Offshore wind turbines could number 30,000 by 2030: New ideas in ocean engineering are needed to install them

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Credit: AI-generated image (disclaimer)

The UK is planning to install 40 gigawatts of offshore wind power by 2030—enough to provide electricity to every home in the country. This would require 5,000 wind turbines—double the number installed offshore worldwide at the end of 2020. Current projections indicate 234 gigawatts of offshore wind energy will be installed globally by 2030, which could mean around 30,000 turbines.

Green energy developers hope to exploit the faster winds that blow offshore and allow larger turbines to generate more electricity than their onshore equivalents. Supplying the equivalent of a UK home's worth of electricity for nine billion people by 2050 would require something like half a million offshore wind turbines. Besides the more than two million fishing vessels, industrial activity in the ocean on this scale is unprecedented. Over the last 70 years, only around 5,000 offshore oil and gas rigs have been installed at sea, and many of these have since been removed.

Developing oil and gas offshore has helped engineers learn how to design ocean structures that remain fixed in one place, far from land, for decades. As the world transitions from low numbers of oil and gas installations to large numbers of renewable energy devices, how engineers design in the ocean must evolve too. Just as fossil fuel extraction must end, so should the design philosophy which sustained this industry. That is, meeting narrowly defined human need and a high return on investment.

Old design philosophies

To make wind turbines work offshore, great technological advances have been made. Using remote sensors, engineers can precisely control the angle of 80 meter-long blades to maximize how much energy they generate, or prevent damage in bad weather. Steel tubes ten meters wide can be hammered vertically into the seabed to support wind turbines installed over vast areas.

Engineers are working to design yet bigger turbines, operating more efficiently and for longer, which can be installed further from shore, like floating turbines for waters deeper than 50 meters. All this innovation has been driven with one job in mind: making electricity. In common with the oil and gas industry (and most others), the prevailing design philosophy of offshore wind is to build something that achieves this purpose while meeting environmental and safety obligations for the lowest price.

However, the price of offshore wind turbines, along with the price of most produced goods, overlooks a range of costs involved in the life cycle of the product. Turbines are up to 70% steel, which is made from recycled or newly extracted iron, which is processed from ores. These ores are removed from rocks by blasting causing disruption to the natural environment, and often from sites with cultural significance to indigenous people. The mined ores are then transported by large trucks, crushed, refined, processed and shipped.

Whether it's emissions from machines processing and transporting the ores or air and water contaminants released during extraction, mining creates pollution. Converting the iron into steel also contributes to climate change. Globally, the iron and steel industry is responsible for 11% of CO_2 emissions.

Steel plates are shipped and then rolled into curved sections, people and machines weld these to form long tubes, which are loaded onto vessels, transported to sea and assembled, processes which are largely powered by fossil fuels.

Credit: Enrique Hoyos from Pexels

The world needs more wind turbines, and fast. But clearly, the environmental and social consequences of making and installing them reduces their positive potential. Currently, the most ambitious designs seek to minimize these negative impacts.

Can we think deeper? Everything we engineer, whether it's clothes, mobile phones or offshore wind turbines needs resources from Earth's biological and physical systems, which are taken, made into these things we use everyday and then discarded as waste. A landmark report recently showed that this way of exploiting nature is outstripping its ability to recover.

What if, as well as building useful infrastructure for society, engineers sought to tie their work into ecological processes? We would need to shift our thinking from simply limiting damage to the natural world, to including its needs, so that we reciprocate and support the natural world as it supports us, and help regenerate these natural systems.

Reimagining ocean engineering

Design principles which aim to meet human needs alongside the needs of the planet have recently been applied successfully to city planning in Amsterdam. Applying similar principles to planning in the ocean might start with a single question: what would it mean for both a windfarm and the habitat it is in to thrive?

In Sweden, a study found that redesigning the foundations of wave energy installations benefited brown crab populations. Simply adding holes in the structure provided shelter for the crustaceans. These foundations can also be designed to cause seawater upwelling, moving nutrients and food up from the deep sea for fish to feed on. Offshore structures could even suck carbon from the air. These examples are just a glimpse of how the windfarms of the future could be designed to support life, both human and non-human.

Technology could help create new relationships between people and offshore windfarms. Apps and smart meters could show energy users how weather patterns and the environment influence the windfarms powering their homes. This could help them understand when it is good to use power and when it is less so, and to use just what is needed.

But what would it mean for the windfarm to support the wellbeing of people touched by each link in its supply chain? This provokes even more questions about how and where steel is sourced from and shipped, or how financial returns from the windfarm support workers to leave the fossil fuel industry as part of a just transition.

Ocean engineers must think ecologically to help species live and evolve through the difficult decades ahead. We will need to challenge the status quo, be open to collaboration and reimagine how we can work with the ocean.

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