

Levator Oy, from Hanko, Finland, invests in wind turbine tower production

Introduction

Levator Oy, based in Hanko, Finland, manufactures heavy-duty steel construction elements. Levator's number one product is cranes, a wide variety of which the company supplies, mostly to ports and dockyards. In the last five years, Levator has also been investing in wind turbine tower production. Financial incentives that support electricity production based on renewable sources of energy have increased the construction of wind power facilities in Finland, creating new business opportunities for the Finnish metal industry. At the end of 2008, Finnish wind power capacity came to 143 megawatts, representing only 0.3% of the country's electricity consumption. Finland's official projected wind power capacity for 2020 is 2000 MW, which will be a challenging goal to reach.

Introduction to wind turbines

Commercial wind turbines are almost exclusively three-bladed horizontal-axis wind turbines whose rotors are above the wind in relation to the tower (see Figure 1). Wind turbines can be categorised on the basis of how the turbine's power output is limited in heavy wind conditions. The principal methods are limiting of power output based on stalling and limiting of power output via blade pitch adjustment. The turbines can also be classified in terms of their rotation speed, as fixed-speed turbines, two-speed turbines, and variable speed turbines. Moreover, they can be divided into geared and gearless turbines according to their power transmission mechanisms. /1/

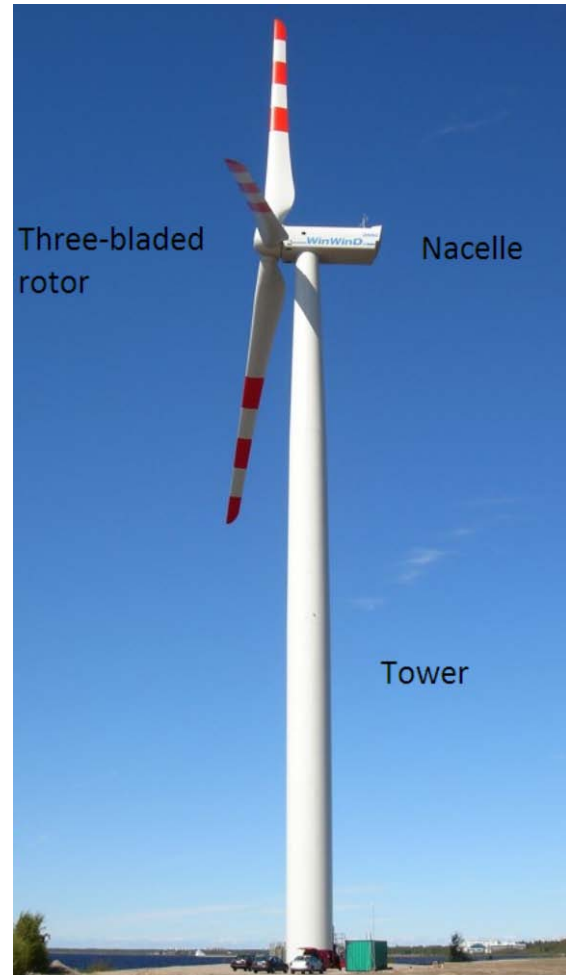
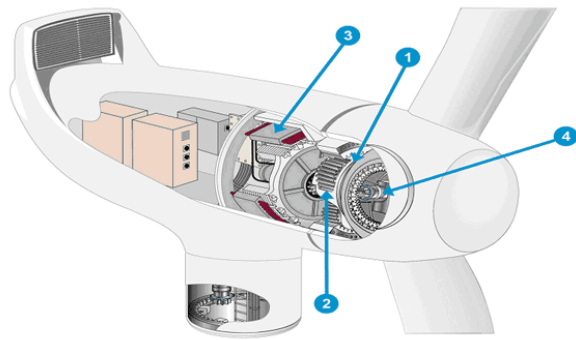


Figure 1. The structure of a Finnish wind turbine constructed by WinWinD Oy. The tower was manufactured by Levator Oy (source: Levator Oy).



- 1) Custom-made three-row roller bearing
- 2) Single-stage planetary gear
- 3) Generator
- 4) Blade pitch mechanism

Figure 2. The nacelle of a 1 megawatt WinWinD turbine. /2/

In most European wind turbines, the towers are tubular steel towers mounted on concrete foundations. Hybrid towers, in which the bottom parts of the tower frame are made of concrete that has been cast on-site, have become more common in recent years. The top parts of hybrid towers are made of steel. Wind turbine towers consist of a number of tower sections, the number of which depends on the height and type of the tower. Hybrid towers usually have two sections, while steel towers commonly have three or four. The tower sections each consist of several tower shells.

The nacelle houses the transmission gear, the generator, and the adjustment and control systems (see Figure 2). Various kinds of motors, controlled by directional sensors and control devices, turn the nacelle so that it faces the wind. The blades of today's wind turbine rotors are usually made of composite materials. The blades also function as the turbine's power output adjustment and stopping mechanism.

Wind turbines have increased in size as the technologies have evolved. The first modern wind turbines achieved a power output of 20–100 kilowatts and their towers were approximately 20 metres tall. This was the typical scale until the late 1980s. In the 1990s, however, the use of wind power started to become more and more commonplace and new, bigger turbines

appeared on the market. In the latest wind turbines, both rotor diameter and tower height are in the range of 100 metres.

Manufacturing a wind turbine tower requires mastery of several technologies

The austere appearance of the wind turbine tower can be deceptive. In addition to the rolling and the welding of tower shells, the manufacturing process involves several stages that are made even more demanding by the considerable wall thickness and shell diameter and the high-precision saddle joints. The primary stages of tower production are listed below. Some of them are described in more detail later.

The primary stages in construction of a steel tower are:

- Cutting of the steel sheets and preparation of the welding joint.
- Rolling of tower shells and tack welding of the longitudinal joint (see Figure 3).
- Longitudinal welding of the tower shell.
- Fitting and tack welding of the end flange to the tower shell.
- Welding of the end flange to the tower shell (see Figure 7).
- Fitting and tack welding of tower shells (see Figure 4).
- External welding of tower shells.
- Internal welding of tower shells.
- Construction of the doorway (flame cutting, bevelling, fitting and welding of the frame).
- Installation of aircraft warning lights (flame cutting, bevelling, fitting and welding of the flange) (see Figure 5).
- Casting of the concrete ring to the top shell.

- Machining of the azimuth flange.
- Painting.
- Internal installation (see Figure 6).



Figure 3. The rolling of the tower shell requires careful work (source: Levator Oy).



Figure 4. The tower section is assembled from a number of tower shells. The photograph shows a fitting and tack welding station (source: Levator Oy).



Figure 5. The flange of the aircraft warning light fitted in place (source: Levator Oy).



Figure 6. Painted tower sections in different stages of internal installation (source: Levator Oy).

Submerged arc welding guarantees efficient, high-quality results

The most important welding process used in the manufacturing of wind turbine towers is submerged arc welding, which guarantees the best combination of efficiency and quality when thick wall materials are used and the joint has been prepared by means of flame cutting. At Levator Oy, submerged arc welding is used not only for the longitudinal welding of the rolled tower shells but for all internal and external circumferential welding. In addition to single-wire welding, tandem welding (DC+AC) is used when maximal production efficiency is required (see Figure 7). Metal active gas flux-cored arc welding is the primary tack welding method used.



Figure 7. The tower shells' flanges are welded using tandem submerged arc welding (source: Levator Oy).

Use of an efficient painting system decreases production time

In 2007, Levator Oy started using a low-solvent polyurethane paint system. The deployment of this system was preceded by a three-year testing run, during which the characteristics of the paint were optimised for wind turbine towers. The new system reduced painting times by almost 50%, eliminating a critical bottleneck from the production line. In addition to decreasing production times, the new paint has reduced the VOC emissions of the frame manufacturing process. The current emission levels are well below regulatory limits.

Summary

The international demand for wind power plants is increasing rapidly. At the end of 2008, Finland's wind power capacity was 143 megawatts, representing only 0.3% of Finland's electricity consumption. The official objective – capacity of 2000 megawatts by 2020 – provides several work and business opportunities. Hanko-based Levator Oy responded to this challenge by investing in new production equipment in 2004. More resources have been allocated for production development since then, and this has resulted in increased productivity and capacity.

Sources

/1/ The Wind Power Project Guide. Motiva, 5/1999.

/2/ The WWD Wind Turbine, 24 February 2009. URL:

<http://www.winwind.fi/tuotteet.html>

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