Ørsted

Hornsea 2

Building the world's biggest offshore wind farm

Photography exhibition guidebook

Grimsby Fishing Heritage Centre, June 1st - 26th 2022

Building the world's biggest offshore wind farm

At Ørsted, our vision is to build a world that runs entirely on green energy. The need to end society's reliance on fossil fuels has never been more urgent or important.

Ørsted has been developing, building and operating offshore wind farms in the UK since 2004. Hornsea 2 is our 13th offshore wind farm in UK waters to date, and when fully operational later this year, will generate up to 1.32 Gigawatts (GW) of clean energy. That's enough to power over 1.3 million homes.

Once construction is complete, the baton will then be passed to our Operations & Maintenance teams based in Grimsby, who will be responsible for the day-to-day running of Hornsea 2 for at least the next 24 years.

This exhibition explains how we built Hornsea 2 and gives a brief overview of how an offshore wind farm works. Many of the photographs used in the exhibition were sent in by our employees and contract partners, so this is truly a team effort. Thank you to everybody who contributed. If you would like to download a copy of this guidebook, you can do so by scanning the QR code on the inside back cover.

Finally, if you have any comments or feedback about the exhibition, we'd love to hear from you. You can email: photoexhibition@orsted.com.

We hope you enjoy it!

Patrick Harnett
VP Programmes UK

Somewhere in the North Sea, far, far away...

Hornsea 2 is approximately 89km from the UK's east coast; the most distant offshore wind farm in UK waters. It is part of the Hornsea Zone, an area of the North Sea covering 2,057km^2, which is roughly the size of Leicestershire!

Generating clean energy for millions of homes

Within the Hornsea Zone are four wind farm projects, Hornsea 1, 2, 3 and 4. Together, they will provide enough clean electricity to power millions of homes in the UK, making a significant contribution to the UK Government's net zero target.

Wind farms in the Hornsea Zone:

Hornsea 1 (operational)
174 turbines, 1.2GW

Hornsea 2 (in construction)
165 turbines, 1.32GW

Hornsea 3 (in development)
Up to 231 turbines, 2.4GW

Hornsea 4 (in development)
Up to 180 turbines, TBC

How it all fits together

1 Monopiles
Steel monopile foundations are driven up to 26m into the seabed. Each monopile weighs between 730 and 1,220 tonnes.

2 Transition piece
The transition piece sits between the monopile and tower section. It is where technicians access the wind turbine during construction and maintenance.

3 Tower
The tower section is 93m high and weighs 479 tonnes. It contains a lift, ladder, crane, essential services and the cable that takes power to the OSS from the wind turbine generator (WTG).

4 Nacelle
The nacelle houses the hub (where the blades attach), the generator which turns the rotational energy into electricity, plus control systems for the turbine.

5 Blades
Each 81m long blade is made of balsa wood, fibreglass and resin. At its highest point, the blade tip is more than 200m above sea level. One revolution of the turbine blades can power an average home for 24 hours.

6 Array cables
66kV array cables link each wind turbine with the offshore substation. They are buried in the seabed.

7 Jackets
The jacket legs are fixed to the seabed and support the OSS and RCS platforms. They are also the anchor points for the high voltage array and export cables.

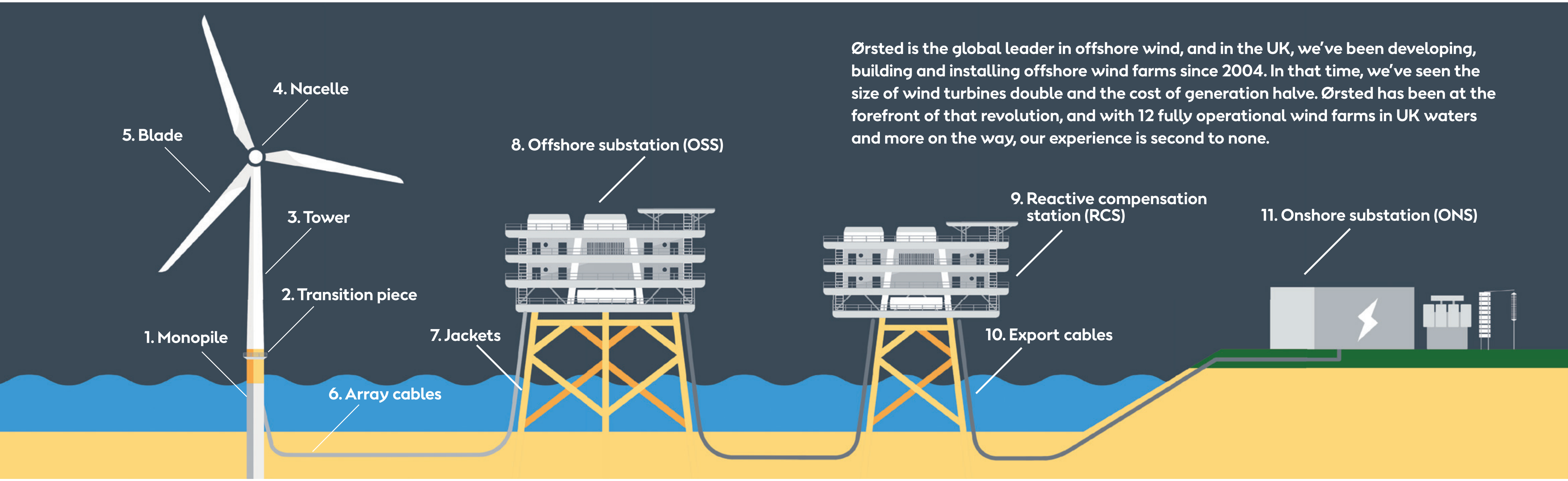
8 Offshore substation (OSS)
The offshore substation links together all 165 array cables from the wind farm, stepping up the voltage from 66kV to 220kV. The power generated is then transmitted to the Reactive Compensation Station (RCS).

9 Reactive Compensation Station (RCS)
Because Hornsea 2 is so far from land, the power generated by the wind farm needs to be boosted by the RCS so that it can be transmitted through the long export cables which take it to the onshore substation. Most wind farms don't need one, but we do!

10 Export cables
The three 130km subsea export cables take the power from the OSS and RCS to landfall at Horseshoe Point, before travelling 39km underground to the onshore substation at North Killingholme.

11 Onshore substation (ONS)
The onshore substation takes the power we generate and steps it up again to 400kV before it is transmitted to the National Grid.

Ørsted is the global leader in offshore wind, and in the UK, we've been developing, building and installing offshore wind farms since 2004. In that time, we've seen the size of wind turbines double and the cost of generation halve. Ørsted has been at the forefront of that revolution, and with 12 fully operational wind farms in UK waters and more on the way, our experience is second to none.



Hornsea 2 Timeline

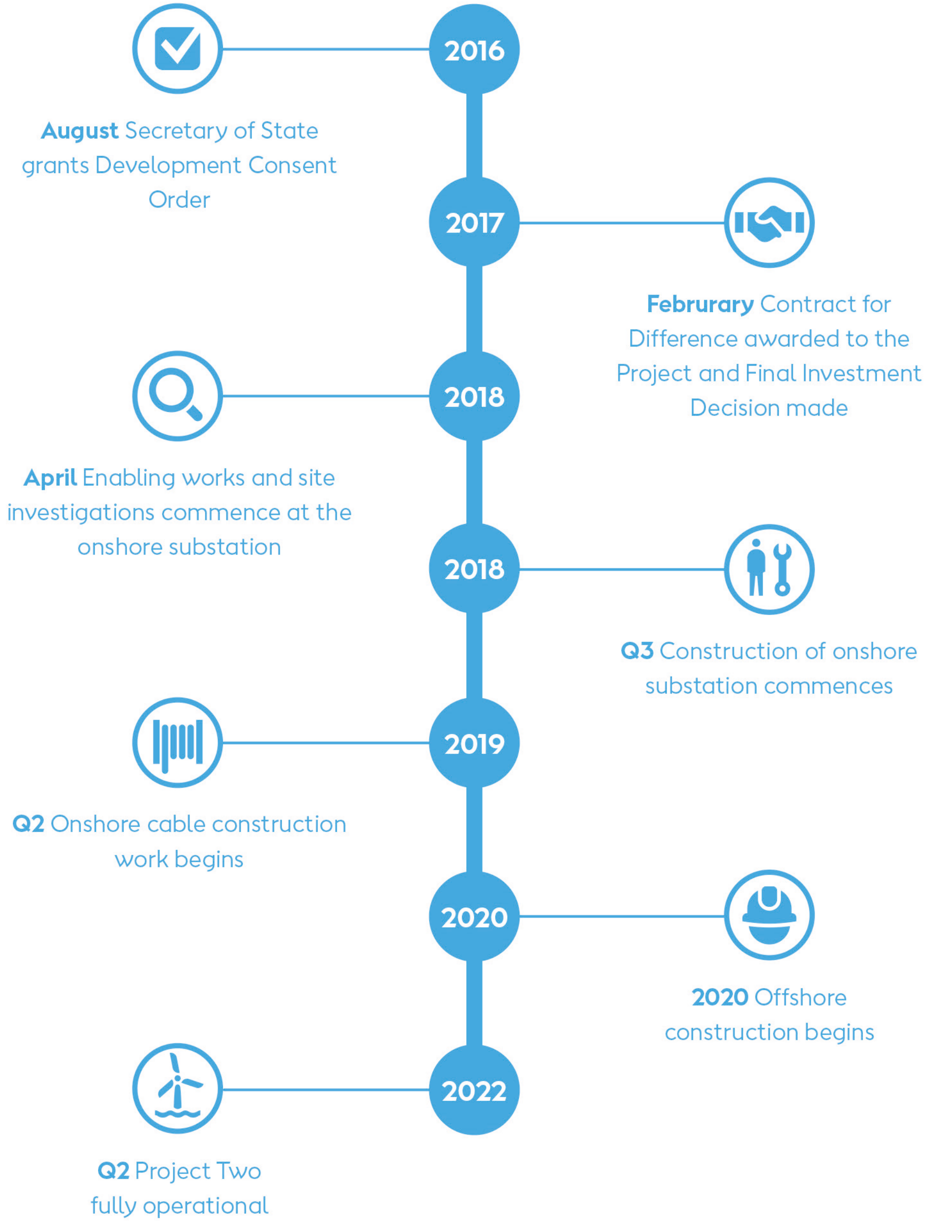
To build a wind farm, a huge amount of work has to happen in advance before construction can begin. The first, and perhaps most important step, is to obtain a Development Consent Order (DCO) from the government, which is needed for all 'Nationally Significant Infrastructure Projects'.

A DCO is only granted when the Planning Inspectorate, Secretary of State and the government are satisfied that all planning requirements have been met. These requirements include an environmental impact assessment, detailed site surveys and public consultation with national stakeholders and local communities. Only when the DCO has been granted can work actually begin on fabrication and installation.

Although this exhibition has been structured around a simple sequence from offshore installation of foundations and wind turbines via cables and the offshore substation to the onshore substation and finally the National Grid, the actual construction of an offshore wind farm like Hornsea 2 is far more complex.

Our commercial, planning, logistics and offshore operations teams all worked together behind the scenes from day one to fit the jigsaw together safely, quickly and efficiently. It's a remarkable achievement when you consider that fabrication, installation and testing often happened in parallel, thousands of miles apart across multiple sites, with a project team made up of hundreds of different contracting companies! You can imagine the additional difficulties our planners and installation teams faced trying to do all this in the middle of a global pandemic.

The graphic on the right shows some of the key dates in the Hornsea 2 project, starting with the date our Development Consent Order was granted in 2016.



Planning, logistics & training

Rehearsal of concept (ROC) drill.
Rehearsal of concept drills were originally used by military planners to test battle plans and simulate operations before engaging the enemy.

On Hornsea 2, we used ROC drills to check how different teams' installation plans fitted together, using scale maps and models to work through the schedule and check each task before performing them 'live' in the field. During COVID-19, when we couldn't meet in person, we used an online application to hold ROC drills remotely.

Marine and Helicopter Coordination Centre (MHCC).
Building offshore wind farms requires an incredible level of logistical planning to move people, vessels and equipment to where it needs to be. Our MHCC, located at our East Coast Hub in Grimsby, uses state-of-the-art technology to coordinate personnel, helicopter and marine traffic movements on Ørsted's wind farm projects across the globe, 24/7, 365 days a year.

The MHCC started work on Hornsea 2 in October 2020. By the end of 2021, the MHCC had already coordinated 61,770 personnel transfers to the wind farm.

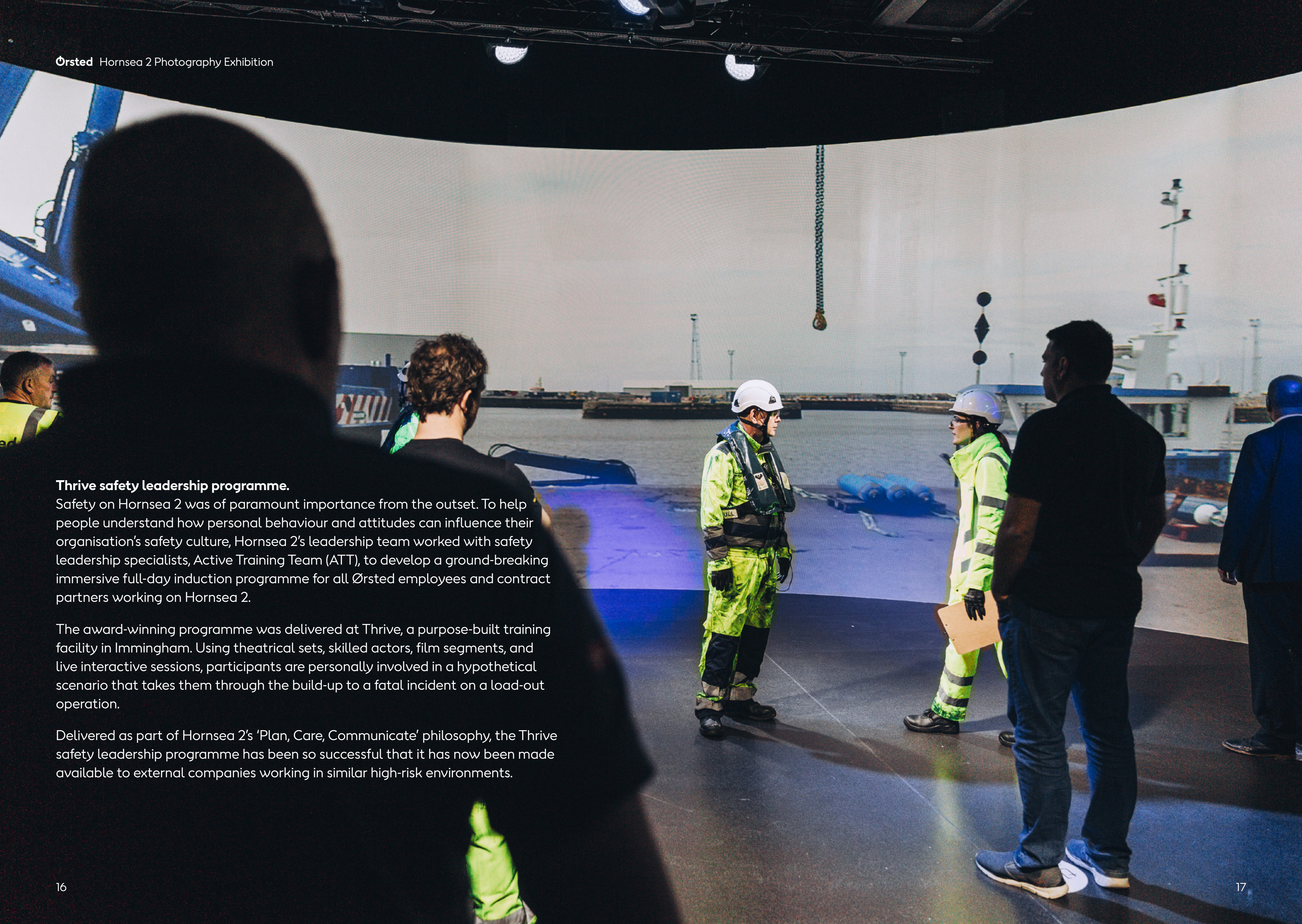
Helicopter taking off.
Building and operating a wind farm 89km offshore would not be possible without helicopter crew transfers; a service provided by contract partner CHC. From our base at Humberside Airport, teams were taken to offshore 'jack-up' accommodation platforms, service operation vessels (SOVs) and specialist installation vessels equipped with helipads. A helicopter transfer from Humberside Airport takes approximately 35-40 minutes compared to 3-4 hours (in good weather!) by crew transfer vessel.

Crew Transfer Vessel (CTV) MHO Asgard
MHO-Co is a specialist crew transfer vessel company that designs and operates some of the most advanced and environmentally efficient CTVs in the world. Developed in collaboration with Ørsted, the MHO Asgard is one of four CTVs used in the construction of Hornsea 2 and is one of the first to use hybrid propulsion technology, significantly reducing carbon emissions.

Jack-up accommodation vessel GMS Endeavour next to the Offshore Substation (OSS).
Along with more traditional Service Operation Vessels (SOVs), self-propelled jack-up accommodation vessels provide stable, high-quality offshore facilities for our installation teams, using a 'walk-to-work' gangway system to access the work site. The GMS Endeavour is equipped with a 230 tonne crane, helideck, hospital, office areas, restaurant, and accommodation for 246 personnel.

'Get Up Safe' training at the Modal Centre, Immingham.
In late 2020, a training and demonstration facility was built for Ørsted's new 'Get Up Safe' system, which was developed in partnership with Pict. Get Up Safe is an advanced electric heave-compensated hoist system used to help technicians access offshore wind turbines.

Installed for the first time on Hornsea 2, technicians can practice using the Get Up Safe system as part of Pict's accredited training programme in a safe onshore environment.



Thrive safety leadership programme.

Safety on Hornsea 2 was of paramount importance from the outset. To help people understand how personal behaviour and attitudes can influence their organisation's safety culture, Hornsea 2's leadership team worked with safety leadership specialists, Active Training Team (ATT), to develop a ground-breaking immersive full-day induction programme for all Ørsted employees and contract partners working on Hornsea 2.

The award-winning programme was delivered at Thrive, a purpose-built training facility in Immingham. Using theatrical sets, skilled actors, film segments, and live interactive sessions, participants are personally involved in a hypothetical scenario that takes them through the build-up to a fatal incident on a load-out operation.

Delivered as part of Hornsea 2's 'Plan, Care, Communicate' philosophy, the Thrive safety leadership programme has been so successful that it has now been made available to external companies working in similar high-risk environments.

Foundations

Foundations feeder port at Eemshaven, The Netherlands. Hornsea 2's monopiles (top), transition pieces (bottom left) and sacrificial anode cages (bottom right)* can be seen at the port of Eemshaven. The delivery vessel is moored at the quay on the top left of the picture. Parts are then craned to the storage yard before being loaded onto the installation vessel.

*Anode cages are fitted to the monopile a few metres below sea level to prevent corrosion of the steel foundation.

Monopile offloading.
Monopiles are being offloaded from the delivery vessel for storage, before being transferred to the installation vessel. Manufactured by partner company EEW in Rostock, Germany, Hornsea 2's monopiles are between 60m and 78m long (varying because of different sea depths), and range between 730-1,220 tonnes in weight. The diameter of the top of the monopile is 6.5m and the base between 8.3m and 9.5m.

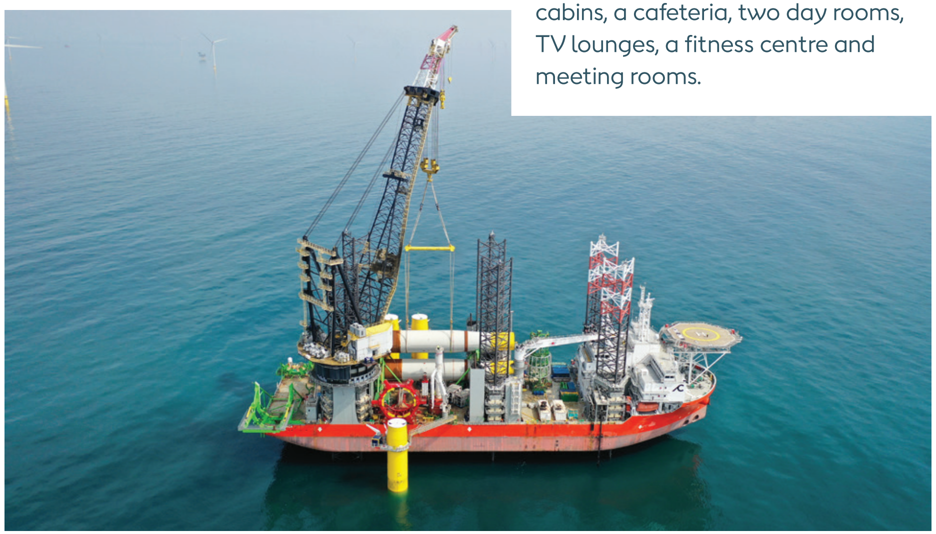
Transition pieces (TPs).
In comparison to the monopile and tower sections, the transition pieces look comparatively small. However, each TP on Hornsea 2 is 22m high and weighs 340 tonnes.

The transition pieces sit between the monopile and the turbine tower, providing an access platform for people entering the turbine via our new 'Get Up Safe' heave-compensated hoist system. TPs are also equipped with a separate Davitt crane for transferring tools and materials to the platform.

Installing a monopile.
The crane on board the foundation installation vessel lowers a monopile overboard through the pile gripper, which holds it in place while it is driven into the seabed by a hydraulic hammer lowered onto it by a crane.

Installing the transition piece (TP).
The transition piece is the final part of the foundation to be lowered into position, guided by a series of bumpers. Once safely lowered onto the monopile, technicians transfer to the TP from the installation vessel to bolt the two sections together. The section protruding from the base forms both a watertight seal within the foundation and acts as a platform for the technicians to work from inside the TP.

The Wind Orca.
Cadeler's Wind Orca jack-up installation vessel carries three monopiles, three transition pieces and three anode cages on each load-out. The vessel is 161m long and is equipped with a helipad and main crane with a capacity of 1,200 tonnes. On board the Wind Orca are 111 single berth ensuite cabins, a cafeteria, two day rooms, TV lounges, a fitness centre and meeting rooms.



Pict's Get Up Safe (GUS) system.
Developed in partnership with Ørsted, the GUS system is used to safely transfer offshore personnel between moving vessels and static transition piece platforms using an active motion-compensated hoist that reacts to waves and swell. Previously, technicians accessing a turbine would have to step from a moving vessel deck onto a steel ladder and climb up through an access gate.

Apart from providing safer access, the installation of the GUS system and removal of ladders has significantly reduced the amount of steel required in the fabrication of each transition piece.

An industry-first for Ørsted and Hornsea 2, the Get Up Safe system has taken roughly five years to develop, test and install, and will shortly be used on a number of Ørsted's offshore wind farm projects in the United States.

Array cables

Load-out of array cable from JDR's manufacturing facility in Hartlepool.
JDR Cable Systems was one of Hornsea 2's two main array cable suppliers, providing over 110km of 66kV array cables for the project. JDR was also responsible for terminating (installing connectors) and testing each of its cables.

This photograph shows cable being prepared for load-out to one of the project's cable installation vessels. It is transferred by a system of rollers across the quayside.

Cable testing facility.
Before being shipped to JDR's Hartlepool base, the high voltage cable cores are fully tested inside a Faraday cage testing facility. This ensures that any problems are identified before the cables are laid and buried, when maintenance or replacement would be significantly more difficult!

Installation of the first array cable on Hornsea 2.
High voltage (66kV) array cables connect the wind turbines to the offshore substation. In total, there are 18 'strings' of wind turbines on Hornsea 2. The cables are then pulled into the yellow offshore substation jacket (pictured). This photograph shows the project's first array cable being overboarded from the Seaway Aimery, with Seaway Offshore Cable's sister vessel Seaway Moxie in the background.

The TM05 trenching remote operated vehicle (ROV) on the Simar Esperanca.
The TM05 is one of two remote operated vehicles used to bury Hornsea 2's subsea cables between 0.8 and 2.9m under the seabed.

Before any cables were buried, each cable route was fully surveyed, looking for unexploded ordinance, boulders or debris. Existing cables and subsea pipelines crossing the site were protected with rock or concrete 'mattresses'.

Developed specifically for the Hornsea 2 project, the TM05 is a 1,310 horsepower, 45 tonne trenching ROV using a combination of a wheel cutter, chain cutter and high-pressure jets to create a trench for the cable. Any areas that couldn't be buried were subsequently protected with rock to ensure they were safe for future fishing activities.

Different cutting methods were used depending on the geology of the cable route, which varied from hard sand to cobbles and stiff clays. Smaller and lighter than the TM05, we also used the ROVJet 1600, which uses high pressure jets to liquefy the sand and bury the cable up to 2m beneath the seabed.

Finally, an inspection ROV was used once the cables were buried to ensure they were at the correct depths.

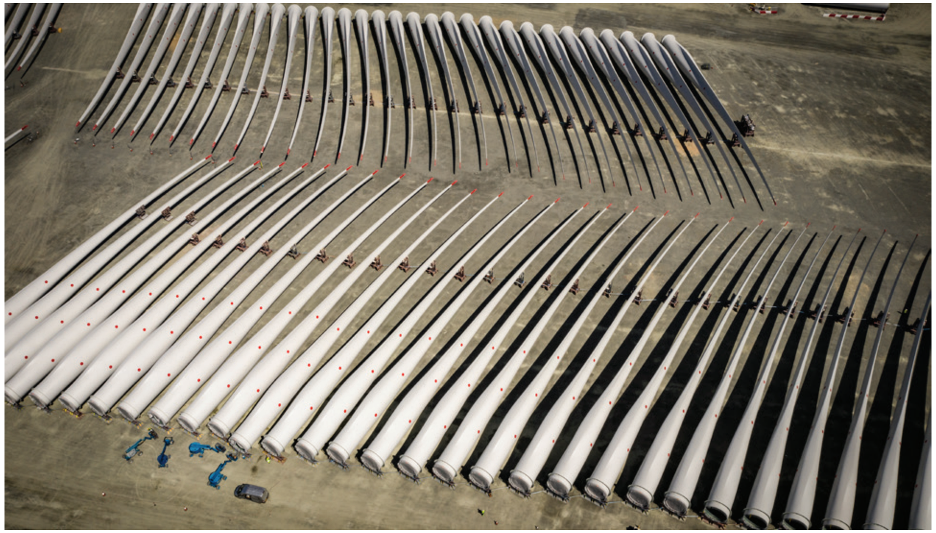
Operating the TM05 from the Simar Esperanca's control room.
A team of six people controlled the ROVs from a control room on board the vessel. Using a combination of GPS, sonar and optical cameras, the ROVs can be safely manoeuvred along the cable route with pinpoint accuracy.

Installing an array cable protection system (CPS).
Protecting the wind farm's high voltage cables from damage, both on installation and over the course of their lifetime, is extremely important. One area of potential weakness from wave movement and currents is where the cable leaves the seabed and enters the monopile foundation. In collaboration with CRP Subsea and our installation contractor, Seaway Offshore Cables (SOC), we tested and installed CRP's cable protection system in a monopile – another first for Hornsea 2!

Array cables connected in the cellar deck of the Offshore Substation (OSS).
Once the OSS had been installed, the 18 array cables had to be connected to the OSS's high voltage systems and fully tested before they could be used to transmit power from the wind turbines. In total, over 1.1 million metres of cable were tested. This photograph shows the cellar deck of the OSS with array cables connected.

Wind turbine generators (WTGs)

Wind turbine load-out to DEME's Sea Challenger in Hull. We have had two jack-up installation vessels working on the Wind Turbine Generator (WTG) installation campaign: DEME's Sea Challenger and Sea Installer. Both can carry four full WTG sets each, comprising three blades, one full tower section and a nacelle. It is hard to appreciate the scale of this enormous vessel, but when you remember that each tower is roughly the height of Grimsby's dock tower, it puts the scene into perspective!



Blades at Siemens Gamesa Renewable Energy's (SGRE) blade manufacturing facility. Turbine blades are manufactured and stored at SGRE's manufacturing facility in Hull, currently the largest offshore wind manufacturing facility in the UK. £186 million has recently been invested to expand the facility by 41,600m^2, leading to the creation of a further 200 jobs.

Blade manufacturing – final finishing at SGRE's plant in Hull.
Each 36 tonne, 81 metre long blade is hand made from balsa wood, fibreglass and resin. Their shape ensures maximum efficiency and includes a lightning conduction system.

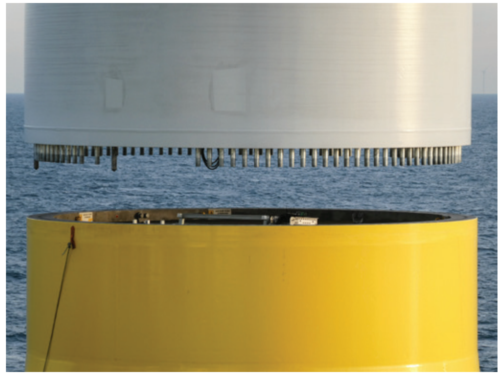
View from the blade rack on DEME's Sea Challenger.
This view from onboard Sea Challenger shows the empty blade racks before load-out commences. The circular structures are where the towers sit.

Looking up at the tower sections. Towers are made up of a number of welded sections. Their height is largely determined by the rotor diameter (the greater the blade length and power output, generally speaking, the taller the tower). As well as a lot of air (!), towers contain a lift to access the nacelle, a crane, a ladder (should the lift fail) essential services and a lot of cabling.

A full load out on its way to Hornsea 2 via the Humber estuary.
The Humber estuary has been a lifeline for local industries for centuries, from the grain, coal and wool importers of the middle ages, to Grimsby's world-renowned fishing fleet in the nineteenth and twentieth centuries. Today, Grimsby, Hull and the Humber are at the heart of the UK's renewables industry. This photograph shows a fully loaded installation vessel heading towards Hornsea 2.

Access to the transition piece via a walk-to-work gangway.
Access to wind turbines has been made far simpler by the introduction of motion-compensated gangways from service operation vessels, together with the new 'Get Up Safe' motion-compensated hoist system developed by Ørsted and Pict for access to the turbines.

Lowering the tower section onto the transition piece.
Each 479 tonne tower is secured by 120 M64 flange bolts, which need to align perfectly. Over 3.15 tonnes of bolts, washers, spacers and nuts are used to secure the tower to the transition piece.



Craning a tower section into place. While craning a 93m tower into position on a calm spring morning may not seem too challenging, the situation is very different in poor weather or heavy swells. The combination of small movements on the installation vessel combined with the impact of waves on the foundation can make alignment extremely difficult.

Installing the nacelle.
Sea Challenger hoisting the nacelle to 120m above sea level to top out the pre-installed tower.

Lifting a nacelle into position from the installation vessel.
The nacelle is the section of the wind turbine responsible for generating electricity. In common with all rotating generators, whether in a nuclear, gas or coal fired power station, a hydroelectric plant or wind turbine, energy of some description (in our case energy from the wind) is required to rotate a magnet on a shaft inside a coil of copper wire, which, in turn, creates an electrical current. The physics are simple, but the technology behind it is very advanced!

Each nacelle used on Hornsea 2 was manufactured in Siemens' Cuxhaven facility in Germany and weighs approximately 379 tonnes.

Blade installation.
The JANET blade lifting device clamps the blade on deck and securely controls the blade from its position in the blade rack all the way to its final position attached to the hub.

Lifting a blade using the JANETT cradle.
Because of the length of each blade (81m), it is essential that it is lifted exactly at its centre of gravity, which is normally marked on the blade by a black spot. However, the size and flexibility of each blade means that the centre of gravity can move in the manufacturing process, so for the first time on any wind farm, green dots were added to the blades to mark the exact centre of gravity and the alignment point for the JANETT cradle.

Stormy weather.
Weather conditions can make working offshore extremely challenging, and on Hornsea 2 we've had it all. From high wind, rough seas and snow to dense fogs and driving rain, our offshore teams are always at the mercy of the elements. Of course, when we want some wind to commission and test our wind turbines, you can guarantee that we'll be in a flat calm!

T29, Ørsted's 1000th turbine installed in UK waters on Hornsea 2, June 2021.
While the installation of each wind turbine is an important milestone, there is still a lot of work to do before they can generate power. Final cabling connections and testing, communication system commissioning and safety system checks all have to be performed before first power can be generated.

Offshore substation (OSS)

The offshore substation (OSS) topside being loaded onto the Hua Hai Long.
On Friday 16th July 2021, the Heavy Transport Vessel (HTV) Hua Hai Long arrived at our fabrication contractor SMOP's facility in Singapore. Load-out of the 8,000 tonne OSS and 2,220 tonne reactive compensation station (RCS) topsides took place during July and August.

Moving the OSS topside onto the Hua Hai Long took eight hours and involved 368 trailer axles (pictured).

The OSS and RCS topsides awaiting sail away from Admiralty Yard in Singapore.
The topsides left Singapore on 15 August 2021 and travelled 8,500 nautical miles via the Suez Canal and the Mediterranean to reach Hornsea 2. Before leaving Singapore, the topsides were secured to the vessel with 200 tonnes of sea fastenings.

The offshore substation (OSS) jacket with export and array cables pulled in prior to installation of the topside. Before the arrival of the delayed OSS and RCS topsides, we took the opportunity to 'pull-in' and prepare a number of cables on the cellar deck of the jackets. The cables were fed up from the seabed through steel J-tubes and mechanically secured. There were a few sleepless nights spent ensuring everything was ready before the arrival of the Sleipnir semi-submersible crane vessel!

Scaffolding work on the reactive compensation station (RCS) platform supported by the Seafox 7 jack-up vessel. Contract partner BGB Scaffolding supplied the scaffolding needed on both the RCS and offshore substation (OSS) jackets to pull-in and support the array and export cables, a task made much more difficult by the limited space and large number of people working on the jackets at the time. Once in place, the cables all had to be lowered from 5m above the jacket deck to 2.5m below deck and the scaffolding removed before the topsides could be installed.

Evening craning of the offshore substation (OSS) jacket into position. Manufactured in Indonesia, the steel 'jacket' structures that support the OSS and reactive compensation station (RCS) weigh over 10,000 tonnes. They were transported from Batam on 13 August 2020 onboard heavy transport vessel (HTV) Big Lift Barentsz.

The offshore substation (OSS) on Heerema's Sleipnir semi-submersible crane vessel.
Built in 2019, the Sleipnir is the world's largest semi-submersible crane vessel. At 220m long and with a gross tonnage of 188,000 tonnes, each of its twin cranes are capable of lifting 10,000 tonnes, which is roughly the weight of 30 fully loaded Boeing 747-100s. Installation of Hornsea 2's topsides began on 18th October 2021.

Lowering the offshore substation (OSS) into position.
The Sleipnir's cranes installed the OSS topside first, followed by the reactive compensation station (RCS) topside, a comparative minnow by comparison at just over 2,220 tonnes (although that didn't make installation any less technically difficult)!

Commissioning work on the offshore substation (OSS) begins, supported by the GMS Endeavour. Both the OSS and reactive compensation station (RCS) were delivered as completed standalone components. However, from installation came a long process of energisation and commissioning to link up the array and export cables and carry out thousands of tests before they could be signed off as operational.

Commissioning and testing underway on the offshore substation (OSS).

To understand what the offshore substation 'does', there are four main elements to the systems it houses:

First is the switchgear, which connects the array cables to the transformers, and the transformers to the export cables for onward transmission of power.

The transformers and shunt reactors step up the voltage from the turbines so that it can be transmitted along the export cables with minimal loss of power.

The SCADA system gives the operators of the wind farm real-time information about the electrical infrastructure of the site, and provides the ability to operate and supervise the wind farm from onshore. The SCADA system for Hornsea 2 is the biggest ever built for an offshore wind farm.

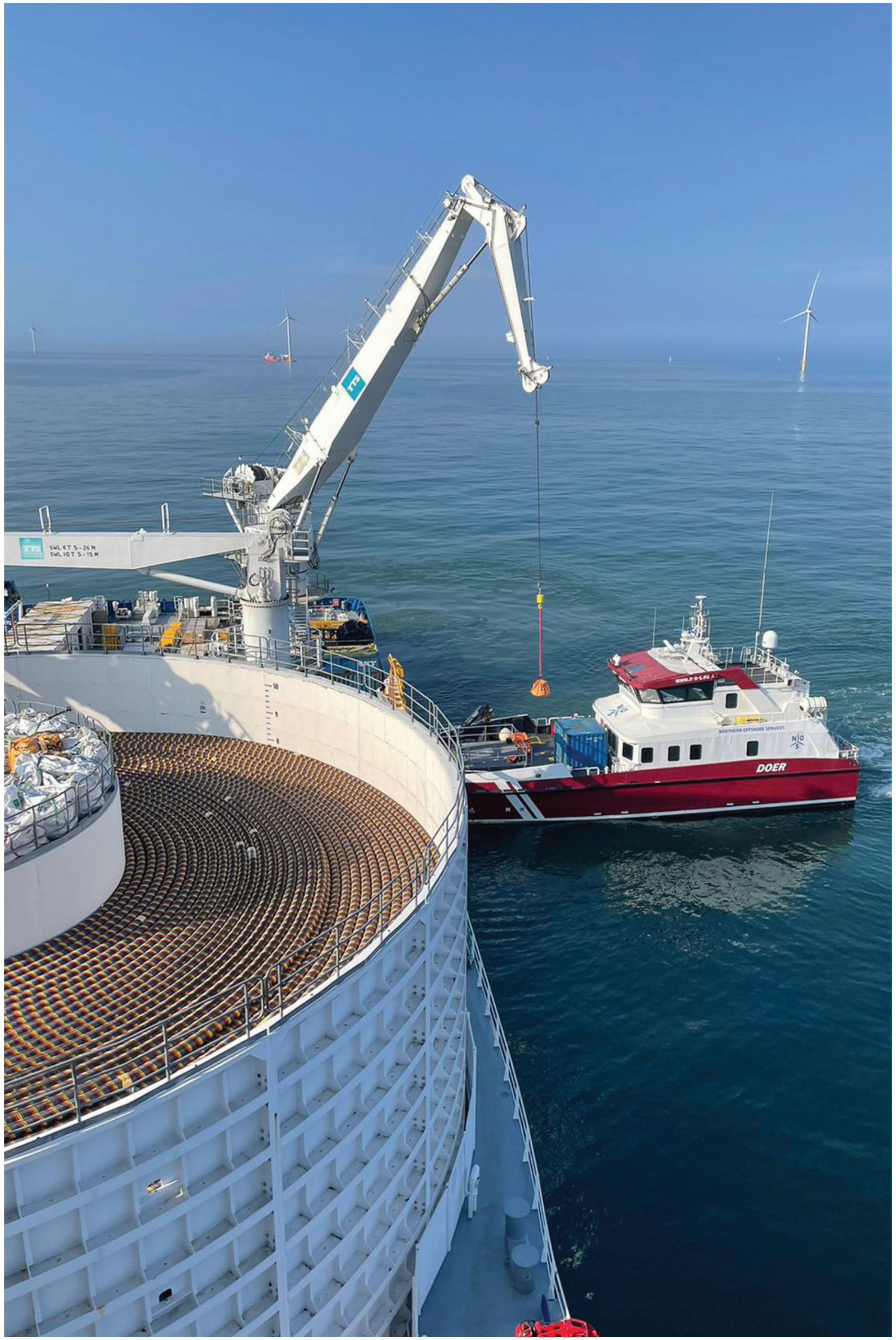
Finally, if there is an electrical fault, protection systems safely stop the flow of power and isolate the equipment affected.

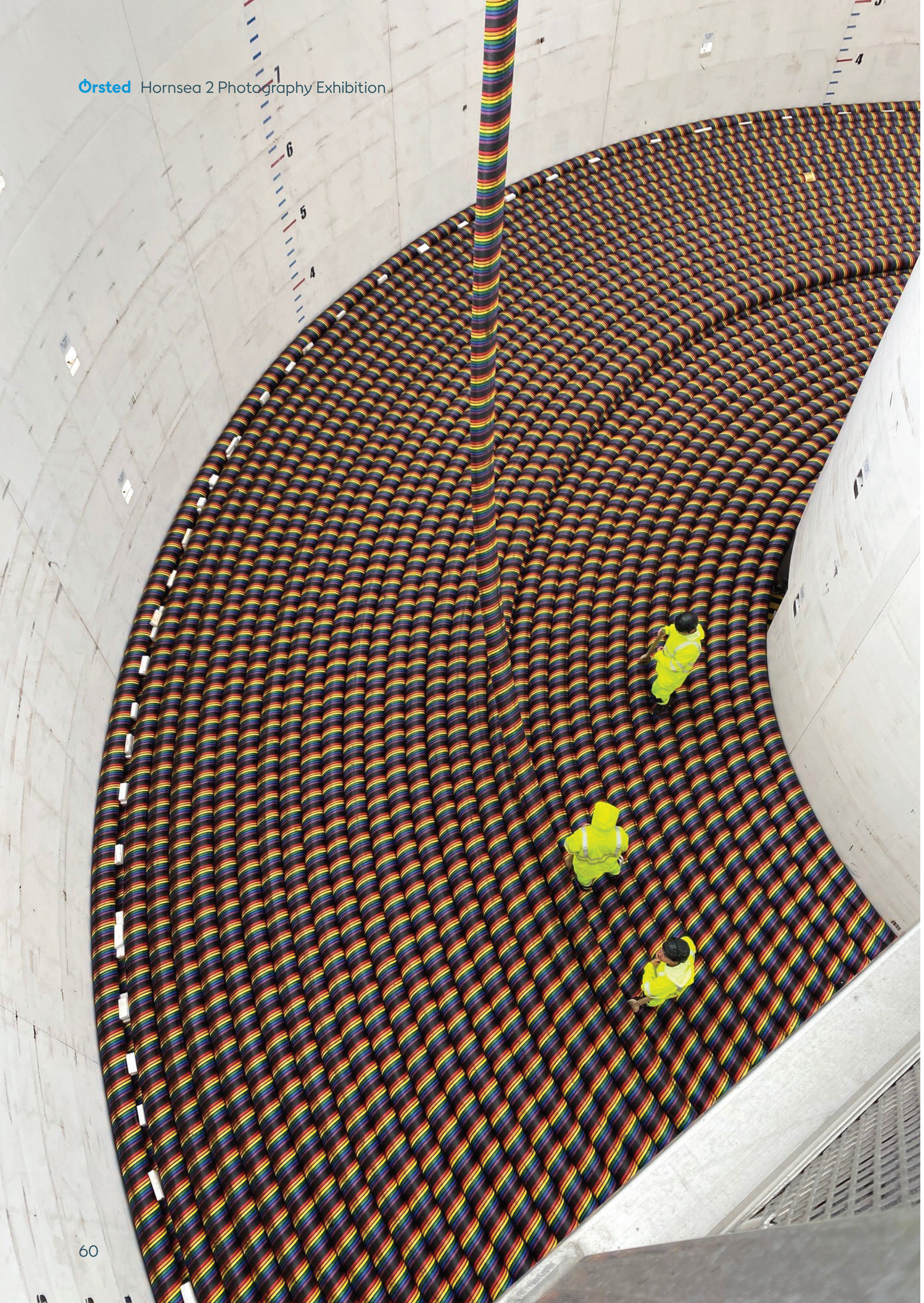
More than 200 people were involved in the commissioning and energisation of the transmission system (comprising the offshore substation (OSS), reactive compensation station (RCS) and export cables), which was completed on the 27th January 2022 after 52 days' intensive work.

Export cables

The NKT Victoria specialist cable laying vessel in the field. The export cable system transfers the power generated by our wind farm from the offshore substation (OSS) to landfall at Horseshoe Point via the reactive compensation station (RCS). The offshore export component consists of 390km of subsea export cable (three circuits of 130km) that connect to 39km of onshore cables stretching from landfall to the onshore substation at North Killingholme.

The NKT Victoria laid the section of cable between the RCS and OSS which had been produced at the NKT factory in Karlskrona. Each cable undergoes a series of quality tests before a final Factory Acceptance Test (FAT test) to confirm that they are ready to be loaded onto the vessels' carousels for installation.





Monitoring winding on the cable carousel onboard the NKT Victoria.
In this picture, the carousel on the cable installation vessel NKT Victoria is loaded with 66km of export cable for the NE circuit of Hornsea 2. Making sure the cable is uniformly wound is important to prevent it being accidentally damaged.

During installation offshore, the cable passes out of the main carousel through a gooseneck gantry, down onto the back deck, through cable tensioners and a jointing area before passing through a chute and being overboarded at the aft of the vessel. The cable is then monitored as it reaches the seabed using a remote operated vehicle.

Plough trenchers.
Two ploughs were used to bury our export cables, the type used depending on the hardness of the seabed. In softer, sandy soils, the HD3 plough (pictured) was towed on steel cables behind Boskalis' Ndurance to create a trench up to 3m deep. In stiffer clay soils, a larger mechanical plough nicknamed 'Megalodon' was used. This monster was 19m long, 8m wide, 6.5m high and weighed 75 tonnes! To pull it, we needed a more powerful vessel, the BOKA Falcon.

The Boskalis Ndurance cable laying vessel feeding cable onshore via rollers at Horseshoe Point.
To take the cable over the intertidal area at Horseshoe Point, special cable rollers and a landfall bridge were installed to bring it safely onshore, minimising disruption to the sand dunes which are a Site of Special Scientific Interest (SSSI).

Export cable being pulled ashore in a race against the tide.
This photograph shows the north east export cable pull-in, which took place on 26th June 2021. With Boskalis' Ndurance cable laying vessel backing up to the beach on anchors, a winch was used to pull the cable ashore.

Cable pull-ins are always tide-dependent, so the team had to wait for high tide before beginning. Once the cable was visible over the beach chute, the 1.8km beach pull continued through the night from 22:00 to 06:00.

Map of the cable route.
Three 220kV export cable circuits were installed by contract partner VolkerInfra beneath 39km of Lincolnshire countryside, running from Horseshoe Point to North Killingholme.

For most of the route, cables were laid in trenches that were subsequently backfilled, but the installation also involved a number of locations where major features (e.g. railway lines) had to be tunnelled under using horizontal directional drilling technology provided by AMS. The 39km construction corridor included 23 joint bays per circuit (reinforced steel-lined sections where cables are joined together).

Land reinstatement.
Land agents Dalcour Maclaren managed Ørsted's relationships with local landowners along the 39km onshore cable route, consulting with them throughout and overseeing land reinstatement and compensation payments to farmers for lost revenue during cable laying activities.

Onshore substation (ONS)

220kV reactor
This is one of the 220kV reactors which maximises the amount of power transmitted from our wind farm.

Hornsea 2's onshore substation (ONS) being constructed at North Killingholme.
The ONS' main purpose is to step up the power generated by our wind farm from 220kV to 400kV before onward transmission to the National Grid. It also ensures that the power we generate is stable, reliable and of sufficient quality to be transmitted to the network.

Construction of Hornsea 2's ONS started in April 2018. Balfour Beatty were responsible for the overall construction of the site, with Hitachi and LS Cables providing the high voltage components. The ONS was fully energised in September 2021.

Completed onshore substations.
Hornsea 2 (right) with Hornsea 1 (left).
Aerial view of the completed onshore substations at North Killingholme.

Operations

Ørsted's East Coast Hub operations and maintenance base in Grimsby.
The final piece of the jigsaw as far as Hornsea 2's construction team is concerned, is to make sure the wind farm is functioning perfectly before handing it over to Ørsted's operations and maintenance team, based at the company's East Coast Hub in Grimsby.

Like a test pilot in a new plane, the pre-handover process involves rigorously stress-testing every aspect of the wind farm, simulating numerous scenarios to make sure Hornsea 2 is stable, safe, reliable and compliant. Once all those tests are complete and handover documentation has been prepared and signed off, the wind farm will be 'system ready'. It will then be fully transferred to Ørsted's operations team, who will be responsible for the day-to-day running of the wind farm for at least the next 24 years!

Ørsted's Wind of Hope service operations vessel (SOV) in the field.
On 6 August 2021, the brand new 84 metre Wind of Hope SOV completed its sea trials and went into service. Built to support both Hornsea 2 and Hornsea 1, the Wind of Hope provides high quality accommodation for up to 60 wind turbine technicians working offshore. Facilities include a gym, hospital and cinema.

Thanks for coming!

We hope you enjoyed this brief glimpse behind the scenes of how the world's biggest offshore wind farm was built.

Constructing Hornsea 2 has been an incredible journey for everybody working on the project, and we would like to thank all our employees and contract partners for their hard work and commitment since the project began. It's great to know that every wind farm we build is reducing our reliance on fossil fuels and helping to power the world with green energy.

Thanks also to the people of Grimsby and all the community groups and businesses who have supported us over the years. We're proud to call Grimsby our home, and are delighted to be able to help local organisations through our community investment fund, sponsored events and outreach programmes.

To find out more about Ørsted and our Hornsea Zone projects, do have a look at our website: www.orsted.com. If you would like to download a copy of this brochure, you can use the QR code on the inside back cover.

Finally, if you have any comments or feedback on this exhibition, or just want to say hello, we'd love to hear from you. Please email: photoexhibition@orsted.com.

The Hornsea 2 Team

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