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Topic addressed: 'Carbon Capture'

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Title: Integrating Prospective Life Cycle Assessment into Early Development of Carbon Capture Technologies

Carbon Capture and notably Direct Air Capture (DAC) is widely recognized as a key technology for achieving net-zero greenhouse gas emissions. However, its large-scale deployment remains constrained by high energy demands and material requirements. Within the CETP-funded SENSATION project and the EU-funded eREGENERATE project, ifeu supports carbon capture technology development and scale-up by integrating life cycle thinking-based metrics at early stages of technology development.

Our recently published life cycle assessment (LCA) results of adsorption-based DAC technologies indicate that energy use is the primary driver of DAC's carbon footprint, while sorbent-related impacts become relevant mainly for short-lived or energy-intensive materials [Mennitto et al. 2025]. Since the choice of sorbent also influences the process energy demand, material and process design must be jointly optimized. Another key challenge is air humidity, which affects carbon capture efficiency and energy use; both projects are therefore developing and testing alternative concepts to address this.

Our work highlights the importance of an integrated view that connects sorbent properties, process design, and environmental metrics based on prospective LCA from the earliest phases of carbon capture technology development. This approach can guide innovation toward more energy-efficient and sustainable carbon dioxide removal pathways.

Mennitto, R., Blom, R., Dörr, M., Rosental, M., Rettenmaier, N. (2025): Solid sorbents for direct air capture: a technological and environmental perspective. *Current Opinion in Chemical Engineering*, Vol. 50, p. 101195. https://doi.org/10.1016/j.coche.2025.101195.