation
CCUS	Carbon Capture, Utilisation and Storage
CDR	Carbon Dioxide Removal
CRCF	Carbon Removal Certification Framework
CHP	Combined Heat and Power
DACCS	Direct Air Carbon Capture and Storage
FID	Final Investment Decision
LCOC	Levelised Cost of Capture
NZIA	Net-Zero Industry Act
OPEX	Operational Expenditure

INTRODUCTION

Biogenic CO_2 is the carbon dioxide (CO_2) resulting from the decomposition, digestion, chemical reaction or combustion of biomass-derived products.

Atmospheric CO_2, assimilated by biomass through photosynthesis, is subsequently returned to the atmosphere or the soil as biogenic CO_2, depending on the type of conversion and final use of the biomass, in what is known as the **natural short carbon cycle**[1].

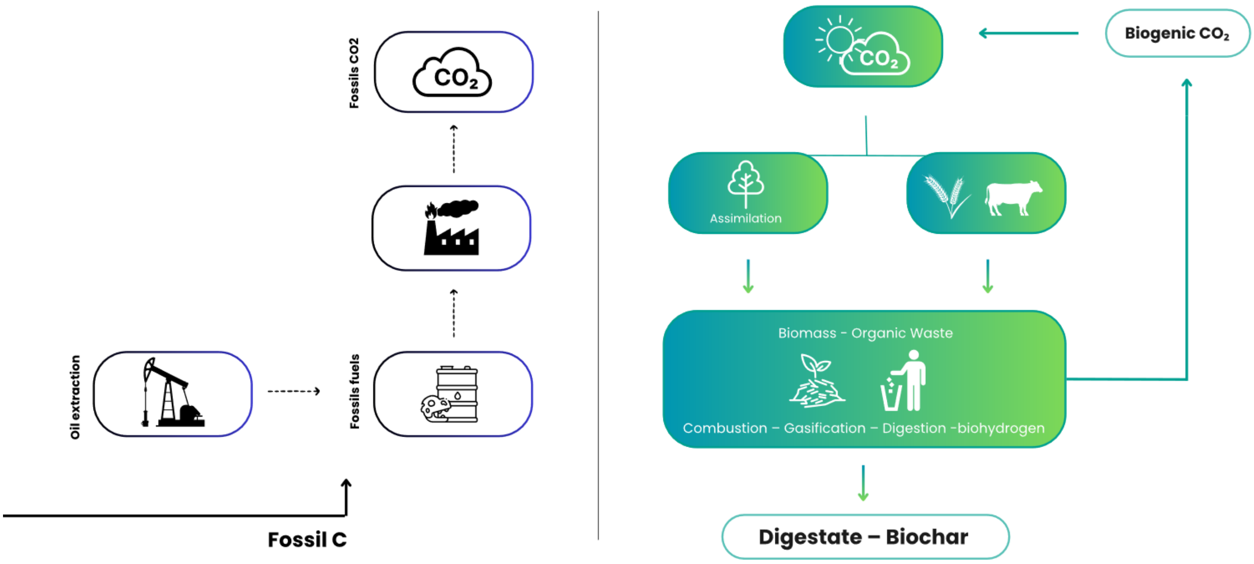

Figure 1 Biogenic CO_2 natural short carbon cycle compared to disruptive fossil CO_2 source

The production and use of biogases emits carbon that is part of the natural short carbon cycle. Conversely, burning fossil fuels releases carbon dioxide (CO_2) formerly stored in the ground, increasing the overall content of CO_2 in the atmosphere. It is important to note that there is still no common definition of biogenic carbon, and the EU only recently introduced a proposal in this regard in the draft Delegated Act on Permanent Carbon Removals.

Biogenic CO_2 can be **captured and stored** or **utilised** as a feedstock in several industries and other sectors, helping to **achieve zero or even negative emissions and mitigate climate change.**

Since the demand for CO_2 is increasing due to emerging markets, and at the same time there is a certain regulatory pressure for the adoption of green products and industry defossilisation to drastically lower carbon footprint, biogenic CO_2 will become essential to supplying a sustainable source of CO_2 in order to meet the increased demand while also lowering GHG emissions.

[1] IEA Bioenergy. (2018, January). *Fossil vs biogenic CO2 emissions.* https://www.ieabioenergy.com/iea-publications/faq/woodybiomass/biogenic-co2/

Main benefits of utilising biogenic CO_2

ADVANTAGES OF LEVERAGING BIOGENIC CO_2	
GHG emission savings	• The capture, storage and utilisation of biogenic CO_2 in various applications contributes to climate targets by replacing fossil carbon and avoiding the associated emissions. • When biogenic CO_2 is captured and stored, it results in net CO_2 removals (potentially leading to negative emissions if the overall carbon balance is negative), which contribute to the EU goal of carbon neutrality. This is not possible when capturing and storing fossil CO_2.
Circular economy	• Biomethane production facilities represent circular economy hubs, turning organic materials into several valuable co-products: renewable energy, organic fertiliser (digestate) and biogenic CO_2. • The use of biogenic CO_2 in different industries contributes to the transition towards a circular and resource-efficient economy aimed at using all the inputs and outputs of the natural short carbon cycle.

Economic development	• Biogenic CO_2 capture, storage and utilisation can provide biogas producers with a new revenue stream:
	  ○ Capture of biogenic CO_2 can be used to lower the carbon intensity of biomethane production, creating a price premium on biomethane itself.
	  ○ Biogenic CO_2 can be sold to different end users, such as e-fuels, creating additional revenues for biomethane producers.
	• Carbon removals and storage from biogenic CO_2 enable the issuance of carbon removal credits[2] that can be traded on voluntary carbon markets. In addition, the Carbon Removal Certification Framework (CRCF) introduces the first EU-wide voluntary framework for certifying permanent carbon removals, carbon farming and carbon storage in products.

[2] Title for offsetting GHG emissions based on the removal of an equivalent amount of GHGs from the atmosphere.

CCUS

The term CCUS (Carbon Capture, Utilisation and Storage)[3] refers to a set of technologies enabling the mitigation of CO_2 emissions through capture and storage (CCS) or re-use (CCU) of carbon dioxide.

- **Carbon capture and storage (CCS)** refers to the process of capturing and storing CO_2 permanently in natural reservoirs or in materials (e.g. geological storage and permanent storage in construction products). Permanently storing CO_2 of biogenic origin is designated as **bioCCS**.[4]
- **Carbon capture and utilisation (CCU)** refers to a range of applications through which CO_2 is captured and used. CO_2 can be used directly (without further processing) or indirectly in various products[5]. CCU can involve either the direct recycling of carbon (in industrial processes such as the production of e-fuels, chemicals, food and beverages, fertilisers etc.) or its durable storage in products. When biogenic CO_2 is employed as the feedstock within CCU processes, it is referred to as **bioCCU.**

The above concepts of CCUS do not imply the use of any particular type of carbon dioxide, and can therefore refer indiscriminately to fossil, atmospheric or biogenic CO_2. Only when CCS and CCU rely on atmospheric or biogenic CO_2 do the associated activities qualify as carbon removals under the CRCF regulation, specifically as permanent carbon removals or carbon storage in products.

BioCCS and Direct Air Carbon Capture and Storage (DACCS) are two methods of carbon capture and storage that qualify as carbon removal.

Table 1 Legal definitions and applicability of carbon capture based on the type of carbon source

	Applicability of the legal definition		
Legal definitions based on CRCF	Atmospheric carbon	Biogenic carbon	Fossil carbon
Carbon removal	✓	✓	X
Permanent carbon removal	✓	✓	X
Carbon storage in products	✓	✓	X
Carbon farming	✓	✓	X

[3] United Nations Economic Commission for Europe. (n.d.). *Carbon capture, use and storage (CCUS)*. UNECE. https://unece.org/sustainable-energy/cleaner-electricity-systems/carbon-capture-use-and-storage-ccus

[4] Due to a lack of harmonisation in definitions, the term Bioenergy with Carbon Capture and Storage (BECCS) has been used interchangeably in certain documents, including the European Industrial Carbon Management strategy. The CRCF methodology consultation proposes a definition for *"bioCCS activity"* without explicitly referring to BECCS but subsequently distinguishes between BECCS and other biomass-based approaches under bioCCS. Everson et al. (2024) noted that *"the term bioCCS generalises the umbrella covered by BECCS, which is commonly used to reflect only the production of heat and/or power."*

[5] International Energy Agency. (n.d.). *CO_2 capture and utilisation.* https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage/co2-capture-and-utilisation

POLICY CONTEXT

At present, **biogenic CO_2 does not have a dedicated legal framework**. However, in recent years the topic has been addressed within several EU climate and energy initiatives, including the Commission's 2021 Communication on Sustainable Carbon Cycles, the Communication on an Industrial Carbon Management Strategy and the impact assessment accompanying the revision of the Climate Law. More recently, the Net Zero Industry Act and the Commission's proposal for a 2040 climate objective introduced relevant legal targets which, although not specifically focused on bioCO_2, are expected to significantly influence the development of the bioCO_2 market.

Within the existing legal framework, however, legislation provides some incentives for bioCO_2 use. Under the RED framework, the capture of biogenic CO_2, either for storage or replacement of fossil CO_2 in industrial applications, translates into lower GHG emissions for biogas and biomethane. A further driver is found in RFNBO legislation: while fossil CO_2 use is subject to a final cut-off date (no later than 2041), biogenic CO_2 remains permissible without limitation. This gives biogenic CO_2 a clear medium- and long-term advantage for producers and investors.

More recently, **political initiatives with stronger and more direct relevance** have been launched, including at regional levels within Member States. Chief among them is the adoption of the Carbon Removals and Carbon Farming Regulation and the draft Delegated Act on Permanent Carbon Removals, designed to support the development of high-quality removals through a voluntary EU certification scheme. For the first time, a broad legal definition of biogenic CO_2 has been proposed: "*CO_2 produced from a source of biomass by a chemical process acting on the carbon atoms in the biomass*." The regulation also sets out quality criteria for certifying removals based on biogenic CO_2, providing clarity on biomass requirements and GHG accounting methodologies. Looking forward, the 2026 revision of the ETS Directive is expected to open up the possibility of offsetting allowance obligations by generating or purchasing CRCF-certified carbon removal credits.

Finally, the Commission is preparing a legislative initiative on CO_2 infrastructure and markets, scheduled for adoption in Q3 2026. Its goal is to ensure the rapid and cost-efficient emergence of a well-functioning, EU-wide, market-driven CO_2 value chain. The initiative seeks to remove barriers to cross-border CO_2 transport and market access caused by insufficient interoperability, regulatory obstacles and legal uncertainty. It will also clarify the rules applying to infrastructure that enables CO_2 flows through or into interconnected non-EU countries, where significant storage capacity for EU emitters may exist.

CHAPTER 1: APPLICATIONS OF BIOCO₂

CO_2 is a versatile molecule with a wide range of applications and end uses. This commodity can either be captured and utilised, through conversion into high-value products such as chemicals and e-fuels, mineralised and sequestered in construction materials, including concrete and cement, or directly applied in various industrial processes.

Alternatively, carbon can also be stored in offshore or onshore geological formations, such as wells or cavities. Figure 2 illustrates the markets in which CO_2 can be used:

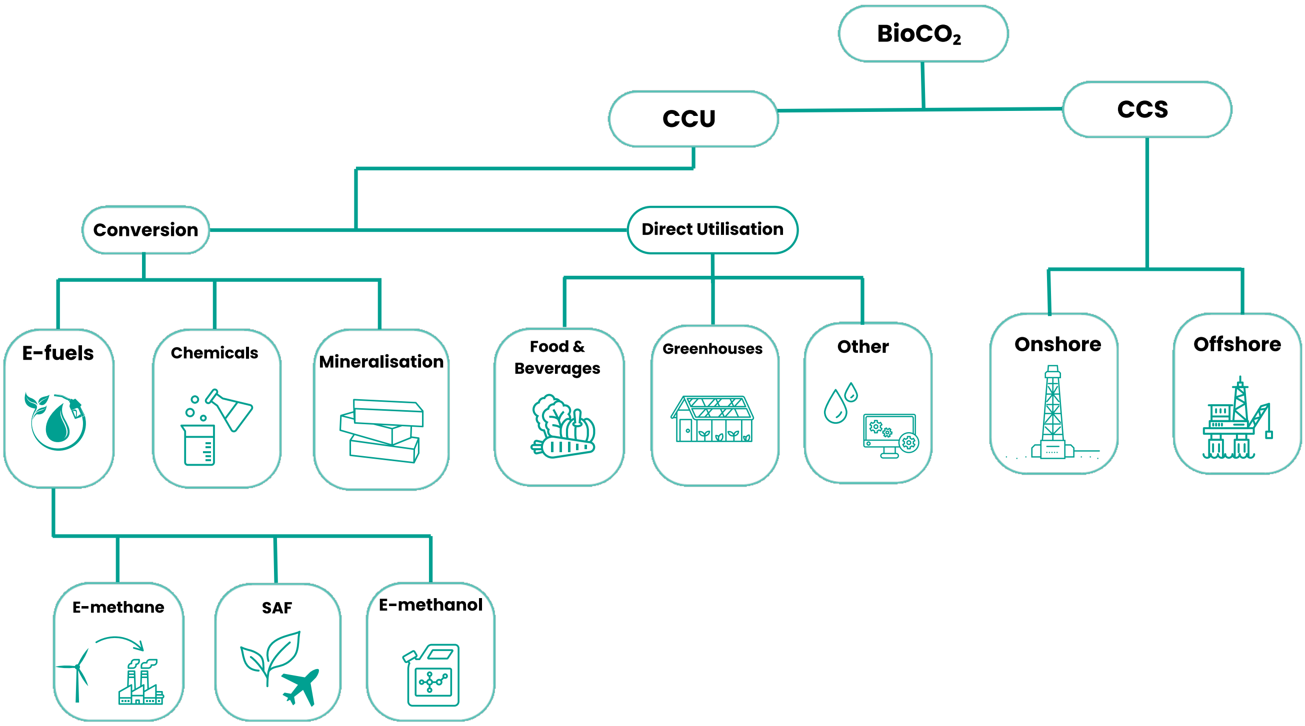

Figure 2 Overview of CO_2 markets

bioCCU

Fossil CO_2 can be replaced by bioCO_2 across all utilisation pathways, with biomethane plants already providing bioCO_2 to a diverse range of applications (see *Chapter 5*). The transition towards more sustainable industrial practices and the drive to reduce emissions are fuelling demand for sustainable bioCO_2 across these sectors.

Direct utilisation

Food and beverage

CO_2 is used in the food industry for modified atmosphere packaging, chilling, freezing and maintaining quality during food processing[6], as it inhibits bacterial growth and oxidation. It is also employed in the beverages sector, for the carbonation of soft drinks, mineral water, sparkling wines and beers. In these markets, which combined represent the largest share of merchant CO_2 demand in Europe, the origin and traceability of the CO_2 is important. For certain customers, the origin of biogenic CO_2 particularly when derived from industrial waste or manure fermentation may raise concerns related to specific dietary or cultural standards.[7]

Greenhouses

Plant growth can be enhanced with higher CO_2 concentrations, and in greenhouses, the large number of plants require additional CO_2 to support their growth. Many greenhouses across Europe are usually equipped with combined heat and power (CHP) units that burn natural gas and supply CO_2 directly to the plants.

It should be noted that carbon dioxide demand in greenhouses is highly seasonal and particularly high from May to July and low from October to December[8]. Plants in greenhouses are sensitive to certain pollutants, especially ethylene, so removing impurities is essential.

Metal fabrication

CO_2 is employed in metal fabrication processes such as laser cutting and serves as a shielding gas during gas metal arc welding of carbon steel, stainless steel and other alloys[9], owing to its low ionisation potential. A mixture of 75% argon and 25% CO_2 is commonly used for welding carbon steel. Additionally, it can be used as a surface cleaning agent.

[6] Ricardo. (3 January 2025). *Why the food industry needs CO_2 and how to make it sustainable.* Link

[7] Kalsbeek, S., & Paap, R. (6 January, 2025). *Marktstudie: Toepassing biogene CO_2 – Kansen voor biogene CO_2 uit biogas*. Research & Innovation, New Energy Coalition. Toepassingen-Biogene-CO2-Ruud-Paap-Steef-Kalsbeek.pdf

[8] CTBM (ATEE Club Biogaz) & GT CO_2 du CSF. (14 June 2023). *Guide pour réaliser un projet de valorisation du bioCO_2 issu de méthanisation*. Link

[9] Singh, R., 2020. 3 – Welding and joining processes. In: *Applied Welding Engineering*, 3rd ed. Oxford: Butterworth-Heinemann, pp. 157-186. https://doi.org/10.1016/B978-0-12-821348-3.00015-X

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Other conventional direct uses

Carbon dioxide can be directly used in many other direct applications[10] including but not limited to wastewater treatment, vaccines, medical devices, algae production and industrial cleaning, among others.[11,12]

Conversion routes

Sustainable e-fuels

The defossilisation of the European economy requires the integration of multiple existing and new energy vectors. Sustainable e-fuels will play a crucial role in enabling energy transition and achieving European defossilisation targets. The syntheses of sustainable e-fuels will require the sourcing of sustainable CO_2 via, for example, biogenic processes such as biogas and atmospheric carbon from DACC.

Enabling and encouraging different energy sectors to work together will optimise how the energy system functions as a whole.[13] Throughout the remainder of the paper, the term bioCO_2 is used to refer to the primary carbon source for the various conversion routes; however, it can also be substituted with other sustainable CO_2 sources, depending on cost and availability.

The production of sustainable e-fuels involves reacting bioCO_2 with hydrogen through various pathways:

- the **Sabatier reaction,** which yields e-methane;
- **CO_2 hydrogenation,** which produces e-methanol;
- the **reverse Water Gas Shift (WGS) reaction,** which converts CO_2 into syngas, then processed via the **Fischer–Tropsch synthesis** to generate liquid hydrocarbons.

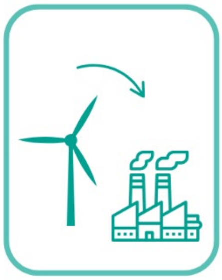
[10] Denysenko, V., Daniel-Gromke, J. (DBFZ), Binder, P. M., & Foix, L (UVIC). (November 2023). *D 4.1 Opportunities for the valorisation of CO_2 extracted from biogas*. SEMPRE-BIO. https://sempre-bio.com/library/

[11] For further details on other applications, refer to EBA. (2022). *Biogenic CO_2 from the biogas industry*. https://www.europeanbiogas.eu/wp-content/uploads/2022/10/Biogenic-CO2-from-the-biogas-industry_Sept2022-1.pdf

[12] Kircher, M. & Schwarz, T. (eds.) (2024). *CO_2 and CO as Feedstock: Sustainable Carbon Sources for the Circular Economy*. Circular Economy and Sustainability. Springer, Cham. eBook ISBN 978-3-031-27811-2. https://doi.org/10.1007/978-3-031-27811-2

[13] EBA. (September 2024). *Mapping e-methane plants and technologies*. https://www.europeanbiogas.eu/mapping-e-methane-plants-and-technologies-2/

Sustainable e-methane



In the methanation process, low-emission hydrogen, produced from, for example, excess renewable electricity, can be combined with biogenic CO_2 or directly with biogas from the anaerobic digestion process to produce sustainable e-methane[14]. This process allows e-methane to function as a fuel for hard-to-abate sectors, but also acts as an easy energy storage solution, as the excess electricity is stored as gas in existing gas infrastructure.

As e-methane production technologies require electricity for the electrolyser (hydrogen production), the cost of sustainable e-methane is highly sensitive to the price of low-emission hydrogen.

Chemicals

CO_2 can be transformed into a broad range of chemical products, including methanol, formic acid, dimethyl carbonate, sodium bicarbonate, oxygenated compounds such as oxygenates, formaldehyde, and various hydrocarbons including ethylene, propylene. Biogenic CO_2 offers a sustainable route for the chemical industry, responsible for approximately 3.2% of EU greenhouse gas emissions[15], by enabling the substitution of fossil-based materials while providing essential raw materials for industrial growth.[16]

As is the case with e-fuels, reliance on low-emission hydrogen for sustainable chemicals remains one of the main economic constraints, alongside limitations in catalysts and thermodynamic performance.

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[14] This process can be carried out ex-situ or in-situ. The latter involves valorising biogenic CO_2 directly at the production site by injecting renewable non-biological hydrogen into the digester to produce renewable synthetic methane of non-biological origin. This approach offers advantages by avoiding both the costs of upgrading raw biogas into biomethane and the costs associated with CO_2 transport.

[15] European Environment Agency, *EEA greenhouse gases — data viewer*, April 2025, European Environment Agency, https://www.eea.europa.eu/en/analysis/maps-and-charts/greenhouse-gases-viewer-data-viewers

[16] Awogbemi, O., & Desai, D. A. (11 February 2025). *Novel technologies for CO_2 conversion to renewable fuels, chemicals, and value-added products*. Discover Nano, 20, Article 29. https://doi.org/10.1186/s11671-025-04214-w

Building materials

BioCO_2 can be used as a feedstock in the production of building materials, such as cement, concrete and construction aggregates. This can be achieved through a curing process, in which water in concrete is replaced or by recycling construction and demolition waste (mineral waste, such as concrete, slags and ashes) into aggregates via a mineralisation process, also referred to as carbonation. Mineral carbonation processes use higher CO_2 concentrations in combination with humidity, temperature, solvents and optimised particle size of the concrete to accelerate the process of carbonation[17]. Some CO_2-based building materials may offer a superior performance compared with their conventional counterparts[18].

In 2022, construction and demolition waste accounted for 38.4% of the total waste generated in the EU, the highest share of any category[19]. Overall, production of building materials, especially via the recycling of construction waste, offers considerable potential for durable CO_2 storage, turning the built environment into an important carbon sink.

See the Annex (*A2: TRL of Conversion and Utilisation Pathways*) for further information on the TRL of selected technologies for bioCO_2 conversion and utilisation pathways.

SFP Group has operated a biomethane plant in Zeeland, Netherlands, since 2019 (400 GWh). It digests 600,000 tonnes of agricultural residues and manure, while capturing and liquefying **20,000 tonnes of bioCO_2 mainly used in greenhouses**. Two additional SFP biomethane installations in the Netherlands (800 GWh), which digest agricultural residues, are expected to enter operation this year, liquefying an additional **40,000 tonnes of bioCO_2, primarily for greenhouse use**, with future plans to integrate CCS.

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[17] The Gold Standard Foundation. (28 May 2025). *Methodology Carbon mineralisation using reactive mineral waste.* https://globalgoals.goldstandard.org/standards/432_V2.0_CDR_Carbon_Mineralisation_Using_Reactive_Mineral_Waste.pdf

[18] International Energy Agency. (2023). *CCUS technology innovation*. IEA. https://www.iea.org/reports/ccus-in-clean-energy-transitions/ccus-technology-innovation

[19] Eurostat. (2024, September). *Waste statistics*. European Commission. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_statistics

bioCCS

Onshore and offshore storage

CO_2 can be permanently stored using various geological formations, including saline aquifers (TRL 9), depleted oil and gas fields (TRL 5–8)[20] and dissolved injection methods (TRL 5–8.5). Other storage options with lower technology readiness levels include mineral carbonation in basalt and ultramafic rocks.[21]

Storage solutions for biogenic CO_2 are commonly abbreviated with bioCCS. This route is a carbon sink that provides the ability to create negative carbon removal certificates. The development of this route will depend heavily on the future development of storage infrastructure across Europe, alongside factors such as biogenic CO_2 certification, potential capture incentives and the geographical location of the storage facilities.

BioCirc is developing one of Europe's biggest biomethane production portfolios **with permanent CO_2 removal** in Jutland, Denmark, by retrofitting five of its eight industrial-scale biogas plants (~1,9 TWh/y). The first storage under the bioCCS project is planned for 2026, with approximately **140,000 tonnes/year of bioCO_2** will be captured from sustainable biomethane produced from agricultural residues, organic waste and manure, and permanently stored in the Greensand Future geological storage underneath the Danish North Sea. BioCirc's project is one of the first large-scale negative emission projects in Europe. It is supported by the Danish NECCS subsidy scheme and will be certified under Puro.earth's Geologically Stored Carbon methodology.

[20] Kearns, D., Liu, H., & Consoli, C. (March 2021). *Technology readiness and costs of CCS*. Global CCS Institute. https://www.globalccsinstitute.com/wp-content/uploads/2022/03/CCE-CCS-Technology-Readiness-and-Costs-22-1.pdf

[21] European Commission, JRC, Martinez Castilla, G., Tumara, D., Mountraki, A., Letout, S., Jaxa-Rozen, M., Schmitz, A., Ince, E. and Georgakaki, A., *Clean Energy Technology Observatory: Carbon Capture, Utilisation and Storage in the European Union - 2024 Status Report on Technology Development, Trends, Value Chains and Markets*, https://data.europa.eu/doi/10.2760/0287566, JRC139285.

CHAPTER 2: MARKETS AND FUTURE LANDSCAPE

Current global and European CO_2 demand

Global demand for CO_2 is largely met by fossil-based sources generated from industrial processes. Total demand in 2024 was estimated at approximately 267 million tonnes per year, with around 14% consumed in liquid or solid form within what is referred to as the merchant market. The remaining 229 million tonnes, in gaseous form, were mostly consumed in internal processes, mainly in urea production and enhanced oil recovery.[22]

Within the merchant market, CO_2 consumption is distributed as follows: approximately 25% in the food industry, 23% in beverage carbonation, 13% in fabricated metal products, and the remainder across various other applications, as shown in Figure 3:

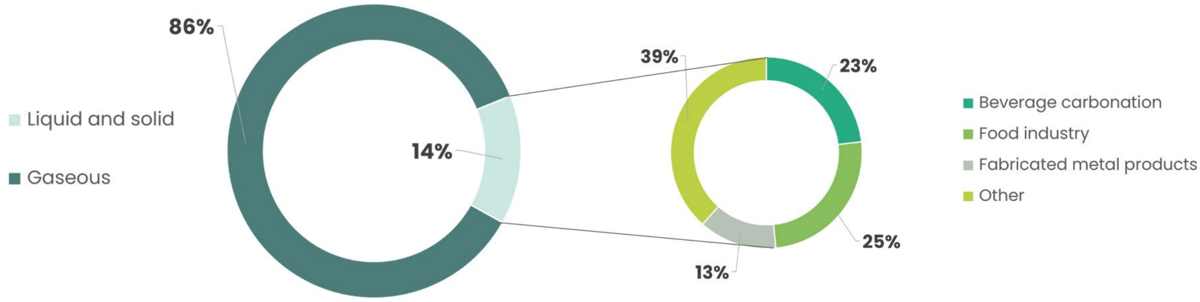

Figure 3 Global CO_2 consumption of the merchant market of liquid and solid CO_2 by end use (right) based on S&P Global (2024)

North America and mainland China are the largest markets for the combined carbon dioxide use (merchant and gaseous form), accounting for respectively 31% and 27% of total global consumption in 2024, while the European market accounted for 5%. Europe's CO_2 consumption in 2024 was estimated at 13.9 million tonnes per year, with 44% used in gaseous form and the remainder entering the merchant market. Over 63% of merchant market demand originated from the food and beverage industry, followed by fabricated metals (7%), water treatment (2%) and various other applications.

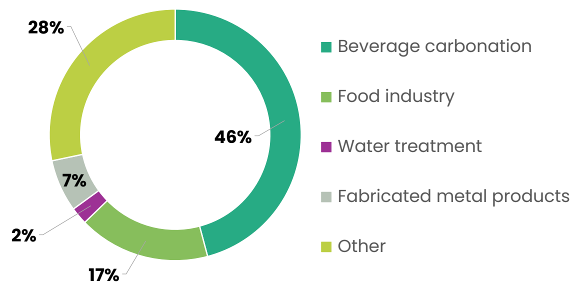

Figure 4 European CO_2 consumption of liquid and solid CO_2 by end use based on S&P Global (2024)

[22] S&P Global Commodity Insights. (2024). *Chemical Economics Handbook® (CEH) – Carbon Dioxide.* https://www.spglobal.com/commodityinsights/en/ci/products/chemical-economics-

Future shares of CCUS

Logistically, the European merchant CO_2 market is structured around regional supply chains, whereby CO_2 is typically sourced in smaller batches, especially when compared to volumes associated with permanent storage. It is predominantly transported by truck. Due to high transport costs, which rise considerably beyond 200 km, delivery distances are limited leading to the development of local or regional ecosystems capable of meeting demand.

Emerging markets, such as those of e-fuels, chemicals, storage and mineralisation, are opening up potential future end-use pathways for sustainable CO_2, sourced either locally or centrally.

Diverse modelling scenarios have estimated the market shares that these novel end uses will represent in the coming decades[23,24]. In its impact assessment report for the Climate Law target[25], the European Commission estimates that by 2040, a total of 344 Mt CO_2 will be captured, with a shift required towards biogenic carbon dioxide and direct air capture (DACC) to achieve a 90% reduction in net GHG emissions.

Within just 15 years, 29% of the total captured carbon volume is expected to be used for e-fuel production, which corresponds to more than thirteen times today's merchant CO_2 market. This underscores the urgent need to secure additional volumes, while preventing the creation of new fossil-based CO_2.

Additionally, it is forecast that the remaining 243 Mt of CO_2 will be placed in underground storage; the model does not consider the possibility that this carbon will be stored in materials, used in chemical processes or absorbed by the conventional CO_2 markets already in place, as shown in Figure 5:

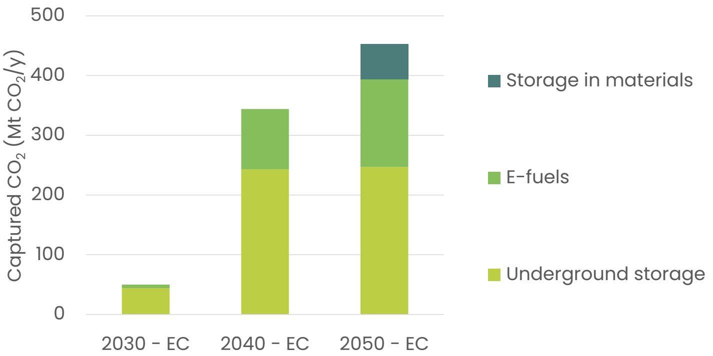

Figure 5 Captured CO_2 by end use based on EC Impact Assessment (2024) [25]

[23] Ricardo Energy & Environment. (30 May 2022). *European CO_2 availability from point-sources and direct air capture* (Final v3, Ref. ED16147). Report for Transport & Environment. https://te-cdn.ams3.cdn.digitaloceanspaces.com/files/DAC-final-report.pdf

[24] CO_2 Value Europe. (2024). *The contribution of carbon capture & utilisation towards climate neutrality in Europe: A scenario development and modelling exercise*. https://co2value.eu/wp-content/uploads/2024/01/FINAL-LAYOUT_CVEs-EU-Roadmap-for-CCU-by-2050.pdf

[25] European Commission. (6 February 2024). *Commission staff working document: Impact assessment report. Part 2/5* (SWD(2024) 63 final). Accompanying the communication *Securing our future: Europe's 2040 climate target and path to climate neutrality by 2050*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD%3A2024%3A63%3AFIN

By 2050, the model projects an additional 108 Mt of CO_2 will be captured, with underground storage remaining the primary end use at 55%. Over the same period, 59 Mt will be stored in materials and 46 Mt will be needed for the e-fuels sector. Combined, the demand from materials and e-fuels would exceed the current merchant market by more than twenty-six times.

In terms of sources, the estimations significantly undervalue the potential of biogenic CO_2 from biogases (see *Future potential of bioCO_2 from biogases*). By 2030, it is estimated that only 4 Mt of CO_2 will come from biomethane upgrading, rising to 22 Mt in 2040 and 30 Mt in 2050, while the REPowerEU Plan targets 35 bcm of biomethane by 2030. Assuming at least 50% of this biomethane production is equipped with CO_2 capture, this would already amount to 23 Mt of biogenic CO_2 in 2030, more than five times higher than the figure used in the Impact Assessment.

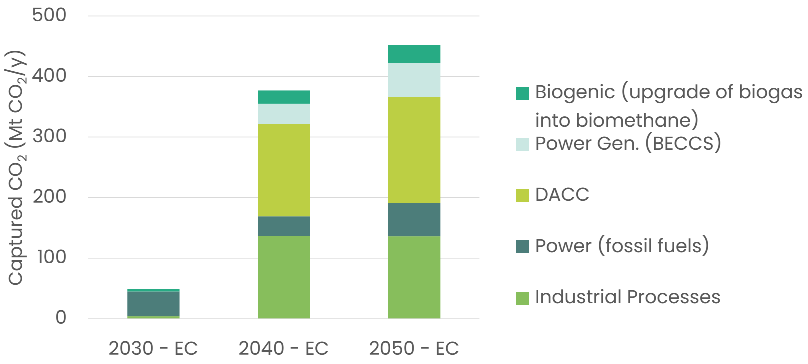

Figure 6 Captured CO_2 by source based on EC Impact Assessment (2024) [25]

The model assumes fossil CO_2 from industry will remain constant between 2040 and 2050, with biomass power generation contributing 10–12% of captured CO_2. Direct Air Carbon Capture (DACC) is expected to exceed 40%, yet its reliance on dilute CO_2 streams and high energy demand will keep capture costs high, estimated at €300–500 per tonne by 2050[26]. DACCS will undoubtedly play a role in achieving climate neutrality. However, its high cost underscores the need to fully recognise and leverage existing low-cost bioCO_2 sources such as biomethane.

[26] Sievert, K., Schmidt, T. S., & Steffen, B. (2024). Considering technology characteristics to project future costs of direct air capture. *Joule, 8*(4), 979–999. https://doi.org/10.1016/j.joule.2024.02.005

Sources of bioCO_2 from biogases and other sustainable CO_2 sources

Biogenic CO_2 can be captured from various technological processes in the biogas industry, as illustrated in Figure 7:

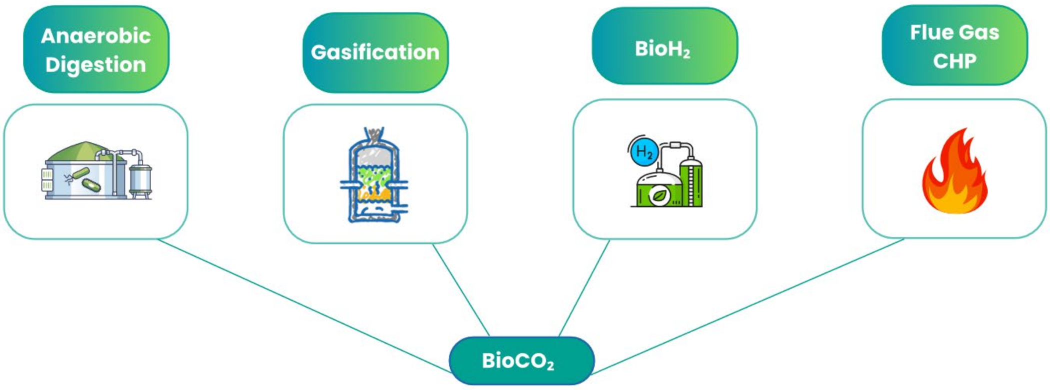

Figure 7 Sources of biogenic CO_2 from the biogas sector

The capture of biogenic CO_2 from biomethane produced through anaerobic digestion represents the most technologically mature process and is extensively deployed across Europe. Currently, 125 biomethane plants actively capture and utilise or store biogenic CO_2 (see *Chapter 5*).

Biomethane production and biogenic CO_2 separation

The anaerobic digestion (AD) process yields biogas as its main product, typically composed of 60% biomethane (bioCH_4) and 40% bioCO_2. To produce biomethane, a separation process is required. As a result, one stream of high-purity biomethane (>99%) is obtained, while another stream of highly concentrated gaseous biogenic CO_2 is simultaneously separated (96% to over 99% purity). This is followed by compression and removal of any remaining impurities. The CO_2 is then liquefied and distilled to eliminate any biomethane slip, before being stored in a tank[27]. Depending on its intended end use, the required purity of the final CO_2 product may vary (see *A1: Quality*).

Gasification

Gasification is a thermochemical process that converts organic materials (e.g. agricultural residues, forestry by-products, wood waste and organic fraction of municipal solid waste or solid recovered fuels (SRF)) into syngas (a mixture of hydrogen, carbon monoxide and other hydrocarbons).[28]

The syngas generated through gasification can be directed towards several applications, each offering opportunities for biogenic CO_2 capture. These include:

[27] See Figure 9 for a general overview of the process

[28] EBA. (December 2024). *Gasification: diversification of biomass processing and waste utilisation.* https://www.europeanbiogas.eu/eba-paper-explores-gasifications-role-in-supporting-europes-energy-transition/

- **Electricity and heat generation via combined heat and power (CHP) systems** (CO_2-rich flue gas suitable for capture);
- **Hydrogen production through syngas purification** (CO_2 separated after water–gas shift (WGS) and subsequent processing stages);
- **Methanation of syngas to produce biomethane** (concentrated CO_2 by-product).

Biohydrogen production

Biohydrogen refers to hydrogen obtained from biogenic sources (e.g. biogases and biomass) and can be produced through numerous types of processes, including biological, thermochemical and bioelectrochemical processes[29]. These processes often result in the generation of biogenic CO_2 as a by-product. Biohydrogen can be produced through steam methane reforming (SMR), the most common industrial hydrogen production process in use[30], whereby raw biogas or biomethane react with steam (water) to produce biohydrogen and bioCO_2, and a further WGS reaction increases the biohydrogen yield from the steam.

Capture from biogas and biomethane post-combustion

The flue gas stream produced when **biogas is combusted** in a CHP unit for electricity and heat generation contains a relatively low concentration of CO_2 (<10%), which will vary depending on the feedstocks used. Exhaust gas volumes are not comparable to the fossil CO_2 flue gas capture of large-scale industrial processes, making CO_2 capture from biogas combustion economically challenging.

According to the EBA database, 6,632 GWh of the **biomethane** produced in the EU in 2023[31] was used in industry. This spanned multiple sectors, serving as a replacement for natural gas, both as a source of high-temperature heat and as a carbon-rich feedstock for steel, cement, glass, ceramics, chemicals and fertiliser production. As industries turn to implementing CO_2 capture projects for their post-combustion emissions[32], the use of biomethane in industry not only reduces their direct emissions, but also enables subsequent bioCO_2 capture, providing a pathway for carbon removals.

Other bioCO_2 and sustainable CO_2 sources

Beyond biogases, other technologies can also provide a source of sustainable CO_2, among them:

[29] For further details, see: EBA. (14 June 2023). *Decarbonising Europe's hydrogen production with biohydrogen.* https://www.europeanbiogas.eu/decarbonising-europes-hydrogen-production-with-biohydrogen/

[30] International Energy Agency. (June 2019). *The Future of Hydrogen: Seizing today's opportunities.* https://www.iea.org/reports/the-future-of-hydrogen

[31] EBA. (10 December 2024). *Statistical Report 2024*

[32] Barlow, H., Shahi, S. S. M., Jeddizahed, J., & Kearns, D. (29 July 2025). *State of the art: CCS technologies 2025* (Technical Report). Global CCS Institute. https://www.globalccsinstitute.com/wp-content/uploads/2025/08/State-of-the-Art-CCS-Technologies-2025-Global-CCS-Institute.pdf

- **Bioethanol**: its production entails a fermentation process of biomass rich in starch (corn, wheat, sugar beet, cereals and crops, among others)[33], which is converted into bioethanol and bioCO_2.
- **Solid biomass for centralised power & heat production**: this involves the direct combustion of biomass in a CHP, including forest residues, agricultural residues and mixed urban solid waste[34]. The latter feedstock stream may also contain non-organic materials, resulting in a combined stream of bioCO_2 and fossil CO_2.
- **Direct air carbon capture (DACC)**: as its name suggests, this is a capture technology in which atmospheric CO_2 is directly captured from the air. Due to the low CO_2 concentration (~0.04%), the process requires substantial amounts of energy and is the costliest capture technology[35].

[33] Wang, P., & Lü, X. (2021). Chapter 1 - General introduction to biofuels and bioethanol. In *Biofuels and Bioethanol* (pp. 1–7). Elsevier. https://doi.org/10.1016/B978-0-12-818862-0.00006-6

[34] Mabee, W., & Walker, B. (April 2025). *Review of feedstock supply for bioenergy in IEA Bioenergy Task 43 Member Countries*. IEA Bioenergy: Task 43. https://www.ieabioenergy.com/wp-content/uploads/2025/07/Review-of-feedstock-supply-for-bioenergy-in-IEA-Bioenergy.pdf

[35] International Energy Agency. (2022). *Direct Air Capture 2022*. https://www.iea.org/reports/direct-air-capture-2022/executive-summary

Future potential of bioCO_2 from biogases

The latest estimates of the Impact Assessment (IA) conducted by the Commission[25] - despite recognising the crucial role of biogas and the bioenergy sector in Europe's decarbonisation - underestimate the actual capacity of the biogas and biomethane sector, possibly due to somewhat limited consultation with industry experts.

The ENTSO-E and ENTSOG Ten-Year Network Development Plans (TYNDP) 2024[36] modelling of captured bioCO_2 from biogases aligns with the EU-27 bioCO_2 potential from AD, as calculated based on the biomethane potentials[37] from the 2024 Guidehouse report[38]. These findings confirm the vast untapped potential of biogenic CO_2 derived from biogases. Taking into account gasification, this potential expands significantly[39], underlining the sector's strategic role in achieving Europe's climate objectives. Figure 8 illustrates the results of the different modelling approaches:

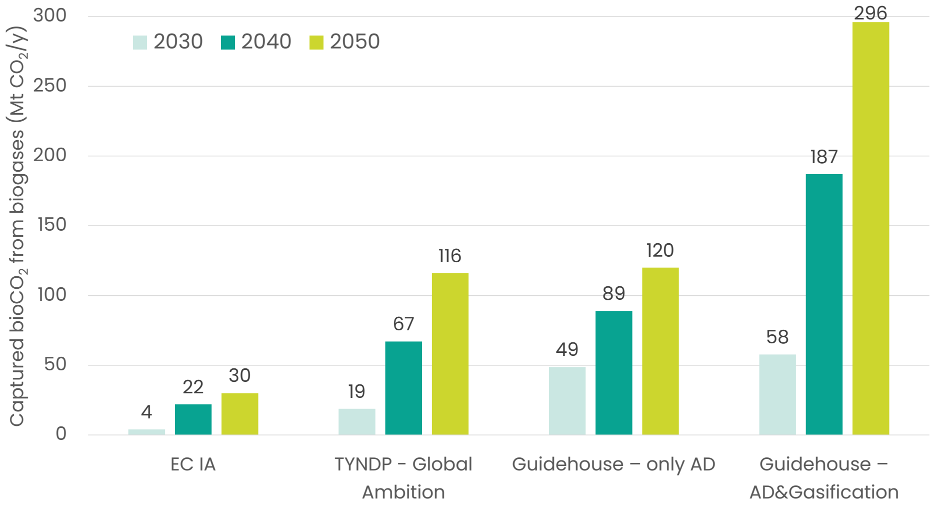

Figure 8 Captured bioCO_2 projections from EC IA, compared to TYNDP and Guidehouse potential

Compared to other sustainable CO_2 production routes, the biogas and biomethane sector offers one of the most effective, cost-efficient, safe and scalable options for CO_2 capture. By combining its substantial sustainable potential with low-cost, efficient production pathways, the sector provides a scalable and economically viable solution capable of meeting forecast demand. In 2023, biogases production in Europe reached 22 bcm, with approximately 5.4 Mt of bioCO_2 per year already being separated during the upgrading of biogas to biomethane (4.9 bcm/year). If all biogas produced in 2023 had been upgraded, the biogas industry would have separated a total of 29 Mt of biogenic CO_2.

[36] ENTSO-E & ENTSOG. (2024). *TYNDP 2024 Scenarios Report*. https://2024.entsos-tyndp-scenarios.eu/#download

[37] The subsequent capture from post-combustion of biomethane is not considered in the calculation.

[38] Alberici, S., Toop, G., Monchen, B., Peeters, S., & Peterse, J. (2024, April). *Biogases towards 2040 and beyond*. Guidehouse Europe Ltd. https://guidehouse.com/-/media/new-library/services/sustainability/documents/2024/biogases-towards-2040-and-beyond.pdf

[39] At present, due to the many possible utilisation routes of syngas from gasification, quantifying the amount of captured biogenic carbon for market purposes is complex. For this reason, it is assumed for estimation purposes that all syngas from gasification is upgraded to biomethane and based on the Guidehouse (2024) report.

CHAPTER 3: ECONOMICS OF BIOCO_2

The feasibility of each biomethane project to capture biogenic CO_2 will depend on a variety of factors, including but not limited to:

- plant size, CO_2 capture capacity and seasonality, with economies of scale enabling cost degression;
- electricity prices, and operation and maintenance (O&M) costs;
- the geographical location of the biomethane plant, as this will influence:
  - the availability of nearby off-takers and the competitive landscape (market saturation or scarcity)
  - the economic viability of transporting CO_2 within a limited radius;
- feedstock type, as this can influence:
  - purification steps;
  - composition of the purified CO_2, and traceability requirements for quality standards.
- project type (greenfield development vs. brownfield retrofitting);
- regulatory landscape:
  - regulatory clarity is essential to unlock large-scale investment and minimise risks for project developers [40]
  - strategically structured national support schemes can reduce upfront capital costs, provide price stability and foster long-term demand.

Conventional CO_2 markets can absorb only a limited volume, and as previously mentioned, emerging CCU applications will be needed to generate additional demand and open up new business opportunities with sustainable CO_2. CCS can also open up another economic pathway for operators and may also serve as a solution for saturated markets. However, given the uneven geographical distribution of storage sites across Europe, this will not be a viable option for all producers. Furthermore, the feasibility of storage options for biomethane will largely depend on the pace of CO_2 infrastructure development.

Levelised cost of capture (LCOC) from biomethane production

EBA has built a robust database using input from industrial stakeholders on Capital Expenditure (CAPEX) and Operational Expenditure (OPEX) for operational and planned commercial-scale biomethane facilities capturing biogenic CO_2. All data underwent thorough validation and analysis. Because upgrading costs are built into standard

[40] For further details into policy barriers, see: European Biogas Association. (31 March 2025). *2040 climate target and beyond: The role of biogenic carbon from the biogas sector.* https://www.europeanbiogas.eu/wp-content/uploads/2025/03/EBA_BiogenicCO2-towards-2040_PositionPaper_31.03.25.pdf

biomethane production, the levelised cost of capture (LCOC) analysis only covers downstream steps (mainly liquefaction and CO_2 storage tanks) after biomethane has been separated from biogenic CO_2. The system boundaries are illustrated in Figure 9:

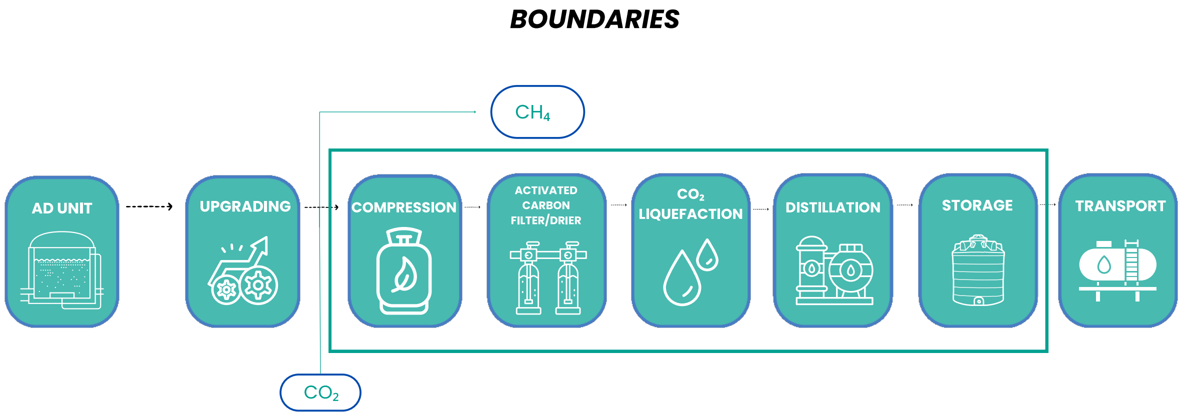

Figure 9 System boundaries of the process for LCOC calculation

The LCOC (see Figure 10) ranges from **€40–80/t CO_2** for large plants (>10,000 t CO_2/year), reflecting economies of scale. Mid-scale plants (5,000–10,000 t CO_2/year)[41] fall within €44–105/t CO_2, while small-scale plants (<5,000 t CO_2/year) see costs increase to €53–137/t CO_2, due to less dilution of investment and operational costs. Variability is primarily driven by case-specific factors. One way to lower LCOC for smaller plants is to aggregate biogas from several sites at a central processing hub for combined biogas upgrading and CO_2 purification and liquefaction.

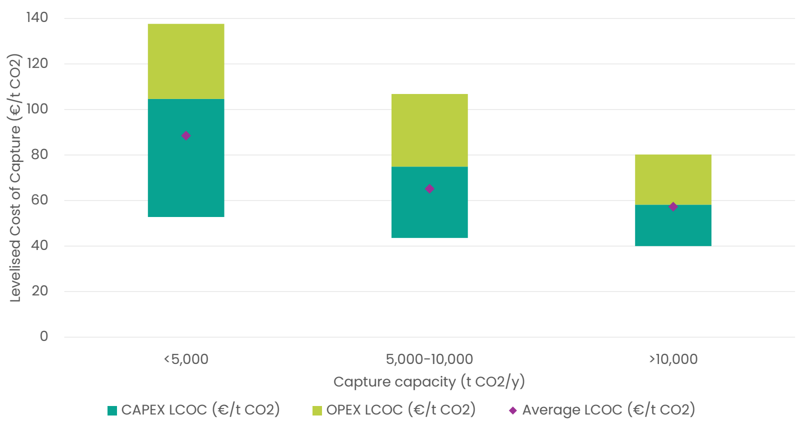

Figure 10 LCOC from biomethane facilities based on capture capacity

For CAPEX, the liquefaction unit represents the costliest component, while liquefaction electricity drives over 60% of OPEX, followed by O&M expenses.[42]

[41] This is equivalent to a biomethane production capacity ranging between approximately 474 and 950 Nm³/h.
[42] Electricity for liquefaction was considered as a separate component of the O&M to enable its impact in the process to be fully understood.

Greenfield investments exhibit a lower LCOC due to process optimisation in their initial design; for brownfield investments, retrofitting can involve extra components or higher operational costs.

Cost of capture compared with other technologies

The capture of biogenic CO_2 from biomethane has two distinct advantages over its capture from other CO_2 sources:

- highly concentrated stream of CO_2 (96% to over 99% purity);
- possibility of direct integration with biomethane production during the biomethane upgrading step.

As a result, bioCO_2 capture from biomethane offers a lower LCOC than that from other dilute sources. Given its biogenic origin, which enables negative emissions, and the sector's significant deployment potential, it represents a key lever for achieving climate targets. The IEA[43] (2025) reported that large-scale biogas upgrading facilities can attain capture costs of approximately €14–35/t CO_2[44,45], while the LCOC from diverse sources is depicted in Figure 11 (IEA system boundaries only include compression).

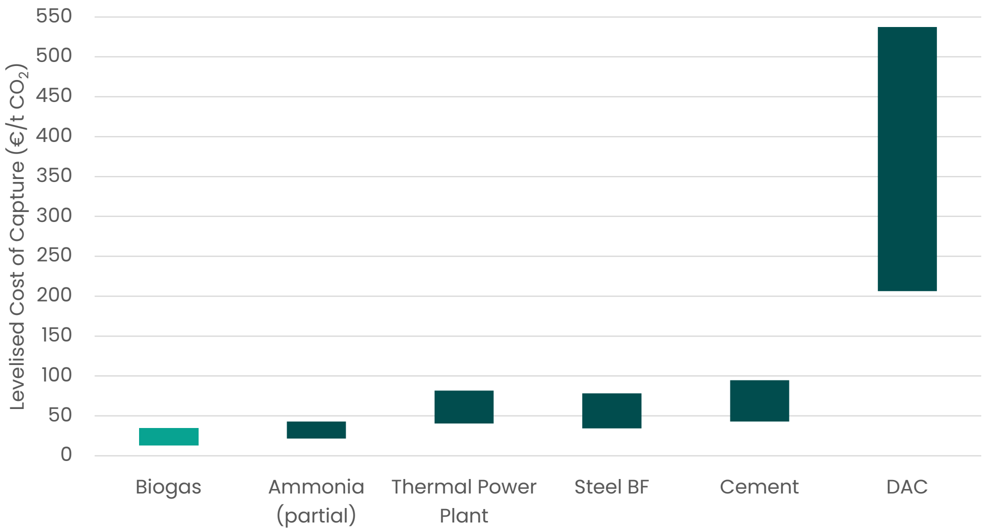

Figure 11 Levelised cost of capture from biogas upgrading and other sources of CO_2 based on IEA (2025)[43]

CO_2 capture costs mainly depend on CO_2 partial pressure and plant scale. Lower concentrations require higher capital expenditure, so concentrated streams, like those from ammonia (€14–30/t CO_2)[43,46], are less expensive to capture than those from cement, steel

[43] International Energy Agency. (May 2025). *Outlook for biogas and biomethane: A global geospatial assessment (World Energy Outlook Special Report).* https://iea.blob.core.windows.net/assets/5b757571-c8d0-464f-baad-bc30ec5ff46e/OutlookforBiogasandBiomethane.pdf

[44] IEA estimates account only for the capture and compression stages, without including downstream processes.

[45] Assuming that USD 1 = €0.86, based on the exchange rate of the European Central Bank Link

[46] International Energy Agency. (2019). *Levelised cost of CO_2 capture by sector and initial CO_2 concentration, 2019*. IEA. https://www.iea.org/data-and-statistics/charts/levelised-cost-of-co2-capture-by-sector-and-initial-co2-concentration-2019

or power plants. Further cost factors include location, pretreatment requirements, energy/cooling needs, capture rate and chosen technology. [47]

Among biogenic sources, solid biomass used in centralised power and heat production represents the largest potential for bioCO_2 capture. However, due to the relatively low CO_2 concentration of its flue gases (10-12%), its capture is associated with higher costs (€60-80/t CO_2)[48]. Bioethanol production also constitutes a low-cost source of biogenic CO_2 (€22-30/t CO_2)[49]. However, its production is expected to decrease by 2050 as a result of electrification[50], e-fuel deployment[51] and use of hydrogen[25].

The JRC[52] estimated bioCCS capture costs in the range of €40–70/t CO_2, whereas DACC (0.04% CO_2) was projected at €100–800/t CO_2 due to its highly energy-intensive process. The study also provides values consistent with the IEA for fossil processes, ranging from €10–30/t CO_2 for highly concentrated streams, such as ammonia, to €25–120/t CO_2 for medium-concentration streams, including cement, iron and steel, and pulp and paper production[53].

Support schemes for bioCO_2

Unlocking the full theoretical potential from biomethane plants requires several barriers to be overcome. Currently, there are no dedicated support schemes ensuring price visibility for operators. This lack of predictability makes it more difficult for some operators to establish a stable business case for CO_2 capture.

The implementation of a flexible policy mix composed of support schemes based on prioritising GHG emissions reduction, such as a tariff per tonne of captured CO_2, combined with demand-side instruments and tax incentives that favour biogenic CO_2 over fossil alternatives, would significantly support the scale-up of capture projects in the biomethane sector. This should take into account the maturity of their biomethane market, its national context and the associated barriers, as various strategies and combinations may be suitable depending on their specific circumstances.

Other schemes tackling capital expenditure may help initiate some early-stage projects and infrastructure development, but their impact remains limited if not combined with complementary measures accompanying long-term commitment to stimulate future

[47] Barlow, H., Shahi, S. S. M., & Kearns, D. T. (30 January 2025). *Advancements in CCS technologies and costs*. Global CCS Institute. https://www.globalccsinstitute.com/wp-content/uploads/2025/01/Advancements-in-CCS-Technologies-and-Costs-Report-2025.pdf

[48] Biomethane Industrial Partnership (9 April 2024). *Biogenic CO_2: The role of the biomethane industry in satisfying a growing demand* (Task Force 4.1)

[49] International Energy Agency. (2019). *Levelised cost of CO_2 capture by sector and initial CO_2 concentration, 2019*. IEA. https://www.iea.org/data-and-statistics/charts/levelised-cost-of-co2-capture-by-sector-and-initial-co2-concentration-2019

[50] Concawe (2021). *Transition towards Low Carbon Fuels by 2050: Scenario analysis for the European refining sector*. https://www.concawe.eu/wp-content/uploads/Rpt_21-7.pdf

[51] Frontier Economics (2025). *Scenarios for the Market Ramp-Up of E-Fuels in Road Transport*. Link

[52] MARTINEZ CASTILLA, G., TUMARA, D., MOUNTRAKI, A., LETOUT, S., JAXA-ROZEN, M., SCHMITZ, A., INCE, E. and GEORGAKAKI, A., *Clean Energy Technology Observatory: Carbon Capture, Utilisation and Storage in the European Union - 2024 Status Report on Technology Development, Trends, Value Chains and Markets*, Publications Office of the European Union, Luxembourg, 2024, doi:10.2760/0287566, JRC139285.

[53] JRC's estimates refer only to the capture stage and does not include subsequent downstream processes and associated costs.

demand, which can provide visibility, certainty and risk reduction for developers. Moreover, biomethane production spans several policy domains (agriculture, waste management, energy, at a minimum), which calls for cross-sectoral synchronisation of measures to maximise the benefits and internalise the positive externalities.[54]

Furthermore, an alternative route for capturing biogenic CO_2 involves retrofitting biogas plants to upgrade to biomethane. Therefore, clear incentive mechanisms for biomethane production and biogenic CO_2 capture could also encourage investment in the retrofitting of existing biogas facilities.

A stable business case with a guaranteed minimum price is essential to encourage investment in capture infrastructure. Availability is closely linked to demand and demand-sided incentives to use biogenic CO_2.

Despite the significant potential of biogenic CO_2 from biomethane, only a limited number of support schemes have been introduced across the EU, with only one directed towards CCU. These schemes are spread across just three countries and compete directly with large-scale emitters[55] (see *A3*: *National Support Schemes for bioCO2*).

[54] BIP. (January 2024). *Biomethane incentives and their effectiveness*. https://bip-europe.eu/downloads/?filter%5B%5D=12
[55] EBA. (June 2025). *Support Schemes for Biogas and Biomethane*. https://www.europeanbiogas.eu/support-schemes-for-biogas-and-biomethane-eba-members-only-report/

CHAPTER 4: EUROPE'S FUTURE CO_2 INFRASTRUCTURE

CO_2 not used on site requires transport infrastructure to reach end users. Developing a cross-border CO_2 network is essential to create a unified European market and foster wider investment. The JRC[56] estimates that the transport network could grow to 15,000–19,000 km by 2050, with development costs between €9.3 billion and €23.1 billion. However, current EU funding is far below requirements, with only €982 million[57] allocated by the Connecting Europe Facility (CEF)[58] to CO_2 infrastructure from 2014 to 2025.

Without stronger de-risking tools, such as guarantees, volume commitments, infrastructure bookings and carbon capture installations, as well as dedicated subsidy schemes or Contracts for Difference, projects will struggle to secure private capital.

The JRC also modelled multiple infrastructure scenarios, including announced capacities only, offshore storage only, and targets under Fit-for-55 and the Net-Zero Industry Act (NZIA 2030)

Storage infrastructure

According to the IEA (2025)[59] CCUS database, Europe's current operational CO_2 storage capacity is 3.37 Mt CO_2/year, with the Northern Lights project alone contributing 1.5 Mt CO_2/year following its first offloading in June 2025[60]. An additional 0.03 Mt CO_2/year of storage capacity is currently under construction.

By 2030, total capacity is projected to reach to 172.67 Mt CO_2/year. The UK will hold 38% of this, followed by Norway (20%), Denmark (18%), the Netherlands (12%), the Belgium–Netherlands cross-border corridor (4%) and 7% across nine other countries.

Most storage infrastructure is being developed in Northern and Northwestern Europe, primarily due to suitable geology and the proximity to large emitters (see Figure 12)[61]:

[56] Tumara, D., Uihlein, A. and Hidalgo Gonzalez, I., *Shaping the future CO_2 transport network for Europe*, Publications Office of the European Union, Luxembourg, 2024, doi:10.2760/582433, JRC136709.
[57] Silla, O. (22 May 2025). *CEF Energy PCIs and PMIs call: Virtual Info Day* [Virtual information session]. European Commission, Connecting Europe Facility—Energy Call: Projects of Common & Mutual Interest.
[58] A full list of funded CEF projects for CO_2 infrastructure can be found on EU Funding & Tenders Portal.
[59] International Energy Agency. (2025). *CCUS projects database*. https://www.iea.org/data-and-statistics/data-product/ccus-projects-database
[60] Northern Lights JV DA. (25 June 2025). *Key highlights in June: Longship complete, first offloading and a royal visit.* https://norlights.com/news/key-highlights-in-june-longship-complete-first-offloading-and-a-royal-visit/
[61] Joint Research Centre (JRC), 2023. *Carbon capture and storage projects*. Energy & Industry Geography Lab. https://energy-industry-geolab.jrc.ec.europa.eu/

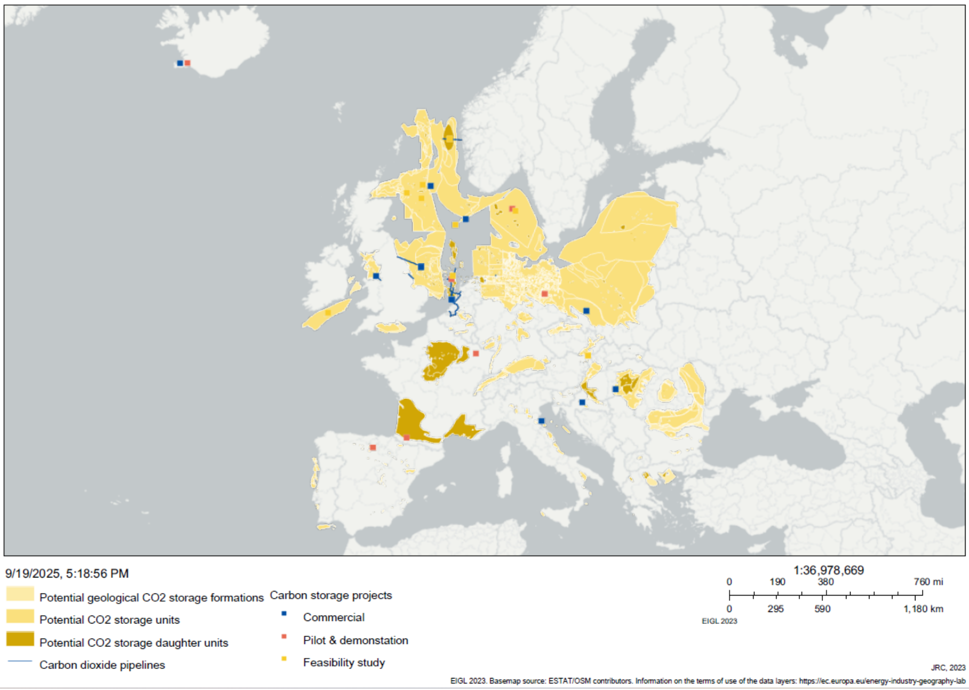

Figure 12 Potential geological CO_2 storage[62] units and carbon storage projects from the JRC (2023) database

Based on IEA (2025), a further 92 Mt CO_2/year of storage capacity is expected by 2035 (see Figure 13), with 48% in the United Kingdom, 22% in Norway, 12% in Denmark, 8% in the Netherlands, 2% in the Belgium–Netherlands cross-border corridor and the remaining 7% across nine European countries.

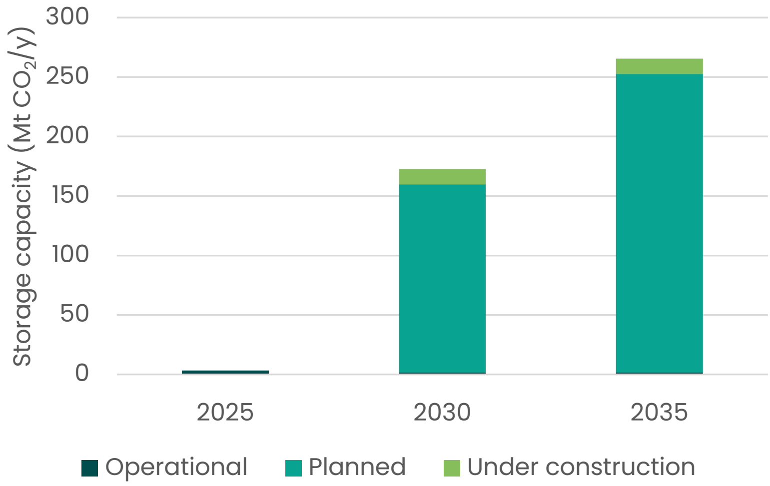

Figure 13 Storage capacity operational, planned and under construction based on IEA (2025) [59]

[62] The Clean Air Task Force (CATF) (2023) estimated Europe's theoretical CO_2 storage capacity at 262–1,520 $GtCO_2$, while recognising that the operational capacity available in the future will represent only a fraction of the theoretical and effective volumes identified.

Transport infrastructure

By 2035, transport and storage (T&S) and transport projects are expected to reach a total transport capacity of 408.33 Mt CO_2 per year[59]. Norway will provide 19% of this capacity, followed by the UK at 16% and the Netherlands at 13%. Belgium–Germany and Germany–Netherlands corridors each add 7%, Denmark and Germany each hold 6%, France and the Netherlands–Norway corridor each supply 5%, and Belgium adds 4%.

The remaining capacity is distributed across other regions, including Poland, Latvia, Lithuania, Italy, Spain, Greece, Iceland, Hungary, Bulgaria and various cross-border corridors such as France–Spain, France–Italy and Italy–Greece.

This unequal distribution across countries is illustrated in Figure 14, which highlights the transport capacities of different projects by country or region:

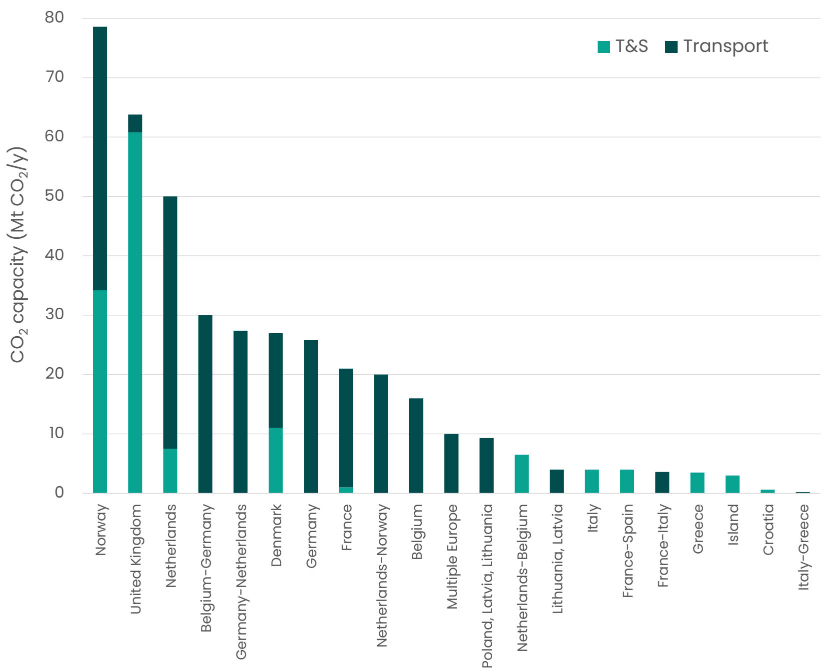

Figure 14 Expected transport and T&S capacity by 2035 based on IEA (2025)

Critical aspects to consider for enabling the integration of biogenic CO_2 from biomethane into emerging carbon infrastructure

The development of CO_2 infrastructure **can address the logistical and market barriers** by linking regions with surplus production to those with deficits. Moreover, it could reduce transport costs, support cross-border trade, improve access to stable off-take agreements, and support more viable business cases. However, the emerging CO_2 T&S infrastructure across the EU is predominantly **designed around large, fossil-based, point-source emitters and overlooks decentralised biomethane biogenic CO_2** sources operating on a smaller scale. This structural bias presents technical and economic barriers, particularly for biomethane operators reliant on liquid-phase CO_2, which face limited access to injection points, an additional phase conversion penalty and high transport costs. Small-scale CO_2 pipeline networks, integrated with local producers and complementing the main transmission system, offer a solution, but require strong policy commitment and public support.

Projects focused on liquefied CO_2 storage, such as CO_2 Next[63] in the Netherlands and the proposed facility at Peterhead in Scotland, focus on shipping bulk CO_2 and lack facilities for road-delivered liquid CO_2.

As current projects **predominantly target large emitters**, the development of CO_2 clusters is centred around pipeline-based infrastructure of fossil origin, either through direct capture from major point sources into pipelines, or via the reception of liquefied CO_2 transported by ship from coastal industrial sites, thereby excluding anaerobic digestion sources from current infrastructure planning and investment strategies.

Moreover, transport to CO_2 facilities may require either a truck or multimodal logistics involving both truck and ship, thereby adding further operational expenses. Converting liquid CO_2 to a pipeline-ready state (gaseous or dense-phase) also creates an energy penalty.

Lack of harmonised certification and traceability for biogenic CO_2 further undermines its market value in mixed systems. Moreover, limited integration of CO_2, biomethane and green/low-carbon hydrogen grids leads to inefficiencies and missed synergies. Without regulatory clarity and targeted de-risking, biomethane cannot compete fairly within the EU carbon market.

[63] CO_2 Next. (2025). *Terminal for liquid CO_2*. https://co2next.nl/

CHAPTER 5: MAPPING OF CURRENT AND FUTURE BIOMETHANE FACILITIES CAPTURING BIOCO₂

EBA conducted an extensive market data study on both current as well as future planned biogas-based biogenic CO_2 production sites. The data gathered focused on projects that are either operational, under construction, have received all necessary permits or have reached a Final Investment Decision (FID). Demonstration, pilot and non-commercial projects were not included in the analysis. The inventory covers facilities that came online between 2014 and 2025 and those with an anticipated starting date between 2025 and 2027.

Number of plants and capture capacity

The market data study shows the number of biomethane plants capturing biogenic CO_2 in Europe has increased eightfold over the past five years, from 15 plants capturing 0.16 million tonnes in 2020 to 125 plants capturing 1.17 million tonnes in 2025, **equivalent to around 14% of Europe's merchant liquid and solid CO_2 demand.** With confirmed and under-construction projects, capacity is expected to exceed 2 Mt annually by 2027, with 179 biomethane plants. Figure 15 tracks this evolution:

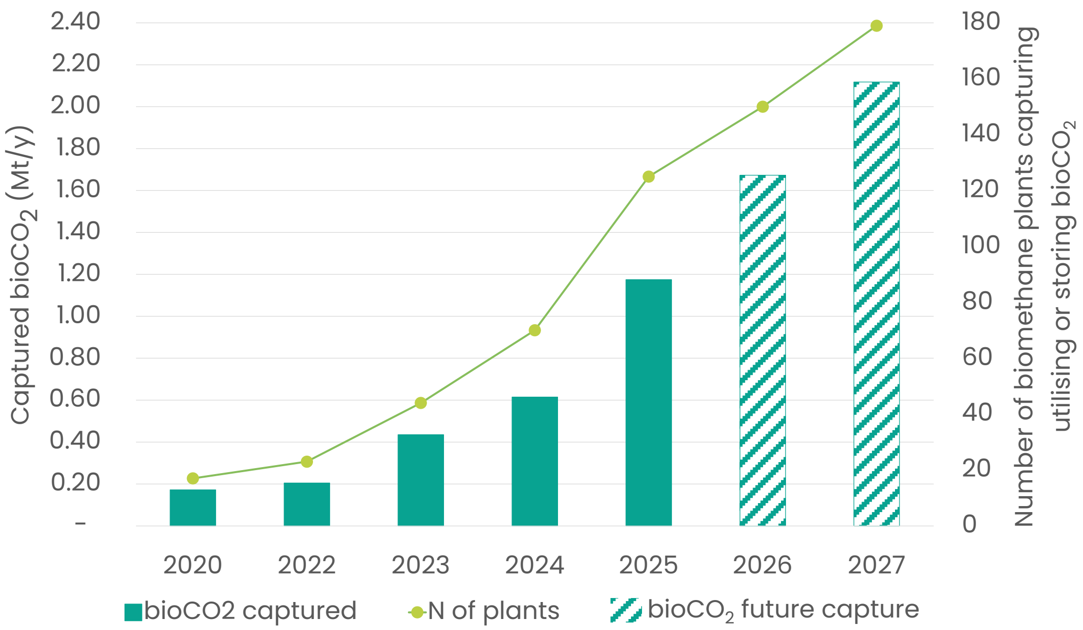

Figure 15 Historical and projected captured biogenic CO_2 per year and number of capturing biomethane plants

Biomethane production capacity varies significantly across Europe, with countries such as Denmark and Sweden typically operating larger-scale facilities, whereas others, including Finland, Switzerland and France, predominantly operate smaller-scale plants. By 2027, 31% of facilities are expected to have a capture capacity of less than 5,000 t CO_2/y, i.e. below the average biomethane plant size (483 Nm³/h) in Europe, with France leading the way in the number of smaller-scale facilities.

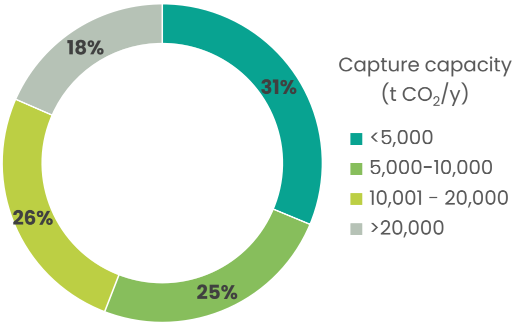

Figure 16 Size distribution of biomethane CO_2 capture capacity in Europe by 2027

In contrast, larger-scale capture facilities (>10,000 t CO_2/y) represent a combined share of 44%. This trend can be explained by economies of scale, which contribute to significant cost reductions, as discussed in Chapter 3.

Upgrading technology shares

Among the 125 plants currently capturing biogenic CO_2, 73% utilise membrane separation technology, followed by Pressure Swing Adsorption (11%), chemical absorption (2%), water scrubbing (2%) and cryogenic separation (less than 1%). The remaining 11% rely on technologies that have not been specified. Membrane separation is expected to remain the dominant upgrading technology to 2027, as illustrated in Figure 17:

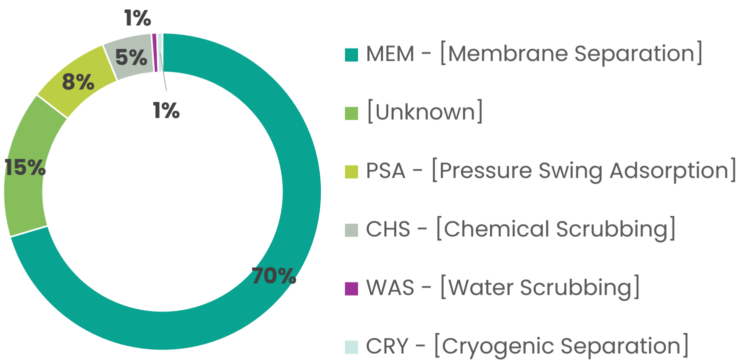

Figure 17 Separation technologies shares by 2027

Leading countries

As of today, the United Kingdom leads in the capture of biogenic carbon, accounting for 22% of the total currently captured volume. It is followed by Germany (15%), Denmark (14%), France (14%), the Netherlands (12%) and Italy (12%).

The UK will remain the largest capturer (23%) through to 2027, with Denmark rising to second place (19%), followed by Italy (15%), the Netherlands (10%), France (9%) and Germany (9%), as can be seen in Figure 18:

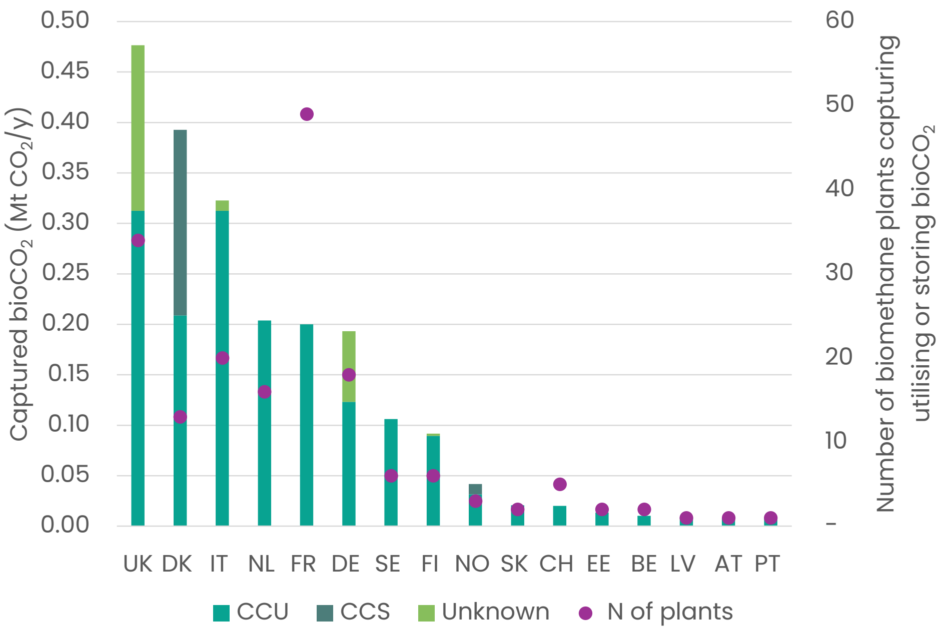

Figure 18 Captured bioCO₂ per country and number of plants expected in 2027

A more detailed analysis of the main potential drivers in the top six countries capturing bioCO_2 from biomethane can be found in the Annex *(A5: Drivers of Biogenic CO_2 Capture from Biomethane in Leading Countries by 2027).*

bioCCU or bioCCS?

BioCCU is, and is expected to remain, the primary business model for the biomethane industry in the coming years, centred on established liquid CO_2 markets, such as food and beverages, greenhouses and other conventional uses. These sectors rely on regional supply chains, whereby smaller volumes of CO_2 are transported mostly by truck over limited distances. Supply-demand imbalances, such as CO_2 surpluses in Northern Germany, underscore the need for improved logistics. Moreover, biogenic CO_2 originating from the biogas sector serves as a secure supply solution to the merchant CO_2 sector, which has been challenged by recent shortages. Emerging markets like e-fuels, chemicals and mineralisation will absorb additional volumes not needed in established regional markets.

As of today, 75% of the 1.16 Mt of captured bioCO_2 from biomethane is directed towards CCU applications. 2% is used for CCS, specifically in concrete mineralisation. For the remaining 25%, the final application is unknown. Among conventional CCU applications, greenhouses account for 32%, food and beverages 21%, e-fuels 10%, concrete mineralisation 2%, other applications 6%, chemicals 0.24% and the remainder is unknown, as illustrated in Figure 19:

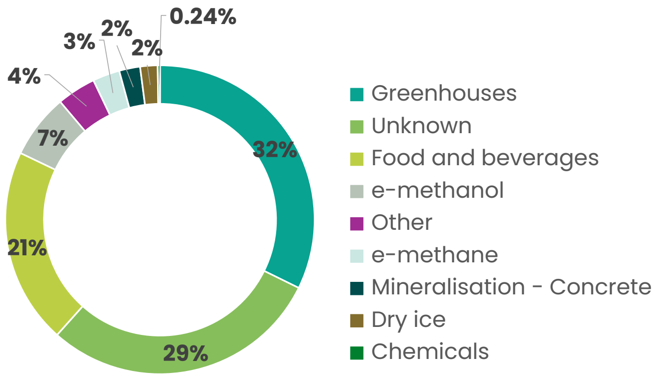

Figure 19 Share of biogenic CO_2 uses in 2025

The share of CCS is anticipated to increase to 9% by 2027, while CCU is expected to remain the dominant application at 79%, with the remainder being of unknown destination. The projected rise in CCS is mainly attributed to storage projects expected to become operational in Denmark by next year.

In cluster areas where the legislative framework, storage capacity and infrastructure are aligned, CCS may offer a viable solution for biomethane operators. However, in regions where these conditions are not met, local or regional CCU markets become essential.

By 2027, foods and beverages are projected to account for the largest share of CCU end-uses, at 31%, reflecting its current market dominance. They already account for around 63% of total demand for liquid and solid CO_2 in Europe. Greenhouse applications are expected to absorb 19% of captured bioCO_2, followed by offshore storage at 9%, e-fuels at 8%, mineralisation at 3%, other applications at 3%, while 26% of the use remains unspecified, as illustrated in Figure 20:

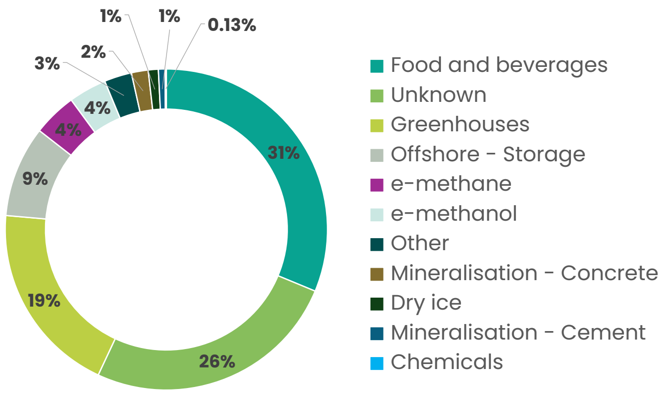

Figure 20 Share of biogenic CO_2 uses in 2027

The strong position of the food, beverage and greenhouse markets arises from their well-established infrastructure compared to CCS. No significant uptake of biogenic CO_2 utilisation in the e-fuels segment is expected over the next two years, as the initial scale-up of the e-fuels industry is anticipated only after 2028.[64] Based on the IEA database of CCUS[59] projects, growth of the CCU market from other sources is expected to reach only 3.6 Mt CO_2 by 2027, with nearly all projects directed towards e-fuels.

The future distribution of CCUS uses for the biogases sector will depend on a variety of factors, including plant location, infrastructure availability, e-fuels and green hydrogen developments, carbon credits integration into the ETS, bioCO_2 certification schemes, design of national support schemes in the biomethane market (specifically for bioCO_2 capture) and policy stability at both European and national levels. A combination of these factors will be decisive in unlocking the significant potential of biogenic CO_2 from biomethane, as well as shaping the distribution of CCUS end uses within the sector.

[64] Chirita, I. (14 November 2024). *Long-term outlook for e-fuels in Europe*. S&P Global. https://www.wko.at/oe/oegew/long-term-outlook-for-e-fuels-in-europe.pdf

POLICY RECOMMENDATIONS

EBA proposes the following policy actions to enable the scale-up of bioCCUS:

1. EBA recommends an **ambitious EU-wide target for biogenic carbon capture.**

As the capture of CO_2 emissions is the common starting point for all industrial carbon management pathways, EBA recommends that policy makers set an **ambitious EU-wide target for biogenic carbon capture** and explicitly prioritise utilisation and storage solutions[65] based on biogenic carbon over fossil carbon. Indeed, the EU must purposely avoid legitimising the continued use of fossil fuels by endorsing any offsetting solutions and, instead, consistently prioritise the promotion of renewable alternatives.

2. EBA urges policymakers to engage in discussions with our sector to define carbon capture targets and a concrete roadmap towards 2040 and 2050.

The sector's carbon capture capacity could play a pivotal role in meeting the Commission's carbon capture targets (as illustrated in Figure 8).

3. EBA calls on EU policy makers **to develop a comprehensive framework and adopt all measures that support the business case for biogenic carbon capture, utilisation and storage in the biogas and biomethane sector.**

To make this possible, EBA recommends the following measures:

- **Introduce a legal definition of biogenic carbon** – This would facilitate legal recognition and enable standardised certification.
- **Establish common criteria for biogenic carbon certification** - This is essential to differentiate it from fossil-based CO_2 and to ensure it qualifies as sustainable. **To reduce the administrative burden, compliance with these criteria should be certified within the context of existing certification frameworks for biogas and biomethane.**
- **Create a single market and infrastructure for biogenic carbon across the EU:**
    - **Introducing targeted financial support instruments**, such as support schemes, tax incentives or contracts for difference, to address the currently low market value of biogenic CO_2;

[65] Generally referred to as Carbon Capture and Utilisation (CCU) and Carbon Capture and Storage (CCS) or Carbon Dioxide Removals (CDR).

- **Streamlining CCUS permitting procedures** to reduce administrative burdens and accelerate deployment;
- **Developing an EU-wide traceability system** to track the origin of carbon within shared networks and ensure proper valorisation of renewable sources;
- **Supporting both carbon utilisation (CCU) and storage (CCS)** to enable flexible market development in line with infrastructure readiness;
- **Promoting regional CO_2 hubs** to aggregate volumes from decentralised producers and reduce transport costs;
- **Ensuring integrated planning and governance** of CO_2, biomethane and hydrogen infrastructure, avoiding siloed approaches and maximising synergies across sectors.

- **Establish a carbon credit system under the EU ETS** - ETS should be extended to incorporate carbon credits generated by carbon removal certificates while also rewarding the use of renewable captured carbon that replaces fossil CO_2 in industrial processes.
- **Set targets for minimum biogenic carbon content and leverage public procurement power** - To create and sustain demand for low-carbon products, minimum biogenic carbon-content targets should be mandated for sustainable products, for example under the Ecodesign for Sustainable Product Regulation (ESPR) and the Construction Products Regulation (CPR).
- **Remove existing barriers to the viability of the business case for biogenic carbon in the biogas sector** - Current legislation should be amended to eliminate barriers to the capture and use of biogenic carbon, in particular the unjustified time limit for claiming the "ECCR" emission-saving factor by the biogas sector[66]. The market should therefore be allowed the flexibility to determine where and how to claim this factor.
- **Ensure that investments in biogenic CO_2 capture, already recognised as Taxonomy-aligned for anaerobic digestion (including purification, liquefaction and compression), are also acknowledged for all anaerobic digestion types** and other biogases technologies, including gasification and biohydrogen plants.

[66] As mandated by Annex VI, part B, point 15 of RED.

ANNEX

A1: Quality Requirements

Meeting the required quality standards does not represent a technological constraint for the biomethane sector, as the typical CO_2 capture process can cost-effectively comply with the most stringent specifications due to the highly CO_2 concentrated stream and the maturity and widely commercially available solutions for capturing carbon dioxide during the upgrading process.

Food-grade quality represents the most rigorous standard in the direct use of CO_2 in Europe and also accounts for the largest share of the conventional CO_2 market, particularly in the food and beverage sector. The coexistence of food-grade and non-food-grade applications can complicate logistics for transport operators, considering that **for other CCU applications**, there are no specific standards or general accepted specifications. Therefore, the required quality depends on a specific customer or an industrial gas supplier.

As a result, merchant biogenic CO_2-producing facilities based on biogas opt to meet food-grade specifications by default. This approach simplifies operations, ensures compatibility with all end uses and avoids the risk of exclusion from higher-quality markets, since complying with the strictest requirements also covers less demanding applications without limiting flexibility for suppliers.

Food and beverage use

Food quality involves both regulatory and contractual dimensions. From a regulatory perspective, compliance with EU standards, such as Regulation 1333/2008 (CO_2 as E290) and the specifications of Regulation 231/2012, is mandatory.

On the contractual side, clients increasingly expect a certified food quality management system, even if not legally required. This often includes CO_2 quality conforming to the EIGA Doc 70/17[67] or ISBT[68] standards and, in some cases, reference to FSSC 22000, one of the most established food safety systems. Thus, meeting these expectations may require investment in high-cost analytical equipment, as the standard mandates certification that very low ppm concentrations are achieved for certain contaminants.

Storage

There are no harmonised European standards that regulate the required quality of CCS transportation and storage. Projects have developed their own quality requirements, as impurities can lead to corrosion, affect phase boundaries and cause the formation of solid deposits, all of which can compromise the safety and efficiency of transport and storage

[67] European Industrial Gases Association AISB. (2016). *Carbon dioxide food and beverages grade, source qualification, quality standards and verification* (EIGA Doc 70/17, revision of Doc 70/08). https://www.eiga.eu/uploads/documents/DOC070.pdf

[68] International Society of Beverage Technologists (ISBT). (October 2021). *Bulk carbon dioxide: Quality & food safety guidelines and analytical methods and techniques reference* (BVG-00001). https://www.isbt.com/resources/guidelines-best-practices-and-white-papers#BeverageGases

operations[69]. Last year the European Committee for Standardization (CEN) launched a European Technical Committee (CEN/TC 474) to develop European Standards across the CCUS value chain[70].

Impurities can interact with CO_2 and are therefore classified into different categories[71]:

- **Reactive impurities**: these undergo chemical reactions, forming new compounds such as acids, solids or salts through acid–base reactions.
- **Non-reactive impurities**: these can contribute to the formation of an aqueous phase once their solubility in CO_2 is exceeded.
- **Impurities linked to cracking**: these are believed to promote cracking when concentrations surpass a specific threshold.
- **Reaction products**: compounds that result from interactions between CO_2 and impurities.

Table A1 presents a summary of the main quality requirements established by EU CCS projects:

Table A1 Overview of published CO_2 specifications for European projects (all concentrations are given in ppm-mol unless specified otherwise)[72]

Compound	Porthos	Fluxys Gas	TES OGE	Aramis pipeline	Aramis ship	Northern Lights[73]
Year	**2021**	**2022**	**2022**	**2023**	**2023**	**2025**
CO_2	**≥95%**	**>95%**	**>98%**	**>95**	**Balance**	**99.81**
H_2O	≤70	<40	<30	<70	<30	≤ 30
H_2S	≤ 5	5	<10	<5	<5	≤1
CO	≤ 750	<750	<100	<1200	<750	≤100
O_2	≤ 40	<40	<30	<40	<10	≤10
SO_x		<10	<1	-	<10	≤10
Sulphur comp	≤20	<20	<30	<20	-	
NOx	≤ 5	<5	<1	<2.5	<1.5	≤1.5

[69] Drescher, M., van der Meer, R., & Neele, F. (February 2025). *Report of the ICM Forum Working Group on CO_2 Standards: Towards EU-wide CO_2 specifications*. ICM Forum Working Group on CO_2 Standards.

[70] European Committee for Standardization & European Committee for Electrotechnical Standardization. (20 February 2024). *The launch of European standardization on carbon capture, utilization and storage (CCUS)* [Brief news]. CEN-CENELEC. https://www.cencenelec.eu/news-events/news/2024/brief-news/2023-02-20-ccus/

[71] JIP (Joint Industry Project). (July 2024). *Industry guidelines for setting the CO_2 specification in CCUS chains: Work Package 2 – Reaction chemistry* (522240-WP2-REP-001 Rev 2). https://www.woodplc.com/insights/reports/Industry-Guidelines-for-Setting-the-CO2-Specification-in-CCUS-Chains

[72] JIP (Joint Industry Project). (September 2024). *Industry guidelines for setting the CO_2 specification in CCUS chains: Work Package WP10 – Geological storage* (522240-WP10-REP-001 Rev 3). https://www.woodplc.com/insights/reports/Industry-Guidelines-for-Setting-the-CO2-Specification-in-CCUS-Chains

[73] Northern Lights JV DA. (2025). *How to store CO_2 with Northern Lights*. https://norlights.com/how-to-store-co2-with-northern-lights/

As already mentioned, biomethane plants produce biogenic CO_2 streams in compliance with food-grade standards, which are more stringent than the specifications required for CCS. Consequently, all biomethane facilities can inherently deliver CO_2 of a quality that fully qualifies for CCS applications.

A2: TRL of Conversion and Utilisation Pathways

Table A2 summarises the Technological Readiness Level (TRL) of selected mature and emerging conversion and utilisation pathways.

Table A2 TRL of selected emerging and mature CO_2 conversion and utilisation pathways [74,75]

	Technology	TRL
CO_2-to chemicals	Urea	9
	Formic Acid	5-6
	Polyethylene	7
	Dimethyl carbonate[76]	7-9
e-fuels	Methanol production	7-9
	Synthetic liquid hydrocarbons	5-7
	e-methane production (methanation)	8-9
Building materials	Injecting CO_2 into concrete mix	8-9
	CO_2 uptake in concrete curing chambers	8-9
	CO_2 carbonation for mineral waste recycling	8-9
Algae	CO_2 conversion by microalgae	7-8
	Microalgae cultivation	4-6

[74] Biomethane Industrial Partnership (9 April 2024). *Biogenic CO_2: The role of the biomethane industry in satisfying a growing demand* (Task Force 4.1)

[75] Turakulov, Z., Kamolov, A., Norkobilov, A., Variny, M., Díaz-Sainz, G., Gómez-Coma, L., & Fallanza, M. (2024). Assessing various CO_2 utilization technologies: a brief comparative review. *Journal of Chemical Technology & Biotechnology*, *99*(6), 1291-1307.

[76] Raza, A., Shah, A., & de Marco, I. (2022). *Review of carbon dioxide utilization technologies and their potential. Progress in Energy and Combustion Science*. https://doi.org/10.1016/j.pecs.2022.100XXX

A3: National Support Schemes for bioCO_2

Table A3 Overview of specific CO_2 support schemes applicable to the biomethane sector

Country	Name of policy	Type of support	Capture support (€/t CO_2)	Length (years)	Remarks
Netherlands	SDE++ CCU Greenhouses[77]	Carbon capture feed-in premium	80.20 - 121.15	15	• Tariffs only available when CO_2 supplied to greenhouses. • Support limited to 4,000 full-load h/year to prevent the application of *'summer heating'*.[78] • Expected to support a limited number of initial bioCO_2 CCU projects. • Impact is unlikely to drive widespread adoption across the industry.
Netherlands	SDE++ CCS pre-combustion	Carbon capture feed-in premium	139.71 - 273.42	15	• Base tariff calculations rely on CO_2 emissions from fossil-based SMR, not on AD.[79] • Not expected to significantly impact the industry.
Denmark	NECCS	NECCS tender	126-338	8	• Three biomethane projects will collectively capture and store 160,350 tonnes of CO_2 annually from 2026 until the end of the contract period in 2032[80].
Denmark	CCS tender (fossil and bio-CO_2)	CCS tender	N/A	15	• High capture thresholds and competition with fossil-based projects. • Not expected to significantly impact the industry.
Sweden	bioCCS tender	bioCCS tender	N/A	15	• Targets large-scale facilities (e.g. incinerators or biomass combustion plants). • Only one contract was awarded (direct biomass combustion plant).[81]

[77] SDE++ proposed base tariffs per technology pbl-2025-Onrendabele-top-model-eindadvies-SDE-2025-5473.xlsx
[78] Summer heating entitles burning natural gas in the summer only to produce CO_2.
[79] Lensink, S., & Eggink, E. (Eds.). (21 February 2025). *Eindadvies basisbedragen SDE++ 2025* (PBL-publicatienummer: 5472). PBL Planbureau voor de Leefomgeving. https://www.pbl.nl/publicaties/eindadvies-basisbedragen-sde-2025
[80] Danish Energy Agency, (17 April 2024). *Three new CCS projects are awarded funding to capture and store CO_2*. https://ens.dk/presse/tre-nye-ccs-projekter-faar-tilsagn-om-stoette-til-fange-og-lagre-co2.
[81] Swedish Energy Agency. (14 February 2025). *SEK 20 billion to capture and store over 11 million tons of biogenic carbon dioxide*. https://www.energimyndigheten.se/en/news/2025/20-billion-to-capture-and-store-over-11-million-tons-of-biogenic-carbon-dioxide/

A4: Future CO_2 infrastructure by 2050 modelled by JRC

JRC scenario D2 on how CO2 infrastructure may develop.

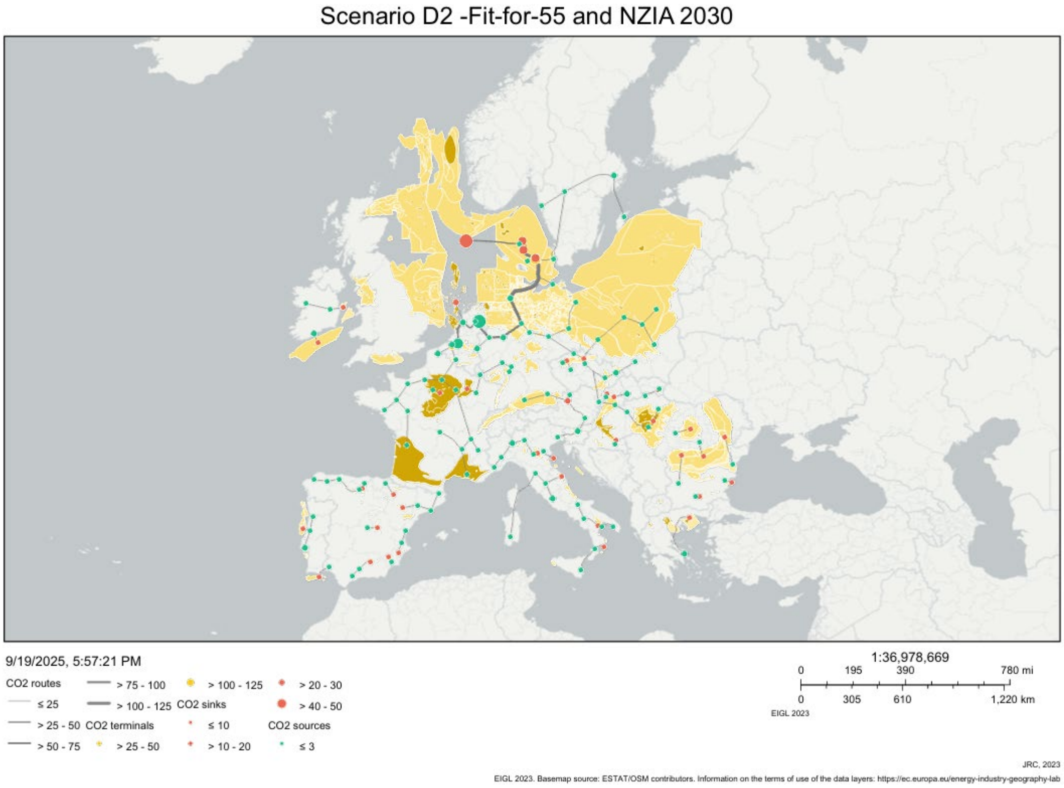

Figure A1 JRC projected CO_2 infrastructure by 2050 based on scenario D2 – Fit-for-55 and NZIA 2030

A5: Drivers of Biogenic CO_2 Capture from Biomethane in Leading Countries by 2027

The **United Kingdom** is leading the race in captured carbon from biomethane for several reasons, one of which relates to the fragile traditional CO_2 market in the country, as unfavourable economic changes disrupted previously dominant CO_2 producers.[82,83,84,85] As a result, the UK has experienced CO_2 shortages during summer periods[86], exposing the vulnerability of its existing market. Those factors drove the emergence of CO_2 capture from biomethane, providing a secure and stable source of CO_2 and creating a market for biogas

[82] Food and Drink Federation. (2018). *Falling flat: Lessons from the 2018 UK CO_2 shortage.* https://www.fdf.org.uk/fdf/resources/publications/reports/falling-flat-lessons-from-the-2018-uk-co2-shortage/

[83] CF Fertilisers UK Limited. (July 2023). *Proposal to permanently close the ammonia plant at the Billingham Complex*. CF Industries. https://www.cfindustries.com/newsroom/2023/billingham-ammonia-plant

[84] CF Fertilisers UK Limited. (8 June 2022). *CF Fertilisers UK announces proposals to restructure operations to enable continued supply of fertiliser, carbon dioxide and other industrial products to customers in the UK.* Business Wire. https://www.cfindustries.com/newsroom/2022/ukrestructuringproposals

[85] Biofuels International / Woodcote Media Ltd. (18 June 2025). *Bioethanol plant faces closure amid tariff changes, operator warns.* https://www.biofuels-news.com/news/bioethanol-plant-faces-closure-amid-tariff-changes-operator-warns/

[86] Environment, Food and Rural Affairs Committee. (2023, 28 July). *Food Security* (Seventh Report of Session 2022–23). House of Commons, UK Parliament. https://publications.parliament.uk/pa/cm5803/cmselect/cmenvfru/622/report.html

operators. In addition, sustainability requirements have also played a role in incentivising further bioCO_2 capture.

The surge in **Denmark** for biogenic CO_2 is due to the combination of e-fuel plants coming into operation (driving the demand for bioCO_2) and capture projects that were supported by the Danish government's Negative Emissions Carbon Capture and Storage (NECCS) fund, which allocated DKK 2.5 billion (€325 million) to achieve an additional 0.5 million tonnes of negative emissions annually from 2025 onwards through CO_2 capture[87]. Only one tender procedure was launched, in which contracts were awarded exclusively to biomethane producers[88]. The investment required for these projects could not be met through tender revenues alone, but was made viable in combination with revenue from biogenic carbon dioxide removal (CDR) credits. The Danish NECCS tender serves as a concrete example of how targeted support measures can incentivise the capture and storage of biogenic CO_2.

In **Italy**, the Biomethane Decree[89] can be considered one of the drivers of biogenic CO_2 expansion from biomethane, as the Decree provides CAPEX support equivalent to a maximum of 40% of the investment incurred, which also covers equipment for biomethane and CO_2 liquefaction plants and that for the related storage of bioLNG and bioCO_2.

Through the SDE++ scheme incentives for CCUS technologies, **the Netherlands** has granted support to some projects. However, the CCU incentive is limited to 4,000 operating hours and restricted to selling the CO_2 to greenhouses, while the CCS incentive is designed for large-scale emitters. For these reasons, under current conditions, the scheme on its own will not be enough to ensure widespread project development. First movers seeking sustainable bioCO_2 sources have also stimulated demand.

Moreover, the reduction obligation for transport, which from next year will be based on GHG emissions savings[90], together with the renewable gas blending obligation entering into force in 2027, could represent additional drivers for the development of biomethane projects that capture bioCO_2. Finally, with the entry into operation of large CCS projects such as Porthos and Aremis, new business opportunities may arise for biomethane operators with negative carbon certifications

Although **France** is expected to have the highest number of plants capturing bioCO_2, their individual capacities are smaller, with **French** biomethane plants typically being below the European average size, at around 251 Nm^3/h. This may pose additional challenges for operators with regards to competitiveness. However, there are currently 380 sites with a

[87] Danish Energy Agency. (2024). *CCS tenders and other support for the development of CCS.* https://ens.dk/forsyning-og-forbrug/ccs-fangst-og-lagring-af-co2/ccs-udbud-og-anden-stoette-til-udvikling-af-ccs

[88] Danish Energy Agency. (17 April 2024). *Three new CCS projects are awarded funding to capture and store CO_2.* https://ens.dk/presse/tre-nye-ccs-projekter-faar-tilsagn-om-stoette-til-fange-og-lagre-co2.

[89] Gestore dei Servizi Energetici (GSE). (2022). *Produzione di biometano - DM 15/9/2022.* https://www.gse.it/servizi-per-te/attuazione-misure-pnrr/produzione-di-biometano

[90] Ministerie van Infrastructuur en Waterstaat. (19 January 2023). *Kamerbrief over start implementatie RED III voor vervoer* [Parliamentary letter]. Rijksoverheid. https://www.rijksoverheid.nl/documenten/kamerstukken/2023/01/19/start-implementatie-red-iii-voor-vervoer

capacity greater than 15 GWh/year that could potentially liquefy their bioCO_2 under a satisfactory economic model.

As the French CO_2 market is dominated by the food and beverage sector, sourcing biogenic CO_2 from anaerobic digestion (AD) plants with mixed feedstocks can sometimes present a barrier to market entry due to customer requirements, including religious and food-related considerations. This is particularly relevant given that most AD plants in France are agriculturally based, typically utilising a combination of manure, crop residues and occasionally biowaste from households or industry.

Moreover, the Biomethane Production Certificates (BPCs) quota system, which is set to begin operating next year, will support larger installations exceeding 25 GWh/year. Although the scheme is not specifically designed to incentivise biogenic CO_2 recovery, it may open up an opportunity for these higher-capacity facilities to benefit from economies of scale.

Despite **Germany** being the leading biomethane producer in Europe, growth in capture from biomethane is not anticipated to be significant in the next two years, with the country dropping from the second-highest capturer in 2025 to the sixth-highest by 2027. In certain regions, large industrial sites with a considerable surplus of low-cost fossil CO_2 are available. However, the **lack of a premium price for biogenic CO_2** compared to fossil CO_2 may hinder investment and project development. Added to this is the presence of substantial bioethanol production, which also offers CO_2 at a low cost. As a result, intense competition and market saturation make it difficult for biomethane producers to secure favourable prices. However, in some other regions of the country, CO_2 may be in short supply due to the lack of nearby regional sources. Lastly, the value of GHG quota certificates for biomethane has declined[91], driven by fraudulent Chinese imports that have dampened the market and also affected the bankability of future projects.

[91] Bensmann, M. (2025). *Biomethan-Einspeisung: Kleines Wachstum – 21 neue Anlagen in 2024.* BIOGAS Journal, 4, Fachverband Biogas e.V.

About the European Biogas Association (EBA)

EBA fully believes in the future potential of renewable gas in Europe. Founded in 2009, the association is committed to the deployment of sustainable biogas and biomethane production and use throughout the continent. Today, EBA counts on a well-established network of over 350 national associations and other organisations covering the whole biogas and biomethane value chain across Europe and beyond.

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