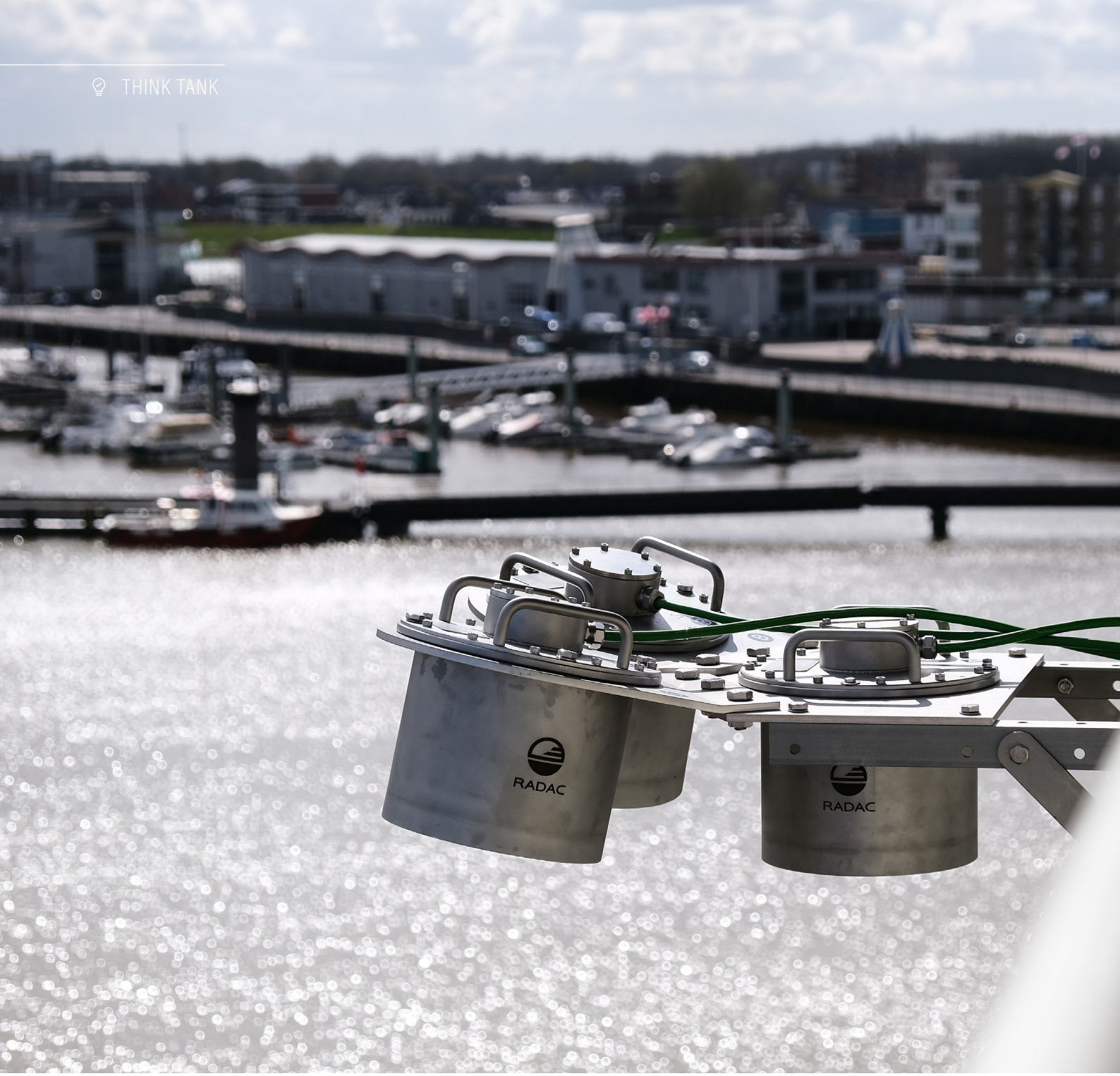


Real-time data on the crest of a wave

Offshore wind farm operations are hugely affected by weather conditions. Finding the right weather windows and suitable sea states is a challenge and often it's a race against time to finish the operations within safe conditions. Radac explains how real-time wave data can help.

The weather has a huge role to play in offshore wind farming; windy conditions increase energy output, a calm temperament is the ideal time for planning in any maintenance to keep downtime to a minimum with easy and safe turbine access, for example.

Yet, too much wind and stormy seas can be hugely detrimental to a turbine's performance, raising the potential for damage and making access to the site challenging.

Predicting the weather and accurate forecasting is therefore vital in an industry that is so reliant on it, be it in terms of output or maintenance.

Having a sound knowledge of the present and predicted site conditions assists OEMs in determining an optimum weather window during which operations can be performed safely. This increases operational efficiency, reduces costs and prevents workability issues from occurring.

One such solution lies in real-time wave monitoring, providing essential information for jack-up vessels during offshore operations. Jacking operations, crane operations, towing and such are typically limited by a maximum wave height of two meters or even less, so riding the waves at the optimum time is key to optimising site performance while maximising safety and efficiency overall.

Information gathering

Radac's WaveGuide 5 Height & Tide system presents a robust, low-maintenance solution. Designed for installations without direct water contact, this plug-and-play option is well-suited for a variety of applications. Its ability to endure harsh offshore conditions is exceptional, and its high-mounted configuration eliminates the need for preventive maintenance or cleaning, thanks to its absence of moving components.

In addition, the necessity for calibration and recalibration is obviated by the system's enduring zero reference stability and unwavering sensitivity over the long term. This system, characterised by its compact design and robust construction, offers a straightforward installation process. Significantly, it possesses the capability to provide precise measurements of wave heights and tides, even in the harshest environmental conditions.

Directional wave radar is a similarly no-hassle option with Radac, with its WaveGuide 5 Direction featuring unique technology that accurately measures wave direction, wave height, wave period and tide. Once again, there is no water contact, and no requirement for maintenance, calibration or recalibration.

By employing a trio of radars, it becomes possible to measure sea surface elevations at three distinct positions. This data, in conjunction with the information regarding slopes and phase relationships, enables the precise calculation of the directional spectrum.

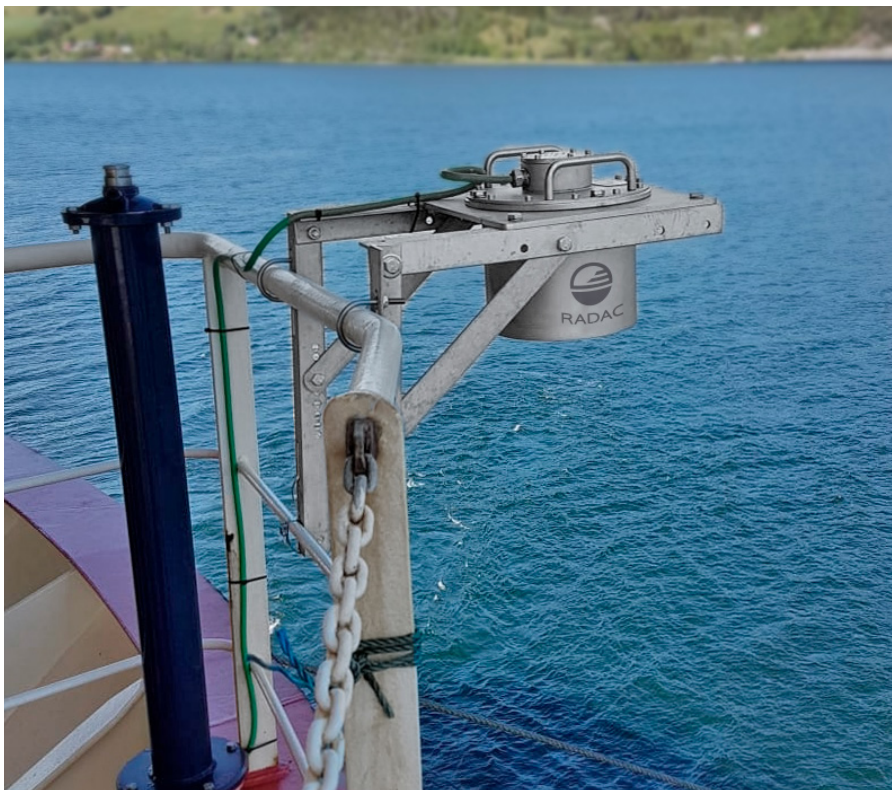
The directional system comprises three radars, all oriented downward, creating a virtual triangular configuration at the water's surface. The typical configuration within a single-point reference frame comprises one radar pointing directly downward, while two are angled at 15 degrees.

The directional wave radar is available in two versions: Compact and Explosion-proof, offering flexibility to suit various operational needs.

Bucking the trend

Over the past 30 years, the standard for wave directional information has been set by wave directional buoys. The main advantage of using a buoy is its independence from support structures. However, disadvantages of this method are high maintenance costs and the risk of long periods without measurements when a buoy breaks from its mooring or runs out of power.

To assess the precision and dependability of wave direction measurements using its Directional WaveGuide, Radac initiated a



field experiment. This involved a comparison between data gathered from a Directional Waverider buoy and data obtained from the WaveGuide. This comparative study took place at Prinses Amaliawindpark, situated 25 kilometres off the Dutch coast. Over the course of several months, two variations of the Directional WaveGuide were evaluated alongside a Directional Waverider.

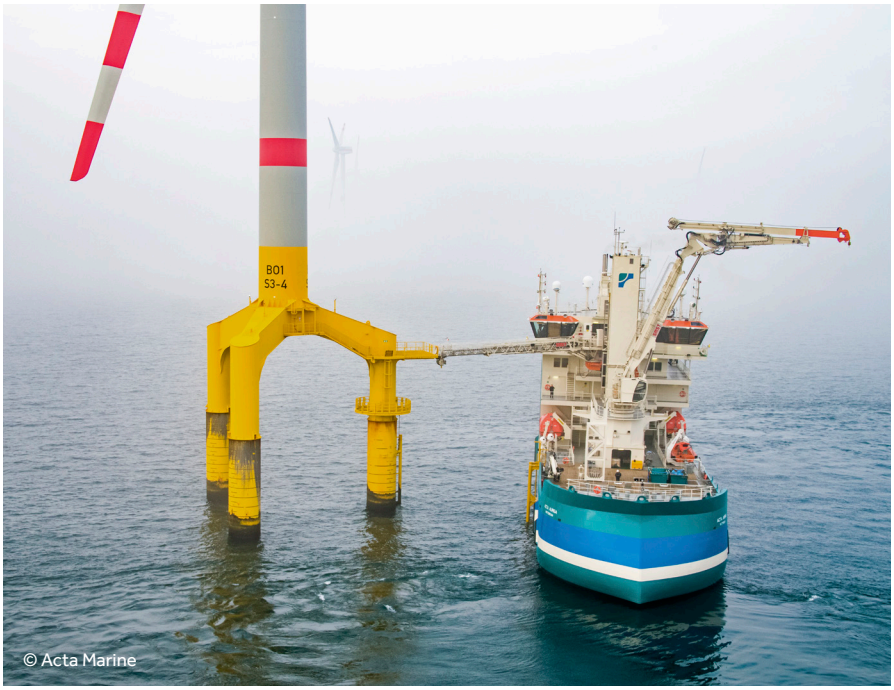
The test revealed no statistical difference in the directional information from the buoy and from the WaveGuide radars, concluding that the Directional WaveGuide can accurately and reliably measure wave direction.

At locations where an onshore mounting construction is readily available, the major advantage of this relatively new technology lies in the contact-free measuring technique. As the aforementioned tests suggest, the technology provides a maintenance-free solution to obtain valuable oceanographic information.

Floating challenge

Knowing full well the challenges of finding the right weather windows and suitable sea states for offshore operations, Radac systems were employed on the TetraSpar foundation, the world's first full-scale demonstration of an industrialised offshore floating foundation. Carried out in a partnership between Shell, RWE, TEPCO Renewable Power, and Stiesdal Offshore Technologies, the TetraSpar floating turbine is a tetrahedral structure assembled from tubular steel components. It is expected to offer important competitive advantages with its potential for lean manufacturing, lean assembly and installation processes, and low material costs.

The foundation and keel were assembled using no welding at the Port of Grenaa in Denmark. A 3.6 MW wind turbine from Siemens Gamesa Renewable Energy was mounted on the foundation at quayside using a land based crane after the launch of the structure in the harbor basin.



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The floating structure of the TetraSpar was then towed from Grenaa Harbour to the Marine Energy Test Centre (Metcentre) near Stavanger in Norway. Covering approximately 360 nautical miles, this was a project that required stable conditions at sea. Each step of the route involved differing wave limitations for structure operability and stability. Using Radac wave radar, operators could ensure that the forecast was trustworthy and the critical operations could take place.

The system, installed to the railing on one side of the towing vessel, monitored the waves in real time. The radar facilitated data acquisition, processing, presentation and remote service functionalities, as well as internal data storage. Data was internally stored on the device and distributed over the vessel's network, enabling any device connected to the private network to access the web-based user interface.

With an unobstructed view of the water surface, the unit measured the distance to the water 10 times per second, with centimeter precision. Due to the long-term stable zero reference of the fmcw (frequency modulated consistent wave) radar, calibration wasn't needed and the distances measured compensated for the heaving, pitching and rolling motion of the radar thanks to a highly sensitive motion sensor incorporated into the radar unit. The Radac WaveGuide Onboard measured the waves the ship actually had to endure, ensuring the structure arrived safely at its destination.

www.radac.nl

About the company

Radac is a Dutch company, based in Delft, and has been developing, manufacturing and marketing the WaveGuide since 1996.

Today, its professional systems are trusted across the industry, with its highly accurate wave radar having proven itself for over 25 years.

The easy to use, reliable and robust sensor is particularly suited for the extreme conditions offshore.