

Engaging coastal communities on ocean alkalinity enhancement



A how-to best practice guide



INSTITUTE *for* RESPONSIBLE
CARBON REMOVAL

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ACKNOWLEDGEMENTS

This report was made possible through the generous support of ClimateWorks Foundation.

DESIGN AND LAYOUT

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SUGGESTED CITATION

Nawaz, S., & Belotti, G. (2025, July). *Engaging coastal communities on ocean alkalinity enhancement: A how-to best practice guide*. Institute for Responsible Carbon Removal.

Version 1: April 2025

EXECUTIVE SUMMARY

As marine carbon dioxide removal technologies like ocean alkalinity enhancement move from lab to field, attention to engaging local communities on this subject is growing. However, minimal information is currently available on structuring and implementing this kind of engagement. This guide is intended as a resource to a diverse range of groups who may be looking to conduct (or review or fund) community engagement activities on ocean alkalinity enhancement. It draws on the authors' experiences conducting engagement on ocean alkalinity enhancement in several different contexts, as well best practices from related fields and technologies.

This guide does the following:

- Introduces what we mean by '**meaningful community engagement**' and its importance
- Describes how to **tailor engagement** to different stages of ocean alkalinity enhancement research and/or deployment
- Offers ideas for **creative and interactive ways to work with communities** to understand and deliberate on ocean alkalinity enhancement
- Discusses the ways that **engagement with Indigenous communities** requires additional attention, recognition and care
- Introduces **10 best practices** to keep in mind when engaging communities
- Provides suggestions on **key concepts** to introduce when introducing ocean alkalinity enhancement
- Offers suggestions on **navigating your role as an engagement practitioner** when interacting with both participants and technology/project developers
- Shares examples of **questions you might expect** to receive when conducting engagement activities
- Describes **three case studies** of engagement on ocean alkalinity enhancement that the authors have conducted

This is the first version of this guide. We may update the guide in the future with additional resources, tools and guidance as these become available.



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1. INTRODUCTION

Why think about community engagement on ocean alkalinity enhancement?

At current emission levels, decarbonization alone will not suffice to meet the climate goals outlined in the 2015 Paris Agreement. To prevent global warming from exceeding 1.5°C above pre-industrial levels—and thus avoid the most severe consequences of climate change—substantial amounts of carbon dioxide (CO₂) must be removed from the atmosphere and stored. Carbon removal technologies, also referred to as carbon dioxide removal (CDR) or negative emissions technologies, include a wide range of approaches to durably remove CO₂ from the atmosphere.

What is carbon removal?

To be truly considered carbon removal, it must adhere to the following principles:

- **Durable storage**

CO₂ must be stored safely and for a long duration, anywhere from centuries to millennia. Using CO₂ in commercial products, such as beverages or synthetic fuels, does not qualify as removal, as the CO₂ will eventually return to the atmosphere in the short term.

- **Additionality**

It must result in the removal of CO₂ beyond what would have otherwise been released. This makes carbon removal distinct from carbon capture and storage (CCS), where the CO₂ emitted during fossil fuel combustion is subsequently captured. CCS does not directly lower atmospheric CO₂ levels and should not be considered equivalent to carbon removal.

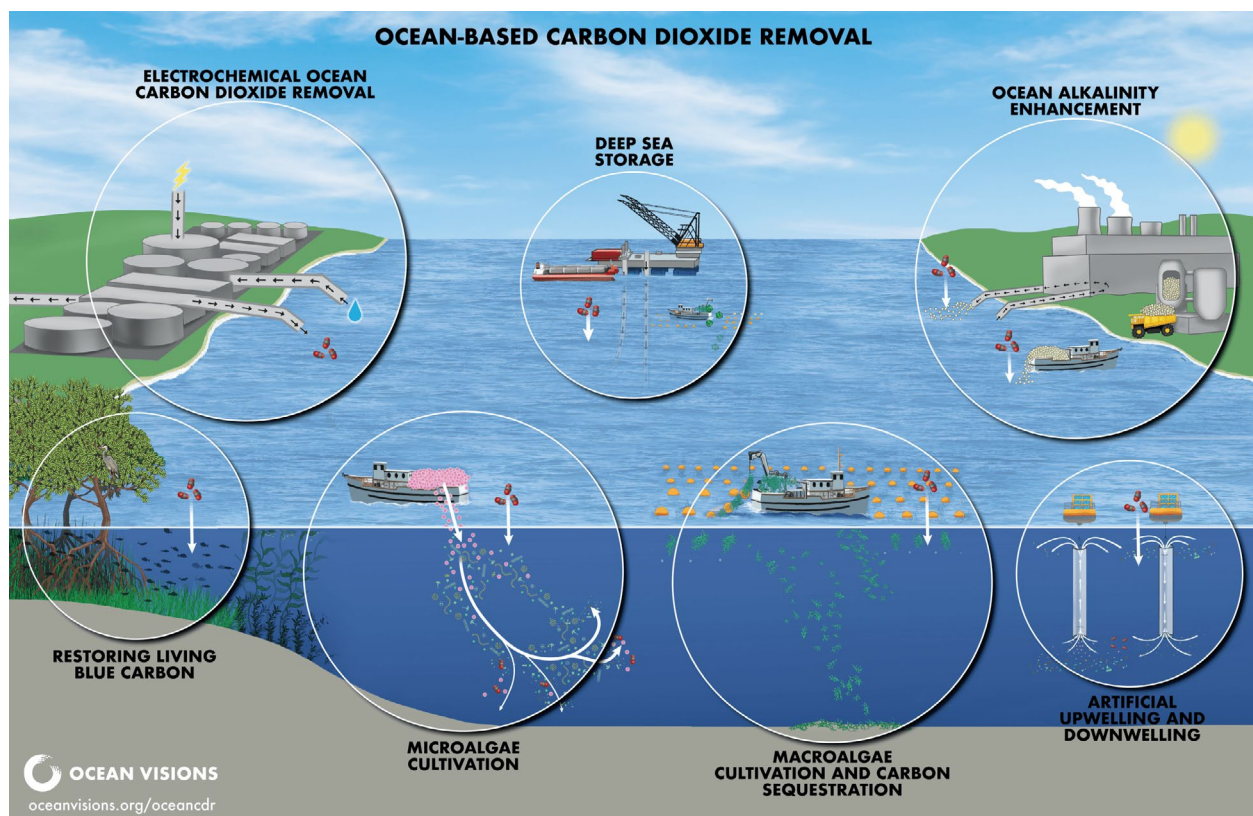
At the Institute, we also believe that an essential aspect of ‘responsible’ carbon removal is that it must **complement, not substitute for, emissions reductions**. It must not serve as a justification for delaying significant emissions reductions. Instead, it should be viewed as a necessary complement to drastic emission cuts.

While there is broad consensus among scientists and experts on the need for carbon removal, significant uncertainty remains about the exact amount required each year. High-end estimates at approximately 10 gigatonnes (Gt) of CO₂ per year by mid-century, increasing to 20 GtCO₂/yr by the end of the century. With current annual anthropogenic emissions at roughly 36 billion tonnes, this implies that about one-third of annual global emissions will need to be permanently removed each year. In this guide, we focus on a novel approach to carbon removal that is currently being researched in the lab and increasingly at the field-level, with a theoretical potential for scaling to gigatonne levels.

Approaches to marine carbon removal

Marine carbon dioxide removal (mCDR) approaches can be broadly classified into two categories: abiotic, which leverage the ocean's physical or chemical properties to remove CO₂ from the atmosphere, and biotic, which rely on biological processes. Some of the most widely recognized mCDR approaches include coastal wetland restoration, seaweed cultivation, artificial upwelling, nutrient fertilization, artificial downwelling, ocean alkalinity enhancement, and electrochemical CO₂ removal. The approach that we focus on in this guide—ocean alkalinity enhancement, or OAE—is receiving increased attention, with substantial investments being directed toward its development. Part of the reason for the growing attention on OAE is its theorized potential to scale to gigatonne levels of removals.

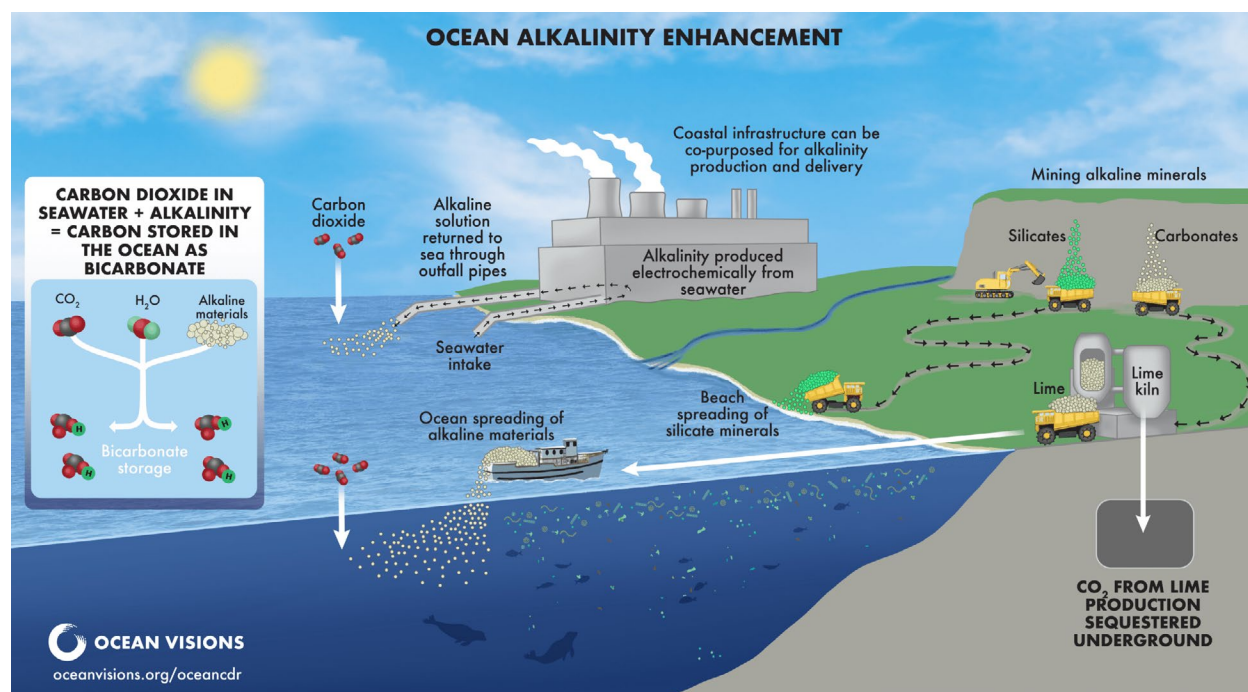
FIGURE 1. *Different approaches to marine-based carbon removal*



What is ocean alkalinity enhancement?

OAE involves adding alkaline substances to marine waters, where they react with seawater to convert dissolved CO₂ into bicarbonates and carbonates—safe and stable forms of carbon that can be stored long-term. There are several ways to implement OAE, such as spreading ground minerals like lime or olivine in ocean waters or on the coast, or using electrochemical processes to split seawater into acidic and alkaline streams, with the alkaline stream subsequently released into the ocean.

FIGURE 2. *Different ways to do ocean alkalinity enhancement*



What is meaningful community engagement and what does it have to do with ocean alkalinity enhancement?

Community engagement encompasses all instances in which communities are involved in a specific project or decision-making process. It is essential that communities who might be affected by a project are involved in decision making about it, and this is particularly crucial with small, early trials that may lead to many future scaled-up activities, as is intended with OAE. For engagement to be truly valuable, we believe it must go beyond mere consultation or one-way feedback sessions. Meaningful community engagement fosters open and transparent communication, ensures communities have access to the necessary resources and information to understand the foundational aspects of the technology, and offers genuine opportunities for participation and shared decision making. Meaningful engagement is essential to ensure that OAE, and carbon removal more broadly, are conducted in a just, equitable, and responsible manner.

Who is this guide for?

We are social scientists, but this guide is intended for people who may not necessarily be focused on academic, published research. Instead, we orient this guide to any individuals and entities who wish to lead engagement efforts on OAE. This guide seeks to apply social scientific methods and insights to produce a practical resource of value to a wide range of users. In other words, we draw on methods and insights from a broad range of social science scholarship and aim to present them in a jargon-free, accessible manner.

We envision this guide as being of interest to those looking to carry out their own engagement activities, or those tasked with evaluating the engagement plans of others who are designing such engagement initiatives, for example:

- OAE project developers
- OAE research consortia
- City, community, local planners
- Environmental and climate NGOs
- Local community groups who hear about OAE research and are interested to think about it more
- Funders who want to understand what 'good engagement' might involve in mCDR and OAE projects they are funding

Social scientists who haven't yet worked on mCDR or OAE

While community engagement is often treated as a tool to avoid backlash against a project, it is not a mere means to an end. It is essential for developers and external entities proposing projects to recognize and respect the wealth of knowledge that communities hold. Local residents understand their territory and waters, the social context, and the intricacies of their environment often much better than outsiders. Concerns dismissed as NIMBYism are sometimes well-informed and valid, reflecting a deep awareness of the potential risks and impacts within a unique local context. For this reason, those looking to implement projects such as OAE research or deployments should seek to involve communities as active partners and co-producers of knowledge, rather than treat them as one-way, passive recipients of information.

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2. TAILORING ENGAGEMENT TO THE STAGE of research and/or project development

Let's say you are planning an OAE (or even other mCDR) field trial. Where should you begin? Possible community engagement activities will look different depending on your specific stage of research or project development. That said, it is essential that engagement begins as early as possible (see Best Practice #4, below). People may be angry if you are coming to tell them that a trial or a deployment is underway for something they have never heard of before! Ideally, outreach should begin well in advance of any trial or project proposal, allowing communities to learn about OAE and other CDR technologies that might impact their region in a hypothetical future.

In early stages of engagement, when a project has not yet been proposed, it may be possible to engage only a small portion of the community. Once a technology like OAE reaches larger scales of deployment, however, we believe it requires larger scale participation from the public. This means not just involving local communities, but also more representative samples of population.

The table below outlined suggestions for what goals community engagement might emphasize at each stage of OAE research and deployment, understanding that engagement 'on the ground' is often complex and evolving.



TABLE 1. Tailoring engagement to three stages of research

			
	Lab experiments <i>Bench research; mesocosm research (contained field trials)</i>	Field trials <i>Early pilot deployments (e.g., hundreds to thousands of tonnes of removals)</i>	Larger deployments <i>(e.g., tens of thousands of tonnes of removals and up)</i>
FOCUS OF ENGAGEMENT	■ Introduce participants to carbon removal and OAE ■ Begin understanding if proposed project might align with community and public priorities – this means understanding community priorities in the first place ■ Explore support for (or opposition to) continued research beyond the lab, or possible deployment ■ Explore any specific conditions of support (e.g., “I support this only if XYZ occurs”)	■ Generate understanding of community or public stances on specific project-related decisions ■ Discuss previous iterations of the project with communities: which concerns have been addressed? Which priorities remain unmet? ■ Continue understanding support for (or opposition to) ongoing work ■ Continue understanding specific conditions of support	■ Leverage established relationships with local communities for continuous project evaluation ■ Engage a broader population sample to inform decision about larger projects, moving from co-creation of knowledge to collaborative decision making



Engagement activities must be carefully selected to address both the specific needs of the communities and the overarching objectives of the engagement process. In hopes of sparking your imagination, the table below provides a non-exhaustive list of possible activities for fostering participation and collaborative decision making. This list primarily includes activities most suited for community workshops. While we acknowledge that engagement can also involve surveys, public hearings, open houses, and similar activities, we emphasize workshops as we have found that these tend to emphasize participants' roles in actively shaping outcomes.

A final point: because OAE is still in its early stages, certain activities—such as mini publics and deliberative polling—may be more appropriate for later stages of the engagement process and may be less relevant at this point of the technology development. This does not mean that more participatory methods should be ruled out (on the contrary, we believe that this is exactly what engagement practices should ultimately aim to achieve), but we recognize that exploring these in greater detail might only happen in later stages.

TABLE 2. *Ideas for engagement activities*

Engagement activity	Description	Further reading
 Interactive games	Purpose-driven, interactive games, often called 'serious games,' can serve as a powerful tool to promote social learning and inspire collaborative action. These games can offer participants an engaging way to explore different technology configurations, think about tackling complex challenges, and foster meaningful discussions.	Flood et al. (2018) Edwards et al. (2019) Bakhanova et al. (2020)
 Future scenarios	Scenarios are a tool that can help individuals envision and develop plausible, cohesive versions of futures with (or without) a project or technology. The creation of scenarios can be approached both qualitatively (through qualitative scenario assessment) and quantitatively (through modeling). Comparing different scenarios is useful for people to understand the trade-offs and complexities of future socioecological and technological configurations and make informed decisions about the systems they would like to see unfold in the future.	Iwaniec et al. (2020) Tori et al. (2023) Louen et al. (2023)
 Charrette	Charrettes are collaborative, interactive design workshops and planning processes aimed at developing a project plan or solving a problem. Typically held over several days, they bring together a diverse group of stakeholders—including community members, experts, and designers—who work together to refine the plan based on a shared vision and public input. The goal is to create solutions that reflect the collective perspectives and priorities of the group.	Kilbane and Roös (2023) National Charrette Institute American Planning Association (2018)
 Storytelling and facilitated dialogue	Storytelling is a social and cultural practice that involves sharing stories and narratives. While often viewed as a way to reflect on the past, it can also serve as a tool for imagining, questioning, and planning for a future that communities collectively aspire to create. Facilitated dialogues encompass a range of methods, but generally involve structured conversations led by one or more facilitators, with the goal of addressing a challenge or developing a plan.	Liguori et al. (2021) Drimie et al. (2021) American Planning Association (2023)



Engagement activity	Description	Further reading
 Community mapping	Community mapping is a participatory process in which local residents actively engage in identifying and documenting the assets, resources, and characteristics that they value within their community or region. In addition to mapping existing resources, the exercise can also serve as a tool for planning and envisioning future development. Community mapping can more generally support the development of capacity for community-driven decision-making by strengthening local relationships. It recognizes communities' knowledge and encourages their ownership of the planning process.	Delgado and Humm-Delgado (2007) Maptionnaire (2023) Cochrane and Corbette (2018)
 Deliberative polls	Deliberative polling is a method used to engage the public in informed decision-making by gathering a random, representative sample to deliberate on specific issues. Participants first take a baseline survey, then come together to discuss the issues in depth, guided by briefing materials and facilitated discussions with experts and stakeholders. After the deliberation, the same survey is administered to assess changes in opinion. The process aims to reveal how public opinion may evolve when people are given the opportunity to become more informed and engage with diverse perspectives.	Fishkin (2018) Fishkin (2021) Stanford Deliberative Democracy Lab
 Mini publics	Minipublics are structured, two-way engagement and deliberative processes designed to facilitate informed decision-making. They typically involve selecting a random, representative sample of the public, which could include individuals from a specific geographic area (e.g., a city) or a particular demographic group (e.g., young people or renters). The process usually unfolds in three stages: a learning phase where participants are provided with relevant information, a deliberation phase where they engage in discussions, and a final decision-making phase.	Ainscough and Willis (2024) Curato et al. (2021) Smith and Setälä (2018)



ENGAGING INDIGENOUS COMMUNITIES

Centering rights and knowledge

OAE projects will likely be explored in regions where Indigenous communities—who are rights holders, not stakeholders—are present and must give consent to projects. This distinction is crucial: Indigenous peoples have inherent rights over their lands, waters, and resources, including the right to Free, Prior, and Informed Consent (FPIC), as recognized by the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) and relevant local treaties and laws. Engagement must honor these rights and, at its core, be built on respect for Indigenous sovereignty and self-determination over traditional lands and waters.

When engaging Indigenous communities in OAE projects, the following are additional things to be attentive to. Many of these are not entirely different from what 'meaningful engagement' looks like elsewhere, but may be particularly crucial in Indigenous contexts.

- **Decolonize the process**

We believe that decolonizing the process begins with informing yourself of the historical and ongoing impacts of colonization on Indigenous territories and cultures. It also involves recognizing Indigenous communities as knowledge-holders and experts in their own lands and waters.

- **Prioritize long-term relationship building**

Engagement with Indigenous communities requires centering the development of long-term relationships and partnerships. This means that it may take quite a while to be able to have the kind of engagement that you are hoping for.

- **Co-construct engagement**

Indigenous communities should be active partners in shaping the priorities of engagement. This means co-developing questions, identifying culturally significant species and sites, and centering the future they envision for their territories.

- **Recognize Indigenous knowledge**

Indigenous knowledge embedded in diverse worldviews, histories, and culture offers essential perspectives for project decision making.

- **Respect established protocols**

Many Indigenous communities have existing protocols or agreements around research collaboration. These may include conditions on accountability, intellectual property, compensation, and confidentiality, and they can be legally binding. Depending on how you are planning to use your engagement findings, a research agreement may apply.





FURTHER RESOURCES

- **Co-producing Sustainable Ocean Plans with Indigenous and traditional knowledge holders**
(World Resources Institute/Strand et al.)
- **Free Prior and Informed Consent An indigenous peoples' right and a good practice for local communities**
(Food and Agriculture Organization of the United Nations)
- **Social considerations and best practices to apply to engaging publics on ocean alkalinity enhancement**
(Satterfield, Nawaz and Böttcher)
- **Sealaska Heritage Institute Research Policy**
- **Co-production of knowledge**
(Navigating the New Arctic-Community Office)
- **Inclusive ocean data for decision making**
(Ocean Nexus/Sey and Rothschild)
- **Community Energy Planning: Best Practices and Lessons Learned in NREL's Work with Communities**
(National Renewable Energy Laboratory)

3

3. BEST PRACTICES FOR ENGAGING

communities on OAE (with many relevant best practices for mCDR as well)

NOTE | These best practices are not universally applicable to all audiences reading this guide. Some suggestions will be more relevant for those designing, initiating, or funding projects, while others are specifically geared towards individuals responsible for carrying out engagement activities.



Best Practice ①

Thoroughly research potential partners

Evaluating partners

- ✓ Reputation
- ✓ History of public engagement
- ✓ Alignment with the goals of the OAE project

Before launching any community engagement efforts for OAE projects, it is critical to conduct thorough research on your potential partners. Because partnerships are generally formed early in the planning stages, often before formal community outreach begins, they can heavily shape your engagement approach before you might even realize it. Carefully vetting potential partners from the perspective of public reputation will be helpful,

whether they are government agencies, industry leaders, local businesses, or community organizations. You may be surprised who is liked or disliked! Try to evaluate their reputation, history of public engagement, and alignment with the goals of the OAE project. Partnering with an organization that has strong local support can enhance the chances of fostering productive relationships, while selecting a partner with a history of contentious relationships with the public can create hurdles and undermine trust-building.



Best Practice ②

Identify the most relevant participants

How do you ascertain who interested and relevant groups might be? One approach is to conduct a broad mapping exercise early on in the project, using tools like stakeholder analysis, surveys, and local interviews. Connect with local community organizations and attend community meetings to understand the landscape.

Broad mapping exercise



Stakeholder
analysis



Surveys



Local
interviews

Often, existing networks of trusted community leaders will help guide you to the most relevant groups and individuals. A good starting point is to build relationships with these local intermediaries who can offer valuable insights about the local context and who should be included in your discussions.

The groups most relevant to OAE projects often include a variety of actors—such as local fishermen, environmental activists, coastal industry workers, Indigenous communities, policymakers, and scientists. In the case of our OAE research in places like Sequim, Washington, we identified key groups like commercial fishers, local conservation organizations, and municipal and state governments as key participants, each bringing unique interests and concerns.



One major risk at this stage is reinforcing existing power dynamics, where only the most vocal and influential groups are consulted, sidelining the voices of marginalized or less represented communities. It is essential to proactively seek out groups that are typically not at the center of discussions. Existing literature and community studies can provide valuable insights on who might be these historically and contemporarily marginalized or oppressed groups in your region of interest (e.g., newcomers, racialized communities, youth, or other underrepresented groups).

Another important consideration is when to involve the broader public. It may be appropriate to focus your engagement efforts only on a subset of ‘interested’ actors at the initial stage of engagement, such as when no major decisions have been made, or before a project has been proposed. But as the process progresses, it will likely be important to expand engagement to the broader public, involving individuals who may not belong to specific community groups in order to ensure a more inclusive approach and capturing a wider range of perspectives and experiences.



Best practice ③

Know the history of the community

Knowing the history of the area where community members live and work is a next critical step. Communities often have deep-rooted histories that shape their current attitudes and values. What has been the **local reception to related projects or technologies** that have been introduced in the region? **Local views on fishing management** may be critical—communities that depend on fishing for their livelihoods may be particularly sensitive to any concerns about marine ecosystems or local fisheries. Any perceived threat to marine biodiversity or the sustainability of the fishing industry could lead to resistance or heightened scrutiny. Similarly,

Community views on ...



fishing
management?



coastal
industries?



marine renewable
energy?



mining?

the **local history of marine renewable energy** policies—such as offshore wind or tidal energy projects—should be considered.

Perceptions of coastal industries—such as tourism, shipping, and aquaculture—are also important to consider. For example, communities reliant on tourism might be concerned about the visual impact of an OAE project or its potential effects on local marine life, which could in turn harm the area’s appeal to visitors. Finally, local perceptions of mining are also relevant to mineral-based OAE approaches.



Best Practice 4

Engage communities early

Why engage communities early?

Engaging communities early builds ...

- ✓ Relationships with community
- ✓ Trust
- ✓ Understanding of preferences and concerns
- ✓ Local knowledge of development process

Challenges if communities are **NOT** engaged early ...

- ✗ Resentment and suspicion
- ✗ Distrust
- ✗ Misunderstanding
- ✗ Strong opposition

A fundamental feature of good engagement is involving communities early in the process—ideally before any major decisions about OAE deployment are made. Early engagement allows you to establish solid relationships with the community, build trust, understand preferences and concerns, and integrate local knowledge into the development process—before pivotal decisions are finalized. Conversely, failing to engage communities at the outset can lead to significant challenges later on, with one of the most prominent risks being the erosion of trust. When communities feel like decisions are being made without their input or that they are being excluded from the decision-making process, it can foster resentment and suspicion. If engagement efforts occur too late—after key decisions are finalized or the technology is already implemented—people are far more likely to feel disempowered and alienated, further complicating efforts to build community

support. Late engagement also increases the risk of misunderstanding, risking escalation of (potentially unfounded) worries to strong opposition that might otherwise not have occurred.



Best Practice ⑤

Take care in framing the conversation on OAE

One of the greatest challenges in communicating about OAE is effectively explaining the complex science behind marine carbon cycles and how OAE might fit into the broader picture of carbon removal, climate change action and marine conservation. For most people, even scientists, the marine carbon cycle is not an intuitive concept. Communicating these ideas in a clear and accessible way requires a balance of scientific accuracy and simplicity, especially when engaging with groups or individuals that may have limited background in these topics.

Key concepts to introduce when talking about OAE

The following concepts are ones that we have found to be important and useful to introduce when discussing OAE with various non-expert groups.

- Greenhouse gas effect
- Carbon dioxide
- Anthropogenic climate change
- Marine carbon cycle
- pH
- Alkalinity
- Ocean acidification

For each of these, there are specific best practices to consider when communicating them to a general audience.

Concept

How to introduce

Greenhouse gas effect

When introducing the greenhouse gas effect, it may be helpful to acknowledge that carbon concentrations have varied over geological times, and the Earth's climate has changed as a result. However, it is important to emphasize that the current rise in carbon concentrations is due to human activities, particularly the burning of fossil fuels, not natural processes.

Carbon dioxide (CO₂)

Carbon dioxide is a gas that naturally exists in the Earth's atmosphere and is crucial for life, as plants use it for photosynthesis. However, when we burn fossil fuels (like coal, oil, and gas), we release large amounts of CO₂ into the atmosphere. This extra CO₂ traps heat, contributing to global warming. To make it more relatable, you can compare CO₂ to the glass in a greenhouse, helping people understand how excess CO₂ leads to a "thicker" atmosphere and higher temperatures.

Anthropogenic climate change

When discussing climate change, research suggests avoiding framing it as an urgent emergency or using language of doom and gloom. While it's critical to be honest about climate change's potential impacts, it's equally important to focus on hope and solutions. When asked "why it matters," explain the consequences of inaction, but highlight the power of collective efforts to mitigate its effects.¹

Marine carbon cycle

Keep explanations of the marine carbon cycle simple and relatable. You likely will want to avoid getting too technical with the chemistry, but this depends on the group. You can explain how carbon moves between land, ocean, and atmosphere, highlighting its importance in regulating global climate without delving into too much complexity.

pH

To explain pH, use a visual scale and relate it to everyday items that people can easily understand, such as lemon juice (acidic) and baking soda (basic).

Alkalinity

When explaining alkalinity, it might be helpful to simplify the concept by describing it as the "basic" property of a solution, similar to how you might explain things like baking soda or soap being basic. You can note the simplification you've made; we have found that this simplification avoids overwhelming the audience while still conveying the key idea.

1 A brief note: It is possible (or even likely) that you will encounter individuals who are skeptical of climate change. In these situations, it might be helpful to refer to scientific evidence such as CO₂ levels trapped in ice cores, which confirm the link between human activity and current climate change (with over 99% certainty). However, keep in mind that your short engagement session likely won't be able to convince skeptics that climate change is real and anthropogenic.

Concept**How to introduce****Ocean acidification**

To explain ocean acidification, first describe how the ocean absorbs excess CO₂ from the atmosphere: explain that over time, this process increases the acidity of seawater, which can harm marine life, particularly organisms with shells or skeletons, like corals and shellfish. Use simple visuals, such as a diagram showing CO₂ entering the ocean and lowering pH, to help make the process easier to understand. Emphasize that while ocean acidification is a process that occurs regardless of human CO₂ emission, the current rate of acidification is much faster due to this additional, anthropogenic CO₂.

Ocean alkalinity enhancement (OAE)

When explaining ocean alkalinity enhancement, we have found it important to clarify that the approach involves a chemical process that increases the ocean's ability to absorb and store carbon in more stable forms. Crucially, it doesn't 'extract' carbon from the atmosphere or generate a concentrated source of CO₂. Instead, OAE causes the ocean to absorb more CO₂ from the air by making the water more alkaline, which allows more carbon to be stored in the ocean over longer periods.

We have found it helpful to work with a **technical expert**—someone who has an in-depth understanding of the science of marine carbon cycles and the mechanisms behind OAE. This person can provide the nuanced explanations needed to accurately communicate how OAE works, as well as the broader implications of altering the ocean's chemistry to enhance its capacity for carbon removal. An important note: it is important to prepare and guide the technical expert in advance of an engagement activity to ensure that their communication style is accessible to a non-expert audience. One risk to be aware of when working with a technical expert is the possibility that technical answers will be 'conversation enders' instead of 'discussion openers'; when a participant asks a question, a technical expert's answer should ideally be followed by an exploration of the 'why' behind the participant's question. To offer an example: "that's a great question. Here's a brief answer of what we know so far about this. Can you tell me more about why you asked that question, or where that concern comes from?"

One area to watch carefully is the temptation to use **analogies** that tie OAE closely to "natural" processes. While it might be appealing to describe OAE as "mimicking natural carbon cycles" or "restoring natural balance," this kind of language may inadvertently generate false trust. Extensive empirical research suggests strong preferences for what is 'natural', and associations of 'naturalness' with OAE can backfire once participants learn more about the complexities and risks involved and differences between 'natural' processes and anthropogenic OAE. Because of this, we suggest avoiding language that implies OAE is 'natural'.

Similarly, while it's important to make clear that OAE is part of the solution to the climate crisis, we also suggest avoiding placing excessive emphasis on the urgency or 'emergency'

aspects of climate change during early community engagement. While the climate crisis is an undeniable reality, framing the project too heavily in terms of ‘immediate’ climate action can alienate communities who may already feel overwhelmed or skeptical about the urgency of the issue. Overstating the crisis in relation to the technology can also lead to feelings of fear or anxiety, especially if the community feels like they’re being asked to take action on something they don’t fully understand or trust. Instead, focus on explaining OAE’s potential benefits in a more neutral way, and explain how it fits into a broader portfolio of climate solutions.

Given that the marine carbon cycle is not an intuitive concept for most people, **visual aids** are invaluable in explaining how OAE works. Consider using **simple diagrams** and **infographics** that illustrate how carbon moves through the ocean. As discussed above, a key point to emphasize is that with OAE, **carbon removal occurs in a distributed way throughout the ocean**—OAE does not produce a concentrated stream of CO₂. We have found this distinction important to people’s grasping of OAE, as they may tend to conceptualize carbon removal in terms of pulling carbon out of the environment. Work with graphic designers or scientists to create **images** and **animations** that clearly show the flow of carbon through the ocean, from atmospheric CO₂ to the water column and deep ocean, and how OAE might help accelerate this process. Ensure that these visuals are **simple, straightforward**, and stripped of overly technical jargon, but also accurate enough to convey the scientific integrity of the process. Moreover, when discussing marine carbon cycles and OAE, it’s important to take the time to **explain the process step by step**. Offer plenty of space for questions and clarify any points of confusion. Emphasize that the science behind OAE is not just theoretical—it’s based on **real-world observations** of how carbon behaves in the ocean, even though much of the technology is still in development.

It is crucial to acknowledge that, while the science behind OAE is promising, it remains a new and evolving technology. Being transparent and up-front about the **uncertainties** and potential risks associated with the project—and explaining how these are being actively studied and managed—builds trust. Communities are more likely to engage positively if they feel that you are not overselling the technology or glossing over the challenges.



Best Practice ⑥

Discuss multiple dimensions of OAE technologies

When discussing OAE with communities, it is important to provide a comprehensive explanation of the technology itself—its dimensions, methods, and potential variations—even if your project is only considering a specific approach. By providing a full picture of the different dimensions of OAE, you allow community members to make more informed decisions and feel that their concerns are being fully addressed. This level of transparency and openness is a cornerstone of good community engagement and ensures that people feel informed, respected, and involved in the conversation from the start. OAE is not a single, one-size-fits-all technology; it’s an area of active research with several potential methods and variations that could impact the community in different ways. It is worth exploring if and

how people might prefer alternative arrangements, even if your project has a very specific approach it is anticipating using.

The key dimensions to discuss include:

- **Dispersal methods**

One of the core questions that often arises with OAE is how alkalinity will be dispersed or introduced into the ocean. There are several potential dispersal methods, from adding minerals to the ocean via ships or pipelines to more passive methods like enhancing natural weathering processes. Each method carries its own set of benefits and challenges, both environmental and logistical. It is important to clearly explain how these dispersal methods work, the potential impacts they may have on marine and coastal ecosystems, and how they will be monitored and managed.

- **Location**

People are naturally concerned about the local environment, so it is essential to be transparent about where the project could take place and why that location was chosen. Will the project occur offshore or closer to shore? In a deep-sea environment or in shallower coastal waters? Be sure to explain the reasoning behind location choices and how you plan to assess the potential environmental and social impacts in these areas.

- **Types of OAE**

There are various methods of ocean alkalinity enhancement that are still being researched, including the addition of minerals like olivine or basalt, the use of electrochemical processes to increase ocean alkalinity, or the promotion of biological mechanisms that may increase carbon sequestration.

Discussing all the possible alternatives shows respect for the community, acknowledging that they have a right to know, and giving them a sense of agency in the conversation. It also allows a broader and richer discussion of the potential trade-offs between different approaches. For example, some methods may be more scalable but have greater environmental risks, while others might have smaller-scale benefits but be less intrusive to local ecosystems. Providing insight into this helps people participate in evaluating these trade-offs. While we acknowledge that it may not be possible to discuss in detail every configuration of OAE, or even more challenging, all existing carbon removal technologies, we believe it is important to at least mention that these alternatives exist, and address any questions the community may have about these options in a clear, transparent, and informative way.

The goal of this level of detail is not to overwhelm the community with unnecessary complexity but to give them a well-rounded understanding of the options on the table. When people feel that they have been presented with all the options and have had an opportunity to ask questions about each one, they are more likely to trust the process and feel that their



concerns are being taken seriously. By contrast, withholding information or glossing over alternative methods can create a sense of exclusion and mistrust, which may make it much harder to gain community support as the project progresses.



Best Practice ⑦

Help communities grasp the full potential scale of OAE

One of the most crucial aspects to address when presenting OAE to communities is the **scale** of the project—both in terms of its immediate impact and its potential for future growth. People need to understand the scale of the proposed intervention—not just how large the project will be initially, but also what the long-term commitment looks like. Will the project be implemented on a small, pilot scale initially, or are there plans for much larger-scale deployment in the future? Don't overstate the immediate impacts or potential of early research. Field trials are valuable tools for understanding the feasibility of OAE technologies in real-world conditions, but they are not guarantees of large-scale success. By being upfront about the **limited scope** of initial studies, you set realistic expectations and avoid overhyping the technology, potentially preventing disillusionment later if early trials do not yield the expected results or face unforeseen challenges. At the same time, participants will likely want to know what will be learned from these studies and how these insights will guide future scaling decisions. Presenting research or a trial as a **learning process** can underscore the necessity of **ongoing evaluation and decision making**.

Discussing these future plans is important to help community members grasp the potential scope of the intervention and the possible risks or benefits associated with different scales of operation. For example, large-scale OAE could have more significant effects on ocean chemistry, local ecosystems, and nearby coastal communities than smaller, more localized interventions. On the other hand, smaller-scale projects might be more manageable but may have limited effectiveness in addressing broader climate goals which might be a downside for communities. Being upfront about the scale of the project also gives you the opportunity to discuss mitigation measures—such as environmental monitoring, regulatory oversight, and adaptive management strategies—that would be in place at larger deployment levels.

What is 'scale'?

An important note is that by 'scale' we do not just mean the level of carbon removals created. 'Scale' also involves:

- **Temporal scale**

How long will the project last, and how long will its impacts be felt?

- **Environmental scale**

What are the potential ecological impacts in terms of local ecosystems, biodiversity, and carbon sequestration? What will be the cumulative effects of these with other marine impacts? How does OAE fit within larger ocean health initiatives?

- **Social and economic scale**

What might the effects be on local industries, employment, and community health? How might the benefits or risks scale with the project's size? Again, what kind of cumulative effects will result if these layer on top of the social and economic impacts of other anticipated activities?

Ensuring that you are exploring each of these various categories can help support participants in developing a much more comprehensive and nuanced understanding of a project's potential effects if expanded. Some of the questions here are large and difficult to answer, and we include them not because we think you need to have answers to them, but rather to give you a sense of what you are looking to invoke in helping communities think through these scale-related aspects.

A helpful way to frame the **future potential** of OAE, especially when it comes to scale, is through **scenario exercises**. These are hypothetical, exploratory discussions that allow you to present different possible futures based on varying assumptions—such as changes in technology, environmental conditions, or policy. Scenarios help people understand the range of possible outcomes without making definitive predictions about what will actually happen. Be sure to emphasize that these are **not predictions** but rather potential pathways that the project might take depending on a variety of factors. This distinction is crucial because it allows you to highlight both **positive and negative potentialities** without leading the community to believe that one particular outcome is set in stone. For example, you might explore scenarios in which OAE is successfully scaled and contributes to global carbon removal efforts, alongside scenarios where unexpected environmental or social impacts require adjustments to the project, or even render the project ineffective.

Another effective way to convey scale is by **visualizing it in a regionally relevant context**. Rather than using abstract figures or distant examples, we have found it helpful to **use local comparisons** that people can relate to. For example, if you are talking about the amount of ocean that might be impacted by OAE, try to make that comparison to something familiar—such as the size of local fishing zones, nearby marine protected areas, or the scale of other large-scale marine projects, like offshore wind farms. Using **maps, diagrams, and infographics** can show not just the potential area of impact but also how OAE might interact with other local industries, ecosystems, and communities. Visuals like these help people



conceptualize the project's scale in a way that is more tangible and locally relevant, helping them better understand the actual magnitude of what is being proposed.



Best Practice 8

Place socio-political context front and center

When engaging with communities about OAE, it is essential to pay close attention to the **socio-political configurations** that might accompany different versions of the technology. OAE is not just a scientific or environmental project—it is also a socio-political endeavor that involves multiple stakeholders and rightsholders, funding sources, regulatory frameworks, and governance models. These elements are critical in shaping how the technology will be perceived and how it can be implemented in different communities.

One of the first socio-political factors to address is the **funding** behind OAE projects. Who is financing the project, and where is the money coming from? Are there external investors or private companies involved? Is the project publicly funded, or is it being developed through partnerships with large corporations or international institutions? The answers to these questions can greatly influence the community's perception of the project. For example, communities may be more comfortable with OAE projects that are publicly funded or backed by non-profit organizations, as these sources are often viewed as more aligned with the public good. On the other hand, if the project is funded by private companies or foreign investors, people may be more concerned about **profit motives** and the potential for **private interests** taking precedence over community welfare. Being transparent about funding sources, and explaining how the financial arrangements will impact local communities, is crucial.

Linked to this, communities are very likely to be curious about where the funding for OAE engagement initiatives comes from. Is the funding provided by the local government, or is it coming from the project developer? Disclosure about funding allows participants to assess the impartiality and credibility of the engagement process. In our experience, if you do not bring this up yourself as the engagement facilitator, participants will almost certainly ask about it.

The importance of being transparent and up-front about your role as an engagement practitioner

It is critical to disclose your positionality—your role, affiliations, and sources of funding—at the outset of any engagement activity. In addition to being an ethical necessity, it also helps establish trust and ensures that community members understand the context and purpose of your involvement. We suggest welcoming any discussion on this subject and inviting community members to ask any questions they may have about your motivations, funding, and role in an OAE project.

Key elements to disclose and/or discuss:

- **Your role and expertise**

Be transparent about your position in the project and your academic or professional background. This allows community members to assess where you are coming from in your orientation to the OAE research or trial. Make sure to mention that your role is not to convince people to embrace the technology, but rather to share knowledge and support communities to ultimately make their own informed decisions (note that this should truly, always be the goal of engagement activities.)

- **Your personal views on OAE and/or the project**

You may be asked about your own personal views. We would suggest being forthcoming about your motivation—i.e., why you are interested in doing this work of engaging communities on OAE, what brings to you this topic, and what hopes or concerns you may generally have. However, we suggest refraining from sharing too much detail about your personal views on the subject, in order to avoid the risk of making people feel that different views from yours are not welcome. As a general rule, it is best to avoid expressing unconditional support or outright opposition to OAE. Instead, our own personal approach tends to be acknowledging both the potential and the limitations of the technology, while recognizing its inherent complexity.

- **Funding sources**

Clearly communicate who is funding your research, whether it's government bodies, private industry, NGOs, or other entities. This transparency helps mitigate concerns about potential conflicts of interest or external pressures that might influence how you interpret the findings from your engagement (e.g., if you are paid by the company itself, communities may perceive you to be under pressure to depict engagement outcomes more positively).

- **Power dynamics**

Understand that your role in leading engagement activities, along with the institutional and financial backing behind the project, can create power imbalances in outcomes of the engagement. You have the ability to report on engagement findings in ways that may serve your own interests, whether you intend to or not, and people will likely be attentive to that fact.

Another important socio-political issue for OAE projects is the **role of carbon markets** and **carbon credits**. As OAE is a form of carbon removal, it may (eventually) be eligible to generate carbon credits—tradable certificates representing the removal of carbon dioxide

from the atmosphere. These credits might be sold on carbon markets, potentially generating revenue for the project or for local stakeholders. However, some participants may be wary of existing projects (e.g., reforestation and afforestation initiatives) that have been integrated into carbon markets with questionable success, ultimately producing carbon credits that did not accurately reflect their market value, or being sold to international buyers rather than benefiting local communities. Might there be opportunities for communities to participate directly in the carbon credit market, or to capture a portion of the financial benefits? Is the generation of carbon credits something that communities are even interested in and, if so, under what conditions?

The **ownership structure** of an OAE project is another relevant socio-political consideration. Who owns the technology, and who will have control over the decision-making processes? Ownership models can range from public-private partnerships to community-led initiatives to models where private companies maintain ownership of the technology. In some cases, OAE projects may be developed by a private company that retains control over the technology and profits, while in other cases, local stakeholders—such as Indigenous communities, local governments, or environmental groups—may have a larger say in how the project is run. The ownership structures under consideration will likely be of interest to participants.

The **decision making model** for an OAE project must also be tailored to the local socio-political context. Some communities may have well-established systems for participatory decision making, such as Indigenous-led governance models or community councils, while others may be more reliant on local government or external decision-makers. Participants may be interested in seeing the establishment of advisory committees, for example, or other ways to ensure that community representatives are included in project oversight or governance. On the other hand, others may prefer to see local authorities represent community interests.

Negotiating the relationship with developers

Whether you are an independent researcher or a collaborator, it is crucial to establish clear boundaries around your role in community engagement when working with an OAE project developer. While project developers may have specific expectations for the engagement process, research indicates that it is important to trust-building that the engagement team maintains independence from the project. This is so that—as discussed above—community engagement is in fact a genuine effort to listen to and incorporate community concerns and insights into the development process, rather than used as a means to simply gain support. From the outset of a research arrangement, it is essential that the researchers establish this understanding with the developer to avoid potential conflicts later. Developers should also be transparent about how they plan to integrate the insights, feedback, and concerns raised by the community into the project, ensuring an open and accountable process.



Best Practice 9

Be prepared to manage group dynamics

In group discussions, certain dynamics may naturally emerge, such as some voices being louder or more confident than others, which can unintentionally silence more hesitant participants. In our experience, this can lead to a situation where others, particularly those who are less initially certain in their views, feel pressured to align with the dominant opinion. While valuable insights can still come from such dynamics, the risk is that quieter or more indecisive participants may withdraw further, fearing backlash or feeling that their perspectives are less valid. To mitigate this, we find it helpful to establish ground rules from the outset. To do this, you might encourage participants to be mindful of how often they speak and to ensure everyone has an opportunity to contribute. Consider gently prompting quieter individuals by asking, “Is there anyone who hasn’t shared yet and would like to offer their perspective?” without putting them on the spot. Additionally, remind participants throughout the session that there are no “right” or “wrong” answers, especially given the complexity and uncertainty surrounding OAE as a developing technology. Offering opportunities for written feedback can also offer a way to tap into the views of those who might be intimidated to share verbally.

Effectively managing group dynamics involves not only navigating conflicts between participants but also addressing interactions between participants and facilitators. Sometimes, participants may not fully grasp the purpose of the workshop or the technology being discussed, and this can lead to frustration—which might be directed at the facilitators. For example, someone who does not view climate change as an urgent issue might challenge the value of a workshop on carbon removal technologies, potentially expressing anger or sarcasm or even direct attacks on you, the researcher or facilitator.

In these situations, we find it important to (try) not to take comments personally. Instead, you might try to calmly reinforce that you believe in the importance of the work you are doing to understand community perspectives, emphasizing that you believe community input is crucial, even when opinions differ. It can be helpful to acknowledge the validity of a participants' emotions. At the same time, it will benefit the overall engagement process if you can try to understand the root of their frustration via open-ended questions. As much as you can, try to maintain a reflective, non-defensive approach, and encourage a constructive dialogue that respects all viewpoints. (We do realize that this is something easier said than done!) Something to keep in mind is that it can be easy to get sidetracked by a few particularly critical and vocal participants, and lose focus on the rest of the group, so if you are able, it is worth trying to bring the focus back to the rest of the group.

A final note: Group dynamics can be unpredictable, and our experience suggests that the responses you'll receive may vary significantly, even among groups from the same region. We'd recommend approaching each new group of participants with an open mind, prepared for any range of reactions or dynamics.



Best practice 10

Make the engagement dynamic and fun

Community engagement plays a vital role in ensuring the just and equitable deployment of OAE and other carbon removal technologies—but this does not mean the process should be overly formal, rigid, or (dare we say it) boring. Engagement activities that are interactive, enjoyable, and accessible will generally work better at giving you a better sense of participants' evolving views and perspectives. Engaging with the complexities and trade-offs of climate technologies, such as OAE, can be difficult, but there is a lot you can do to make it feel less like a burden and more like an opportunity to learn about new ideas and possibilities, and explore creative and diverse visions for the future. Hopefully, the suggestions for activities we shared in the previous section offer a jumping off point for brainstorming new and entertaining ways to invite people to think about OAE. But we are certain that the creative minds reading this guide will come up with many other ways to draw in participants and make this subject come to life for them.

4

4. PREPARING FOR ENGAGEMENT

Examples of questions you might receive

The following are questions that we have received during our engagement activities. We share these here as examples of questions you might anticipate receiving during a community or public engagement workshop on OAE. Please note that some of these questions pertain to OAE in general, while others are more relevant to contexts in which you are discussing a specific research project or trial.

OAE process-related questions

- Will there be any sediment? If so, what will happen to the sediment? Will it accumulate over time, and if so, where?
- You're telling me that OAE involves the transfer of atmospheric CO₂ into more stable forms of carbon in the ocean. But what does 'stable forms of carbon' mean? Where will these forms of carbon go? Do they solidify under pressure? Will they just drift around in the ocean?
- What can be done to reverse possible issues that might arise after the release of alkalinity? In other words, once we put alkalinity into the ocean, is there any way to get it back out?
- How long was the area studied prior to the release of minerals?
- How do we know that the OAE process is working? What measurements or monitoring will happen?
- On what basis will the trial be determined a 'success'?
- How much alkalinity will be added?
- How are specific mined products selected?





- Does this process affect drinking water?
- Is this worth the effort?
- Have OAE trials been conducted anywhere before? What did they find in other trials?
- Will we have to do OAE forever, or can we stop doing it once we reach our removal target?
- Are there other ways of doing marine carbon removal, other than OAE? What do they involve?
- Are there different ways of doing OAE?
- How is the OAE process affected by tides and seasons?

Ecosystem-related questions

- What would OAE mean for ocean species generally?
- What environmental impacts will be measured? How will these be measured and reported?
- Will the 'stable forms of carbon' be harmful to marine life if there is too much of them?
- Will there be ecological effects that we can't predict?
- Aren't we disrupting the 'natural process' of the ocean?
- How does the concentration of alkalinity at the site affect marine life? Will there be overconcentration at dispersal sites?
- How much further do we need to learn about the ocean to feel confident about employing this method? Would technology to study the deep ocean environment have to be developed before we can proceed with OAE?
- What organisms use bicarbonate as a nutrient? Will OAE cause proliferation of CO₂-producing organisms?
- Will we have a build-up of alkaline substances in the fish we consume?
- Will an increase in pH cause existing toxins in the ocean to become more bioavailable, harming marine life?

Scale-related questions

- How will the developer decide if their trial was successful, and if they do decide it was successful, what will be their next steps?
- What is the decision tree around whether or not to increase / decrease dosage?
- Can OAE even be done at a global scale? Is it even scalable?
- OAE might work on a lab-scale, but how do we know it works on larger scales?
- How effective would OAE be if done on a large scale?
- Is the process of creating alkaline materials sustainable at scale?
- Do we have enough alkaline material globally to remove CO₂ at the scale we need?
- How should we think about negative consequences at scale?
- Will using OAE at large scales only end up creating more problems down the road?

Governance- and policy-related questions

- What regulatory bodies will oversee OAE projects?
- What regulations will need to be in place to monitor these projects?
- What permitting processes will be involved?
- Do new government agencies have to be created for oversight of these projects?
- Why haven't we heard about OAE until now? When will other people hear about this?
- Does OAE imply paying more taxes?
- Why should I care about OAE if I'm struggling to make ends meet? What is the benefit to me?
- How do we ensure global coordination on this?
- Will there be employment increase thanks to the deployment of this project?
- Who needs to approve this project?
- Who will be held accountable if something goes wrong? Who will be responsible and who will pay for negative consequences?



5

5. CHECKLIST FOR PLANNING YOUR community engagement activity

We've developed the following checklist as what we hope is a user-friendly review sheet for many of the elements we have discussed in this guide. This is not intended as a comprehensive list, but rather as a prompt to get you reflecting as you progress with designing (or reviewing someone else's) engagement effort.

1. Selecting the right audience. Did you...

- Invite people who will be affected by the OAE project
- Invite people who might take an interest in the OAE project proposed

2. Knowing your audience. Did you...

- Do some thorough research on the groups you are engaging
- Know the history of the area where the groups you are engaging live and work

3. Engaging people early on in the process. Did you...

- Initiate community engagement before a field trial or deployment is underway
- Try to build relationships with the community before discussing a project

Keep in mind

Engagement is not a tick-box exercise!

We hope that this list above can provide a summary of some of the main elements to keep in mind when engaging communities. However, we caution that community engagement should not represent a box-ticking exercise. As we have sought to convey throughout this best-practice guide, community engagement is a complex, ever-changing, and by nature adaptable endeavour.

4. Being transparent and building trust. Did you...

- Disclose your funding sources
- Disclose the goal of engagement activities and what will be done with the findings

5. Talking about marine carbon cycles and key concepts underpinning OAE. Did you...

- Involve independent, physical science researchers to co-facilitate the engagement
- Avoid depicting OAE as a “natural process”
- Present visuals and graphs tailored to a non-expert audience
- Present complex information in a clear, accessible manner

6. Talking about OAE itself. Did you...

- Talk through all relevant dimensions of OAE (i.e., lifecycle dimensions, dispersal methods, types of project sites, etc.)
- Present to your audience all types of OAE (and perhaps other types of mCDR or CDR approaches) to give them a sense of alternatives

7. Talking about scale in OAE. Did you...

- Discuss scale in a regionally relevant way
- Design an exercise that allows your audience to better visualize scale (e.g., a scenario exercise or an in-depth poster describing the details of OAE at scale in the local context)

8. Helping people understand how OAE might develop in practice. Did you...

- Find ways of introducing questions of sociopolitical context
- Ask them to consider their views on OAE generally and/or your specific project in the context of different funding, ownership, and governance structures

6. CASE STUDIES IN OAE ENGAGEMENT

In the next section, we introduce and discuss different approaches to engagement with communities on OAE that we have been involved in. We have included these case studies as examples of different ways of structuring and designing OAE engagement activities.



Case Study 1

'Solid Carbon' project research in Victoria, Canada

- **Where:** Victoria, British Columbia, Canada
- **What type of OAE:** Three CDR approaches discussed: Offshore direct air carbon capture with storage (DACCS), marine biomass sinking, and mineral-based ocean alkalinity enhancement.
- **Relationship to an existing project or field trial:** This work was conducted as part of the social science work for the Solid Carbon project, which is a feasibility study for an offshore DACCS system in the Cascadia Basin, off the coast of Vancouver Island.
- **Who led the engagement:** Academic social scientists (Terre Satterfield and Sara Nawaz)
- **Who participated:** The engagement involved two small-group workshops, one with members of First Nations from the broader region of Western Vancouver Island involved in marine topics professionally or personally, and the other with members of climate and environmental NGOs in the broader region. These groups were theorized to be important to include in early discussions on carbon removal, for reasons of their influence and rightsholding.
- **When did it occur:** January and February 2023
- **What activities were done:** Each workshop was 6 hours long, and involved a mix of presentations, individual written feedback, group discussions, and prioritization exercises. First, participants were introduced to climate change, and specifically carbon removal's role in climate change, through short presentations, with ample opportunity for feedback and discussion. Next, participants were introduced to three examples of carbon removal approaches that could be deployed off the coast of Vancouver Island

Coming soon

Community advisory boards for mCDR & using oceanographic models in engagement activities

The Institute for Responsible Carbon Removal is beginning a new project to conduct community and local engagement on mCDR (including OAE) in two geographic locations, funded by the Sloan Foundation. This work, in partnership with [C]Worthy, will aim to use oceanographic models as a novel tool for engagement. The project will also aim to build capacity for regional decisionmaking on mCDR via the development of 'Community Advisory Boards'. Stay tuned for updates to come!

- **What was the goal:** The goal of this work was better understanding of the views of important coastal communities and representatives on emerging carbon removal approaches. The work aimed to understand to what extent participants were interested in seeing further research on and any future deployment of these technologies, and the conditionalities of these views.
- **How long did it last:** These were one-off workshops, not part of a longer and ongoing engagement process.

Removing 2 million tonnes of CO₂ from the atmosphere is about 10% of BC's total anticipated need per year within the next few decades.

Option A:
Adding minerals that store CO₂ to the ocean

1 Gathering raw materials

- Raw materials such as magnesium-rich rocks could be added to the ocean to capture CO₂. To obtain these materials, they could be mined, or drawn from mining residues (tailings) at existing mines
- To capture and store 2 million tonnes of CO₂ per year, about 2 million tonnes of minerals would need to be gathered per year
- This is about 1/3rd the output of one of Canada and BC's largest quarries

2 Process raw materials

- Preparing rock to be added to the ocean would involve grinding the rocks and extracting any contaminants
- Processing 2 million tonnes of materials per year would require as much energy as 10,000 households consume in a year

3 Material transportation

- Minerals would be transported from nearby mine/processing sites to coastal facilities using rail or ships
- Transporting 2 million tonnes of CO₂ equivalent in minerals would take about 121 trains or 18 ships per year, if filled to capacity

4 Mixing materials into seawater

- A coastal facility would draw in seawater, add processed minerals to the water, and return the mixture to the ocean
- This mixture would absorb CO₂ from the atmosphere at the facility
- The process would also increase the ocean's ability to store CO₂ in seawater

Seawater → **Seawater with increased alkalinity and CO₂**

Some possible implications

- Environmental and social impacts from mining and processing
- Ecological impacts to marine organisms
- Release of accompanying minerals, some potentially toxic
- Reduction to local ocean acidification

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<https://www.spa.gov/media/photo-view/1010-2000000-1330-4017-6736-ANABAC71965>



Case Study 2

Independent research in Washington State, USA

- **Where:** Sequim, Washington, USA
- **What type of OAE:** mineral-based and electrochemical-based, and coastal enhanced weathering
- **Relationship to an existing project or field trial:** The region was selected for this work due to its relevance to ongoing research on OAE, including studies conducted at the Pacific Northwest National Laboratory (PNNL) in Sequim and a planned field trial in Port Angeles by the CDR start-up Ebb Carbon. The workshop organizers, however, were entirely independent of these activities and had no formal affiliation with Ebb Carbon. The site was chosen for its potential to scale up field trials and its suitability for OAE, positioning it as a promising location for future research and collaboration.
- **Who led the engagement:** Academic social scientists (Sara Nawaz and Giulia Belotti).
- **Who participated:** Generally, people who had an interest in what happens on the coast. This included: marine resources committee members, shellfish farmers, conservation groups, environmental NGOs, tourism and recreation groups, local governments, and educational institutions.
- **When did it occur:** June 2024
- **What activities were done:** Each workshop began with a general introduction to climate change, kept brief given the audience's familiarity with this subject. This was followed by an overview of carbon dioxide removal and related concepts (e.g., net zero, etc.), and an introduction to OAE as a CDR approach. After each presentation, participants had the opportunity to ask questions and share their perspectives on the information presented. Following the educational component of the workshop, participants engaged in a best- and worst-case exercise. They were asked to imagine the most favorable and unfavorable outcomes of OAE development, write their thoughts on sticky notes, and attach them to a poster for group reflection. The workshop also included a scenario exercise (see Figure 4), where participants were divided into smaller groups and assigned one of four potential future scenarios for OAE deployment. Each scenario incorporated different technological and sociopolitical components, which participants were asked to discuss in detail. Participants then rotated through the scenarios proposed, to ensure they had the opportunity to engage with all four. To conclude the workshop, a debriefing activity was conducted, during which participants shared their main takeaways, outstanding questions, and reflections.
- **What was the goal:** This work aimed to achieve three important goals: to develop an understanding of best practices for conducting community engagement activities on OAE, to initiate conversation with local communities as part of early engagement efforts, and to explore community perceptions and concerns about OAE.
- **How long did it last:** We conducted two day-long (~6 hours) workshops, each workshop with different participants. We aim to build long-lasting relationships with communities in this region, and are currently planning future engagement activities in the area (see Box on page 31).



Case Study 3

Research along field trial in Vancouver, Canada

- **Where:** Vancouver, British Columbia, Canada
- **What type of OAE:** mineral-based OAE
- **Relationship to existing project or field trial:** Planetary Technologies, a company based in Halifax, Nova Scotia, Canada, is funded by BC's Center for Innovation and Clean Energy to conduct a field trial in partnership with Metro Vancouver, the local utility. Engagement research is being conducted by independent academic researchers.
- **Who led the engagement:** Engagement activities were conducted by social science researchers (Terre Satterfield, Sara Nawaz and Giulia Belotti), as part of a project funded by the BC Center for Innovation and Clean Energy.
- **Who participated:** Two workshops were conducted with members of the general public residing in Metro Vancouver municipalities. Participants were selected to reflect the demographic composition of the region. A third workshop was conducted with people who we believe have interest in what happens on the coast. This included civic and environmental NGOs, fisheries organizations, and conservation groups.
- **What activities were done:** Interviews were first conducted to gain a deeper understanding of the location and community. These interviews informed the design of three subsequent workshops. Each workshop began with a general introduction to climate change, followed by an overview of carbon dioxide removal and related concepts (e.g., net zero, etc.) and an introduction to OAE as a specific CDR approach.



FIGURE 4. Example of card game activity from workshops in Vancouver

Participants were also provided with information about the planned field trial by Planetary Technologies. After each presentation, participants had the opportunity to ask questions and share their perspectives on the information presented. Following this educational component, an interactive activity was conducted where participants were divided into smaller groups and engaged with a poster illustrating an OAE approach at scale, discussing each phase of the approach in detail. The workshop also included a card game exercise. In this activity, participants received a set of cards covering various topics related to OAE, such as material sourcing, monitoring, ownership, and governance. They were asked to select their preferred option from the cards and then discuss their choices within their groups. To conclude the workshop,

participants were briefly introduced to other mCDR technologies. This session aimed to provide foundational knowledge about alternatives to OAE, offering a broader context for understanding different mCDR options.

- **What was the goal:** The goal of this work was to inform responsible and inclusive decision making about the prospect of pursuing OAE by Planetary (or others in the future) in the broader Vancouver, BC area.
- **How long did it last:** We conducted three long-day (six hours) workshops, each workshop with different participants. The project activities, including engagement, will span 1.5 years. We aim to build long-lasting relationships with communities in this region, and are currently planning future engagement activities in the area (see Box on page 31).

Another example

Project Vesta community engagement in the Dominican Republic

In addition to the three studies we ourselves have been involved in, another example of engagement research on OAE is a collaboration between the start-up Project Vesta and researchers located in the United Kingdom and Dominican Republic, where the study was located. The original plan for this research was to conduct research on coastal enhanced weathering by placing olivine in the coastal environment, but no field pilot was carried out.

Engagement was led by a local female leadership team (community engagement manager, community engagement coordinator, and senior regional manager), and finally, independent social science researchers. Local community members who participated in engagement activities included a women's collective, fisherman's group, beach guardians, local government representatives, educational and religious leaders, a handicraft group, a cattle rancher group, and the neighborhood council. Central activities conducted included initial baseline surveys, focus groups, and open-ended interviews. Focus groups were established as working groups, where members were presented with information and encouraged to express their concerns, ask questions, and make suggestions. These insights were communicated to the Vesta management team to review recommendations and adapt approaches. Changes were reported back to the working groups at the following sessions. Based on this engagement research, the project established a long-term plan for community outreach and activities to support community development in the areas where the trials were planned to take place.



FURTHER READING

Localized governance of carbon dioxide removal in small island developing states (Hilser et al.)



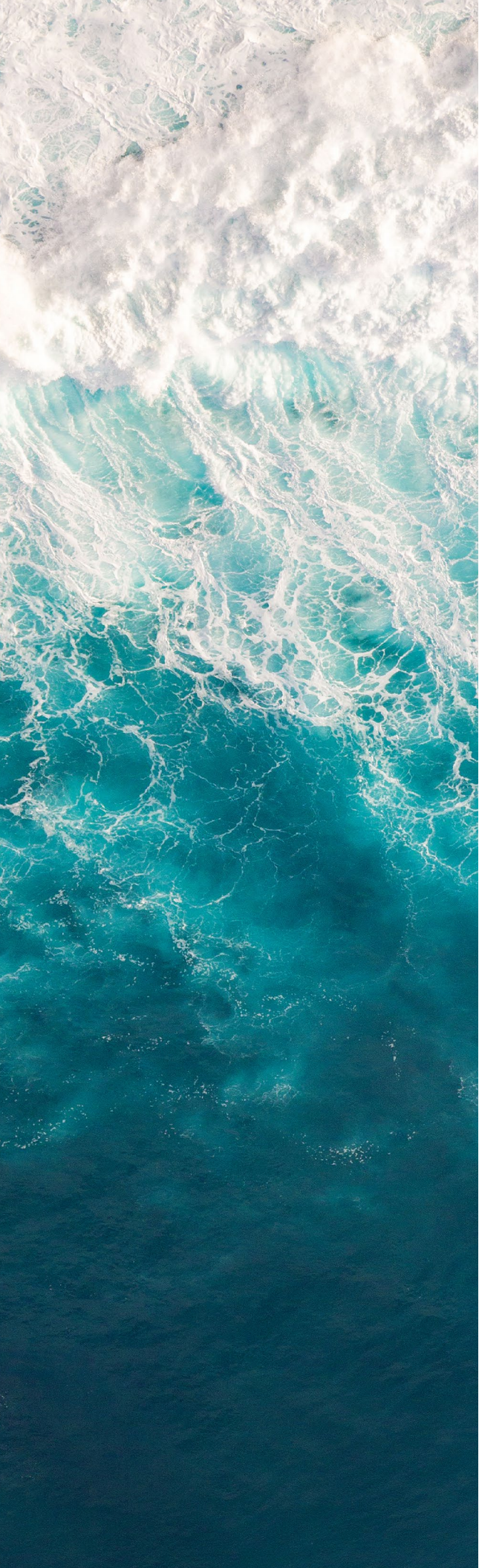
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7. CONCLUSION

Community engagement done well is really important for the growing mCDR and OAE fields, and yet there is little (practical) information currently available on what good community engagement on OAE could look like. We hope this guide helps provide some tangible guidance on how to go about conducting early engagement on this subject. One important point: we have focused in particular on some of the research methods that we ourselves have used in conducting public and community engagement on OAE, but the methods and tools we have shared here are by no means a comprehensive list. There are endless ways of discussing this topic and learning from people about their views on it, and we are eager to see what creative methods others develop in the future.

We'd like to close on the following note: Moving towards more deliberative and participatory forms of engagement (e.g., minipublics, citizens jury, etc.) is something that both academic and non-academic actors need to start doing. What exactly this looks like remains to be fleshed out, but we hope that the guidance provided here will be of use as those activities are considered and developed in the future.





The Institute for Carbon Responsible Removal is an initiative of American University's School of International Service. It was founded in 2018 in response to growing scientific and political attention to carbon removal technologies and practices. The Institute grew out of the Forum for Climate Engineering Assessment, a separate research initiative dedicated to assessing the social, ethical, political, and legal implications of emerging technologies that fall under the broad rubric of climate engineering.

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