New sizing of wind turbine generators (WTGs) requires a new perspective of wind towers

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The wind market is continuously evolving to bigger and more powerful WTGs, both onshore and offshore, each one has its limitations, but they need to include new solutions and continue to reduce the associated LCoE. Until now, the onshore market has represented approximately 70% of the total MW installed (GWEC), but offshore is growing.

Onshore WTGs are evolving from 2-3 MW to 5-6MW platforms, but will be close to 8MW and more in the years to come.

Each wind farm placement will determine the best configuration of the WTGs and the associated tower with the existing technology. However, the logistical requirements of the whole process will determine the feasibility of the final options.

Low wind sites require higher towers, forest and plains, on the other hand, higher towers bring a homogeneous flow that is better for the WTG component lifecycle and reduces O&M costs. Anyway, extra height supposes extra yearly MWh production.

High wind sites usually are on top of mountains with no easy access, where WTGs <2MW were installed. Gusty wind reduces the lifetime of the WTG components. Now a lot of the first wind farms are waiting to be repowered, but due to logistical restrictions, the new WTGs cannot be placed on these sites.

Offshore WTGs are growing from 8MW to 12-15MW and the next developments are focused on 20MW

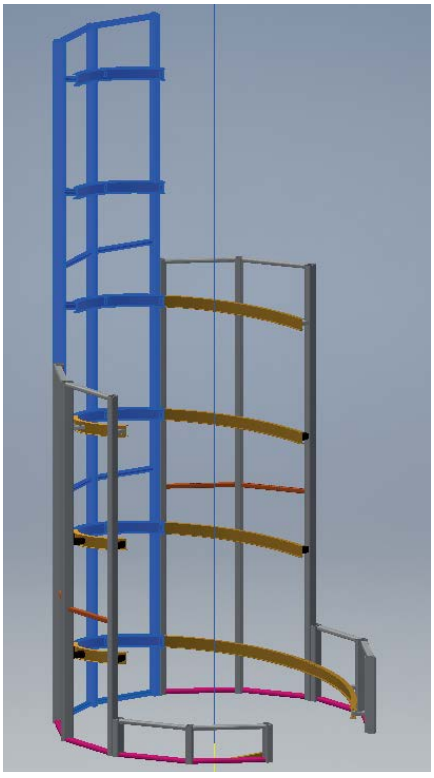
Offshore wind market providers are usually close to ports to avoid logistical limitations due to the massive size of components, this is the reason for the difference from the onshore market. The offshore market is divided into fixed and floating, where the O&M of WTGs will be decisive for the final LCoE.

The increasing component size of both markets means there is a need to explore new solutions. These need to be more competitive, keeping in mind an affordable production, reducing the associated carbon footprint of renewables. The only way to reach new limits is to use modular components.

WunderOcean is focused on developing renewables software to optimize the location of the offshore wind farms (LOOP Wind), offshore commercial projects and working on Self-erecting Towers (SeT), in collaboration with The University of Coimbra. A Portuguese grant towards the IDT program, which is a patented system that uses standardized modular components to fulfil the new requirements of WTGs.

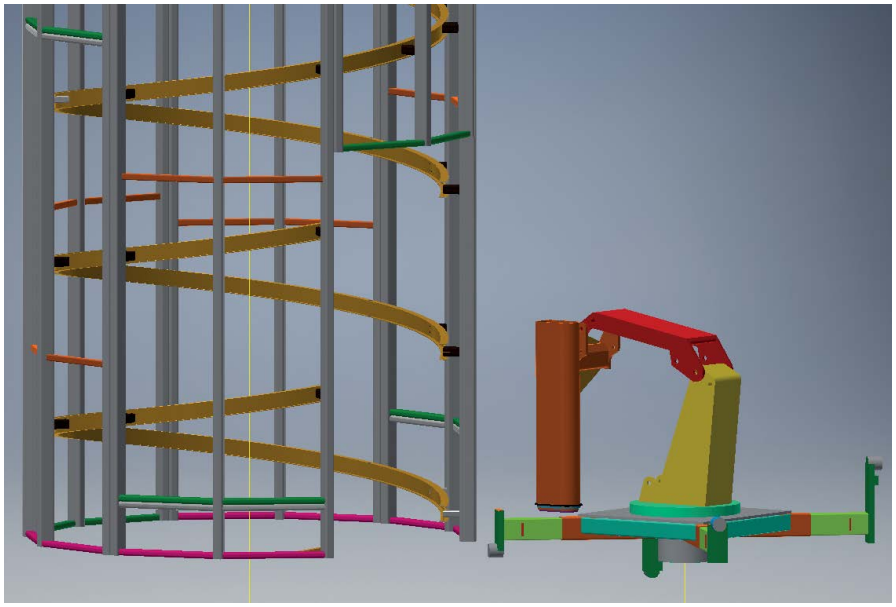
SeT reduces the whole impact of the wind farms before manufacturing to dismantling, both onshore and offshore, thanks to the modularity

SeT is composed of unique geometry, scalable to any size that uses standard



Embedded foundation simulation

Adapting shell foundation
Blue: foundation transition



Schematic standard crane over adapted platform approximation
NB: frame does not include shell cover to allow for helical rail

market components to generate a structure built in a self-lifting system. Shell production can be highly industrialized thanks to standard raw materials, no flanges, no huge plates, an increasing number of providers and H&S conditions. Indirectly it reduces incidences, logistics, infrastructure and energy consumption during manufacturing enabling the global scope of providers and emerging countries.

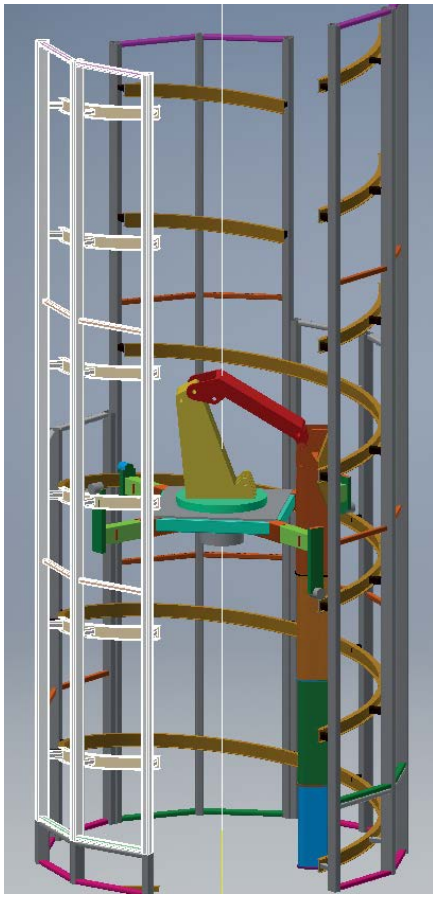
Shell geometry does not require special storage or transport, thus avoiding logistical limitations, increasing the placements and reducing the wind farm access requirements, environmental impact and the associated carbon footprint.

During assembly, the shells generate an internal helical rail to hold the crane platform and lifting components. The platform rises from the helical rail without any extra load until the safety position is blocked. Then each shell is hoisted without needing to use huge cranes and there is no height restriction for the tower. Mechanical joints are used to raise the instant rigidity of sloped shells on each ring, avoiding flanges or grout.

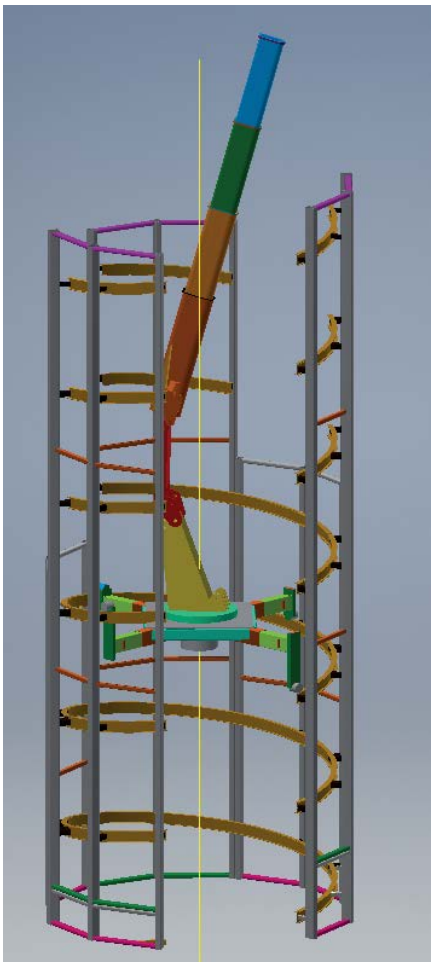
On top of the tower, the standard crane over the platform is used to couple the rest of the components of the nacelle housing. This includes lifting components to hoist into modular nacelle components. The cylindrical tower generates extra space in the nacelle, allowing the optimal placement of components in the modular chassis.

Nacelle housing will allow self-maintenance, crucial for the offshore market and dismantling operations. SeT has several adaptations for each WTG manufacturer, from wind turbine carrier to modular chassis, enabling internal or external hoisting of WTG components. A preliminary design has been done for a 3.4MW by 160m high hub rotor. SeT could exceed a 200m high hub with a small geometrical adaptation.

Ultra-high towers are focused on the onshore market, so no cranes dependency will reduce costs during the O&M and dismantling. These placements of medium-low wind were previously discarded because until now this type of towers had a huge financial impact due to costs not being proportional for +130m towers.



Self-positioning crane to rail. White: shell sizing

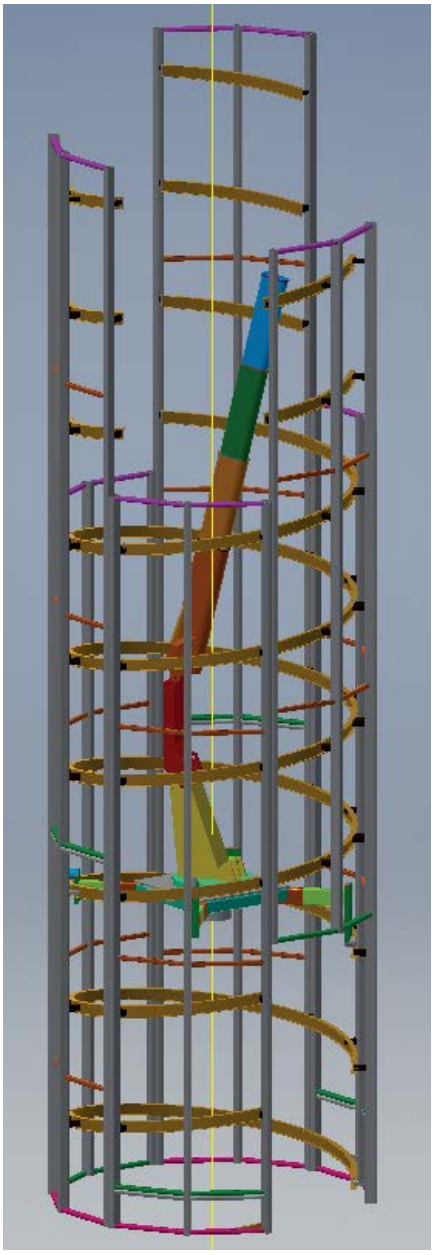


Fixed platform to start self-hoisting process

‘Possibly this is the way to attain true ‘net zero emissions’ and offer to emerging countries the opportunity to obtain renewables.’

Now a single tower wind farm project is viable, no minimum number of WTGs, keeping proportional costs and offering the opportunity of creating wind energy communities to expand renewables, not only PV.

Once again, modular components are going to be the key element to the reduction of the associated carbon footprint in the wind market and reaching emerging countries, where logistics and infrastructures are not the best and improving the local manpower and supply chain.



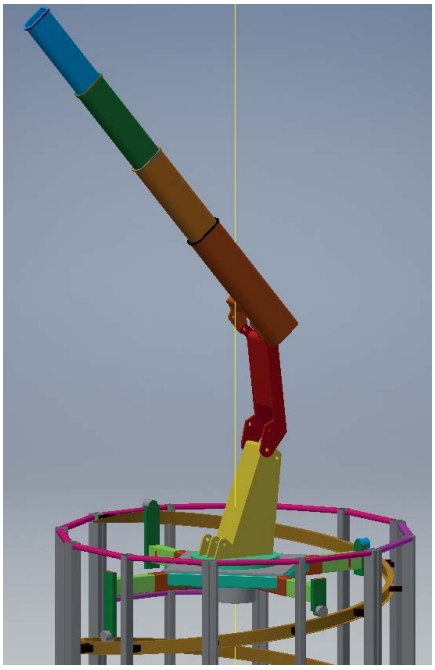
No height limitation geometry

WTGs are divided into horizontal (HAWTG) and vertical (VAWTG) axis geometry, so SeT can contain both technologies, because of the high capability of adapting the diameter and top tower geometry. It can be adapted to hold disruptive configurations such as generators, even coupled tested geometries instead of up-scaling generators, which would increase materials and manufacturing technologies: bigger components, so bigger manufacturing facilities are required.

The offshore market

The offshore market does not need the same extra height as onshore due to the higher density of air, but WTG requirements will be bigger than onshore, which means a bigger diameter for towers.

At this point, a nacelle housing that provides O&M independence will be decisive, especially for floating wind farms, to avoid risky and expensive procedures after commissioning, using only standard vessels. Fixed offshore can use specific large jack-up vessels, but floating will need massive platforms to make huge corrections on WTGs. SeT also plans gravity, like a modified ultra-high onshore tower and floating foundation version for the offshore market.



Top tower leveling

The offshore market is managed by big players due to massive structures involved and associated logistical requirements, once again modularity will generate a diversification of providers and a reduction of the logistics’ needs.

Currently, WunderOcean is collaborating to develop a ‘Blind Bolting System’ (BBS) for high strength connections, with only one side access. A patent to get modular structures that help to avoid critical welds, using mechanical joints that are easy to industrialize and check, which decrease risks and logistical requirements.

The ‘BBS’ applications could be the floating offshore platforms or jackets: outside surface, or bolted towers: inside surface. However, it also can be used for industrial and civil construction. It will help to accelerate the offshore floating wind, avoiding huge shipyards requirements to manufacture them a slow and expensive welding process and allowing new, or restructured industrial ports to offshore wind terminals, for the assembly of these massive platform structures.

Renewables is still an emerging sector representing huge opportunities for the R&D companies to cover the gaps left by the big players, especially analyzing disruptive concepts, hybrid and wasted materials.

So the wind market must continue evolving to be more competitive, but also diversify the use of providers, such as smaller companies through modular components to decentralize the industrial production and contributing to reaching the UN 17 Sustainable Development Goals, because most of them are linked.

In parallel, renewables must follow a green philosophy and should focus on the whole carbon footprint reduction, not only to install new renewables resources. This way the impact before installations has also a huge value and the industry must adapt to it. Possibly this is the way to attain true ‘net zero emissions’ and offer to emerging countries the opportunity to obtain renewables.

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