Energy Brainpool

POWER PURCHASE AGREEMENTS II: MARKET ANALYSIS, PRICING AND HEDGING STRATEGIES

Berlin, 29 January 2019

White paper

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1. INTRODUCTION

Power Purchase Agreements (PPAs) have become a central component of current discussions in the energy industry. PPA principles and an initial assessment of their potential were the core contents of the first Energy Brainpool White Paper on the subject. After an introductory overview of the state of play in Europe, the second part focuses on how PPAs can be integrated into the German energy industry: What opportunities and risks do they have for the operation and expansion of renewable energies? What contractual options exist? How can fair pricing be achieved for buyers and sellers? What hedging strategies do the contracting parties use to manage market risks?

2. MARKET ANALYSIS: CURRENT DATA ON PPAS

2.1. MARKET VOLUME OF PPAS IN EUROPE

In Europe, Power Purchase Agreements (PPAs) have so far played a role primarily in Scandinavia, Great Britain, Spain and the Netherlands, but more recently also increasingly in Italy. **Fehler! Ungültiger Eigenverweis auf Textmarke.** shows that wind power is the main subject of contracts, with the exception of Spain. The majority of these contracts were concluded in 2017 and 2018. Both traditional energy suppliers and large industrial companies acted as buyers. In total, at least 7,300 MW of installed wind capacity (on- and offshore) and over 2,100 MW of installed PV capacity in Europe today are covered by PPAs. In Germany, the capacity secured by PPAs is low by European standards. In the market analysis less than 100 MW of capacity could be found.

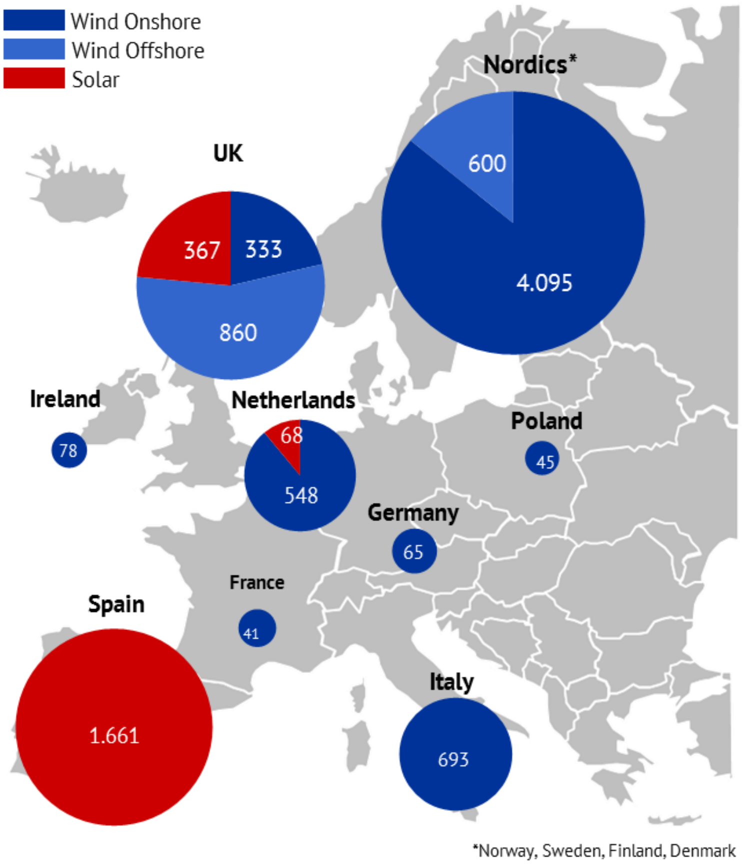

Figure 1: PPA in Europe published in news, state of play end of 2018, accumulated in MW [Source: Presentation based on own research of public sources]

2.2. DISCUSSION OF THE POTENTIAL OF PPAS IN GERMANY

The importance of PPAs as a sales instrument for electricity from renewable energies is currently increasing in Europe. In Germany, a yearly increasing number of wind and PV plants will lose their entitlement to financial EEG promotion from 2021 (subsequently called “Ü21” installations), and long-term electricity supply contracts are the currently expected central sales option. Here is a look at Figure 2: while the cumulative PV generation capacity of these plants will increase to several gigawatts only until the end of the 2020s, it will already grow to more than 16 GW by 2025 for onshore wind plants. The "levelised costs of electricity" (LCOE) of these plants essentially consist of possible investment costs for continued operation and operating costs. From today's perspective, it is possible to hedge the electricity from continued operation for at least three years with future market products. However, the requirements for portfolio management are sometimes complex. Therefore, high demand for wind power PPAs with a fixed price over three to five years is likely in this market segment.

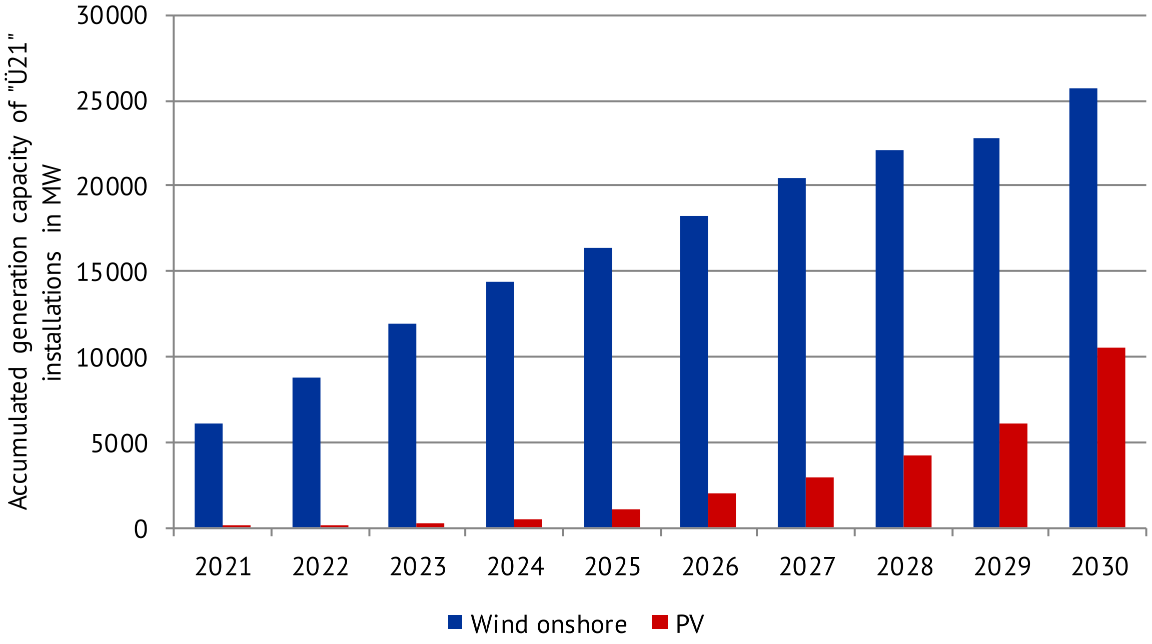

Figure 2: Development of the accumulated generation capacity of “Ü21” installations, wind onshore and PV until 2030 [Source: Own presentation according to the Federal German Ministry of Economics and Technology]

PPAs are also gaining in importance in the medium-term: on the one hand for new plants that do not receive financial support, and on the other hand for existing plants that do not receive financial support. In both variants, the green power characteristic, which has recently risen in price, is retained, as these plants are not subject to the prohibition of multiple sale.

In principle, existing plants would then switch from EEG promotion to other direct marketing if the sales revenues attainable there exceed the EEG remuneration. The surcharge values of previous auctions for the EEG promotion were in some cases already below the sales revenues achievable in a few months. The future sales revenues for the next decade, calculated in current scenarios[1], are expected to also exceed the annual average subsidy amounts. Depending on the future development of electricity prices and the exact surcharge values, up to 600 MW of eligible PV or 2.5 GW of eligible onshore wind energy could be considered for such a switch to long-term electricity supply contracts each year. In the case of offshore wind energy, this potential amounts to 8.5 GW until 2030 after deduction of the capacities already subsidised in the first two tender rounds.

In contrast, new plants that do not claim any subsidy are outside the volume restrictions of the EEG tender system. If the market develops favourably, these could provide for additional expansion.

The prerequisite for demand-driven, additional plant expansion is that the LCOE of these plants fall below their sales revenues. It should be noted here that in renewable energy projects a large part of the capital costs is incurred at the start of the project and the change in the risk position is highly relevant for the capital costs. To illustrate this, a projection of the possible development of the electricity production costs of wind power in Germany is shown in Figure 3. The focus of this sample calculation is on the cost of capital:

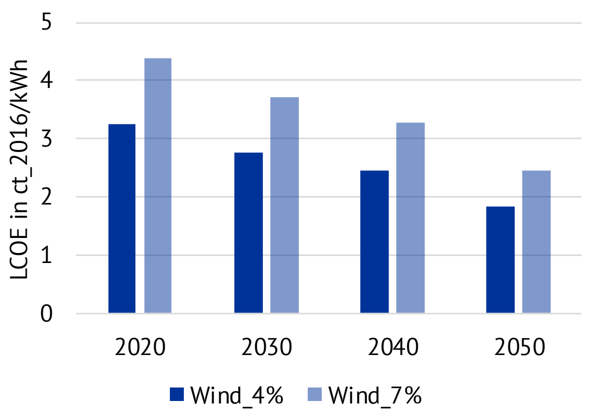

Figure 3: Comparison of the LCOE development with (dark blue) and without EEG promotion (light blue) from 2020 to 2050
(Exemplary assumptions: CAPEX sink from 1.000 to 750 EUR/kW, OPEX 2,5 % of CAPEX)

without the security of the financial EEG promotion (e. g. WACC 4 %), the plants are confronted with additional risks, which entail a higher equity ratio, as well as higher dept capital and thus LCOE (e. g. WACC 7 %). For the year 2020, for example, the LCOE would increase by 1.12 ct/kWh or 34 %. If PPAs are to provide financial security for new plants, the achievable prices must be high enough to take account of this changed cost situation.

2.3. DIGRESSION: PPAS IN THE CONTEXT OF THE ENERGY TRANSITION

How would increased hedging of volatile generation by means of PPAs be assessed in terms of energy policy? Where can PPAs contribute to the success of the energy transition, where can

[1] Cf. Energy Brainpool (2019): EU Energy Outlook 2050

problems arise? What is certain is that in the course of all the discussions about PPAs, the overall societal perspective should not be neglected. Some arguments are therefore discussed below.

PPAs change the security and level of revenue streams from renewable energy plants and thus also affect the cost structure for project planners. This has an influence on the energy transition as a social project:

On the one hand, it has an impact on the diversity of players, as increasing demands on equity and venture capital as well as high creditworthiness put large companies at an advantage over small citizens' energy cooperatives. PPAs are also not used to subsidise specific additional areas such as roof systems or smaller systems on a system-specific basis. Here, large projects have an advantage over small ones.

On the other hand, the expansion rate of renewable energies can be both slowed down and accelerated, depending on the energy policy embedding. Unsubsidised expansion has the potential to react quickly to changing demand in a self-optimising ratio of PV and wind. An increase in the share of renewable energies without increasing the EEG apportionment can be achieved with PPAs as a financing instrument. It also enables industrial companies to play an active and visible role in shaping the energy transition through corporate PPAs. On the other hand, such a build-out can also slow down the transition if it is based on electricity prices and these fall. The liquidity of investors also has the potential to slow down renewables expansion: after the construction of a plant, they have little capital available for reinvestment, since the plant revenues of the first few years have to be increasingly used to repay the debt.

Increasing development of renewables outside the EEG also poses challenges for political and regional expansion control. This is primarily intended to promote the regional distribution of the plants, for example through the reference yield model of the wind tenders, and to make the need for grid expansion controllable. A corresponding model for high expansion rates outside the EEG has yet to be developed.

Green power procurement via PPAs is given a high degree of credibility and visibility to the outside world. In contrast to green electricity labelling by means of guarantees of origin, this variant shows a directness of the contracting parties. The reputational advantage for the buyer of a PPA can be summarised as follows: "This PV/wind park could only be built or continued to operate on the basis of our acceptance guarantee". The buyer can be both a green electricity distributor and an electricity consumer.

Another point that plays a role in this context is the societal acceptance of the energy transition. This is because the increasing expansion of unsubsidised renewable energies means that the energy transition loses the attribute of an expensive, subsidy-dependent project.

From an economic point of view, PPAs as a market instrument strengthen cross-technology competition between wind energy and PV on the one hand, and cross-market competition between, for example, PV expansion in Germany and Spain on the other. In the medium-term, a harmonized European market for the expansion of renewable energies can emerge. This has enormous efficiency potential if PPA plants are built at the most favourable locations in Europe.

3. LONG-TERM ELECTRICITY SUPPLY CONTRACTS IN DETAIL

A Power Purchase Agreement (PPA) is a long-term electricity supply contract concluded bilaterally between a buyer (electricity consumer) and a seller (plant operator). This contract regulates the supply of a quantity of electricity at a fixed or variable price or an equivalent financial compensation. The profile of the quantity of electricity may be explicitly unknown.

The buyers can be electricity consumers, usually corporates ("Corporate PPA"), as well as energy supply companies or aggregators ("Utility PPA"). The latter, for example, collect a portfolio of plants and use the green electricity in end customer sales. PPAs offer opportunities and risks for both parties. Sellers receive price security, but in Germany at the present, achievable prices are still below the financial EEG promotion. In the case of new plants that do not qualify for financial support, a PPA with a solvent customer can sometimes be the only way to make project financing possible at all. Buyers, on the other hand, can hedge part of their electricity supply costs with verifiable green electricity over the long-term and thus reduce the risk of fluctuating wholesale prices. However, in a phase of falling prices, price fixing can also be a disadvantage compared to competitors. Since the profiles of electricity consumption (buyer) and electricity generation (seller) generally do not match, it is necessary for the buyer to at least balance the market.

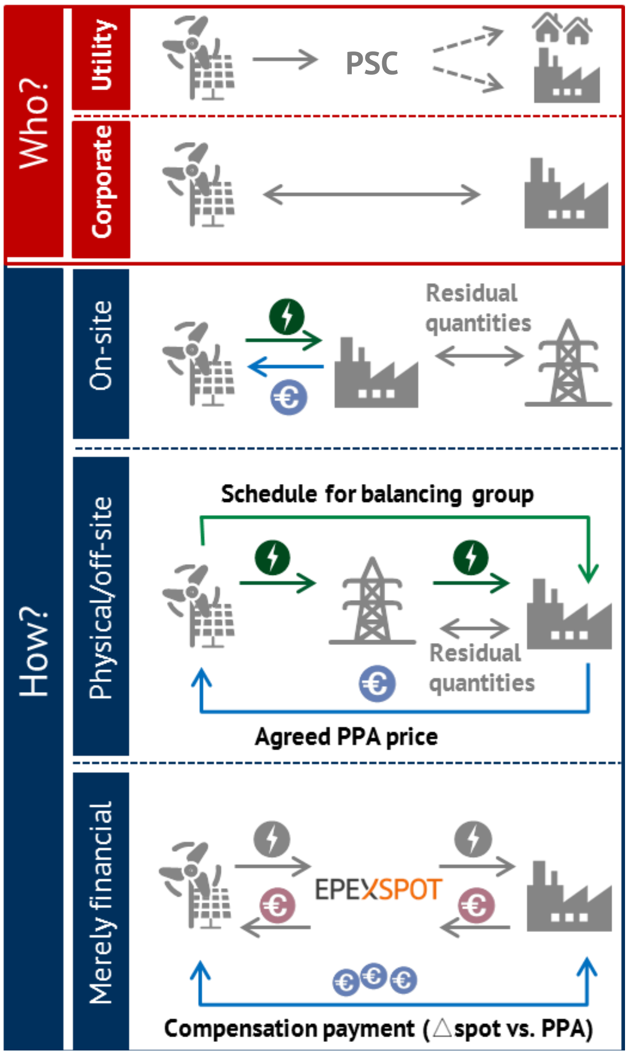

Figure 4: Classification of various PPA types (money flows within the PPA in blue, electricity flows in green)

3.1. POSSIBLE CONTRACTUAL RELATIONSHIPS

In addition to the question of who are the contracting parties, the contract structure also differs. There is a significant difference between off-site and on-site PPAs. Off-site PPAs can be further subdivided into contracts with physical, balance sheet schedule delivery and contracts for purely financial compensation. In the case of the latter, it should be noted that these are legally treated like derivatives and must therefore always be shown in the company balance sheet. What is more, the special case of on-site PPAs is generally only possible as corporate PPAs, but offers additional advantages by purchasing electricity "on-site", since taxes and apportionments are no longer levied. The structure summarised in Figure 4 is also suitable for classifying further terms for PPA types. Some of these were formed without clear terminology in various markets[2].

3.2. VARIATIONS OF PRICE AND QUANTITY AGREEMENTS

The determination of quantity and price plays a central role in all electricity supply contracts. Since PPAs are used to hedge such an electricity supply beyond the typical forward market period for a weather-dependent quantity of unknown profile, this specification is the main challenge. A large number of contractual options is available, entailing a heterogeneous distribution of risk between the two contracting parties. The quantities can be either "as-produced" or purchased as a fixed partial quantity (e. g. P90 or P50 quantity). While the former variant is particularly suitable for smaller plants due to its reduced complexity, the latter also requires the contractual definition of the structure of the purchased quantity. This can be based on the generation profile or be designed as a base load PPA.

With regard to price agreements, several variants are conceivable: fixed prices, step prices adjusted over the term or price indexation. Minimum prices or price corridors as well as mere price caps are also possible here. A hybrid form of these variants can look like this: a fixed price is agreed for 80 % of the volume produced, while the remaining production is purchased via spot price indexation. In addition, prices and quantities are sometimes differentiated according to season; a practice that appears to be particularly useful for solar power PPAs.

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[2] Merchant PPAs roughly correspond to utility PPAs; virtual and synthetic PPAs are examples of merely financial PPAs; a sleeved PPA is a mixed form of utility and corporate PPA in which a service provider takes over defined parts of the processing.

4. FINANCIAL EVALUATION OF PPAS

4.1. EVALUATION METHOD “SALES REVENUE”: EXAMPLE WIND ENERGY

In order to determine an appropriate purchase price within the framework of a PPA with a renewable energy plant, the future value of the generated electricity must be determined. The procedure to be applied can be illustrated with the example of the assessment of the average wind feed-in in Germany. A similar procedure is possible for PV systems.

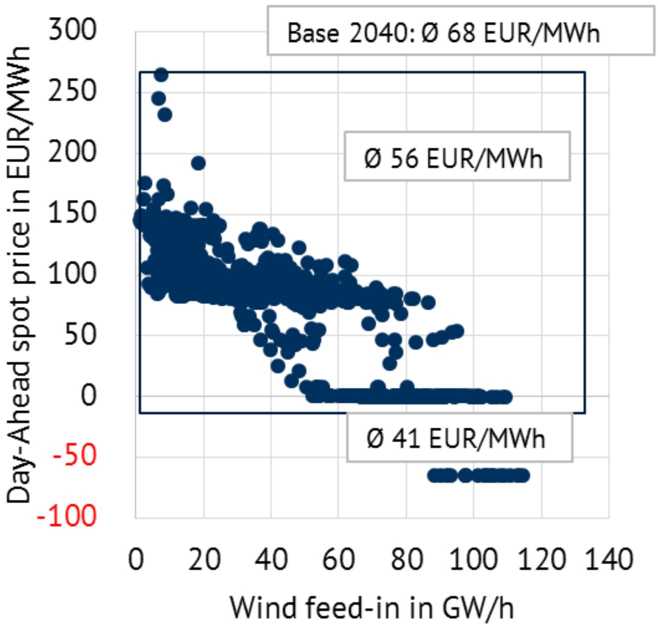

Figure 5: Distribution of hourly DAM wholesale prices in relation to wind feed-in, as well as average base price, market value of subsidised installations and sales value of non-subsidised installations

If wind power is to be evaluated for a PPA, the possible sales revenue can be calculated using hourly electricity price scenarios and the hourly wind profile. This is necessary because wind turbines only generate below-average market prices for direct marketers. Historical market values were already below the average base price, as the merit order effect of renewable energies with the addition of wind turbines increasingly reduced achievable revenues. The question for a PPA is: How may these revenues develop in the future with very high wind power shares? Figure 5 shows modeled spot prices in connection with the hourly wind feed-in for November 2040 in the weather year 2009[3].

First of all, the anti-correlation between wind power feed-in and electricity prices is striking. This is due to the aforementioned price-reducing cannibalisation effects during wind feed-in. With very high feed-in volumes, prices of 0 EUR/MWh or negative electricity prices are therefore formed. The latter reflect a high feed-in of subsidised EEG plants, which can bid with negative marginal costs. However, wind turbines outside the financial EEG support can only market their

[3] The modeling was based on the scenario "Energy Brainpool", which is in turn based on the WEO 2018 price scenario "Sustainable Development" with strongly rising CO_2 prices. The selection of this period was premised on a very high proportion of wind power: In the scenario, approx. 140 GW of wind capacity are installed. Furthermore, November of the weather year 2009 is a particularly windy month. Thus, the share of wind in the monthly gross electricity generation in November 2040 is 61 % in this scenario.

electricity profitably at positive prices. As a result, there are different values and feed-in volumes for wind power from EEG and non-EEG plants: The volume-weighted average price per hour with wind feed-in corresponds to the market value of subsidised plants and amounts to 41 EUR/MWh in the example month, around 60 % of the base price. If this market value is adjusted for the hours with negative prices, the sales value of unsubsidised plants is 56 EUR/MWh or 82 % of the base price. Even though this price is higher, in this very windy month only about 80 % of the unsubsidised wind power can be profitably marketed[4].

In order to calculate achievable revenues on the electricity market from the physically generated amount of wind power, we multiply the expected base price by a discount for the marketable amount (80 %) and for the feed-in profile (82 %), i. e. a total base parity ratio of 66 %. Even in the case of very high wind power shares, the modelling results point to sufficient sales revenue: Each megawatt hour of wind power that can be produced generates an average revenue of 45 EUR. By no means does a high share of renewable energies lead to the electricity market revenues falling to zero due to always low hourly prices with a lot of wind. In addition, the revenues are also above the expected LCOE for 2040 (cf. Figure 3), so that an additional expansion of renewables outside the EEG seems conceivable.

4.2. FURTHER INFLUENCE PARAMETERS FOR A FINANCIAL EVALUATION

In addition to the value of the electricity produced, a number of other parameters must also be taken into account in order to determine a fair purchase price. For example, the transfer of guarantees of origin is usually a central component of a PPA. For this reason, their value development should be estimated where possible and priced in accordingly.

On the other hand, depending on the contractual quantity and price agreements, there is a different distribution of risks among the contracting parties. If, for example, the P90 quantity is agreed as the purchased quantity, the quantity risk lies with the producer, whereas it is transferred to the buyer side in the case of as-produced PPAs. In general, these risks need to be identified and quantified as well as possible. Based on this, the risks can be distributed fairly or priced in as a corresponding discount on the respective risk carrier's side. Table 1 provides an initial overview of relevant risks in this respect.

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[4] Assumption: Sales also take place for exactly 0 EUR/MWh. This is referred to as the "sales volume" of 80 %, which itself refers to the "sales value" of 56 EUR/MWh.

Table 1: Overview of possible risks in the of sales electricity from wind and PV

	RISK	DESCRIPTION
Weather impact	**Volume**	▪ Plant availability? ▪ How much electricity does the plant produce? Range of fluctuation? Seasonality? ▪ Correlation to the average plant fleet? Curtailment? ▪ GOs part of it?
Weather impact	**Price**	▪ Development of electricity prices? ▪ Development of commodity prices? ▪ Price expectations beyond the tradable forward market horizon? ▪ Individual profile value? Cannibalisation effect with the expansion of non-subsidised renewables?
	Liquidity	▪ Fluctuations during the year due to weather conditions, also liquidity burden due to variation margin, if applicable
	Balancing energy costs	▪ Regulatory risk ▪ Difficult predictability
	Counterparty	▪ Creditworthiness of the contractual partners

4.3. EXAMPLE: QUANTIFICATION OF THE WEATHER IMPACT ON PRICE AND VOLUME RISK

Among the risks of electricity sales via a PPA, the weather impact stands out in particular, and will therefore be quantified by using wind power as an example. Even today, the revenues for operators of EEG-supported plants vary with the weather. High wind volumes are followed by high revenues and vice versa. Since electricity prices also fluctuate with the weather, the risk resulting from the weather must be taken into account twice when evaluating a wind PPA. As we will show below, there is an anticorrelation between the two weather effects that stabilizes revenue from a seller’s perspective.

This effect becomes clear when looking at the modelling results of a scenario calculation for the year 2021 using the weather years 2005 to 2016. Figure 6 shows the proportional fluctuations of sales volumes and sales values around their average. Moreover, the resulting revenue variations are both expressed as a percentage and in EUR/MWh; they relate to fluctuations around their long-term average. The figure illustrates that windy years such as 2007 show high volumes with low sales values, wind-poor years such as 2010 or 2016 show low volumes with higher sales values. However, this anticorrelation does not occur equally in every weather year. The main influencing factor here is the cannibalisation effect with concurrent solar feed-in, an effect which is part of ongoing studies. Initial results suggest that the combination of wind and solar PPAs in a PPA portfolio reduces the cumulative weather risk. It is therefore surprising that so far technology-specific PPAs have not been combined into risk-mitigating solar-wind portfolios.

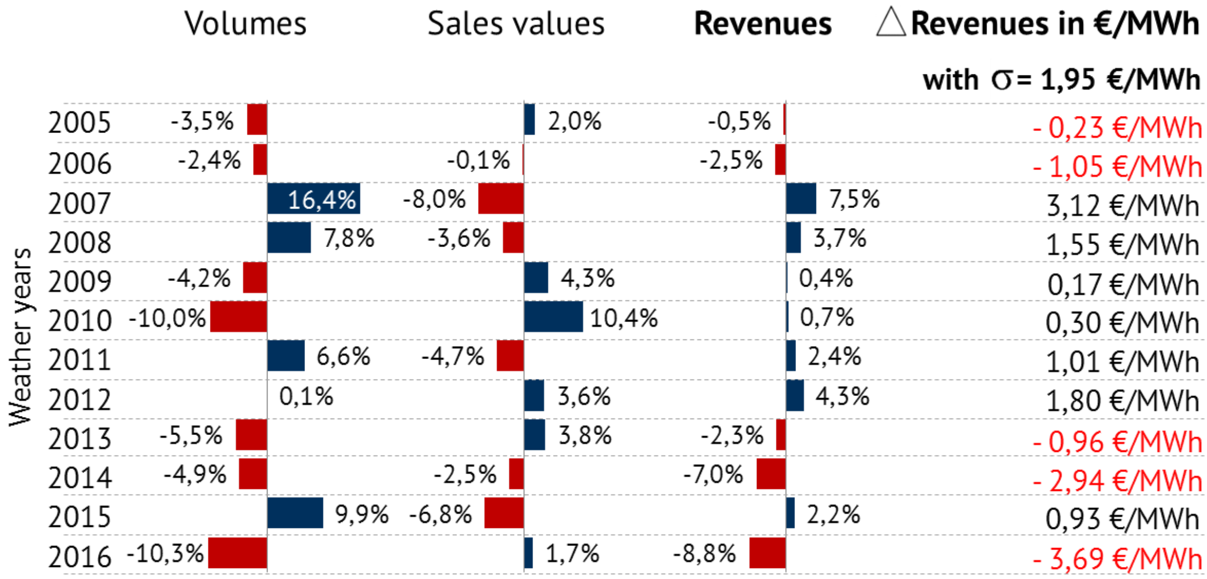

Figure 6: Comparing the impact of different weather years on sales volume and value in 2021, as proportional deviations from the average of all weather years [Source: Energy Brainpool]

Overall, there are weather year-specific fluctuations in revenues that reflect both weather-related volume risks and value risks. Depending on individual risk aversion, these could be priced into the purchase price of the PPA as a risk discount. For 2021, a standard deviation of 1.95 EUR/MWh would be the basis for calculating such a discount.

5. HEDGING STRATEGIES FOR PPA PORTFOLIOS

5.1. CHOOSING THE RIGHT TIMING OF SALES: THREE HEDGING STRATEGIES

If an energy supply company or direct marketer aggregates several renewable energy installations through the conclusion of PPAs, offsetting positions should be built up to balance the underlying market price risk. The closing out can take place either via standard products of the futures market or via the end customer portfolio. With regard to choosing the right timing of sale, three main hedging strategies can be distinguished. These are shown schematically in Figure 7.

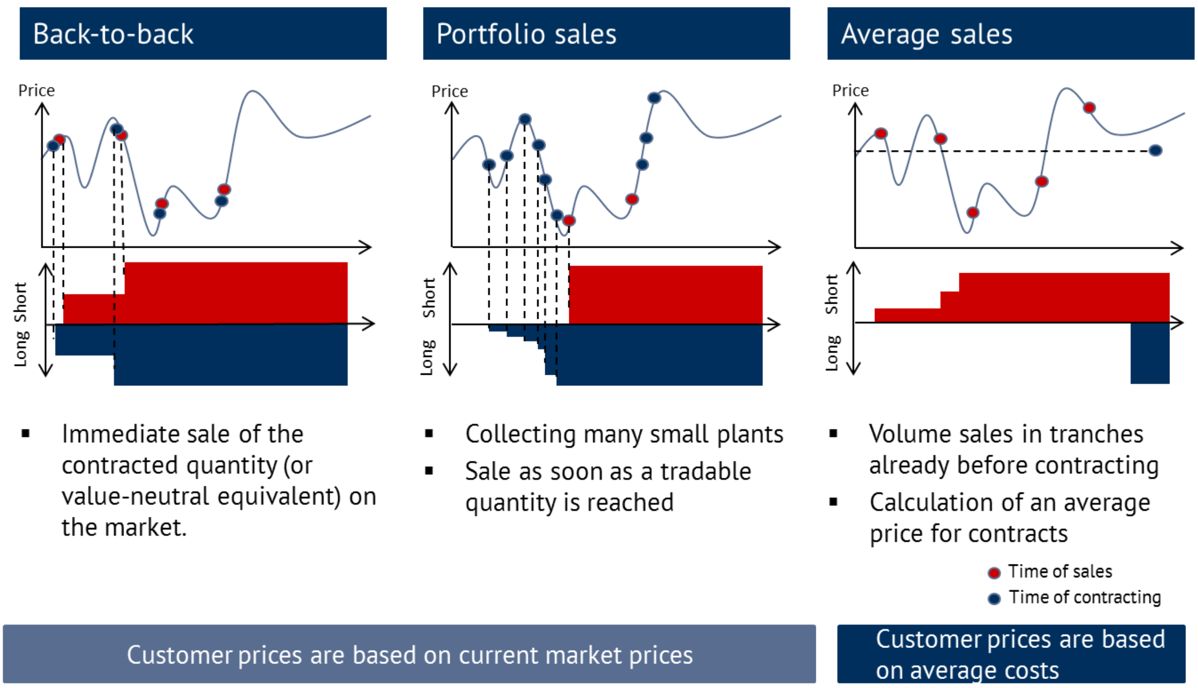

Figure 7: Overview of hedging strategies for PPA portfolios, differentiated by timing of sales [Source: Energy Brainpool]

In back-to-back sales, open positions only exist in the period between price fixing and countertrade, leaving little scope for close-out losses or gains. As an example, a utility could offer a PPA to a large wind farm and immediately close out this position in the end customer portfolio.

However, if this energy supplier collects many small „Ü21“ turbines over several months, the contracted volumes are often too small to be able to sell them directly on the market. Here the close-out as portfolio sale only takes place when tradable quantities are reached. This inequality in time results in a higher close-out risk. Furthermore, depending on the assessment of market price developments, the formation of offsetting positions can also take place prior to the contracting of PPA electricity.

In an average sale, for example, a supplier may offer a fixed tariff for the surplus electricity from 21-PV roof systems. He may plan to have an output of 50 MW in 3 years and would now be starting to sell part of the electricity in order to be able to offer an average tariff. The average price in EUR/MWh calculated in this way can then also be taken into account as the lower limit, and settlement risks are minimised.

5.2. CHOOSING THE RIGHT VOLUME: ROLLING, VALUE-NEUTRAL HEDGE

The parties to a PPA can hedge against market price risks on today's futures market. To do this, however, the decision on the planned sales quantities must be taken at a point in time when neither the volume nor the structure are known with certainty. The rolling, value-neutral hedge represents a risk-minimizing option in this regard. The principle is known from the evaluation of fluctuating load profiles of electricity consumers, but can also be used for fluctuating generation. The procedure is shown here for a wind turbine.

The wind-dependent load profile of such a plant does not correspond to the products on the futures market (base/peak). The sale of wind power as forward/future leads to over- and under-coverage or to residual long and short positions in different hours. The balancing on the spot market on which the load profile can be traded generates revenues in some hours and costs in others. If one sells just enough electricity on the futures market to balance the expected revenues and costs, this results in a value-neutral hedge. In Figure 8, this is achieved with a sale of 80 % of the quantities generated, which corresponds to the base parity ratio of the plant. This ratio fluctuates with the electricity price structure, the plant profile and the merit order effect. It can be modelled on a monthly or annual basis.

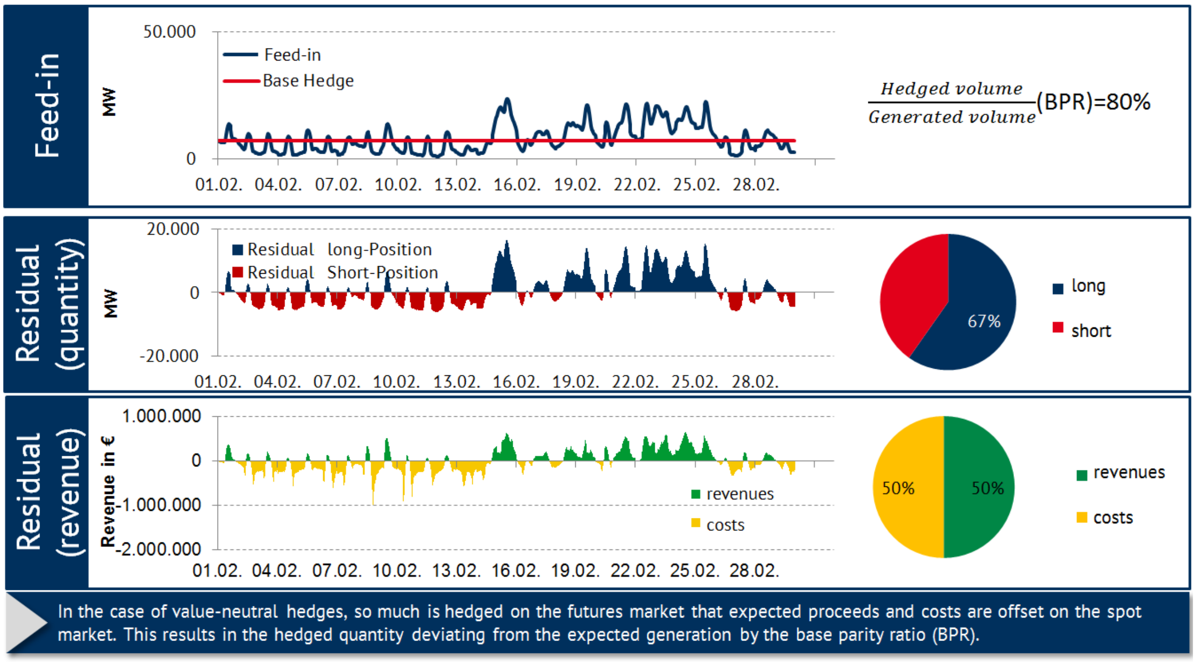

Figure 8: Determining a value-neutral hedge based on the example of a wind park [Source: Energy Brainpool]

A concrete example case illustrates the approach. The procedure for the value-neutral marketing of a 44 MW wind farm with approx. 2,000 full load hours is as follows:

1. Determine the expected annual work, e. g. 87,600 MWh
2. Determine the expected base parity ratio, e. g. 80 %
3. Determine band for value-neutral hedge: e. g. 0.8 * 87,600 MWh / 8,760 h = 8 MW
4. Sell band as future or forward
    a. Choice of the time of sale
    b. Selection of the time horizon, e. g. y+3
5. Closing out the load profile on the spot market
    a. Future: Market all wind power on the spot market
    b. Forward: Close out the difference between generation and 8 MW on the spot market

Since only 80 % of the average expected capacity of 10 MW per hour is marketed, the expected revenue from the unsold 20 % offsets the costs incurred on the spot market in closing out the feed-in profile. However, it should be noted here that the value-neutral hedge does not function perfectly in practice and can only be approximated. The reasons: Firstly, electricity generation, baseload parity factor and electricity price are not statistically independent variables; secondly, forecast errors must be taken into account.

Ideally, hedging of 8 MW each over the entire term of the PPA is possible on the futures market. However, this is currently only possible with electricity exchange products for up to six calendar years in advance. In addition, future and forward contracts with a term of more than three years are hardly traded. This lack of liquidity leads to less competitive prices and therefore additionally restricts hedging possibilities. A rolling hedge can remedy this situation by hedging quantities for years not yet tradable year after year on a rolling basis with products of the maximum liquid tradable maturity. This can best be illustrated by a practical example shown in Figure 9. The procedure for back-to-back marketing of 8 MW over 5 years is as follows:

1. 2018 you sell 8 MW each in the tradable maturities 2019 to 2021
2. In 2018 you sell an additional 16 MW with the due date 2021
3. 2019 you convert this 16 MW into the now tradable maturity 2022
4. 2020 you convert 8 MW to maturity 2023

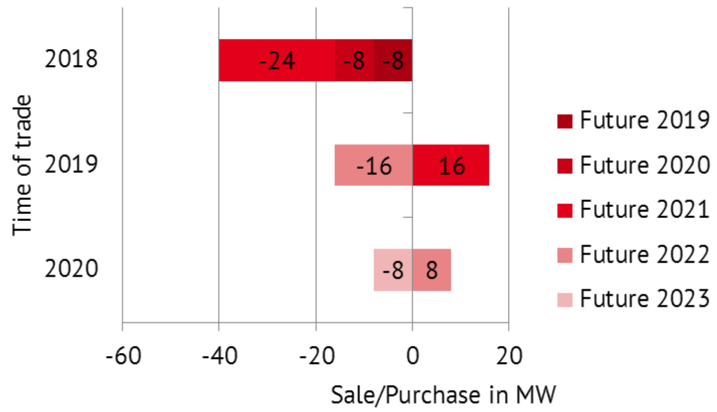

Figure 9: Procedure of a rolling hedge for 8 MW over 5 years [Source: Energy Brainpool]

Since the maturities are traded at a different price, this results in close-out losses or gains for the years 2019 and 2020. These price differences reflect the prevailing market sentiment about long-term price developments, including inflation expectations. In the 2018 trading year, this price difference for the due dates 2020 (y+2) and 2021 (y+3) was between -0.75 EUR/MWh (netting gain) and 2.94 EUR/MWh (netting loss). Overall, the value-neutral electricity quantities of a PPA can thus be hedged over the entire term on the futures market by means of a rolling hedge, thus significantly reducing the risk from open positions. Nevertheless, this results in closing out losses or gains, which represent a limited, quantifiable residual risk.

6. AT A GLANCE

Yet today, at least 7.3 GW of wind energy and 2.1 GW of PV systems in Europe are covered by PPAs.

In Germany, the discussion on this topic is currently still ahead of the quantities of actual contracts concluded. But this can change quickly, because 25 GW of wind energy and 10 GW of PV systems will lose their entitlement to financial support by 2030; hedging instruments such as PPAs can make a contribution to enabling continued operation. In the medium-term, PPAs, as a market instrument, can control the demand for climate-neutral power generation and convert it into additional renewable energies. However, large-scale expansion via PPAs can also lead to challenges for regional control and impair the diversity of actors in the energy transition process. Here, energy policy must provide regulatory support for the development of a futures market for electricity from fluctuating renewable energies.

PPAs secure future electricity supplies in the long-term and reduce the risk of fluctuating prices in the energy-only market. But will this market still function at all in 2040 with a high proportion of electricity producers without marginal costs? Modelling results show sufficient sales revenues for wind turbines with a 61 % share of wind energy in electricity generation.

The sum of marketing risks that the EEG has so far passed on from the plant operators to the contribution-liable end consumers has a relevant order of magnitude. Capital-intensive investments without subsidies but with marketing risks increase overall electricity generation costs. In an example calculation for a wind turbine, they increased by about 1/3.

Although the weather impact on the revenue risk plays an important role in the financial evaluation, it is often overestimated. For model year 2021, the standard deviation of weather-related fluctuations in the revenue of wind turbines is only just under 2 EUR/MWh. The fluctuation in revenues due to volatile electricity prices is of greater significance.

In order to counter these market risks, a suitable hedging strategy must be selected. A value-neutral, rolling hedge makes many of these manageable, at least for a period of about five years. Back-to-back, portfolio and average sales are possible hedging strategies for renewable energy portfolios.

SHORT PORTRAIT OF ENERGY BRAINPOOL

The Energy Brainpool GmbH & Co. KG offers independent energy market expertise with a focus on market design, price development and trading in Germany and Europe. In 2003 Tobias Federico founded the company with one of the first spot price forecasts on the market. Today, the company offers fundamental modelling of electricity prices with the Power2Sim software as well as a wide range of analyses, forecasts and scientific studies. Energy Brainpool advises on strategic and operational issues and has been offering expert training since 2008. The company combines knowledge and expertise in business models, digitisation, trading, procurement and risk management with many years of practical experience in the field of controllable and fluctuating energies.

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January 2019