Novel carbonate production process designed in the light of a life cycle assessment

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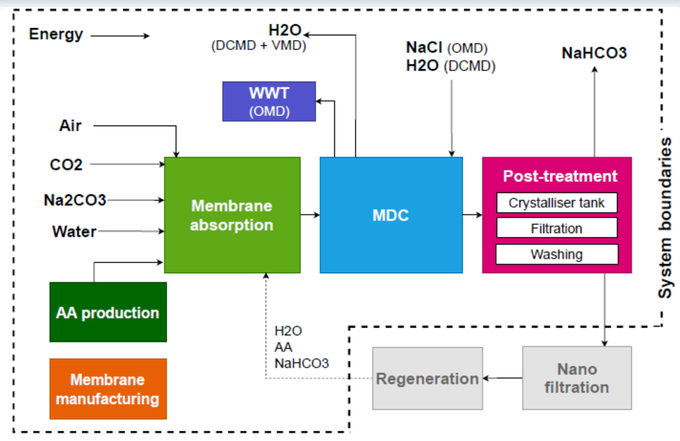
Motivation and innovation

In this work, a **novel CO_2 capture and revalorization process** is studied, taking advantage of membrane technologies and their inherent properties to produce sodium bicarbonate out of the captured CO_2. The process is divided in **two steps**: first, an **absorption** step wherein the CO_2 is captured using a membrane contactor. Then, a **crystallization** step resulting in the recovery of bicarbonate salts using membrane distillation-crystallization. As different routes are considered for this crystallization step, **a life-cycle assessment** is performed in order to determine the **best configuration** in terms of environmental burden. Three configurations are compared: osmotic (OMD), direct contact (DCMD) and vacuum membrane distillation-crystallization (VMD).

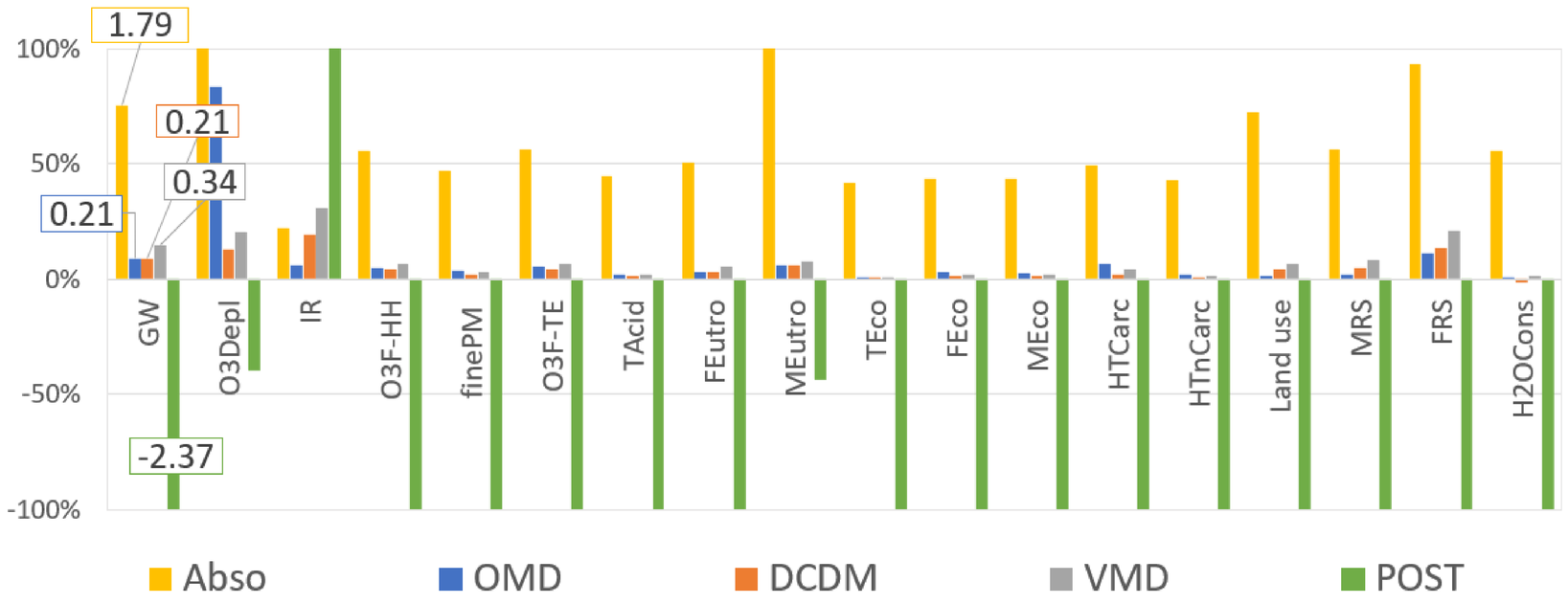


Materials and methods

The consumption of materials and energy and the emission to air, soil and water from the production process of carbonates were reported to the functional unit of 1 kg CO2 absorbed/hr. The analysis was limited to a "cradle to gate" approach hence the use phase and end of life were not modelled. The SimaPro® software and the Ecoinvent v.3 database were used. Scenario analyses for a set of selected parameters were performed.

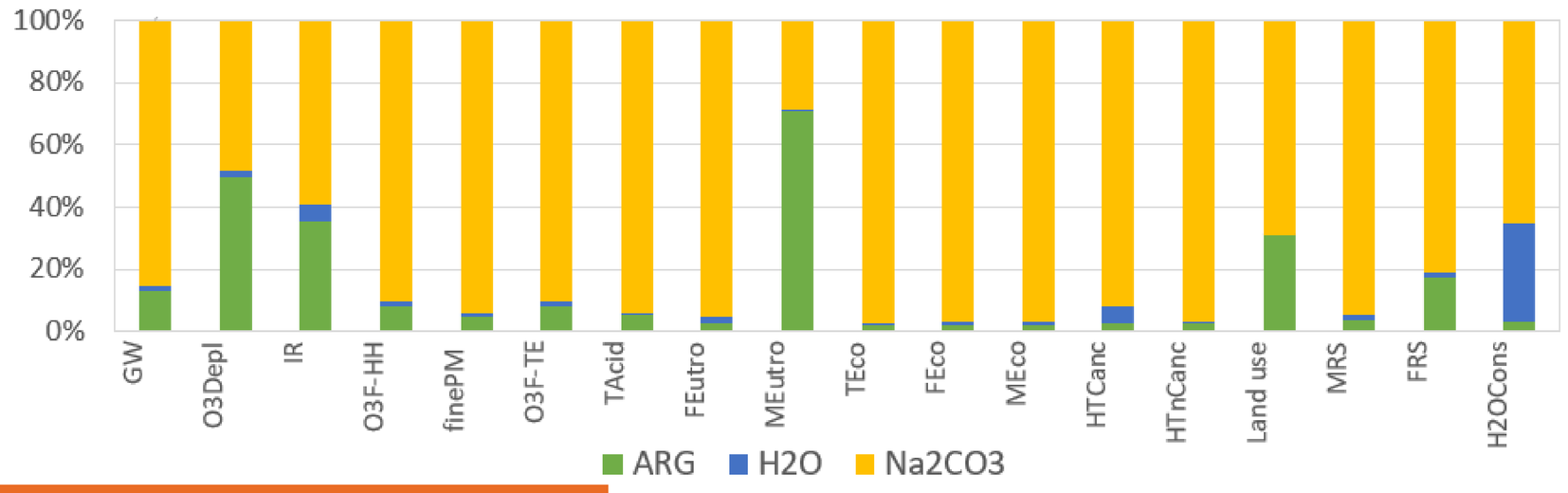
Results and discussion

1 Display of the impacts from the absorption step (Abso) and the 3 different crystallization options (OMD, DCMD, VMD) in comparison to the potentially avoided emissions – characterization.



The absorption step is the most impacting one in all categories except for the Ionizing Radiations (IR). Regarding the crystallization step, VMD is always more impacting than DCMD. Globally, the new carbonate production process modeled as such seems to outperform the current one in several impact categories.

2 Zoom on the absorption step (Abso) – characterization.



The primary material Na_2CO_3 used to capture the CO_2 is the hotspot in the absorption step in most of the categories except for the Marine Eutrophication (MEutro).

Conclusions and future work

When considering the environmental impacts of this new carbonate production process, the absorption step was shown to be the most impacting one because it includes the use of most of the primary materials. The crystallization step was shown to be more effective using DCMD or OMD depending on the impact category of interest. Globally, this preliminary work showed that the new carbonate production process could be of interest compared to the conventional one. However, further investigation should be performed in order to include the process considerations that were discarded up to this point (regeneration and nanofiltration steps, machinery, control devices, …).

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