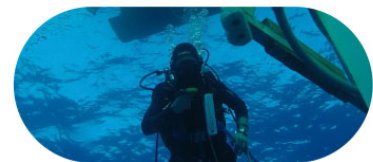




# Ocean-based Negative Emission Technologies



Deliverable Title	<b>D7.2 Summary report on deliberative workshop with stakeholders on mesocosm research in Bergen, Norway</b>
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<b>Abstract:</b> This report summarises the stakeholder engagement work conducted with actors in the Bergen region during OceanNETs research activities on ocean alkalinity enhancement. We describe our approach to stakeholder engagement and summarize some key insights derived from this process.	



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## Document History

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## 1. Introduction

### 1.1 Context

OceanNETs is a European Union project funded by the Commission's Horizon 2020 program under the topic of Negative emissions and land-use based mitigation assessment (LC-CLA-02-2019), coordinated by GEOMAR | Helmholtz Center for Ocean Research Kiel (GEOMAR), Germany.

OceanNETs responds to the societal need to rapidly provide a scientifically rigorous and comprehensive assessment of negative emission technologies (NETs). The project focuses on analyzing and quantifying the environmental, social, and political feasibility and impacts of ocean-based NETs. OceanNETs will close fundamental knowledge gaps on specific ocean-based NETs and provide more in-depth investigations of NETs that have already been suggested to have a high CDR potential, levels of sustainability, or potential co-benefits. It will identify to what extent, and how, ocean-based NETs can play a role in keeping climate change within the limits set by the Paris Agreement.

### 1.2 Purpose and scope of the deliverable

The deliverable summarises the stakeholder engagement activities conducted in conjunction with the mesocosm studies carried out in Bergen, Norway from May through July 2022. It analyzes key insights gathered from the stakeholder workshop carried out in June 2022, and the individual meetings with stakeholders convened during the mesocosm studies.

### 1.3 Relation to other deliverables

This deliverable informs further stakeholder engagement work across OceanNETs. It provides insights useful for future WP7 deliverables, including the final report on deliberative stakeholder workshops (D7.8), OceanNETs' work on a sustainable development goals framework for ocean-based NET evaluation (D7.9), and policy briefs assessing the local or regional fit of proposed NETs. It should also inform OceanNETs work on governance, specifically D2.3 (Report on regional and global governance challenges and opportunities for emerging ocean-based NETs) and D2.6 (Policy brief identifying challenges and opportunities for emerging ocean-based NETs in regional and global ocean governance frameworks targeted to EU and global policy makers).

## 2. Summary report on stakeholder engagement work in Bergen, Norway

### 2.1 Introduction

As we indicated in our report of the public outreach work carried out in Gran Canaria during the first series mesocosm studies, research on the environmental impacts of ocean alkalinity enhancement (OAE) offers an opportunity to localise and deepen discussions with stakeholders about the development of OAE, and of ocean-based negative emissions technologies (NETs) for carbon dioxide removal (CDR). The main purpose of the stakeholder engagement work conducted in Bergen is to inform local actors of OceanNETs research activities, elicit views on the mesocosm work, and create venues for discussions of ocean-based NETs attuned to local expectations, concerns and priorities.

Conducted a few months after the work carried out in Gran Canaria, the stakeholder engagement work in Bergen also provides an opportunity to compare and contrast the issues raised by local actors in two different contexts. This comparison will be developed in a forthcoming report (Deliverable 7.8: Report on mesocosm experimentation deliberative workshops with stakeholders).

### 2.2 Background review and stakeholder mapping

We began the stakeholder engagement work by identifying key issues relevant in the Norway/Bergen context. This first involved searching for and reviewing social science literature, grey literature and media coverage relating to issues of marine environments/oceans, coastal areas, CDR, and climate change. Our review uncovered documents relating to public debates, social conflicts, and issues of public perceptions on the following topics: climate change and climate transitions, coastal issues and coastal zone planning, fishers and fisheries, aquaculture, conservation, the blue economy, renewables and offshore wind power, and carbon capture and storage (CCS).

Drawing upon this review, we worked with OceanNETs colleagues at NORCE to identify a list of relevant actors and institutions to contact across these sectors. We used the networks established through the ‘Havlunsj’ meetings, a series of events that bring together actors connected to the maritime economy and marine environments in the Bergen region. We also conducted several in-person meetings with actors in Bergen in order to (1) introduce the OceanNETs research agenda, including the mesocosm experiments, and (2) further identify stakeholders who might be interested in the project.

We met with the following groups:

- Social science researchers at the University of Bergen’s Centre for the Study of the Sciences and Humanities who work on topics of environment, climate, and natural resources;

- Leadership from the Bergen Aquarium, which is connected to and collaborates with stakeholders in the Bergen region that range from environmental NGOs to CCS industry to academic marine research projects on related topics like microplastics;
- Interdisciplinary researchers from NORCE and the University of Bergen who work on CCS from legal, public perceptions, biogeochemistry, and engineering perspectives;
- Members of an aquaculture industry innovation hub called NCE Seafood Innovation, which comprises many of the key aquaculture companies active in Norway;
- Leadership from a large Norwegian shipping company, Grieg Maritime, which is active in other maritime industries as well;

We used these meetings to further identify relevant stakeholders or make contact with specific individuals (e.g., contacts at environmental NGOs, marine research institutions, and in maritime finance). These meetings also helped us identify several historical trends that could be relevant to understand local or national perceptions of ocean alkalinity enhancement. For example, several of our meetings flagged the history of river and lake liming in Norway, recent debates over other climate change mitigation policies (e.g., CCS and offshore wind), and the evolution of different sectors of the maritime economy. We come back to some of these themes in the discussion below.

Following these meetings, we reviewed the list of participants and identified several remaining gaps in our coverage of stakeholders, such as smaller fisheries institutions and government environment departments. We conducted further internet research to identify additional stakeholders in those spaces.

Ultimately, we used the full list of stakeholders to circulate invitations to an online discussion seminar to discuss the OceanNETs mesocosm studies and ocean-based CDR more generally. We circulated invitations in several waves to 55 stakeholders across the following areas: aquaculture (both large companies and start-ups), fisheries, CCS, environmental and conservation NGOs, start-ups working on CDR-related topics, other maritime industries (e.g., shipping, marine minerals, marine technology), water and environmental research institutes, trade organisations, a commerce organisation, a recreational fishing organisation, government fisheries and environmental departments, a local Bergen governmental body, business advisory organisations, banks, innovation centres in energy and maritime industries.

### 2.3 Stakeholder seminar

We designed an online seminar specifically tailored to local stakeholders. Conducted in collaboration with colleagues at NORCE and GEOMAR, the seminar was structured around two short presentations. The first one introduced the concept of ocean-based

negative emissions technologies, as broadly as possible, and offered some insights into the overall OceanNETs research agenda. The second presentation introduced the topic of ocean alkalinity enhancement, and explicated the design of the mesocosm studies. Participants first had a chance to ask any questions or raise issues in relation to the themes of the presentation, after which we moved into a moderated discussion organised around key themes on which we sought stakeholder input (see Appendix 1 for the discussion guide). Although the presentations were in English, the opening and closing of the seminar were in Norwegian, and participants were offered the chance to speak in Norwegian.

## 2.4 Key insights

### Environmental impacts and ‘safe operating space’ for OAE

Several questions regarding environmental impacts were flagged. Following the discussion of the mesocosm experimental design and its use of compounds to simulate lime and olivine, one participant asked whether the toxicity of trace minerals was evaluated prior to the mesocosm experiments. This was particularly relevant in relation to olivine, which contains nickel, chromium and other trace elements. (There was perhaps an uncommon awareness of olivine, as Norway is by far the largest global producer, and the largest olivine mine, the Gusdal Olivine Pit, is located in the country). It was explained that the mesocosms simulate the use of olivine, by including some of its key components, but does not include nickel or any other trace elements.

One concept that was introduced in the second workshop presentation that captured and addressed some of these concerns was the idea of using contained experimental work to define a ‘safe operating space’ for ocean alkalinity enhancement. The overarching criterion to define this space would be environmental safety – minimising impact not just on individual organisms, but on marine biological communities. Depending on the materials under consideration for OAE, future engagement work should proactively engage with potential toxicity issues, as these may not be immediately clear to some stakeholders (or public groups), and yet may be key to their evaluation of different OAE methods.

Other exchanges flagged other potential environmental concerns. One participant asked whether OAE might have similar effects of mineral bio-accumulation in sea sponges as those observed in the wake of deep sea mineral mining deep sea minerals (in their words, “the equivalent of ‘smokers’ lung”). Given that sea mining has generated controversy over environmental impacts,<sup>1</sup> this possibility may require further investigation. Environmental concerns did not always imply an opposition to OAE. The discussion included references to the potential of OAE to reverse acidification (discussed further below), or the potentially positive effects of carbonation.

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<sup>1</sup> <https://www.iucn.org/resources/deep-seabed-mining>  
[https://www.biologicaldiversity.org/campaigns/deep-sea\\_mining/pdfs/Deep-seaMiningFAQ.pdf](https://www.biologicaldiversity.org/campaigns/deep-sea_mining/pdfs/Deep-seaMiningFAQ.pdf)

### Uncertainties illuminated by mesocosm studies and timescales for development of OAE

In addition to providing empirical evidence on the impacts of additional alkalinity on marine ecosystems, the experimental work conducted in Gran Canaria and Bergen is revealing new areas of uncertainty. An issue that raised the interest of participants was the precipitation of calcium carbonate observed in the mesocosm studies, which imply a potential net loss of alkalinity and corresponding release of carbon into the atmosphere. Support for further research on OAE appeared widespread, but raises the question of plausible timelines for the evaluation and potential adoption of OAE. One of the participants in the workshop raised the example of carbon capture and storage (CCS), a technology that is currently receiving a great deal of attention and investment in Norway, but which only garnered sufficient support after more than a decade of discussions and debates in the country. The need for extensive research on fundamental aspects of OAE suggests risks in any premature transition to uncontained experiments.

### Interactions with existing marine uses and industries

Norway's strong reliance on maritime industries might signal particular scepticism about intervening in marine environments, but stakeholders emphasised the country's particular interest and openness to emerging technologies and innovations, citing examples from CCS to green shipping fuels. The question is whether OAE could include co-benefits, conflicts or overlaps with existing maritime activities, such as aquaculture, fisheries, and other elements of the regional and national 'blue economy.'

Hypothetically, such a co-benefit might align to address existing priorities that these sectors have identified. Multiple stakeholders cited ocean acidification as an environmental challenge facing Norway, along with related issues like extinction of fish species. One seafood company identified ocean acidification as one of its key sustainability challenges, along with sea lice and creation of anoxic environments. However, whether this overlap serves as a synergy or tension requires further investigation.

In some of the one-on-one meetings, stakeholders had queried the potential synergies with existing economic sectors and infrastructures. Norway has one of the largest shipping industries in the world, and ideas floated in these discussions included repurposing very large crude carriers (VLCCs) for mineral distribution once they can no longer be used for their original use, retrofitting greywater systems for the on-board conversion of mineral powders to solutions (assuming solutions are a more environmentally sound and efficacious approach to OAE), or using hull sensors as part of a monitoring infrastructure.

These discussions remained speculative, and somewhat disconnected from the specific purpose of the mesocosm studies, but suggest the relevance of potential synergies to local stakeholders (similar discussions took place in Gran Canaria during the first phase of experimental work). They point to the relevance of the policy and economic frameworks,

within which OAE might be developed (including the possibility of a market for OAE-derived carbon credits). Participants inquired about matters relating to monitoring, verification and reporting, and this remains a key dimension to gauge stakeholder perceptions of OAE and other ocean-based NETs.

### Norwegian experience in artificial liming

Some actors mentioned Norway's fairly unique experience in the liming of rivers, lakes and catchments. Since the 1980s, liming has been used to restore fish populations in acidified waters in several southern counties. The key goal of this programme has been to re-establish extinct or nearly extinct populations of Atlantic salmon in many rivers, generally by the deposition of powdered limestone in the relevant catchments or lakes. The operational features of these programs vary, but in some cases approximate (at a smaller scale and in fresh water systems) some of the scenarios that OceanNETs is considering. In some cases liming is carried out directly on lake surfaces, in other cases lime dosers for continuous liming of running water are used. A particularly salient aspect of these programs is the extensive monitoring of environmental effects, including the possible impact of trace metals. We are collecting more evidence to assess its relevance of this experience to our research on ocean alkalinity enhancement.

## **3. Conclusion**

Although many local actors appreciated the opportunity to learn more about the research OceanNETs is conducting in Bergen, the mesocosm studies themselves seemed to have limited salience to the stakeholders we approached. This is why, in the group discussion, we aimed to emphasise the *trajectory* of OAE development, rather than immediate *implications* of the experimental studies. Engaging stakeholders on hypothetical trajectories of development proved challenging, given gaps in the scientific evaluation of OAE and the many potential deployment options (e.g., different materials, with their associated industries and life cycles of these materials, uncertain options for dispersal, and lack of clarity on regulatory aspects, including removals certification).

We plan to continue the stakeholder engagement work in the region with further individual interviews. Given the interest of some local institutions to host further discussion we are considering a further workshop when the full results of the mesocosm studies are available. The insights gathered in this follow-up work will inform the final report on deliberations with stakeholders (Deliverable 7.8 [36]).



## Appendix 1: Discussion guide for stakeholder seminar on OAE in Norway

1. [Follow up on any questions or comments made during the Q&A session that might deserve further discussion]

2. Norway has declared an intention to reach ‘climate neutrality’ by 2050. [The Parliament adopted a resolution in 2016 that Norway should be ‘climate neutral’ in 2030, but this has not been enshrined in law]. There is, however, no specific policy to develop NETs (as far as we can tell).

- What role could you imagine ocean-based NETs playing in Norwegian climate policy?
- Can you imagine OAE being part of climate change mitigation strategies in Bergen/Norway? Why/why not? How does it compare to other kinds of ocean-based NETs tackled by the project?
- Could you imagine this being done in the fjords, or only far off the coast?
- Can you imagine potential synergies, or tensions, with other uses of marine space?

3. At this point [as the presentations have suggested] it is unclear whether OAE can play a significant role in meeting carbon neutrality targets, or which particular type of OAE will offer the best risk-benefit profile.

- The first priority is to conduct further research on the impact of OAE on marine ecosystems, and on its potential as a method of carbon dioxide removal. Do you see the Bergen region playing a role in further research efforts, or are there aspects that should be clarified before further research is conducted?
- Bergen has a thriving set of economic sectors related to the ocean economy. What do you think is the role of ocean-based NETs in this context?

4. At the moment [as mentioned in the presentations] the regulation of OAE is uncertain. How removals could be verified and certified (for example as a way of generating carbon credits) is also highly uncertain. In your view, what are the key questions that would need to be resolved before this type of ocean-based NETs is developed further.

5. Who should be involved in future discussions about the prospect of OAE and its governance? Can you think of relevant stakeholders that should be part of this conversation?

6. In our preliminary research we have noticed a history in Norway of liming lakes and rivers in the 1970s and 1980s to reverse the effects of acidification and replenish fish stocks. Are you aware of that history, and do you see that experience as relevant to the research OceanNETs is conducting?

7. Norway has a tradition of upholding the “polluters pay principle”. Considering the presentations and discussions thus far, is this a relevant principle that should be applied to the governance and financing of OAE and/or other approaches discussed in this session?