



# PPA Insights

## Price developments in Europe

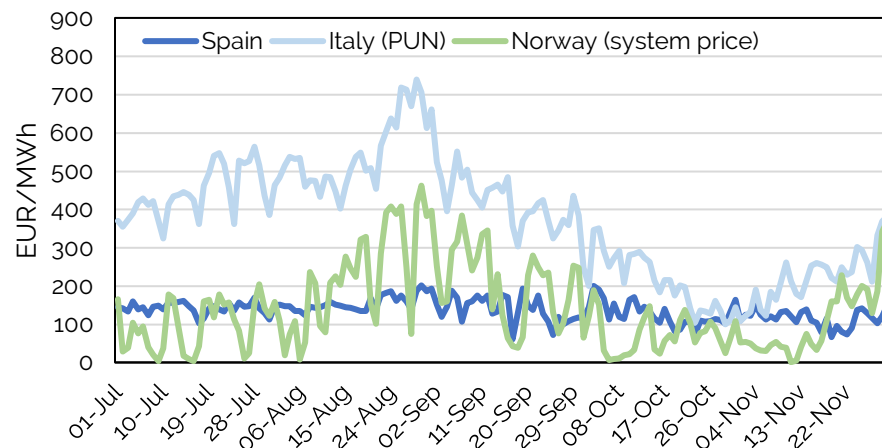
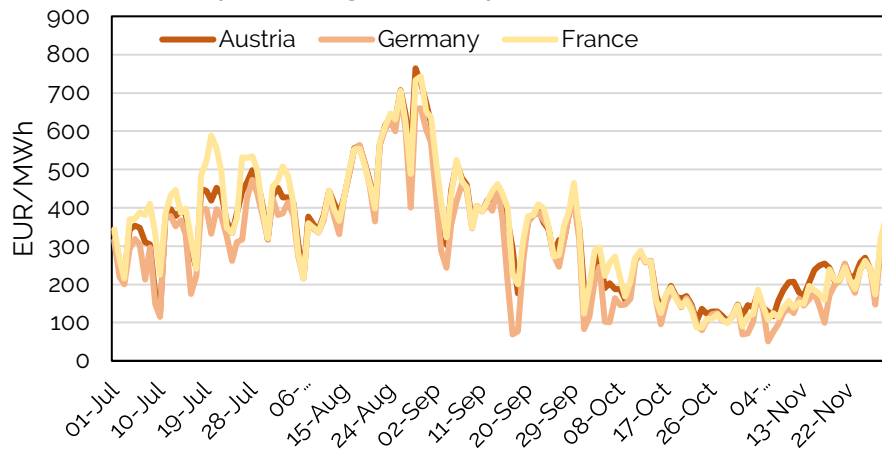
**KYOS Energy Analytics**

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# Developments in the European power markets

Full gas storages, healthy LNG supplies, and a EU power price mitigation package have dampened the extremely high power prices seen in the previous quarter. But the recent cold spell has made both gas and power markets nervous again.

Daily average of day-ahead prices in 2022



Since our last update in September, 2022:

- In October, TTF gas prices decreased amidst the expectations that the Nord Stream 1 (NS1) pipeline would partially resume operations. Eventually, however, daily gas price fluctuations increased when Gazprom announced NS1 could not resume operations due to oil leaks, and then again after the explosion due to alleged sabotage. In November, fears of gas shortages eased as storage facilities were well on their way to reach the targets set by the EU and an increasing LNG supply was supported by U.S. exports. But the cold spell in the first half of December has made the market nervous and bullish again.
- The EU approved a package to mitigate soaring electricity prices, which comes into force this December. The package consists of a binding target of 5% cut in peak hour demand for the system and revenues capped at a price of 180 EUR/MWh for infra-marginal generators such as renewable, nuclear and lignite power plants. In addition, individual member states have reacted accordingly on the matter: Spain prolonged windfall tax on utilities until the end of 2023, while Italy intends to raise its windfall tax from 25% to 35%.
- Unplanned outages of the French nuclear fleet persisted in this quarter due to maintenance works and personnel strikes. EDF's nuclear production was consistently below their projections, and closed November with an average available capacity of 29.6 GW. At this point, EDF has reduced their nuclear availability outlook from 45 GW to 40 GW for January, 2023.
- The autumn was wet and mild, which enabled hydro stocks to get filled again after a dry summer. Additionally, November was very mild and therefore did not trigger any gas-heating demand. This, together with full gas storage facilities, put further pressure on the downward trend of gas and power prices.



# KYOS methodology to assess 10-year PPA prices



The diagram below shows the methodology employed by KYOS to assess the development of PPA prices in Europe.

Build power forward curves

We build power forward curves for 34 European markets. Given the 10-year period, we use our fundamental power market model (KyPF), which calculates power prices using fuel and CO<sub>2</sub> price projections, future electricity demand, renewable generation, storage, interconnection capacities, etc.

Perform Monte Carlo simulations

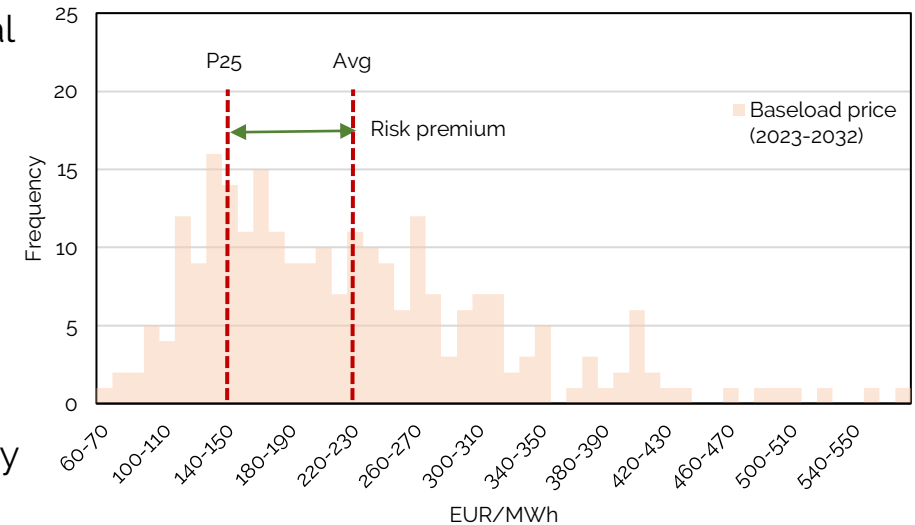
We simulate forward & spot prices with the fundamental power curves as reference. Our Monte Carlo simulation model (KySim) captures short-term, long-term and seasonality effects on forward contract pricing, plus mean-reverting behavior of spot prices. The model is calibrated using two years of historical data (counting from the trading date = **2022-12-09**).

Adjust prices for risk

We calculate the baseload price per simulation path. However, expected prices do not reflect the risks that PPA counterparties are exposed to, and which ultimately determine the fixed price of a PPA. To account for this, we consider a risk premium defined as the difference between the average baseload price and the P25.

Benchmark the PPA price

Our research shows that 10-year fixed-price PPA contracts are currently signed at around the P25 of the power price distribution. In the previous report we used a lower (more conservative) P-level, which is still included for reference.



The *risk premium* reflects the discount for a fixed price guarantee on a 10-year PPA. It offers compensation for managing fixed-price PPA exposures in the market, leading to credit risk, liquidity (margin) risk, trading costs and other costs.

# KYOS price assessments (2023-2032)

Risk discount for solar and wind: 33.82%

Note: All baseload prices start from 2023. PPA prices too, unless otherwise stated next to the price.

## KYOS baseload and PPA price assessments (EUR/MWh)



### Northern Europe

	Baseload	Solar	Wind onshore
Great Britain	138.1	86.2	82.0
Denmark DK1	155.0	83.0	91.5
Denmark DK2	147.8	79.4	85.2
Norway NO1	152.2	63.2 (2026)	94.4
Norway NO2	143.0	58.2 (2026)	90.6
Norway NO3	127.9	60.9 (2026)	74.6
Norway NO4	106.4	56.2 (2026)	64.2
Norway NO5	139.8	61.4 (2026)	94.8
Sweden SE1	94.5	56.6	46.7
Sweden SE2	95.2	55.0	47.0
Sweden SE3	142.0	70.6	86.3
Sweden SE4	142.9	71.2	86.0
Finland	136.9	85.7	73.2
Ireland	140.6	91.0	84.1



### Southern Europe

	Baseload	Solar	Wind onshore
Italy (excl. Sicily)	161.1	95.6	107.6
Sicily	164.2	96.6	102.0
Portugal	140.1	80.8	86.5
Greece	160.7	90.8	103.5
Spain	137.2	71.9	84.9



### Central-Eastern Europe

	Baseload	Solar	Wind onshore
Czechia	164.5	87.7	107.0
Slovakia	160.5	86.9	102.9
Hungary	158.3	85.1	100.9
Poland	175.8	101.2	111.5
Romania	154.9	84.1	99.4
Bulgaria	158.4	88.9	105.6
Serbia	140.4	79.1	91.6
Croatia	153.1	84.8	98.2
N. Macedonia	162.5	87.9	107.5



### Western Europe

	Baseload	Solar	Wind onshore
Netherlands	150.9	76.2	90.7
Belgium	153.4	82.6	99.5
Germany	164.8	84.1	100.4
France	147.5	80.7	93.5
Switzerland	162.3	88.2	106.9
Austria	166.0	90.5	108.1

Since our last update in September, 2022:

- PPA prices have been fluctuating over the past three months, because of the high price volatility and regulatory uncertainty affecting the electricity market. In our price assessments (left) as per trading date **2022-12-09**, forecasted capture prices for renewables do not take into account the revenue cap, although this cap will actually affect realized prices in the first half of 2023.
- The first drafts of the EU power price mitigation package sparked uncertainty among developers, who worried about the possibility of market fragmentation in case countries chose to implement different price cap levels; about how the cap would apply to PPA contracts; and how it could potentially discourage off-takers, who would be less motivated to hedge against market prices.
- Liquidity in the PPA market dried amid high demand and low supply. While more and more corporates look at PPAs as a hedge against high wholesale prices, developers face rising interest rates to finance projects, and increasing costs due to components prices adjusting to a sky-rocketing inflation.
- The interest for cross-border PPAs seems to be on the rise, with buyers looking at the possibility of closing deals in cheaper markets.

# KYOS price assessments (2023-2032)

Risk discount for solar and wind: 25%

Note: All baseload prices start from 2023. PPA prices too, unless otherwise stated next to the price.

## KYOS baseload and PPA price assessments (EUR/MWh)



### Northern Europe

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Denmark DK1	155.0	94.1	103.7
Denmark DK2	147.8	90.0	96.5
Norway NO1	152.2	71.6 (2026)	107.0
Norway NO2	143.0	66.0 (2026)	102.6
Norway NO3	127.9	69.0 (2026)	84.6
Norway NO4	106.4	63.7 (2026)	72.7
Norway NO5	139.8	69.6 (2026)	107.4
Sweden SE1	94.5	64.1	53.0
Sweden SE2	95.2	62.3	53.2
Sweden SE3	142.0	80.0	97.8
Sweden SE4	142.9	80.7	97.4
Finland	136.9	97.2	82.9
Ireland	140.6	103.1	95.3



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Belgium	153.4	93.7	112.8
Germany	164.8	95.3	113.8
France	147.5	91.5	106.0
Switzerland	162.3	99.9	121.2
Austria	166.0	102.6	122.5



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Italy (excl. Sicily)	161.1	108.3	122.0
Sicily	164.2	109.5	115.6
Portugal	140.1	91.6	98.0
Greece	160.7	102.9	117.3
Spain	137.2	81.5	96.2



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Czechia	164.5	99.4	121.3
Slovakia	160.5	98.5	116.6
Hungary	158.3	96.4	114.4
Poland	175.8	114.7	126.4
Romania	154.9	95.3	112.6
Bulgaria	158.4	100.8	119.7
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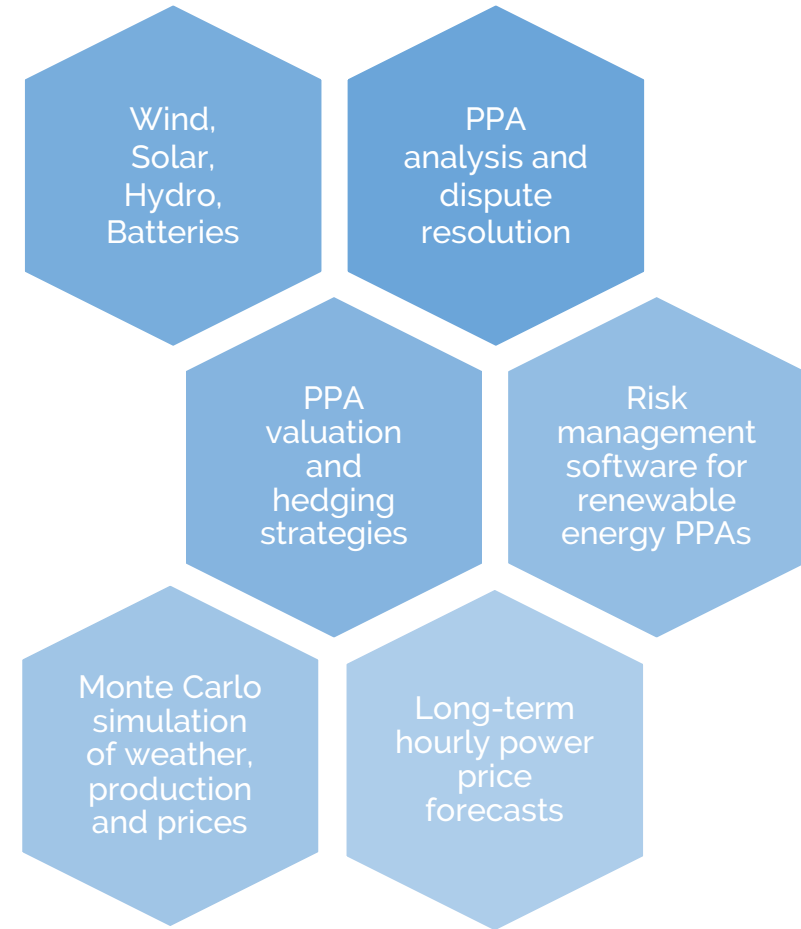
# KYOS Analytical Platform



# KYOS PPA valuation

PPAs often include complex pricing structures, e.g. price floors, risk sharing elements and specific reconciliation mechanisms. To capture all of this, KYOS offers:

- A fundamental power market model (KyPF) to create long-term electricity price forward curves. This is important given the long duration of many PPAs.
- Software modules to simulate price and volume risks. These are necessary to assess future earnings and hedging strategies.
- The ability to calculate capture rates using historical data, long-term fundamental curves, or user-defined.
- A flexible tool that breaks down PPA valuations into different components (e.g. price risk, cannibalization risk, etc.) With this tool, it is also possible to define own pricing structures.
- The option to evaluate and monitor the risk of one or more PPAs or as part of a larger portfolio, with or without hedging strategies.





# KYOS Renewable Risk Management

The KYOS renewable risk management system is part of the KYOS Analytical Platform, a cloud-based software solution. This system provides a complete picture of a renewable power portfolio with PPA contracts and hedges. Reporting includes: volumetric position, mark-to-market value, value-at-risk and earnings-at-risk.

The system also allows users to analyze the effect of applying different hedging strategies to lock-in value of e.g. a specific renewable project. Strategies range from basic static hedges to advanced stack and roll strategies. If the project is in a market with limited liquidity, our system will show the effectiveness of proxy hedging the exposure in other markets, even by using other commodities than electricity.

We offer five different modules/packages to assess renewable power portfolios:

## KYOS PPA Modules



Advanced	<b>Module D:</b> Single project / PPA valuation Monte Carlo simulations	<b>Module E:</b> Portfolio management Monte Carlo simulations
	PFC builder KyCurve or KyPF	PFC builder KyCurve or KyPF
	Price data services – market prices	Price data services – market prices
Intermediate	<b>Module B:</b> Forward curves builder KyCurve Market curves	<b>Module C:</b> Forward curves builder KyPF Fundamental power curves
	Price data services – market prices	Price data services – market prices
Basic	<b>Module A:</b> Price data services – market prices	





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