Reply to referee 1

We would like to thank the reviewer for their constructive and positive feedback on our manuscript. Below we provide a response to all their comments and suggestions and indicate how we have altered the manuscript in response; our responses are in blue, altered text is in shaded in grey.

1. The term "water usage" and the idea that AWL has a large water usage needs to be change throughout the ms to "seawater usage". Without this clarification the average reader will infer that this can be freshwater usage and hence AWL will be limited by freshwater availability, competition with other freshwater demand and hence cost. Chai et al (2025, https://scijournals.onlinelibrary.wiley.com/doi/full/10.1002/ghg.2329) do describe freshwater AWL, but fail to consider the economics and practicality of this, esp in freshwater limited areas. Still, compare/contrast the experiments, modeling and conclusions of Chai et al. and those of this present ms? In any case, coastal AWL is not limited by the availability of seawater, but it can be limited by the cost of pumping that seawater to and from AWL reactors, hence the need to minimize seawater usage in order to reduce pumping cost, not because the resource is limited at coastal sites.

Recent studies, like Damu et al. (2024) and Chai et al. (2025), use fresh water for their AWL reactors and thus the term "water usage" over "seawater usage" is more accurate. The high water demand of the AWL process does restrict its possible usage to locations where the water source is essentially unlimited. In section 4: AWL feedstock, we highlight that seawater is the preferred feedstock for AWL applications.

2. Some of the dissolved carbon discharged by an AWL reactor will be in the form of excess, flue-gas-derived CO2 that has not or will not react with CaCO3 to from more stable Ca++ + HCO3-/CO3--, thus this CO2 fraction can easily degassed to air once discharged in the ocean. The question is are there cost effective ways to reduce this leakage and thus increase the fraction of CO2 removed from the flue gas that is "permanently" stored? While the addition of Ca(OH)2 to the effluent is a plausible solution, it has not been shown here that it is a practical and cost effective one, especially considering the current cost and CO2 footprint of its production. More cost-effective solutions could include site selection where the surface ocean water subduction rate is maximized thus limiting air/sea gas exchange, and/or where subsurface discharge of the effluent occurs (pg. 4). In any case, isn't the $cost/t CO2 captured and stored what ultimately matters, not what max fraction of flue gas CO2 removal might be (theoretically) possible? The important questions not adequately addressed in the paper are can AWL be cost competitive with other forms of emissions reduction and what is the design that optimizes cost effectiveness?

The cost per tonne of CO_2 sequestered will indeed determine the economic feasibility of the process, and this would require an assessment of different possibilities to optimize the CO_2 sequestration efficiency and limit the CO_2 degassing in cost-effective and environmentally safe ways. However, the goal of this manuscript is to provide a framework to compare the efficiencies of different reactor types based on measured inlet and outlet alkalinity and DIC values. An economical analysis of different reactor designs and different possible ways to reduce CO_2 degassing would require a complete life-cycle analysis, which is well outside the scope of this paper.

3. Table 1 The pCO2 and DIC are uncharacteristically high for starting, ambient surface seawater and hence pH and Omega(ca) are uncharacteristically low. Implications for modeling results as used to infer realistic AWL performance?

We added a note in the manuscript text to highlight the fact that these values are uncharacteristically for ambient surface water conditions.

Line 118 – 119: "note that the inlet process water has a higher $pCO_{2,water}$ and thus a higher DIC value than ambient surface water"

If we assume starting values of starting seawater equilibrated with atmospheric pCO2 and keep the alkalinity constant, the starting DIC changes from 2.13 mM to 2.06 mM. If we assume everything else would stay the same, the ΔDIC_{seq} for the unbuffered and the buffered case become 0.13 and 0.90 mM respectively. This does not change the overall conclusion that the majority of the dissolved CO_2 is degassed for this specific example.

4. Compare/contrast the experimental modeling output and conclusions here with those of Dong et al. (2025)? https://www.science.org/doi/10.1126/sciadv.adr7250

The results of Dong et al. (2025) discussed in section 3.2: Two-step reactor. As no inlet and outlet DIC and alkalinity values are provide by Dong et al. (2025) further calculations of different efficiencies and comparisons with their model results can not be made.