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An economic evaluation of eight regional scenarios for the deployment of carbon capture, use and storage in Southern and Eastern Europe to 2050

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Abstract:

During the three-year STRATEGY CCUS project† (2019-2022) funded by the EU, Carbon Capture Utilization and Storage (CCUS) scenarios formulated for eight Southern and Eastern European regions were developed and assessed up to 2050.

This paper compares the main economic Key Performance Indicators (KPIs) of these CCUS business cases based on the same techno-economic modelling and hypothesis. The techno-economic model‡ used to evaluate the eight regional scenarios allows for common comparison of different CCUS business models for the first time in Europe. The KPIs calculated reflect mainly the costs and revenues expressed in tons of CO_2 avoided or removed for each process step of the CCUS chain (i.e., capture, transport, storage) and for the entire regional scenario up to 2050. The volume of CO_2 avoided and/or removed at the regional scale and the costs associated illustrate the techno-economic potential of the CCUS technologies in the eight regions.

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† Strategic planning of regions and territories in Europe for low-carbon energy and industry through CCUS

‡ CO2 Capture, Transport, Use and Storage Cluster Analyses model owned by IFPEN, NORCE, IGME and U. EVORA

These regional CCUS scenarios are based on both the performances of local industries in operation and for which CCUS is a relevant mitigation alternative, as well as the regional storage capacities known to date. The eight CCUS regional scenarios are located in : 1) the Paris basin and 2) Rhône Valley in France, 3) Ebro basin in Spain, 4) Lusitanian basin in Portugal, 5) Northern Croatia, 6) Upper Silesia in Poland, 7) West Macedonian area in Greece and 8) Galati area in Romania and cover an extensive portfolio of possible CCUS business models.

Each CCUS scenario is specific to its region of origin and focuses on high CO_2 emitting industries such as power generation, cement, chemicals, refining, steel, or waste-to-energy factories. The captured CO_2 is transported to selected storage sites by a combination of pipeline, truck, train, and/or ship modes, estimated by the techno-economic model. This leads to a region-specific CO_2 transport network that is linked to the existing geographic and infrastructure configurations. Some scenarios provide CO_2 for utilization which dependently on the region is used regionally for methane or chemical production, but the majority of captured CO_2 is send to CO_2 storage facilities. In some scenarios the CO_2 can be used for EOR purposes before the reservoir retrofits into CO_2 storage.
The method and the tool developed within this research can be easily used for creating numerous scenarios which can be incorporated in further sensitivity analyses.

These regional scenarios illustrate the different possible combinations of links in the CCUS chain in several European regions - no two scenarios are identical - and carry out extremely interesting techno-economic studies on a variety of CCUS business model cases based on common economic assumptions and modelling tool.
Another innovative aspect of the economic analysis of these CCUS scenarios is the consideration of captured biogenic CO_2 at a regional scale. The techno-economic evaluation traces the capture and use of biogenic CO_2 along the CCUS chain while considering the temporary storage time of recycled CO_2 when it is re-used in chemistry or methane production for example. The economic evaluation also accounts the negative CO_2 emissions when biogenic CO_2 is captured and stored for the long term, which is important for reaching the regions' 2050 carbon neutrality goal.

For each of the regional scenarios evaluated, the cost difference between investing in CCUS or paying the carbon penalties to remain in compliance with the EU ETS is calculated, leading to an estimate of the breakeven price of CO_2 for each of the scenarios deployed.

Preliminary results show that the CCUS chain costs range between 50 to 120 €/t CO_2 avoided according to the regions, with capture representing the main share of the costs.
Finally, for each regional CCUS scenario, an estimation is made between the CCUS share of the deployed scenarios and the national decarbonization trajectory in the eight countries.

Keywords: Type your keywords here, separated by semicolons ;

CCUS, cluster, hub, techno-economic evaluation, CO_2 value chain, EU ETS, business model

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