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Renewable Energy Price Risk Management at the Energy Exchange

Viviana Ciancibello
Senior Business Developer
European Power Derivatives

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Table of Contents

1. Introduction

With subsidy schemes being gradually phased out across Europe, renewable energy assets are entering the world of merchant risk management and energy trading. Whilst PPAs are one tool to set a baseline for prices that can be relied upon by developers and banks, there remains a price risk when exposed to wholesale market movements. For several decades, energy trading has primarily been the territory of utilities, trading houses and banks. Now, renewable energy project developers and offtakers exposed to wholesale prices must learn how to employ the financial products available to manage the risk exposure to variable prices. This paper was created in order to help educate newcomers to energy trading, and provide clarity around the various opportunities it can offer for price risk management across Europe.

2. The Energy Exchange

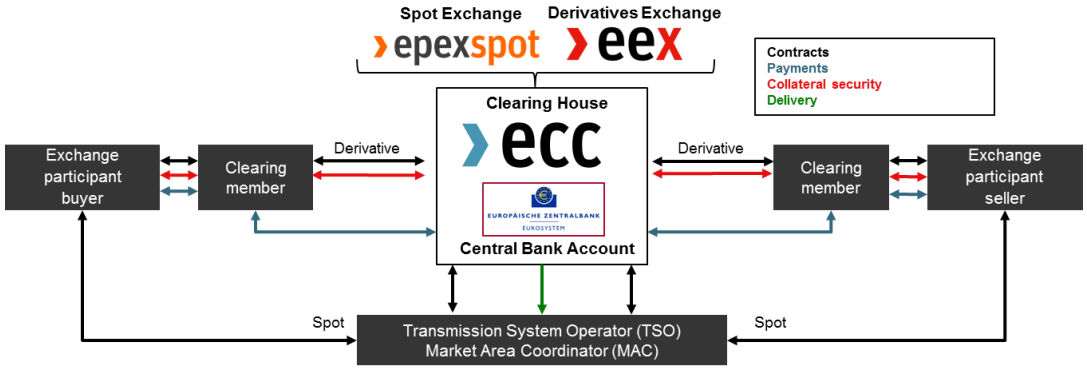
Currently, the largest marketplace for the financial trading and clearing of electricity (also known as “power”) contracts in the world lies within EEX Group. As part of EEX Group, the European Energy Exchange (EEX) is a regulated exchange where various commodities including power, emission allowances, freight and agricultural contracts are listed. To understand power trading as it relates to managing renewable energy price risk, one must first understand the basic functions of an energy exchange and clearing house.

The core function of an exchange is to ensure fair and orderly trading and the efficient dissemination of price information for any contracts trading on that exchange. The exchange also manages and operates the technical systems that allow for trading. Trading of products can occur either via an electronic trading screen where it is possible to see transparent order books with “bid” prices from those who wish to buy, or “offer” prices from those who wish to sell. It is also possible to trade Over-the-Counter (OTC), where the price and volume of a trade has been agreed upon bilaterally or pre-arranged by brokers, before the trade is registered with the exchange for clearing.

A key benefit of trading on an exchange or registering pre-arranged transactions for clearing is counterparty risk management. The entire operation of an exchange with an attached clearing house has been designed to ensure that your trade will be fulfilled, even if your counterparty does not hold up their end of the bargain. Firstly, the financial settlement is fully managed between the exchange participant’s clearing member (CM) and the clearing house. The CM is a bank appointed by the exchange participant as its payment and delivery agent. A clearing house acts as the central counterparty between a buyer and seller. Its main role is to make certain that the buyer and seller honour their contract obligations through active financial management of counterparty risk. These contract obligations are primarily distinguished between two types of market segments: the spot market and the derivatives market.

The diagram below shows the general process of the exchange and clearing house through the perspective of EEX Group. Power contracts with physical delivery and a time horizon of up to 1 day ahead are available for trading at EEX Group’s spot exchange EPEX Spot. Power contracts with financial fulfilment and a time horizon of up to 6 years ahead are available for trading at EEX. Both exchanges are cleared by EEX Group’s clearing house, European Commodity Clearing (ECC). This ecosystem forms the foundation of energy trading.

General Process: Exchange and Clearing House

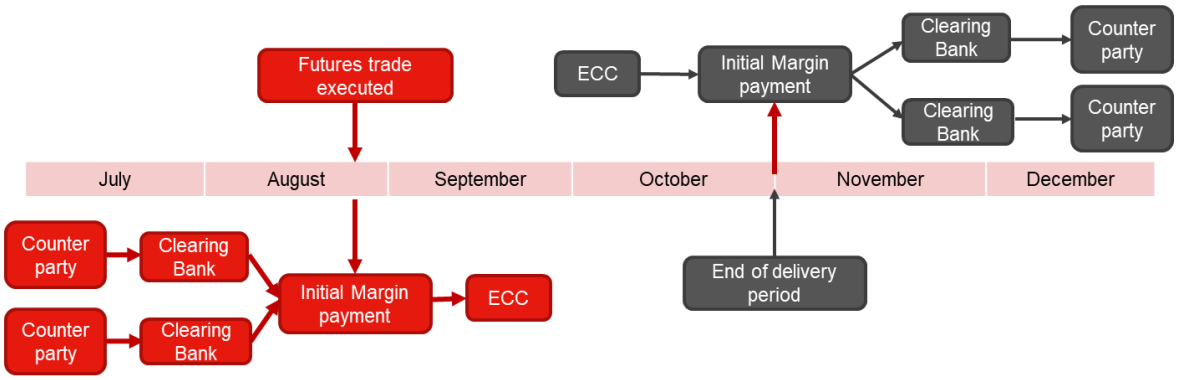


3. Spot and Derivatives

Spot products are financially and physically settled on the same day the trade was executed or the day thereafter. In the case of physical electricity markets, this means the buyer receives the electricity and has to pay the respective purchase price, whereas the seller has to deliver electricity and receives financial payment. When it comes to Spot trading, counterparty risk is typically limited due to the short time span of the deals. The clearing house of a spot exchange needs to ensure that buyers have enough cash available in their clearing bank's account to fulfil the contract payment. Additionally, the clearing house manages the physical settlement of electricity spot transactions by interacting with Transmission System Operators (TSOs). Within EEX Group, EPEX SPOT operates spot trading for European electricity markets. EEX operates derivatives trading for 20 European markets. Both exchanges are cleared by ECC.

Derivatives products (futures and options) are where the value of the clearing house truly comes into play. When trading a financial commodity derivative, one is transacting on the future value of an underlying physical product; in this case, electricity. If the trade has been executed but has not been settled yet, an "open position" is created, whereby the buyer is "long" an electricity contract and the seller is "short". "Open" refers to the fact that each counterparty does not have to pay for the full value of the contract right away or deliver the full amount if selling. Instead, the clearing house takes an "initial margin" payment in the form of a security deposit from both the buyer and seller. The initial margin is only a portion of the notional value of the transaction. The amount of the initial margin is determined by the clearing house. Several factors influence the initial margin including the contract size, contract tenor, volatility parameters and underlying liquidity of the given contract. Furthermore, if a counterparty has traded in other ECC-cleared products that day, their initial margin can be reduced through the benefits of "cross-margining" which nets positions according to risk correlations between products. The initial margin is reimbursed to the counterparties at the end of the delivery period of the contract. This process is illustrated in the diagram below, showing a transaction in an EEX Power Future monthly contract for September, which was executed in July.

Initial Margin Payment Flow for a Month+2 Futures Trade

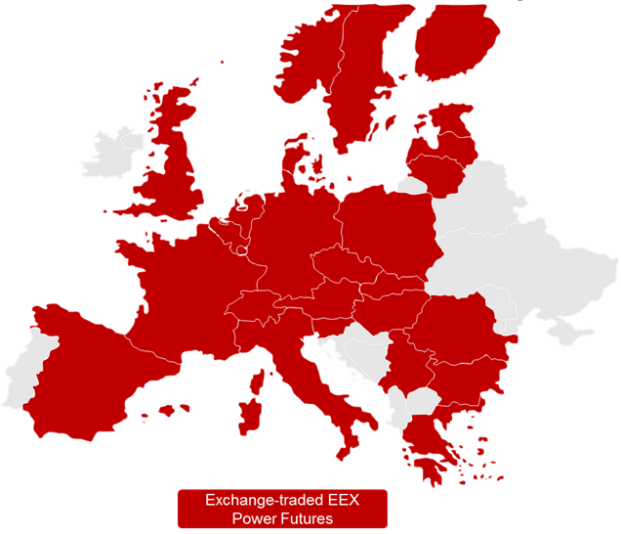


The initial margin payment serves as the first level within the so-called 'default waterfall' of the clearing house. In derivatives markets, the clearing house takes on the responsibility to ensure that each buyer or seller can be paid out at any point in case of a default of their counterparty. Since derivatives products can have a long life – currently up to 6 years on EEX Power Futures - the clearing house manages daily counterparty risk for the life of an open position through "variation margin" payments. Each open position receives a "mark to market" margin call where the value of their position is evaluated against the daily settlement price of the respective exchange contract. Buyers and sellers are then credited or debited according to whether the value of their open position has gone up or down. This is a crucial function for managing counterparty risk and ensuring viability of the market.

4. Markets and Contracts

Now that we've covered how trading electricity on an exchange like EEX works, the question becomes - what exactly can be traded? Power derivatives contracts typically reference a particular bidding zone of a power spot market. In Central-Western Europe, these are most often nationally demarcated. This means there is typically a single price for electricity in a given country. EEX lists Power Futures contracts based on the spot market index of a given bidding zone (also known as the "underlying"). These Power Futures are then colloquially referred to by the respective country they reflect: German Power Future, French Power Future, Spanish Power Future, etc. At present, EEX operates the most liquid Power Futures markets of any exchange in Europe, with 20 different market areas offered:

EEX Power Futures Market Coverage



Within each market area, a variety of standardised EEX Power Futures contracts are available to provide traders a range of opportunities for managing their future price risk. Standardised contracts means that all market participants are trading the same product with the same conditions and obligations. Since the primary user for power contracts are utilities, Power Futures are listed in line with the industry framework for delivering electricity. Hedging needs for the electricity market have been historically driven by managing pricing and demand between Base load and Peak load. Power Futures listed for Base load represent the average spot prices between 00:00 and 24:00. Peak load represents the average spot prices between 08:00 and 20:00, typically for all days Monday-Friday within the delivery period. Furthermore, each Base and Peak contract have different “maturities” or “expiries” representing the “delivery period” into the future that each underlying is traded.

The table below shows the futures contracts listed by EEX for the German Power market. Each number represents the number of available maturities; 14 Days means there is one contract each for D+1 up to D+14, while 6 Years denotes one contract per delivery year up to Y+6. As such, hedging electricity spot prices can already be done up to 6 years in advance. EEX is also planning to extend Power Futures up to 10 yearly expiries to enable more long-term hedging.

EEX German Power Base and Peak Contract Expiries

	German Power Base						German Power Peak					
	Day	WkEnd	Week	Month	Quarter	Year	Day	WkEnd	Week	Month	Quarter	Year
DE (Phelix)	14	2	5	10	11	6	14	2	5	10	11	6

The contract volume is calculated by multiplying the number of delivery hours (h) during the delivery period with the constant output (MW) specified in the respective contract. The maximum amount of power per day is usually 24 MWh, on the day of the switch from winter time to summer time it amounts to 23 MWh, whereas on the day of the switch from summer time to winter time it amounts to 25 MWh. The minimum "lot size" (quantity) that can be traded on EEX is 1 MW.

For sophisticated traders, EEX lists Power Options contracts based on its most liquid futures markets and contracts. For the purposes of this paper Options will not be discussed in detail, but they can offer interesting opportunities for hedging.

An important reference price published by the exchange on any business day is the daily settlement price of a given futures contract. This price represents where the exchange’s members see the value of that underlying for its specified delivery period in the future. The sources for settlement prices are other traded prices, bid/ask orders, and fair values provided by exchange members. The closer to expiry, the more the settlement price of the futures converges with the spot price. Settlement prices for each of the 20 European markets offered for trading are publicly available on the EEX website, and are one of the key ways exchanges like EEX help create transparency in a market. Easy access to market prices helps industry participants answer a very important question: what is a fair price for the product I would like to buy or sell?

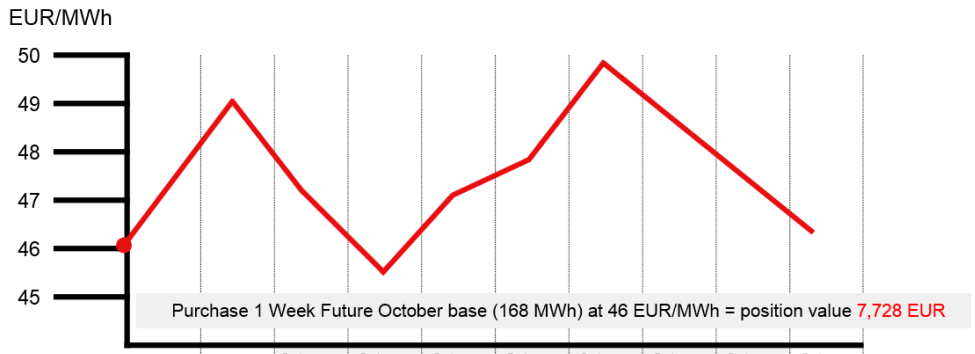
5. Hedging Electricity using Power Futures

Now we get to the logic behind using financial derivatives for risk management. By trading electricity derivatives products, one can effectively hedge against extremes of future price movements on the spot market. So, if you are a generator who will be selling power into the spot market grid, or a buyer who needs to buy directly from the grid, the Power Futures market could be right for you. This is since the “underlying” of the derivative contract is the average of all relevant daily spot market traded prices for the contract period. As a result, the outcome of the derivative contract is fully fungible with the spot market value.

In conventional cases, if one is a buyer (also known as "long") on spot, one should also buy the future in order to hedge; and vice versa. This is because the main risk lies in the spot price going up and raising procurement costs. However, rising prices will also lead to a more profitable futures position, so the profit from the futures will offset the loss from the spot market. Conversely, selling (also known as going "short" on) a future will result in a position which is profitable when the price goes down. Sellers who would be losing out on revenues from the spot market would then have those losses curbed by the gains from the futures hedge.

The graphs below demonstrate this concept using a simple example. Here, a buyer purchased a 1MW Week Future at 46 EUR/MWh. The price movements throughout the week resulted in variation margin payments which were credited to and debited from the buyer. At the end of the week the price settled 0.71 EUR higher than the trade price, so position result was profitable and the cash settlement was 119.24 EUR.

Example Profit & Loss of an Electricity Month Future 1: Long Position



	Oct 16th Thu	Oct 17th Fri	Oct 21st Mon	Oct 22nd Tue	Oct 23rd Wed	Oct 24th Thu	Oct 25th Fri	Oct 26th Sat	Oct 27th Sun	Oct 28th Mon	Position Result
Trade price [EUR/MWh]	46										
Settlement price [EUR/MWh]	47	49	47	45	47	48	50				
Spot price [EUR/MWh]			*49.25*	*46.55*	*47.51*	*48.20*	*51.31*	*41.58*	*42.60*		
Final settlement price [EUR/MWh]										*46.71*	
Change [EUR/MWh]	+1	+2	-2	-2	+2	+1	+2			-3.29	**+0.71**
Contract volume [MWh]	168	168	168	168	168	168	168	168	168	168	168
Position (MW)	1	1	1	1	1	1	1	1	1	1	1
Variation margin [EUR]	+168	+336	-336	-336	+336	+168	+336			-552.72*	+119.24

*The last variation margin is called cash settlement

Over the same week, the same amount was bought on a daily basis with a price-independent bid on the spot market, whereby the bid accepts all prices and there is nearly no risk that the order isn’t executed. In the table below, 1MW of electricity is shown to be bought at an average price of 46 EUR/MWh for the week 21st – 27th October 2019. The average spot price in that week results at

46.71 EUR/MWh, which would equal a loss of 0.71 EUR/MWh. However, that loss is offset due to the variation margin payments from the corresponding position in the EEX Week Future contract.

	Oct 16th Thu	**Oct 17th** Fri	Oct 21st Mon	Oct 22nd Tue	Oct 23rd Wed	Oct 24th Thu	Oct 25th Fri	Oct 26th Sat	Oct 27th Sun	Oct 28th Mon	**Result unhedged**	**Result hedged with EEX Week Future**
Trade price [EUR/MWh]	**46**											
Settlement price [EUR/MWh]	**47**	**49**	**47**	**45**	**47**	**48**	**50**					
Spot price [EUR/MWh]			***49.25***	***46.55***	***47.51***	***48.20***	***51.31***	***41.58***	***42.60***			
Purchase price in the auction [EUR]			**-1,182**	**-1,117.2**	**-1,140.24**	**-1,156.80**	**-1,231.44**	**-997.92**	**-1,022.4**		-7,848	-7,848
Final settlement price [EUR/MWh]										***46.71***		
Change [EUR/MWh]	+1	+2	-2	-2	+2	+1	+2			-3.29		**+0.71**
Contract volume [MWh]	168	168	168	168	168	168	168	168	168	168		168
Position (MW)	1	1	1	1	1	1	1	1	1	1		1
Variation margin [EUR]	+168	+336	-336	-336	+336	+168	+336			-552.72*		+119.24
Total Costs											**-7,848**	**-7,728**

As a result, the overall cost of purchasing power on the spot market for the week of 7,848 EUR was reduced by the amount of the profit from the futures hedge to 7,728 EUR. This is the value of hedging: it limits the overall risk exposure either on the cost side, as in this example, or the revenue side (in the opposite case, a seller on spot would sell on futures to hedge).

This principle can be extrapolated to the long term. Currently it's possible to hedge power prices up to the next 6 years in 19 European power markets on EEX, with additional yearly expiries planned. As long-term price stability is a key concern of renewable energy developers and buyers, Power Futures products can be a valuable tool to ensure the viability of a wind or solar project.

6. Hedging Renewable Energy using Power Futures

PPAs have emerged as a key driver of investment in new wind and solar projects. There is much discussion around the various risks in a PPA and how developers can manage merchant risk in the case where PPAs do not cover the full output of a generation asset (or where there is no PPA at all). One answer can be found in the futures market.

In the case of financial or virtual PPAs, where the physical electricity flows are transacted via the wholesale spot market, an inherent price risk is created. This is the risk that as a seller, you may sell the future amounts of electricity generated at a lower price than expected, which could impact cash flows and profit margins. As a buyer, this is the risk that the wholesale price falls below the PPA price, which results in higher payments to the renewable generator. Depending on the structure of the PPA, corporate buyers may wish to hedge any remaining purchase volume, which may not be covered by the agreement. In this case, they would hedge against having to buy electricity at higher prices than expected.

Whilst the PPA contract serves to manage price risk to a certain extent by setting a baseline price value, the volatility of the electricity markets is significant enough that it is prudent to manage the exposure to the highs and lows of fluctuating spot prices and hedge any remaining generation or procurement risk exposure not covered by the PPA. Furthermore, due to the long-term tenor of PPAs resulting in a price risk exposure out to 10 or 15+ years, the risk is considerable.

Power Futures can serve as a valuable tool for price risk management. Market participants who enter into long-term PPAs can trade a strip of cash settled calendar futures out to 6 years ahead (Y+6) to

hedge their price risk exposure. Due to the size and duration of the deal, counterparties will very likely negotiate on the price and volume bilaterally then register the trades for clearing via the exchange's trading system. The contracts then go directly to the clearing house (ECC) and are said to have been OTC Cleared, although the legal term according to the EEX rules is Trade Registration. The counterparty risk of the long-term deal is entirely managed by ECC.

EEX is in the process of listing further calendar futures expiries up to 9 or 10 years ahead, in order for buyers and sellers of renewable energy to manage a greater portion of their risk. By placing this long-term price risk in the hands of the clearing house, more internal capacity is freed up to sign additional PPAs, particularly within utilities and aggregators. This is one of the key benefits that energy exchanges bring to the PPA market as a whole.

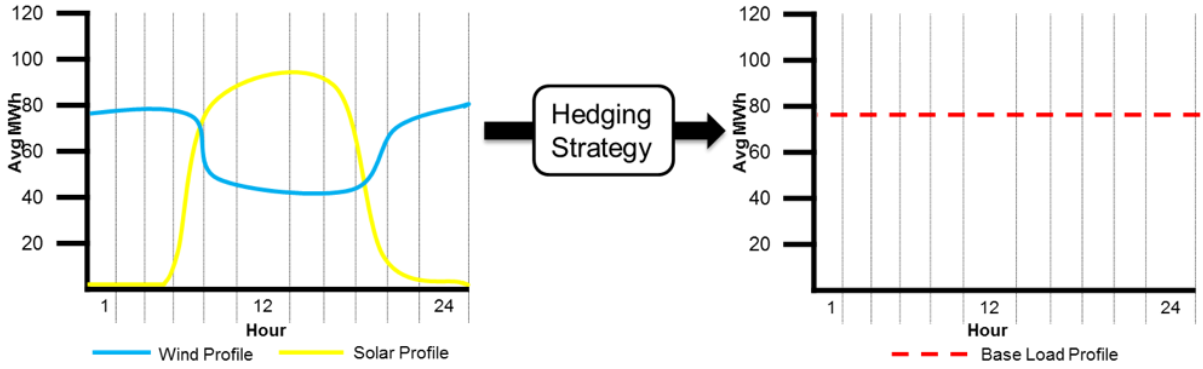
This concept has already been proven in EEX's Spanish Power market. Spain is one of the fastest-growing subsidy-free renewable energy markets in Europe. As a result, market players are already actively managing their price risk exposures and have been using EEX Power Futures to do so. Trading participants of EEX have registered strips of trades starting as early as the next month, going out to Cal+6, at a flat price and flat volume. This can be compared to a flat price PPA price exposure. The example below shows a long-term hedge registered on January 10th, 2019. Each line represents a separate contract and trade. The Initial Margin is shown as well as its percentage compared to the Notional Value of the contract. The Notional Value is found by multiplying the Trade Price with the Trade Volume.

Example Long-Term Hedge on EEX Spanish Power Base Futures

Trade Date	Product	Expiry Year	Expiry Month	Trade Price	Initial Margin per Contract	Lots (MW)	Initial Margin (in EUR)	Trade Volume (in MWh)	Notional Value
10/01/2019	Spanish Power Base Month	2019	2	52.54 €	2,903 €	2	5,806 €	1,344	70,614 €
	Spanish Power Base Month	2019	3	52.54 €	2,608 €	2	5,216 €	1,488	78,180 €
	Spanish Power Base Quarter	2019	4	52.54 €	6,880 €	2	13,759 €	4,368	229,495 €
	Spanish Power Base Quarter	2019	7	52.54 €	7,264 €	2	14,529 €	4,416	232,017 €
	Spanish Power Base Quarter	2019	10	52.54 €	6,163 €	2	12,326 €	4,416	232,017 €
	Spanish Power Base Year	2020	12	52.54 €	15,196 €	2	30,393 €	17,568	923,023 €
	Spanish Power Base Year	2021	12	52.54 €	13,140 €	2	26,280 €	17,520	920,501 €
	Spanish Power Base Year	2022	12	52.54 €	11,826 €	2	23,652 €	17,520	920,501 €
	Spanish Power Base Year	2023	12	52.54 €	17,958 €	2	35,916 €	17,520	920,501 €
							167,877 €	**86,160**	**4,526,846 €**
							Initial Margin in % of Notional Value		**3.71%**

Since May 2018, 28 long-term hedges have been registered on EEX Spanish Power Base Futures, with a total volume of 14.9TWh. This proves that market players are committed to using the exchange for their long-term price risk management.

You may have noted though, that the product being used to hedge in Spain is a Base Load future, which is quite different from a wind or solar profile. As one can imagine, using a futures product for hedging works best when the product reflects the actual risk exposure of an asset in terms of generation profile. But, as many electricity generation assets have different profiles and risk exposures, market players have concluded that using the Base Futures as a best-fit product attracts the most liquidity. This means most buyers and sellers in an electricity market come together to trade the Base Futures, creating a strong price signal and multiple opportunities for trading at fair market prices. To use the Base Futures to manage the risk of wind and solar assets, a translation needs to be made from the variable nature of the generation profile into a constant Base Load profile, and a decision needs to be made on the portion of overall risk to be hedged using futures.

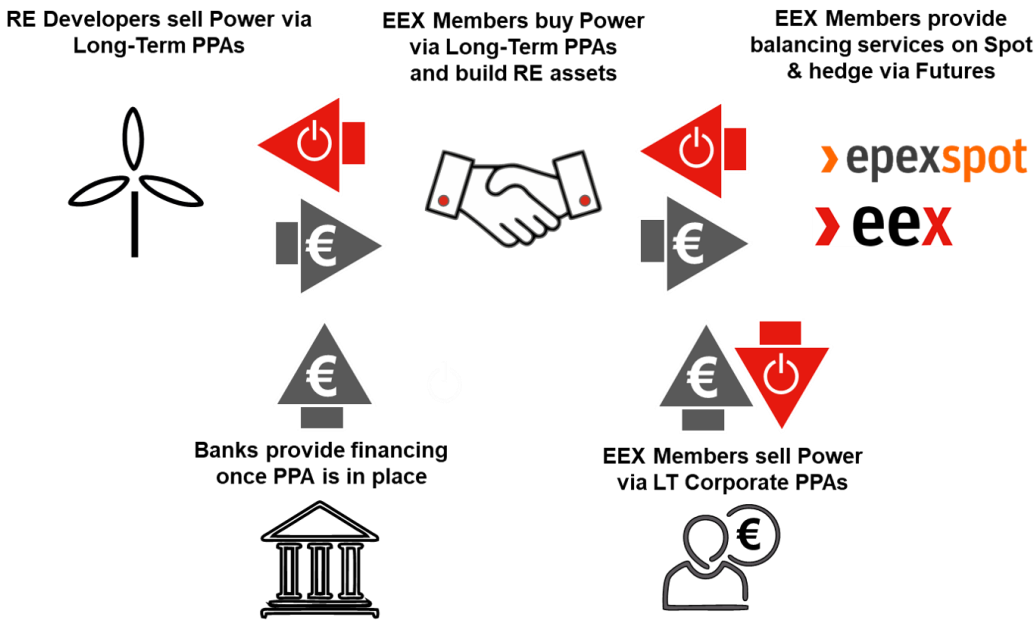


Different hedging strategies can be employed to do this. It is often the job of a Risk Manager to study the overall risk profile of the generator and determine the best hedging strategy; although increasingly, renewable energy producers are outsourcing this task to utilities' trading desks and energy trading companies.

6. The Importance of Network Effects

When considering which exchange to choose and trade on, market participants should take into account the importance of network effects. Exchanges thrive on liquidity, and liquidity is driven by a strong membership base with a depth and breadth of market players wishing to trade the same products. EEX Power Derivatives markets have more than 250 trading participants, and behind these members is an even higher number of indirect market participants trading EEX power products from all over the world via intermediaries. Whilst the volume of electricity futures is largely driven by utilities locking in prices for their future power production, financial players such as banks and trading houses also participate in electricity markets and often take the opposite position of utilities. Industrial, heavy energy users are active members of the exchange as they hedge their energy procurement. Brokers participate directly on exchange and bring with them the demand from their client bases, which often includes smaller and medium sized companies with both buying and selling demand. Overall, the variety of players, interests, and strategies (ie. geographical spread trading across price-correlated markets) creates attractive trading opportunities in inter-linked, liquid markets: the so-called network effect.

Looking at price hedging for renewables at EEX, participants benefit from the network effect in the sense that potential buyers of long-term futures need not necessarily be buyers of the PPA which is being hedged. The buyer of a long-term hedge can be any EEX member who would be willing to buy at the agreed-upon price, volume and tenor. For example, utilities have natural long-term buying interest as they seek to manage the supply available for their retail clients. The diagram below shows how EEX members are active in PPAs and are both on the buy and sell-side of renewable energy. Another point to note here is that brokers can play a key role in matching trading interest, as they use their own network effects to bring together counterparties for long-term, complex deals.



To access the exchange there are two possible channels. The first is directly via exchange membership, which requires fulfilling the admission requirements. The main benefits of direct membership are paying one membership fee to have full access to all the exchange's markets and products, only paying the fixed exchange and clearing fees for trades, as well as the opportunity to trade on behalf of clients. You may find details on EEX's membership requirements here. The second possible channel is indirect access via a third-party exchange member, otherwise known as Direct Market Access (DMA) providers. These DMA providers have their own set of requirements and may charge a margin on top of the exchange's fees.

7. Conclusion: Power Futures are a Smart Solution for Subsidy-Free Renewable Energy

To sum up what we have learned: renewable energy price risk can be hedged using Power Futures; but a solid risk management strategy must be devised to do so. EEX provides the tools to manage price risk across Europe through its extensive Power Futures markets and an established network of trading participants. To provide even more opportunities for long-term price risk management, EEX is planning on extending its Power Futures yearly expiries, starting with German, Italian, and Spanish Power Futures markets. In this way EEX serves to provide its members and the overall renewable energy industry with the risk management products required to successfully transition to a subsidy-free world.

For more information on EEX Power Markets please contact: powerderivatives@eex.com