Introduction to Power Purchase Agreements (PPAs)

by Ralf Bernhard, 06.01.2021

QUICK INTRODUCTION

- MPhil in Sustainability Engineering from the University of Cambridge
- 7 years in renewable energy sector
- Large range of projects, from rural electrification in Africa to large scale development in emerging markets and Europe
- Five years in corporate PPAs, negotiated some of the first deals in certain markets
- Currently working as Senior Originator Renewables at French utility ENGIE based in Berlin

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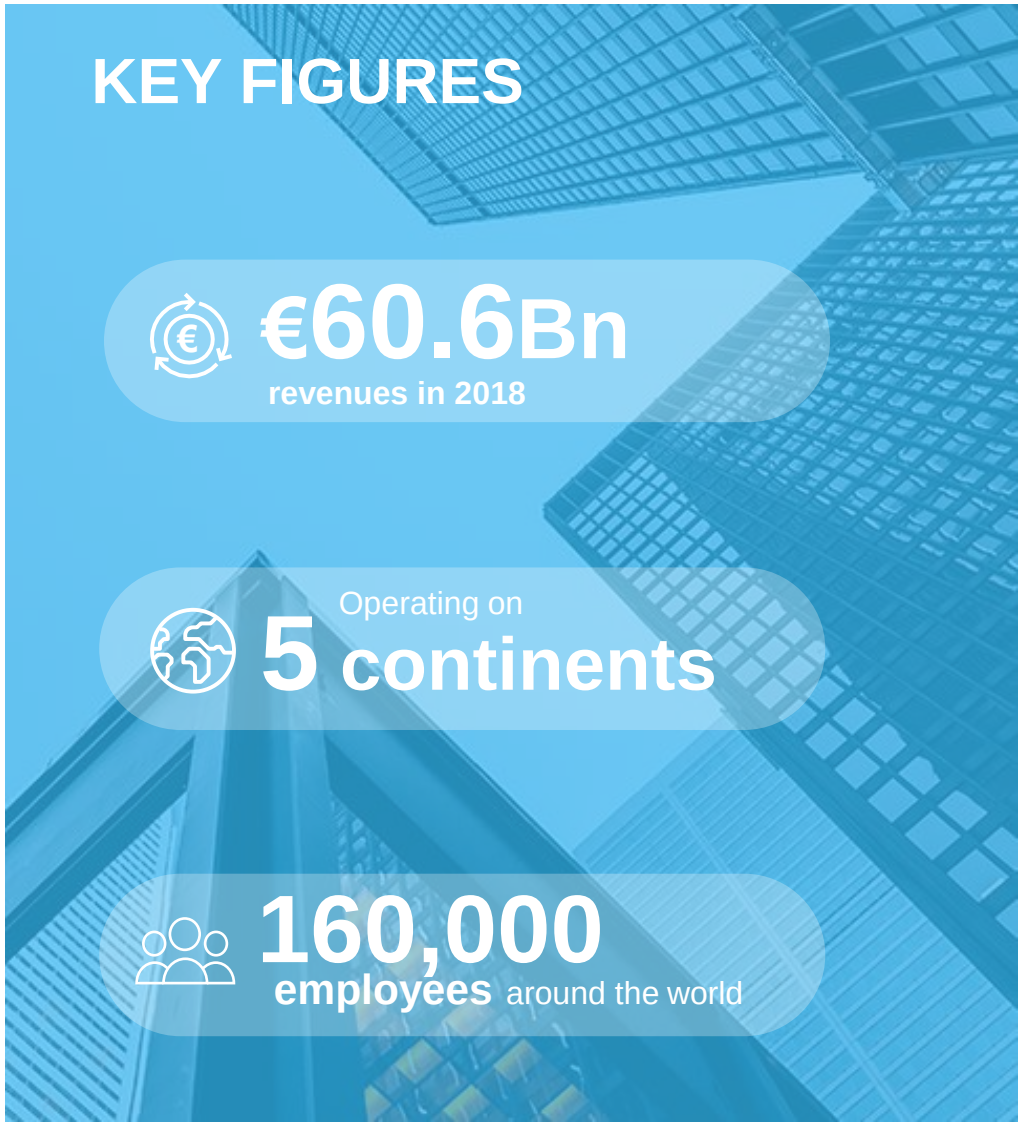
- In response to the urgency of climate change, our ambition is to become **the world leader in the zero-carbon transition "as a service"** for our customers, especially for global companies and local authorities

ENGIE's renewables production capacity*

- **Capacity: 24,3GW**, including hydro (16,4) + wind (5,4) + solar (2) + other (0.5)



*31/12/2018

Disclaimer: *the views, information, or opinions expressed during the lecture series are solely those of the author and do not necessarily represent those of ENGIE.*

CONTENTS

PPAs – The new hype?

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PPAS ARE UBIQUITOUS – WHAT IS GOING ON?

Bayer inks PPA for Iberdrola's 590-MW solar mega-project in Spain

November 17 (Renewables Now) - German pharmaceutical and life sciences company Bayer AG (ETR:BAYN) has purchased the output of the 590-MW Francisco Pizarro solar farm that Spanish utility group Iberdrola SA (BME:IBE) will build in Spain.

The two companies signed a ten-year power purchase agreement (PPA) under which Bayer secured the supply of electricity for its three factories, five research and development centres and the company's Iberian

Iberdrola team building a solar park. Image by Iberdrola (www.iberdrola.com)

Engie signs wind PPA with Air Liquide in Spain

Engie SA signed a 10-year contract to supply wind-generated electricity for Air Liquide International S.A.'s industrial gas production assets in Spain.

The power will be sourced from Engie's wind portfolio in Andalusia, the company said in a Sept. 3 news release. The contract begins in January 2021.

The electricity will be equivalent to 15% of Air Liquide's current consumption for i Spain, enough to power 15,000 households yearly.

Google Pledges 24/7 Carbon-Free Energy by 2030

"We are the first major company that's set out to do this, and we aim to be the first to achieve it," says Google CEO Sundar Pichai.

JEFF ST. JOHN | SEPTEMBER 14, 2020

19 March 2020

Amazon continues PPA surge

By Andries Wantenaar

Amazon has announced a round of investment in four renewable energy projects, continuing its drive for power purchase agreements (PPAs) to power its data centers.

The projects signed include 60 MW from the 165 MW Gunnedah solar farm due for 2021 in New South Wales, Australia; a 122 MW wind project due for 2022 in Vasternorrland, Sweden; a 50 MW solar plant due for 2021 in Zaragoza, Spain; and a 65 MW solar farm in the US state of Virginia.

Ørsted and Covestro Sign Largest-Ever Offshore Wind PPA

December 4, 2019, by Nadja Skopljak

Covestro has signed a ten-year corporate power purchase agreement (PPA) with Ørsted to buy the output of 100MW from the Borkum Riffgrund 3 offshore wind project in Germany.

Related news

Germany's first corporate wind PPA offers model for 6 GW of ageing assets

Feb 6, 2019

Mercedes-Benz' five-year power purchase agreement in Germany shows how owners, offtakers and service companies can mitigate commercial and technical risks to extend turbine lifespans.

In December, Daimler subsidiary Mercedes-Benz Cars signed Germany's first corporate renewable power purchase agreement (PPA) with Statkraft, a power generation and trading company.

From 2021 to 2025, Mercedes-Benz will source 46 MW from six ageing wind farms in northern Germany, commissioned in 1999-2001. The power will supply an electric car manufacturing facility under Mercedes-Benz' commitment to source 100% of additional power purchases from renewable sources.

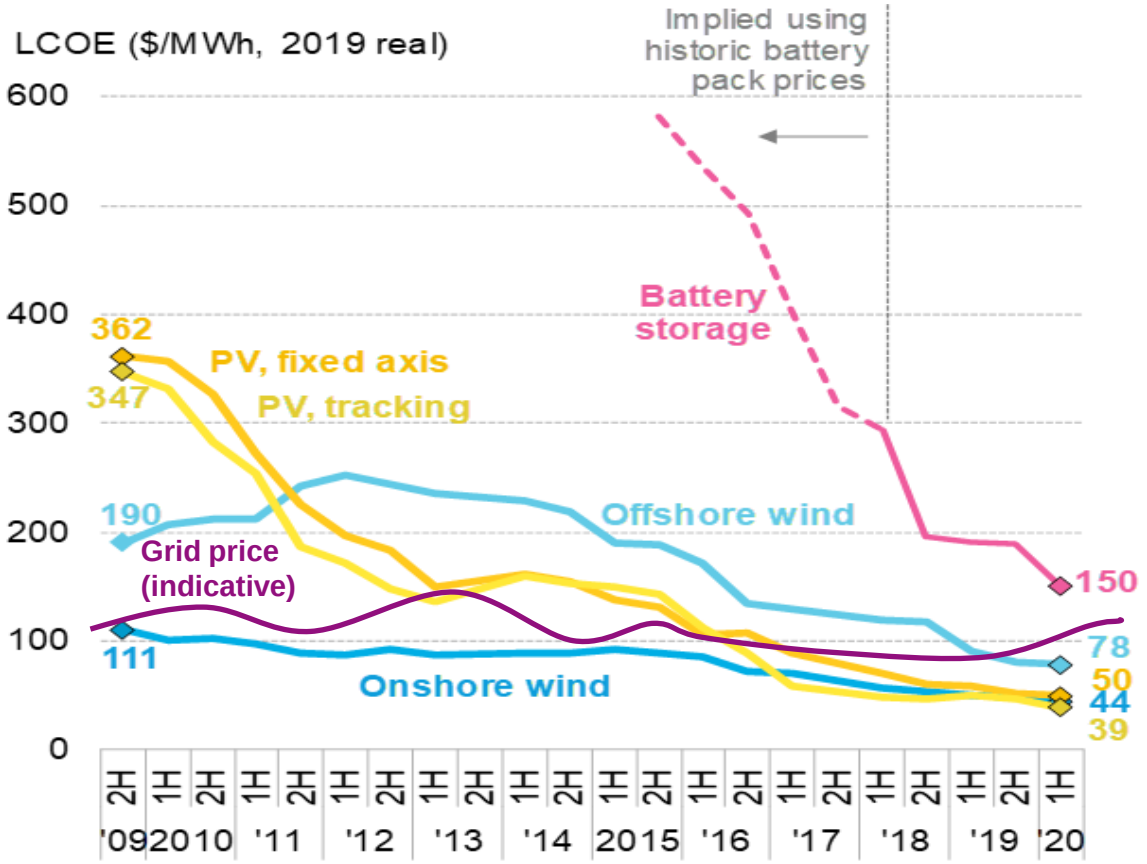
AB InBev to brew 100% renewable in Western Europe under BayWa solar deal

January 9 (Renewables Now) - BayWa re renewable energy GmbH will be providing solar electricity to Anheuser-Busch InBev (EBR:ABI), or AB InBev, so that the Belgian brewer can power all of its Western European operations with renewables.

The unit of German diversified group BayWa AG (ETR:BYW6) said on Thursday it has signed a 10-year virtual power purchase agreement (VPPA) to supply the brewing firm with electricity from two Spanish solar parks of almost 200 MW in total. AB InBev will get the output of an over 130-MW portion of the overall capacity.

AB InBev hq. Author (beer-tower-party.com) License: all rights reserved.

Renewables have become so cost effective, that they are increasingly able to compete with wholesale electricity prices…



Global LCOE Benchmarks, Source: Bloomberg NEF,2020

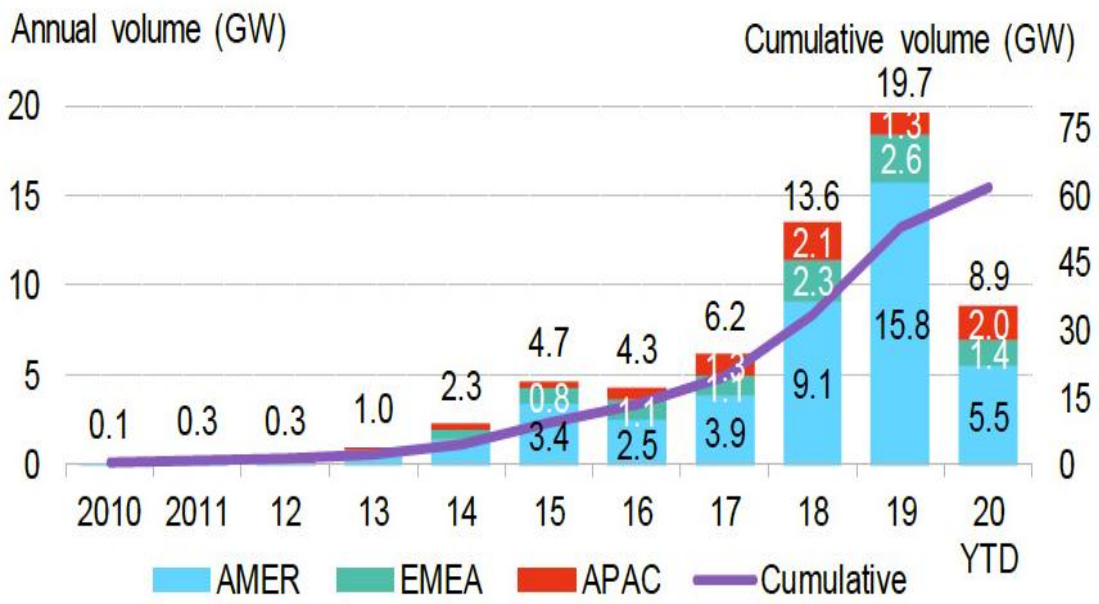
Grid parity as enabler

- The point at which production from renewables becomes cheaper than the cost of electricity on the wholesale markets

- Factors that drive this intersection point:
  - **LCOEs:**
    - Output (irradiation, wind)
    - Development cost (Land, taxes, grid connection, etc.)
    - Technology cost (module efficiency, economies of scale, etc.)
  - **Wholesale cost:**
    - Cost of commodities (Oil, Gas)
    - Cost of Carbon (EU ETS)
    - Electricity demand
    - Merit order

…at the same time an increasing number of companies commit to making their electricity supply 100% renewable…

Cumulative Volume of cooperate PPAs globally



Source: Bloomberg NEF, 2020

RE 100 COMPANIES

260 RE100 companies have made a commitment to go '100% renewable'.

facebook · Carlsberg · BMW GROUP · HSBC · DANONE ONE PLANET. ONE HEALTH · Adobe · DECATHLON · LEGO · H&M · MARS · Microsoft · Unilever · Google · VISA · P&G · IKEA · DSM · TATA MOTORS · ABInBev · Nestle · PHILIPS · AstraZeneca

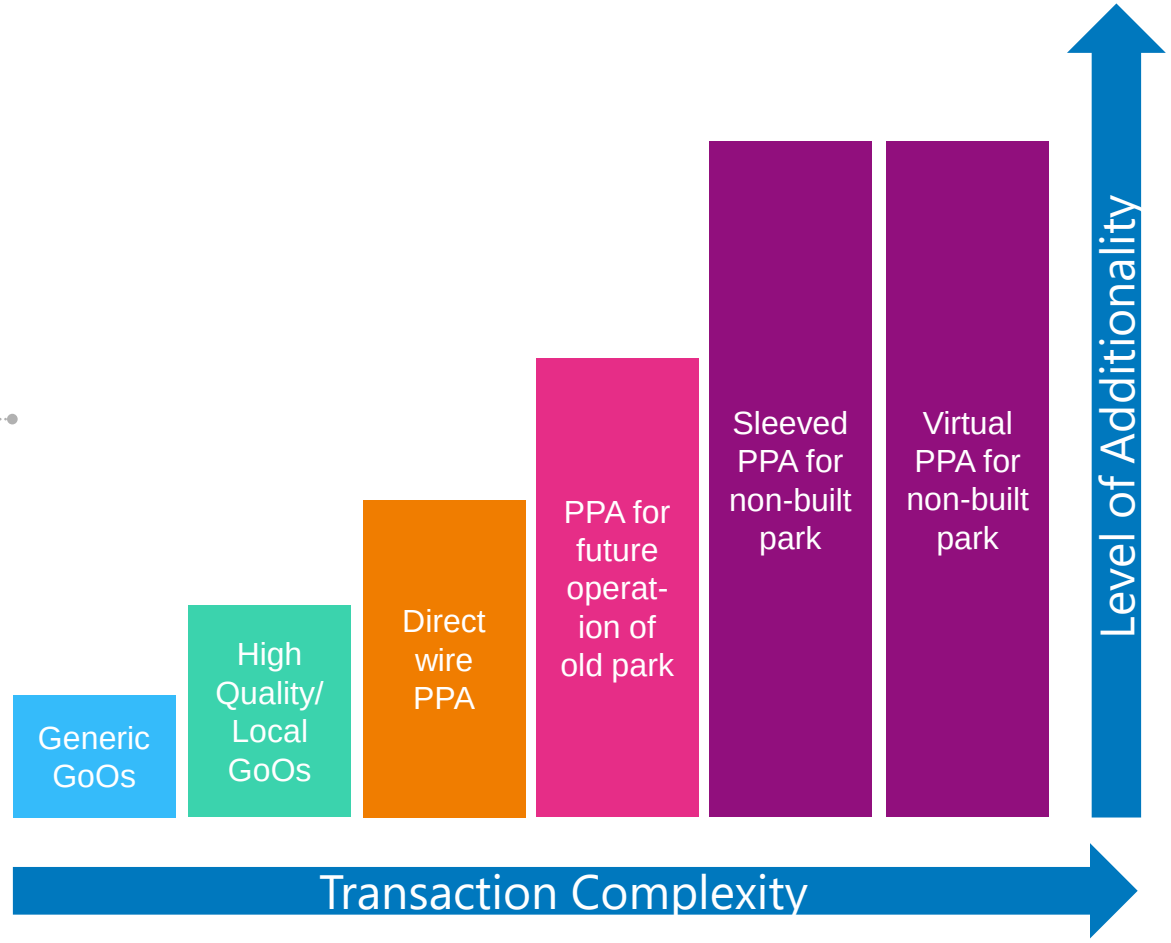
THERE ARE SEVERAL WAYS FOR COMPANIES TO CLAIM CARBON FREE ELECTRICITY SUPPLY

Guarantees of Origin (GoO)

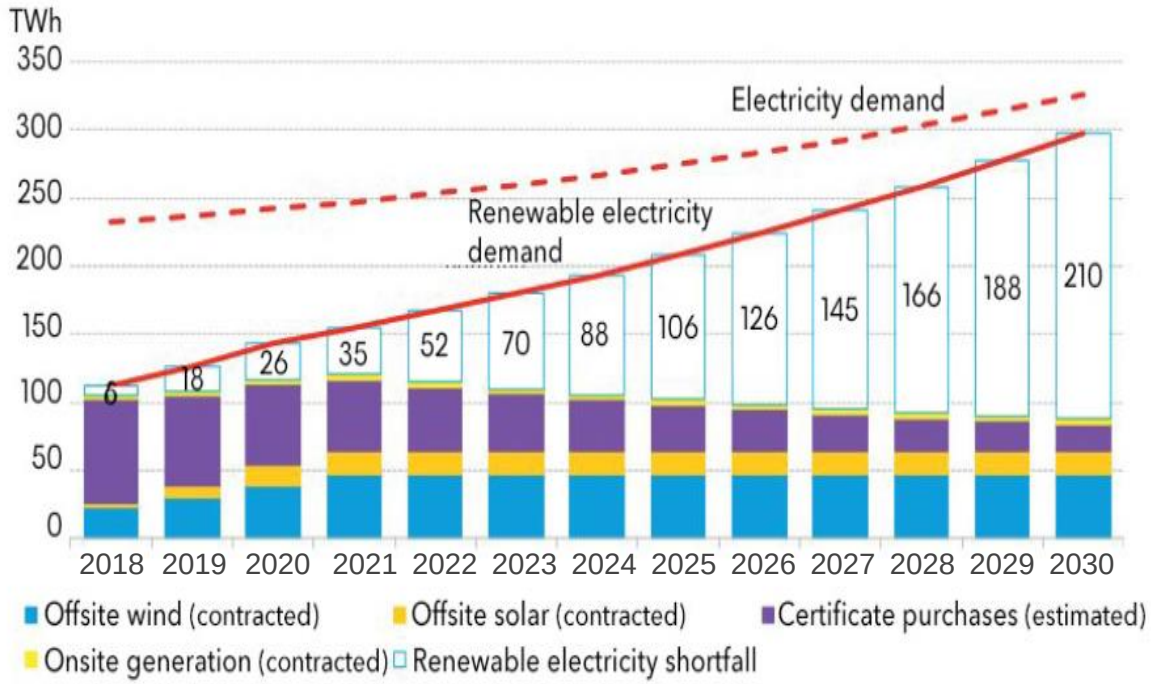
Guarantees of Origin are **a certificate** or a piece of paper, that provide proof that electricity has been generated from renewable energy sources. It **specifies the generation type, the year it was produced, the location and type of the asset and country and date of issuance.** Typically one GoO = 1 MWh.

Additionality

The degree to which the actions of an energy buyer contribute to additional RE capacity on the grid.



To reach their ambitions a lot more renewable capacity will be needed!



Source: Bloomberg NEF, 2020

Key drivers for companies

- Low-cost electricity supply
- Long term hedging of power prices
- Supply chain pressure to decarbonize (Scope 3)
- Investor pressure to decarbonize (ESG-ratings)
- Corporate Sustainability goals
- Public scrutiny

Also in Germany PPAs are gaining strong momentum

Energiekontor und ENGIE schließen 15-jähriges PPA für Solarpark in Deutschland

5. Mai 2020 - Berlin/Bremen. Mit ihrem ersten la
Sonnenenergie in Deutschland bestätigt ENGIE ih
Energien im deutschen Markt.

Umweltbank finanziert ersten förderfreien Solarpark von Baywa re in Deutschland

Der Solarstrom aus der Photovoltaik-Anlage mit 8,8 Megawatt wird über einen PPA von der Baywa re-Tochter Clens abgenommen. Die Umweltbank hat nun eine langfristige Finanzierung für das Projekt gewährt. Die Planungen für das kommende Jahr lassen Finanzierungen von PPA-Projekten mit mehr als 100 Megawatt in Deutschland erwarten.

Daimler and Statkraft Unveil PPA for German Wind Farms After Feed-In Tariff Expiration

Daimler will source electricity for its German Mercedes-Benz Cars manufacturing plants from six community-owned wind farms whose feed-in tariffs expire after 2020.

JUSTIN GERDES | JANUARY 01, 2019

SWM, Hanse Windkraft und Siemens schließen Abnahmevertrag für grünen Windstrom

- Gemeinsam für die CO2-Reduktion
- Siemens Campus in Erlangen vom Tag eins an klimaneutral

So what are PPAs and why do we need them?

PPAs demystified - Types and raison d`être

– 02 –

A PPA is simply a contract between a seller and a buyer of electricity

A power purchase agreement is **a contract between a seller (producer) and a buyer (off-taker) of electricity**, that specifies a certain price, tenure and delivery structure.

Aspects to be negotiated:

- Price of power and pricing mechanism
- Tenure
- Share of contracted volume/delivery structure
- GoOs
- Termination rights
- Damages
- Availability/Volume guarantees
- Change in law
- Force Majeure
- etc.

The goal is to reach a contract that is „bankable“ i.e. it fulfills the requirements of the financing bank (and investors).

! These contracts typically run at least for 10 years and have a face value of > 50 M €.

A well constructed contract with a clear identification of risks is essential. A lot can happen in 10 years…

…see EFET for a template contract.

PPAs for a developer: Cash flow security

Imagine you are a project developer…

…you found a great piece of land, have secured the rights, finished all required studies and were granted a grid connection. You are ready to start construction.

…to start construction you will need some (project) finance from a bank

…the bank wants to make sure you will repay all your principal and interest. As a project company (SPV), your only way to generate cash is the sale of electricity produced by your asset.

Q How can you sell your power?

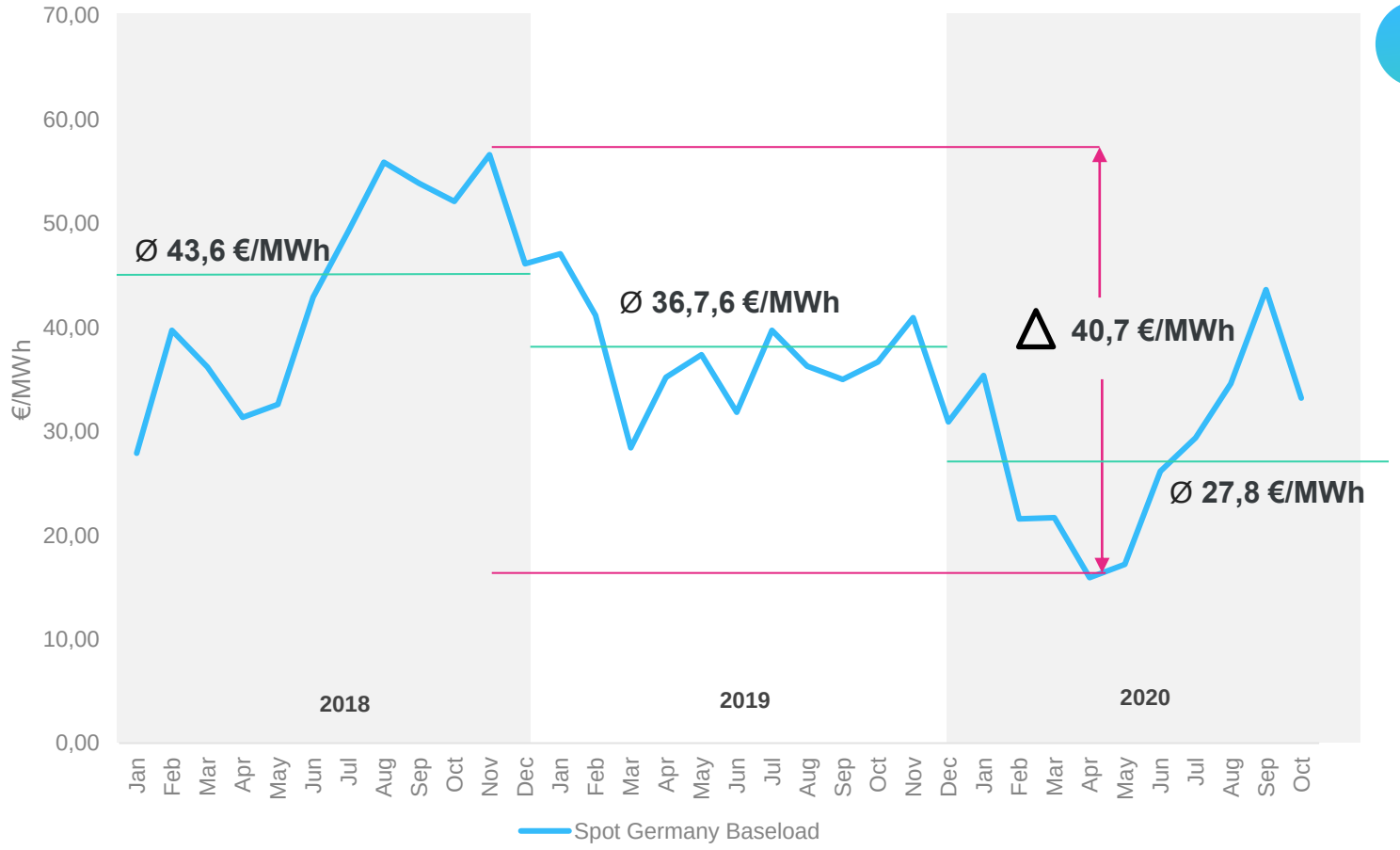
- EEG subsidies
- 3rd party PPA
- Sell on the market (merchant)

Q What will the bank like best and why?

PPAs for a developer: Cash flow security

Year		Key aspects	Banks perspective	Key limitations
2000	EEG subsidies	• Guaranteed feed in tariff for 20 years • Price determined at competitive auction • German state as off-taker with 0 credit risk	• Full plannability over financing horizon • No market price exposure • Revenue risk limited to volume and technical risks	• Uncertainty of competition outcome • Limited to 10 (20) MW project size • Not all areas eligible • Regulatory risks
2020	3rd party PPA	• Off-taker guarantees a price level for delivered electricity • Typically for ~10 years • Creditworthiness?	• (Part of market) price risk is hedged • Credit risk of the off-taker • Contractual risk distribution?	• Suitable corporates that can take off-large volumes for a long contract tenure • Pricing expectations
2030 ?	Sell on the market (merchant)	• All power is sold on the wholesale market as it is produced	• No certainty on cash flows, only fundamental view of market price expectations • High risk exposure due to volatile nature of power markets	• No liquidity on forward markets > 5 years • High volatility of power prices • Uncertainty of future development (cannibalization, commodity prices, etc.)

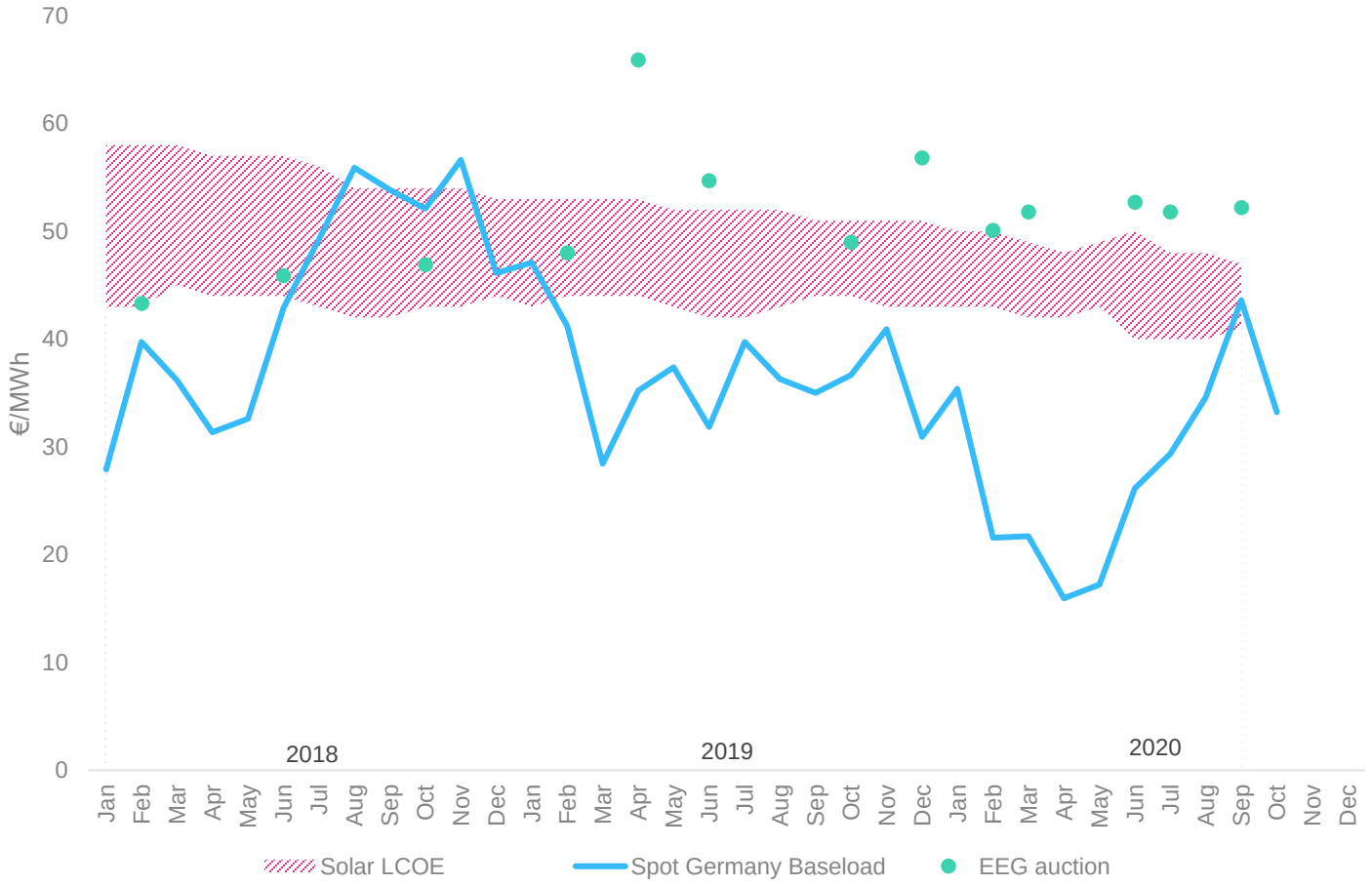
Power prices show a very high volatility exposing producers to cash flow risks



Wholesale power prices

- Wholesale power markets are amongst the most volatile markets
- Delta of 41 EUR/MWh over past three years, 28 EUR/MWh without Covid 19 impact
- High volatility
  - Between years
  - Between seasons
  - Between certain trading hours
- How will volatility develop with increasing penetration of RE?
  - Negative hours?

Power prices show a very high volatility exposing producers to cash flow risks



Q PPA prices vs wholesale

Imagine you had secured an auction price in the Feb 2019 auction for 48 EUR/MWh, your project will get connected to the grid 01.01.2020.

You are also offered a PPA price at 48 EUR/MWh but are also considering going merchant.

In hindsight, which scenario was best for the producer

- in 2020?
- With prices as seen in 2018 in 2020?
- Over the 20-year project life-time?

The contracting parties to a PPA typically have a diverging interest

Seller of power

Project developers/owners (& utilities)

EnergieKontor · ENERPARC · ENGIE · BayWa r.e.

Key drivers
- Long term revenue certainty
- Planning security
- Access to new markets (e.g. no or limited subsidies)
- Get financing for the project

Key interests
- No risks
- High price
- Fixed price
- Long term
- Sell power as its produced

The PPA contract seeks to find a compromise that addresses the needs of the sell and buy side.

Buyer of power

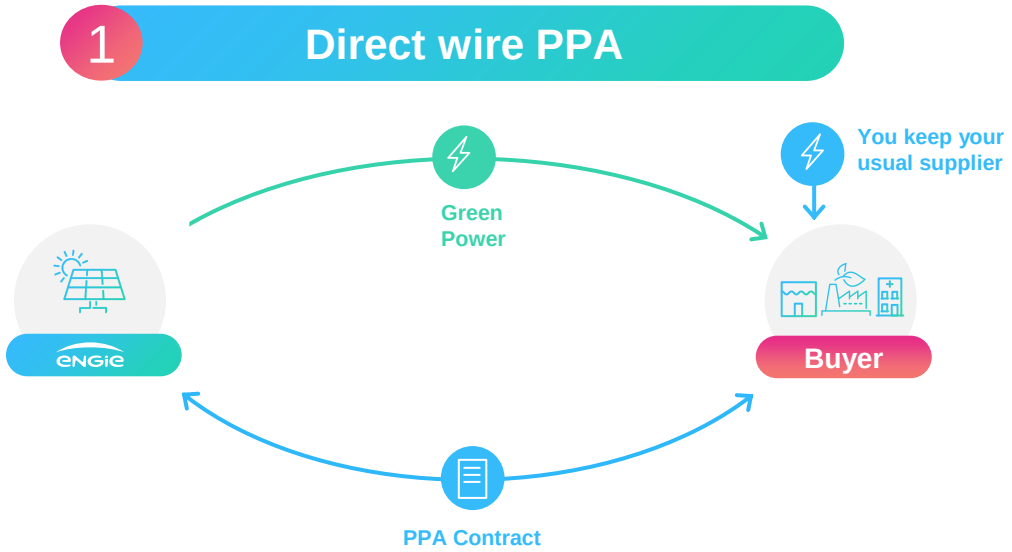
Utilities (Utility PPA) and consumers (Corporate PPA)

ENGIE · E.ON · Microsoft · Google

Key drivers
- Reduced power cost
- Environemntal marketing
- Risk diversification

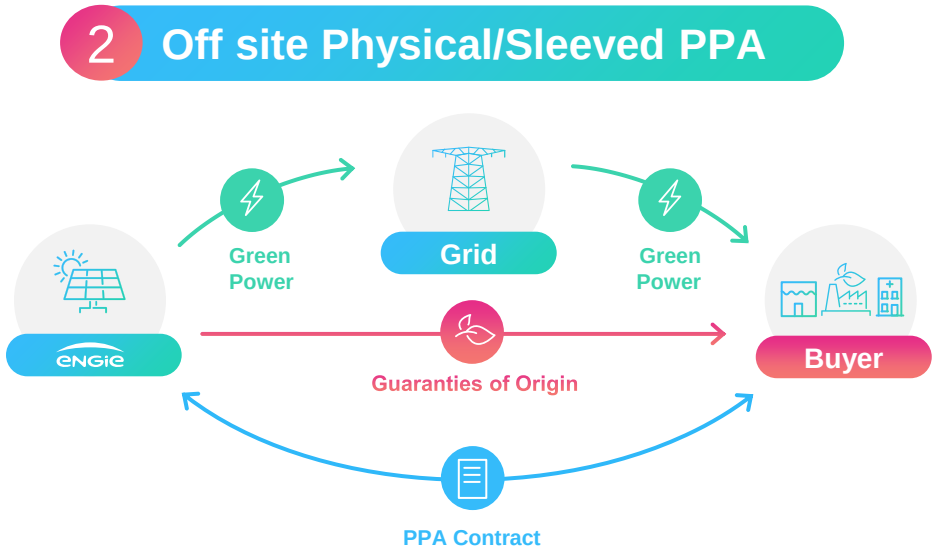
Key interests
- Low risks
- Low prices
- Flexible pricing
- Short term
- Power when needed

One distinguishes between three types of PPAs: Direct Wire PPA, Off-site physical PPA, Off-site financial PPA



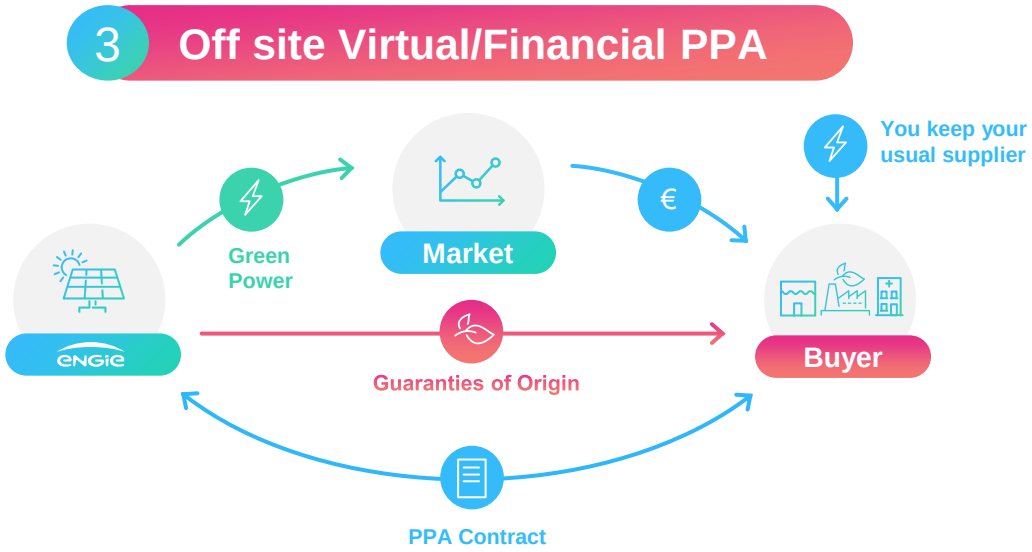
- The solar plant is directly installed at the premises of the consumer and **connected with a direct wire** (rooftop or adjacent land)
- **Green Power is typically directly consumed,** with our without surplus feed in of electricity
- **Size of plant is limited by** rooftop space and space of adjacent land
- Size of plant should reflect the **load of the consumer**

One distinguishes between three types of PPAs: Direct Wire PPA, Off-site physical PPA, Off-site financial PPA



- **Green Power is injected into the Network** and then delivered to the Buyer's designated balance responsible party (BRP)
- **The BRP will handle Green Power injected and add additional power** needed by the Buyer for its consumption profile
- **Guarantees of Origin (GoOs)** are also delivered to the Buyer for its environmental reporting
- The **consumer has no direct connection** to the RE plant, but is within the same grid network
- **Independent of consumption location** within the grid network, e.g. the wind plant could be in Hamburg, the factory in Munich
- **Possibility to build larger plants**, since not confined by rooftop space or land owned by the consumer

One distinguishes between three types of PPAs: Direct Wire PPA, Off-site physical PPA, Off-site financial PPA



- Green Power is sold on the power market **at spot prices**
- Buyer and seller agree on a **Contract for difference (CfD) with a fixed strike price**
  - If realized spot prices > strike price: seller compensates buyer for delta
  - If realized spot prices < strike price: buyer compensates seller for delta
- Buyer continues to **be physically supplied** by its usual supplier
- **Guarantees of Origin (GoOs)** are also delivered to the Buyer for its environmental reporting
- **The virtual PPA is a purely financial hedge** and is completely decoupled from the physical supply of electricity
- **The plant can be located anywhere**, irrespective of the location of the consumer, e.g. a solar plant producing in Spain and the factory consuming in Germany

Understanding the mechanism behind financial PPAS: Contract for Difference (CfD)

Source: adpated from Next Kraftwerke

Motivations for CfD

- **Seller** makes sure he reaches his minimum price to reach his required IRR
- **Seller** sacrifices further upside potential to be hedged against falling prices

- **Buyer** makes sure he will not pay more than his desired price level
- **Buyer** sacrifices further savings in case power prices fall to hedge against rising prices

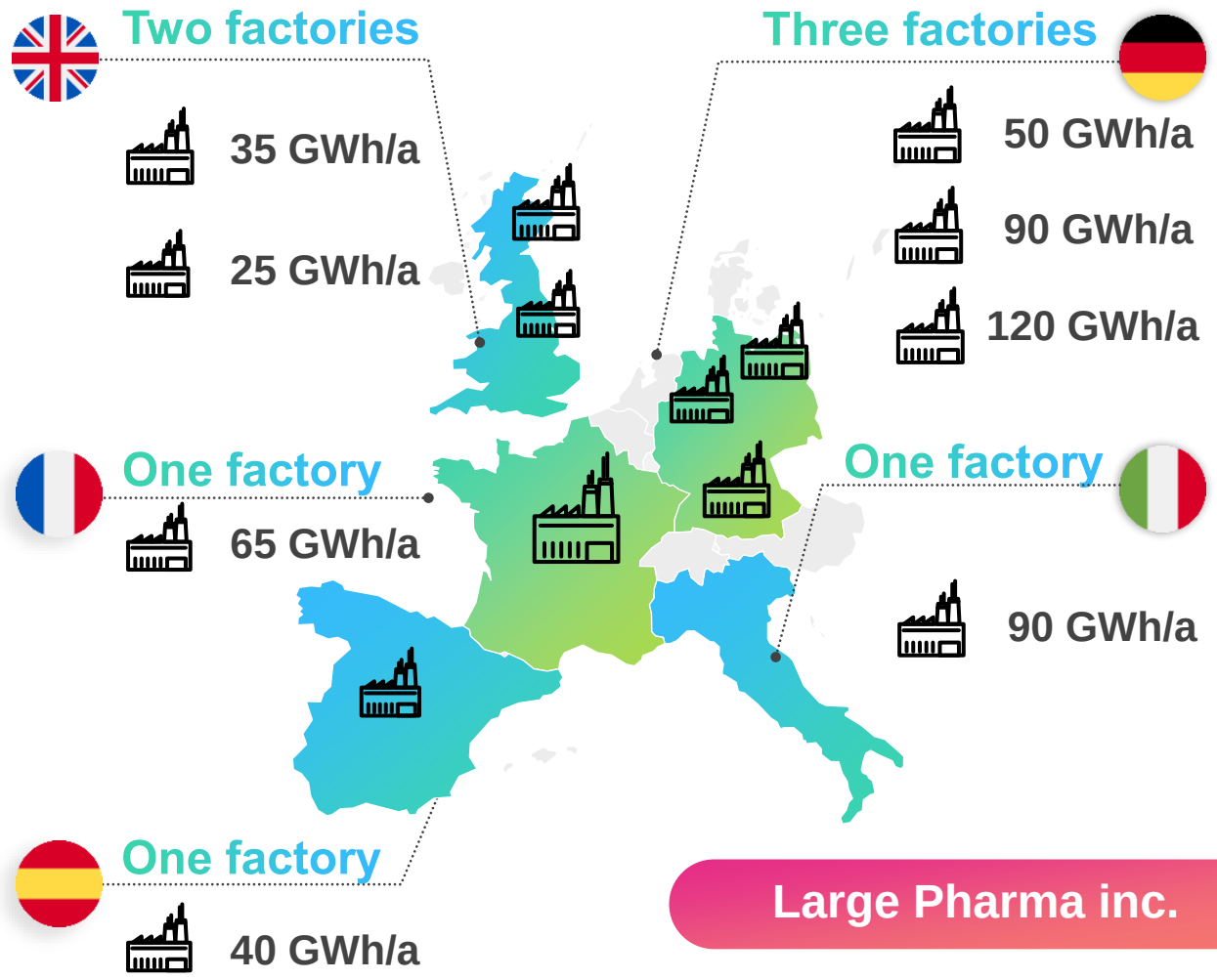
CASE EXAMPLE: PAN-EUROPEAN PPA

Q Finding the right PPA

Imagine you are a large Pharmaceutical company with production sites in five countries in Europe

Your management has pledged to use 100% renewable electricity by 2022 across all production sites in Europe

- What are your options to fulfill this commitment by 2022?
- Which type of PPA might be the most suitable?



CASE EXAMPLE: PAN-EUROPEAN PPA

A Understanding the options

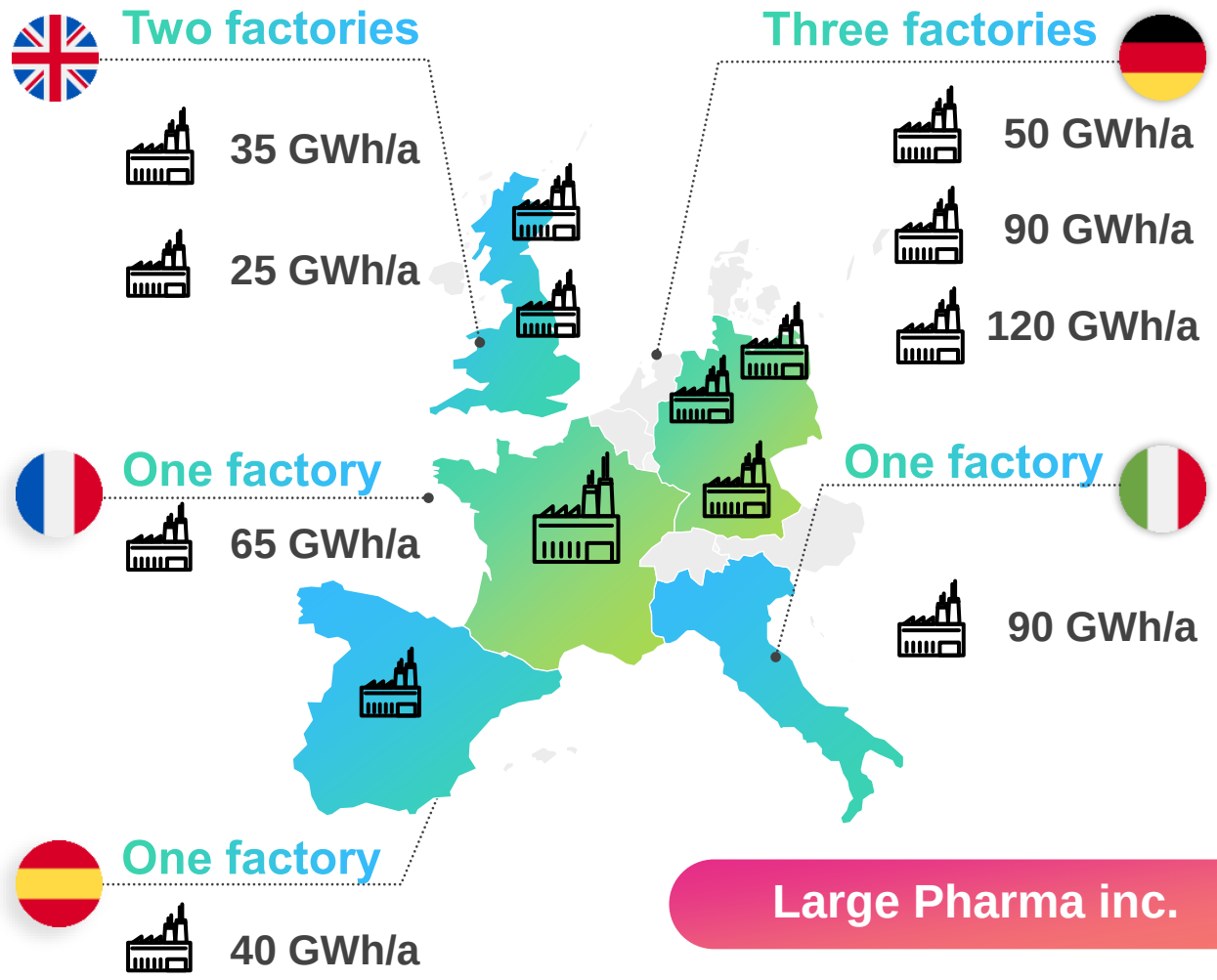
Option 1: Buy **Guarantees of Origin** that cover all your demand in Europe
→ buy 515 GWh worth of certificates from any AIB Member state

Option 2: Complete **physical PPAs** in all target countries
→ negotiate five separate PPAs, one for each market

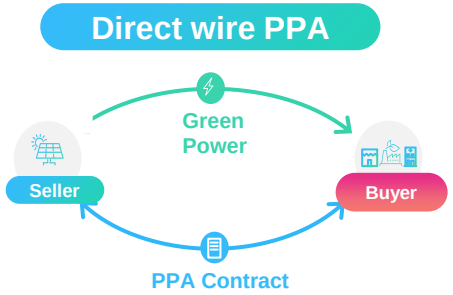
Option 3: Complete **one virtual PPA** covering the demand of all European sites
→ contract a solar farm in Spain with a capacity of ~ 250 MW, producing ~ 515 GWh/year
→ Transfer the AiB GoOs from Spain to off-set all of Europe (learn more)

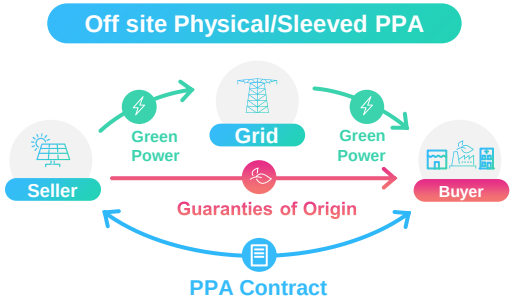
Q What is a key risk executing the VPPA in Spain?

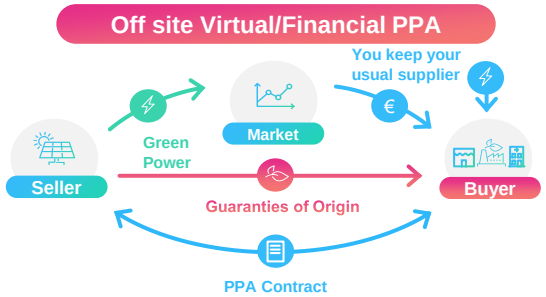
High “basis risk” since most of the consumption is located outside of Spain. How to mitigate the basis risk?



Comparison of the three major forms of PPAs







Benefits	Downside	Case example
• Electrons are produced where they are consumed • High visibility for customer • Making use of unused space • Often economically attractive (e.g. saving 60% EEG levy)	• Limited by available space • Not every land/roof is suitable • For own investments, long amortization time • Challenging tenant/ownership structure	“EDF Renewables UK will install 15,000 roof-mounted solar PV panels on seventeen Tesco stores across England, a total of 5 MW of installed capacity.”
• A new RE plant can be financed, built and connected to the grid • RE plant can be built at locations where conditions are best • Large volumes possible	• Has to be within the same grid network • Less visible compared to roof-top • Complex, individualized contract structures	“The PPA between wpd’s own onshore wind farms and ENGIE is a so-called offsite PPA with physical delivery of electricity, covering 100 % of the projects’ electricity generation, i.e. more than 900 GWh”
• A new RE plant can be financed, built and connected • RE plant can be built at all locations irrespective of load • Aggregation of many sites	• No direct flow of electricity • Financial contract: Derivative Accounting	“AB InBev and BayWa r.e. announce biggest ever Pan-European corporate solar power deal to brew Budweiser with 100% renewable electricity for all Euoprean locations”

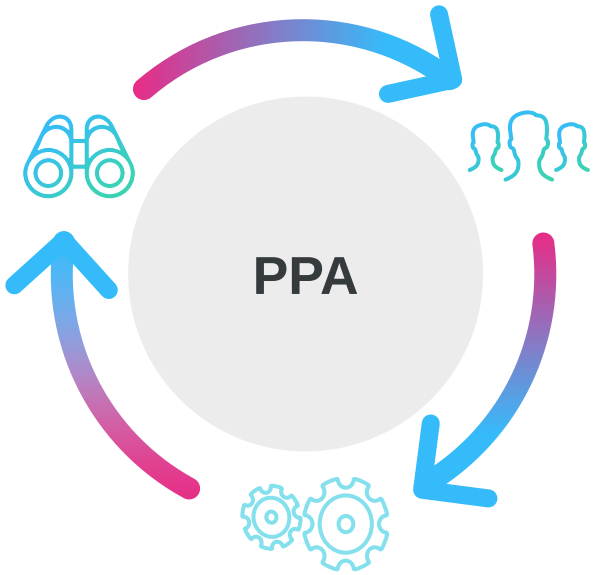
Recap Chapter 1 & 2: Key aspects of a Power Purchase Agreement

Purpose

- Cash flow security for seller
- Price hedge and green credentials for buyer

Types

- Direct wire PPA
- Physical/Sleeved PPA
- Financial/Virtual PPA



Parties

- A seller of electricity (developer, IPP, Utility)
- A buyer of electricity: Utility (utility PPA) or a consumer (Corporate PPA)

Form

- A PPA is a long-term contract between the seller and buyer

Understanding the key elements of a PPA price

– 03 –

THE VALUE OF ELECTRICITY

Wind/Solar power generation

EEG subsidies

- Fixed for each MWh produced
- (Balancing risks)
- (negative prices +6 hours)

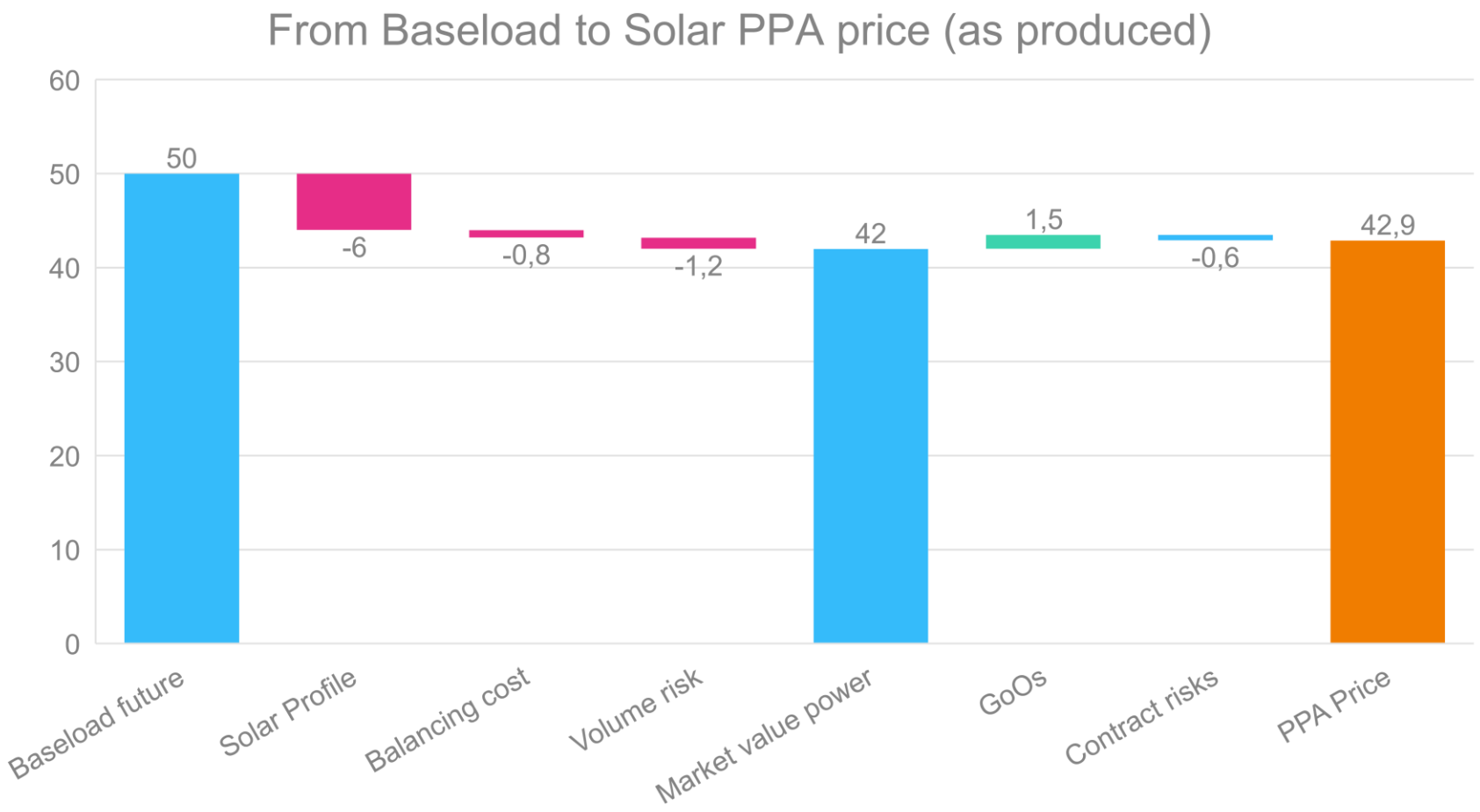
Maximize Production

Wholesale market / (PPA)

- Baseload forward price
- Seasonality & Intermittency
  - Volume risk
  - Profile risk
  - Balancing
- Value of GoOs
- Negative prices

Optimize Production & risk exposure

A „FAIR“ PPA PRICE COMBINES THE VIEWS ON THE FUTURE WITH A QUANTIFICATION OF RISKS



- Baseload Future Price
- Profile costs
- Balancing costs
- Volume risks
- Guarantees of Origin

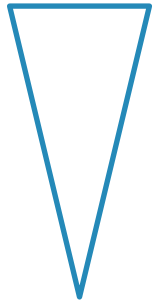
THE BASELOAD FORWARD PRICE IS USUALLY ONLY TRADEABLE WITH HIGH LIQUIDITY FOR 3-5 YEARS, PPA HORIZON > 5 YEARS

Baseload

Name	Letzter Preis	Letztes Volumen	Abrechnungspreis	Volumen Börse	Volumen Trade Registration	Anzahl offener Kontrakte
Cal-21	39,70	8.760	39,75	2.776.920	2.286.360	130.342
Cal-22	43,20	8.760	43,13	341.640	621.960	20.578
Cal-23	45,25	8.760	45,13	175.200	17.520	6.980
Cal-24	47,20	8.784	47,10	52.704	8.784	809
Cal-25	-	-	47,75	-	-	1

Source: EEX, Phelix DE Futures, 16.10.2020

Liquidity



Link to EEX futures

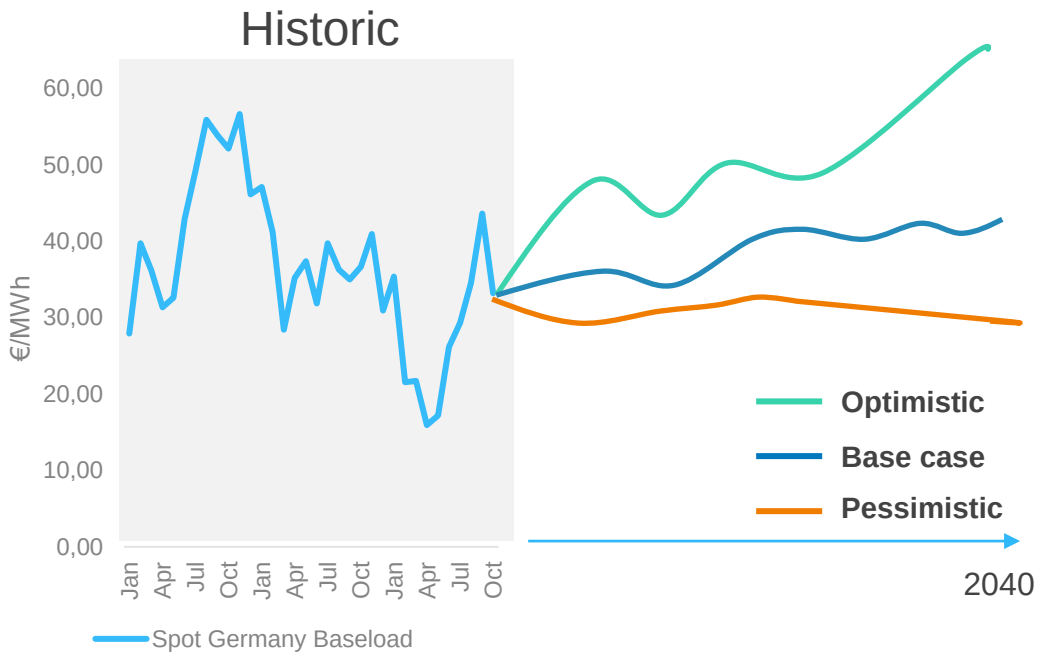
- Limited visibility on price levels beyond five years on future wholesale markets
- Limited liquidity for more than 3 years
- Limits the ability of an off-taker to hedge his position in the market

To find a PPA price, producer and off-taker will each need to find a view on the price levels beyond the tradeable horizon:

— What will wholesale power prices look like for the PPA time horizon (10+ years)?

→ Forward curve based on own models or purchase of third-party power price forecasts

PRODUCER AND OFF-TAKER NEED TO ESTABLISH A VIEW ON FUTURE BASELOAD PRICES FOR CONTRACT HORIZON



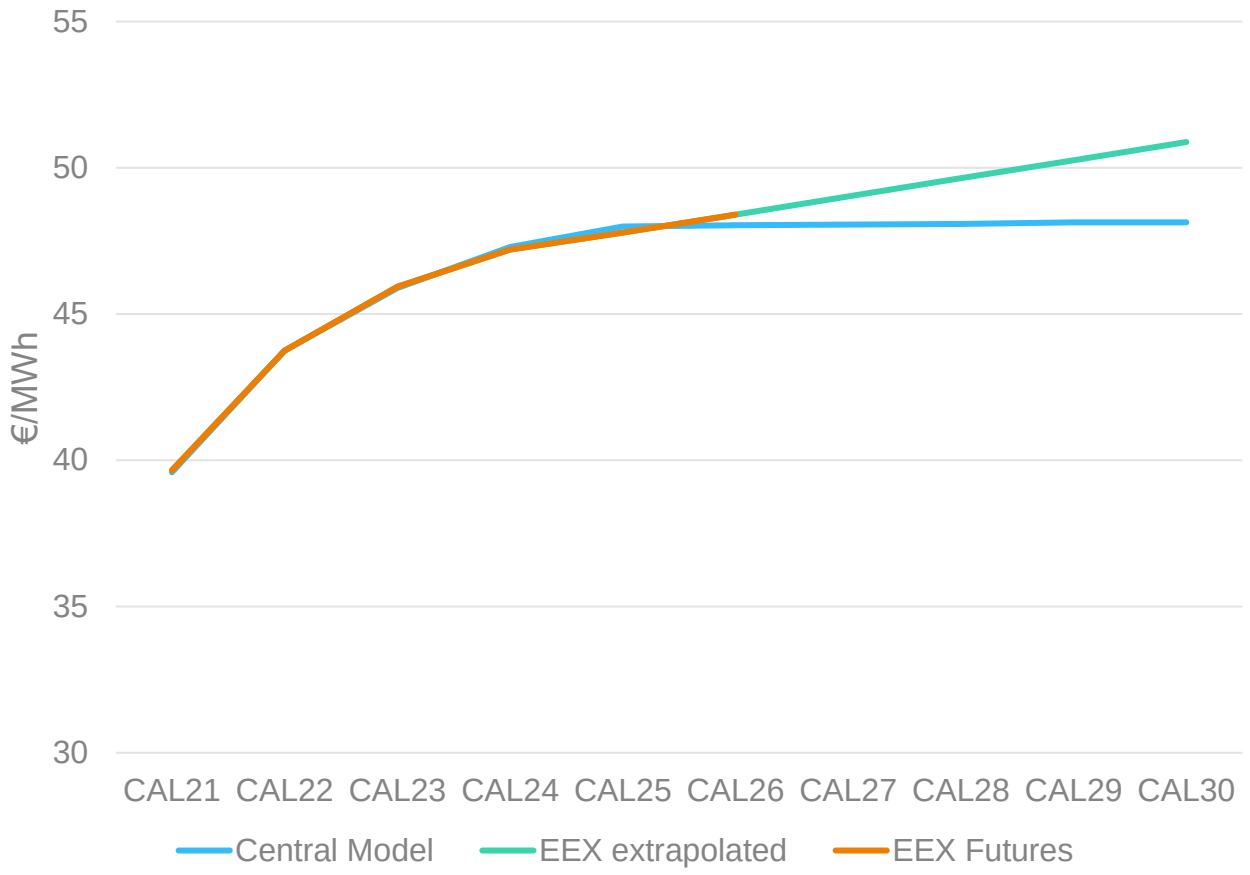
AURORA ENERGY RESEARCH · Baringa · Energy Brainpool · AFRY ÅF PÖYRY (and others..)

- By nature, all forecasts are typically wrong
- Scenarios differ based on **fundamental modeling** views on commodity price development, RE growth, conventional capacity, demand shape, CO2 prices, etc.
- Typically a low case, central and high case scenario

Q Which scenario will each of the parties use?

- **Bank?**
- **Off-taker?**
- **Investor?**
- **Developer?**

THE GERMAN POWER MARKET IS IN „CONTANGO“ – A PPA HEDGES YOU AGAINST LONG TERM PRICE INCREASES



*based on 20/11/2020

Main drivers for power price development

Commodity and carbon prices

- Oil and gas prices
- CO2 prices
- Coal prices

Power demand

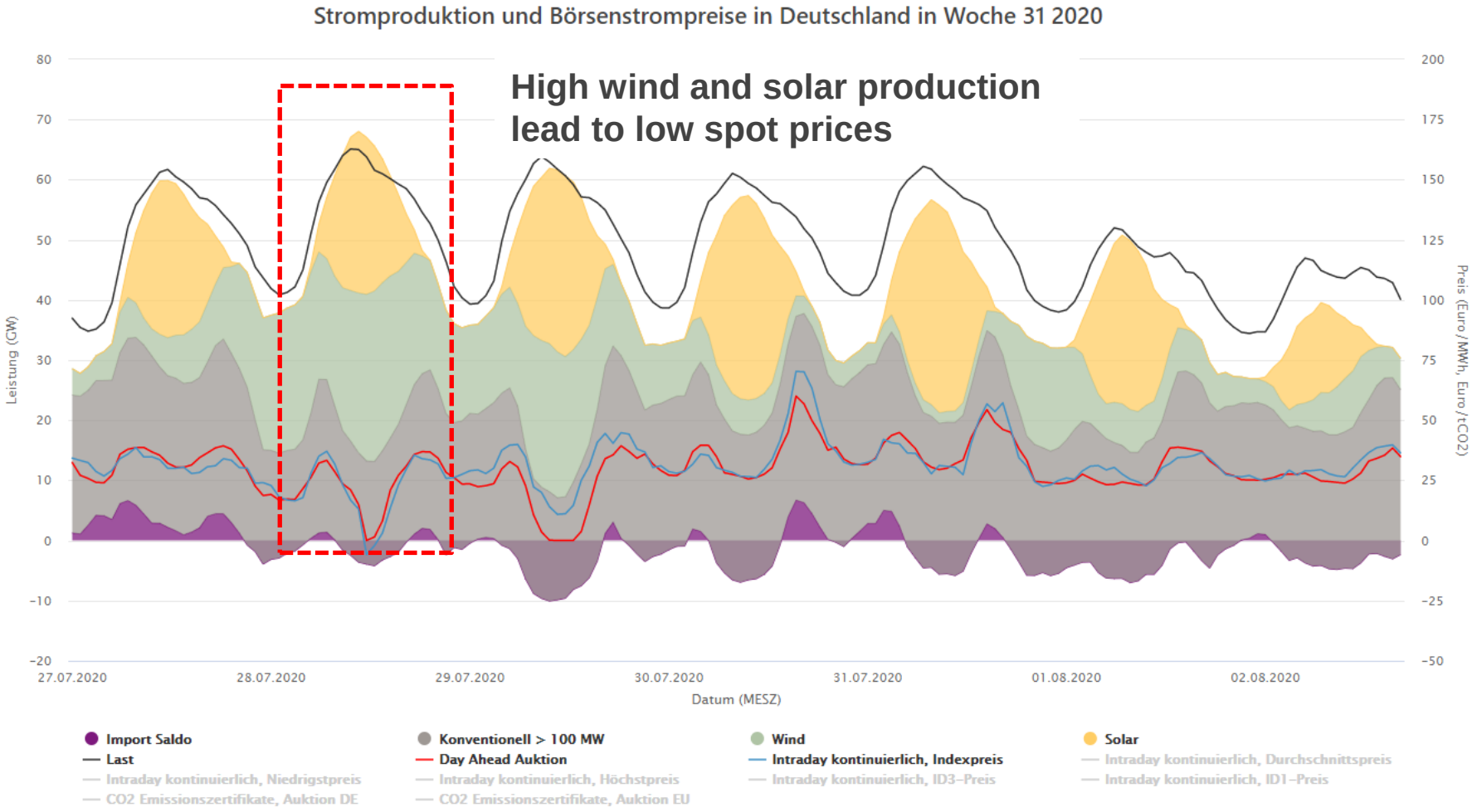
- Electric vehicles
- Heat pumps
- Green hydrogen

Power supply

- RE energy
- Nuclear
- Coal

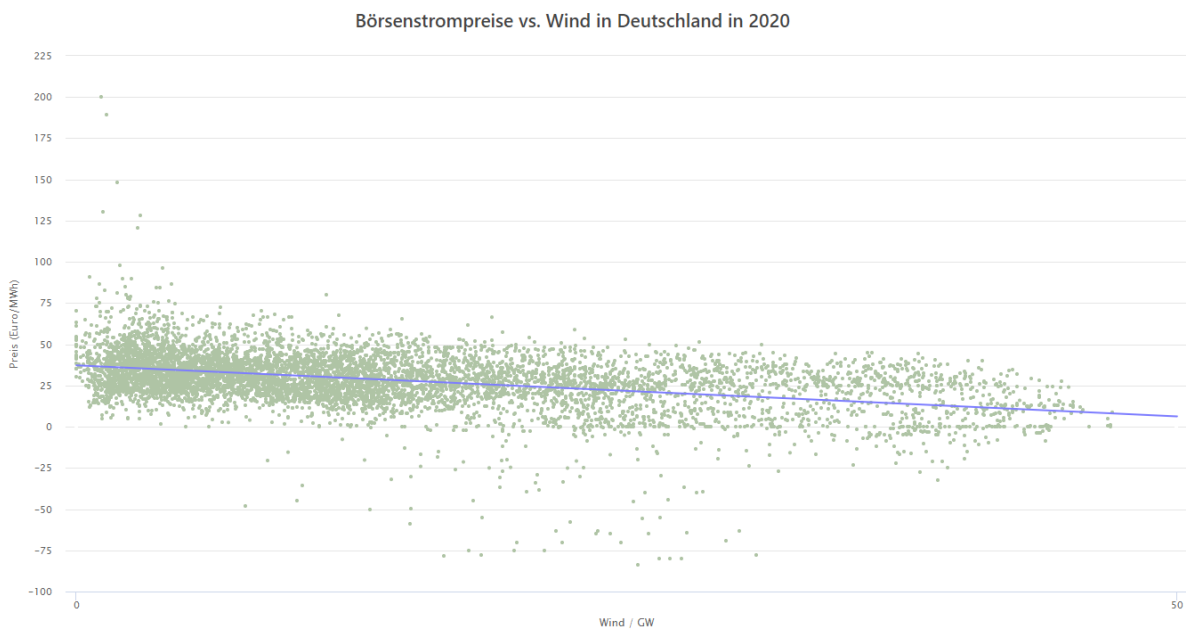
- Baseload Future Price
- Profile costs
- Balancing costs
- Volume risks
- Guarantees of Origin

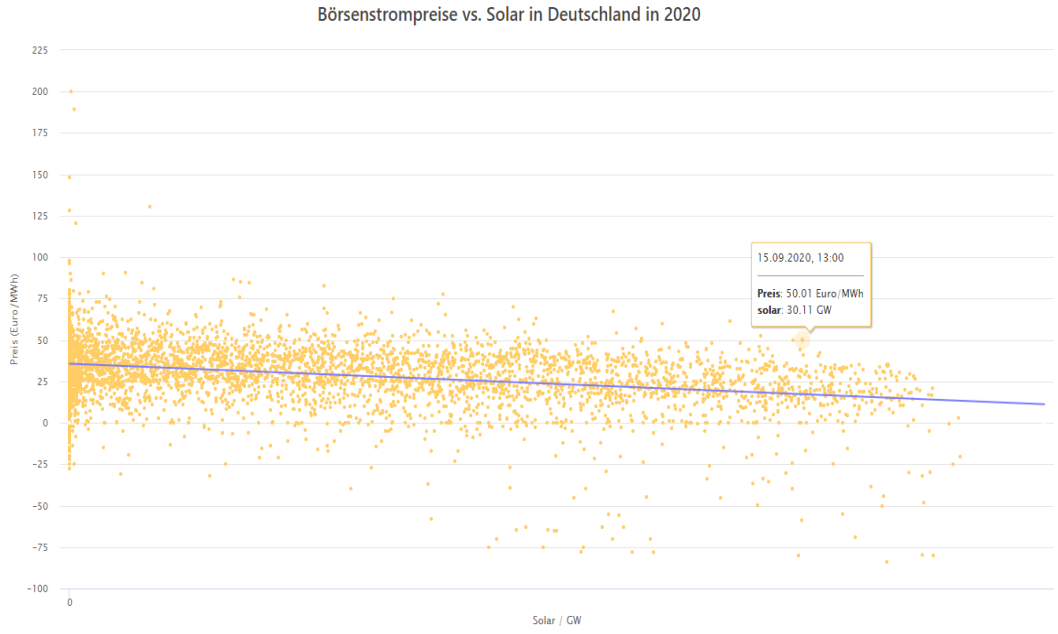
UNDERSTANDING THE PROFILE VALUE OF RE GENERATION



Source: Frauenhofer ISE, Energy charts

HIGH PRODUCTION HOURS OF WIND AND SOLAR CORRELATE WITH LOW AND NEGATIVE POWER PRICES



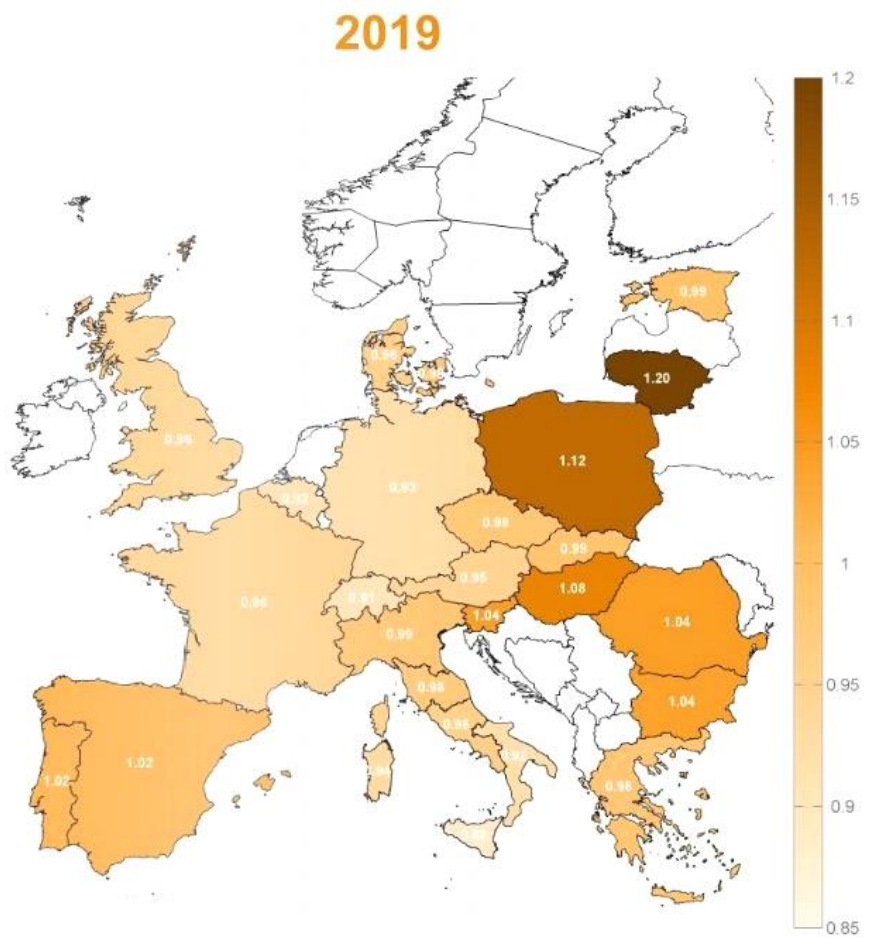


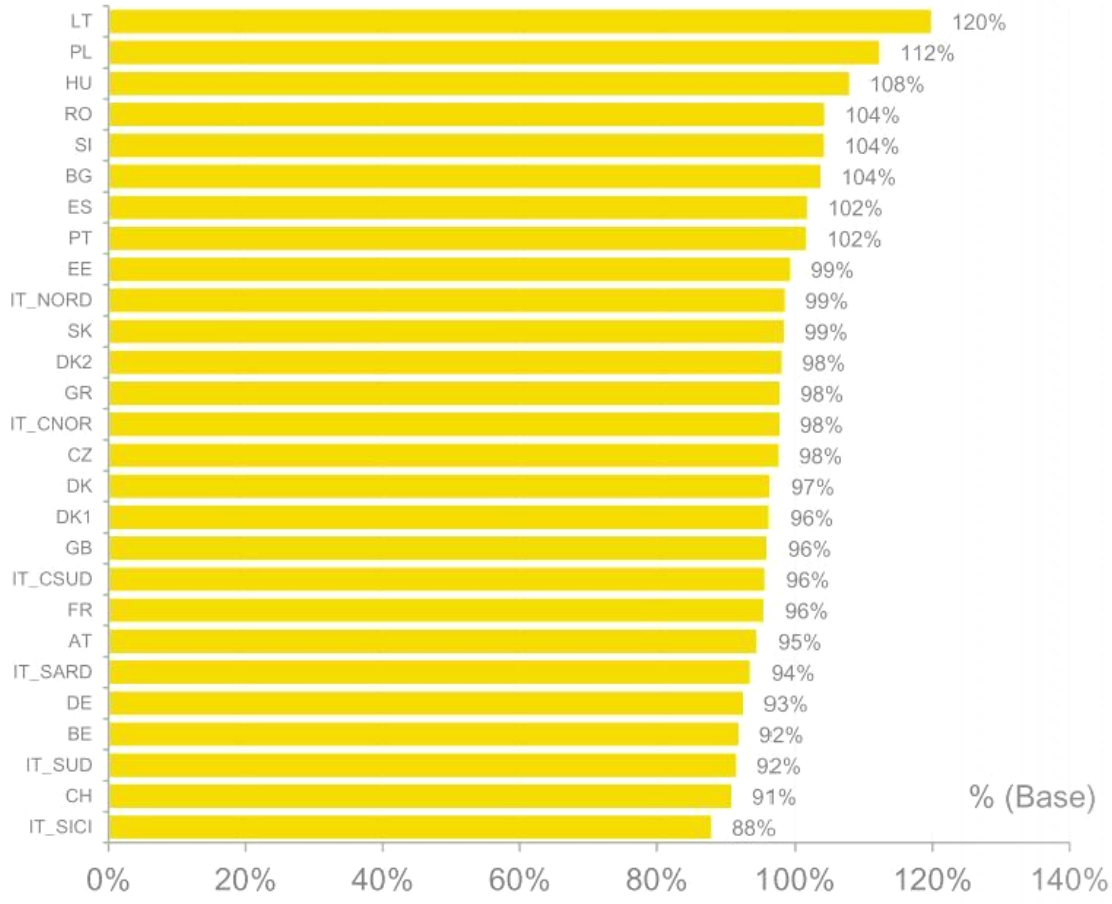
Source: Frauenhofer ISE, Energy charts

→ **What is the value of electricity during each hour of my production?**
→ **How does this compare to the overall average power price over all hours of the year?**

CAPTURE RATES FOR SOLAR IN EUROPE 2019

The **capture rate** is defined as the price a certain technology realizes on the wholesale market over a whole year / the average prize in the entire pool over the same year for all technologies (the baseload price)

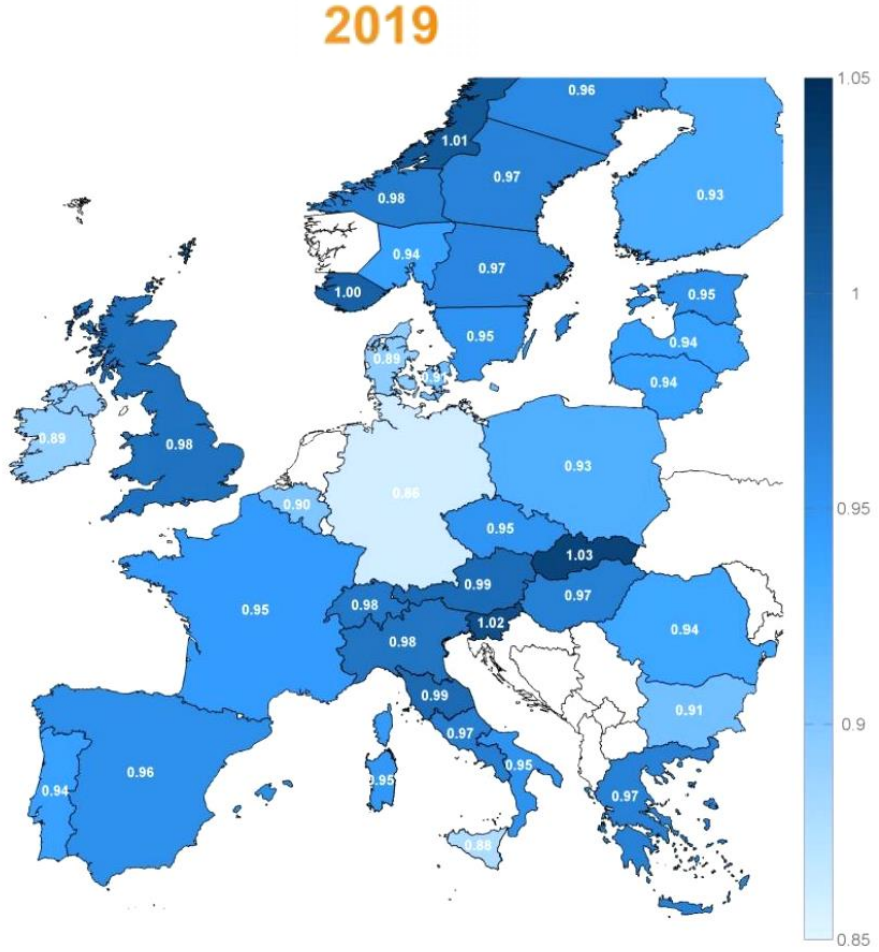


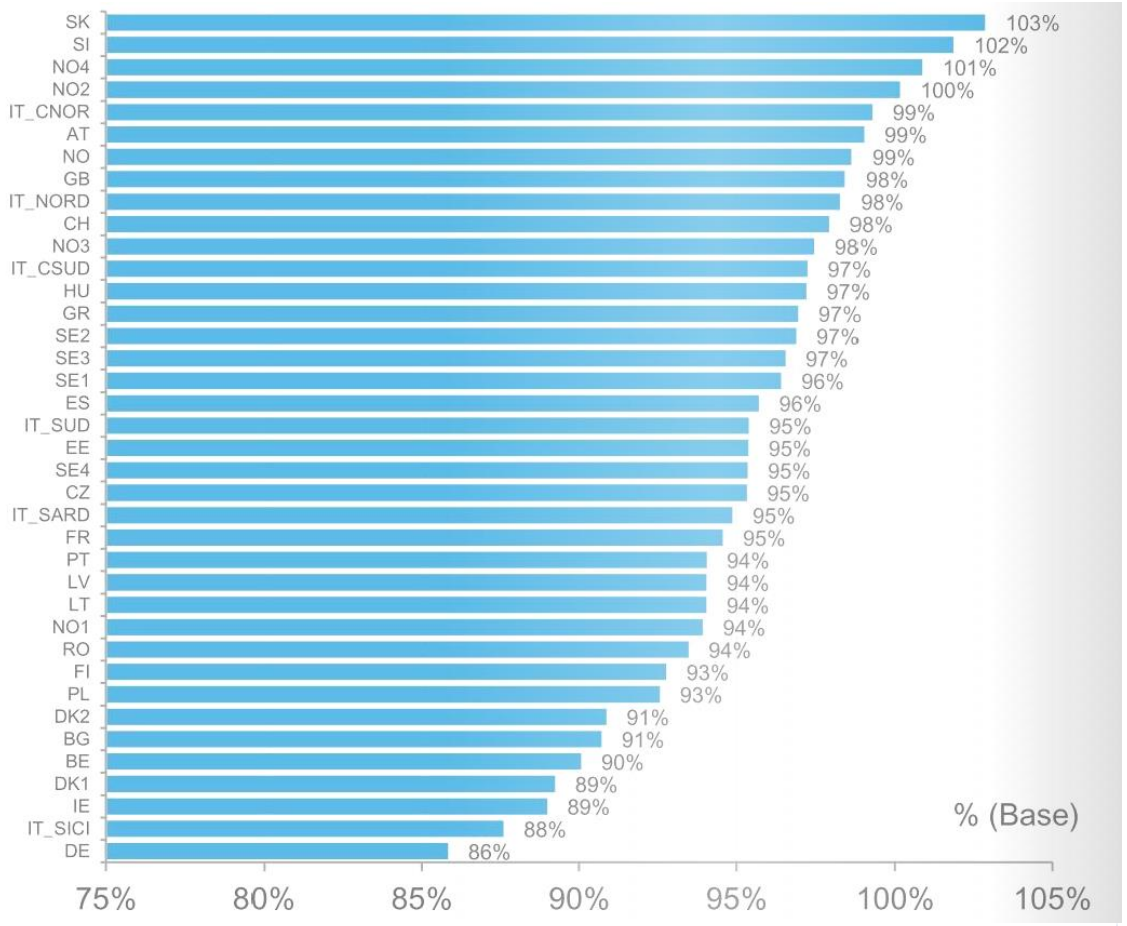


Source: Enervis, Status Quo: Market parity of renewables in Europe (01/20)

CAPTURE RATES ONSHORE WIND IN EUROPE 2019

The **capture rate** is defined as the price a certain technology realizes on the wholesale market over a whole year / the average prize in the entire pool over the same year for all technologies (the baseload price)





Source: Enervis, Status Quo: Market parity of renewables in Europe (01/20)

UNDERSTANDING PROFILE VALUE OF RE ASSETS

Q Why are some capture rates for solar and wind > 100% in certain markets?

If during hours of solar/wind production the power prices are higher than the average power price over the year (baseload). Typically if not too much capacity of a RE is installed. Usually higher power prices in winter which correlates well with wind power generation.

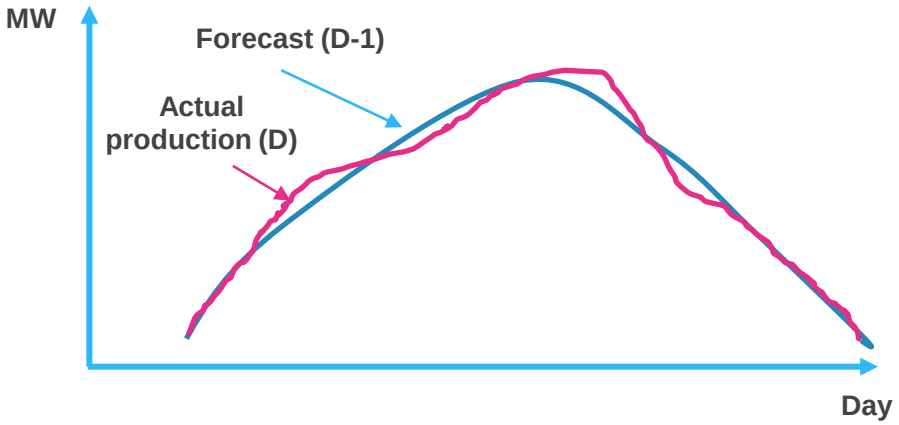
Q How will capture rates develop over the time horizon of a PPA?
-Which factors mainly drive the development of capture rates?

Nobody knows – fundamental own or third party models.
Will depend on rate of new RE capacity addition, cannibalization, location of the asset, future merit order, etc.

- Baseload Future Price
- Profile costs
- Balancing costs
- Volume risks
- Guarantees of Origin

BALANCING COST REFLECT THE FORECASTING ERROR AND IMBALANCE PRICE FOR VARIABLE RENEWABLE ENERGY

Balancing cost occur due to the variation of day ahead production schedules to actual production. The net cost occur due to intraday trading and imbalance cost.



→ Typical balancing cost in Germany are
~ **0,6-1 EUR/MWh for wind** and ~ **0,5 – 0,7 EUR/MWh for solar**
→ In some markets (e.g. Hungary, Romania), balancing cost can reach **up to 8 EUR/MWh**

Q What can a producer/marketeer do in order to decrease the balancing cost?

Day-ahead

- Producer/Marketeer delivers a day ahead forecast detailing expected production for each hour/trading interval
- Producer/Marketeer is compensated on the day ahead market for the volumes at the spot price for each trading interval

Intraday

- After delivery of the day ahead schedule, further intraday short-term production forecasts are delivered
- Producer is either short or long compared to delivered day ahead schedule
- Surplus is sold and shortage is bought on the intraday market

Grid feed in

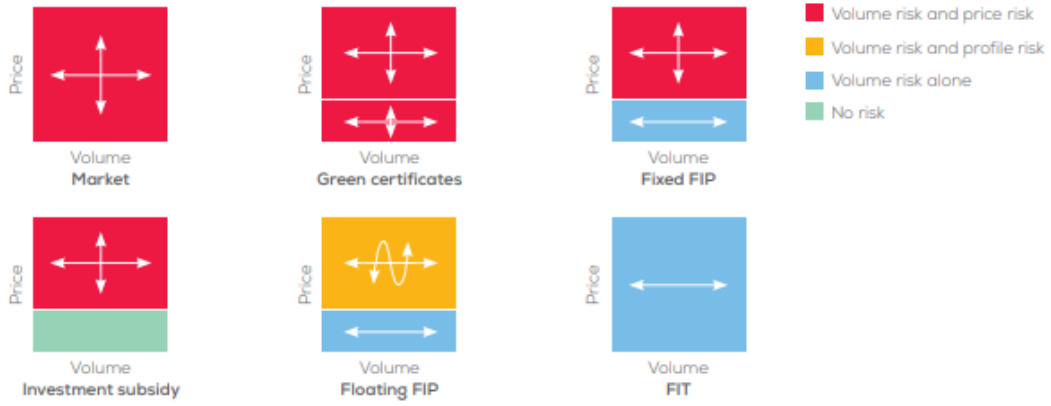
- Small deviances between short term forecast and real generation remain
- Deviations (postive or negative) need to be paid on the imbalance market (depending on market design)
- Trading strategies allow for higher/lower volumes on the imbalance market

- Baseload Future Price
- Profile costs
- Balancing costs
- Volume risks
- Guarantees of Origin

VOLATILE AND UNPREDICTABLE GENERATION OF VARIABLE RENEWABLES EXPOSES CONTRACT PARTIES TO VOLUME RISKS

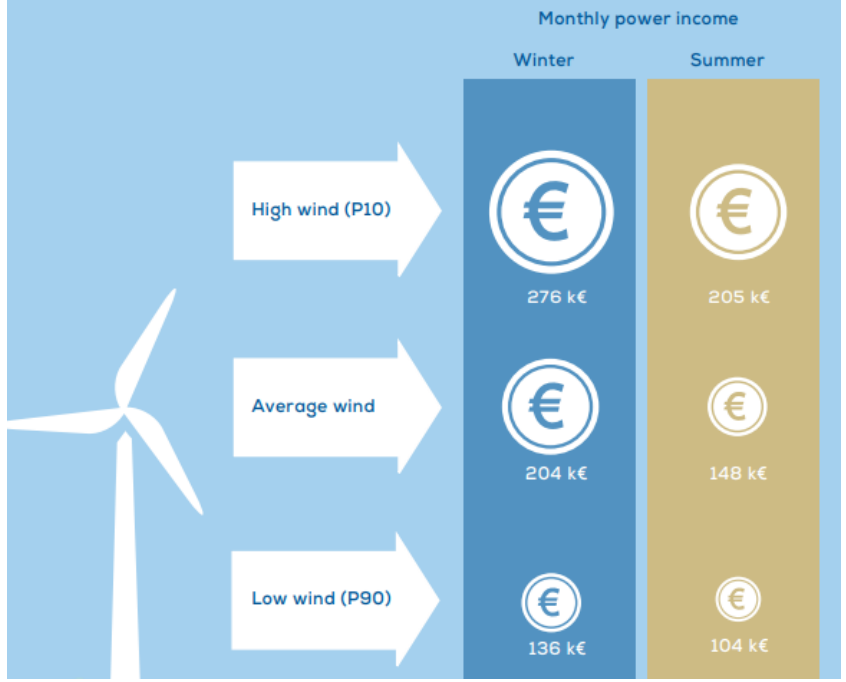
- Wind and solar power generation will vary depending on the weather year, availability of the RE asset, production forecasting
- This exposes the producer/marketeer to cash flow fluctuations and/or open hedging positions (short/long) that need to be priced in
- Actual volume risk cost estimation will depend on the market (and PPA design)
- Typical figures for wind in Germany are between 1 € - 1,5 €/MWh

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



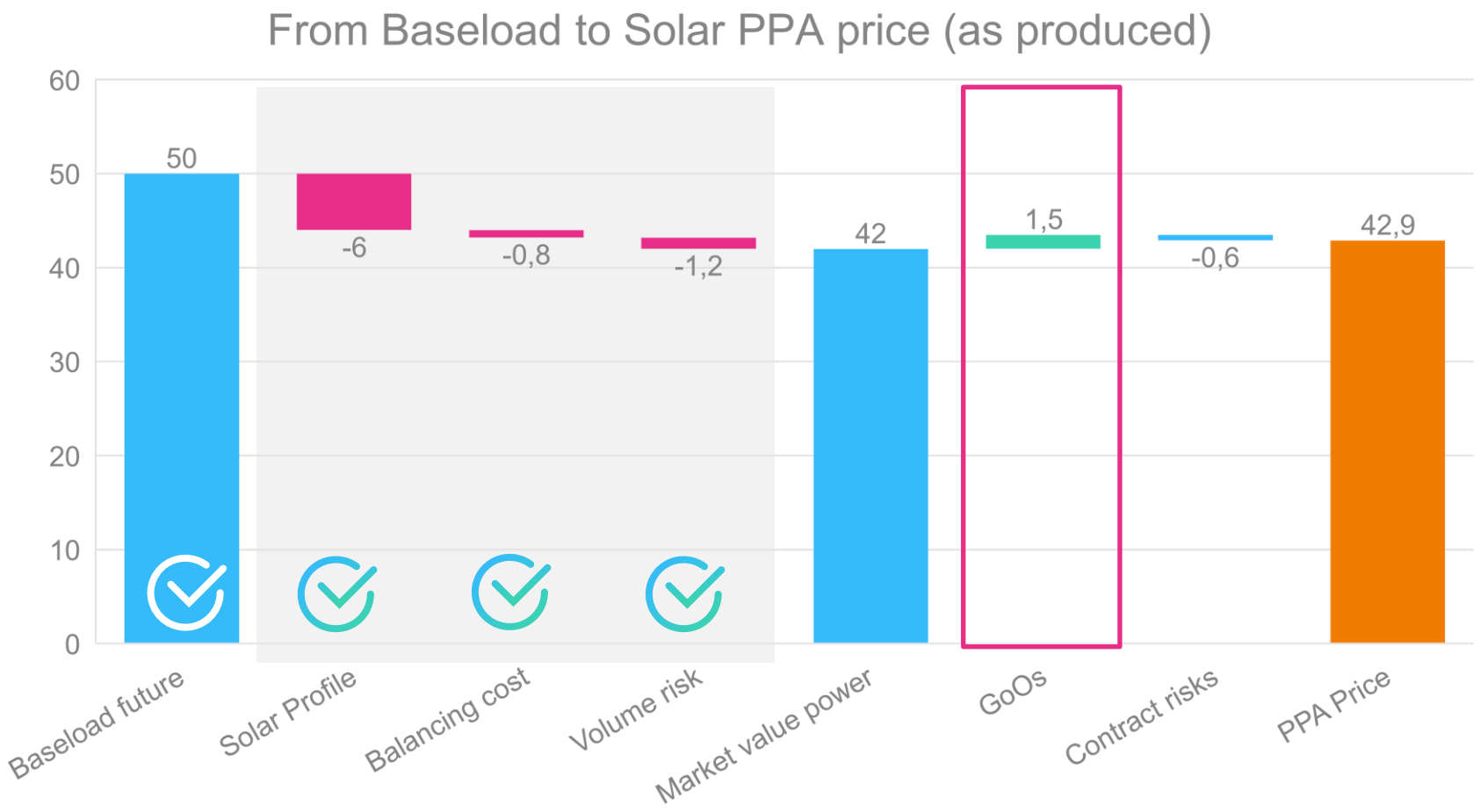
Case study: Monthly revenue risk of a 6 turbines wind farm in Germany in winter and in summer

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



Source: Wind power Europe/Swiss Re: The value of hedging (2017)

A „FAIR“ PPA PRICE COMBINES THE VIEWS ON THE FUTURE WITH A QUANTIFICATION OF RISKS



- Baseload Future Price
- Profile costs
- Balancing costs
- Volume risks
- Guarantees of Origin

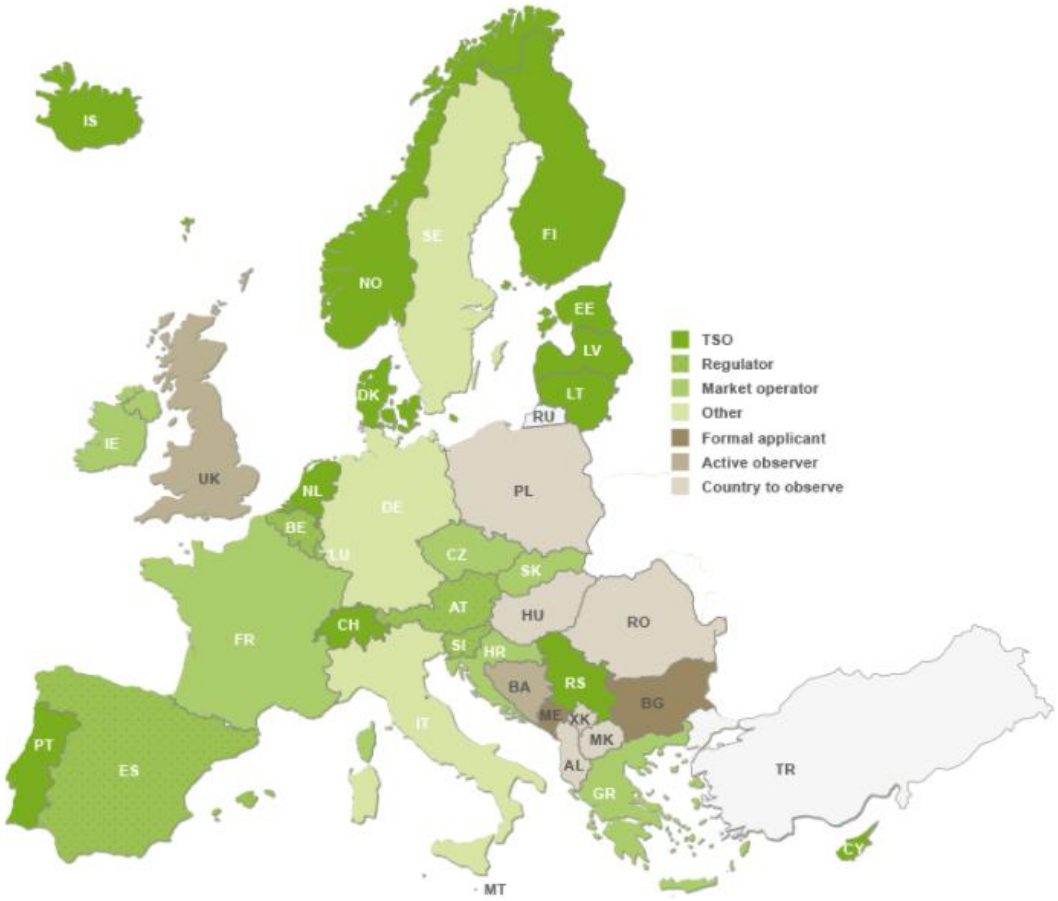
GUARANTEES OF ORIGIN (GOOS) CAN BE TRADED FREELY BETWEEN AIB MEMBER COUNTRIES

- Members of Assoication of Issuing Bodies (AIB) can trade GoOs freely across borders
- → energy consumer in Germany can buy GoOs or power and GoOs from a solar installation in Spain and make it count for its consumption in Germany
- For countries outside AIB member states, International Renewable Energy Certificates (I-RECs) or country specific GoOS (e.g. REGO in UK) are used

Q What is a fair price for a certificate?

Q Does my purchase contribute to reduced emissions?

- Market for GoO prices is highly in transparent and illiquid
- Prices differ largely between technologies and countries
- In Germany, subsidized projects are not eligible to issue GoOs

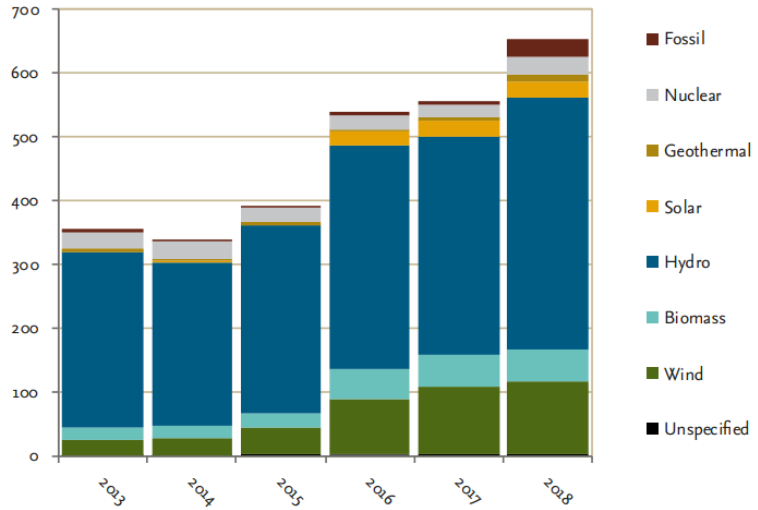


Source:AIB Website, retrieved 28.10.20

GUARANTEES OF ORIGIN (GOOS) CAN BE TRADED FREELY BETWEEN AIB MEMBER COUNTRIES

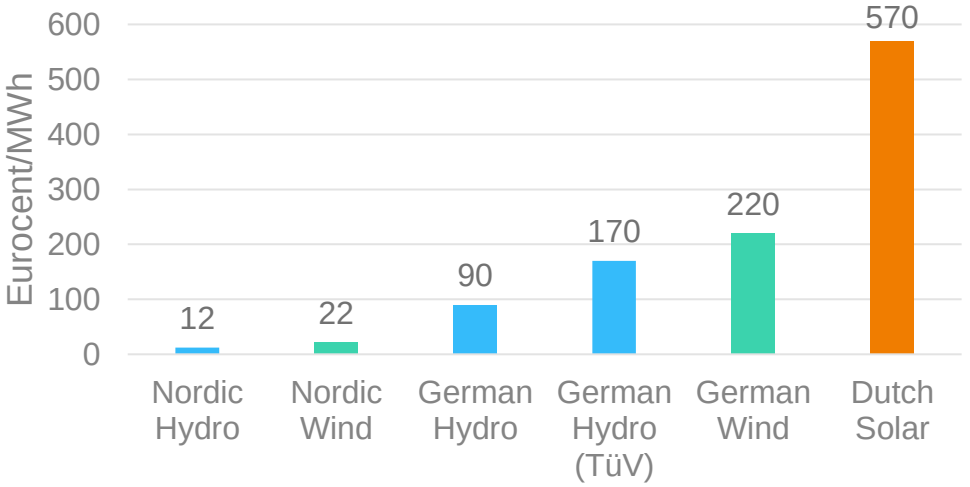
- Most GoOs that are currently issued are Hydropower from Norway, followed by Wind in the Nordics
- GoOs in most countries cannot be issued if the asset is subsidized (e.g. Germany), but exceptions exists (e.g. France)
- Prices differ quite drastically between the various “Qualities” of GoOs
- Certification bodies help to differentiate the quality of GoOs (e.g. TÜV Süd, EKO Energy)

Issued GoOs in TWh by technology



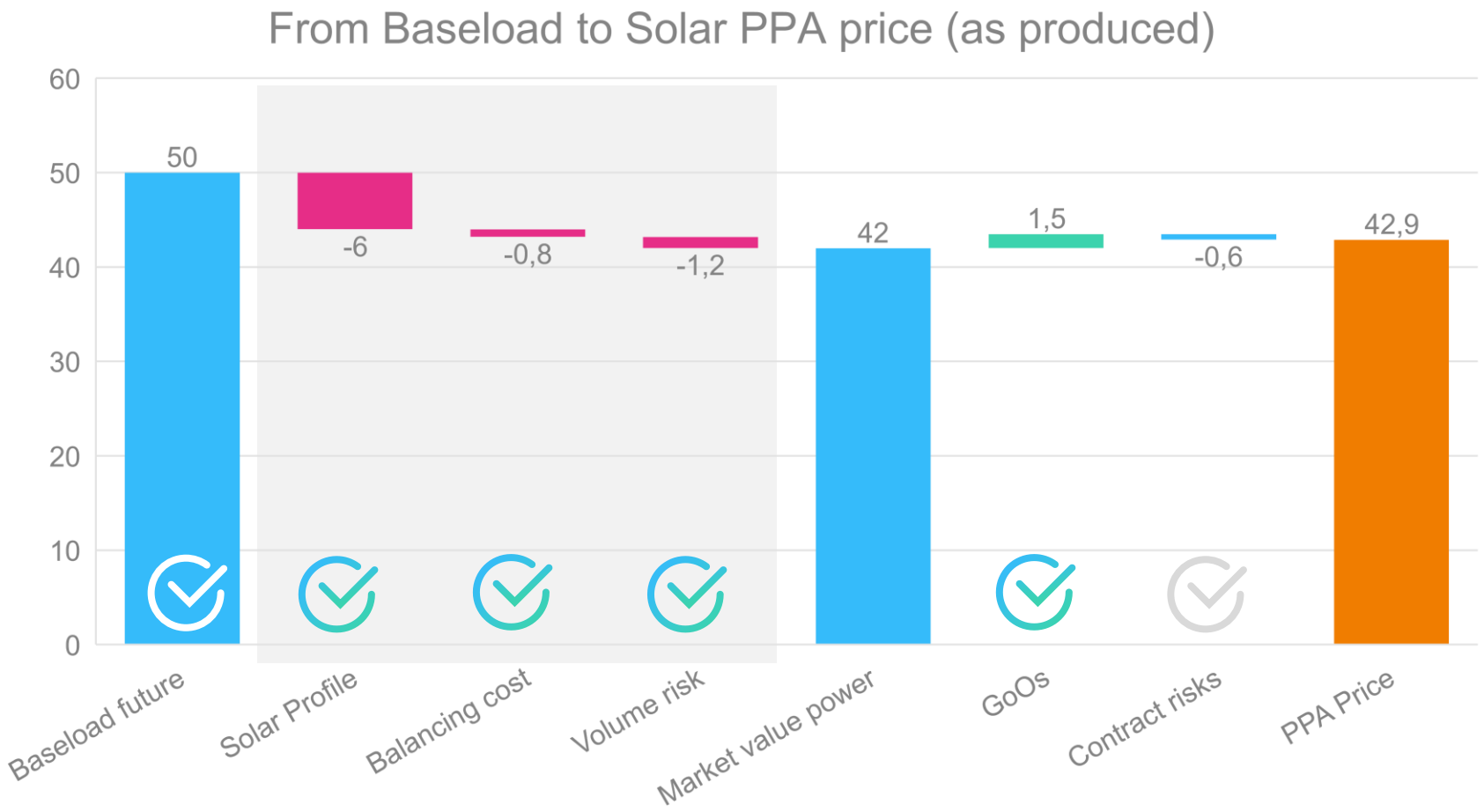
Source: AIB Annual report 2018

Snapshot of GoO prices across Europe (10/2020)



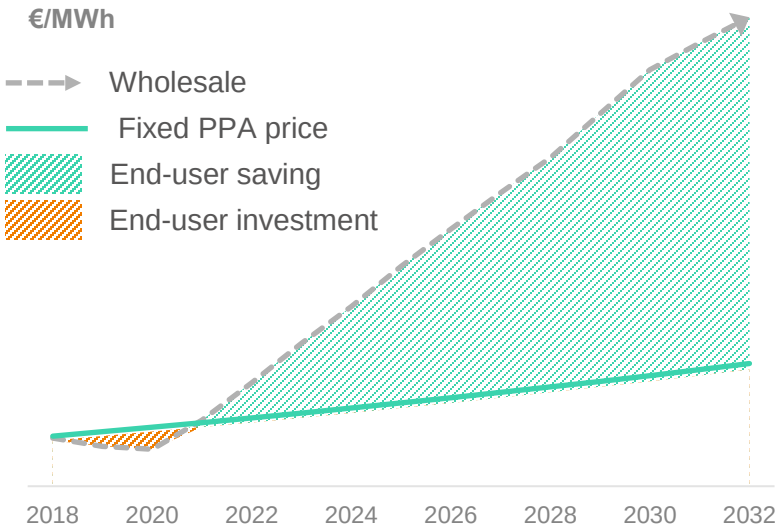
Source: Market quotes October 2020 based on ENGIE data

NOW THAT YOU FOUND YOUR FAIR PPA FIXED PRICE, WHICH PRICING MODELS CAN YOU PRESENT YOUR CUSTOMER?



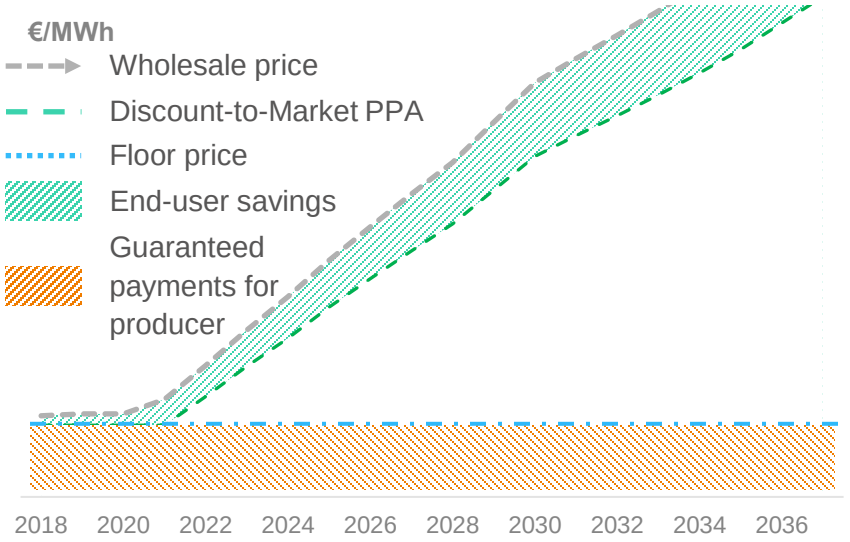
PPA PRICES CAN BE STRUCTURED INDIVIDUALLY ACCORDING TO THE NEEDS OF BOTH COUNTER PARTIES

1 Fixed PPA price (or indexed with CPI)



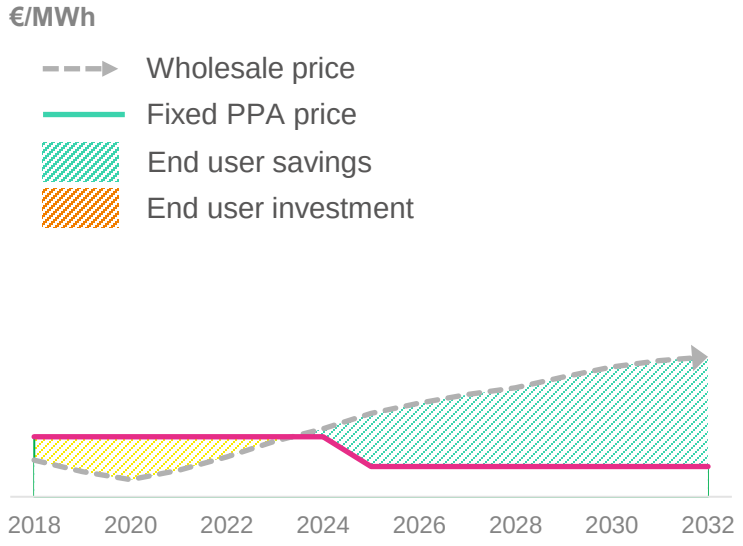
- Most common structure is a fixed price for the entire contract tenure
- Fixed price can be linked to inflation (e.g. yearly CPI)

2 Discount to market with a floor



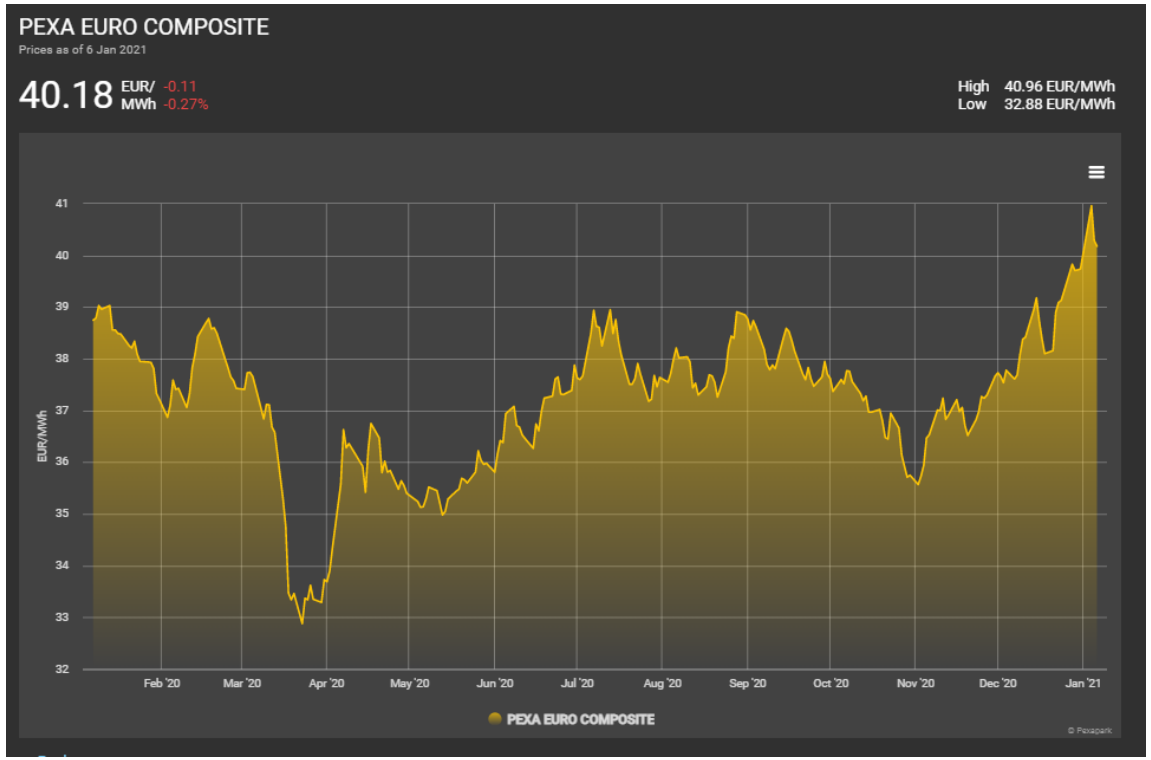
- Consumer receives a discount on the market prices, in exchange, he guarantees the producer a minimum price level (Floor)
- Maximum price levels can be agreed upon (Caps) to guarantee maximum power price to consumer

3 Two staged fixed price



- Off-taker guarantees a higher price in the front years, when principal and interest payments are higher
- For the remaining year, the parties agree on a lower price

PPA PRICES DIFFER LARGELY ACROSS THE VARIOUS MARKETS



Index	Price	Denomination
PEXA France	42.10	EUR/MWh
PEXA GB	44.28	EUR/MWh
PEXA Germany	41.94	EUR/MWh
PEXA Italy	42.60	EUR/MWh
PEXA Netherlands	39.49	EUR/MWh
PEXA Nordics	27.41	EUR/MWh
PEXA Poland	49.57	EUR/MWh
PEXA Portugal	33.90	EUR/MWh
PEXA Spain	34.22	EUR/MWh

Source: www.pexapark.com

Q Which PPA price is best and why?

Answer depends on the wholesale prices in the country and the expected wholesale price development. PPA price alone does tell you little about the PPA value.

Common PPA delivery structures & risk distribution

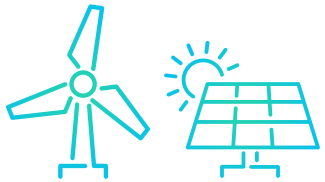
– 04 –

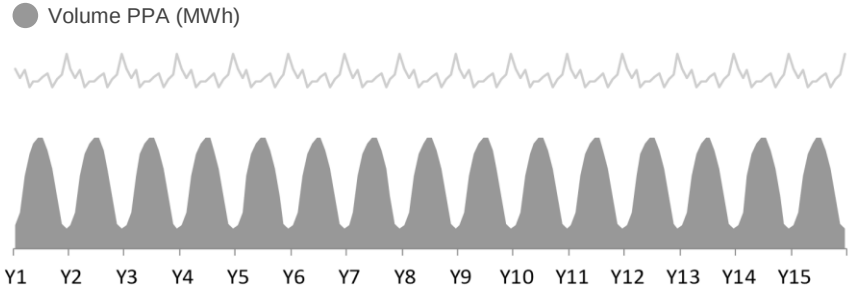
MOVING FROM AS PRODUCED TO AS CONSUMED

PHYSICAL PPA

1 AS PRODUCED

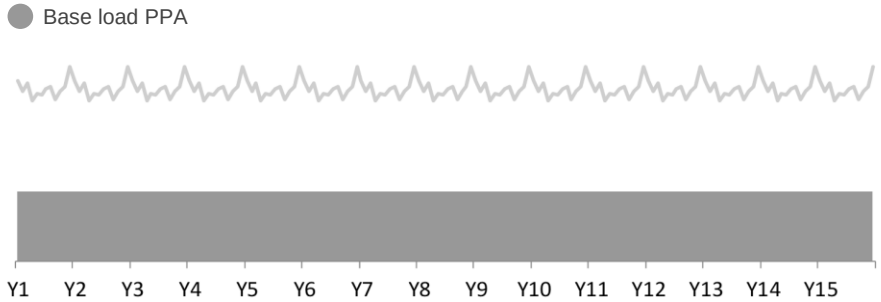
Supply of intermittent volumes of renewable power produced by the assets





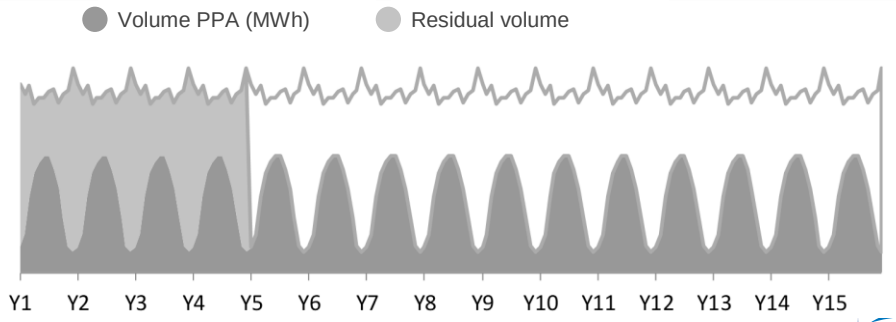
2 FIXED SHAPE or BASELOAD

Supply of pre-determined fixed shape over the delivery period



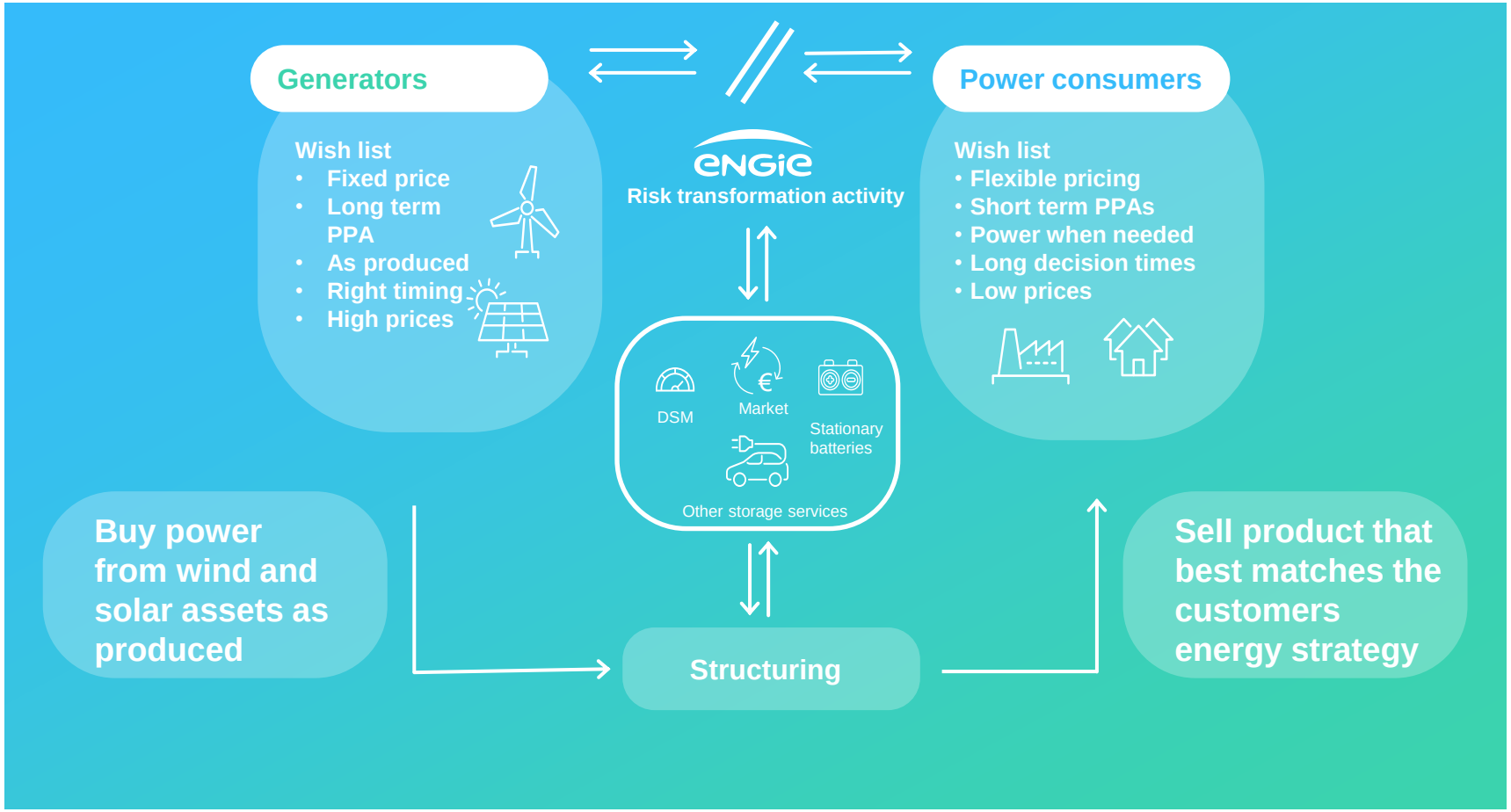
3 FULL SUPPLY

Supply of all the consumption profile of the customer via a PPA and an ESA (Energy Supply Agreement)

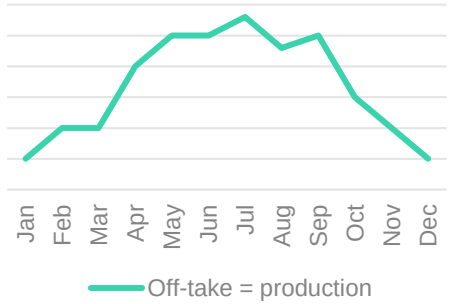
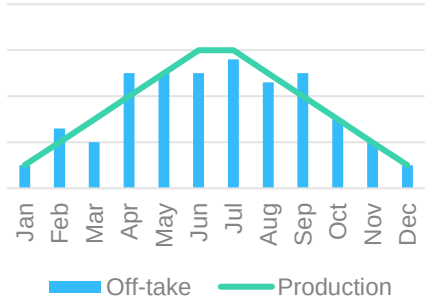
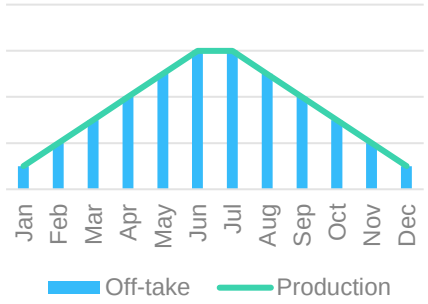
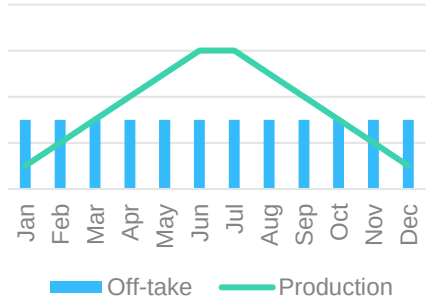
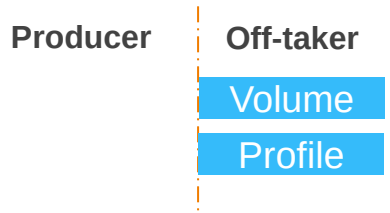
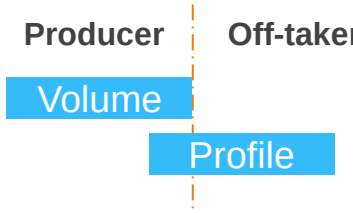
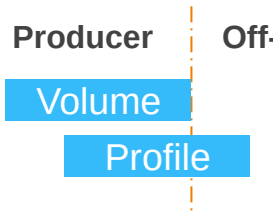
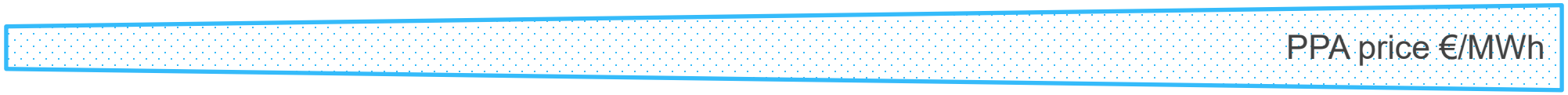


AN INTERMEDIARY CAN MATCH THE DEMANDS OF THE POWER CONSUMERS AND THE PRODUCERS

- Mid streamers (traders & utilities) **align the mismatching interests** between the two sides
- Through their **Energy management expertise**, they can take on risks to structure products that best meet the demand of industrial power consumers



DIFFERENT TYPES OF OFF-TAKE PRODUCTS (EXAMPLE SOLAR)

	Pay-as-produced	Hourly fixed profile	Monthly baseload	Annual baseload
Off-take vs production				
Key aspects	• All production is taken off as produced • Sometimes minimum yearly/monthly volume	• Off-take according to 8760 forecast • Producer needs to deliver agreed volumes each hour	• For each month a specific volume is taken off for each hour of the month	• For each hour of the year the same volume is taken off at the same price
Risk allocation				
Price effect				

4-8 €/MWh

TECHNOLOGY OPTIONS FOR THE GERMAN MARKET

Ü20 – Wind Installation

- **Continues operation of German wind installations**, that drop out of the EEG subsidy scheme
- Availability as early as 2021 for offshore and onshore wind installations
- Short-to medium-term tenure (2-5 years)
- Large range of volumes between 20 up to > 200 GWh/year*

New Build Solar Installation

- **Enables construction of new solar assets,** free of state subsidies
- Availability as early as 2021
- High degree of additionality and strong signal to the market
- Price stability for a long-term period (~10 years)
- Flexible structure from pay-as-produced to baseload
- Typical volumes between 20 – 100 GWh/year*

New Build Wind Installation

- **Enables construction of new wind offshore assets**
- Availability as early as 2025
- High degree of additionality and strong signal to the market
- Price stability for a long-term period (10+ years)
- Flexible structure from pay-as-produced to baseload
- Typical volumes > 100 GWh/year*

The technology should match the requirements of the customer. Each technology implies a variety of risks, contract tenures and volumes.

*indicative price ranges as pay-as-forecasted, price will depend on each individual park, contract tenure, delivery structure, timing and contract modalities

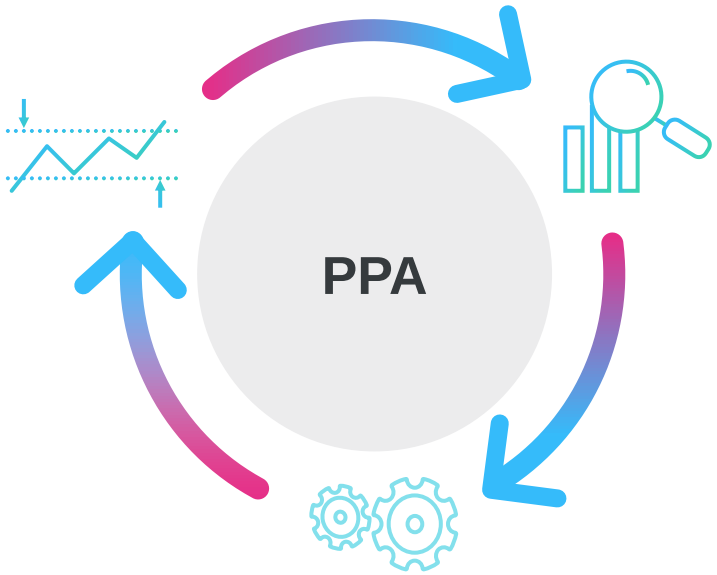
Recap Chapter 3 & 4: PPA Pricing and Delivery structures

Baseload power price

- Yearly average power price of all hours
- Starting point for PPA Price finding
- Limited tradability on markets

PPA options

- Old onshore wind farms
- Newly built solar
- Newly built off-shore wind



Value of RE power

- Profile cost
- Balancing cost
- Volume risks
- Guarantees of Origin (GoOs)

Structuring power

- As produced
- Fixed shape
- Baseload

Case study

– 05 –

PPA CASE STUDY – GREEN ELECTRICITY FOR CAR GERMANY AG (1)

Car Germany AG wants to start producing electric vehicles in their plant in Germany, starting in January 2023. Since potential buyers are increasingly asking critical questions about the resource used in the production, the company wants to switch their power consumption to green electricity.

The management decided, that they do not want to only purchase certificates, but want to make sure that by switching towards renewable energy new capacity will be added to the German electricity grid.

Currently power is delivered by the Full Supplier GmbH, the yearly power consumption is 130 GWh. The load profile is relatively flat, without notable load peaks. Their focus is on electricity supply only, process heat is currently not being discussed.

PPA CASE STUDY – GREEN ELECTRICITY FOR CAR GERMANY AG (2)

1) Which options does Car Germany AG have to switch to green electricity while simultaneously enabling new renewable capacity to be added to the grid?
   1.1) Which two main options are available?
   1.2) Quickly explain the difference between the two main options.

2) Which renewable energy technologies would be most suitable?

Car Germany AG decides to cover 80 GWh of their annual consumption through a physical, off-site corporate PPA. They are now discussing their options with a renewable energy developer.

3) Apart from the requirement by their customers, which other reasons could speak in favour of contracting a PPA for Car Germany AG?

4) For which reasons would the renewable energy developer want to close a contract with Car Germany AG?

5) How big would the installation need to be to cover the PPA demand during an average weather year? Please show for a wind and solar installation.

PPA CASE STUDY – GREEN ELECTRICITY FOR CAR GERMANY AG (3)

6) Name five key aspects that are crucial for the PPA contract and will be negotiated between Car Germany AG and the project developer over the coming months. Multiple answers possible.

7) The delivery of electricity can be structured in multiple ways. The choice of delivery structure will change the risk distribution among the two contracting parties.

- 7.1) Which primary kind of delivery structures are possible?
- 7.2) Which structure will Car Germany AG likely prefer? Which structure will the developer prefer?

After weeks of evaluation the different options, Car Germany AG decides to sign a PPA for a solar project. The asset is planned to be 78 MWp large and will be built in Brandenburg, near Wriezen. The construction shall be finished by 01.01.2023. The production shall be delivered “as produced” into the balancing pool of the Full Supply GmbH. The contract shall run from 01.01.2023 until 31.12.2032

8) Briefly explain the terms Volume and Profile risk.

PPA CASE STUDY – GREEN ELECTRICITY FOR CAR GERMANY AG (3)

9) Calculate a fair PPA price, based on:

- The tradeable baseload futures on the EEX.
- The German wholesale electricity market is in “contango”. Assume that after the liquid horizon, the German baseload power price will rise by 2% per year.
- For the 10-year time horizon, the capture rate of the solar asset is 90% on average.
- The cost for balancing are 1€/MWh
- You agree on a fixed price for all GoOs of 1,5 €/MWh over the contract horizon
- Assume your volume risks are 1€/MWh
- No pricing of contract risks

Show your results in a waterfall chart, starting with the baseload price on the left and moving to a Pay as produced price on the right.

To satisfy the needs of the investor, the developer needs to reach a price that is 5% higher than his LCOEs. The Capex for installing your solar installation is 650 EUR/kwp, the OPEX is 13€/MWh.

10) Calculate the needed PPA price for the developer
11) Will the two parties be able to agree on a PPA price?

SOLUTIONS

1) Which options does Car Germany AG have to switch to green electricity while simultaneously enabling new renewable capacity to be added to the grid?

1.1) Which two main options are available?

A virtual or a physical PPA. For an on-site PPA, the demand is too big. Certificates are not an option, since no new capacity will be added to the grid directly.

1.2) Quickly explain the difference between the two main options.

See slide 25.

2) Which renewable energy technologies would be most suitable?

See slide 54.

3) Apart from the requirement by their customers, which other reasons could speak in favour of contracting a PPA for Car Germany AG?

See slide 10.

4) For which reasons would the renewable energy developer want to close a contract with Car Germany AG?

See slide 18.

SOLUTIONS

5) How big would the installation need to be to cover the PPA demand during an average weather year? Please show for a wind and solar installation.

Assume an average output value for wind and solar in Germany, e.g. 1800 kWh/kW for wind and 1000 kWh/kWp for solar. This would result in
Wind: 80,000 MWh / 1,800 MWh/MW ~ ***44 MW***
Solar: 80,000 MWh / 1000 MWh/MWp ~ ***80 MWp***
Multiple answers possible, as long as methodology makes sense.

6) Name five key aspects that are crucial for the PPA contract and will be negotiated between Car Germany AG and the project developer over the coming months. Multiple answers possible.
See slide 13.

7) The delivery of electricity can be structured in multiple ways. The choice of delivery structure will change the risk distribution among the two contracting parties.

7.1) Which primary kind of delivery structures are possible?
As produced delivery and baseload delivery

7.2) Which structure will Car Germany AG likely prefer? Which structure will the developer prefer?

Car Germany will likely prefer a baseload structure, since in that case they carry no risk, it easily fits into their purchasing strategy and their consumption profile is flat.

The developer will likely prefer as produced, since he can transfer the risks to the consumer. *See slide 53.*

SOLUTIONS

8) Briefly explain the terms Volume and Profile risk.
See slides 43 and slides 35-38 .

9) Calculate a fair PPA price, based on:
See slide 29.

Steps:

- *Take the baseload price from the EEX Baseload futures page (https://www.eex.com/de/marktdaten/strom/futures) . Take the values for Year 1-5*
- *Extrapolate 2% on the year 5 price for the remaining years 6-10*
- *Take the average price over the 10 year time frame as your baseload reference price*
- *To calculate the profile cost, take (100-90% capture rate)*your 10-year baseload price*
- *The other values are given*

SOLUTIONS

10) Calculate the needed PPA price for the developer.

Calculate the LCOE based on a Cash flow analysis using the location of the PV plant, the size, the CAPEX and OPEX assumptions. Ideally use an (Excel) tool for the LCOE calculation. Add 5% on the LCOE to reach an “acceptable” PPA price for the developer.

11) Will the two parties be able to agree on a PPA price?

Compare your fair PPA price with the needed price for the developer. If the PPA price > needed price, the two parties will be able to agree on a PPA price.

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Link

10%

of people on work/study contracts in the Group's workforce in France by the end of 2021

10 %

of people on work/study contracts in the Group's European workforce by the end of 2023

50 %

The Group's ambition: hiring on fixed-term or permanent contracts of 50% of people on work/study contracts in France by the end of 2021

Thanks for your attention & feel free to reach out.