

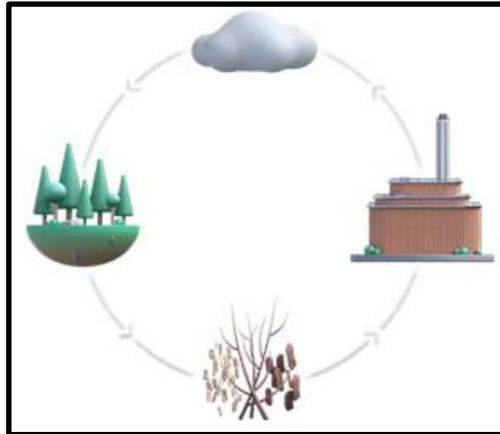


Value for Society on Bioenergy with Carbon Capture, Utilisation, and Storage (BECCUS)

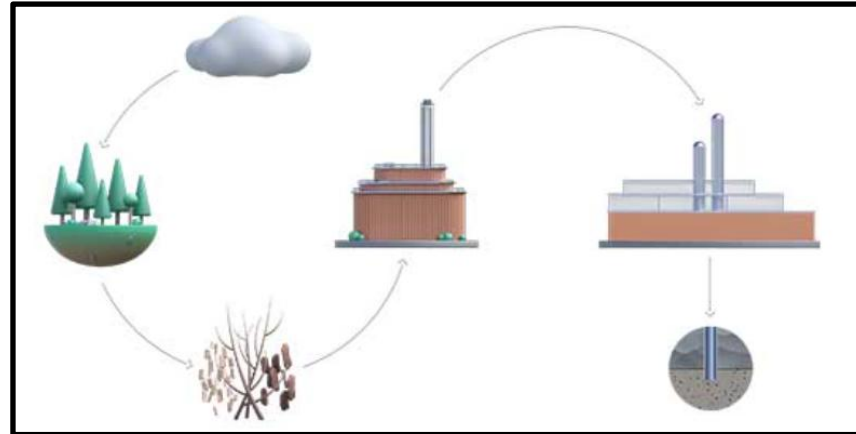
Master Thesis Project

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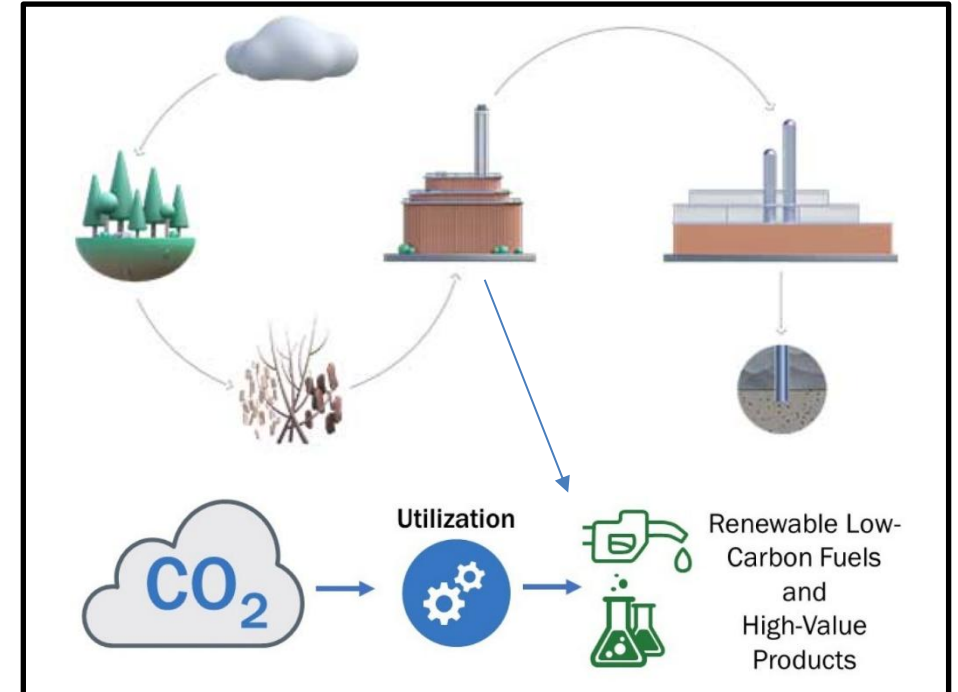
Bioenergy with Carbon Capture, Utilisation and Storage (BECCUS): the integration of bioenergy production with the capture of biogenic CO₂ for utilization and/or permanent storage, potentially resulting in net carbon removal.



The natural carbon cycle in a bio-fired combined-heat plant, where net emissions are zero (Bio-CHP)



The natural cycle supplemented with capture and storage, which leads to negative emissions (Bioenergy with Carbon Capture and Storage – BECCS)



*The natural cycle supplemented with capture, storage, and **utilization** (BECCUS)*

(Adapted from: Stockholm Exergi)

Research gaps

Despite promising potential, significant knowledge gaps persist in the socio-techno-economic dimensions of BECCUS



Labour economics & just-transition dimension of BECCUS

Background

- Most existing BECCU/S techno-economic assessments (TEAs) generally account for labour under CAPEX/OPEX, but often represent it through simplified assumptions rather than systematically modeling it in terms of occupational structure, skill requirements, job creations, workforce transitions, and associated reskilling costs (Almena et al., 2025)
- Further research is needed to examine human capital, workforce reskilling, labour demand across the value chain, in order to evaluate human capital investment & reskilling costs, including hiring and retraining, for a bioenergy-carbon management transition

Potential research question

- *What new occupations does BECCUS create?*
- *Which existing workers can transition?*
- *What is the labour-transition cost of deploying BECCUS?*
- *What is the economy-wide impact of BECCUS employment?*

Potential methodology

- Mathematical modelling of BECCUS labour demand using ILOSTAT data and literature-derived employment factors, validated through industry experts (e.g., Stockholm Exergi, Tekniska Verken, Perstorp, etc)

Expected contribution

- The findings can later serve as methodological groundwork for integrating workforce economics into a comprehensive BECCUS TEA, to calculate BECCUS costs more realistically
- The research can support more informed decision-making for industries and educational institutions to increase the supply of necessary skills and workforces for BECCUS technologies, leading to fairer value for society



Technology learning & commercialisation pathways for BECCUS

Background

- Techno-economic assessments (TEAs) of BECCUS can be misleading if they don't account for technological learning and more granular/component-level learning curves, because different process units have different maturity levels and scalability challenges (Beiron & Johnsson, 2024)
- For technologies in the very early stages of commercialisation, such as BECCUS, insights into their potential development trajectories can be gained by examining analogues from the emergence and growth of existing energy technologies (Rai et al., 2010)

Potential research question

- *How can technology learning curves across different stages and components of the BECCUS value chain be incorporated into TEA of BECCUS?*
- *What lessons can BECCUS learn from the technological development and commercialisation of analogous energy technologies, and how can these lessons inform BECCUS transition from demonstration to commercial deployment?*

Potential methodology

- Comparative historical case-study analysis using cross-case synthesis of analogous energy technologies (e.g., CCS, LNG, wind, etc)

Expected contribution

- The findings can later enhance BECCUS TEA, to account for potential future cost reductions due to learning curves
- The research can identify the economic and governance conditions necessary for large-scale BECCUS adoption, by learning from historical experiences of analogous energy technologies



Mapping the BECCUS policy landscape using machine learning

Background

- BECCUS deployment is strongly influenced by policy and governance frameworks, including carbon pricing, subsidies, sustainability criteria, carbon accounting rules, and infrastructure regulation. However, evidence on BECCUS policy is dispersed across both academic literature and policy documents, making it difficult to assess the overall policy landscape and identify gaps.
- Recent advances in machine learning and natural language processing (NLP) have enabled large-scale mapping of policy-relevant knowledge (Callaghan et al., 2025)

Potential research question

- *What are the dominant themes, policy instruments, and governance approaches discussed across BECCUS academic literature and policy documents?*
- *What policy gaps, research gaps, or mismatches exist between academic literature and policy documents that may hinder the large-scale commercialisation and deployment of BECCUS?*

Potential methodology

- Machine learning and NLP to find texts in the academic literature and policy documents

Expected contribution

- The research can create a comprehensive database and visualisation of BECCUS-related academic publications and policy documents classified by policy instrument, sector, geography, and governance focus
- The findings can provide policymakers, industry stakeholders, and investors with evidence-based insights into effective policy frameworks, regulatory needs, and emerging governance challenges for scaling BECCUS



Thank you!