



# MARINE ECO- ENGINEERING NEWS

WINTER 2023/2024



Pembroke deployment, September 2023



Sam during the September monitoring trip

## 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 Winter issue, we will explore the latest developments at Exo Engineering, celebrating the projects we have been fortunate enough to take part in with contributions from partner collaborations.

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ExoHedrons ready for deployment



The team in Pembroke

## DEPLOYMENT OF EXOREEF UNITS IN PEMBROKESHIRE, WALES

At the beginning of September, the Exo Engineering team travelled down to Pembrokeshire to assist with our biggest pilot deployment to date. Over **16 tonnes** of our ExoReef units were deployed in the Celtic Sea, including 2 articulated mattresses, 1 frond mattress, 70 ExoSpheres, 20 25kg ExoHedrons and 5 100kg ExoHedrons.

The deployment took place at a Phase 2 **Marine Energy Test Area (META)** site in **East Pickard Bay**, which is managed by **Marine Energy Wales**. This collaboration with ORE Catapult's Marine Energy Engineering Centre of Excellence (MEECE) will enable much-needed data to be collected about the possibilities of increasing Welsh marine biodiversity through the use of ecologically enhanced hard engineering. This will inform the prospects for integrating nature-inclusive designs into offshore wind infrastructure in a wider context, but more importantly within the Welsh offshore renewable energy sector.

The deployment marks the start of an 18-month monitoring period, during which a range of monitoring methods will be used. **Environmental DNA (eDNA)** and ROV surveys were conducted upon deployment of the units to establish baseline data for the site and will also be conducted at the end of the 18-month study period to determine any impacts and changes to the benthic community. Baited Remote Underwater Video (BRUV) surveys will also be used during the 18-month period to examine the presence of elusive species which may go undetected through the use of ROVs.

## PEBL MONITORING

As part of the Celtic Sea ExoRock deployment, Exo Engineering teamed up with marine monitoring company **Plant Ecology Below Land (PEBL)**. The following article was very kindly submitted by PEBL's **Project Manager, Christian Berger**.

PEBL is a marine monitoring company specialising in underwater technology designed to empower marine research and eco-engineering projects. Our flagship products, the **SubCam** and the **GrowProbe**, are designed to monitor and document marine environments, particularly in the context of biodiversity conservation, enhancement and restoration within offshore eco-engineered infrastructures.

**The SubCam is our advanced programmable underwater camera, engineered to operate at depths of up to 60 meters.** With its extensive 240-minute battery life, it is suited for capturing extended video sequences, allowing for comprehensive monitoring over time. This makes it an crucial tool for observing the development of marine life on eco-engineering structures, such as the biodiversity-inclusive blocks and mats designed by our partners at Exo Engineering. By offering the capability to record short videos over several months, the SubCam provides researchers and engineers with invaluable insights into the gradual processes of ecosystem establishment and development.

Complementing the visual capabilities of the SubCam, **our GrowProbe is a multiparameter data logger that comprises cutting-edge sensor technology within a robust underwater housing.** It's capable of running autonomously for up to 60 days, periodically recording high-resolution data on current speed, direction, turbidity, and temperature. This data is essential for understanding the abiotic factors that influence the success of biodiversity on eco-engineered structures. By analysing the GrowProbe's detailed measurements, eco-engineers can refine their designs to better facilitate the establishment and persistence of diverse marine communities.

Together, the SubCam and GrowProbe offer a comprehensive toolkit for monitoring and assessing the ecological performance of offshore infrastructure. Our technologies support a data-driven approach to eco-engineering, helping to ensure that these structures not only protect coastlines but also enhance the marine biodiversity that is so vital to the health of our oceans.



Various mounted SubCams

## ADVANCING BIODIVERSITY MONITORING IN MARINE ECO-ENGINEERING: A BREAK-THROUGH WITH ENVIRONMENTAL DNA

The following article has kindly been contributed by Sebastian Mynott from Applied Genomics Ltd.

**Nature Inclusive Design (NID)** is emerging as a key consideration in the construction of environmentally friendly manmade infrastructure. One such application involves eco-engineered armouring, where artificial reef structures are designed to enhance marine biodiversity. A pioneering study, conducted off the UK south Devon coast, sheds light on the efficacy of these structures, providing a crucial understanding of their impact on invertebrate biodiversity and the alteration of natural ecosystems.

**Applied Genomics Ltd.**, based in Norwich, UK, employed environmental DNA (eDNA) techniques to investigate marine sediment samples in and around the artificial reef structures before and after installation. Unlike traditional sampling methods, eDNA allows for a comprehensive analysis of genetic material present in the environment, providing a nuanced view of the biodiversity within a given habitat.

The study aimed to assess the success of eco-engineered armouring in promoting Biodiversity Net Gain, a concept increasingly emphasised by regulators and statutory bodies globally. Biodiversity Net Gain seeks to ensure that anthropogenic activities contribute positively to biodiversity, a goal that aligns with the principles of Nature Inclusive Design.

A **Before-After Control-Impact (BACI)** study design was adopted to accurately evaluate the ecological impact of interventions. Employing this methodology enabled Applied Genomics to distinguish between natural variations and the actual effects of the artificial reef structures on marine biodiversity.



Washing sediment sample



Day Grab in action

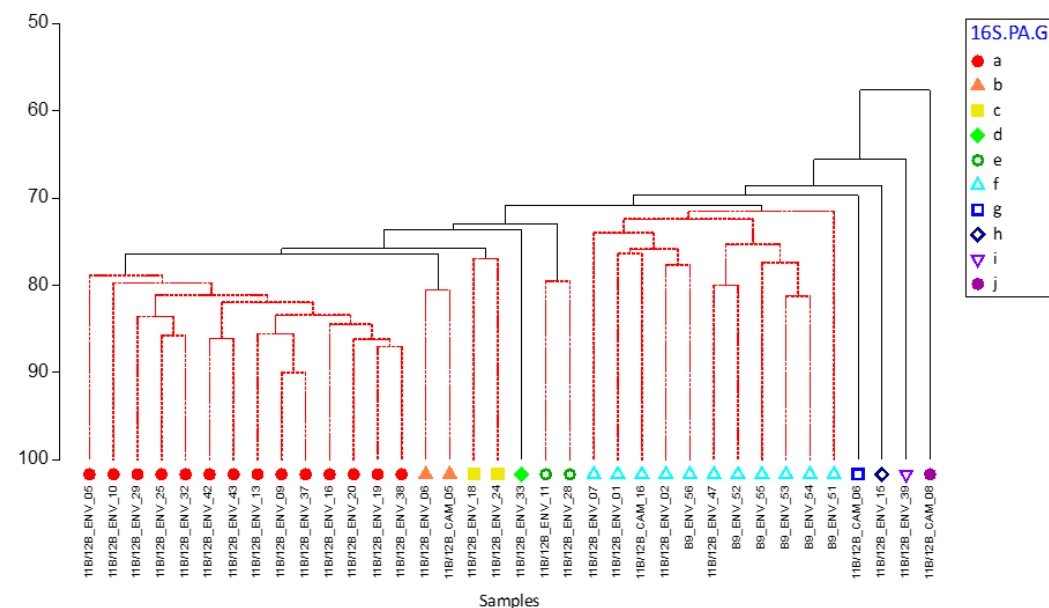
## ADVANCING BIODIVERSITY MONITORING IN MARINE ECO-ENGINEERING: A BREAKTHROUGH WITH ENVIRONMENTAL DNA (CONT.)

The eDNA analysis focused on key parameters, including taxonomic richness, taxonomic diversity, and genetic diversity of various species. Results revealed a significantly higher biodiversity of invertebrates around the artificial reef structures, with specific taxa such as benthic epifauna, suspension feeders, and carnivores exhibiting notable diversity. Intriguingly, the eDNA analysis also detected a rich assemblage of genetic material from sedimentary infaunal organisms within and near the artificial reef structures.

The findings suggest that the design features of the artificial reef structures, with their internal void spaces, contribute positively to biodiversity enhancement and mitigate the impact of anthropogenic activities on underlying natural ecosystems. This marks a pivotal advancement in the field of marine eco-engineering, showcasing the potential for low-footprint solutions compared to solid manmade structures.

The use of eDNA analysis in this study provides a comprehensive and efficient means to assess genetic diversity across various taxonomic levels. This not only enhances our understanding of the immediate impacts of eco-engineered structures but also paves the way for more informed and effective conservation strategies.

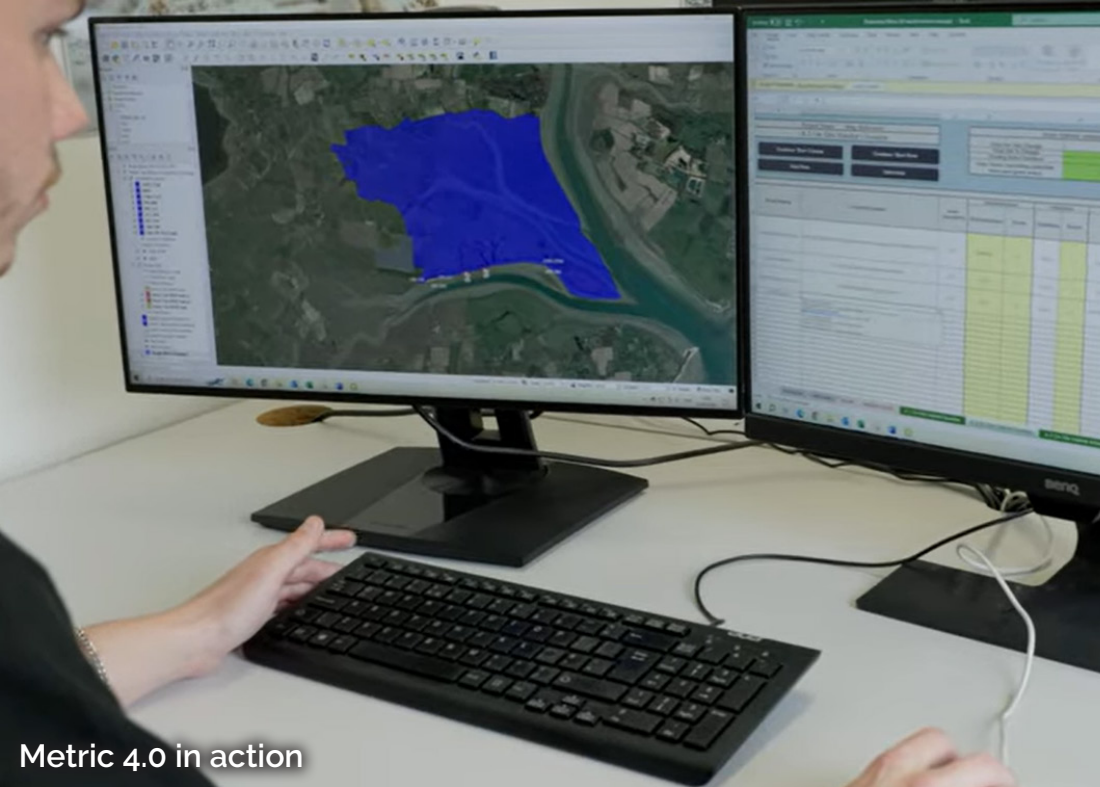
The integration of eDNA analysis in monitoring the biodiversity effects of artificial reef structures signifies a major leap forward in marine eco-engineering. Applied Genomics' contribution to this work underscores the importance of advanced scientific techniques in evaluating the success of Nature Inclusive Design. As humanity continues to expand globally, this research provides a crucial framework for sustainable and nature-friendly infrastructure in marine seascapes.



### eDNA sample analysis



Applied Genomics sampling equipment



Metric 4.0 in action



## BIODIVERSITY NET GAIN CPD TALKS

At the beginning of August, we began to host our lunchtime Continuous Professional Development talks on the topic of new **Biodiversity Net Gain** legislation which has been implemented in England from **January 2024**. The purpose of these talks was to inform a range of individuals and organisations about the necessary considerations, such as the types of developments that will be impacted and what measures can be taken to achieve Biodiversity Net Gain in line with legislation.

Impacting all developments taking place in England which are over 25m<sup>2</sup> and above the mean high water level, the new BNG legislation represents a significant change to the development process. Developers must ensure that their projects result in at least a 10% increase in biodiversity at the development site, which can be achieved through **habitat creation, enhancement**, or through the **purchase of biodiversity credits**.

We offered three sessions introducing the new legislation, drawing over 75 individual sign-ups. The talks lasted approximately 30 minutes and were split into two sections: a 15 minute presentation on BNG legislation, followed by a 15 minute interactive session. This enabled the opportunity for attendees to raise any points for consideration or ask any questions.

We also offered three follow-on talks which discussed the calculation tool, **Metric 4.0**, which has been developed by **Natural England** and **DEFRA**. The talk was structured in the same way as the introductory talks, but focussed more specifically on how the calculation tool is used to derive a percentage net biodiversity change which results from developments. Our existing relationship with Natural England has allowed us to pass on any feedback or questions that we were unable to answer to clear up any uncertainties about BNG legislation.

The talks drew positive feedback and enabled much needed logistical discussions about how Biodiversity Net Gain legislation will be implemented and the additional challenges and concerns. A recording of both the introductory talk and the Metric 4.0 calculation tool talk have been uploaded to our YouTube channel, so head over to there if you missed them!

## ORE CATAPULT'S LAUNCH ACADEMY PROGRAMME

Running from **June to December 2023**, ORE Catapult's Launch Academy programme seeks to provide new, innovative Offshore Wind businesses with the necessary tools to **accelerate technology development** and expand business skills to maximise commercial success. This is achieved through the wide range of modules offered by the programme, and through linking businesses with industry professionals.

The latest run of Launch Academy has focussed on businesses in the East of England and is **sponsored by RWE**. This region in particular holds large potential for further expansion of offshore wind energy generation due to the large number of existing offshore farms. With continued innovation enabled by the Launch Academy programme, businesses will be able to streamline routes to success and reduce risk at all levels of development and maintenance. This will positively influence the local supply chain and create job opportunities across East Anglia.

During the first 'term', the cohort completed modules on **Intellectual Property, accounting, value propositions and the general Offshore Wind industry**, with the aim to inform the cohort of how they can protect and develop their innovations and find a niche within the market.

At the Mid-Term event on the 28th of September, Exo Engineering travelled to the University of Essex for a morning of talks from wind farm developers, ORE Catapult Operations and Management (Grimsby) and Stronger Stories. In the second half of the day, each of the cohort had a 30-minute slot to discuss their innovation with four representatives from RWE. This was incredibly beneficial as it allowed those taking part to understand how developers view and value their innovations.

**The Launch Academy programme concluded on January 10th, 2024, with presentations from all the cohort showing how the programme enabled them to grow into and within the offshore wind sector. We would like to thank everyone from the ORE Catapult, RWE and Norfolk, Suffolk and Essex county council teams who made this incredible programme possible!**



ORE Catapult presentation





Discussing the ExoReefs with Hiraeth Energy



## HIRAETH AND FLOATING OFFSHORE WIND

As part of our collaborative ExoReef deployment in the Celtic Sea, we were also fortunate enough to partner with **Welsh renewable energy company Hiraeth Energy** on the deployment of our ExoReef units. Hiraeth Energy are looking to drive innovation within the offshore wind energy sector in Wales and are particularly keen to take advantage of the growing potential for floating offshore wind.

Floating offshore wind has been gaining increasing amounts of attention in recent years, due to the opportunities for **harnessing the higher windspeeds** of the open seas. There are a number of ways floating offshore wind turbines can be deployed, but most rely on floating platforms that are moored to the seabed for stability. This also enables the deployment of larger wind turbines, maximising the amount of wind energy which can be harnessed.

**Collaboration with Hiraeth Energy** has helped to forge our understanding about the role eco-engineering can play within floating offshore wind energy applications. This is increasingly important as we move towards a future where sustainable approaches to development are imperative.

Hiraeth Energy Project Partner, Joseph Kidd said:

**“Safeguarding our ecosystems, and improving biodiversity and nature, are core to the Hiraeth Energy approach. We are delighted to be able to support the evaluation of Exo Engineering’s innovative products that could improve the health and biodiversity of Wales’s coastal areas”.**



View from the Sea Leopard, looking out at META



## MARINE ENERGY TEST AREA (META), MARINE ENERGY WALES

**Testing and evidencing the effectiveness of artificial hard structures with Nature Inclusive Design (NID)** represents a significant barrier to their adoption by the offshore wind industry. Marine Energy Wales have allocated an area for the testing and continued monitoring of innovative new artificial hard structures with NID, **META (Marine Energy Test Area)**. Designating areas for these purposes will help to facilitate real testing in the marine environment and encourage innovation within the marine energy sector.

Marine Energy Wales have developed a range of pre-consented and pre-licensed test sites along Milford Haven Waterway, off the Pembrokeshire coast in Wales. Part funded by the **European Regional Development Fund (ERDF), the Coastal Communities Fund, and the Swansea Bay City Deal**, these sites permit the study of devices and components at various Technology Readiness Levels (TRLs). This reduces the time, cost, and risks faced by marine energy developers, eliminating the challenges associated with pre-deployment testing. **A range of environments** are encompassed within the numerous test areas, from sheltered, port-based locations to areas of open sea, offering a range of environmental conditions for testing.

We were fortunate enough to have access to META as part of our recent deployment of ExoReef units, which were deployed at **East Pickard Bay**. This much-needed testing will allow us to further evidence the capabilities for artificial hard structures with NID to increase biodiversity. This is especially important ahead of the anticipated announcement of Marine Net Gain legislation in the coming years, which is expected to legally require net biodiversity gain as part of marine development projects.

The allocation of these sites for testing therefore demonstrates the importance of grant funding in streamlining the testing process and encouraging innovation within the marine energy sector.

## HAMBLE EXOHABITAT MONITORING

This summer, we concluded three-year biodiversity surveys on six of our first concept ExoHabitats which were installed at **Mercury Yacht Harbour in Hampshire** in 2020. The structures use our **Greening the Grey®** surface textures and artificial rockpools, which are designed to enhance biodiversity by providing unique niches for marine species.

**We recorded the number of species present** on the ExoHabitats during low tide and compared the findings to those on adjacent sheet piling areas at the same tidal height. This allowed us to identify whether there was a difference between the extent of marine colonisation between the two environments. Additionally, a **Remotely Operated Vehicle (ROV)** captured high-definition video of the Exo Habitats at high tide when they were completely submerged.

The results indicate that the ExoHabitats attracted twice as many species when compared to control sheet piling areas, which were dominated by filamentous green algae and barnacles. The artificial rockpools played a crucial role in creating both **water-retaining features and shade**, resulting in an abundance of oysters, keel worms, and barnacles colonising the ExoHabitats. The ROV footage revealed that marine species were also thriving behind the ExoHabitats at the base of the harbour wall, suggesting that the ExoHabitats produced a “halo effect”. The ExoHabitats seemed to be capable of extending the habitat range of various species which has colonised them.

Since the initial concept design, we have improved our ExoHabitats by increasing cup size and subsequent water retention capabilities. We will be deploying some of our latest concepts later this year so stay tuned for updates!

**This innovative marine conservation approach** highlights the positive impact of human-made structures on marine ecosystems, offering hope for a more sustainable future by implementing similar initiatives in coastal areas.



1st Concept ExoHabitats in place



Latest design of ExoHabitat



Barnacles and filamentous green algae on the ExoHabitat cups

## WHAT'S NEXT?

Over the next 18 months, we will **continue to monitor our latest ExoReef designs** which have been deployed at the East Pickard Bay META in the Celtic Sea. The results will be used to assess the potential for ExoReef units to achieve the joint objectives of protecting offshore wind infrastructure whilst creating habitats for a wide range of marine species.

We are also **collaborating with Catchment to Coast (CtoC)** to bring about innovations in nature inclusive design within coastal defences. This project will examine our intertidal solutions more thoroughly, complementing the continued research of our subtidal solutions.

We will be **attending the Coastal Futures 2024 conference** on the 24th and 25th of January which promises to be an amazing event!

We are also looking forward to the **Multi-use in Offshore Renewable Spaces: Defining the Pathway to Success Workshop** on February 7th at Fishmongers Hall. It is looking to be a very exciting event!

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.

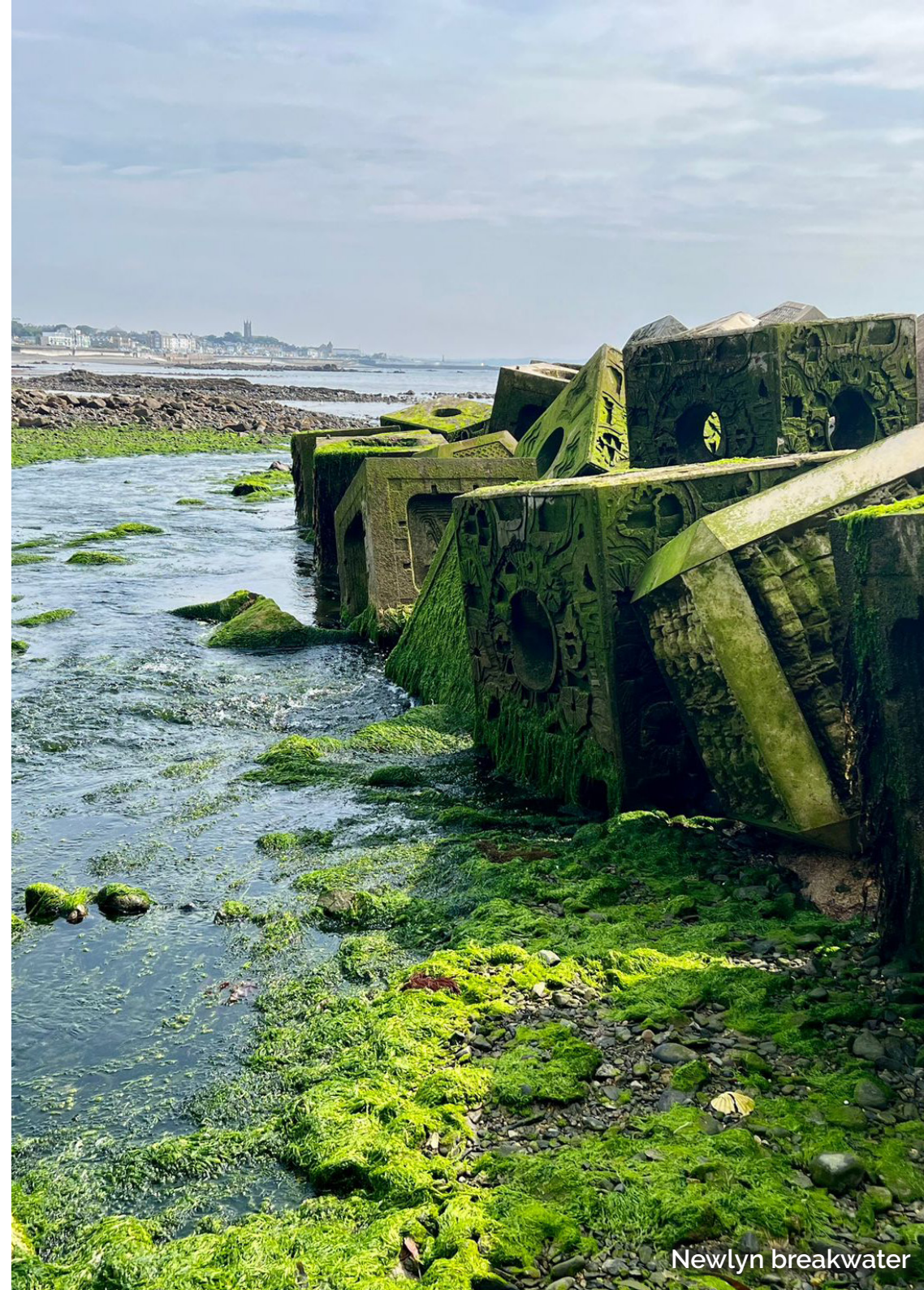




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Newlyn breakwater