



POWERING THE FUTURE

IMPACT REPORT
2016/17

CATAPULT
Offshore Renewable Energy

ore.catapult.org.uk

We work with
Innovate UK

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CHAIRMAN'S FOREWORD

As the UK Government develops its industrial strategy to deliver strong economic growth, innovation has never been more important and the Catapult Network never more relevant.

As we look to both reinforce and establish world-leading positions in some of the 21st century's fastest growing industrial sectors, we have the opportunity to capitalise on our strong research base and our historical strengths in innovation, leveraging public investment many times over to deliver significant Gross Value Add (GVA) and thousands of jobs across the country.

I am pleased to report that the Offshore Renewable Energy Catapult has continued to grow and to increase its impact through 2016-17, building our expertise, investing in our assets and expanding our scope of activity. Working directly with more of the industry's largest companies to reduce risk and cost is enabling us to support more businesses to grow and deliver extensive

research programmes in key areas of technology and operations.

The offshore wind sector in particular has taken huge steps in reducing costs. The Catapult is at the heart of this key industry, ensuring that progress continues and is deeply rooted in our regions, often those with the greatest need for jobs and development.

ORE Catapult will continue to evolve in support of the renewables industry: convening expertise from other sectors; leveraging the depth of the Catapult network, and delivering targeted technology innovation. In the meantime, I am pleased to provide this summary of the strong progress that we have achieved during the past year.

Colin Hood
Chairman, ORE Catapult

OUR IMPACT IN 2016/17

137
academic
collaborations

94
active R&D
projects

134 SMEs
supported

257
industry
collaborations



> **Launched**
the Offshore Wind
Innovation Hub to
coordinate innovation
across industry,
government and
academia

35
international
projects



Return on Investment

1:3:21

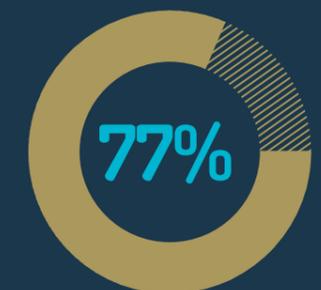
For every £1 of core grant invested we
have leveraged £3 of additional research
funding driving £21 of activity



> **Tested and supported**
turbine assembly and
deployment for the world's
first tidal stream array

51 companies
whose product development
we've supported through our
testing and validation services

Operating
£1/4bn
of world-leading test and
demonstration facilities in
support of UK innovation



Year-on-year uplift
in competitive R&D
revenue



EXECUTIVE SUMMARY

I am pleased with the progress made this year. By working more closely than ever with partners from across industry and academia, and using and investing in our world-leading test and demonstration facilities, we have continued to deliver impact across our expanding portfolio of projects and services, and to support the offshore renewables industry to reduce costs, improve efficiency and reliability, and create UK jobs.

Our key relationships with many of the industry's biggest operators are helping to deliver new technologies and ways of working in offshore renewable energy, reducing costs and growing UK businesses. Continued backing from Innovate UK has allowed us to expand both our team and our facilities, investing to stay ahead of market needs and enabling innovation to underpin the continued strong progress of the sector.

One of the Catapult's main roles is to help coordinate innovation activity across the offshore renewables landscape, and to provide the vital link between early-stage academic research, SMEs, industrial application and commercialisation. The UK Government-backed Offshore Wind Innovation Hub will be a major enabler of this coordination, bringing industry, academia and Government together to help UK businesses seize opportunities in offshore wind by presenting UK offshore wind innovation priorities, supply chain growth opportunities and a comprehensive view of the funding landscape.

We continue to enjoy considerable success in securing research funding, both where it is centred around our test and demonstration facilities and in specific areas of technology specialism, such as foundations, sensors, and Operations and Maintenance (O&M).

Expanding this expertise and resource through partnerships with leading universities ensures this vital activity continues to deliver cutting-edge research and development opportunities. Our Blades Research Hub at Bristol University is the first of these and we anticipate more in the future.

Pushing forward the development of our own highly innovative testing programmes, we work in close collaboration with leading manufacturers to prove and demonstrate accelerated, representative testing programmes for wind and marine systems and components. We've enhanced our testing capability with the addition of a 1MW drive train test rig and a blade rain erosion test facility, and we are about to install the largest grid emulation system in the world. This activity is

lowering the cost of energy by reducing time to market and enhancing reliability, ultimately reducing risk and the resulting cost of capital.

Our work with SMEs - the agile innovators bringing new technologies forward to address some of the biggest challenges facing the offshore renewables sector - is an exciting and growing area of activity for us. From completely new designs for key components, to remote and robotic inspection devices or more efficient and effective access methods, these are companies who are seizing the opportunities that the market presents, and we are delighted to be able to support them in their growth through providing expertise, technology assessment and validation, demonstration and market access.

Sharing of best practise is a key enabler of progress and we continue to publish both examples from industry, such as our series of O&M Case Studies, and Analysis and Insight papers from within our own team, providing key market insights on topics as diverse as cost reduction and supply chain management

to floating wind foundations, information modelling and offshore grid standards.

While the outstanding progress in offshore wind has been much heralded, I am also hugely encouraged by the progress seen in marine energy. The first electricity generation from the MeyGen tidal array in the Pentland Firth is a huge milestone, and we are proud to have supported both Atlantis on the testing and commissioning of its 1.5MW turbine, and MeyGen on the successful deployment of the world's largest tidal array.

Regionality is one of the industry's major economic strengths, with particular concentrations of activity in some of the coastal communities with the greatest need for development and opportunity. Our own activities mirror this geographic spread, and we are operating the length and breadth of the country: from the north of Scotland to Cornwall, Glasgow and Blyth to East Anglia and Swansea.

Finally, we are more aware than ever of our impact internally, in our own facilities, and externally in the communities in which we operate. Investment in our own people, practices, processes and performance will remain our top priority, but we have also increased the support we have been able to provide in communities close to our main facilities, and we will continue to focus such activity in the support of science, technology, engineering and maths (STEM) education.

We are proud of the work that we have delivered to date and the wide impact that it is having, and look forward to continuing to grow this in the coming months and years.

Andrew Jamieson
CEO, ORE Catapult



GWEC/WindEurope/Dennis Schroeder

IMPACT THROUGH STRATEGIC INFLUENCE

ORE Catapult has been successful at positioning itself at the very heart of the UK's growing and world-leading offshore renewables sector. We play a key role in UK and European industry, and have collaborated extensively with some of the world's leading companies and research organisations.



We are trusted by industry to lead on numerous sector-defining programmes and projects, and we are directly supporting a variety of innovative small businesses to bring some of the most exciting new technologies to commercial reality.

From this strong foundation, we deliver a first-class service to customers in industry and academia, enhancing the role of innovation in growing the UK's economic success in the growing offshore renewable energy sector.

The pyramid diagram on the opposite page illustrates our underlying business model. It guides how we develop our key industry relationships and deliver impact.

The model in action

Our test and demonstration assets can test 15MW drive trains and 100m turbine blades. By comparison, the largest commercially available turbine is 8.3MW and the largest blades under 90. When coupled with our technical expertise, this is a compelling proposition for turbine OEMs.

Our strategic relationships with these clients provide us with a deep understanding of the key innovation challenges as the next generation of 10MW+ turbines are developed.

For each of these strategic relationships with OEMs, we expect to develop a number of relationships with Tier 1 suppliers to support them, alongside less established companies looking to enter the sector. Further down the supply chain, we are creating routes for a larger number of innovative UK players to break into the market.

Through working with ORE Catapult to the same professional standards as the OEMs, early stage UK technologies gain credibility faster. We expose these technologies to the more established players, brokering relationships which may otherwise not happen. For example, we arranged for one of our multinational OEM clients to witness trials of a prototype of a disruptive drive train from a UK SME on our 1MW test rig.

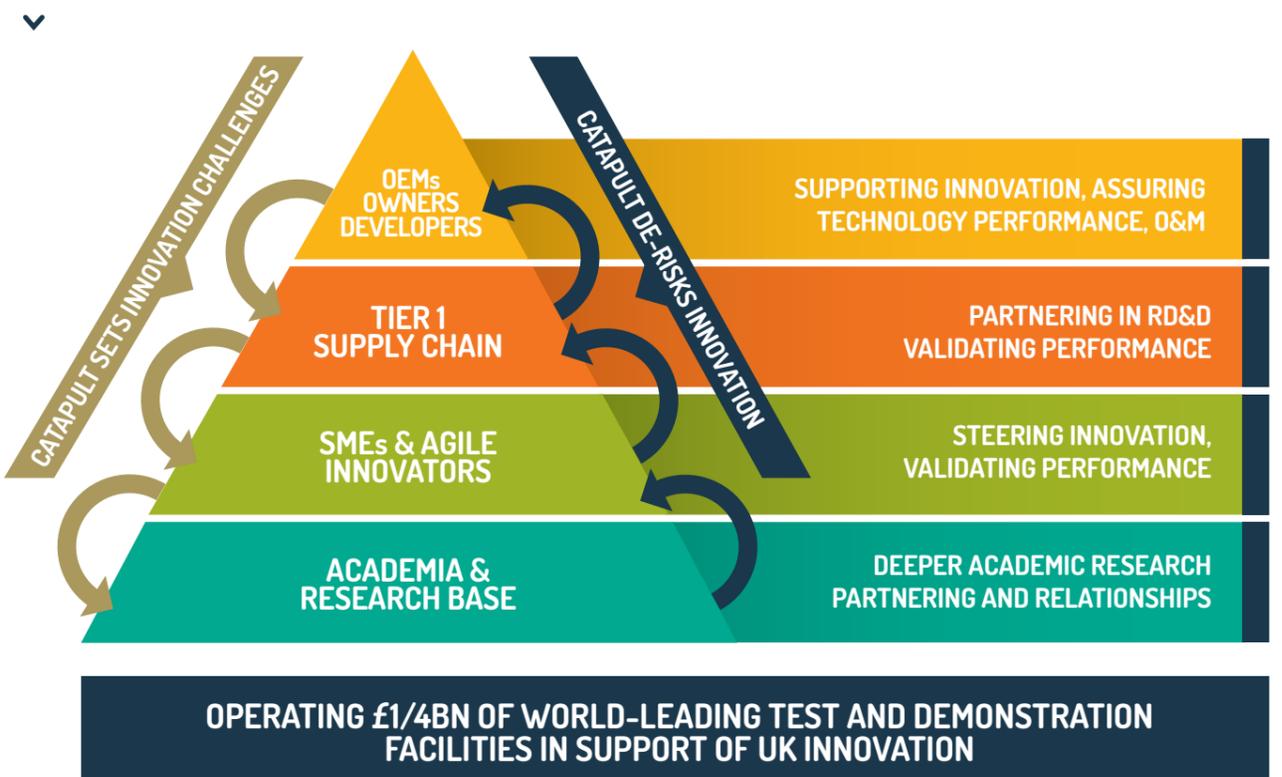
Our in-house research capability is key to helping high performing companies (HPCs) and others accelerate their product development. We are partnering with UK

companies to access R&D funding to support their technology development, and our new Academic Research Hubs give us deep reach into the core technical areas that companies at all levels in the value pyramid need to access to underpin their success in the sector. This allows us to provide many more UK companies with opportunities to supply products and services to the Tier 1 suppliers and OEMs.

Based on our recent level of support to UK SMEs (134 in 2016/17) and planned growth, we anticipate supporting 1000 HPCs and SMEs over the next six years.

Continuous development of our test and validation assets is therefore an essential part of our investment plan, as it expands the ways we can assist the market entry process. For example, upgrades in the high-voltage and wet electrical capabilities of the electrical labs will help UK-based companies such as JDR Cables stay at the forefront of the global market.

Key:	Catapult impacts by:
▲ OEMs, Owners & Developers	Validating technology, supporting incremental innovations and their R&D programmes
▲ Tier 1 Supply Chain	Partnering to secure development funding, and improving functionality or performance. Validating technology performance
▲ SMEs & Agile Innovators	Steering direction of innovation activity. Linking these agile companies to the end market, providing expertise and facilities needed for development. Validating performance
▲ Academia & Research Base	Linking innovative UK companies to deep expertise within academia. Signposting industry's R&D priorities to our academic research partners



IMPACT THROUGH TEST & VALIDATION



Tony Quinn
Test & Validation
Director

“

Testing and validation of major equipment such as turbines, blades and electrical components is a key activity for ORE Catapult. In total, we own and operate state-of-the-art facilities worth £250m for demonstrating, testing and validating cutting-edge offshore wind, wave and tidal technologies, including the world's largest open-access research turbine and blade test facility. These are critical assets for ensuring that innovative UK companies are integrated with high-value global supply chains. ”

Six degrees of freedom – The future of renewables testing

We operate a system of continuous improvement in our test methodologies to stay ahead of current industry standards, allowing us to more accurately simulate the complex, real-world operating environments of a variety of turbine systems and components in order to deliver the most representative testing possible. Robust test regimes carried out in a controlled environment at full-scale on wind and marine turbine components, coupled with focused, applied research can significantly influence the rate of cost reduction.

Our National Renewable Energy Centre in Blyth is at the forefront of developing representative testing methods. Our blade, drive train and electrical test facilities are capable of accelerated lifetime testing, allowing the precise, controlled emulation of International Electrotechnical Commission (IEC) wind events and other in-field conditions.

Representative testing brings many benefits to OEMs, asset owners and investors. These benefits include improving the reliability of prototype designs, through reduced design margins for unplanned maintenance and saving on materials costs which all contribute to increased investor confidence.

It also allows the Catapult to build a solid knowledge base and expertise in key areas, sharing that knowledge for the wider industry benefit and driving technology innovation that will ultimately make renewable energy more competitive.

Bespoke bearings testing

During August 2016, a multinational wind turbine OEM awarded ORE Catapult the contract for the full engineering design, procurement, manufacture and installation of the components required to test a wind turbine main rotor and pitch bearing. This project is conducting tests to validate and provide confidence in the robustness and reliability of the rotor bearing system design. To date, we have undertaken design, procurement and installation activities and taken delivery of the rotor bearing system. Testing will commence in the second half of 2017 and is expected to last for approximately five months. The award of this contract is significant for the business as it strengthens our long-term relationships with the major players in the global offshore renewables market, while the novel contract is testament to our own expanding technical knowledge.

15MW drive train test rig

ORE Catapult must create state-of-the-art test and validation assets and continually upgrade these if it is to ensure it remains relevant for industry's efforts to develop the latest generations of offshore renewable technologies. A major capital project to create the world's largest and most advanced test facility for offshore wind turbine drive trains has been underway at our Blyth facility. Although under the formal direction and ownership of the Energy Technologies Institute, this project has necessarily required substantial input from the Catapult, with increasing project responsibility being transferred to us

in anticipation of a full handover of the asset. Commissioning of this 15MW drive train test rig has seen substantial progress over the last 12 months and, once operational, the facility will be capable of performing independent performance, validation, functionality, endurance and accelerated life testing.

The test rig has now been coupled and passed the significant milestone of being successfully tested for the first time. It is due to be commissioned this year.

This year we also awarded a contract for the supply of a Grid Emulation System that will allow electrical power quality testing of turbines undergoing validation on the 15MW rig (and devices under test on the Nautilus 3MW rig). At 18MVA, this will be the largest Grid Emulator in the world, enabling the effect of grid faults on the turbine to be tested.

New 1MW facility to complement existing drive train offering

Our 1MW facility was commissioned in January 2017 following testing of Tocardo's T2 turbine. The new test rig, which was designed, built and commissioned by the Catapult, will be used for research and development to validate the efficiency and reliability of new turbine designs, and for upscaling developer prototypes to multimegawatt scale.

The rig was developed as part of Tidal EC, a European FP7 project on power take-off optimisation of tidal turbines. It allows us to

offer sub-megawatt powertrain and component testing to the UK and European tidal market and further support SME product development.

With our support, UK SME Greenspur Technology has successfully generated power from its innovative ferrite magnet permanent generator.

Enhanced blade testing capability with new rain erosion test rig

A new test rig, designed to simulate the erosion caused by the impact of water droplets on a wind turbine blade during operation, was installed at our Blyth site in 2017. The rig will enhance our blade testing capabilities and research activities, and will enable us to provide deep engineering and technical analysis and interpretation of test results for customers and research programmes. By having a better understanding of the fundamental physics of erosion, we will ultimately be able to ensure greater efficiency, realise reduced costs and assist in the development of future protective coatings. We now have the ability to test blade erosion solutions from multiple UK innovators, partner on improving and troubleshooting their technologies, and demonstrate their effectiveness to the market.

The 7MW Levenmouth Demonstration Turbine is revolutionising offshore wind research

In 2015, ORE Catapult acquired the 7MW Levenmouth Demonstration offshore wind turbine in Fife. The turbine offers UK industry and academia an unrivalled opportunity to develop a deeper understanding of a wide range of technologies, as well as the O&M aspects of offshore wind turbines, with the ultimate goals of reducing the cost of energy

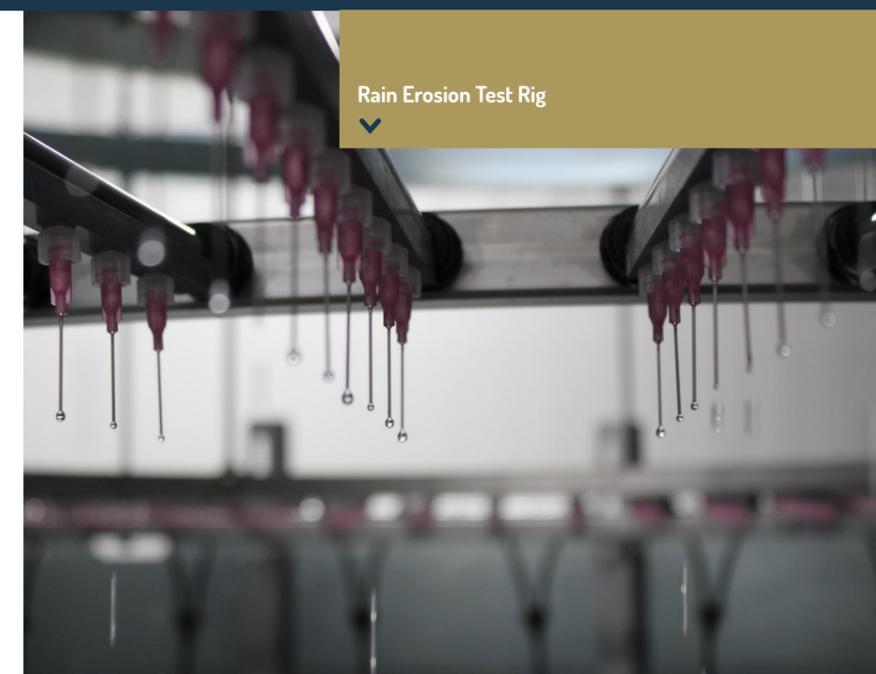
and accelerating the commercialisation of innovative new technologies.

In the last year, we have worked closely with key academic and industry stakeholders to align the research programme of the Levenmouth turbine with industry priorities. Recent EU-funded Demowind calls for projects relevant to the demonstration of new offshore wind technologies prompted strong interest among the industry and international research communities to use the Levenmouth turbine for research purposes.

Edinburgh SME Limpet Technology used the 7MW Levenmouth Demonstration Turbine to display its innovative crew transfer solution to in a real-world setting. Testing, demonstrating and proving a new product at work in its operational environment is especially beneficial to any SME in showcasing the innovation to potential investors and customers.



15MW Drive Train Test Facility



Rain Erosion Test Rig



DRIVING CHANGE

COST REDUCTION

The UK offshore wind LCOE has dropped below £100/MWh four years ahead of expectations. Offshore wind energy cost reduction continues apace and the industry is setting its sights on further reductions, economic growth and job creation

In 2012, representatives of the offshore wind industry, the Crown Estate and the UK Department for Energy and Climate Change (now BEIS) agreed on a strategy for development of the industry to 2020, setting out a target for reducing the cost of energy from offshore wind to below £100 per MW/hr.

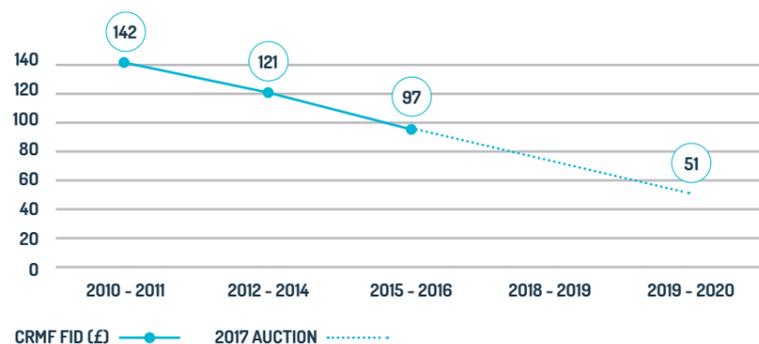
The third annual Cost Reduction Monitoring Framework (CRMF) report, delivered by ORE Catapult on behalf of the Offshore Wind Programme Board (OWPB), shows that UK offshore wind projects that made a Final Investment Decision (FID) in 2015/16 achieved an average LCoE of £97/MWh. This is now below the joint UK Government and industry target of £100/MWh by 2020, and has been achieved four years ahead of schedule. The cost of energy from offshore wind has fallen by 32% in five years,

due to the faster than anticipated deployment of larger turbines, increased competition, and lower cost of capital as the risk profile of the sector improves.

Since this report, the latest round of Contracts for Difference (CfD) auction results were announced. The results were astounding, indicating a further reduction in LCOE of 33-47% by 2020 and a staggering 64% reduction in 10 years. This is further evidence of the huge progress the industry has made in substantially cutting costs through innovation, creating thousands of UK jobs.

Technology innovation remains at the heart of driving further cost reduction and remains the critical enabler of this continued downward trajectory and the huge economic benefits that will ensue.

LCOE Financial Investment Decision (FID)



The latest round of Contracts for Difference (CfD) auction results were astounding, indicating a staggering 64% cost reduction in 10 years

INFLUENCING THE AGENDA

ORE Catapult takes over coordination of the Offshore Wind Industry Council and Programme Board

In May 2016, we officially took over from The Crown Estate the secretariat role for two key industry bodies - the Offshore Wind Industry Council (OWIC) and the Offshore Wind Programme Board (OWPB).

OWIC is a senior government and industry forum, which was established in May 2013 to drive the development of the UK's world-leading offshore wind sector. The forum is responsible for overseeing implementation of the Offshore Wind Industrial Strategy and is the sponsoring body of the Offshore Wind Programme Board - a joint government / industry body responsible for driving cost reduction in offshore wind.

Our continued involvement provides a platform to guide the sector agenda.

INDUSTRY COLLABORATION

ScottishPower Renewables and ORE Catapult join forces to drive forward UK's offshore wind industry

We signed a collaboration agreement with ScottishPower Renewables (SPR) to help identify and prioritise SPR's innovation needs for its portfolio of offshore wind projects, and identify the high-growth UK companies with the potential solutions to solve these challenges.

The partnership will develop projects to tackle some of the key technology challenges facing the sector, working together to reduce offshore wind costs through technology innovation and deliver benefit to the UK supply chain through increased investment and job creation.

The first such project is a foundation fabrication feasibility study. The aim of this study is to review efficiency opportunities in foundation fabrication, including a review of the potential opportunities for innovation to help UK companies gain a competitive edge and maximise longer term economic benefit.

ANALYSIS & INSIGHT

Relevant, actionable advice on key industry issues, written by our experts

We introduced a regular series of Analysis and Insight (A&I) reports designed to provide up-to-date, practical insight and advice on the biggest issues facing the offshore renewables industry. Throughout the year, our A&I series has covered a broad range of topics - including economic analysis, O&M best practice, maintenance strategy, financial modelling and research and technology development - all linked to ORE Catapult's project and research activity and in response to key industry priorities.

Our Analysis and Insights papers are a series of concise, informative studies of critical issues in our industry, aimed at a technically-literate but non-expert audience. In 2016/2017 we published 25 papers, resulting in over 1600 downloads.

Major Owner/Operators and OEMs have participated in the O&M Case Study series, sharing up-to-date knowledge and best practice. A project is in development after the Catapult was approached by a company in direct response to one of our O&M Case Studies, while findings from our economic analysis papers have been reported on by national and trade press in the UK and across Europe.

SUCCESS STORIES



BLADES

Innovations in the design, materials and manufacture of offshore wind turbine blades can significantly lower the cost of offshore wind energy. It is an area of strategically important research and development, and one in which we believe the UK can become a global leader. ORE Catapult is at the forefront of blades research and we have captured a selection of case studies that demonstrate our impact in this key area.



DUAL AXIS BLADE TESTING

Blade testing that is more representative of real-world operating conditions, reducing overall test duration and cost

Wind turbine blades need to be tested statically for extreme loads and fatigue tested to prove that they will survive for the designed lifetime. Longer blades require tests that can last for many months, significantly increasing costs and time to market.

Dual Axis began as a co-funded PhD with Durham University, continued as a Knowledge Transfer Partnership project and then as core ORE Catapult research, utilising its blade test facilities. Our research has developed software and a test methodology that enables blades to undergo flapwise and edgewise fatigue testing simultaneously, more realistically recreating real-world operating conditions and significantly reducing the time and cost of such tests. This breakthrough could help to reduce overall blade test times by up to 25%.

The fatigue analysis software has received independent accredited certification.

The project has attracted considerable industry interest, including a major collaboration with leading international blade manufacturer LM Wind Power and its customer, wind turbine manufacturer Adwen. LM Wind Power provided extensive data and a 40.3m blade for initial testing, then provided our facility with an 88.4m blade – the longest in the world – for ongoing development as part of a €13.2 million European project.

The research is now being used in teaching and to develop further academic papers by Durham University, as well as providing a case study for how academic research leads to real industry impact.

▲ OEMs ▲ SMEs ▲ Academia

The project has attracted **considerable industry interest**

25%

This breakthrough could help to **reduce overall blade test times** by up to 25%



ACT Blade's disruptive design has the potential to reduce offshore wind energy costs by 8.7%, by increasing energy production by 9.7%

ACT BLADE LTD

Groundbreaking technology transfer from the sailing industry to offshore wind

We continued to grow our relationship with Edinburgh-based SME ACT Blade to develop and test next-generation engineered textile wind turbine blades.

After they responded to one of our Innovation Challenges, we worked with engineers from world-leading yachting design specialists SMAR Azure, resulting in the spin-off company ACT Blade Ltd.

The aim was to study the feasibility of adapting their sail modelling technology into modular blades that are over 50% lighter than those in use today. Put simply, a lighter blade can achieve greater power production. Lighter blades can be made longer, and longer blades capture more wind. That increases energy production, which lowers the Levelised Cost of Energy.

Made up of an internal composite structure and high-tech textiles, as opposed to the prevailing fibreglass, ACT Blade's disruptive design has the potential to reduce offshore wind energy costs by 8.7%, by increasing energy production by 9.7%.

The development of modular blades also has implications for developing countries, where poorer infrastructure means full-length blades are all but impossible to transport. And there are environmental advantages, too: while glass fibre blades are landfilled at the end of their working life, ACT Blades will use recycled carbon fibre.

After helping the company to secure several rounds of investment, we developed the new rain erosion test rig at our facility in Blyth, which will validate and demonstrate a section of the blade. We're proud to be playing a major role in helping this fledgling Scottish company to develop, and confident that when brought to market, its technology can have a huge impact on the cost of offshore wind.

BLEEP

Benefiting clients through greater efficiency and reduced costs

We have successfully developed a multi-partner, 100% industry-funded project to investigate erosion of the leading edge of wind turbine blades. In light of in-field problems appearing across multiple wind turbine product platforms, we convened manufacturers, Owner/Operators and maintenance service providers to scope out a research programme to investigate the causes and determine possible solutions. In collaboration with Centrica, we successfully delivered the first in-field measurement campaign under this pioneering blade project and concluded that an uplift in annual energy production (AEP) of between 1.5 to 2% is possible following the repair of moderate blade erosion.

The results allow Owner/Operators to optimise their repair and maintenance strategies, balancing cost versus benefit in order to minimise LCoE impact and maximise revenue. A further two measurement campaigns will be carried out as part of a wider collaborative industry programme of works, and to validate the results and the methodology used.

XL BLADE

Collaborating with wind industry leaders in designing, validating and deploying two of the world's largest offshore wind turbine blades

XL Blade is funded through the EU and UK-supported DemoWind scheme, along with international partners from Denmark and Spain. It aims to reduce the cost of offshore wind by designing, validating and deploying the world's largest offshore wind turbine blade. This project is an example of the increased utilisation of our large-scale test and validation assets, which have previously been used to primarily provide direct commercial testing, by the offshore wind research community. In March 2017, one of the world's longest offshore wind turbine blades arrived at our 100m blade test facility.

The XL Blade project provided the funding for the 88.2m prototype wind turbine blade from Adwen. Undertaking a project of this scale is challenging, but it will have a very positive effect on the industry. This project was a successful outcome of our plan to increase the intensity of research activity taking place on and in association with our test and validation assets, to ensure our unique facilities are providing a route to enhanced innovation and commercial success for UK technology solution providers.

The market potential is estimated at £70 million – with significant UK jobs and investment as a result

WIDEBLUE LTD

New technology could reduce the number of inspections needed for offshore wind turbine maintenance

Regular inspection to ensure the smooth operation of a turbine is vital, but the process can be challenging, time consuming and expensive. A team of imaging specialists at Wideblue Ltd recognised an opportunity to dramatically reduce the need for these inspections, and we are now working with Wideblue to develop its optical technology into a sophisticated system of sensors that can detect blade deformation in real time.

The BOHEM (Blade Optical Health Monitoring) project will develop a low cost, optimised, optical condition monitoring solution for blades that can be used during the development of new designs, and in the operational field.

Wideblue's sensing technology has already been applied to our research blade to learn more about its capabilities. It will then be deployed on the 7MW Levenmouth Demonstration Turbine, where it will undergo trials in a real-world, operational offshore environment. The data generated will be used to monitor individual blade health, allow early detection of any changes in performance, instruct more effective maintenance, and allow for better justification of life extensions.

The resulting product could be available to the wider market as early as next year and, at a fraction of the cost of current systems, the market potential is estimated at £70 million – with significant UK jobs and investment as a result.



The Hub will enable us to develop the people and the elite technical skills that the industry needs. We hope that many of our postgraduate students will go on to forge careers in the industry, and that the University will have an impact in influencing the future strategic research agenda in this area. ””



Professor Paul Weaver
University of Bristol

BLADES RESEARCH HUB

A pioneering centre to support development of next generation turbine blades

We have set up a £2.3 million Wind Blade Research Hub (WBRH) with the University of Bristol, a five-year partnership which has its sights set on building more efficient blades that harness more energy from the wind. This will prove crucial as the industry prepares to nearly double the power of offshore wind turbines, from 8MW today to 13-15MW by 2025.

Phase one of the industry-leading programme of strategic research and development will investigate blade materials and manufacturing technology, blade integrity, blade design and performance.

It is also expected that the WBRH will provide a blueprint for future industry/academic collaborations in areas such as electrical infrastructure, foundations and powertrains.

The Hub will be supported by a group of PhD and EngD students, a post-doctoral researcher and a lecturer from the University of Bristol, working alongside the Catapult's blades research team.

▲ OEMs ▲ Tier 1 Supply Chain ▲ SMEs ▲ Academia

RAIN EROSION TEST RIG

New testing capability focuses on the impact of rain erosion on blades

In early 2017 we installed a new rain erosion test rig, designed to simulate the erosion caused by the impact of water droplets on a wind turbine blade during operation.

The rig was purchased with support from Innovate UK and supplied by R&D Test Systems A/S. It is enhancing the Catapult's extensive blade testing capabilities and research activities, enabling us to provide deep engineering and technical analysis and interpretation of test results for customers and research programmes.

This will lead to a better understanding of the impact that rain erosion can have on materials, repair applications and methodologies.

Better understanding of the fundamental physics of erosion, and how it can be mitigated, will lead to greater efficiency and reduced costs, as well as assisting in the development of protective coatings and materials.

▲ OEMs ▲ Tier 1 Supply Chain ▲ SMEs ▲ Academia

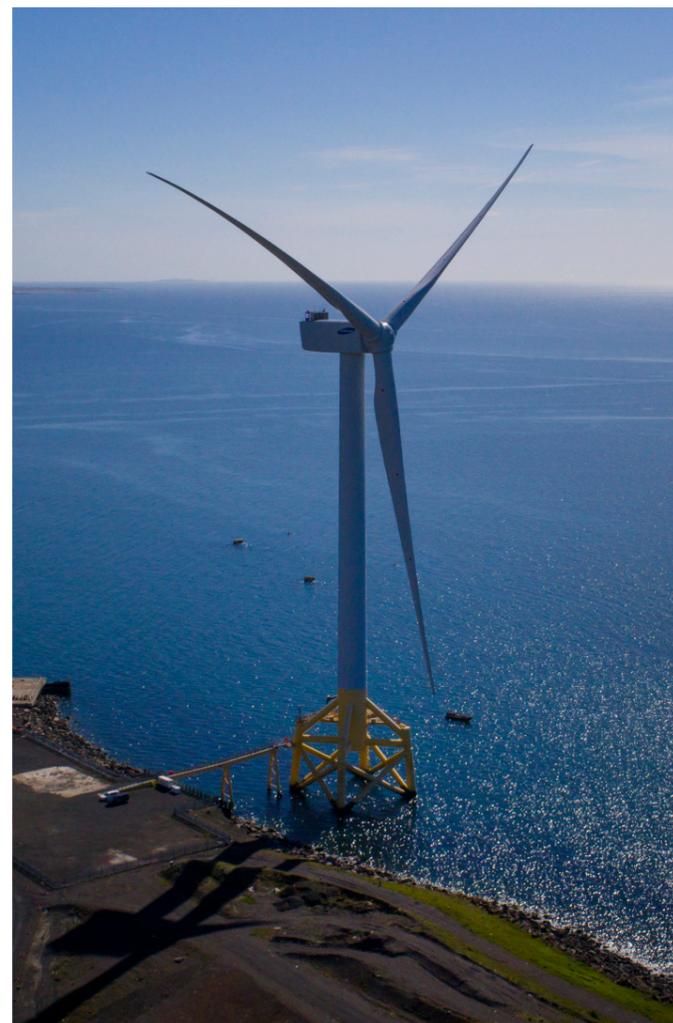
OPERATIONS & MAINTENANCE



With O&M costs accounting for up to 25% of the overall LCoE from an offshore wind farm, cost reduction is key. However, we must also build on the UK's leading position in operating offshore wind farms to increase the value of operational plant. There is a fantastic opportunity to enable a significant and sustainable impact on the UK economy through increasing productivity and performance, improving cross-sector supply chain and SME engagement and driving the export potential of this fast growing domestic and international market. Here is a collection of snapshots on our impact in this vital area. ””



Chris Hill
Operational Performance Director



CLOWT

A real-world insight into the behaviour of the 7MW Levenmouth Demonstration Turbine thanks to an innovative digital clone project

CLOWT (Clone of the 7MW Levenmouth Offshore Wind Turbine) is a project using data gathered from innovative sensor instrumentation to advance the industry's understanding of how large-megawatt turbines behave under the strains of real-world operation.

The £450k project, with £215k funding support from the Scottish Government, will enable the Catapult to instrument the 7MW Levenmouth Demonstration Turbine's (LDT) blades, tower and substructure, to monitor its behaviour in real-world conditions. We will then use the outputs to validate the current design methodologies and tools available for building large-scale offshore wind turbines, reducing flaws and design inefficiencies.

Throughout the load measurements campaign, outputs will be used within ORE Catapult to develop the digital clone, progressing research activities and inspiring new projects:

- // Development of a high fidelity aeroelastic model of our LDT
- // Instrumentation to enable validation of technology and accelerate learning
- // Optimisation of component design for cost reduction
- // Demonstration competition run in parallel to provide SME opportunity to install sensing technologies
- // Opportunities for further research projects

▲ Tier 1 Supply Chain ▲ SMEs ▲ Academia

SPOWTT

Improving technician health, safety and well-being could lead to a reduction in O&M costs

We are coordinating a €3.6 million international collaborative project involving seven partners from across Europe to tackle one of the most significant Health and Safety risk areas for offshore operations – ensuring the health and well-being of technicians during transit to and from offshore wind farms.

The DemoWind2-funded project Improving the Safety and Productivity of Offshore Wind Technician Transfers (SPOWTT) will, for the first time, measure in parallel the motion of crew transfer vessels in certain weather conditions and sea states, as well as the impact on the psychological and physiological well-being of the technicians on board.

These findings will then be used to create a tool that will aid marine coordinators in deciding on safe technician transfers, or what special conditions the transfers may be subjected to. Ultimately, this will improve service productivity, reducing O&M costs by as much as 2% and increasing turbine availability.

▲ OEMs ▲ Tier 1 Supply Chain ▲ SMEs ▲ Academia

O&M FORUM

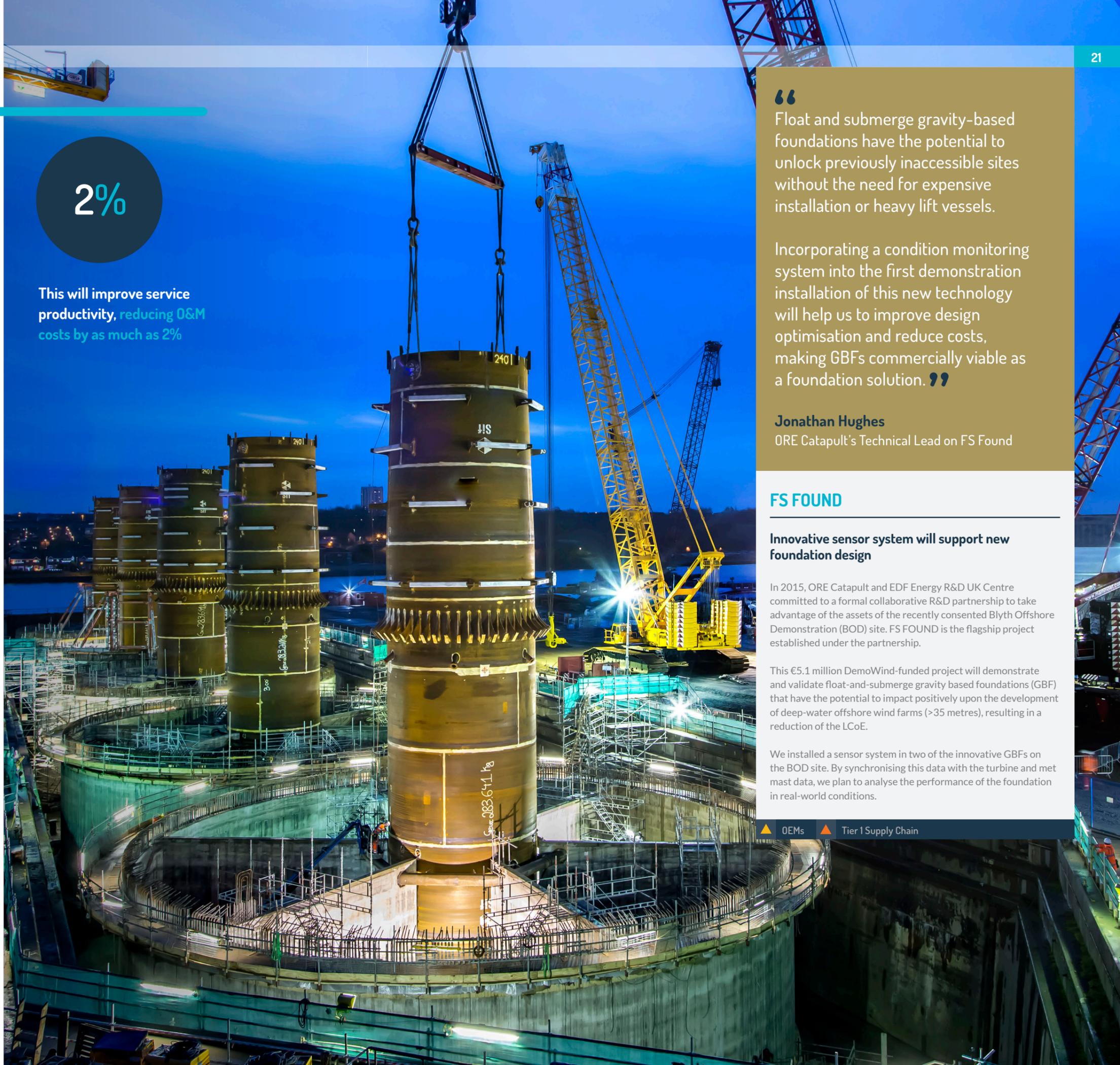
We've brought together Owner/Operators E.ON, SSE, EDF Energy Renewables, ScottishPower Renewables, XCECO, Vattenfall and Innogy to focus on improving performance in operating and maintaining offshore wind farms.

The O&M Forum is a unique platform to investigate the common issues that affect offshore wind farm performance and reliability, and to develop and test potential solutions. This has included areas such as blade erosion and cable damage and failure, which have been identified as affecting almost all operational wind turbines in UK waters.

O&M CASE STUDIES

Our O&M Case Studies project has continued to create a records and reference resource to promote best practice in O&M in offshore wind. The case studies are developed by Owner/Operators and supply chain, allowing us to capitalise on shared experience and knowledge, identify common problems, and spot opportunities for innovative solutions. A total of 12 case studies were published in 2016/17, and continue to be presented at dedicated ORE Catapult-hosted workshops.

▲ OEMs



2%

This will improve service productivity, reducing O&M costs by as much as 2%

“

Float and submerge gravity-based foundations have the potential to unlock previously inaccessible sites without the need for expensive installation or heavy lift vessels.

Incorporating a condition monitoring system into the first demonstration installation of this new technology will help us to improve design optimisation and reduce costs, making GBFs commercially viable as a foundation solution.”

Jonathan Hughes

ORE Catapult's Technical Lead on FS Found

FS FOUND

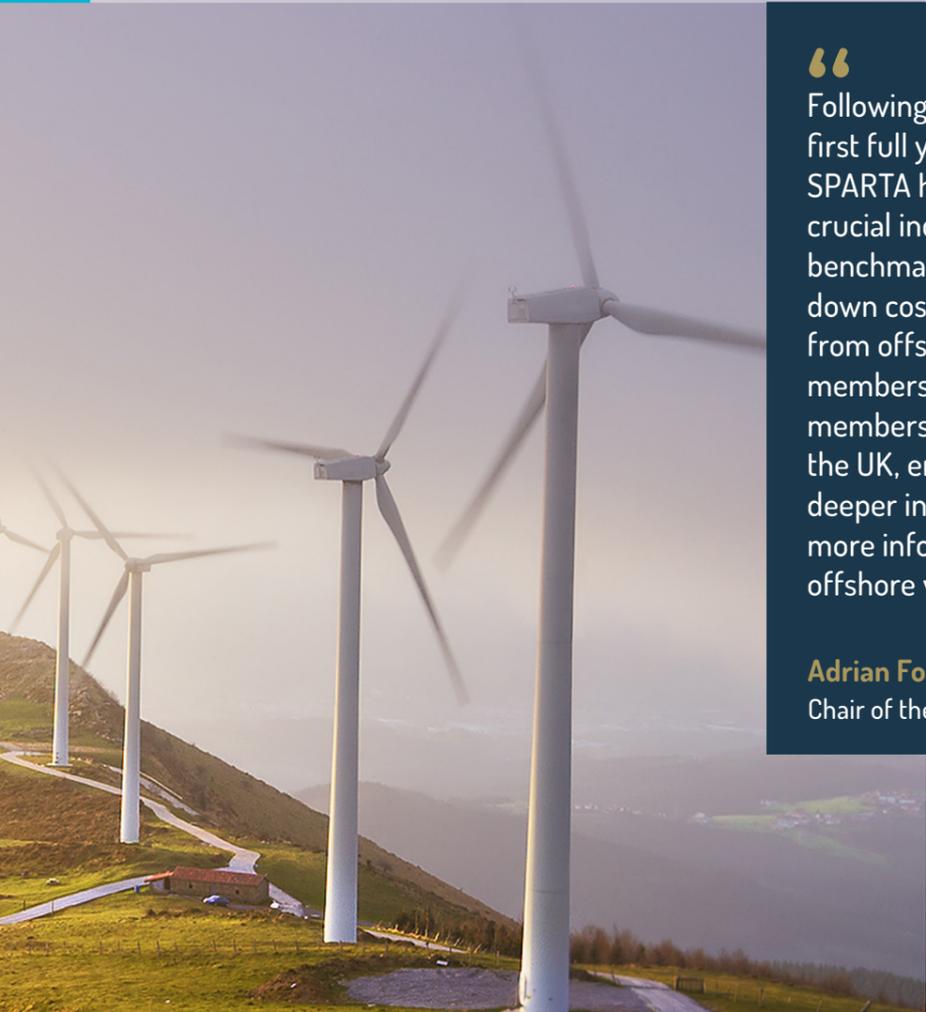
Innovative sensor system will support new foundation design

In 2015, ORE Catapult and EDF Energy R&D UK Centre committed to a formal collaborative R&D partnership to take advantage of the assets of the recently consented Blyth Offshore Demonstration (BOD) site. FS FOUND is the flagship project established under the partnership.

This €5.1 million DemoWind-funded project will demonstrate and validate float-and-submerge gravity based foundations (GBF) that have the potential to impact positively upon the development of deep-water offshore wind farms (>35 metres), resulting in a reduction of the LCoE.

We installed a sensor system in two of the innovative GBFs on the BOD site. By synchronising this data with the turbine and met mast data, we plan to analyse the performance of the foundation in real-world conditions.

▲ OEMs ▲ Tier 1 Supply Chain



“ Following a successful pilot phase and first full year of enduring operations, SPARTA has demonstrated how crucial industry collaboration and benchmarking is in continuing to drive down costs and increase production from offshore wind farms. Industry members are now working to widen membership and reporting outside of the UK, enabling them to undertake deeper insight and analysis and make more informed decisions regarding offshore wind farm management. ”

Adrian Fox
Chair of the SPARTA steering group

BENCHMARKING

WEBS

Helping companies identify improvement opportunities for cost optimisation and performance

WEBS (Wind Energy Benchmarking Services) Ltd is a business formed in April 2016, and is now a joint venture between ORE Catapult and Natural Power.

WEBS provides a unique, secure, anonymised, and independent web-based benchmarking service for wind farms. The benchmarking service compares onshore wind farm performance, enabling users to identify opportunities to focus resource and improve approaches to operations and maintenance.

Using consistent Key Performance Indicator (KPI) benchmarks, WEBS has the potential to strengthen operational strategy, improve performance, reduce costs and manage risks.

The extensive database contains anonymised performance data from a growing international fleet of onshore wind farms, with over 1GW of data currently held, and aspirations of significant growth throughout 2017/18 and beyond.

SPARTA

SPARTA review launched giving insights into first full year of successful operations

ORE Catapult, along with co-sponsors The Crown Estate, marked SPARTA's first full year of operations by publishing the SPARTA Portfolio Review 2016. The world's first benchmarking platform for offshore wind farms, SPARTA (System Performance, Availability and Reliability Trend Analysis), is actively seeking to expand the system's coverage to offshore wind farms beyond the UK.

The latest SPARTA Portfolio Review provides some key insights from the offshore wind farm performance and maintenance data gathered by the system, which covers 93.7% of the installed capacity of UK operational offshore wind.

SPARTA has a vision to be the hub of essential industry O&M performance data across the offshore wind sector, enabling Owner/Operators to continuously improve and deliver the best possible performance, while continually driving down lifetime costs and maintaining the highest health and safety standards offshore.



LIMPET TECHNOLOGY

Breakthrough personnel transfer technology could lead to 60% improvement in accessibility to offshore wind turbines in challenging weather conditions

For companies developing cutting-edge technologies in the renewables industry, the 7MW Levenmouth Demonstration Turbine is a stage unique in its scale and position. It's the world's largest open-access offshore wind turbine dedicated to research, and the only facility of its kind in the UK. It allows firms like the Edinburgh-based SME Limpet Technology to display their award-winning height safety solutions in action in a real-world setting.

Maintenance of offshore wind farms is an essential activity but wave conditions can make transferring from crew transfer vessels to turbines tricky, at best. Wave heights above 1.5m are considered too challenging, so failed transfers are an expensive and all too common business. But, as wind farms go further offshore, these are the conditions that maintenance crews will typically face.

Limpet Technology has developed a solution in the form of a game-changing dynamic hoist platform. Its personnel transfer system can double the safe crew transfer height to three metres, increasing accessibility to far-offshore installations from 50% of the year to 80%.

The system uses in-built lasers to track the motion of a vessel's deck, adjusting the height of the hoist in real time. As the deck moves up and down with the waves, so does the hoist, allowing the technician to clip in and climb onto the turbine as the boat is at its highest.

Limpet has been able to accelerate product development and simultaneously introduce the product to the market because the firm has access to ORE Catapult's 7MW Levenmouth Demonstration Turbine in Fife, Scotland.

Increased accessibility to far-offshore installations





DRIVE TRAINS

The drive train represents about 16% of offshore wind's levelised cost of energy. Steadily growing turbine capacities and the potential for step-changes in size, require continued testing and innovation in this area.

Increasingly, developers and their suppliers are seeking our support in testing and developing components such as bearings and ancillary motors, in addition to complete drive trains. In order to establish the UK as a major centre for development and testing of the next generation of offshore wind turbines, it is crucial that we are able to test and validate large and small-scale drive trains and components. This provides routes for high growth companies who have approached us with novel concepts for next-generation turbines, to be integrated into OEM product development and supply chains.

GREENSPUR RENEWABLES

Innovative SME's direct drive generator uses ferrite magnets, eliminating the need for rare-earth metals

Essex-based SME Greenspur Renewables has developed a disruptive ferrite-based direct drive permanent magnet generator for the offshore wind market. By using iron ore instead of scarce and expensive rare-earth magnets, it has the potential to slash the cost of offshore wind.

We partnered with Greenspur to secure over £1m in funding from Innovate UK to build a prototype of their revolutionary generator technology. We have adapted our 1MW drive train test rig to run a Greenspur unit under test conditions to demonstrate operation.

This project is fast-tracking product R&D and shortening the time to market by generating the technical and commercial validation required for the technology to be adopted globally.

To this end, ORE Catapult has additionally brokered an arrangement for one of its multinational OEM clients to witness our testing and validation of Greenspur's technology.

▲ OEMs ▲ SMEs

ATLANTIS RESOURCES LTD

Test and validation for the world's flagship tidal stream project

Atlantis Resources, world-leaders in tidal power generation, returned to ORE Catapult's 3MW facility to prove and de-risk its next-generation AR1500 turbine. Ahead of its deployment at MeyGen, the world's largest tidal stream project in the Pentland Firth, the turbine underwent a rigorous representative testing programme.

The tides in the Firth, which connect the North Sea and the Atlantic Ocean, are among the fastest in the world. Millions of tonnes of water surge through the area every day, accelerated by a natural channel.

At our testing centre in Blyth, our state-of-the-art 3MW drive train test facility simulated the extreme dynamic loading conditions that the AR1500 will experience in the water.

By carrying out controlled tests on the turbine in conditions as close as possible to the tidal environment, we gave Atlantis the confidence to move forward with the deployment phase.

It also helped Atlantis reduce the length of the offshore commissioning phase: a particularly expensive period of the project.

Testing was completed within the 21-day schedule, and the AR1500 was shipped north for installation in early 2017 and is currently operating well, producing low carbon electricity.

▲ OEMs ▲ SMEs

“

Performing drive train testing at this facility brings us enormous benefits as it enables us to test the turbine as a system, which enormously de-risks the operational phase, and reduces the commissioning phase offshore – a very expensive period in the overall operation plan.”

Dave Rigg

Head of Engineering Services,
Atlantis Resources



ELECTRICAL INFRASTRUCTURE

Cable arrays, offshore electrical infrastructure and medium and high voltage transmission cables make up roughly 14% of offshore wind's levelised cost of energy. Between 8,000km and 12,500km of inter array cabling is associated with Round 3 offshore wind developments, making cost reduction a priority.

Reliability considerations are also highly important for cables and power electronics. Failure in an array or transmission cable could disable multiple turbines, leading to lost revenue while awaiting repair. We are therefore aiming to address the overall system availability, robustness and cost concerns through our activity in this area.

By working with ORE Catapult, Trelleborg was able to successfully perform eight full-scale wet tests of NjordGuard™, covering a range of installation scenarios, without the associated time, effort and costs of going offshore

TRELLEBORG

Enabling controlled wet testing for innovative cable protection system

Trelleborg, a world leader in engineered solutions that protect critical applications in demanding environments, utilised ORE Catapult's open-access shallow water testing facilities to prove NjordGuard™, its latest innovation in cable protection.

With developers under increasing pressure to reduce costs and de-risk offshore wind farm power cable installation, Trelleborg's innovative NjordGuard™ solution required a series of wet tests to prove its capability of installing and removing offshore cables into both monopile and J-tube openings, without the need for intervention by remotely operated vehicles.

Using ORE Catapult's controlled testing environment, Trelleborg was able to develop a test procedure to represent the pulling and locking of cables into an offshore foundation, under the same loads potentially experienced during offshore installation. With the Catapult's support, Trelleborg installed a simulated testing foundation into the dock, using a crane and winch assembly to replicate a cable-laying vessel.

As a result of the test, Trelleborg was able to successfully perform eight full-scale wet tests of NjordGuard™, covering a range of installation scenarios, without the associated time, effort and costs of going offshore.



JDR CABLES

HV LABORATORY

Tailored electrical testing for the next generation of offshore wind array systems

As offshore wind farms increase in size and capacity, the demands on the subsea cables that connect the turbines and substations become greater. By doubling the voltage of the industry-standard 33kV inter-array cable, subsea cable manufacturer JDR's pioneering 66kV technology allows increased transmission between turbines at higher-capacity wind farms: a vital factor in reducing the cost of offshore wind.

To bring its technology to market, JDR chose ORE Catapult's high voltage laboratory to provide electrical testing throughout its development, qualification and type testing programme.

As a long-term test partner of JDR, we developed a bespoke facility to validate and de-risk the new cables. The development, qualification and type testing programme was inherently collaborative: the supply chain, developers and other stakeholders played key roles.

After the unveiling of the new cables in July 2016, what happened next was unprecedented. JDR was awarded its first 66kV array cable contract, to manufacture over 20km of cables for the 92.4MW European Offshore Wind Deployment Centre in Aberdeen Bay. April saw further success for the cable manufacturer, with a contract to supply 155km of 66kV cables at ScottishPower Renewables' €100 million East Anglia One – a project that will see the world's first commercial deployment of the technology. The order represents a sure sign that offshore wind markets see value in – and are ready to step up to – 66kV array systems.

The benefits – in reducing technical, commercial and project costs for the offshore wind industry, in UK supply chain content, and in creating jobs – have already been enormous, and they haven't yet been fully realised. This is a UK-forged success story that has the potential to keep getting bigger.

▲ OEMs ▲ Tier 1 Supply Chain

3%

Upgrading to 66kV inter-array cables has the potential to bring about a 3% reduction in the LCoE of offshore wind

MATERIALS LABORATORY

The UK's only open-access, UKAS-accredited laboratory for electrical ageing and materials analysis

Electrical infrastructure makes up almost a fifth of the lifetime costs of an offshore wind farm. This, coupled with insurance claims arising from cable failures, makes electrical systems and associated materials a leading area for technology research and innovation to drive down the cost of energy.

That's why we've invested in upgrading our state-of-the-art, open-access laboratory for the testing of high voltage insulation materials. The lab has recently been refurbished and enhanced with a cutting-edge suite of systems, helping our scientists carry out atomic-level analysis of the materials that make up offshore power systems.

It makes the Charles Parsons Technology Centre the only open-source, UKAS-accredited facility that can carry out the full ageing and materials analysis workflow under one roof.

During the design and development of the 66kV cable system, JDR commissioned ORE Catapult to carry out highly-accelerated life testing, followed by a thorough package of tests that included detailed analysis of the new cable's insulation layer. To conform to international standards, these tests must be undertaken within 15 minutes of the cable being cut after it leaves the water in the ageing tank. Having the electrical and materials laboratories under one roof provides a unique facility for this.

We're trusted by large-scale, multi-national utilities and smaller companies alike to provide materials assessment for projects ranging from kW to multi-MW-level in scope.

That versatility, combined with an unrivalled depth of expertise and experience and our open-source nature, is why the world's leading cable manufacturers choose us to test, demonstrate and validate their new products.

▲ OEMs ▲ Tier 1 Supply Chain

15min

Hot set testing must be completed within 15 minutes of a cable leaving water. Our facility is uniquely positioned to perform this

“

ORE Catapult's testing facilities, and their capability and expertise, were vital in allowing us to move to 66kV inter-array power supply – a key driver in ensuring future offshore renewable energy developments are cost-effective and reliable.”

Jeremy Featherstone

Product Development Director at JDR Cable Systems



WAVE & TIDAL

The UK has around 50% of Europe's tidal stream energy resource - potentially 30-to-50 gigawatt (GW) of installed capacity, or enough to supply around 20% of the UK's current electricity demand, although significant cost reduction through innovation will be required to make this resource affordable.

We support the key market challenge of reducing the cost of energy - a challenge that encompasses proof of concept, demonstration, and de-risking. We are helping to effectively evaluate new technologies both at the device and component level, de-risking existing solutions that have yet to be fully proven using our test and validation services.

The UK achieved a milestone in 2017 when ORE Catapult client MeyGen, the world's first commercial tidal stream project, began supplying power to the grid in northern Scotland.



MEYGEN SECONDMENT

Demonstrating deep technical expertise to strengthen relationships

ORE Catapult has worked with tidal developer Atlantis Resources for several years now. Having tested its AR1000 machine at our 3MW drive train facility in Blyth, Atlantis Resources returned in 2016 to test its next generation AR1500 turbine - the series that has been installed at MeyGen, the UK's first tidal array.

The MeyGen project, which is 100% owned by Atlantis, is located in the Inner Sound of The Pentland Firth in Scotland and is the largest planned free stream tidal energy project in the world. When fully operational it is estimated that 42,000 Scottish homes will be powered each year and 122,455 tonnes of CO2 will be offset per annum.

In 2016, our relationship with Atlantis was strengthened further, when two ORE Catapult engineers were seconded into the MeyGen project to provide specialist engineering support to the team in Edinburgh. This secondment enabled MeyGen to access strong technical and commercial expertise, an in-depth knowledge of tidal technology and management of specific scopes of work as part of the two different project phases. It also offered a real insight into the challenges associated with such a project, and proved extremely beneficial to both parties.

ORE Catapult's deep technical expertise, allied to its unparalleled test and demonstration capabilities, have proven critical enablers of MeyGen's progress towards delivering the world's first commercial tidal energy array.



NOVA INNOVATION LTD

ORE Catapult and Nova Innovation join forces to win flagship €20.2 million European tidal energy project

ORE Catapult is part of a major new European tidal energy project along with a consortium of nine leading industrial, academic and research organisations, led by Scotland-based tidal energy leader Nova Innovation.

This game-changing SME is in the process of proving that tidal energy can compete with other sources of renewable energy, including offshore wind. ORE Catapult began working with Nova Innovation in 2013 and the relationship has flourished since then, to cement Nova Innovation as a key account for the Catapult's wave and tidal team.

In 2016 Nova Innovation scored the world's first grid connected tidal array in the world, delivered with 80% Scottish supply chain content. We partnered with Nova Innovation on a European funding bid, and successfully won the largest EU-funded ocean energy project to date. This five-year, €20.2 million flagship project called 'Enabling Future Arrays in Tidal' (EnFAIT) involves nine EU partners, and will scale-up the existing Shetland Array to six turbines, making it the largest tidal array in the world. It will periodically reposition the turbines to explore the optimum layout for the array to operate most efficiently.

This project will prove that the reliability and availability of tidal energy arrays can be increased significantly and ORE Catapult will use sector-leading computer modelling software to demonstrate that the project could reduce the cost of tidal energy by 40%.

“

Our relationship with ORE Catapult has gone from strength to strength, and the support we've received from the team has been invaluable in winning the bid for the EnFAIT project, in what was a very competitive call. We are looking forward to achieving further world-class results, working with the Catapult team and the other consortium partners. ”

Simon Forrest
CEO, Nova Innovation Ltd

40%

ORE Catapult will use sector-leading computer modelling software to demonstrate that the project could reduce the cost of tidal energy by 40%

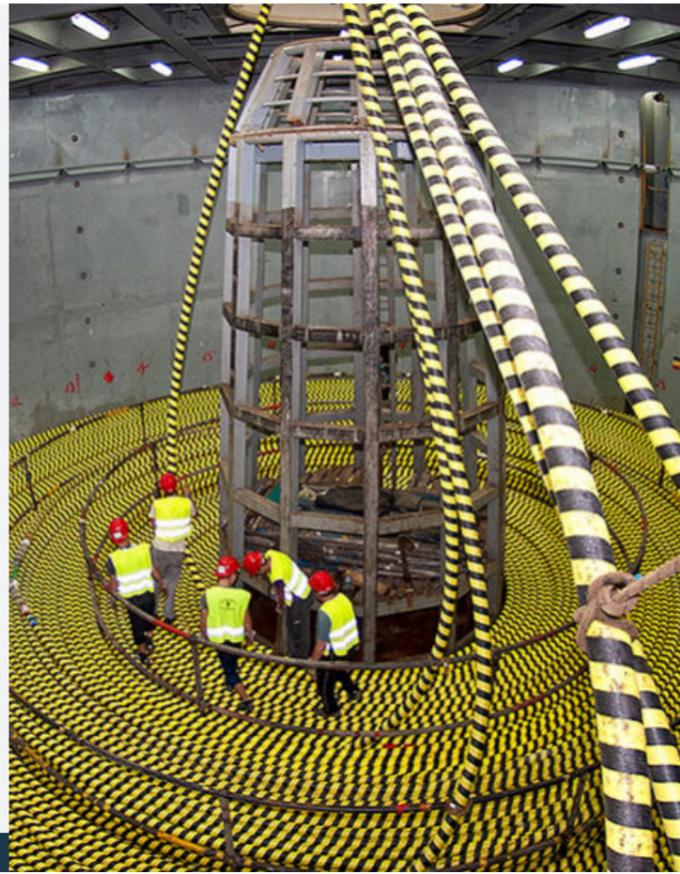
RECODE

Development and demonstration of critical components for monitoring, control and electrical connection for reliable Ocean Energy Arrays

The RECODE project, in collaboration with project partners Tecnalia, Zunibal, Ditrel, WavEC, Smartbay and Cluster, aims to answer the challenge of identifying common components in ocean energy technologies by developing a set of industry-enabling cost effective components, specifically designed for reliable and sustainable delivery of ocean energy.

These components comprise a safety monitoring and control device, a wave measurement buoy, an umbilical cable monitoring device and an underwater device-to-cable connector for a floating energy converter. Ocean energy technologies are moving steadily from laboratory scale models to real scale prototypes and arrays of converters.

Delivering reliable and cost-effective technologies will be paramount to the ultimate commercial success of Europe's ocean energy industry and therefore identifying common components will help reduce costs by driving down both capital expenditure (CAPEX) and operational expenditure (OPEX), and ramping up volume manufacturing.



▲ OEMs ▲ Tier 1 Supply Chain

TECHNOLOGY ASSESSMENT PROCESS (TAP)

An integrated evaluation and development pathway for early stage wave and tidal technology developers

Following the launch of our Technology Assessment Process (TAP) last year, our marine experts have worked with developers across a range of disciplines to understand key uncertainties and risks associated with costs and performance.

This approach significantly de-risks technologies before they reach prototype testing stage and allows developers to focus on the areas which are most important, resulting in a cheaper, quicker and more focused development pathway.

The TAP methodology is designed to track progress, and build evidence of performance as technological ideas progress from one stage of development to another. In the last year we have successfully taken four companies through the TAP process, with a further 10 companies already in the process, or building the process into grant requests for technology funding.

▲ OEMs ▲ SMEs

MARINET2

Subsidised rates for wind, tidal and subsea testing at ORE Catapult

MaRINET2, the Marine Renewables Infrastructure Network, is composed of 39 organisations aiming to accelerate the development of wave, tidal and offshore wind energy technologies and infrastructure by opening up access to 57 test facilities across 13 European countries.

The project is supported by the EU's Horizon 2020 programme and provides companies and researchers with funded access to marine energy experts and the world's leading offshore energy test facilities.

ORE Catapult has committed three facilities to the project, each equipped to support the testing, development and research of wind, wave and tidal technology. Within these facilities, we have the following assets:

- 50m blade test facility
- 1MW powertrain test rig
- HV electrical networks - for component testing
- Materials laboratory
- Marine and subsea test facility

▲ OEMs ▲ Tier 1 Supply Chain ▲ SMEs

CORPORATE SOCIAL RESPONSIBILITY

Health and Safety/Standards

We are delighted to have had our quality and environmental management systems re-certified to the revised international standards ISO 9001:2015 and ISO 14001:2015 respectively. These certifications, together with that for health and safety (OHSAS 18001:2007) and the organisation's ISO 17025:2005 accreditation, demonstrate the robustness of the company's management systems that ensure best practice in the solutions and services it provides to all our stakeholders, both internally and externally.

We recognise that effective management systems and a comprehensive resource base provides a solid platform for continual improvement, and that a strong organisational culture will further strengthen our position. As a result, we have embarked on a culture-based safety (CBS) programme that will ultimately lead to us becoming a learning organisation. With the programme, our leaders will drive a culture of best practice and safety for everyone within the organisation.

Our commitment to health and safety was further strengthened with the delivery of a 5S workplace organisation methodology to improve efficiency and safety across the business. We continued to drive a strong health and safety ethos, using our CEO HSE

committee, our monthly business update and by placing health and safety at the forefront of all agendas, to further support and embed our SHEQ performance and culture.

Developing our people

At the core of our organisation are people with world-leading skills across research, projects and services that focus on providing cost reduction and value to industry, both now and for the future needs of offshore renewable energy. Significant developments include our apprenticeship programme that has produced three multi-skilled technicians, who now deliver some of the world's largest test programmes. We have also recruited two new apprentices.

Elsewhere, our PhD programme continues to thrive, with six projects currently covering a diverse range of highly relevant topics, including health and structural monitoring, dynamic cables, HVDC transformers and economic analysis of maintenance costs. In addition, we have supported internships, giving six placements to students in our Glasgow office, who have worked on live engineering projects and challenges to develop both their studies and professional experience.

Education

We continue to successfully deliver across a wide range of Corporate Social Responsibility activities, with a particular focus on Science Technology Engineering and Maths (STEM), supporting and delivering lessons and events across 13 schools, as well as hosting three separate engineering work experience weeks.

We sponsor a STEM engagement officer at Levenmouth Academy, and a new STEM hub in Blyth, supporting local schools and communities in the areas local to the Catapult. In addition to STEM, we are involved with the North East Local Enterprise Partnership's Enterprise Advisor programme, and are now linked with a local secondary school in Ashington, helping to develop the school's links between its pupils, teachers and local industry.

We have also supported the communities around our 7MW Levenmouth Demonstration Turbine through educational and training programmes delivered through local educational bodies, including Fife Council, Fife College, Levenmouth Academy and the Energy Skills partnership. These programmes support local young adults to move on to further and higher education and provide a unique curriculum to ensure local training programmes deliver employment-focused, in-demand skills to local people.



▲ 2016/17 apprentices with Test & Validation Director Tony Quinn

DRIVING INNOVATION



Steve Wyatt
Research & Innovation
Director

“

The next generation of offshore wind turbines, taking the industry norm beyond today's 8MW+ machines, will substantially reduce the levelised cost of energy. The development of these new turbine platforms is a significant investment, so leading turbine OEMs will need to partner with all parts of the supply chain to share development cost and risk. Competition, and the sheer scale of the challenge, means OEMs must access new technologies from all corners of the industry, providing opportunities for innovative UK companies to enter the supply chain - often for the first time. At ORE Catapult we work to de-risk these emerging technologies, and link supply chain new entrants with those developing the next generation of wind turbine.

Our strategic research programmes in the areas of Blades, Drive trains and Electrical Systems aim to fill the knowledge gaps which exist in our sector. Through a better understanding of how these sub-systems perform we are able to develop better testing and validation techniques, helping industry to design better turbines and developers to solve in-service issues facing today's wind farms. I believe this winning combination of highly innovative supply chain players and our strategic research creates the means to bring forward disruptive UK innovations to the global turbine market, drive down cost and drive up UK value. ”



INNOVATION CHALLENGE PROGRAMME

Creating a path to market for the most innovative UK companies

Our Innovation Challenge programme is the interface between technology innovators and the wider offshore renewables industry. The aim of the programme is to uncover the needs of the industry and to share them with as wide a group of innovators and solution providers as possible, with the aim of stimulating the development of game-changing technologies within the UK supply chain that solve real-world challenges and reduce costs for the sector. We have created a set of targeted challenges across the main technology areas including turbines, O&M, substructures and electrical systems.

Developed and refined over the past three years, the programme is now the go-to location for any innovator looking to address the challenges of the sector. What makes it so attractive is that we have worked hard to gain the trust of the renewable power generation asset operators and turbine manufacturers, enabling them to share their prioritised 'wish list' of innovation challenges, which are anonymised and then advertised to the Catapult's extensive network.

Innovators, both from SMEs and high growth companies, who apply to the programme are taken through a structured process, starting with an initial assessment of the technology concept and its relevance to the challenge being addressed. The Catapult will then help to identify a route to commercialisation including funding (if required), and will bring in the partners needed for a collaborative R&D project that solves the challenge. If the project is successful, introductions will be made to end-users to help bridge the final gap towards commercialising the concept.

▲ OEMs ▲ Tier 1 Supply Chain ▲ SMEs ▲ Academia

INNOVATION HUB

Turning the spotlight onto sector innovation priorities

During January 2017, funding was announced for the Offshore Wind Innovation Hub (OWIH), a four-year programme to coordinate UK innovation activities in offshore wind.

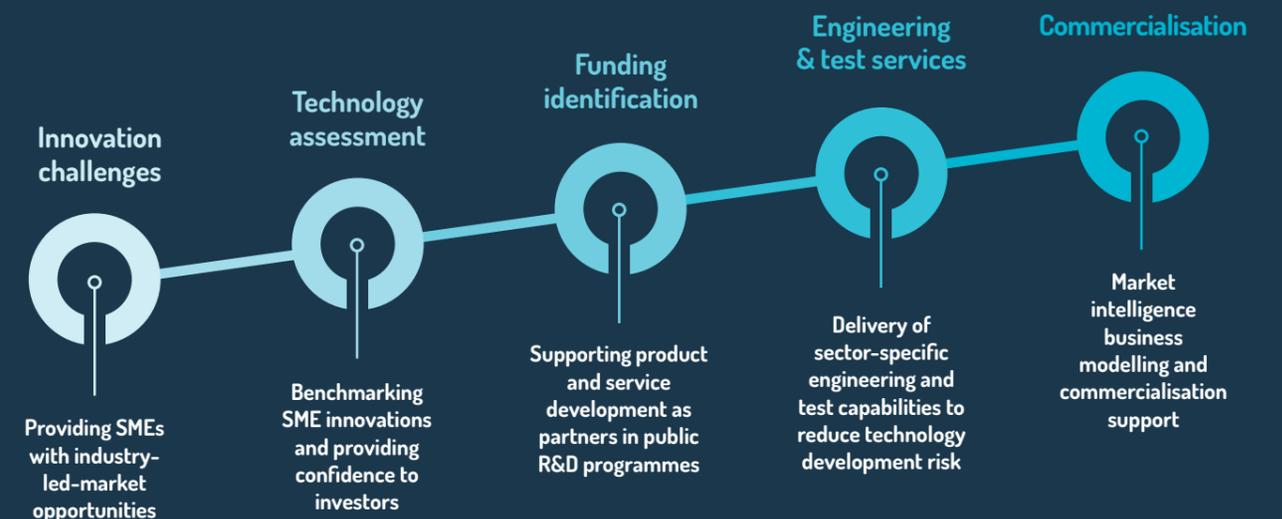
The programme will see collaboration with Innovate UK's Knowledge Transfer Network to provide a holistic and cooperative approach across the UK's offshore wind innovation sector. OWIH will operate as the primary coordinating body for offshore wind innovation and will identify main sector priorities, scope and maintain road-mapping of innovation priorities, and disseminate project and programme outcomes while showcasing innovators and coordinating international programmes to allow for global engagement.

In a short period of time, OWIH has already seen significant mobilisation with the development of a key strategic vision for the hub, its first programme the Offshore Wind Innovation Exchange (OWIX), the establishment of a technical advisory group comprised of senior industry representatives, and provision of support to sector innovators with regard to a recent Innovate UK Infrastructure systems call. Looking forward, we see OWIH as a key component of continued innovation offer within the sector.



▲ OEMs ▲ Tier 1 Supply Chain ▲ SMEs ▲ Academia

Commercialising technology with SMEs



MAKING A NATIONAL IMPACT

The implementation of our Regional Engagement Strategy, outwith our primary operational locations, began in 2014/15 with a series of visits to regions of the UK with strong and growing supply chain strengths in the sector. From this we formed working partnerships with LEPs, universities and the Welsh Devolved Administration, and have developed and continue to grow a range of activities tailored to the strengths of each region.

The Regional Coordinator ensures that all ORE Catapult's resources are available to offshore renewable energy device developers and supply chain companies to support the innovation that the industry needs to reduce costs and risk.



Wales

In a notable accomplishment for the programme, in 2016 the Welsh Government agreed to renew the service contract for our Regional Coordinator.

This renewal provides a strong indication of the value of our activities and impact to date. We continue to support the Welsh European Funding Office (WEFO), to help ensure that their €100 million funding for marine energy is delivered effectively. This has a particular emphasis on securing supply chain benefits from the two Crown Estate-approved demonstration zones in Wales (wave demo zone in south Wales/the south west and tidal demo zone in north Wales).

Significant activity has taken place to develop a Marine Energy Engineering Centre of Excellence (MEECE), to be based in Pembroke Dock. This culminated in March 2017 with MEECE being selected as a key project that

will benefit from the Swansea Bay Region City Deal. This has in-principle agreement from the UK Government and Welsh devolved administration for overall funding of £1.3 billion. MEECE is a partnership with Cardiff and Swansea Universities, the Port of Milford Haven and Marine Energy Wales and is envisaged as a five-year, £10 million project, employing up to 22 people.

Hull

Our activity in the Humber region gained traction in 2016/17, culminating in the launch of an offshore wind O&M Centre of Excellence in Hull.

This £2 million collaboration between the Catapult and the University of Hull will see a series of research and innovation projects developed to improve the way offshore wind farms are operated and maintained, building on the region's energy heritage, location and experience of servicing UK offshore wind farms.

O&M activities make up almost a quarter of the lifetime costs of an offshore wind farm, providing a huge opportunity for UK companies to supply their products and services.

Anchoring this Centre of Excellence to the Humber region is a valuable addition to the growing offshore wind industry regionally, nationally and globally and provides an excellent opportunity for innovation and collaboration across the O&M supply chain.

Solent

We are supporting the Isle of Wight Council to re-launch the Solent Offshore Renewable Consortium (SOREC). We helped secure European Regional Development Fund (ERDF) funding for a £4 million SME technology innovation programme for the region – the Innovation Network.

South East - SCORE2

As a direct result of our regional engagement in the South East of England, we are partners with Orbis Energy, based in Lowestoft, in the £6 million Supply Chain in Offshore Renewable Energy "SCORE2" project. Since the project's inception in July 2016, over 50 SMEs have already been assisted, with the Catapult taking the lead on 13 SME applications for support. This project will distribute innovation grants to around 200 SMEs and we will be developing Innovation Challenges for the regional SME market players.

South West

Our presence in the south west of England has opened up other exciting opportunities, such

as Marine-i, which is providing support to marine businesses in Cornwall and the Isles of Scilly.

Up to £6.8 million of European Regional Development Funding (ERDF) has been secured as part of a £9.3 million programme to develop marine technology research, development and innovation activities in the region.

The project is a collaboration between ORE Catapult, the universities of Exeter and Plymouth, The Cornwall College Group, Cornwall Marine Network and Cornwall Development Company to enable the generation of new innovation in Cornwall and the Isles of Scilly's marine sector, which has been identified as an area of high growth potential.

It will focus on four interconnected themes:

- marine energy
- marine manufacturing
- maritime operations
- marine environmental technologies

Marine-i also forms part of the Marine Hub Cornwall sector collaboration, which aims to showcase Cornwall as a world-class centre for marine renewables technology.

At the heart of the Marine-i is a £3.18 million Marine Challenge Fund offering a range of grants from £5K to £150K – a dedicated scheme that has been specifically designed to drive marine sector research, development and innovation.

Further activities are also planned to encourage and enable businesses to gain access to the region's key research and development and innovation assets, facilities, knowledge and expertise required to develop new and improved products, improve business processes and downstream applications, which will create well-paid, skilled jobs.

ORE Catapult's involvement in this high-profile project is a major success for the business, as it clearly demonstrates our grounding in the south west, while opening up potential for further collaboration with key regional partners, and the project itself is a good fit with our ongoing SME engagement activities.



INTERNATIONAL

International activities have been a key focus for us, and in a relatively short space of time we have come to be regarded as an equal partner in international networks dominated by research and technology organisations with long involvement in the sector.

EU energy strategy regarding offshore renewables is particularly important as it influences the market and the direction of technology development, and therefore impacts upon our goals and activities. We have made it a priority to be connected at the right level with UK and EU decision makers regarding R&D in offshore renewables to ensure access to competitive public funding and to guarantee alignment of our activities with industry and the research community.

We are party to a number of international organisations, including the European Energy Research Alliance, Ocean Energy Europe, TPWind, European Marine Energy Centre and the International Energy Agency. We have used our position in these fora to influence the international research agenda in ways that align with the priorities of UK industry, for example by contributing to and commenting on the draft strategic plans that ultimately are adopted by the European Commission as the guiding documents for the H2020 research programme.

The International Energy Agency (IEA) is a key reference for our R&D activities, since it is the leading initiative to develop

a collaborative international R&D programme focused on different energy technologies. Likewise, participation in TPWind activities gives us an opportunity to engage with the European industry, ensuring that our strategy is aligned with the priorities defined by the main industrial stakeholders.

The most significant future opportunity to access European funding is Horizon 2020 (H2020), the largest European research and innovation programme. H2020 has nearly €80 billion of funding available for 2014 – 2020. Climate change mitigation, security of supply and competitiveness are driving H2020, with renewable energy one of the key elements responding to all the dimensions of the challenge.

Achieving our ambitions for H2020 is critical to reaching our competitively won public funding target, but the benefits of H2020 go beyond the revenue generation. The European R&D and innovation projects are a unique opportunity to engage with European industry and to develop our technical and research capabilities.

ORE Catapult has directly helped create projects with a cumulative value of:

Region	Project	Overall value	Catapult contribution
CORNWALL	Marine-i	£9.3m	£473k
NEW ANGLIA	SCORE 2	£6m	£120k
HULL	O&M CoE	£2m	£1m
SOLENT	Innovation Network	£4m	£100k
WALES	MEECE	£10m	£1m
TOTAL		£31.3m	£2.693m

note this excludes any subsequent revenue generation

FORWARD LOOK >>



The direction of our industry is clear: costs for offshore wind are coming down; turbines are getting bigger; there is a requirement to dramatically improve how we operate windfarms, and opportunities to bring forward a new generation of science and technology-led innovations to disrupt the status quo. The role for ORE Catapult is to ensure that the UK is the best place to develop the new products and services required to underpin this exciting future.

We are investing further in our state of the art testing assets, technical skills and links to UK-based innovators to develop 10MW+ turbines

Validating next generation turbine technology

Our industry is accelerating towards 10, 12, even 15MW turbines. Larger turbines mean major technology development programmes costing several hundred million pounds. The development and validation of these supersized machines requires new testing protocols, more accurate models and an ever deeper understanding of mechanical behaviour and materials used. Over the coming months we are investing further in our state of the art testing assets, technical skills and links to UK-based innovators to develop 10MW+ turbines.

Levenmouth networks and storage

The future shape of our energy network is key for offshore renewables. With cost rapidly disappearing as a barrier in the minds of policy makers, thoughts turn to ensuring our electricity system is appropriate for mass deployment of renewables. We are working with Fife Council, Scottish Government and the Energy Systems Catapult to develop a future energy network demo zone around our Levenmouth turbine. This will help us to understand how we can best integrate the mass deployment of offshore renewables into the UK's energy mix.

In the coming year we will place even more dedicated resource behind this successful programme

Further investment in our Innovation Challenge programme

UK SMEs are the engine room of future technologies. Our role in drawing forward these innovative, agile companies has never been more important. At ORE Catapult we have a firm grasp on which technology areas will be key as we move towards subsidy free offshore wind. Our Innovation Challenge programme plays a key role in directing innovators to the biggest opportunities and challenges in our sector. In the coming year we will place even more dedicated resource behind this successful programme, and work closely with UK Government to ensure the financial support is in place for these companies to sit alongside the technical expertise we provide.

International

With our relationship with Europe looking uncertain for the next few years, we are also looking further afield to China and the US. We already have a dedicated programme looking at both research collaboration and supporting SMEs looking to work with these emerging offshore renewables markets. Our friends and colleagues in research centres around Europe remain as important as ever, and regardless of any bumps in the road ahead we are confident that, with our increased efforts, these alliances will strengthen in the year ahead.

The new hubs will see up to £5 million of targeted research funding for offshore renewables, on top of the £2.3 million already committed for blades

Academic research hubs

Some of ORE Catapult's boldest plans lie in the new Research Hub network we are creating. Building on the success of our Blades Hub with the University of Bristol, we will establish further strategic partnerships with leading universities in the areas of electrical systems and drive trains. The new hubs will see up to £5 million of targeted research funding for offshore renewables, on top of the £2.3 million already committed for blades.

Building our regional engagement

Next year will see ORE Catapult establish a new office in the Humber region with a special focus on O&M. This sits alongside our presence in Wales, Cornwall and the South East. Working with Local Enterprise Partnerships our focus on place is very important as we help the UK realise the opportunities that offshore renewables brings, often to the areas that stand to benefit most from the jobs and growth our sector can provide.

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