ELECTRIC POWER RESEARCH INSTITUTE

ZEUS HEAVY LIFTING SYSTEM FOR WIND TURBINES WITH VERY TALL CONCRETE TOWERS

For Any Height, For Any Turbine, No Mobile Cranes Required

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The companies VSL and INGECID have developed a new lifting solution called the Zeus Heaving Lifting System (HLS) for the installation of wind turbines on very tall concrete towers. The Zeus HLS uses the concrete tower as a vertical support and enables lifting and installing the nacelle and rotor with no limitations on tower height.

The world market for wind power is booming like never before, and, since its origin, wind tower technology has continuously evolved. Today, the wind power industry is characterized by rapid growth—not only in cumulative installed capacity, but also in increases to turbine power ratings, rotor sizes, and tower heights to reduce the cost of the electricity produced. Higher energy capture through larger, lower-specific-power rotors [1] and access to higher wind speeds thanks to increasingly taller wind towers that can support more powerful wind turbines [2, 3] are making wind power a very competitive source of renewable electricity generation.

For the industry to expand its use of very tall (140+ m) towers that will further increase wind turbine capacity factors, it will need to overcome a significant logistical barrier. Lifting cranes powerful enough to install, service, and replace heavy equipment (such as rotors and nacelles) on uneven terrain and under high-wind conditions have been the only option to date. The cost to build and move these special cranes is the first factor—the mobilization of them for the purpose of erecting turbines on very tall towers can easily involve more than 50 trucks and five special transports. The second problem is the limited availability of large lifting cranes.

Therefore, the development of a more economical lifting concept is key to decreasing the cost of installation and facilitating the adoption of very tall wind turbine towers. The Zeus HLS concept provides a solution that is light and easy to mobilize, consisting of fewer elements to assemble compared with those for large mobile cranes. The system can be transported in only 10 trucks, does not require special road access or ground preparation, and demands only a small footprint area for assembly. Also, the mobilization operation between towers inside the farm can be performed without disassembling the platform structure.

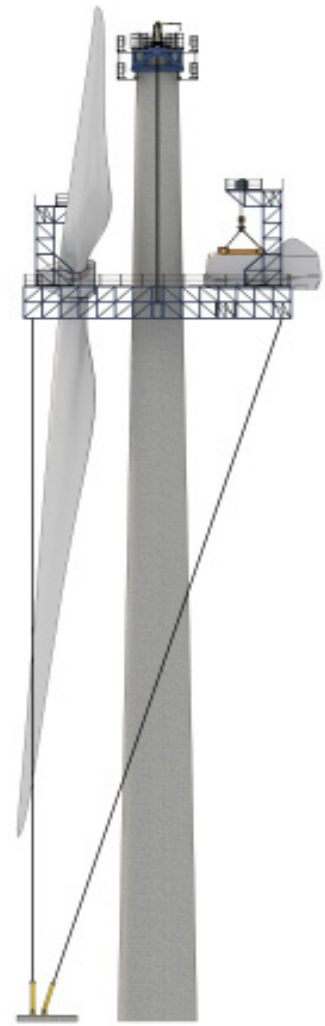

Figure 1 – The Zeus HLS during the nacelle and rotor installation

The loads transmitted to the concrete tower are lower than the design loads, and the system can operate in wind speeds of up to 25 m/s. Furthermore, the Zeus HLS can be used for maintenance and repair jobs requiring tower downloading of heavy components. It can also be used to dismantle or decommission nacelles, rotors, and other heavy elements at the end of their useful life.

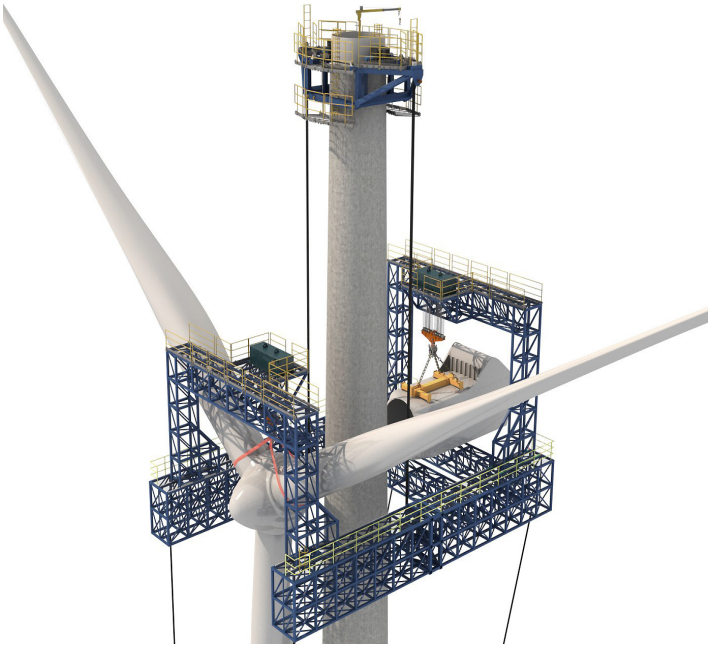

Figure 2 – Zeus HLS during lifting operation

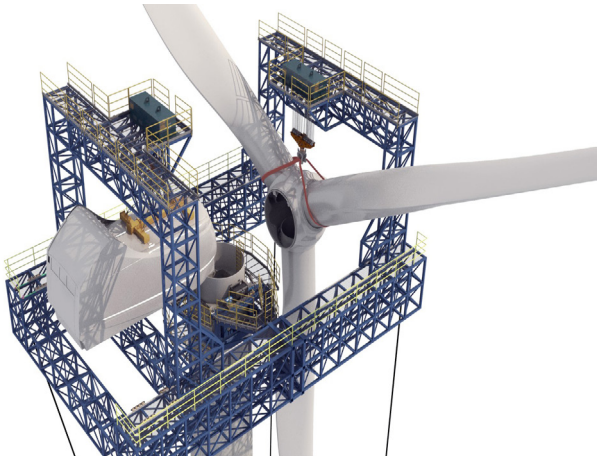

Figure 3 – Zeus HLS during the installation of the rotor and nacelle

Figure 1 shows the main components of the Zeus HLS. The system consists of a light steel platform unit with self-lifting/lowering capability and an anchoring system installed on the top of the tower. The lifting/lowering process is performed by strand-jacking lifting equipment installed on the platform and supported by the anchoring system (see Figure 2).

The platform's main components are two longitudinal beams, placed on both sides of the tower and connected by a cross-beam, and two portal frames located over the longitudinal beams to suspend the nacelle and rotor (see Figure 3). The system is equipped with tie-down cables anchored to the ground that compensate for the difference in weights during lifting and horizontal movements of the nacelle and rotor.

For ease of mobilization, the lifting equipment is located inside the platform. The lifting cables extend vertically from the platform to the tower's top unit. The lifting equipment consists of four sets of hydraulic strand jacking units climbing up the lifting cables by intermittent mechanical gripping action. Each strand jacking unit is made up of a pair of hydraulic strand lifting jacks (type VSL SLU) arranged as a tandem unit. This allows a continuous lifting operation with high lifting speeds.

The anchorage for the lifting cables is provided inside the tower's top unit (see Figure 4). The anchoring unit is made up of modules lighter than 2.5 t so that it can be dismantled using the nacelle crane. Therefore, the installation and dismantling process can be performed without external cranes.

Figure 4 – General view of the anchoring system

The installation of the anchoring unit can be completed in 7 hours. It starts with the placement of a small winch inside the top of the tower, which is used to install the working platforms and two frames at opposite faces of the tower. The frames are supported in the openings on the tower top (left for this purpose). Subsequently, two winches of higher capacity (15 t) are lifted and installed on the support frames. These winches are used to lift the brackets, at the end of which the lifting cables are fixed. Figure 5 illustrates the installation of the anchoring system.

Once the anchoring system is installed, the platform is assembled at the base of the tower and connected to the lifting cables attached to the tower top unit. Then, the nacelle is picked up by the corresponding portal frame. The rotor is fully assembled on the ground under the second portal frame and subsequently suspended at the hub in a horizontal position and mounted to the frame. During the lifting operation of the platform, the rotor is rotated from a flat position to an upright position with the assistance of a small support crane.

As stated previously, the system is equipped with tie-down cables, eliminating the need to use counterweights to counteract the overturning moment created by the different weights of the nacelle and rotor while minimizing the size of the lifting platform. The

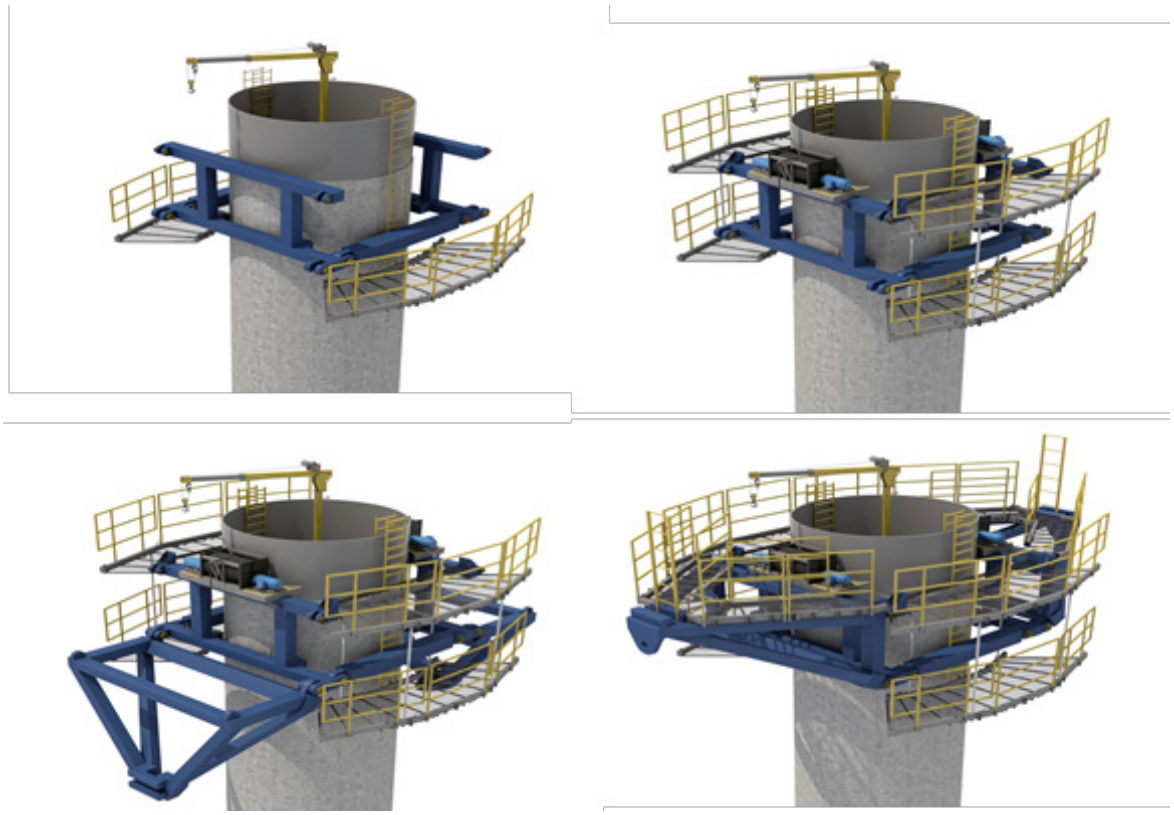

Figure 3 – Geothermal power generation technologies are at varying stages of development and commercial maturity, as shown by this Grubb Curve.

tie-down cables further stabilize the platform during the horizontal movement of the turbine components at the final top height. Once the rotor and nacelle are installed, the platform is lowered and the anchoring system is dismantled using the main winches and nacelle auxiliary winch.

In summary, the Zeus Heavy Lifting System is a versatile tool for the erection and operation of wind farms with very tall concrete towers, with no limitations on the height of the tower nor the weight of the turbine. The system offers an economic and technically effective solution, with easy mobilization both to the wind farm and between towers. The entire operation—including installation of the anchoring unit, assembly of the platform, lifting and installation of the nacelle and rotor, and equipment removal—can be completed in 20 hours.

References

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