



STEEL IS THE VITAL INGREDIENT

Solutions in Steel for Offshore Wind Energy
Installations

DILLINGER 

OFFSHORE WIND POWER – THE ENERGY OF THE FUTURE

High waves, turbulent weather. The world's oceans are brim full with energy. The high wind velocities constantly prevailing there, in particular, contain a highly promising energy potential. For numerous European countries, the expansion of the offshore wind energy generation is therefore the most important element in future energy concepts. The success of this energy source is dependent to a very large extent on stable and highly durable offshore foundations that are able to defy the hostile conditions encountered far out to sea.

Heavy plate: The backbone of the regenerative energy

Steel's high specific load bearing capability and durability, combined with its versatility, make it the material of choice for these offshore foundations. Its role in the generation of renewable energy achieves dual sustainable use of resources, since steel, with its excellent recyclability, is in itself a resources conserving material.

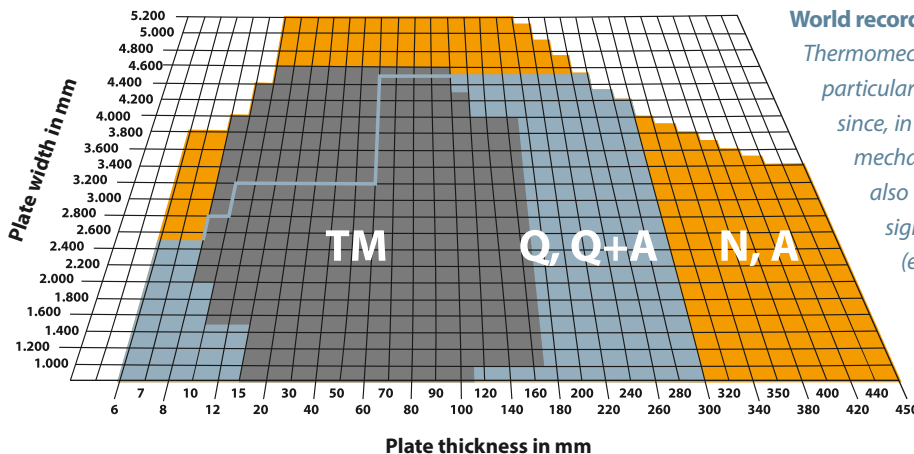
Dillinger: The industry's partner for dependable solutions

Wind energy installations need stable foundations to withstand the conditions found in deeper waters. Equally, dependable partners are needed to assure trouble free completion of major projects. Dillinger,

with its broad range of tailor-made products, is precisely this reliable partner: even high tonnages can be supplied in extremely short times. It is therefore no coincidence that the majority of the offshore wind energy projects completed up to now have been based, irrespective of the type of steel foundation, on plate supplied by Dillinger.

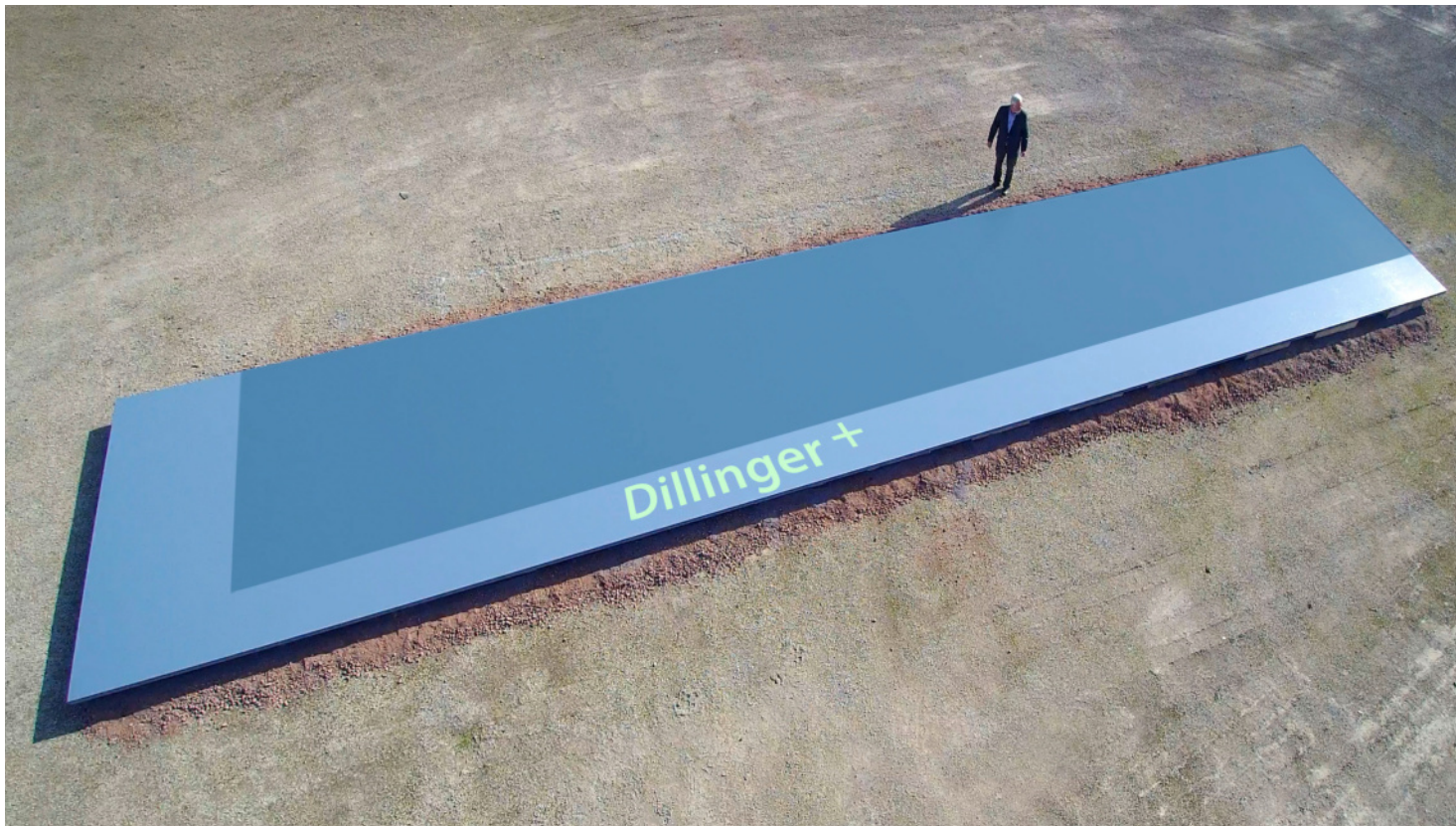
Tailor-made ultra high quality plate solutions

Plate thicknesses ranging from 6 to over 510 mm, widths of up to 5,200 mm and lengths of up to 28 m, with item weights exceeding 42 t – these are the sizes in which Dillinger can produce and supply its world leading grades of steel. But it is not only these unique dimensions, but also, and above all, the "inner"



World record for Dillinger TM plates

Thermomechanically rolled plate (TM) has become particularly well established in offshore applications since, in addition to an optimum combination of the mechanical properties of strength and toughness, it also assures, thanks to its low carbon equivalent, significantly superior conditions for welding (e.g. the reduction of preheating temperatures or even the elimination of preheating). Here Dillinger sets again new standards, with available plate thicknesses up to 170 mm and item weights exceeding 42 t.



values and good working properties which give Dillinger heavy plate its outstanding reputation. Excellent weldability, assurance of maximum strength and toughness performance at low temperatures may be mentioned here only as examples of the special, tailor-made customer requirements that Dillinger plate makes possible.

Convincing customer support

Technical and commercial boundary conditions can be fixed jointly with the customer and the project participants at the early stages of a project, assuring availability of the necessary capacities, maximum logistical support and thus trouble free implementation. Top solutions in steel, achieved equitably with the customer – this is the proud record of Dillinger.

Pure dependability

Maximum quality and safety specifications that our customers can rely on: this is the challenge we set ourselves every day. Dillinger has proven its capability for meeting these maximum dependability standards throughout its many years of experience in projects.

Reliability

Multiple investments like chamfering milling machines, extension of the flame cutting capacity, the investment in further capacity for thick plates for offshore wind foundations and especially the project of superlatives, the new vertical continuous

caster (CC6), have conditioned Dillinger to the future. This consistent orientation around the production of thick heavy plates in both rolling mills gives Dillinger the ability to supply large quantities of plate on time and within narrow time windows. Maximum delivery reliability and logistical support for the customer are our constant top priority. The successful completion of many extremely diverse major projects provides the definitive proof.

Service Plus: Edge preparation

An additional service provided by Dillinger is individual weld preparation by means of milling, assuring extra cost effectiveness of welding for the customer. Edge machining is possible both on rectangular format plates and on radius and conical plates. The most diverse range of edge geometries, in the dimension range up to 160 mm thickness, 5,000 mm width and 30 m length, can be milled with ultra high accuracy. Tolerances of ± 1 mm are achieved in length and width, ± 0.5 mm for edge position and $\pm 0.5^\circ$ for the milled angle. The sandwich configuration of the milling tools, in combination with an automated tool changing system, assures the necessary flexibility for individual edge geometries. The plates are shipped with an individual marking including barcode.

HEAVY PLATE FROM DILLINGER FOR THE OFFSHORE WIND FARMS BORSSELE

Borssele is an offshore wind farm located in the Dutch exclusive economic zone (EEZ) of the North Sea and consisting of four lots (I, II, III and IV) generating some 350 MW each and a fifth, smaller lot (20 MW) for the installation of innovative demonstration equipment. The wind farm as a whole is designed for generation of 1,500 MW.

Borssele I and II - Dillinger steel, pillar of the energy transition

With a total generating capacity of 752 MW each, the Borssele I and II sectors will supply around a million Dutch households with clean electricity. In addition, they will also contribute to the decarbonization of coastal industries: a new electrolysis system delivering the hydrogen for carbon neutral fertilizer production will also be powered using renewable electricity.

The Borssele I and II sectors were, upon their commissioning in November 2020, the largest wind farm in the Netherlands and the second largest operational offshore wind farm in the world. Occupying an area of some 128 km², the wind farm consists of 94 Type SG 8.0-167 DD wind turbines and an offshore transformer substation. The 8 MW Siemens Gamesa offshore wind turbines have been installed here for the first ever time in a commercial project. Their dimensions are extremely impressive, with a total height of 200 m and a rotor diameter of 167 m.

They are located in water of depths varying from 14 to 38 m and are mounted on monopile foundations with diameters of up to 8.3 m, lengths of up to 76 m and weights of up to 1,188 t. Dillinger supplied around 105,000 t of heavy plate in thicknesses ranging from 30 to 108 mm for these monopile structures. A further approximately 3,700 t of Dillinger steel can also be found in the transformer substation situated at this wind farm (Borssele Alpha).

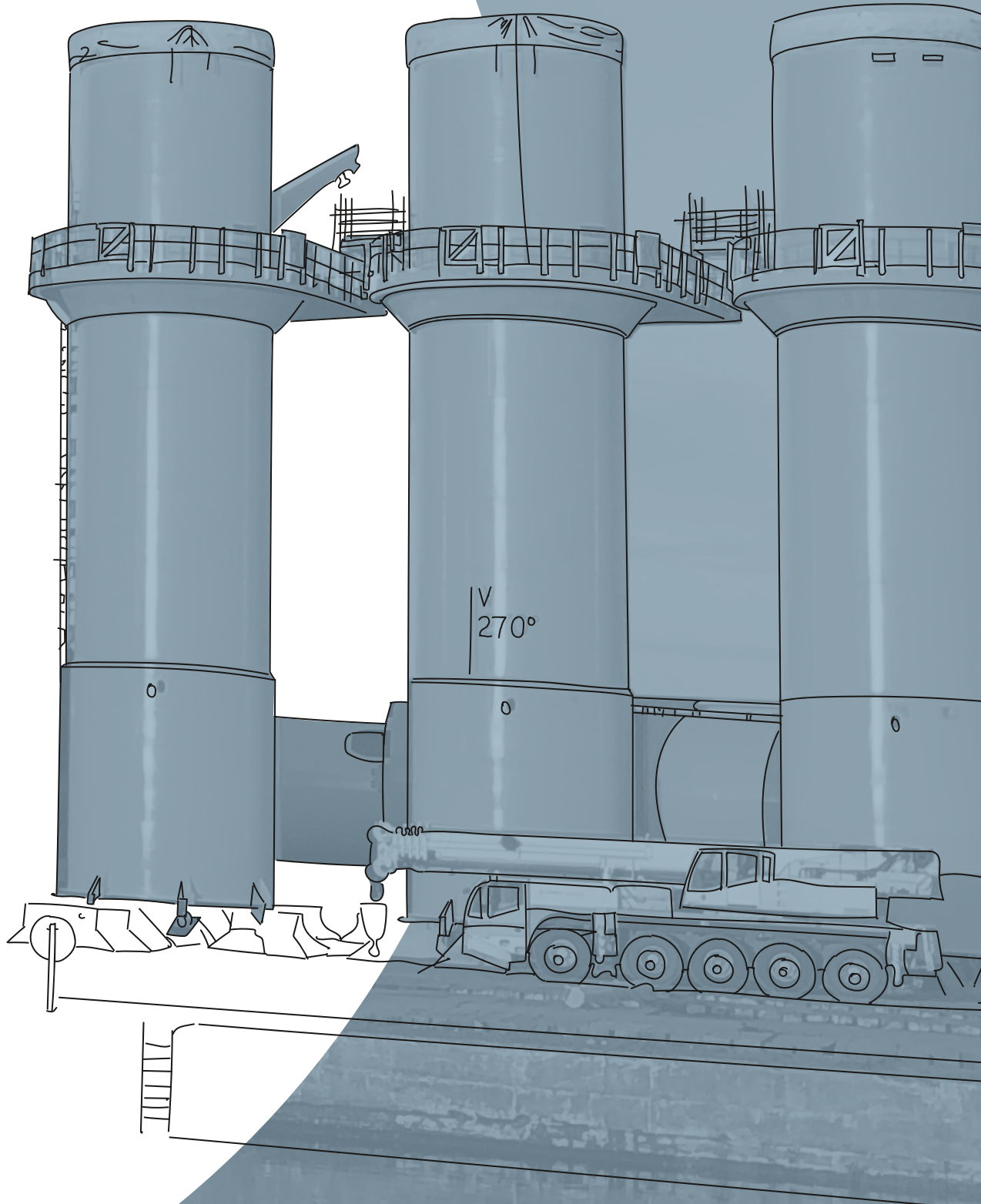
Borssele III and IV - Use of Dillinger record TM plates

The 77 wind turbines installed on the two fields Borssele III and IV will supply around 825,000 Dutch households with environmentally friendly electricity and save over 1 million tons of CO₂ each year. The 77 MHI Vestas V164-9.5 MW turbines are founded on monopiles. Here, TM record plates with individual plate weights > 40 t were used in large quantities for the monopile foundations, which optimized fabrication in terms of welding and handling. Each monopile is 85 m long and weighs 1,280 t. For these monopile foundation structures, Dillinger supplied approximately 70,000 t of heavy plate.

Borssele V - Dillinger steel for innovation

The Borssele V offshore wind energy lot is designated a demonstration site at which technical innovations are to be installed and tested. This special wind farm started generating during 2021 providing clean energy for 25,000 households.

The topic of "size" again plays a special role here, since the trend toward higher-output turbines also means that all the other components need to be developed from new – providing ample opportunities for innovation and for Dillinger's heaviest-ever thermomechanically rolled plates. At Borssele V, for example, two MHI Vestas 9.5 MW turbines are used; they are mounted on monopile foundations. The heaviest thermomechanically rolled plates ever produced at Dillinger, each weighing in at individual item weights of around 42.7 t, were used in these innovative foundations.



HEAVY PLATE FROM DILLINGER FOR THE BALTIC 2 OFFSHORE WIND FARM

Dillinger plates support the production of green energy

The offshore wind farm, officially inaugurated in September 2015, is able to generate 1.2 TWh of electricity a year, sufficient to supply approximately 340,000 German households with eco-friendly electricity. So it makes a decisive contribution to save over 900,000 t of CO₂ every year.

With its 80 Siemens SWT-3.6-120 turbines erected in the waves of the Baltic Sea, the wind farm covers an area of almost 27 km², making it the largest offshore wind farm in the Baltic Sea area. The wind turbines rising 138 m above the surface of the water are almost as tall as the Cheops Pyramid in Giza. Its location in the German exclusive economic zone (EEZ), 32 km north of the island Rügen, with varying water depths between 23 and 44 m and difficult soil conditions presented a new challenge for the wind farm developers. Finally, depending on the water depth, the wind turbines have been erected on different foundations.

Monopiles have been used for water depths up to 35 m, while three-legged jackets have been utilized at depths over 35 m.

For the monopile and jackets foundations Dillinger supplied around 37,700 t of thermo-mechanically rolled heavy plates (S355ML, S420ML, S355G10+M) in thicknesses from 20 to 85 mm.



HEAVY PLATE FROM DILLINGER FOR THE AKITA NOSHIRO OFFSHORE WIND FARM IN JAPAN

Steel from Dillinger travels around the world

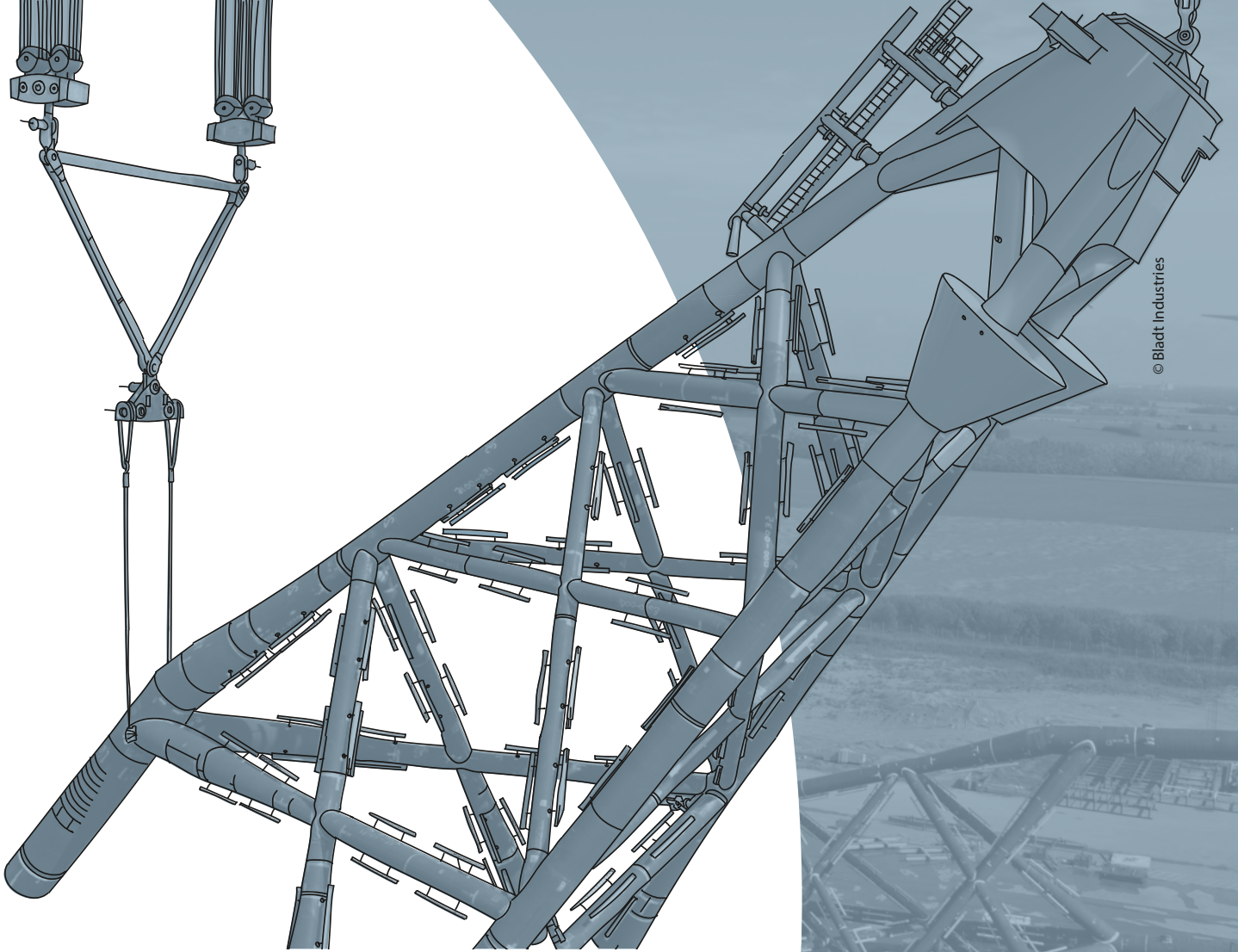
The Akita Noshiro offshore wind farm comprises of the Akita and Noshiro offshore wind farms with a total capacity of 139 MW (55 MW for Akita and 84 MW for Noshiro). These were built in the coastal zone of Akita Prefecture. The total project area of both wind farms covers 730 ha. The wind farms can supply electricity to 48,950 (Aktita) and 75,308 (Noshiro) households annually.

When it comes on stream in April 2022, Akita Noshiro is the first large-scale offshore wind farm ever built on a commercial basis in Japan. The country has only had four pilot fields with a capacity of roughly 20 MW.

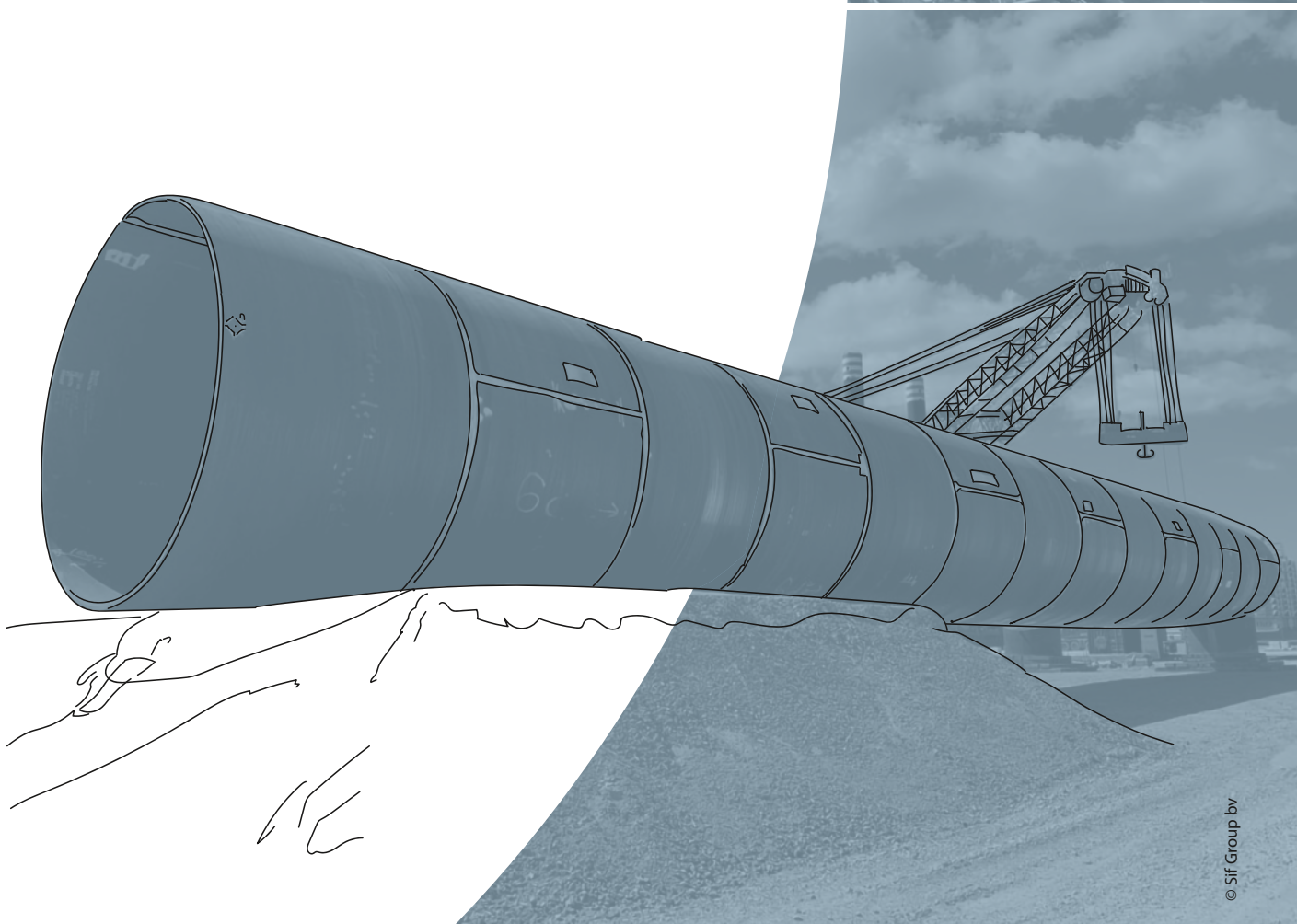
In water depths of 10 to 30 m, both wind farms were built with V117-4.2 MW turbines (Typhon variant) from MHI Vestas (13 for Akita, 20 for Noshiro), which are founded on monopiles. The V117-4.2MW turbine is designed for

medium to high wind speeds and can withstand extreme wind conditions which can occur in this water zone. It was thus developed specifically for Japanese weather conditions.

The 33 monopiles and transition pieces account for a total of over 25,000 t of steel. A single monopile weighs up to 883 t, has a length of over 78 m and a diameter of 4.7 to 6 m. For these monopile foundation structures, Dillinger supplied approximately 26,300 t of heavy plate in thicknesses of 50 to 100 mm.



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HEAVY PLATE FROM DILLINGER FOR THE OFFSHORE WIND FARM HORNSEA ONE

With 1.2 GW, the British offshore wind farm is the world's biggest offshore wind farm and the first to have more than 1 GW of capacity. The site is located around 120 km (75 miles) off England's Yorkshire coast in the North Sea, further off shore than any other wind farm completed to date. The farm spans an area of 407 km², that's bigger than the Maldives or Malta. It will generate enough wind power annually to supply over one million households in the UK with green electricity.

The 174 wind turbines (7 MW per wind turbine) rise some 190 m into the sky, with a rotor diameter of 154 m, so that the 75 m long rotor blades, by their rotation, cover an area larger than the observation wheel of the London Eye. They stand in water depths of 30 to 40 m on monopile foundations with diameters of up to 8.1 m and a weight of approximately 900 t each. For these monopile foundations, Dillinger supplied around 99,000 t of thermo-mechanically rolled heavy plate in thicknesses ranging from 30 to 90 mm.



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HEAVY PLATE FROM DILLINGER FOR BELGIAN OFFSHORE WIND FARM NORTHWESTER 2

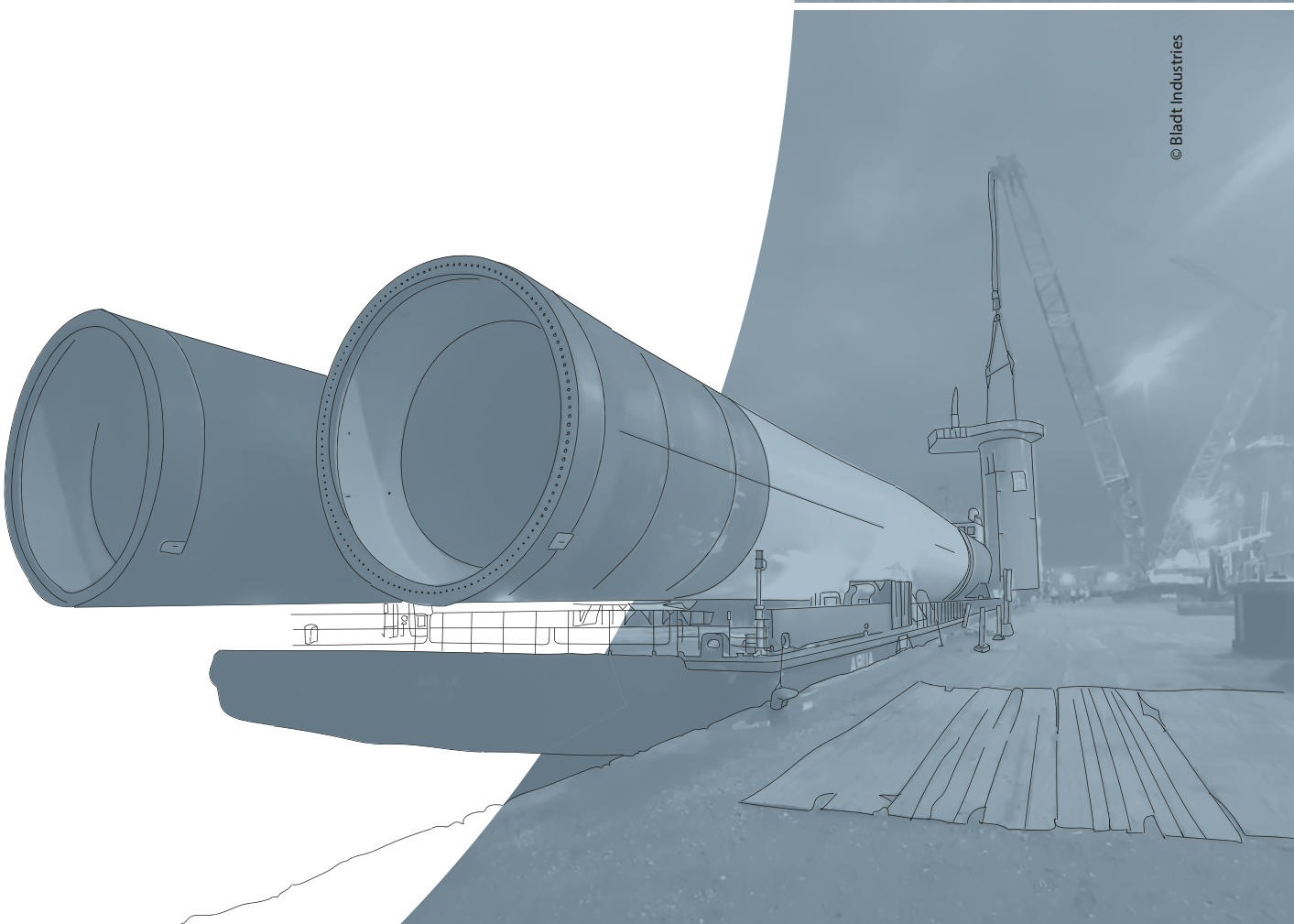
Belgian clean electricity relies on Dillinger steel

The 12 km² Northwester 2 wind farm is located in the Belgian North Sea, approximately 50 km off the coast of Ostend. It is the first offshore wind farm to be equipped with the world's most powerful wind turbine, the 9.5 MW V164 turbine manufactured by MHI Vestas. Comprising 23 wind turbines, the total production capacity of the wind farm reaches 219 MW, thus being able to meet the clean electricity needs of 220,000 households in Belgium, this means 9,500 households per turbine! It makes a significant contribution to European climate and energy policy, saving around 500,000 t of carbon emissions per year, the equivalent of 170,000 cars.

Record breaking wind turbines stand on monopiles

These wind turbines are not only the most powerful in the world but also the highest. And with their 190 m, they become the highest building in Belgium! Each direct drive wind turbine has a three-bladed rotor with a diameter of 164 m and a swept area of 21,124 m². One blade is 80 m long and weighs 35 t, while the nacelle is 20 m long, 8 m high and 8 m wide.

At water depths of 25 to 40 m, they are installed on monopile foundations with diameters of up to 8 m, lengths of up to 82 m and a weight of about 900 t each. The transition piece that is mounted on the monopile has a diameter of 6.8 m and a length of 20 m and weighs 210 t. For these monopiles foundations, Dillinger supplied around 25,400 t of heavy plates in thicknesses up to 100 mm.



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HEAVY PLATE FROM DILLINGER FOR THE MERKUR OFFSHORE WIND FARM

Dillinger steel at the heart of the German energy transition

Located in the North Sea, off the Dutch and German coasts, in the German Exclusive Economic Zone (EEZ) about 45 km (28 miles) north of the island of Borkum, the Merkur wind farm, covering an area of 47 km², is one of the largest wind farms in the German North Sea and represents a major milestone in Germany's energy transition. It consists of 66 wind turbines (total capacity of 396 MW) and generates approximately 1,750 GWh annually, enough clean energy to supply nearly half a million German homes and to eliminate over 566,000 t of CO₂ emissions.

These wind turbine generators impress not only with their innovative gearless technology (GE Haliade 150-6MW) but also with the size of the towers and foundations on which they are mounted more than 100 m over the water level. They are equipped with one of the largest rotors in the wind industry, having a diameter of 150 m (73.50 m long blades) and sweeping an area equivalent to three football fields. The towers weighing 400 t each are twice as high as the Statue of Liberty. At water depths of 27 to 33 m, they are installed on monopile foundations with diameters of

up to 8 m, lengths of up to 73 m and a weight of about 970 t each.

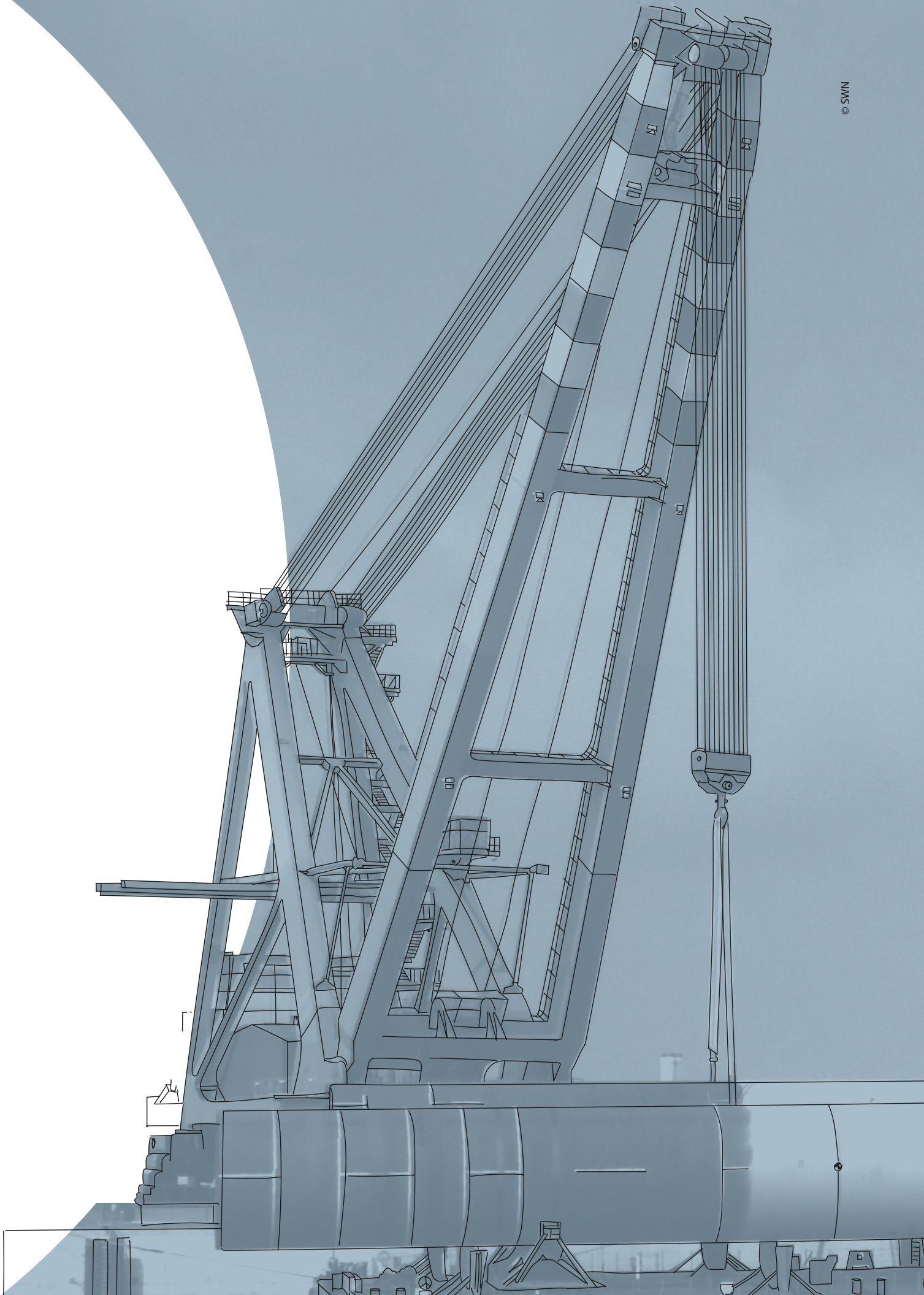
For these monopile foundations, Dillinger supplied around 57,000 t of thermo-mechanically rolled heavy plates in thicknesses from 30 to 100 mm. Furthermore around 10,000 t of Dillinger steel are used in the towers of this wind farm.

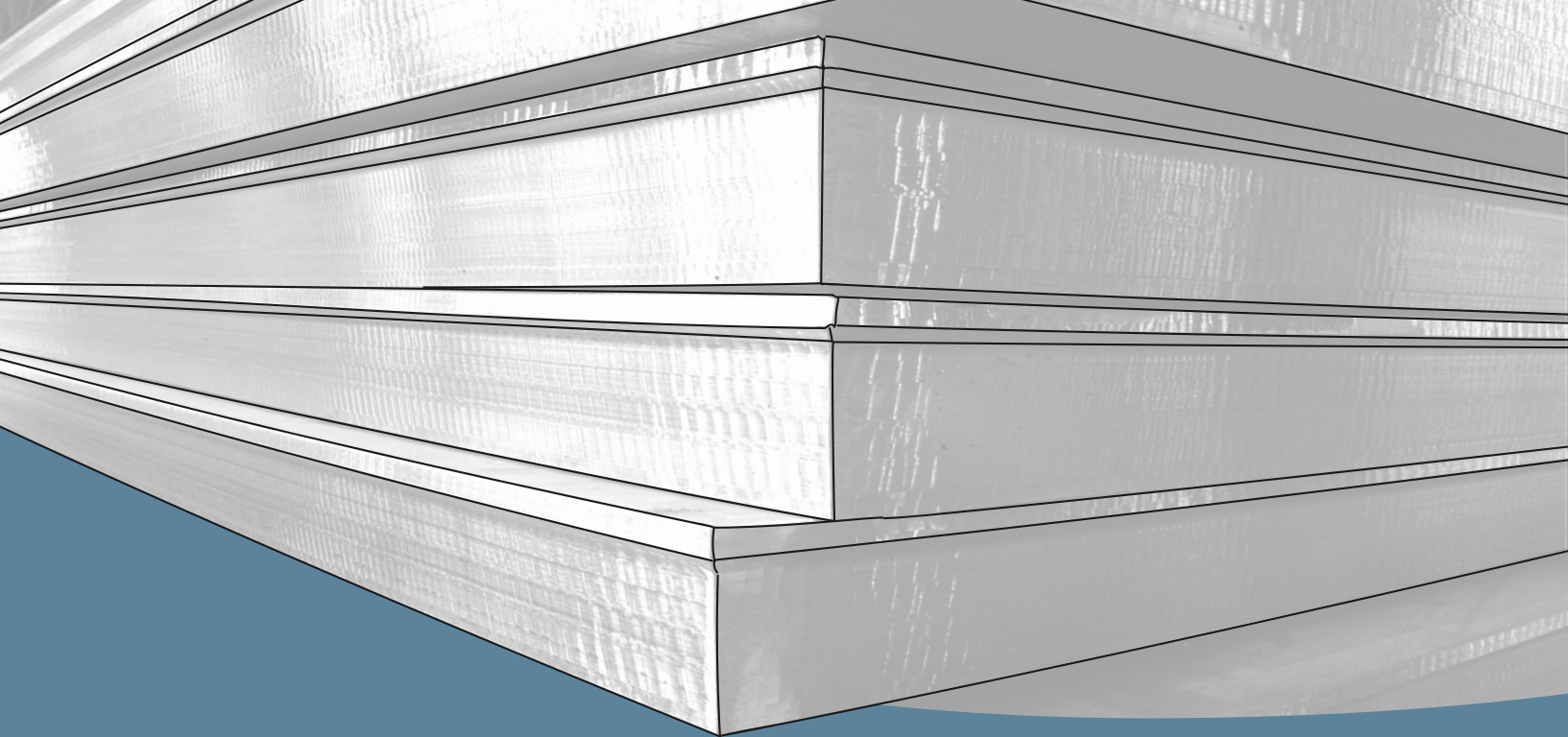
Transformer substation: Dillinger steel converts

Heavy plates from Dillinger have also been used for the construction of the farm's transformer substation (2,700 t thermo-mechanically rolled plates in thicknesses from 16 to 90 mm). Set up in a water depth of 25 m, this substation with a total weight of 4,200 t collects the energy from the wind farm's 66 turbines, converts it to a higher voltage (from 33 kV to 155 kV) and sends it to a power transfer station. The electricity obtained is then transported through an underwater cable to its final destination.



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Please contact one of our partners for individual advice,
both technical or commercial.

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