AWEA Wind Power
Value Chain

Metal Working for the Wind Industry

Metal components make up nearly 90% of the weight and over one-third of the value of a modern wind turbine[1]. The wind industry installed over 5,000 commercial-scale wind turbines in 2008[2], which translates into 15,000 tower sections, 2.4 million bolts and 27,000 miles of rebar in the turbine foundations[3]. The industry saw an investment in wind turbine equipment in the U.S. of over $8.5 billion in 2008 -- which translates into a $3 billion industry for steel or cast iron components -- and the annual demand is projected to double during the next few decades as the industry ramps up to produce a larger share of the nation's electricity.

Because of the worldwide economic crisis, 2009 will likely be slower than 2008, but industry analysts are hopeful that new renewable energy incentives will quickly bear fruit. Around 3,000 new commercial-scale wind turbines are expected to be commissioned in 2009. The rapid growth the industry has experienced and is expecting to see in the future opens up opportunities for forges, foundries, fabricators, machine shops and integrators that can produce the thousands of components and sub-assemblies that go into a wind turbine. These components begin as castings, forgings or fabrications then undergo multiple machining operations, post-processing -- such as heat-treating and stress relieving -- and then are typically coated to prevent corrosion. The components are delivered to the OEM for assembly. Ultimately the turbines are shipped to the wind farm for installation. Wind turbines have many subsystems that include the nacelle yaw and blade pitch units. There are fluid systems used for lubrication, cooling and hydraulic power. Electronic control systems are utilized for the generator and power electronics, as well as the yaw and blade pitch systems.

Forged Parts[4]

The main shaft and gear blanks are hammer- or press-formed while bearing rings and tower flanges are rolled as seamless rings. The rolled rings used in today's turbines measure up to 6 meters in diameter and 12 tons in weight. One U.S. supplier recently increased its capacity to make seamless rolled rings that exceed 7 meters in diameter and 17 tons in weight. Additionally, one forge bought a 4,500-ton hydraulic press to produce main shafts that weigh up to 18 tons.

AWEA has been teaming with state economic development offices and other local groups to offer a series of supply chain workshop. Check the events calendar at www.awea.org/events for the full calendar.

The first workshop, held in Ohio, attracted over 600 representatives from a diverse range of industries, including foundries, tooling companies, gearbox manufacturers, railroads and other transportation providers, electronics manufacturers and metal fabricators, as well as state economic development officers.

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1. Supply Chain - the Race to Meet Demand (European Wind Energy Association, Jan-Feb 2007). Value includes towers but does not include gearboxes and electrical components.
2. AWEA Planned and Existing Wind Power Projects Database.
3. Information from Mortenson Construction.
4. Most information on forged components from "Forging an Opportunity: Wind Turbines, Forge Magazine, October 2008.

Cast Parts[5]

Cast iron is typically used for the rotor hub, mainframe, forward housing or frame, gearbox housing and bearing housings. Depending on the size of the turbine, one wind turbine requires between 10 and 25 tons of ductile iron castings ranging in size from less than 100 lbs. to 50,000 lbs. (45-22,680 kg). Some wind turbines' rotor hubs weigh 36,000 lbs. (16,000 kg) and can be as large as 15 ft (4.6 m) in diameter. Like the hubs, the bases are castings of ductile iron in a grade with superior low-temperature properties. The bases are configured like a gigantic bowl-shaped lower jaw weighing and can exceed 32,000 pounds.

The majority of wind turbine parts are made out of the more challenging ductile iron grades, such as the EN specification 1563. This grade of ductile iron features the properties necessary to withstand the force of the wind and long-term exposure to the environment without failure. The castings must achieve high-impact strength at low temperatures, so the metal must be modified to achieve lower silicon and phosphorus levels. The alloy also must have high nodularity without a high nodule count, so great care is taken during solidification to achieve optimal nodularity.

Wind turbine manufacturers prefer these properties to be met as-cast in the critical castings. The components must pass stringent mechanical property tests and are subjected to extensive non-destructive evaluations that include ultrasonic, magnetic, and penetrant inspection methods.

Machined Parts

Studs, bolts and nuts are either machined or forged, depending on the application or the client specification. High-quality fasteners, washers and dowel pins are utilized for internal and external bolting of the tower sections, blade and hub joints, and nacelle components such as the generator and gearbox assemblies.

Many of the main components are large castings with features that require hundreds of hours of precision machining. The processing of these components includes boring, milling, drilling, tapping, turning and welding. Handling these large castings requires stout cranes and other material handling devices and, most importantly, machine tools that can accommodate the enormous size and weight while machining them with great precision.

Barriers

The barrier that most metal workers face when considering entering the wind industry is four-fold;

- ability to efficiently handle the heavy large scale components,
- meeting the rigorous quality requirement,
- maintaining on-time delivery with constantly increasing quantities, and
- achieving cost competitiveness in a global market.

The lack of certainty in U.S. federal policies has caused fluctuation in the demand for wind turbines and has a large impact on annual sales projections. The recently-passed American Recovery and Reinvestment Act (ARRA) of 2009 includes several provisions that will provide a better long-term footing for the wind industry, including a three-year extension of the renewable energy production tax credit (PTC) and a new program that allows renewable energy developers the option of forgoing the PTC and instead securing a grant from the Treasury department in the amount of a 30% investment tax credit (ITC). This program to help monetize renewable tax credits is considered critical for the wind industry to continue its growth in the face of the economic downturn, which has dramatically reduced the ability to secure value for renewable tax credits.

5. Most information on cast components from "Wind's Cast Crop", Modern Casting, September 2006.