CATAPULT
Offshore Renewable Energy

RE ENERGISE

#4 SPRING 2021

CIRCULAR ECONOMY: OFFSHORE WIND'S SUSTAINABLE FUTURE

GOING CIRCULAR: AN UNTAPPED OPPORTUNITY

Increasing sustainability in offshore wind

ACHIEVING NET ZERO

The importance of a cross-sector circular economy

FUTURE-PROOFING BLADE DESIGN

Is bigger really better in a circular economy?

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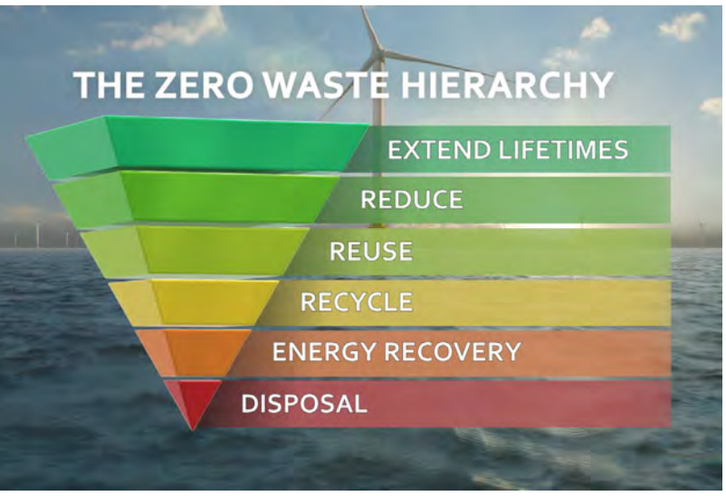

Launching this spring, the Circular Economy in the Wind Sector JIP (CEWS JIP) is led by ORE Catapult in partnership with the UK's foremost regulatory, research and investment bodies.

We are leading cutting-edge research and technology innovation to find sustainable decommissioning solutions for wind farms and support the creation and growth of UK SMEs in tomorrow's circular economy.

Get ahead of the game and join us today

ORE.Catapult.org.uk/CIRCULAR
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WELCOME

GUEST FOREWORD

DR ANNE VELENTURF

RESEARCH IMPACT FELLOW IN CIRCULAR ECONOMY AND OFFSHORE WIND AT THE UNIVERSITY OF LEEDS

Offshore wind's spectacular growth continues apace. At the same time, first-generation turbines are starting to reach the end of their service lives. This wave of new construction, combined with mass decommissioning, presents the industry with fresh challenges in how it manages its resources.

How can we sustainably secure the huge volumes of materials required? And how do we manage components and materials in line with sustainability and zero waste ambitions? There is a stream of exciting research and technology innovation underway in the UK that will turn these challenges into new business opportunities.

A circular economy is about making better use of products, components and materials. Grounded in sustainability thinking, a circular economy aims to improve environmental quality and social well-being while maintaining economic prosperity.

It also opens exciting prospects for increased local supply chain content and high-skilled job creation, both directly in offshore wind but also in the cross-transfer of technology and know-how to other sectors too.

At the global scale, circular economy approaches could help to reduce global carbon emissions by 63% by 2050 while opening $25 trillion in new business opportunities. To realise these opportunities, we will need technology innovation and research and far greater integration of policies and regulation on energy, resources and waste, and infrastructure planning.

UK policy is increasingly embracing circular economy because of its fantastic ability to deliver environmental, social and economic benefits. The offshore wind sector must be at the heart of these discussions, which will balance the costs and benefits of new circular economy practices for stakeholders along the offshore wind value chain.

This edition of ReEnergise showcases offshore wind's innovative capacity and how the sector is embracing new circular economy approaches. In the following pages, you will find plenty of food for thought on the journey ahead.

Department for Business, Energy & Industrial Strategy

EUROPEAN UNION Investing in Your Future European Regional Development Fund 2007-13

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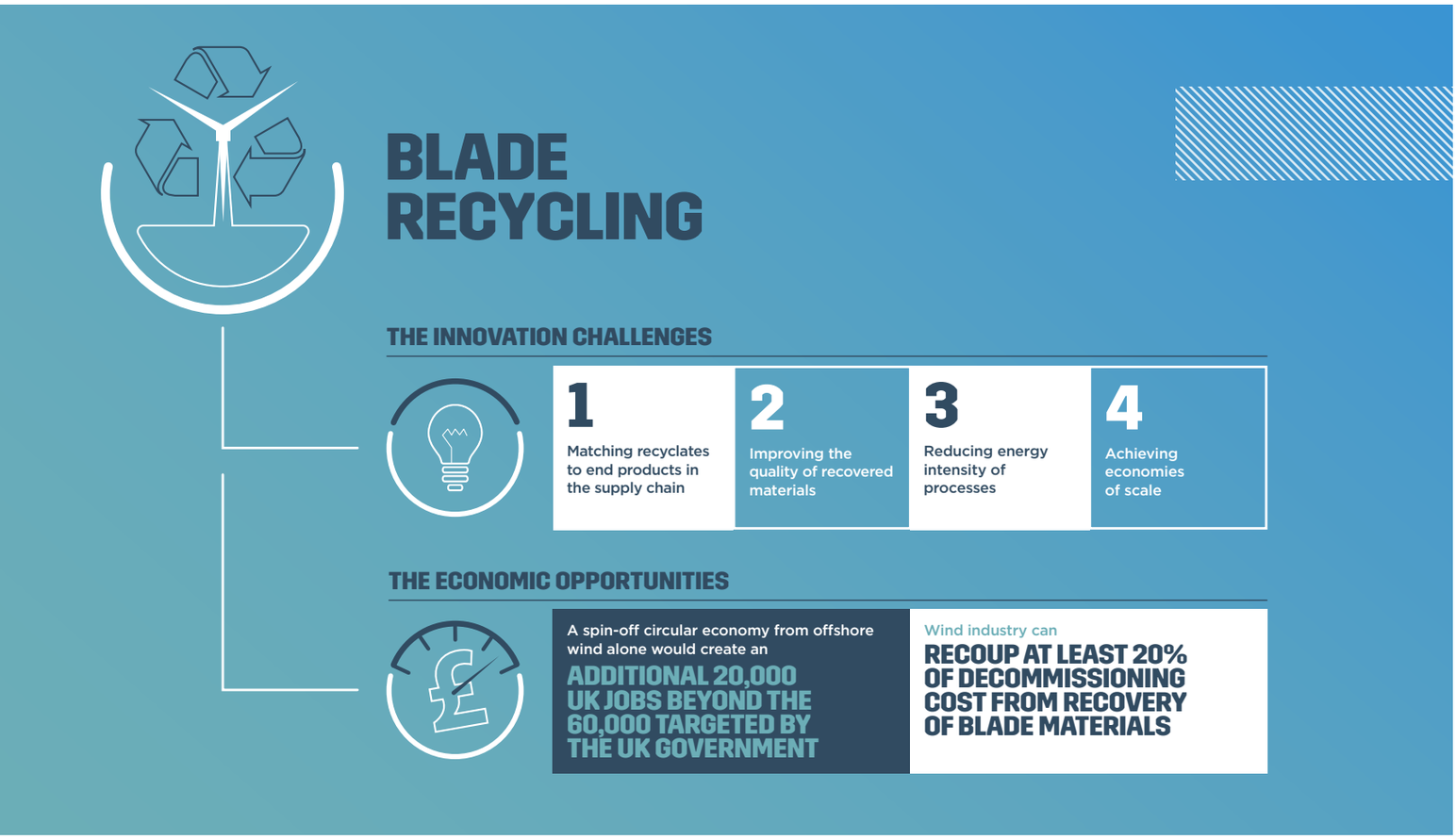

Blade recycling challenges and the economic opportunities of a circular economy approach.

GOING CIRCULAR:
AN UNTAPPED ECONOMIC OPPORTUNITY IN THE WIND SECTOR

Thirty years ago, it would have been hard to imagine that offshore wind could power every home in the UK. Today, that target is one of the key pillars of the UK Government's climate change policy. This vision has been driven by the passion of offshore wind's pioneers to forge an alternative to fossil fuels and make renewable energy a commercial reality.

And now, having achieved impressive cost reduction targets, our first-generation offshore turbines are approaching the end of their lives. These turbines do not just pose a practical question around their imminent disposal; they are also providing vital expertise for increasing sustainability for their successors. Last year, Vestas was the first manufacturer to pledge zero-waste turbines by 2040, and industry sustainability projects have rocketed over the course of the past year.

The environmental imperative to adopt circular economy practices is well documented and will be key if the UK is to meet its Net Zero targets by 2050 and kick start a green economic recovery post COVID-19. A new report from ORE Catapult on behalf of the Energy Transition Alliance (ETA), a collaboration between ORE Catapult and the OGTC, highlights the need to engage the UK supply chain and address low awareness of the growing opportunity in areas such as blade recycling, repowering and turbine life extension.

THE HARD FIGURES OF OPPORTUNITY

We estimate that by 2050, the global offshore wind industry will need to decommission as much as 85GW of capacity, and onshore wind will decommission 1,200GW. While these figures do not take into account innovation (assuming 25-year lifecycles will continue to be the norm), they provide an idea of the scale of the future circular economy in the sector.

Within two years, we will see 16,000 offshore wind blades being decommissioned, and without changes to core materials, that will reach 325,000 by mid-century. This brings us to the golden supply chain opportunity for the next decade: blade composite recycling as the beginning of a spin-off circular economy from the wind sector.

The ETA Blade Recycling Report shows that a solution for recycling these carbon and glass reinforced plastics is not yet on the table. And that goes not just for the wind sector, but for the many industries that use these materials in everything from car seats and surfboards, to aeroplanes and pipes. Those suppliers that can offer a good solution will benefit from a huge global market. But what do we mean by 'good'?

For adoption at scale, composite recycling processes need to make environmental sense (i.e., they should not be energy intensive or produce by-product pollution) and they should result in fibres and resins that are high enough quality to meet market demand. Ultimately, none of the available technologies today tick these boxes.

Through initiatives such as the ETA's Blade Recycling Project, collaboration on the SuSWind and Carbo4Power projects, and the new Circular Economy in the Wind Sector Joint Industry Project (CEWS JIP), the Catapult has an action plan for addressing this market need:

- Targeting an at-scale demonstration of blade recycling in the UK within five years through the CEWS JIP.
- Engaging the UK supply chain and academia in meeting innovation challenges outlined as essential to overcome for at-scale blade recycling. Ultimately, the success of a blade recycling drive will be judged by the saleability of end products that come from it and the quantity of virgin material avoided.
- Matching composite recyclates (carbon and glass fibres, resins) to end products, an approach so far missing from R&D in this area.
- Collaboration with other sectors that are working on their own composites challenges, e.g., through the UK's National Composites Centre (part of the High Value Manufacturing Catapult) and our Energy Transition Alliance with the OGTC.

INCREASING UK JOB CREATION TARGETS

While blade recycling is an obvious stopgap for the wind industry, solving the challenge of what to do with legacy materials is far from an end goal. With composite recycling, the industry will close its recycling gap (a turbine is already 85-90% recyclable in theory) and kick-start a supply chain in the UK that can extend to more advanced circular economy practices. These include extending components (through refurbishment, for example), reuse and remanufacturing, as well as designing out waste and tough-to-recycle materials from the start.

There are few UK companies in this arena, but that is set to change as the scale of the economic opportunity becomes clear around the ever-more ambitious sustainability targets of the industry, anticipated tightening of national and international legislation, and just the sheer scale of decommissioning ahead. Altogether, we estimate that a spin-off circular economy from the UK wind sector could generate an additional 20,000 UK jobs, beyond those already targeted by Government. See pg 11 for more information on some of the UK companies pioneering a circular economy approach in offshore wind.

WHERE NEXT?

Watch our latest video **Exploring Scenarios for a Circular Economy in Offshore Wind** and to find out more about our work in this area, contact: **CIRCULAR@ore.catapult.org.uk**

NATIONAL COMPOSITES CENTRE

Technology Driving Transition OGTC

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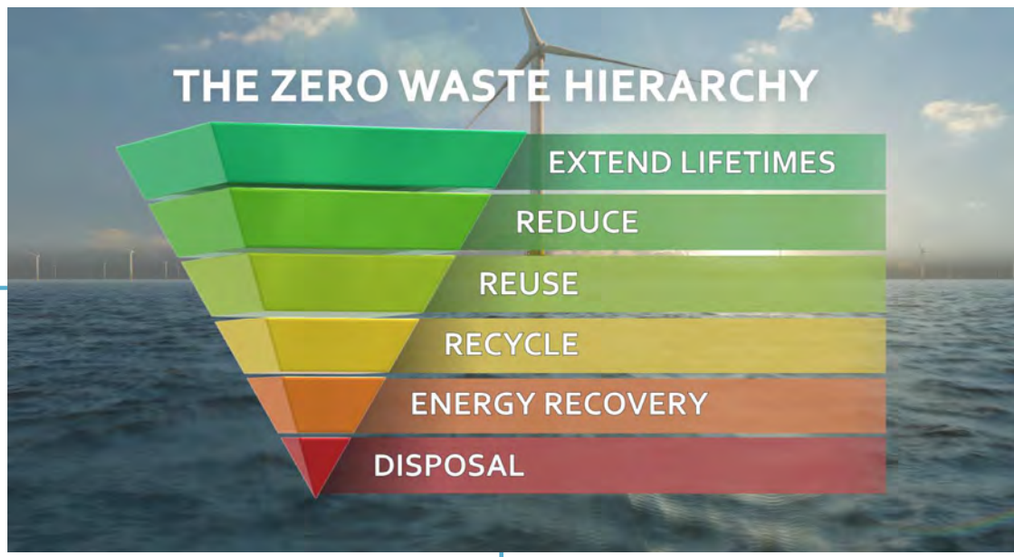


CIRCULAR ECONOMY IS FOR LIFE… NOT JUST FOR DECOMMISSIONING

ORE Catapult Project Engineer and Circular Economy Lead, Lorna Bennet, discusses the importance and benefits of a true circular economy approach in offshore wind.

In this issue of Re-Energise, we talk a lot about adopting a circular economy approach at the end of the turbine's life, through recycling, repurposing or reusing different components of the turbine. However, in order for the industry to fully commit to a circular economy, we must go beyond the end-of-life management of an offshore wind farm.

We must also work, at the same time, to future-proof technology for the next generation by building more environmentally friendly and sustainable end-of-life-management into the early design processes of, for example, turbine blades. To achieve the turbines of the future requires a significant shift in terms of technology and manufacturing, requiring new designs and adapting manufacturing processes.

One sustainable design approach that the wind industry is beginning to adopt is the use of easier to recycle thermoplastic composite materials in turbine blade designs, instead of the current difficult-to-recycle thermosetting polymers. This is the focus of our SusWIND project, in collaboration with the National Composites Centre (part of the HVM Catapult) and a consortium of industry partners.

SusWIND will discover and demonstrate viable ways to sustainably dispose of, or recycle, operational operational blades. It is also exploring the use of more sustainable materials and processes in developing composites for blades, reducing waste from the very beginning and innovating blade design to future-proof the turbine blades of tomorrow.

INVESTING NOW IN THE FUTURE OF OFFSHORE WIND FARM SUSTAINABILITY WILL HELP UNLOCK THE BENEFITS OF A CIRCULAR ECONOMY IN THEIR DESIGN, MAINTENANCE AND END-OF-LIFE PLANNING

LORNA BENNET
Project Engineer, ORE Catapult

Artist's representation of what our future wind turbines might look like.

Another important element that should be considered is design for upgradability and remanufacturing, ensuring that turbine components can be repaired and refurbished with parts that are easy to inspect, replace and even upgrade. Designing to be repairable – not replaceable – will help to sustainably maintain the different components of the turbine and significantly improve resource efficiency, while reducing the environmental impact of the products.

For example, within a gearbox there may be some elements that are likely to wear faster than the other components. Having the ability to replace only individual and small parts of the system instead of the entire component not only reduces the downtime and maintenance costs, it also drastically lowers the waste of replacing the whole gearbox.

Designing for necessity instead of excess will help the industry to reduce its waste in turbine operations and maintenance procedures. This, combined with preventative rather than reactive maintenance processes from robotics and autonomous systems, will help to scale-up the sustainability of the industry.

Finally, one sustainable design aspect that has already begun to highlight the economic and environmental benefits of a circular economy is the repowering of offshore wind farms. Turbines that were built 20 to 25 years ago had the average capacity of 1 to 2MW, meaning that a 30MW wind farm required up to 30 turbines – that's 90 blades that must be disposed of during the decommissioning of the wind farm.

However, the rapid scale-up of the offshore wind industry over the past decade has also coincided with a significant increase in capacity. A 30MW wind farm installed in 2021 would only require just three of the latest 9.5MW turbines being installed in wind farms today. Repowering is a potentially simple step towards a circular economy – reusing the wind farm's balance of plant components and reducing the amount of waste when it comes to the decommissioning.

Investing now in the future of offshore wind farm sustainability will help unlock the benefits of a circular economy in the design, maintenance and end-of-life planning of offshore wind farms for the next generation of sustainable products, accelerating the industry's mission to design out waste from the start and create thousands of jobs in the repair, remanufacture and recycling sectors.

ACHIEVING NET ZERO: THE IMPORTANCE OF A CROSS-SECTOR CIRCULAR ECONOMY

Earlier this month, as part of our ReEnergise podcast series, we spoke with two leading experts in sustainability from the Catapult Network: Lucy Edge, Chief Operating Officer of the Satellite Applications Catapult and Graeme Cruickshank, Chief Technology and Innovation Officer for the Centre for Process Innovation, part of the High Value Manufacturing Catapult. We probed a little deeper on the importance of adopting a circular economy approach across all industry sectors, including space, aerospace and automotive, as well as offshore wind.

RECYCLING COMPOSITE MATERIALS - THE LAST PIECE OF THE PUZZLE

For the wind industry, blades made from composite materials are powerful workhorses and make the clean wind energy we need a reality, but the benefits from composites are not solely reaped by the sector.

Lucy noted: "In the aerospace industry, composites lend themselves really well to developing many meters of very specific rigidity of structure but can also withstand extreme temperatures and G-forces. The next step, however, is understanding how we leave behind a sustainable legacy."

"Designing for end-of -life has to be the next phase in all sectors, including aerospace and offshore wind, as we can no longer turn a blind eye to the unintended consequences of creating a solution for one problem but leaving a carbon-fuelled mess for future generations to clear up" noted Graeme.

He added: "Composites were intended to be a good thing for the environment, reducing CO2 emissions by creating lightweight and durable materials for products such as vehicles, which allowed for more fuel efficiency and a lower carbon footprint. However, now we must address the end-of-life management for these composite materials to ensure a clean, green impression is left behind."

CATAPULT Offshore Renewable Energy
CATAPULT High Value Manufacturing
CATAPULT Satellite Applications

IT DOESN'T MATTER WHAT INDUSTRY YOU OPERATE IN; A NET ZERO, CIRCULAR ECONOMY IS COMING.

FUTURISTIC MATERIALS AND MANUFACTURING

The offshore wind industry has the opportunity to lead the way in creating a zero-waste economy for materials and manufacturing. With new materials and techniques such as ACT Blade's textile-based solution for blades or through additive manufacturing and 3D printing, the industry is pioneering a way forward in material advancements.

Lucy added that innovations in new materials should be partnered with novel approaches to the way in which we create things. "Within the space industry, early stage research is already underway on how best we can reuse the materials that we have already sent up to space, also known as space junk. Repurposing the man-made materials on these satellites and spacecraft not only provides raw materials for sustainable construction; it can also create a revenue stream to fund it.

Graeme also commented: "We need to design things to be repairable not replaceable. It's about understanding the value of a component long after its operational lifetime that is key to implementing a circular economy approach across all aspects of society."

ECONOMIC OPPORTUNITY OF A CIRCULAR ECONOMY

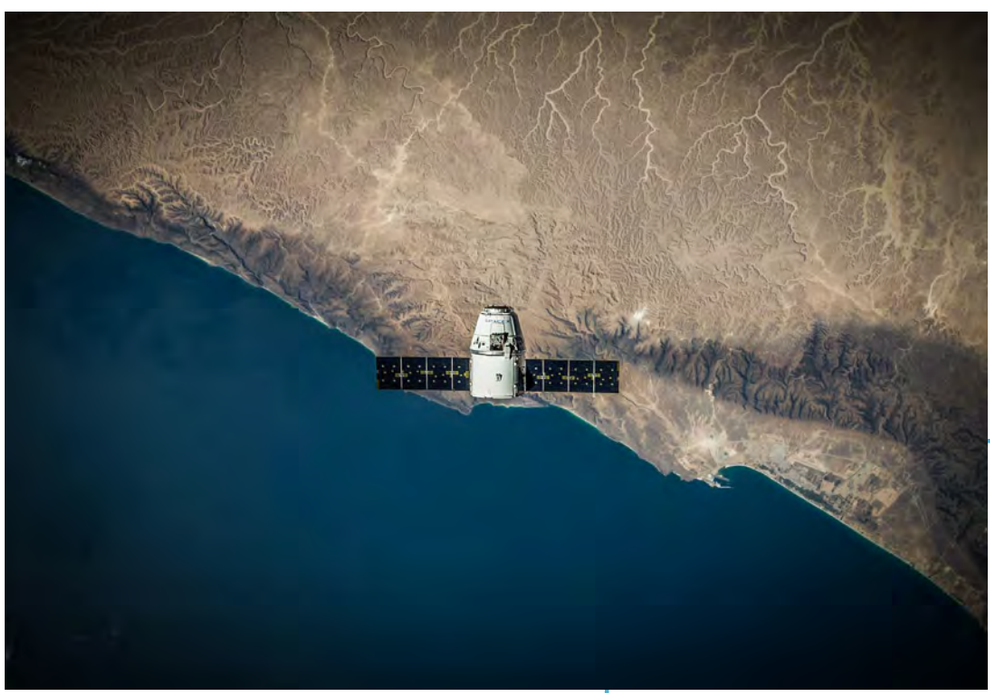
Adopting a circular economy approach presents a huge economic opportunity across the UK. The Energy Transition Alliance's latest blade recycling report suggests that if we can invest now in the birth of a circular economy sector, the UK can realise thousands of new jobs within this decade alongside exportable Intellectual Property (IP), services and technologies.

From the offshore wind industry's perspective, with the target to triple the number of green collar jobs in the industry to 27,000 jobs by 2030 set out in the Offshore Wind Sector Deal, this could easily be exceeded with the development of new markets and supply chains for repair, reuse and reclaimed components and materials.

Lucy added: "It doesn't matter what industry you operate in; a Net Zero circular economy is coming. Every space industry job will eventually be a circular economy job as this approach will affect all aspects of the sector and is the next step to reducing the sector's carbon footprint."

Graeme also noted that implementing a circular economy will also create new supply chains and new waste management sectors. "The waste product from one reaction is the feedstock of another and for that reason, the offshore wind industry can maximise its UK content, with a constant flow of refurbished, reused or recycled wind turbine materials in the UK for the next generation components, reducing both the volume and cost of new and imported materials required."

Listen to the podcast >

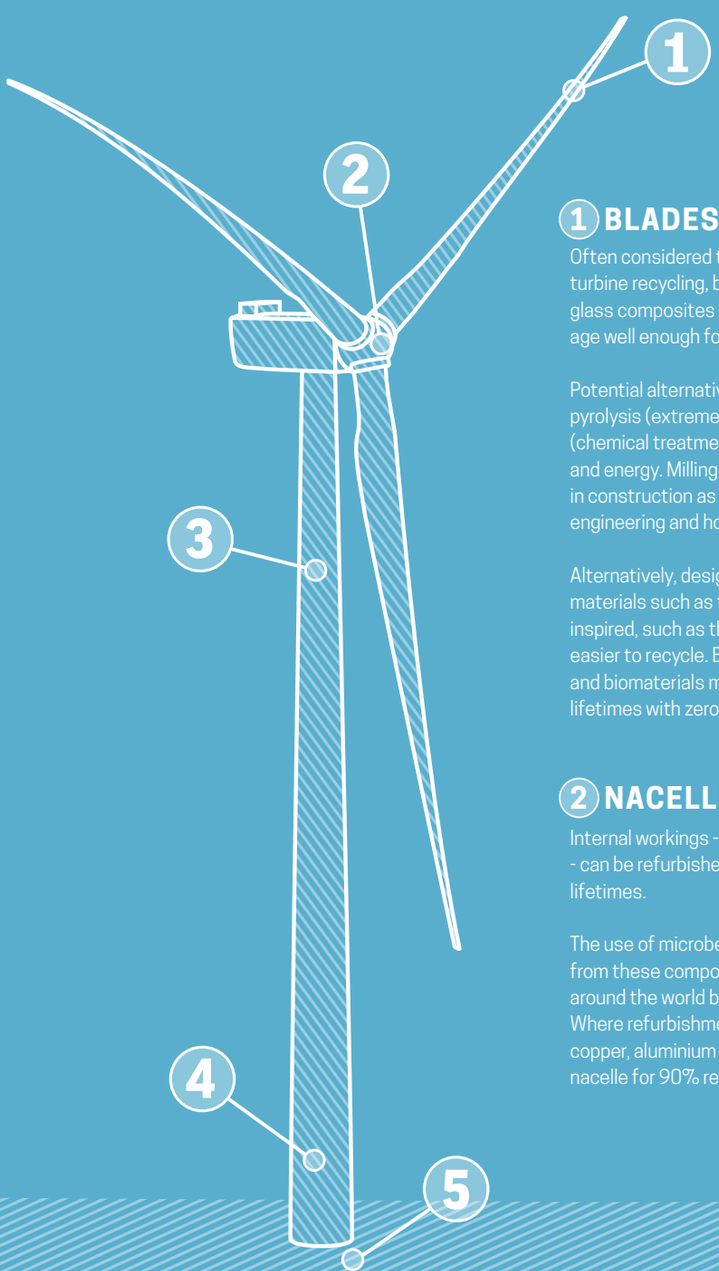


SpaceX
(Credit: Unsplash)

WHAT WILL MAKE UP A CIRCULAR ECONOMY TURBINE?

Turbine design is evolving rapidly, and the race is on to bring the biggest offshore wind turbines in production today to market. However, as the UK continues this green revolution and offshore wind becomes the country's largest producer of renewable energy , the sector must now look to creating a more sustainable and recyclable waste management approach.

The graphic below highlights the current practices in place for the disposal of wind turbines well as potential solutions to make these green giants just as sustainable in their end of life as they are when powering the UK.



1 BLADES

Often considered the stubborn final step in wind turbine recycling, blades are commonly made of fibre-glass composites that are hard to recycle and rarely age well enough for refurbishment and re-use.

Potential alternatives under consideration are pyrolysis (extreme heat treatment) and solvolysis (chemical treatment) to recover fibres, resins and energy. Milling and grinding blades for use in construction as well as using sections in civil engineering and housing are all now possible too.

Alternatively, designing out waste through novel materials such as the lightweight, stiffer textile-inspired, such as those being trialled by ACT Blade, are easier to recycle. By 2050, advances in self-healing and biomaterials mean that blades could live many lifetimes with zero waste.

2 NACELLE

Internal workings - such as generators and gearboxes - can be refurbished and guaranteed for second lifetimes.

The use of microbes for recovery of rare earth metals from these components is actively being investigated around the world but requires significant space. Where refurbishment is not an option, metals such as copper, aluminium and steel can be stripped from the nacelle for 90% recyclability.

3 TOWER

The turbine tower is the biggest and heaviest component, having doubled in height in the past 20 years. Finding lighter and more durable materials for multiple lifetimes is the priority. Concrete is being investigated as an option that could double a tower's lifetime, offsetting the higher CO2 emissions of its use.

4 MONOPILE FOUNDATIONS

Most turbines sit upon steel monopile foundations that can be lifted entirely from the sea floor for a pristine restoration of marine conditions. Most of this material can be recycled into good-as-new steel.

Repurposing monopile remnants into artificial rocky reefs is also possible as developed by Cornwall's ARC Marine.

By finding ways to extend the lifetime of steel and concrete in marine environments, we can also minimise disruption to sea life and reduce materials.

5 CABLES

Cutting and leaving cables in the seabed has been common practice for over a century with billions of pounds worth of valuable and reusable materials lying on the ocean floors.

These materials could be a rich mine of future cables. Recovered cables can be separated into metals and plastics by cutting and shredding the components.

The ultimate goal is to design them for longer lifetimes so they could be leveraged for a repowered site or be made from more sustainable materials.

ACT's blade being tested at the National Renewable Energy Centre, Blyth.

MEET THE CIRCULAR ECONOMY PIONEERS IN WIND

The Catapult is working with UK technology developers to highlight the future circular economy opportunities presented by the end-of-life of a typical wind turbine. The opportunity is a cross sector one - open to UK engineering companies, processing plants and shipyards, among many others. Inspiration can be found among some of the first, pioneering companies to enter this arena:

Renewable Parts, a company based in Argyllshire, Scotland, that is currently expanding its operations to meet growing demand from UK wind farms for its refurbishment of wind turbine components. They currently move 136,000 parts through their supply chain and divert 50 tonnes of waste from landfill per year.

ACT Blade is a spin-off from yacht-sail developer SMAR-Azure. Based in Edinburgh, the company has invented an alternative to today's blade using a textile-based solution for modular blades that can be potentially made from recycled materials. Currently in testing at a commercial site is its latest prototype, which is both 32% lighter than today's wind farm blades (cutting material use) and increases energy production by nine per cent.

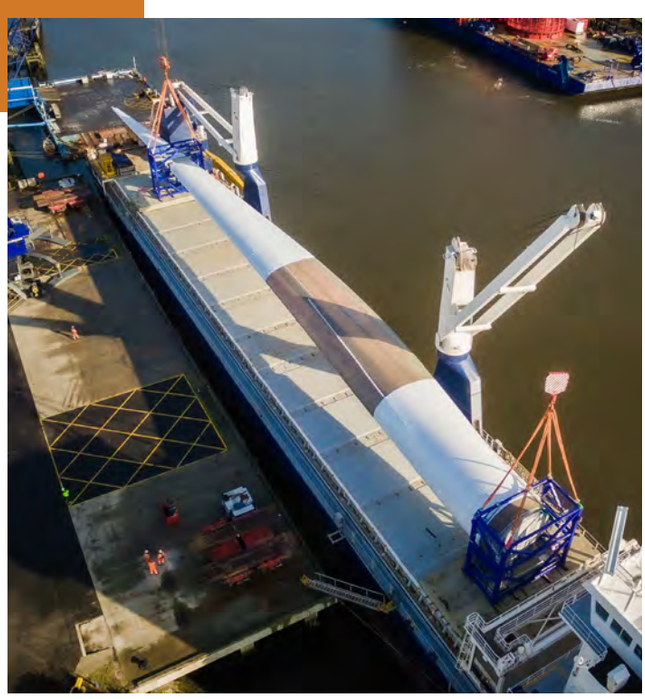
Greenspur, based in Hatfield, is pioneering a more sustainable alternative to rare earth magnets for turbine generators. While rare earth is a scarce resource and involves toxic processes in its mining, their ferrite solution comes at a lower cost and with a more sustainable and secure supply.

Cornwall's **ARC Marine** is currently trialling its Reef Cubes®off the Cornish coast. Built from 98% recovered materials from local quarrying, these cubes create complex marine habitats at the base of wind turbines, while protecting subsea assets such as cables, monopiles, foundations and pipelines.

Renewable Parts Ltd · ACT Blade Ltd · GreenSpur · ARC Marine ACCELERATING REEF CREATION

FUTURE-PROOFING BLADE DESIGN: IS BIGGER REALLY BETTER WHEN IT COMES TO A CIRCULAR ECONOMY?

As the offshore wind industry enters the era of the 'double digit' turbine, the drastic upscaling of offshore wind turbine blades to over 100m in length and in the region of 45 tonnes has become a major feat of engineering. Catapult experts Dr Kirsten Dyer and Dimitrios Mamalis discuss some areas of active blade research.



LM Wind Power's 107m blade arriving at Blyth testing facilities

Blade upscaling is critical to the energy yield an individual turbine can return, and the economies of scale make sense to achieve lower costs from energy production in the offshore environment. However, the installation of turbines offshore – by early 2020 there were almost 10,500 operational turbines in UK waters – means there are sustainability challenges for next-generation blades. So, can we seize the opportunity to achieve a circular economy at this scale, especially over the next 10 years as UK offshore wind capacity gets set to quadruple?

An important place to start is the design, materials and manufacturing process for blades to create lighter, stronger and more reliable products, with a longer offshore lifespan, whilst reducing maintenance and replacement needs. Blades are likely to increasingly include the use of novel materials - one example is recyclable Thermoplastic Fibre Metal Laminates (FMLs), hybrid materials consisting of alternating layers of monolithic metallic sheet and plies of fibre-reinforced thermoplastic. FMLs offer several benefits, such as their high resistance levels to fatigue and impact, low-weight and versatile manufacturing. ORE Catapult is involved in collaborative research to investigate the novel concept of low-cost thermoplastic composite FMLs through an in-situ polymerisation route, advancing conventional manufacturing methods.

Advanced manufacturing concepts for blades to enable recyclability are also being explored through projects such as PERISCOPE, which is looking at 3D printing technologies to produce modular no-mould blades. The modularity aids disassembly for recycling and 3D printing using recyclable thermoplastic multi-materials deposited

BladeBUG, a partner in the MIMRee consortium, testing at ORE Catapult's Levenmouth Demonstration Turbine

in a controlled designed fashion allows blade section manufacture without moulds, and only using materials where necessary to achieve the required structural properties. In addition, the Carbo4Power project – a four-year Horizon2020 project – has set out to develop a new generation of lightweight, high-strength, multifunctional, digitalised multi-materials for blades that will increase their operational performance and durability while reducing the cost of energy production, maintenance, and their environmental impact.

As well as the design and manufacture of future blades, the thousands of operational blade assets offshore are another piece of the circular economy puzzle. With constant exposure to extreme environmental conditions, well-publicised issues such as blade leading-edge erosion are problematic for blades, so life extension solutions are needed – especially with tip speeds of large blades potentially hitting 110m/s. For example, projects such as Leading Edge for Turbines (LEFT) transferred the best aerospace and defence leading-edge erosion-resistant material - electroformed Nickel Cobalt (NiCo) alloy - to the offshore wind industry. The alloy, predicted to last 369 years on current turbines in standard rain conditions, demonstrates a feasible way to extend blade lifetime and create a higher sustainability profile for offshore wind turbine blades.

Another potential solution that could make a direct contribution to extending blade lifetime performance is robotics and autonomous systems for predictive maintenance. Recent advances in autonomous mobile systems, such as crawling robots and Underwater Autonomous Vessels (UAVS), enable the digitisation of the maintenance process, eliminating risks from physical interactions and operating in weather-and-time-independent conditions. The feasibility of a fully autonomous robotic process for blade inspection has been introduced by the MIMRee (Multi-Platform Inspection, Maintenance and Repair in Extreme Environment) project. By performing regular, unmanned inspection, blade damage can be anticipated and resolved long before any critical failure may occur – again, reducing the need to replace and discard used blades.

With all of this activity, we are confident of a progressive implementation of new recyclable materials and manufacturing techniques to boost longevity for offshore wind turbine blades over 100m by 2030, particularly if modular blade manufacturing concepts take off. From design, materials and advanced manufacturing processes, to upgrading and protecting existing assets and then recyclability, the volume of research and projects that will contribute to a circular economy for blades is extensive, but it must also be an interconnected process driven by continuous collaboration between research communities and industry.

RESEARCH PROJECT SNAPSHOTS

Carbo4Power

Launched in November 2020, Carbo4Power sets out to develop a new generation of lightweight, high strength, multifunctional, digitalised multi-materials for offshore turbine rotor blades that will increase their operational performance and durability while reducing the cost of energy production, maintenance, and their environmental impact.

The overall goal of the four-year project is to provide the frame that will create new pathways for manufacturing of fibre-reinforced plastic for multiple processing life cycles, and explore the emerging price stabilisation opportunities in the offshore energy sector.

ORE Catapult is part of an 18-strong consortium from eight countries that provides technological know-how and industrial leadership for the Horizon 2020 project.

LEFT

Ensuring that turbine blades operate at maximum energy generating capacity for the life of an offshore wind turbine, often in harsh environmental conditions, is of paramount importance to keeping costs down and energy production up.

As a result, the Innovate UK-funded Leading Edge for Turbines (LEFT) project was established to transfer the best aerospace and defence leading-edge erosion-resistant material - electroformed Nickel Cobolt (NiCo) alloy - to the offshore wind industry.

In LEFT, a sample of the metal alloy underwent testing in the Catapult's rain erosion test rig at an accelerated tip speed of 173 m/s. After a single early test failure at 85 hours, the NiCo alloy was shown to just meet design lifetime requirements for future high tip speed turbines of 110m/s in standard 1000mm/yr rainfall locations and is predicted to last 369 years on current turbines in standard rain conditions. With this technology implemented, future, more aerodynamic blades with higher tip speeds to increase the annual energy production, could be enabled with no AEP degradation over time as seen on all other current leading-edge solutions.

Fibre Metal Laminates for Blade Applications

Over the next decade, our ability to environmentally dispose of thousands of old offshore wind turbine blades will be tested. As such, there is a vital need to develop advanced hybrid 'green' low-cost structures characterised by superior mechanical performance, extensive service life and recyclability.

Fibre metal laminates (FMLs) are hybrid materials consisting of alternating layers of monolithic metallic sheet and plies of fibre-reinforced polymeric materials. Taking advantage of the hybrid nature, these composites offer several benefits such as their high resistance levels to impact, durability, low-weight, and versatile manufacturing, as well as good resistance to fatigue.

This research project investigated the novel concept of low-cost recyclable thermoplastic composite FMLs through in-situ polymerisation as presented for the first time at two feasibility studies at Edinburgh University. ORE Catapult provided its research skills and experience to facilitate further investigation of the thermoplastic-FMLs and will help accelerate the journey to market for such multi-functional structures. Additionally, the Catapult used its extensive network of renewable SMEs and OEMs, to help direct the specification and development of the thermoplastic-FML concept in the renewables sector.

ORE Catapult's Rain Erosion Test Rig, Blyth

Additive Manufacturing for Turbine Blades

Recently, the use of additive manufacturing technologies has shown considerable reductions in costs and lead times while providing various advantages in terms of design freedom and rapid iterations regardless of part complexity. Furthermore, the production of lightweight tooling directly simplifies transportation and storage operations. Advancements in the development of composite 3D printers motivated the growth in pre-blended materials with fillers such as nanoparticles, carbon nanotubes, fibres and graphene, aiming to achieve unique properties and capabilities.

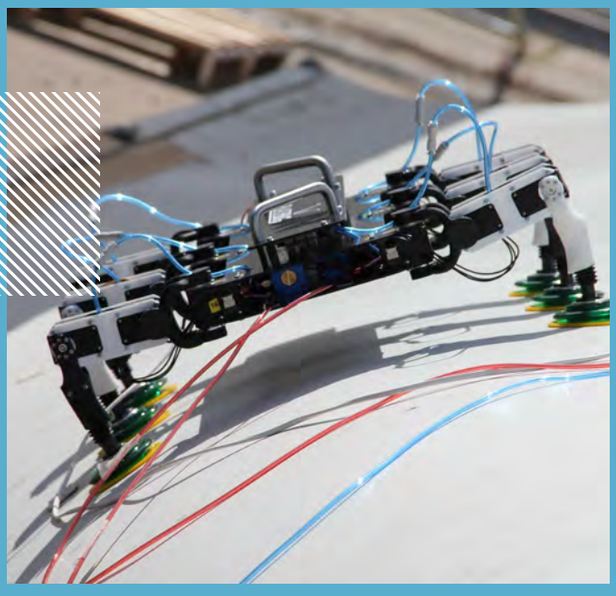
As a result, ORE Catapult's vision through research projects such as PERISCOPE (funded by the European Regional Development Fund) is to identify current state-of-the-art 3D printing technologies and the scale of them in the context of wind blades, tidal blades and marine vessels. A roundup of current large-area additive manufacturing methods is of particular focus, along with a review of current materials suitable for large scale additive manufacturing aiming to highlight further research questions for the production of modular no-mould components.

Another research project exploring additive manufacturing is the 'The Additive Manufacturing for Wind Blades' project, which aims to identify to what extent fused filament fabrication (3D printing) may be used as a composite manufacturing method in wind industry, considering along the way what progress has been made and what challenges remain to be tackled. While this is still a relatively undeveloped avenue of research, the lower production cost and the high degree of automation could be the keys to adaptation of this advanced technology.

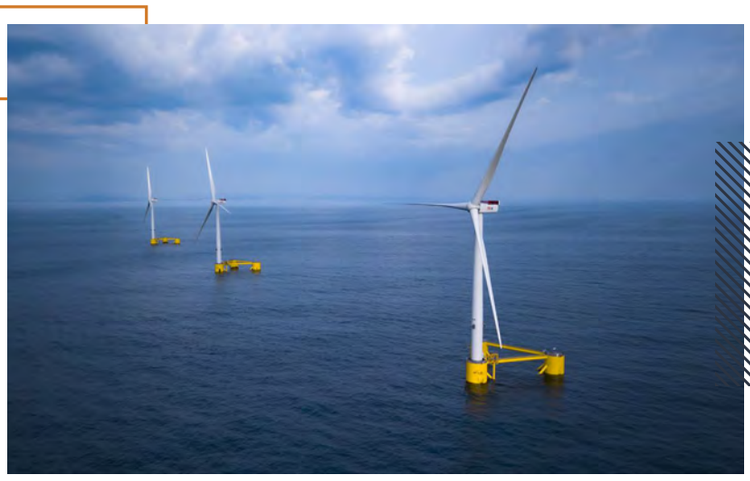
Robotic and Autonomous Systems

The time-consuming and expensive nature of offshore wind turbine blade inspection has resulted in a dramatic industry shift towards robotics and autonomous systems to complete the difficult task. With our world-leading testing and validation facilities and deep industry expertise, ORE Catapult is leading the way in robotics research for the sector. From autonomous vessels that take personnel out of hazardous environments, to sophisticated drones that can perform blade inspections in minutes, robotic solutions are set to play an enormous role in the sector. This concept was first introduced as part of the Innovate UK-funded Multi-Platform Inspection, Maintenance and Repair in Extreme Environment (MIMRee) project.

The project's core aim is to unite these robotic and autonomous systems into a holistic solution capable of planning, communicating, sharing data, and working together on complex sequences of tasks. The Catapult will provide invaluable industry insight, engineering expertise, and world-leading representative testing and validation facilities to prove the MIMRee technologies.



BladeBUG
MIMRee robotics



Wind Float Atlantic final hookup at Viana do Castelo, Northern Portugal
(Credit: DOCK90, Principle Power)

NEWS ROUNDUP

UK floating offshore wind could be subsidy-free by 2030

UK floating offshore wind could reach "subsidy-free" levels by the early 2030s, according to a study completed by our Floating Offshore Wind Centre of Excellence (FOW CoE).

The study suggests large floating offshore wind projects could secure Contracts for Difference (CfD) strike prices below current wholesale electricity price forecasts as early as 2029, depending on the deployment scenario pursued by the UK.

It also highlights the vital role floating offshore wind will play in the UK's journey to Net Zero and towards delivering 100GW of offshore wind by 2050, in line with the recent Climate Change Committee's Sixth Carbon Budget.

Read the full report here >

ORE Catapult welcomes GE Renewable Energy's Teesside factory announcement

ORE Catapult has warmly welcomed the tremendous news of GE Renewable Energy's investment in a new blade factory in Teesside. Chief Executive Andrew Jamieson said:

"We're justifiably proud of the strong partnership that we have built with both GE Renewable Energy and LM Wind Power over recent years, directly supporting the rapid delivery of their ground-breaking Haliade-X turbine and bringing UK innovation, research & development to the forefront of global offshore wind technology development. The new jobs announced today are a huge boost to the North East of England and the whole UK supply chain as we look to accelerate a green economic recovery on our path towards Net Zero."

The new facility is expected to start production in 2023 and create up to 750 direct renewable energy jobs and up to 1,500 indirect jobs in the area to support the entire value chain needed to operate this facility.

Innovative autonomous survey vessels to slash cost of offshore surveys and inspections

Exeter-based HydroSurv has worked closely with ORE Catapult and project partners Reygar and Core Blue as part of an Innovate UK-funded project to develop its unmanned survey vessels (USVs), which have the potential to cut the cost of offshore surveys and inspections at sea by up to 60%.

The project supported the company's journey to market by accelerating their Technology Readiness Level (TRL) from 3, experimental proof of concept, to 7, prototype demonstration in an operational environment and contributed to a 10-fold increase in their personnel, from two at the beginning of the project to 20 predicted by summer 2021.

Chris Hill, ORE Catapult's Operational Performance Director, added: "Robotic and autonomous systems technologies, like HydroSurv's USVs, will play a crucial role in the UK's transition to Net Zero and represent a huge opportunity to leverage its world-leading role in offshore wind, using its advanced robotics and autonomous systems sector to develop solutions for a global market."

ANALYSIS & INSIGHT DIGEST

The benefits of hybrid bottom-fixed and floating wind sites

With increasingly ambitious offshore wind deployment targets in the UK, floating wind will undoubtedly constitute a significant portion of future installed capacity.

In this paper, Analysis and Insights Manager, Miriam Noonan, examines the feasibility of bottom-fixed / floating offshore wind hybrid sites in Scottish waters.

Floating and bottom-fixed offshore wind have many asset requirements in common. A site with sufficiently deep water that can accommodate both bottom-fixed and floating turbines could share common assets across a hybrid site, allowing the floating part of the project to benefit from economies of scale and reduce the cost of deployment of pre-commercial technology in comparison to standalone sites.

Read the paper here >

Using floating offshore wind to power oil and gas platforms

Analysis and Insights Manager, Tom Quinn, analyses the feasibility of powering oil and gas facilities with floating wind and provides a case study for a specific site.

This report examines the possibility of connecting floating wind turbines to offshore facilities to reduce power generation from gas or diesel generators. Three hypothetical sites are analysed with a range of power requirements and asset lifetimes. A detailed case study has also been carried out for the Kraken FPSO (floating production, storage and offloading vessel) to assess its

Read the paper here >

Setting a benchmark for decarbonising O&M vessels of offshore wind farms

As a growing number of nations set Net Zero emissions targets to tackle the effects of climate change, increasing focus is being placed on decarbonising industry. With the huge growth expected in offshore wind, a sector that will contribute significantly to these Net Zero goals, an area that is becoming of interest is the decarbonisation of vessels involved in the 20+ year operations and maintenance (O&M) phase of offshore wind farms.

Dr Anthony Gray, Techno-Economic Analyst at ORE Catapult, has written an Analysis and Insights Paper to provide an estimate of annual vessel usage during the O&M phase of modern and future offshore wind farms and therefore define a benchmark for the associated fuel emissions.

Decarbonising offshore wind O&M vessels is seen as 'low hanging fruit', given the industry's vital role in achieving 'Net Zero' targets, and can contribute to the International Maritime Organization's (IMO) strategy of reducing the annual Greenhouse Gas emissions of shipping by at least 50% by 2050, compared to 2008.

Read the paper here >

CATAPULT
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