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## TITLE: CCS Value Chain

### Modeling the carbon footprint and cost of CCS in Europe

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Carbon Capture and Storage in Europe is held back by misalignments in the supply chain. Capture, transport and storage of CO<sub>2</sub> are typically handled as individual projects, whereas commercial success is critically dependent on near-flawless integration of the various components.

To help deal with this challenge, a modeling workflow and an open-source Python package is presented that models the entire CCS Value chain, by quantifying material, energy, and environmental requirements, along with capital and operating costs, for pan-European CCS networks.

Leveraging a spatial map of European emitters based on the E-PRTR database enhanced with the emitters' flue gas composition, the tool employs capture techniques tailored to each emitter's industrial sector, flue gas composition, and proximity to existing or potential pipelines and selected subsurface storage sites.

Our computational model constructs a network using a Graph data structure, connecting emitters along existing European gas pipelines and power cables to simulate potential future pipeline routes.

Energy consumption is determined based on process models, and correlations are applied for capital cost estimation. Operating costs are projected using the spatial cost of fuel and electricity across Europe.

Our software ensures realistic CCS network design and accurate estimations of environmental footprints, energy demand, capital, and operating costs. This will facilitate informed planning and decision-making by taxpayers, investors, operators, and policymakers.

The software also distinguishes between biogenic and non-biogenic CO<sub>2</sub> emission sources, making it useful for the investors interested in negative emission and bio-energy CCS, or companies looking for bio-CO<sub>2</sub> for utilization and power-to-X.