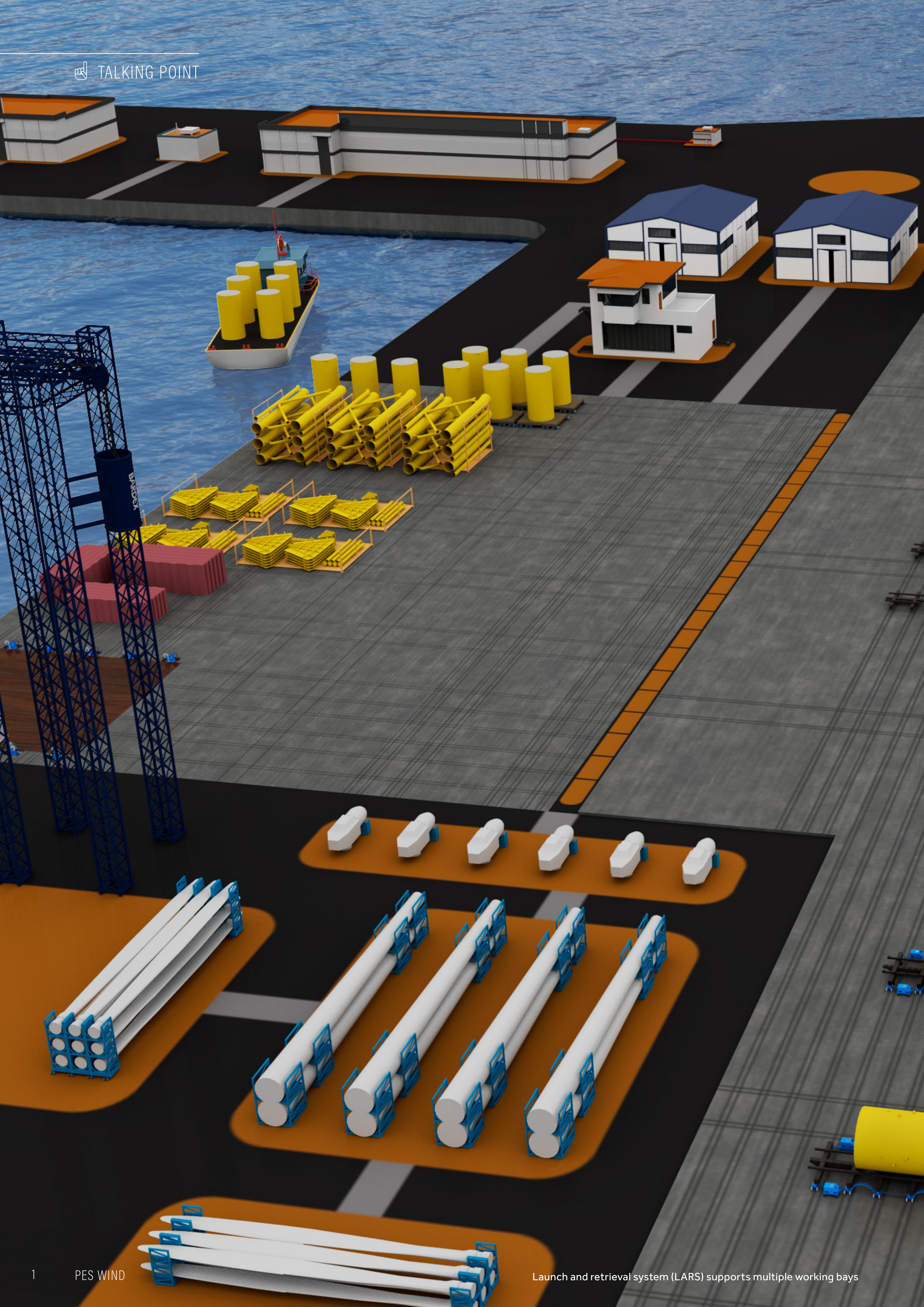

Launch and retrieval system (LARS) supports multiple working bays

Monopile delivery directly to the sea

Commercial scale offshore wind farms pose many challenges for the industry. One is the ability to promptly produce and deliver monopiles to the field to meet offshore installation schedules. The same weather conditions that define an ideal wind farm also drive the installation schedule offshore. Rapid deployment is important to achieve a maximal number of installations in a working season. For a project to be financially successful, it must be installed and commissioned as quickly as possible, simultaneously, with as little operational and safety risk as possible.

Logistical challenges

One aspect affecting the success of an offshore wind power project is the ability to quickly deliver monopiles to the field. The methods commonly believed to be state-of-the-art usually include loading out each monopile onto a barge or heavy lift vessel (HLV) and towing it from the port to the field for installation. This method faces multiple logistical challenges.

Some ports have congested entrances and/or shipping channels that are used by other stakeholders, such as fishing, ferry, military, and cargo shipping fleets. When the port has shared use, monopiles can be delivered only when there is ample space for the barges to enter and exit. Depending on the location, other users may have priority, causing wind farm project delays.

Barges used to transport monopiles are large ocean going vessels that require multiple tugs and standby tugs to ensure safety and reduce risk. These extra tugs cost the project more money and add to the greenhouse gas (GHG) emissions of installation. Additionally, large barges with monopiles possess a large sail area, which can make it difficult or dangerous to maneuver in poor weather and limit operations.

HLVs offer many benefits for sea transport but the tradeoffs are high cost, limited availability, and increased project GHG emissions. These vessels are already in heavy demand globally with offshore wind in its early years. Couple the expectations for nations to reach their 2030 and 2050 climate goals simultaneously with the simple truth that the fossil fuel industry will also face the need for these vessels but with much larger budgets, and the math quickly becomes clear. Also, many ports do not have the water depths required for HLV operation.

Operational challenges

Depending on the Wind Turbine Generator (WTG) size and depth of water, typical monopile foundations weigh between 3,000 and 5,000 metric tonnes each. They are 60 to 80 meters long, roughly the length of a commercial passenger plane, and 12 to 19 meters in diameter, about one to two double

Queueing container vessels

decker buses end to end, making crane lifts extremely impractical or impossible for a commercial scale wind farm. Engineered lifts are impractical at this scale, necessitating the use of Self Propelled Modular Transporters (SPMTs) to load monopiles onto ocean going barges.

These transporters provide great flexibility for moving large, heavy objects like monopiles. However, they require substantial maintenance, and their high day rates make them costly for prolonged use on large scale projects. Additionally, SPMTs are usually powered by diesel driven hydraulic units, contributing to the project's greenhouse gas emissions.

A successful loadout requires consideration of many variables. These operations cannot be performed in inclement weather due to the sail area and potential barge movement during the critical moments of transferring the load from the ground to the barge.

Additionally, tidal changes must be considered, allowing the loadout only during specific windows. Monopiles can be subjected to point loading as they are transferred from land to barge, which can cause wall buckling or other damage.

Once the monopile is loaded onto the barge and the transporters are moved back to land, the monopiles need to be carefully sea fastened for transport to the field. This takes time and labor and presents safety hazards from working on the water.

Barges require dynamic ballasting capability to maintain deck alignment with the yard during elevation. This limits what types of barges can be used.

Regulatory and supply chain challenges

Assuming dynamic ballasting is being used, many ports have strict environmental regulations, which will make ballast water management difficult or impossible. For most barges, this is a manual process involving portable pumps and diesel generators. If the barge came from another region, major environmental challenges could preclude the ability to simply pump potentially contaminated water into the harbor or port.

Typical OmniLift system

Every project will face challenges related to local regulations, which can vary by region. For example, barges operating in the United States must be built and operated by US companies to comply with the Jones Act. In other markets, there may be a lack of barges available to move so many monopiles, affecting the overall project schedule.

A solution to the challenges of monopile launching at scale

The OmniLift™ system is a multi purpose Launching and Recovery System (LARS), comprising of a steel platform structure that is raised and lowered by a series of chain jack hoists on both sides. This system is not subject to tidal change and can safely operate in high winds, leading to improved productivity and efficiency.

A typical example can lift and transfer floating objects, such as vessels or monopiles of up to 100 meter length and 20 meter beam, or diameter, with a displacement of well over 5,000 metric tonnes. There are 20 chain jacks of 375Te lift/lower capacity each in the example system described and shown here.

This type of system can be built on a greenfield site or modified to fit in an existing graving dock if there is a legacy dock conveniently out of service in a given port. It can also be built out into the water between finger piers or recessed into the land area of a given port depending on space availability.

Serial production for monopile delivery

For the load out of monopiles, SPMTs are typically owned and operated by a third party contracted to perform a single operational load transfer. Mobilizing this equipment can be costly, so moving it in and out when needed is not practical. Conversely, paying a day rate when not using the equipment is also wasteful.

When serial production is required over a long period, or many movements are needed to martial large components in a port, a more streamlined method is preferable.

In the case of a large monopile with dimensions of 60 meter length and 19 meter diameter with a weight of 5,000 metric tonnes, a simplified version of a typical cradle system normally used for vessels could be repurposed to transfer the monopile with sealed end caps on and off the launch platform using a rail based bogie transfer system.

These transfer systems are designed for cases where there is a clear and repeatable path from the assembly area to the launching area. This is typical for large scale serial production like an automotive or aviation plant, where there is a defined and repeatable manufacturing process and no need to maneuver the load to different locations within the available land space.

Another benefit of this type of system is that the ground needs to be reinforced only in areas where rails are located, reducing the overall civil costs of the infrastructure investment compared with using SPMTs that may go to any location the operator chooses.

Bogies can be designed to run on traditional crane rails or flat plate running surfaces. Crane rails can be installed below the yard level so that normal vehicles can traverse the yard or flat rails can be used, which provide some benefits in terms of the complexity of construction.

Environmental considerations

Both the OmniLift™ launching system and the bogie transfer system can be powered by the grid, significantly reducing the GHG emissions for the project compared with traditional methods. Further reductions in GHG emissions can be realized when we consider that there will be no diesel driven ballast pumps, and fewer tugs are required to tow the monopile to the field.

Without the need to do any ballasting, water pollution and the possibility of introducing foreign water borne species are eliminated.

The chain jack hoisting system does not require greasing for any submerged components, including the lift chains. One example system works in harmony with the biomimicry fish nursery that it was built with to enhance the native fish population of the region.

Operational benefits

Operational safety and weather windows are improved because the monopile presents a much smaller mass and sail area above and below the waterline compared with a barge with a sea fastened monopile on top. This allows the project to put more monopiles in the water per season and get to power production faster, both lowering levelized cost of energy (LCoE) and increasing bankability.

This OmniLift™ and bogie transfer system is engineered to transfer the load, specifically a monopile in this instance, from any of five working bays to the launch platform, and then lower it into the water within three hours.

The cost and personnel risks associated with sea fastening the monopile on a barge are eliminated. Removing the need for a barge also eliminates the problem of local regulations for barges, such as the Jones Act or other regional requirements.

Solutions built for safety and reliability

Bardex uses superior lifting technology. Our chain jack systems have never experienced a mechanical failure in which the load was released or lowered in an uncontrolled manner. In shipyard environments, rugged equipment that works with 100% reliability and is simple to maintain and inspect is preferred.

Chain is selected as the lifting element because it has a superior duty life in the marine environment and is easy to inspect visually without any disassembly required. There are no brakes, gear boxes, or pulleys that need repetitive greasing and maintenance and that require mechanical disassembly for inspection.

We use and recommend elastomeric pads to reduce load spikes that inevitably occur when moving large, heavy, rigid objects over different support structures using steel transporters on steel or concrete supports.

These elastomeric pads are designed to compress at predictable rates, providing the compliance necessary to reduce or eliminate load spikes, and eliminating the potential for damage to the monopiles during transfer or launch. Elastomeric pads are impervious to seawater, require no maintenance, and have decades of proven performance.

Bardex is committed to providing innovative engineered products that exceed our clients' expectations while simultaneously reducing CAPEX and OPEX costs. We do not believe in 'one size fits all solutions' that do not align with our clients' business goals and operational aims. This approach is what drives the development of new products and, just as importantly, the discovery of new applications for existing products.

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This yard can service up to six yachts simultaneously with the OmniLift and Transfer system