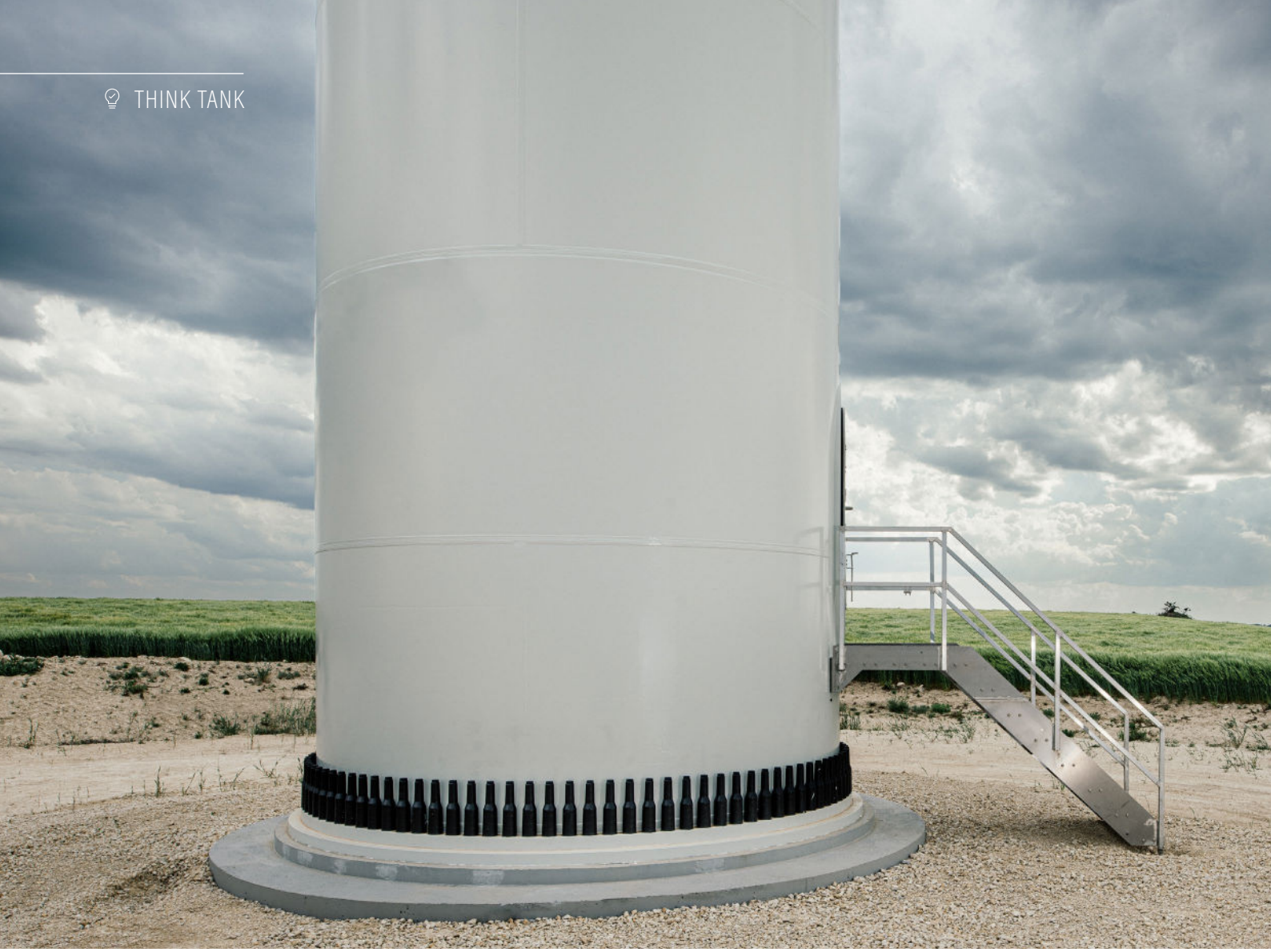


Bolting in quality and resilience

Accurate bolting lies at the heart of the successful installation and maintenance of wind energy structures. Unlike any other working environment, wind energy, both onshore and offshore, represents a major challenge to bolting tool manufacturers. The design of the bolting tool, its resilience and accuracy are going to come under scrutiny as never before.

The need for accurate torquing and tensioning are a given. Now let's add height and accessibility issues, exposure to extreme weather conditions and complexity of turbine structures and components. That's just onshore; go offshore and things get a lot more complicated. Add limited weather windows and the high cost of vessels, now the efficiency of bolting procedures come centre stage, getting it right first time is critical.

Bolting is used to secure the various flanges that make up the wind turbine. These are the base of the tower, the sections that make up the height of the tower, the connection of the nacelle to the tower and finally attaching the blades. It's a lot of bolts.

Depending on the manufacturer, construction of a wind turbine may involve as many as 25,000 bolts. The more powerful and larger the turbine, the more bolts needed. With wind turbines now capable of generating up to 15 MW, bolting is more critical than ever as tower become taller and blades longer.

Precision bolting

Bolting tools used in wind energy projects include tensioners and torque wrenches. They allow controlled bolting,

the process of applying an accurate bolt load to a mechanical joint to meet design specifications. Bolt load can be measured directly using hydraulic bolt tensioners, ultrasonics, or calculating torque values determined by the bolt material, size, and friction of the stud and nut. Having the means to measure bolt load during or immediately following the bolting process is essential for ensuring joint integrity and safety.

While torque wrenches and bolt tensioners work to accomplish the same objective, to clamp nuts and bolts together for joint integrity, tensioning directly stretches the bolt against the flange rather than nut rotation from the torque wrench. Tensioning typically creates a more accurate load often required on larger bolts.

Torque wrenches, on the other hand, apply rotational force onto a nut to stretch, not yield, the bolt to achieve bolt load. A hydraulic torque wrench, when coupled with a specially designed torque pump, creates the torque output, or torque load, necessary to create the clamping force to secure bolted-joint integrity.

Typically, tensioners are used for the base of the turbine, the connection of the nacelle to the tower and for attaching the blades. Specialised bolt tensioners are often used for controlled bolting during installation and maintenance checks on wind turbines, including the foundations.

For critical fastening applications Enerpac offers single-stage and double-deck tensioners, which provide the speed and accuracy required for safe operation at the wind turbine site. These include the PGT-Series, FTR-Series, and FTE-Series designed specifically for wind tower foundations or base bolts.

These elliptical and round tensioners provide a fastening solution on wind tower foundations where long bolt stretch is required, and limited space between the stud and wall prevent the use of standard tensioners. They feature an elliptical geometry, which fits in narrow foundation applications, and exceeds bolt load design requirements.

Bolting challenges

Earlier we touched on some of the environmental and practical challenges when bolting during wind turbine construction and subsequent maintenance. Overcoming height and accessibility issues has led to the introduction of a new generation of torque wrenches that set a higher standard in safety, versatility, simplicity, and performance.

For example, when it comes to safety, a built-in, work-at-height safety tether connection, such as that on the Enerpac DSX-Series aluminium torque wrenches, helps prevent injuries to workers below. Meanwhile, a fully enclosed square drive keeps technicians' hands protected from moving parts, and its optimised weight-to-output ratio and slim design help prevent operator fatigue.

Versatility is a benefit of the DSX-Series modular torque wrench. The module drive units and hex cassettes are interchangeable with a wide range of hex- and square-drive cassettes from several manufacturers, while the combination of superior alloys makes it one of the most durable wrenches in its class.

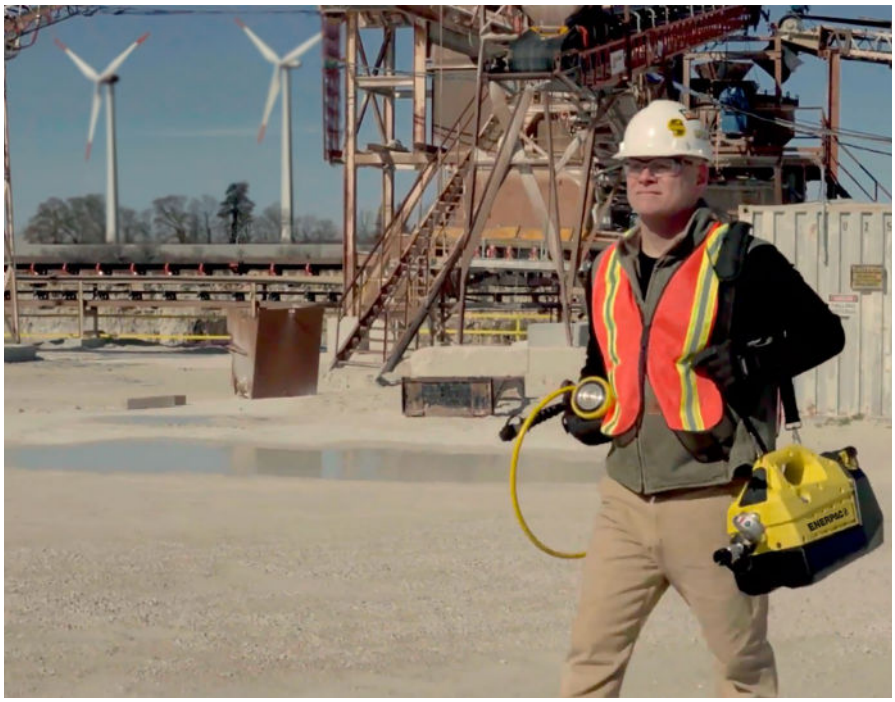
Factors to consider when selecting torquing tools include handle options, size, and material strength. Some designs allow handles to mount on both sides of a square-drive torque wrench, which can provide safer manoeuvrability.

While push-button square drives and secured reaction arms allow fast changes and adjustments, even with gloves on. Where these is limited working space, compact designs provide a smaller operating radius than larger options. Other things to consider are the wrench's strength-to-size ratio and flexibility of use, which can be enhanced in some cases with an optional tilt-and-swivel manifold for the torque hose.

Larger wind turbines invariably use larger bolts which in turn means higher torque requirements. Every bolt on a wind turbine must be tightened to a specific torque. Torque wrenches and tensioners are set to the required torque and the bolting performed.

With up to 25,000 bolts, record keeping is becoming a crucial factor in the construction and maintenance of wind turbines. The bolt torque required is simply entered into the torque wrench ahead of bolting.

Developments such as the Enerpac BTW-Series Battery Torque Wrench, a self-contained, handheld and portable tool requiring just a single operator, has the potential to double the productivity of two-man bolting teams. Its compact, handheld,



battery-powered design makes it ideal for scenarios where physical space is limited or where access is challenging.

The BTW-Series establishes a new benchmark for bolting productivity. More importantly, it brings a new level of pinpoint precision performance. By putting every unit through the most comprehensive pre-programing and calibration process of any battery torque wrench in the market. With meticulous calibration at 60 distinct points, far beyond the standard seven points of other products, BTW-Series Torque Wrenches achieve +/- 5% accuracy across their entire operational range.

This contrasts sharply with leading competitors, who only claim to achieve such accuracy at the peak torque reading. Importantly, the BTW-Series rigorous testing process provides the confidence to know that every fastening and loosening task is executed with the utmost precision.

Bolting confidence

Why is this so important? Tightening requirements, torque specifications and the complexity of turbine structures and components means significant variation in bolt types, sizes, and torque and tensioning requirements. Confidence in the precision of the torque wrench is fundamental to record keeping for both construction and maintenance.

Schedules for wind turbine maintenance are dictated by the turbine's original equipment manufacturer. For bolting, maintenance may need to occur every three months, six months, or annually. If there is zero variation in the bolted joints from the last maintenance check, the wind tower operator can ask for an exemption on the next service, which saves time and money. Consistency of performance makes record keeping more valuable. Changes in bolting torque can be spotted and acted upon with confidence.

Of course, it must be remembered that the torque wrench and tensioner itself does not do the work of bolting alone, it is part of a system that also includes a hydraulic pump, hose, and accessories. Designing a solution with components all ergonomically devised to work together enhances operator safety and productivity.

A complete system from a single brand means a functional design that is intuitive to use through common fittings, safety handles, and on/off pendant controls, all while ensuring hand comfort when repeatedly operating the tools.

As part of an integrated bolting tools system, Enerpac continues to develop pumps that support advances in torque and tensioning tools. These offer high flow, fast performance, and portability as key advantages. A cordless torque wrench pump, such as the new XC2 Cordless Hydraulic Battery Powered Pump is the perfect portable solution for working on wind farms. It is designed for ergonomic, portable, and safe use where weight and power are critical factors.

To ensure optimal productivity for tensioning jobs on the wind turbine tower, operators can choose from air-driven, electric, or manual tensioner pumps. Operators can choose from air-driven, electric, or manual tensioner pumps. Electric tensioner pumps combine high efficiency with a compact and lightweight design. For example, a two-stage pump, like the Enerpac air ATP and electric ZUTP -Series, can provide high flow at low pressure for fast system fills and controlled flow at high pressure for safe and accurate operation.

Enerpac is one of the few companies whose bolting tools are approved by all the leading wind turbine OEMs. They recognise the quality of design, materials and construction needed to serve wind energy contractors with tools that are hard wearing and provide bolting precision. They also value the global reach of Enerpac, it's reassuring to know that whether the wind farm is in the North Sea or offshore Japan, Enerpac tools are available and supported locally.

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