

Mapping and categorization of different bio-CO₂ sectors

The M²ARE project is developing a **low-cost, low-carbon methanol** fuel for the shipping industry, synthesized from **biogenic CO₂** and **renewable H₂**. This fuel is essential for achieving a reduction in maritime CO₂ emissions. A foundational step in scaling this technology is securing a reliable, sustainable carbon feedstock. This factsheet presents the findings of the M²ARE project on the **categorization and mapping of available bio-CO₂ streams** across Europe. It assesses the quality and quantity of CO₂ from various biomass sources—such as biogas, bioethanol, and pulp & paper—to qualify them as feedstocks for the next-generation Maritime Methanol process.

Different factors related to bio-CO₂ streams



Bio-CO₂ emissions points in the plant

The precise location of emissions can **vary significantly** within different processing plants.



CO₂ concentration

The concentration of in the biogenic stream is **heavily dependent** on the **composition** of the feedstock used.



Seasonality

The majority of feedstocks are subject to **seasonal availability**, leading to **fluctuations** in their supply throughout the year.



Current uses of the bio-CO₂ stream

The bio-CO₂ can either be **stored**, already be **used**, or **released** into the atmosphere.



Geographic distribution

The bio-CO₂ stream may be **geographically scattered** across various locations complicating the Maritime Methanol value chain



Impurities and other compounds

The bio-CO₂ streams often contain **various impurities** and other compounds that may **require removal** to **avoid damage** to the methanol synthesis catalyst.



Total bio-CO₂ sector emissions

This is an important indicator for determining which sector is **most promising** to provide the carbon feedstock to the methanol synthesis

Investigated CO₂ sources

Biomass combustion

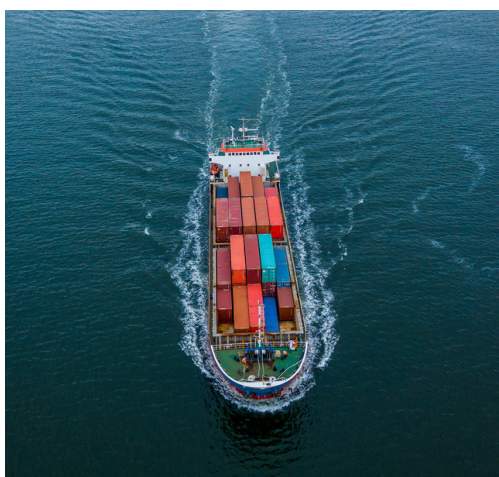
Biomass power plants create **electricity by burning various materials** like wood and farm waste. The biogenic CO₂ is captured from the exhaust gas, where it is a small to moderate part of the mix. **Operations can change depending on the season**, as the availability and price of fuel fluctuate, or if the plant also provides heat, which is needed more in the winter. **These plants vary greatly in size**, from small to very large polluters, and the total estimated CO₂ emissions in the EU are substantial.

Pulp and paper

Making pulp, primarily with the Kraft method, creates **large, concentrated sources of emissions**, and the biggest CO₂ source is the recovery boiler, where CO₂ makes up a noticeable fraction of the off-gas, while the lime kiln releases an even greater concentration of CO₂, coming from both fossil and biogenic sources. Unlike biomass, the **seasons don't significantly impact** how these plants operate but pulp and paper factories are considered large CO₂ polluters: the total biogenic CO₂ emissions for this EU sector were very high in 2022.

Biogas

Biogas is produced through a natural process called **anaerobic digestion** and is a mixture of methane and a large portion of CO₂. After the gas is "upgraded" to methane, the **CO₂ is mostly released into the air** without being used. Seasonality has little effect on this operation and although there are many biogas plants across Europe, each one releases a small amount of CO₂. The total biogenic CO₂ released across Europe is moderate.



Bioethanol

Bioethanol is made through **fermentation**, and the resulting biogenic CO₂ is very pure, making it easy to capture and reuse. Because it is so pure, this CO₂ stream is often **used again** within the same facility or **sold** to other food and beverage companies. Furthermore, bioethanol plants are **spread out geographically**, and each plant has small emissions. Total biogenic CO₂ emissions were low in 2023.

Food and Beverage

Fermentation processes, like those used to make wine and beer, create very pure biogenic CO₂ and like the bioethanol sector, this pure CO₂ is **often reused** within the company or **sold**. Wine fermentation is **heavily impacted by the seasonal harvest** of grapes, and this sector accounts for a relatively small part of the total biogenic CO₂ emissions in the EU. Total biogenic CO₂ emissions were quite low in 2023.

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The information contained in this factsheet is part of the results obtained in the context of the M²ARE project. Further information can be found in the full paper available at this [link](#).



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