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Wind-Power

in Europe

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EUROPE'S WIND-POWER INDUSTRY

CONTENTS

EXECUTIVE SUMMARY

In 2017, Europe's wind-power generating capacity of 169 GW, ranked second after gas and ahead of coal. Whilst onshore installations dominate, there are now over 4,000 offshore wind turbines producing 15.8 GW of grid-connected output. The wind-power sector currently has an annual turnover of €72bn and employs around 330,000.[i] Wind energy accounted for half of all energy investments in Europe during 2017.

Between 2017 and 2020 an additional 50 GW of wind-power is forecast to be installed across Europe. And the increasing importance of offshore wind farms can be seen in the fact that 53 are scheduled to come online between 2016 and 2022. By 2030 the EU is expected to have installed 323 GW of wind energy, dominated by onshore turbines generating 253GW and offshore installations generating 70 GW.[ii]

Germany, Spain, the UK, Italy and France are Europe's leading wind-power producers. The industry is oligopolistic, with the leading five wind-power developers accounting for 54 percent of all new installed capacity during 2017. EU energy policy and UN climate accords together with generous government subsidies, feed-in-tariffs and priority access to the grid, have underpinned the emergence and take-off of the wind sector.

Compared with the oil industry, wind generating ownership is short-term since the operating life of a wind farm is just 20 years. Ownership is diverse ranging from the large European utilities and late entrant big oil companies who are responsible for large-scale grid connected plants at one end and the small-scale plants, whose owners include local towns and cities, local co-operatives of farmers and individuals, energy intensive companies such as car manufacturers, retailers and IT companies. Wind-farms are often in the hands of multiple owners and ownership is not static as portions are often farmed out during the lifetime of the project.

Image Wind turbine decommissioning

Source Copyright: <a href="https://www.123rf.com/profile_vadimorlov">vadimorlov / 123RF Stock Photo<

DECOMMISSIONING

The first wave of mainly onshore wind installations is approaching its end-of-life stage. By 2020, 28 percent of the onshore wind fleet will be over 15 years old. Denmark, Germany and Spain are the key markets for decommissioning services at the end of this decade and in the early 2020s. In fact decommissioning has already begun with 174 wind turbines decommissioned in Denmark last year.

The trend towards offshore installations, increasing scale of wind farms and size of turbines increases the complexity, cost and difficulty of future decommissioning. For example, a typical 1980s-build wind tower stood about 20 meters tall, its blades spanned about 17 meters and it had a capacity of about 75 kilowatts of electricity. A modern tower is more than 100 meters tall and its blades span 126 meters. Decommissioning challenges and costs differ according to location i.e. between onshore and offshore; age of installation i.e. between old first-wave installations at the millennium and current installations and lastly project scale e.g. small and large wind farms. Moreover, the current trend towards offshore installations in deeper waters means that decommissioning is likely to be more costly and difficult than either those in shallow waters or on land if the experience of decommissioning offshore oil rigs is anything to go by.

Decommissioning includes complete dismantling and removal of the installations and, more often than not, keeping the site to repopulate it with new turbines (re-powering), or replacing the turbine's blades (re-blading) or refurbishment to extend life for a few more years. Redundant equipment can be sold to the established second-hand market, dumped in landfill, or what seems increasingly more likely, recycled since all but the blades are recyclable and the steel, iron, copper and silica can be recovered for other uses.

RESPONSIBILITY FOR FINANCING DECOMMISSIONING

Planning for the decommissioning of wind installations is now *de rigueur* for new builds. The UK's Energy Act 2004 requires developers of offshore installations to present details of the scope of decommissioning, removal, financial provisions and safeguards for environmental damage in their applications for approval. Post-consent, developers are required to review their decommissioning plans and provisions at regular 3-5 year intervals. In Europe, developers of new builds are required to present their decommissioning plans and provisions even before the final investment decision. A typical example can be seen in Appendix 4.

Although new projects commit to setting aside 2-3 percent of the project's capital costs each year for decommissioning, the question remains whether this is sufficient given the likelihood of unexpected costs 20 to 25 years later. As for the first wave of wind projects the situation is unclear since an unknown number may not have earmarked funds for decommissioning. In the UK the Treasury is the financier of last resort.

INTRODUCTION TO EUROPE’S WIND SECTOR

Theoretically wind-power can satisfy 11 percent of Europe’s power needs but its contribution varies according to the wind’s volume, speed and air temperatures. For instance wind-power output was 2,128 GWH on 3 January 2018 split between 1,900 GWH onshore and 229 GWH from offshore installations.[iii] This is enough to power 215 million EU households or to meet 75 percent of the average industrial electricity demand in Europe, according Eurostat’s database. In contrast, during this exceptional summer heatwave wind’s contribution fell dramatically. On 31 July 2018 wind output was just 512 GWH sufficient to meet just 6.2 percent of Europe’s needs, divided between onshore output of 429 GWH and 83 GWH offshore.[iv]

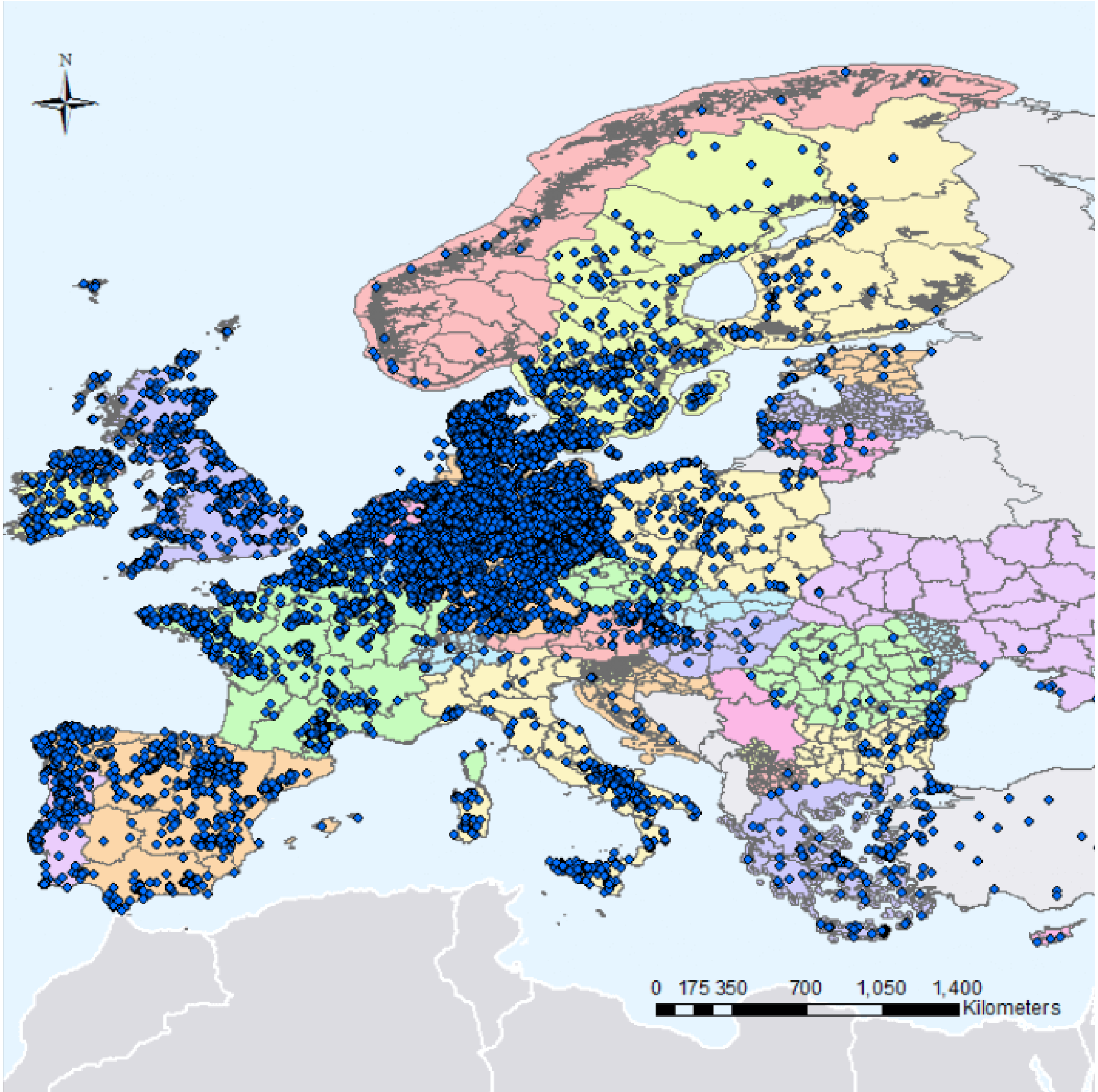
According to industry lobby group Wind Europe, 2017 was a record year for Europe’s wind sector with a hefty 16.8 GW of new capacity installations. In that year, the EU itself added some 15.6 GW of wind capacity divided into 12,484 MW of onshore and 3,154 MW of offshore capacity. [v] Indeed, wind accounted for 44 percent of all new power installations across Europe – more than any other technology. With a total net installed capacity of 169 GW, wind energy remains the second largest form of power generation capacity in Europe, closely approaching gas installations.

WIND-POWER PRODUCERS

The leading wind-power producers in 2016 were Germany with 28,000 onshore wind turbines and generation capacity of 56,132 MW; Spain with 23,170 MW; the UK with 18,872 MW; Italy with 17,455 MW and France with 13,759 MW. [vi]

The location and density of on and offshore wind farms and parks across Europe are depicted in Figures 1, 2 and 3 below.

Figure 1 Map of onshore Wind farms in Europe



Source https://britishbusinessenergy.co.uk/wp-content/uploads/Map-of-European-Wind-Farms.png

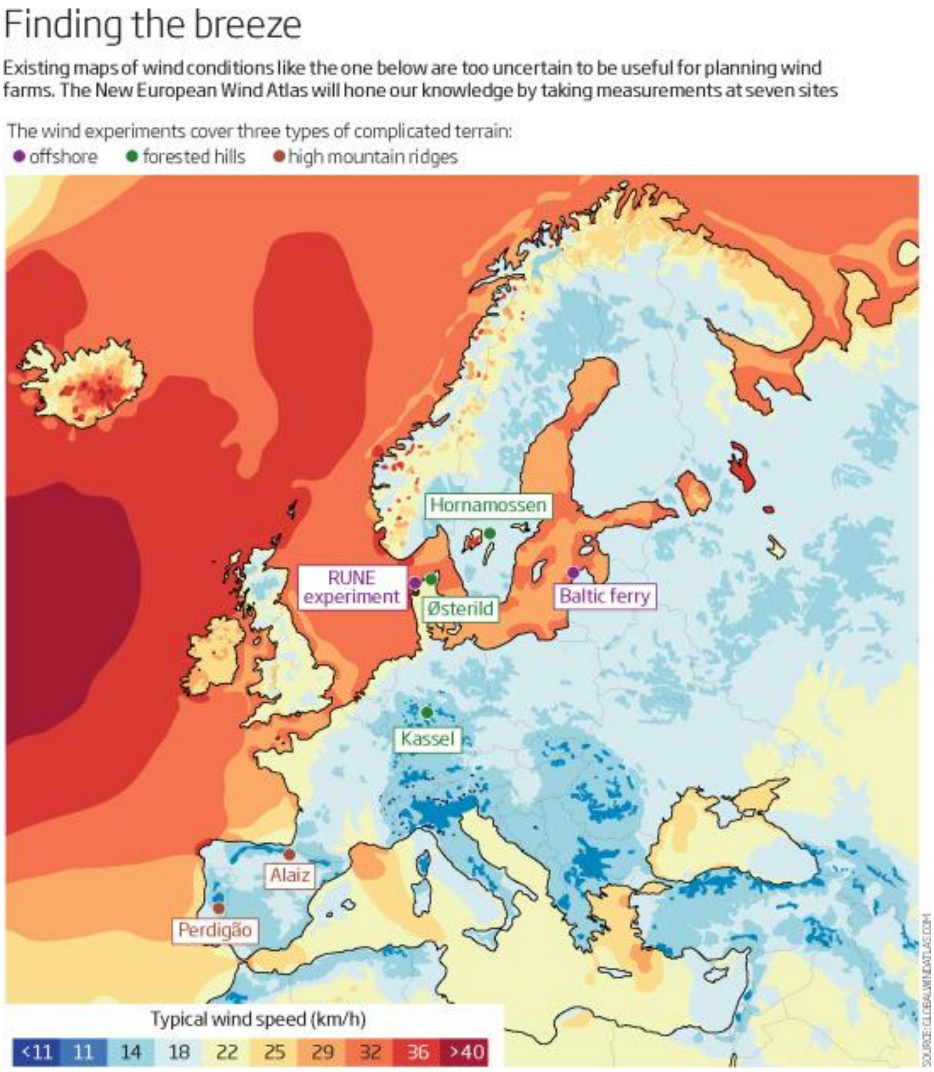
Figure 2 Existing and planned offshore farms in Europe

Source https://image.slidesharecdn.com/offshorewindenergyplanetos-160729085550/95/a-new-market-overview-offshore-wind-energy-in-europe-5-638.jpg?cb=1469783496

WIND RESOURCES GOVERN LOCATION OF WIND FARMS

As can be seen from the maps above and below, wind turbines are concentrated in areas of high wind flows such as the Alps, the Apennines and Scandinavian mountain ranges, in coastal areas or offshore in the North and Baltic Seas. These locations, by their nature, will have repercussions on decommissioning methods and costs.

Figure 3 Wind resource map



Source https://ars.els-cdn.com/content/image/1-s2.0-S0262407917309776-gr1.sml

LEADING DEVELOPERS IN 2017

In 2017, the leading wind-power developers/owners were Ørsted2 with a 19 percent market share followed by Iberdrola at 11percent, Macquarie Capital with 10 percent, Northland Power (9%), and Statoil (5%). Together these five accounted for 54 percent of all new installed capacity in Europe.[vii]

In 2017 €51.2bn was invested by the wind energy sector in Europe. This included investment in new assets, refinancing transactions, mergers and acquisition at project and corporate level, public market transactions and private equity. The technology is seen as a major driver for moving beyond fossil fuels and conventional power assets. Cost competitiveness and reduced risk perceptions have brought in domestic and international market players looking to diversify their portfolios and/or align with their sustainability targets.[viii]

MARKET PROSPECTS

Between 2017 and 2020 an additional 50 GW of wind-power is forecast to be installed across Europe. And the increasing importance of offshore wind farms can be seen in the fact that 53 are scheduled to come online between 2016 and 2022. By 2030 the EU is expected to have a total of 323 GW of installed wind energy capacity, enough to meet a quarter of power demand, dominated by onshore turbines generating 253GW and offshore installations generating 70 GW .[ix]

COST PROFILE OF WIND PLANTS

A typical grid- scale wind turbine costs between £1 million to £2 million per MW of nameplate capacity installed. Most of the commercial-scale turbines installed today are 2 MW in size and cost roughly £3-£4 million installed.

Total costs for installing a commercial-scale wind turbine will vary significantly depending on the number of turbines ordered, cost of financing, when the turbine purchase agreement was executed, construction contracts, the location of the project, and other factors. Cost components for wind projects include things other than the turbines, such as wind resource assessment and site analysis expenses; construction expenses; permitting and interconnection studies; utility system upgrades, transformers, protection and metering equipment; insurance; operations; warranty, maintenance, and repair; legal and consultation fees. Other factors that will impact on the economics of wind projects are taxes and government incentives.

DRIVERS

Underpinning the boom in renewable energy are European Energy policies combined with the latest UN accords on combating climate change. In 2009 the EU's Renewable Energy Directive set a target of meeting 20 percent of its energy needs by 2020 from renewables, a target which has since been raised to 32 percent by 2030.[x] In keeping with EU policy, governments helped kick-start the wind industry by offering generous levels of subsidies, feed-in tariffs and priority grid access, which have helped to bring down the cost curve for wind and solar energy, so much so, that some current new projects are commercially viable without subsidies.

The falling cost of wind,[xi] and solar combined with the arrival of competitive grid- scale onsite energy storage,[xii] alongside increasing international agreement to enforce cuts in greenhouse gases are potentially turning renewables into a normal commercial investment, rather than something driven by subsidies. By the early 2020s a number of subsidy-free projects will be in operation. For example:

- In 2022, the 750 MW Hollandse Kust Zuid, will be able to call itself Europe's first offshore wind farm, built entirely without government subsidies.[xiii]
- By 2025, the "He Dreiht" subsidy- free 900 megawatt wind farm in the German section of the North Sea, a joint venture between Germany's EnBW and Danish DONG Energy will come on-stream. [xiv]
- The UK's first subsidy-free onshore wind farm, was announced in May 2018, after developer Energiekontor had reached financial close on its 8.2MW Wither wick II extension project in Yorkshire.[xv]

However, since more and more wind projects are being presented as cost savings for consumers, as opposed to just for meeting renewable energy goals, the economics of future projects are going to be heavily scrutinised.

Other factors include:

- Declining prices: new consumer demand for renewables is encouraged by a steady decline in the overall costs of wind and solar.
- Improved component durability and reliability.
- Investor pressure: the growing emphasis for 'responsible investment' is driven by the recognition that environmental, social and governance (ESG) factors play a key role in determining risk and return while also supporting the investors' fiduciary duty to their clients.
- Customer and employee pressure: today's customers want to feel good about the companies they do business with.
- Changes to information reporting standards: under 'true value accounting' principles, corporations are being asked to identify and quantify the financial impact of climate-related risks in their organization and to outline the potential threats and opportunities to their own stakeholders through appropriate financial disclosure.
- Industry peer pressure: The impact of peer pressure within an industry to support renewables was led by software and IT giants such as Microsoft, Apple and Google and has been followed by leading companies IKEA, BMW, General Motors, Nissan, Honda, CEMEX, Heineken, LEGO, Facebook and Amazon.[xvi]

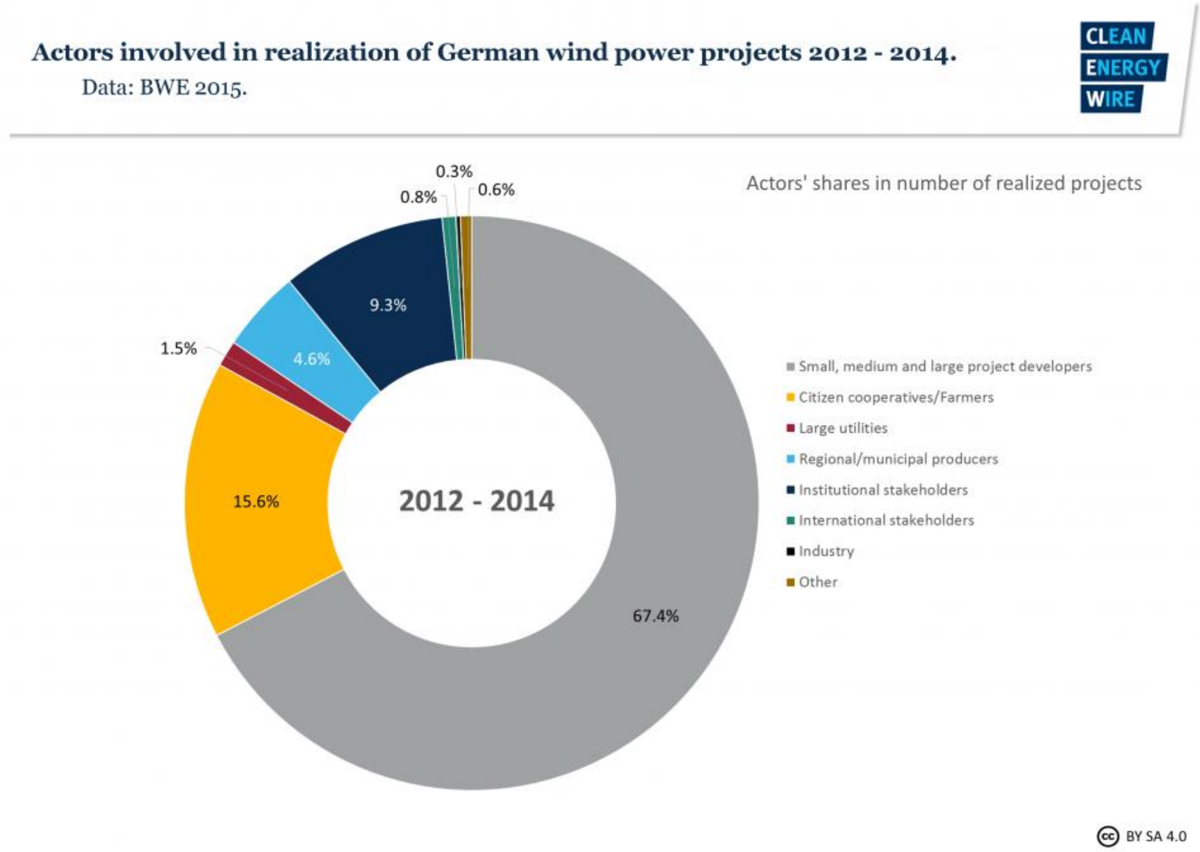
OWNERSHIP

Over the past few years the global trend is toward public utilities and large Independent Power Producers (IPPs) developing and owning large- scale (normally about 20 to 500 MW) wind farms. Wind-power managing owners, along with other financing parties and equity partners, typically sell the electricity generated from wind farms to other public utilities under long-term (typically 20 year) Power Purchase Agreements (PPAs) where they receive a fixed or annually adjusted price for the electricity produced. Renewable energy incentives (which vary by country) also play a role in the revenue stream of a managing owner.

Compared to the oil and gas industry, wind ownership is diverse and short term. For example, the oil industry is now largely in the hands of mainly state-owned entities such as Saudi Aramco , Kuwait Corp., Pemex, Rosset, Equinor (formerly Statoil) and Chinese companies plus private international oil companies including BP, RDS ExxonMobil etc. In effect over 90 percent of global reserves are in state hands. In contrast, wind farms are often in the hands of multiple owners and ownership is more fluid and short term.

What is immediately apparent is the diversity of ownership as seen in a snapshot of Germany's wind-power projects as in figure 4.

Figure 4



Source https://www.cleanenergywire.org/sites/default/files/styles/large/public/images/dossier/actors-involvement-wind-power-project-realizations.png?itok=Efi6LVyz

Large European utilities such as Iberdrola (Spain), EDF and Engie (France), Enel (Italy), E.on and RWE (Germany) alongside EDP Renováveis and Acciona Energie (Spain) and Sweden's Vattenfall dominate Europe's wind-power assets. However, Europe's utilities are not alone in owning and operating wind-power facilities since they have been joined by 'big oil' including, America's ExxonMobil and Chevron, Dutch Royal Dutch Shell, Britain's BP, France's Total SA, Italy's Eni and Norway's Equinor (formally Statoil) and Danish based

Ørsted (formally Dong Energy) which has left the oil business altogether to focus on renewables.

In the case of small scale projects under 20 MW, owners include local towns and cities like Denmark's Aarhus and Germany's Hamburg; local energy co-operatives like Britain's Westmill Sustainable Energy Trust and Drumlin Wind Energy or societies as well as energy intensive companies in IT, car manufacturers including BMW and Nissan and retailers such as IKEA. In addition, many farmers and land owners like, Britain's Forestry Commission and the Royal family own outright or have stakes in wind farms on their land.

In addition, whilst small scale wind farms tend to have stable single ownership, the larger facilities, perhaps due to their higher capital requirements and investor interest, tend to have multiple owners and farming- out fractions is becoming more common. See table 1.

Table 1 Sample of wind projects and their ownership

Project	Size	Came on line	Original ownership	Current ownership
Tvindkraft Wind Farm, Denmark	900 kW	1978	Tvind climate centre	No change
Vindeby Offshore Wind Farm, Denmark	4.95 MW	1991	DONG Energy	No change
El Cabrito	30 MW	1993	Acciona Energia	No change
Sotavento Wind Farm, Spain	17.5 MW	1999	Sotavento Galicia SA	No change
Schiavi d'Abruzzo Italy		2002	E2i Energie Speciali	No change
North Hoyle Offshore Wind Farm	60 MW	2003	RWE npower renewables	In 2017 Greencoat UK Wind (UKW) entered into an agreement to acquire the North Hoyle offshore wind farm.
Walney Offshore Wind Farm Project, UK	367 MW	2012	Dong Energy 100%	In December 2009 SSE acquired a 25.1% share and In December 2010 a consortium of PGGM and Dutch Ampere Equity Fund acquired 24.8 %
West of Duddon Sands, UK	500 MW	2013	Morecambe Wind Ltd, a partnership between Scottish Power, Elsam and Eurus Energy	By 2014, West of Duddon Sands was a " joint venture project between Scottish Power Renewables and Dong Energy

			were the original owners. Elsam, a Danish company was later acquired by Dong Energy.	
Âncora Wind farms, Portugal	171.6 MW	2014	Galp Energia SGPS S.A., Martifer SGPS S.A. and Ferrostaal GmbH.	Galp Energia SGPS S.A., Martifer SGPS S.A. and Ferrostaal GmbH.
DanTysk, Germany	288 MW	2014	Geo Gesellschaft für Energie und Ökologie	The project was purchased by Vattenfall in 2007. In 2010, Vattenfall sold 49% stake in the project to Stadtwerke München.
EnBW Baltic 2, Germany	288 MW	2015	German power utility EnBW (Energie Baden-Württemberg) holds a 50.11% stake in the project, while the remaining is held by PGGM.	Macquarie Capital acquired a 49.89% interest in the wind farm on 8 January 2015, for €720m (approximately $799m), and sold it to PGGM in June 2015.
Lacedonia wind farm, Italy	42 MW	2015	Nisida	The German company bought an interest in the project from the family-owned developer Nisida. The German company bought an interest in the project from the family-owned developer in 2014, in 2014,
Borkum Riffgrund 2, Germany	8.3MW	2019	Dong Energy	DONG Energy earlier sold a 50% stake in Gode Wind 2 to a consortium of Danish pension funds PKA will acquire 24.75%, Industriens Pension 10.5%, Lærernes Pension 8.75% and Lægernes Pensionskasse 6% for €600m.
Sources: various sources				

DECOMMISSIONING

DECOMMISSIONING INVOLVES

Decommissioning of onshore installations, which are in the majority, older and with smaller turbines, involves complete disassembly, removal and disposal of the installed equipment.

Consultants at Arup defined offshore decommissioning as " inter-array cables being disconnected and their ends being buried, wind turbines being dismantled and transferred to shore, and foundations being cut below the seabed, and the top section removed and returned to land". Generally, the dismantling time is between half to two thirds of that taken for installation, which is helpful for a process that can take place during favourable weather conditions only.

DECOMMISSIONING PLANNING

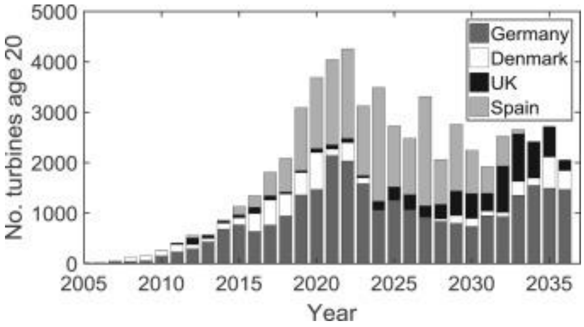
The UK's, Energy Act 2004 requires developers of offshore and marine energy installations to include details of the scope of decommissioning, removal plans, financial security safeguards and residual liability for the end-of-life stage of the project in the Environmental Statement supporting a planning application. Moreover, post -consent, the developer is expected to review the decommissioning plan at least every 3-5 years. However, for the first generation of on and offshore plants, which are now approaching or have reached the end of their operational life, arrangements for financing decommissioning and associated environmental damage are unclear.

In Europe, according to Jonas Pagh Jensen of Siemens Gamesa Renewable Energy, manufacturer of wind turbines and wind farm developer, "every customer is obliged to make a plan [for] what they intend to do in 20-25 years' time when the turbine is expected to come down." This means that developers have to make a plan for decommissioning, which may include re-powering, re-blading or life extension, at the start of the project's conception, often even before the final investment decision, a practice which is standard for oil and gas projects in the North Sea. For a typical example of this practice, see Appendix 4 French Offshore Wind Developer Thinks Decommissioning Before final Investment Decision.

DECOMMISSIONING PROSPECTS

Of direct relevance for decommissioning prospects is the age of Europe's wind turbine fleet. The early wave of mainly onshore wind turbines installations will soon reach the end of their designed service life of 20 years. In 2016, 12 percent of Europe's installed wind turbine capacity exceeded 15 years of operations, a figure that is set to increase to 28 percent by 2020.[xvii] Denmark, Germany and Spain are the key markets for decommissioning services which are set to rise starkly towards the end of this decade and in the early 2020s. See Figure 5.

Figure 5 Number of onshore wind turbines reaching 20-years of operation annually in Denmark, Germany, Spain and the UK.



Source various data sources

In 2016, Germany had roughly 3,400 wind turbines which had exceeded their 20 year lifespan followed closely by Denmark with 1,250 turbines. Spain currently has 500 turbines over 20 years old and this will increase to more than 4,200 turbines in 2020 reflecting the take-off of such installations at the turn of the century. Today, about 20 percent of the installed wind-power capacity in Italy (approximately 2,000 MW) is over ten years old.[xviii]

- According to Germany's wind lobby, the country had 28,000 onshore wind towers in mid-2017. Germany, a pioneer of wind-power and the prospect of generous government support programmes ending in 2020, could very soon be a prime market for decommissioning. Moreover, rising maintenance costs and lower power output from ageing turbines, could increase pressure to take them out of service sooner and replace them with newer, more effective turbines.[xix]

- In 2017, Denmark decommissioned 174 turbines with a total capacity of 98 MW and connected 220 new ones generating 373 megawatts according to the Danish energy agency.

- In the UK, in November 2016, 19 onshore wind farms had exceeded their operational life, of which eleven are still in operation, two have been decommissioned and five were re-powered. In total, fourteen re-powering projects have been completed or approved in the UK since 2010.

New wind turbines are far more productive than old models and this might accelerate the pace of decommissioning. Also, owners of life-time extended installation have already lost subsidies in Denmark, Spain and from 2020 also in Germany. This leaves developers with the spot market price, which not only fluctuates but is expected to fall below the current price. This reality should also tend to accelerate the pace of decommissioning of life-expired farms and reduce the incentive to invest in life- extensions.

DECOMMISSIONING OPTIONS

Decommissioning encompasses a gradation of investment options:

(1) **Refurbishment** to extend the operating life of the infrastructure and equipment to gain a few more years of output.

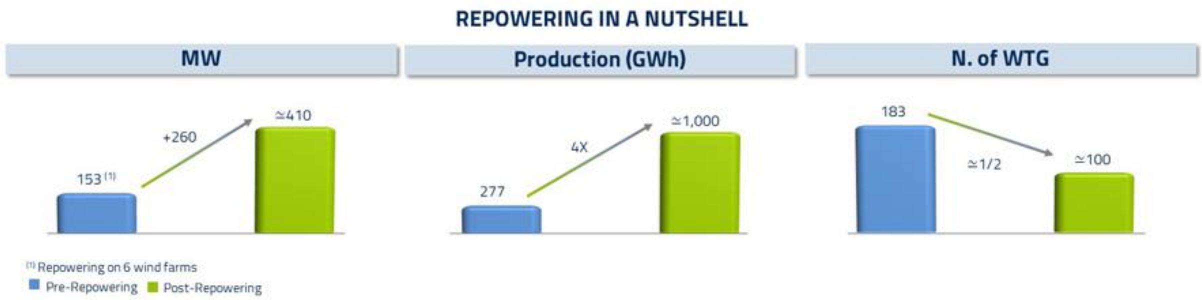
(2) **Re-blading** which involves replacing existing blades to gain a boost in output.

Figure 7

Source https://www.erg.eu/documents/10181/375034/49_Repowering_885.jpg/2b3364a2-b0dc-4526-8836-e115ddb2ddaa?t=15319293600001

(3) **Re-powering** which involves removal of turbines and replacement with a smaller number of modern, more powerful and productive turbines to gain significantly more output and maximise re-use of existing infrastructure and maximise recovery of materials from removed turbines. Figure 8.

Figure 8



Source https://www.erg.eu/documents/10181/375034/49_Repowering_885.jpg/2b3364a2-b0dc-4526-8836-e115ddb2ddaa?t=1531929360000

For many owners, the best option is re-powering, since a modern wind turbine produces 180 times the electricity at half the cost of one built 20 years ago, states the New Zealand Wind Association.

*(4) **Full decommissioning: Removal and Disposal***

For some owners, total removal and disposal of all equipment is the only option, since the guaranteed tariffs that were set for the original installation for wind-power are terminated after 20 years, thereby making them unprofitable. The cost of decommissioning an onshore wind turbine can be as little as $200,000.[xx] However, the actual cost can vary depending on the location, size, weight and number of turbines. For example, the further and deeper the wind farm is offshore the higher the expense of decommissioning. [xxi]

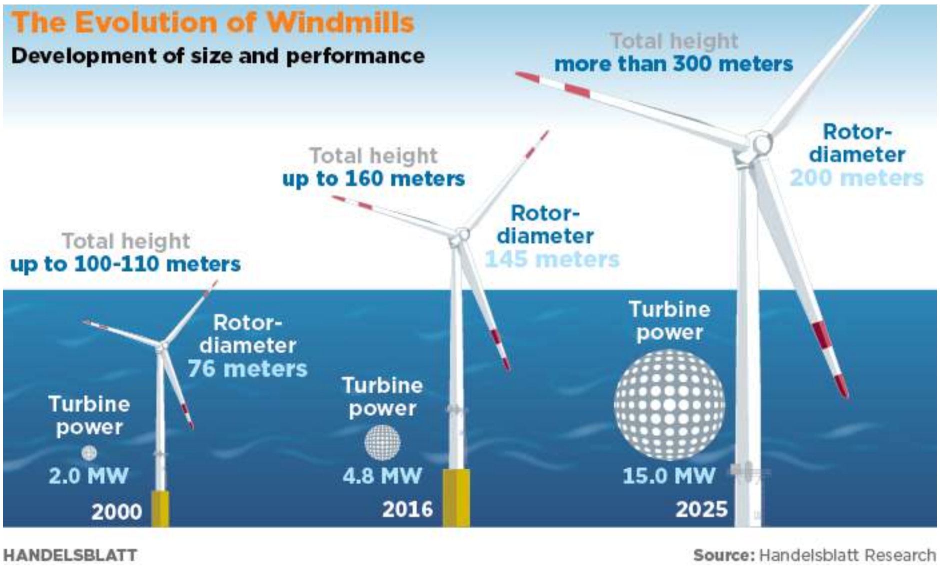
Denmark's offshore Vindeby wind farm, commissioned back in in 1991, was dismantled in early 2017. Its decommissioning involved dismantling the blades, nacelles, towers individually by a mobile crane on board a jack-up vessel and removal from site.

PRACTICAL CONSIDERATIONS

Wind farms and turbines are getting bigger and bigger

It is important to note that the increasing number and scale of offshore wind farms has implications for decommissioning years down the line. The average capacity and therefore number of turbines in new offshore wind farms in 2017 was 493 MW, a 34 percent increase on 2016. Moreover, the turbines themselves have undergone significant changes. In the 1980s, a wind tower stood about 20 meters tall, its blades spanned about 17 meters and it had a capacity of about 75 kilowatts of electricity. A modern tower can stretch more than 100 meters tall, with blades that span 126 meters and have a capacity of 7.5 megawatts. In fact, one of the world's largest rotors has a diameter of 164 meters. Its 82-meter blades correspond to the wingspan of an A380 airplane and it produces some 9.5 megawatts. In the not-too-distant future, current offshore wind turbines are set to be surpassed by 11 MW colossi with hubs 125m above sea level and blades spanning 190m. Their blade tips will scythe the air, at a height two-thirds that of the Empire State building in New York.

Figure 6 The increasing size of wind turbines



Source https://global.handelsblatt.com/wp-content/uploads/2017/05/16-p14-The-Evolution-of-Windmills-01.png

In terms of weight, the modern rotor weighs in at 60 tonnes, the nacelle at 82 tonnes and the tubular steel tower weighs 162 tonnes.[xxii] A typical offshore 4.1MW turbine with a 90-metre hub height, plus tower could weigh double.

A typical wind turbine is made up of about 8,000 parts which will need to be disassembled often in increasingly remote places including, high-altitude locations in the Alps or in the North Sea, for transport and disposal. The majority of offshore wind farms that are due to be decommissioned in the next few years are located in shallow waters with smaller sized turbines and monopole foundations.

Shifting and lifting such equipment has been helped by the development of specialised equipment including, the use of blade adapters, self-propelled modular transporters, jack-up rigs, floating cranes, pile drivers and mono bucket foundations.

To sum up, the decommissioning challenges and costs differ according to location i.e. between onshore and offshore; age of installation i.e. between old first wave installations at the millennium and current installations and lastly project scale i.e. small and large sized wind farms. Moreover, the current trend towards offshore installations in deeper waters means that decommissioning is likely to be more costly and difficult than either those in shallow waters or on land, if the experience of decommissioning offshore oil rigs is anything to go by.

It is also worth noting that wind turbine manufacturers are adopting new materials and technologies to cut the weight of a 5 MW turbine in half. This would allow for a commensurate reduction of the tower portion for it would only have to support around 551,000 pounds in weight instead of the current million. This would have knock-on impact on the size of the wind turbine's foundations. [xxiii]

DEALING WITH REDUNDANT EQUIPMENT

(1) Refurbish and sell to the second hand market

There is a significant second hand market in refurbished wind equipment in former Soviet Union countries, southeast Europe, Latin America and Asia. For instance, a Dutch company Dutchwind BV sells a wide range of refurbished second hand wind turbines in sizes ranging from 80 kW to 3.6 MW .Brands on sale include Vestas, Enercon, Nordex, GE, Gamesa, NEG Micon, Lagerwey, AN Bonus / Siemens, Micon, Nordtank and many more. Currently, most used wind turbines for sale are sourced from Germany, Denmark, the UK, Italy, the USA and The Netherlands. However, market prospects for second hand turbines are diminishing as "from year-to-year, more wind plants are being dismantled, and not every plant finds a secondary market," Bundesverband WindEnergie (BWE) the German wind association research paper 2017.

(2) DUMP IT

Thanks to tougher EU waste rules, burying the blades in landfills is becoming increasingly difficult. Europe's wind industry claims that it is still unclear how the 10 percent landfill cap on municipal waste by 2030 will affect industrial and construction waste but concedes that disposing waste through landfills or incineration without energy recovery are the "least favoured" waste treatment methods.

(3) RECYCLE AND RECLAIM

New rules agreed to last year (2017) are aimed at boosting recycling rates to reduce the need for landfilling. According to Michael Schneider, spokesman for Remondis, “everything, except for rotor blades, is very well recyclable.” An audit of a wind installation would find that wind tower foundations are made of concrete and steel. Towers tend to be composed of steel. The nacelle — the casing atop the tower — contains gears, the drive shaft, generator and transformer (containing oils and lubricants) and is made up of a mix of steel, iron, copper and silica. According to BWE about 80 percent of the complete wind installation could be recycled leaving just the turbine blades. These are designed to be very light and very strong to withstand enormous force without bending and breaking and are made now from either reinforced carbon or glass fibre, combined with polyesters and thermoplastics. The blade’s qualities of strength and durability come at a price since its material composition is not easily recycled.

FUNDING OF DECOMMISSIONING

In the UK, developers and owners are liable to cover the decommissioning costs, which are believed to be less than 1% of levelised cost of energy produced, according to a study carried out for the Department for Businesses, Energy and Industrial Strategy (BEIS). One estimate cites a $200,000 cost to take down a turbine, but once the metals like copper and steel and the resalable components are stripped out and sold the cost could be less. [xxiv] However, how much is gained from sale will depend on the stage of the commodity cycle and state of the second hand market. [xxv]

“Fund allocation represents the biggest issue when it comes to decommissioning offshore wind farms,” says NewEnergyUpdate.com. Although developers are committed to setting aside between 2 and 3 percent of the project’s capital costs each year (according to ScienceDirect.com) industry observers fear that the duration and the costs of decommissioning are not being adequately captured in decommissioning plans - for how do you adequately calculate the cost of an uncertain process 20 to 25 years before it needs to be performed? Indeed, this possibility is recognised by the UK’s Department for Business Energy and Industrial Strategy (BEIS) which states that finances may prove inadequate in the face of unexpected increases in costs.[xxvi] To illustrate the potential gap, decommissioning firm Niras, estimates that the decommissioning market itself traditionally operates on a cost uncertainty of up to 50 percent. (see Appendix 4)

As for the first wave of projects, “financing could be a major challenge, for some of the first-build projects, where you don’t necessarily have an earmarked fund to cover decommissioning,” says, Ole Nielsen, Offshore Project Execution Director for BU Renewables, in Wind Energy Update.

LAST RESORT FINANCING

But should the owners be unable to organise and fund decommissioning, BEIS, the seabed landlord, the Crown Estate and the Scottish government could ultimately pick up the bill.

BEIS is the 'executioner of last resort' if a project's developer or owner cannot fund decommissioning.

The recent BEIS report, *Cost Estimation and Liabilities in Decommissioning Offshore Wind Installations* estimated that the decommissioning cost of Britain's 37 offshore wind farms could cost the Treasury between £1.28 billion (€1.44 billion) and £3.64 billion (€4.12 billion), excluding decommissioning costs of associated offshore transmission assets, which are expected to add £158 million in tax relief.

CONCLUSION

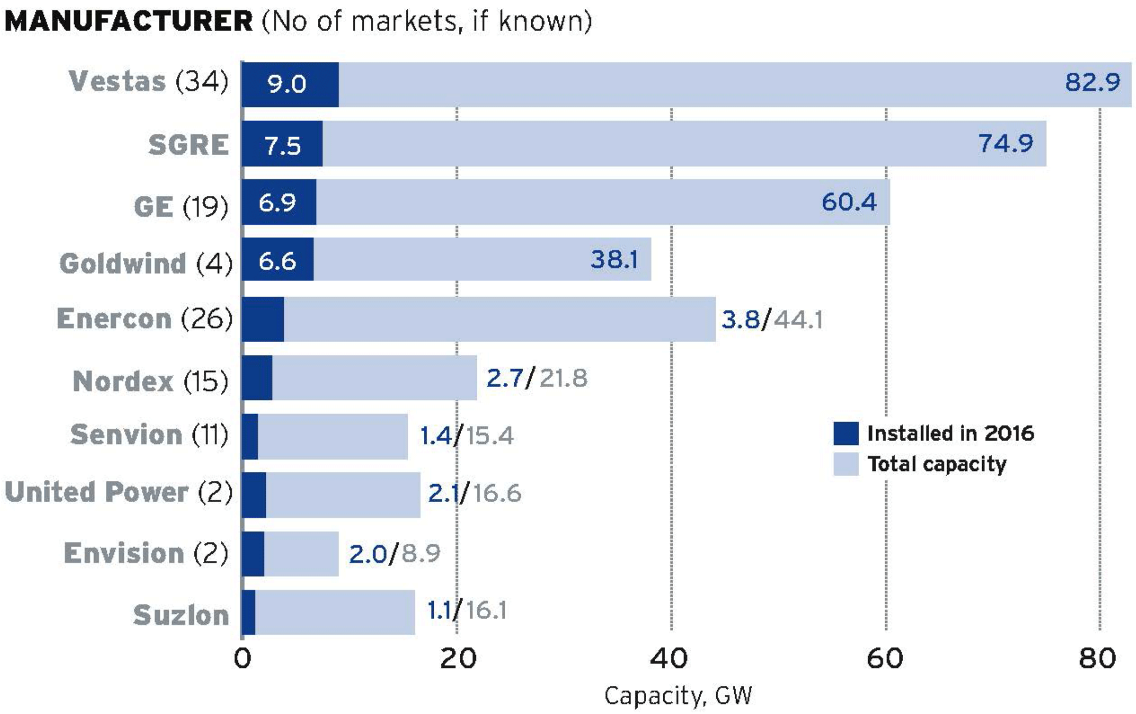
According to Bloomberg, the first trillion watts of green energy cost global developers $2.3 trillion and took nearly half a century. The next trillion could be online within the next five years and cost over $1 trillion less. One thing is clear, the market for wind-power is likely to continue to grow worldwide, as further innovations in technology and construction, together with the need to meet Paris Accord targets, encourages many countries to invest in renewables.

As for Europe, it is likely that in many developed locations, operators will seek to upgrade and replace existing equipment, since many of the existing locations are optimum sites, saving on grid connection and planning approval costs. As for the redundant equipment, if dumping and resale is not possible, new solutions will have to be found for disposing of redundant components, as Europe imposes ever tougher recycling standards.

APPENDIX 1

LEADING TURBINE MANUFACTURERS

Top ten turbine makers of 2017



Source https://cached.offlinehbpl.hbpl.co.uk/news/MPW/richedit/OEM-chart.gif

APPENDIX 2

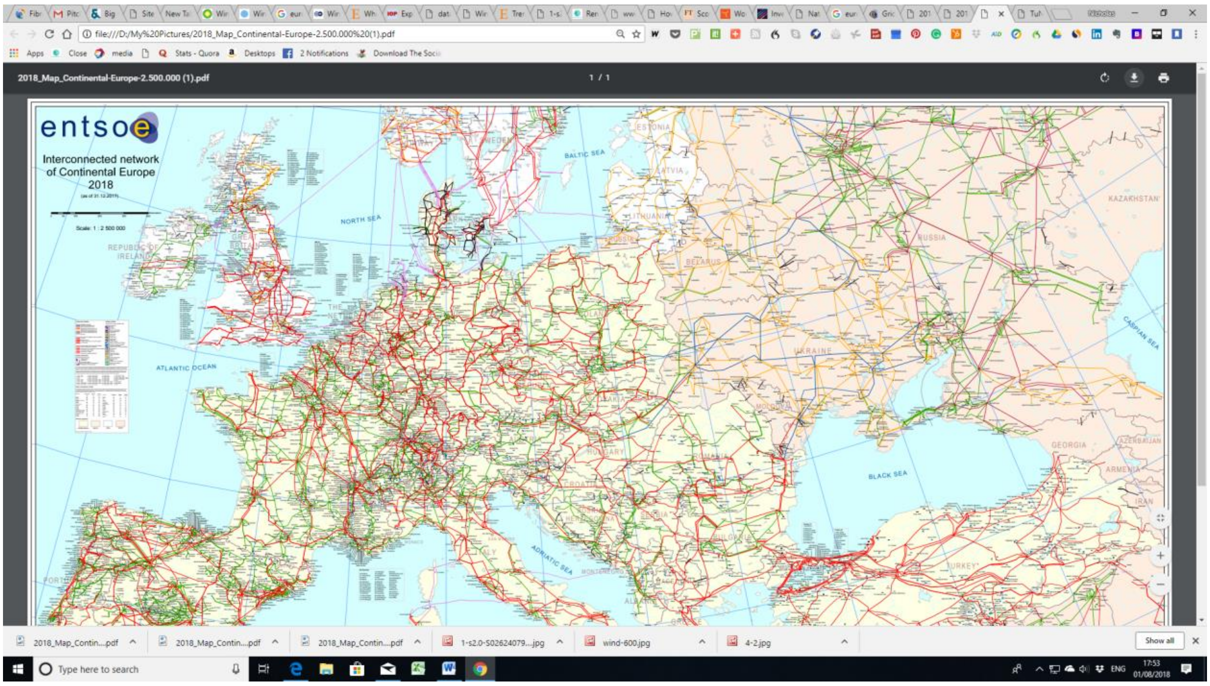
CHALLENGES FACING WIND-POWER

Both on and offshore installations are vulnerable to opposition from the environmental lobby who stress the damage to migratory birds, the impact on fish or the aesthetic damage to views.

GRID ACCESS

Europe's main transmission network is primarily designed to serve major population centres, rather than the often remote best locations, for wind parks. Nor does Europe have a fully integrated single market for power generation. There are also gaps in the cross border network, a situation that is being remedied by EU funding for building key interconnectors linking the Baltic States with Poland, a new subsea Biscay link between Spain and France and a new German SuedOstLink, 580 km of underground high-voltage cables to connect the wind-power in northern Germany to the consumption centres in the south.[xxvii] For instance, the Biscay link will improve access to Spanish wind output to northern Europe, making it easier to balance the grid in Europe, as there is usually somewhere in Europe, where the wind blow. See Figure 9.

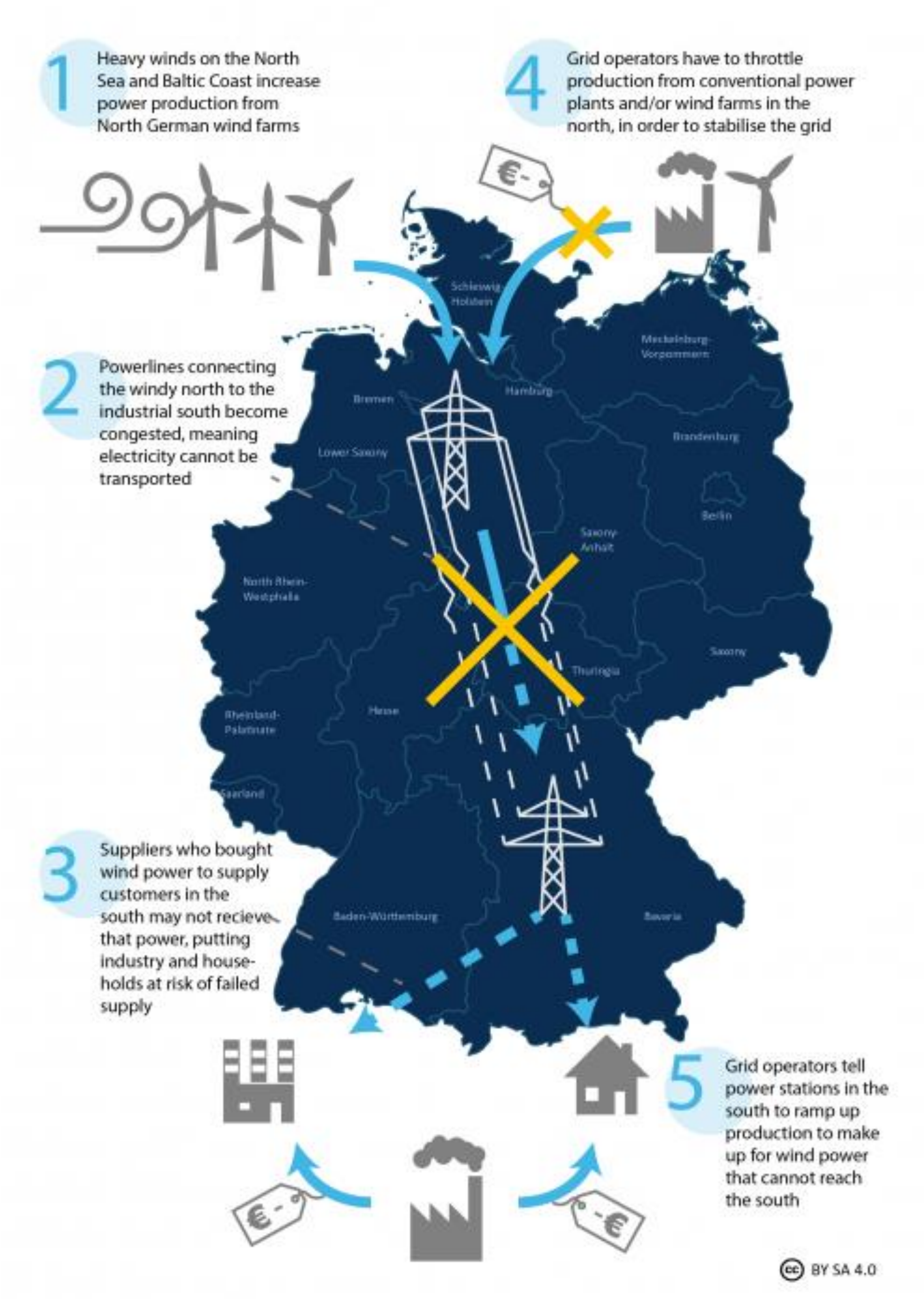
Figure 5 Map of Europe's main transmission grid network as of 2018.



Source file:///D:/My%20Pictures/2018_Map_Continental-Europe-2.500.000%20(1).pdf2

As a result, access to the grid is a problem for both the operators of the wind park and transmission grid, often cables has to be constructed over substantial distances to reach the main transmission grid, which is like a motorway for electricity transmission to customers. For instance, the Dornell wind farm in Scotland had to build, a 22 kilometre transmission line to connect to the grid.[xxviii] In the case of grid operators such as the National Grid in the UK and Tennet in Germany ensuring sufficient grid capacity along the main transmission network, is challenged by congestion problems.

Example of dispatch situation in the German power grid (CLEW)



Source https://energytransition.org/2018/03/the-german-electricity-grid-notoriously-swamped/

Such grid congestion problems can be costly to consumers who have to fund the compensation payments and wasteful in terms of resources. That is why in Scotland, the UK's National Grid is building a £1 billion Western Link subsea power line to transfer around 2,200MW of power across 385-kilometre route of the Irish Sea, to link the transmission networks in Scotland with that in Central England and Wales. Once this 385-kilometre long high voltage subsea cable comes online at the end of 2018, it should end the need of

Britain's grid operator National Grid to pay up to £2 million a week to wind park operators in Scotland to switch off their turbines, due to capacity issues on the existing Scotland to England grid network. [xxix] Similar payments are made elsewhere in Europe including Germany to balance the grid in terms of demand and supply.

APPENDIX 3

ENERGY STORAGE

Across Europe, we are seeing an increasing number of wind-power projects integrated into hybrid power projects that include large scale and small scale energy storage. For instance, Portugal's large scale Alqueva pumped-storage hydroelectric plant has a capacity of 520 MW. Power is generated during high demand periods and at times of low demand, the turbines reverse and pump water using power from wind turbines, from a smaller reservoir below the dam back into the main reservoir. As a result Alqueva is a source of base load and energy storage for Portugal, enabling the country to be totally reliant on renewables for many days at a time.[xxx] Similar schemes are being developed across Europe including at Gaildorf, near Stuttgart in southern Germany, where a 70MWh of pumped hydro energy storage facility is being developed.[xxxi]

For an example of small scale energy storage, look no further than GE, working with Microsoft, to deploy advanced batteries at a wind farm in Ireland. In Spain, Acciona paired two Samsung SDI battery-based energy storage systems to a 3MW wind turbine at an 'experimental wind park' in September.[xxxii]

APPENDIX 4

FRENCH OFFSHORE WIND DEVELOPER THINKS DECOMMISSIONING BEFORE FINAL INVESTMENT DECISION

Danish consulting engineering company Niras has won a contract to set up a plan for decommissioning of two offshore wind projects in France with a combined capacity of nearly 1GW which are still awaiting respective final investment decisions.

Les Eoliennes en Mer Services (LEMS), a joint venture partnership between Engie, EDP Renewables and La Caisse des Dépôts, is developing the 496MW Dieppe et le Tréport and the 496MW Iles d'Yeu et de Noirmoutier offshore wind farms.

Each wind farm comprises 62 Siemens Gamesa 8MW wind turbines and an offshore substation.

Niras has used the ODIN (Offshore, Decommissioning of Installations Niras) proprietary tool and its experience of decommissioning the Vindeby wind farm to create the decommissioning plan for both projects.

"LEMS takes their job seriously and has chosen to think years ahead when they include the full life cycle of the turbines, from birth to last breath, and thus also wish for help with the retirement and clever dismantling," said Johan Finsteen Gjødvad, project manager in Niras, who will help to make the final strategy for decommissioning.

"By using known methods and actual data, we are able to think backwards," Gjødvad said, adding that the decommissioning market is traditionally operating with an uncertainty of up to 50 percent when it comes to calculate what it would cost to take down a wind turbine down.

"But we can reduce the uncertainty to 15% because we base our knowledge on what things have actually costed and which methods have already been tested earlier regarding installing, maintenance and dismantling. We have specific knowledge about what can be sold which metal parts and cables can be recycled, and which stones from the foundation can be used elsewhere. So not only is it about optimal waste management and a reduced environmental impact, but we also reduce costs in relation to the dismantling," Gjødvad said.

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