Life Cycle Assessment of Biogenic Carbon Capture and Storage Processes: Review of Life Cycle Inventories and Recommendations

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1. Introduction

Bioenergy with carbon capture and storage (BECCS) are part of the solution to reduce greenhouse gas emissions into the air [1,2,3]. The idea is to capture biogenic carbon before it is emitted into the atmosphere and stored permanently. If biogenic carbon is stored indefinitely, it generates a flow of carbon from the atmosphere to a permanent sequestration. Thus, BECCS systems are considered as negative emission technologies (NET) [3, 4, 5, 6, 7]. However, in seeking to reduce the climate change impacts of BECCS systems, the technologies that comprise the BECCS system may impact other environmental phenomena [6]. This may result in pollution displacement. Different technologies are available at each stage of the life cycle of a BECCS system. It is important to provide the decision maker with a clear understanding of the environmental impacts associated with the choice of these technologies. Inventory data must be of high quality [8,9]. The objective of this study is to review the quality of the life cycle inventory data available in the literature and to provide recommendations to conduct a quality BECCS Life Cycle Inventory.

2. Materials and Methods

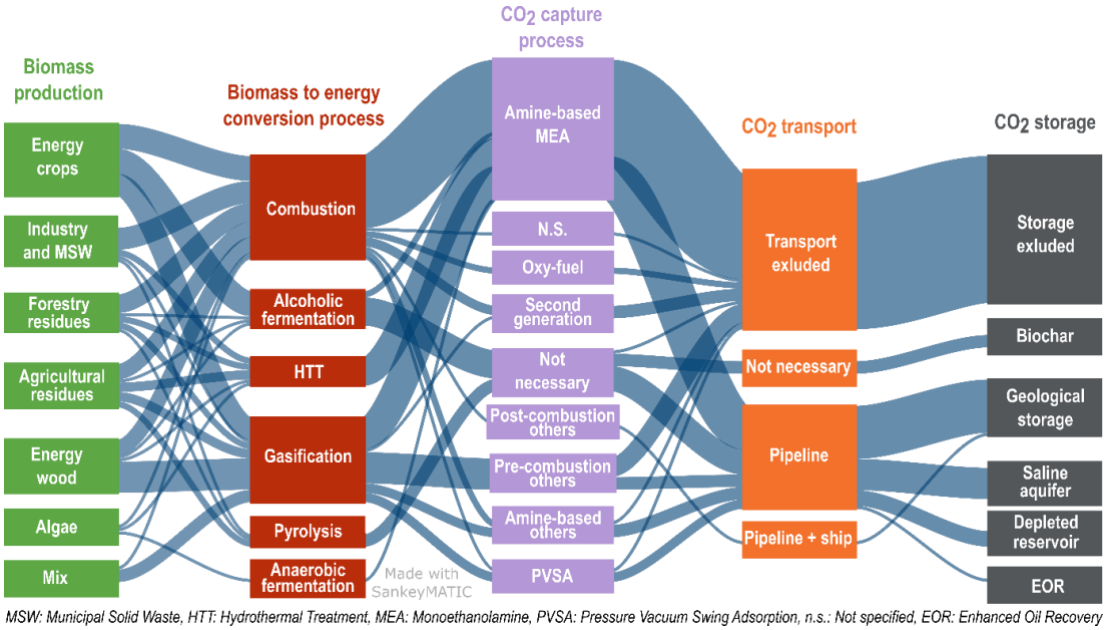
An analysis of 35 LCA studies was conducted. These studies had to propose a BECCS life cycle inventory. Scientific articles were selected using the three following research equations:

1. Bioenergy: "biofuel" or "bioenergy" or "BECCS" or "BECCUS" or "BECCU" or "biochar"
2. Life cycle assessment: "LCA" or "Life cycle assessment" or "Life cycle analysis" or "Life cycle impact assessment"
3. Carbon capture and storage: "CCS" or "Carbon capture and storage" or "CO2 capture and storage"

3. Results and Discussion

The life cycle of BECCS's technologies start in the field of biomass cultivation (depending on the type of biomass and its harvesting). Several technologies are used to ensure the pre-treatment of this biomass, its combustion and gasification, and finally the capture of the biogenic CO_2 emitted. Afterwards, the CO_2 can be compressed for transport and then stored (see Figure 1).

Only 13 of the 35 articles reviewed provide life cycle inventory tables. Inventory data is often marked by a lack of reproducibility, of data. Nevertheless, this study provides LCI data and recommendations for conducting LCIs to facilitate harmonization between future LCAs on the BECCS.



MSW: Municipal Solid Waste, HTT: Hydrothermal Treatment, MEA: Monoethanolamine, PVSA: Pressure Vacuum Swing Adsorption, n.s.: Not specified, EOR: Enhanced Oil Recovery

Figure 1: Case studies identified in the selected articles. The thickness of a flow between technology options is proportional to the number of case studies available for each option.

4. Conclusions

The amount of LCAs available in the scientific literature on BECCS systems is currently limited. However, some studies propose useful inventory data for the environmental assessment of BECCS systems by LCA, as for instance in the work of Antonini *et al.* [10] or Lausselet *et al.* [11]. It is important that the inventory data be transparent with a clear display of boundaries and system assumptions. Each data quality criteria must be discussed as recommended by ISO 14 040/44.

5. References

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