Interreg
EUROPEAN UNION
North-West Europe
FORESEA
European Regional Development Fund

# Ocean Energy and the Regions

## A Partnership for Growth

# Introduction

The ocean energy[1] sector is inherently linked with coastal communities. As well as access to the energy resources of wave and tide, the sector needs to be able to tap into human resources, such as local skill, knowledge and enterprise. Equally, Europe's coastal regions stand to benefit greatly from a thriving ocean energy industry.

Today, most ocean energy activity is clustered around Europe's network of test centres. These activities give us a first glimpse of what the future will look like, for regions that focus on ocean energy. Supply chains are being built around these centres, as more and more ocean energy devices are deployed. Employment is growing, and centres of expertise are emerging.

As well as offering insights into the future, these test centres are also key to turning the sector's potential into a reality.

The testing and demonstration of ocean energy devices, sub-systems and components is crucial to help the sector prove the technology and reach full commercial roll-out. The Interreg North West Europe 'FORESEA' project has been helping technology developers to access Europe's test centres. This has already delivered clear success stories, with many more deployments to come.

The direct experience with ocean energy at test centres has given considerable insights into the sector, its needs, and its potential.

Test centres and regions participating in the FORESEA project have therefore come together to produce a series of policy recommendations. These will not only help bring the ocean energy sector to the point of commercial roll-out, but will do so in a manner that maximises the benefits for Europe's coastal regions.

*Photo: Tocardo*

# Ocean energy and the regions: A partnership for growth

The ocean energy sector is inherently linked with coastal regions. Devices may be close to shore or far out at sea, but the work required to install and maintain ocean energy farms will be centred in and around nearby coastal communities.

The size and weight of ocean energy devices mean that much manufacturing and assembly will take place close to where the machines will be installed. And manufacturing centres are likely to grow from those sites where the first farms are installed.

Alongside manufacturing and assembly, installation and maintenance will be firmly embedded in coastal communities, as close as possible to where the devices are deployed.

Nascent ocean energy economic clusters have already formed in Europe's regions – see the Annex for a snapshot of the ocean energy activities, jobs and infrastructure in each FORESEA-participating region.

By 2050 the ocean energy sector will be worth €53bn a year globally. This will require 400,000 jobs in Europe – many of which will be located in coastal regions.

## Following in the footsteps of offshore wind

The wider economic benefits that ocean energy will bring to communities can already be seen with offshore wind. Starting off only in the early 2000s, by 2017 there was already 15.8GW of offshore wind installed in the EU[2] - enough to power circa 16 million households. In 2016 €8.3bn of European GDP and 20,500 jobs were created by project development, turbine manufacture and substructure provision for offshore wind. This does not include additional economic activity and jobs from the provision of services and the manufacture of turbine components.[3]

Offshore wind has been closely linked to the development of ports and their surrounding environs. For example, Viana do Castelo in Portugal benefited from a €200m investment to transform a former shipyard into a construction facility, which supports 2,500 jobs[4]. Such is the economic opportunity that ports from across Europe have joined together in a joint 'Offshore Wind Ports Platform'[5].

### Egmond Aan Zee Offshore Wind Farm (The Netherlands)

Over €200m was invested into the Egmond Aan Zee farm. Sitting between 10-18 kilometres off the coast, its 26 turbines power 100,000 Dutch households.

At the time of installation, over 350 full time equivalents were hired. These included engineers, technicians, management and administrators. Since operations began in 2006, the farm employs up to 20 full time employees at any one time, and uses several local sub-contractors for various goods and services. A service centre for the farm was opened in Ijmuiden – the nearest deepwater port town. This service centre acts as a base for routine inspections, maintenance and turbine component replacement.

¹ Ocean energy covers technologies such as tidal, wave, ocean thermal energy conversion (OTEC), salinity gradient and seawater air conditioning (SWAC). The FORESEA project covers low carbon technologies and offshore renewables, such as floating offshore wind or subsea data centres.

² *'Offshore wind in Europe – Key trends and statistics 2017'*, Wind Europe, February 2018

³ *'Local impact, global leadership – The impact of wind energy on jobs and the EU economy'*, Wind Europe, November 2017

⁴ *Ibid*

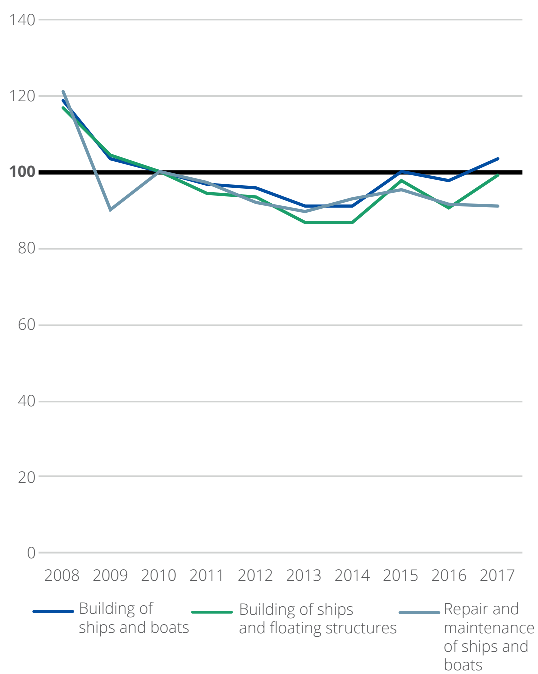
⁵ *'A statement from the offshore wind ports', Wind Europe, June 2017*

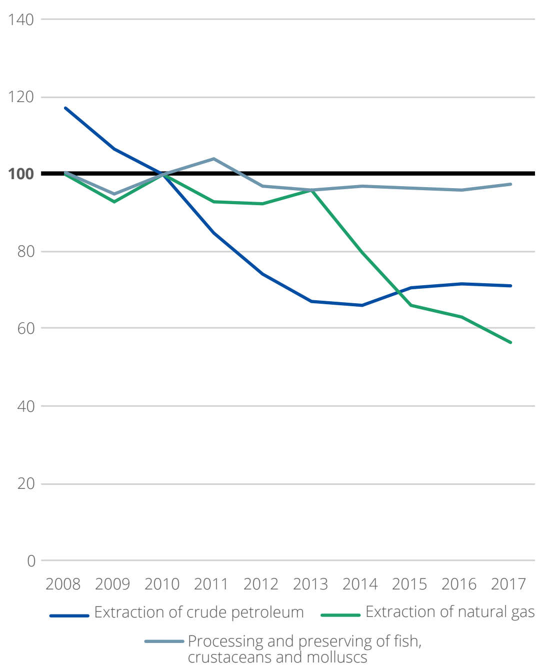
## Delivering jobs where they are most needed

Ocean energy's economic benefits are sorely needed in coastal regions across Europe. These communities have suffered serious economic decline over the past decades – with limited relief in sight.

There has been a structural decline of the industries upon which they historically depended: shipbuilding, fisheries and fossil fuel extraction.

SHIPBUILDING, FISHERIES AND FOSSIL FUEL SECTORAL PRODUCTION




*Source: Eurostat*

FORESEA-participating test centres are operating in local economies which face these exact challenges.

Around 3 of the 4 test centres, local Gross Domestic Product per capita was significantly below national averages.[6] In the case of SmartBay in Ireland, local inhabitant's income was almost half that of the Republic of Ireland.

Of the 4 centres, only SEM REV operates in a region which has comparable income to the rest of the county. But even this was an exception. Coastal French regions have an average GDP per inhabitant which is 33% less than non-coastal French regions[7].

It is clear that coastal communities will benefit greatly from the emergence of a strong ocean energy sector. But it is equally the case that these communities have an important economic potential, just waiting to be tapped into. Local populations are skilled, motivated, and are well suited to the needs of the ocean energy sector.

[6] Gross Domestic Product per capita for NUTS2 regions within which individual test centres are located. Source: Eurostat - 2015, at basic prices'

[7] Eurostat

LOCAL GDP PER CAPITA AROUND TEST SITES, AS A % OF NATIONAL AVERAGES

| Test centre | SmartBay | DMEC | EMEC | SEM REV |
|---|---|---|---|---|
| **GDP per Capita:** % of National Average | 58% | 77% | 79% | 102% |


*Photo:CORPOWER C3 (Colin Keldie)*

# Test centres - Clusters of ocean energy activity

Test centres are crucial steps on ocean energy's path towards commercial roll-out.

Different berths offer varying exposure to ocean conditions, allowing the testing of both scale and full-size devices. The costs of site consenting, monitoring equipment and in some cases grid connections are shared across multiple test site clients. Pre-consented and well-equipped sites significantly reduce risks.

All of this helps get demonstration project into the water – and these demonstrations are essential to prove technology, generate valuable data, and push down costs.

Test centres become clusters of ocean energy excellence: Supply chain builds up around test sites. Experience and expertise build up within these supply chains. This knowledge and know-how is shared to establish common industry standards. And test centres devise common testing procedures to reinforce these standards.

The comprehensive range of ocean energy test facilities is therefore an important competitive advantage for Europe.


## The FORESEA project

FORESEA (Funding Ocean Renewable Energy through Strategic European Action) provides free access to North-West Europe's world-leading network of test centres. To date the project has seen 11 device deployments – allowing the testing of 55 different pieces of technology. Highlights include:

### Scotrenewables Tidal Power

have been testing their SR2000 tidal turbine since August 2017. The device has endured harsh winter conditions and continued to generate through waves in excess of 7m. It has also generated 3GWh - a record volume of power for any tidal device.

*Photo: Scotrenewables Tidal Power*


**Corpower** deployed its ½ scale C3 wave energy converter in January 2018. The device has being exposed to real-life sea conditions, following rigorous on-land test program. Testing will allow the demonstration and refinement of low-cost maintenance and inspection operations.

*Photo:CORPOWER C3 (Colin Keldie)*

**Naval Energies** installed a Microsoft-owned data centre on the seabed, in June 2018. Powered by ocean energy, sea temperatures will reduce the cooling energy needs by up to 95%. The centre will be immersed for 1 year, but has been designed to operate for 5 years without direct intervention.

*Photo: Naval Energies and Microsoft (Scott Eklund_Red Box Pictures)*

**Tocardo Tidal Power** tested its T2 turbine in 2017, as part of the developer's 'Temporary Foundation System'. The demonstration will pave the way for a planned 20 year pre-commercial array, comprised of 5x T2 turbines across their newly developed Universal Foundation Platform System.

*Photo: Tocardo*

**Ideol** and partners worked within the Float-gen project to engineer, construct and install a floating wind turbine at the SEM-REV test site. The testing period of the floating wind turbine designed for this project will be financed partially within the FORESEA project.

*Photo: Ideol*

# Policy Recommendations

**The mutually-beneficial relationship between ocean energy and coastal communities is clear. But what is needed to kick start this virtuous cycle?[8]**

## 1

### Revenue support for the sector at a national level

Ringfenced revenue support for the deployment of ocean energy technology is now essential if the sector is to develop further, and if coastal regions are to benefit from this development.

The sector now needs successive deployment of devices to drive down costs. This requires private investors, who will only finance the deployment of machines in water if project revenues cover project costs. National governments need to provide sufficient revenue support – i.e. additional payments in addition to market prices – to cover these costs.

Conversely, technology developers cannot be expected to continue to invest millions of euros, or to indefinitely employ teams of skilled engineers, in the absence of a credible route to market for their products.

Coastal region companies, workers and communities stand ready to develop the ocean energy sector, but this can only happen if there is a pipeline of projects backed by suitable revenue support commitments.

## 2

### Continued support for access to test sites, including fast-tracked and fit-for-purpose permitting processes

Testing of ocean energy technology at dedicated sites helps the sector develop faster and more cost-effectively. Technology developers can share the costs of site consenting and grid connection. Learnings from testing reduce risk and subsequently costs. A systematic approach allows the comparison of different device performance in the same ocean environment. Data and knowledge are centrally collected, rather than being dispersed across different companies and countries.

Clusters of ocean energy expertise are built up in the regions. These clusters allow for cross-border cooperation, such as knowledge and experience exchange. Test sites in the North West region of Europe have been working closely together for years. Most recently, the experience to date of the FORESEA project has demonstrated the clear value of these facilities.

Continued support for access to ocean energy test sites turbocharges the development of the sector. At the same time, it also ensures that the benefits of ocean energy continue to be felt by coastal region communities and economies around the test centres.

[8] The FORESEA Steering Committee reviewed existing policy recommendations and ocean energy roadmap were reviewed from a regional perspective. From this, 3 policy recommendations were developed. These recommendations seek to support the further development of the sector, but to do so in a way that focuses on maximising the benefits to regional communities and economies.

These policy recommendations also draw upon the valuable experience and learnings that have emerged from the work to date of the FORESEA project

# 3

## Equal investment opportunities for regional players

The European Commission and national governments recently endorsed the creation of an 'ocean energy investment fund'.[9] While several structures are possible, amongst the most likely is an 'Investment Platform' as part of the wider European Fund for Strategic Investment (EFSI).

This will offer opportunities for public and private investors to make a direct financial return on investments into ocean energy projects or technologies.

Coastal regional authorities are incentivised to take a longer-term interest in the development of the sector in their territories. This perspective, also taken by private 'patient capital', facilitates longer-term and more transformative projects. Regional authorities should therefore have the same opportunities as national authorities or private investors, to participate in any future EU Investment Platform focused on ocean energy.

[9] 'SET Plan Temporary Working Group on Ocean Energy Implementation Plan'- March 2018

Photo: Naval Energies and Microsoft (Scott Eklund_Red Box Pictures)

# Ocean Energy Regions in North West Europe

ANNEX[10]

## IRELAND

Ireland has a huge ocean energy resource, relative to its population or economy. There is 27.5-31.1 GW of potential developable wave resource, and 1.5-3 GW of tidal. This means that ocean energy offers the opportunity to export power generated by ocean energy, via current and future electricity interconnectors.

Ireland's focus is primarily on wave energy and more recently, floating wind.

### Ocean energy economic activity

There are currently 135 companies and organisations offering supply chain services to the ocean energy sector. Many are focused on high-value engineering services, with a smaller number of companies providing offshore services (e.g. workboats).

It is estimated that 20 companies have a large volume of ocean energy-related activity. These companies employ approximately 150 people.

### Test facilities

- **Lir National Ocean Test Facility** - a custom designed indoor test facility for laboratory testing of offshore wind, wave and tidal energy devices;
- **SmartBay Ireland** – an intermediate scale test facility for ocean energy devices, as well as novel marine sensors, prototype equipment;
- **Atlantic Marine Energy Test Site** – a grid-connected test site for testing of full-scale wave energy devices in an open ocean environment (under development).

### Academic activities

There are more than 80 students enrolled in courses directly engaged with ocean energy at any one time. About 130 people are employed in ocean energy-related academic work.

National University of Ireland (NUI) Maynooth, the University of Limerick, National University of Ireland (NUI) Galway and the University College Cork provide courses relevant to ocean energy.

The MaREI Centre has over 200 researchers working across 6 academic institutions collaborating with over 45 industry partners.

### Policy

Political: There has been considerable political support for ocean energy:

- **The Offshore Renewable Energy Development Plan:** includes a ringfenced feed in tariff and support for R&D and test facilities;
- **Sustainable Energy Authority of Ireland (SEAI):** The designated development agency for ocean energy. SEAI maintains a dedicated online portal for the sector, supports testing facilities and has provided over €18m of R&D funding to more than 120 separate projects.

[10] Data on companies and jobs sourced from survey sent to FORESEA test site in each region & online data

# PAYS DE LA LOIRE

The regional authorities have an integrated structure of 5 pillars: Industrial strength, strong political support, dedicated infrastructure, focused R&D and innovation, and training and education focused on real-life requirements. By 2020, €180m will have been invested into ocean energy by regional players.

France's first full-scale floating wind turbine is currently deployed off the coast of Pays de la Loire.

## Ocean energy economic activity

There are an estimated 17 businesses with very significant ocean energy activities. These employ circa 128 people, with about 56 working on tidal technology, another 56 working on cross-cutting activities, and wave and OTEC technology each employing 8 people.

Ocean energy firms engaging cooperate via the Neopolia offshore wind and ocean energy (EMR Neopolia) cluster, which currently has 115 companies.

## Test facilities

- SEM-REV - a grid-connected 1km2 site circa 20 nautical miles from the port of Saint Nazaire;
- Laboratoire de recherche en hydrodynamique, énergétique et environnement; atmosphérique (LHEEA) – equipped with a range of specialist testing tanks;
- A range of additonal test facilities, such as an 800kW battery test bench, and a 5000m² wind tunnel that can reach speeds of 280km/h.

## Academic activities

4 institutions have significant volumes of ocean energy activities – University of Nantes, Centrale Nantes, CSTB and Ifsttar. About 250 students have graduated in various initial training courses.

There are circa 200 researchers working at least in part on ocean energy – equivalent to 120 Full Time Equivalents.

Research organisations are federated regionally by 'WEAMEC' (West Atlantic Marine Energy Community).

## Policy

Consistent strong political support for ocean energy at a regional level, combined with national-level financial support.

At a regional level:

- Support to port infrastructures, testing facilities, to R&I projects;
- Partnership between the region and other European funding agencies to support collaborative R&I projects (OceanERA-NET Cofund);
- Dedicated research call for proposals on marine renewable energies, managed by WEAMEC.

At a national level:

- The national 'Programme d'investissements d'avenir' has set aside €500m for offshore wind and marine energy. A 1/3rd of this fund is specifically for ocean energy;
- Various calls have been put out to support TRLs 6-9 projects. E.g. the 'S3' wave energy convertor and the 'Marlin' Ocean Thermal Energy Conversion project.

# SCOTLAND

Scotland has long been a centre of ocean energy sector, reflecting its significant ocean resource and synergies with existing maritime and energy sectors.

Today several ocean energy installations in Scotland export power to the grid, including the world's only 2 tidal energy arrays. MeyGen is a 6 MW project, with plans to expand considerably. Nova Innovation's 3 turbine Shetland Tidal Array will be doubled in size shortly.

## Ocean energy economic activity

There are circa 1,700 people working in the UK wave and tidal sectors, with many in Scotland. 43% of investment in the MeyGen project was spent in the Scottish supply chain. Nova's Shetland Tidal Array had over 80% Scottish supply chain input.

Edinburgh is emerging as a corporate centre for the industry - with the headquarters of SIMEC Atlantis Energy, Nova Innovation and others established there.

The Orkney Islands, with a population of circa 21,000 people, has 29 companies involved in ocean energy. The power from ocean energy is being used to produce hydrogen – simultaneously circumventing grid restrictions and booting the nascent hydrogen economy.

The EMEC test centre has an estimated Gross Value Add (GVA) to the UK of £284.7m.

The Nigg Energy Park is based on renewable activities. Formerly a port servicing the oil & gas industries, the facility has dry docks, over 900 metres of deepwater quayside, shops for maintenance, fabrication & assembly, and supply services.

## Test facilities

- **The European Marine Energy Centre (EMEC)** - for scale and full-scale devices. 8 grid-connected berths for tidal and 5 for wave;
- **The FloWave Ocean Energy Research Facility, University of Edinburgh** - 2.4m litre circular test tank for 1/20th scale testing;
- **The Kelvin Hydrodynamics Laboratory, University of Strathclyde Glasgow** - a 76m x 4.6m x 2.5m tank with a wavemaker and moving platform.

## Academic activities

The Universities of Aberdeen, Herriot Watt, Edinburgh Napier, Edinburgh, Glasgow and Strathclyde have capabilities in offshore renewable energy. For example:

The University of Edinburgh's 'Institute for Energy Systems' has 26 academic staff, 28 research staff and circa 70 postgraduates. Ocean energy is a clear focus.

The University of Strathclyde Glasgow houses the Naval Architecture, Ocean & Marine Engineering department and the Wind & Marine Energy Systems research centre (jointly with the University of Edinburgh). This research centre provides 10 PhD positions.

## Policy

Consistent strong political & financial government support:

- **The WATERS (Wave and Tidal Energy Research in Scotland)** project was the first to target device testing and demo.
- **The £103m Renewable Energy Investment Fund** financed the MeyGen project and invested in Scotrenewables Tidal Power, Nova Innovation, Sustainable Marine Energy and Albatern.
- **Wave Energy Scotland** awarded £28.8m to 77 projects.
- **Scottish Enterprise (SE) and Innovate UK** have funding calls open to ocean energy.
- **SE is the lead for Ocean Energy ERA-NET** and co-leads the Advanced Manufacturing for Energy in Harsh Environment regional pilot.
- **Highlands and Islands Enterprise and SE** invested into port and infrastructure.

# THE NETHER-LANDS

**The emerging ocean energy sector in the Netherlands build upon a long-lasting history in offshore operations and water management. Unique solutions are developed where ocean energy technologies are integrated in civil infrastructures like barriers and bridges. Deployments in the Netherlands could deliver both renewable energy to the local grid and serve as showcases crucial to capitalise on export markets.**

**Two demonstration projects are currently deployed in the Netherlands; Tocardo Tidal Power array in the EasternScheldt Storm Surge Barrier and a salinity gradient facility of REDstack at the Afsluitdijk. A new pilot of REDstack is in development in Katwijk. SeaQurrent deploys a full-scale demonstration tidal kite system close to the Wadden Islands, and Oryon Watermill deploys a power station in Doesburg. Internationally, Tidal Bridge develops a 30 MW project in Indonesia, Bluerise is starting two commercial Ocean Thermal Energy projects in Curaçao (10MW) and in Jamaica (20 MW) and Water2Energy will deploy their tidal turbine at the Port of Antwerp.**

## Ocean energy economic activity

There are an estimated 50 companies with a significant volume of ocean energy related-activity in the Netherlands, employing circa 300 people. Ocean energy activities exploit synergies with the legacy offshore oil and gas industries. The 'North Sea Energy Gateway' has more than 200 service companies, suppliers and main contractors to the offshore, renewables and maritime industry based in the region.

## Test facilities

Eight organisations offer twenty-four different testing facilities. These include

- The Dutch Marine Energy Centre (DMEC) - support companies with deployments at client-specific locations which could be both inshore and offshore depending on client requirements;
- Tidal Technology Centre Grevelingendam – inshore test facility with 10MW connection to Dutch grid and planned 500 kW of storage;
- The Off Grid Test Centre - testing facilities for off grid simulations in combination of wind, solar, tidal and battery storage.

## Academic activities

There are an estimated 150 people directly and indirectly employed in ocean energy-related academic positions. Knowledge institutes like NIOZ, ECN, WMR, Marin, Deltares and TNO have many PhDs working on ocean energy. The Technical University of Delft hosts the Ocean Energy Platform.

## Policy

The development of Ocean Energy is supported both on a Provincial level as on a national level. De Nieuwe Afsluitdijk is a partnership between the provinces of Noord-Holland and Fryslân and neighboring municipalities. They plan for a tidal power plant at Kornwerderzand and classify the Afsluitdijk as a Living Lab. The province of Zeeland and South Holland are committed to build a tidal power plant in the Brouwersdam.

Regional and national governments are more and more joining forces stimulating the full-fledged integration of marine energy in the national energy and innovation policy, amongst which the top sector policy and the new comprehensive energy agreement. The Dutch Top Sector policy is designed to contribute to R&D and innovation in the Netherlands. Within nine designated sector programmes valued at €500 million, solutions are supported that contribute to solving societal problems. Marine Energy is seen as an important cross-over between the Top Sectors Water and Energy. More specifically, several marine energy projects are integrated within the innovation agendas of the Deltatechnology, maritime and watertechnology sectors as well as the offshore wind sector.

# WEST FLANDERS

**West Flanders is increasingly involved in ocean energy. A towing tank and wave basin will open in 2020 in the new Flanders Maritime Laboratory in Oostende. The West Flanders Development Agency brings together industry, knowledge, and government in this field, and is working to establish a development platform 500 meters off Oostende. The Mermaid project has a concession to build a combined wind (266 MW) and wave (5 MW) energy park.**

**This work builds upon existing expertise in the maritime and offshore wind sectors. There are already business and university-backed initiatives (e.g. clusters & incubators) relevant to ocean energy.**

**This work also builds upon existing Belgian successes in ocean energy. The Flansea project demonstrated a wave device in 2013. Laminaria will shortly be deploying a full-scale wave device in the EMEC test centre in Scotland. Deme Blue Energy is involved in 2 tidal projects in the UK, with a combined capacity of 130 MW.**

# OTHER REGIONS IN NORTH WEST EUROPE

Beyond the scope of the FORESEA project, there are several other regions in North West Europe which are involved in ocean energy. For example:

- **NORMANDY** has an estimated 5GW of exploitable tidal energy resource. The Raz Blanchard has been targeted for several tidal projects in recent years.
- **BRITTANY** hosted 2 tidal turbines at the Paimpol-Bréhat site, with an additional deployment of a 1MW HydroQuest device in 2019. The Gulf of Morbihan has significant tidal energy resource, and University of Southern Brittany are currently conducting studies at 2 specific sites.
- **WALES** has two wave and tidal stream demonstration zones, seabed agreements in place for three separate wave and tidal stream projects, and a number of proposals for significant tidal range projects.
- **NORTHERN IRELAND** was the location of the first large scale commercial tidal stream generator. The SeaGen turbine was grid connected and generated power from 208 onwards. Currently there are 200MW of tidal site being consented across two separate sites off the north coast.

**FORESEA (Funding Ocean Renewable Energy through Strategic European Action)** is an €11m Interreg North West Europe project. Its helps bring offshore renewable energy technologies to the market by providing free access to North-West Europe's world-leading network of test centres.

Since 2016, FORESEA has been supporting developers of offshore renewable energy technologies to test in real sea conditions around in North West Europe.

Support is awarded through a series through a series of competitive calls. run by the project consortium.

The programme covers the following test centres:

• European Marine Energy Centre (EMEC): Orkney Islands, UK

• SmartBay: Galway, Ireland

• SEM-REV: Nantes, France

• Dutch Marine Energy Centre: Alkmaar, Netherlands

The test centres are supported by the European industry body for ocean energy, Ocean Energy Europe, based in Brussels.

**ForeseaProject.eu**

**PROJECT PARTNERS**

Interreg North-West Europe FORESEA
European Regional Development Fund
EUROPEAN UNION

EMEC ORKNEY THE EUROPEAN MARINE ENERGY CENTRE LTD

CENTRALE NANTES

DMEC Dutch Marine Energy Centre

Ocean Energy Europe

SMARTBAY IRELAND