Inventory database for biogenic gases production and Carbon Capture, Utilization and Storage (CCUS) technologies applied in the biofuel sector in Europe

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Introduction

The biofuels and bioenergy market in Europe is growing rapidly to reduce greenhouse gas emissions, increase energy security and promote sustainable alternatives to traditional fossil fuels. Although biogenic gases are part of the fast domain of the carbon cycle, they increase greenhouse gas emissions globally. To achieve a circular economy in Europe, it is crucial to track biogenic emissions and create an inventory database for biogenic gas production and Carbon Capture, Utilization and Storage (CCUS) technologies applied in the biofuel and bioenergy sector. This database aims to identify and map biogenic CO_2 production and its CCUS applications by geographical distribution, focusing on operational bio-based plants in the EU, mainly biogas, biomethane, bio-syngas, bio-ethanol, biomass thermoconversion (pyrolysis, gasification and combustion) and biochar production.

Methodology

Identification of plants

- Name, address, company, country, website, end-users, end-product, annual production, production process, feedstock type, annual feedstock, etc.

Are the emissions reported?

- Annual GHG emissions and the annual biogenic GHG emissions
- Calculate if not reported

Are the emissions captured?

- Annual captured emissions, capture technology process, impurities in biogenic gases

Biomass gasification for syngas production

1. $Energy(MJ) = \mathbf{Power(MW)} \cdot Time(s)$
2. $V_{syngas}\,(Nm^3) = \frac{Energy\,(MJ)}{NCV\left(\frac{MJ}{Nm^3}\right)}$
3. $M_C\,(tons) = \frac{P}{R \cdot T} \cdot V_{syngas} \cdot (\%CO + \%CO_2 + \%CH_4) \cdot MW_C \cdot 10^{-6}$
4. $M_{CO_2}(tons) = M_C \cdot \frac{MW_{CO_2}}{MW_C}$

NCV: Net Calorific Value

Biomass combustion for renewable electricity and heat generation

1. $Energy(MJ) = \mathbf{Power(MW)} \cdot Time(s)$
2. $M_{biomass}(tons) = \frac{Energy_{biomass}(MJ) \cdot 10^{-3}}{NCV\left(\frac{MJ}{kg_{biomass}}\right)}$
3. $M_C(tons) = M_{biomass}(tons) \cdot \%C_{biomass}$
4. $M_{CO_2}(tons) = M_C(tons) \cdot \frac{MW_{CO_2}}{MW_C}$

Biomass fermentation for bioethanol production

1. $C_6H_{12}O_6 \xrightarrow{yeast} 2\,C_2H_5OH + 2\,CO_2$
2. $M_{EtOH}(tons) = \rho_{EtOH}\left(\frac{tons}{m^3}\right) \cdot \mathbf{M_{EtOH}}(Nm^3)$
3. $M_{CO_2}(tons) = \frac{MW_{CO_2}}{MW_{EtOH}} \cdot M_{EtOH}(tons)$

Anaerobic digestion for biogas and/or biomethane production

1. $Q_{biogas}(Nm^3) = \frac{\mathbf{E_{input}}\,(kWh)}{HHV_{biogas}\,(kWh/m^3)}$ or $\frac{\mathbf{E_{output}}\,(kWh)}{LHV_{biogas}\,(kWh/m^3) \cdot \eta\,(\%)}$
2. $Q_{CO_2}(Nm^3) = V_{CO_2}(\%v/v) \cdot Q_{biogas}(Nm^3)$
3. $M_{CO_2}\,(tons) = \frac{P \cdot Q_{CO_2}}{R \cdot T} \cdot MW_{CO_2} \cdot 10^{-6}$

η: efficiency to convert biogas to electricity
E_{input}: energy input of the CHP plant
E_{output}: electricity produced by the CHP plant
HHV: high heating value
LHV: low heating value

Biomass pyrolysis for biochar production

1. $C_{yield\,biogenic\,gas} = \frac{Mass\ C_{biogenic\,gas}}{\mathbf{Mass\ C_{biomass}}}$
2. $M_C(tons) = C_{yield\,biogenic\,gas} \cdot M_{biomass}(tons) \cdot \%C_{biomass}$
3. $M_{CO_2}(tons) = M_C(tons) \cdot \frac{MW_{CO_2}}{MW_C}$

Results

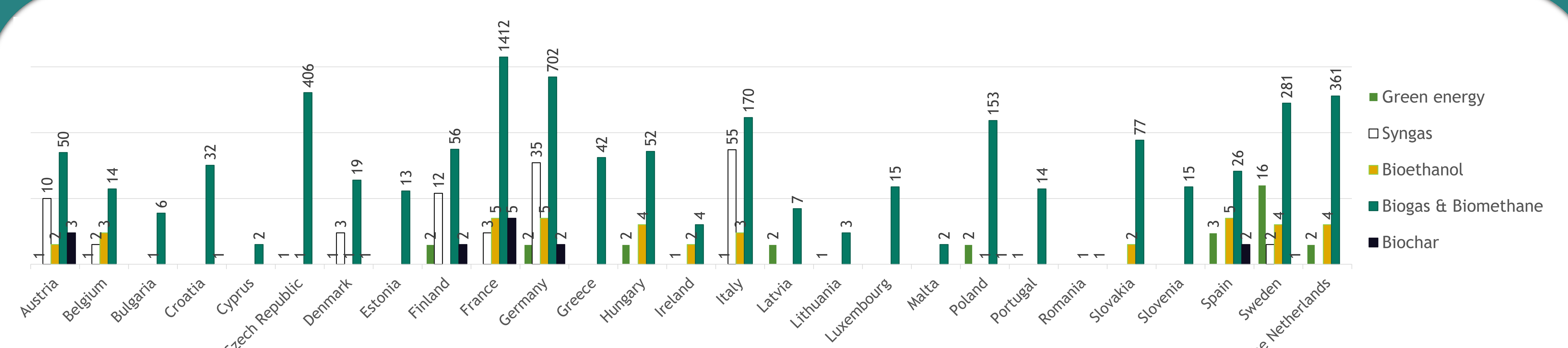

Figure 1: Number of identified plants per biofuel sector and per country

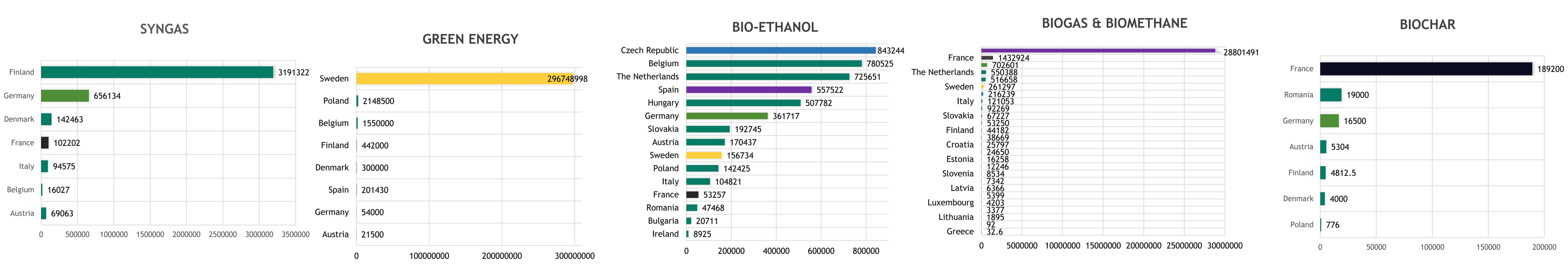

Figure 2: Biogenic CO_2 emissions (tn/y) per biofuel sector and per country

Conclusions

The operational biofuel plants identified include 3,934 production plants of biogas & biomethane, 123 of bio-syngas, 44 of bio-ethanol, 39 large operational production plants of green energy and 19 production plants of biochar. However, in many of the plants, the information available is scarce or incomplete, making it difficult to complete all the information fields. Among those plants, only 26 implement CCUS technologies.

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https://cronushorizon.eu/material/

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CRONUS
Capture and Reuse Of biogenic gases for Negative-emission - sustainable biofUelS