



MARINE ECO- ENGINEERING NEWS

JULY 2023





EDITORS NOTE:

Marine Eco-Engineering news is formulated for Exo Engineering partnerships and collaborations. We view this publication as an opportunity to hear from our partners, associates, and researchers, to forge new collaboration opportunities and strengthen existing connections.

In this July 2023 issue we will report on the second and third Living Windfarm Project Workshops, Project 3DPARE and the Taiwan visit in collaboration with GBIP Taiwan and Innovate UK EDGE, as well as articles from exciting partners throughout a range of sectors.

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AN INTRODUCTION TO THE TEAM

The team at Exo Engineering boasts a wealth of experience in ecological engineering design innovation, concrete chemistry, and environmental research. We asked each team member about their role, what they are most excited about for the future of Exo Engineering, and what they see as the opportunities and challenges ahead.

SAM GREENHILL



Sam has recently joined the team in May. He has a degree in **Ecology and Wildlife Conservation (BSc)** and a Master's degree in **Biodiversity Conservation (MSc)**, both from Bournemouth University. Sam has previous research experience in the eco-engineering of marine infrastructure through his work on the **Interreg funded 3DPARE project**, where he was responsible for the biological monitoring of artificial reef units which had been designed and fabricated using novel concrete 3D printing technology.

"I am particularly interested in promoting sustainable ways to include design features such as holes, tunnels, crevices and grooves into new marine infrastructure, which can provide habitats for a wide range of marine life. I am excited to get involved with the range of projects that are upcoming and currently underway, which can help to provide hybrid solutions to meet the needs of both humans as well as the full range of life using the marine environment".



ABIGAIL NUNNS



Abigail joined Exo this spring after achieving a degree in **Marine Biology and Zoology** at **Bangor University, North Wales**. She has been involved with the development of new **Greening the Grey©** textures and imprints which aim to increase the bioreceptivity of our units, focusing on targeting specialised species and replicating niche habitats based on conservation evidence. As we move towards the implementation of **Biodiversity Net Gain legislation** in November 2023, ecological considerations will become an integral part of project planning. The **artificial reef** units that Abigail has been working on can be used to restore hard sediment environments which have historically dominated the North Sea. As knowledge of baseline environmental conditions have been lost or shifted with time and lack of monitoring, Abigail now sees an opportunity to restore rather than mitigate.

"I was interested to learn about shifting baseline syndrome during my studies and have continued to be mindful of it in my career. It shows just how recent sufficient data collection and project management really is. We should account for this when developing restoration aims, being mindful of the latest scientific evidence which should always be the basis of innovation in this field."





PROJECT 3DPARE: 3D-PRINTED REEFS DEPLOYED OFF EUROPEAN COASTS

by Sam Greenhill

Before joining **Exo Engineering**, I had previously been employed by Bournemouth University as a researcher on the **3DPARE project**, an **EU-funded Interreg project which studied artificial reefs for use in subtidal areas of the Atlantic coasts of Europe, designed and fabricated using novel concrete 3D printing techniques**. This brought together an interdisciplinary team of researchers from the UK, Spain, France, and Portugal with expertise in material engineering, concrete 3D printing, ecology and marine biology.

The project had the dual goals of producing artificial reef units that would be strong enough to withstand high energy Atlantic sea conditions whilst also providing niche habitats for a wide range of sea life.

Although the technology is still in its infancy, 3D printing of concrete and concrete-like materials presents many opportunities for the creation of artificial reefs, which the project looked to explore. One of the main benefits was the ability to create complex textures, shapes and voids, such as curved tunnels and large overhangs, which would be difficult to achieve using traditional moulds and form liners. The designs and habitat features included can also be customised to suit the deployment location, target species and secondary function, such as storm protection. In addition, 3D printing can be easily replicated around the world, with print files able to be sent wherever a concrete 3D printer is located.

After initially testing concrete formulations using a range of cement and geopolymer-based binders and various aggregates such as limestone, glass and seashell, the pilot artificial reef units were printed using low carbon cement and either limestone sand or crushed glass from recycled car windscreens. **All reef units were printed by the University of Cantabria in Santander, Spain, and nine units were deployed at locations off the coasts of the four partner countries during the spring and summer of 2020.** In each country the reef units were quickly colonised by a wide range of marine life, with sessile species such as seaweeds, keel worms, sea squirts, hydroids, bryozoans, barnacles and sponges, and mobile species like fish, crustaceans and molluscs using the holes, tunnels and other habitat features of the units.

Through biological monitoring of our reef units using SCUBA and drop-down video surveys, we ascertained that **after being immersed for 18 months, diversity**



at the 3D-printed reef units was either similar or higher than at nearby natural rocky reefs and artificial infrastructure in each country. We also studied the difference in diversity of the various habitat features and discovered that the highest diversity of marine life was found in the larger of the holes and tunnels in our designs. Despite this, each feature type supported unique marine communities, so all added to the overall ecosystem that was created by the reef units.

The preferences of various species for certain feature types were also recorded. Crabs for example were most commonly found in the larger holes in the reef units, whereas fish preferred tunnels and the alternate escape route that they provided. Some size preferences were also recorded, with smaller fish and prawns often being recorded in the smaller tunnels and holes, whilst the large tunnels and holes were popular with larger fish, as well as octopuses in Spain and Portugal.

There is also evidence that the artificial reef units off the south coast of England created nursery habitats for juvenile fish species more readily than other coastal infrastructure or even natural rocky reefs nearby. Between the second and third year of deployment, the UK artificial reefs also began to support a community of native oysters, which established in the holes and tunnels of the units. **This species has declined by over 95% in UK waters since the mid-19th century, so it's great to see the reef units providing suitable habitat to help aid their recovery.**

The project came to an end in June 2023, and all results from the project are currently being collated and will be disseminated through scientific articles and reports, available on the 3DPARE website. The artificial reef units will be staying in situ and the team hopes to be able to return to them in future to assess longer term changes in the community of marine life that they support.

Find out more at [the 3DPARE website](#) and [Bournemouth University's research page](#).





LIVING WINDFARM PROJECT WORKSHOPS

The second Living Windfarms Project hybrid workshop was held at the University of East Anglia on the 16th of March 2023. The workshop outlined the processes involved in decommissioning, current legislation and the necessary ecological considerations. Many important discussion points were raised, including:

- **The feasibility of recovering rock armour scour protection during decommissioning**, considering the costs and logistical challenges involved, as well as the damage to potentially thriving reef systems that have been established;
- **The limitations involved with not removing structures** as part of decommissioning and policies which should be in place to prevent negative environmental impacts through the use of loopholes, and;
- **The implications of current legislation in regards to shifting baseline syndrome**, where the baseline that must be returned to is devoid of hard substrate that may have been present historically.

This hybrid workshop demonstrated that there are many voices within the industry itself who are not only willing to discuss the potential for environmental restoration across the lifetime of offshore installations but have a real desire to see this encompassed by government policy.

The third Living Windfarms Project workshop was held in the Netherlands in July and was delivered in partnership with The North Sea Foundation, Natuur & Milieu, and others. The workshop encompassed carbon offsetting of offshore projects, with presentations and ensuing discussions focussing on how offshore industry employees believe offsetting could be successfully implemented and integrated into projects. Carbon offsetting could either be achieved by removing equivalent amounts of carbon dioxide from the atmosphere, either through participation in offsetting schemes or by reducing emissions within the project itself.

Our partners and hosts, The North Sea foundation and Natuur & Milieu, aim to coordinate knowledge and expertise within the marine environment, to demonstrate that sustainable solutions are possible throughout the North Sea and beyond.





2018 Rob Spray Seasearch East

We presented the Living Windfarms Project as a viable, scalable example of carbon offsetting in the subtidal environment. Due to our consideration of carbon emissions throughout the development of our ExoReef units, our technology integrates carbon offsetting and is designed to increase biomass throughout the deployment site. Increasing habitat availability and the resulting boost in biodiversity further increases carbon uptake in benthic areas.

If you are interested in being notified of upcoming workshops, please sign up to the [Living Windfarms Project email list](#).



**NATUUR
& MILIEU**

“Marine eco-engineering, or designing *for* nature, is of fundamental importance in today’s world. Whether it involves structures which can help preserve some degree of ecosystem services for local communities, where coral reefs have been destroyed through poor management or climate change, or whether it is providing a much-needed boost to marine biodiversity alongside essential developments like offshore wind, eco-engineering can provide solutions to benefit both people and nature. The scientific evidence base for these benefits is growing all the time, now we need strong collaboration between academia and practitioners to demonstrate the benefits which can be achieved by eco-engineering at scale.”



Professor Rick Stafford, Bournemouth University



GLOBAL BUSINESS INNOVATION PROGRAMME TAIWAN



In 2021 Exo Engineering was selected to join the Innovate UK EDGE Taiwan cohort, providing small innovative businesses access to specialist growth and business skills such as increasing market engagement at events etc. Along with this dedicated framework, cohorts are given the opportunity to visit the countries they are targeting. Our visit was delayed until March 2023, however it was well worth the wait!

First, we visited Taipei where we were given the opportunity to meet with key developers within the Asian offshore wind industry; Northland Power, Corio, Synera, Iberdrola and RWE. This involved corporate introductions, pitches, discussions and networking, amongst other things.

We then travelled to Tainan, taking a tour around the ITRI offices, the Industrial Technology Research Institute is focussed a range of industries, but for our delegation offshore wind energy was the main point of discussion. After that we moved on to Kaohsiung to attend the Wind Energy Asia event. This exhibition and conference followed a classic format and formed an excellent opportunity to continue networking. After the exhibition in Kaohsiung we travelled back to Taipei to take part in more bespoke meetings and opportunities that arose during the last week of meetings and networking.

When we applied for the Innovate UK EDGE Taiwan cohort, we aimed to establish a productive partnership with several key members of the Asian offshore wind market. This in turn would lead to specialised development of our biodiversity enhancing ExoReef scour protection solutions for deployment in Asian marine environments. This would provide Asian market partners with the opportunity to reduce their environmental impacts, fulfilling their agreements laid out during the planning stage of wind farm development, and in the conclusion of the Environmental Impact Assessment.

Our range of ExoReef products can be applied around turbine foundations as well as along cable routes, providing effective scour protection and supporting the colonisation of a wide range of species to help offshore wind projects achieve marine biodiversity net gain. Textures, inserts and unit type used can be specialised for certain environments, which is where we see real value in using our products worldwide.

The latest auction process for offshore wind development has now begun and a selection of developers that we met have already announced that they will be taking part. We wait with excitement to see which developers will be successful in the next round!



Innovate
UK



AN INTRODUCTION TO NORFOLK SEAWEED LTD

At Exo Engineering, we are always looking to establish collaborations and partnerships with businesses who are making a positive, sustainable impact in our seas. Norfolk Seaweed Ltd is a company created by people who come from and live in North Norfolk, with a family background in growing and selling oysters and mussels. Norfolk Seaweed have been awarded their marine licence by the Marine Management Organisation for a nearshore seaweed farm. The following article has kindly been submitted by Willie Athill, Chief Executive Officer of Norfolk Seaweed Ltd.



'We are already growing oysters in Blakeney Harbour and we aim to build a family business that can be replicated within the local community to pave the way for more widespread sustainable and restorative use of Norfolk's coastal waters. Our pilot farm will produce local brown seaweeds for use in bio-fertilisers, bioplastics, food, nutraceuticals and much more.'

Our initial farm will comprise a 5ha pilot project growing to 25ha, with careful environmental monitoring at each stage of the project. The farm will aid regeneration both off and onshore in our region. Seaweeds provide alternative sources of food, feed, fuel and human health products and can be produced in a sustainable and ethical way; Seaweed farming does not need land, pesticide, fertilisers, or freshwater to grow – it has zero inputs and does not produce waste.

Seaweeds have been part of the human food chain for thousands of years. The market is dominated by Asia but now, with global demand more than doubling since 2010, we are at the beginning of what could be a completely new way of using and protecting the coastal waters of the British Isles. Seaweed farming, an initiative already employed with success in the United States and in Europe, uses lateral long lines of seaweed seeded rope suspended in the water column. Growing seaweed absorbs excess phosphates and nitrogen that flow into the sea from land water run-off, reducing eutrophication and the subsequent acidification of coastal waters. Global seaweeds absorb more CO₂ from the atmosphere than land plants and produce over half of the oxygen we breathe. Seaweed based animal feed supplements can also reduce methane production by cattle by as much as 35%.

Located between the shoreline and the windfarm belt, sea farms can easily be coordinated with other local users. The unobtrusive subsurface infrastructure



provides a sheltered habitat to other marine species and protects the seabed from further destruction by the trawl fishing industry. It also, when deployed at scale, can dampen the effect of storm surges, thereby supporting coastal flood defences.

Norfolk Seaweed will encourage and campaign for the replication of successful sea farms on this basis, because once product lines are established at volume, production will encourage the creation of associated local shore-based businesses and reduce the need for foreign imports.'

More details of our business can be found on www.norfolkseaweed.com



NEW WEBSITE!!

We are excited to announce that our new website is now live! We wanted to say a special thanks to **Rob Spray at Seasearch East**, who kindly provided many of the images seen throughout.

Our website has been thoroughly redesigned to offer a more user-friendly experience. It outlines the range of intertidal and subtidal applications which our products can be utilised in, with designs continually evolving and improving as we work with clients to develop specialised solutions. We are especially proud of the Collaborations pages, where you can view these partnerships and products.

Feel free to have a browse at: www.exo-engineering.co.uk



BIODIVERSITY NET GAIN CPD TALKS TO BEGIN

We have been busy working to understand the new Biodiversity Net Gain (BNG) legislation that comes into forces from November 2023.

This legislation requires all development projects in England (with very few exceptions) to achieve at least 10% Biodiversity Net Gain. This can be quantified using DEFRA's Metric 4.0 calculator tool, with legislation applying to terrestrial and intertidal developments.

We are offering 30 minute Continuous Professional Development (CPD) talks, which are available to book now. There will be an interactive element throughout the presentation, with a considerable proportion of the run time dedicated to questions and answers.

Exo Engineering aims to equip developers with the knowledge they require to begin intergrating Biodiversity Net Gain legislation into development planning. It is hoped that these talks will streamline the transition towards inclusion of environment enhancing features within future developments.

To learn more and book a slot, [check out our Eventbrite page](#).

WHAT'S NEXT?

It's been full steam ahead on production at our workshop, as we prepare for several product pilots featuring our full range of ExoReef scour protection products.

In collaboration with our project partners, we hope to establish best practices for deploying these units on the seabed and how best to monitor the marine life that will be making them their new homes. We will use the data we collect to assess the potential for ExoReef units to achieve the joint objectives of providing protection for offshore wind infrastructure, and creating habitats for a wide range of marine species. This is hoped to achieve our long term goal of increasing local biodiversity around the base of offshore wind infrastructure.

Look out for updates over the next few weeks and months on our [Twitter](#) and [LinkedIn](#).



A NOTE OF THANKS TO OUR PARTNERS AND COLLABORATORS

There are exciting times ahead for Exo Engineering. We recognise the important role of all past and current collaborators, partners and clients who have helped us get to where we are today. We are extremely grateful for all these contributions and look forward to forging stronger relationships with new and existing partners in the future as Exo Engineering grows. If you have any ideas for collaborations or contributions to make regarding the future of Exo Engineering, please do not hesitate to get in contact with us.



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