MOTT MACDONALD

Watts up?

Engineering, investment and management solutions for the next generation of offshore wind energy

Harnessing the potential of offshore wind power

Offshore wind is one of the most efficient renewable sources of electricity. A single offshore wind farm has the potential to generate more power than several fossil-fuel power stations operating at capacity, while greater wind speeds offshore mean the output from wind farms in our seas and oceans is typically much higher than for those on land.

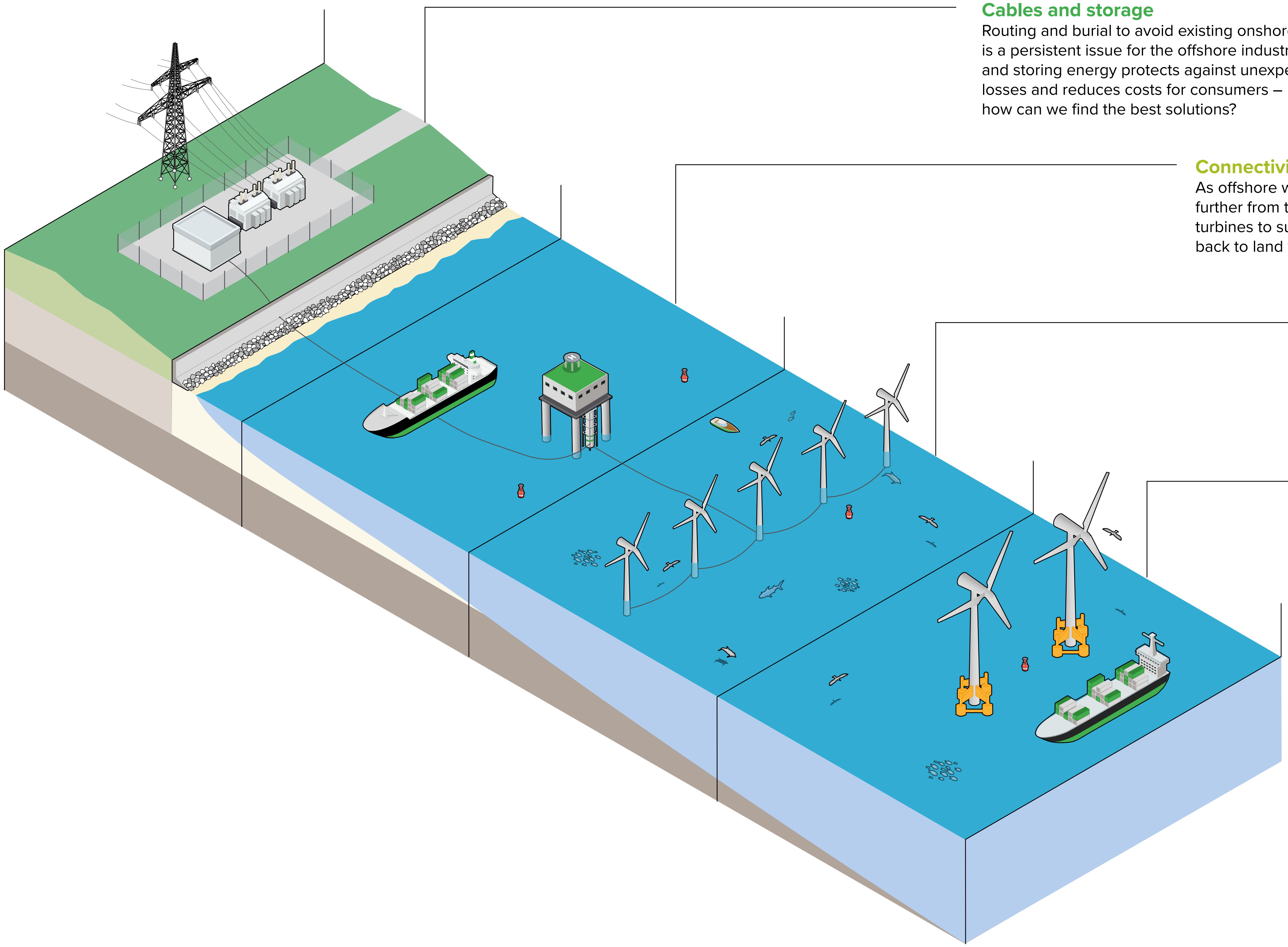
Yet, offshore wind's massive potential is largely untapped. It contributes just 1% of global renewable energy output, compared with 23% from onshore wind, 20% from solar photovoltaics and 48% from renewable hydropower.

We think this needs to change. Offshore wind has a crucial role to play in the global movement towards cleaner and more sustainable energy. Traditionally, investment has been held back due to constraints such as high costs, but, as with all renewable energy technologies, costs are coming down.

Changes to legislation, regulatory frameworks and incentives, together with rapid technological innovation, are making offshore wind an increasingly attractive and financially viable power source. Manufacturers are beginning to produce turbines with outputs of up to 12MW, with rotor diameters now spanning 220m (720ft). Investment is also being channelled into floating and tethered platform technologies, enabling turbines to be located in a broader range of sites and water depths.

The largest offshore wind farms are currently in northern Europe – primarily in the seas around the UK and off the coast of Belgium, Denmark, France, Germany and the Netherlands, as well as Scandinavia – but other countries are looking to tap into offshore wind. The first US site recently began generating power, and emerging markets in south-east Asian regions such as Japan, Taiwan and South Korea have led to exciting new opportunities.

Industry challenges



Cables and storage

Routing and burial to avoid existing onshore assets is a persistent issue for the offshore industry and storing energy protects against unexpected losses and reduces costs for consumers – how can we find the best solutions?

Connectivity and transmission

As offshore wind farms grow in size and are situated further from the shore, efficiently connecting turbines to substations and transmitting power back to land with minimal loss is a big challenge.

The world around us

Marine habitats and aquatic and bird life must be protected, while expansion into regions more prone to extreme weather means finding ways to effectively protect offshore infrastructure – what's the best approach?

Future innovations

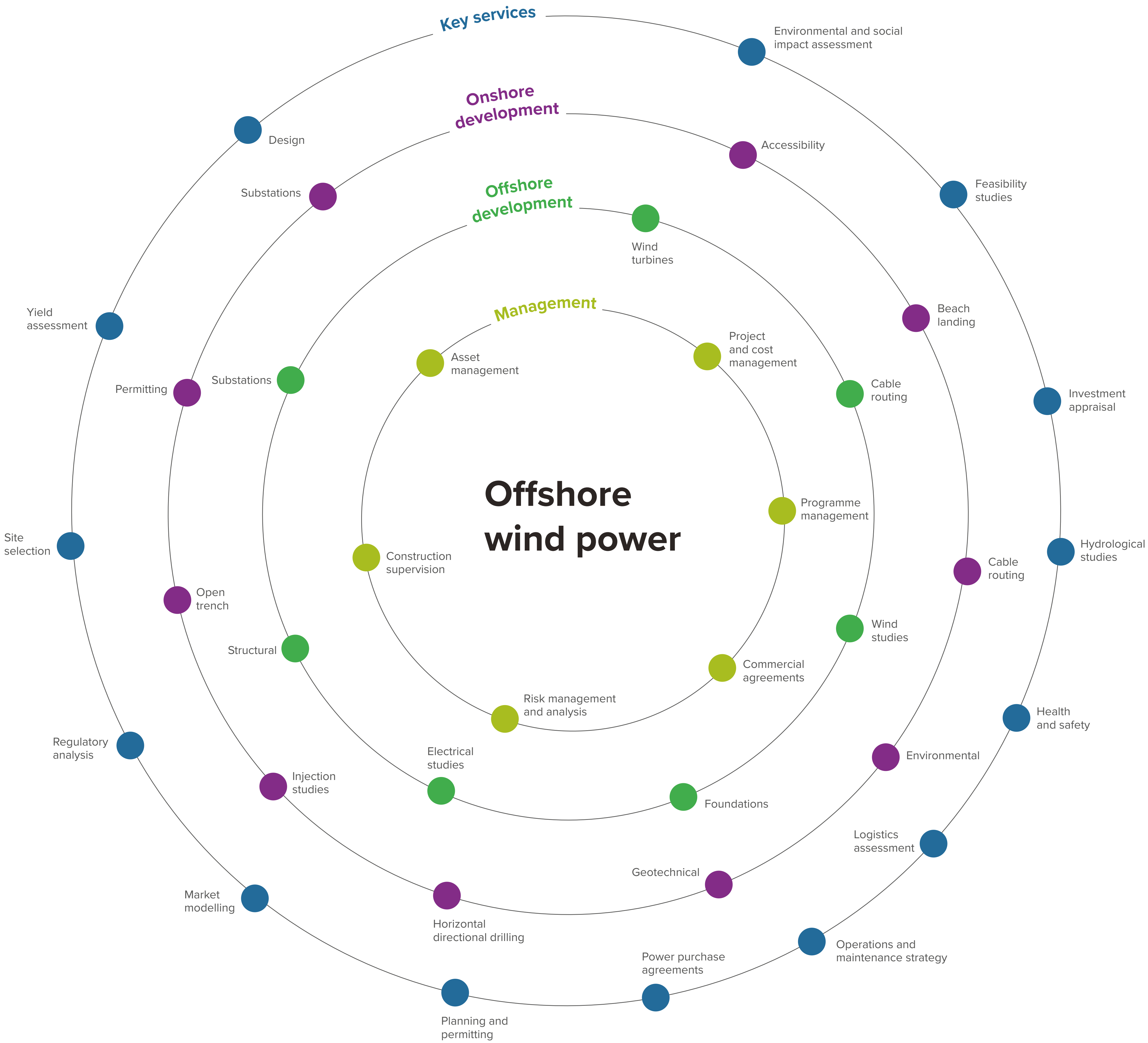
Wind turbine technology used today is vastly superior to 1991, when the first offshore array started generating power. With new innovations such as larger turbines and floating platforms, it's important to always look to the future.

Our services

Our universe of creative thinkers is centred around our clients. We're 16,000 strong, and joined-up across sectors and geographies, giving you access to exceptional breadth and depth of expertise and experience to deliver the best outcomes.

We have more than two decades of experience delivering wind energy projects. Our team unites engineering disciplines, planners, financial analysts, and safety specialists as well as atmospheric and wind modellers, geologists, oceanographers, and social and environmental scientists. We have worked on some of the world's most prestigious offshore wind projects and notable industry firsts.

These include Prinses Amalia in the Netherlands, the first non-recourse financed offshore wind farm anywhere (meaning loan repayments only come from the profits of the project), and Saint Nazaire, 12km off the French coast and the first offshore wind project finance deal in the country, generating a new supply chain and industry for France. Our expertise was also crucial in delivering the first commercial scale wind farms in the US, Belgium, Taiwan and, more recently, in the Mediterranean Sea. Overall, we have advised on more than half of all project financed offshore wind projects.



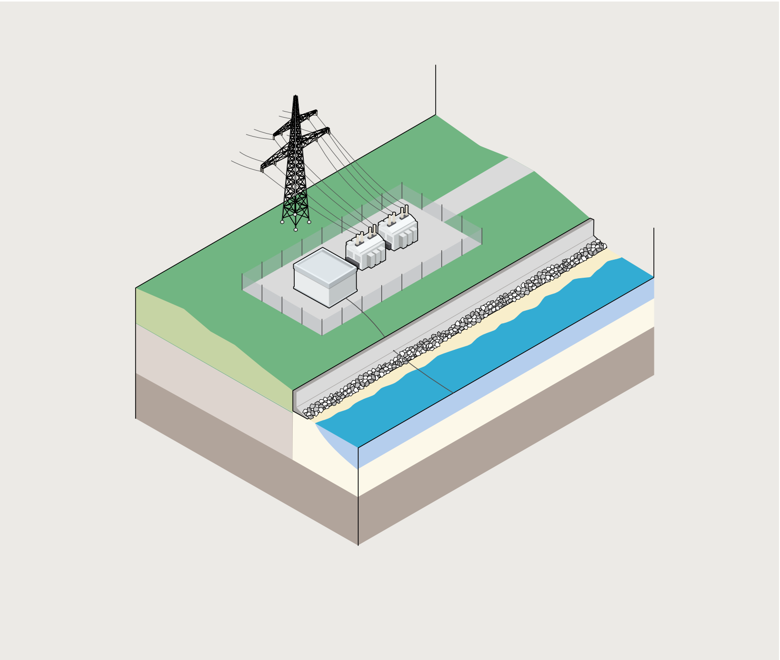
When offshore meets the shoreline

Cable routing and burial

With offshore wind farms being sited further from land and in deeper waters, it has become increasingly complicated to identify optimal cable routes and burial depths. Geohazards and the behaviour of mobile sediments along cable routes must be understood early in the design process, meaning feasibility studies and thorough geophysical, hydrographic and geotechnical surveys are essential.

Comprehensive and accurate data analysis and information sharing is vital, and we work closely with clients and contractors to create a single source of information to support effective assessment of obstacles, helping to identify savings in cable route lengths, or significant problems that may arise during installation or operations and maintenance.

Cable routing and burial is especially important at the shoreline because developers must navigate existing infrastructure and shipping lanes. Accurate information helps to identify the best route available for the transmission cables. We can determine whether horizontal directional drilling, open trench solutions or another technique is appropriate for a specific location, or if an alternative nearshore route must be found.



Protecting generation with energy storage

By investing in energy storage, companies are better protected against loss of revenue due to unexpected outages, while reducing energy costs for the consumer. A 12MW offshore wind turbine has the potential to generate 67GWh annually. With that much electricity being generated, storing any excess for when demand exceeds supply, such as at peak periods, would minimise loss and make commercial sense.

Batteries have traditionally been used to store energy, and offshore wind projects are increasingly designed to incorporate such facilities, but there are several other storage options available. These include power-to-gas, where on-site technology turns wind power into hydrogen, which could be piped to shore for use in stationary fuel cells, or for powering hydrogen vehicles.

In Larne, Northern Ireland we're involved in an innovative storage project – investigating the use of depleted salt mines to store wind energy in the form of compressed air generated at night when there is little demand. Ocean thermal energy conversion (OTEC) is another option that can be used in conjunction with offshore wind generation, producing electricity by using the temperature difference between deep cold ocean water and warm tropical surface waters. OTEC plants pump large quantities of deep cold seawater and surface seawater to run a power cycle and produce electricity.

2015

IJGlobal – Project finance award winner
North America Wind
Deal of the Year 2015

Project
Block Island Wind Farm

Location
Block Island, Rhode Island, US

Client
Deepwater Wind

Expertise
Owner's and lender's engineering services

Delivering America's first offshore wind farm

Opportunity
Block Island offshore wind farm was a major step towards a sustainable future for power generation in the US. It was the country's first offshore wind farm, and the first application worldwide of a new two-piece welded jacket foundation based on proven design concepts from the oil and gas industry.

Solution
We provided owner's and lender's engineering services to developer Deepwater Wind, and undertook bankability assessments before potential lenders were approached.

We further undertook detailed reviews of turbine technology and advised Deepwater Wind on the best terms for turbine supply and operation, and maintenance contracts. Our team of specialists also provided a 'value for money' analysis of key construction contracts, and scrutinised foundation designs and turbine installation plans throughout the due diligence phase of the project.

Outcome
Several technical issues with various contracts were identified from our reviews and we were able to minimise risks to lenders and ensure the project secured timely financial close.

The Block Island Wind Farm began commercial operation in December 2016 and the 30MW array provides enough power for 17,000 US homes. According to the New York Times, the project marks 'the start of a new American industry, one that could eventually make a huge contribution to reducing the nation's climate-changing pollution.'

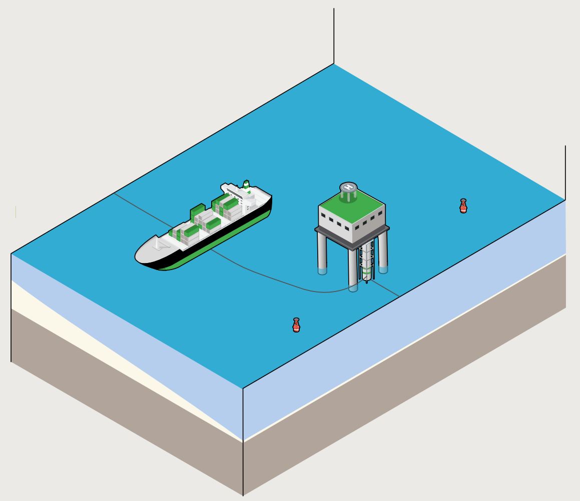
Making the right connections

Solving a complex mathematical puzzle

Offshore wind farm projects targeting installed capacities of more than 500MW require the design of the most efficient and deliverable collector systems to connect turbine generators to high-voltage substation hubs offshore. Finding the best way to lay out a collector system connecting at least 50 turbines is a very complicated mathematical problem comprising a huge number of possible combinations.

Identifying a workable solution requires time, and the larger the number of turbines, the longer it can take to deliver an answer.

Our digital approach combines two algorithms, including our unique routing algorithm, to refine and optimise connectivity. It minimises capital and operational expenditure and significantly reduces the time it takes to plot an optimal route.



The HVAC/HVDC decision

Alternating current (AC) has traditionally been the choice for transmitting power from a local substation to grid-connected infrastructure. But over long distances AC transmission is inefficient and can lead to significant losses.

In recent years, thanks to advancements in high-voltage direct current (HVDC) transmission technology and the electronics to convert DC into useable energy, HVDC has become increasingly viable for projects far away from the grid. Offshore wind is driving innovation in this area and several wind farms – particularly those furthest from the shore – now use HVDC, dramatically reducing energy losses.

With our expert AC and HVDC teams, we have the capability to assist whatever your distribution method and can run comprehensive cost-benefit analysis to establish which option is best for your project.

Driving HVDC innovation

Project
Sofia Offshore Wind Farm HVDC Subsea VSC Interconnector

Location
Dogger Bank, UK

Client
Innogy

Expertise
Technical assurance consultancy

Opportunity

Dogger Bank, off the north east coast of England, is a prime location for offshore wind because it is a relatively shallow area of the North Sea yet has high wind speeds. During the 2020s, four wind farms will be built here, including the 1.4GW Sofia Offshore Wind Farm, formerly known as Dogger Bank Teesside B.

As Sofia is situated 195km from shore, a high-voltage direct current (HVDC) transmission link – the Sofia Offshore Wind Farm Subsea HVDC VSC Interconnector – to the mainland was found to be the most technically feasible and economically viable method of transmitting power back to land.

Solution

We are providing HVDC technical assurance consultancy services on the front-end engineering design of the interconnector. This includes reviewing and assessing the designs for the onshore as well as offshore converter stations and their construction, project delivery schedules and associated auxiliary systems.

As part of our review, we ensure that any technical assumptions and risks that could have an impact on the overall cost and project delivery schedule are identified and mitigated through implementation of possible design changes, bringing down levels of uncertainty and the overall costs submitted by front end engineering contractors.

Outcome

HVDC delivers more power per cable system due to lower losses, and by optimising the design of converters, overall costs were cut by 30%. The interconnector will use two HVDC cables and two converter stations in a symmetrical monopole configuration, which is a proven design in the HVDC market across UK and Europe.

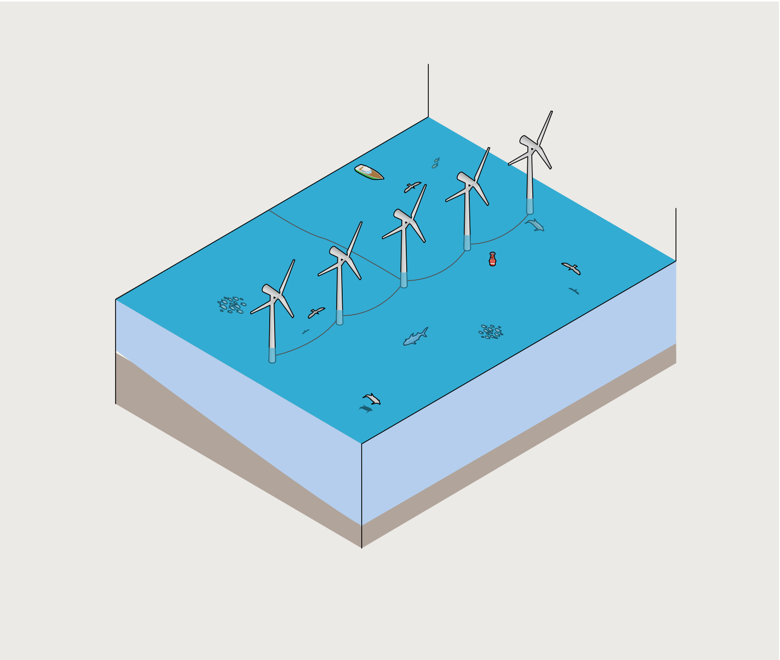
Sofia was awarded consent in 2015 and secured a contract for difference in the 2019 auction at the record low price for offshore wind of £39.65/MWh. Onshore construction work is due to start in 2021, with the offshore installation set to commence in 2022. Sofia is expected to be fully operational in 2026 and will deliver renewable electricity to the equivalent of around 1.2M UK homes a year.

The world around us

Equipped to withstand the harshest conditions

Offshore wind installations contend with stronger weather conditions than those on land, and the further out to sea they are sited, the stronger the wind speed and waves. Climate change will increase the frequency of extreme weather events and must be factored into the design of offshore wind farms. Turbines need to comply with the relevant International Electrotechnical Commission (IEC) specification – for example T-Class turbines in typhoon-prone areas.

Robust modelling is essential when designing new wind farms – either fixed or floating – to ensure they can withstand the stronger wind and waves far offshore as well as extreme weather events. A challenge going forward is the seismic design of wind farms, especially when it comes to protection of foundations. We have extensive experience in assessing seismic risks for major infrastructure projects, including tunnels, bridges and buildings. Our geotechnical expertise can easily be applied to mitigate risk to offshore arrays in earthquake-prone regions.



Protecting the environment

Wind energy is vital if we are to reduce reliance on fossil fuels and achieve the main goal of the Paris climate agreement – to limit the rise in global mean temperature to 2°C, and if possible 1.5°C, above pre-industrial age levels to prevent dangerous climate change. However, it is important that offshore wind energy projects do not damage the marine environment or local communities.

The long-term impacts of wind turbines on marine and avian life remain unclear. Some countries already have robust environmental standards for offshore wind in place – typically those that have an established offshore oil and gas industry.

When working on the Block Island wind farm off the coast of the US state of Rhode Island, for example, we were able to rely on local standards when considering the migratory paths of whales that had to be preserved, as well as the habitats of native nesting ospreys.

Other countries, such as Taiwan, lack similar standards because they do not have a mature offshore oil and gas industry, so the first step is to develop local arrangements that comply with international standards. This is what we did to enable the 8MW Formosa 1 wind farm off the Taiwanese coast to be built.

Project
Formosa 1 Offshore Wind Farm

Location
Miaoli, Taiwan

Client
Swancor Renewable

Expertise
Environmental and social advisory

IJGlobal – Project finance award winner
Asia Pacific Offshore Wind Deal of the Year 2018

Safeguarding the environment in Taiwan

Opportunity

Taiwan's first offshore wind project, the 128MW Formosa 1 array off the north-west coast, was envisaged as part of a national movement towards clean energy generation, capitalising on some of the world's best potential sites for offshore wind. Phase I, the pilot stage, consists of two turbines with a combined capacity of 8MW. Phase II adds a further 20, bringing the overall capacity to 128MW.

Solution

We have been involved with Formosa 1 from the start, providing environmental advisory services since the pilot phase. We reviewed and expanded on the approved national environmental impact assessment report, as well as the suite of existing environmental management plans. As the sponsor's environmental advisor, we supported the project sponsors to fulfil the financiers' prescribed requirements in terms of international environmental and social standards.

Our current scope of work involves safeguarding the environment and the local population from site activity that may cause harm or nuisance. We helped develop assessments and management plans for general construction, protecting Indo-Pacific humpback dolphins and migratory birds in the project vicinity, as well as livelihood restoration for local fishermen due to loss of designated fishing areas during construction and operation of the array.

Outcome

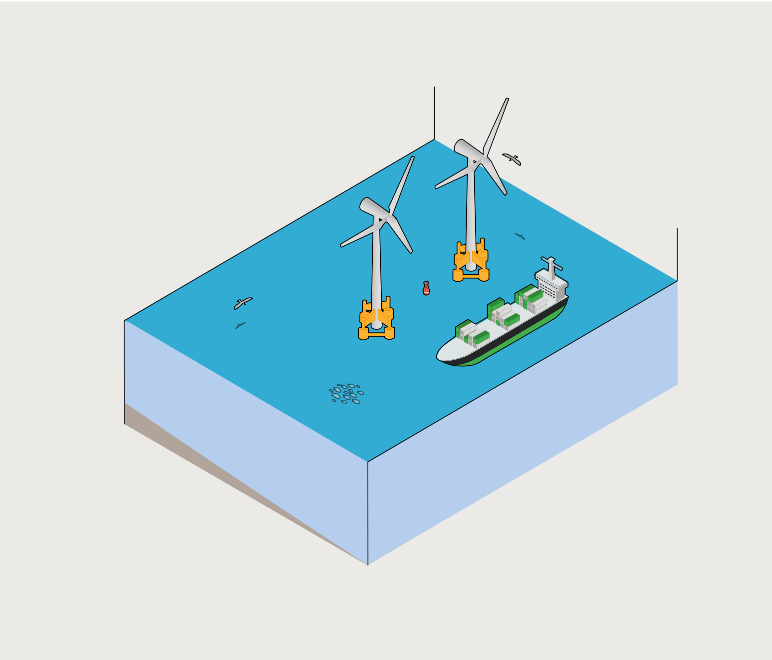
Phase I has been in operation since April 2017 and phase II completes commissioning in December 2019. Formosa 1 is one of three offshore wind projects awarded by the Taiwan Bureau of Energy under its incentive programme for offshore wind. As the first offshore array in Taiwan, it plays a key role in the government's target to generate 520MW of electricity from offshore wind by 2020, rising to 5.5GW by 2025, as part of its goal to be nuclear-free by 2025.

The evolving industry

Floating platforms

Considerable untapped offshore sites around the world have the wind speeds suitable for development, but many are in waters that are too deep for fixed-bottom conventional technology. Monopiles and jacket foundations are typically installed in water depths of 30m–60m. For water depths approaching 100m, the only viable solution is floating wind turbines on semi-submersible, spar or tension-leg platform foundation structures, all of which require secure mooring systems to the seabed.

Countries such as Japan have installed several test and demonstrator floating wind turbines, with Scotland laying claim to the first commercial scale floating wind project in the world – Hywind II. Commercial floating wind turbines are at an early stage of development, but their potential is recognised, with several developers trialling designs.



Technological advancements

Larger wind turbines will make installations further offshore more cost-effective from a construction perspective, due to increased economies of scale. However, due to the size of the turbines and foundations, the depth of water and distance from shore, new transportation and installation logistical solutions for both fixed bottom and floating wind farm developments will need to be found.

This includes the need for high tonnage capacity floating crane barges, or new novel transportation solutions to tow and install combined wind turbine and foundation structures in deep water. The industry will have to invest in installation vessels with the right sized cranes as there are currently not enough.

The constantly changing technological landscape also makes it difficult to accurately forecast operation and maintenance costs. However, the general trend is towards operations and maintenance cost reduction in order to lower the overall life-time levelised cost of energy.

Local knowledge, international expertise

Project
Akita Offshore Wind Farm

Location
Akita Port and Noshiro Port, Akita Prefecture, Japan

Client
Akita Offshore Wind Corporation (AOW)

Expertise
Lender's technical advisory

Opportunity

The winds off the coast of the Japanese prefecture of Akita in the north of Japan's main island are some of the most reliable in the country. The Akita Offshore Windfarm, a project split between two sites at Akita Port and Noshiro Port, is being developed to capitalise on these ideal conditions. It is on course to be the first non-recourse finance offshore wind farm in Japan.

A special purpose company was formed by trade, construction, development and utilities firms – the Akita Offshore Wind Corporation (AOW) – in 2016. This consortium assessed the feasibility of the project, investing in it and remaining a steering committee throughout development.

Solution

We worked with AOW on the engineering procurement construction and installation (EPCI) tender, and we are currently involved as lender's technical advisor. We provide bankability assessments through review of the project's financial modelling, energy yield assumptions, construction and operations execution plans, environmental and social impact assessments, capabilities of parties involved, and technical and engineering designs. We evaluate where risk can be mitigated through the review to assess financial viability for the life of the project.

Outcome

The developers are learning from our vast experience of the European offshore wind market, while the team in our local Japanese office provides local knowledge and expertise. The two project sites are expected to provide a combined output of 140MW, enough to power 70,000 homes. Commercial operation is expected to begin in December 2022.

Opening opportunities with connected thinking.

Talk to us: futureenergy@mottmac.com

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