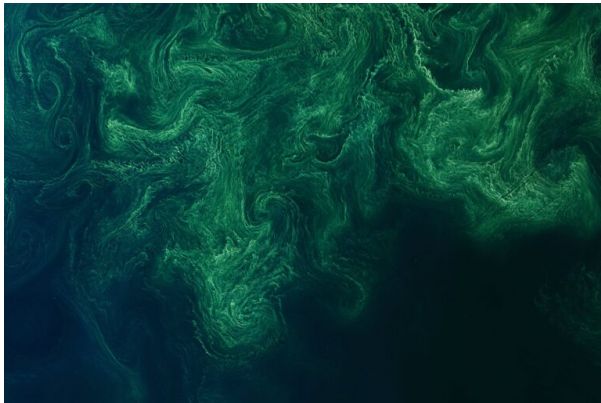


Artificially fertilising the ocean in order to sink carbon as a climate solution is gathering momentum

June 24, 2026



This update on Ocean Fertilisation and Artificial Upwelling summarises the latest developments on the [Geoengineering Monitor Map](#), highlighting new trends for civil society and climate justice movements to follow in their efforts to oppose geoengineering globally.

*This update is Part One of a four-part series on marine geoengineering, where we will cover other technologies like biomass sinking and Ocean Alkalinity Enhancement. It was researched and written by **Anja Chalmin**, and published with the support of the Geoengineering Monitor team.*

Marine geoengineering developments covered in this update:

- A large number of Ocean Fertilisation (OF) and Artificial Upwelling (AU) projects are aiming to commercialise schemes that artificially fertilise surface waters in order to increase the growth of phytoplankton and other marine species, so that they sink to the ocean floor
- The negative connotations associated with OF and AU have led companies to rebrand in creative ways, referring to their approaches as “marine permaculture” and other terms aimed to obscure their true purpose
- In addition to selling carbon credits on voluntary carbon offset markets, companies commercialising OF and AU technologies are also devising new types of offset financing, such as MARINIX tokens and Sea Shares
- The New Zealand Environmental Protection Agency has prohibited GigaBlue from conducting a large-scale OF trials, stating that marine dumping is illegal under domestic and international law
- The ExOIS research project has applied to the US Environmental Protection Agency for permission to conduct OF trials using iron in the Gulf of Alaska.
- Blue Carbon is set to deploy its AU device in ocean-based commercial aquaculture off the coast of Australia

Artificial Upwelling and Ocean Fertilisation: Two sides of the same deep ocean plankton sinking coin

Both Artificial Upwelling (AF) and Ocean Fertilisation (OF) share the same goal: to increase the concentration of nutrients in nutrient-poor surface seawater to stimulate phytoplankton growth. Phytoplankton photosynthesis is limited by the availability of nutrients such as iron and nitrogen, so in theory, increasing surface water nutrient concentration can stimulate photosynthesis, phytoplankton growth and therefore carbon fixation as carbon dioxide is drawn out of surface waters, which in turn draws it out of the atmosphere.

Proponents claim that the carbon that phytoplankton fix in surface waters is sequestered over long timescales when dead plankton sink to the ocean floor and are buried under anoxic conditions, where decomposition is a much slower process. Both OF and AU therefore aim to slow down the remineralisation of organic carbon, and target the deep ocean for plankton sinking. OF involves adding nutrients such as iron and nitrogen to surface waters, which can be dumped by ships, for example. AU introduces nutrients to the surface by pumping nutrient-rich water from deep ocean layers to the surface, using wave-powered pumps and other technologies.

Both geoengineering proposals have the potential to trigger widespread impacts on marine ecosystems:

- Adding nutrients to the surface seawater can lead to harmful phytoplankton blooms that produce toxins, a decline in oxygen levels, and a reduction in light penetration, which would result in a wide range of impacts on marine biodiversity and productivity.
- Artificially fertilising surface waters can lead to changes in the species composition of phytoplankton, which could have a detrimental effect on the entire marine food chain.
- Increased phytoplankton sinking can negatively impact deep-sea ecosystems by altering naturally-occurring benthic communities, for example.

At the same time, they risk increasing greenhouse gas concentrations in the atmosphere, rather than reducing them:

- Adding nutrients such as iron to surface waters can stimulate growth in one area of the ocean while reducing it in others, a process that can result in additional emissions of potent greenhouse gases such as methane and nitrous oxide.
- As well as transporting nutrient-rich water to the surface, AU can also transport large quantities of carbon dioxide and other more potent greenhouse gases to the surface along with it.
- Another significant risk associated with AU is the termination effect. The upwelling of cold, deep-ocean water increases the absorption of heat in the ocean's subsurface waters. Once AU stops, the absorbed heat can make its way back to the ocean surface and be re-released into the ambient air, leading to surface temperatures exceeding those that would have occurred if AU had never started. This means that, once started at scale, AU would have to operate continuously.

Deploying these marine geoengineering technologies on a climate-relevant scale would inevitably alter ecosystem processes, with potentially serious impacts on biodiversity, habitats and productivity. Although proponents market the technologies as safe and controllable, strong vertical and horizontal ocean currents mean that it is impossible to confine impacts to a specific area.

Additionally, the infrastructure necessary for large-scale deployment would require significant resources in terms of construction materials, transport and energy. This would compete with other marine activities, such as fishing and shipping, and may also pose a safety risk to them.

Several start-ups are developing AU and OF technologies with the aim of testing and commercialising them at scale. Recurring patterns can be observed among these players:

- Due to the clear risks associated with the AU and OF labels, many start-ups are rebranding by using alternative names for their approaches to escape these negative connotations, such as 'ocean iron replenishment', 'marine permaculture', 'deepwater irrigation', 'ocean nourishment' or 'simulated whale poo'.
- Open-ocean experiments are often planned and executed in an opaque manner with little concern for rights-holder engagement or consultation.
- Companies typically aim to finance OF and AU projects by selling carbon credits on the voluntary carbon markets, and have also developed other payment systems, such as Sea-Up's "Sea Shares".
- OF and AU projects are often based on unsubstantiated claims, such as the assertion that marine geoengineering is safe and controllable, that the residence time of carbon on the seabed is known, and that

there are positive side effects, such as increased fish production.

Updates on key OF projects

ExOIS, USA: Research consortium is preparing to perform large-scale open-ocean trials in the Gulf of Alaska

The international consortium Exploring Ocean Iron Solutions (ExOIS), founded in 2022, is housed at the Woods Hole Oceanographic Institution (WHOI) in Massachusetts, USA. Its steering committee comprises representatives from the WHOI, the South Korean Polar Research Institute, Xiamen University in China, US-based University of Maine and Moss Landing Marine Laboratories. The consortium is investigating OF using iron and intends to conduct open-ocean experiments in various regions, including the north-east Pacific and the Southern Ocean.

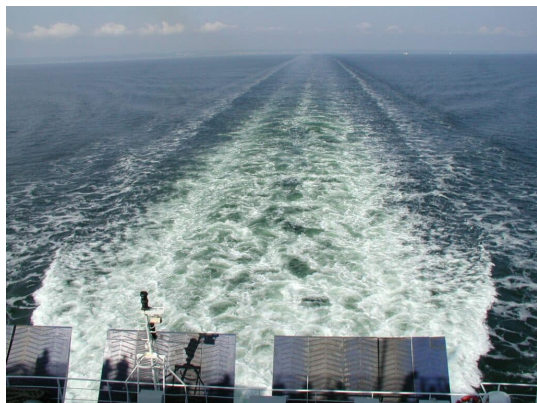
Initially, the consortium plans to undertake a large-scale open-ocean experiment in the north-east Pacific, 260 kilometers north-west of the National Oceanic and Atmospheric Administration's (NOAA) Ocean Weather Station Papa in the Gulf of Alaska, departing from a US port. ExOIS aims to conduct two identical open-ocean experiments at the same study site, discharging 10 to 50 tonnes of ferrous sulphate (FeSO_4) in liquid form in the propeller wash of a ship and adding a tracer. The iron will be discharged over an area of up to 2,500 square kilometers over a seven to 10 day period. The area will then be observed for three to six months, for example using ship-based measurements and surface drifters, with a particular focus on the upper 500 meters. Originally proposed for 2025, the experiments have been postponed to 2027 and 2028, pending a requested permit from the US Environmental Protection Agency.

Positive Polar, USA and OceanX, Germany: Plans to fertilise the polar oceans using expedition vessels

Positive Polar, a US-based company founded in 2023, plans to offer polar expedition cruises to the Arctic and Antarctica and to dump fertiliser in the wake of its expedition vessels. The company promises to increase fish stocks and capture carbon, and expects to "generate multimillion-dollar value" by selling carbon credits, although it does not disclose the scientific basis on which these statements are made. Initially, Positive Polar intends to conduct laboratory experiments to develop a fertiliser "*created from processed cruise ship food waste with added engineered nanoparticles and organic ligands*", and to measure phytoplankton growth. Each vessel is expected to conduct around 25 expeditions per year and Positive Polar is currently seeking partners to help realise these plans.

The company is also open to using its cruises for additional research, and in 2025 began negotiating an MoU with the Bright Ice Initiative, which is interested in conducting ice-albedo experiments aboard the vessel. In early 2026, Positive Polar also signed a Letter of Intent with OceanX, a German OF company.

Over the next two to three years, OceanX aims to remove one to two gigatons of carbon dioxide from the atmosphere annually by dumping iron into the ocean to stimulate the growth of phytoplankton, which the company claims will sink to a depth of 3,000 meters and to remain there undisturbed for 1,000 years. The first open-ocean OF experiments are scheduled for 2026, although specific details have not been disclosed. The iron will be discharged by ships in international waters, and OceanX intends to embark on four voyages in 2026, with the aim of capturing 30,000 tonnes of carbon dioxide on each trip. It plans to finance this by selling carbon credits, which are currently priced at €23 per tonne.



A ship's wake. *Marcin Sochacki/Wikimedia Commons*

GigaBlue, Israel/New Zealand: Permission for a trial refused on the grounds of marine dumping

GigaBlue Ltd. aims to finance commercial OF by selling carbon credits, and in early 2026 received US\$ 20 million in seed funding from Austrian venture Planet Ocean Capital and other venture capital firms. The company's approach involves releasing nutrient-enriched particles into the ocean to attract and stimulate the growth of phytoplankton. Within two weeks, the phytoplankton are supposed to aggregate and the particles are expected to sink into the deep ocean and remain there.

GigaBlue is headquartered in Israel and has opened a branch office in Auckland, New Zealand. The company has applied to the New Zealand Environmental Protection Agency (EPA) for permits to conduct open-ocean trials. So far, the EPA has permitted three trials, one off the east coast of Kaikoura and two off the coast of Dunedin. For its latest trial, GigaBlue applied to dump 1,000 tonnes of particles off the coast of Dunedin. However, the EPA did not approve the proposal, stating that it fell within the definition of marine dumping, which is illegal under domestic and international law. Ultimately, the EPA granted permission for the deployment of 55 kg of particles.

As well as applying to the EPA for open-ocean trials, Radio New Zealand reported that the company also held meetings with the Ministry for the Environment in 2025 in order to demand changes to New Zealand's marine regulations that would allow it to conduct open-ocean experiments without approval. GigaBlue described the current regulations as "*a hindrance to marine carbon removal*".

Gigablue is opaque about the composition of the particles and nutrients it intends to use, and the results of the trials that have already been carried out. There are no independent studies on GigaBlue's claims, including their promise to bind carbon for hundreds to thousands of years, or "*to responsibly scale its technology toward gigaton-level impact*".

A recently published—though not yet non-peer reviewed—Gigablue paper claims that their concept is both safe and controllable. However, no supporting evidence is provided. The methodology's feasibility has been called into question by a number of marine scientists, who expressed astonishment at the fact that Gigablue has already sold carbon credits on this basis.

WhaleX and ONC, Australia: Testing patented ocean fertiliser in open waters

The WhaleX Foundation Ltd., formerly the Ocean Nourishment Foundation Ltd., was founded in 2006 and registered as the Australian subsidiary of the Ocean Nourishment Corporation (ONC) in 2021. The companies aim to commercialise dumping nutrients into the ocean through the sale of carbon credits, although they avoid the term OF and instead try to market their project as 'ocean nourishment', 'ocean restoration' or 'simulated/artificial whale poo'.

The ONC has developed and patented PhytoPlus, a fertiliser "*comprised largely of nitrogen with a sprinkling of phosphorous and trace elements such as silica and iron*". The fertiliser has been tested in several trials, but hardly

any information about these trials is available because both companies operate with a high degree of opacity. Known open-ocean trials include one conducted off the coast of Sydney, New South Wales, in 2021, where 300 litres of nutrient solution were discharged. Another open-ocean trial, probably releasing about 200 litres of nutrients, took place in the Coral Sea in 2024. Edwina Tanner, the CEO of WhaleX and a member of the ONC team, announced plans to release 1,500 litres of nutrients in the Tasman Sea in 2025. However, there is no available information as to whether this trial took place or not.

The ONC and WhaleX developed a type of mesocosm, called a biopod, which is a five-meter-long flexible plastic tube. Since 2023, biopod trials have been conducted off the coast of Australia, including at the Calico Marina south of Sydney. The biopods are tethered to a boat and filled with seawater collected offshore. These trials aim to measure the growth of phytoplankton after the addition of fertiliser. Future trials plan to mix fertiliser with seawater in the biopods and leave the mixture inside for a few days before releasing it into the ocean. WhaleX plans to measure phytoplankton growth in the biopods and calculate carbon capture based on these results. However, their methodology is flawed as it does not consider the amount of carbon released back into the environment through the marine food chain, as well as other potential sources of release.

WhaleX plans to commercialise OF via techniques such as repurposing oil rigs, using existing ship movements and robotics. *"The WhaleX Foundation's ultimate goal is to remove 1.5 billion tonnes of carbon dioxide per year by spraying fake excrement into 300 nutrient-poor areas of the ocean"*. WhaleX claims that 200 litres of nutrients can capture one tonne of carbon dioxide, but this claim has not been proven by independent studies, nor has a life cycle analysis been conducted.

Such an analysis would also need to consider PhytoPlus, as its nitrogen source is ammonia, produced using the energy-intensive Haber-Bosch process which accounts for around 1.5% of global energy consumption and carbon dioxide emissions. In this process, ammonia is produced from atmospheric nitrogen and hydrogen usually derived from natural gas. Although ONC has stated its intention to use renewable energy for ammonia production, energy consumption remains high, and the green energy consumed cannot be used elsewhere to replace fossil fuels. Obtaining the other PhytoPlus nutrients, some of which are likely to be mined, and spreading the fertiliser are also energy and cost-intensive processes.

Oceanry, Finland: Plans to conduct OF research off coast of the Canary Islands

The Finnish company Oceanry, founded in 2024, intends to research, trial and commercialise OF using iron-rich mineral dust. It plans to conduct a first open-ocean trial by 2028, larger-scale trials by 2030 and, in the long-term, an *"expansion to new areas with target to cover research to all global high-seas"*. Janós Pasztor, an executive director of the Carnegie Climate Geoengineering Governance Project, a privately funded group of geoengineering lobbyists, and advisor to the solar geoengineering company Stardust, is among the members of Oceanry's advisory board.

Even before they have been conducted, the results of the experiments appear to be predetermined. In an interview with Garden Culture, Oceanry founder Tomi Nyman claims that a single experiment could generate billions of Euros in benefits by capturing CO₂, improving marine biodiversity and the food web, reducing ocean acidification, increasing cloud cover and creating consistent rainfall, decreasing the number of droughts and generating positive social impacts. However, there is no evidence to support these claims. He also mentions costs of up to €40 million for a single experiment, a huge sum for such a risky and unproven approach.

In 2025, Oceanry signed a *"mutual intention to collaborate on research exploring the impacts of ocean iron fertilisation (OIF)"* with the University of Las Palmas de Gran Canarias (ULPGC) and stated that *"its [the ULPGC's] location in the Canary Islands provides unique access to diverse marine ecosystems, making it a hub for marine research"*, and that the *"experiment is planned to be conducted within strictly outlined areas of the high seas"*. Information on the trial's exact location, duration, schedule and the type of mineral dust to be used is not yet publicly available.

OPR Alaska, USA: Proposal for an OF project in the Bering Sea

Ocean Pasture Restoration (OPR) Alaska Inc., formerly Planktos Inc., was founded by Russ George, who has spent 25 years promoting and attempting to commercialise OF. He has dumped iron compounds into the ocean off the

coast of Hawaii and near the Haida Gwaii islands in western Canada. However, his attempts in the Canary Islands and the Galapagos Islands were prevented by protests and government intervention.

Since 2017, Russ George has established several new companies to realise his vision. OPR Madagascar was set up to carry out OF in Madagascan waters, and OPR New England announced plans to conduct OF experiments in the Atlantic Ocean off the coast of New England in 2022. Both companies have since gone out of business.

In 2021, OPR Alaska announced a three-year trial in the Gulf of Alaska, south of Kodiak. The plan was to dump 100 tonnes of “*iron-rich dust*” over a 25,000 square kilometers area. There have been no updates since 2024, although the company has now proposed a three-year OF trial in the Bering Sea, scheduled for 2025–2027. This project also involves dumping 100 tonnes of iron-rich dust across multiple sites, with the aim of demonstrating the feasibility of iron fertilisation and quantifying ecological responses. It also intends to “*demonstrate safety, transparency, and economic viability*”, and pave the way for larger-scale OF after 2027. Currently, there is no indication that implementation is imminent.

Lillianah Technologies, USA: Trials involving the fertilisation of diatoms

Lillianah Technologies was founded by Benjamin Slotnick in 2021 and is based in Spring, Texas. The company cultivates diatom varieties in proprietary photobioreactors. Diatoms are microalgae that are found worldwide in both freshwater and saltwater environments. Through photosynthesis, they produce a significant proportion of the oxygen in the Earth’s atmosphere and play a pivotal role in the marine food chain. Lillianah Technologies’ diatoms are released into nearshore waters and supplemented with silica-rich nutrients to enhance their growth. The company expects them to absorb excess nutrients from the water and then sink, which “*allows for carbon geological storage*”. Since 2022, the company has been conducting small-scale trials off the coast of Boothville-Venice in Louisiana, USA. The trials are taking place in local bays, estuaries and nearshore marine waters. In addition, Lillianah Technologies is also preparing to conduct trials in the Bras d’Or Lakes area and the Bedford Basin in Nova Scotia, Canada.

Liquid Trees LLC, USA: Carbon capture with diatoms in rivers

Liquid Trees LLC, formerly 1010 Solutions Inc., was founded in 2021 and is headquartered in San Francisco, USA, with offices in Bangladesh and India. Liquid Trees aims to generate carbon credits on a large scale by fertilising diatoms in the open ocean and in rivers. Liquid Trees claims to have already conducted capture projects in nutrient-rich rivers, such as the Jamuna River in Bangladesh, the Amba River in India, the Conchos and Salinas rivers in Mexico, and the Kech and Kenchab rivers in Pakistan. The company is seeking further project sites in freshwater environments, for example in India, and has announced plans to conduct open-ocean OF trials. Information about the planned locations and scope of the experiments has not been made publicly available. Liquid Trees claims that adding iron to high nutrient, low chlorophyll waters stimulates phytoplankton growth and promises carbon capture “*from the atmosphere for years to centuries*”. The company is currently seeking “*funders and partners who can help advance our field trials*”, and previous investors include Unruly Capital, Tiny Capital and Aleka Capital.

Envisionation Ltd., UK: Sale of Empathy Coins to fund OF with buoyant flakes

Envisionation founder William Clarke started researching OF in 2014, and has developed a process involving dispersing buoyant flakes “*onto nutrient-deficient ocean surface waters*” from vessels. The flakes consist “*of rice husks coated with a mix of hot-melt, water-insoluble lignin (e.g. Organosolv) and rice water glues, urea leavening agent, and waste mineral powders rich in the phytoplankton nutrients of iron, phosphate, opaline silica and trace elements*”. They are expected to drift on the ocean surface, slowly releasing the nutrients to stimulate phytoplankton growth. Diurnally vertically migrating species, such as krill, would feed on the phytoplankton and transport them to the depths, where the plankton and the carbon they contain would be excreted. The composition of the flakes and the type and amount of nutrients they contain would vary depending on the target ocean area. The flakes are promoted as a means to capture carbon, boost fish stocks and increase ocean albedo. Clarke claims that “*the phytoplankton fed by the flakes are of lighter color than the deep blue of the open ocean and thus reflect more sunlight*”.

Clarke has marketed the concept through various distribution channels, including Winwick Business Solutions P/L, Envisionation Ltd. and The Climate Restoration Foundation. The Australian company Winwick Business Solutions P/L was deregistered, and the Foundation is no longer operating either. With Winwick, Clarke intended to test the production of flakes in a pilot plant and conduct open-ocean experiments, each with an estimated cost of £1 million. Funding for these projects has not been secured, however, Devon-based Envisionation, is aiming to finance them by selling Empathy Coins. Unlike voluntary carbon credits, Empathy Coins are sold based on the purported restoration of living biomass rather than the carbon theoretically captured.

MARINIX Ocean Tech AS, Norway/Croatia: Sale of MARINIX tokens to finance the formation of marine snow

MARINIX Ocean Tech AS is a Norwegian-Croatian start-up company founded in 2019. The company aims to enhance a phenomenon known as marine snow in the Southern Ocean by adding iron chelates to surface waters, which are compounds that bind iron to organic molecules and significantly improve its absorption. The US National Oceanic and Atmospheric Administration (NOAA) describes marine snow as “a shower of organic material falling from upper waters to the deep ocean”, and describes how marine snow serves as food for many deep-sea creatures, but that only a small portion of it remains on the ocean floor.

According to the company, the snow sinks to the seabed sediment, “where carbon remains trapped for centuries to millennia, avoiding the risk of re-release seen in some other CDR methods”. MARINIX published a white paper on its approach in 2025, but it primarily covers funding issues and does not address the concept of adding iron to the ocean. According to the company’s website, applying six kilograms of iron into an area of 100,000 square kilometers is sufficient to initiate the formation of marine snow in the Southern Ocean. No scientific evidence is provided to support any of these statements. MARINIX intends to finance its operations through the sale of MARINIX tokens, similar to the sale of voluntary carbon credits. The company currently aims to raise €11 million by selling 5.5 million MARINIX tokens, each valued at €2.

Germany, Switzerland, USA, UK: Open-ocean trials and commercialisation of Iron Salt Aerosol (ISA) are delayed or abandoned

The ISA method aims to combine OF, methane removal and marine cloud brightening. It involves releasing ferric chloride (FeCl_3) into the lower atmosphere, which acts as a cloud condensation nucleus, promoting the formation of marine clouds while simultaneously breaking down methane into carbon dioxide and water through an oxidation process. Ultimately, the ferric chloride is expected to be washed out of the atmosphere and into the ocean, where the iron acts as a fertiliser.

Franz Oeste developed the ISA method and has been trying to commercialise it through his German company, gM-Engineering, since 2011. In 2023, the company abandoned a planned open-ocean trial in the Bass Strait, north of Tasmania, due to a lack of funding and permitting issues. Since then, there have been no new developments at the company.

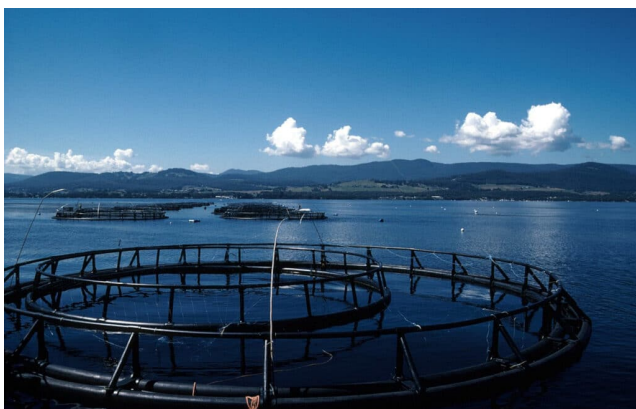
The Swiss Atmospheric Methane Removal (AMR) AG was founded in 2021 with the goal of further developing, field-testing and commercialising ISA. The company originally scheduled a one-year open-ocean trial for 2023, but then postponed it to 2025, and there is currently no indication that the trial is due to take place soon. AMR’s preferred dispersal locations are subtropical ocean regions, including the South Pacific.

The companies Climate Arks Ltd. and Blue Dot Change have also attempted to conduct field trials and market ISA. Climate Arks was dissolved in 2025, whilst Blue Dot Change changed its name to Bennu Climate Inc. and stopped focusing on ISA for unknown reasons in 2024. Instead, the company started testing and promoting a different methane removal method involving high-frequency UV light. The first pilot tests aboard ocean vessels were conducted that same year, and, starting in 2026, a 12-month pilot trial will be conducted on a vessel to test Bennu’s system during normal ship operations. Bennu plans to sell carbon removal credits on the voluntary carbon market and is currently working towards certification.

Updates on key AU projects

Blue Carbon, Australia: Deployment of an AU device in aquaculture

Blue Carbon Pty. Ltd., founded in 2022 and based in Brisbane, Australia, has developed a patented AU and downwelling system called the oPod. According to Blue Carbon, the oPod is an autonomous ocean pump powered by wave and solar energy. The company aims to use the oPod to enhance phytoplankton growth and thus carbon sequestration through upwelling cold, nutrient-rich deep seawater into nutrient-depleted surface zones. The phytoplankton is expected to sink to the ocean floor and remain there “for hundreds to thousands of years”, although the company has not provided any evidence to support this claim. Blue Carbon also proposes using oPods to cool reefs and provide aquaculture with fresh, cooler water, as well as to pump seawater for desalination and brine discharge. oPods can be deployed either individually or in fleets, and in 2024, the company conducted trials off Triabunna in Tasmania, in cooperation with an Australian aquaculture producer. In 2025, Blue Carbon received an Australian government grant to deploy the oPod prototype in ocean-based commercial salmon farming operations.



Salmon cages in Australia. *CSIRO/Wikimedia Commons*

Desert Ocean, Sweden: Producing algal biofuels using genetic engineering and AU

Desert Ocean, founded in 2021 and based in Helsingborg, Sweden, is an Uppsala University and EU-funded Photofuel research project spin-off. The project studied the cost-effectiveness of the production of alternative fuels derived from biomass. Desert Ocean proposes using cyanobacteria as feedstock to produce algal biofuel, and plans to enhance algal growth in a ‘water farm’ using AU. However, the company has not yet revealed how they intend to implement their approach or the AU technology they plan to use. From 2022 to 2023, Desert Ocean collaborated with Uppsala University on a research project aimed at optimising algal biofuel production using genetically engineered cyanobacteria.

Sea-Up, USA: Sale of ‘Sea Shares’ to fund AU

Ocean-Based Climate Solutions Inc. was founded in 2018 by Philip Kithil and is based in New Mexico, USA. It is a spin-off of Atmocean Inc., which was also founded by Kithil, and develops ocean wave-powered upwelling and downwelling technology, including the Ocean Surface Carbon Relocation (OSCAR) pump. In 2008, Atmocean’s technology was tested as part of the Ocean Productivity Perturbation EXperiment (OPPEX-1) off the coast of Hawaii.

Building on Atmocean’s work, Ocean-Based Climate Solutions has developed upwelling technology further, creating the Oxygenator, a wave-powered upwelling and downwelling device that was tested in Morrow Bay, California, and off the Canary Islands as part of the Test-ArtUp project. However, Ocean-Based Climate Solutions appears to now be inactive.

Atmocean, on the other hand, is still headed by Kithil, and has redesigned ocean pumps to either convert wave action into electricity or pump seawater towards the shore for use in reverse osmosis desalination systems. The company is still advertising its OSCAR pump as a means of sending “*carbon rich surface water into deeper water where it is sequestered for decades to centuries*”, and as “*the only scaleable system for sequestering gigatons of carbon for an intermediate period of time (decades to centuries)*”.

Kithil also continues to advertise upwelling technology through another of his companies, Sea-Up, short for Sea Upwelling Company LLC, which was also founded in 2018. According to its website, Sea-Up produces, deploys and operates wave-driven upwelling pumps designed to reach depths of up to 500 meters. The pumps are expected to transport cold, nutrient-rich water from deeper ocean layers to the sunlit surface, thereby stimulating phytoplankton growth. Sea-Up also claims that upwelling increases the water’s pH level and cools the ocean surface. However, the company provides no evidence to support these claims and offers no information on its technology readiness level. Despite this, the company is selling so-called “Sea-Shares” to individuals and companies in order to finance its activities. The company claims that each Sea-Share, worth US\$ 100 captures 200 tonnes of CO₂..

The Climate Foundation, USA: Exploring marine geoengineering in Tasmania

The Climate Foundation (TCF), founded in 2007, aims to deploy AU on a large scale. TCF has developed floating seaweed farming platforms called Marine Permaculture Arrays (MPAs), which use wave-powered pumps to transport cooler, nutrient-rich deep-ocean water to the sunlit surface layers. TCF has been particularly active in number of projects in Tasmania:

- From 2015 to 2018 it tested its MPAs at a nearshore location that hasn’t been publicly disclosed.
- From 2019 to 2020 the company participated in a project testing giant kelp varieties in Storm Bay.
- Since 2021, TCF has participated in several Blue Economy Cooperative Research Centre (BECRC) research projects, financed by the Australian government.
- From 2022 to 2026 TCF participated in two projects led by the University of Tasmania, one modeling the scalability of offshore seaweed mariculture platforms, and the other developing production systems for offshore kelp mariculture. These projects also examined the possibility of upwelling nutrients from deeper ocean layers by, for example, exploring the use of “*wave energy to pump water from 80-100 m depth to irrigate kelp growing at the surface*”. The second project conducted an open-ocean trial in the Tinderbox region off the coast of Tasmania, growing kelp on lines suspended from rings. This trial did not include AU, but a second project phase involving trials in deeper waters is envisaged.

TCF also participated in a BECRC project on ocean carbon markets in Australia and New Zealand, which classified AU as a risky technology.