Is the future of energy in the sea?

The crucial role of offshore wind power in advancing the journey to net zero

As the wind industry ventures into deeper waters, floating wind turbines and substations have emerged as viable solutions, increasing the potential of this renewable source of energy while being recognized as an important contributor to the global shift toward sustainable energy generation and a cornerstone of the future energy system

Offshore locations experience stronger and more consistent winds than onshore areas, and additionally wind speeds over open water are typically more stable, leading to higher energy yield

If onshore wind was the first step in wind generation technology, floating offshore wind farms are effectively the next frontier. As the wind industry ventures into deeper waters, floating wind turbines and substations have emerged as viable solutions, increasing the potential of this renewable source of energy while being recognized as an important contributor to the global shift toward sustainable energy generation and a cornerstone of the future energy system.

However, realizing these potential needs significant scaling and innovation, particularly in the development of robust infrastructure and equipment capable of withstanding the unique challenges presented by floating infrastructure in offshore environments.

Critical electrical equipment like transformers is indispensable to facilitate the efficient collection of electricity generated by wind turbines at the sea and their connection to onshore grids. They must be designed to be robust, reliable, and specifically engineered to withstand these harsh conditions such as corrosive saltwater, strong winds, vibrations and dynamic weather conditions.

Why move offshore?

One of the primary advantages of offshore wind is the accessibility to a large energy potential. Offshore locations experience stronger and more consistent winds than onshore areas, and additionally wind speeds over open water are typically more stable, leading to higher energy yield. This increased efficiency allows offshore wind farms to generate more electricity per turbine, making them a reliable source of renewable energy.

Another key benefit is the reduced land use impact, since offshore wind farms are built at sea and do not compete with agricultural, residential, or commercial uses. Being typically located miles away from the coastline, offshore wind turbines cause lower visual and noise pollution, making them less intrusive and more socially acceptable option for large-scale renewable energy development. Additionally, and considering that many of the world's largest cities are located near coastlines, offshore wind easily becomes a convenient energy source for urban centers. By generating electricity closer to areas of high demand, offshore wind reduces the need for long-distance energy transmission, lowering transmission losses and improving grid efficiency.

Alongside all those aspects, these assets have the potential to be much larger than their onshore counterparts with fewer space constraints, leading to greater total energy output that could also open the potential to hybrid energy systems; offshore wind farms, indeed, can be integrated with other renewable energy solutions, such as hydrogen production facilities. This synergy could enable greater efficiency and energy storage capabilities. Innovations such as green hydrogen production, where excess wind power is used to generate hydrogen, are being explored to enhance the benefits of offshore wind projects.

A very relevant area of focus is the development of floating offshore wind applications, which can enable the exploitation of deep-water locations with abundant wind resources, previously inaccessible with traditional fixed-bottom structures

Are we ready to move offshore? ...and floating?

Yes, we are. The installed base of offshore wind projects already in several countries and the fact that new countries are setting plans and regulatory frameworks for the offshore wind development is a proof of it.

To capitalize on these benefits and bring the application to the next level, there is a collective effort to advance the research of offshore-specific technologies, focusing on creating solutions that are both efficient and resilient but also more affordable in harsh marine conditions.

A very relevant area of focus is the development of floating offshore wind applications, which can enable the exploitation of deep-water locations with abundant wind resources, previously inaccessible with traditional fixed-bottom structures. But in general, the move towards scaling-up offshore wind and, in particular, the industrialization of floating technology involves providing the industry with solutions specifically designed for these applications.

Transformers and shunt reactors are critical assets for wind turbines and offshore and onshore substations; they are instrumental for collecting and connecting the generated electricity to the grid in an efficient manner. Therefore, their maximum reliability and efficiency during the operation and their maintainability throughout the lifetime of the project is a must, while being prepared to withstand harsh environment conditions, vibrations, and the tilt and inclinations of the mechanical structures, requiring non-standard transformer solutions.

Hitachi Energy's contribution to scale up offshore wind

Scaling up offshore wind power requires a combination of innovative technology, system-wide efficiency improvements, and dedicated solutions that address this application's unique challenges.

Hitachi Energy's transformers have been part of the wind industry since 1993 with an unmatched installed base of more than 48 GW of offshore wind connections enabled with our transformers and more than 28000 units installed on wind turbines around the world (both onshore and offshore), generating more than 75 GW of energy. The year 2005 marked a major milestone in offshore wind with the first deliveries of transformers for offshore turbines and the rise of WindSTAR.

To contribute to offshore wind power expansion, including floating, Hitachi Energy has developed OceaniQ™, a complete portfolio of products, solutions and services for offshore wind applications.

OceaniQ™ focuses on offshore-specific solutions and embraces a full qualified portfolio of transformers (for turbine and substation installation), shunt-reactors, components and services at fixed platforms and floating structures. This portfolio ensures that transformers and other components can withstand the demanding conditions of marine environments, with high humidity and salt exposure, and mechanical stresses coming from strong winds and waves.

A cornerstone of Hitachi Energy offering is WindSTAR. WindSTAR transformers are engineered for both fixed and floating offshore wind applications. Their compact and energy-efficient design makes them suitable for installation within the confined spaces of wind turbine towers or nacelles. Their robust construction ensures they can endure the mechanical stresses and vibrations inherent in offshore environments, thereby enhancing the reliability and longevity of wind power installations. Additionally, they use ester fluids in their insulation toward improving the environmental profile of offshore wind infrastructure, providing fire safety, biodegradability, and enhanced thermal performance.

To contribute to offshore wind power expansion, including floating, Hitachi Energy has developed OceaniQ™, a complete portfolio of products, solutions and services for offshore wind applications

Other transformer solutions such as CompactSTAR and HiDry exemplify advancements in transformer design that enhance efficiency, resilience, and ease of integration into offshore wind installations.

CompactSTAR is transformer optimized for offshore applications where space is limited, offering a compact footprint while maintaining high electrical performance. HiDry, a higher voltage dry-type

Hitachi Energy has structured strategic roadmaps targeting significant advancements by 2030 and following with preparations to meet the projected demands of 2050

WindSTAR transformers are engineered for both fixed and floating offshore wind applications

transformer up to 66kV, is completing a wide range of high performance and efficient solutions for offshore wind.

Collaborative expertise and engagements

The transition to a renewable-centric energy system requires a comprehensive approach, as future power systems will be larger, more interconnected, and inherently more complex. Hitachi Energy has structured strategic roadmaps targeting significant advancements by 2030 and following with preparations to meet the projected demands of 2050. Our efforts are also focused on strengthening existing power systems, expanding their reach and scalability to support the growing electrification of the energy sector. Concurrently, there is a focus on evolving the power system to ensure it is both sustainable and resilient, capable of adapting to the dynamic nature of renewable energy sources.

Hitachi Energy's expertise in renewable energy, bolstered by extensive experience and a substantial installed base, is crucial in navigating this transition. However, there is a recognized need to continually expand know-how and education programs to keep pace with the speed of the required technological advancements and emerging challenges. Developing specialized knowledge is an essential step in supporting the anticipated growth in offshore wind energy applications.

In conclusion, the advancement of offshore wind energy is a multifaceted endeavor that encompasses technological innovation, sustainability, strategic planning, and collaborative efforts. By addressing these areas collectively, the energy sector is poised to harness the full potential of offshore wind, contributing significantly to a sustainable and resilient energy future.

The scalability of offshore wind power is essential for meeting the growing global demand for electricity while reducing dependence on fossil fuels; hybridization will play a very relevant role due to integration between different renewable energy sources, adding new production and storage systems like hydrogen production facilities. This synergy will enhance efficiency and maximize the output of generation, making offshore wind an important component of future energy generation mix.

The scalability of offshore wind power is essential for meeting the growing global demand for electricity while reducing dependence on fossil fuels

Learn more about Hitachi Energy's Transformers for Offshore Wind