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Hywind – Delivering the future technology to the world

Rajnish Sharma
Statoil

Abstract:

The Hywind concept has been developed since 2001, and has been successfully tested since 2009 through the Hywind Demo project in Norway. The concept consists of a standard offshore wind turbine on top of a ballasted slender steel cylinder, anchored to the seabed by three anchor lines. The substructure is suited for mass production, and inshore assembly reduces time and risk of offshore operations. The concept has beneficial motion characteristics, and uses a Statoil patented blade pitch control to dampen global motions.

The full-scale measurements and experience gained from the Hywind Demo project provided the basis for further developments of the Hywind concept to form the basis for a Hywind Scotland pilot park. The Hywind Scotland project was consented in October 2015, and has started construction. The 30 MW floating wind project consists of five 6MW turbines placed on a floating substructure and anchored to the seabed.

The purpose of the Hywind Scotland project is to demonstrate cost efficient solutions and to lower the risk of future utility scale deployment. The project will test that multiple units in a wind farm configuration and verify an upscale in design to 6 MW. Assembly and installation will be optimized, and we will verify the reliability and availability of a multi-turbine concept.

A marine license was granted in 2015, and lease was exercised in 2016. The project has firm grid connection. The substructure contract has been awarded to Navantia in Spain, and the turbine will be delivered by Siemens. The anchors will be constructed in Scotland. Hwyind Scotland will be installed in Buchan Deep outside Peterhead. Average wind speeds exceed 10 m/s, and the average wave height 1.8 m. The wind farm will be connected to the grid via a 30 km offshore and 1.5 km onshore 33 kV cable.

In addition a battery package (Batwind) will be installed as integrated part of the Hywind Scotland wind park. The objective of the Batwind pilot project is to install a 1 MWh lithium battery based storage system at the Hywind Scotland (HWS) wind park. The battery is expected to be placed inside one or several containers, located within a fenced area at the substation where the energy from the Hywind park is connected to the distribution grid. Batwind is important because it’s one of a handful of large-scale examples where companies are using storage devices to balance the variable power flows coming from a renewable energy generator. Batwind will mitigate the issue of variability in wind power, balance the system cost challenge related to increased renewables in the power mix.

The cost level of floating wind is expected to reach the same level as fixed in a mature market. Floating wind technologies will open up new acreage for offshore wind and enable more flexible siting. Floating wind is also beneficial from an environmental perspective; pilling is not needed, and the decommissioning will be simplified. Floating wind will also enable opening of new premium markets within the offshore wind segment, in the US, Europe and Japan.

Scale-up of wind turbine sizes and their impact on key floating offshore wind technologies

Bruno G Geschier and Thomas Choisnet
IDEOL

Abstract:

Following several pre-commercial arrays, the deployment of commercial size floating wind farms will reach an initial cruising altitude by the years 2023-2025 with projects expected on several continents. Several world-leading wind turbine manufacturers have launched development programs aiming at manufacturing wind turbines of 10MW and over. Looking at the evolution of offshore wind turbine sizes over the last 10 years as well as the current order backlog for turbines of 7 and 8MW one can easily agree that turbines of 10MW and more will defintely be part of the offshore landscape by 2023 – 2025. Leading project developers are in any case already including such scenarios in their consent application envelopes. With such highly probable evolution in mind and given the foreseeable share increase of floating in the renewable energy mix it seems important to review the key floating technology architectures and the impact such large wind turbines might have on their sizes, their constructability and their mass manufacturing, their launching at sea, their offshore installation and their O&M operations ; this with an eye on the inevitable race for cost reductions and further drops in the LCOE of floating wind.

Initial comparison of concrete and steel hulls in the case of Ideol’s square ring floating substructure

Thomas Choisnet and Bruno G Geschier

IDEOL

Abstract:

Summer of 2016 will see the start of the construction of both versions of Ideol’s square ring floater. Despite these hulls being constructed on different continents and under different class rules, some key differences and comparisons are worth highlighting and reviewing. From initial conception through hull and mooring system design, from installation methods through construction and launching, both concrete and steel hulls have their own specificities as well as their own areas where specific and particular attention need to be considered. Ideol’s square ring floater is currently the only solution that can be built using both materials, offering a unique flexibility in markets where either steel or concrete can be considered or where only steel or concrete are manageable given the specificities of a local supply chain.

Floating Offshore Wind with SCDnezzy 8.0 MW

Jan-christoph Hinrichs and Sönke Siegfriedsen

aerodyn engineering gmbh

Abstract:

SCDnezzy 8.0 MW is a two-bladed downwind floating offshore wind turbine. The guyed tower design is able to transfer thrust forces by steel wires direct into the mooring system. Avoiding tower bending loads the tower top is fixed with redundant steel wires to each leg of the Y-shaped foundation. The pre-stressed guyed structure allows a shaped tower cross section. Decreasing the tower shadow effect the tower cross section is optimized for less tower turbulence. Additionally the tower structure inclination is 10° with wind direction to increase the distance between tower and aerodynamic center of the blade. The Y-shaped foundation is build up from pre-stressed reinforced concrete with a specific and current depended shape. All floaters are build up from glass fiber reinforces plastics or steel and are accessible via boat for planned maintenance. SCDnezzys floating body is optimized for wave and current environment and the system is self-aligning with wind direction due to a single mooring point as mechanical and electrical interface. Instead of a yaw-system at the tower top the system will turn at the mooring point. A mayor advantage of the fully-integrated system is the possibility to assemble the system in a drydock where all necessary facilities are available. At first the concrete structure and the floaters will be assembled followed by the tower. In parallel the turbine itself contains all components for the drive train including the rotor is assembled. Next the turbine itself will be installed with only one lift to the tower top and the steel wires will be attached. All components are now installed and the system will be towed out only by a tug boat to the commissioning at the quayside. All components can be tested and after finishing the commissioning the system will be disconnected, towed out and reconnected at the wind farm site. Due to the holistic design approach the turbine and the foundation are carefully matched and can operate only as an integrated system. In consequence no special vessels like jackup or crane ships are needed for the installation. Regarding big water depths these vessels are not able to operate anyway. Operation site will not need any special seabed preparation or pile driving. The six anchors with anchor lines will be installed by conventional marine operation ships at operation site. This feature allows an easy exchange of the system if mayor parts have to be exchanged. Minimum operation water depth is 35 m and for bigger water depth the mooring system will be adapted. With a 5-year maintenance interval and the described features the installation cost and maintenance cost can be reduced significantly to a LCoE of 85 €/MWh.

Being Holistic on the path to cost reduction for offshore wind

What can we learn from each other to create a global offshore wind industry?

Jan Matthiesen

Carbon Trust

Abstract:

The offshore wind industry has seen considerable cost reduction and industrialisation in Europe. However, many countries struggle to reduce cost and commercialise offshore wind. This presentation will examine the potential cost reduction for offshore wind, lesson learned from European experience and will share a vision of a global offshore wind future. It will examine the potential of innovations to achieve cost reduction and will introduce the audience to the benefits of a collaborative approach to R&D – the Offshore Wind Accelerator.

Offshore Wind has seen many technologies with the potential to significantly impact the cost of energy – if commercialised in time.

Development: Technologies such as floating LIDAR are a tenth of the cost of conventional meteorological masts. However, the challenge is ensuring banks are comfortable with the accuracy of these wind records

Layouts and yields can be improved through enhanced wind resource assessment tools designed for offshore wind conditions. The challenge is proving these models can accurately simulate the physics of offshore wind flows.

CAPEX: There are a number of promising new larger turbines and innovative foundation designs that have the potential to significantly reduce the cost of offshore wind. However, before they can be approved for use on commercial projects, developers typically require two-years of operating experience.

Some innovators including the DONG Energy suction bucket jacket, Keystone’s “twisted jacket” and Universal Foundation offer the potential for significant CAPEX savings from reduced steel, serial fabrication and safer more expedient installation.

Floating wind is another emerging area of interest, which can unlock new markets for offshore wind in deeper water.

OPEX: There has been great progress in OPEX saving through innovative access solutions. Great designs like Fjellstrand and Umoe Mandal’s innovative crew transfer vessels are making a huge impact to turbine availability. The challenge here is understanding performance and quantifying the benefit of a new O&M strategy.

The challenge we face as an industry is getting these new ideas to market, creating attractive market conditions to drive investment and to upscale the industry to reduce cost.

The presentation will cover: Potential of cost reduction for offshore wind, The need for innovation to achieve cost reduction, Enablers to create attractive market conditions for investment, which will drive cost reduction in offshore wind. An assessment of the long-term outlook for cost reduction given the status of commercialisation. The material will draw on learnings from the Carbon Trust’s Offshore Wind Accelerator and observations from projects in the UK and overseas.

Japan: Steps towards market maturity and cost reduction

Magnus Christian Ebbesen and Carl Sixtensson

DNV GL

Abstract:

Japan has a strategy to enhance its share of renewable energy and reduce its dependency on nuclear power. Wind power is considered as one of the major sources of renewable energy for the future with adequate cost reduction. Based on this political background, in 2014, feed-in tariff (FIT) price for offshore wind has been introduced at 36 JPY/kWh (excluding tax) for 20 years for bottom fixed offshore wind turbine deployments. Though floating offshore wind turbines (FOWT) is still in the phase of technology validation, it is crucial to reduce the cost also for this industry, in order to meet this level and achieve market penetration of FOWT.

Although Europe may have installed the first floating wind turbines, Japan is rapidly taking the lead in floating wind technology. Largely triggered by the Fukushima nuclear disaster in 2011, the Japanese Government have invested considerably in floating wind projects in order to tap into the large potential for floating wind in Japan. While the floating wind projects installed in Japan to date have proven the technical feasibility of FOWT, the structures have had considerable cost and brought and uncertainty whether FIT and ultimately reach grid parity could be reached.

DNV GL has recently conducted a study to estimate the potential cost reduction from the current status of floating wind towards 2030. DNV GL has identified more than 30 cost reduction opportunities which together with a maturing market were estimated to lead to a 54% reduction in LCOE towards 2030. DNV GL will in the presentation describe the key cost reduction opportunities and how these are assumed to significantly lead to cost reduction. Some of the key cost reduction opportunities that will be presented and discussed are Increased rated power, Shared anchor points, Lifetime Extension, Optimized major replacement, Enhanced control systems for WTG, Improved drive train concept for the WTG, and Optimization of support structure design. DNV GL will also present estimates for the total floating wind capacity in the period and how this is considered to impact the supply chain and the cost.

While cost in itself is a significant barrier that needs to be overcome to achieve market penetration of FOWT in Japan, there are also other barriers such as the limitations in offshore experience, bottlenecks in the gird, low availability of installation vessels and the co-existence with the fishing industry that also could be important for the success of FOWT in Japan. DNV GL will in the presentation address these barriers and on how these potentially could be overcome.

Perspective on Offshore Wind in Japan

Yoichi Oda

MITSUI GLOBAL STRATEGIC STUDIES

Abstract:

If we would compare UK and Japan for example, there are similarities and differences. On one hand, both counties are surrounded by ocean. On the other hand, there is no commercial offshore wind in Japan because of differences from UK or European countries.

First step of the presentation is the study on what we can learn from European experiences and how Japan can create new offshore wind industry in the ocean. Second step is the recognition of the bottlenecks in Japan such as GRID, Stake Holder Management and so on. Third step is the foresight on the future Cost of Energy from offshore wind in Japan.

The purpose of this presentation is the study for the road map of offshore wind in Japan. The presentation will cover following items:

Developments:

- Since the world first offshore wind farm was installed in 1991 in small scale off shore Denmark, it was not a short way that CAPEX per MW of European offshore wind has tended to be lowering after 2007 or 2008.
- It would not be a short way too that Japan would achieve the competitive energy source but Japan can learn from European experience to create offshore wind industry.

Issues:

- GRID is one of the bottlenecks in Japan for offshore wind farm.
- Japan has less experience for zoning the ocean and stake holder management including fishery.
- Market size of Japanese offshore industry is much smaller than that of Europe but Japanese industry possess high technology capabilities.

Necessary Step:

- Strategic discussion seems to be effective to study the road map to create the new offshore market with the target of the cost of energy.

Measuring system and records of a 2MW floating offshore wind turbine

Shigesuke Ishida[1], Tadashi Nimura[1], Tomoaki Utsunomiya[2], Iku Sato[3] and Takashi Shiraishi[4]

[1]National Maritime Research Institute, [2]Kyushu University, [3]Toda Corporation, [4]Hitachi, Ltd.

Abstract:

The first grid-connected floating offshore wind turbine (FOWT) in Japan, with a 2MW turbine onboard, started its operation at sea in 2013 as the demonstration experiment of Ministry of the Environment. The site was off Kabashima island, Nagasaki prefecture, the southern part of Japan. It is unique that the support foundation is a hybrid spar, higher part made of steel and lower part made of pre-stressed concrete. The turbine is downwind type. After the experiment ended in March 2016, it started the second life as the world-first FOWT in commercial operation at 5km off Fukue island.

In the experiment many items were measured, for the floater part, such as its motions by GPS and a gyroscope, strain at 20 points by strain gauges, tension of a mooring chain by newly developed load cells of pressure type, motions of the power cable by 3-direction accelerometers attached at 3 points, and some others. The sampling frequency was 20Hz. The measurement was automatically conducted for 10 minutes every hour on the hour, however was occasionally continued without interval when storm attacked and some test was carried out. Through internet all data could be monitored and be downloaded. In this paper, the monitoring system is introduced with the overview of the measuring devices, which was good and which was not.

Some examples of data are also presented. From the whole record in the experiment the safety of the structure can be clarified even in stormy weather. From the distribution of strains it is understood that the spar behaves as single beam. From the spectrum analysis the frequency components of wave and natural frequencies are clearly recognized.