

PPA pricing in four areas: methods

github.com/jacobazu/ppa · October 2026

The fair fixed price and the risk of a 10-year PPA (2027–2036) for a solar park and an onshore wind farm in DK1, SE3, Finland and Germany, each producing 100 GWh in an average weather year. A case study in Python.

Contracts	Pay-as-produced: the buyer takes all output at a fixed price. Baseload: the park delivers its average output every hour and buys any shortfall at the day-ahead price.
Capture rate	Output-weighted price over the average price, per area and year (Hirth, 2013). The park stops when the price is negative.
Price level	Exchange forward prices for each year, the last listed year held flat (the last 12 months' average where there are none); for DK1 also Energistyrelsen's outlook (Energistyrelsen, 2026). The yearly level moves as an AR(1) in logs (Lucia and Schwartz, 2002), estimated on DK1's yearly prices 2000–2025 and scaled to keep the expected level.
Hourly patterns	Prices and production of one of the last three 12-month periods, one drawn for each contract year, so the link between when a park produces and what power is worth is kept.
Volume	35 weather years (1991–2025) from ERA5 (Hersbach et al., 2020): hourly wind at 100 m through a Vestas V126 power curve (Staffell and Pfenninger, 2016), and yearly solar radiation.
Fair price	The production-weighted expected price (Qorbanian et al., 2024): both sides get the same expected present value, at 5.6% (3.5% real, Finansministeriet, 2026, plus 2% inflation). Split into the forward price, the park's profile and the price–volume covariance (Chatziandreou and Karbach, 2026). No risk premium.
Risk	20,000 paths. The 1 in 20 worst 10-year present value and the average below it (Artzner et al., 1999), for the park and the buyer.
Hedge	The baseload volume sold forward that minimises the variance of the 10-year income (Ederington, 1979).
Sensitivities	Only the last 12 months' pattern; no stop at negative prices; capture rates one point lower each year.
Rules	Assumptions are set before running and listed with sources in the README. Not included: balancing costs, tariffs, subsidies, counterparty risk, and a link between windy years and low prices.

References

Artzner, P., Delbaen, F., Eber, J.-M. and Heath, D. (1999). Coherent measures of risk. *Mathematical Finance*.

Chatziandreou, K. and Karbach, S. (2026). Pricing and semi-static hedging of green pay-as-produced power purchase agreements. *arXiv:2607.27814*.

Ederington, L. H. (1979). The hedging performance of the new futures markets. *Journal of Finance*.

Energistyrelsen (2026). *Samfundsøkonomiske beregningsforudsætninger for energipriser og emissioner 2025*, table 7.

Finansministeriet (2026). *Nøgletal*, February 2026.

Hersbach, H. et al. (2020). The ERA5 global reanalysis. *Quarterly Journal of the Royal Meteorological Society*.

Hirth, L. (2013). The market value of variable renewables. *Energy Economics*.

Lucia, J. J. and Schwartz, E. S. (2002). Electricity prices and power derivatives: evidence from the Nordic Power Exchange. *Review of Derivatives Research*.

Qorbanian, R., Löhndorf, N. and Wozabal, D. (2024). Valuation of power purchase agreements for corporate renewable energy procurement. *arXiv:2403.08846*.

Staffell, I. and Pfenninger, S. (2016). Using bias-corrected reanalysis to simulate current and future wind power output. *Energy*.