Mapping available EU bio-CO_2 sources as feedstock for methanol synthesis

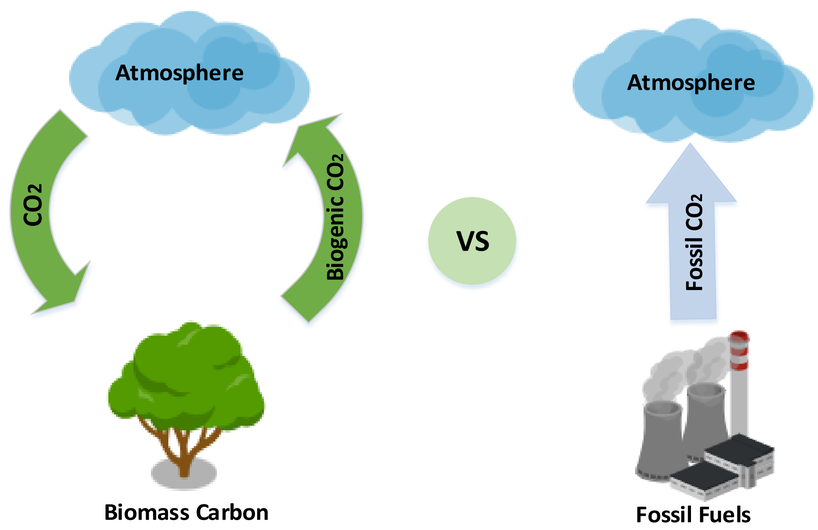
M. Bampaou[1], P. Stratigousis[1], H.Schloesser[2], S. Haag[2], K.D. Panopoulos[1]

[1]Centre for Research and Technology Hellas, 57001 Thessaloniki, Greece

[2]Air Liquide Forschung und Entwicklung, 60388 Frankfurt am Main, Germany

Introduction

- **The shipping industry** contributes around **3% of the world's CO_2 emissions**. In 2018, the IMO approved an initial plan to reduce GHG emissions at least 50% by 2050 compared to 2008.
- The European Union's Emissions Trading System obligates ships using carbon-based fuels to acquire carbon credits to offset emissions generated during voyages to and from EU ports.
- **Biogenic CO_2** emissions refer to those naturally occurring within the carbon cycle or arising from processes like combustion, fermentation, or digestion of organic materials.
- **The M²ARE project** is investigating the incorporation of **bio-CO_2** resources in conjunction with **renewable hydrogen** to produce **methanol** tailored for **maritime applications**.

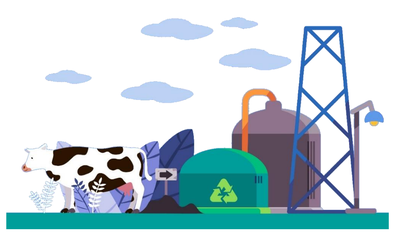


Methodology

To categorize and map the different bio-CO_2 sources, different aspects related to each source must be considered. The categorization is based on the aspects that are directly linked to the suitability of those streams for MeOH synthesis. These criteria are:

- **Total EU bio-CO_2 emissions** of each sector
- **CO_2 concentration (%)** in the bio-CO_2 stream in each sector
- **Seasonality** of the sector
- Bio-CO_2 **emissions points** in the plant
- **Potential impurities** that could harm the catalyst
- **Other compounds** included in the stream
- **Current uses** of the bio-CO_2 stream
- **Geographic distribution** of the plants

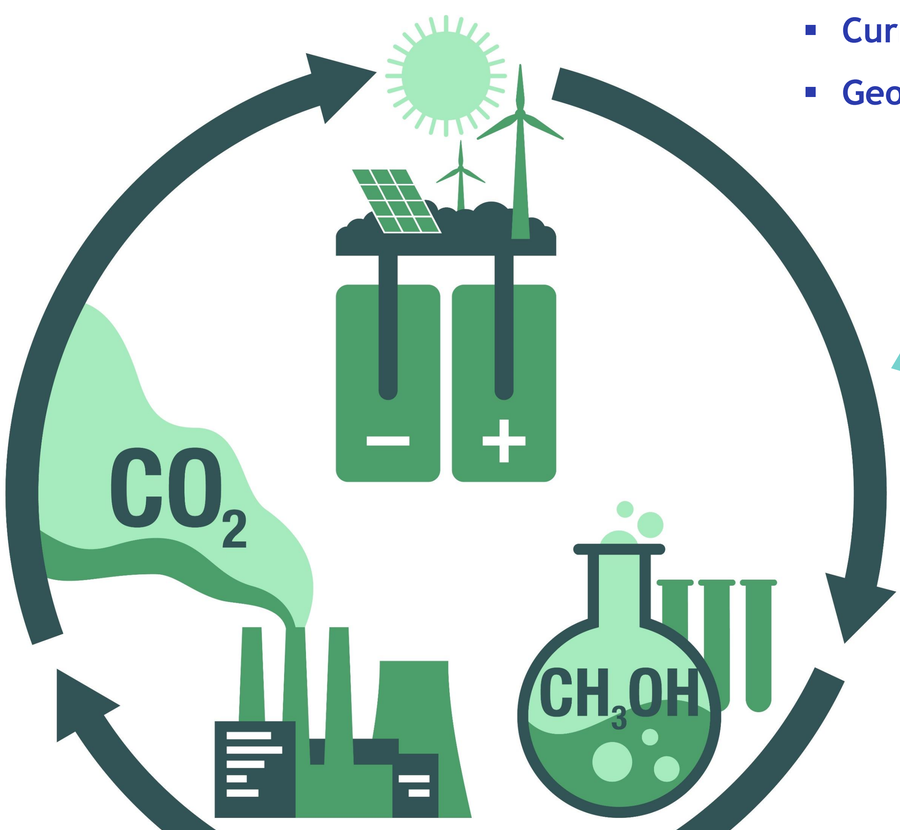
Biogas Plants



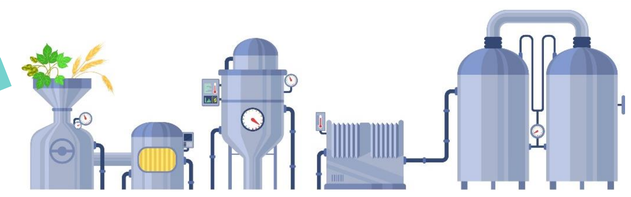
- **24** Mt bio-CO_2/year
- **25-50%** CO_2 purity
- **0.001-0.006** Mt CO_2 emissions/plant
- N_2, O_2, H_2, H_2O, CO, NH_3, H_2S, HCN, HF, HCl, BTX, Halogens, Terpenes, Siloxanes

Biomass Power Plants

- **225.5-313.3** Mt bio-CO_2/year
- **3-12%** CO_2 purity
- **0.36** Mt CO_2 emissions/plant
- $PM_{2.5,10}$, Dust, NO_2, NO, CO, H_2S, HCHO, HCl, NH_3, SO_2, Aromatic compounds, Heavy metals



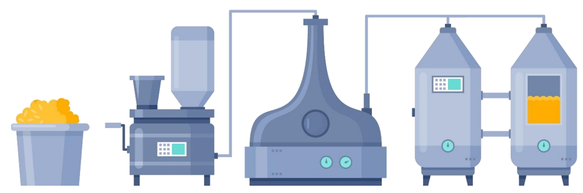
Bioethanol Plants



- **4.3** Mt bio-CO_2/year
- **99-100%** CO_2 purity
- **0.06** Mt CO_2 emissions/plant
- Alcohols, Acids, Esters, Acetaldehyde, H_2S

Food & Beverage Plants

- **2.8** Mt bio-CO_2/year
- **99-100%** CO_2 purity
- **0.0004** Mt CO_2 emissions/plant
- Alcohols, Acids, Esters, Acetaldehyde, H_2S



Pulp & Paper Plants

- **92** Mt bio-CO_2/year
- **10-20%** CO_2 purity
- **0.68** Mt CO_2 emissions/plant
- SO_2, NO_2, NO, CO, H_2S, TRS, Dust

Key Points

- **Contained impurities** due to different feedstocks and processes demand **gas cleaning before MeOH synthesis.**
- Biomass feedstocks are **affected by seasonality** such as for FAB **industries** and/or **biomass combustion** coupled with district heating.
- **All sectors** exhibit **large geographical distribution and different emissions per plant** (economies of scale).
- **Cost** for CO_2 **capture**, **storage** and **transportation** must be considered.

Next Steps

- Analysis and sampling of bio-CO_2 in industrial sites.
- Analysis of the complete methanol synthesis **value chain.**

Main Contact

Dr. Michael Bampaou
bampaou@certh.gr

CERTH
CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

Acknowledgements

This project has received funding from the European Union's Horizon Europe Research and Innovation Programme under Grant Agreement number 101136080.