AURORA
ENERGY RESEARCH

Hybrid PPAs in Europe– multi client study

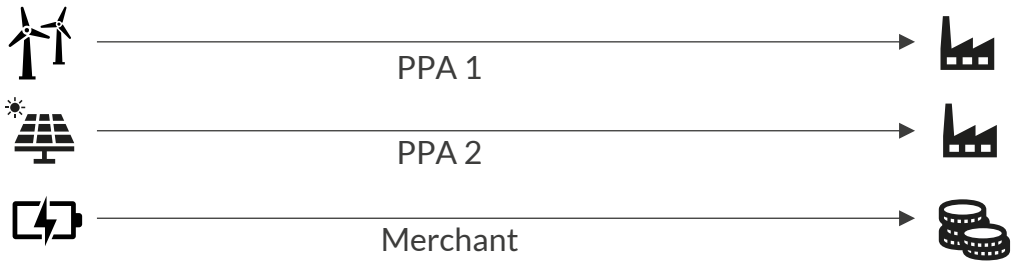
May 2025

In our multi-client study, we will highlight the advantages of hybrid and shaped PPAs over traditional PPA structures

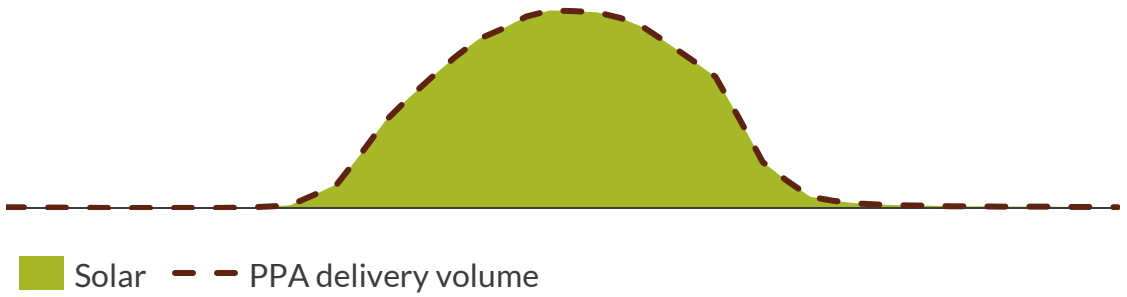
AURORA

Traditional PPA structures

So far, PPAs have primarily been used to sell energy from a single asset. Batteries, however, are rarely secured under long-term offtake agreements and are typically traded in wholesale and balancing markets.

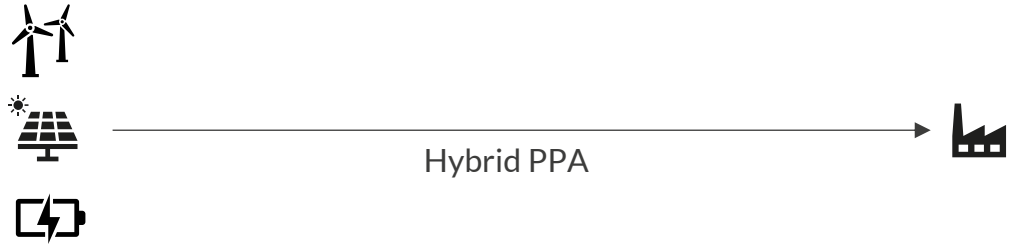


The most common volume structure for wind and solar PPAs is pay-as-produced, exposing the offtaker to volume and cannibalisation risk.

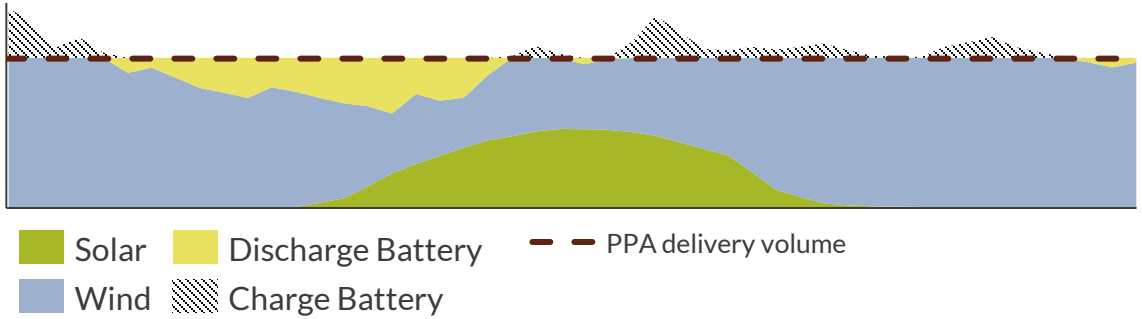


Hybrid and shaped PPA structures

Under a **hybrid PPA**, co-located assets are bundled under a single offtake agreement, enabling the business case optimisation and long-term revenue security of the entire portfolio.



Under a **shaped PPA**, volume structures deviate from the standard pay-as-produced model by following a predefined pattern, such as annual or monthly baseload or a fixed profile. To ensure shaped PPAs remain 100% green, a hybrid setup incorporating multiple assets is required



Sources: Aurora Energy Research

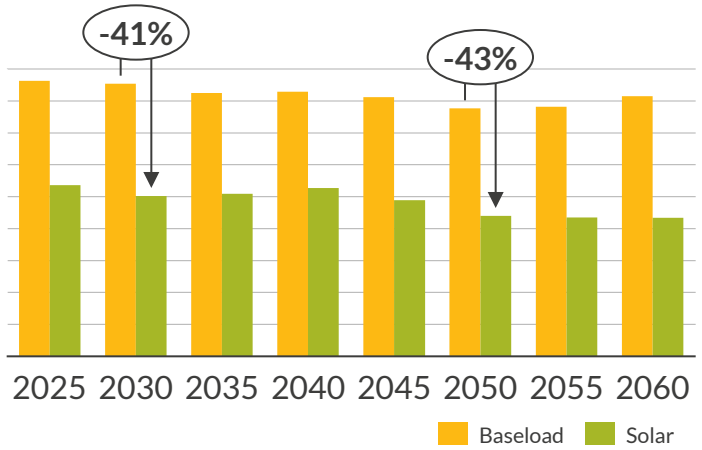
What challenges are providers and offtakers of traditional PPA profiles facing in the market today?

AURORA

1 Decreasing value for traditional PPA shapes

Increasing renewables penetration leads to cannibalisation of capture prices and a rise in the frequency of negative price hours– traditional "as-produced" PPAs struggle to achieve capture prices that ensure sufficient revenue.

Solar capture prices vs. baseload prices (Germany)
EUR/MWh



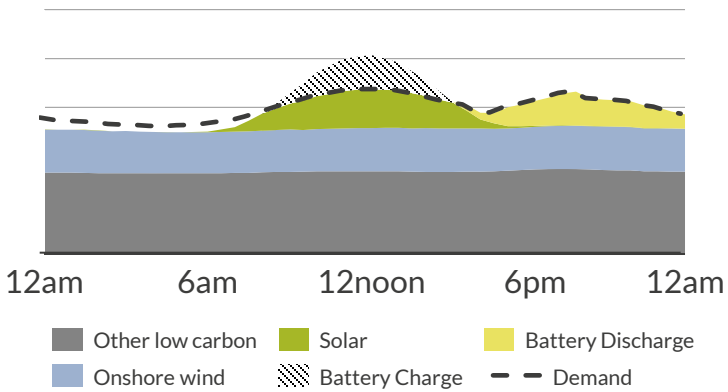
Projects in mature markets struggle to achieve a positive business case with as-produced PPA.

2 Challenging integration of as-produced profiles

(Industrial) offtakers can only absorb a limited amount of "as-produced" PPAs into their portfolio, significantly limiting industrial PPA demand.

Corporates with high green ambitions need to explore shaped profiles to reach ambitious green goals e.g. 24/7 matching of green power usage.

24/7 carbon free power matching (illustrative)
MW



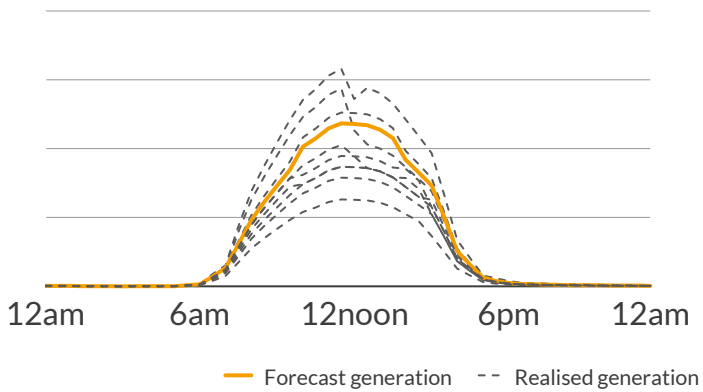
Offtaker demand for as-produced profiles is significantly limited, integration into larger portfolios challenging.

3 Imperfect hedge for offtakers from as-produced

As-produced profiles expose offtakers to challenges in hedging their residual energy demand due to unpredictable and volatile nature of as-produced generation.

Additional risks from curtailment and negative prices reduce reliability of as-produced profiles.

Forecast error solar pay-as-produced PPA (illustrative)
MW



As-produced PPA increase hedging complexity and risk profile for offtakers, introducing additional cost to power procurement.

Sources: Aurora Energy Research

Shaped PPAs provide an answer to the challenges faced by industry and increase the attractiveness of PPAs in mature markets

AURORA

Questions

1. How can shaped PPA address the challenges PPAs face in the market today, such as cannibalisation of capture prices and negative price risk – what type of shapes are conceivable and what benefits do they offer to suppliers and offtakers?
2. How does shaping a PPA increase the market value of the energy sold? Under which conditions is there a positive business case?
3. What type and size of renewable assets (solar PV, wind, storage) do you need to combine in order to firm a shaped PPA at minimal cost? What are residual risks and shaping cost from required wholesale market interaction?
4. Which additional revenue streams can be realised from an asset portfolio, e.g. from storage dispatch on secondary markets?
5. Which regulatory, legislative, technical and operational hurdles or risk exist to realise the proposed shaped PPA?

Proposed scope of the Multi-Client Study

1. **Identify conceivable PPA shapes and derive their inherent fundamental market value.**
2. **Derive the cost-optimal portfolio of renewables and storage in order to firm the targeted PPA shapes while minimizing cost and market risk.**
3. **Derive secondary revenue streams for the proposed setup, primarily from dispatching storage in secondary markets.**
4. **Evaluate overall shaped PPA business case under different scenarios**
5. **Create transparency over feasibility of shaped PPA and identify major hurdles for implementation in specific markets.**

Source: Aurora Energy Research

With a specific focus on the German market, our study will provide crucial insights for key market players

AURORA

Focus on one of the most mature European PPA markets…

…targeting to unlock benefits for key market players

Utilities and Traders

- Enable offering new PPA products to offtakers and improve value of renewables portfolio
- Catalyst for deployment of new flex technologies like batteries in portfolio

Developers and IPPs

- Ensure financing for renewables pipeline through value-add of shaped PPA
- Optimise storage dimension for existing RES portfolio
- Increase value of potential asset for PPA offtakers

Lenders and Investors

- Understanding portfolio synergies and key risk factors of shaped PPA structures
- Business case assessment

Corporate and industrial offtakers

- Closer matching of power procured with demand profile
- Support achieving ambitious sustainability goals
- Reduce exposure to residual wholesale market risk

The study comprises two work packages featuring in-depth analysis, enhanced by Aurora's in-house software solutions

The multi-client study approach reduces individual costs to clients, and allows us to build a product tailored to the needs of the majority of our clients

Kick-off
Bilateral alignment on methodology and key outputs

- Introduction of Aurora team and study participants
- Alignment on goals and expected outcomes of the study

Workshop 1
Selected shape valuation and portfolio optimisation

- Expected revenue from selling selected PPA shape to the market
- Potential upside compared to pay-as-produced default setup
- Determination of optimal asset mix to achieve target shape at minimal cost

LUMUS for PPAs
AMUN for wind
SOLARIS for solar

Workshop 2
Additional storage revenue assessment and integrated business case analysis

- Additional revenue streams generated by portfolio setup
  - Dispatching of storage in secondary markets (Day-Ahead, Intraday, Anc. Services) and Capacity Markets
  - Long term GoO outlook

CHRONOS for batteries

Final report
Key results of the study taking into account participants' feedback

- Feedback and exchange
- Comprehensive report with key results and accompanying databook

May	June	July	August
Virtual Meeting	Virtual Workshop	In-person Workshop	Publication

Source: Aurora Energy Research

Deliverables & Insights: Key Outcomes of the Hybrid PPA Study

AURORA

Participants in our multi-client study will gain exclusive insights, data, and strategic guidance on hybrid PPA setups. Key benefits include:

1	**DELIVERABLES - Early and exclusive access to in-depth study results**	Participants will be the first to receive a comprehensive report detailing the study's findings, covering market trends, risk assessments, and best practices.

2	**DELIVERABLES - Accompanying databook with granular business case insights**	A detailed databook for the selected market will provide numerical and scenario-based insights, including granular datasets on an annualized level:
		▪ Business case calculations for a set number of configurations agreed upon with study participants
		▪ Break down of business case into individual revenue stacks
		  ▪ Battery revenues from day-ahead, intraday and balancing markets
		  ▪ PPA revenues
		▪ Underlying input and assumptions:
		  ▪ Wholesale prices and renewable capture rates
		  ▪ PPA fair value benchmarks

3	**Tailored input on PPA shapes & portfolio configurations**	Participants can provide input on specific PPA structures and portfolio configurations, ensuring the study evaluates the most relevant scenarios for their needs.
4	**Answers to key legal, technical & operational questions**	Our study will address participants' specific concerns regarding the feasibility, risks, and practical implementation of hybrid PPA models. Based on this, we will identify the market specific feasibility of a given hybrid PPA structure.
5	**Exchange with Other Market Players**	Participants will have the opportunity to engage with industry peers, gaining valuable perspectives from other market players facing similar challenges. This exchange fosters knowledge sharing, discussion of best practices, and a deeper understanding of evolving trends in hybrid PPAs.

Sources: Aurora Energy Research

Our analysis will be conducted by Aurora experts with extensive knowledge of European energy markets and power procurement strategies

AURORA

Fritz Arnold

PPA Market Lead, Europe

- Leading the PPA topic at Aurora across functions and markets in Europe, including Lumus software.
- Previously spent six years at McKinsey, advising industrial clients on their decarbonization and energy procurement strategy.

Ryan Alexander

Principal

- Responsible for renewables transactions and strategic advisory in Central Europe
- Previously led Aurora's pan-European Power Markets Team with responsibility for European power model inputs and analysis

Linda Reißmann

Senior Associate

- Extensive experience in PPA valuation and market strategy in various European markets
- Previously worked as an energy trader with focus on algorithmic trading strategies on spot and intraday markets

Luciano Fuso

Senior Analyst

- Experience with multi-country bespoke scenario modelling
- Holds BSc and MSc degrees in Mechanical Engineering, with a thesis on the hybridization of solar thermal collectors

Source: Aurora Energy Research

Join us on our Multi-Client Study focusing on Hybrid PPAs Analysis – registration open until May 12!

AURORA

The study aims to provide in-depth insights into the market dynamics and optimisation of Hybrid PPAs , via a Multi-Client-Study (MCS). This allows us to create a comprehensive analysis at a competitive rate, while simultaneously bringing key players in the PPA market together.

HYBRID PPAs MULTI-CLIENT STUDY – Key topics to be covered

- Market assessment of different PPA shapes to maximise revenue.
- Optimal asset mix (renewables & storage) to minimise costs.
- Evaluation of extra income from secondary markets and GoO revenues.
- Financial and risk analysis to assess profitability and feasibility.
- Evaluation under different market conditions and regulatory frameworks.
- Focus on mature European PPA markets

Integrated deliverables…

Multi Client Study Report and databook
Compiling all work and feedback

3 Workshops
Dicuss in a collaborative format

LUMUS for PPAs

Free trial subscription **to Aurora's Lumus PPA pricing software**

… with additional benefits

1500 hours of resources from Aurora's teams

Priced at a competitive rate

Drawing on Aurora's extensive experience

For more information on the Hybrid PPAs MCS , please contact

Mar Escobedo, Commercial Associate

mar.escobedo@auroraer.com

+34 661338022

Aurora has developed extensive experience in Power Purchase Agreements (PPAs)

AURORA


Multi-client-study for 15 industrial PPA offtakers on PPA pricing, risk and market sizing


Extensive commercial advisory on PPA and renewable strategy, long term price forecasts and analysis


Commercial transaction advisory to a large corporate on their PPA strategy to decarbonize their group-wide scope 2 emission


PPA sourcing support for a 100 MW onshore Wind farm for the RES developer Greenovative in Germany


Valuation of a fixed solar profile compared to a pay-as-produced PPA, accounting for weather variability


Evaluation of the settlement clauses of the PPA and the market access contract for a 98.7 MW onshore wind farm in Spain


Red flag report on PPA commercial terms, price analysis, overview of the Greek market and recommendations


PPA valuation for a 60 MW offshore wind farm (IJmuiden Ver) in The Netherlands


Support on PPA sourcing and review of commercial PPA terms for a large telecommunication company


Evaluation of the residual value of PPA contract for a 650 MW wind farm in Sweden

Source: Aurora Energy Research


AURORA
ENERGY RESEARCH