In deep water with tension leg platform design

The installation procedure of the ECO TLP® system for floating foundations, which is designed for extra-large (XXL) wind turbine generators in deep water, is a patented innovation capable of operating in water depths of up to 2000 meters. PES was keen to gain insight into the technology and the benefits it brings to the offshore wind sector. Chief Technology Officer, Jelte Kymmell, and Chief Executive Officer, Nicole Johnson Murphy were eager to shed light on the subject.

PES: I'm fascinated to learn more about ECO TLP®'s installation process. Am I correct in believing that it has been identified as a preferred solution for 24GW+ of deep water floating arrays worldwide?

Nicole Johnson Murphy: As floating offshore wind arrays have finally begun to line up to complement fixed bottom arrays, several developers have identified extreme depth installation areas across all continents. For these, many see that ECO TLP®'s installation process works well, both from a technical and cost perspective. We allow them to find margin and cost savings in their projects.

So far, our pipeline adds up to well over 24 GW+ of potential ECO TLP supported wind farms. The world is a game board for offshore wind at the moment, so it's hard to predict how the developers' intended plans will play out, but we are preparing for this pipeline by simplifying our process, lining up a non-proprietary, i.e., competitively bid supply chain and applying AI to optimise aspects of our installation to help them predict technical and economic success.

PES: What makes it the preferred option? Is it a combination of cost, ease of installation and other factors?

NJM: The key to any complex endeavor, of which installing floating offshore wind qualifies, is to limit the points of failure along the way. We provide a solution that tackles this during the installation and over the long-term operation and maintenance phase. We developed a predictable process that offers clients control and we have value engineered our cost inputs from day one.

The solution stems from a practical, rather than a hydrodynamics first approach. So it looks different from other solutions, but we achieve the main objectives of stabilising the wind turbine generators (WTGs) over the lifespan of the array, limiting motion at the nacelle, maximizing the energy capacity factor and allowing easy access for servicing the equipment.

Jelte Kymmell: For deeper waters it is indeed the preferred option. It can be produced anywhere in the world with a standard local workforce, it significantly increases the amount of renewable energy per lease area and it is fast and cost effective to produce while using a small footprint. It is easy to install, it is low in maintenance cost and friendly to the WTG due to the unrivalled motion response.

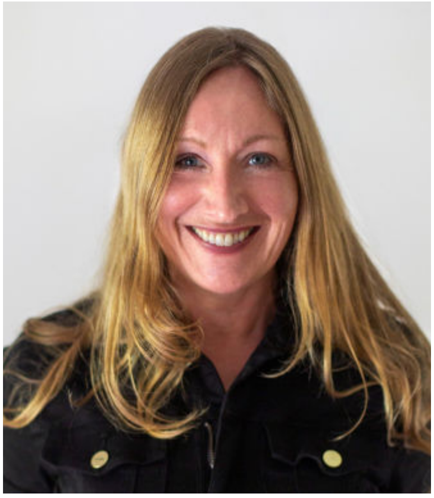
The ECO TLP® has been designed keeping in mind all relevant stakeholders that will play a role in realising a floating array. Our design cycle addresses the key risks in developing large scale floating wind farms.

PES: Just how deep is deep water? What's the range and where typically are you seeing your innovation being put to use?

JK: As with any tension leg platform type concept we need some water depth. Our optimal, most economical installation is between 250 to 2000 m depth off coastlines like the US west coast and areas where content and labor requirements are amenable. For our solution, this covers most anywhere that has access to concrete and where this water depth range is close enough to shore to the power off-take resource to accommodate transmission.

PES: How is it possible to scale with XXL floating offshore wind turbines while also keeping the cost of installation and O&M in check? These are obviously important factors, so it's good to know there is a solution out there, but how does it work?

JK: For floating wind to become a mature and economically self-sustaining industry it is essential to think big. This means 15 to 25 MW turbines in parks of 1 GW in 1000 m or deeper waters. To achieve this, the supporting foundations have to scale up rapidly, in size, fabrication capacity and in installation capacity. We have identified early in the design process that steel structures become difficult to scale up due to welding related issues, as well as very limited content, yard and workforce capacity. However, changing the concept to a slip formed concrete solution helps resolve or complement production.



Nicole Johnson Murphy

Jelte Kymmell

Further, there are scale limits related to the availability of crane vessels to install the WTG onto the foundations offshore. We therefore designed a stable system to carry the WTG, via wet tow, from the yard without the requirement for an offshore crane vessel for installation and service. The cost of O&M is often overlooked in the early design phase, but can often form the largest part of the life-time-cost of an offshore WTG. Floating wind will typically be further from shore, so this will only make accessibility more difficult.

By using concrete instead of steel, we prevent issues related to painting, cathodic protection corrosion resulting in significant reduction in O&M costs on the floater. O&M on the WTG benefits from the improved motion response of tension leg platforms (TLP) compared to catenary moored systems.

NJM: Relative to WTG size increases, our floater size increase is relatively small and that footprint helps maximize the energy capacity of the array.

A concrete solution provides an opportunity to set up a production line parallel to a steel production line to install arrays more quickly.

PES: Can you explain about the parameters for installation? How are these set and what is the reasoning behind them?

JK: We have developed a parametric design model that includes the outcome of a very high number of automated analyses runs. The data generated allows us to quickly determine the key parameters of any site-specific ECO TLP® based on site conditions such as wave, current and wind climate, water depth and port facilities. The installation methodology is designed around this parametric model, so that in each site we can adopt at least two effective installation methods.

The key parameters that are most relevant for the installation method are the bathymetry near the fabrication yard and the availability of heavy lift vessels. But rest assured, our default assumption is that there are no heavy lift vessels available, so we have adopted a vessel independent installation sequence. This sequence relies on ECO TLP®'s own spar-like stability and the use of pumping water or air to lift and lower any structure weighing over a 1000 m.

PES: Technical simplicity is important isn't it? How do you ensure this requirement is met on something that could so easily be quite complex?

JK: Concepts should be easy to understand and based on proven technology. The parties who will be financing these projects typically agree with this philosophy. They focus on mitigating financial risk and uncertainty. For instance, the simple shape of the ECO TLP® is optimised not only for hydrodynamic response, but also for scalability in size and production speed, as well as installation costs. Pouring concrete by slip-forming is relatively simple and fast compared to welding thick walled steel, especially if there are no shipyards around. This avoids a large number of risks that could ground the project due to lack of funding.

PES: Can you explain the cost reduction advantages, in real terms of money saved by adopting this system and the benefits of this over other methods perhaps?

NJM: Project procurement success relies upon the ability to competitively bid input components, to not be tied to a single, proprietary source. By design, our installation process meets this goal. Our component and labor inputs are available worldwide and can be included in a localised project model that still achieves the technical installation requirements.

Reducing the longer term O&M around these arrays is critical to asset owners and, though we cannot control the WTG and cable equipment costs, we can limit motion impact on this equipment. We provide ease of access and a low maintenance solution for the foundation portion of the installation.

PES: Each ECO TLP® foundation offers megatons of carbon removal, creating a form of carbon sink and an artificial reef marine habitat. The foundation offers energy storage capabilities as well. The environmental benefits weigh up don't they?

NJM: Absolutely. An installation of the magnitude of floating offshore wind has the opportunity to offer more than one thing, more than just hold up the WTG. These added benefits are inherent to our solution so, we would like to optimise them over the long-term life of the array. We do not rely on these added bonuses, however. Our main objective is to offer a cost effective solution. Yet while doing so, we can have a further net positive impact on the ocean and the overall climate targets.

PES: Is maintenance over time a particular challenge though? How do you ensure that this is as straightforward as possible?

JK: Maintenance costs contribute the largest part of the life-time costs in fixed offshore wind farms. For more distant floating wind farms in deeper waters this will likely be even more so. It is relevant to identify the maintenance requirements for the mooring, the floater and the WTG itself. The WTG will most likely govern maintenance cost.

The ECO TLP®, however, minimises this by providing a stable platform in heave, enabling better accessibility and due to the small water cross sectional area and mooring pretension it results in less nacelle motions and in turn reducing fatigue related damage. It has neither mechanical nor ballasting systems that require monitoring, nor does the platform require painting below sea level. The primary monitoring will be on the points of connection at the tendons, which is easily achieved.

Also, I think it is relevant to note that compared to other TLP concepts we will remain upright in the unlikely event that we lose one of the four tendons. Our unique hybrid spar-tlp solution enables this. This implies that the consequence of such an event is much smaller, which in turn results in a less stringent maintenance schedule.

PES: Overall then, what would you say are the biggest advantages of the system and are there plans in the pipeline to make it even better, to meet new demands in the future?

NJM: It's a simple, low-cost solution that employs a standardised, predictable serial production process. It allows our clients an area in which to find margin, to make a project pencil.

Beyond the economic benefits of local content inclusion, it offers community members a sense of pride and connection to what they have built. These are challenging, large scale feats of installation and so offering that participation can have a significant, positive impact for generations.

Many countries around the world do not have access to large government subsidies yet deserve access to clean energy. Our mission was to develop a solution that can participate without subsidy, to offer a way to install offshore wind economically everywhere.

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