REUSE Project

CCUS (carbon capture, utilisation and storage) and requirements in former eastern EU countries

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Reuse

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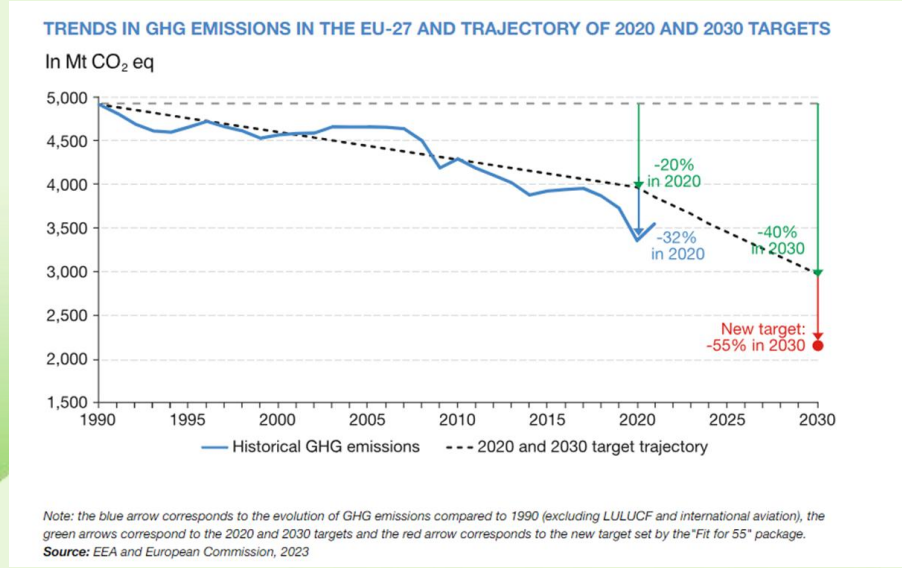
1. EU overall basis for CCUS (1/2)

- Reduction of EU's net greenhouse gas emissions at least 55% by 2030 (from the current ~ 40%, compared to 1990 levels) under **European Climate Law[1] as part** of **European Green Deal**
- **Climate neutrality by 2050** legally binding ("EU roadmap for climate neutrality") as main target
  - ➢ Corresponds to **3.204 Mt CO2 equi.** (GHG) / ~ **2.582Mt CO2[2]** overall reduction potential (from 2023 until 2050 "net zero emissions")

1990 Basis		2023		2030		2050	
Mt CO2 eq	reduction share	Mt CO2 eq	reduction share	Mt CO2 eq	reduction share	Mt CO2 eq	reduction share "Net zero emissions"
5.000	0%	3.204	36%	2.250	55%	0	100%



[1]Regulation (EU) 2021/1119
[2]share of 80,6% CO2 in GHG emissions

1. EU overall basis for CCUS (2/2)

- **Estimated** outlook of **realistic potential for CCUS technologies** until **2050**

"Remaining CO2 saving potential, which cannot be reduced by i.e. modernisation, adaption (change to electricity…)"

- CO2 storage CCS
  - EU 27 ~ 147 Mt CO2
  - Former eastern EU ~ 36 Mt CO2
- CO2 utilisation/conversion **CCU**
  - **EU 27:**
    ~ 173 Mt CO2, 1.730 plants*
  - **Former eastern EU countries:**
    ~ 43 Mt CO2, 429 plants*

Item	Value	Unit
1. Overall CO2 reduction potential		
EU 27 countries	3.204	Mt CO2 equi.
	2.582	Mt CO2
former 10 eastern EU countries	794	Mt CO2 equi.
	640	Mt CO2
2. Estimated overall CCUS potential		
EU 27 countries	320	Mt CO2
former 10 eastern EU countries	79	Mt CO2
2.1 Estimated potential for CO2 capture and storage "in underground"		
EU 27 countries	147	Mt CO2
former 10 eastern EU countries	36	Mt CO2
2.2 Estimated potential for captured CO2 converted to useful products CCU		
EU 27 countries	**173**	Mt CO2
"share of overall CO2 reduction potential"	**6,7%**	-
number of equivalent 100.000t CO2 CCU plants	**1.731**	-
former 10 eastern EU countries	**43**	Mt CO2
"share of overall CO2 reduction potential"	**1,7%**	-
number of equivalent 100.000t CO2 CCU plants	**429**	-

[1]Source: https://co2value.eu
* Based on 100.000t CCU plants

2. CCUS Technology in Reuse – CO2 capture

2. CO2 capture

direct air capture

from atmosphere

- **Absorption**
- **Adsorption**
- Membrane based

[not REUSE project relevant]

REUSE

capture from point sources

from i.e:
- industrial processes
- biogas from local biological sources
- **combustion (heating/power) (post combustion)**

capture technologies

typically in EU used for capture and utilisation from point sources:

- **Absorption (mainly)**
- Adsorption
- Membrane based

3. Returned filled-in inquiries: *Pyrolysis and use for construction and agriculture (Kynast – KfW) – 1/2*

Quantitative

Energy & Resource Efficiency: Water supply: -5-10%, Energy supply: -11-15%

CO2 reduction: -11-15%

Qualitative

Industrial Compatibility of Pyrolysis (integrated seamlessly into existing industrial processes without causing disruptions to production efficiency, quality, or continuity)**:** **[Likert:** 4 – **Agree]**

Technology Readiness & Scalability (…adaptation to different operational scales): **[Likert:** 4 – **Agree]**

Operational Flexibility (operate efficiently under varying industrial conditions): **[Likert:** 4 – **Agree]**

3. Returned filled-in inquiries: *Pyrolysis and use for construction and agriculture (Kynast – KfW) – 2/2*

Qualitative

Heat & Energy Integration (…effectively utilize industrial waste heat to enhance energy efficiency) **[Likert:** 4 – **Agree]**

Space & Infrastructure Considerations (… designed to minimize space requirements and integrate seamlessly into existing industrial sites): **[Likert:** neutral]

Sustainability & Future Scaling-up (… prioritize long-term sustainability): **[Likert:** 4 – **Agree]**

Ref.: https://www.carbon-twister.com/?gad_source=5&gad_campaignid=20691443491&gclid=EAIaIQobChMI0ufpgaWHjgMVSQuiAx006jvuEAAYASAAEgIyK_D_BwE

Feedback of potential CCUS projects – quantitative 1/2

CCU - Processes	Pyrolysis	Bioethanol production 1	Post-combustion capture with amine solv. Prod.	Bioethanol production 2
Energy & Resource Efficiency - energy	- 11-15%	-20-30%	- 11-15%	-20-30%
Energy & Resource Efficiency - water	-5-10%	- 16-20%	- 11-15%	- 16-20%
Environmental Impact - CO2 reduction	- 11-15%	-20-30%	- 16-20%	-20-30%

- **Analysis result twins of two responded interviewers regarding quantitative criteria of Bioethanol productions**
- **With Reuse novel BCS (biomass combustion system)-RPB-CO2R system we intend to be in a range of the Pyrolysis processes.**

Feedback of potential CCUS projects – qualitative 2/2

CCU - Processes	Pyrolysis	Bioethanol production 1	Post-combustion capt-ure with amine solv. Prod.	Bioethanol production 2
Industrial Compatibility	4	5	4	5
Technology Readiness & Scalability	4	5	4	5
Operational Flexibility	4	5	5	5
Heat & Energy Integration	3	5	5	5
Space & Infrastructure Considerations	4	5	4	5
Sustainability & Future Scaling-up	4	5	5	5

- **Analysis result twins of two responded interviewers regarding qualtitative criteria of Bioethanol productions -** it is not evident this should always be the objective ?
- **Taking the TRL 5 level of, Reuse pilots into account we can identify and de-risk systems interfacing without compromising system performance in respect of technical efficiency and sustainability. Related hypothesis is under investigations among the competing CCU- processes.**

4. CCUS– CO2 utilisation/conversion

3. CO2 utilisation/conversion "main technologies"

no conversion

main technologies:

- **CO2 storage in:**
  Saline Aquifers
  Depleted Oil/Gas Reservoir
  Unmineable Coal Seams
- **Direct use:**
  Food and Beverages
  Greenhouses
  Cooling (refrigerant)

not REUSE project relevant

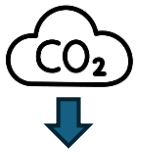
REUSE

products REUSE:
CO, FA
in future fuels

conversion to useful more valuable products

main technologies:

- **Mineralisation:**
  building materials "additives"
- **Electrochemical conversion:**
  Chemicals, Fuels…
- **Thermochemical conversion**
  Fuels, Urea
- **Photocatalytic conversion**
  "early research stage TRL 1-3"
  Fuels
- **Plasmacatalytic conversion**
  "early research stage TRL 1-3"
  Chemicals, Fuels…
- **Biological conversion**
  Methane



Chemicals, fuels, plastics, solvents, feedstocks…

Legend:
CO….Carbon Monoxide
FA…Formic Acid

5. Conclusions

- Bioethanol can be produced via mild processes such as fermentation, which occur under near-ambient conditions and offer significant advantages over high-temperature methods like pyrolysis.
- The low operational temperatures imply minimal energy input, thereby reducing associated emissions from conventional fuel sources.
- Water loss through evaporation is expected to be negligible, suggesting a potentially lower water footprint.
- The CO_2 produced is likely to be highly concentrated and relatively pure, facilitating straightforward capture and separation.

Summarized: These are all based on logical assumptions, however they may not be entirely valid. The only way to know for **sure is through detailed analysis in Reuse**.

Thank you!

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