Returning to Old Wind Turbine Tower Designs via Hybrids

The wind power industry is trending towards taller towers to capture greater wind energy capacity curves, and turbine capacity is following suit to meet the demands of higher-output designs. Historically, the wind energy turbine tower has grown from 40 meters to over 100+ meters within the past 30 years, and turbine sizes have grown to reach 6 MW and more.

In order to meet the demand for ever taller and ever larger turbines, many companies are turning toward hybrid tower designs. Not only does this return to old-world construction add stability to the conventional turbine design, it may also play a role in lowering costs as the industry reaches ever higher for greater energy outputs.

Recognizing the Hybrid Tower's Advantages

Today's all-steel turbine tower design causes several challenges in terms of construction, transportation, and installation. For instance, the diameter of the steel tower is limited in one sense to the maximum dimension that can be shipped on public highways – usually 5 metres. Since taller towers require a larger diameter, the steel tower can have a significantly restricting impact on the height of the turbine. Additionally, steel towers start to lose efficiency once they go above 85 metres in height, making it necessary to seek out other materials that perform better at higher heights.

New hybrid tower designs may be the answer, usually composed of a concrete base and a steel shaft at the top. One example of this hybrid design is Gestamp's GRI Hybrid Towers. They are composed of three sections. The first is an 85 metre steel tower, with a maximum of three sections. This upper design allows the tower to take advantage of technologies already in use with existing towers.

In the middle is an adapting ring that creates the union between the steel section and the lower shaft. It is a mixed concrete-steel section that is hollow and cylindrically shaped. It can be adapted to the geometry of any metal tower and assists in reducing the stress bearing on the concrete shaft.

GRI Hybrid Tower by Gestamp

Finally, the hybrid tower is composed of a prefabricated post-tensioning concrete shaft section. This section is up to 50 metres tall and is composed of 6 dowels. By forgoing complex horizontal joints, the concrete shaft can be installed quickly to lower overall costs. It is anchored into place directly to the foundation without costly anchors.

The foundation has an innovative design. The nerves and inner ring can be prefabricated, which allows for less on-site installation time. The foundation is also adaptable and compatible with any terrain, piles, gravel columns, and more. In total, the GRI Hybrid Tower can reach 140 metres in height.[i]

The most important advantage to the hybrid design is the fact that concrete can greatly reduce the cost of a tower while providing added weight to reduce bending movement at the foundation. Not only that, but concrete has excellent strength characteristics, making it an ideal material for use on the lower portion of a tower. Further, many hybrid-designed towers are constructed with much larger diameters inside the tower. This space is being used by tower designers for the installation of equipment that would otherwise have to be installed elsewhere.

What's more, by choosing a hybrid construction model, often times separate components can be made smaller, simplifying the shipment process compared to other tower designs. This can further reduce installation costs and time required for project completion.

There are also several lifecycle benefits of opting for a hybrid model. For instance, maintenance for these towers can be lower since the concrete shaft portion doesn't require painting or upkeep. The concrete also provides greater stability, which reduces noise and vibrations – a welcome advantage for overall wear and tear on the turbine, and a welcome perk for local residents and wildlife. What's more, concrete is 100 percent recyclable, so at the end of life it is more easily disassembled for a smaller overall environmental footprint.

As you can see, they hybrid design offers many advantages, and as a result many companies are turning to it in favour of an all-steel construction.

Putting Hybrid Turbine Towers into Action

REpower is one such company putting hybrid wind turbine towers into commission. They have recently completed the construction of their tallest wind turbine to date using a hybrid tower structure. The tower, which reaches a hub height of 143 metres with a rotor diameter or 114 metres, will be rated to 3.2 megawatts of power and will be installed near Newmarkt, Bavaria. Dubbed the Winnberg 4, this concrete and steel hybrid tower has a total height of 200 metres.

The design of the Winnberg 4 includes pre-manufactured steel-concrete segments as well as a standard steel tower. What's unique about the installation of this type of turbine is the use of REpower's mobile tower crane which climbs up the tower as progress moves along. This makes it possible to lower expensive crane costs while permitting installations in even forested areas or along complex terrain. This is expected to be the first in a long line of hybrid towers set to be built in this fashion by REpower in Germany.

ATS Hybrid Towers

This particular installation highlights another advantage of hybrid towers: the ability to harness power even in low-wind locations as well as hilly terrain and

forested areas. With an increase in hub height from the traditional 93 metres to 143 metres, this hybrid turbine tower will be able to increase yields by 50 percent.[ii]

Growth for hybrid towers is likely to continue given the fact that, at present, hybrid towers allow manufacturers to reuse existing steel tower designs that are simply mounted on to concrete bases. That said, over time as full concrete towers become more feasible they may take over more of the market than hybrid towers.

In the meantime, however, companies like ATS are putting a lot of energy into building hybrid wind towers that are adaptable to other existing designs. Their tower configurations are being sold to a variety of manufacturers allowing them to increase the height of steel towers with the addition of a concrete segment. Most existing designs can reach 100 to 150 metres in this hybrid form.[iii]

Recognizing that concrete structures are much easier to manufacture locally than steel structures, ATS is leveraging their capabilities in this area to produce the concrete portions of their towers using only three moulds which can be easily transported close to the wind farm site. As a result, local materials and labour can be used to construct these portions, and transportation costs are also significantly lowered.

Further, ATS has also worked hard to reduce installation time with their hybrid tower design. Using full ring lifting, individual prefabricated concrete sections are assembled on the ground. Together they form a ring that is assembled into a complete tower using only a few moves. This saves significant time and lowers erection costs. To date, ATS has already equipped 20 wind turbines with their steel-concrete hybrid design, and they have plans to build another 40 towers this year.[iv]

Where Will Hybrid Towers Be in a Few Years?

Experts have speculated about whether hybrid towers will become increasingly popular over time or not. Many suggest that the advantages of these designs will push them into the mainstream, though some are predicting a market share of only three percent for hybrid towers by 2015.[v] While this is relatively small, over time if these towers prove to be lower-cost to install and capable of pushing tower heights further into the clouds, they no doubt will increase in popularity with wind farm operators and owners alike.

Additional factors will have an influence on the growth of hybrid towers in the wind energy market. Steel prices, for instance, have been historically very volatile, especially when compared to concrete prices. If this trend continues, the use of more concrete in tower designs will certainly become more common.

What's more is the fact that emerging markets, such as those in Latin America, Brazil, and parts of Africa where local steel manufacturing is cost-prohibitive, are more likely to opt for locally-constructed concrete towers that are more cost effective. Not only is concrete less costly and requires fewer specialized tools, it can be produced using precast processes in small mobile factories, making it ideal for these developing nations hoping to get more renewables into the mix.

Whether hybrids become the norm or not remains to be seen. What is certainly true is that their cost and time-saving advantages make them a great stepping-stone design until even more advanced techniques for constructing these behemoth turbines can be developed.

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