

## **Seeing Suction Buckets and Large Monopiles Cut Offshore Wind's Expenses**

Everyone knows that offshore wind energy costs need to continue to come down in order to gain more of the energy market from less sustainable options like fossil fuels. With foundations near the top of the list of potential places for offshore wind developers to spend their money, this is one area designers have been focusing on with great interest, especially since offshore turbine foundations are much more expensive than onshore ones. In fact, compared to the 5% to 9% onshore wind developments spend on foundation construction, the 21% that is often allocated to offshore wind developments is a significant jump, and therefore a potential source for savings. Making offshore wind energy more cost-effective will, therefore, depend a great deal on how well engineers can tweak their designs in order to minimize both installed and operational costs of these behemoth systems.

### **Dudgeon: Suction Bucket Jacket Foundations**

One of the rising stars in the world of offshore wind foundations is the suction bucket. This technology is not at all new, but the application to offshore wind is relatively. The design normally combines a jacket foundation with welded tubular space frames which are anchored firmly into place on the seabed by suction buckets. This bucket foundation (known as a suction caisson) has been in use in the oil and gas industry for more than 30 years, especially for platforms installed in the North Sea, and has seen much success. It is only recently that offshore wind foundation designers have started to consider this technology as an option for offshore wind applications.<sup>1</sup>



Image Via Flickr: [Darren B. Hillman](#)

Supporters of the suction bucket jacket foundation concept have suggested many benefits of using this system over other options. Suction bucket foundations are less costly to build compared to other foundations, and they also have far lower installation costs as well. Additionally,

they are more environmentally responsible in terms of the installation process. The suction process for securing these foundations to the seabed not only reduces installation noise, it also requires less time, which means a shorter marine environment impact. These environmental benefits of suction bucket technology will be significant, especially when it comes to markets such as Germany where environmental disturbances from installation noise must be limited.<sup>ii</sup>

And the idea seems to be gaining some traction in the wider offshore community. In January 2014, the UK government body Carbon Trust awarded £6 million (\$9.9 million) to DONG Energy to further speed up the development of the suction bucket foundation concept for deep water wind turbines. Through the Offshore Wind Accelerator programme (OWA) the Carbon Trust aims to achieve a full scale demonstration of the suction bucket jacket design through a prototype project.<sup>iii</sup>

The funds awarded by Carbon Trust will go toward a prototype installation using a new tripod structure based on an SPT Offshore design (a finalist in Carbon Trust's global competition to find lower cost foundation solutions for offshore wind<sup>iv</sup>) at the Borkum Riffgrund 1 wind farm off of Germany later in 2014. The aim is to have this technology finalized soon in order to use it in the 2017 UK Round 3 offshore projects.<sup>v</sup>

One example of the use of suction bucket foundation technology is that of the Dudgeon Offshore Wind Farm. Statoil and Statkraft, organizations that just recently acquired the Dudgeon Offshore Wind Farm 20 miles off of the Cromer coast, have changed the design of that farm which will include some new elements, such as suction bucket jacket foundations. Not only are they reducing the size of the entire project in order to avoid wake effects and increase efficiency, they are also looking to use suction bucket jacket foundations to offset the risks to foundation stability which is often a problem for chalk seabed.<sup>vi</sup>



Image Via Flickr: [RichardAsh1981](#)

According to Carbon Trust's CEO, Tom Delay, "Cutting the costs of offshore wind quickly is the greatest challenge facing the industry over the coming few years. Having identified that lower cost foundations remove significant cost we are delighted to be working with DONG Energy to take this exciting

design forward and sharing the concept with other players in the industry.”<sup>vii</sup>

## **Butendiek: Large Monopiles, Suction Buckets, & Customized Investigation Program**

Likewise, one of the defining features of the Butendiek offshore wind project is its foundation design which includes the use of suction bucket technology. The technology they have chosen - Universal Foundation Suction Bucket called a Suction Installed CAisson (SICA) - is an all-in-one substructure plus foundation that can support substations, wind turbines, and met masts. By applying suction during installation, they’re able to evacuate water and then once installed, the gravity foundation provides the support.<sup>viii</sup>

Though many of the details need to be confirmed with a real-world project, the proponents of this design tout benefits such as lower LCoE as well as shorter project schedules. They argue that given the right soil conditions and met ocean conditions, the bucket design is a very feasible support structure.<sup>ix</sup>

This suction bucket technology will be used in conjunction with large monopile foundations. The monopile foundations will be equipped with double-walled tube noise mitigation systems that enclose the monopile completely. This design will lower the emitted noise below critical values, ensuring the structures contribute minimal environmental disturbance. Further, at the base of the structure, a bubble curtain will surround the jacket foundation with compressed air pushed through hose holes to bring noise levels down even further.<sup>x</sup>

Another unique aspect about this project is that, given that it was one of the earliest offshore wind farms to be developed in Germany, the project required the creation of its own investigation programme for BSH. In the end, the process developed for this project became the benchmark for the basic guidelines for approval on many future offshore wind farms in Germany.<sup>xi</sup> The project also faced some regulatory challenges especially in light of the fact that Germany has very strict regulations for grid connectivity as well as regarding the impact on the environment during installation requiring specialized tools and systems which reduce vibrations or mitigate noise. Nevertheless, the Butendiek project overcame these issues and was able to reach financial closing in early 2013, giving a boost of confidence to the industry.<sup>xii</sup>

## **New Foundation Designs Reducing Installation Costs**

Combining technologies such as large monopiles and suction buckets is just one way the offshore wind industry is attempting to lower their installed and operational costs. Given DONG Energy's aim to reduce the costs of wind electricity by 40% for projects sanctioned by 2020, no doubt they and Carbon Trust and other developers like them are all banking on suction bucket technology to more cost effective. And the number suggest that it will be, though we have yet to see a full-scale installation completed and in operation. As these companies inch closer to a finalized design and finish their testing, it will be very interesting to see just how much they're able to lower installed costs and times.

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Maryruth can't help but seek out the keys to environmental sustainability - it's the fire that gets her leaping out of bed every day. With green writing interests that range from sustainable business practices to net-zero building designs, environmental health to cleantech, and green lifestyle choices to social entrepreneurship, Maryruth has been exploring and writing about earth-matters and ethics for over a decade. You can learn more about Maryruth's work on [JadeCreative.com](http://JadeCreative.com).

## Sources

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<sup>i</sup> *DONG Gets GBP 6 Mln for Suction Bucket Jacket.* (2014, January 28). Retrieved February 27, 2014, from offshoreWind.biz: <http://www.offshorewind.biz/2014/01/28/dong-gets-gbp-6-mln-for-suction-bucket-jacket/>

<sup>ii</sup> *DONG Energy and Carbon Trust team up to cut the costs of offshore wind: DONG Energy awarded £6m in co funding for new offshore wind turbine foundation.* (2014, January 28). Retrieved February 27, 2014, from Carbon Trust: <http://www.carbontrust.com/about-us/press/2014/01/dong-energy-and-carbon-trust-team-up-to-cut-the-costs-of-offshore-wind>

<sup>iii</sup> *DONG Gets GBP 6 Mln for Suction Bucket Jacket.* (2014, January 28). Retrieved February 27, 2014, from offshoreWind.biz: <http://www.offshorewind.biz/2014/01/28/dong-gets-gbp-6-mln-for-suction-bucket-jacket/>

<sup>iv</sup> *DONG Gets GBP 6 Mln for Suction Bucket Jacket.* (2014, January 28). Retrieved February 27, 2014, from offshoreWind.biz: <http://www.offshorewind.biz/2014/01/28/dong-gets-gbp-6-mln-for-suction-bucket-jacket/>

<sup>v</sup> Snieckus, D. (2014, January 28). *UK backs Dong for 'suction bucket'.* Retrieved February 27, 2014, from RECHARGE: <http://www.rechargenews.com/wind/offshore/article1350487.ece>

<sup>vi</sup> *Dudgeon Offshore Submits Applications to Vary Its Offshore Consents (UK).* (2013, August 30). Retrieved February 27, 2013, from offshoreWIND.biz: <http://www.offshorewind.biz/2013/08/30/dudgeon-offshore-submits-applications-to-vary-its-offshore-consents-uk/>

<sup>vii</sup> *DONG Energy and Carbon Trust team up to cut the costs of offshore wind: DONG Energy awarded £6m in co funding for new offshore wind turbine foundation.* (2014, January 28). Retrieved February 27, 2014, from Carbon Trust: <http://www.carbontrust.com/about-us/press/2014/01/dong-energy-and-carbon-trust-team-up-to-cut-the-costs-of-offshore-wind>

<sup>viii</sup> *Universal Foundation Suction Bucket: A solution in support for offshore wind.* (2013, April). Retrieved February 27, 2014, from Red Olsen United: [http://www.windpower.org/download/1922/14\\_Universal\\_Foundation\\_Suction\\_Bucket\\_Henrik\\_Lundorf.pdf](http://www.windpower.org/download/1922/14_Universal_Foundation_Suction_Bucket_Henrik_Lundorf.pdf)

<sup>ix</sup> *Universal Foundation Suction Bucket: A solution in support for offshore wind.* (2013, April). Retrieved February 27, 2014, from Red Olsen United: [http://www.windpower.org/download/1922/14\\_Universal\\_Foundation\\_Suction\\_Bucket\\_Henrik\\_Lundorf.pdf](http://www.windpower.org/download/1922/14_Universal_Foundation_Suction_Bucket_Henrik_Lundorf.pdf)

<sup>x</sup> *Noise Mitigation.* (n.d.). Retrieved February 27, 2014, from Butendiek: <http://www.owp-butendiek.de/environment/noise-mitigation/>

<sup>xi</sup> *State of the Offshore Wind Industry in Northern Europe: Lessons Learnt in the First Decade.* (2011). Retrieved February 27, 2014, from Green Offshore.dk: [http://greenoffshore.dk/wp-content/uploads/State-of-the-Offshore-Wind-Industry-in-Northern-Europe\\_Lessons-learned-in-the-first-Decade-1.pdf](http://greenoffshore.dk/wp-content/uploads/State-of-the-Offshore-Wind-Industry-in-Northern-Europe_Lessons-learned-in-the-first-Decade-1.pdf)

<sup>xii</sup> Hahn, M. (2013, October 17). *Offshore Wind Market and Economic Analysis: Annual Market Assessment.* Retrieved February 27, 2014, from US Department of Energy: [http://www1.eere.energy.gov/wind/pdfs/offshore\\_wind\\_market\\_and\\_economic\\_analysis\\_10\\_2013.pdf](http://www1.eere.energy.gov/wind/pdfs/offshore_wind_market_and_economic_analysis_10_2013.pdf)