Most of the biggest wind farms currently under construction will be equipped with 10-MW class wind turbines, such as the 13-MW General Electric Haliade-X specified for the Dogger Bank A Wind Farm in the North Sea, located about 130 km off the UK's Yorkshire coast.

GE RENEWABLE ENERGY

419.5 TWh

The estimated electricity production from wind power in the EU of 27 in 2022

WIND ENERGY BAROMETER 2023

A study carried out by EurObserv'ER.

The European Union's wind energy sector is still on track despite the disappointing state of the winds. EurObserv'ER puts newly installed capacity in 2022 at about 15 GW, including 963 MW of offshore capacity. Once the capacity of decommissioned turbines is subtracted, and replacements by more powerful units is allowed for, the net additional wind turbine capacity figure increased by at least 14.4 GW in the twelve months to the end of 2022, which amounts to 28% growth on the 2021 level (11.3 GW). While this result is a step in the right direction, the growth pace is too slow to meet the European Union's renewable energy production targets. In 2022, wind power output picked up again after the turmoil of 2021, increasing by 8.4% to 419.5 TWh (i.e., 32.6 TWh more than in 2021).

202.7 GW

Wind power capacity installed in the European Union at the end of 2022

16.1 GW

Wind offshore capacity installed in the EU of 27 at the end of 2022

Preparation of this barometer came too early for the release of the 2022 global wind energy market figures. However, preliminary indications suggest that the global wind energy market took a buffeting, resulting in poorer performance levels from the United States and especially China. In contrast, the European Union wind energy market was much busier in 2022 than in 2021, yet its growth pace is nowhere near enough to meet the EU's decarbonation goals and political ambitions for renewable energy production.

THE 2022 WIND ENERGY MARKET CONTRACTED IN CHINA AND THE UNITED STATES, WHILE EXPANDING IN EUROPE

THE CHINESE MARKET UNDER CONTROL

The Chinese national statistics bureau published a press release on 28 February 2023, claiming that 365.4 GW of installed wind energy production capacity had been connected to the grid by the end of 2022, which is 11.2% more than the previous year. Annual wind power output, was quantified at 762.7 TWh, marking a 16.2% increase on 2021. This development is in line with the net capacity increase of about 36.8 GW between 2021 and 2022 and is consistent with the 14 February 2023 press briefing confirmation by a national energy administration spokesperson of 37.6 GW of newly installed wind energy capacity in 2022 (while 87.4 GW of solar and 3.3 GW of biomass capacity were installed over the same time frame). Therefore, in 2022, for the second year running, the country's wind energy installation efforts contracted (the figures for 2021 and 2020 were 46 GW and 72.6 GW respectively). The 2022 offshore wind energy data is not so clear and was still awaiting official checking from the energy authorities when this barometer was being drafted. Last year, the NEA announced the record installation of 16.9 GW in 2021 taking the China's offshore capacity to 26.4 GW. The axing of the offshore Feed-in Tariff at the end of 2021 created an installation rush. Now, according to the **World Forum Offshore Wind** report published in February 2023, which makes a global inventory of offshore wind energy sites, China installed 6.8 GW of offshore capacity in 2022 (compared to 12.7 GW in 2021), which raises China's offshore wind capacity to 25.6 GW at the end of 2022 – a little lower than the NEA's estimate for the same date. One could contend that the difference is caused by the fact that the NEA quantified part of the wind farms' capacity in 2021 on the basis of connection contracts of sites that were not yet fully installed or connected to the grid. One thing is certain. China's drive to expand its offshore wind segment in 2022, was boosted when the **Shanwei Jiazi offshore wind** project in waters off the city of Shanwei, Guangdong province started injecting power into the grid at the end of the year. It is its biggest unsubsidized offshore wind farm (this 900-MW wind farm comprises 128 turbines). China's wind energy market should improve significantly in 2023. A report published by the National Energy Administration (NEA) on

OFFSHORE WIND POWER IS MAKING GIANT STRIDES IN ALL THE WORLD'S SEAS

In February 2023, the World Forum Offshore Wind (WFO) published its annual global offshore wind power report. The publication claims that global offshore capacity increased by 9.4 GW (9 433 MW) in 2022, with China accounting for 6.8 GW of this. The installation figure is lower than that of 2021 (15 666 MW), yet it is much higher than that of 2020 (5 206 MW). The expiry of China's Feed-in Tariff at the end of the year created the 2021 installation record. The report claims that the additional capacity installed in 2022 took global offshore capacity to 57.6 GW, with 44% of that capacity installed by China and counts 247 offshore wind farms in service: 140 in Asian seas, 115 in European seas and 2 in the United States' seas. In 2022, 19 countries had offshore wind energy sectors – two more than in 2021, as France (Saint-Nazaire Wind Farm) and Japan (Noshiro Port Wind Farm) connected their first wind farms to the grid in 2022. EurObserv'ER adds that Italy should be admitted as the twentieth country, with its commercial offshore wind farm operating in the Mediterranean.

Furthermore, the study reports that 12.4 GW of offshore capacity is under construction in the coastal waters of China – 3 388 MW, the UK – 2 790 MW, Taiwan – 2 505 MW, the Netherlands – 2 259 MW, France – 993 MW, Germany – 257 MW, Japan – 129 MW and Norway – 88 MW. Three of these wind farms have more than one GW of design capacity, namely, the UK's Seagreen (1 140 MW) and Dogger Bank A (1 200 MW) and the Netherlands' Hollandse Kust Zuid (1 500 MW).

In the coming years, as the global wind energy market shapes up, it will play an increasing role in countries' climate ambitions. The BloombergNEF annual offshore wind energy installation volume forecasts suggest more than 25 GW by 2025 and up to 45.7 GW in 2030, with a potential total global wind energy base of 519 GW by 2035. These high installation levels can be credited to increasing internationalisation and the provision of more and more powerful offshore wind turbines. Most of the biggest wind farms currently under construction will be equipped with 10-MW class wind turbines, such as the 13-MW General Electric Haliade-X specified for the Dogger Bank A Wind Farm, the Siemens-Gamesa SG 11.0-200 DD specified for the Hollandse Kust Zuid Wind Farm, the Vestas V164-10 MW specified for the Seagreen Wind Farm and the Mingyang MySE 11-230 and MySE 12-242 and Dongfang DEW-D10000-185 turbines that will equip the various Chinese wind farms. Even more powerful wind turbines will be specified for tomorrow's wind farms. Of these we can quote the V236 MW-15 MW prototype which generated its first MWh at the end of 2022 on the Østerild National test site in Jutland to the west of Denmark and for the first time will equip Denmark's Frederikshavn Wind Farm in 2024. There are also the Siemens Gamesa SG 14-222 DD and SG 14-236 DD direct drive wind turbine prototypes that have been trialled since 2021, planned to go into mass production in 2024 and the 14-MW Haliade-X, certified in December 2022 to produce 14.7 MW that has been specified for the Dogger Bank C Wind Farm and others in 2025. More powerful Chinese-manufactured 18-MW prototypes are already announced. At the start of 2023, the company CSSC Haizhuang, a subsidiary of the shipbuilding corporation CSSC, rolled out the first nacelle of its H260-18 MW prototype, a huge construction that will be fitted with a 260-metre rotor, capable of sweeping an area of almost 53 000 m², i.e., the equivalent of seven football pitches. In 2023, the installation of an even more powerful wind turbine than the Mingyang MySE 16.0-242 and MySE 16.0-260 prototypes is planned, that are due to be launched on the market in 2024. Not to be outdone, Mingyang responded very swiftly, by taking the wraps off its new MySE 18.X-28X concept just a few day's after the revelation made by its rival CSSC. With a rotor diameter in excess of 280 metres, the Mingyang wind turbine's sweep range will be 66 052 m2 – i.e., nine football pitches. Mingyang claims that with the average annual wind speed running at 8.5 m/s, each wind turbine will be able to generate 80 GWh of electricity per annum, enough to supply 96 000 inhabitants, while reducing CO2 emissions by 66 000 tonnes. Economic considerations are the main reason for this rush to increase capacity. Mingyang claims that compared to the installation of 13-MW wind turbines, the higher capacity of the MySE 18.X-28X will reduce the number of wind turbines for a 1-GW wind farm by 18, and thus slash construction costs per MW by 120 000–150 000 dollars. Lastly, America's General Electric has unveiled to its investors its plan to develop a Haliade-X wind turbine project capable of achieving 17 MW and up to 18 MW of capacity.

Table No. 1

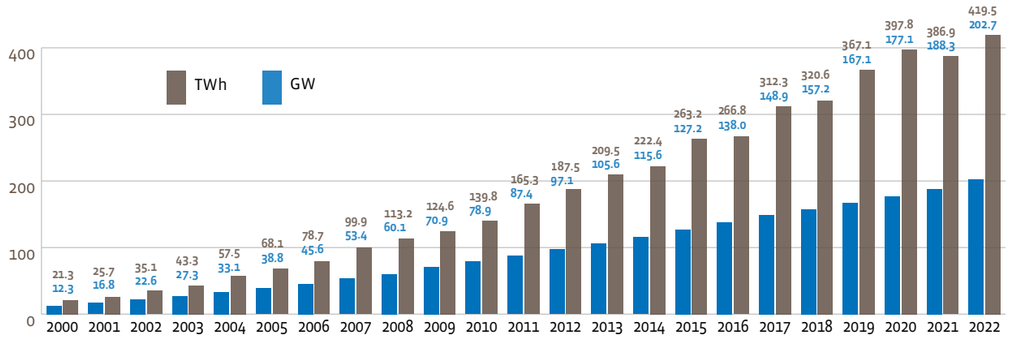
Wind power capacity installed* in the European Union at the end of 2022** (MW)

	2021	Of which Offshore	2022	Of which Offshore	Installed in 2022	Of which Offshore
Germany	63 745.0	7 787.0	66 206.0	8 129.0	2 747.0	342.0
Spain	27 907.7	0.0	29 042.9	0.0	1 135.2	0.0
France	18 740.0	0.0	20 698.0	480.0	1 974.0	480.0
Sweden	12 116.0	193.0	14 585.0	193.0	2 469.0	0.0
Italy	11 253.7	0.0	11 700.0	30.0	446.3	30.0
Netherlands	7 770.0	2 460.0	8 747.0	2 571.0	1 077.0	111.0
Poland	6 967.3	0.0	8 129.5	0.0	1 162.1	0.0
Denmark	7 020.8	2 305.6	7 100.0	2 305.6	129.0	0.0
Finland	3 257.0	73.0	5 677.0	73.0	2 429.0	0.0
Portugal	5 427.3	25.0	5 671.0	25.0	243.7	0.0
Belgium	4 948.4	2 261.8	5 236.4	2 261.8	303.0	0.0
Greece	4 649.1	0.0	4 681.4	0.0	32.3	0.0
Ireland	4 339.0	25.2	4 527.3	21.6	188.3	0.0
Austria	3 422.0	0.0	3 586.0	0.0	267.0	0.0
Romania	3 015.0	0.0	3 015.0	0.0	0.0	0.0
Croatia	986.9	0.0	990.2	0.0	3.3	0.0
Lithuania	671.0	0.0	938.0	0.0	267.0	0.0
Bulgaria	704.4	0.0	704.4	0.0	0.0	0.0
Czechia	339.4	0.0	339.4	0.0	0.0	0.0
Hungary	324.0	0.0	324.0	0.0	0.0	0.0
Estonia	315.0	0.0	315.0	0.0	0.0	0.0
Luxembourg	137.0	0.0	165.9	0.0	29.4	0.0
Cyprus	157.5	0.0	157.5	0.0	0.0	0.0
Latvia	77.1	0.0	137.0	0.0	59.9	0.0
Slovakia	4.0	0.0	4.0	0.0	0.0	0.0
Slovenia	3.3	0.0	3.3	0.0	0.0	0.0
Malta	0.1	0.0	0.1	0.0	0.0	0.0
Total EU-27	188 298.1	15 130.6	202 681.1	16 090.0	14 962.3	963.0

Note: The total installed net maximal capacity installed at the end of 2022 takes into account the decommissioned capacity during the year 2022: 286 MW in Germany, 103 MW in Austria, 100 MW in Nederlands, 50 MW in Denmark, 16 MW in France, 15 MW in Belgium, 9 MW in Finland and 0.5 MW in Luxembourg.
** Net maximum electrical capacity. ** Estimation.* ***Sources: EurObserv'ER 2023.***

Graph No. 1

Evolution of Wind power capacity installed* (in GW) and gross wind electricity production (in TWh) from 2000 to 2022** in the EU 27



** Net maximum electrical capacity. ** Estimation.* ***Sources : Years 2000-2020 (Eurostat), Year 2021 and 2022 (EurObserv'ER).***

31 December 2022 suggests that the central government intends to relaunch the wind energy sector in 2023. The document states that China aims to achieve total installed wind energy capacity of 430 GW by the end of 2023, in addition to total solar energy capacity of 490 GW. The combined 920 GW of wind and solar energy capacity in 2023 would amount to over 70% of China's target for 2030.

THE RES PRODUCTION TAX CREDIT (PTC) CUT DEFLATES THE US MARKET

The United States' tax adjustments always make Q4 the busiest installation period of the year. The American Clean Power (ACP) Q4 report claims that onshore wind energy had its best quarter when 4 GW of new projects were commissioned at the end of 2022. Nonetheless, the 8.6 GW (8 612 MW) installed over the course of the year resulted in a 35% decrease on the 2021 level (12 747 MW), making it the lowest installation level since 2018. This downturn was expected, going hand-in-hand with the reduced Production Tax Credit (PTC) allotted to wind power. Other factors may be the delays due to supply chain issues and grid interconnection problems. The United States' wind power capacity now stands at 144 226 MW (144 184 MW onshore and 42 MW offshore), and like China, growth is expected to pick up this year. The same source counts 96 onshore wind energy projects in the pipeline for a total of 20 811 MW, including 10 402 MW under construction and 10 409 MW at the advanced development stage. While no offshore installations were connected in 2022, more will come on stream in 2023 when the Vineyard 1 offshore wind farm (800 MW) , the United States' biggest, is connected. It will be fitted with 62 General Electric Haliade-X 13.6-MW turbines. Many US states have set offshore wind power goals. New York State is the most active in this arena with 4 230 MW under development, followed by New Jersey State with 3 758 MW. Massachusetts lies in third place with 3 242 MW followed by Virginia with 2 587 MW.

THE EUROPEAN UNION CROSSES THE 200-GW THRESHOLD

EurObserv'ER puts the European Union's net installed wind power capacity, defined as the net maximum capacity that can be injected into the grid, at no less than 202 681 MW at the end of 2022 (including 16 090 MW of offshore capacity), i.e., 14 383 MW of additional net capacity over the 2021 figure (including 959.4 MW of offshore capacity) (Table 1 and Graph 1). This signifies that 28% more net wind power capacity was installed between 2021 and 2022 than in the previous twelve-months (11 238.7 MW). Consequently, a higher amount of capacity was connected during 2022 (14 962.3 MW including 963 MW offshore) that leaves out any computation of the decommissioned capacity. This new installation record can also be ascribed to the many European markets – seven in all – that have crossed the one-GW threshold. EurObserv'ER reckons that at least 580 MW of capacity was decommissioned in 2022 across the European Union (286 MW by Germany, 103 MW by Austria, 100 MW by the Netherlands, 50 MW by Denmark, 16 MW by France, 15 MW by Belgium, 9 MW by Finland and 0.5 MW by Luxembourg)... a trend compounded by repowering operations. One of Ireland's 3.6-MW Arklow Bank Wind Farm turbines is also out of order after being struck by lightning that set off a fire in the nacelle in October 2022. We should point out that some of the decommissioned wind turbines have been replaced by repowering, thereby harnessing the latest technological innovations and replacing older generation wind turbines with more newly designed, bigger and more powerful wind turbines that offer decidedly higher yields. The overriding interest of repowering is to increase a site's electricity output while reducing operating costs.

The industry players downplay these figures, considering the capacity installed in 2022 to be very much below par. The WindEurope association, that represents Europe's wind energy industry, publishes its own indicators that tend to be provided by its members earlier than the official statistics bodies' data. EurObserv'ER attributes any reporting disparities to the fact that they include the wind turbines installed at the end of the year that have yet to be officially commissioned. This data is somewhat more representative of the commissioned wind turbines' nominal capacity operating, which is a little higher than the net maximum electrical capacity (the indicator used by Eurostat).

EU ELECTRICITY SECTOR EMISSIONS RISE DURING 2022

A new IEA (International Energy Agency) analysis published at the beginning of March 2023 claims that the record rollout of renewable energies ensured that the use of coal was lower than predicted by some observers, reducing the European Union's CO2 emissions by 2.5% in 2022 (70 million fewer tonnes of CO2). The milder winter in Europe and the energy-saving measures in response to Russia's invasion of Ukraine were also contributing factors. Yet, the report avows that the EU's electricity sector emissions increased by 3.4% all the same, with a lower than anticipated increase in the use of coal (resulting from the war in Ukraine). On the positive side, wind and solar power output taken together outstripped that of natural gas.

Table No. 2

Gross electricity production from wind power in the European Union in 2021 and 2022* (TWh)

	2021	Of which Offshore	2022	Of which Offshore
Germany	114.647	24.375	125.287	25.123
Spain	62.061	0.000	62.705	0.000
France	36.831	0.000	37.900	0.647
Sweden	27.244	0.547	33.072	0.600
Netherlands	18.005	7.952	21.152	8.030
Italy	20.927	0.000	20.353	0.000
Poland	16.258	0.000	19.352	0.000
Denmark	16.054	7.593	19.010	8.743
Portugal	13.216	0.051	13.255	0.051
Belgium	11.998	6.926	11.924	6.648
Finland	8.507	0.267	11.561	0.300
Ireland**	9.776	0.000	11.224	0.000
Greece	10.483	0.000	10.500	0.000
Austria	6.740	0.000	7.242	0.000
Romania	6.576	0.000	7.006	0.000
Croatia	2.062	0.000	2.263	0.000
Lithuania	1.362	0.000	1.513	0.000
Bulgaria	1.434	0.000	1.505	0.000
Hungary	0.664	0.000	0.670	0.000
Estonia	0.733	0.000	0.664	0.000
Czechia	0.602	0.000	0.641	0.000
Luxembourg	0.314	0.000	0.302	0.000
Cyprus	0.246	0.000	0.209	0.000
Latvia	0.141	0.000	0.200	0.000
Slovenia	0.006	0.000	0.006	0.000
Slovakia	0.005	0.000	0.005	0.000
Malta	0.000	0.000	0.000	0.000
Total EU-27	386.891	47.712	419.522	50.142

** Estimation. ** Data for Ireland's offshore wind gross electricity generation are not differentiated from total wind gross electricity generation.* ***Source : EurObserv'ER 2023.***

The WindEurope capacity estimate of the European Union's new installations in 2022 is 16 148 MW (including 1 221 MW of offshore capacity), which signifies a 40% rise on its 2021 performance, while it puts the EU's wind turbine capacity to date at 204 499 MW (including 16 283 MW of offshore capacity). WindEurope warns that the Member States' current installation pace is too slow to achieve the 2030 climate and energy targets. It feels that the European Union will have to install at least 31 GW every year between 2023 and 2030, for a target capacity of 440 GW if it is to achieve its 2030 targets and a 45% RES share of final energy consumption. WindEurope forecasts that average annual wind power construction from 2023-27 in the European Union is more likely to be around the 20 GW mark (resulting in 98 GW). Nevertheless, it considers that the build-up in capacity installation can be at a pace compatible with the EU's climate targets, provided that the Member States simplify the rules and licensing procedures, give investors clear signals again and invest substantially in the wind energy value chain (factories, grids, ports, vessels and qualified workers). The association believes that repowering also provides a prime opportunity to rapidly revitalize Europe's wind power installations. As it stands, the oldest wind farms generally occupy the best located wind energy sites, the infrastructure is already provided (roads, substations) and there is generally less opposition from the local communities, even if their involvement is vital, not to say crucial when the proposed new wind turbines are taller and more powerful.

THE EU COMMISSIONED ALMOST 1 GW OFFSHORE CAPACITY IN 2022

The European Union's offshore wind power capacity increased by 963 MW in 2022, according to EurObserv'ER, which is an improvement on the additional 595.3 MW installed in 2021. France's long-awaited Saint Nazaire Wind Farm (480 MW) went on stream in 2022 and has been fully operational since 23 November. It is the country's first commercial offshore wind farm, equipped with eighty General Electric GE Haliade 160-6 MW type wind turbines. Germany, which made no installations in 2021, has commissioned its sixth offshore wind farm, namely the Kaskasi Wind Farm (342 MW), which is equipped

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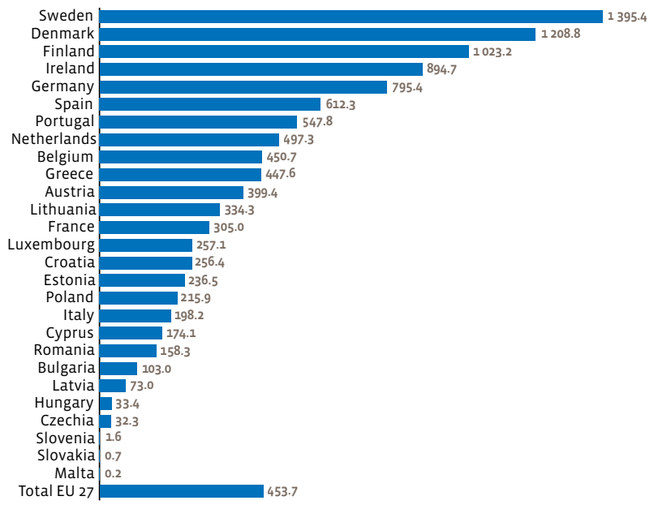
with thirty-eight SG 8.0-167 DD Flex wind turbines each upgraded to 9 MW of capacity. Kaskasi is the first offshore wind farm to be fitted with recyclable resin turbine blades. The Netherlands, for its part, has connected the first wind turbines of its Hollandse Kust Zuid 1&2 Wind Farm... the world's first unsubsidized offshore wind farm. According to Statistics Netherlands (CBS), 111 MW were officially included in the 2022 project total figure of 770 MW. CBS points out that it examines the grid supply and disregards any non-generating capacity in its calculations. At the end of April 2022, Italy connected its first offshore wind farm, the Beleolico (30 MW) project – the first wind farm to be installed in the Mediterranean – near the Taranto harbour. It is the first European offshore wind farm to use Chinese wind turbines (ten 3-MW Mingyang MySE 3.0-135 turbines). Initially, it was due to be fitted with SENVION 3.0M122 wind turbines, but the German manufacturer's collapse in 2019 opened the door to the European offshore market for the Chinese supplier. This newly commissioned capacity raises the EU's total offshore capacity to 16 090 MW, i.e., 7.9% of its total wind turbine capacity, according to EurObserv'ER,

Offshore wind energy activity across the EU will surge in 2023 with the scheduled commissioning of six large wind farms currently under construction. The Netherlands will continue construction work on the Hollandse Kust Zuid 1&2 and Hollandse Kust Zuid 3&4 Wind Farms (1.5 GW in all, i.e., one hundred and forty SG 11.0-200 DD 11-MW wind turbines with 200-metre rotor diameters). When completed, the wind farm complex will generate the equivalent of 2 million Dutch households' annual power consumption, according to Vattenfall, the joint owner of this wind farm with BASF. Construction of the Hollandse Kust Noord Wind Farm (759 MW, sixty-nine SG 11.0-200 DD turbines) kicked off in October 2022 and it should be ready by the middle of the year. The project owner, CrossWind, a joint venture between Shell and Eneco, will deploy several construction innovations, such as offshore hydrogen production and floating solar panels. In fact, Shell Nederland and Shell Overseas Investments, both Shell subsidiaries, have taken the Final Investment Decision (FID) to construct Holland Hydrogen I, which will be Europe's biggest hydrogen production unit when it comes on stream in 2025. France began construction work on its Fécamp Wind Farm in 2020 (497 MW, seventy-one SWT-7.0-154 turbines) and Saint-Brieuc Wind Farm in 2021 (496 MW, sixty-two SG 8.0-167 DD turbines) that will be fully operational at the end of 2023. Output at the Fécamp Wind Farm will equate to 60% of the electricity consumption of the Seine Maritime department (380 000 households), while that of the Saint-Brieuc Wind Farm will cover 9% of Brittany's electricity consumption (also 380 000 households). In Germany, the Arcadis Ost 1 (257 MW) project generated its first kWh at the start of January 2023 and will be fully operational some time during the year. This wind farm will be the first commercial project to use a Vestas 9.5-MW turbine with a 174-metre rotor (V174-9.5 MW). Once it is fully on stream later on this year, Arcadis Ost 1 should supply enough electricity to cover the needs of up to 300 000 German households. Construction of the Vesterhav Nord/Syd (344 MW) Danish offshore wind farm foundations started in February 2023. The cables and 41 wind turbines (SG 8.0-167 DD turbines, upgraded to 8.4 MW) will be installed in the spring and summer for commissioning planned for the end of 2023.

Additional wind farms will be commissioned with the Germany's Baltic Eagle (476.3 MW) and God Wind 3 (241.8 MW) in 2024, Borkum Riffgrund 3 (900 MW), EnBW He Dreiht (900 MW) and N-3.7 (225 MW) in 2025, Nordsee Two (433 MW) and Windanker (300 MW) in 2026. Several French pilot floating offshore wind farms will be connected early in 2024, starting with Golfe du Lion (30 MW), Provence Grand large (25.2 MW), then in mid-2024 the Eolmed Wind Farm (30 MW). The wind farm installed off Courseulles-sur-Mer (448 MW) will be commissioned in 2025. The Netherlands will add the Hollandse Kust (West) VI (756 MW) and Hollandse Kust (West) VII (760 MW) wind farms in 2026. Denmark's Thor (1000 MW) wind farm should be fully operational at the latest at the end of 2027 and is designed to generate enough green electricity to supply the equivalent of over a million Danish households.

Graph No. 2

Wind power capacity per 1,000 inhabitants in the EU in 2022 (kW/1,000 inhab.)*.



** Estimation.* ***Source: EurObserv'ER 2023***

WINDS WERE LESS ERRATIC IN 2022

For many of Europe's major regions, 2021 was a bad year for wind power production. Across the European Union, increases in production capacities generally make up for production variations intrinsic to weather conditions, but 2021 was an exception to the rule. Major "wind drought" episodes and lower-than-normal average wind speeds led to a 2.7% drop in wind power output across the European Union (from 397.8 TWh in 2020 to 386.9 TWh in 2021), notwithstanding the 11.3-GW increase in useable net installed capacity. According to the 2021 European State of the Climate (ESOTC) Copernicus report (the European Union programme that collects and delivers continuously updated data on the state of the Earth) part of which analyses wind speed anomalies in Europe, some parts of the north west and centre of Europe experienced some of the lowest average annual wind speeds in 2021 since at least 1979. These anomalies led to lower wind power production potential in many European Union countries, primarily in the large production areas: Ireland, Germany, France, Belgium, the Netherlands and Denmark. In contrast, Spain, Portugal, Sweden and Finland suffered few anomalies, and higher average wind speeds swept Italy, the Baltic States, Greece and Bulgaria. The 2022 ESOCT report and its section on Europe's wind speeds anomalies was not available at the time of writing, but should describe a less dramatic situation. These analyses are very useful to developers and the wind power sector as they give finer insight into the impact of climate warming on wind conditions in Europe's various geographical zones and consequently for adapting wind turbine dimensioning. So, wind turbines with longer blades can be installed not only for the purpose of generating as much energy as possible but also to get them to start turning at lower wind speeds, rotating more often, that helps smooth out production over time. According to EurObserv'ER, based again on the preliminary official estimates, wind power output in 2022, while not exceptional, picked up across the European Union. Better wind conditions in Northern Europe, combined with the additional newly commissioned capacity, led to a total of 419.5 TWh of wind power output (onshore and offshore) across the European Union (Table 2), which equates to an 8.4% year-on-year increase (32.6 TWh). The increase in offshore wind power output was smaller (5.3% between 2021 and 2022), yet enough to cross the 50 TWh threshold (50.1 TWh at the end of 2022). In spite of this, 2022 performance was patchy with wind deficits compared to a normal year in France, Germany and Belgium. For these three countries, wind power output was even less than in 2020, despite the addition of new production capacities (drops of 6.8 TWh between 2022 and 2020 for Germany, 2 TWh for France, 0.9 TWh for Belgium). Admittedly, these countries' climate conditions were particularly favourable in 2020 with record load factors posted at the time.

The Borkum Riffgrund 2 offshore wind farm is located in the German Exclusive Economic Zone (EEZ) in the North Sea, 17 km to the east of the border with the Netherlands, 34 km north of Borkum island and 50 km north of Germany's northwest coast. The 450-MW capacity wind farm is connected to Germany's power grid.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NEWS FROM AROUND THE MAIN MARKETS

GERMANY APPROVES ONSHORE WIND POWER ACCELERATION LEGISLATION

After an indifferent year for installations in 2021, Germany installed more wind power capacity in 2022. The German environment agency, UBA (UmweltBundesamt), responsible for monitoring the country's


BEYSSIER-EDF

Saint Nazaire Wind Farm (480 MW) has been up and running since 23 November 2022, and is the France's first commercial offshore wind farm, equipped with eighty General Electric GE Haliade 160-6 MW type wind turbines.

renewable energy statistics agency reports that 2 747 MW of capacity was installed and connected, including the 342 MW of the above-mentioned Kaskasi offshore wind farm. Once decommissioned capacity is subtracted, the country posts 66 206 MW of net installed capacity to date (including of 8 129 MW offshore capacity), which equates to almost one third of the European Union's net capacity. Germany's brisk installation pace should be maintained over the coming years. In July 2022, Germany adopted a highly ambitious legislative package designed to accelerate renewable energy development and safeguard the country's power supply. One of the key measures is a new amendment to the Renewable Energy Sources Act for the electricity sector (EEG 2023), which substantially raised the country's renewable energy targets for the 2030 timeline, namely 115 GW for onshore wind power as much as 30 GW for offshore wind power and 215 GW for solar photovoltaic power. The German government has thus set its sights on at least doubling its base in the space of 8 years.

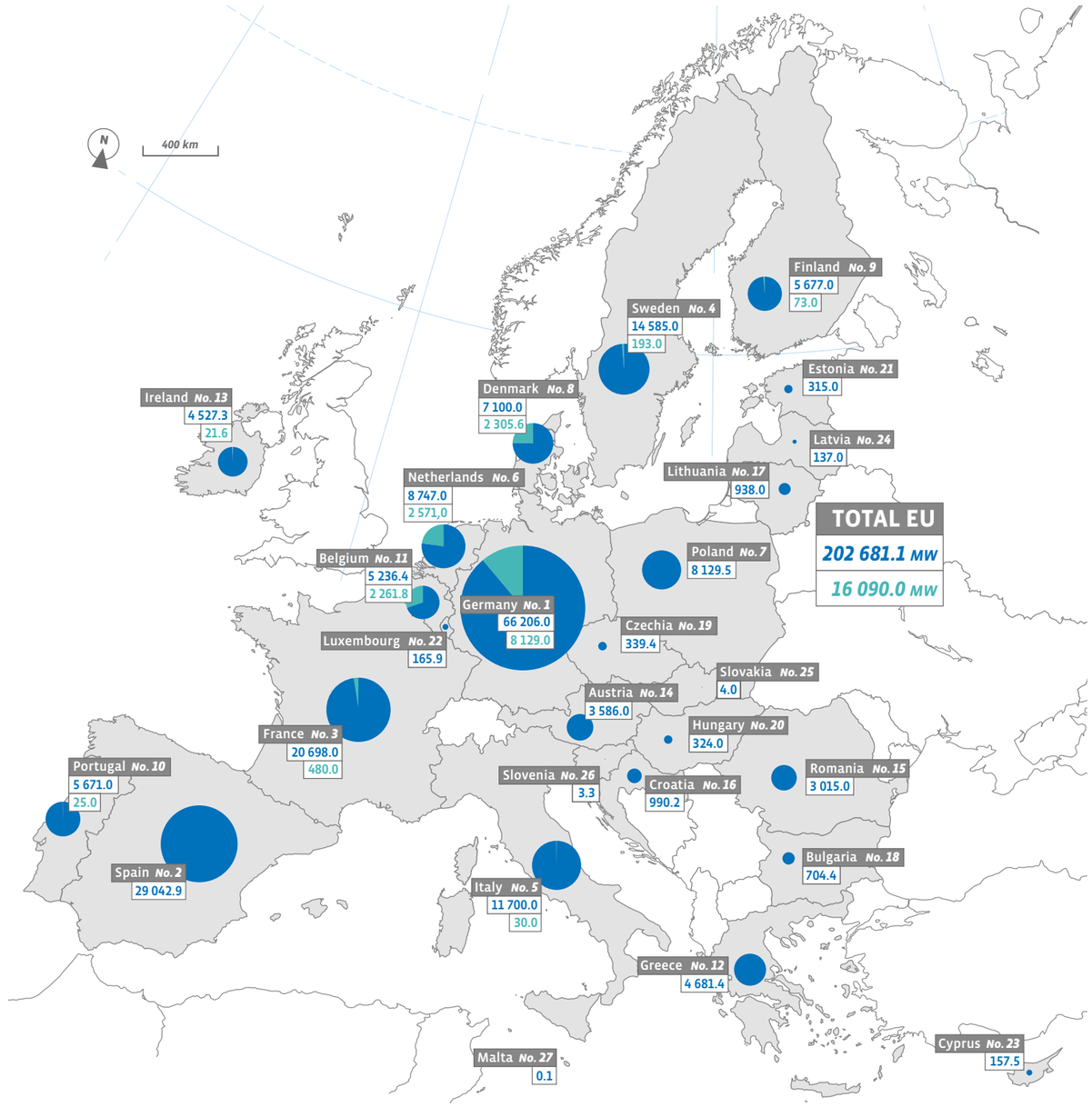
For the time being, this level of political ambition is struggling to materialize on the ground, and particularly felt in the area of tenders. Of the four relating to onshore wind power launched in 2022 for a total volume of 4.5 GW (1.3 GW each in February, May and September and 0.6 GW in December), the last three tenders were significantly under-subscribed. Bids for only 3 279 MW of the total capacity of these 4 tenders were made (including 45 MW of disqualified bids). The scarcity of sites may explain this under-subscription. More to the point, inflation and raw material price rises (concrete, copper) make wind turbine construction more expensive, and thus some investors deem the 5.8 euro cents/kWh reference remuneration cap too low to make bidding worthwhile. Despite an increase in the maximum authorized remuneration value of 7.35 euro cents/kWh, the results of the first onshore wind power tender in February 2023 (of which 60.4 MW was disqualified) were similarly affected, with a bid volume of 1 501.5 MW out of a total of 3 210 MW. The German government is working on introducing a more enticing legal framework for project bearers. An extensive programme to accelerate licensing procedures for renewable energy installations was adopted in the autumn of 2022 including the "Wind-an-Land-Gesetz" onshore wind power act that came into force on 1 February 2023. This law aims to develop onshore wind power in Germany much faster by accelerating planning and licensing procedures for wind farms and the provision of the land required. Legally binding zone targets for onshore wind power have been defined for each state (Land) with the possibility of transferring a set share of these zones between states. By 2027, 1.4% of Germany's terrain must be made available for onshore wind power and 2% by 2032. It is a huge challenge, as only 0.8% of federal territory is currently earmarked for wind turbine construction, but as it stands only 0.5% is actually used because of local opposition.

FRANCE PASSES ITS FIRST RENEWABLE ENERGY LAW

On 31 December 2022, the 4th Quarter 2022 Wind Power dashboard released by the SDES (Sustainable Development Ministerial Statistical Department) of the French Ministry of Ecological Transition, showed that the capacity of the French wind power facility base was approaching 21 GW (20 915 MW), a provisional figure that awaits consolidation. We should mention a point of methodology here, as the SDES counts installations as soon as the grid connection comes into force, namely, when the wind turbines are ready for commissioning. The capacities included are the maximum capacities delivered to the grid, as committed to in the connection contract. Above a certain capacity, wind farm commissioning is staggered (commissioned in stages). When this occurs, the connected capacities may temporarily overstate the effective production capacity. The net maximum useable capacity indicator actually measured on the grid, is the preferred indicator of the international statistics bodies such as Eurostat and the IAE (also published by the SDES but at the end of the year) and is always a little lower. According to EurObserv'ER, it should be close to 20.7 GW. About 2.0 GW of capacity was connected to the grid during 2022, which is almost double the 2021 connection figure (1.1 GW). Commissioning of France's first offshore wind farm in the second quarter of 2022 accounts for a fourth of all new grid connections (480 MW). The SDES reports the level of ongoing application projects at 13.8 GW of capacity, including 10.7 GW of onshore and 3.1 GW of offshore wind power capacity. Wind power output stood at 37.9 TWh during 2022, i.e., 8.3% of France's electricity consumption.

On Tuesday 31 January and 7 February 2023, he National Assembly, followed by the Senate passed the first French renewable energy law, known as the "Renewable Energy Acceleration Act", enacted on 10 March 2023, and published in the Official Journal on the following day. The law's initial aim is to streamline renewable energy installation to make up for delays in this area. The legal text centres on four lines of action – planning renewable energies, simplifying procedures, making use of land

Wind power capacity installed* in the European Union at the end of 2022** (MW)



Key

202 681.1 Total wind power capacity (onshore and offshore) at the end of 2022** (in MW)

16 090.0 of which offshore wind power capacity at the end of 2022 (in MW)

Net maximum electrical capacity. **Estimate.* ***Source: EurObserv'ER 2023.*

take areas to roll out renewable energies and better share the value generated by these energies. The law aims to reconcile "this acceleration" with the improvement of local acceptability, while it guarantees the protection of biodiversity and minimizes land take. This conflict between renewable energies versus land take, biodiversity protection and landscapes make the headlines of France's national discussions and at the National Assembly, led by objectors to renewable energies and proponents of nuclear energy. An example of this is that the deputies thought it useful to add an amendment to the law focussing on landscape that encourages communities to "take care to limit the visual saturation effects". The text makes it possible to modulate tariffs to encourage project bearers to install their facilities in areas whose natural conditions are initially less conducive, the idea being to spread the renewable energies more evenly over the territory, which again underpins the notion of improving "acceptability" and "saturation effects". The legislators decided to put local councillors at the heart of this mechanism to resolve all these contradictions, which are particularly relevant to wind power as it is quintessentially local. The law effectively introduces a territorial planning mechanism for renewable energies to simplify local approval of projects and more even-handedness in the territories. The French state will have to provide the local authorities with the data available on the renewable energy siting potential. After holding public consultations, the communities will be tasked with identifying the acceleration zones conducive to accommodating and establishing the installations. The public intercommunal cooperation debate on these areas will be held in the light of the territorial project. In theory, they will have 18 months to define these acceleration zones, and also be empowered to define exclusion zones (provided the Prefect judges that the acceleration zone conditions meet the Multiannual energy plan). This new planning process will take many months to complete and implies extensive work for the communities before the project developers can go ahead. Even if in theory, there will be potential constructions outside of these zones, granting of permissions will probably be delayed by the communities' zone definition process. A planning mechanism for offshore wind farms is also intended with initial offshore mapping of the priority zones for installing offshore wind turbines, the first of which will be identified in the middle of 2024. The strategic seaboard document should establish priority zones for the wind farms and their connections for the four seaboards, over ten years and to the 2050 timeline. One last important point of the law is that a presumption of imperative reasons of overriding public interest (RIIPM), one of the three criteria that allows derogation from the obligation to protect endangered species, is imposed for specific renewable energy projects, their connection and storage facilities.

Renewable energy analysts, such as the consultant Cédric Phillibert, are dubious about the accelerating effect of the law, as he views it rather as the establishment of new planning process that "will stifle or overlap the tools already available to the local communities, provide objectors and waverers with additional arguments to decide nothing, commit to nothing". For the FEE (France Energie Eolienne), that represents the French wind energy industry, "the so-called acceleration law will now make local politicians jointly responsible for the success or failure of the implementation of energy transition". This year, 2023, when the first tenders for commercially operated floating wind farms are expected to be awarded, will also be important for floating wind power. They will offer a total of 750 MW of capacity divided over three sites, two in the Mediterranean and one in the waters of Southern Brittany. The first pilot floating wind farms (Eolmed, Golf du Lion and Provence Grand Large) will go on stream in 2024.

Table No. 3

Main European wind farm developers and operators in 2022

	Country	Wind capacity operated in 2022 (1)
Iberdrola	Spain	20 228 MW onshore 1 258 MW offshore
Enel	Italy	17 562 MW (including 5 051MW in Europe)
EDP renewables	Portugal	14 416 MW onshore (5 334 MW in Europe) 322 MW offshore (322 MW in Europe)
ENGIE	France	13 042 MW onshore 1 462 MW offshore
Orsted	Denmark	4 175 MW onshore 8 871 MW offshore
RWE	Germany	7 455 MW onshore 3 517 MW offshore
ACCIONA	Spain	8 781 MW
EDF renewables	France	8 GW (including 480 MW offshore)
Vattenfall	Sweden	1 781 MW onshore 2 602 MW offshore

1) Worldwide figure. Note: Large energy companies are well represented in this ranking because of their size and their ability to raise capital, but besides these type of players, there is a large number of private developers specialized in renewable energy, with substantial portfolios.
Source: EurObserv'ER 2023 based on diverse sources (Annual report 2022, corporate websites).

The Netherlands' Hollandse Kust Zuid 1&2 Wind Farm is the world's first unsubsidized offshore wind farm.

WIND POWER, THE KEY SECTOR IN SWEDEN'S SOCIETAL ELECTRIFICATION

The Swedish Energy Authority, the Swedish Energy Agency, Kraft, the grid system operator, and the Swedish Transport Administration, in addition to other selected competent authorities have been tasked by Swedish government to work on the resources to use for society's electrification without recourse to fossil energies by 2045 as part of its national electrification strategy. They published their initial findings in the middle of December. The report examines several strategically important issues for societal electrification, primarily the future electricity requirements, the electricity system's capacity, the EV-charging and hydrogen infrastructures, the electricity grid expansion rate and electricity market development. The report's analysis includes Sweden's future electricity needs. At the high end, annual demand will rise to double the current electricity consumption of about 140 TWh, namely 280 TWh in 2035, and then rise to 370 TWh in 2045. At the low end, electricity demand would only be 210 TWh. The report suggests that onshore wind power should provide the bulk of new electricity production until 2035, boosted until 2045 by the high potential of offshore wind power or nuclear energy, depending on a 100% renewable or 100% low-carbon energy scenario.

Unfortunately, Sweden's official wind power capacity data for 2022 will not be available until April 2023. In the interim, WindEurope, which published its statistics in February, estimates the country's cumulative power at 14,585 MW in 2022. This total allows the country to have the highest installed wind capacity ratio per inhabitant with 1,395.4 kW per 1,000 inhabitants at the end of 2022 (Graph. 2). This increase means that the installation volume was more than 2.4 GW in 2022 and combined with much better wind conditions than in 2021, was naturally accompanied by a surge in wind power output. According to Statistics Sweden, it was quantified at 33.1 TWh, which represents 21.4% growth on its 2021 level. Svensk Vindenergi reports that in 2023 installed capacity should increase, by about 2 075 MW. Wind power is developing as never before in Sweden and new wind power orders rose during the last quarter of 2022. Yet the association explains that due to the lack of construction licences the expansion pace will probably lose speed from 2024 onwards. It reckons that Sweden has the wherewithal to handle the doubling of its electricity production by 2035, but that Sweden must keep the "climate sweet" to encourage investments.

THE EUROPEAN WIND ENERGY INDUSTRY STRIVES TO BE FAULTLESS

Many wind energy players feel that it is delusional to focus on least-cost tendering as the sole bid adjudication criterion, which leads to sourcing components and raw materials from countries with the least stringent social or environmental standards, and results in weakening or outsourcing European supply chains. It is vital that the criteria for awarding tenders are no longer based exclusively on price, but are also based on environmental and social considerations, guaranteed by European standards and preferential European sourcing, to safeguard the industry and jobs in Europe. The European wind energy industry would like to take this even further by committing to circular economy manufacturing methods, while taking back the "ethical" control of their value chains abroad. Vestas provided an example that addresses the first point early in February 2023, when it unveiled a " circularity" solution to end turbine blade disposal in landfills or by incineration in cement kilns. Vestas announced the development of new technology that can make epoxy resin wind turbine blades totally recyclable and thus reusable for manufacturing new blades out of old. This major technological breakthrough is based on a solution that was recently developed through the CETEC (Circular Economy for Thermosets Epoxy Composites) initiative, a coalition of industry players and research workers focussed on innovation in wind turbine blade recycling. Lisa Ekstrand, Vice-President of Vestas, stated in a group press release: "Until now, the wind industry has believed that turbine blade material calls for a new approach to design and manufacture to be either recyclable, or beyond this, circular, at end of life. Going forward, we can now view old epoxy-based blades as a source of raw material. Once this new technology is implemented at scale, legacy blade material currently sitting in landfill, as well as blade material in active windfarms, can be disassembled, and re-used. This signals a new era for the wind industry and accelerates our journey towards achieving circularity". On the second point, that of ethics, a broad alliance of wind and solar energy manufacturers, industrial associations and others, signed an international corporate responsibility principles (ICSR) agreement with the Dutch government for the renewable energies sector on 6 March 2023. In doing so, they have undertaken to make all their international value

chains more sustainable. The signatories will now deal with and prevent risks in the area of human rights violations and potential damage to the environment such as deforestation and natural habitat loss.

THE EUROPEAN UNION WANTS TO PROTECT ITS "GREEN" INDUSTRIES

The European Union has long been a frontrunner in the race for clean technologies, however the situation has gradually deteriorated for renewable energies, which are key sectors of energy transition. Much of solar power manufacturing has already been relocated to the industrial colossus, China, while the wind energy value chain is increasingly dependent on it too. China's impressive five-year plans, characterised by major economic development and industrial strategy implementation tools, its industries largely financed by its state banks, have enabled China to dominate the global market for clean energies. The fear is now that excessive dependence on China could compromise Europe's ecological transition. Despite the European renewable energy industries' repeated warnings, including those of the wind power sector, the United States' enactment of the IRA (Inflation Reduction Act) on 16 August 2022 finally forced Europe to react. The IRA, whose name is obscure to say the least, is a public investment plan for the climate. One of its measures is to assign a budget of about 370 billion dollars to support the United States' green industrial policy (GIP), via production aid, "Made in USA" grants and tax relief. These openly protectionist measures provide the world's investors with breathing space, attracting them with grants, at the same time distorting competition with the Europeans positioned on the same markets. Incidentally, a few months earlier, in May 2022, Japan unveiled a similar plan. The Japanese 20 000 billion yen (about 140 billion euros) green programme transformation also aims to support Japan's industry in new decarbonisation technologies. The plan should particularly support the supply chains in the transition to alternative energy sources such as hydrogen and ammonia and also with car battery production and electricity storage.

The Inflation Reduction Act, perceived as a threat to the competitiveness of the European clean technologies industry, prompted the European Council of 15 December 2022 to ask the European Commission to propose measures early in 2023 to improve climate investment and the competitiveness of European industry under the European Green Deal. Thus, the European Commission presented its Green Deal Industrial Plan on 1 February 2023 that aims to reposition the EU in the frantic race for clean technologies (and energies). To support Europe's place "as the hotbed of industrial innovation and clean technologies", the Green Deal Industrial Plan covers four key pillars: a predictable and simplified regulatory environment, speeding up access to finance, enhancing skills, and open trade for resilient supply chains. The European Commission has announced several initiatives to achieve the goals of the first pillar, including a regulation (a European law) for a zero emission industry (the Net-Zero Industry Act), to identify the goals for net-zero industrial capacity and provide a regulatory framework suited for its quick deployment. Other texts are being drafted: legislation on critical raw materials, such as rare earths, that are vital for manufacturing key technologies (but not commonly used in renewable energies) and the reform of the electricity market design, to make consumers benefit from the lower costs of renewables.

In a WindEurope press release dated 3 March 2023, several wind energy and industry CEOs expressed their expectations for the Net-Zero Industry Act and the modifications to the European electricity market design to the European Commission and leaders. For example, Jochen Eickholt, CEO of Siemens Gamesa Renewable Energy declared: "To deliver on an energy transition made in Europe we need auctions that do not focus on price only. Auctions need to reward the actual value of a European renewable energy supply chain: security of supply, sustainability, technological innovation, recyclability, and engagement with local communities." For Henrik Andersen, CEO of Vestas: "The EU Net-Zero Industry Act must invest in expanding grids, ports, roads, vessels, access to raw materials, and new production facilities. Building scale across these areas is critical to support growth in wind energy, but it's not the whole story. Public financial support on its own cannot sustain European competitiveness in wind, a functioning market that creates demand will. We therefore need faster permitting, as scaling up without a market is not sustainable." Fred van Beers, CEO of SIF asserted: "Europe's wind energy supply chain is not big enough to meet the huge volume of new wind farms Europe wants. The need for investments in new manufacturing is especially acute for offshore wind. There are particular bottlenecks in making the foundations for offshore turbines. Europe can make around 500 of them a year today but needs to be making 1,500. The EU needs to help us scale up." Lastly Giles Dickson, CEO of WindEurope proclaimed: "The EU needs to mobilise the firepower of the European Investment Bank to support renewables supply chains. And the EIB should be able to finance individual factory investments."

Thus, the two salient points to emerge are that Europe's wind energy supply chain is too under-developed in Europe to cover the enormous volume of new wind farms the EU plans to install and that dependency on China for the supply of strategic components increases European industry's and vulnerability and jeopardises energy transition in Europe.

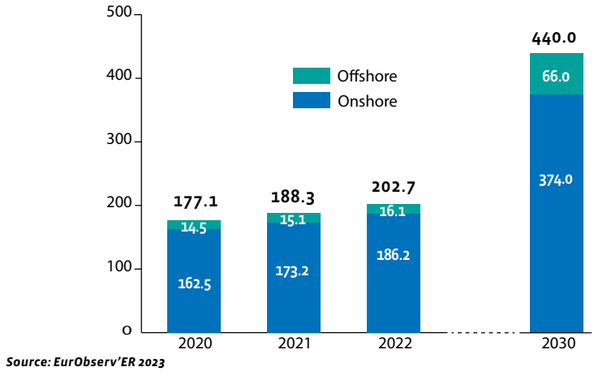
The draft "Net-Zero Industry Act", was finally presented on 16 March. Broadly speaking, this act should provide the relevant industrial sectors with simplified regulatory procedures, faster access to funding, training programmes and trade agreements. The overall aim is for at least 40% of clean technologies to be manufactured in the European Union by 2030 as part of the efforts to achieve its climate ambitions and enhance its energy independence. Eight strategic net-zero technologies have been targeted, and listed in Annex, including onshore and offshore wind energy, solar photovoltaic and solar thermal, heat pump and geothermal, biogas and sustainable biomethane technologies, storage and battery, electrolyser and fuel cell technology, carbon storage technology and grid infrastructure. Note that at this stage, "advanced technologies to produce energy from nuclear with a minimum of waste and small modular reactors" (which excludes existing nuclear technologies) are included in the list of technologies "net zero emissions" defined in Article 3 but are not currently considered "strategic" and therefore do not appear in the Annex.

On 14 March 2023, the European Commission proposed a review of the EU's electricity market design, which makes contracts for difference (CfD) the new standard for supporting investments in renewable energies. It enables operators to sell their electricity via power purchase agreements (PPA) or directly on the electricity market. The wind energy industry, European Council and Parliament must now stick to this balanced proposal and remove the current uncertainty surrounding investment caused by uncoordinated interventions in the EU's domestic markets. The NZIA regulation and the electricity market reform must now be examined and approved by the European Parliament and European Union Council before they are adopted and come into force. The European Union will have to take action if it wants to live up to its claims and must make an appropriate financial assessment for this investment plan in clean technologies.

Giles Dickson, WindEurope' CEO, was interviewed by Euronews in an article on 17 March. Answering the question of whether the "Net-Zero industry Act" would be a game-changer for the European wind energy sector he declared: "Game changing may be going to far. The aid will be less generous than that awarded by the United States through the Inflation Reduction Act. But by definition, this will always be the case, because the EU does not award tax relief. So, the national governments will have to be relied on to set up tax credits for investment, for a measure to parallel the central mechanism of the United States' I.R.A. Will that be game-changing? It is part of a longer process. During the year, the European Commission will introduce a new sovereignty fund. It will provide a crucial funding source for new investments in the wind power supply chain in Europe. It is part of an ongoing process. Europe has evidently woken up to the fact that it must do more to support its clean energy supply chains." □

Graph No. 3

EurObserv'ER projection of the evolution of wind power net capacity in the EU 27 (in GW)



Source: EurObserv'ER 2023

Sources: UBA (Germany), Ministry for the Ecological Transition and the Demographic challenge (Spain), SDES (France), Terna (Italy), Statistics Netherland, ENS (Denmark), ARE (Poland), DGEG (Portugal), SPF Economie (Belgium), HWEA (Greece), EIRGRID (Ireland), Statistics Austria, FWEA (Finland), Energie (Finland), Hops (Croatia), Statistics Lithuania, Ministry of Industry and Trade (Czechia), Statistics Sweden, STATEC (Luxembourg), INSSEE (Romania), Elering (Estonia), CERA (Cyprus), WindEurope.

The next barometer will cover photovoltaics.

Funded by the European Commission

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