

# EMEC

## PIONEERING THE TRANSITION TO A CLEAN ENERGY FUTURE

Not-for-profit innovation catalyst  
reducing the time, cost and risk  
to progress low carbon technology to market







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Ocean energy demonstration sites

- 1 **Fall of Warress**  
Grid-connected tidal test site
- 2 **Billia Croo**  
Grid-connected wave test site
- 3 **Shapinsay Sound**  
Scale tidal test site
- 4 **Scapa Flow**  
Scale wave test site
- 5 **Floating Wind**  
Grid-connected floating wind test site (planned)

Hydrogen demonstration sites

- 6 **Caldale**  
Hydrogen production and storage plant  
Vanadium flow batteries
- 7 **Kirkwall Pier**  
Fuel cell
- 8 **Kirkwall Airport**  
Combined heat and power unit (CHP)

EMEC offices

- 9 **Stromness**  
Headquarters
- 10 **Kirkwall**  
Satellite office

Orkney decarbonisation projects

- 11 **Kirkwall Airport**  
Sustainable Aviation Test Environment (SATE)
- 12 **Hatston**  
ReFLEX Orkney – Experience Centre
- 13 **ICNZ**  
Islands Centre for Net Zero
- 14 **West of Orkney Windfarm**
- 15 **Flotta Hydrogen Hub**





# CELEBRATING 20 YEARS OF CLEAN ENERGY INNOVATION

EMEC is the world's leading centre for demonstrating wave and tidal energy converters in the sea and is pioneering the development of green hydrogen and a clean energy economy.

EMEC is a not-for-profit innovation catalyst pioneering the transition to a clean energy future.

As a plug-and-play facility EMEC helps reduce the time, cost and risk of testing innovative low carbon technologies.

**1** **WORLD'S FIRST**  
test centre for  
demonstrating  
wave and tidal  
energy technologies  
in the sea

**1** **WORLD'S FIRST**  
offshore wave  
energy device  
to generate  
electricity to the  
national grid

**1** **WORLD'S FIRST  
AND ONLY**  
ISO/IEC 17025  
accredited test  
laboratory

**1** **UK'S FIRST**  
tidal stream turbine  
to generate electricity  
to the grid

2001

Recommendation by House of Commons Science and Technology Committee to set up a wave and tidal energy test facility to kick start a marine energy industry in the UK...

EMEC  
ESTABLISHED

2003

2004

2005

2006

2007

2008

2009

2010

2011

2012

2013

# REDUCING THE TIME, COST AND RISK OF TESTING OCEAN ENERGY TECHNOLOGIES

EMEC was established in 2003 to kick start the development of the ocean energy industry. The centre provides pre-consented grid-connected test sites in harsh wave and tidal regimes as well as scale test sites in gentler conditions for testing smaller scale technologies, subsystems and components.

EMEC is the world's only accredited ocean energy test laboratory (ISO/IEC 17025) and inspection body (ISO/IEC 17020).

To date, EMEC has hosted more ocean energy devices than at any other site, providing operational, technical and business support to help clients commercialise.

**22**  
WAVE AND  
TIDAL CLIENTS

**11**  
COUNTRIES

**35**  
MARINE ENERGY  
DEVICES

**WORLD LEADER**  
MORE MARINE ENERGY DEVICES TESTED AT EMEC  
THAN ANY OTHER SITE IN THE WORLD



## DEVELOPING A GREEN HYDROGEN R&D ECOSYSTEM

**Building on its experience in developing the ocean energy sector, EMEC has diversified into green hydrogen, floating wind, clean transport and energy systems.**

EMEC has established an R&D hydrogen ecosystem, featuring electrolyzers, fuel cells, storage and refuelling, for first-of-a-kind and pilot scale projects aiming to decarbonise power, heat and transport applications. Projects range from renewables integration, storage and logistics, through to e-fuels and end-use case demonstrations, particularly within the maritime and aviation sectors.




**WORLD'S FIRST**  
tidal-powered  
hydrogen  
generation

# DEMONSTRATING THE CLEAN ENERGY SYSTEM OF THE FUTURE

We are pursuing further diversification with the development of a floating wind test site to the west of Orkney. EMEC's infrastructure and experience is also increasingly being used in wider energy systems innovation. For example Microsoft demonstrated a subsea data centre at Billia Croo and EMEC is leading the creation of the Islands Centre for Net Zero to support Orkney, Shetland and the Outer Hebrides to become lighthouse communities in the energy transition.

EMEC was set up to kick start an ocean energy sector and boost economic development in the Highlands and Islands. Over the years we have grown and diversified, with over 80 people working at the test centre today. The unprecedented activity that has taken place in Orkney due to the presence of EMEC has been a catalyst for economic development, creating jobs and a world-leading supply chain now exporting skills and knowledge around the globe.

 **WORLD'S FIRST**  
and only ocean  
energy facility  
designated with  
**RETL status**  
by IECRE

 **WORLD'S FIRST**  
international power  
performance  
assessment delivered  
to Verdant Power  
in New York

**WORLD'S MOST POWERFUL TIDAL TURBINE**  
Orbital O2 being demonstrated at EMEC



2014 >>> 2015 >>> 2016 >>> 2017 >>> 2018 >>> 2019 >>> 2020 >>> 2021 >>> 2022 >>> 2023 >>>



# TEST SITES FOR CLEAN ENERGY DEMONSTRATIONS

With two decades of experience, EMEC is attracting developers from around the globe to prove what is achievable in some of the harshest of marine environments.

Across our range of facilities and services, we can support your technology development from early stage technology readiness levels through to deployment at EMEC and beyond.

Our sites are used by technology developers, supply chain companies, equipment manufacturers and academics for a wide range of activities.

Whilst initially designed for ocean energy testing, our sites have been sought out by other industries looking to demonstrate clean energy and sustainable technologies in the sea, including a subsea data centre.

The very nature of us being a test facility means innovation is at our core, and we're ready to support a wide range of demonstration activities.

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# TEST WITH US



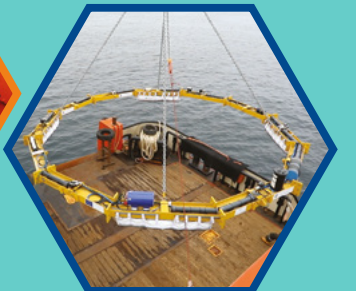
## ENVIRONMENTAL MONITORING



## COMPONENTS AND SUB-SYSTEMS



## TOOLS DEVELOPMENT



## MARINE OPERATIONS TRIALS FROM INSTALLATION TO DECOMMISSIONING

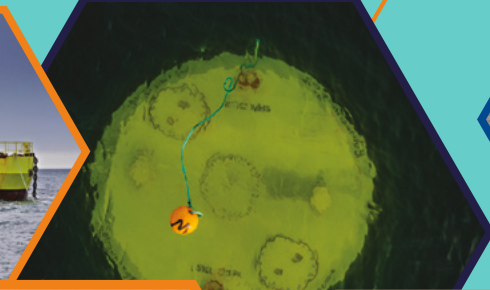


# DEVICE DEMONSTRATIONS

## MATERIALS TESTS



## MOORINGS, CABLING AND CONNECTIONS



## STORAGE AND LOGISTICS



## H&S PROCEDURES



## TRAINING



## RESEARCH PROJECTS





# OCEAN ENERGY TEST SITES

Increase investor confidence by proving real sea performance. EMEC is the only accredited test centre in the world, suitable for testing multiple devices simultaneously while producing electricity to the national grid.

## OCEAN ENERGY DEMONSTRATION SITES

- 1 Fall of Warness  
Grid-connected tidal test site
- 2 Billia Croo  
Grid-connected wave test site
- 3 Shapinsay Sound  
Scale tidal test site
- 4 Scapa Flow  
Scale wave test site

# SCALE TEST SITES

Based in the less challenging conditions of Shapinsay Sound and Scapa Flow, the non-grid connected test sites provide a more flexible sea space helping to close the gap from tank testing, and acting as a stepping stone towards larger scale projects.

## FALL OF WARNESS TIDAL TEST SITE

Our grid-connected tidal test site is situated in a narrow channel between the Westray Firth and Stronsay Firth. The site has a very strong tidal current, with a typical spring flow of 4 m/s (8 knots). The site is based 22 km from Hatston Pier in Kirkwall.

## BILLIA CROO WAVE TEST SITE

Our grid-connected wave test site is situated off Orkney's west coast. The site is open to the large powerful waves of the Atlantic Ocean, with close access to harbour facilities at Stromness (8 km) and Lyness (21 km).

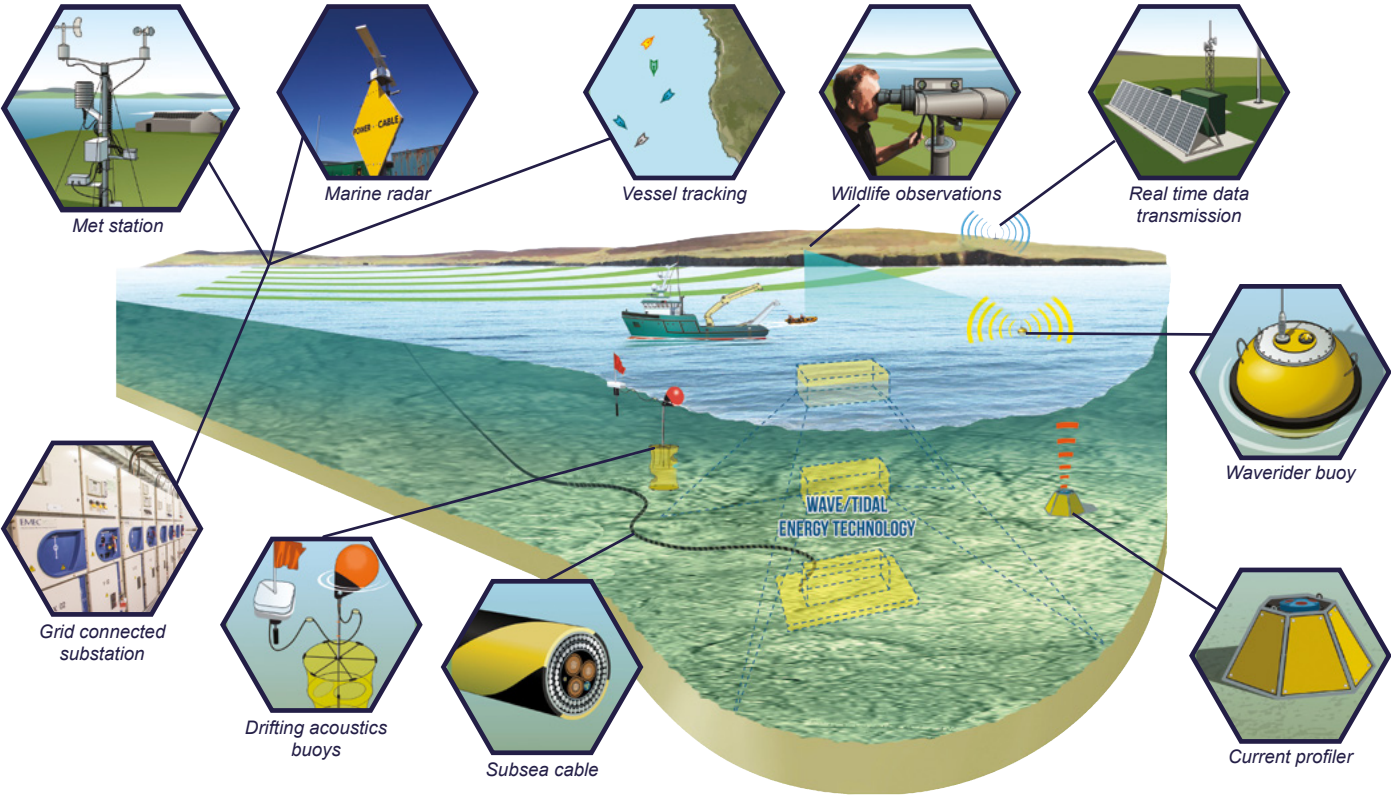
These test sites provide accessible in-sea testing options to help you learn lessons at smaller scale, thus minimising the cost of development, reducing the need for big vessels or large plant, and removing risk from future in-sea deployments.

EMEC holds an overarching site licence, simplifying the consent process within an agreed envelope of activity.

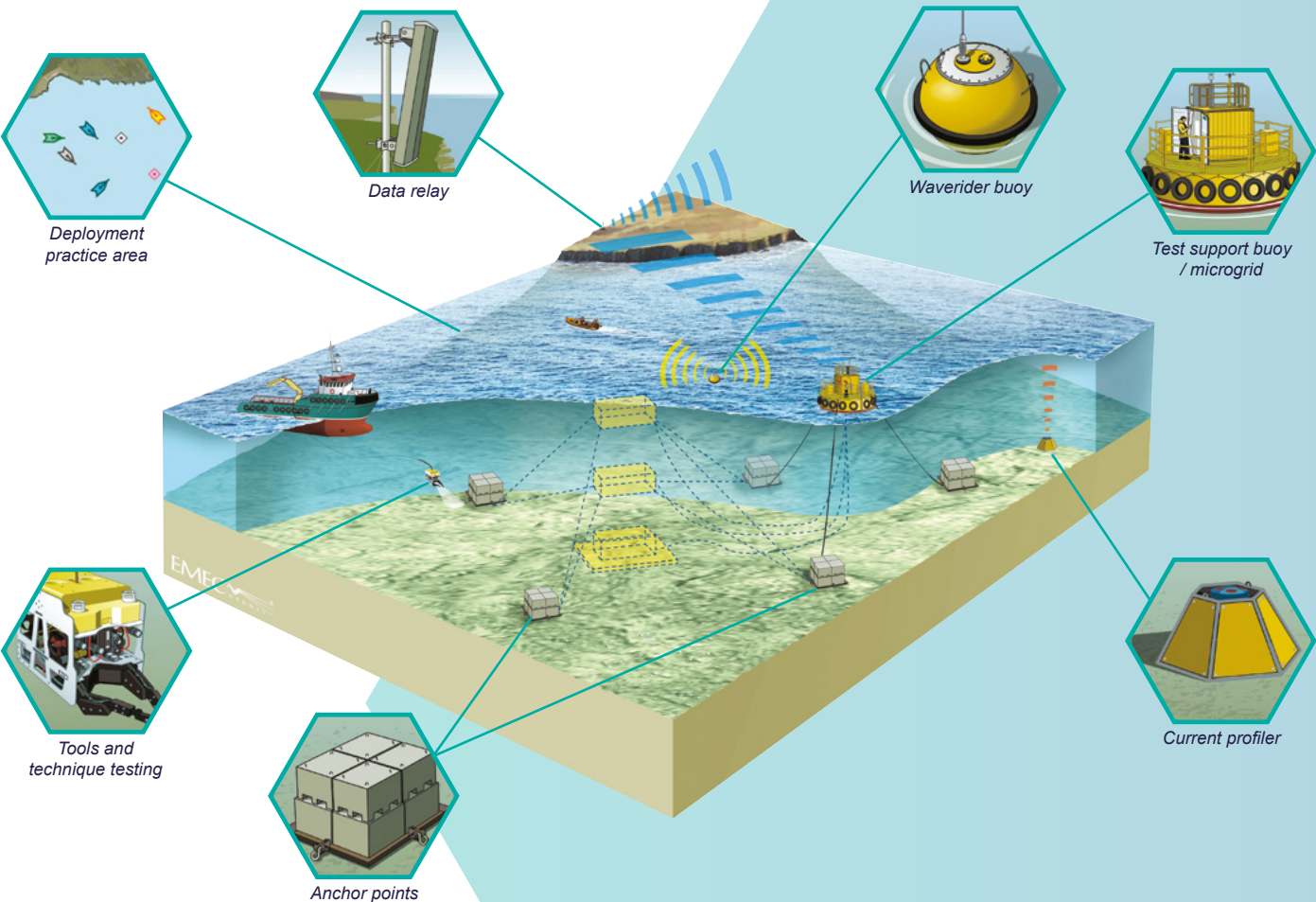
- Test support buoys enable dissipation of electricity, as well as remote monitoring and control.
- Microgrid can be set up to simulate grid connection.
- Pre-installed anchor points provide mooring options.
- An area of seabed is available for rehearsal or deployment of tools and techniques.

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# GRID CONNECTED TESTING



# SCALE TEST SITES





# GREEN HYDROGEN R&D ECOSYSTEM



Complementing our endeavours in ocean energy testing, EMEC has established an R&D ecosystem for green hydrogen and battery storage technology.

EMEC's R&D ecosystem covers the full value chain from renewables integration, hydrogen production, storage and logistics, through to e-fuels and end use applications, particularly within the maritime and aviation sectors.

Our sites and infrastructure are used for first-of-a-kind and pilot scale projects exploring how to decarbonise power, heat and transport applications to support the transition to a clean energy future.



## HYDROGEN PRODUCTION

EMEC own and operate both fixed and re-deployable hydrogen production assets.

### ELECTROLYSER AND STATIC STORAGE

EMEC's hydrogen production plant is located onshore in Eday neighbouring EMEC's grid-connected tidal test site at the Fall of Warness. It comprises a 670 kW rapid response



PEM (Proton Exchange Membrane) electrolyser, compressor and static storage with capacity to hold up to 500 kg of hydrogen.

Based on the electrolyser running at full power for 24 hours, up to 260 kg of high purity, fuel cell grade hydrogen can be generated.

The production plant is integrated with renewable energy input, either tidal energy converters testing at the Fall of Warness or from the Eday 900 kW community wind turbine.

### VANADIUM FLOW BATTERIES | ENERGY STORAGE

EMEC is exploring the integration of the hydrogen plant with flow battery technology to optimise hydrogen production, 'smoothing' tidal generation to create continuous, on-demand electricity to power EMEC's electrolyser.



Located adjacent to the hydrogen production plant, EMEC's energy storage building houses 48 vanadium flow battery (VFB) modules with a combined storage capacity of 1.8 MWh.

### RE-DEPLOYABLE ELECTROLYSER

EMEC's re-deployable modular electrolyser supports demonstration projects by providing on-site hydrogen generation in locations where there is no fixed hydrogen infrastructure.



Rated at 24 kW, the anion exchange membrane (AEM) electrolyser can be coupled with our mobile refuelling solution to offer an end-to-end system.

## TRANSPORTING AND REFUELLING WITH HYDROGEN

### MOBILE STORAGE TRAILERS

Five specially designed mobile storage trailers each transport up to 250 kg of hydrogen, from point of production to supply end applications across power, heat and transport in technology demonstration projects.



### MOBILE REFUELLING SOLUTION

EMEC's mobile, ADR-certified hydrogen refuelling solution, provides hydrogen refuelling capabilities to locations with no existing or fixed hydrogen infrastructure.

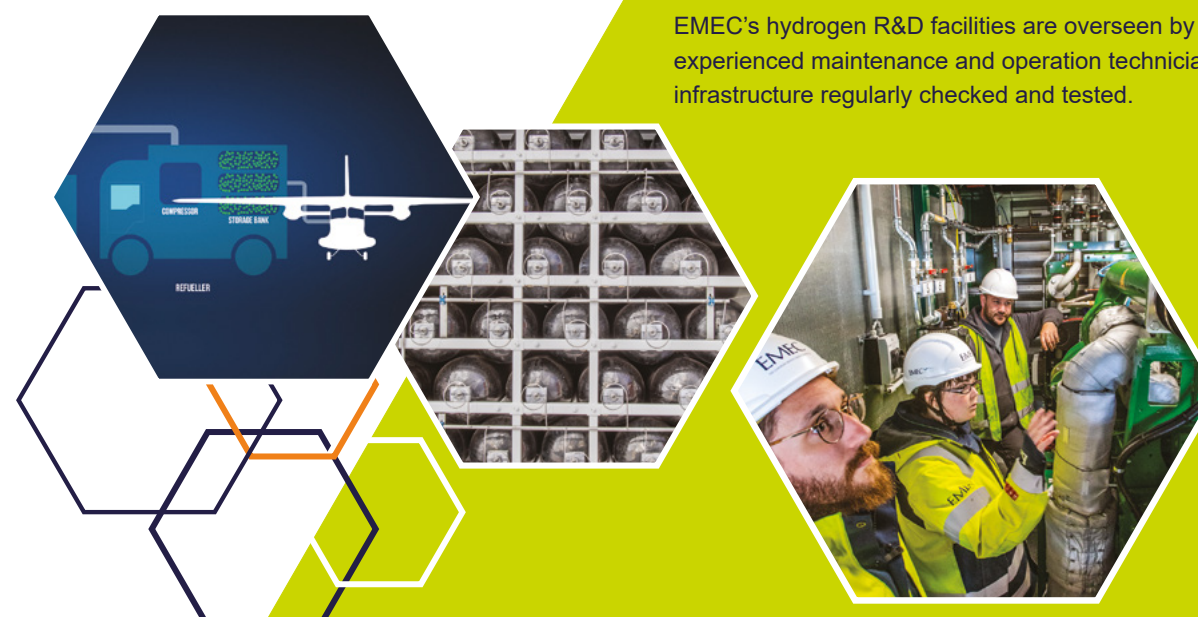


The refuelling solution takes hydrogen gas and compresses it up to 450 bar. It is capable of dispensing up to 20 kg hydrogen at 350 bar per operation.

The mobile refuelling solution can be coupled with EMEC's 24 kW re-deployable modular electrolyser for on-site hydrogen generation for a full end-to-end system.

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## END USE DEMONSTRATIONS

### KIRKWALL PIER FUEL CELL

A 75 kW fuel cell is housed at Kirkwall Pier to convert hydrogen back to electricity. The electricity can then be used to 'cold iron' local inter-island ferries while berthed overnight at the pier. Designed to resemble the vessel engine room of a ship, the fuel cell can be used as a training rig as part of a first of a kind MCA-approved hydrogen training course. Developed by Orkney College UHI's maritime studies department, in collaboration with EMEC and Orkney Ferries, the course equips mariners with the necessary skills and knowledge to work on-board hydrogen fuelled vessels.



### COMBINED HEAT AND POWER (CHP)

A combined heat and power (CHP) unit is being trialled at Kirkwall Airport to demonstrate the use of hydrogen for heat and power requirements in the airport terminal building.



## SAFETY

EMEC's hydrogen R&D facilities are overseen by experienced maintenance and operation technicians with infrastructure regularly checked and tested.



# DEMONSTRATION SITES FOR FLOATING WIND



As EMEC and Orkney are ideally located at the heart of 27.6 GW of ScotWind offshore wind developments, we're supporting clients with research and innovation programmes to accelerate the development of these sites.

We can host demonstrations of subsystems and components at our Billia Croo offshore test site and are pursuing the development of a floating wind test site to the west of Orkney.

## PROPOSED 100 MW DEMONSTRATION SITE

With more than 17.8 GW of floating wind due to be deployed in Scottish waters over the next 20 years, we have concluded concept design for a new 100 MW floating offshore wind test and demonstration site.

### COMPONENT AND SUBSYSTEM TESTING

Our grid-connected demonstration site at Billia Croo is suitable for testing floating wind components and subsystems, for example floating platforms and anchoring solutions, as well as installation methodologies.

### R&D PROGRAMMES

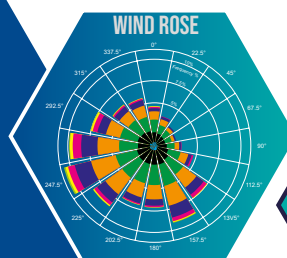
EMEC is leading the research and innovation (R&I) programme for West of Orkney Windfarm to cover a broad range of challenges including the exposed location, environmental impacts and increased remote operations.



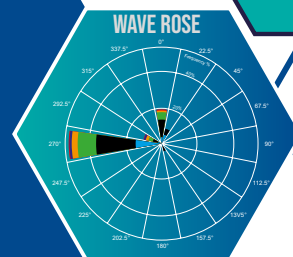
EMEC's proposed test site will comprise six berths for floating offshore wind turbines of up to 20 MW rated capacity. Four of the six berths will be grid-connected, while the final two berths will be reserved for power-to-X applications such as hydrogen generation.

The site will offer floating wind developers representative metocean conditions to those in ScotWind, Celtic Seas and future leasing rounds. The site has been designed specifically for floating wind developers to de-risk technologies, putting turbines, floating structures, moorings and other components to the test in an energetic offshore environment. This will enable performance to be refined on a wide range of technologies prior to commercial scale-up and build-out.

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**10.7 M/S**  
 MEAN WIND SPEED  
**80-95 M**  
 WATER DEPTH



Floating offshore wind  
 Fixed to seabed  
 Sites yet to be allocated

# ISLANDS OF INNOVATION DEMONSTRATING THE ENERGY SYSTEM OF TOMORROW

The Orkney Islands have been home to, and centre of, renewable energy innovation for more than 60 years.

### KEY STATS\*:

- **10% of homes on Orkney have microgeneration** compared to 2.8% in the UK;
- **Orkney has over 3 times as many EVs** per home than the UK average;
- Orkney has 2.0 kW of renewable energy capacity per home – **9 times higher than UK average**;
- Orkney has **12 times more domestic RHI** installations per home than the UK average;

Since 2013, Orkney has generated over 100% of its electricity demand from renewable power sources.

Orkney has a long-standing heritage as a national location for testing modern wind turbine technology since the first deployment at Costa Head in the 1950s. Over the last 20 years there has been a marked diversification in activity, starting with energy efficiency, then deploying wind turbines to decarbonise electricity, establishing a world leading marine energy test facility, introducing innovative heating, and innovation projects exploring green hydrogen, energy storage and balancing technologies.

### LIGHTHOUSE COMMUNITIES FOR THE ENERGY TRANSITION

Orkney's energy ecosystem is being used as a case study to help other communities and regions across the world. Visitors come to Orkney to learn from the pioneering energy R&D activities taking place, and Orkney-based expertise and equipment has been exported all over the world to help facilitate, encourage, and inspire communities to achieve their own sustainable energy solutions.

Orkney has largely decarbonised its electricity and are working hard to decarbonise heat and transport by 2030. Collaboration is key and EMEC works closely with partner organisations, locally and internationally, to help demonstrate the clean energy system of tomorrow.

A new pan-island distributed innovation centre, funded through the Islands Deal, will support Orkney, Shetland and the Outer Hebrides to become lighthouse communities in the energy transition. **The Islands Centre for Net Zero** is being developed by an islands-based consortium, led by EMEC, and including the three Island Councils, Heriot-Watt University, Aquatera and Community Energy Scotland.

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\* Dept of Business, Energy and Industrial Strategy, and Dept of Transport: 2020





# RESEARCH AND DEVELOPMENT IN ORKNEY AND BEYOND

20 years of front-line experience in providing test and demonstration facilities for ocean energy has given rise to a range of wider collaborations generating cross-sectoral innovation and knowledge sharing.

EMEC plays a fundamental role in supporting industry to develop products, reduce risk, cut costs and improve efficiency.

To date, we have taken part in R&D projects totalling £538 million for the development of the renewables industry. From projects looking at subsea cables, to subsea data centres and renewables integration with hydrogen, our infrastructure and experience is being used to facilitate innovation across various sectors.

As is the nature of a test centre, a lot of the work we do is experimental and first-of-a-kind demonstrations. We have a lot of experience working in a fast-paced, ever-changing environment and we are always looking for new ideas to support innovation challenges in the clean energy space.

We will work with you to develop a bespoke service package to meet your needs.

If you have ideas for a R&D project, or would like to chat about how EMEC can support your technology development programme, please get in touch. We'll work with you to scope out your challenges and the potential solutions, and can support with grant funding bids as required.

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# SUPPORT SERVICES FOR YOUR R&D PROGRAMME



## DEMONSTRATION SUPPORT

- **EMEC test sites:** provision of test sites and testing infrastructure, consenting, electrical, H&S, O&M, data collection and decommissioning support.
- **Site development and operation:** including site selection, characterisation, design, consenting, set up, O&M, site management, and project development.
- **Hydrogen specific:** green hydrogen supply, real-world performance and production data.

## TECHNICAL SUPPORT

- **Accredited services:** to provide assurance to investors and funders.
  - **Technical Inspection** (operating to ISO/IEC 17020)
  - **Power Performance Assessments** (operating to ISO/IEC 17025)
- **Metocean:** data collection, analysis, modelling.
- **Environmental:** monitoring, impact assessments, acoustic characterisation, and modelling.
- **Consenting:** support, guidance, and feasibility studies.
- **Feasibility studies:** technical assessments, pathways to commercialisation, regulatory roadmaps, techno-economic assessments.
- **Hydrogen specific:** plant running strategies, capacity factors, model validation and design review

## BUSINESS SERVICES

- Test centre consultancy support
- Project management
- Bid writing and grant applications
- Procurement
- Communications and dissemination
- Stakeholder engagement
- Market analysis







The development of EMEC and the marine energy supply chain has had a positive effect locally, and across the UK, in terms of employment and encouraging public and private investment to help service the sector.

## CAREERS

EMEC has created highly skilled, high value jobs and is now one of the top 20 employers in Orkney.

The number of people directly employed increased from 44 to 85 between 2017 and 2023, with average earnings higher than the Orkney average.

The creation of high value jobs helps to retain young people in Orkney, attracting back those who had previously moved away for work or study, as well as enticing new people to move to the county. This is particularly important as the working age population of Orkney is projected to decrease by 13% between 2021 and 2043.



## ECONOMIC IMPACT\* IN NUMBERS



\*Economic impact assessment by BiGGAR Economics on total cumulative impacts attributable to EMEC: 2003-2023

## LOCAL CONTENT GLOBAL IMPACT

By taking advantage of the resources available in the Highlands and Islands, we are supporting the economic development of rural peripheral areas.

50% (over £30 million) of EMEC spend 2005-2022 has been spent in Orkney.

Further afield, concentrated effort is being made by the marine energy sector to ensure local content is front and foremost in procurement. For example, Orbital Marine Power's O2 tidal turbine was made with 80% UK supply content. From Scottish steel work and main manufacturing through to anchors from Wales and blades from the south of England. The launch of the O2 marks the first vessel launch from Dundee since ship building ended over forty years ago.



## SUPPLY CHAIN DEVELOPMENT

EMEC's activity has fostered a cluster of activity in Orkney that is enabling other companies to develop and thrive. The services available locally have developed substantially since EMEC was established with evidence of diversification from other sectors such as fishing, diving and oil and gas into the marine renewables sector.

## EXPORTS AND INWARD INVESTMENT

EMEC has exported its knowledge across the Americas, Europe, Asia and Oceania to support the development of a global marine energy sector and facilitate wider clean energy R&D. EMEC has secured £49.5 million R&D funding since 2016, the vast majority of which was inward investment.

A hub of knowledge has therefore been created through the creation of EMEC. Local consultancies, diving companies and vessel operators are now selling knowledge obtained by working on EMEC's sites and with our customers to others around the world.

## INFRASTRUCTURE

£23 million has been invested by OIC and HIE in supporting harbour infrastructure for the marine energy sector in Orkney, which has also benefited the fisheries industry and cruise sector.

## A JUST TRANSITION TO A MORE EQUITABLE ENERGY FUTURE

KEEP UPDATED ON LARA'S RESEARCH.



## PHD - IN THE SPOTLIGHT

Exploring the justice dimensions of emerging energy technologies

An energy justice and responsible innovation inquiry into marine renewables and green hydrogen in island communities.

This research explores these emerging technologies which are not yet 'locked into' our current systems, to anticipate their potential risks of injustice, and the opportunities they offer for building just energy transitions.



Lara Santos-Ayllon





# INNOVATE COLLABORATE GENERATE



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