The Deutsche Bucht Offshore Wind Farm

Basic Press Kit

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Overview: Deutsche Bucht offshore wind farm

Deutsche Bucht is the third offshore wind farm of Canada-based independent power producer Northland Power. The offshore wind project is located in the North Sea, more than 100 kilometres from the mainland in the German Exclusive Economic Zone. Deutsche Bucht will use one of the most powerful offshore turbines currently available – MHI Vestas' 8.4 MW model. The wind farm has a grid connection capacity of approximately 269 megawatts. 33 wind turbines are expected to generate approximately 1.1 billion kilowatt hours of climate-friendly electricity per year, enough to meet the needs of approximately 328,000 households.

Two of the turbines will be installed for the first time on Mono Buckets as a pilot project. To test this new foundation type, the Federal Grid Agency (BNetzA) assigned the Deutsche Bucht wind farm 16.8 megawatts of additional grid connection capacity.

Various factors played a role in the site selection for this wind farm on the high seas. The area where Deutsche Bucht is located is characterised by favourable North Sea wind conditions. In addition, the project is ideally sited to minimize impacts on the environment, shipping and tourism.

Construction of the wind farm is due to commence in summer 2018. Completion of the commissioning phase is planned for the second half of 2019. The offshore wind farm Deutsche Bucht is being built by the project company Northland Deutsche Bucht based in Hamburg, which is 100 per cent owned by Northland Power Inc.

The Wind Farm

Location

The Deutsche Bucht wind farm is located over 100 kilometres from the German mainland. It lies in the German Exclusive Economic Zone, an area explicitly designated for economic development in the North Sea. The location offers optimal conditions for generating electricity, with consistently good wind conditions, and an average wind speed of around 10 metres per second. The depth of the water is around 40 metres.

As well as the wind speed and the constant winds, protection of the marine environment also played a significant role in the site selection. Deutsche Bucht is located some distance from the Wadden Sea National Park.

Another major factor in site selection was the safety of maritime traffic. The project was sited far from much-travelled shipping routes. The distance from the mainland is also an advantage for tourism: The project cannot be seen from the shore.

Size & Power

The Deutsche Bucht wind farm will install 33 MHI Vestas turbines of type V164-8.0 MW. This turbine has a rated output of 8.4 megawatts. With a grid connection capacity of almost 269 megawatts, Deutsche Bucht can produce up to 1,1 billion kilowatt hours of renewable energy a year, enough to supply more than 328,000 households with an average electricity consumption of 3,440 kilowatt hours.

Grid Connection

The transmission system operator TenneT is responsible for connecting the Deutsche Bucht wind farm to the German power grid. It collects the three-phase current from the offshore substation of the North Sea wind farm and transfers it to the BorWin beta converter station via two export cables.

The BorWin beta offshore converter station has been in operation since 2015, and by converting the three-phase current generated into direct current, it ensures that the electricity is brought on land with little loss. The onshore converter station in Diele converts the power back and feeds it into the German power grid. The direct current cable between the two converter stations runs for 125 kilometres through the North Sea and 75 kilometres overland.

Protecting the North Sea

Protection of the marine environment plays a major role throughout the project's lifecycle, beginning with site selection. For example, the Deutsche Bucht wind farm is located at a distance of over 100 kilometres from the coast, in an area which is designated for economic development and far removed from the Wadden Sea National Park.

The environmental impact assessment (EIA) is critical to the project's approval process, i.e. before permission is granted to build a wind farm. The EIA includes a detailed survey of the fauna and flora in the area of the wind farm. In carrying out this initial survey, wind farm developers must determine exactly which species among the so-called "protected assets of the marine environment" may be found on the site, and their populations. Species tracked include birds, fish, marine mammals such as porpoises and grey seals, and ocean floor life. Subsequently, a forecast of the possible impact of the wind farm is produced, based on the survey data. Project approval is only granted if the EIA leads to a positive result, meaning that the wind farm can be built in an environmentally-friendly manner.

The approval authority for the German Exclusive Economic Zone is the Federal Maritime and Hydrographic Agency of Germany (BSH); they have defined the scope of the examination in the standard examination concept "Investigation of the Impacts of Offshore Wind Turbines on the Marine Environment (StUK 4)". This survey also serves as the basis for monitoring the environment during a wind farm's construction and operating phases. At several defined intervals, local fauna and flora are examined in detail, to track and identify all potential impacts.

In addition to studies on the environmental impact, detailed concepts on soundproofing during the laying of foundations must be presented and implemented. Among marine mammals, porpoises, which are a protected species, are considered to be particularly sensitive to noise. As they use their

hearing to take their bearings, special rules apply for their protection in German waters: during the noise-intensive work to install the monopiles, the noise level must not exceed 160 decibels within a radius of 750 metres from the building site. The Deutsche Bucht project team is using a combination of two proven technologies as part of the noise mitigation concept: a hydro sound damper and a double Big Bubble Curtain.

A hydro sound damper (HSD) is a net which is placed around a monopile and lowered to the sea floor. Various foam elements (HSD elements) are fitted to the net to dampen the underwater noise at different frequencies during the noise-intensive work. A double Big Bubble Curtain is also deployed. It comprises two long hoses, each several hundred metres in length, with several holes throughout, which are laid in a circle around both the monopile building site and the installation vessel. Compressors pump air into both hoses, releasing air bubbles which travel upwards. This 'double big bubble curtain' stops the sound from propagating. The combination of these two systems, HSD and bubble curtain, is particularly effective, as the different effects of the two techniques result in the absorption of a wide frequency range of sound waves. The efficacy of the soundproofing systems is regularly reviewed as part of an efficiency check.

Further, Deutsche Bucht is the first commercial wind farm to test Mono Buckets as a type of foundation for two additional turbines. With this technique, foundations are anchored in the ground by a suction effect. This installation method is quiet and does not require additional soundproofing systems. This type of foundation can also be completely dismantled once the project is retired.

Environmental study on porpoise population

In 2014, three research organizations, BioConsult SH, IBL Umweltplanung and Institut für Angewandte Ökosystemforschung GmbH (IfAÖ) released a study on the impact of ramming noise on porpoises in the German Exclusive Economic Zone. In a comprehensive study covering the period from 2009 to 2013, they evaluated the data from eight offshore wind farms with a total of 400 foundations. The study found that overall, the porpoise population in the North Sea remained constant, in spite of a steady increase in foundation work. Soundproofing measures proved effective; during the direct pile-driving phase, with soundproofing measures in place, the animals did show a short-term avoidance reaction. This means they stayed away from the area during the noise-intensive work, for a distance of up to 14 kilometres. The study concludes that offshore wind farms have no negative consequences for the porpoise population in the North Sea.

Press release and study results „Effects of offshore pile driving on harbour porpoise abundance in the German Bight. Assessment of Noise Effects".

Technology & Construction

Foundation

The Deutsche Bucht wind farm's monopiles are steel tube piles measuring 8 metres in diameter, narrowing conically to 6.5 metres at the top, each weighing around 1,100 tons. A transition piece is fitted to the monopile foundation with a flange connection. The turbine tower is mounted on the transition piece. The joint between the transition piece and the turbine is approximately 17.5 metres above sea level.

Logistics: The marshalling port for the foundations is the brand new 290 meter long berth no. 4 of terminal operator Cuxport located in Cuxhaven. From there, they are loaded onto the installation vessel. A transport barge delivers the monopiles from Rostock as required, to be loaded directly onto the installation vessel. The transition pieces are brought to Cuxhaven from Spain by heavy lift vessel; they are then offloaded to interim storage until being transported to the construction site for installation.

Environment: A modern noise mitigation system will be used during installation of the monopiles, in order to minimize any impact on the environment and marine life. The system includes a Hydro Sound Damper (HSD) and a double Big Bubble Curtain.

Wind Turbines

The rated output of each of Deutsche Bucht's 33 V164-8.0 MW MHI Vestas offshore turbines is 8.4 megawatts. Per year, the Deutsche Bucht offshore wind farm is expected to produce approximately 1.1 billion kilowatt hours of offshore wind power - enough to supply more than 328,000 households with renewable energy.

Each turbine has three 80 metre rotor blades, equivalent to the length of nine London double-decker buses lined up in a row. The rotor area, i.e. the area described in the air by the rotors, is 21,124 m^2 - larger than the London Eye Ferris wheel. The height of the turbines is also enormous: the hub to which the rotors are attached, is a good 100 metres above the water level. The tip of the rotor blade is located almost 190 metres above the water.

The turbines are designed to make efficient use of the wind. They switch on automatically from a wind speed of 4 metres per second and start to generate electricity. They reach their peak output of 8.4 megawatts at 13.5 metres per second. In severe storm conditions, i.e. if the wind reaches speeds of 31.5 meters per second, equivalent to 113 kilometres per hour, the turbines will automatically shut down for safety reasons. Incidentally, the tips of the rotor blades reach a maximum speed of around 325 kilometres per hour.

Logistics: The marshalling harbour for the turbines is located in the Danish port of Esbjerg. The individual major components – rotor blades, hubs, nacelles and tower segments – are transported to Esbjerg from their places of manufacture. Pre-assembly of the towers is also carried out in the base port. The components are transported by jack-up vessel to the offshore wind farm for installation.

Operation and maintenance: Maintenance work on offshore turbines has to be well-planned, due to both the distance to the mainland and the weather conditions in the North Sea; 24-hour monitoring ensures constant online supervision during operation. An early warning system indicates malfunctions or possible technical problems in time to enable offshore service deployments to be well-planned. Northland and MHI Vestas Offshore Wind Germany GmbH, manufacturer of the turbines, have executed a 15-year service and maintenance contract.

Offshore Substation

Energy produced by the turbines is directed to the offshore substation and transformed from 33 kilovolts to 155 kilovolts. It is then transmitted to the BorWin beta converter station by grid operator TenneT.

The 4,500 ton, unmanned transformer substation has two components: the jacket foundation and the 19 metre high platform (topside). A total of five decks – four on the platform and one cable deck on the jacket – house all the electrical equipment needed to transform the current and connect the North Sea power station to the grid. This includes the power transformers and the high-voltage switchgear. Every deck is 22 metres wide and 33 metres long, with an area of approximately 730 square metres.

A helicopter pad located on the top deck, around 80 metres above the seabed, provides access to the transformer substation when transfers by vessel are not possible due to environmental conditions. This enables the accessibility required for planned maintenance and trouble-shooting, supporting smooth operations.

Logistics: Both components comprising the offshore substation – the jacket foundation and the topside – will be loaded onto offshore barges in Vlissingen in the Netherlands. They will be installed by Seaway Heavy Lifting's vessel Oleg Strashnov.

Inter-array Cabling

More than 40 kilometres of medium-voltage cables (33 kilovolts) will be laid on the Deutsche Bucht wind farm to convey the electricity generated by the 33 turbines to the offshore substation. There it will be transformed to its transmission voltage of 155 kilovolts for onward transmission to the mainland.

Four or five turbines are connected in a series; in total eight strings of turbines are connected to the substation. To enable reliable transmission and communication even in the event of a damaged cable, an emergency link is created by interconnecting two strings to form a ring circuit. This creates a bridge connection – a secondary route to direct electricity and communications to the wind turbines.

Power cables have strong sheathing to protect them from corrosion and wear that results from the severe environmental conditions in the North Sea, such as tides, salt water and waves. Fibre-optic conductors are also built into the cables to facilitate the high-speed exchange of data between the turbines and substation, and/or the control centre on land. This enables remote control and

monitoring of the turbines. Malfunctions or possible technical problems are displayed immediately and can be addressed efficiently.

Logistics: The submarine power cables are loaded onto Van Oord's cable-laying vessel at the cable manufacturers' production facility in Nordenham. From there they are transported to the North Sea and installed in defined corridors located up to 1.5 metres below the seabed.

Contractors – manufacturing, installation, project management

Balance of Plant

- General contractor: As the general contractor, Van Oord OW Germany GmbH ("Van Oord") is responsible for the design, procurement, manufacturing and installation of the Balance of Plant. This includes all trades on the wind farm, except the turbines; namely, the offshore substation, the foundations and inter-array cabling. Van Oord has commissioned sub-contractors to produce the individual components.
- Monopiles: Manufacturing - EEW Special Pipe Constructions GmbH; installation - Van Oord
- Transition piece: Manufacturing - Joint Venture Idesa and Windar Renovables, Spain; installation - Van Oord
- Inter-array cables: Manufacturing - Norddeutsche Seekabelwerke GmbH; installation - Van Oord
- Offshore Substation: Manufacturing - Joint Venture Iemants-Eiffage; installation - Seaway Heavy Lifting, installation vessel Oleg Strashnov

Wind Turbines

- Manufacturing and installation: MHI Vestas Offshore Wind Germany GmbH (installation vessel by Van Oord)

Project Management

- On behalf of Northland Deutsche Bucht, K2 Management is responsible for project management during the construction phase.

Company

Northland Power – Intelligent Energy for a Greener Planet

The 269 megawatt Deutsche Bucht wind farm is Northland Power's third North Sea wind farm. Northland Power Inc. (Northland) is a listed power company headquartered in Toronto, Canada. The company was founded in 1987, and develops, builds, owns and operates power facilities generating clean and green energy from natural gas, solar and wind power.

The Company owns or has an economic interest in 2,458 MW (2,029 net Northland interest) of operating generating capacity, including existing North Sea wind farms Gemini and Nordsee One, in which Northland Power has stakes of 60 and 85 percent, respectively. In addition, 1,044 MW (net 626 MW Northland interest) of grid capacity has been allocated to Northland's Hai Long 2 and 3 offshore wind projects in Taiwan, and the Company is pursuing additional growth, with significant opportunities across multiple development markets and technologies. Northland's cash flows are diversified over five geographically separate regions and regulatory jurisdictions in Canada and Europe.

At Northland, success is realized by focusing on continued growth and robust financial results. Northland's actions are guided by a commitment to excellence and sustainability by all definitions – environmental, financial and operational.

The offshore wind farm Deutsche Bucht is being built by the project company Northland Deutsche Bucht based in Hamburg, which is 100 per cent owned by Northland Power Inc.

Facts

Location:	North Sea, in the German Exclusive Economic Zone (EEZ) around 95 kilometres North-West of the island of Borkum
Area:	22.6 square kilometres
Water depth:	approximately 40 metres
Grid connection capacity:	268.8 megawatts
Production:	approximately 1.1 billion kilowatt hours per year, sufficient to supply 328,000 households
Turbines:	33 turbines of type V164-8.4 MW MHI Vestas Offshore Wind, including the pilot project with two turbines on Mono Bucket foundations
Rated output of turbines:	8.4 megawatts
Rotor diameter:	164 metres
Start of construction:	summer 2018
Scheduled commissioning:	second half of 2019
Investment:	approximately 1.4 billion Euros
Investor	Northland Power Inc.