RE-Source

European platform for corporate renewable energy sourcing

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Risk mitigation for corporate renewable PPAs

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Please get in touch with the RE-Source Platform if you have any comments or feedback on the report and its content in order to enrich our ongoing work in this field.
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Vocabulary used in this report

As in any sector, there are many ways of saying the same thing in the renewable energy and power markets sector. This often creates confusion. In the table below, we have specified a set of words and phrases which we have tried to use consistently throughout this report, what we mean by them, and alternative words/phrases that can be used.

TABLE 1
List of key words and phrases

Word/phrase used in report	Meaning	Other common names/phrases
Buyer	The entity purchasing electricity from a renewable power plant	Corporate buyer, corporate off-taker, off-taker, corporate consumer, purchaser
Seller	The renewable power plant producing electricity to sell to the buyer	Producer, supplier, renewable asset developer, generator
Renewable electricity	Electricity produced from renewable power plants such as wind and solar farms	Green electricity, green energy, clean energy, renewable power, renewable energy
Renewable power plant	Solar parks, wind farms etc. which produce electricity	Renewable asset, renewable installation, renewable generator, generation facility, project
Renewable energy supplier	Owner of renewable power plants or renewable power plants themselves which supply electricity to the grid	Renewable asset owner, renewable power producer
Corporate sourcing	The procurement of renewable electricity by a corporate buyer. This can be through a PPA or other types of contracts such as leasing or green energy tariffs	Renewable electricity sourcing, renewable energy procurement

Why have we written this report?

The European Union has set targets for the decarbonisation of the economy to reduce our impact on the environment and tackle the biggest risk in our lifetime: climate change. In order to meet the targets, Member States need to facilitate the build-out of renewable energy and invest in grid infrastructure to incorporate the changing supply-and-demand characteristics that come with an electricity grid with high volumes of renewable power.

Corporate renewable electricity sourcing is set to play a large part in the transition of the economy and can provide developers with long term revenue stabilisation which allows them to obtain financing to build renewable energy projects. This is especially important in Members States where government support schemes do not provide revenue stability. In addition, corporates are increasingly looking at ways in which they can reduce the impact of their own operations on the environment, both for reputational reasons and to gain a competitive edge in a society in which awareness and the importance of environmental impacts are ever increasing.

Corporate renewable power purchase agreements (PPAs) can provide the security of returns which a developer of renewable power plants needs to secure lending to build the project. But they are not simple. PPAs have many risks associated with them, risks that have traditionally been handled by utilities, developers and energy traders. Now these risks need to be engaged and owned by corporates who generally do not have expertise in the area. This is one of the main barriers to the development of PPAs throughout Europe. RE-Source is committed to facilitating PPAs, be it by helping to raise awareness at the national level of administrative barriers which governments should remove, or by providing educational material in our Corporate Buyers' Toolkit. This report, which will be a living document in that Toolkit and will develop over time, is one of the tools.

The report has been written in two parts. Part 1 outlines the current trends in PPAs and describes the risks associated with PPAs, the typical PPA contract structures, and how the risk-sharing differs between the counterparties. Part 2 is written by providers of risk mitigation products, and sets out how that product mitigates certain risks.

We hope this report helps you on your way to signing a PPA and contributing to the build-out of new renewable power.

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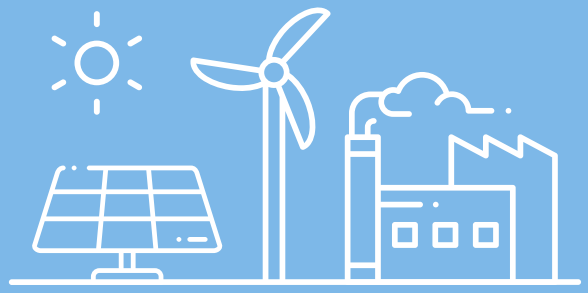
Corporate Renewable PPAs and associated risks



Introduction

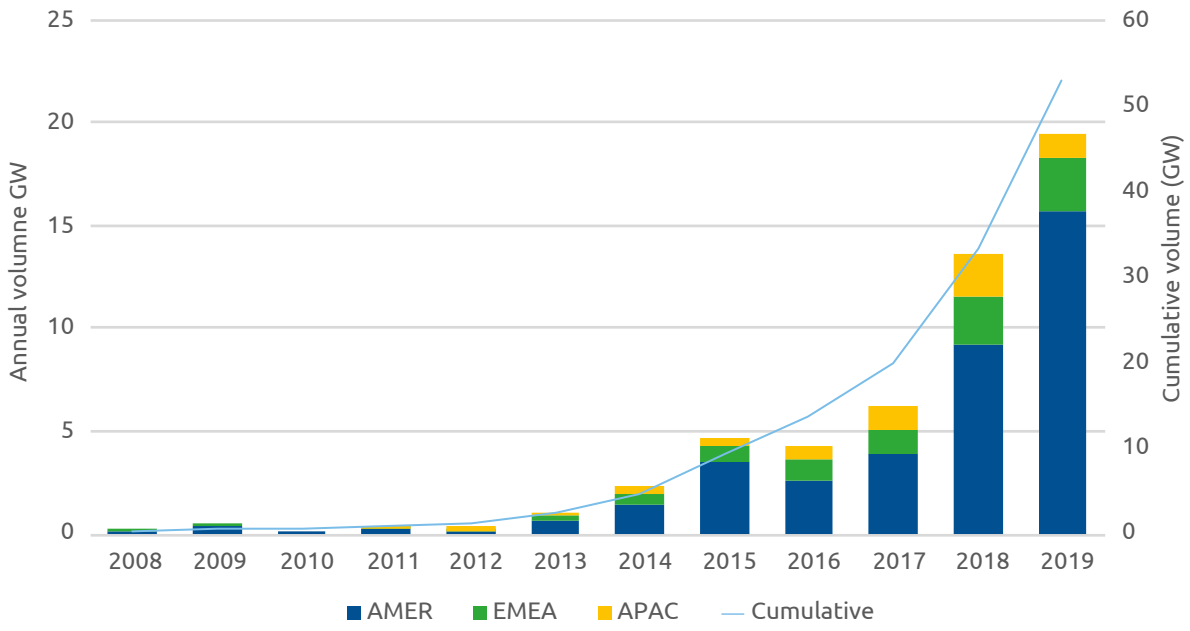
The **corporate sourcing** market in Europe has taken off over the last few years. Starting in earnest in 2014, the corporate renewable Power Purchase Agreement (PPA) market in Europe has grown to a cumulative capacity of over 8 GW for offsite projects. In 2018, there were 1.3 GW and 2.1 GW of commercial and industrial on-site renewables contracted respectively. In 2019 alone, over 2.5 GW of offsite PPAs were contracted (see **Figure 1** and **Figure 2**).

The RE-Source Platform was founded in June 2017 as an alliance of stakeholders representing renewable energy **buyers** and **sellers**. The Platform pools resources and coordinates activities to promote a better framework for **corporate renewable energy sourcing** at EU and national level.

Corporates have a variety of different drivers for looking to source power from renewables, but the possibility to lower and fix electricity costs is a major part of the rationale for these deals. A recent survey of 1,200 companies across six countries showed that, of those sourcing renewables, 92% of them are doing so in order to reduce energy costs[1]. Although decarbonisation commitments often provide the initial driver to consider renewable corporate sourcing, the ability for a PPA to reduce energy cost volatility and generate savings on energy bills over the long term is cited by most corporates as providing the main business case.

The potential for the renewable **corporate sourcing** market in Europe, which includes both PPAs and other forms of **corporate sourcing**, is significant. Europe has a less mature market than the United States in this respect, where renewable PPAs have been commonplace since 2013, as shown in **Figure 1**.

FIGURE 1
Global corporate offsite PPA volumes, by region



Source: WindEurope

1. BayWa r.e. Energy Report 2019, published in partnership with the RE-Source Platform. Available here: https://www.baywa-re.de/en/energy-report-2019/

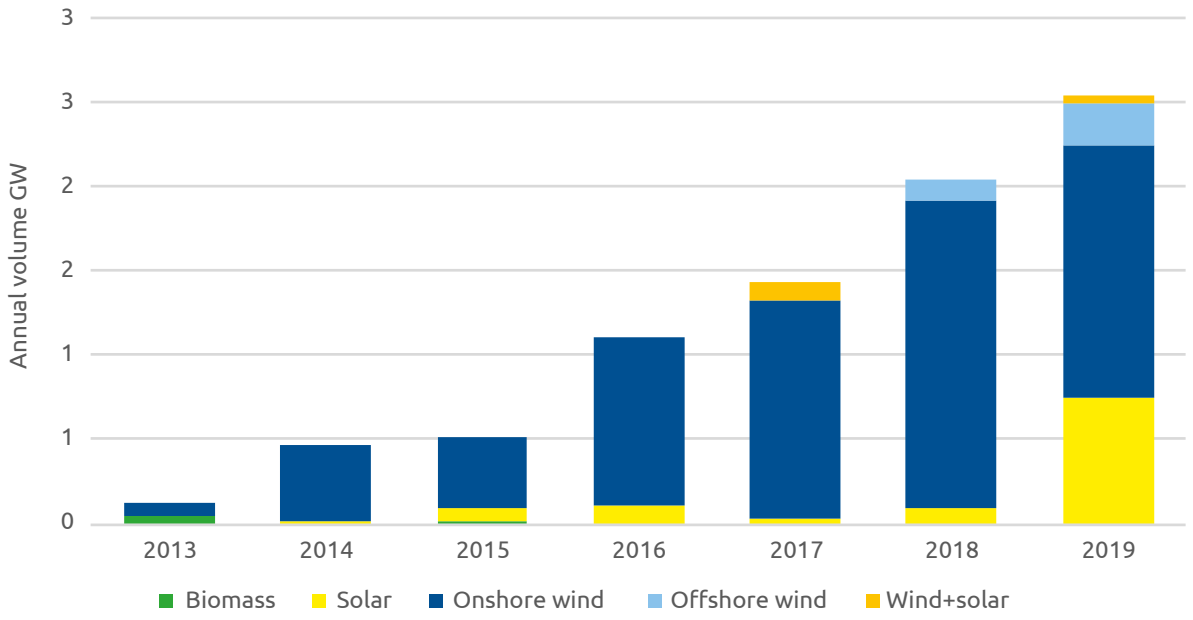
Around 85% of corporate renewable PPAs in Europe have been signed for wind energy. This is largely because much of the activity has been focused in Norway, Sweden and the UK; all countries with a high wind resource. Additionally, wind projects are typically larger than solar PV projects, allowing corporate **buyers** to procure larger volumes of power in single transactions.

In 2019, solar photovoltaic ("PV") PPAs accounted for almost 30% of the contracted capacity, including 199 MW contracted by Amazon Web Services in Spain, 160 MW contracted by Google in Denmark, and 143 MW signed in France by SNCF.

Long-term PPAs are used by r**enewable power plant** developers to secure a project's future income and provide assurance to lenders that loans can be repaid; in other words: to improve a project's bankability in the absence of stable income from government support schemes. However, these PPAs have an inherent number of risks which corporates are typically not used to dealing with.

Traditionally the risks associated with long-term energy contracts have been dealt with in Europe by utilities which have a deep understanding of the energy market and large diversified portfolios of projects and technologies to spread the risk. They have had to develop sophisticated strategies to incorporate an increasing amount of variable **renewable electricity**. As renewables become the main energy technology for large energy companies and new **renewable energy suppliers** enter the market, corporates are increasingly interested in signing long-term PPAs. It is essential they gain an understanding of the risks they could be exposed to.

FIGURE 2
European corporate offsite PPA volumes, by technology



Source: WindEurope

Towards 100,000 corporates...

There are a number of different risks for corporates to consider when entering into a long-term renewable PPA compared with a traditional electricity contract. The RE-Source Platform recognises that it can be difficult for a corporate new to this market and has committed to creating a European Renewable Energy Buyers' Toolkit to help navigate the market with increased confidence. This report is part of that toolkit.

FIGURE 3
The European Corporate Sourcing Buyer's Toolkit

Other products in the Toolkit include:

- The *Introduction to Corporate Sourcing of Renewable Electricity in Europe* report which gives an overview of the more common models of renewable energy procurement in Europe.
- The *European Corporate Sourcing Directory* which sets out for each European country which models of corporate sourcing are administratively possible and which are known to have been used.
- The *EFET Template Corporate PPA Contract* which can be used as a starting point for PPA contract negotiations. It was developed by the European Federation of Energy Traders (EFET) and released in 2019.
- PPA Training Courses across Europe, provided by our partner Pexapark.

The RE-Source Platform is helping **buyers** and **sellers** to work together to help simplify transactions and reduce costs in the market whilst ensuring the innovation necessary for the development of the market is not hindered.

This is a new and constantly evolving market in Europe and across the globe. This report is designed to help corporates understand the risks associated with renewable PPAs, learn about the tools available to mitigate them and thereby encourage more active corporate **buyers** of **renewable electricity** in the European market. We hope that this will help us to achieve our goal of increasing the 100 companies leading the way in renewable energy sourcing to the 100,000 we need to make the difference.

#100to100k

Risks associated with corporate renewable PPAs

The corporate renewable Power Purchase Agreement (PPA) is an electricity supply contract between a **renewable power plant** (or several power plants) and a corporate **buyer** (or several buyers). The corporate PPA has developed from a traditional supply contract between utilities and conventional power installations. However, the risks associated with a **renewable electricity** supply are significantly different to the risks involved with a conventional electricity supply. This is because **renewable power plants** have zero cost for fuel and produce based on the resource availability (which is variable) whereas conventional power producers' costs are dependent on fuel prices but can produce a stable output, generally better matching the buyer's demand profile.

As such, the corporate renewable PPA has developed into an extensive legal document with a myriad of clauses to assign the various risks to the relevant counterparties. As corporate PPA contracts become more commonplace, various innovations are likely to simplify the burdensome contracts and a number of different methods to mitigate the various risks for each party are likely to evolve.

This report, with contributions from the providers of such risk mitigating products, aims to provide corporates new to renewable PPAs with information on how risks can affect their business and the various strategies/products available to mitigate them.

The report is not a comprehensive database and is intended to be a dynamic resource with more tools added as they become available or when a mitigation provider contributes to it.

If you would like to contribute to this report with an example of a risk mitigating service or tool which you provide, please contact info@resource-platform.eu

On the next page **Table 2** sets out the main risks which should be considered when working with long-term corporate renewable PPAs.

TABLE 2
Risks associated with corporate renewable PPAs

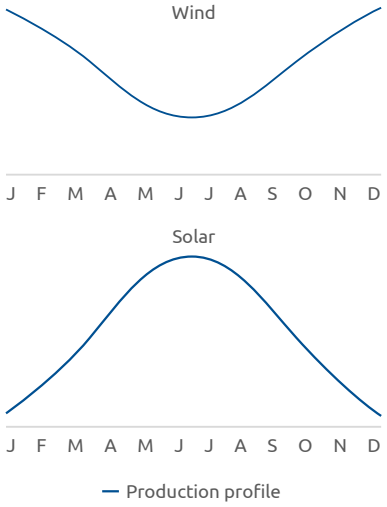
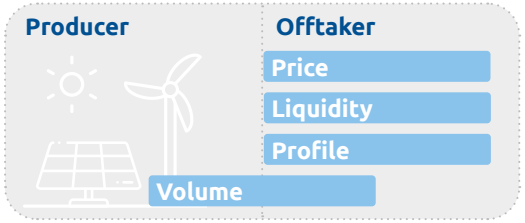
Risk	Summary
Development	The **renewable power plant** is not consented/permitted or constructed on a timely basis or at all
Performance/Operational	The **renewable power plant** does not perform as expected (for example it fails to achieve a minimum agreed level of operational availability)
Volume	The **renewable power plant** does not produce the volume expected from modelling of long-term (i.e. 20-30 years) meteorological data as a result of different than expected resource levels (wind speed / solar irradiation etc.)
Shape/Profile	Even if the overall volume of output is produced as expected, the hourly production from a **renewable power plant** will differ from a 24-hour baseload delivery of electricity (quoted for standard products). Differences in hourly prices lead to a production value which is greater or less in aggregate than the equivalent standard baseload product
Cannibalisation	The spot price of electricity has a negative correlation with the supply of **renewable electricity** and this is expected to increase as more **renewable electricity** penetrates the market. For example, when the wind is blowing, more electricity from wind farms enters the grid at very low marginal cost and the abundance of cheap power pushes prices down. When the wind is not blowing and the wind farms are not producing power, spot prices are likely to rise again. The same negative correlation applies to solar photovoltaics
Basis	The reference price of electricity for payments in the PPA contract can differ from electricity prices that the corporate **buyer** is exposed to under its local (physical) electricity supply arrangements (more relevant for financial PPAs or physical PPAs in markets with zonal pricing)
Balancing	The hourly deviations between scheduled production and real production due to error in weather/ electricity production forecast
Credit – settlement	The **buyer** may pay late or fail to make a payment at all for the electricity delivered
Credit – replacement	The **buyer** may default (or the subsidy may be cancelled or altered) and a replacement arrangement has to be made
Liquidity	Electricity cannot be traded quickly enough to avoid a change in price, determined by the bid-ask spread
Price	Losses can occur from adverse movements in the market price of electricity. For instance, if a corporate **buyer** locks in a price based on projections of future prices and the spot price falls below the agreed PPA price for long periods
Merchant risk	The combination of revenue (or cost) risks for a **seller** (or **buyer**) arising from an unknown volume **and** unknown price of electricity to be produced
Tenor / Length of contract	The **buyer** (or seller) can be locked into costs which can be above or below market price. The risk increases with length of contract
Legal	Credit support, Force Majeure, Change of Control, Termination, and Conditions Precedent amongst other key clauses that need to be negotiated
Changes in law	Changes in law may affect the balance of benefit or risk between the parties, e.g. tax changes
Regulatory	Regulatory changes can affect the economics of a project. For example, retroactive changes to Feed-in Tariffs systems seen in Spain, Romania and the Czech Republic in the early 2010s
Force Majeure	Events can occur which are out of the control of any of the parties involved which can delay the completion of a project or impact its generation e.g. flood, fire or storm damage

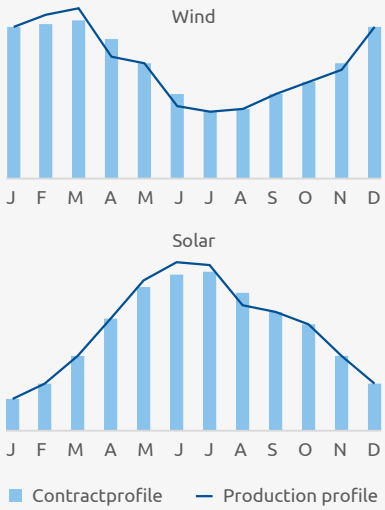
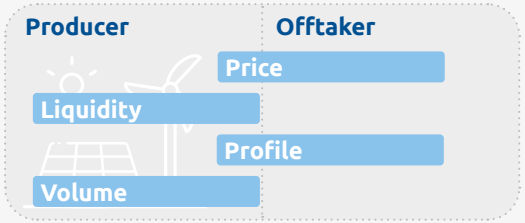
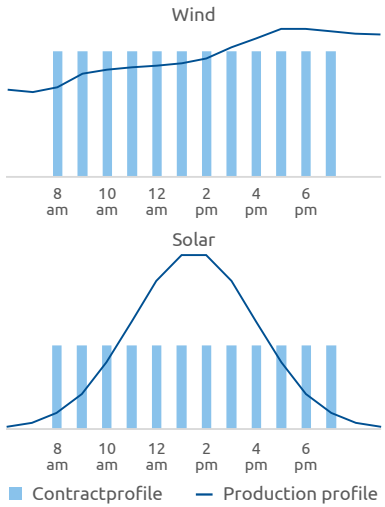
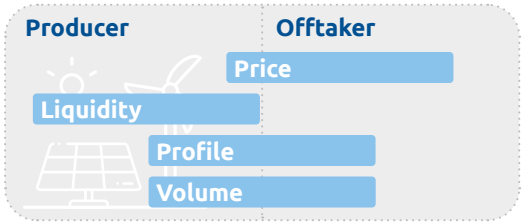
Contract structures and allocations of key risks

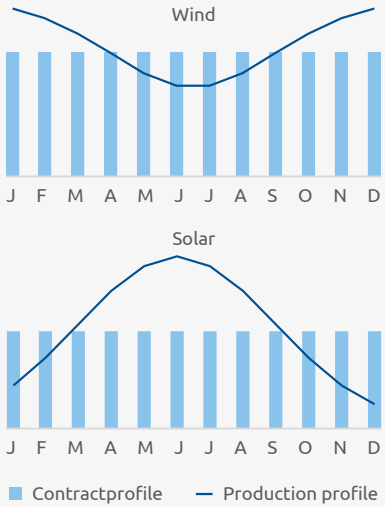
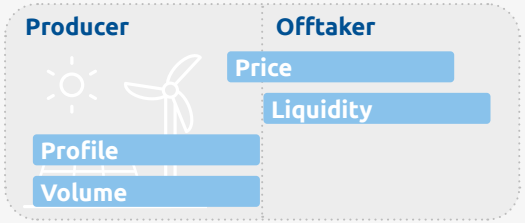
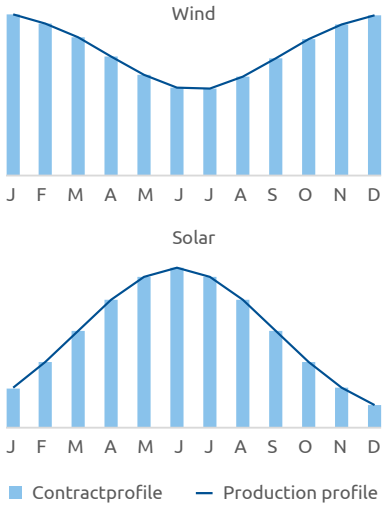
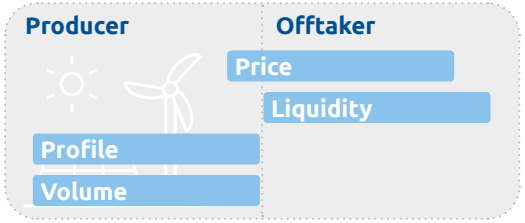
The allocation of the risks presented in **Table 3** will be determined in the negotiation of a PPA contract. However, there are five common contract structures which have typical volume, price and profile risk allocations, as shown below. Each of the five contracts can be applied under different business models.

A full description of these business models can be found in the Introduction to Corporate Sourcing of Renewable Electricity in Europe report.

TABLE 3
Five common PPA contract structures

Contract structure	Details	Production profile	Profile, price and volume risk allocation	Business models
Pay-as-produced	The sale of electricity is at a pre-defined fixed price and the **buyer** is obliged to pay for any volume produced by the **renewable power plant.**		**Price risk** and **profile costs** are borne by the **buyer** as the PPA price remains fixed for the tenor of the contract. The **volume risk** is theoretically carried by the **buyer**, but the **seller** remains liable in case of under- or over-performance. 	A3 On-site PPA A4 Private-wire PPA B1 Physical PPA B2 Financial PPA C2 Multi-buyer PPA C3 Multi-seller PPA C4 Cross-border PPA C5 Multi-technology PPA C6 Proxy generation PPA

Contract structure	Details	Production profile	Profile, price and volume risk allocation	Business models
Pre-defined profile	Electricity is sold with a pre-defined daily profile. For example, an artificial solar profile on a fixed volume (say 70% of P50) based on a monthly average of historical production profile (same daily profile for all the days in January, etc.) scaled with specific monthly values. This gives a different 24-hour production profile for every month of the year.		The **profile risk** is partly borne by the **seller** but mostly borne by the **buyer** under this structure. The **volume risk** is carried by the **seller** as the volumes are to be guaranteed on a monthly basis by the **seller** regardless of weather conditions. The **price risk** for the contracted volume is borne by the **buyer** (they may end up paying more than the market price). The uncontracted volume (e.g. 30% of P50) has a lower value depending on the profile value of renewable power. 	B1 Physical PPA B2 Financial PPA C2 Multi-buyer PPA C3 Multi-seller PPA C4 Cross-border PPA C5 Multi-technology PPA C6 Proxy generation PPA
All day peak load	All day peak profile has the same volume for all hours 8am-8pm in January, etc. scaled with specific monthly values .		About 50% of the **profile** and **volume risk** is carried by the **seller**. The **price risk** for the contracted volume is borne by the **buyer**. 	B1 Physical PPA B2 Financial PPA C2 Multi-buyer PPA C3 Multi-seller PPA C4 Cross-border PPA C5 Multi-technology PPA C6 Proxy generation PPA

Contract structure	Details	Production profile	Profile, price and volume risk allocation	Business models
Annual baseload	A contract that commits the **buyer** to purchase a fixed volume of electricity for every hour or day over the year. This implies that the difference between the actual volume produced and the fixed volume payed by the contract must be settled at the spot market inducing a cost or gain for the **seller**.		The **profile risk** is borne by the **seller** under baseload contracts. The **volume risk** is carried by the **seller** as the volumes are to be guaranteed on a yearly basis by the **seller**. The **price risk** for the contracted volume is borne by the **buyer**. 	B1 Physical PPA B2 Financial PPA C2 Multi-buyer PPA C3 Multi-seller PPA C4 Cross-border PPA C5 Multi-technology PPA C6 Proxy generation PPA
Monthly baseload	A contract that involves the purchase of a fixed and constant volume of electricity for every hour (or day) over each month, usually to account for the expected seasonal variation of the production. This implies that the difference between the produced volume and the fixed volume payed under the contract has to be settled at the spot market inducing a cost or gain for the **seller**.		The **profile risk** is borne by the **seller** under baseload contracts. The **volume risk** is carried by the **seller** as the volumes are to be guaranteed on a monthly basis by the seller. The **price risk** for the contracted volume is borne by the **buyer**. 	B1 Physical PPA B2 Financial PPA C2 Multi-buyer PPA C3 Multi-seller PPA C4 Cross-border PPA C5 Multi-technology PPA C6 Proxy generation PPA

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Part 2.

Risk mitigation for corporate renewable PPAs

Risk mitigation products

The following sections of this report have been written by the providers of services and tools which help mitigate some of the risks associated with corporate renewable PPAs.

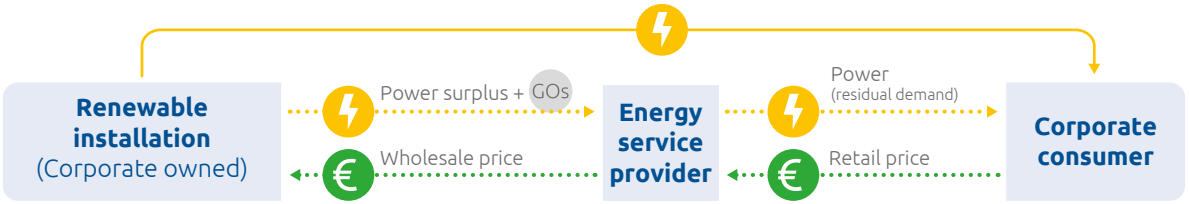
Table 4 sets out the risks identified in **Table 2** which can be mitigated by the services/products described in this section.

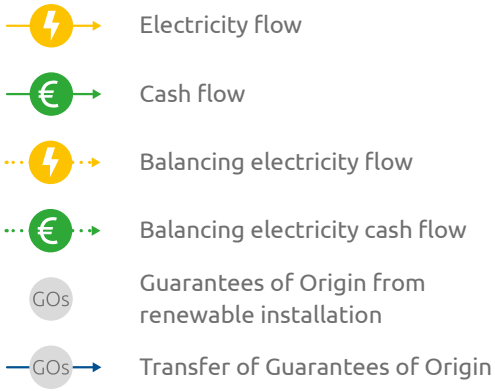
TABLE 4
Risk mitigation products checklist

Risk	Risk mitigating service/product			
	Third party	Volume Firming Agreement	Proxy Generation VFA	Energy Exchange
Development	•			
Performance/Operational			•	
Volume	•	•	•	
Shape/Profile	•	•	•	
Cannibalisation	•	•	•	
Basis				
Balancing				
Credit – settlement				
Credit – replacement				
Price	•			•
Legal	•			

Key for electricity and cash flow diagrams

The diagrams of contract structures in part 2 have been designed consistently with the Introduction to Corporate Sourcing report, the main features are shown in the key below.





Managing risks through a third-party

(Text provided by AXPO)

In a merchant risk world, **renewable energy suppliers** and corporates **buyers** are exposed to volatile electricity prices. A corporate PPA can seem like the obvious solution for both parties if the buyer can achieve prices lower than current market prices at an acceptable risk, and the **renewable power plant** owner secures an acceptable return on their project over a suitable long-term period. However, entering into a corporate PPA may not be straightforward for all corporates and counterparties.

The Nordic area has dominated the corporate PPA market in recent years. The Nordics have a well-functioning spot market and a financial market available for long-term hedging. The financial market has been struggling with falling liquidity in recent years, but still serves as an important marketplace for **sellers, buyers** (corporates or industrials) and utilities to manage their energy risk. This market should be seen as a benchmark to bilateral renewable electricity sourcing, and will still serve as an important tool for risk management in a corporate PPA world.

Figure 4a and Figure 4b show two common structures for a corporate PPA. The PPA can be either Physical (also known as Sleeved) or Financial (also known as Virtual or Synthetic). For more information, see the report Introduction to Corporate Sourcing of Renewable Electricity in Europe.

FIGURE 4A
Corporate renewable PPA via Physical contractual structure

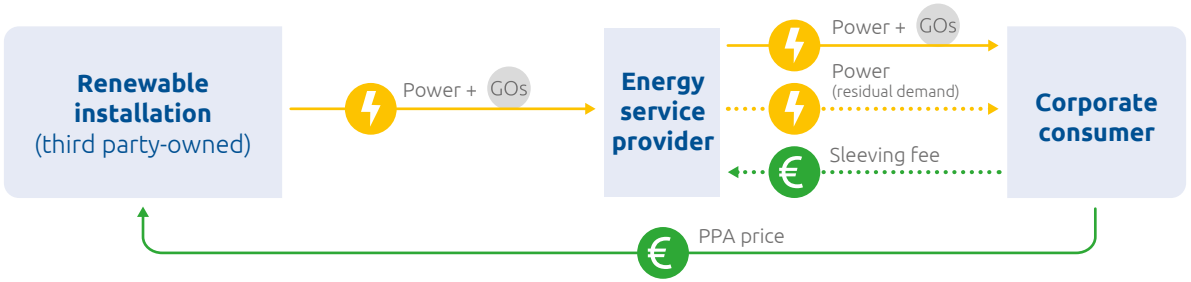


FIGURE 4B
Corporate renewable PPAs via Financial contract structure

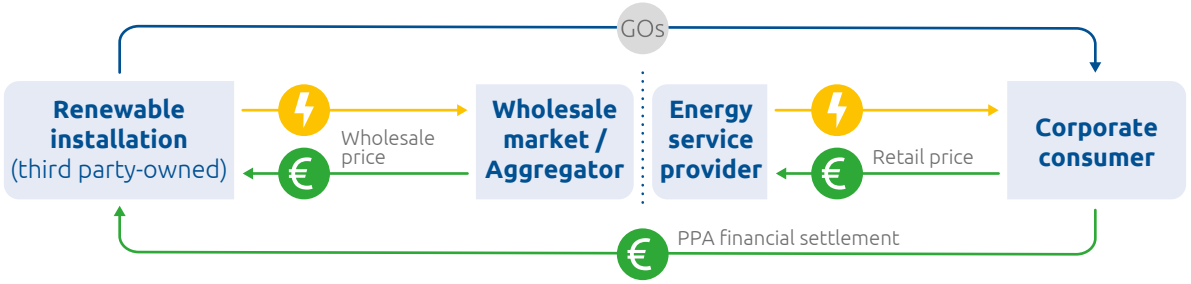


FIGURE 5

Corporate renewable electricity supply via Energy Service Provider

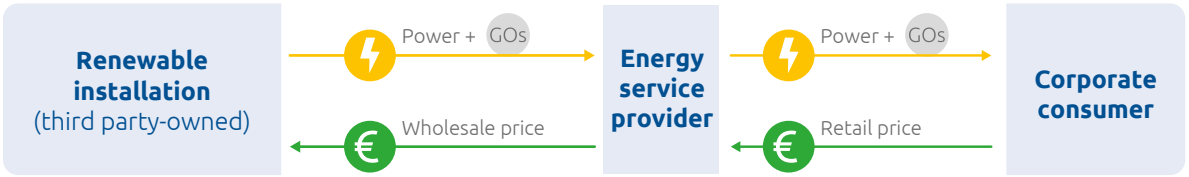


Figure 5[2] shows an alternative procurement structure as a renewable electricity supply contract via an Energy Service Provider.

In **Figure 4a** and **Figure 4b** the corporate buyer and the **renewable power plant** (sometimes structured as a Special Purpose Vehicle or 'SPV') have a direct PPA agreement, whereas in **Figure 5** the renewable power is procured through an electricity supply contract via a utility/third party energy service provider.

There are a number of different and additional risks for corporate **buyers** to consider when entering into a long-term renewable PPA compared with a traditional electricity contract, and these risks have been described earlier in **Table 2**.

If a corporate **buyer** is comfortable and capable of managing most of these risks, or if the corporate has a strategic reason to build this internal competence, then the structure illustrated in **Figure 4** could be the preferred solution with the lowest long-term transaction cost. If this is not the case, the corporate could involve a professional third party to ensure that all risks are understood and priced according to best practice.

Non-construction and credit risk

A PPA is commonly signed at or before financial close, meaning that the price and contractual terms are closed before construction and commissioning of the **renewable power plant**. Depending on the size of the power plant a PPA can be signed several years before actual electricity production and delivery starts.

For a corporate **buyer** it is important to manage the risk from signing up to the commercial operation date (COD). In a situation where the project does not reach COD, experiences a lack of capacity, or if the project timeline is delayed, this could cause substantial financial loss to the **buyer**, as market conditions could change significantly. It is therefore important that the buyer secures guarantees to cover these potential losses. The size of this guarantee will depend on the market situation and characteristics where the PPA is signed, the counterparty and its stakeholders.

Counterparty and credit risks are also central for the whole duration of the contract, and the **renewable power plant** or SPV will most likely demand guarantees from the corporate **buyer** once the PPA starts delivery. If a third party steps in as illustrated in **Figure 5**, the **buyer** is not exposed to pre-COD risk, if the Energy Service Provider guarantees to source the renewable power from an alternative plant.

2. Note that renewable electricity supply models are not included in the contracted volumes in Figure 1 Global corporate offsite PPA volumes, by region or Figure 2 European corporate offsite PPA volumes, by technology

Market price, volume and cannibalisation risk

A typical PPA would be a fixed-price contract (with or without inflation-based indexation) with a duration from 10 to 15 years. The fixed price will depend on what type of risk the various parties are taking on. The common price structures are listed in **Table 3**.

A **renewable power plant** is usually willing to give a significant market price discount for a "pay-as-produced" contract as it leaves them with a very secure cash flow with no price and volume risk (if they sell 100% of the volume). However, not all corporate **buyers** have the resources and competence to manage this type of PPA, and cannibalisation risk is very difficult to sell (because counterparties are cautious of purchasing output at a fixed price when there is a risk that the market price at the time of production could be lower). In a market with increasing variable generation, cannibalisation risk is a growing concern for **sellers** and **buyers**.

For wind projects a profiled forward (or monthly baseload) is a baseload contract with a "winter profile", meaning that the contracted volume is higher during winter than summer. This is a good match with the positive seasonal production of wind power but requires more sophistication when pricing. A baseload contract is usually a good match for a corporate **buyer** but leaves the wind energy installation with the volume and cannibalisation risk.

Utilities and aggregators can shape PPAs to make them a better fit for corporate **buyers**. We see **renewable power plants** selling PPAs to utilities that allow them to get rid of some volume risk, or to get a price premium on a pre-defined profile contract, and then utilities and aggregators sell it on to the corporate **buyer** as a baseload (**Figure 5**). This structure allows both parties to get rid of the liquidity risk they would face in the financial market, or a stand-alone financial hedge, which could be significant for long term contracts. The better the fit for the corporate **buyer** and **renewable power plant** with regards to desired hedging volume and tenor, the lower the liquidity risk.

It is important to highlight that the financial market still serves as the most important marketplace for energy risk management for all market players, and any remaining risk after signing a corporate PPA can most likely be managed in this market. Creating parallel trading platforms for corporate PPAs that attempt to detach these transactions from the financial market could impact market liquidity, increase the cost of risk mitigation and reduce transparency even further, leading to a collective disadvantage for all market players.

Transaction cost and timing risk

A corporate PPA is not a standardised product, since every PPA is unique. Negotiating a PPA is a time-consuming affair and often demands specialised legal competence, commercial/financial advice and local market knowledge. In some countries in Europe, utilities or professional third parties can offer legal and contractual competence, assisting the corporate with negotiation of more standardised financial (or physical) baseload contracts. Utilities can offer market insight as well as pricing of risk and PPAs for all parties involved.

Hedging in the financial market is the actual alternative cost of a corporate PPA, and it is important that all transaction costs are taken into account when considering different hedging alternatives. In a volatile market, timing is everything. At the point of signing, a PPA should reflect all relevant market conditions and the real cost and risks for the corporate **buyer**.

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Managing price risk with Energy Exchange Based Trading

(Text provided by EEX)

With subsidy schemes being gradually phased out across Europe, **renewable power plants** 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 **renewable energy suppliers** and banks, in the case of financial PPAs there is still a price risk exposure to the agreed settlement market for wholesale electricity. For a corporate **buyer**, the price risk can be important because they pay a fixed amount for the electricity produced by the **renewable power plant** but receive an amount based on the settlement market price for that electricity.

For several decades, energy trading has primarily been the territory of utilities, trading houses and banks. Now, **renewable energy suppliers** and corporate **buyers** who are exposed to wholesale prices must learn how to employ the financial products available to manage wholesale price risk. This section has been created to help educate newcomers to energy trading, and to provide clarity around the various opportunities it can offer for price risk management across Europe.

The Energy Exchange

An energy exchange is a marketplace where commodities, derivatives and other financial instruments are traded. 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.

A key benefit of trading on an exchange is that the financial settlement is fully managed by the exchange participant's clearing bank and the exchange's clearing house. The clearing house acts as the central counterparty between a buyer and seller. Its main role is to ensure that the buyer and seller honour their contractual obligations through active financial management of counterparty risk. These contractual obligations are primarily distinguished between two types of products normally traded on an exchange: 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 electricity markets, this means the buyer receives the electricity and the seller receives financial payment. However, in the case of spot transactions there is minimal counterparty risk. The clearing house may only ensure that buyers have enough cash available in their clearing bank's accounts in order to fulfil the contract payment. The clearing house manages the physical settlement of electricity spot transactions by interacting with Transmission System Operators (TSOs).

Derivatives products (Futures and Options) leverage the full value of the clearing house. When trading a financial derivative, one is transacting on the future value of an underlying commodity; 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" on the electricity contract and the seller is "Short". 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, which is approximately 3% to 15% of the notional value of the contract. The amount of the Initial Margin is determined by the clearing house. Several factors influence the amount of Initial Margin including the contract size, contract tenor, volatility parameters and underlying liquidity of the given contract. The Initial Margin is reimbursed to the counterparties at the end of the delivery period of the contract.

By trading electricity derivatives products, one can effectively hedge against extremes of future price risk of the electricity spot market. This is because the

"Underlying" (the commodity to which the derivative contract relates) is the average of all relevant daily spot market traded prices for the contract period. Therefore, the outcome of the derivative contract is fully fungible with the spot market value.

Using Power Futures to Manage Price Risk

In the case of Financial 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 energy supplier**. 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 this 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 volume or profile risk 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[3] out to 6 years ahead (Y+6) and longer tenors (up to 9 and 10 years ahead) are being introduced. This allows **buyers** and **sellers** (particularly utilities and aggregators) to transfer a greater portion of their long-term risk to the clearing house and free up more internal capacity to sign additional PPAs.

Due to the size and duration of the long-term deals, market participants will very likely negotiate on the price and volume bilaterally and then "register the trades for clearing" via the exchange's trading system. The contracts then go directly to the clearing house and are commonly said to have been "OTC Cleared", although the legal term according to the EEX rules is "Trade Registration".

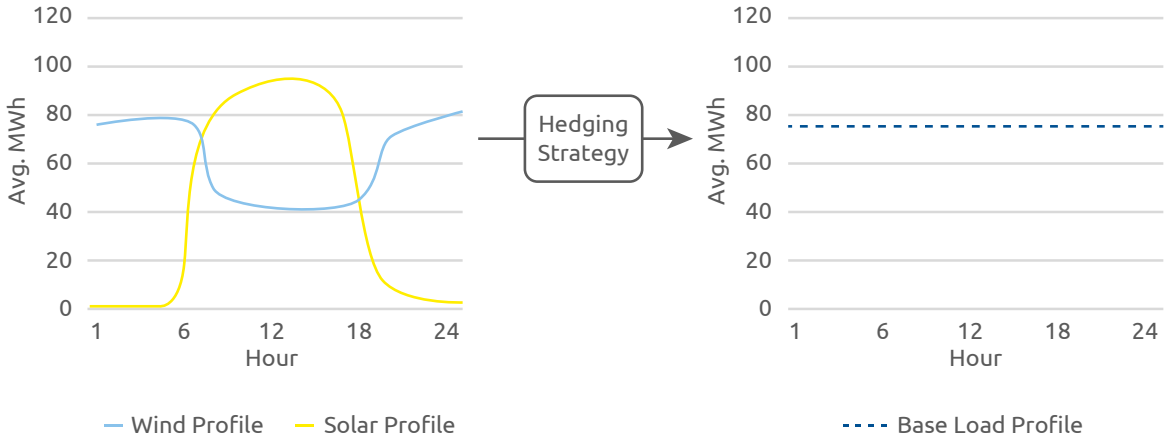
Using the Base Futures for Hedging Wind & Solar Profiles

Using a futures product for hedging works best when the product reflects the actual risk exposure of a wind or solar power plant. However, as many power plants have different profiles and risk exposures, market players have come to the conclusion that using the Base Futures as a best-fit product attracts the most liquidity. This means the majority of **buyers** and **sellers** in an electricity market come together to trade the Base Futures, creating a strong price signal and many opportunities for trading at fair market prices.

In order to use the Base Futures to manage the risk of a wind or solar profile, a translation needs to be made from the variable nature of the generation profile into a constant baseload profile; and a decision needs to be made on the portion of overall risk to be hedged using futures. In order to do this, different hedging strategies can be employed. 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 power plants** are outsourcing this task to utilities' trading desks and energy trading companies.

3. There is no physical delivery of electricity, just an exchange of cash depending on the underlying electricity price at the time of settlement

FIGURE 6
Translating a Wind/Solar Profile into Base Load for Hedging



Wholesale electricity price risk can be hedged using Power Futures; but a solid risk management strategy must be devised to do so. Energy exchanges such as EEX provide the tools to manage price risk across Europe through its extensive Power Futures markets and an established network of trading participants.

The information provided here is a summary of an article written by EEX, you can find the full version here.

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Managing volume risk in Financial PPAs with Volume Firming Agreements

(Text provided by REsurety)

Companies across the globe are setting ambitious renewable energy procurement targets, aiming to achieve the dual mandate of reducing emissions and managing energy costs. While renewables provide a multitude of economic and environmental benefits, **buyers** are also quickly realising the scale and complexity of risks being assumed through their renewable energy contracts and are seeking solutions to efficiently manage some or all of those risks.

The Volume Firming Agreement (VFA)

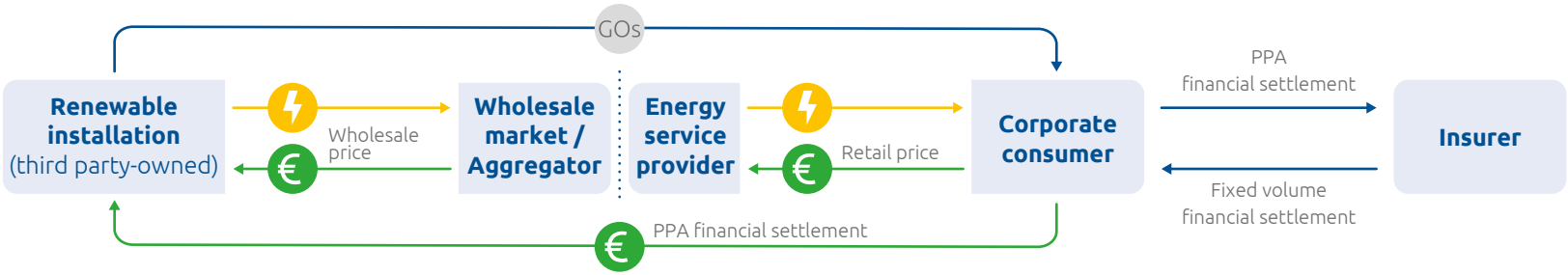
In response, insurance market participants have introduced risk mitigation products that are becoming increasingly common in the USA. One such product is the Volume Firming Agreement (VFA), co-developed and implemented by Microsoft in 2018. This structure is most applicable to a renewable electricity **buyer** that has executed a financial PPA (also known as a virtual PPA) with a **renewable energy supplier** while purchasing electricity at wholesale market prices to meet their physical electricity consumption.

Many corporate customers have a predictable electricity consumption profile and pay variable-rate wholesale market prices for the electricity they use. When a corporate enters into a renewable financial PPA, it agrees to pay a **renewable power plant** a fixed price for the electricity generated and receives an amount based on a variable market price in return.

As a result of these two contracts – the physical wholesale contract for electricity and the financial PPA – the cost that the corporate **buyer** pays for electricity is fixed, but only during the hours when the **renewable power plant** generates exactly the same amount of electricity that the corporate **buyer** physically consumes.

As a result, financial PPAs are only a partial solution to managing energy consumption costs, as hourly over- or underproduction by the renewable energy installation creates exposure to wholesale commodity markets. To address this problem, the VFA transfers the financial risks of a **renewable power plant**'s over- or underproduction from the corporate **buyer** to an insurer, who can diversify that risk across a portfolio of weather-linked exposures.

FIGURE 7
Volume Firming Agreement (VFA)



To illustrate this structure, assume a corporate **buyer** operates a set of Texas data centres with a consistent, 50 MW hourly consumption profile. The **buyer** signs a 10-year financial PPA for the full output of a 100 MW wind farm in the same region that is expected to have a 50% capacity factor. For the next 10 years, the **buyer** agrees to pay the wind project $15/MWh for generated electricity – no matter when and how much power is produced. In return, the **buyer** receives variable payments based on the market price.

Unfortunately, the wind power plant's variable generation does not match the data centres' consistent demand. The power plant might significantly overproduce when electricity prices are low and then significantly underproduce when electricity prices are high. As a result, the corporate **buyer's** all-in electricity costs for any given settlement period actually fluctuates between $14/MWh and $35/MWh.

To solve this problem and enable the financial PPA to serve as a complete hedge on electricity consumption costs, the corporate **buyer** executes a 10-year VFA with an insurer for 50 MW of around-the-clock power. For a $6/MWh cost, the buyer transfers all of the power plant's weather-driven volatility to an insurer, resulting in a constant $21/MWh energy cost – regardless of when and how much the wind blows or the sun shines. As a result, the corporate achieves its dual goals of sourcing **renewable electricity** and locking in its electricity consumption costs.

A number of risks are therefore mitigated through the Volume Firming Agreement:

1. Volume risk[4]: the risk that the **renewable power plant** over- or underproduces electricity (MW) in the settlement period compared with the expected production is removed as the insurer provides a financial settlement for the fixed volume.

1. Shape/profile risk: the risk that the hourly production profile doesn't match the **buyer's** hourly demand profile is removed, particularly the risk that the r**enewable power plant** produces excess electricity when prices are very low or negative and vice versa.

Proxy Generation

It is important to note that insurance providers' typical preference is for VFAs to settle on a resource-based calculation known as Proxy Generation. Proxy Generation is a value calculated using a power plant's operational and meteorological data that reflects the amount of electricity the project should have produced had it achieved its stated operational performance expectations. Using Proxy Generation simplifies the contracting process by removing the need for provisions such as availability minima, production guarantees, and restricted maintenance schedules. Proxy Generation also aligns interests between **buyers** and **sellers** by allocating operational risks such as turbine performance, electrical line losses, turbine availability, and grid curtailment to the **renewable power plant**'s owner. As a result, many corporate customers in the US have already or are planning to sign Proxy Generation-based financial PPAs in order to make it easier to execute a VFA.

See an explanation of Proxy Generation PPAs in the Introduction to Corporate Sourcing of Renewable Electricity in Europe.

We look forward to seeing increased European adoption of VFAs and Proxy Generation in the future. Initial success in the US certainly illustrates these tools' abilities to mitigate financial risks faced by corporate **buyers**. Those interested in learning more about Proxy Generation-based contracts can read the whitepaper co-authored by Microsoft, REsurety, and Orrick, Herrington and Sutcliffe LLP.

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4. Some volume risk remains related to production of Guarantees of Origin which are associated with real-time production. The risk of underproduction leading to failure to meet sustainability targets is retained by the buyer

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Final thoughts

This report does not cover all the risks which corporate buyers are exposed to when entering a long-term PPA but it has been designed to be a living document to be updated with more solutions over time. We hope to cover more risks and new risks which emerge from an electricity market which will necessarily be evolving to incorporate more and more renewable electricity.

If you have any comments, questions, or if you would like to make a contribution to this document, you can contact us at info@resource-platform.eu

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