

LIFE CYCLE ASSESSMENT OF A CO₂ NEGATIVE EMISSION PROCESS THROUGH H₂ FROM BIOMASS, OCEAN LIMING AND CO₂ STORAGE

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The Life Cycle Assessment of a new process to remove CO₂ from the atmosphere and at the same time address the problem of ocean acidification is presented.

The process is based on a) a gasifier where the biomass is converted to syngas; b) a thermal steam reformer working at high temperature where the hydrocarbons and tar-oils are converted to H₂ and CO; c) a lime kiln that exploits the enthalpy of the hot syngas to produce CaO from limestone, then converted in Ca(OH)₂ (slaked lime); d) the spreading, by means of vessels, of the slaked lime into the seawater to achieve ocean liming; e) the delivery of syngas to a water gas shift reactor producing CO₂ and H₂, that are then separated; f) the final geological storage of all CO₂ produced in the process; g) the use of H₂ for decarbonized energy production, offsetting part of the production cost, thus generating “low cost” negative emissions

The ecoinvent database (version 3.4) and SimaPro software (version 8.5.2) was used in support of the analysis and data processing.

The results of the LCA extend, for global warming category, the previous carbon mass balance done by Caserini et al. [1]. The functional unit used is 1 kg of calcium oxide. For the climate change category, total contribution is -2.9 kgCO₂eq/kgCaO, it means that the net atmospheric CO₂ removed by the process is 2,7 ton per ton of biomass used.

The LCA penalty is 6% of the total carbon benefits generated by the process. The main LCA contributions are the maritime transport for spreading slaked lime in ocean, accounting for 42% (mainly the ships fuel), the biomass planting and harvesting activities (24%), and biomass transport (10%). CO₂ storage, and limestone mining, transporting and crushing are less relevant.

[1] Caserini, S.; Barreto, B.; Lanfredi, C.; Cappello, G.; Ross Morrey, D.; Grosso, M. (2019): Affordable CO₂ negative emission through hydrogen from biomass, ocean liming, and CO₂ storage. In: Mitig Adapt Strat Glob Change 208 (2), S. 1389.