Optimal hedging of a renewables PPA portfolio

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Agenda

- Introduction
- A simulation approach to assess risks and hedge effectiveness
- Hedging price risks of renewable assets
- Case study – optimal PPA sizing
- Q&A and discussion

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Intro KYOS Energy Analytics

KYOS: Our analytics, your advantage

Software models for energy

Various models for valuation, optimization and risk management, coupled with advanced forecasting and price simulation tools will provide you will the best basis possible to base your decisions on.

Power plants
Renewable generation
Gas storage
Gas swing contracts
Batteries
Options
.....

Software models for multi-exposure commodities

The Commodity Portfolio & Risk Management software combines physical commodity management with financial risk reporting and price analytics.

It swiftly reveals the company-wide financial risks in clear reports.

Consultancy

We offer a wide range of top analytical services to companies in the energy and commodity markets. We are specialists in valuation, optimization and risk management.

Our expert services range e.g. from a one-off deal valuation to a complete solution for the risk management of a portfolio of assets and contracts.

Price data models

Live or End-of-day market price forward curves are essential for trading, structuring and risk management.

In addition we also have a fundamental model for long-term (>30 year) power prices..

KYOS Energy Analytics

- International client base across Europe, plus Americas and Japan
- 30+ people, of which 20+ in Haarlem
- More than 100 corporate clients for its software services

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KYOS renewable energy services

KYOS supports all players in the renewable energy sector

	Project developer	Bank or investor	Utility or Aggregator	Corporate off-taker
Software	• KYOS Analytical Platform - complete software system to price and manage renewable assets and PPAs • Make long-term power price projections and perform what-if analysis • Monitor and manage a complete portfolio of assets, PPAs and hedges • Analyse different hedging strategies before entering in new deals • Obtain detailed risk reports for managers, investors and analysts			
Advisory	• Get valuation support during PPA negotiation and M&A activities • Get regular PPA valuations for accounting and trading purposes • Get support with arbitration cases, re-financing and re-powering			

A simulation approach to assess risks and hedge effectiveness

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KYOS Analytical Platform – location based pricing

Price data | Time series | Curves | Assets & Contracts | Risk analytics

Production, Demand & Weather

Profile name * Windturbine De Haagse Molen

Type Wind speed

Granularity Hour

Weather data import

The Platform can import weather data directly from Meteoblue, based on the coordinates.

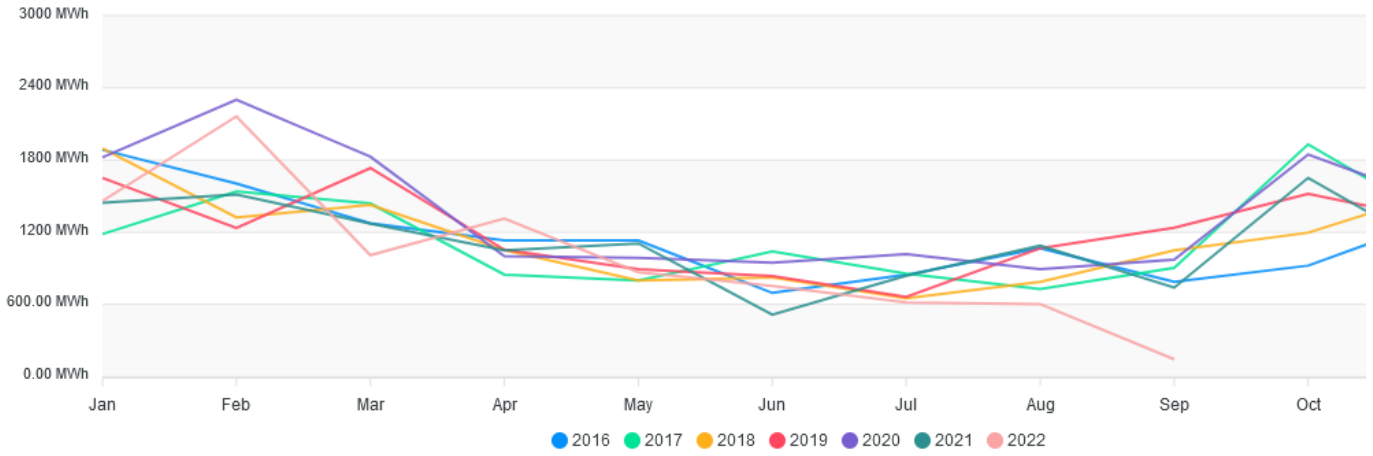
Import automatically

Latitude * 52.071092
Min: -90 Max: 90

Longitude * 4.386485
Min: -180 Max: 180

Turbine height * 100

- Price a PV or wind asset at any location, based on:
  - Coordinates
  - Orientation
  - Power curve
  - P50 generation levels
- Create generation patterns of different weather years with historical weather data from Meteoblue
- Combine with fundamental power market model to estimate future capture rates



- Get immediate insights in generation statistics

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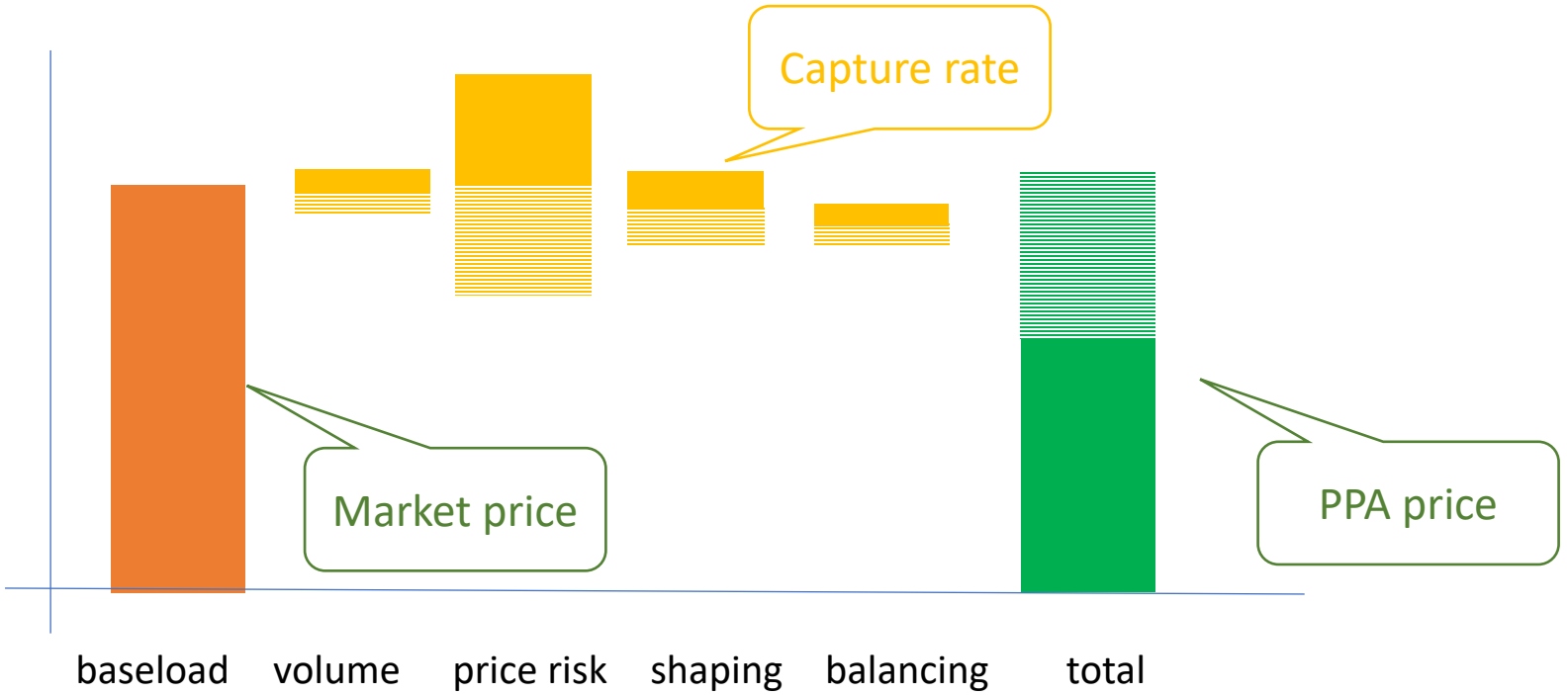
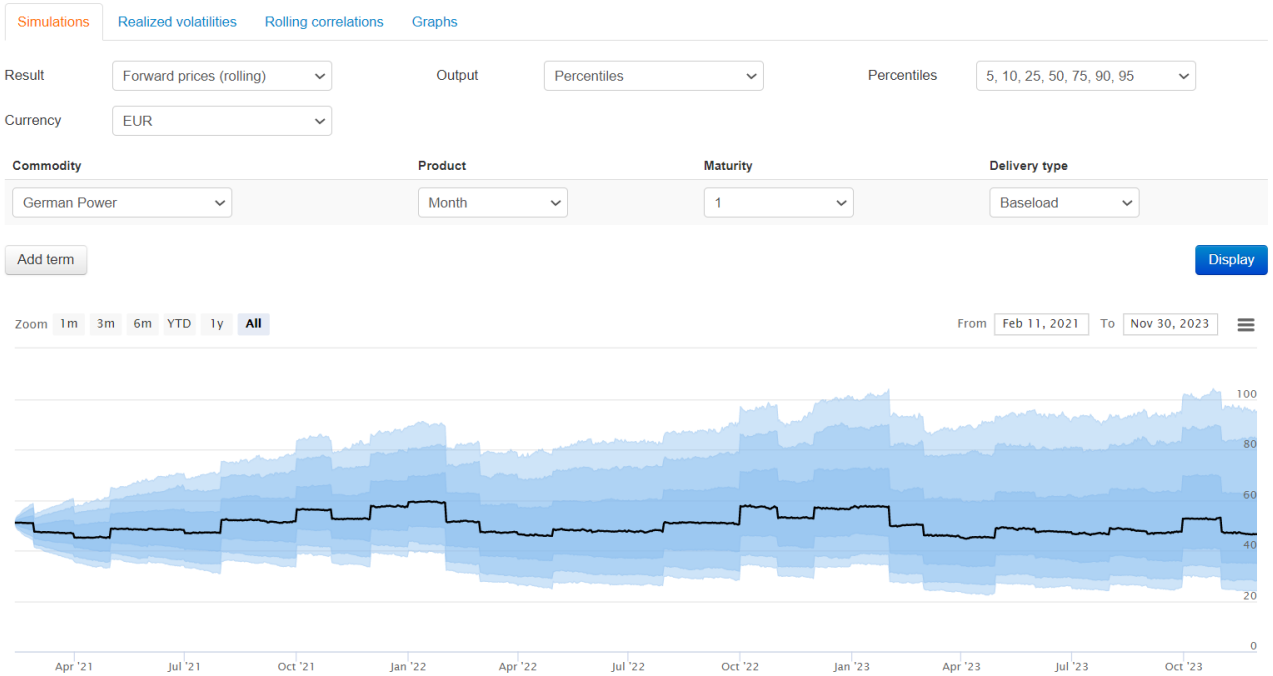
PPA value components and risk

- Some risk components are easier to hedge.
- Power price risk is typically largest risk component



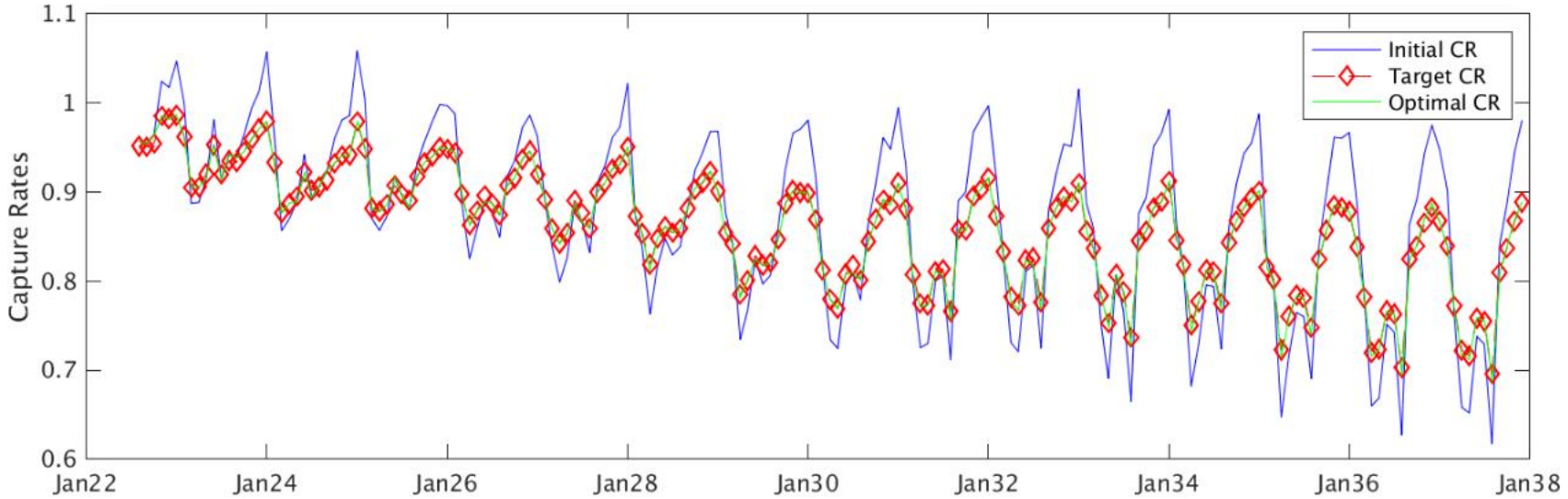
Why simulate prices?

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



Why simulate volumes too?

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



Hedging price risks of renewable assets

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Gain an edge with a hedge

- **The challenge:**
  - Huge investments in merchant projects
  - Investors are exposed to long-term price risks
  - Buyer's market for long-term contracts (3+ years)
  - Long-term contracts are selling at a discount

- **Hedging capability creates a competitive advantage:**
  - Reduce risk capital
  - Attract external capital, incl. debt
  - Maximize revenues
  - Create a larger portfolio

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Hedging – many choices

- Long term PPA (e.g. with corporate) 5-10 year
  - Baseload or pay-as-produced
- Market hedges for shorter period (1-3 years)
  - Baseload or peakload
  - Calendars or more refined with quarterly and monthly contracts
  - In 'own' market or in 'proxy' market
- Dynamic:
  - Trade shorter dated products when available
  - Rebalance positions based on prices
  - Stack and roll

The size (volume) of the hedge is most important.
Value-neutral is better than volume-neutral.

The optimal hedge volume is often even lower,
e.g. <80% of P50 volume

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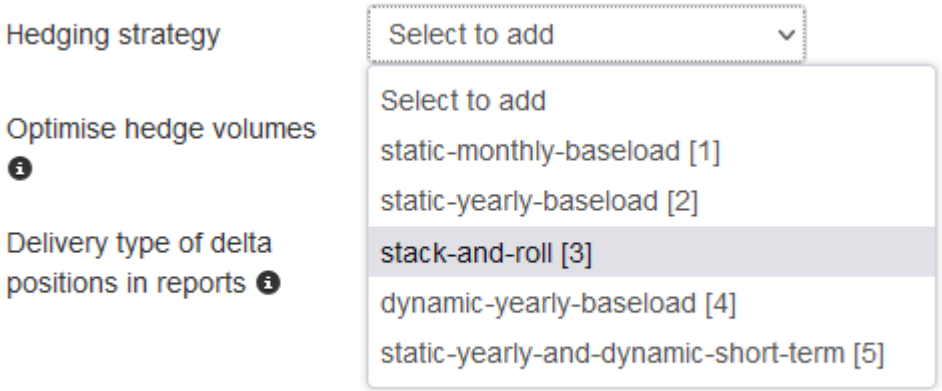
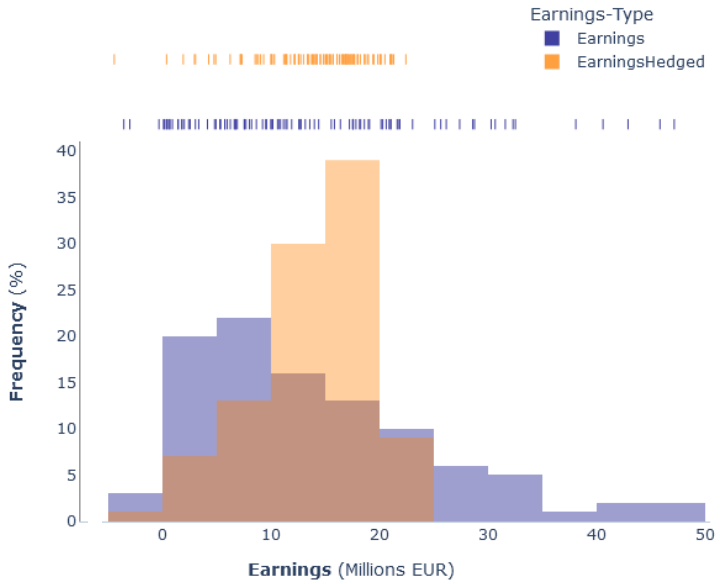
Hedging - analysis

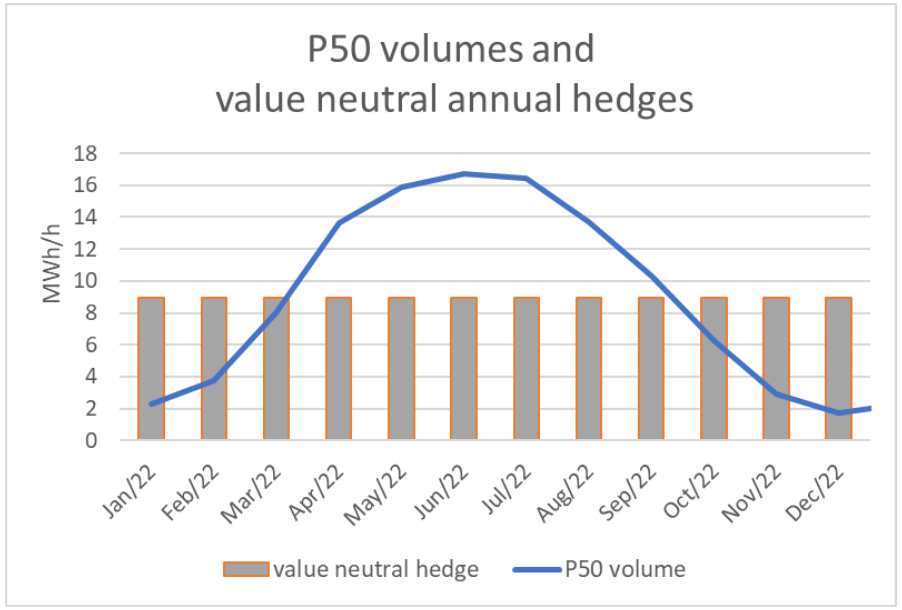
- Hedging lowers your risk
- But optimal hedge requires sophisticated valuation, including using Monte Carlo simulations
  - KYOS Analytical Platform comes with out-of-the-box functionality to easily test different hedging strategies



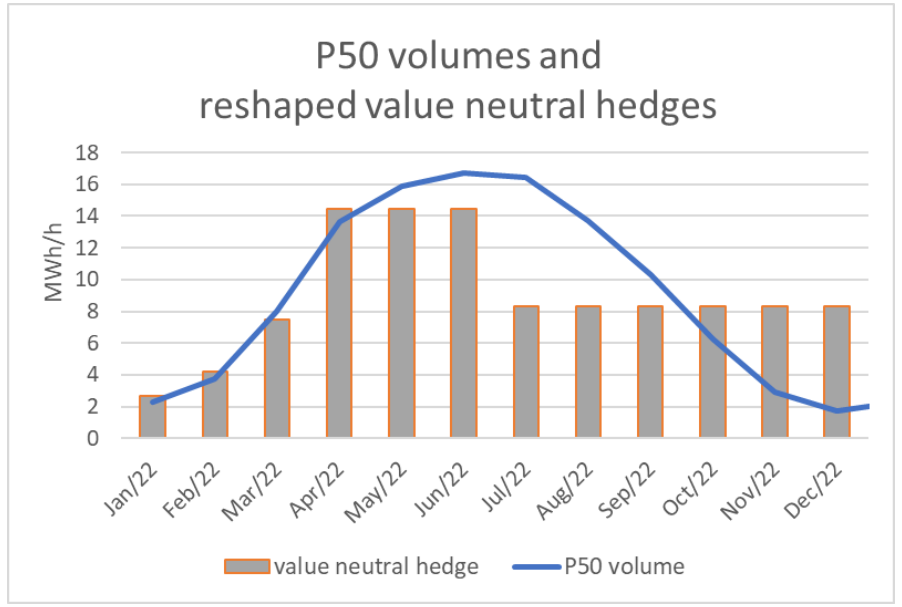


Dynamic hedging (1/2)

- Refine hedging
  - Rebalance hedge based on products becoming tradable
  - Example: initially only years tradable, later this can be reshaped using months and quarters



Initial annual hedge

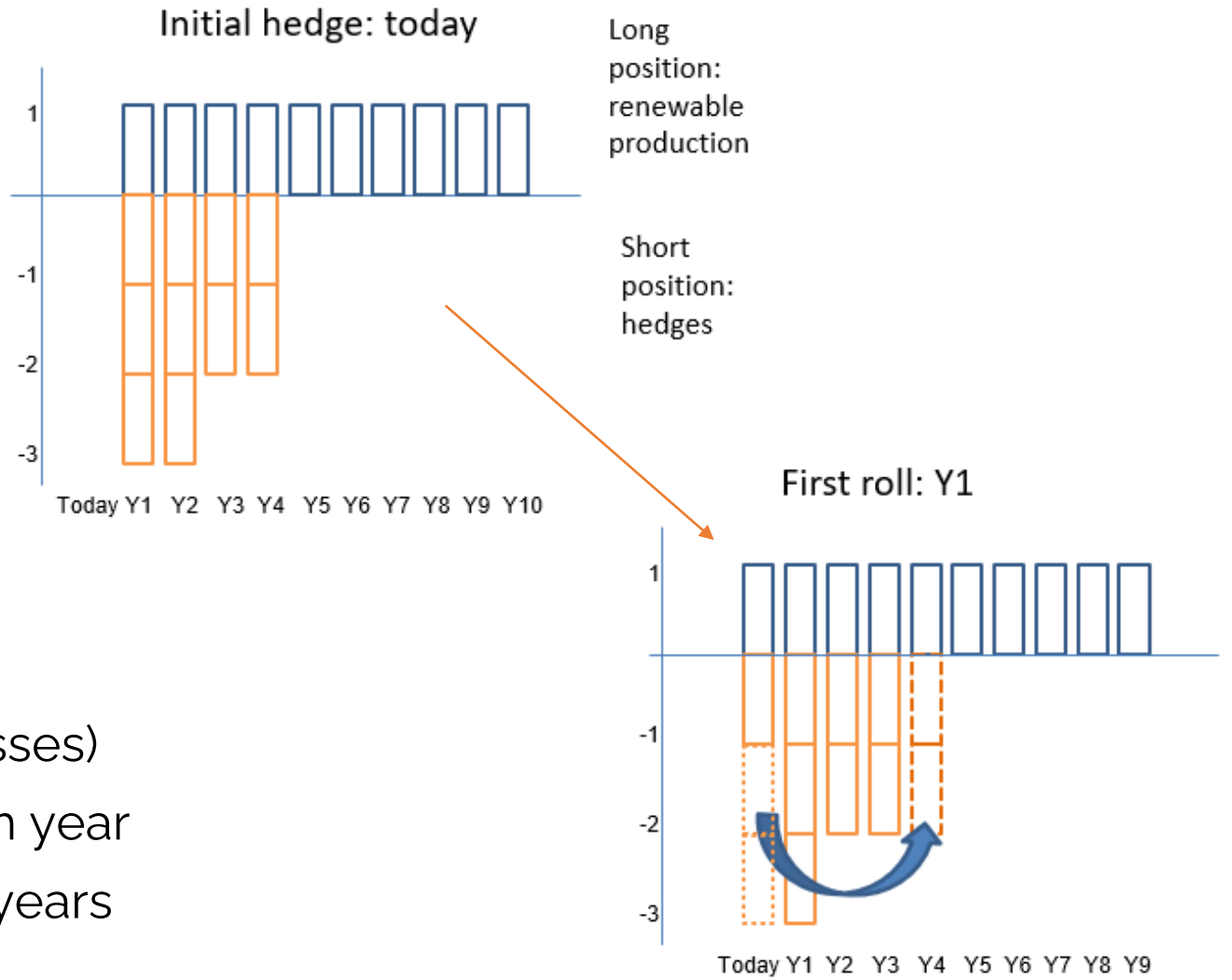


Reshaped hedge

Dynamic hedging (2/2)

Hedge illiquid period with liquid periods

Roll position when they become tradable



Challenges

- Liquidity in the forward market
- Capital for margin calls (MtM losses)
- Trading costs to make rolls each year
- Breaking correlations between years

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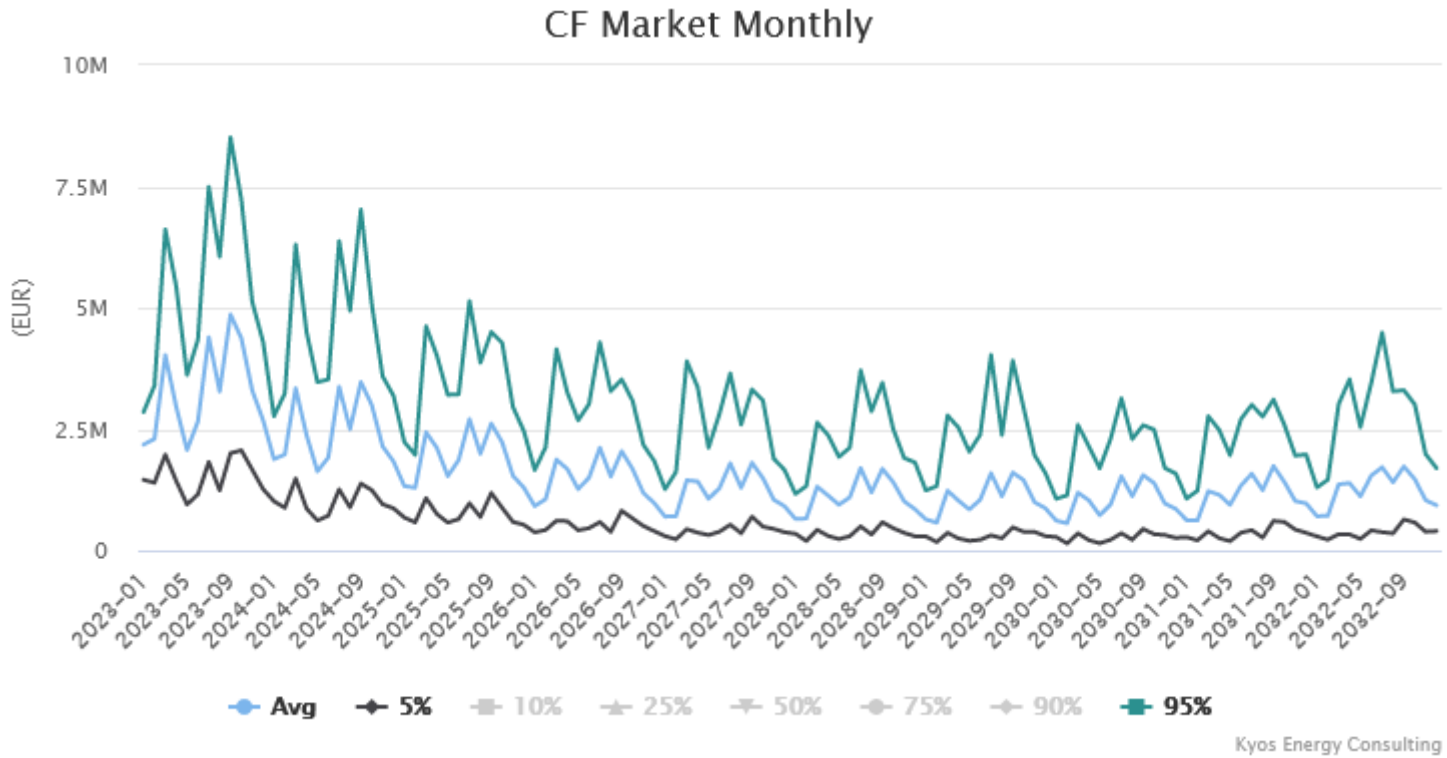
Case study

Case study - outline

- We analyse in this example how a proper PPA risk management system can support a renewable asset owner making informed decisions!
- PV asset owner in France with 100 MWp
- Asset owner wants to assess effect of different PPAs on debt service coverage ratio

Valuation asset in market

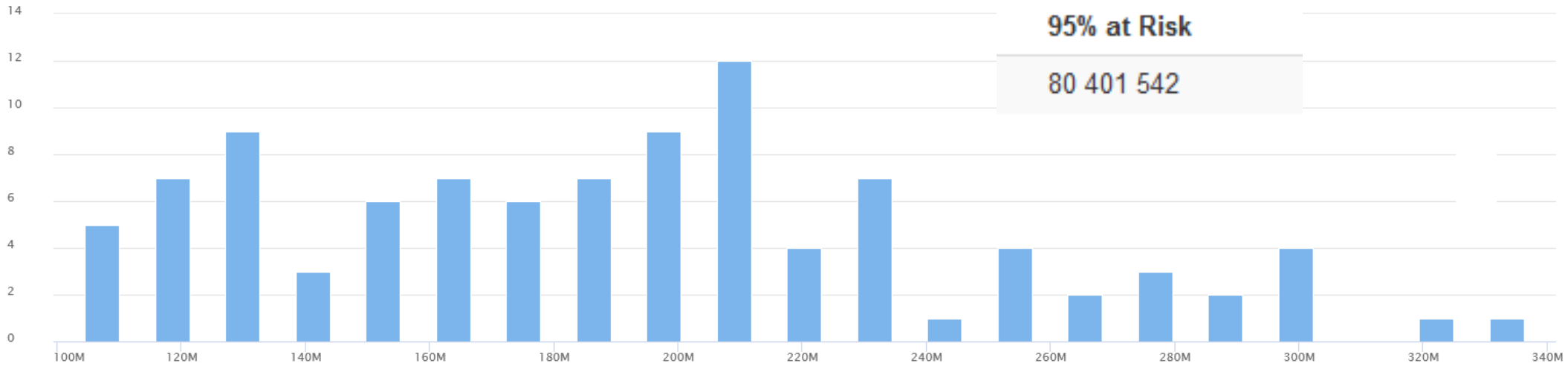
- In the first step we calculate (in KyPPA) the asset value in the (spot) market



- Wide distribution of possible cashflows -> large risks

Valuation asset in market

- High risk can also be seen when looking at distribution of cashflows over the 10-year valuation period



- Indicator for this risk is the Cashflow-at-Risk metric

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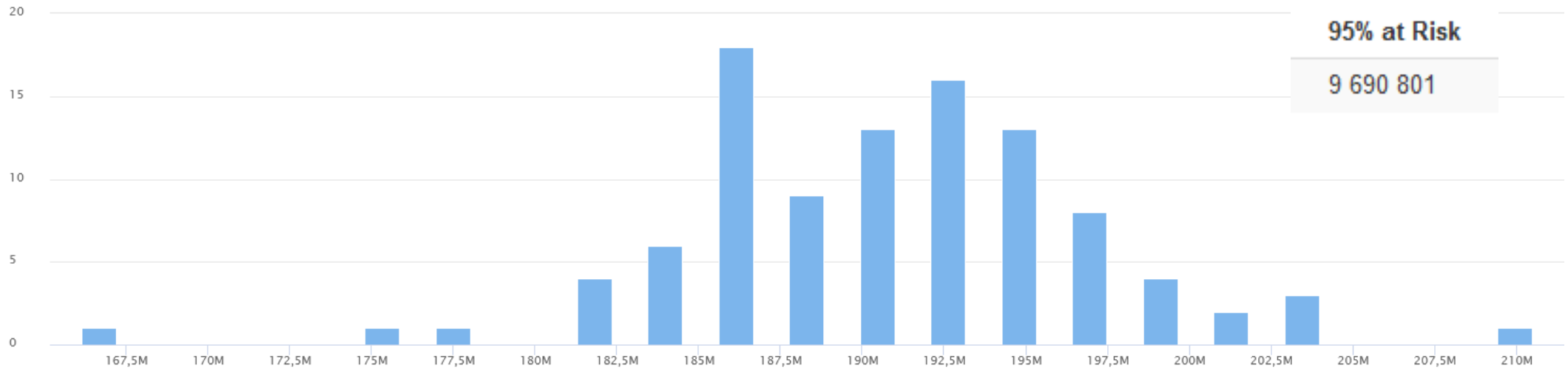
Hedging

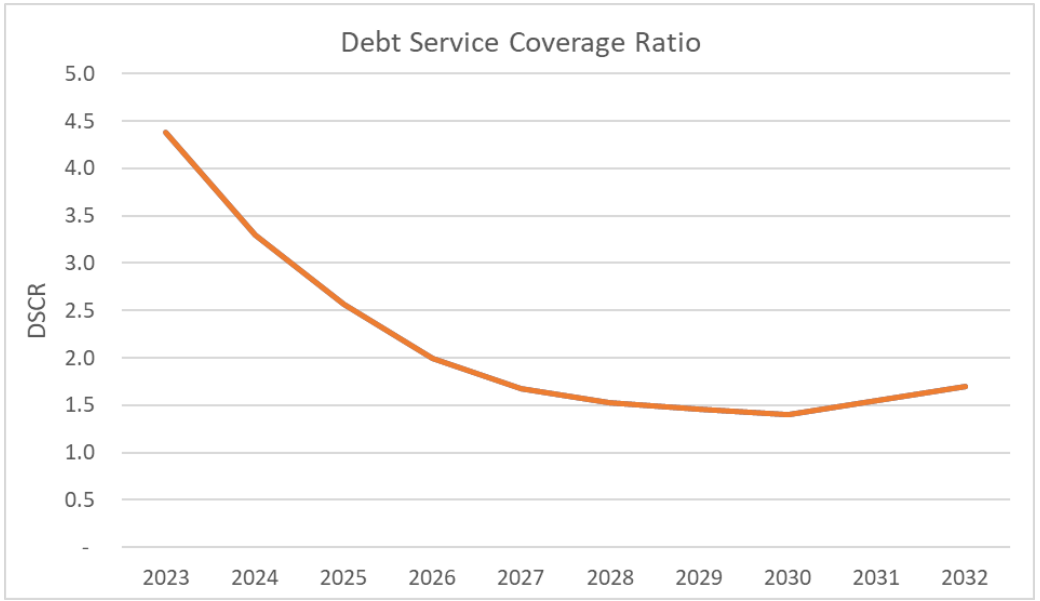
- We now introduce an annual baseload hedge
  - Using a value neutral hedge as calculated by KyPPA
- Much tighter risk distribution



- CfaR metric is now only €9.6mln (from €80mln of unhedged asset)

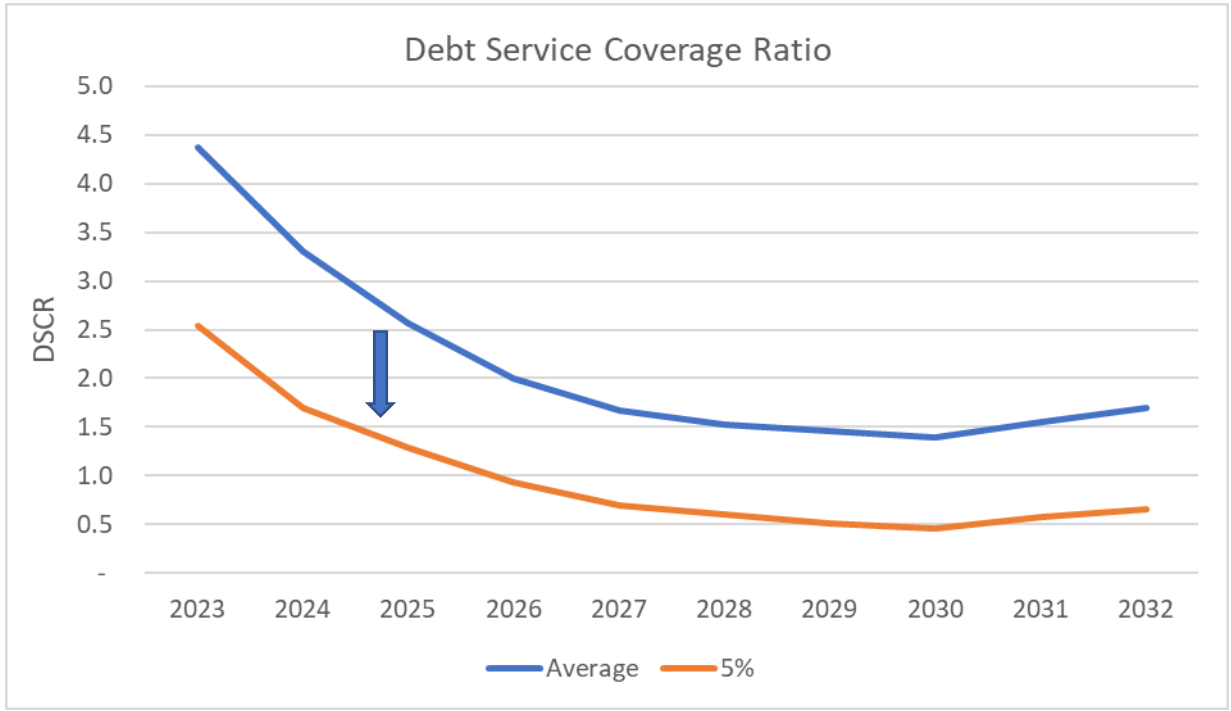
Supporting financing (1/3)

- Banks look at debt service coverage ratio (DSCR)
- Assume total investment around 800€/kWh and debt repayment over 10 years
- Based on <u>expected</u> cashflows of the unhedged asset, DSCR looks healthy



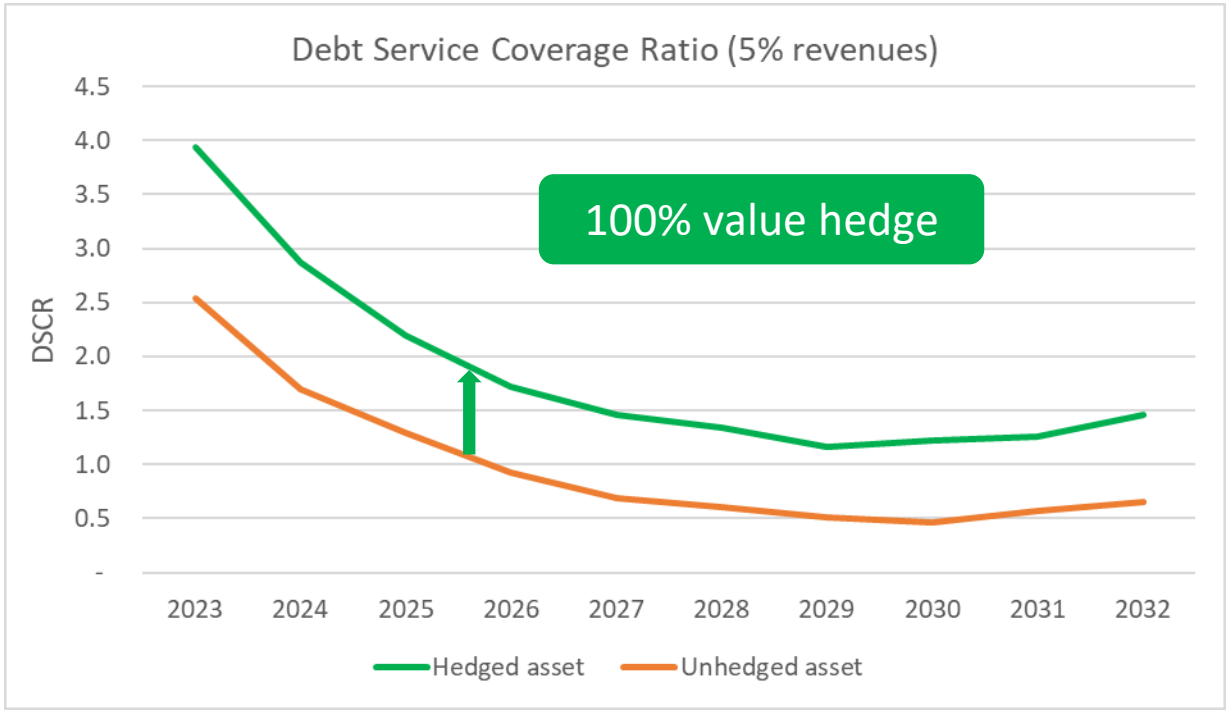
Supporting financing (2/3)

- But banks want certainty and will not look at expected revenues, but at worst cases
  - E.g. 5% worst case of cashflows
- DSCR of unhedged asset becomes very low, making financing difficult



Supporting financing (3/3)

- Same analysis with hedged asset
- Brings DSCR back to values close to “expected DSCR”
- KYOS software can be used to easily analyse different hedging strategies on DSCR.
- For example, hedging **91%** of the value neutral hedge maximizes the average DSCR.
- Or: if the DSCR should not go below 1 in any year, the minimum size of the hedge volume is **60%.**



Summary

- Simulation based valuation of renewable assets and PPAs is key to understand price and volume risks
- Valuable tool for
  - Pricing PPAs
  - Defining PPA strategies
  - Optimizing market hedges
  - Supporting financing/investment analysis
  - Daily risk management and reporting

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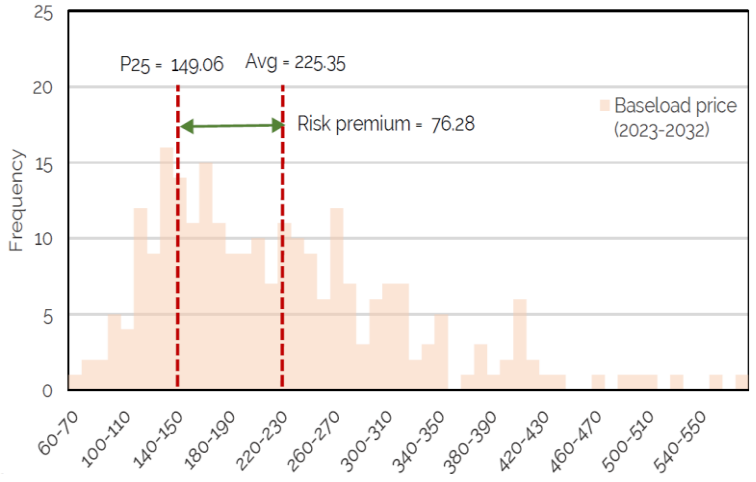
Thank you

Report provides PPA assessments, covering almost whole of Europe

Includes a risk discount in the solar and wind PPA assessments (as of September issue)

Risk adjusted price = P25 price



Western Europe

	Baseload	Solar	Wind onshore
Netherlands	230.6	116.0	136.2
Belgium	240.1	133.0	146.9
Germany	240.8	135.9	143.8
France	218.4	124.2	133.4
Switzerland	253.9	143.9	169.5
Austria	255.5	147.6	166.4

Book describes systematic approach to renewable financing and PPA pricing / hedging