What is an offshore substation

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Offshore substations -- the systems that collect and export the power generated by turbines through specialized submarine cables -- are an essential component of offshore wind farms, especially at large, multi-megawatt sites. These systems serve an important function: to stabilize and maximize the voltage of power generated offshore, reduce potential electrical losses, transmit electricity to shore, and do so in a manner that supplies the greatest return on investment.

But the wind industry is still young, and there is a long way to go before the development of offshore substation systems fully mature. Given that the typical cost breakdown for large-scale offshore wind installations includes 7.5% for platforms, cabling, substation equipment, and more, there is opportunity for greater cost-effectiveness and efficiency.

Sizing up substationsEarly substations for offshore wind farms consisted of simple topside frames with basic modules installed on top or as a covered deck. These structures were intended to operate unmanned, and required few visits from personnel. In many cases, these substations weighed as little as 400 tons.

That"s not much compared to today"s more advanced structures that weigh upwards of 10,000 to about 22,000 tons. These substations are more fully developed, and consist of a topside or a deck installed on monopole or jacket structures. Options today include self-floating and self-installing structures that eliminate need for expensive marine lifts or cranes.

Over and above serving as an offshore power-converter station, a substation"s platform may be equipped with boat landings, a helicopter deck (yes, a helicopter deck), accommodations, and act as a logistics" service base during installation and operation of an offshore wind farm. Not surprisingly, one of the greatest cost challenges to developing an offshore substation is the sheer size of the structure. Much like transporting and installing wind-turbine components offshore, careful logistical planning is key.

The two substations installed at what"s been dubbed "the world"s largest wind farm at sea," the UK"s London Array offshore wind farm, required use of a 3,300-ton, lift-capacity floating crane just to maneuver the systems onto a foundation that"s 15 km from shore -- undoubtedly a costly venture.

With an area of around 20 x 20 m, the substations are each 22-m high, and feature three levels of structural steel decks. They weigh in at 1,250 tons and are supported on transition pieces, connected to monopile foundations driven into the seabed. The substations let the wind farm operate more efficiently by transforming the energy generated from 33,000 to 150,000V, after which electricity is exported through cables 50-km long to an onshore substation.

Self-installing structuresOne option for overcoming the size and cost challenges related to substation

installation is a self-installing platform, a design used by ABB and Alstom Grid. Their floating and self-installing HVDC offshore substation was used to connect the 400-MW, MEG 1 offshore wind farm to the German high-voltage, direct current system.

According to Alstom, the platform uses a "suction can" method to set the foundations to the seabed floor and is fully self-contained to protect electrical equipment. The method reduces cost, noise pollution, and is believed safer on the environment when compared to conventional options.

Siemens is also working on a more efficient installation system for offshore substations. The company"s WIPOS (wind-power offshore substation) is available in different options, including self-lifting, topside and jacket, and floating, all of which involve pre-fabricated sections with flexible configurations for ac and dc applications.

Much like, Alstom"s system, Siemens" self-lifting platform can self-install to reduce the need, costs, and risks related to heavy lift vessels. In this configuration, the foundation is the substructure base frame, which connects to piles that are driven into the seabed. The topside includes a rectangular pontoon with customizable internal walls and decks. Self-jacking legs, attached to the topside, are immersed and then connected to the substructure base frame.

Operations & maintenanceConfiguration of a substation, its access points, and storage areas for maintenance equipment are important when considering the design for use at an offshore wind farm. These factors impact how often a substation may require servicing and its accessibility. But the factors are also difficult to assess because of extreme weather conditions and vibrations an offshore substation must endure, so routine O& M is typically a guess.