The value of hedging

New approaches to managing wind energy resource risk

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CONTENTS

EXECUTIVE SUMMARY

By 2030 installed wind power capacity in Europe could double to 323 GW: 253 GW onshore and 70 GW offshore wind. The anticipated growth of the wind energy sector could require an additional €239bn in investments between 2016 and 2030. As the industry transitions to auctions and feed-in-premiums for allocating renewable energy support, wind power projects are getting more exposed to market risks.

With the growth of the wind power sector and the increased market exposure there will be a need for credit enhancement solutions and structured products that transfer the risks from the project company to a counterparty willing to accept these risks. This report studies the potential impact of hedging the variability of wind energy generation.

KEY FINDINGS

- By 2030 only 6% of the European wind capacity – from 75% today – will be fully protected against market risks through support schemes. 67% of the capacity by 2030 will be partially exposed to power markets, and 27% will be fully exposed.

- By 2030 there will be at least 190 TWh per year of market potential for hedging instruments against price risk. This would be the equivalent of the electricity demand of a country such as Poland.

- Hedging the wind resource risk would provide revenue stabilisation and cash flow predictability to asset owners. By reducing the variability of the returns, cash flows move closer to the profile of a fixed-income investment, similar to a bond. If the hedge provider is a high-grade counterparty, then the expected yield could be in the range of 3-4%.

- Hedging can also impact the capital structure of a project, by creating more debt capacity and enhancing risk adjusted returns. WindEurope estimates €239bn in investments by 2030 to finance an additional 170 GW of new wind energy assets. Project finance debt has raised on average 70% and 40% of the capital requirements needed for onshore and offshore wind projects respectively.

- An average wind farm of 30 MW may need to hedge for +/-10% annual variations in its production forecast. Risk management services such as hedging could extract a value worth €2.5bn for new wind assets installed between 2017 and 2020. This may go up to €7.6bn for new wind power installations between 2017 and 2030.

1. INTRODUCTION

This report studies the potential impact of hedging the variability of wind energy generation. With the growth of the wind power sector, we expect these wind energy derivative products to open up the market to new and risk averse investors and improve the credit standing of merchant wind power financing.

Historically, the inability to lock in a portion of revenue has not hurt the ability of the industry to finance a very large amount of growth. The policy support schemes for renewable energy took away most of the market risk from power generating assets. In some countries, power purchase agreements had a similar effect – paying a fixed price for the power that was actually produced.

Those support mechanisms are rapidly coming to an end. In 2014 the European Commission introduced new rules on allocating support for renewable energy sources. Those changes are taking effect today with a shift towards competitive tender mechanisms and the use of market based mechanisms. As a result, several Member States have already moved towards feed-in premiums for utility scale renewable energy generators, restricting the use of feed-in tariffs to small installations and emerging technologies. Feed-in tariffs still remain the dominant support scheme in Finland and Ireland, but their application is expected to come to an end by 2018.

The first auctions in Europe have delivered cost reductions with record low prices - some even as low as zero. However, the short-term spot price does not deliver adequate economics to pay for new wind energy investments. Additionally, there is uncertainty related to the volume of sales. While auctions partially limit a project's exposure to price risk, uncertainty on the volume of sales remains entirely with the asset owners. As a result, merchant risk exposure – or the uncertainty on both price and volume – is likely to arise in the future.

Without a long-term mechanism in place that can underpin returns and limit the risks for wind energy developers, the project runs the risk of not generating enough revenue to cover all its obligations, including the servicing of debt and the dividends to shareholders. The more volatile the revenues become for asset owners, the higher will be the need for credit enhancement solutions and wind derivative products able to transfer market risks from the asset owner to a counterparty willing to accept them.

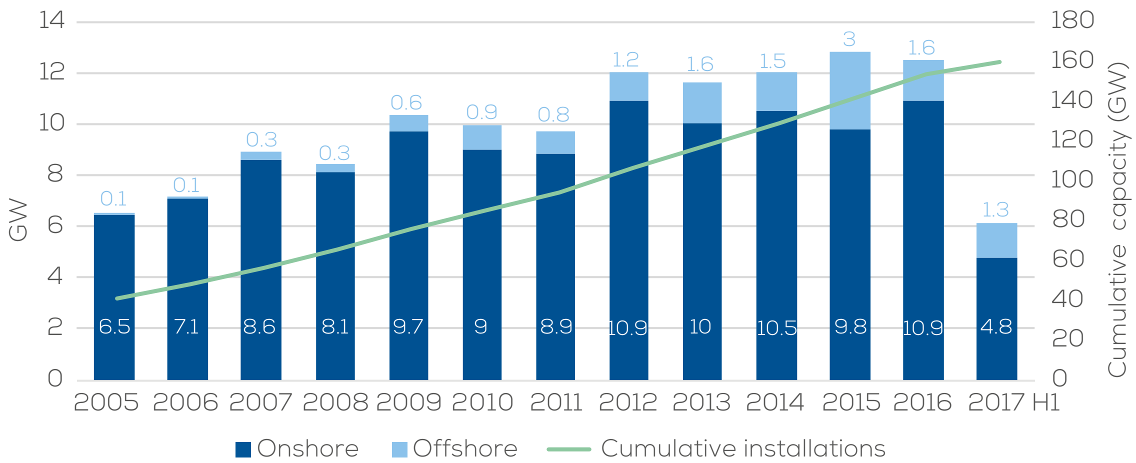
To assess the variability of wind and the potential impact of hedging instruments on the cost of capital, the report uses 20-year time series from a portfolio of wind farms in Southern Europe. The value creation of hedging in the energy commodity business, its applicability to wind and the market potential for such instruments are further explored in this report.

2. MARKET TRENDS

2.1 WIND ENERGY MARKETS TODAY

Wind power capacity in the European Union reached 159.8 GW at the end of June 2017, with installations increasing at an average annual rate of 11 GW over the last decade. Out of the total installed capacity in the EU, 145.5 GW are in onshore wind and the remaining 14.3 GW in offshore wind.

FIGURE 1
Annual wind energy market until the first half of 2017

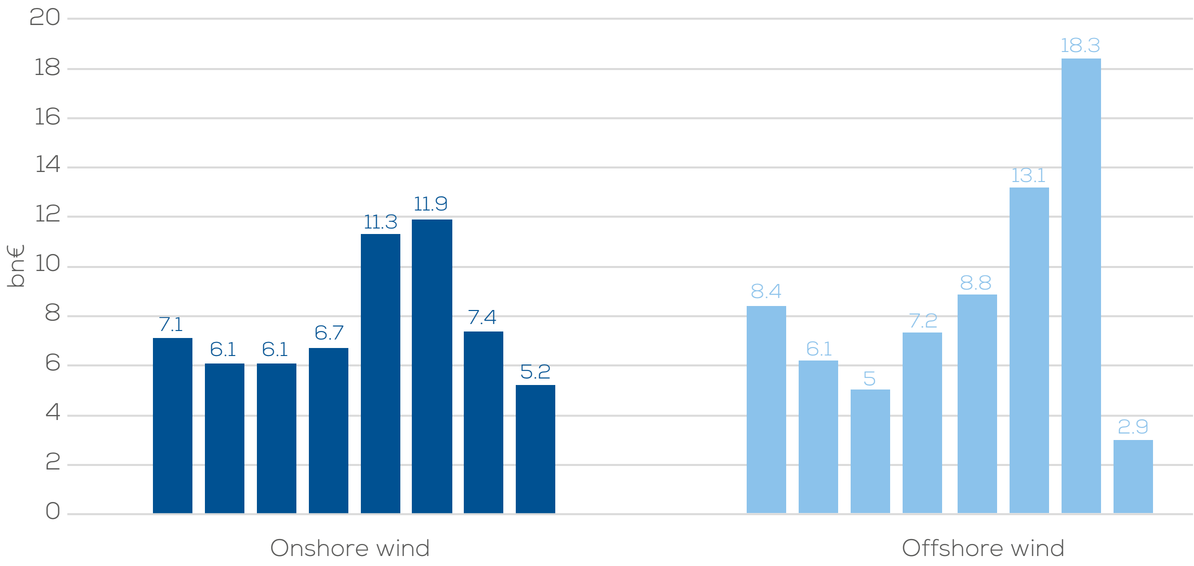


Source: WindEurope

Germany leads the European wind energy markets, with 33% of the total installed capacity. Spain, UK, France and Italy follow. These five biggest wind energy markets account for over 72% of the total installed wind power capacity in the EU.

Europe has invested a total of €140bn in new wind energy capacity since 2010. Over this period, investment flows have increased steadily at an average annual growth rate of 11%. Offshore wind markets continued to grow, with a pronounced spike in the last two years. In 2016 onshore wind markets experienced the first decline in the last five years.

FIGURE 2
New investments in onshore and offshore wind 2010-2017 H1



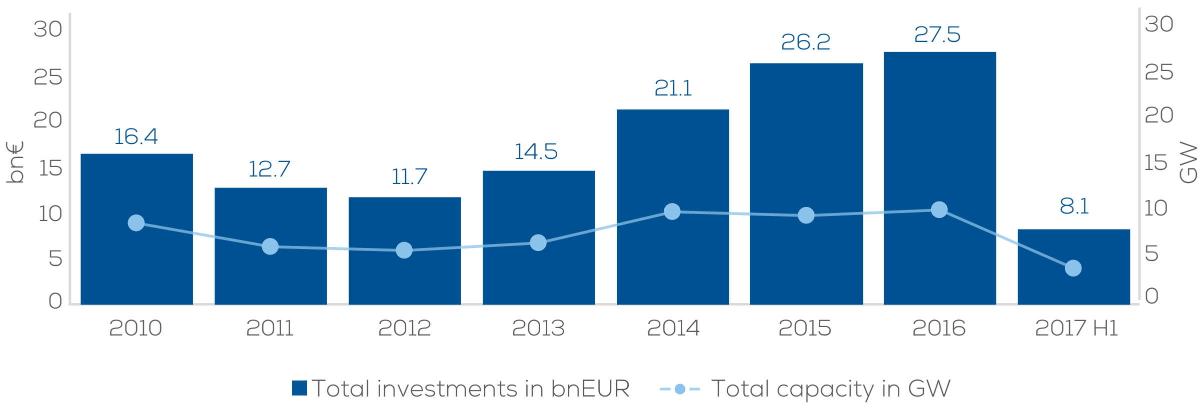
Source: WindEurope

Whilst 2016 saw a record level of new investments, lower volumes are expected in 2017. There are three key reasons for this trend. First, there has been a slowdown in activity in key wind energy markets. In particular, investments in Southern and Eastern Europe (SEE) remain very low over regulatory concerns and macroeconomic stability.

Second, the transition of Member States to new support schemes and tender mechanisms, along with regulatory uncertainty for the post-2020 period, is also expected to slow down the activity in some markets. While auctions are being rolled out in a larger number of markets, there will be a lull in investments before they lead to Final Investment Decisions (FIDs) for new projects.

Third, technological developments and increased operational efficiency have reduced costs across all the industry's supply chain. Overall, investors today are financing more wind power capacity for less money.

FIGURE 3
New investments in wind energy and new capacity financed 2010-2017 H1



Source: WindEurope

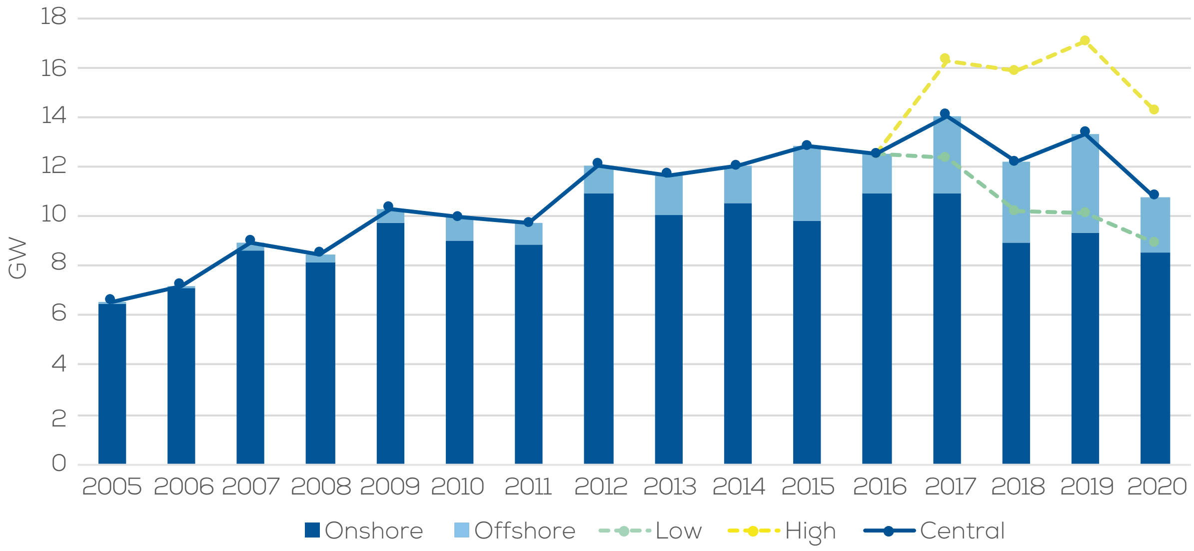
2.2 ROAD TO 2020 AND 2030

WindEurope expects another 44 GW of wind power installed capacity in the electricity mix by 2020. This would bring the total wind energy installed capacity in the EU to 204 GW by 2020. Western Europe will continue to dominate. Germany, Spain and the UK are expected to be the three largest markets. Capacity additions in Eastern Europe are expected to remain low, with less than 3% of the new installations between 2017 and 2020. Poland and Czech Republic will be the biggest markets in the region. Offshore wind could represent one quarter of the market between 2017 and 2020, with the UK hosting almost half of the new grid-connected capacity.

WindEurope estimates wind energy investments to top €90bn over the period 2017 and 2020. However, the record years that Europe has seen in 2015 and 2016 could be hard to replicate, mainly due to falling investment costs.

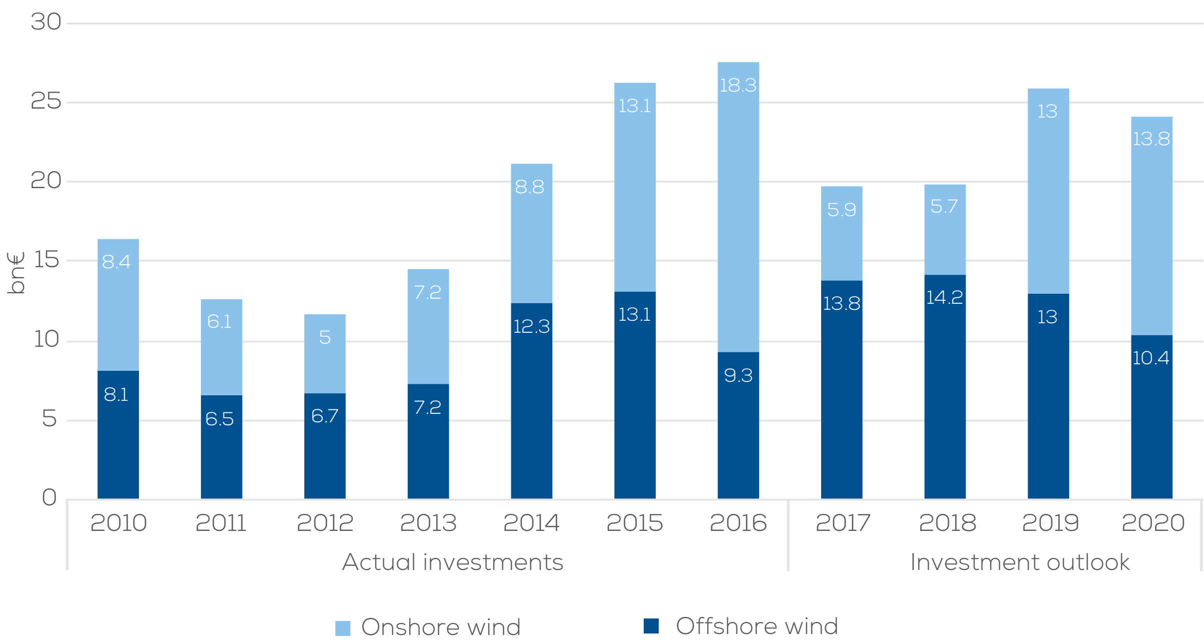
WindEurope has also developed a *low* and *high scenario* for 2020, according to which the cumulative capacity of wind power could grow to 195 GW and 217 GW respectively.

FIGURE 4
Wind power capacity additions in the EU: Forecast to 2020



Source: WindEurope

FIGURE 5
New asset financing in onshore and offshore wind: Forecast to 2020 Central Scenario



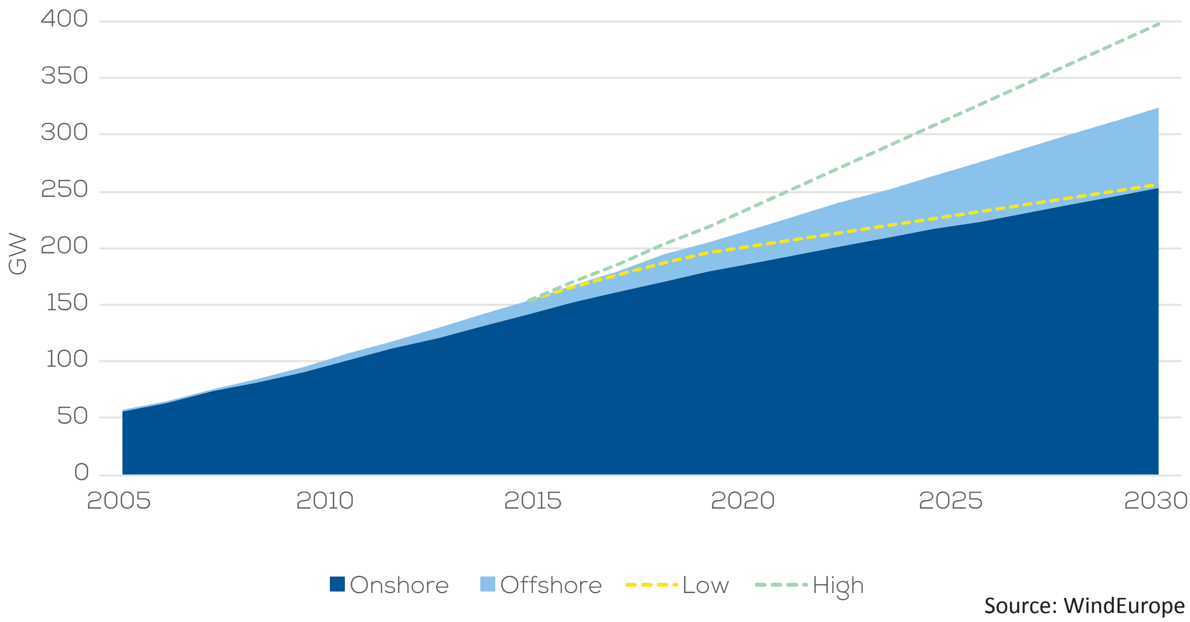
Source: WindEurope

By 2030 WindEurope expects the EU to double its wind power installed capacity to 323 GW under the *Central Scenario:* 253 GW onshore and 70 GW offshore. Wind energy could produce 888 TWh of electricity, equivalent to 30% of the EU's power demand. A total of €239 bn in investments are needed between 2016 and 2030 to bring this capacity online.

WindEurope's *High Scenario* assumes favourable market and policy conditions including the achievement of a 35% EU renewable energy target. In this scenario, 397 GW of wind energy capacity would be installed in the EU by 2030: 298.5 GW onshore and 99 GW offshore. This would be 23% more capacity than in the *Central Scenario* and two and a half times more capacity than currently installed in the EU.

In the *Low Scenario,* however, there would be 256.4 GW of wind capacity in 2030: 207 GW onshore and 49 GW offshore, producing 21.6% of the EU's power demand in 2030. That is 20% less capacity than in the *Central Scenario.*

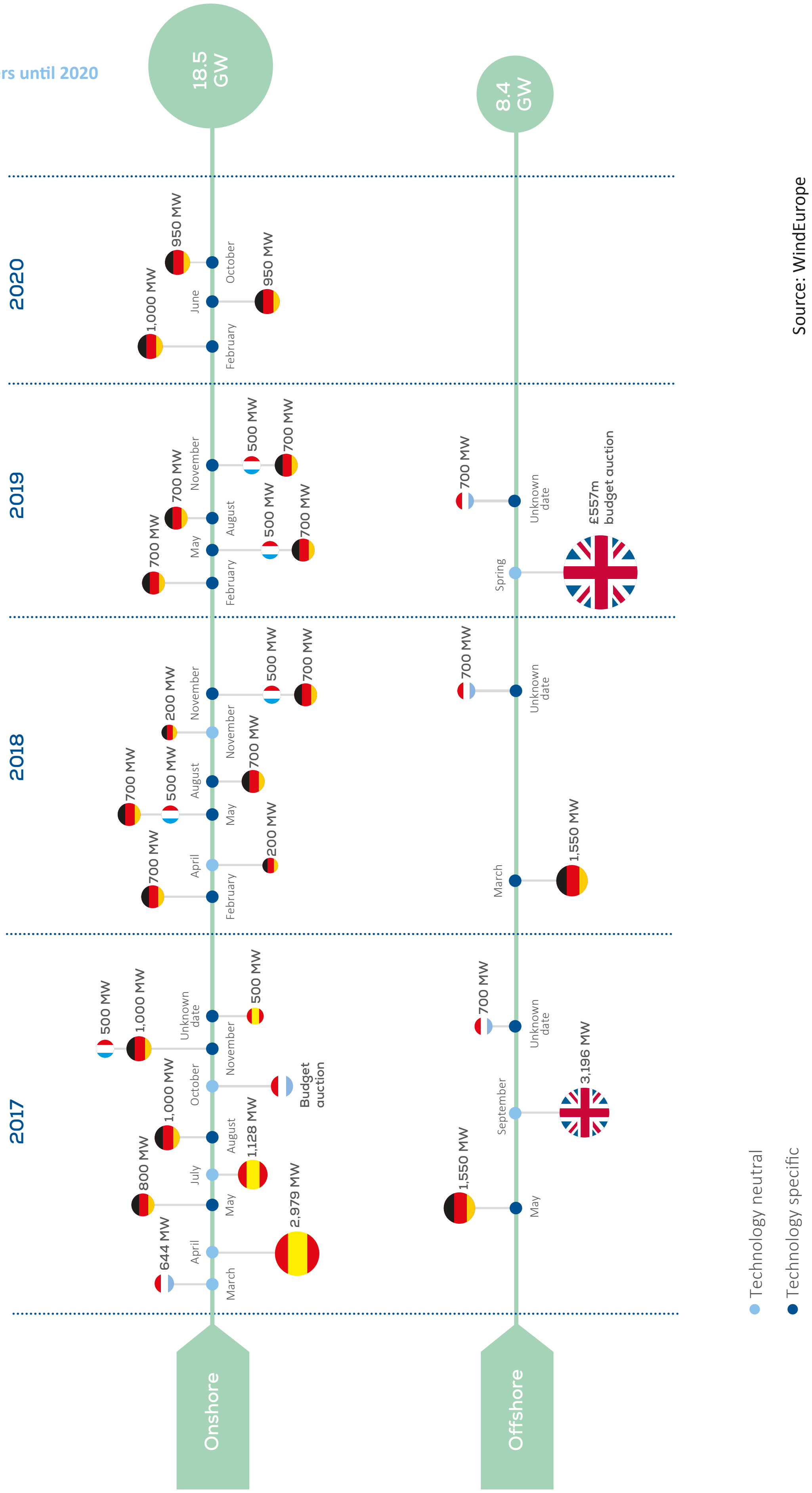
FIGURE 6
Cumulative installed capacity to 2030



Source: WindEurope

Auctions are taking over in Europe. Until 2017 less than 10 GW were allocated to onshore wind via competitive auctions, mainly in the UK, the Netherlands, Italy and Portugal. Between 2017 and 2020, more than 25 GW of renewable energy projects, including wind power projects, are set in the plans of five countries. Most of this capacity is expected to be auctioned in 2017.

FIGURE 7
Announced tenders until 2020



Box 1: Allocation of support and support schemes

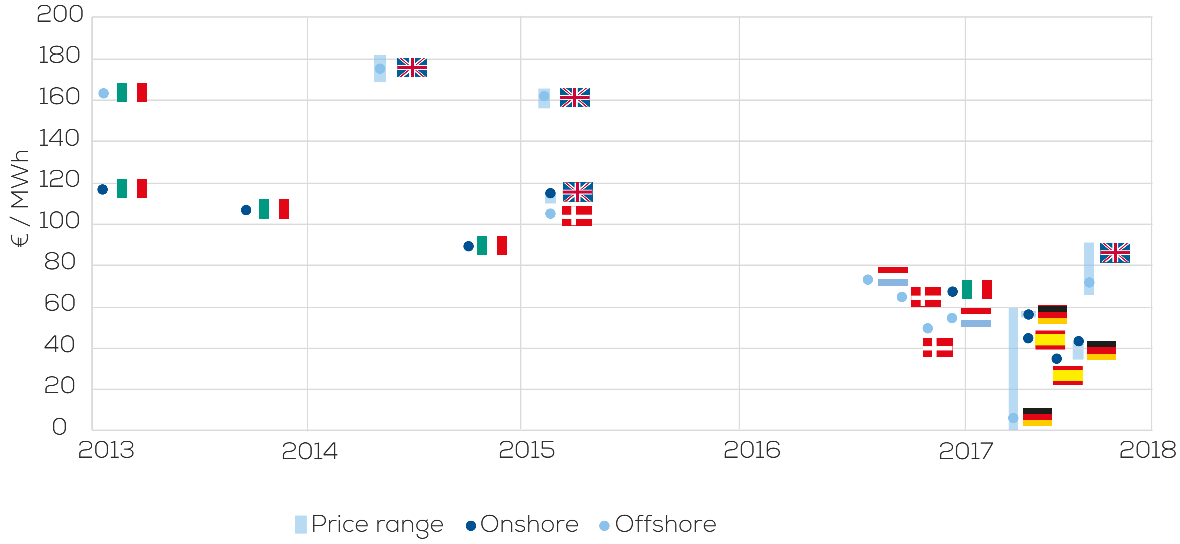
In the past, most European countries used to allocate support schemes administratively without any competition between the different wind energy projects. Since 2016, they have started to allocate more and more support schemes through auctions in order to support only the most competitive projects and reach the most competitive price. The following support schemes can be allocated to wind power producers:

Support	Short description	Related exposure to power markets
Feed-in tariff	Tariff for every MWh produced over a given period. Assessment is done for systems where the price is set administratively in advance or as a result of an auction.	No exposure
Feed-in premium	Premium on top of the market price for every MWh produced over the given period. Assessed with or without price caps and floors (maximum / minimum level for the overall price resulting from adding up market price and premium), and for where the price is set administratively in advance or as a result of an auction.	Partial exposure
Green certificates	Electricity suppliers and big industrial power producers would be obliged either to produce themselves a certain volume of green energy, or to buy a certain quota of green certificates on top of the power market price. Green certificates are traded on a separate market. Power producers are therefore exposed to both the fluctuations of the power and the green certificate market prices.	Full exposure

The evolution of tender results for wind energy in Europe has recently shown drastic cost reductions. However, comparing results is complex, owing to the wide range of tender designs. For instance, the price can be guaranteed for 10 or 20 years, or for a fixed number of full-load hours (e.g. Denmark). In some cases, producers need to reimburse the government if wholesale market prices are above the guaranteed strike price (e.g. contracts for difference in the UK). In other cases, governments provide support to the investment (instead of operational support) by calculating it as a discount of the initial investment to ensure a fixed internal rate of return (e.g. Spain). Some of the tenders are based on pay-as-clear allocation (all producers receive the same amount, resulting from the highest awarded bidder), while others are based on pay-as-bid (e.g. offshore tender in Germany with large spread between the winners).

FIGURE 8

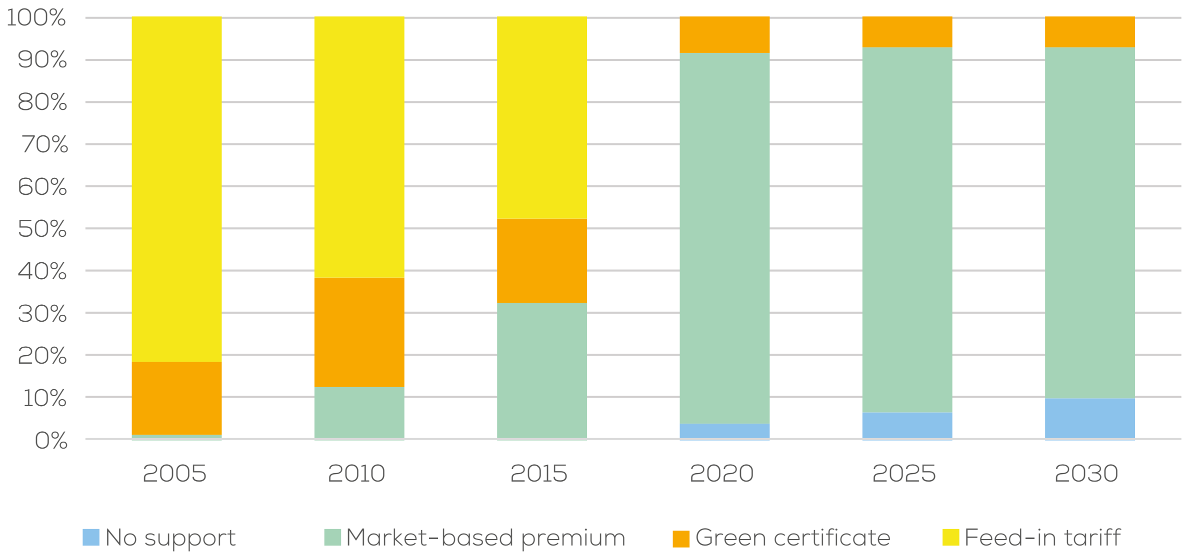
Results of wind energy tenders 2013-2017.
Transmission connection costs are only included in UK offshore projects. Price range refers to tenders with pay-as bid prices or several tenders happening on the same date.



Source: WindEurope

FIGURE 9

Share of new wind capacity per type of support



Source: WindEurope

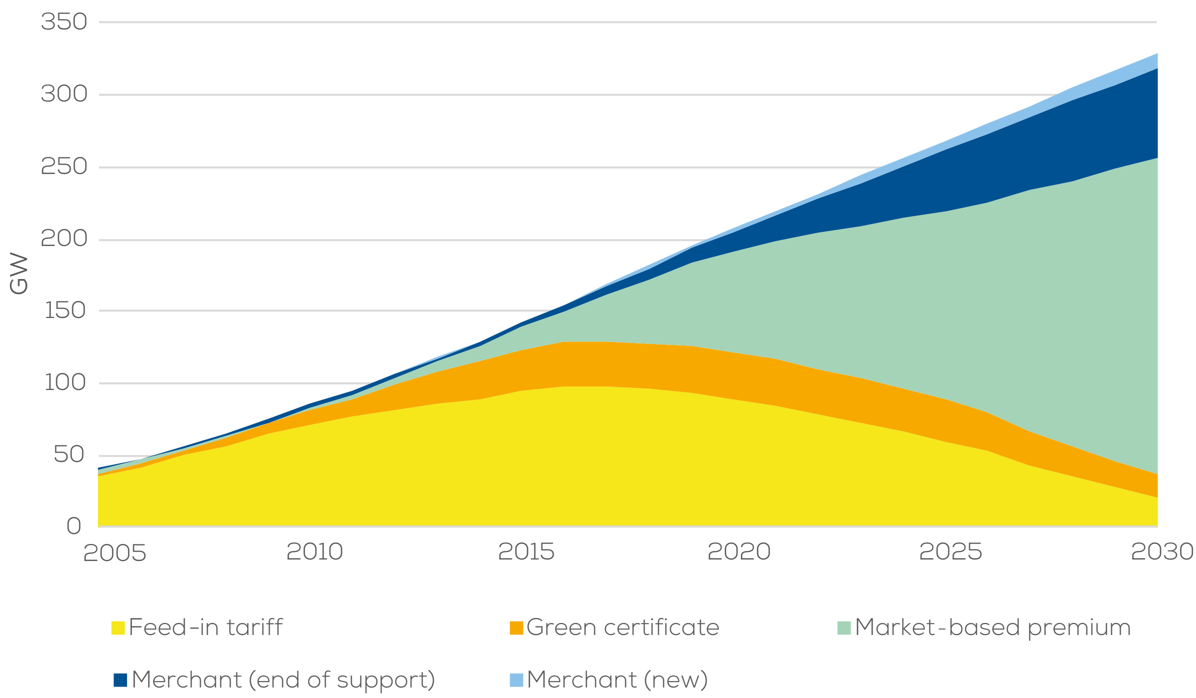
Since 2016, the vast majority of the new installations have already been partially exposed to power market risks, mostly through feed-in premiums. This is due to the adoption of new state aid guidelines on public support for renewable energy that stipulate that feed-in premiums should replace feed-in tariffs in 2014.

This shift will entail a massive increase in the overall exposure to power markets of the European installed wind fleet. In 2030, only a mere 6% of European wind capacity will be supported by feed-in tariffs down from almost 65% today. The wind parks running on feed-in premiums and CfDs will represent the vast majority of assets with almost 230 GW or 67% of the total European capacity. This capacity will be partially exposed to the market.

As administrative tariffs generally run for a period of 15-20 years, most installations erected in 2000-2010 will see their support expire in the period 2020-2030, leaving them with no support a couple of years before their retire. In addition, we expect more and more new capacity to be grid-connected without any support (10% of new capacity by 2030). Green certificates should be used less and less as Poland and the UK are abandoning this type of support for new generation. The total installed capacity still benefitting from green certificates could drop to 16 GW by 2030, from more than 31 GW today.

In 2030 all this fully market-exposed wind capacity could represent 90 GW, most of it being old projects for which the support expired.

FIGURE 10
Type of support used on the total cumulative EU wind capacity to 2030



Source: WindEurope

By 2030, fully merchant wind power plants receiving no support from governments could generate 155 TWh of annual wind power production. This volume corresponds to the annual electricity demand of a country such as Poland.

3.

WIND PROJECT FINANCING

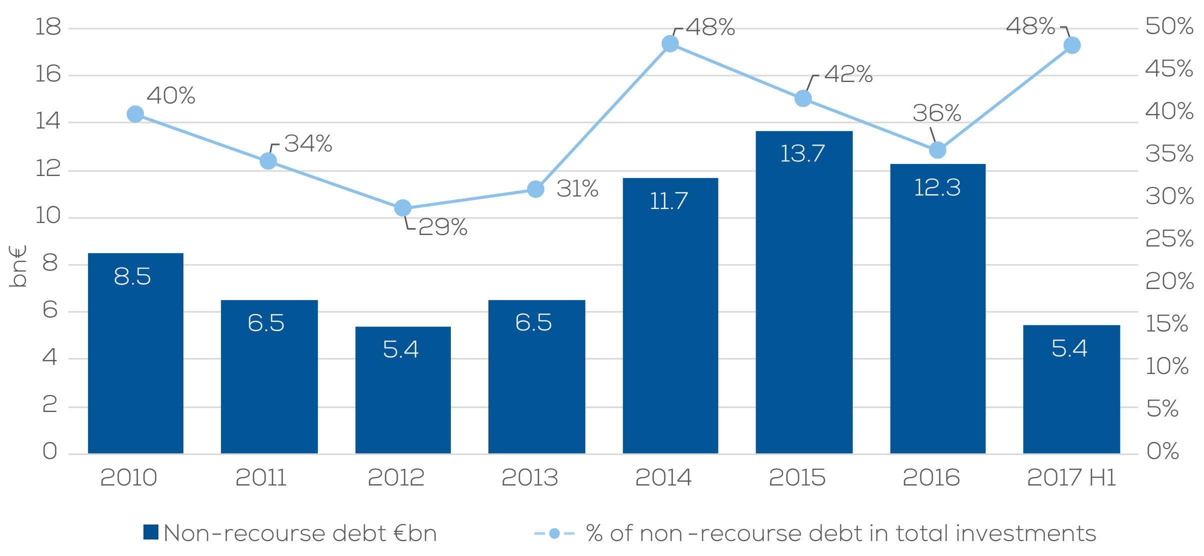
Investments in wind energy depend on policies as well as on the availability of finance. Most wind power projects are financed either on-balance-sheet (corporate finance) or through a mix of debt and equity raised at project level (project finance).

3.1 DEBT MARKETS

Emerging new business and ownership models have unlocked the potential for long term sources of finance in Europe. As a result, a well-developed market exists to provide project debt, and banks – particularly European and Japanese banks – have funded a large part of the growth of the wind industry.

FIGURE 11

Non-recourse debt within asset financing 2010 – 2017 H1 (€bn)

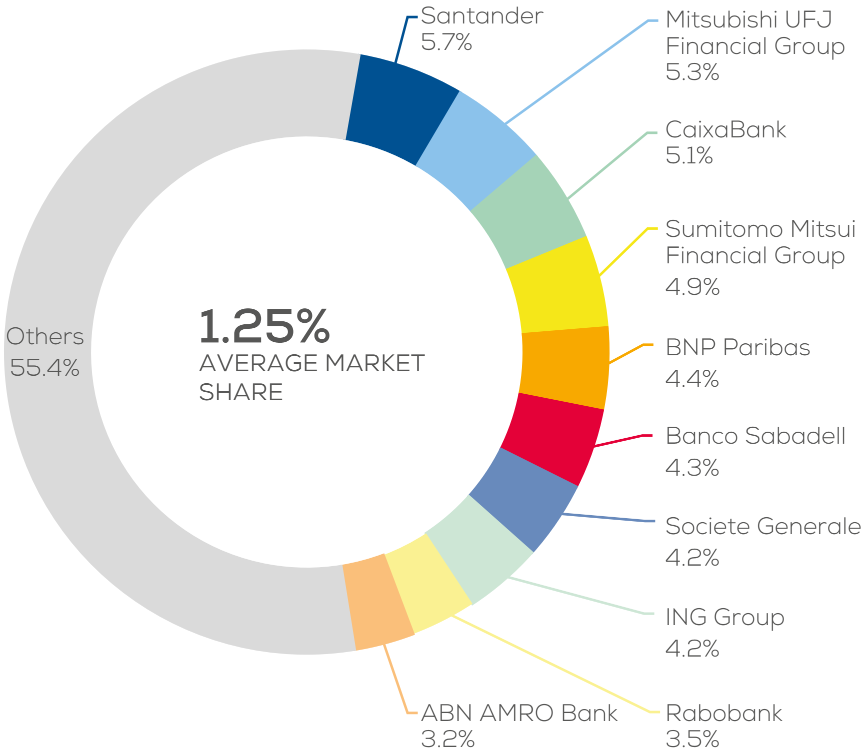


Source: WindEurope

Non-recourse financing, or project debt, has increased over time. During the first half of 2017, non-recourse financing provided 48% of the capital investment needed in the market for the construction of new wind farms and the refinancing of existing ones. Over the years, the trend for larger scale projects – offshore wind in particular - has created a dynamic project finance market. Sector maturity and decades of experience have also made it easier to raise attractive financing on a non-recourse basis.

Non-recourse finance has traditionally been the predominant model for onshore wind, leveraging on average 70% of the capital expenditure requirements. In the recent years, offshore wind has also witnessed a growing demand for off-balance sheet, non-recourse financing. However, given the large scale of offshore wind projects and the billion-euro investment requirements, non-recourse financing has provided on average between 35% and 45% of the Capex.

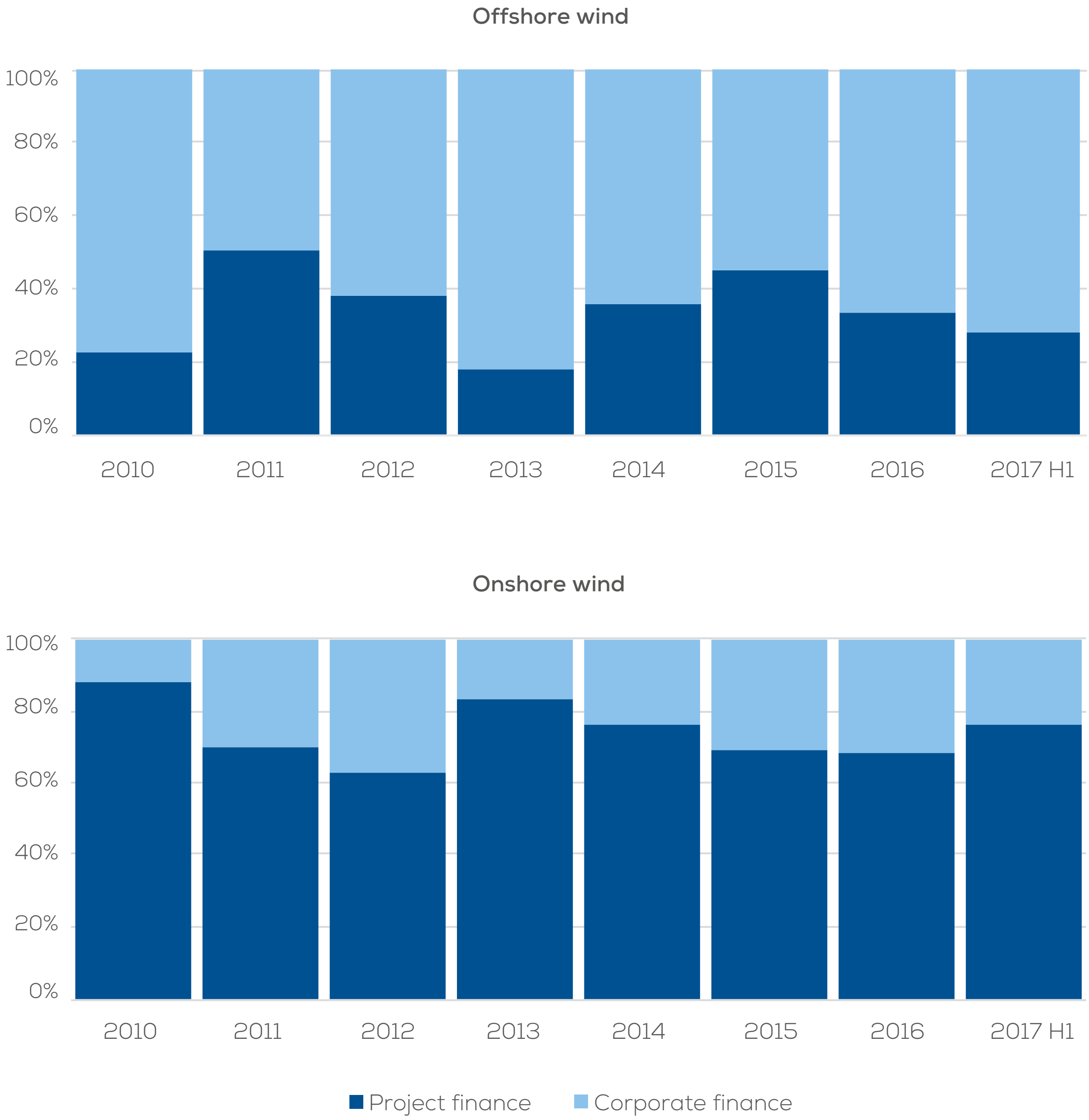
FIGURE 12
Market share of commercial banks active in wind energy financing in 2017



Source: WindEurope

Alongside traditional debt and project finance debt, a wind power project may also seek mezzanine finance to feel in the financing gap that results from insufficient debt and equity. Mezzanine finance has been amply available in wind project financing, not only from banks but also from institutional investors. As the name implies, mezzanine type of lending sits between senior bank debt and the equity ownership of a project. Such arrangements are good for some projects as they take on more risk than traditional debt. Mezzanine loans are usually shorter in duration. They have variable payments that fluctuate with the output and therefore place the wind variability risk onto the debt finance provider. However, they come at an extra cost and are usually more expensive for the borrower.

FIGURE 13
Share of non-recourse debt in new investments

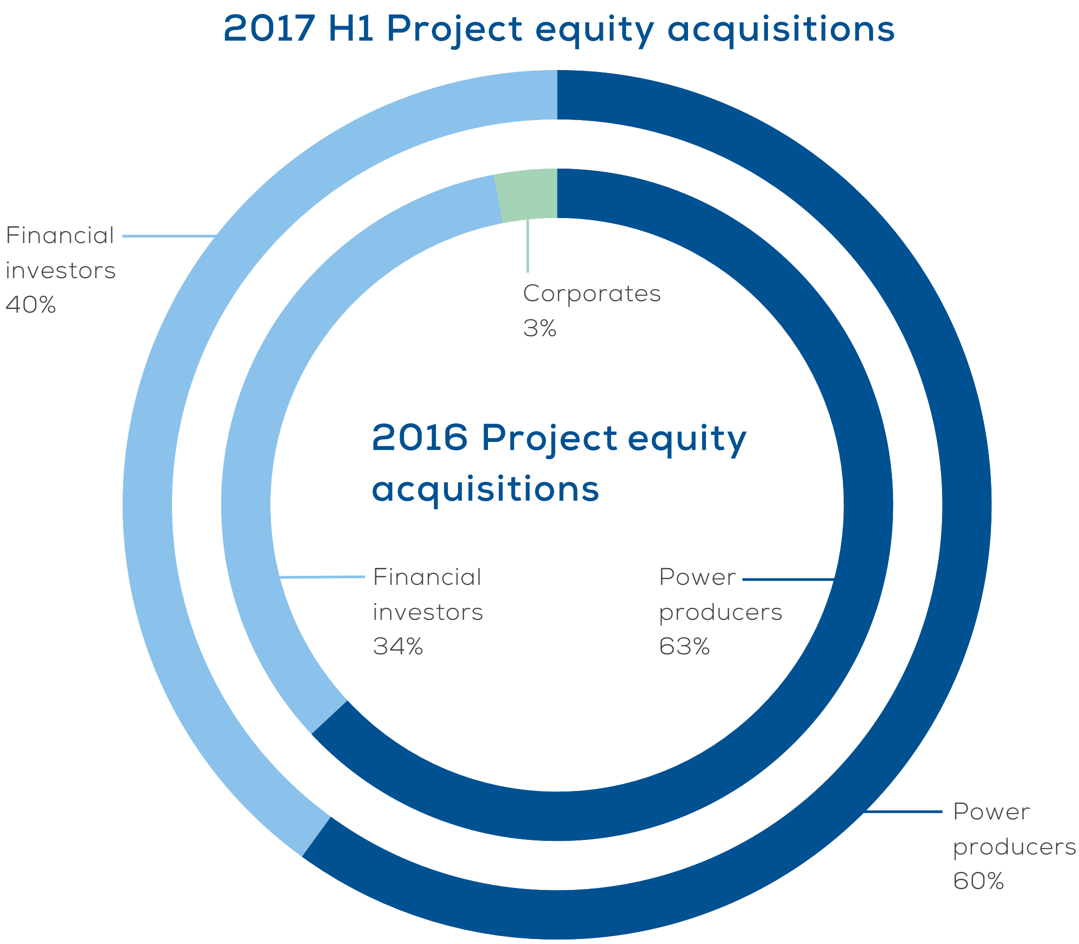


Source: WindEurope

3.2 EQUITY MARKETS

Power producers have traditionally provided the major equity requirements in the sector. However, the equity mix continues to bring in more corporate, financial and in particular for offshore wind, overseas investors. Financial investors, such as pension, insurance, infrastructure and private equity funds, are gradually increasing their participation in both onshore and offshore wind markets.

FIGURE 14
Market segmentation of major equity investors in wind energy in 2016 and 2017 H1



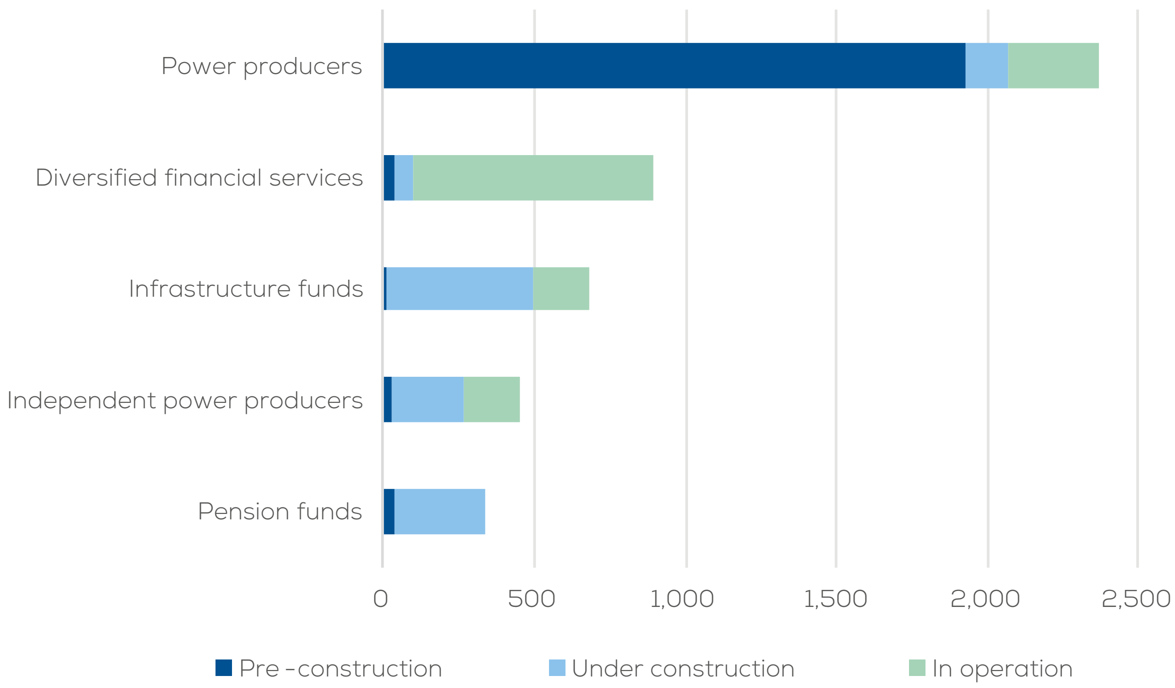
Source: WindEurope

During the first half of 2017, financial investors acquired 40% of the project ownership divested during the period, up from 36% at the end of 2016. Within the financial investors, institutional investors have a substantial exposure to onshore wind. On average, this equals to a quarter of the yearly project acquisition activity.

One recent development has been an uptake in project equity from corporate players. Sustainability agendas as well as economic reasons are the main drivers for this trend. Two main segmentations have emerged over the years in onshore and offshore wind respectively. The different asset scale and risk profile of the two technologies have attracted different types of corporates. Japanese trading houses and major industrial retailers looking for infrastructure investments as an asset class are more present in offshore wind projects. Other corporates looking for clean energy to power their facilities will most likely invest in onshore wind farms, with location and cost competitiveness as the main drivers.

Fundraising remains critical, in particular through the development phase where capital from the developer is the main source of equity. Institutional investors are increasingly getting comfortable with construction risk. While very heterogeneous in their risk profiles, most institutional investors adopt long term investment strategies, where they buy assets to hold them through operations phase.

FIGURE 15
Market entry stage of equity investors in 2017 H1



Source: WindEurope

4. GENERATING ELECTRICITY WITH WIND

Wind energy offers many advantages, which explains why it is one of the fastest-growing energy sources in the world. Wind is free and abundant. Contrary to dispatchable generation (nuclear, biomass, coal, gas and fuel oil), it has no marginal cost. This puts wind energy as a must-run source of generation in the power mix, except when curtailment measures are taken.

Therefore, wind asset owners face challenges related to the nature of the resource and need to cope with its variability.

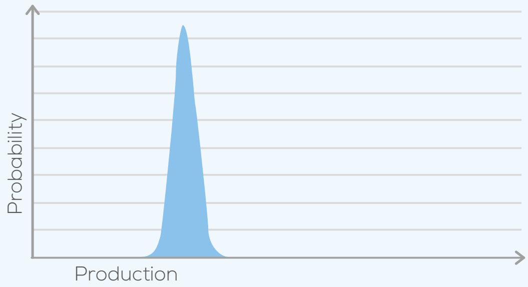
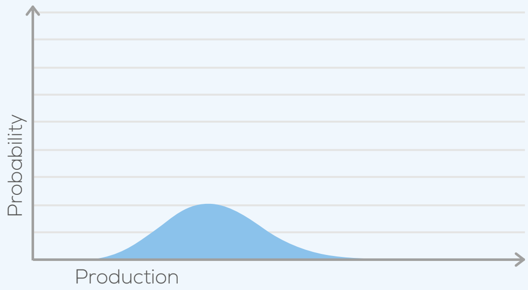
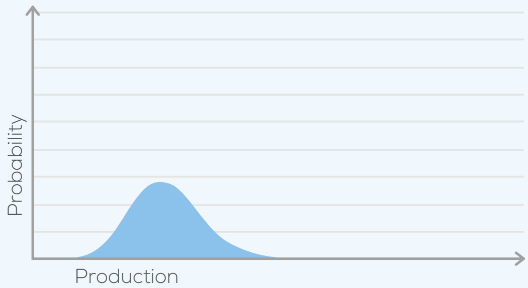
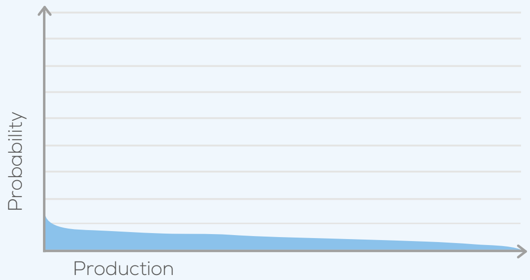
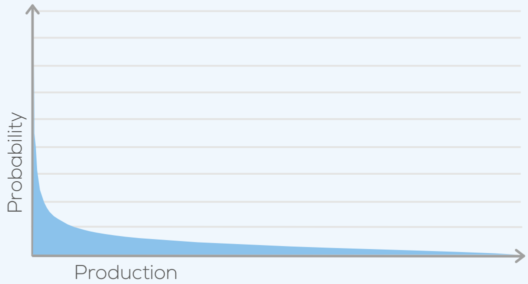
The following analysis focuses on three wind farms based in different locations and measures the variability of wind energy production and its patterns.

The impact of this variability is then illustrated on the cash model of a German wind farm. Here are the main findings:

- Wind asset owners need to cope with +/-10% variation of their annual wind power production.
- Due to the seasonality of wind, asset owners can expect 30-45% more power during winter than during summer.
- Uncertainty on volume is higher in winter than in summer, with variance almost doubling in winter months compared to summer months.
- Daily generation is very uncertain. It usually varies between 0% and 100% of the total possible output of the plant.

FIGURE 16

Summary of the main statistics of the capacity factors of the analysed wind farms

	Average	P90	P10	Standard deviation	Probability distribution on power production
Annual	31.2%	28.2%	34.2%	2.3%	
Winter month	36.9%	24.7%	49.7%	9.7%	
Summer month	27.5%	18.7%	36.9%	7.1%	
Winter day	37.3%	4.9%	77.1%	26.5%	
Summer day	27%	1.2%	66.6%	25.1%	

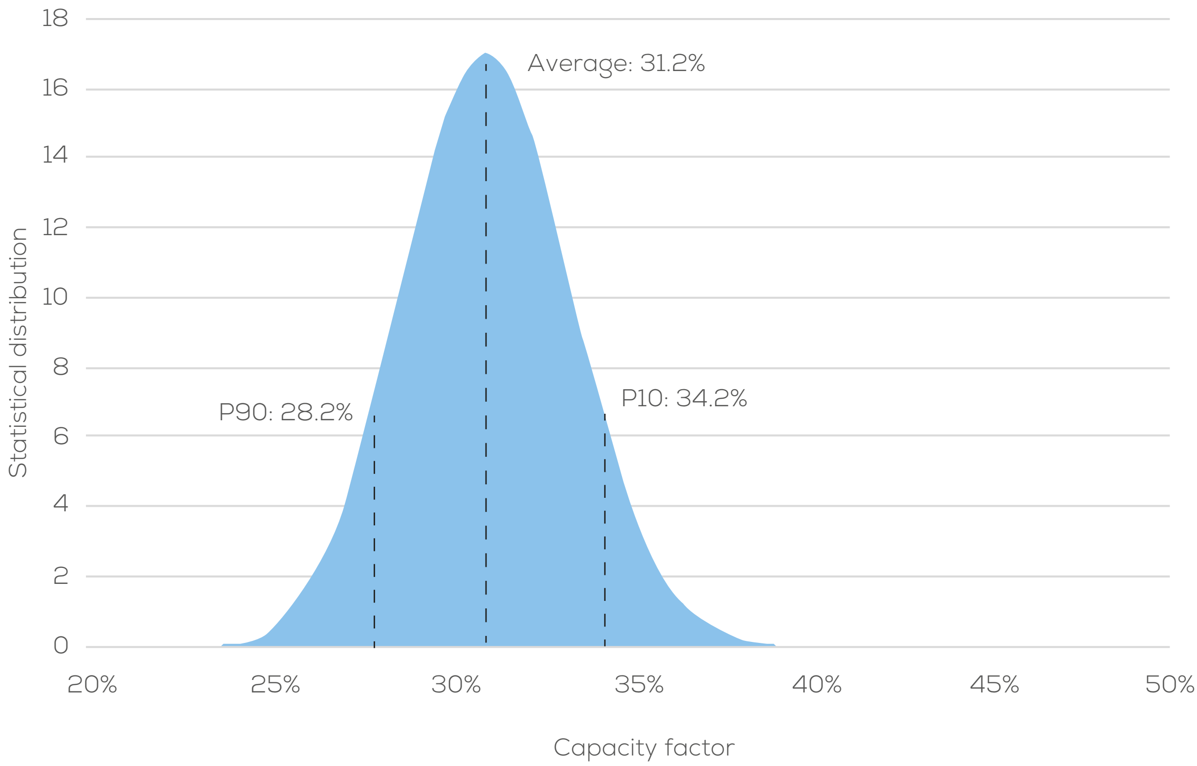
4.1 ANNUAL PRODUCTION

The first risk wind asset owners need to cope with is the variability of weather patterns year-on-year; this is key to forecast potential annual incomes. The evolution of power production on the analysed data samples shows that the annual changes in weather have a strong impact on power generation.

The risk that a wind asset sees a below average power production is similar to the potential to observe a higher power production. On the samples observed the average annual capacity factor of 31.2% could decrease to less than 28.2% in 10% of the cases (P90) but it could also be improved to over 34.2% in 10% of the cases (P10).

FIGURE 17

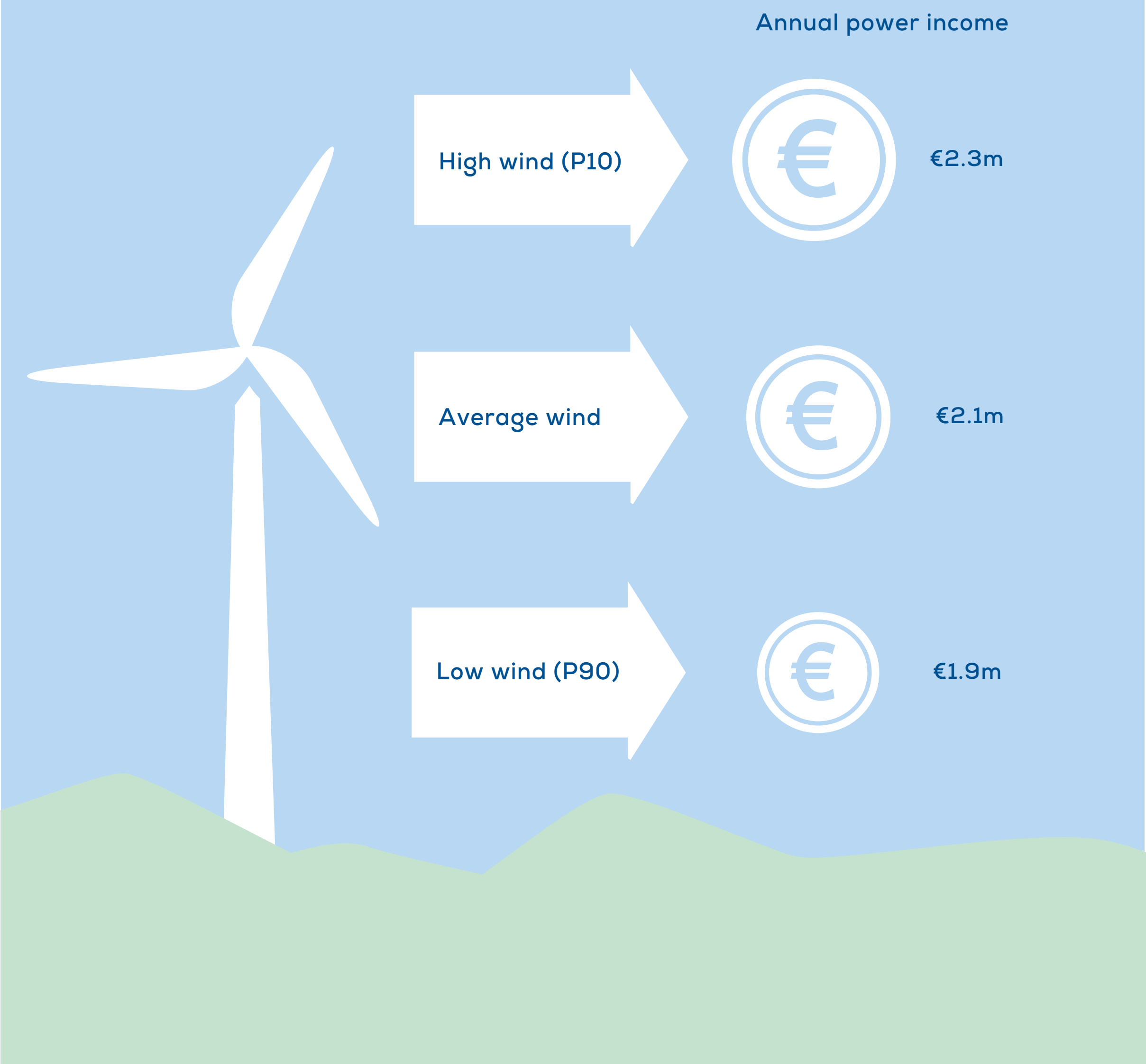
Aggregated statistical distribution of annual wind capacity factors in the samples



Source: WindEurope

Case study: Annual revenue risk of a 6 turbines wind farm in Germany

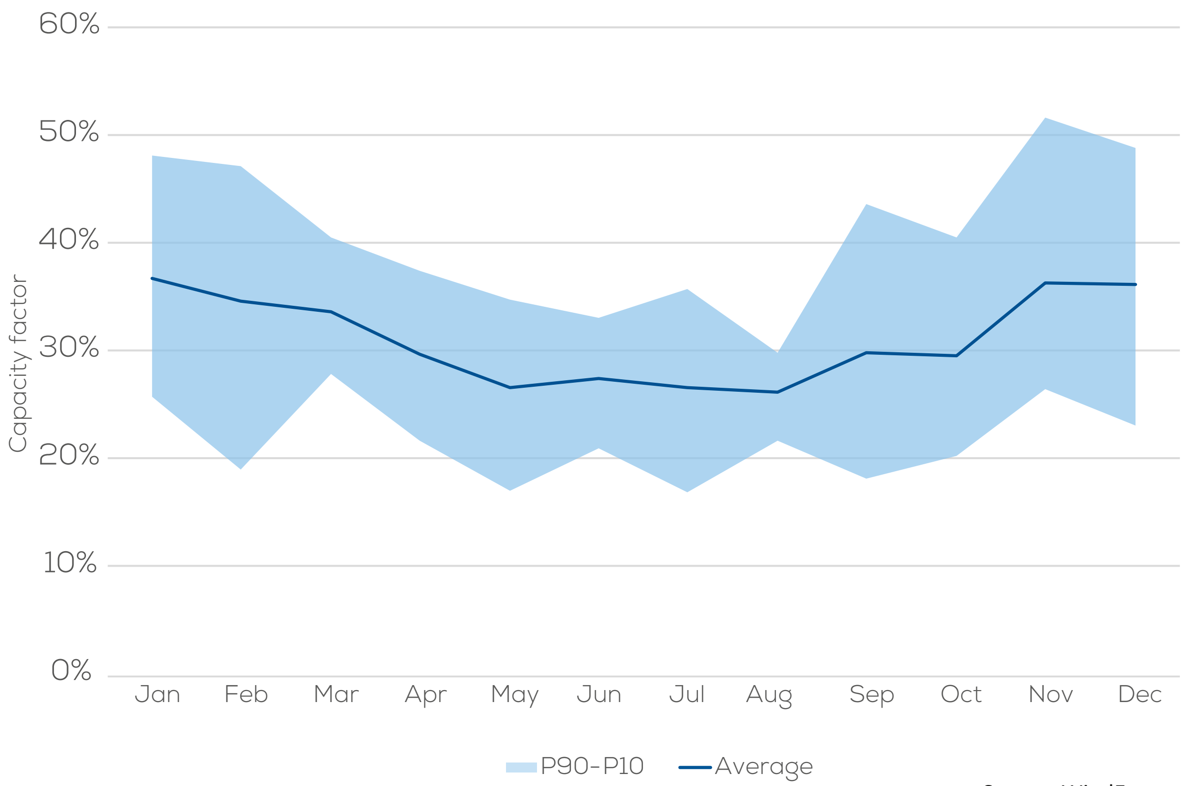
In August 2017, the 800 MW German onshore wind auction led to a strike price of 42.8 €/MWh. An asset owner of a typical 6 turbines wind farm of 18 MW remunerated with this support mechanism would generate electricity for €2.1m on average. The asset owner also need to cope with potential variations to average of +/-10%:



4.2 SEASONALITY AND MONTHLY PRODUCTION

Wind also follows seasonal patterns that are repeated every year. Winters usually provides strong winds to generate more power than summers, which often lead to lower wind power generation. Wind power asset owners can expect their power generation to increase by 15-20% during winter months and to decrease by 13-17% during summer months compared to their annual average.

FIGURE 18
Capacity factor seasonality observed in the samples

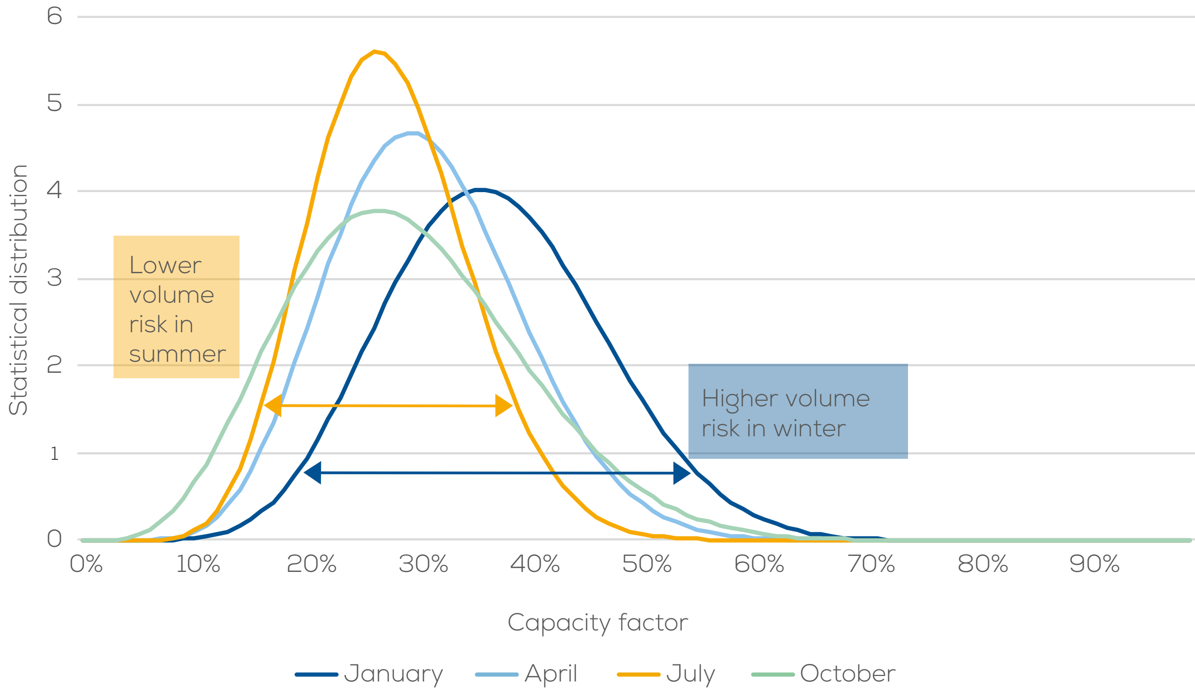


Source: WindEurope

Although winter months usually enable higher generation for wind farms, power output is more uncertain. Consequently, wind power asset owners need to prepare for higher revenues but also higher volume risks during winter. In the worst 10% years, power generation in December is lower than in an average July.

FIGURE 19

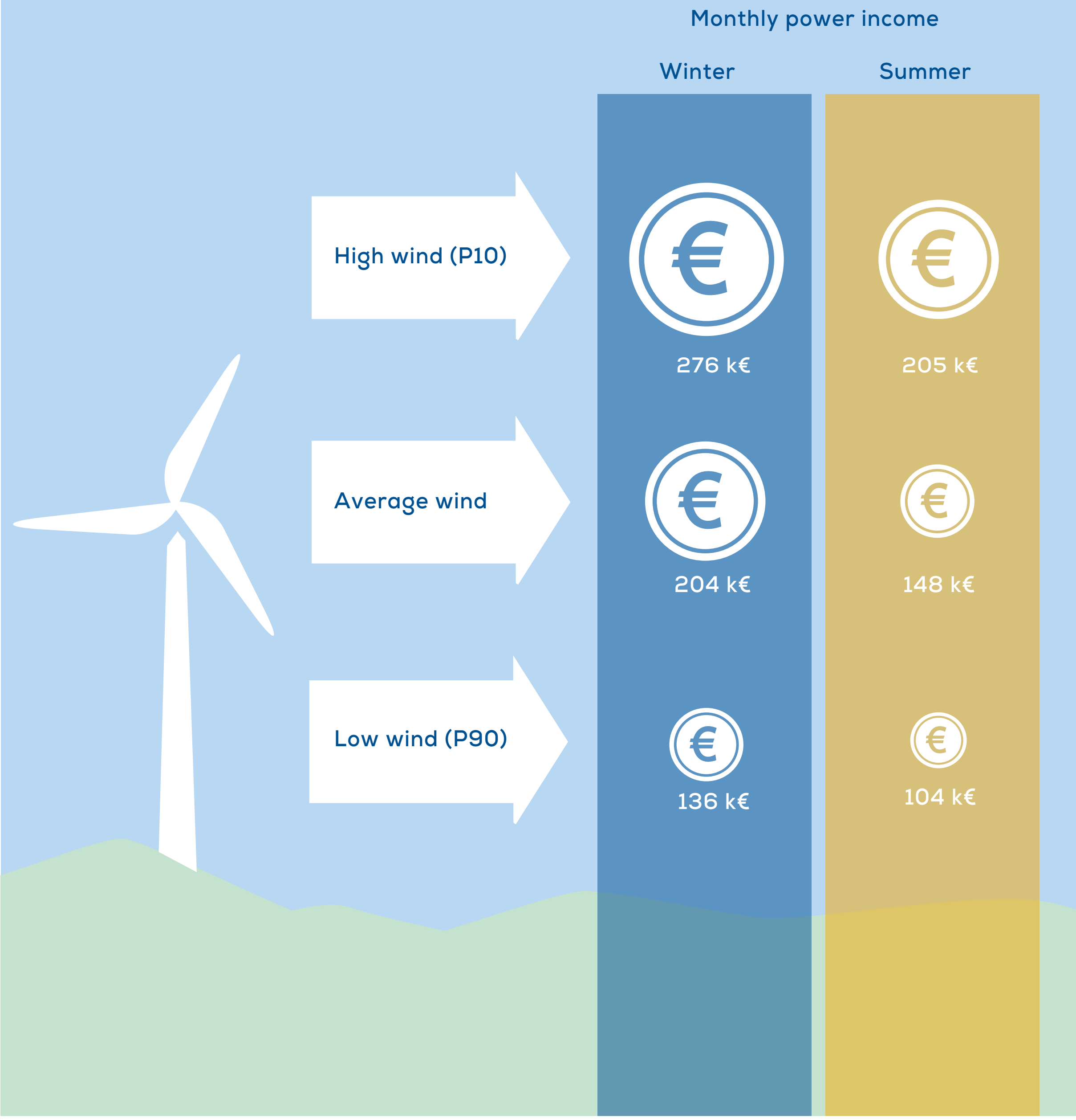
Aggregated statistical distribution of monthly wind capacity factors in the samples



Source: WindEurope

Case study: Monthly revenue risk of a 6 turbines wind farm in Germany in winter and in summer

A typical 6 turbines wind farm of 18 MW remunerated at 42.8€/MWh would generate more money in winter (€204,000 per month) than in summer (€148m per month). It would however need to cope with higher uncertainty in winter (+€72,000 with high winds or -€68,000 with low winds) than in summer (+€57,000 with high winds and -€44,000 with low winds). Therefore, the asset owner would earn a similar amount of money in an average winter month as what it would earn in a very windy summer month.

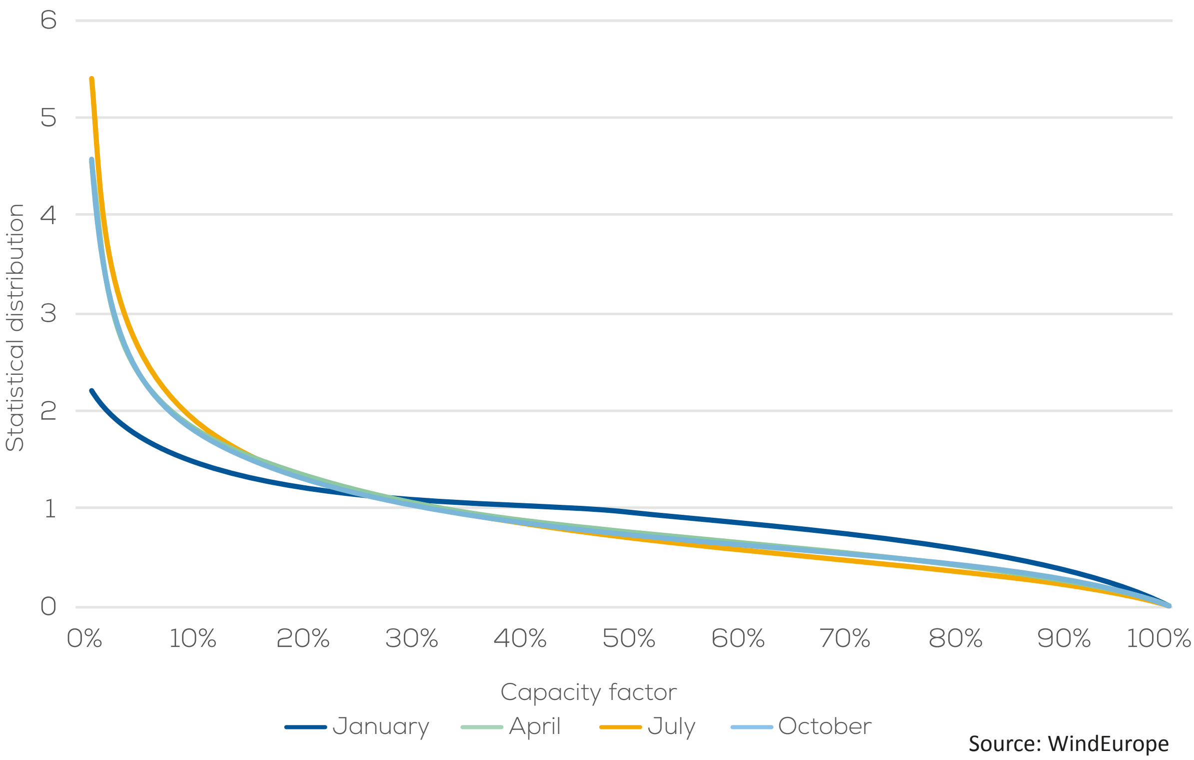


4.3 DAILY PRODUCTION

On a daily basis, wind power generation is even more volatile-daily averaged capacity factors can vary between 0% and 100%. As with the monthly production, the volume risk is more important during winters when average power production is higher than during summers when average power production is lower.

FIGURE 20

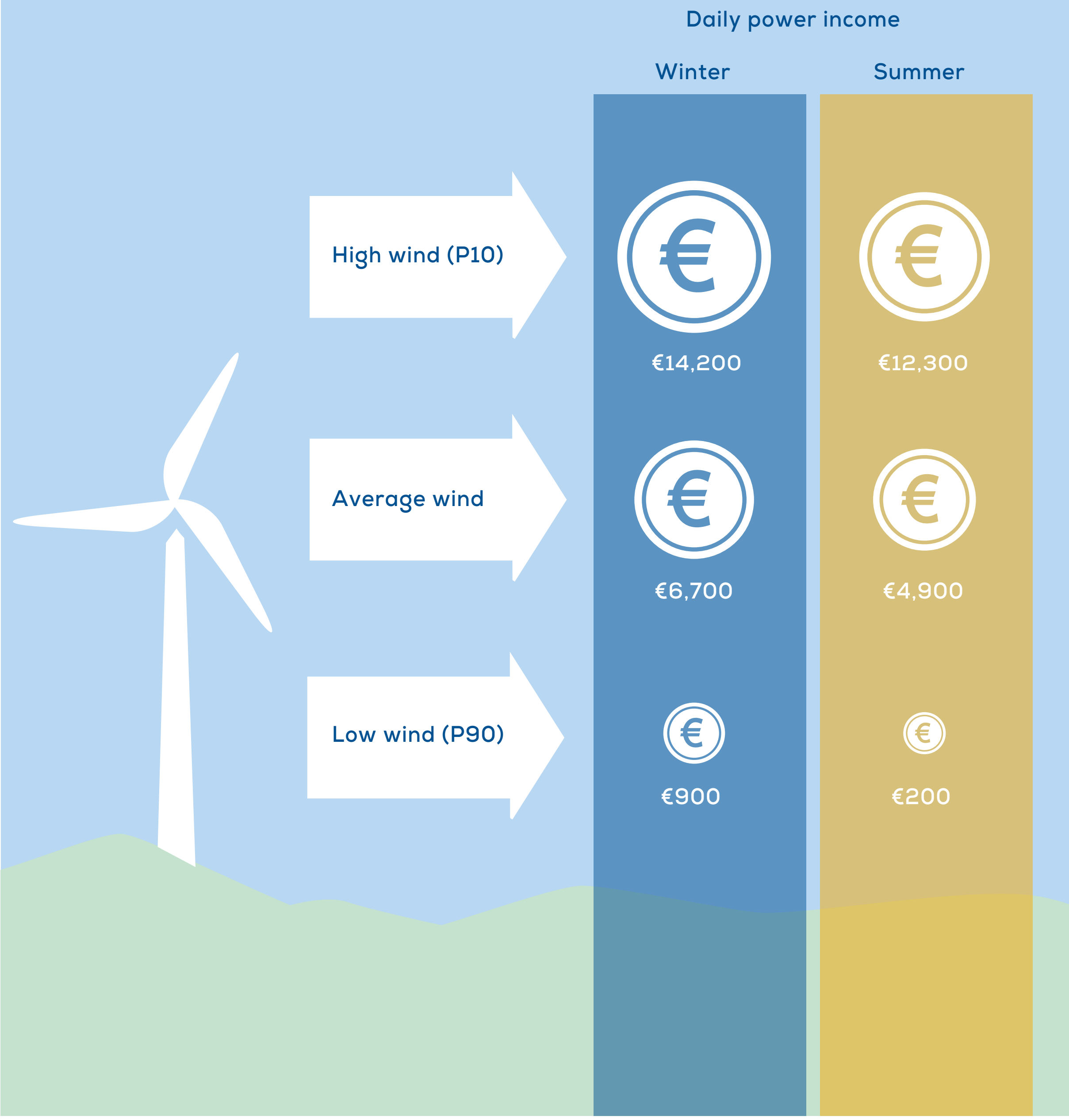
Aggregated statistical distribution of daily wind capacity factors in the samples



Source: WindEurope

Case study: Daily revenue risk of a 6 turbines wind farm in Germany in winter and in summer

A typical 6 turbines wind farm of 18 MW remunerated at 42.8€/MWh would need to cope with the high uncertainty regarding monthly incomes in summer (-87% to +110% of average) and winter (-96% to 150% of average).



5. HEDGING WIND CAN CREATE VALUE

Hedging in energy markets refers to the use of financial products to manage risk in commodities. While the rationale for hedging varies between companies and sectors - based on their risk profile, objectives, and risk appetite - the benefits of hedging can take several forms[1].

Box 2: Defining volume risk in the long and short term[2]

To define volume risk in the short and long term, there are three elements that need to be considered. The first one is under-production related to resource risk. For wind power plants, this is driven by the availability of wind as well as its daily, monthly or seasonal variability as described in Chapter 4.

The second element of volume risk is the short-term demand for power. This refers to the power demanded around the clock, the power used to meet an expected increase in demand, as well as the power used to meet unexpected demand peaks. Priority dispatch has so far applied on wind power projects. But, priority dispatch will come to an end under the revised Renewable Energy Directive.

At any point in time in this short-term frame, wind power projects can also be subject to curtailment for a number of reasons. These depend on regional and local market characteristics and include local congestion, oversupply, and operational issues.

The third element of volume risk relates to long term demand for electricity due to demographic changes and shift in consumer patterns.

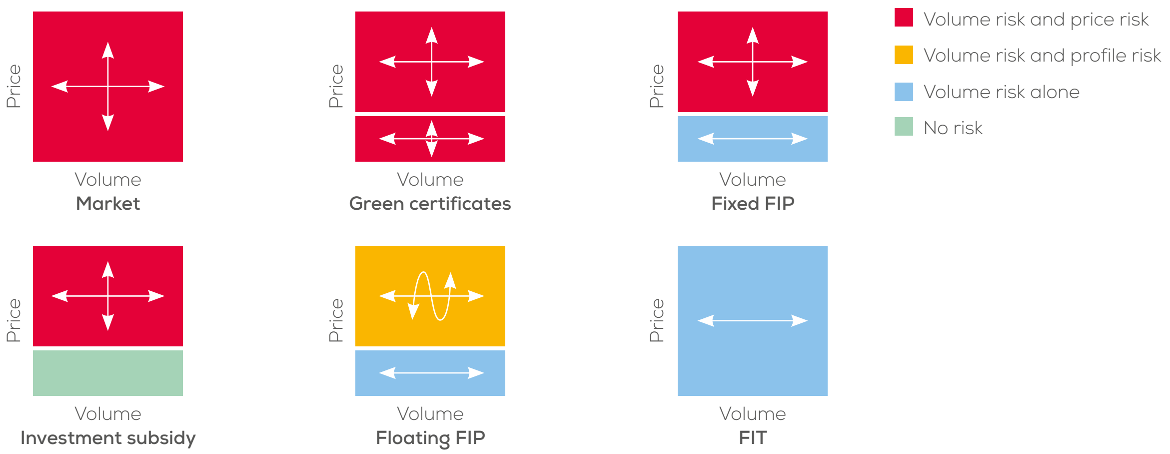
1. Kovacevic, Pflug, Vespuci (2013)
2. Idem

5.1 WHY THERE IS A NEED FOR HEDGING

Risks related to price and volume of sales are increasingly becoming a concern for wind asset owners due to the transition towards market based mechanism for allocating renewable energy support. Different support schemes will result in different risk implications for investors[3].

Figure 21 shows the risks – and therefore the volatility of revenues – for each support scheme of the power plant. The squares represent the revenues as the product of a volume of sales and a unit price and are split when the project has several different sources of revenues (e.g. the market plus a premium). The arrows represent the dimension about which the project developer has uncertainty.

FIGURE 21
Type of risks supported by investors according to the type of support scheme[4]



Source: WindEurope based on Market4RES project

Power purchase agreements, auctions and feed-in-premiums take away some of the price risk. But they still leave the projects exposed to a certain degree of volume risk, due to the uncertainty in the total amount and timing of wind output. Therefore, there is a risk that a project's cash flows will differ from expectations as a result. This risk is even higher for those projects that will not win the auctions and, if not cancelled, will eventually have to operate on a merchant basis.

As revenues become more volatile, wind energy producers will need to engage in hedging and structural enhancement to mitigate these risks. Several products exist in the derivative power market that allow the trading of energy in advance to reduce exposure to volume risk, price risk, or a simultaneous hedging of both. However, there are liquidity weaknesses in the power market compared to other commodities.

Reserve accounts have been used in wind energy financing to reduce exposure to merchant risk. The level of funding of the reserve is indexed to spot prices. If spot prices decrease below certain thresholds, then funding of the reserve from the project cash flows is required.

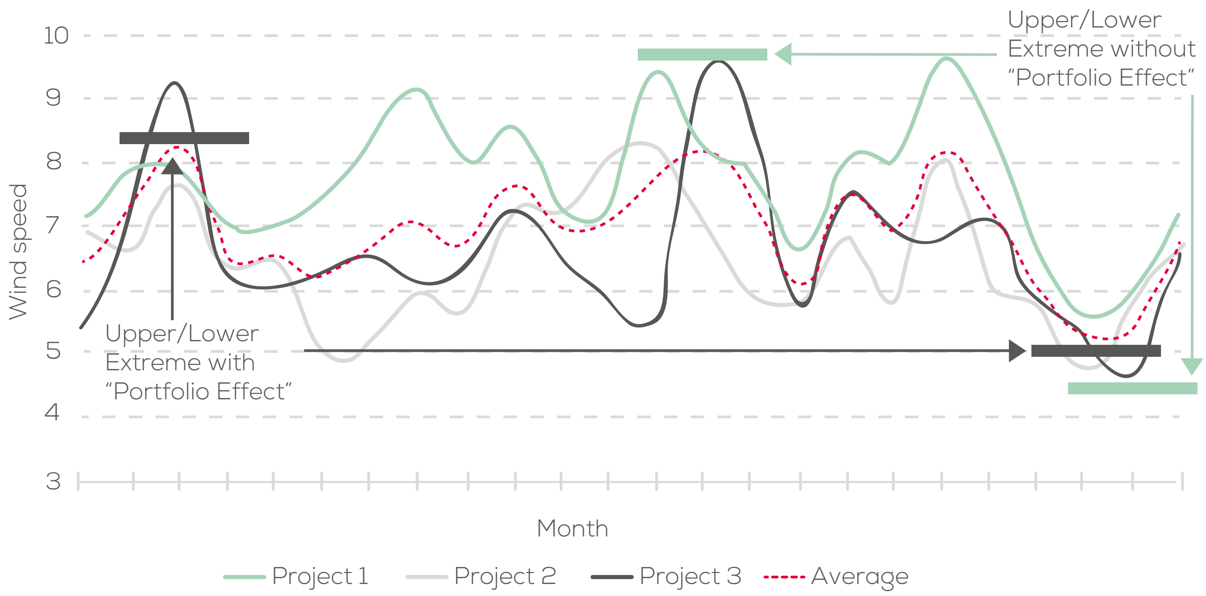
Bigger wind energy producers benefit also from the portfolio effect, whereby a portfolio of assets supports a larger debt amount than if each project was financed individually. Combining wind energy assets across different regions allows for the balancing of extreme wind conditions and low wind output. The hedging therefore, happens within the portfolio[5].

3. Market4Res project (2016): http://market4res.eu/
4. Idem
5. Credit Agricole (2016)

However, portfolio financing is not always possible. First, because the ownership of wind power assets is becoming more diverse. Risk averse investors, finance houses and corporates whose main business is not wind are increasing their participation share in the wind energy equity mix. Second, because the ownership of wind power assets is becoming more fragmented with smaller entities taking control of projects.

In 2017, 96% of the awarded capacity in the first onshore wind auction completed in Germany resulted in community based projects. In total, 807 MW were awarded across 70 projects. That brings the average project size in the auction at approximately 10 MW. At least half of the installed capacity in Europe today comes from projects smaller than 50 MW, unable to reach economies of scale, smaller projects find it difficult to raise or access low-cost financing, unless aggregated in large portfolios where risk is better diversified.

FIGURE 22
Individual project performance vs. portfolio average



Source: Credit Agricole

TABLE 1
Summary of the most commonly used hedging strategies in commodity markets

	Definition	Benefits	Risks
Futures	A legally binding agreement for delivery of power in the future at an agreed upon price. The contracts are standardised as to quantity, quality, time and place of delivery, with only price as the only flexible variable. The majority of these contracts are traded across multi-country platforms and organised exchanges	They hedge against price and volumetric risk, while offering more financial leverage to a project, i.e higher risk return investment vehicles	There are liquidity weaknesses in the futures market in Europe, with little activity on both demand and supply sides. Only Austria, Germany and the Nordic market experience a higher level of turnover than the rest of Europe[6]
Forward	Similar to future contracts, forward contracts are also a legally binding agreement for the delivery of power in the future at a predetermined price, time, quality and location. Unlike future contracts, forward contracts are mostly traded through brokers and are therefore less standardized than future contracts	They hedge against price and volumetric risk, while offering more financial leverage to a project, i.e higher risk return investment vehicles	Similar to future contracts, there are liquidity weaknesses also with this type of hedging instrument
Swaps	An agreement whereby a buyer and a seller swap their cash flows over a specified period of time. As such, a floating or market price is exchanged for a fixed price, or vice versa	Energy producers utilise swaps to lock in their revenues and cash flows, whereas consumers to lock in their energy costs	Besides the liquidity in electricity market – finding a counterparty willing to swap the risk – these contracts require dynamic monitoring of the hedged portfolio or asset
Spreads	Standard contracts traded in regulated exchanges or through brokers to help an energy producer fix the margins between the costs and the revenues. The possible applications of spreads are clean dark spread (power-coal-CO_2), clean spark spread (power-gas-CO_2) or country spread	It is an effective hedge against falling electricity prices. It allows the energy producer to better control the cash flows by providing the necessary liquidity to cover costs	Exposure to more markets, for instance coal, gas, oil, CO_2 markets
Options	Standardised contracts which provide the buyer of the contract with the right, but not the obligation, to purchase or sell a particular amount of a specific commodity on or before a specific date or period of time	Electricity options provide both producers and consumers with a protection against unfavourable changes in electricity prices	The volume of contracts traded is an issue also with these hedging instruments due to lack of sufficient buyers and sellers in a given timeframe

The most common market instruments used as hedging strategies against electricity price risks are forwards, futures, swaps, spreads and options. The table above summarises some of the common hedging strategies that can be used in commodity markets. The choice of the instrument largely depends on the corporate goals and risk profile[7].

6. Agency for the Cooperation of Energy Regulators (2015)
7. Kovacevic, Pflug, Vespuci (2013)

5.2 WHY HEDGING CREATES VALUE

The optimal hedging product would depend on the exposure as well as the risk profile and the risk appetite of the asset owner. For instance, an asset owner or a project operator may want to be protected against a loss of revenues, or keep the earnings within their projections. Likewise, they may want to make sure that their cash flows are sufficient to cover short-term obligations.

Hedging increases debt capacity

Project debt has leveraged an important part of the capital needed to finance the growth in the wind energy sector. Capital structures in wind project finance are usually based on common equity and senior debt. The leverage in these projects varies between 50-80% debt, but it can go even higher depending on the project specifics and profile of the sponsors. Therefore, the structure of a project needs to ensure that before paying any dividends to shareholders, it will generate enough revenue to pay – first and foremost – its debtholders.

Lenders assess the creditworthiness of a project by making sure that the interest and principal repayments can be covered when cash flows are low. For wind farms, this is driven by low wind. Hence, lenders will make sure that downside scenarios of production, such as would result from wind at levels below P90 or even P95, do not result in default.

Hedging the wind risk will protect the project revenues against these downside scenarios and unlock more debt capacity for a project. In a world where debt costs less than equity, this would translate into a lower cost of capital for the project and higher returns for the shareholders. Moreover, no reserve funds would be needed to cope with merchant exposure in a project finance structure.

For an onshore wind farm of 102 MW that benefits from a wind hedge, total benefits on the Net Present Value (NPV) could accumulate to €4.5m. The hedge is structured as a floor on production struck at P75 wind level. Under this hedging contract, the wind farm receives a fixed cost / MWh of underproduction. As a result of this low wind protection, the project could increase its debt capacity from 65% to 75%, while reducing lending margins by 50 basis points. At the same time, debt service reserves could be lowered to three months from six months.

FIGURE 23
Value of hedging against underproduction in a 102 MW project

Source: Swiss RE

By 2020 WindEurope foresees wind power installed capacity to increase by another 50 GW. By 2030, cumulative wind installations may reach 323 GW, adding an additional 166 GW between now and 2030. Demand for market related risks is also expected to increase as some projects reach the end of support scheme and risk averse investors take more ownership in wind assets. Risk management services such as hedging may extract a value worth €2.5bn for new wind assets installed between 2017 and 2020. This may go up to €7.6bn for new wind power installations between 2017 and 2030.

Hedging enhances risk-adjusted returns

Once the project has secured enough revenue to repay its debt obligations, investors will look to improve their risk adjusted returns. As most of the costs in wind power projects are known and sunk at development through construction phase, the value creation lies in controlling the revenues – which is the basic idea behind a wind hedge. By swapping variable with fixed wind production revenue, the project transfers its operational risks to the swap counterparty. The risk reduction in this case will depend on the cost the power producer has to pay and the hedging counterparty.

In today's market, average expected returns for an onshore wind farm investments are in the range of 7-8%. If the variability of those returns is reduced, the cash flows move closer to the profile of a fixed-income investment, similar to a bond. Bond yields depend on the quality of the counterparty. If the hedge provider is a high-grade counterparty, then the expected yield could be as low as 3-4%.

Wind farm owners can monetise this benefit by selling the hedged asset to a buyer with an appetite for long-term, climate-friendly infrastructure investments but with no familiarity with taking wind risk. Alternatively, they can keep the asset and simply benefit from the portfolio impact of the risk reduction.

Hedging increases revenue yield of producing wind assets

Hedging can also help create some of the liquidity that is missing in the forward electricity markets, notably by firming up the level of production that can be sold at a fixed price in the market. Smaller power producers in particular, are limited in their ability to sell power forward because of the output uncertainty and the time of delivery.

A hedge of this risk would allow the wind producer to get higher return on the wind investment by selling more power in the forward market. The contract would be set to financially guarantee a level of production by compensating the producer for the loss of revenue. It serves as a simultaneous hedge for both price and volume risk. This would depend on the amount of electricity not produced – and therefore the make-up power needed from the spot market – as well as difference between market price and contract price.

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