

KYOS Webinar  
11 May 2021  
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## Webinar: Hedging price risks in renewable energy

Cyriel de Jong & Ewout Eijkelenboom  
KYOS Energy Analytics

11 May 2021

# Hedging price risk in renewable PPAs



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# Agenda

15:00 Overview PPAs – Ewout Eijkelenboom

- Introduction in PPAs
- Value and risk elements of renewable energy projects

15:15 Hedging PPA price risk – Cyriel de Jong

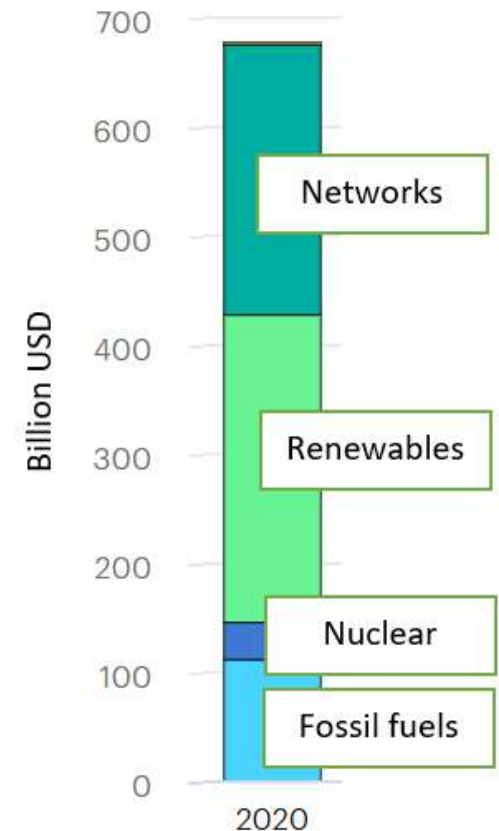
- Case study of a onshore wind PPA
- Performance of different hedging strategies

15:35 – Q&A and discussion

15:45 – End of the webinar

# Why are PPAs such a hot topic?

- Global trend:
  - Expansion of renewable generation to combat global warming
  - End of stable feed-in-tariffs (FiT)
- Financing and risks:
  - Outright exposure to power price
  - Also to volume and other risks
- Financial reality:
  - Lenders require cash-flow predictability
  - PPA's with utilities and corporates are crucial to provide some predictability



Global investments in power sector, IEA 2020

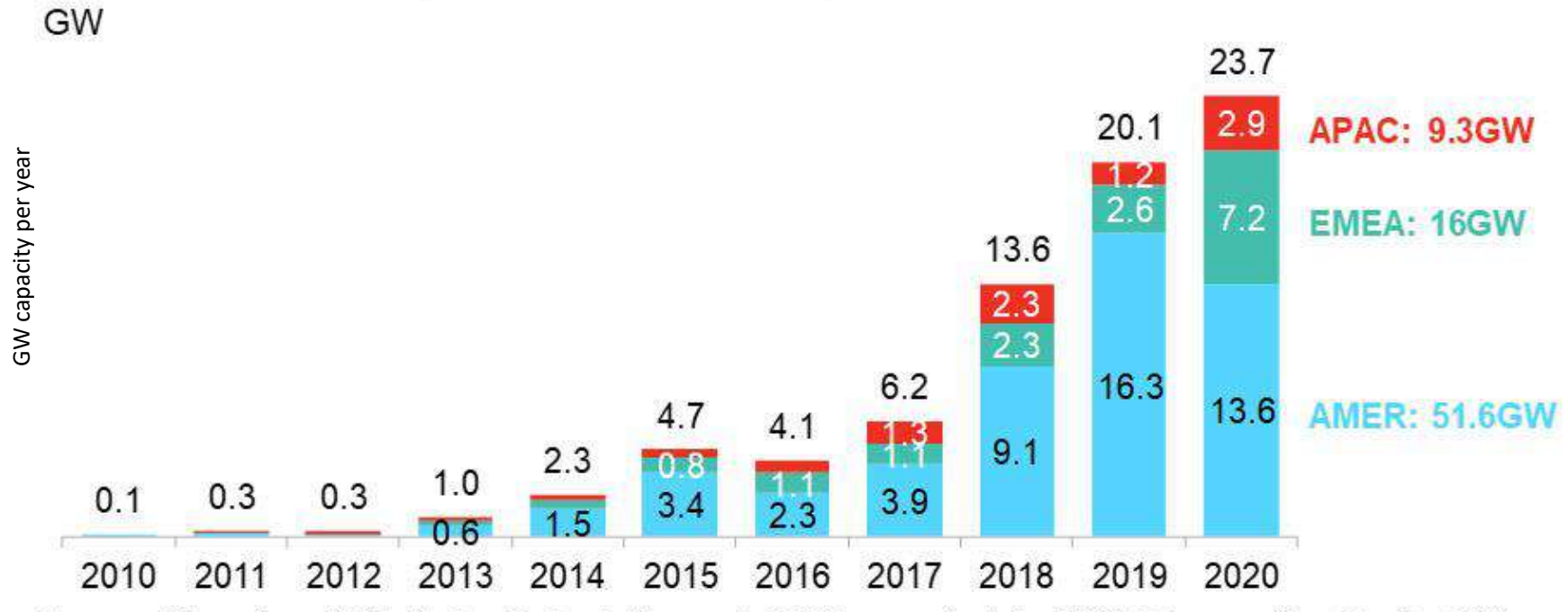
# Different types of companies involved

## Some typical questions around PPA's

- Project developer
  - Will the PPA guarantee cashflow and reduce risk?
- Investors/banks
  - Which risks are transferred via the PPA and which remain?
- Aggregator
  - How to price PPA from developers?
  - What risk to keep in portfolio?
- Corporates
  - What are the risks when buying a PPA?
  - How to define the price of a PPA?

# Market rapidly growing

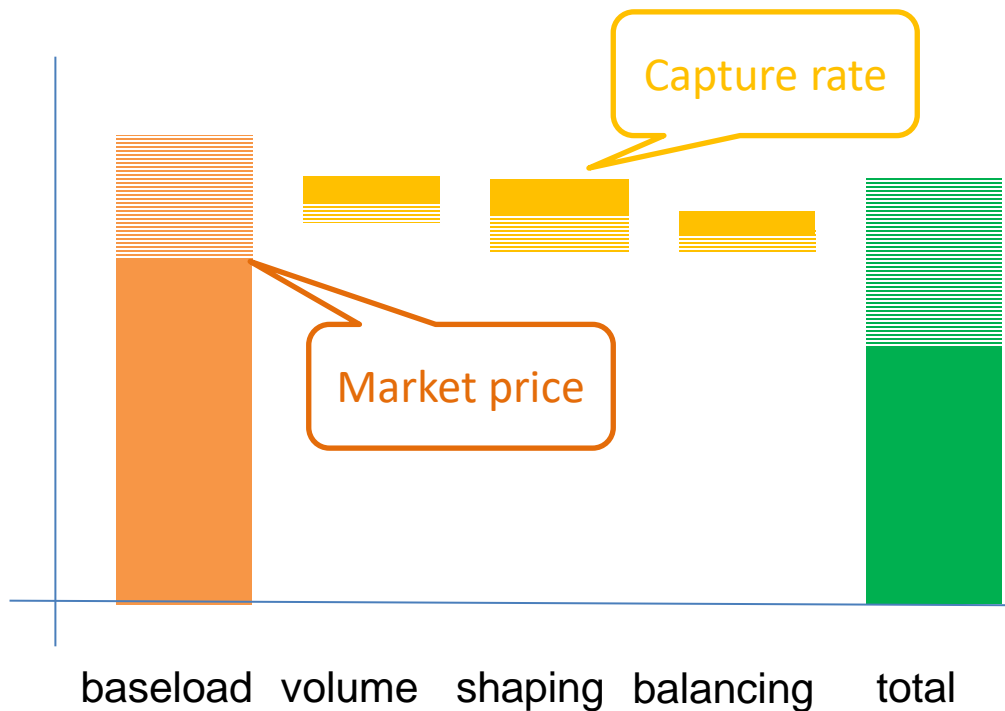
## Global corporate PPA volumes, 2010-2020



Source: BloombergNEF

Corporate PPAs have a small share,  
but it is growing.  
Other PPAs are with utilities.

# PPA value components and risks



Each PPA may distribute the value components differently, but ultimately they have to land in someone's pocket.

- Each value component has a level of uncertainty
  - understand how to hedge this risk
  - and what risks remain unhedged

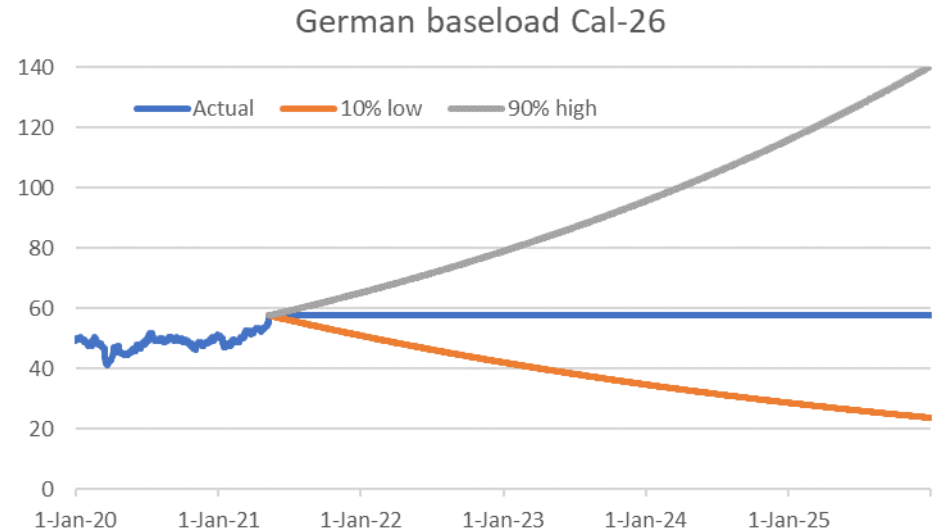
# Risk component 1: baseload market price

## Baseload power price

Is the main source of uncertainty for merchant projects.

Uncertainty may be divided into:

- Temporary price changes (individual bad year)
- Structural price changes (parallel shift in the forward curve)



## Tools to hedge

- Fixed price PPA
- Market hedges (static/dynamic strategy)

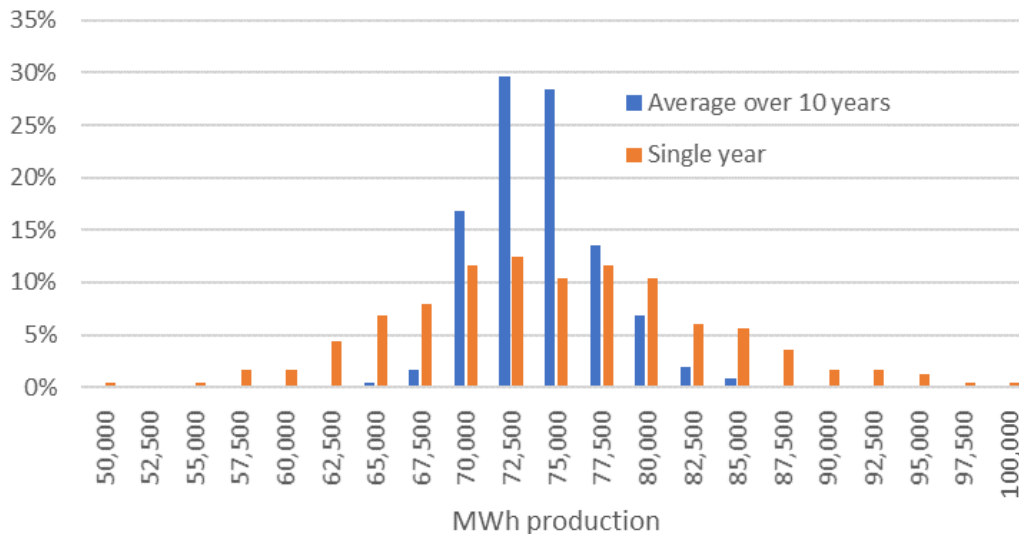


# Risk component 2: volume

## Volume risk

- The actual production volume may be lower than expected (e.g. less wind)
- Large risk for an individual year (+/- 20%)
- Smaller risk for average over many years

Distribution of annual production volume



## Tools to hedge

- PPA, pay-as-produced
- Well diversified portfolio (technologies, geographies)

## Interaction with price

- An unhedged project is exposed to risk of a low market price
- A project hedged with a baseload PPA is exposed to risk of a high market price and low project volume

# Risk component 3: shape risk

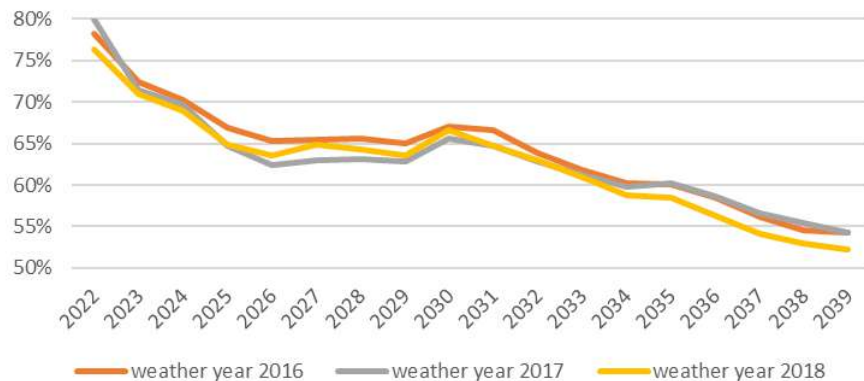
## Seasonal shape risk

- Risk of low summer prices versus winter (solar) or vice versa (wind)

## Capture rate risk

- Intraday patterns are uncertain
- Risks depend on long-term factors (generation mix, storage, interconnection capacities) and short-term factors (weather)

Capture rates Nordic wind farm:  
sensitivity to weather year



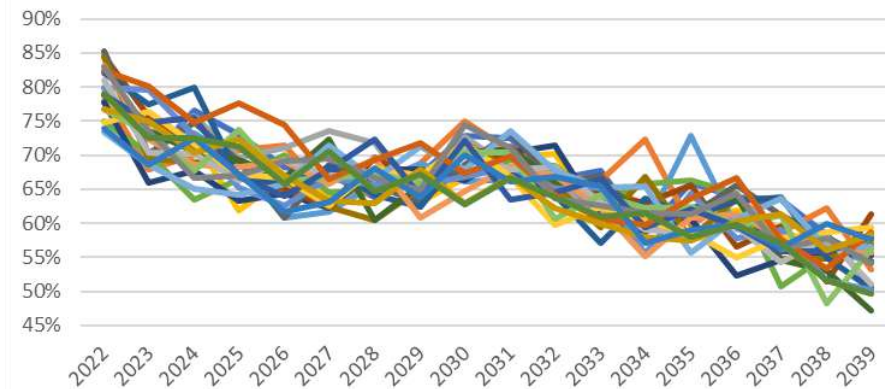
## Hedging tools

- Difficult to hedge
- Pay-as-produced PPA

## Risk assessment

- Use fundamental model with different scenarios (structural)
- Use simulations of capture rates (short-term)

Capture rates Nordic wind farm:  
variation in the simulations



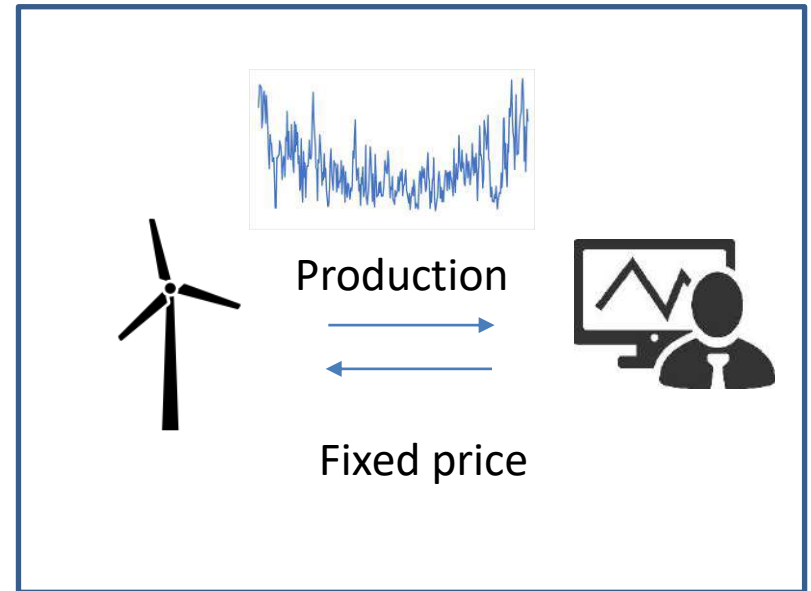
# Case study for hedging PPA price risk



# Hedging strategies

## Case study

On-shore wind project in Germany.  
Aggregator purchases 10 year pay-as-produced PPA at fixed price.  
So, aggregator takes over all price and volume risks.



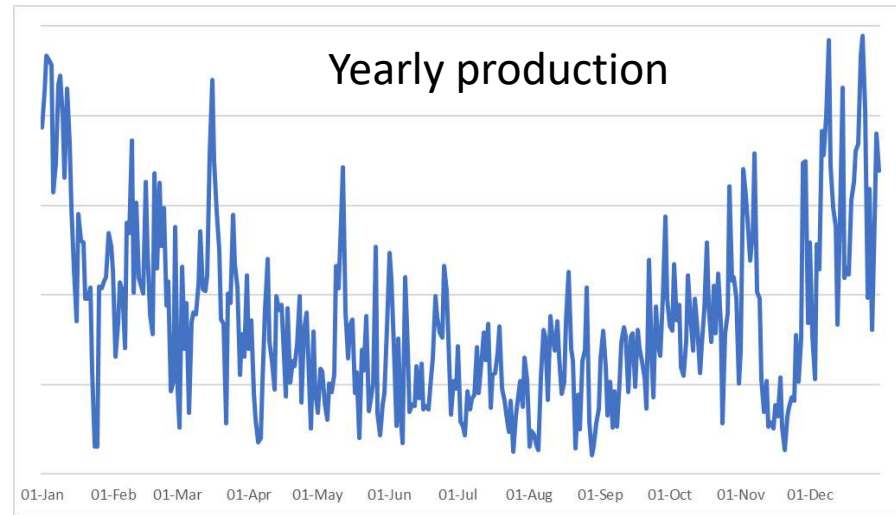
We analyze different strategies

- Sell in market, no forward hedging
- Hedge with annual baseload PPA at fixed price
- Hedge with stack and roll strategy

# Production profiles

Daily profiles show typical pattern of Northwest European wind farm.

Capture rate forecast made with fundamental power market model KyPF.



[Graphs](#) [Tables](#)

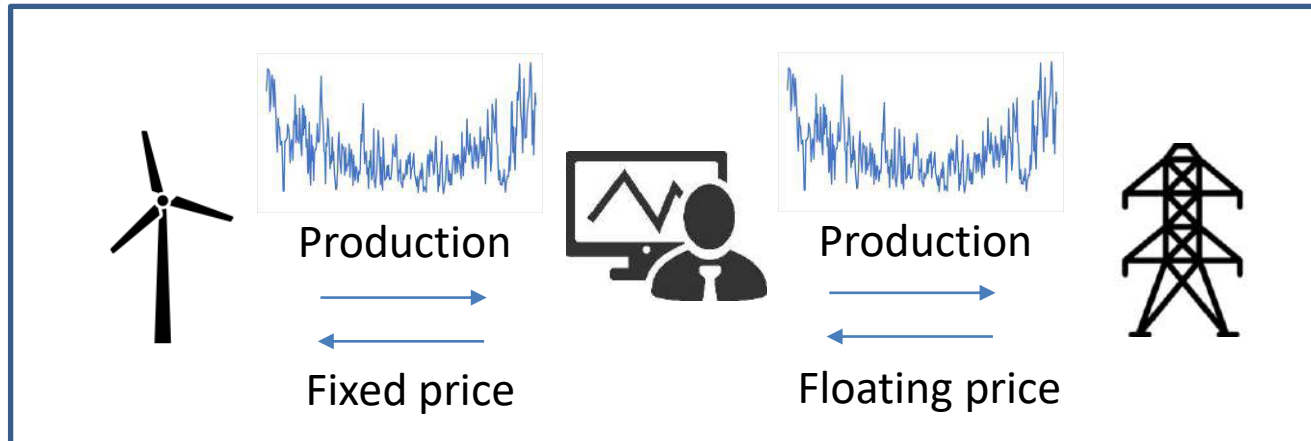
## Yearly Valuation

Year	Positions (MWh)	Earnings (EUR)	CF PPA (EUR)	CF Market (EUR)	CF Imbalance (EUR)
2022	75 941	460 417	-4 662 780	5 161 168	-37 971
2023	74 738	248 948	-4 588 927	4 875 244	-37 369
2024	76 236	76 455	-4 680 877	4 795 450	-38 118
2025	75 063	16 514	-4 608 845	4 662 890	-37 531
2026	75 513	-64 308	-4 636 499	4 609 948	-37 757
2027	74 986	-149 766	-4 604 147	4 491 875	-37 493
2028	75 937	-185 824	-4 662 526	4 514 671	-37 968
2029	75 354	-201 094	-4 626 710	4 463 293	-37 677
2030	74 650	-85 313	-4 583 500	4 535 512	-37 325
2031	75 206	-57 853	-4 617 644	4 597 394	-37 603
Total	753 623	58 177	-46 272 454	46 707 440	-376 812

# Strategy 1 – sell in spot market

Offtaker markets full output in day-ahead spot market

- Baseload price risk (large!)
- Risk of changes in price shape and capture rate
- Forecast error lead to imbalance costs



# Strategy 1 – Results in high risks

- We look at the distribution of earnings (KYOS PPA software)

## Earnings at Risk Summary

Custom Analytics: 33 Example DE Wind Webinar

Currency

EUR

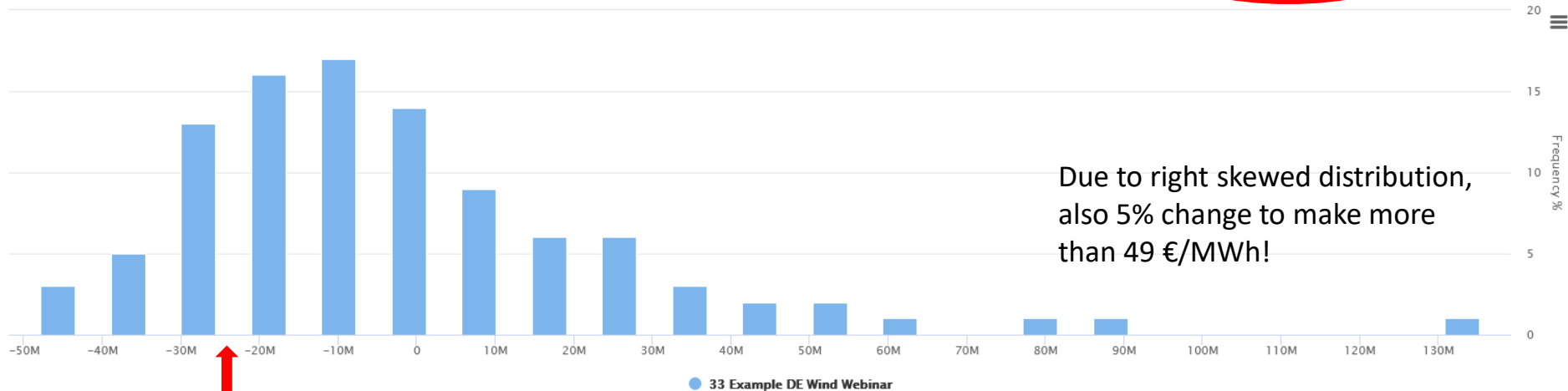
95% at Risk

24 382 159

5% probability to lose 24 mln € or more over 10 years = 32 €/MWh

## Custom Analytics: 33 Example DE Wind Webinar

### Histogram graph



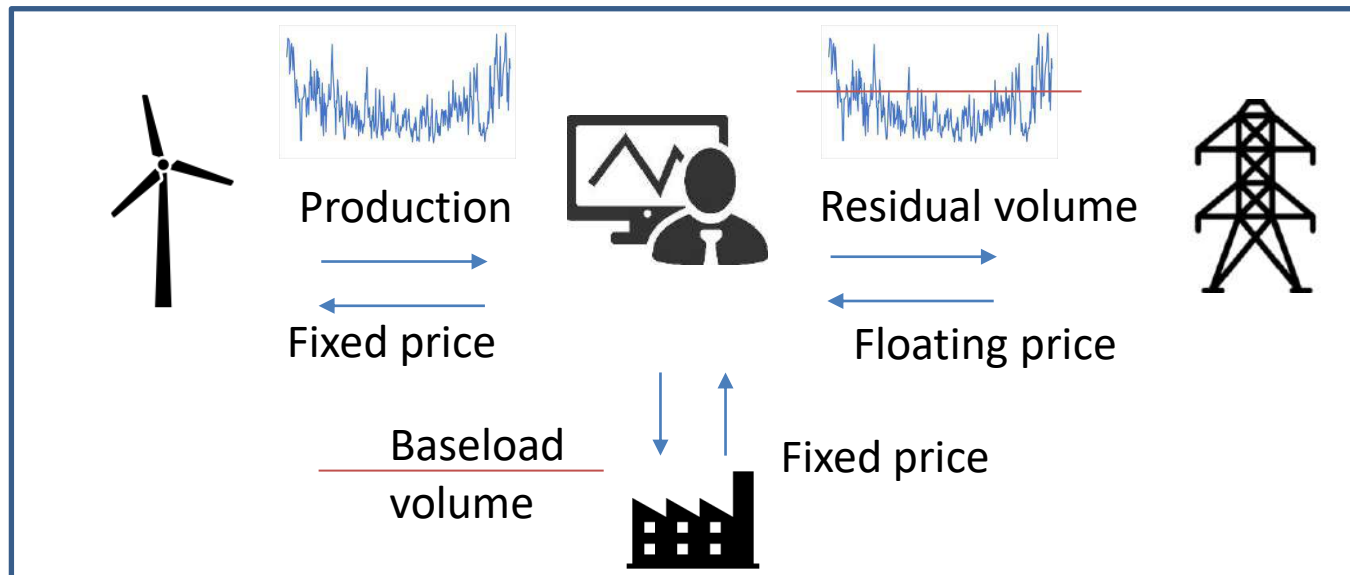
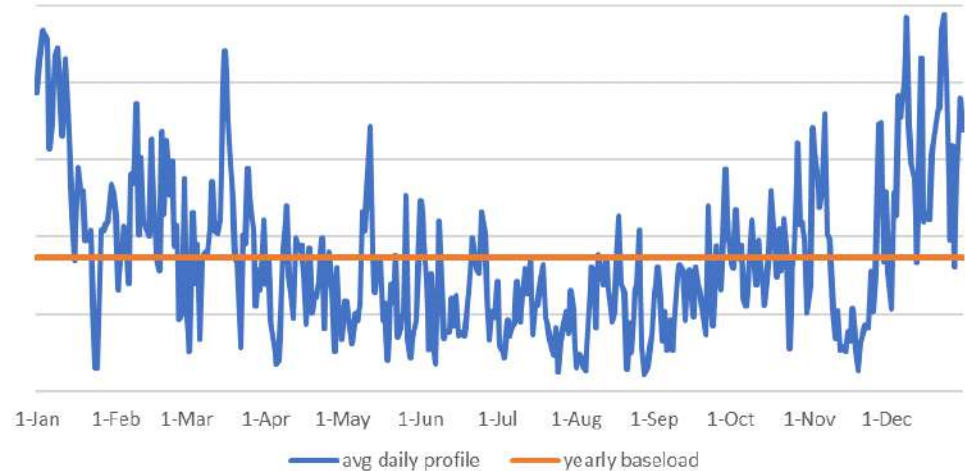
95% Earnings-at-Risk = 24 mln €

- Very wide earnings distribution, primarily price risk

# Strategy 2 – Hedge with baseload PPA

Aggregator sells fixed price, baseload 10 year corporate PPA at P50 volume. Risks:

- Shape risk
- Volume risk
- Imbalance risk





# Strategy 2 – clearly risk reducing

## Earnings at Risk Summary

Commodity: German Power

Currency

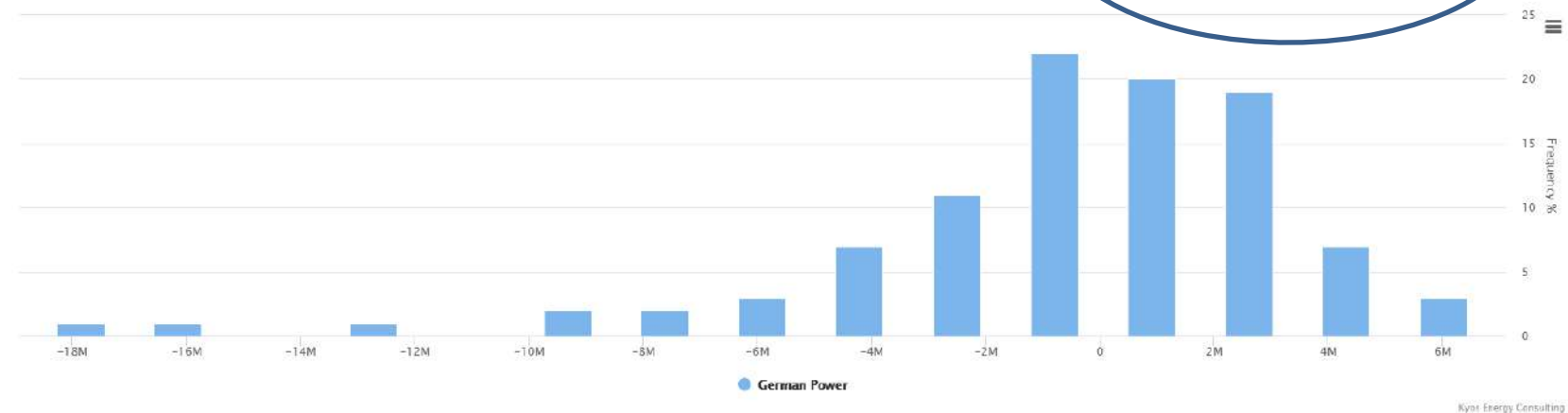
EUR

95% at Risk

4 858 702

Commodity: German Power

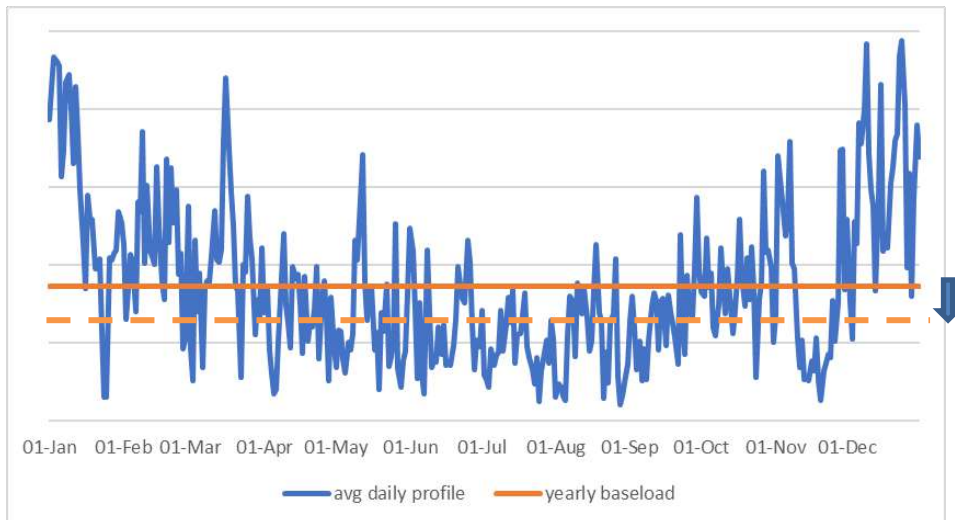
Histogram graph



- Very strong reduction of risk in earnings distribution: from 24 to 4.9 mln € for the 95% 'worst case' result.
- Nature of the risk has changed: worst case result when production volume is low and market price is high:
  - In one scenario, the average generation is 9% below P50 and the average market price 189 €/MWh

# Strategy 2 – improvements

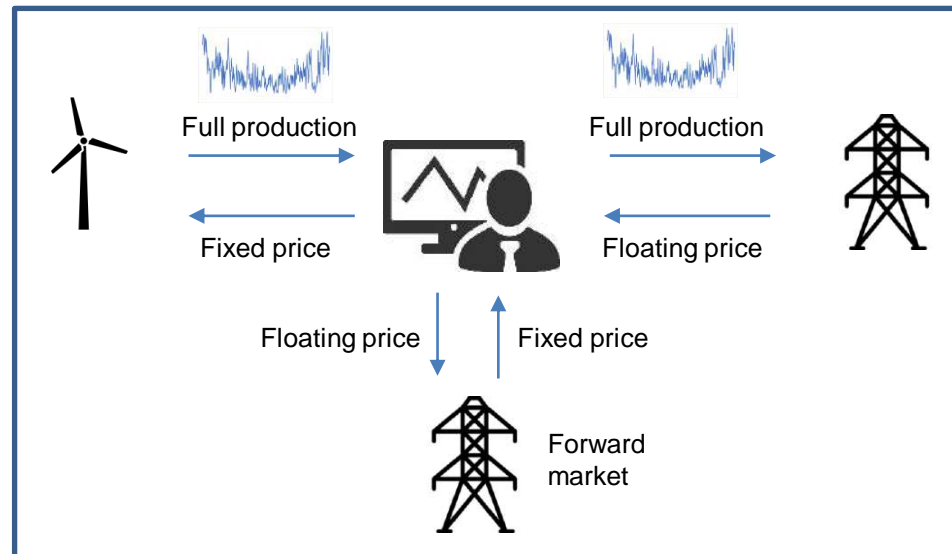
- Baseload PPA was volume neutral hedge based on P50
- Very common in practice, but suboptimal!
- Hedge can be improved by:
  - Shape baseload profile in monthly blocks
  - Reduce the hedge volume: value-neutral hedge is better than volume neutral



- Hedge reduced to 85% based on capture rate
- Reduces 95% EaR from 6.5 €/MWh to 4.0 €/MWh

# Strategy 3: stack and roll

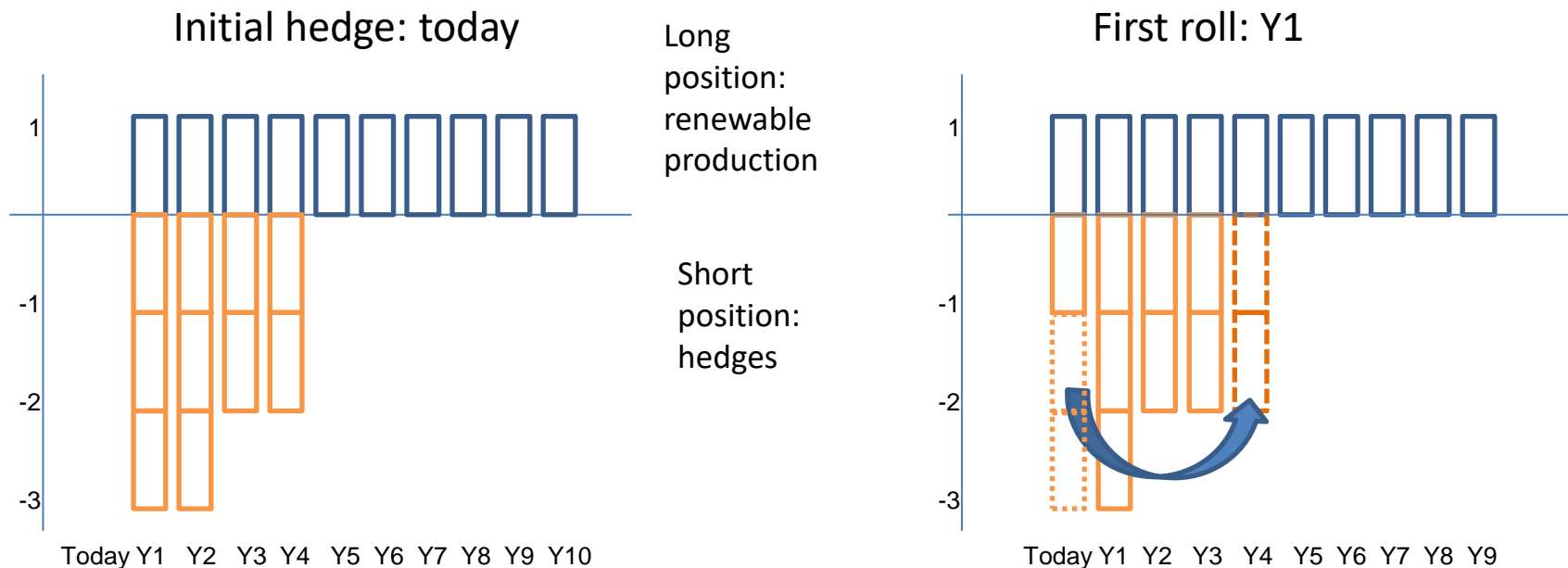
- Use standard forward and futures in the market
- But: liquid products are at most 3-4 years out
- ‘Solution’: place the exposures of longer horizons (5+) into shorter-term contracts (1-4 years)
- Every year, roll from short-term to long-term *tradable* contracts



# Strategy 3 – Stack and roll

Stack and roll strategy:

- Hedge illiquid periods with liquid periods
- Roll position when they become tradable



# Strategy 3 – Stack and roll

## Advantages

- Way to hedge price exposure of illiquid long-term periods
- Intuitive approach

## Disadvantages

- Requires enough liquidity in the forward market. Every year requires large position changes and you may be squeezed.
- Requires capital to deal with margin calls (MtM losses).
- Trading costs to make rolls each year.
- Risk of breaking correlations between the years. Example roll:
  - Buy (back) 2022 year contract @ 60 €/MWh
  - Sell 2024 year contract @ 50 €/MWh

Spot market

# Strategy 3 – Stack and roll

Earnings at Risk Summary	Currency	95% at Risk	95% at Risk (hedged)
Commodity: Total	EUR	24 382 159	17 733 815

## Commodity: Total

### Histogram graph



Kyos Energy Consulting

- Earnings-at-Risk reduced from 24 to 17.7 mln €
- More positive: number of 'bad' scenarios largely reduced

# **KYOS approach to valuation & risk assessment of PPAs and renewable projects**



# KYOS approach

- Each project and PPA is unique:
  - Location and technology
  - Market and regulation
  - Contractual parameters
- But all project and PPA assessments require insight in:
  - Expected volumes, prices and cash-flows
  - Distribution of volumes, prices and cash-flows
  - Possibilities to reduce risk with the right structures and hedging strategy



# PPA Assessment



Test Ewout Eijkelenboom

Settings Price data Time series Curves Assets & Contracts Analytics Custom analytics Reports Logs

KyPPA Prototype Templates

## KyPPA

Create profile

Show all filters Load filter Save filter Reset selection

Filter

IDs

x

5 results found.

20 per page

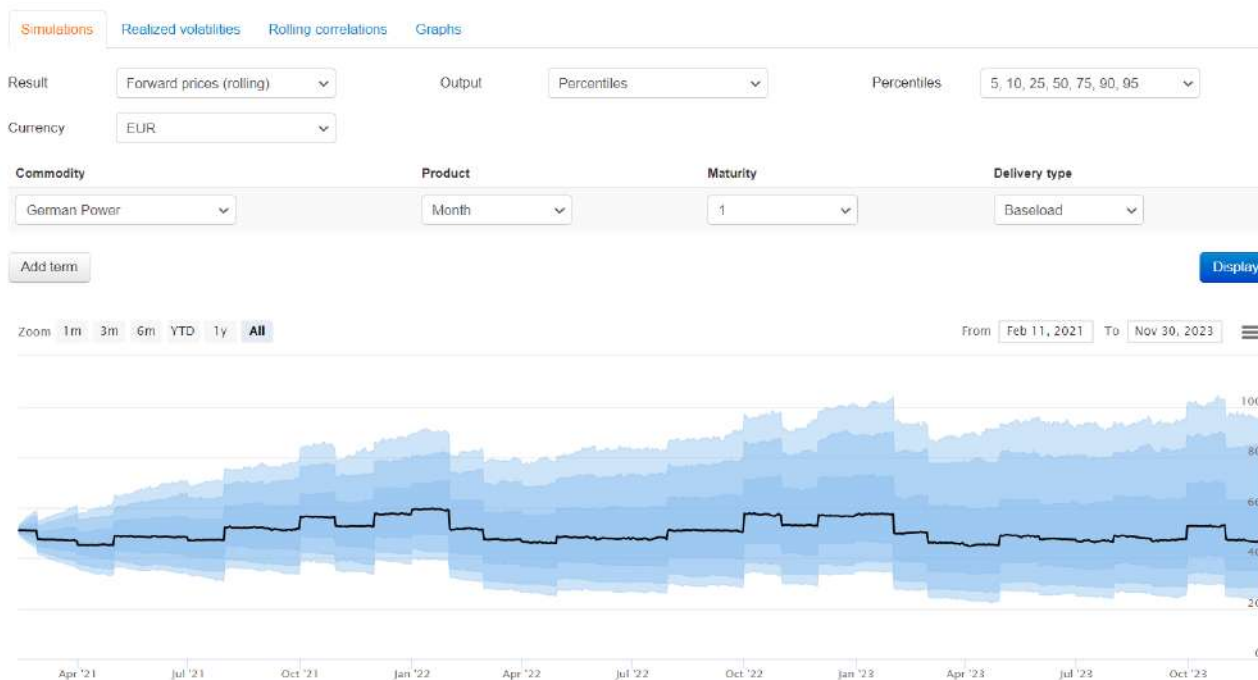
<input type="checkbox"/>	ID	Name	Simulation profile	Scheduled	Automated	Jobs	Reporting	
<input type="checkbox"/>	5	Example DE Wind Fixed Price	DE power for Halle	No	<input checked="" type="checkbox"/>	6	Yes	Last result
<input type="checkbox"/>	6	Example DE Wind Indexed Price Cap/Floor	DE power for Halle	No	<input checked="" type="checkbox"/>	3	Yes	Last result
<input type="checkbox"/>	7	Example DE Solar Fixed Price	DE power for Parchim	No	<input checked="" type="checkbox"/>	3	Yes	Last result
<input type="checkbox"/>	9	Demo RO Solar Fixed Price	RO power with solar demo	No	<input type="checkbox"/>	1	No	Last result
<input type="checkbox"/>	10	Demo RO Solar Spot Index	RO power with solar demo	No	<input type="checkbox"/>	1	No	Last result

## KyPPA module:

- Out of the box standard PPA pricing structures
- Possibility to define your own pricing structures

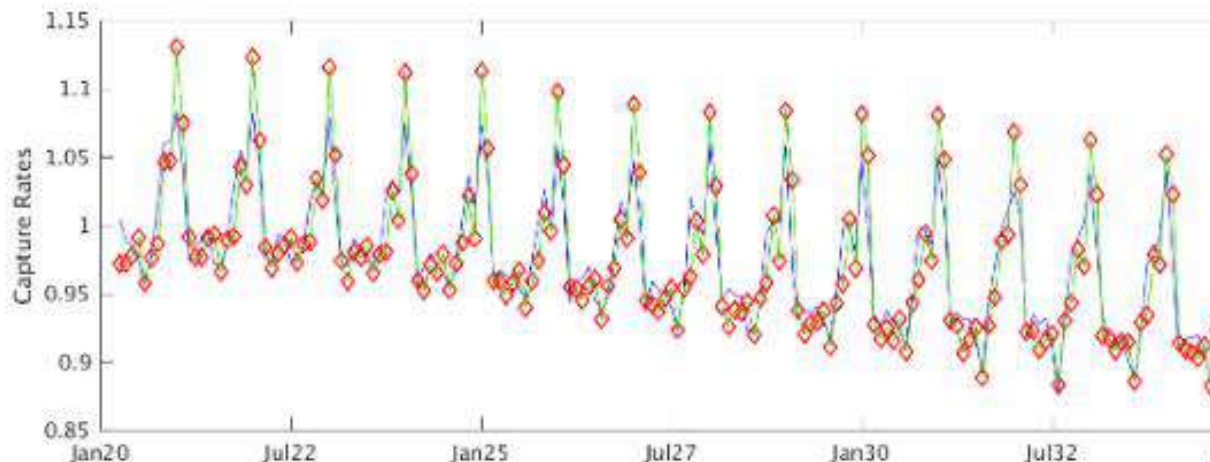
# Simulate prices and volumes

- A single forecast of power prices is not enough
- Monte Carlo simulations of power prices:
  - Forward prices and hourly spot prices
  - Arbitrage-free: on average equal to forward curve



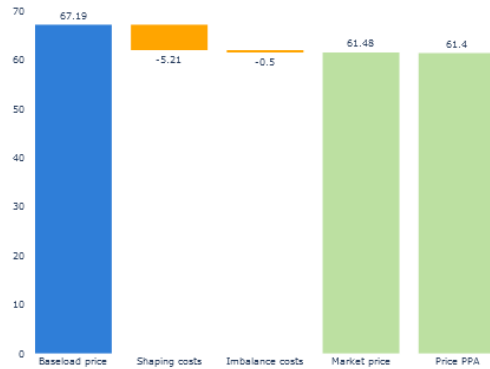
# Simulate prices and volumes

- A single scenario of production forecast is not enough
- Production is negatively correlated to power prices
- Simulate weather and renewable power:
  - Smart historical sampling from historical years
  - Imposing a negative correlation with the power prices to meet the expected capture rates

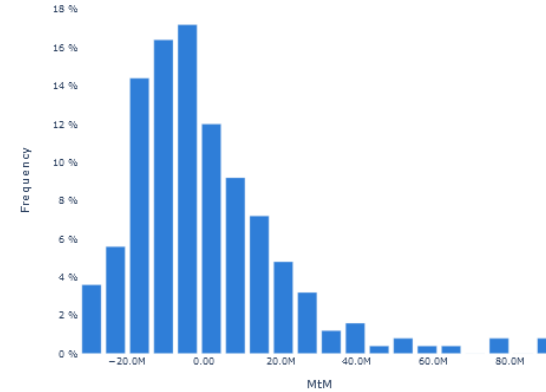


# PPA risk assessment

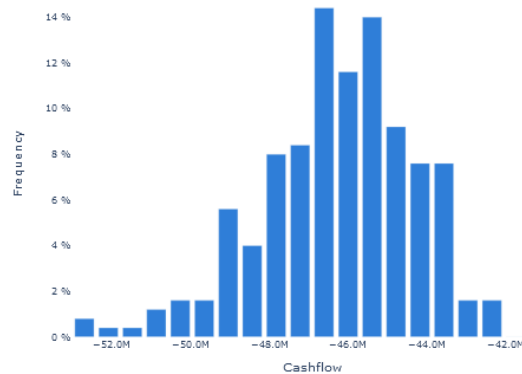
Breakdown PPA valuation



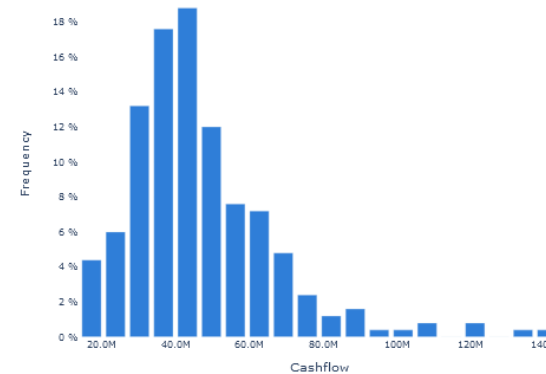
Total Earnings (EUR)



Total Cashflow PPA (EUR)



Total Cashflow Market (EUR)



- Assess value and risk profiles per project and per PPA

# PPA risk assessment

Earnings at Risk

Cash-flow at Risk

Volumes at Risk

## Earnings at Risk Summary

Commodity: Total

Currency

EUR

95% at Risk

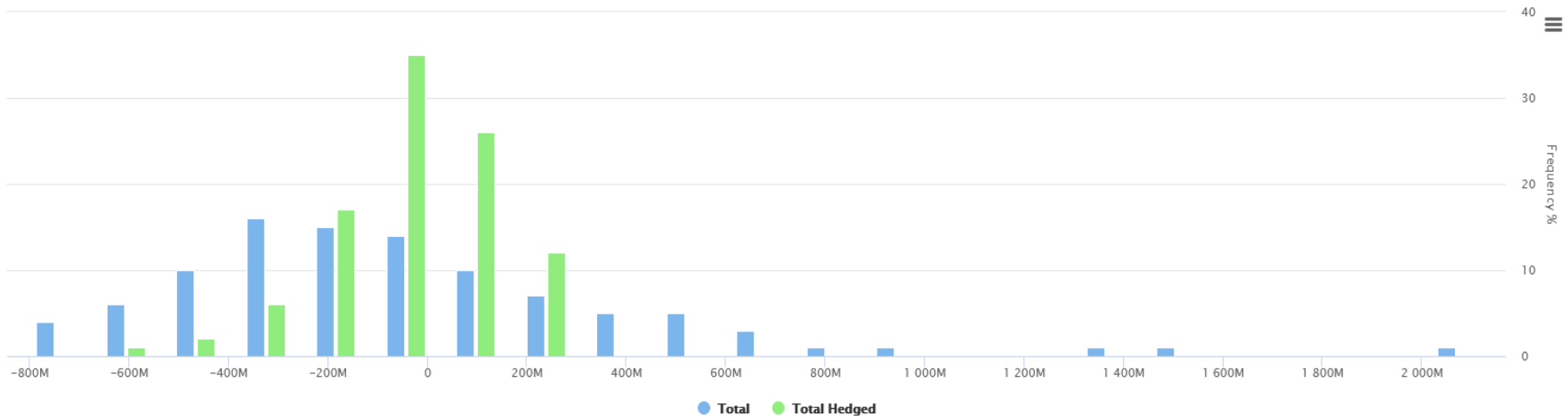
399 538 718

95% at Risk (hedged)

190 977 997

## Commodity: Total

### Histogram graph



Kyos Energy Consulting

- Full risk profile of one project or portfolio of projects
- Include effect of hedging strategies, static or dynamic

# KYOS PPA services

KYOS supports all players in the renewable sector

Project  
developer

Bank/investor

Aggregator/  
Utility

Corporate

- Valuation support during PPA negotiation/M&A activities
- Regular PPA valuations for accounting and trading purposes
- Support with arbitration cases

- KYOS Analytical Platform - complete tool to capture and manage PPAs
- Python scripts allows user to create own PPA pay-off formulas
- Detailed risk reports for managers and analysts



Thank you

Time for Q&A

# We look forward to supporting you in the rapidly changing energy sector!

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