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CaCTUS

CARBON CAPTURE, TRANSFORMATION, UTILIZATION & STORAGE

CCU AND CCS PERSPECTIVES FOR AUSTRIA

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SESSION "POLICIES FOR PHASE-OUT FOSSIL FUELS AND CARBON MANAGEMENT"

Project Key Facts

An in-depth evaluation of the potential contribution of CCU and CCS for the Austrian long-term climate goals

- **Lead:** Energieinstitut an der JKU Linz (EI-JKU)
- **Consortium:** Montanuniversität Leoben (MUL) (Energy Network Technology / Process Technology and Environmental Protection / Reservoir Engineering / Petroleum Geology), denkstatt, CCCA (subcontract)
- **Funding scheme:** 14th Austrian Climate Research Programme (ACRP)
- **Duration:** August 2022 – January 2025 (30 Months)

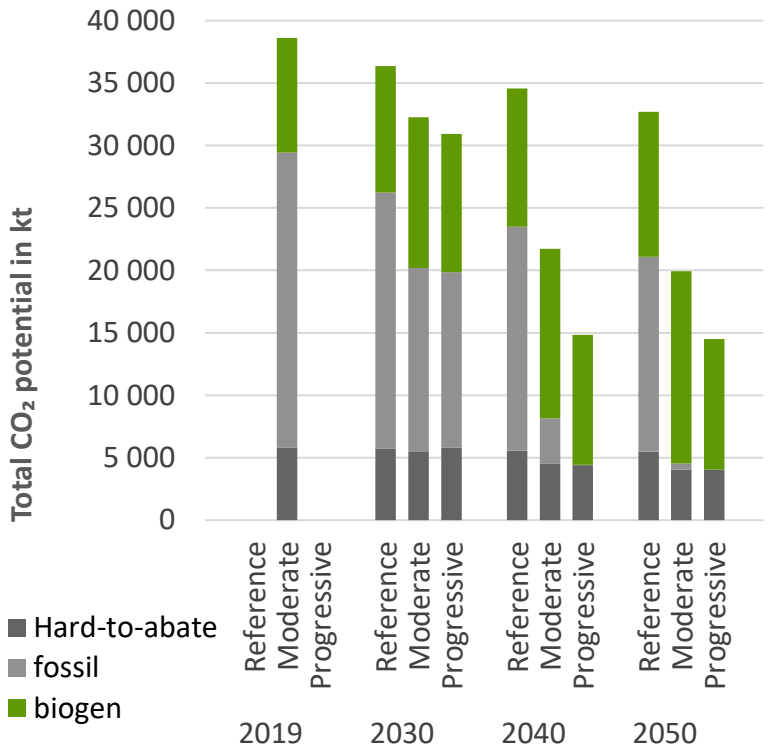
"In the scenarios for meeting the 1.5°C target, Carbon Capture and Storage (CCS) or Carbon Capture and Utilization (CCU) is de facto unavoidable" (see IPCC Special Report on 1.5°C).

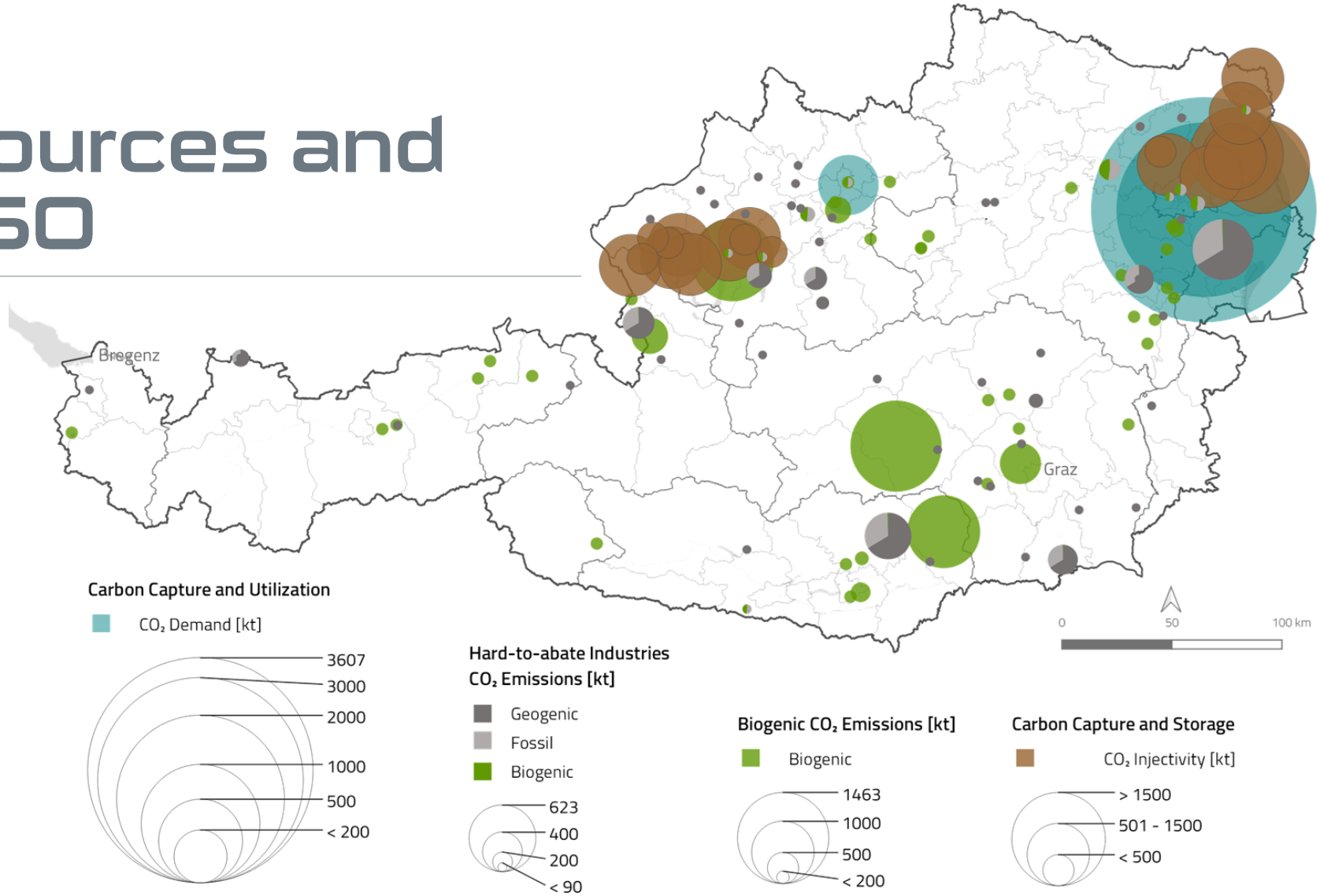
→ CaCTUS addresses the **lack of reliable data and information** on the potential of these technologies **in Austria**

Objectives

- **Identification and quantification of technical potentials** for CCU/CCS in Austria
- Identification of **source-specific climate impacts** and **sink-related net mitigation potentials** of CCU/CCS
- **Techno-economic assessment** of the identified carbon pathways and their **contribution to climate neutrality**
- Assessment of **current barriers and regulatory shortcomings** that hinder early implementation and maximize impact

CO_2 point sources and sinks in 2050





3 decarbonization pathways
based on NEFI and UBA scenarios

Hochmeister et al. (2024)

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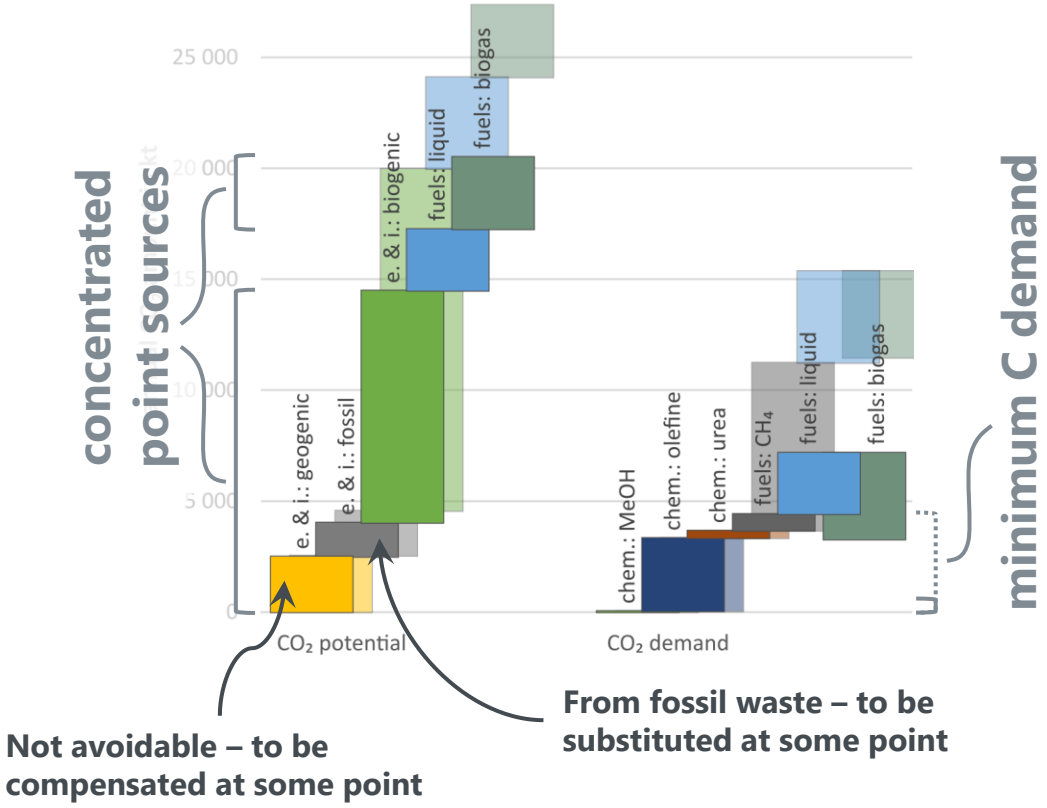
Quantification of resource and demand potentials for CCUS

Identification of relevant products and demands – carbon balance

- total “emissions”: **17.3 – 27.3** Mt/yr
  - capturable: **14.5 – 23.2** Mt/yr
    - fossil/geogenic: **4.0 – 4.6** Mt/yr
- utilizable CO_2*: **3.3 – 15.4** Mt/yr
  - circular: **0.5 – 11.2** Mt/yr

* if all e-fuels produced in AT; upper bounds without exploiting biogas potentials

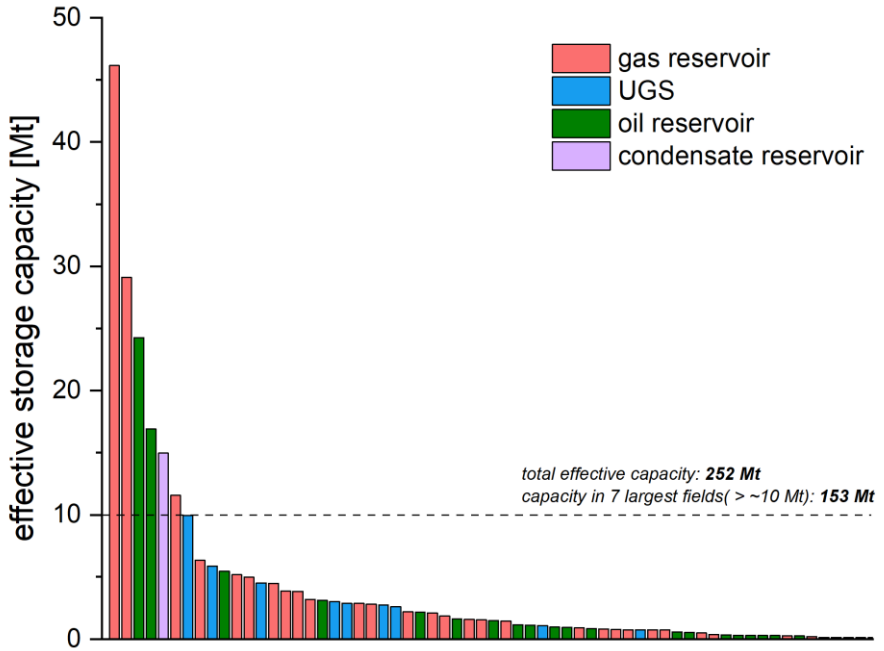


CO_2 storage potentials in Austria

Classification by …

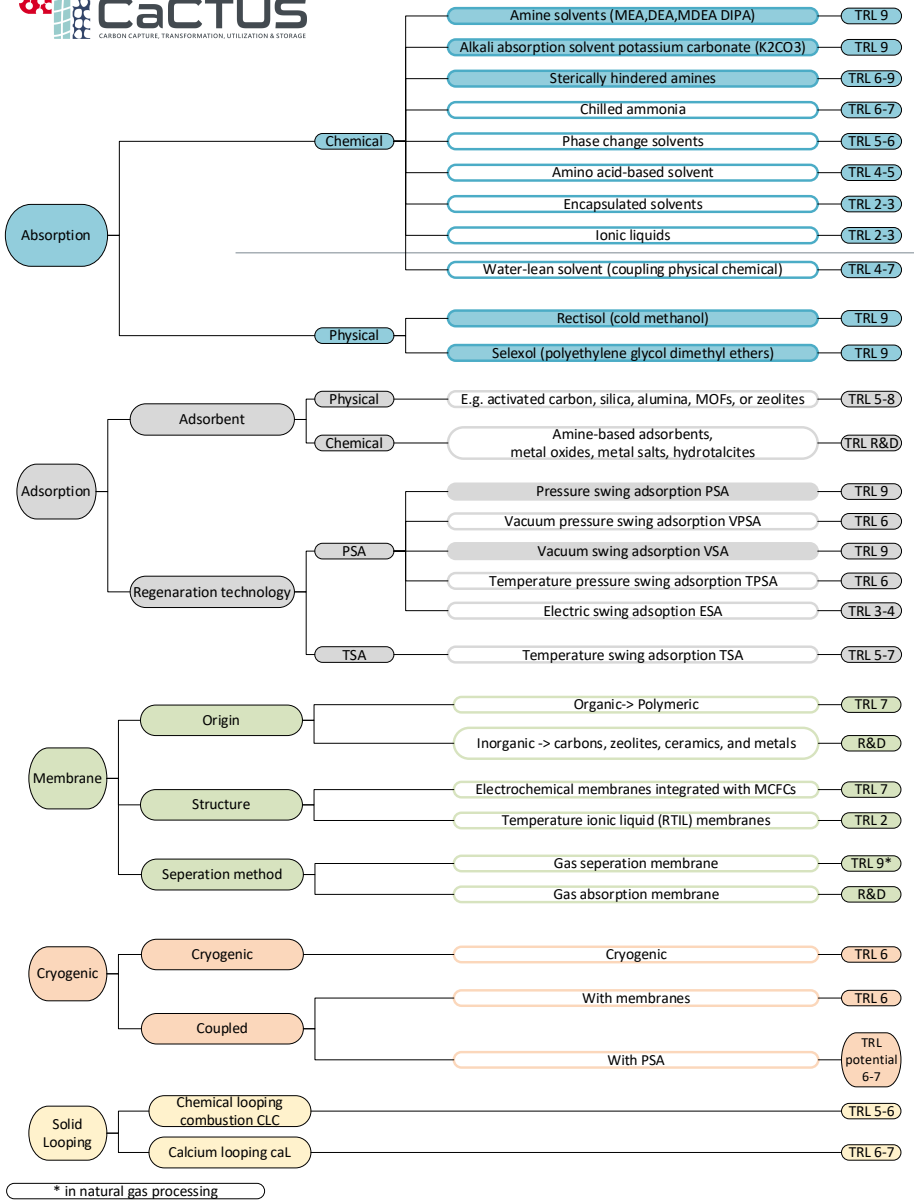
- **… state of the fluid**
  - supercritical
  - adsorbed (on coal)
  - gas phase
  - carbonated water
- **… storage medium**
  - saline aquifers (TRL 9)
  - oil & gas fields (TRL 9)
  - mafic/ultramafic rocks (TRL 2-6)
  - coal seams (TRL 2-3)

Potentials in depleted hydro-carbon reservoirs

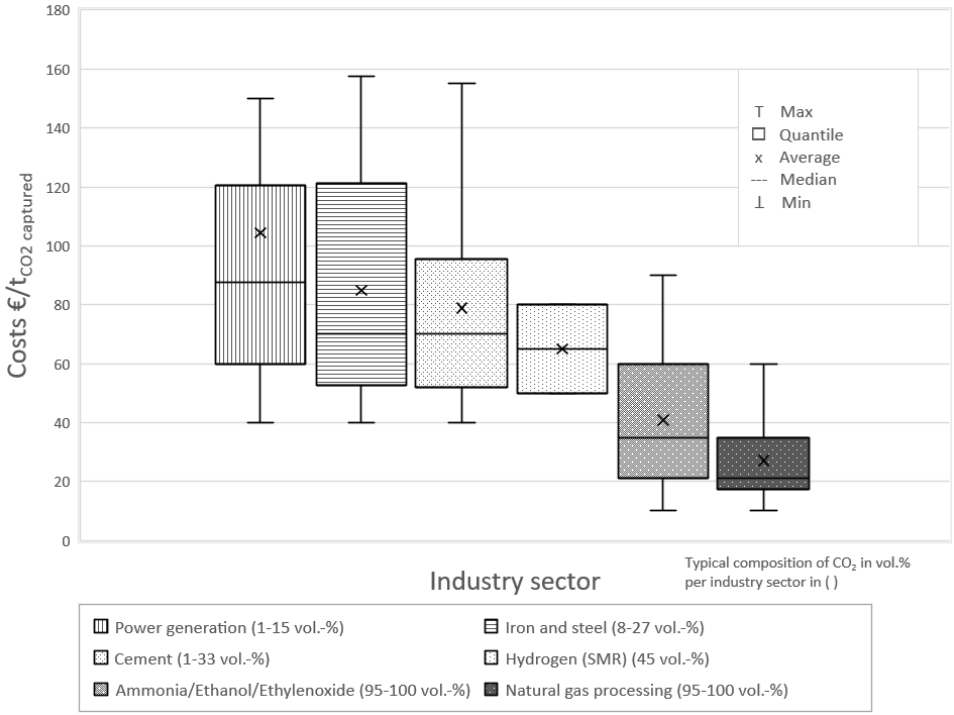


Kulich et al. (2024)

Carbon Capture - Classification & Properties



	Technology	Energy demand (th) GJ/t_{CO2}
	Absorption	**2,0 - 9,2**
Selection	MEA, DEA, MDEA, etc.	3,0 - 4,5
Selection	New/optimised solvents	2,1 - 2,9
Selection	Potassium carbonate	2,0 - 2,6
Selection	Chilled ammonia	2.0 - 2.9
Selection	Amino acid-based solvent	2.4 - 3.4
	Adsorption	**2.4 - 9,0**
	Amine-based adsorbents	1,3 - 2,0
	Metal-organic frameworks	0,4 - 0,8
	Membrane	**0,5 - 6,0**
	Cryogenic	**2,4 - 5,2**
	Solid Looping	**2,0 - 10,0**



Wolf-Zöllner et al. (2024)

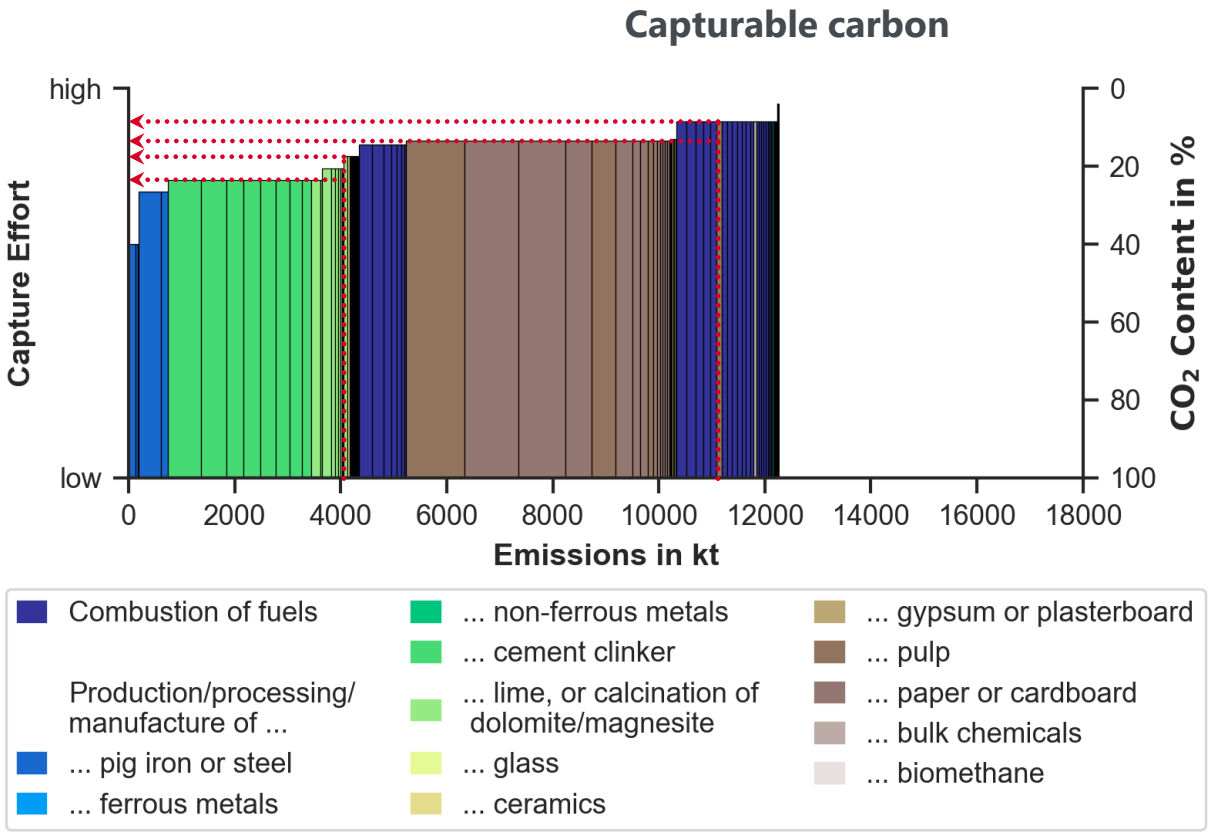
Assessment of CO_2 avoidance costs for identified CCUS paths

Determination of capture effort and merit of sources

- **high-purity CO_2 streams will not suffice** to compensate long-term fossil/geogenic emissions
- depending on exploited **CCU** potentials, the **use of highly diluted sources** will become necessary

to be considered:

- omitting potentials from **biogas production** shifts the curve towards higher efforts
- with higher carbon demands, **decentralization of sources** increases
- **additional efforts** for transport, purification, etc. yet to be included



Current legal and regulatory framework on CCUS

- Legal situation regarding CCU and CCS strongly influenced by **EU law**
- Main legal basis at European level regarding CCS: Directive 2009/31/EG on the geological storage of carbon dioxide (CCS-Directive)
  - Outline and analysis of the provisions of the CCS-Directive
  - Right not to allow any storage in the Member State → Austria has made use of this: Federal Act on the **Prohibition of Geological Storage of Carbon Dioxide**
  - **Evaluation of the ban** at regular intervals; next evaluation upcoming: presentation to the Council of Ministers (AT, Ministerrat) that it will probably be recommended that geological storage of CO_2 be permitted exclusively for **residual emissions in "hard-to-abate" sectors**
  - Analysis of the conditions for an **exemption from the obligation to surrender allowances in the EU ETS** in connection with CCU and CCS
  - Exemption for CCS as defined by the CCS Directive
  - Exception regarding CCU only if CO_2 is permanently chemically bound in products

Stakeholder involvement

- **Stakeholder WS in Q2/23**
- **Survey on CC / CCU / CCS**
  - General information
  - CCUS Potentials
  - CCUS Barriers and Opportunities
  - Activities in the area of carbon capture
  - Activities in the area of carbon storage
  - Activities in the area of carbon utilisation
- **Interviews in Q4/23 + Q1/24**
  - Necessary advancements in the company
  - Regulations
  - Subsidies
  - Technical criteria
- **Stakeholder WS in Q3/24**

Barriers

CCU: **Financial burden** and lack of enabling instruments

CCS: **Legislative restrictions**, lack of political will and negative public perception

Drivers

CCU: **Updated ETS regulation** and improved profitability

CCS: **impact towards climate targets**, reduced costs and updated ETS regulation

Conclusions

- Even with progressive defossilization there will be remaining fossil/geogenic emissions from industry and energy sectors
  - → These have to be compensated via storage or long-term fixation
  - → Storage potentials in Austria are limited and may compete with energy storage
- There is a significant potential for CCU from today's products and emerging renewable fuel demands
  - → Efforts for utilization increase with degree of exploitation of these potentials
  - → Mechanisms to compensate costs of utilization over storage may be needed
- Under current legislation …
  - … CCS is not allowed in Austria → unblocking for "hard-to-abate" emissions is expected
  - … CCU is not creditable against ETS certificates → incentive effects for carbon cycling are missing
- CCU and CCS will be required for carbon neutrality in Austria, but are dependent on regulatory adaptations and appropriate infrastructure (domestic and beyond)!

Contact

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