OCEAN NETs

Ocean-based Negative Emission Technologies

Analyzing the feasibility, risks, and cobenefits of ocean-based negative emission technologies for stabilizing the climate

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OceanNETs – an EU Horizon 2020 project

The impacts of climate change are already being felt and projected to increase unless much more action is taken to limit warming. The Paris Agreement (2015) and the IPCC Special Report on the impacts of global warming of 1.5 °C (2018) describe the international goals and broad measures required to limit global warming to “well below 2 °C above pre-industrial levels” and to pursue efforts to limit the temperature increase to 1.5 °C.
Limiting warming requires reducing CO_2 emissions to a net zero level as soon as possible. However, it is extremely difficult, and potentially impossible, to achieve the Paris Agreement goals by reducing greenhouse gas emission alone. Modelling scenarios that keep global warming within the limits of the Paris Agreement require the large-scale application of negative emission technologies (NETs) to achieve a net zero level of CO_2 emissions or to additionally remove CO_2 from the atmosphere.

NETs are a range of methods that aim to reduce atmospheric CO_2 levels. This can be done either by seeking to engineer the removal and subsequent storage of CO_2 or by deliberately enhancing land or ocean carbon sinks to increase the removal of CO_2 from the atmosphere.

Why focus on ocean-based NETs?

A range of potential approaches exist for removing CO_2 from the atmosphere, but the majority of NETs research has focused on land-based methods. However, meeting the Paris Agreement goals with land-based NETs alone will be extremely difficult. This is because land-based NETs have side effects, sustainability related trade-offs (e.g., competition for land use, accelerated loss of biodiversity), limited individual potentials, and/or issues of carbon storage permanence. For many NETs, current policies, international laws, public resistance, a lack of incentives and infrastructure, justice issues, and current costs are also barriers that must be overcome.

The ocean covers over 70 % of the Earth’s surface, contains many times the amount of carbon in the atmosphere and terrestrial biosphere, and will be the predominant, largest long-term sink for anthropogenic CO_2. These factors, as well as a limited number of ocean-based NET studies, suggest that ocean-based NETs should have a large CDR potential. However, not enough information exists to comprehensively assess the feasibility, risks, and co-benefits of ocean-based NETs.

Project duration:	**4 years**
	July 2020 – June 2025
Funding:	**€ 7.19 million**
Number of partners:	**14**
Coordinating institute:	**GEOMAR**

The project

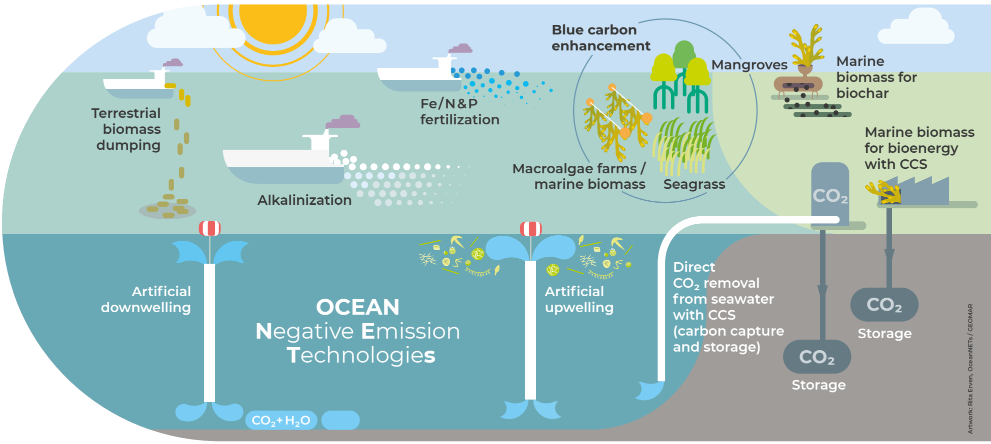
OceanNETs is funded through the European Commission research funding program Horizon 2020 under a call aiming to assess the feasibility of negative emissions for climate stabilization.

OceanNETs aims to determine to what extent, and under what conditions, the deployment of ocean-based negative emission technologies could contribute to realistic, sustainable and effective pathways for Europe and the world to achieve climate neutrality and reach the goals established in the Paris Agreement. The project also intends to identify and prioritize options with the most potential in regard to CO_2 mitigation, environmental impact, risks, co-benefits, technical feasibility, cost effectiveness, and political and societal acceptance.

What are the specific objectives of OceanNETs?

- Determine the most effective ocean-based NETs with low environmental and ecological risks (e.g., to biodiversity, ecosystem services) and high co-benefits.
- Identify the degree of (and factors affecting) social and political acceptance, affordability, and societal impacts and risks (e.g., to food security, human safety) for different ocean-based NETs.
- Comparatively assess ocean NETs – by combining new multi-disciplinary data, stakeholder knowledge, and case study assessments – and provide this information to society and policymakers to increase their capacity to enable and design optimal medium-to-long-term sustainable mitigation pathways.

OceanNETs will contribute to major international, national, and EU assessments of possible climate mitigation options. The project breaks new ground by bringing together recognized NET experts from economic, political, legal, social, and natural sciences and establishing a tight dialogue with stakeholders in a single integrated project. The scientific experts will synergistically work in parallel and together, whilst interacting with stakeholders, to evaluate ocean-based NETs within a UN sustainable development goals framework. The strength of OceanNETs lies in its transdisciplinary approach as opposed to existing disciplinary studies.



Ocean-based NET approaches

Ocean Alkalinization	Increase the alkalinity of the upper ocean to chemically increase the carbon storage capacity of seawater and thus, also increase CO_2 uptake. Alkaline minerals can be mined and crushed (e.g. olivine) or created (e.g. lime) and added directly to the ocean or alkaline solutions can be added after ex situ reactions (e.g. electrochemical weathering)
Marine biomass for biochar or bioenergy with carbon capture and storage	Grow algae or macroalgae and (a) pyrolyze the biomass to form biochar to spread on land or (b) create biofuels from the biomass that can be burned in conjunction with carbon capture and storage technology
Direct CO_2 removal from seawater with carbon capture and storage	Technology that chemically or electro-chemically remove CO_2 from seawater and concentrate it for storage; in surface waters this will increase the oceanic uptake of CO_2 as seawater chemistry/ physics compensates for its removal
Artificial upwelling	Use pipes or other methods to pump nutrient-rich deep ocean water to the surface where it has a fertilizing effect; see ocean fertilization below
Artificial downwelling	Artificially enhance the transport of carbon that has been taken up at the surface ocean into the deep ocean where it will be stored for hundreds to thousands of years
Blue carbon sink enhancement	Plant and manage mangroves, wetlands, seagrass beds, or macroalgae to increase CO_2 uptake (via primary production), storage in biomass, and burial in sediments
Ocean fertilization	Add micronutrients like iron or macronutrients like nitrogen and phosphorus to increase phytoplankton growth (CO_2 fixation) and ocean carbon storage via the biological pump (the transport of this fixed carbon into the deep ocean)
Terrestrial biomass dumping	Harvest and dump terrestrial biomass, which contains the carbon that vegetation has removed from the atmosphere during growth, in the deep ocean or bury it in coastal sediments

Work packages

Work package 1: “Economic prospects and incentives” contributes to understanding and assessing the role of ocean-based NETs in globally coordinated and non-coordinated climate policies.
Leaders: IfW and FMI; Participating partners: UiO, Leipzig University

Work package 2: “Governance, policy, and international law” focuses on governance frameworks and resulting responses, challenges, and opportunities to ocean NETs at scales from national to global, including an assessment of potential legal issues.
Leaders: IASS and UHAM

Work package 3: “Public perception” explores volunteer laypersons’ perceptions of and attitudes toward ocean-based NET research and deployment to provide insights into public knowledge, engagement, and opposition to/support for ocean-based NETs.
Leaders: IfW and NORCE

Work package 4: “Simulations” uses a hierarchy of regional and global models to comprehensively assess the carbon sequestration potential, side effects and the associated uncertainties of different ocean NETs.
Leaders: NTNU and NORCE; Participating partners: GEOMAR, AWI, FMI

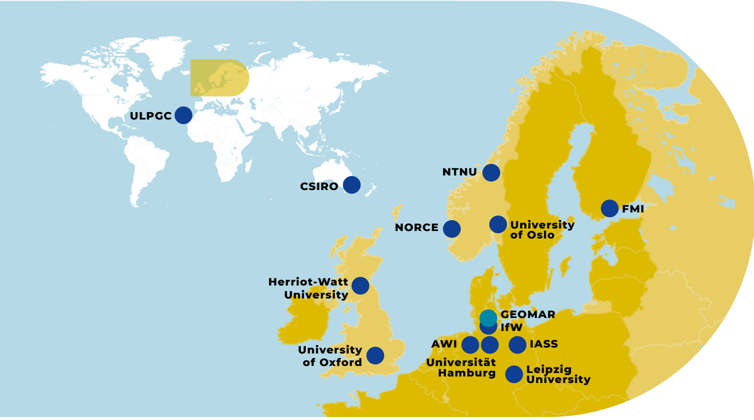
Work package 5: “Ocean alkalinization biogeochemistry and ecosystem impacts” conducts a series of experiments at different scales and complexities to generate a robust data base on the suitability of relevant minerals for ocean alkalinization purposes and the ecological impacts of ocean alkalinization approaches.
Leaders: GEOMAR and UHAM; Participating partners: HWU

Work package 6: “Ocean alkalinization case studies” uses a multi-disciplinary and reflexive approach to develop two case studies for different ocean alkalinization approaches.
Leaders: HWU and UOXF

Work package 7: “Stakeholder dialogue and the provision of knowledge” is designed to establish a dialogue with stakeholders, enable the synthesis and facilitation of science that cuts across work packages, and conducted dissemination, communication, and exploitation of project results.
Leaders: GEOMAR and UOXF

Work package 8: “Data management” ensures that all OceanNETs related data are easily accessible and can be put to use while following international standards and best practices.
Leader: GEOMAR

Work package 9 and 10: “Project management” and “Ethics” covers all tasks of general management of the project and ensures that ethical requirements are met.
Leader: GEOMAR



OCEAN NETs

Participating institutions

Coordinator
GEOMAR Helmholtz Centre for Ocean Research Kiel

Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research

Commonwealth Scientific and Industrial Research Organisation

Heriot-Watt University (HWU)

Finnish Meteorological Institute

Kiel Institute for the World Economy

Institute for Advanced Sustainability Studies

Norwegian Research Centre

Norwegian University of Science and Technology

University of Oxford (UOXF)

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