"Without the Boom Raising System, we would have been pressed to rent another crane or wouldn't have been able to bid on the job."

Ron Babb — Crane Operator, Reed & Reed Construction

The Boom Raising System for the 400 t Manitowoc 16000 Wind Attachment is designed for customers like Reed & Reed to win more jobs. It allows operators to raise the longer wind attachment boom lengths needed for 100 m wind turbine projects — without an assist crane.

> See it in action: **www.youtube.com/manitowoccranes**

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Manitowoc

The future of wind turbine erection?

Whatever an individual country's policy on wind power there is no denying that it is still growing rapidly on a global scale. According to the European Wind Energy Association statistics, the European wind energy sector installed 11.6 GW of capacity in 2012 increasing the total wind power capacity by more than 10 percent to 105.6 GW. More than a quarter of all new generating capacity installed last year was based on wind power, with an investment of up to €17.2 billion and it now meets seven percent of Europe's electricity demand - up from 6.3 percent at the end of 2011.

There are however several clouds on the horizon for wind power. The 2011 and 2012 figures in the table below do not show the negative impact on the market of the regulatory and political uncertainty sweeping across Europe since early 2011. Many of the turbines installed in 2012 were permitted, financed and ordered prior to the crisis and this will probably result in a reduced level of installations during this year, possibly continuing into 2014.

As can be seen from table, the top two EU wind power countries, Germany and Spain have by far the largest capacity, almost three and four times greater than the third placed UK. Germany installed 2,415 MW capacity in 2012 which is more than the whole of the total capacity of Austria, Belgium and Czech Republic put together.

Wind power and wind power installation is big business, particularly for the large crane manufacturers. Germany's huge annual installed capacity is probably the main reason why so many large crawler cranes have been sold in the region. It is thought that Terex has orders for at least 15 of its new 650 tonne capacity Supalift 3800 crawler cranes (the CC2800 replacement) from Germany alone, just six months from launch - a huge number for such a large crane in one country.

On a global scale China now has the largest installed capacity with 75,564MW followed by the USA with 60,007MW, although the European Union is the largest wind power region with 105,696MW installed capacity.

South America still has a relatively small amount of wind power, with Brazil its largest producer only 15th in the world. Mexico (23rd) is set to expand significantly over the coming years. Current installed wind capacity is 1,400MW but this is set to increase to 12,000MW by 2020.

Wind problems

While wind power is growing rapidly around the world, in the more established areas such as Europe that already have large installed capacities there are increasing problems both in finding suitable sites and also from environmentalists wanting to stop the damage caused to areas of outstanding natural beauty or from residents that do not want them in their back yard. Increasingly sites are being found in remote areas and forests. These sites are a major challenge in both transporting the towers, nacelles and blades to site and in finding enough space to rig the larger crawler or mobile cranes needed to erect the taller and heavier turbines that best suit these sites. The concerns over environmental damage while erecting these turbines puts increasing pressure on clients and contractors to minimise the amount of space that is cleared for erection.

With Germany now the leading European wind power nation, it is not surprising that it has a very

Top 10 EU countries for Wind Power capacity

Country	MW Installed	Total capacity end 2011 - MW	MW Installed	Total capacity end 2012 - MW
Germany	2,100	29,071	2,415	31,308
Spain	1,050	21,674	1,122	22,796
UK	1,298	6,556	1,897	8,445
Itay	1,090	6,878	1,273	8,144
France	830	6,807	757	7,564
Portugal	341	4,379	145	4,525
Denmark	211	3,956	217	4,162

Moving equipment through remote areas and forests is a a major challenge

The Liebherr 630EC-H70 working in Bischberg Germany

healthy and innovative wind sector constantly looking at the trends and developments of the industry, along with new simpler ways of working.

The tower crane solution

One interesting development over the past year or so has been the use of tower cranes to erect the wind turbines with German tower crane manufacturers Liebherr and Wolffkran at the forefront of this move. Liebherr and Neumarkt-based Max Bögl Wind were probably the first companies to develop a special tower crane for the erection of wind turbines, aimed at hub heights of 110 metres and higher, in weak-wind regions. The crane - a 630 EC-H 70 Litronic - is built-up on the foundation of the wind turbine and is configured so that the necessary lifting height can be attained with only one tie point to the wind turbine tower. In this configuration the 630 EC-H 70 can lift up to 70 tonnes.

As a rule, wind turbines in weak-wind areas (such as Germany) are not generally part of large wind farms but are erected in forests or in inaccessible areas. According to Liebherr, using a tower crane offers particular advantages when erecting in such locations. Transportation vehicles with special permits are not required for the delivery and removal of components on roads that are often of poor quality, and the assembly of the crane and the wind turbine can be carried out in a relatively small area.

The first tower crane erection contract was in Bischberg in the Upper Palatinate when a 630 EC-H 70 was used to erect a new generation of hybrid towers with a hub height of 140 metres. The 630 EC-H 70 can achieve a maximum lift height of 151 metres with the single tie point and can lift up to a lift height of 93.1 metres when freestanding.

The 70 tonnes capacity allowed the crane to erect the entire turbine - tower, nacelle and the rotor blades. The maximum load at the 30.9 metre jib tip is 10,700kg. The tower crane was built-up on a reusable foundation frame which means that in subsequent years smaller tower cranes can be used to cost-effectively carry out maintenance work on the nacelle or on the blades.

Just 21 trucks were needed to transport the tower crane for the Bischberg project and the area needed was 1,200 square metres, half what other cranes would have required. A mobile crane is initially needed to erect the tower crane to a hook height of 50 metres and then it climbs itself to its maximum free standing height of 93 metres. If going higher the tower is tied in at 82 metres with a patented guying system allowing the crane to then climb to its maximum height. The tower is good for winds up to 72 km/hr but over 20 km/hr the jib is released for free slew. Lifting a 70 tonne nacelle to 140 metres takes about 30 minutes, but the crane operator has an excellent view when positioning the nacelle and blades from his cab above, rather than being 140 metres below in the mobile crane.

Demand from wind turbine manufacturers following the first contract has led Liebherr to look at larger cranes to lift heavier nacelles leading to the development of the 125 tonne 1000 EC B 125 Litronic specifically for the erection of wind turbines. The crane has a new hoist solution for wind turbines with hub heights of over 120 metres. Maximum lift capacity is 125 tonnes in the six-fall version or 100 tonnes in the four-fall version. A completely new faster, safer and simpler climbing arrangement has also been developed for the 1000 EC-B 125 Litronic. Said to be twice as fast as conventional equipment, the crane will climb to a free-standing hoist height of more than 100 metres and after being anchored to the turbine tower, the climbing process can continue until the crane reaches a hoist height of around 170 metres, a maximum height of 190 metres is possible for jobs other than wind turbine erection. Work can continue in wind speeds of up to 18 metres a second, one of the main features of using tower cranes, along with their low space and transport requirements.

Other developments on the 1000 EC-B 125 Litronic include the infinitely adjustable crane drive units ensuring high working speeds whilst 'Micromove' ensures that heavy components can be positioned and set down with greater precision. The transportation on the 1000 EC-B 125 Litronic has also been improved. Most of the various crane sections can be transported with standard semi-trailers. The crane's jib sections can also be placed inside the tower sections to save space.

Main advantages of using a tower crane for turbine erection

- Reduced amount of space needed to erect crane
- Can operate in higher wind speeds (up to 20 m/sec)
- Reduced transport requirements
- Better operating position with the operator close to the nacelle
- Foundations already in place to erect smaller tower crane for maintenance

So with nacelles increasing in capacity, size and weight, hub heights getting higher and sites

One of the main advantages of using a tower crane is the reduced amount of space needed to erect the crane.

Powerful and precise.

The new 1000 EC-H 50 Litronic High-Top crane.

- Efficient transportation
- Fast and safe erection
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becoming more remote, the tower crane has an increasing number of factors in its favour - and these are likely to become more important as time goes on. Liebherr however, while convinced that the tower crane is cost effective for single, large turbine installations in remote areas, maintains that for lower height wind farms and those in less remote areas a lattice boomed crawler or telescopic All Terrain is the better solution - a sentiment that Potain also agrees with.

"Wind farms are becoming more remote and wind turbines are getting bigger," said Carsten Bohnenkamp, director of special application tower cranes at Potain. "This has caused a notable rise in the number of tower cranes used to build wind farms. Remote locations make it difficult or even impossible to transport a large mobile crane or crawler crane on site, while tower cranes can be broken down into smaller sections to reach even the most remote sites. The growing scale of wind turbines means mobile cranes have not the reach or capacity to be a viable option - we expect the majority of nacelles to weigh between 60 and 100 tonnes by 2018. Crawler cranes are strong enough but the sheer size of crane needed to build the biggest wind turbines requires far too many trucks and far too much time for their erection. In those cases, tower cranes are the best option."

"But when it comes to tower cranes at wind farms, we must remember that this is a niche market and it's not rocket science. Wind farms need cranes with big capacities that are quick and easy to erect and have excellent load control (to contend with heavy loads and high winds). Rather than developing new technology at great expense which would drive up costs, we simply adapt our current capabilities and product range to meet the market's needs. The key is to find the best compromise between light wind tower design and powerful tower crane attachments."

"While tower cranes are a powerful option for the largest wind turbine erections, mobile cranes and crawlers remain a good option for smaller wind parks and to carry out maintenance where the crane must be moved to several positions on site."

Currently the lattice boomed crawler is prefered for turbine erection

Tower cranes can operate in higher wind speeds

Just 21 trucks were needed for the Bischberg project tower crane erecting turbines with a 140m hub height

The Grove GTK is another solution for turbine erection

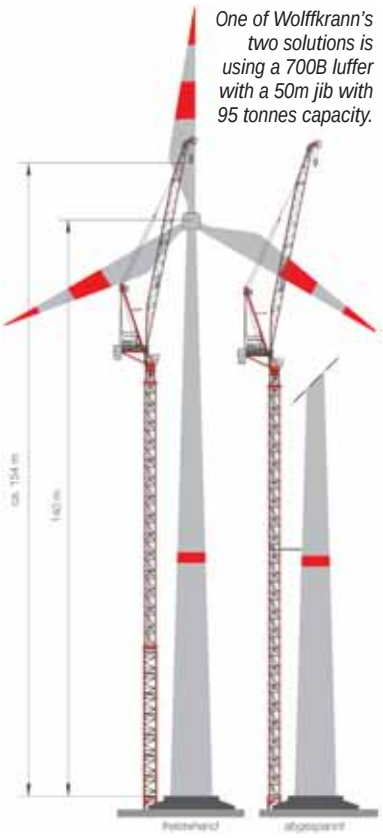
Wolffkrann's sensible solution

Peter Schiefer chief executive of German tower crane manufacturer Wolfkrann says the company has been toying with the idea of lifting turbines for about three to four years.

"In one of my previous positions I built one of the largest wind farms in Germany," says Schiefer. "At that time most were situated on greenfield sites and it was easy to move in with a large crawler crane, put up 50 turbines and leave. The new sites are now in the middle of a forest or in nature preservation areas and people are concerned about the damage caused in erecting these turbines - not only the area needed for the erection but also the road required for access. A large crawler crane takes up too much space and too much of the forest - the sensible way is to use a tower crane. Our tower footprint is 2.3 by 2.3 metres and the foundation is a little extension to the turbine base foundation. Working in inner cities we are used to coping with narrow situations so it is not a problem."

"In the early days the crawler was the number one choice but times and attitudes to power generation are changing," adds Schiefer.

"Following the Fukushima Daiichi disaster in March 2011 the focus has been more on renewable energy. The growth and expansion in wind power means having to use sites that are more difficult to access with the larger equipment. The cost of a crawler crane per day is far more than a tower crane and when the down times are added in it is killing its efficiency when compared to the tower crane."



One of Wolffkrann's two solutions is using a 700B luffer with a 50m jib with 95 tonnes capacity.

Wolff has two tower crane solutions - a trolley jib crane similar to the Liebherr EC-B – and a luffing jib alternative which it says is ideal for wind turbines with hub heights of up to 140 metres as it can operate with or without tower ties.

The Wolff 700B luffer fitted with a 50 metre jib has a lifting capacity of 95 tonnes and a radius of 10 metres. During assembly the luffer is anchored directly into the foundation of the wind turbine and assembled to its initial height using a mobile crane. It then climbs to the final height using the Wolff external climbing unit. Due to the jib angle of the 700B, the tower height can be kept low eliminating the need to tie into the turbine tower. The crane is assembled to its initial height in one to two days and then climbs as the installation of the turbine progresses.

"With our luffer solution we can climb up and down 15/16 sections at between 30 to 45 minutes per section," says Schiefer, "compare that to erecting and dismantling a crawler with 140 metres of main boom."

"With two days to erect and dismantle, we think there is no time advantage for the crawler, even when carrying out multiple turbine erections in a wind park. Advantages of the luffer are that you don't have to tie it into the tower, it uses far fewer tower sections and the erection and dismantling is therefore even quicker. True we don't have a 125 tonne maximum lift crane like Liebherr, but this lift capacity is not yet needed and it is only a five to six month development exercise if we need to do it."

Demand increasing

So far there have only 25 wind turbines or so have been erected using tower cranes, however there has been a lot of interest in the concept. Belgium, France, Austria and Switzerland all have similar issues to Germany in that all the easy greenfield sites have been used and turbines now have to be sited in nature preservation areas or in areas that are tricky to reach.

"A crawler capable of lifting the future sized hubs to 140 plus metres is a big crane and comes with big costs," says Schiefer. "Four days hire for the crawler would be an entire month for a tower crane. On a development of say 10 turbines you could use a smaller crane for the towers and then a big crawler - but 40 days hire of a big crawler would cost a fortune - probably about 10 month's rent on a tower crane during which time you could build say 20 turbines."

"When we set up our tower cranes we install them as close as possible to the turbine tower so having a luffer with a very short counter-jib is advantageous. This also means that the tower crane base can be included into the turbine base - in such a big foundation this is a minor issue."

"The use of tower cranes to erect turbines is an important and growing market - just look at the number of turbines that need to be erected and where the sites are situated," he said. "As the turbines get heavier and hub heights higher, it plays into the hands of the tower crane. Some companies are already looking at turbines with hub heights of 160 to 170 metres - just imagine the size and cost of the mobile crane needed for those?"

High in the Alps

Nine wind turbines have been installed in Styria, Austria almost 1500 metres above sea level by crane and access rental company Prangl. The new wind farm situated on the Stanglalm-Hochpürschtling mountain ridge has turbines with hub heights of 100 metres and rotor diameters of 92.5 metres.

Intensive planning is the key to completing such a project made easier in that all services from transport to logistics, handling and cranes were provided by a single supplier - Prangl.

Heavy transporters moved the hubs and the rotor blades from Germany to Austria. The tower segments - five units per wind turbine, each weighing between 26.5 and 60.5 tonnes and up to 20 metres long - arrived from the Czech Republic. All components were temporarily stored at a handling location in Stanz with a 220 tonne All Terrain and a 100 tonne telescopic crawler crane doing the unloading. All wheel drive trucks with heavy-duty modules shuttled the components to the installation points and due to slopes of up to 17 percent, a second all wheel drive tractor was needed as lead vehicle.

To protect the environment Prangl used a self-propelled heavy load module with a specially developed blade transport device allowing the 45.6 metre long rotor blades to be elevated up to and angle of 60 degrees to negotiate the narrow twists and turns on the mountain roads, the 16km distance taking up to four hours to cover. Because space was so tight, it was not always possible to store the components near the cranes and therefore had to be delivered just in time which required precise logistical coordination.

The turbines were erected with a 600 tonne lattice boom crane with 102 metre main boom and 12 metre jib with the support of a 120 tonne All Terrain. Bad weather including snow, heavy storms and floods posed a further challenge but the project was completed successfully and on time.

The 45.6 metre long blades were elevated up to 60 degrees to negotiate the narrow turns on the mountain roads.

Canada's biggest

In rough, mountainous terrain, four Manitowoc 16000 crawler cranes are currenty working on the Lac Alfred Wind Farm near Amqui, Quebec, the biggest wind farm in Canada and one of the largest in North America. The project consists of 150 turbines with an installed capacity of 300MW and is being built by Quebec-based Borea Construction.

The cranes - rented from Quebec-based Guay - are used to lift the top sections of the towers, nacelles and full rotors. The heaviest component is the 72 tonne nacelle hoisted to the top of the 80 metre towers.

The 400 tonne capacity 16000's are fitted with the Manitowoc Wind Attachment, which boosts capacity and increases maximum boom length to 96 metres. The project has been made more difficult because of the mountainous roads, extremely cold winter temperatures, snow and icy winds blowing from the St. Lawrence River.

"The four Manitowoc 16000s turned out to be the most cost-effective, productive and simple solution," said Guillaume Gagnon of Guay. "Despite the wide range of difficult conditions the 16000s have been excellent workhorses - durable, reliable and simple to operate."

The project - being developed by EDF EN Canada - began in May of 2012 and is due to finish in October 2013.