Creating trust through strength

“We care deeply about the future of energy.”

Jens Hald Jensen believes the time has come to create a new energy system. Why? Because he’s convinced that the transition to a sustainable energy infrastructure can stop climate change. And because he wants to pass on to future generations a world worth living in. Jensen, a Siemens employee who’s project manager at the test center for wind turbines in the Danish town of Østerild, is working every day to make our energy supply a little bit greener – one step at a time.

Making a successful transition to a new energy system will require implementing a complex puzzle of measures. As an integrated technology company, we offer a virtually unrivaled portfolio of products and solutions spanning the entire Power Matrix. On the following pages, Jens Hald Jensen describes how he’s taking personal responsibility to help shape the future of energy. And in an interview with Dr. Hans-Josef Zimmer, Chief Technology Officer for our key customer EnBW Energie Baden-Württemberg AG, you’ll learn how one of Germany’s major utility companies views that future.
A logistical tour de force was required just to transport the Siemens B75 rotor blades 320 kilometers from the Danish port of Esbjerg to Østerild.

Clear instructions for the team: Siemens engineer Jens Hald Jensen (left) oversees the assembly of the wind turbine with the longest rotor blade currently in operation worldwide.

The housing – or "nacelle" – for the generating components of the Siemens SWT 6.0 gearless wind turbine is 15 meters long and 6.5 meters wide.
“These rotor blades have a very special magic for me. I saw them while they were still on the ground, I was there when they were raised up, and now I’m watching them rotate and produce energy – it’s simply magical.”

“At 75 meters in length, the new rotor blades have nearly the wing-span of an Airbus A380.” When Jens Hald Jensen talks about his work, he makes generous use of superlatives. And today is a very fitting occasion for them: on this gorgeous August day, the Siemens engineer is supervising the assembly of the world’s largest wind turbine rotor. Sporting a white hardhat and neon-yellow safety vest, Jensen stands in the middle of a test center in the Danish town of Østerild, where we’re testing our latest products before they are commissioned on site. The test subjects arrived several days ago: our SWT 6.0 wind turbine, which has a capacity of six megawatts, and our B75 rotor blades, which, at 75 meters in length, are the longest blades of their kind currently in operation worldwide. And although Jens Hald Jensen has worked in the wind industry ever since earning his university degree, he sees this test as the highlight of his career to date. “It’s simply incredible to stand here between these gigantic rotor blades – just look at these unbelievable dimensions,” exclaims the engineer from the Danish town of Brande. “It really is a technical tour de force to be able to manufacture something this imposing in one piece.”

More than just an impressive rotor

For decades, Jensen has dreamed of an energy infrastructure that relies more heavily on renewable sources such as wind. “The wind delivers an unbelievable amount of energy around the clock, especially offshore,” says the engineer enthusiastically. “The transition to a new energy system is offering us the opportunity to help shape the future of energy – and that’s where I feel a very personal responsibility to future generations.”

It’s no wonder that Jensen is excited about combining the SWT 6.0 turbine with the B75 rotor blade: a single turbine will be able to supply green energy to 6,000 European households – emission-free and without the use of fossil fuels. And the first customers are already lining up to make large-scale use of the new technology: plans call for installing 300 SWT 6.0 turbines with a total capacity of 1,800 megawatts off the coast of the UK between 2014 and 2017.
Years of offshore experience

Once the turbines and rotor blades have successfully completed the test phase, two giant cranes lift the housing for the SWT 6.0's generating components into the air. Under Jensen's watchful eye, the housing – or the "nacelle" – is moved in slow motion to the top of the 120-meter tower. The culmination of more than 20 years of experience in offshore projects, the SWT 6.0 is remarkable not only for its output but also for its new drive technology, which is entirely gearless. Such innovations have enabled our engineers to reduce the number of components by about 50%. The streamlined design facilitates maintenance while also cutting down on weight: the SWT 6.0 is by far the lightest wind turbine in its class. And this, in turn, lowers costs for the foundation and the tower – making wind energy more competitive and moving us a step closer to Jensen’s vision of a greener energy future.

**BELOW** – Once installed, the gigantic rotor will sweep an area equivalent to two-and-a-half soccer fields. An enormous amount of space is also required for unload-ing the rotor blades and mounting them on the hub (pictured on the left).
“The transition to a new energy system is Germany’s project of the century. It’s the right strategy, and it’s feasible. But we still have a long way to go in order to make it happen. The greatest challenges are the tight schedule and the required expansion of the power grid. The world is watching closely to see how Germany tackles these challenges.”
The largest single-cast fiberglass component
But Jens Hald Jensen has no time for visions today. Because once the turbine is assembled, it’s time to hoist up the three giant rotor blades with steel cables. “This is the biggest rotor blade we’ve ever installed,” notes Jensen. “It’s a monumental challenge to hoist up the blades – which have a total rotor diameter of 154 meters – and attach them to the turbine.” Each rotor blade looks a bit like a beached whale, and people standing beside it look as small as they would next to one of the giant creatures of the sea. After all, the B75 is the largest single-cast fiberglass component ever constructed. And it’s innovations like this one that Jensen always finds exciting. “Our intense involvement in this field demonstrates very clearly that we intend to be pioneers in shaping the future of energy,” he says during a break. “The products shown here in Østerild underscore our commitment to leadership.”

Our technologies are bringing the future of energy closer
Siemens offers its customers not only wind power installations but also a broad portfolio of other products and solutions that will facilitate the transition to a new energy infrastructure: long-distance low-loss high-voltage direct-current transmission systems, components for the smart grid of the future, gas turbines with record efficiencies, and high-efficiency electric motors that cut energy consumption. Only an integrated technology company with a broad portfolio can provide such a complete range of offerings – thus strengthening public confidence that the transition to a new energy system can indeed be achieved. Because rebuilding our energy infrastructure will require much more than “just” phasing out nuclear energy. Many individual innovations along the entire energy chain will have to fit together perfectly like the pieces of a puzzle in order to make tomorrow’s energy supply both reliable and sustainable. And it’s here that our Environmental Portfolio is equipping us to play a key role.

In Østerild, we’ve just taken another step forward. After hours of exacting work, two crane operators and a handful of our technicians have attached the three rotor blades to the wind turbine. Jens Hald Jensen looks up with rapt attention, captivated by the imposing sight. “These rotor blades have a very special magic for me,” he says pensively. “I saw them while they were still on the ground, I was there when they were raised up, and now I’m watching them rotate and produce energy – it’s simply magical.” Nothing more stands in the way of the exhaustive testing that will follow in the weeks ahead. But for now, Jensen has called it a day. “We did it!” he exclaims, making no attempt to hide his feelings. “We’ve just installed one of the world’s largest wind turbine rotors – now that’s something you just have to be proud of.”

Dr. Felix Ferlemann, CEO, Siemens Wind Power
“Every second that the rotor, which has a total diameter of 154 meters, operates at a wind speed of ten meters per second, it captures the energy of 200 metric tons of air.”
LEFT – A job well done: after two huge cranes have positioned the rotor – which has a total diameter of 154 meters – specialists connect it directly to the generator shaft.

ABOVE – Smiles all around following the successful assembly of the wind turbine: Dr. Felix Ferlemann, CEO of Siemens Wind Power (center), and Jens Hald Jensen, project manager in Østerild (back right), share a proud moment with colleagues.
“Renewables will be a vital pillar of our future energy supply. As an energy company, we need strong, reliable partners for the challenges ahead.”
Dr. Zimmer, the future of energy is currently a hot topic in Germany.

What stance is EnBW taking?

Dr. Zimmer: Building a new energy system is a huge challenge for Germany. And as one of the country's largest energy companies, we’re tackling it head-on. In terms of our strategy, this means we’re continuing to safeguard our position as a low-carbon energy producer. In addition to supplying power from highly efficient conventional plants, we intend to double the amount of power we generate from renewable energies by 2020. We already have a relatively large share of hydropower-based renewables in our portfolio. By 2020, we want to further expand our installed capacity from renewables by about 3,000 megawatts.

One step in this direction is certainly the EnBW Baltic 1 wind farm, Germany’s first commercial offshore wind installation. Your company partnered with us on its construction in 2011. How did the idea for this project develop, and what conclusions have you drawn from the operation of the wind farm?

Dr. Zimmer: We on EnBW’s executive board decided in fiscal 2007/2008 that we wanted to invest more heavily in renewable energies. Complementing our traditionally strong involvement in hydropower, we’ve defined wind energy as a further focus. Following extensive analyses, we concluded that wind turbines and wind farms, both onshore and offshore, could be particularly profitable. That’s why in 2008 we bought four licenses for offshore installations – two in the Baltic Sea and two in the North Sea – and now we’re in the process of developing these projects. The EnBW Baltic 1 wind farm has 21 wind turbines from Siemens and a total capacity of up to 48.3 megawatts. We’re very satisfied with its current performance. Availability is very good, and we achieved quite gratifying overall results the first year.

How’s the partnership with Siemens worked out?

Dr. Zimmer: When planning and implementing projects of this magnitude, we need reliable partners who keep their promises. Since the very beginning of the EnBW Baltic 1 project, the cooperation with our colleagues at Siemens has been characterized by great trust. And this trust is also based on our experience in other major projects on which we have partnered.

EnBW Baltic 1 is quite far from your home region in southwestern Germany. How is the electricity generated there distributed throughout the country?

Dr. Zimmer: Our wind farm in the Baltic feeds directly into the 50-hertz grid. From there, the energy is further distributed within Germany via an extensive interconnected grid. If we build more wind farms on the coast and offshore, where there’s lots of wind, we’ll have to transport large amounts of energy to the southern part of the country. By 2030, offshore wind farms operating off Germany’s coasts are expected to be supplying 25,000 megawatts of electricity. That’s why we’ll also need low-loss high-voltage direct-current (HVDC) transmission in the future. The grid development plan prepared by our
subsidiary Transnet BW and three other grid operators foresees HVDC transmission lines along several corridors. However, I'm assuming the approval process will take a very long time. There are also technical challenges to be mastered – because, even though HVDC lines have already been installed in countries like China and India, that doesn't mean such routes can be planned and implemented overnight in Germany. On the contrary, the process will take several years. But we must address this challenge if we want to succeed in restructuring the energy system.

In our view, highly efficient power plants like our combined cycle plants are another factor that can facilitate the transition to a new energy infrastructure: Stadtwerke Düsseldorf, a municipal utility in which EnBW holds a majority stake, plans to build just such a plant at the Lausward site in Düsseldorf. As with the EnBW Baltic 1 and 2 projects, Siemens will be the supplier. What criteria played a role in your investment decision?

Dr. Zimmer: Combined cycle power plants of the type supplied by Siemens are highly efficient systems that generate low-carbon power. They have fast-start capability and are highly flexible in terms of startup and shutdown – which makes them particularly suitable for an energy market moving toward fluctuating renewable energies. Of course, in addition to boasting high efficiency and rapid startup, every new plant must also be economically viable.

Another concern is reducing energy consumption, in other words, saving electricity. What can an energy company like EnBW contribute here?

Dr. Zimmer: A couple years ago, our slogan was “Empowered to cut consumption.” Now you could, of course, say that a utility company should be happy if its customers use lots of energy. But quite the opposite is true: we want to help our customers conserve energy and boost energy efficiency. For years, we’ve been offering tailored solutions that make our customers’ operations more energy-efficient. One thing is clear to us: at EnBW, we can be competitive only if we provide our industry customers with energy that is so affordable that they can keep their production in Germany.

Smart grids are one option for flattening consumption peaks. To what extent is EnBW involved here?

Dr. Zimmer: We’ve been testing smart grids in trial communities for several years now. We’re also analyzing how our customers can benefit from intelligent electricity meters. We want to help our private, business and industry customers consume less energy. For example, appliances and equipment that require a lot of energy should be operated at night, when electricity is less expensive, rather during the day, when demand is high.

That sounds like a business field with lots of potential for EnBW. How can Siemens provide support here?

Dr. Zimmer: Siemens is a technology leader in many fields. Since the entire development process for the production, distribution and consumption of energy is extremely complex, system providers like Siemens have major market opportunities.

In your view, what factors are most crucial for the successful transition to a new energy system?

Dr. Zimmer: We need a wide range of technical solutions to make the new system a success. In addition, a very stable legal framework for marketing renewables must be in place. We also need to expand the grid so that energy from the generation centers, which in the future will be in northern Germany, can be transported to the consumption centers in the south. We’ll need a greater number of highly flexible power plants, such as the combined cycle plants I’ve already mentioned. In addition – and this is very important –
we’ll need a public consensus to implement all of these things. Grid expansion will entail installing hundreds of kilometers of transmission lines all across Germany. And the construction of additional pumped-storage hydropower plants to store energy temporarily will also have an impact on the environment. We have to convince people and make it clear that the transition to a new energy system cannot be accomplished from one day to the next but will require a great deal of patience, money and effort.

In which of these fields do you anticipate major advances?

Dr. Zimmer: We need highly efficient plants, but it will take time to develop them. After all, Siemens didn’t develop its high-efficiency combined cycle plants overnight. And we’ll also need time to install HVDC transmission lines and smart grids throughout Germany. Until that happens, coal-fired plants will also be a component of the evolving energy system. While such power plants will still be necessary as a backup for many decades to come, they’ll be more efficient than before, delivering the same output while consuming much less fuel.

Now you’ve brought up the topic of the energy mix. How will the energy mix at EnBW look ten years from now?

Dr. Zimmer: While EnBW will also still be operating conventional plants in ten years, we intend – compared to today – to double the share of renewables by 2020, expanding their capacity by about 3,000 megawatts. Renewable energy sources include offshore wind, onshore wind, photovoltaics, biogas and water. To obtain an economically viable mix, all types of renewable energies will have to be combined. That’s how the restructuring of the energy system will succeed.

What do you expect of Siemens in this context?

Dr. Zimmer: We expect that Siemens will always be at the cutting edge of technology and that we can count on Siemens as a technology leader who provides us with efficient solutions – solutions that make sense from both an economic and an environmental perspective. We value Siemens’ power of innovation. And we value the trust that we have in Siemens, which has evolved over many decades, just like the plants that we built together and are successfully operating today. We expect Siemens to continue pursuing this strategy and to offer us the best solutions on the market. And we at EnBW wish Siemens every success in this endeavor.

www.siemens.com/ar/strength

www.siemens.com/ar/strength-movie

LEFT – Plans are far advanced for the construction of the world’s most efficient natural gas power plant – an order placed by Stadtwerke Düsseldorf, a municipal utility in which EnBW holds a majority stake. Here EnBW Chief Technology Officer Hans-Josef Zimmer examines up-to-date project planning information from Siemens. The plant is expected to begin supplying eco-friendly electricity and district heating in 2016.
Northern Ireland’s Strangford Lough is home to the world’s first commercial tidal current power plant. Since November 2008, two turbines have been producing a combined output of 1.2 megawatts – enough electricity to meet the needs of 1,500 households. To date, the installation has fed more than five gigawatt-hours of electrical energy into the grid, making it the world’s largest tidal turbine project. Further tidal farms are now in the planning phase: the eight-megawatt Kyle Rhea project in Scotland and the ten-megawatt Anglesey Skerries project in Wales.
Efficiency class

Fifteen years ago, there were only a few hundred energy producers in Germany. In the future, there will be thousands, generating power from solar, wind and biomass installations and residual cogeneration units. Energy consumers are increasingly becoming producers too – “prosumers.” This development, coupled with the growing use of fluctuating renewables, is making smart grids indispensable. Using sensors, variable network components and self-organizing software modules, smart grids maintain a balance between production and consumption. We’re testing these grids in Germany’s Allgäu region, where private producers are generating over three times as much electricity as they use.

Balancing supply and demand

If companies, towns and cities are to cut their energy consumption even when budgets are tight, they’ll need intelligent financing solutions. One proven approach is our energy-saving performance contracting – a combination of consulting, installation and financing services. Customers are not required to make any upfront investment; project costs are amortized with the energy savings achieved. Using this model, we’ve upgraded more than 4,500 facilities worldwide – generating savings of roughly €1 billion.

Offering intelligent financing solutions

Ensuring a reliable power supply

The foremost aim of all the measures that are bringing about sustainable change in the energy system must be to ensure the reliable availability of energy – at all times and at prices that are affordable for all. Blackouts must be avoided, and the international competitiveness of industry must not be endangered by excessive energy costs. That’s why the various measures comprising the pieces of the energy puzzle require careful planning and implementation. Only if these measures find broad public acceptance and fit together perfectly will the restructuring of the energy system be a success and the solutions deployed succeed on international markets.

Boosting the efficiency of conventional power plants

When the wind subsides or clouds cover the sun, fluctuations in power output must be offset fast – for example, by using combined cycle power plants. In less than 30 minutes, such plants can be generating enough power for a city the size of Berlin. As the world’s most efficient model – from Siemens – shows, combined cycle plants can reach an efficiency of almost 61% when converting natural gas into electricity, and waste heat can be used for heating. In many countries, coal will remain a key pillar of power generation for years to come. Coal-fired plants can also be made much cleaner and more efficient. What’s more, CO₂ can be separated from waste gas, stored underground or used for industrial purposes. Researchers are working on converting CO₂ into methane and the raw materials needed to produce biofuels and bioplastics.

Saving electricity and using it more efficiently

The cleanest energy is always the energy that’s not used. Industry offers considerable potential for savings. Electric motors – for pumps and drives, for example – account for nearly two-thirds of industrial power consumption. Our energy-saving motors and intelligent controls slash power consumption by up to 60% and pay for themselves in under two years. In the area of transportation, electric motors – in buses, trains and cars – are about three times as efficient as combustion engines. In buildings, which consume 40% of the power required worldwide, substantial savings can be achieved by using insulation, heat pumps, intelligent building technologies and efficient lighting systems. Household appliances also harbor huge savings potential. Today’s advanced models use less than half the power needed by their predecessors in the 1990s.

Making renewables competitive

If half of Germany’s energy is to come from renewable sources by 2030 (and some 80% by 2050), then these must be competitive without being subsidized. For wind power in particular, this goal will soon be reality. We’re currently pushing innovations that are expected to make electricity from wind power as economical as energy from coal. Our innovations range from scimitar-shaped rotor blades and gearless turbines to adaptive software that optimally adjusts wind loads, automated production processes and the longest rotor blades currently in operation worldwide for the most efficient offshore wind turbines on the market.

Smart grids: Making power grids more intelligent

Making energy storage facilities

When the weather changes, so does the output of wind and solar installations. That’s why facilities that can store excess energy for hours or even weeks are indispensable. One promising technology is electrolysis, which uses surplus energy to produce hydrogen, an energy carrier that can be fed into the natural gas grid, stored in subterranean caverns, reconverted into electricity and used in industrial processes or fuel-cell vehicles. Batteries in buildings and electric cars can also act as intermediate energy storage devices. We’re conducting research in all these fields.

Offering intelligent financing solutions

Smart grids: Making power grids more intelligent

Ensuring a reliable power supply

Building low-loss power superhighways

Western link HVDC connection

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We’re convinced that the transition to a new energy system will succeed. It will unleash a wave of innovation and create an exemplary energy infrastructure. Our technologies are making it possible to increase the share of renewables in the energy mix and slash greenhouse gas emissions. To make the transition a success, a variety of measures will have to be implemented – measures that fit together like the pieces of a puzzle. Here are some examples of how our technologies are already shaping the future of energy.

www.siemens.com/future-of-energy

Our self-learning software system is stabilizing the power grid operated by Swissgrid in Laufenburg, Switzerland. The program can forecast the electrical output of renewable energy sources over a 72-hour period with more than 90% accuracy. This information helps grid operators calculate power demand in their networks and achieve the greatest possible precision when determining the amount of additional electricity to be ordered in advance.

MUNICH, GERMANY

We’ve partnered with Stadtwerke München, Munich’s municipal utility, to develop and implement a so-called virtual power plant in which a number of small-scale, decentralized power generation installations are networked and operated as a single system. In the first stage, cogeneration plants with a total output of eight megawatts were virtually combined with renewable-energy generating units with a capacity of 12 megawatts. The main aim of the virtual power plant is to improve the reliability of planning and forecasting for the decentralized power generation systems in the area served by Stadtwerke München. Operation is more efficient and economical than when the individual units are deployed separately. What’s more, the virtual power plant can serve as a key element of a smart grid, maximizing the benefits for both the operators of the decentralized energy installations and the power suppliers. The core component of this virtual interconnection is our Decentralized Energy Management System (DEMS), which is enabling the Munich utility not only to optimize the deployment and operation of decentralized power generation facilities and power loads but also to create value through enhanced marketing scope.
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We’re building a record-breaking combined cycle power plant in Düsseldorf, Germany. Boasting an electrical output of 595 megawatts, the facility will set a new world record for a single power plant in combined cycle operation. With a net efficiency of more than 61%, it will also surpass the previous world record of 60.75%. And the plant will set a third record as well: never before has it been possible to extract 300 megawatts of thermal energy from a single combined cycle plant for use in a district heating system.
**Italy's most advanced brick-making plant, located in the town of Alfonsine, showcases the potential of energy-efficient technologies.** Thanks to our highly efficient asynchronous motors, the amount of power consumed by the factory’s electric drives – 170 motors with a total capacity of 1,065 kilowatts are in operation on the drying line alone – has been slashed by 500,000 kilowatt-hours. Investment costs were amortized within a short time. The result? Not only have costs been cut; the plant’s environmental footprint has also been reduced.

**ALFONSINE, ITALY**

**Saving electricity and using it more efficiently**

**500,000 kWh in annual savings**

**5,000 kW**

**Efficiency class IE2**

**Cost amortization after only six months**

**Electric motors for a brick factory**

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**HUNTERSTON/CONNACH’S QUAY, UNITED KINGDOM**

We’re building the first submarine direct-current grid connection in the Irish Sea. With a voltage of 600 kilovolts, this link will surpass the previous record of 500 kilovolts. The low-loss high-voltage direct-current (HVDC) transmission system will connect Hunterston, near Glasgow on Scotland’s western coast, with Connach’s Quay, in northwestern England. The link, which will have a capacity of 2,200 megawatts, is scheduled to go into operation at the end of 2015.

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**IRVING, TEXAS, U.S.**

With more than 1,000 stores in North America, Michaels is the largest supplier of arts and crafts merchandise in the U.S. Energy is the company’s second-highest line-item expense, after labor costs. With this in mind, Michaels has equipped nearly all its stores with our RCS energy management platform. Intelligent sensors and software operate on a real-time basis to monitor and regulate heating, cooling, lighting and humidity – resulting in energy savings of some 25%.
The town of Vellinge, in southern Sweden, has implemented a self-financing energy modernization project for its municipal properties. Thanks to our advanced building technology systems, energy consumption and costs for the town’s administrative buildings, schools, retirement homes and public swimming pools have been slashed. Under our energy-saving performance contracting model, we covered all upfront costs. The community of Vellinge will pay for the modernization through contractually guaranteed energy cost savings within the next few years.

It’s a promising solution for storing electricity generated by wind and solar power: electrolysis is used to split water into oxygen and hydrogen. The hydrogen is then stored and later used to power vehicles and turbines or for applications in industrial processes. A test unit with a peak power rating of 0.3 megawatts produces two to six kilograms of hydrogen an hour. When electricity from renewable sources is used for electrolysis, hydrogen production is virtually climate-neutral. The next generation of electrolyzers, which will have a rated power of two megawatts, is expected to be ready for use in the medium term. Researchers are aiming to develop an electrolyzer that has up to a triple-digit-megawatt maximum power rating and can accommodate the surplus energy generated by a large wind farm.