


"HOW INAPPROPRIATE TO CALL THIS PLANET EARTH," THE science-fiction writer Arthur C. Clarke is credited with saying, "when it is clearly Ocean." The line speaks not only to the fact that oceans cover 71% of the earth's surface, but also the tendency for land-dwelling humans to overlook their importance.

- Oceans are (merely) responsible for "driving weather, regulating temperature and ultimately supporting all living organisms," says the US National Ocean Service.
- There is no tackling climate change without tackling the nature crisis—and there is no tackling the nature crisis without addressing the oceans. The UN calls the ocean "the world's greatest ally against climate change." It is the world's largest carbon sink, storing 50 times more carbon dioxide than the atmosphere, and "the reason we're not experiencing more or worse climate impacts than we already are," according to

UN Foundation Senior Advisor and Senior Director for Ocean and Climate Susan Ruffo.

- Absorbing all that carbon has made the oceans warmer and more acidic. That has disturbed fragile ecosystems—14% of the world's coral reefs were lost in a single decade—and threatens the marine species that depend on them, which the UN estimates could number as many as 10 million.
- As climate change harms the oceans, so does the human activity driving that change. Overfishing has depleted fish stocks—migratory freshwater fish have declined 76% since 1970—meanwhile pollution has choked the water and marine species. The infamous Great Pacific Garbage Patch, pictured below, covers 620,000 square miles—three times the size of France. There are four smaller garbage patches like it. By 2050, there could be more plastic than fish in the ocean.
- As ever with the oceans, it can be difficult to grasp the scale: not only of

New Solutions for the OCEANS



The Great Pacific Garbage Patch, located between Hawaii and California, has become a symbol of the plight of the oceans. Even so, it is below the surface that restoration of the oceans is most needed.

the problems, but also the potential of solving them. Restoring the oceans can remove carbon from the atmosphere, lessen the severity of climate change, help feed the world more sustainably and enrich the world's biodiversity. • For that to happen, there needs to be systemic change—in industries ranging from food to transportation—and massive technological innovation. Brunswick spoke with five companies, large and small, helping pioneer that innovation and working to change systems. Those conversations have been edited and condensed. • At a time when so many stories about the oceans are dispiriting, these companies inspire a sense of hope. "If we weren't hopeful, we wouldn't be doing this work," Running Tide CEO and Founder Marty Odlin told Brunswick. "But optimism is not a license for complacency. We are hopeful that ocean health can be restored because we are doing the work to restore it."

5 PERSPECTIVES FROM COMPANIES BIG & SMALL

ØRSTED, the world's largest developer of offshore wind power, is designing wind farms with nature in mind. *Pg. 32*

RUNNING TIDE, in Portland, Maine, heals the ocean through everything from shellfish farming to carbon removal. *Pg. 34*

CCELL, headquartered in London, creates artificial reefs that enrich biodiversity and help combat coastal erosion. *Pg. 35*

PLANETARY TECH, headquartered in Nova Scotia, Canada, transforms mine waste into a safe "antacid" for the ocean. *Pg. 36*

CLEARBOT, headquartered in Hong Kong, builds self-driving boats powered by renewable energy and AI. *Pg. 37*



Renewable Energy in Harmony with Nature

Why is ocean biodiversity a problem Ørsted cares about? What are the problems you want to solve?

I'd say it's only within the last few years that the world—and I'd include ourselves—grasped how interlinked climate change is with the nature crisis.

It cannot be said often enough: The first thing the world needs is to stop extracting and burning fossil fuels. That is the largest contributor to stopping the destruction of our planet. As the market leader in offshore wind, we play a key part in the transition to renewable energy—and when we build those renewables, we obviously want to help halt the loss of biodiversity, whether that's on land or offshore.

The dialogue about the importance of oceans really began at COP26 in Glasgow and then continued at COP27 in Egypt. As the world's leading wind energy operator, we are a key actor in that conversation, albeit a newer one compared to the shipping industry, fishers, the defense industry and tourism.

Talking about offshore wind means also talking about marine spatial planning. To meet the 1.5°C scenario, the world needs to build out offshore wind fast. In this decade alone, the global offshore wind capacity is expected to increase by a factor of seven.

What's the impact of offshore wind energy on our oceans' biodiversity?

During the construction of an offshore wind farm, two of the main impacts are local habitat change around foundations and noise when piling the foundations into the seabed, which can be harmful to marine mammals. As the wind turbines operate, the spinning blades can pose risks for birds.

We've implemented measures to avoid or mitigate these risks during the construction and operation phases. But the broader conversation is focusing more on actually being a force for good.

Can you say more about those measures to avoid or mitigate?

To protect marine mammals from noise during construction, for instance, we can use underwater curtains of air bubbles around individual foundations that can reduce that noise outside of that bubble-curtain significantly. In deeper waters it may also

ØRSTED is the world's largest developer of offshore wind power. **INGRID REUMERT** is a Senior Vice President with the company. She talks about designing wind farms with nature in mind to Brunswick Partner **WOLFGANG BLAU** and **IGNACE BEGUIN BILLECOCO**, Oceans lead at the UN Climate Change High Level Champions.



Ingrid Reumert joined Ørsted as Senior Vice President, Stakeholder Relationships, in May 2022. She told Brunswick: "I came here because of the vision: create a world that runs entirely on green energy."

be possible to use floating wind turbines over fixed-bottom foundations that do not require piling.

Which then can be positioned farther offshore?

They still need anchoring on the ocean floor, but they don't need as much piling activity as fixed-bottom foundations and you can reach different depths with them. But again, the new paradigm is to actually be net positive for the ecosystem you are operating in.

What could "net positive" look like?

We are working with NGOs and scientists from different universities to try to find out.

In the North Sea's Humber region, where we run the world's largest wind farm, we are doing a seascape restoration project that includes reintroducing half a million oysters and restoring sea grass and salt marsh. In Denmark, we are experimenting with 3D-printed reefs and in Taiwan we are testing whether corals can grow on offshore wind turbine foundations.

One of the main challenges is understanding how to measure biodiversity, particularly in the marine environment, so that you have metrics and are able to measure whether you are making a substantial, positive difference.

We are working on developing our own measurement framework in line with disclosure frameworks such as Taskforce on Nature-related Financial Disclosures and target-setting frameworks such as Science Based Targets for Nature.

No one has all the solutions yet, but we have to experiment, learn and test rather than sit and wait for the method to arrive from somewhere else.

With wind farm projects growing larger, there are reports that some projects are inadvertently becoming fish sanctuaries as trawlers don't want to enter these areas for fear of their nets getting caught in wind turbine foundations. Is that true?

As a renewable energy developer, we strive to ensure co-existence with other marine users. In places where fishing is not allowed in operational wind farms, it's possible that local fish populations may grow, but that depends on the specific location.

I would imagine some of your investors might say: "Wind energy is so much cleaner than fossil-fuel extraction in the oceans. Do we really have to attract public attention to the negative impacts of our company on ocean biodiversity?"

It's true that we have to maintain proportionality



here and not forget just how much better wind energy is for our oceans than the extraction of oil and gas.

Having said that, we have to do everything in our power to minimize our impact and actually improve biodiversity. What is key here is to account for biodiversity as early in a project as possible. These wind farms have a lifetime of up to 50 years, so addressing biodiversity early can have a lasting positive effect.

You're tackling a systemic challenge that is bigger than Ørsted. At Brunswick, we often see leaders organize industry-wide coalitions, pushing for regulatory changes that mobilize their industry. What are your policy-focused activities?

We work both within our industry, through industry organizations, and across industries. We are co-founders of the Climate Group's SteelZero initiative and the World Economic Forum's First Movers Coalition, with the aim to decarbonize steel. We are

Ørsted, which built the world's first offshore wind farm, now has wind farms off the coasts of six countries, including the US, UK, Taiwan and Denmark.

WOLFGANG BLAU is Managing Partner of Brunswick's global Climate Hub and co-founder of the Oxford Climate Journalism Network at Oxford University, a global network that trains journalists from more than 250 leading news organizations each year on how to improve their climate journalism. He is based in London.

IGNACE BEGUIN BILLE-COCQ is Oceans lead at the UN Climate Change High Level Champions.

founding members of the coalition's "near-zero" concrete commitment as well. We also speak with the automotive industry to create broad demand for these new technologies.

And then there is our work in the policy space. Most of our clients are, effectively, governments. We try to inform them during the tender phase about the importance of biodiversity in commissioning wind farms.

What advice can you give on working with NGOs? What works? What doesn't?

The best is to create proper partnerships. The years of off-the-shelf sponsorships are over—I'd call those marketing initiatives, which might serve a purpose but don't generate real change. Create joint projects with measurable targets. And realize that there can be friction between the NGO mindset and the corporate mindset.

When you make it through that friction, and learn to look at things from the other side, good things can happen. ♦



An Operating System for the Ocean

“Carbon buoys made from forestry residue and limestone, and seeded with kelp” isn’t a solution that jumps to mind when we think of tackling the carbon crisis. How did you arrive at that?

Even with my background in ocean operations, I didn’t actually start by looking at the ocean. I’m an engineer, so I started by looking at first principles. Carbon removal needs to become the largest mass-moving exercise in human history. According to the IPCC, just to keep the world from surpassing 1.5°C of warming, we are going to have to move 660 gigatons of carbon from the fast cycle (atmosphere, biosphere, upper ocean) to the slow cycle (geological reservoirs and the deep ocean). And +1.5°C itself is a pretty awful world. To stabilize the climate and secure the future for all life on Earth, we need to collectively move back the 2,000+ gigatons of carbon that we moved from the slow cycle to the fast cycle since the Industrial Revolution, primarily by burning fossil fuels.

That’s the overarching challenge, so I started looking at pathways for carbon removal. I’ve seriously

RUNNING TIDE
Founder and CEO
MARTY ODLIN
speaks with
Brunswick.



Marty Odlin founded Running Tide in 2018. The company is building technology to map—and also help restore—the health of the ocean.

considered and studied the operations of direct air capture and other high-order systems—but realized I couldn’t make the logistics work out. We have to move mass in ways that are energy efficient, ecologically restorative, and scalable. There is no better way to move mass on the planet than through the ocean, and nothing scales better than natural systems. The ocean’s biological pump is an already incredibly powerful natural carbon sink, transferring about 2 gigatons of carbon from the fast carbon cycle to the slow carbon cycle each year.

You are right that one iteration of our system will combine forestry residue, coated with alkaline materials and seeded with macroalgae. This iteration has a number of advantages. Our materials are sustainably sourced and designed to increase mass transfer of carbon from the fast cycle to the slow. Forestry residue and agricultural residue (which would otherwise be burned or left to decompose) is repurposed into our buoys. The buoy’s coating dissolves to combat ocean acidification. Macroalgae, of which kelp is a species, can grow very fast, and pull carbon out of the atmosphere and upper ocean as it grows. We are continuously iterating upon our system design to optimize for scalability and sustainability, so that we can best amplify the ocean’s natural capacity to restore itself.

Looking at what Running Tide does, John Muir’s line comes to mind: “When one tugs at a single thing in nature, he finds it attached to the rest of the world.” Because you don’t just create those buoys, but also restock shellfish beds, enhance macroalgae, plus a handful of other initiatives to restore the health of the ocean. Is there a risk, as a smaller company, in trying to tackle so many issues simultaneously?

Yes. Absolutely. But it’s the correct way to do it. We are building a platform to understand the ocean and find ways to intervene positively, and in that, the John Muir line is precisely right. You can’t build an ocean alkalinity company and ignore how the change in pH and aragonite affect the health and distribution of the flora and fauna in the surrounding waters. You must understand the system.

We are building Running Tide with the aim of being a platform for positive ocean health interventions. We have developed a sophisticated suite of ocean health diagnostic, monitoring and verification tools. This includes innovative and cost-effective hardware and software measurement systems and cutting-edge ocean modeling techniques that work in tandem to refine each other and our

collective understanding of ocean health and ocean health interventions.

Your sources of revenue are selling oysters and clams, and will eventually include selling carbon offsets. What sort of growth are you envisioning—and what sort of financial returns?

Without getting into the financial details, at the highest level, we envision that Running Tide will be an operating system that connects capital to nature and assists the world-scale mobilization effort to save natural systems. We will be enabling a global supply chain to solve environmental challenges, and providing insights and understanding to a variety of partners and governments. Ecosystem service credits (carbon removal, offsets, nitrogen abatement, alkalinity enhancement, environment restoration) will flow through our systems into voluntary, commodity and compliance markets around the world. We will be partnering with governments, militaries and merchant marine fleets to execute Earth-scale solutions to the climate crisis. We will be supporting projects large and small in communities around the world, ensuring equitable participation and distributed benefits in the effort.

What's the biggest challenge your business is facing at the moment?

This stuff is complex. It's a new vision for how to integrate capital and natural systems, and the language and communications pathways haven't been fully developed. So just getting out the message about what we do and why and how it will work today, tomorrow, or 10 years from now is difficult.

If you had every Fortune 500 CEO in a room, what would your message to them be?

Same thing I say to myself every morning: What will your children and grandchildren say about you and the mark you left on the world?

The carbon removal and climate services markets are unequivocally the biggest opportunities of the 21st century. Any company seeking to remove their emissions, attract and retain talent, win the next generation of consumers and make a positive contribution in the world while being at the cutting-edge of innovation should be looking at ways to invest in the natural capital systems. Ocean health and ocean ecosystem services like carbon removal offer unparalleled opportunities. They should be at the center of our collective efforts to restore the health of our planet, just as the ocean is at the center of our planet's system. ♦

Building "Digital Living Reefs" to Save Shorelines

WILL BATEMAN,
CEO of CCell, speaks
with Brunswick's
ALEX BURNETT and
JACK STEWART.

How important is it to find a solution to coastal erosion?

Over half of global coastlines are being eroded, as climate change drives larger waves and more frequent storms. Miami University put out a fantastic paper that showed that the global wave energy is increasing by 0.41% year on year. And when we've looked at that same data for Mexico, you're seeing changes of sort of 1 to 2% in places per year. That doesn't really sound like a great deal, but when you accumulate this over a decade you get 20% more energy in the sea. Our goal is really to try and take the edge off the waves, to wind the clock back.

And why coral reefs?

Soon after Hurricane Matthew [in 2016] I went to see my sister, who lives in Grand Bahama. It was striking, walking along her coastline. Where there were reefs, the houses had wind damage and trees were disheveled, but they hadn't lost any land. When you went further up the beach to where the reef stopped, people were losing their entire gardens. It was quite dramatic.

The core issue we're trying to solve is: Can we replicate natural coral reefs? Can we bring in that protection that natural coral reefs provide to vulnerable coastlines?

Steel forms the backbone of CCell's reefs. The company then uses seawater electrolysis to grow calcareous rock around the steel, to which plants and coral can attach.



People have tried to protect coastlines by doing everything from sinking concrete to sinking ships. Why is your solution better?

If you look at the conventional approaches, I'd argue they haven't changed since the time of the Romans. You get a pile of rocks or concrete and you pile these up until something happens. That's the basis of most breakwaters.

If you look at natural coral reefs, on the other hand, which protect the Maldives and many other places, they're actually working a little bit more subtly below the surface to affect change at the surface. They themselves don't take the brunt of those waves. It's estimated around 25% of all the marine life that we know of is either born on or lives in coral reefs, and we have lost 50% of our coral reefs—in the Caribbean they've lost 80%. We've got to start to really seriously think about how to restore our balance.

We looked at that and said: Can we engineer a lightweight structure like a reef? Currently we make them from steel, which can be manufactured in bulk in a factory—150 meters of reef fits into a single container for transport. A lot of design work went into making units that stack together a bit like super-market trolleys.

How do you turn that metal structure into a reef?

We use a technology called mineral accretion. This passes a small electric current through the water around the structure which causes sea-water minerals to form rock crystals. This is similar to limescale that forms in kettles, except instead of boiling the water, we increase the pH of water around the reef. The structure goes from being lightweight to a reinforced heavy mass that can then provide resistance against the waves. Our goal is for a reef with 20% porosity, having started at close to 90%. We monitor the reef remotely and use renewable energy wherever possible. Corals or bivalves are able to rapidly thrive upon our reefs; they offer a haven for diverse marine life, just like natural reefs.

Where have you installed these so far?

Most of our work has been in Mexico. Our biggest installation is 120 meters long in a place called Telchac. We've got a number of smaller pilots in Cancun. We finished a project out in the Isle of Man where we had three pilot units. And we've been running pilot units in Israel, testing out and optimizing the actual rock growth itself. ♦

ALEX BURNETT, a Partner, and **JACK STEWART**, an Associate, are with Brunswick's Business & Society team.



An Antacid for the Ocean

PLANETARY TECH transforms mine waste into a carbon-removal tool. **PETER CHARGIN**, a Vice President at the company, speaks with Brunswick.



Planetary Tech transforms waste from mines into alkalinity that can safely be added to the ocean. Above, a sensor Planetary Tech uses to monitor that process.

Why does the ocean need to be given “an antacid,” and how does that help with carbon removal?

Right now, the ocean and the atmosphere are in equilibrium as far as CO₂ is concerned. Unfortunately, over the last 150 years, a lot of the CO₂ that we've added to the atmosphere has migrated into the ocean. And when you add CO₂ into the ocean, it becomes more acidic. If you add a base to an acid, it neutralizes. When it neutralizes, that reduces the amount of carbon dioxide in the ocean. Since the atmosphere and the ocean are going to reach equilibrium, that means the ocean will draw down carbon dioxide from the atmosphere.

You can make a really big difference in the atmosphere and only make a tiny difference in the ocean. If you removed all of the post-industrial era carbon dioxide that the world has put into the atmosphere, it would make less than a 1% difference in the amount of carbon dioxide in the ocean. It's like a coffee mug versus a bathtub.

And you produce that “antacid” by using products from mine tailings. Is that safe?

Yes. All the science says this is safe. We're just accelerating nature's process—what's called the geologic carbon cycle. It's a natural process that involves the acidity of rainfall reacting with rocks, and the water

eventually winding up in the ocean. It's exactly the same process. You have to get alkalinity to add it into the ocean, and it needs to be pure. We've developed the process to create and purify alkalinity, and we're scaling up now.

We are starting projects around the world to add alkalinity into the water and validate that all the science and all the content is actually true. We're starting incrementally, and then growing over time, as we become more confident that what we believe is true is actually true.

And to put all of this in perspective: We're adding a few thousand tons of alkalinity to the ocean, compared with 38,000 billion tons of carbon the ocean holds. A trace amount, in other words. The good news is that it only takes a small amount of change to make a difference.

Planetary Tech was awarded the X Prize from the Elon Musk Foundation. Do you have any other sources of funding or revenue?

Yes, we have revenue. It's small right now. Most of our funding has come from grants and venture capital. But this year, we will be selling, for redemption in 2023, between 2,000 and 3,000 tons of carbon credits. And then next year, we'll be selling between 10,000 and 20,000 tons, so that will make us one of the largest carbon removal companies on the planet.

Planetary Tech's mission is to remove a billion tons of carbon dioxide. Is that realistic?

Yes, it is realistic. It won't happen overnight.

One of the challenges we face is public knowledge. People just don't know what carbon removal is. There's no draw from the public to say, "We want to support permanent carbon removal." If there were that pull, we'd be able to move much more quickly because there would be more of a requirement from governments and industry to provide these high-value permanent carbon credits. But they're not available now.

It also takes time to scale—it's a challenge any new industry would have. It takes time to build the many production facilities that we need to process the mine tailings and produce the alkalinity. And to do it in a way where we're making sure we're a trusted provider. People aren't sure they should trust organizations that are claiming permanent carbon removal. We want to do projects in places where the local communities really want us to be there.

But by 2035, 2040, we will be in a place where we're able to get close to that gigaton removal we've talked about. ♦

Self-Driving Boats Powered by AI & Clean Energy

CLEARBOT CEO
SIDHANT GUPTA
speaks with
Brunswick.

Clearbot came out of a student trip, right?

My co-founder and I went to Bali in 2019. I was studying computer engineering at the University of Hong Kong. He was studying computer science, specializing in artificial intelligence. We found out the university would pay for your flights and hotels if you did a student project. And we really wanted to go to Bali. So we went, and saw that these surfers were going out every morning and pulling out trash from the water. We spoke to the local government there and found out they spent a lot of money on the issue because they depend heavily on tourism, and tourists don't visit dirty beaches. And while we were there, we actually put together the first concept of our boat; we built it out of aluminum and some local materials. It was a pretty crappy-looking box.

When we came back to Hong Kong, we saw something similar in the marina with these diesel- and petrol-powered boats fishing trash out of the water. We worked out that, because of the amount of fuel they're burning to collect so little waste, they were actually creating more pollution than they were cleaning up. It's a broken system.

Clearbot's boats are being used in Hong Kong and India to do everything from collect trash to remove invasive plant species.



Who are your customers?

Governments first and foremost. We work with basically any marine environmental department. We're working with the government in Hong Kong and we just expanded into India. There are also government contractors—our boats clean up construction sites and can also do marine inspections. In marine construction sites, usually you need to do inspection work under the water or on the surface. It tends to be expensive and dangerous. Our boats have cameras on board and can be driven remotely, so it's cheaper and safer.

We also work with property companies—luxury hotels with waterfronts, yacht marinas, that want to keep the water clean.

Finally, we partner with companies. Microsoft, for instance, helped us to train our machine-learning models. Other companies sponsor a boat. Sponsorships are usually about marketing or carbon credits. And we'll use that sponsorship to try to get the government to support the project after their sponsorship ends. Governments don't want to try your product, they want something that's working; they want to see a six-month pilot before they order. So the sponsorships are actually really helpful.

The boats pick up more than trash, right?

Yes. They can deliver up to 200 kilograms of cargo, for instance.

But just on pollution removal, they also remove invasive vegetation and can clean up small-scale spills. Another problem, and this is big in India, is that foam develops on the surface of lakes because of pollutants in the water. Our boats actually break down the foam.

“We’re not the ultimate solution to ocean plastic—we’re something in a portfolio of solutions. The bigger picture for us is decarbonizing the ocean.”

The idea for Clearbot came to Sidhant Gupta (right) and Utkarsh Goel while the pair were on a student trip in Bali. Sidhant leads the business as CEO, while Utkarsh is the company's CTO.

**How?**

It pulls water up with a small water pump, and then sprays it back on to the water surface, breaking the foam down. That leaves an oil on the surface, which the boat picks up.

What happens to the trash once the boat gets back to its docking station?

It's site-specific. In Hong Kong, for example, with the government sites, they have a designated contractor to collect marine waste. In India, we hired a recycler to pick up waste from our boats, recycle it and share the data of what percentage is recyclable, what percentage was waste, and so on.

What sort of impact has your work had so far?

There's this part of Hong Kong's harbor called the Wan Chai Basin. People live there in apartments along the Harbor, and it's also a fairly big tourist spot. The government had opened a little space for people to rent paddle boards. That site was one of the dirtiest sites that we've had. Our boats were pulling out so much trash. You saw a very immediate, very direct impact. And there was a lot feedback from the community

Going forward, I think our most impactful projects will be in India, because we're targeting the Ganges River, and in Kerala we're doing a lot of the backwaters. These are critical waterways. And we'll not only have an environmental impact—there's a lot of waste in the water in India—but we'll also be supporting the water infrastructure for the country. A lot of the economy depends on these waters being navigable and clean, for boats to be able to move around. Having waste in the water is a real problem. It gets stuck in pillars, it causes damage. And so we're actually adding value.

You're working on marinas, rivers, lakes, shorelines—preventing trash from getting to the ocean, in other words. But you're not collecting trash from the ocean just yet.

To get to the open ocean, we need a bigger boat, something that could survive the waves and the weather. We're building a business flywheel that allows us to generate enough revenue so that, in a few years, we can start building a larger boat and tackling bigger problems.

We're not the ultimate solution to ocean plastic—we're something in a portfolio of solutions. The bigger picture for us is decarbonizing the ocean.

Every time we can replace manual, petrol-powered boats, we're part of that solution. ♦