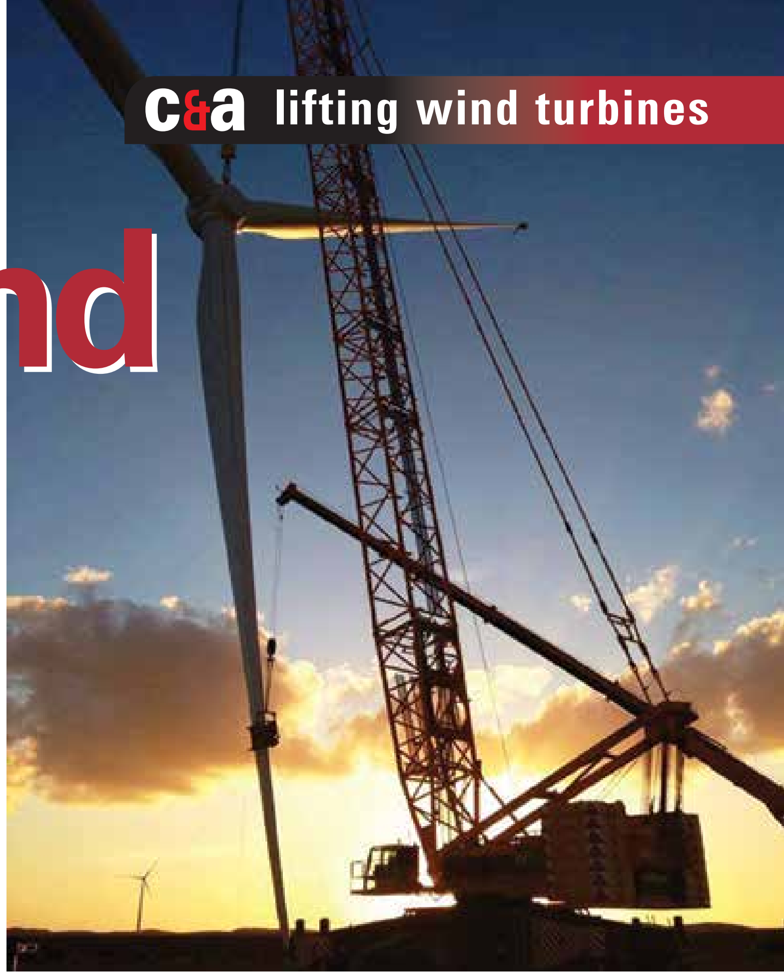
Blowing in the wind

In spite of the fact that the European wind energy industry installed more than double the capacity of new coal and gas combined capacity last year - a total of 11,791MW compared to 3,305MW and 2,338MW respectively - there are some dark clouds on the horizon. Mark Darwin investigates.



The aesthetically unhappy anti-wind turbine lobby is growing in both Europe and parts of North America, this combined with reductions in wind energy tariffs threaten the long-term future of new onshore wind installations.

In the UK - currently Europe's second largest market in terms of new installations - reductions in the Department of Energy & Climate Change strike prices for renewable technologies under the Contracts for Difference (CfD) regime, due to come on stream in 2017 is providing a major financial incentive to install new capacity sooner rather than later. Because of these factors, the wind sector in both the UK and the rest of Europe, is set for a very busy period over the next two years, however what happens after that remains to be seen.

In the UK the CfD is key in the Electricity Market Reform programme which is set to deliver £110 billion of capital investment up to 2023 to replace the country's aging energy infrastructure. CfDs are long-term contracts which are intended to provide stable and predictable incentives for companies to invest in low-carbon generation. This is done by paying a variable top-up between the market price and an estimate of the long term price that is needed to bring forward investment in a given technology, known as the 'strike price'. As well as reducing the cost of financing new projects, the CfD regime is intended to deliver value for money for consumers by encouraging competition between low carbon technologies.

Unfortunately for onshore wind, the strike prices look set to encourage investment in renewable technologies with higher costs, such as offshore wind and tidal, rather onshore wind and solar. Strike prices for onshore wind have been reduced to £95 per MWh, with a further £5 cut in 2017. In comparison, large solar strike prices have reduced to £120 per MWh, with a further £10 cut in 2017. At the same time offshore wind has seen a rise in the strike price to £155 this year.

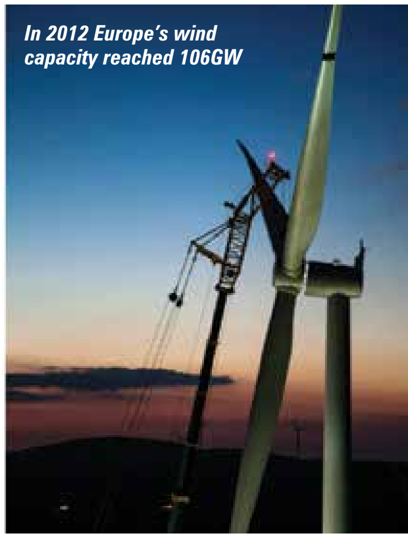
With a significant and rising proportion of UK gas derived from Russia/Ukraine, opposition to renewable energy may be short-sighted. The last time Russia played power politics with gas in 2009, prices jumped by 17 percent, and with UK imports expected to account for around 70 percent of supply by 2020, the risks are clear. In the short term, the onshore wind sector in the UK and Ireland looks set to be very busy in spite of the anti-wind lobby.

Figure it out

In 2012 Europe's installed wind capacity reached 106GW - equivalent to the total electricity consumption of Sweden, Ireland, Slovenia and Slovakia combined. Driven by the EU's binding target to obtain 20 percent of its power from renewables, with a target of 130GW by the end of 2020 (European Wind Energy Association - EWEA - estimate) and 735GW by 2050. Renewable power plants accounted for 79.1 percent of new installations during 2014. Today, grid-connected wind power is enough to cover 10 percent of the EU's electricity consumption, up from eight percent in 2013. Germany and the United Kingdom accounted for 59.5 percent of the total EU wind energy installations in 2014, at 5,279MW and 1,736MW respectively.

Bigger and better?

With improved technology, the output and size of turbines has also grown. In 1985 rotors were typically 15 metres in diameter, with turbine capacities under one MW. Today rotor diameters of 100 metres are not unusual, with an average of 2.5MW output and up to 7.5MW with 120 metre diameter rotors. Rotors look set to get even bigger with turbine capacities of 15MW and even 20MW being planned. A modern wind turbine is available to produce electricity between 80 and 98 percent of the time, but obviously produces different amounts depending on the wind speed. A typical onshore turbine typically generates around 24 percent of its theoretical maximum capacity (41 percent for offshore turbines) compared with 50 to 80 percent for a conventional power station. However when comparing overall efficiency - the relationship between energy in and out wind fares much better with a limit of 59 percent compared to 35 percent coal and 50 percent gas.



In 2012 Europe's wind capacity reached 106GW

The tagline teams have to control the blade assembly

"At the moment there is limited guidance on lifting in wind."

Turbine heights

Contractors working in the European wind sector - particularly outside of the UK - are now installing turbines with hub heights of up to 140 metres, although this will grow to 150 and 160 metres. In the UK the hub height is lower, partly due to pressure from the anti-wind lobby, but also because of the excellent wind farm sites still available. Outputs from 60 metre towers are however significantly less than for 80 or 100 metre towers. The UK still has many sites still to be developed that can produce efficient energy with 80 metre towers.

Are cranes available?

Even though hub heights and turbines are increasing in height and weight, crane development has largely kept pace, and there are cranes capable of erecting the largest turbines. A few years ago, the industry went through a difficult phase including several serious incidents which resulted in an industry gathering in Hamburg organised by ESTA. While this 'contractor vs client' open meeting aired industry grievances regarding pricing and safety, it would appear that very little has actually changed since then. Although there have been fewer serious incidents - particularly in Europe.

One of the UK-based companies operating in the European wind sector is Windhoist. Technical manager Declan Corrigan says that there are a range of crane models available to erect the heavier and higher turbines, but the problem is the extended periods of time the larger components are on the crane hook, increasing the risk of problems from ever changing wind speeds. There is the option of single blade installation to reduce the total surface area exposed to wind but this is not a simple process and the overall installation time is extended which increases the risk of running into wind down-time.

Since Christmas, high winds across Europe as a whole have seriously affected turbine installation. The main problem with the larger turbines is that it may take up to two days to fully erect a typical four or five section tower, nacelle and rotor. Predictions of wind strength and direction may only be valid for 24 hours in advance and are never truly accurate for specific locations. This means that by the time the installation contractor has mobilised cranes, ballast, transport and crew (a team of 20 - 50 people depending on the scale of the project) the whole erection process is entirely weather dependent and the key decisions lie with the crane supervisor.

In a typical four section, 80 metre tower, the base and second section may be erected ahead of the final two tower sections, nacelle and rotor using a smaller capacity crane (500 to 750 tonne telescopic) and can be left freestanding safely. This also allows for work to be carried out inside the lower sections ahead of installing the remaining components. With wind strength and direction forecasts unpredictable at best, the next stage - the final tower sections and nacelle and rotor - have to be fully completed as an uninterrupted cycle until, at least, the nacelle has been mounted , or not at all. Once the third tower section is started it is all or nothing. If the base section and two bottom sections are installed one day then the remaining turbine components (with rotors pre-installed on the ground) may - in ideal conditions - be erected on the second day.

Wind problems and guidance

"At the moment there isn't joined up thinking between the crane manufacturer and the installation contractor about lifting in wind," says Corrigan. "Crane manufacturers look at how a component affects the crane in a set configuration. They consider the characteristics of the larger components i.e. fully assembled rotor and wind loading, the structural strength and integrity of the crane and also torque resistance within the slewing interface. They are not concerned how the component moves and behaves in the wind and how it affects itself. The newer type of 100+ metre diameter rotors the blades are not fully pitched out when lifted and may be set at five or six degrees so when the wind reaches about six metres a second and above, the blade starts to oscillate and move. It will not affect the crane but it does affect the tagline teams who have to try and keep control of it."

Corrigan says there is limited guidance on lifting in wind. "I have asked ESTA to look into this because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Liebherr crawler cranes (LR series).
■ Superior lifting capacities, on-line load chart calculation
■ Great variety of boom configurations
■ Quick and easy assembly
■ Easy and cost-effective transportation
■ Narrow working track for limited space
■ Derrick equipment for enhanced load capacities

if you search for guidance on lifting in wind there is the FEM document (based on a very good Liebherr document) 'The influence of wind on crane operation' but little guidance anywhere else. Crane manufacturers will give the maximum wind speed allowable to lift for a particular crane configuration - say 10 metres a second - but is it safe? The actual limit applied to the lifting operation may often be much less than this - up to 20 percent in some instances - based on a risk assessment of the operational factors needed to maintain control of the suspended rotor.

"In common with other contractors we have had 'near misses' as well. About 18 months ago we were preparing to erect rotor, and from 7am to 10am the wind was three metres/second in line with predictions. Quite suddenly it gusted to 20 metres per second when we were about to lift the rotor from the hub support. Except for the fact that the lift had been delayed due to a technical fault with the pitch system the rotor would have been on its way up to the nacelle and the consequences could have been catastrophic. Of late we have stopped relying solely on the crane manufacturers for guidance when lifting rotors because we were having to down-rate some of the wind speed figures they supplied - primarily to keep control of the component during the lift."

Despite tha anti-wind lobby the UK and Ireland looks set to be very busy over the next two years

Legislation and guidelines?

"Under the legislation and guidelines we operate to, a risk assessment is required to de-risk the worst case scenario and to build contingency measures on how to deal with it. When we apply a wind speed limit to a specific lifting operation our control measures must be sufficiently robust to ensure the lift is completed successfully or the component is made safe; our risk analysis makes allowance for a potential 50 percent increase in wind speed value and this has, to date, not been questioned or rejected by anyone. So if the crane manufacturers say a maximum of nine metres per second is OK for a specific lift is this acceptable? Must I then have sufficient resources to control the component if the wind speed were to rise to 13.5 metres per second! The important factor here is that the decision to proceed with a lift is not taken by the manufacturer's engineer in Germany, but by the crane supervisor on the side of a mountain.

Different crane types?

"When components are of a certain size and scale, the type of crane lifting it - a telescopic, crawler lattice or wheeled lattice - is a secondary consideration to the component itself. Cranes don't make mistakes, they have limitations. Based upon their calculations Liebherr will contend that a 1,200 tonne LTR 11200 telescopic crawler, with luffing jib, lifting a 113 metre rotor onto an 80 metre tower can work up to a maximum of 7.5 metres per second. On the other hand a heavy lattice boom crane e.g. LG1750 may be assigned a higher limit - up to 11metres per second. However, if we cannot control the rotor in windspeeds in excess of 8 metres per second then the difference between both crane types is, in reality, only half a metre per second."

"From early 2013 we began to encounter more and more large rotors up to 101, 108 and 113 metres on 80 metre towers. We were told by the manufacturers that their lattice cranes could install at wind speeds of 10 or 11 metres per second yet we were never able to lift one when the wind speed was more than eight metres."

So how dangerous is turbine erection?

"Since the ESTA wind meeting there has certainly been more awareness when carrying out lifts. When lifting a very large rotors onto 140 metre towers, it can take almost 45 minutes to complete the lift itself and this means a higher risk exposure period. Ultimately, you are relying on your people on the ground to say it is safe to lift, and if circumstances change knowing how to make the load and the crane safe."

Single blade installation is riskier because of the extended time taken

"Lifting in wind is a very inexact science. Wind patterns are not stable and the physical topography affects each site differently, particularly when working on a hill and whether there are trees or not. In the accident in Brazil a few years ago, the rotor was only a couple of metres off the ground, but the load was still acting on the top of the boom having the same result."

Approach roads and counterweight

Another problem area for installation contractors are the approach roads and hard standing areas. "Major clients are now first class at providing appropriate road designs

Liebherr LR 1100 with Power Boom

The wind capacity target by 2020 is 130GW

and construction, complying with the relevant European codes for bearing capacity etc…," says Corrigan. "Small developers however are not so conscientious. Each turbine supplier has its own standard specification for the construction of roads and hardstanding which has to be adequate not only during the installation but for future maintenance and decommissioning which may be in 20 to 25 years' time."

A Terex CC8800-1 erecting a 7.5MW, 170 tonne Enercon E-126 turbine

As turbines get higher and cranes (and booms) become larger, more counterweight is needed increasing mobilisation and operating costs. For example a crane with a 150 metre boom may need up to 400 tonnes of derrick ballast to raise it, then it will continue to complete the installation works with lesser amounts of counterweight. The problem then is the stability of cranes with long booms in out of service conditions, much more consultation is needed between the crane operator and manufacturer to ensure the crane is sufficiently stable when left in an unladen condition and the boom is not lowered. There have already been a number of high-profile incidents where cranes have fallen over in out of service condition.

Big cranes

"Higher hub heights result in increased installation prices. Installation contracts are sub-divided between crane and the labour costs. The number of man hours needed to erect an 80 metre turbine might half that of a 140 metre machine but the crane specification is markedly different and the cost differential is much greater. You could buy a 750 tonne class lattice boom crane equipped to install 100 metre hub height turbines for half the cost of the configuration needed to erect 140m hub height turbines."

"We are looking at 140 metre turbines now and where the stipulation is a wheeled crane, only the Liebherr LG1750 can be used - there is no other wheeled crane in this class with capacities to match this machine on the SL12 boom. If Terex were to offer the CC3800 on a wheeled carrier then it would be another option but I'm not certain this is likely to happen anytime soon.

"Going back 10 years the crane of choice for putting up turbines was the Terex TC2800 or CC2800NT, which we have successfully used in Morocco and now in Mauritania. When using a TC2800 if you put on more than 102 metre boom and 12 metre fly you need derrick to lift off the ground. The CC3800 can lift 114 metre boom and 12 metre fly without derrick which would be attractive if available on a wheeled carrier. I am certain that there will be demand for a 1,000 tonne class lattice boom on wheeled carrier especially as hub heights increase in the UK but the size of the slew-ring needed in this crane class may exceed three metres in diameter and will pose a major problem for carrier design."

Corrigan is obviously a big Liebherr fan. "The telescopic crane world changed forever when Liebherr brought out the LTM 1500. Many still say it is the best telescopic crane ever built," he says. "The Terex AC500 has very good duties but the difference of the longer boom was incredible. Liebherr tried to grow the concept of the LTM 1500 into the LTM 11200. We have used the larger crane very successfully but it isn't an LTM 1500, it is a far more specialist, niche crane. On larger turbines the size and weight of the tower base section has increased significantly. On a 110 or 115 metre tower the base section may weigh up to 100 tonnes and you won't lift that in with a 500 tonner - you now need a 750 tonne capacity crane and one that can move quickly. The 750 tonner is also good for turbines with 80 metre hub heights. The base sections are well over 80 tonnes which is also too much for a 500 tonner. This is the reason the LTM 1750 tonner is good, especially where there is limited civils work because you can add the luffing jib from the existing hardstanding without additional works, reducing costs but also helping with planning, especially if the client has no scope to build secondary hardstanding."

Future?

The UK will see unprecedented turbine installation levels over the next two years and many are worried that safety standards could be pressurised as happened in the run-up to the ROC rebranding deadline in 2013. With the downturn in construction post 2010 many contractors flocked to the wind industry but, for larger scale projects, there is still only a select group - including Windhoist, Global Wind, Total Wind, BMS and Fairwind - that can realistically be considered.

For Windhoist the UK and Ireland is still its biggest market, followed by Western Europe as well as other countries such as South Africa, Morocco and Mauritania. Its fleet is kept current with the addition of one or more heavy cranes a year adding a 1,200 tonne LTM 11200 in 2009 followed by another in 2011, a Terex CC2800 NT and Liebherr LTR11200 in 2013, and a Terex TC2800 last year. This year two Liebherr LTM 1750s have been added.

"This sector of industry demands specialist cranes," says Corrigan. "We generally chose Liebherr at 500 tonnes and above, but smaller Grove, Liebherr, Terex and Tadano all have good quality and performance. We recently added a 300 tonne, 80 metre boom Grove GMK 6300 for example."

Erecting wind turbines is a hard and difficult job, most of the time stuck in the middle of nowhere in very inhospitable locations, so finding staff is not easy. Training is onerous and has become very expensive.

"Installation contractors take on an enormous amount of risk in the erection phase of a windfarm," he said. "For example, a 10 turbine project over an eight week period can involve 20 to 30 crane journeys on freshly prepared roads, 40 to 60 truck journeys, up to six lifts per turbine so you have very intense activity levels in the first weeks of the lifetime of a windfarm…. However given the risks the industry has a good safety record. Standards in the UK wind industry are far higher than in the general construction industry. The biggest risks involve moving equipment. The industry did have issues with cranes going off roads etc…but this has improved. Unfortunately there is always the potential for an incident because of human error but with training and experience this is reduced to a minimum."

Grace Kelly makeover

The world's largest spider crane - the 10 tonne capacity Unic URW-1006 - was used to replace the nine metre long blades of a 24 metre high E-3120 turbine named Grace Kelly, from Huddersfield-based turbine specialist manufacturer DC21. All the turbines manufactured by the company are given names - just along the road from Grace is Rita Hayworth…


The 10t capacity URW-1006C

DC21 manufactures three turbine models. The Endurance E-3120 50kW is its smallest but most popular, and designed for larger farms, schools, hospitals, and commercial sites producing 100,000 to 250,000 kWh a year. It is available on towers of 24.6 and 36.4 metres and has a rotor diameter of 19.2 metres. Slightly larger is the Endurance E4660, while the largest is the 225kW X-29 wind turbine producing 200 to 850 MWh a year.

To replace the blades, the URW-1006 spider crane used its full 31.7 metre reach, more than enough to lift the turbine and rotor hub up to the top of the 25 metre tower. Each blade - which weighs 410kg - had to be installed facing down by an expert installer working at the top of the tower. Once the blade is fitted, the hub is rotated ready for the next blade to be installed. Grace Kelly has offset 164,933kg worth of CO^2 since it was built in 2013.

The URW-1006 is able to pick & carry loads up to 1.5 tonnes, more than enough to move the blades and the 500kg rotor hub. Its variable outriggers provided plenty of levelling and stability on the uneven surfaces.


On top of the 25m tower


Each blade weighs 410kg

Boom Booster eases installation

Belgian-based rental company Sarens used a new 1,600 tonne Terex CC 8800-1 crawler crane with Boom Booster kit for the first time on a job to erect an Enercon E-126 wind turbine at the Netherlands largest wind farm Windpark Noordoostpolder.

Erecting the 170t Nacelle

The kit consists of five 10 metre wide folding inserts and two adapters and can be built up to 72 metres long. It is 50 percent heavier than the standard boom and is designed to increase capacities at short radii and long boom lengths- by up to 60 percent - by reducing lateral deflection, making it ideal in the installation of large wind turbines.

Enercon's preferred crane - Sarens' Terex CC 9800 - was not available for the job, so the CC 8800-1 with the Boom Booster kit was offered as an alternative. Terex Cranes used 12 delivery trucks to deliver the Boom Booster kit directly to the work site from its factory in Zweibrücken. The frame was partly pre-assembled allowing Sarens to save time on site. Almost 120 vehicles were needed to transport all the hardware and supporting materials, including 48 trucks to transport the crane.

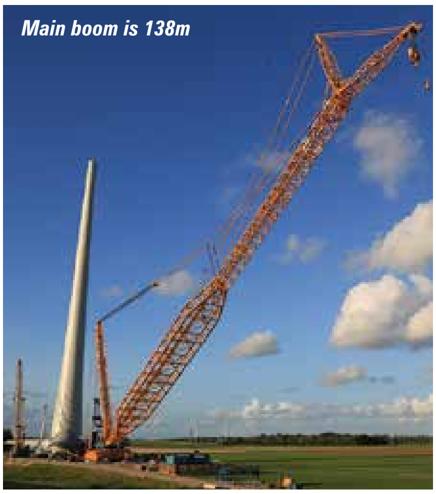
Work conditions on site were unusual and involved creating a three metre raised work platform and a seven metre wide access ramp with a 2.5 percent slope to keep the maximum ground pressure under 10 tonnes per square metre. Because of this all assist cranes had to move on mats and final lifting locations had to be levelled. Trenches on both sides of the access road further complicated matters which meant it was necessary to form a special bridge to set up the booms.

With a main boom length of 138 metres - including 72 metres of the Boom Booster - and an 18 metre LF extension, the CC 8800-1 had a total system length of 156 metres. This was enough to lift the turbine components to a hub height of 135 metres, while using an offset of 20 degrees. To do this, the crane was equipped with 295 tonnes of superstructure counterweight, 60 tonnes of central ballast and 400 tonnes of superlift counterweight.

"We were very pleasantly surprised that the team was able to set up the CC 8800-1 crane with the Boom Booster kit and a BSSL and LF configuration in a similar time to the normal boom," said Sarens project manager Hendrik Sanders. "Once the crane was set up the rest was a routine job. Two assist cranes erected the E-126's tower and the CC 8800-1 then installed the 170 tonne, 7.5MW nacelle at a radius of 40 metres. The 260 tonne generator was installed at a 36.5 metre radius and the 375 tonne hub at a radius of 33 metres. The three fiberglass rotor blades, each weighing 40 tonnes needed a working radius of 23.5 metres."

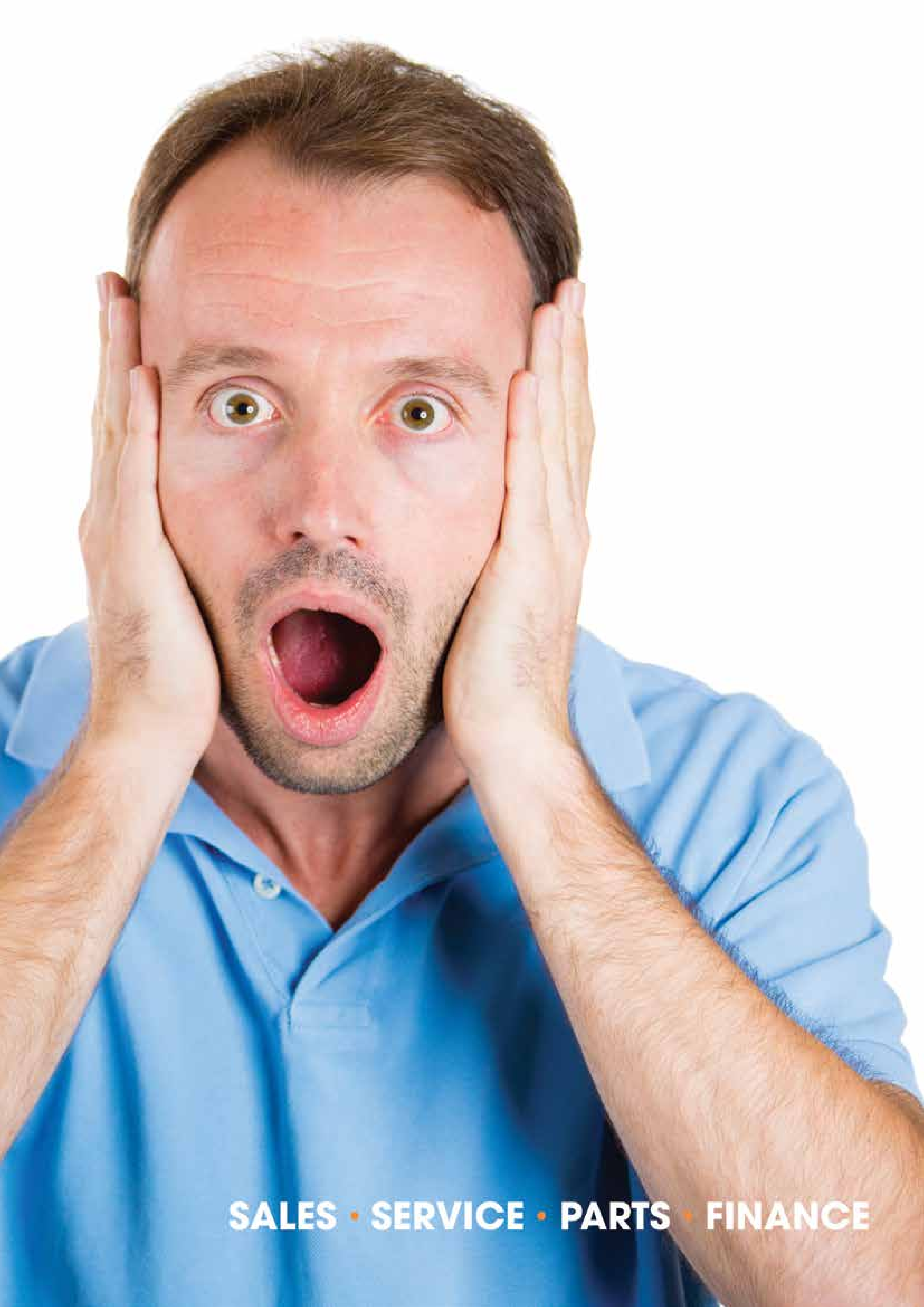
This whole process will be repeated for another 37 wind turbines, meaning that the CC 8800-1 crane will be staying at the site for up to a year, working alongside a CC 9800 crane from Enercon.

The Terex CC8800-1 Boom Booster kit



Main boom is 138m

The 72m long Boom Booster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