**The Contribution Of CO2 Utilisation to GHG Emission Reduction:**

**Some Results BasedoOn A European Supply Chain Optimisation.**

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**Highlights**

* Optimisation of a carbon capture, transport, storage and utilisation network.
* <0.6% of European CO2 from coal/gas plants can be removed through utilisation.
* 5.5% cost reduction achievable thanks to revenues deriving from utilisation.

**1. Introduction**

In the last 50 years, CO2 constituted nearly the 80% of overall anthropogenic greenhouse gases (GHGs) emissions; global actions are therefore needed to tackle the increase of carbon concentration in the atmosphere [1]. Carbon capture and storage (CCS) has been highlighted as one of the most promising options. Recently, also carbon utilisation pathways have been highlighted as potential options to reduce the costs that derive from the installation and operation of a more general CCS and utilisation (CCUS) infrastructure. Nevertheless, there is debate on the actual effectiveness of the chemical conversion of CO2, indicating that only minor environmental benefits could be obtained [2]. In this work, the aim is to evaluate the effects of CCUS from an economic perspective and to assess what contribution may derive from CO2 utilisation for conversion into chemical products at a European level.

**2. Methods**

This contribution proposes a static mixed integer linear programming model for the economic optimisation of European CCUS supply chains (SCs). Building up from [3], the European territory is discretised by aim of set *g* of 124 squared cells and the SC takes into account the location of large stationary sources of CO2, the techno-economic description of set *k* for carbon capture options, of set *l* of transport means, the location and size of storage basins, and the techno-economic features of the CO2 utilisation stage via set *c* of chemical outputs. Given the numerous reaction mechanisms for CO2 conversion [4], a restricted number of processes was selected according to the following principles: (*i*) minimum production threshold according to market demand (>1Mt/year of converted CO2); (*ii*) techno-economic data availability (productivity and costs); (*iii*) environmentally promising (CO2 emissions lower than consumption); (*iv*) current technology economically promising (the conversion process must generate a profit). As a result, set *c* = {PPP, MeOH}.

**3. Results and discussion**

The CCUS model was optimised using the GAMS CPLEX solver on a 16GB RAM pc in 27h (optimality gap <1%). As reference case, results from [3] of the optimal CCS network are reported (Scenario 0). The CCUS system (Scenario A) is optimised according to the selection of a reduction target of 43% of European CO2 emissions from large stationary sources (consistent with [5]), and imposing to satisfy the current European production of PPP and MeOH. As a result, the SC entails a total cost *TC* for installing and operating the CCUS network that is reduced by 5.5% with respect to Scenario 0, because the introduction of chemical conversion brings in some revenues (with a profit equal to 1.57€/t). Conversely, the chemical conversion of CO2 allows just a slight reduction of 0.7% of total capture costs *TCC*, which decrease from 30.93€/t (Scenario 0) down to 30.72€/t (Scenario A). The total transport cost *TTC* slightly varies from 1.96€/t (Scenario 0) to 1.90€/t (Scenario A). Despite a small decrease in the exploitation of geological storage (i.e., -1.44%), total sequestration costs *TSC* are unchanged between Scenario 0 and Scenario A (0.47€/t and 0.46€/t, respectively). In terms of CO2 emission reduction, the net impact of utilisation amounts to 0.58% of the overall captured amount (comparable with [2]). It can be observed that the SC configuration is nearly identical between Scenario 0 and A (Figure 1). Including utilisation, capture points do not change and the main driver to establish the transport system is still the location of the sequestration sites.

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| (a) | (b) |

**Figure 1.** Final SC configurations for (a) Scenario 0 and (b) Scenario A.

**4. Conclusions**

This work has assessed the potential impact of a European CCUS SC. Results show that the environmental impact of CO2 utilisation is likely to be a minor one (<0.6% reduction in GHG emissions for the chemicals considered in this study). The main benefit is the reduction of the overall costs (decreasing by 5.5%), since conversion would provide for new revenues (differently from sequestration).

**References**

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