Catching the Wind

Siemens Wind Power is more than just the global market leader for offshore wind turbines. In Denmark, in a unique, one-shot process, the company produces rotor blades that are up to 52 meters in length. It also manufactures the world’s largest serially-produced wind turbine, which has an output of 3.6 megawatts.

In Brande, a town of 6,000 inhabitants located some 150 kilometers south of Aalborg, 2,000 Siemens employees manufacture the heart of every wind power plant: its turbines’ nacelles (housing). During a trip through the Danish countryside, past its fields and farms and some of the country’s 3,500 wind turbines, I ask why the biggest manufacturers of wind power plants are in Denmark.

“There are historical reasons,” says Henrik Stiesdal, Chief Technology Officer at Siemens in Brande. “It all began with the energy crisis of 1973/1974. In a move to reduce its dependence on oil, Denmark looked at the possibility of building nuclear power plants. In response, talented engineers designed the first wind tur- bines. In the mid-1980s, a number of countries

Whereas some rotor blades are built far from the offshore sector. In the meantime, Siemens has not only become the most experienced, but also the largest supplier of offshore wind turbines.

In a patented process, wind mill blades are baked as a single piece — without any seams. But and prevent the blade from collapsing during production. “With this method it only takes 48 hours from the first step to a completed blade, instead of several days,” says Burchardt with evident pride. “That’s one day to place all the fiberglass, and another to inject and bake. After that the blade is adjusted and painted white — it’s a mixture of high-tech and skilled handi- craft.” Once completed, the rotor blades are de-

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Before installation at sea (bottom), Henrik Stiesdal (right) makes sure that everything is perfect — including turbine assembly (center), and a final endurance test (left).

introduced tax incentives for wind power, making it a lucratative business. As the only country with the know-how to build fully functional wind turbines, Denmark experienced a boom that has continued to this day.

Although it’s good weather outside — in the Danish sense — Stiesdal is evidently content to remain in his cosy office. From a drawer he produces a chronology of wind power, and places it on his desk. “The first wind turbines we built in the early ’80s had an output of only 22 kilowatts. Since then output has doubled around once every four years. At 2.3 and 3.6 megawatts, our modern turbines produce much more power. At least for now, the smaller plants still account for around 80 percent of our business.”

Stiesdal points to a large map of Europe. “We just completed installation of the Burbo Windfarm — our first offshore facility based on the new 3.6-megawatt turbine. The farm is located off Liverpool in the UK and has a total output of 90 megawatts. We needed just one and a half months to do the job. By the end of the year — around 12 percent of Denmark’s electricity is produced off Liverpool in the UK and has a total output of 90 megawatts. We needed just one and a half months to do the job. By the end of the year — around 12 percent of Denmark’s electricity is produced off shore wind farm, off the southern coast of Lolland, 10 years ago they introduced a 3.6-megawatt turbine, which will later adorn the turbine housing, in the middle the machine nacelles, and on the right the gigantic rotor blades, each of which weighs around 35 tons. The blades from Aalborg are delivered straight to the site of installation. The various components for the towers, which are up to 120 meters in height, come from external suppliers in Denmark, Germany, the U.S. and Korea, depending on the wind farm’s location.

Once in the hall, the white nacelle of the 3.6-megawatt turbine is unmistakable. Unlike its smaller relative, it is angular in shape. Measuring some 13 meters in length, four meters in width, and four meters in height, it is also bigger. The insides of the turbine are reached via a ladder. Various systems are spread over two stories, as if it were a small house. “Everything’s bigger in this turbine,” says Stiesdal with typical understatement. “But we’re already working on even bigger ones. In fact, before long the rotor blades on our turbines may be longer than 60 meters.”

The first wind turbines produced 22 kilowatts — that’s less than one hundredth of today’s output. 2007, the facility will be supplying over 80,000 households. Next year we have another project with 54 turbines for what will be the world’s largest offshore wind farm, on the east coast of England. And as the only company able to supply wind turbines of this size, we have already received other orders for our flagship product.”

Stiesdal’s eyes shine with enthusiasm. “This year we will be building wind turbines with a total output of 1,500 megawatts. That’s enough to produce four billion kilowatt hours a year — around 12 percent of Denmark’s electricity requirements. Our 165 MW Myslet offshore wind farm, off the southern coast of Lolland, generates enough energy to supply my home town of Odense and its 185,000 inhabitants, including households, industry, street lighting and everything,” he says, before entering a giant hall where turbines are produced. 1,000 lumen, which is brighter than a 50-watt halogen lamp, the star in the LED firmament is undoubtedly “Distant Lighting.” With its efficiency of about 70 lumens per watt, it literally relegates incandescent bulbs (15 lumen/W) to the shadows. The lamp contains six high-efficiency LED chips, each measuring one square millimeter. “With Osram, we have created a very large illuminated area,” says project leader Dr. Steffen Köhler from Osram Oriel Semiconductors in Regensburg, Germany, a subsidiary of Osram, a Siemens company. In contrast to the trend toward miniaturisation in the electronics industry, LEDs for general lighting should be as big as possible, so that they can supply large amounts of light. Achieving this goal is anything but an easy matter, though. It’s important to bear in mind that LEDs are a combination of differently doped semiconductor crystals. In other words, dopant atoms have been introduced to the crystal lattice, which have to be pure and regularly structured at the atomic level. The larger the crystals are, however, the higher is the probability that impurities and irregularities will be generated. As their number of impurities, the less efficient the conversion of electrical energy into light. Nevertheless, Köhler is confident that even more efficient and bigger chips can be produced. “We know that 2,000 lumens is a feasible goal,” he says.

Another important factor when it comes to producing efficient LEDs is the color of orange-red colors that are applied to the original light source in layers in order to filter out the LED chips’ blue light into white. Osram researcher Dr. Martin Zachau is an expert in this field. He and his team use colorant molecules to control the dispersion properties of the particles, which allows them to vary emitted light. Efficiency is optimized via chemical composition. The stability of the phosphor is increased by means of a protective coating.

LEDs still do not accurately reproduce natural colors. That’s because, unlike sunlight or light from incandescent bulbs, they produce only blue and yellow wavelengths. With this in mind, Zachau’s team has come up with a new system that will transform parts of the blue LED light not only into yellow, but also into green and red light. “As a result, the LED spectrum will be complete — like sunlight — and colors will be superbly reproduced,” Zachau explains.

To accelerate phosphor development, Dr. Ute Liepold of Siemens Corporate Technology in Munich relies on combinatorial chemistry (Pictures of the Future, Spring 2003, p. 26). To that end, Liepold uses a perforated metal sheet about the size of a postcard. The sheet holds as many as 96 crucibles containing mixtures of powders, which create new phosphors when heated in an oven. A computer-controlled manipulator is then used to weigh out the starting materials and position the pans on a sample carrier. The advantage of this method is that several hundred samples can be produced in a single day. “But organizing and evaluating all the data is quite a challenge,” says Liepold. The objective of the screening is to test as many compositions as possible in the shortest period of time.