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METALS INSIGHT

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Steel for windpower: a burgeoning market

Major new offshore and onshore windpower installations are planned as renewable energy is embraced in the race to decarbonize power supplies. This will multiple the sector's demand for high-resistance steel

Cumulative windpower capacity is expected to increase to around 817 gigawatt by 2021, from 2017's installed capacity of 487 GW, most of which is onshore, according to the Global Wind Energy Council's 2017-2021 market forecast. Given there are 1,000 megawatts in each gigawatt and that wind farm operator Orsted (formerly Dong Energy) estimates the usage of steel plates per megawatt of offshore wind turbine capacity installed at around 200 metric tons (although this may be less for onshore installations) the data indicates there will be demand for tens of millions mt of steel for wind turbines in the five-year period. And this is not just ordinary carbon steel, but typically high-value high-resistance plate.

The estimates look reasonable given recent growth in the windpower sector, with almost 55 GW of capacity added during 2016, an increase of 12%, according to REN 21, the Renewable Energy Policy Network for the 21st Century, a multi-stakeholder organization. This may have equated to a steel requirement of around 10 million mt last year, Platts calculates.

Last year's wind generating growth was 14% below the record high in 2015, but still represented the second largest annual growth to date, REN21 said. Last year saw a significant decline in growth in the Chinese market due to financing considerations, even though China still added 23.4 GW in 2016, bringing its total installed capacity to some 169 GW, and accounted for one-third of total global capacity by year's end, the Network said.

For the eighth consecutive year, Asia was the largest regional market, representing about half of added capacity,

(continued on page 2)

Renewables account for 40% of the growth in power generation and are expected to be the fastest-growing fuel source in the power industry, notching up growth of around 7.6% p.a. between 2015 and 2035, according to a report by BP. Photo shows Orsted's Burbo Bank Extension windfarm in the UK which came into commercial operation this year, producing enough electricity to power over 230,000 homes. It has 32 turbines and a generation capacity of 258MW. Photo courtesy of Orsted.

EDITORIAL COMMENT

Offshore wind is "on a high" with costs having fallen by some 50% since 2015, the Global Wind Energy Council said in its Wind Energy Outlook 2016: Wind Power to Dominate Power Sector Growth. GWEC outlines scenarios where wind, offshore and onshore, could supply 20% of global electricity by 2030, generating 2,110 GW, creating 2.4 million new jobs, reducing CO2 emissions by more than 3.3 billion metric tons/year and attracting annual investment of some €200 billion. Steel demand from the sector could rise substantially from Platts' estimates of around 10 million mt/year in 2016.

"Now that the Paris Agreement (effective November 4) is coming into force, countries need to get serious about what they committed to (in December 2015)," said Steve Sawyer, GWEC Secretary General. "Meeting the Paris targets means a completely decarbonized electricity supply well before 2050, and wind power will play the major role in getting us there." Some are less bullish on the rate of growth, which may depend on the attractiveness of other energy sources and available financing. Some countries now consider windpower a mature industry no longer requiring government subsidies. In its 2017 Energy Outlook, BP notes renewables overall, of which wind energy will account for only part, will rise to take a share in global power of nearly 20% by 2035 from 7% in 2015, well below GWEC's vision. Still, the oil producer does expect wind power costs to continue to fall materially through 2035.

Differing global projections disguise advances in specific regions. BP predicts coal consumption in the OECD will fall over 40% by 2035 as the share of coal within the power sector is crowded out by renewables and natural gas. In absolute terms, China will be the largest source of growth in renewable energy over the next 20 years, while the European Union is seen continuing to lead the way in terms of the penetration of renewables in its power sector, seen doubling to almost 40% by 2035. "Offshore wind has been going at an incredible trajectory," said Scottish Equity Partners director Peter Bachmann during a panel focusing on EU renewable energy at the recent Mines and Money conference in London. Still, economics are all-important in the growth equation, with low carbon prices inevitably undermining the investment case for renewables in the UK, he said. — *Diana Kinch*

Steel for windpower: a burgeoning market

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with Europe and North America accounting for most of the rest. Growth in some of the largest markets was affected by uncertainty about future policy changes, and cyclical or policy-related slowdowns affected some markets; however, wind deployment also was driven by cost-competitiveness and by environmental and other factors. "Wind has become the least-cost option for new power generating capacity in an increasing number of markets," REN21 said in its 2017 Global Status Report. "By the end of 2016, over 90 countries had seen commercial wind power activity, and 29 countries – representing every region – had more than 1 GW in operation."

Bigger is better in windpower

In what may be good news for steelmakers, the trend is towards bigger installations overall. "The general trend is to towards larger machines – including longer blades, higher hub heights and, in particular, larger rotor sizes," says REN21. "Offshore, the need to reduce costs through scale and standardization has driven up sizes of turbines as well as of projects."

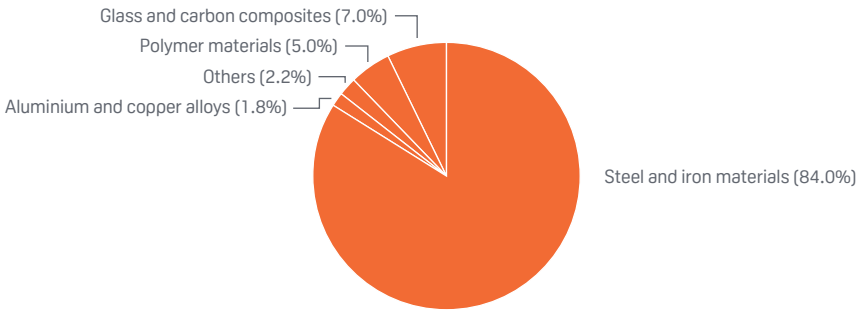
Information displayed on the World Steel Organization website points out that longer blades increase the energy yield of a turbine. They sweep a larger area and so capture more wind. The tower and the foundation have to be adjusted to carry these heavier blades and the bigger rotor that they require. Also, to maximize yield, longer blades mean taller towers.

The largest onshore wind farm is today in China, with Gansu Wind Farm weighing in at 6,000 MW, followed by the US's Alta Wind Energy Center, with 1,548 MW and Muppandal Wind Farm, India, with 1,500 MW. However, growth is occurring more rapidly elsewhere in offshore installations, particularly in Europe, where wind energy covered an estimated 10.4% of EU demand in 2016.

Germany was last year again the largest European market, increasing operating wind power capacity by almost 5 GW to a total of 49.5 GW (45.4 GW onshore and 4.2 GW offshore). Germany's boom was driven largely by the looming shift from guaranteed state financing to competitive auctions for

WIND TURBINE MATERIALS: 84% STEEL

Vestas Wind Turbine: In a case study dated February 2017 the World Steel Association noted that a significant reason for its low environmental impact is the high level of steel and iron used in the V112-3.3 MW wind turbine (up to 84% of the total weight). At the end of the turbine's useful life, all of this steel and iron can be recycled into new steel products with the same, or improved, properties. At least 83% of the V112-3.3 MW turbine is recycled.



Source: worldsteel.org

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most renewables installations as of January 2017, according to REN21. In the UK, Orsted won a contract in September 2017 to build what is described as the world's biggest offshore wind farm, the Hornsea Project Two, 89 kilometers off the Yorkshire coast in the North Sea, with 1.4 GW capacity. This surpasses the 1.2 GW Hornsea Project One which it is currently constructing, along with other projects undertaken by the company in the UK, where its investments are set to reach GBP 12 billion by 2020.

With the price of its energy determined at a Contract for Difference (CfD) auction, at GBP 57,50/MWh, Hornsea Project Two will set a record for the lowest-ever price for offshore wind in the UK, as much as 50% less than energy from similar projects just two years ago. "This is a breakthrough moment for offshore wind," Orsted said.

"Onshore wind costs fall fast, but offshore falls faster," noted Bloomberg New Energy Finance in a June 2017 outlook. "We expect the levelized cost of offshore wind to decline 71% by 2040, helped by development experience, competition and reduced risk, and economies of scale resulting from larger projects and bigger turbines."

Peter Bachmann, director of venture capital firm Scottish Equity Partners, notes that in the UK, there is currently a ceiling of 125 meters on windtower height, although "to be more viable they need to be 150-180 meters high."

Wind project operators

In addition to Orsted, which has various projects in different countries, other wind operators include: Innogy, which owns the £2 billion Triton Knoll offshore wind farm project, located 32km off the Lincolnshire coast. This has a planned installed capacity of 860 MW capable of supplying the equivalent of over 800,000 UK households per year with renewable electricity, and plans to buy 90 turbines from Mitsubishi Heavy Industries and Vestas Wind Systems. A final investment decision on this project is expected in 2018, which may allow construction to start in 2020.

GE and Siemens have also sought to join the renewables revolution, and in wind power they have had some success. GE Wind Energy is a business unit of GE Power Systems. GE Wind Energy designs and manufactures wind turbines with rated outputs of between 900kW and 3,600kW. GE was the world's second-largest wind turbine manufacturer last year.

Siemens acquired the Spanish turbine company Gamesa in April, and has high hopes of becoming a world leader in renewables.

Japanese steel group NSSMC, as well as producing steel for windpower installations and being a part-owner in some projects including Hibikinada Wind Farm, also pursues a range of activities including plant fabrication and building construction, urban development, systems solutions services, new materials business, silicon wafer manufacturing, chemicals production and power supply.

Established in July 1999, Japan Wind Development Co., Ltd. of Tokyo is an international wind project developer.

Vestas Wind Systems, a manufacturer of wind turbines, based in Denmark and with installations in over 70 countries, is dedicated exclusively to wind energy. In the third quarter, it "delivered increased order intake and healthy earning in a market that is seeing accelerated competition and decreasing profitability. Our order backlog and service revenue both increased 18 percent year-on-year, while nine-month revenue is on par with 2016," said Group President & CEO Anders Runevad. "The market continues to evolve at a fast pace." The company's order intake in the quarter reached 2,615 MW – up 48% on Q3 2016.

WHERE IS STEEL USED IN A WINDPOWER INSTALLATION?

Every part of a wind turbine depends on iron and steel, *writes The World Steel Association*. The main components of a wind turbine are the tower, the nacelle, and the rotor. A foundation connects the turbine to the ground or seabed. Whilst the blades are normally made of other materials, such as carbon fiber or alloys, steel holds the blades in place as they turn, using a cast iron or forged steel rotor hub. According to Renewable UK, an energy trade association, around 140 metric tons of steel are required for the average wind turbine.

Most of the steel in a wind turbine is the tower. About 90% of all wind turbine towers are tubular steel towers. To construct a tower, fan-shaped plate segments are cut from rectangular parent steel plates and roll-formed and welded into cone sections. A section's thickness may vary from 8 mm at the top to 65 mm at the base, depending on loads and steel grades used. Offshore installations usually use thicker or stronger plates.

For speed and cost-efficiency, steel towers are transported to site as complete tubes. This limits the maximum tower diameter to roughly 4.3 m. For offshore developments the tower can be lifted onto a barge and shipped out whole. Taller towers are segmented for transport. Higher steel grades can be applied to achieve lighter and taller towers. For example, by upgrading the steel of a wind tower structure from grade S355 to S500, a weight saving of 30% can be achieved. Even with a cost increase of 20-25%/mt for the higher strength steel, the balance is positive since 30% less material is needed. More savings result from lower transport and construction costs.

Sometimes, steel-concrete hybrid towers are used to overcome transport restrictions associated with taller towers. Concrete sections are constructed and combined with steel tubes on site. However, onsite concrete solutions are heavily dependent on good weather, and require a lot of skilled labor and extended construction times. Other turbine manufacturers have installed steel-concrete hybrid prototypes using pre-cast concrete.

Steel lattice tower solutions were popular in the past and may see a revival. Using mainly standardized steel solutions they compare well with other tower concepts when looking at life cycle cost. Lattice towers are constructed of pre-assembled steel sections which are hot-dip galvanized for corrosion protection and bolted together on site. The tower is then lifted by a crane.

At the top of the tower are the rotor and the nacelle. A nacelle can weigh as much as 300 mt, which is 14% of the weight of a large offshore turbine. Steel's strength makes it ideal for the nacelle's frame, housing and machinery. The nacelle contains key components and some of the highest-value steels. These include electrical steels (also known as lamination, silicon or transformer steels) that help save energy. Electrical steels are a specialty steel tailored to producing the specific magnetic properties that make wind energy possible.

Steel products and steelmakers

The offshore windpower segment has become an important pillar of the heavy plate business of German steelmaker Dillinger Hüttenwerke, which describes itself as Europe's leading producer of heavy plate. Dillinger mostly supplies plates for offshore-foundations, where steel has to fulfill the following requirements: a particular resilience and toughness as well as – to ensure an economic production – a good weldability. This is why the use of thermomechanically rolled heavy plates is preferred.

Offshore windpower plants are so big nowadays that plate can be as thick as 150mm for foundations. The grades of plates used have similar requirements as those of the classical offshore surroundings (platforms). The typical qualification profile for onshore wind power plants (steel towers) is however usually significantly lower. They usually use plate thicknesses of over 60mm.

Areas where these types of plates are typically used are in most of the North Sea (Great Britain, Germany, Denmark, Netherlands). Dillinger has supplied for offshore windparks such as "Rhyl Flats", "Thanet", "London Array", "Walney" (Great Britain), "Horns Rev" (Denmark), "Alpha Ventus", "Baltic 2" and "Dan Tysk" (Germany) or the latest commissioned "Gemini" (Netherlands) and "Burbo Bank Extension" (Great Britain). Steel, particularly plates from Dillinger, play an important role for the success of the energy turnaround, the so called Energiewende.

Occasionally, depending on the location of an offshore wind farm, construction material with a mark showing conformity to the Construction Products Regulation (CPR) is demanded (CE-mark) either by regulations or by the end customer, Dillinger states. In the case of heavy plates, this means a requirement to comply with the harmonized standard EN 10025.

Another standard, EN 10225, offers improved toughness properties as well as better weldability of offshore steel grades. Plates of this standard are therefore often requested by designers and fabricators, for instance for substations and jackets. However, as EN 10225 is not a harmonized standard, it does not bear a CE mark.

CHEMICAL COMPOSITION OF GERMAN PLATEMAKER DILLINGER'S DIWIND PRODUCTS

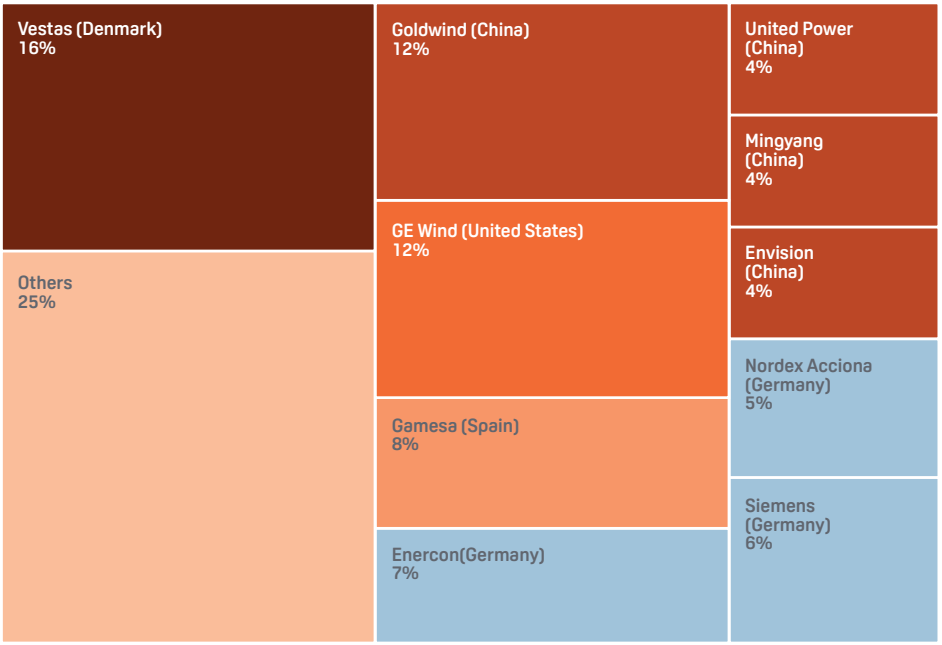
Steel grade	Plate thickness (t) (mm)	Max. CEV*	Max. CEV acc. to EN 10225
S355GX + M + DIWIND	8 < t < 40	0.38	0.41/0.42**
	40 < t < 100	0.39	
S355G10 + N + DIWIND	6 < t < 150	0.42	0.43
S460GX + M + DIWIND	8 < t < 40	0.41	0.43
	40 < t < 100	0.40	

*CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15. **For thickness > 75mm.

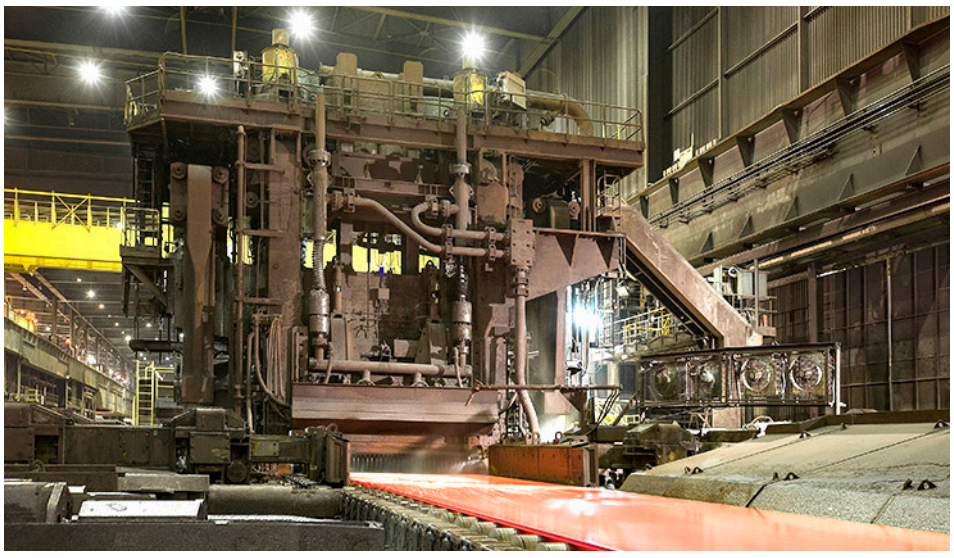
Max CEV = Maximum carbon equivalents.

Source: Dillinger

MARKET SHARES OF WIND TURBINE MANUFACTURERS, 2016



Note: Total exceeds 100% due to rounding.
Source: FTI Consulting, REN 21, the Renewable Energy Policy Network for the 21st Century



A heavy plate being rolled at Dillinger's rolling mill in Dillingen, Germany, before cutting. Photo courtesy of Dillinger.

Dillinger's DIWIND products for wind installations offer a combination of two these steel grades: offshore steel grades with CE marking and the offshore standard EN 10225,as well as improved carbon equivalents of the latter grade.

Nippon Steel & Sumitomo Metal Corporation (NSSMC) is another steelmaker heavily involved in the windpower industry, as a supplier as well as a project developer and part-owner.

As a member of an 11-party consortium for the Fukushima Floating Offshore Wind Farm Demonstration Project, abbreviated as Fukushima FORWARD under the auspices of the Ministry of Economy, Trade and Industry, NSSMC has undertaken studies regarding floating platforms for offshore wind farms since 2011. The steelmaking group is responsible for the development of high-performance steels for floating wind turbine facilities and has conducted demonstration studies on the application of high tensile strength steel plates to floating offshore wind turbine structures, fatigue solutions in welded joints; and corrosion resistance by exposure testing.

In Russia, Power Machines, fully-owned by steelmaker Severstal's majority holder Alexey Mardashov, has projects to produce wind towers and assemble wind turbine nacelles at its Taganrog-based Krasny Kotelshchik plant. The company has promoted Severstal as a long term supplier of steel plate.

Steel indexing

One major wind turbine manufacturer told S&P Global Platts it sources mainly steel plates, following indexes for steel plates, but does not link to them for purchasing and pursues spot market prices where possible, using indexes as a correlation.

The company also follows underlying raw material indexes for scrap and coking coal and slab markets, as well as tracking hot rolled coil prices. It trades directly with mills, through traders, or through other third parties.

"Where we buy plate depends on where the project is," the manufacturer said. "We will always source as locally as possible because transportation costs are high. We

RUSSIA PLANS 25-FOLD BOOST IN WINDPOWER CAPACITY, WITH LOCAL PARTS

Russia, with its plentiful oil, gas and thermal coal resources, has only recently taken steps to establish a "green" energy sector. The world approached the point of grid parity – when the cost of a kilowatt-hour from renewable energy sources equates to the cost of a kilowatt-hour at a thermal power plant – in 2014-2015 and will pass this point in a decade. Russia has fallen behind in this equation but intends to catch up.

Installed onshore wind generation capacity in Russia was estimated at 110-130 MW end-2015, representing only 0.2% of its total installed renewable power generation capacity. In terms of generation, wind-generated electricity was 55 GWh/year and its share was the lowest – below 0.1% – in Russia's total electricity generation. This is because very few wind plants operate and these run at low capacity (circa 40%) partly because of the scant availability of domestic servicing, with most components imported.

Still, Russia is believed to have the world's largest wind potential and under its Energy Strategy 2035, plans to increase its installed wind energy capacity more than 25-fold to 3.35-3.7 GW by 2024 even though in 2030, wind power is likely to remain more expensive. Despite the envisioned massive increase, 3.5 GW is still a very modest capacity for such a big country considering that the global wind power capacity expands by 50-70 GW each year. However, this should still encourage local equipment manufacture for renewable energy power plants.

In contrast to solar, wind is more evenly distributed across the country. Particularly northern and southwestern parts of Russia, with seacoasts' and steppes' highest potential, often have winds with speeds exceeding 8 m/sec at 100 meter heights. These can generate 12 GWh per year. Russia's far east has 30% of the country's total wind resources and a scenario is being discussed for the use of Russia's wind resources located on the Pacific Coast with a view of exporting electricity to China. Since 2015, the countries have been exploring the possibility of investing in 50 GW onshore wind power capacity spread over Taimyr, Sakhalin and southern Siberia. The capacity would cover 2% of China's demand for electricity.

There are various challenges to this ambitious plan, including the current lack of local manufacture of wind power generating equipment at MW-scale. The government has said it will subsidize wind plant construction projects only if the equipment for them is 65% manufactured in Russia by 2019. In 2016, this stood at around 25%.

Another challenge is project cost. While wind has seen significant cost decreases in recent years, in Russia, costs remain above the global average partly due to the very recent introduction of these technologies and also to the country's large territory, requiring long-distance transport of equipment. Wind towers are classified as high-rising constructions under Russian law, and their design and building is subject to the same survey and requirements as multi-storeyed houses, which results in longer engineering and documentation approval and often material overspending when laying foundations. It may also be difficult to convert land registered as agricultural land, even if it is not used as such, to an industrial category.

The incipient sector has so far attracted mainly government-backed investors, namely government-owned capital fund Rusnano, which commercializes nanotechnology, and state atomic energy corporation Rosatom. Among foreign investors showing interest is the Italian multinational renewable-energy corporation Enel Green Power. The government has recently approved projects to build up to 15 new wind power plants with 4.85 GW total capacity by 2030.

Russian companies have to first secure technologies or foreign partners eager to transfer these technologies to Russia. Rosatom has made the production of equipment for wind power plants one of its priorities. Its subsidiary, together with Dutch manufacturer of wind turbines Lagerwey, has gained approval for construction of wind farms in Adygea, in southwest Russia, totalling 610 MW, with commissioning seen in 2018-2020, and the company is looking to set up a production of key components for wind turbines to supply these farms.

Wind Energy Fund created

This year, Rusnano and Finnish energy company Fortnum have set up a Wind Energy Development Fund with Rubles 30 billion ($511 million at today's exchange rate) allocated for wind power plant projects undertaken in the next five years. Rusnano is prepared to separately invest Rubles 1 billion ($17 million) in the production of equipment for them with the launch of manufacturing expected in the next year-year and a half. To this end, Rusnano also signed a memorandum of understanding with Russian energy systems machinery manufacturer Power Machines, establishing both parties' interests in setting up manufacturing of wind power plant components. Power Machines, fully-owned by Severstal's majority holder Alexey Mardashov, is looking at developing towers production and assembly of wind turbine nacelles at its Taganrog-based Krasny Kotelshchik plant. The company has also promoted Severstal as a long term supplier of steel plate. So far, none of the Russian steel companies surveyed by Platts has supplied steel for wind tower construction in Russia due to the lack of demand. — *Katya Bouckley*

do not maintain any special relationships with particular producers."

The former Dong Energy had previously investigated hedging steel plate through northern European hot rolled coil indexes as a proxy, according to market sources.

Financing: subsidies fizzle out

Financing for windpower has changed dramatically as the sector has gained space in energy generation, causing hiccups in some regions. "There are far fewer funding mechanisms available for wind power as renewables have become a more mature market," one turbine manufacturer commented. The UK, for instance, has replaced FIT (feed-in tariff) direct subsidies for renewable power with a "Contracts for Difference" system of auctions as part of reforms to its electricity market, and incentives to investment have also been phased out in Germany.

"Since 2016 there has been no new government support for windpower in the UK," said Nina Skorupska, chief executive of the Renewable Energy Association, at the Mines and Money conference in London early December.

"We won't see more government support for this sector until 2025 according to the new (latest) budget," added Peter Bachmann, director of Scottish Equity Partners, noting that the government's renewable energies development spend has been frozen by the recent budget. "The support isn't there anymore."

The Japanese government has provided part funding to the country's Hibikinada Wind Farm, to encourage the renewable energy industry: the farm is owned by NS Wind Power Hibiki Ltd, in which NSSMC, Japan Wind Development (JWD), Torishima Pumps and Mitsui & Co have been listed as shareholders.

China's determination to end wind power subsidies including FITs by 2020 last year slowed down China's previously astronomical growth in this area. The South China Morning Post reported September that as part of this process, Beijing has approved the nation's first ever batch of wind farms with power prices at parity with coal fired generators. On this basis, 13 wind farms with a total capacity of 707 megawatts have been given the green light for construction by the National Energy Administration, a much smaller scale development than the 149,000 MW installed nationally at the end of last year.

— *Diana Kinch,with Pascal Dick, Laura Varriale, Simon Price and the collaboration of Vaseem Kabhari and Russ McCulloch*

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