AURORA ENERGY RESEARCH

Recent Trends & Price Benchmarks for Nordic PPAs

Public Report

Aurora provides market leading forecasts & data-driven intelligence for the global energy transition

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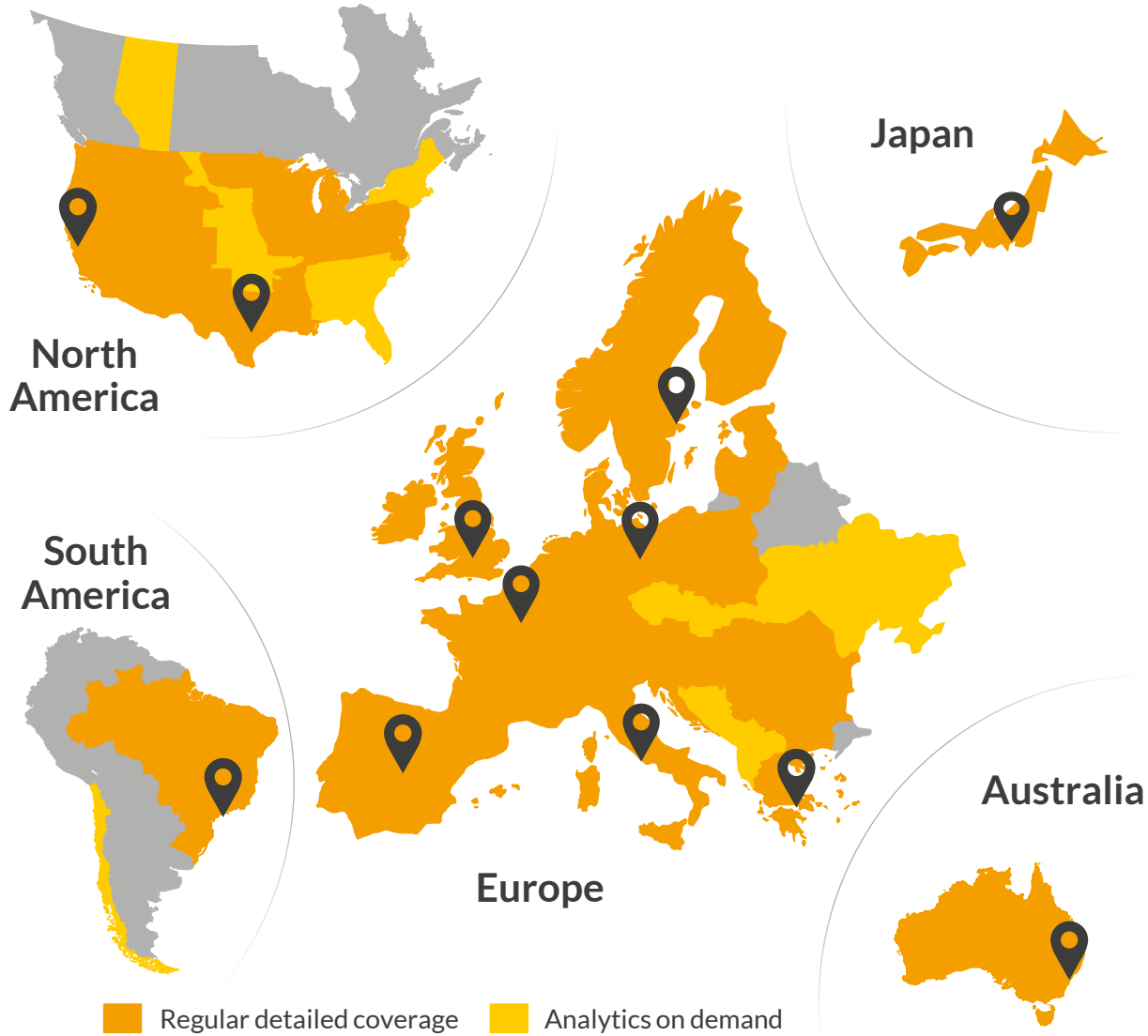
- Power markets
- Renewables
- Storage
- Electric vehicles
- Hydrogen H_2
- Carbon CO_2
- Natural gas



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440+

market experts

700+

subscribing companies

150+

transactions supported in 2022

Source: Aurora Energy Research

Our market leading models underpin a comprehensive range of seamlessly integrated services to best suit your needs

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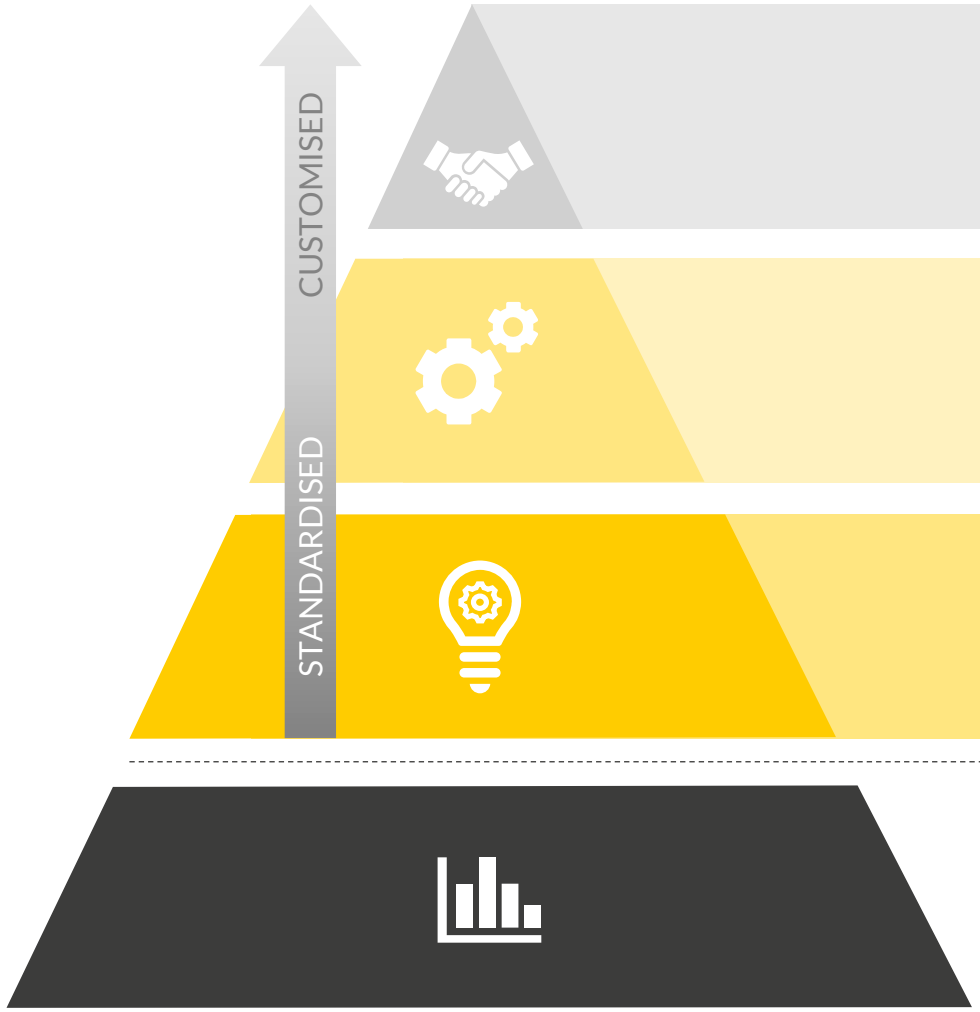

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Proprietary and continuously updated cutting-edge models populated with highest quality curated datasets

Developed over 10 years, 40+ dedicated modellers

Source: Aurora Energy Research

The Nordics are among the most mature PPA markets in Europe, dominating the onshore wind PPA market

Market Maturity

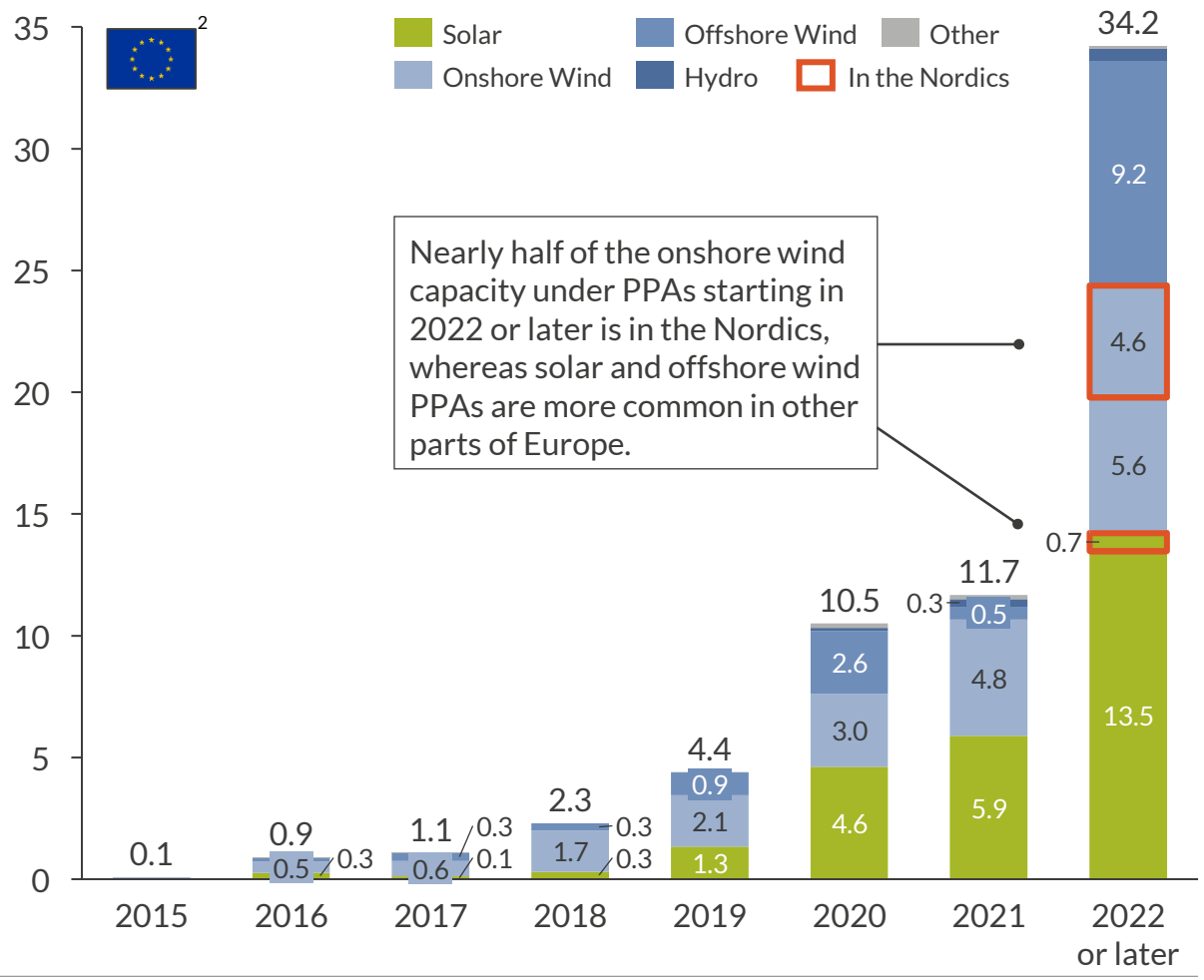
GW

Country	GW under PPA	Market maturity
	22.9	
	15.0	
	13.7	
	4.9	
	3.0	
	1.9	
	1.6	
	1.5	
	1.5	
	1.1	
	1.1	

Less mature — More mature

Announced[1] PPAs by start year and technology in selected EU countries

GW



1) As of April 2023. 2) Countries in scope: Germany, Nordics (Denmark, Finland, Norway, Sweden), Great Britain, Spain, France, Portugal, Netherlands, Italy, Belgium, Poland, Ireland.

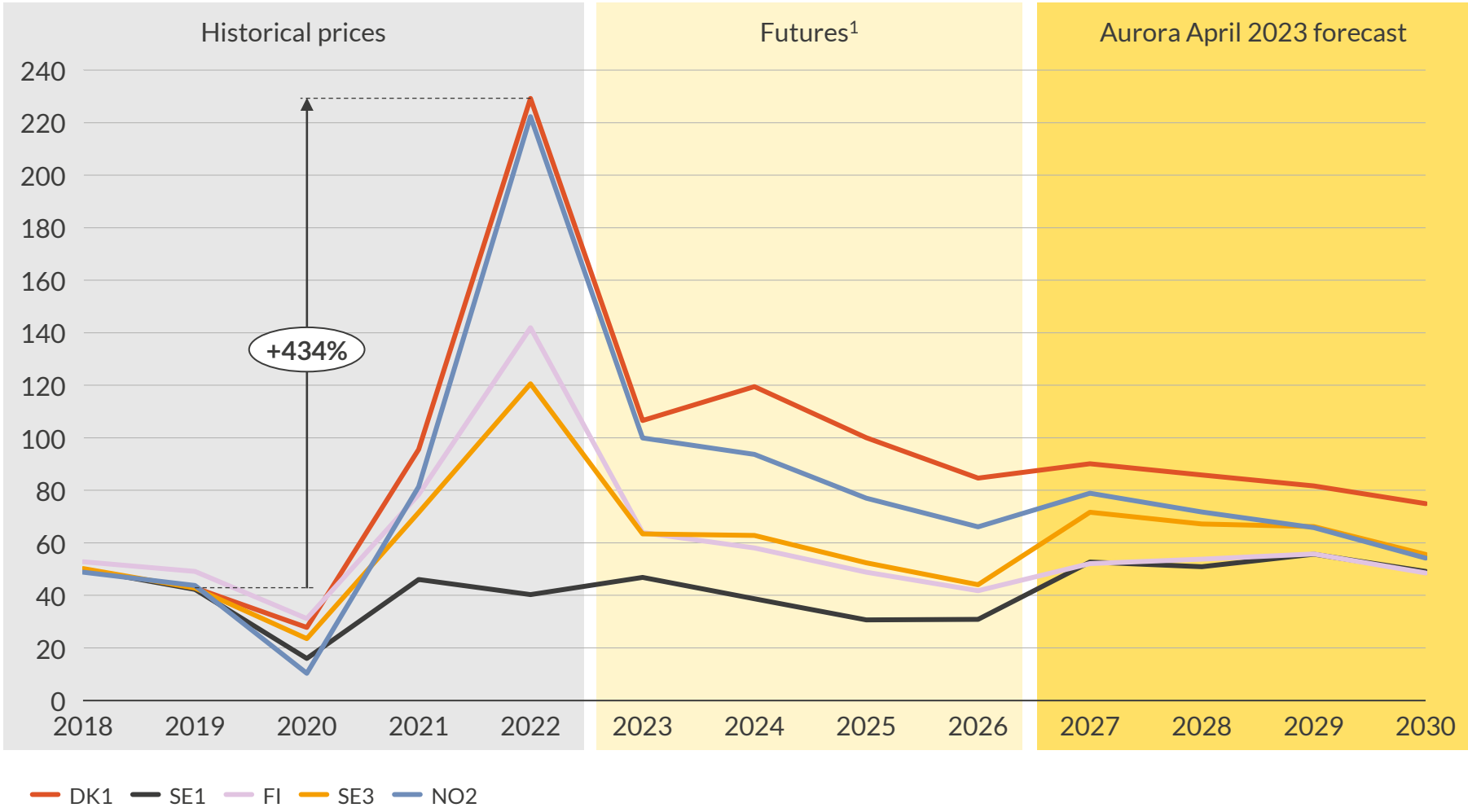
Source: Aurora Energy Research

Comment

- The Nordics are, along with Spain and the UK, one of the most mature PPA markets in Europe.
- The European PPA markets for both wind and solar have grown rapidly in recent years, Nordic onshore wind PPAs being one of the biggest drivers.
- Solar and offshore wind PPAs have so far concentrated in other regions, but there is growth potential for these technologies in the Nordics.

In the Nordics, record high power prices in 2022 and low liquidity of power futures increased hedging needs, hence demand for PPAs

Wholesale power prices
€/MWh (real 2022)



1) As of 10 May 2023. Values for 2023 are a blend of historical and futures prices.

Source: Aurora Energy Research, Nasdaq

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Comments

- In 2022, following the Russian invasion of Ukraine, power prices in most of the Nordics rose to new heights.
- The power prices of the southern price zones peaked in 2022 at prices 3–5 times higher relative to pre-2020 levels.
- High power prices increase the short-term hedging demand of corporates and utilities.
- Interest in PPAs as long-term hedging instruments has therefore been increasing over the past year.
- The futures market liquidity decreased substantially in 2022 with traded volumes declining by half relative to the year before, further contributing to the increased PPA hedging demand.

Aurora's PPA valuations mimic a utility's hedging strategy and key elements are varied stochastically to provide a robust market benchmark

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Key elements of Aurora's PPA price methodology

Aurora's PPA price methodology

Combines market prices with Aurora's forecast of long-term price developments

- Short-term prices are based on futures settlement prices in the liquid market period (varies by market)
- Long-term price developments are simulated based on Aurora's Central, High and Low scenarios

Market-based fair value valuation

- Replicates the power hedging strategy of a utility
- PPA volumes are hedged on a value-neutral basis (NPV)

Stochastic approach

- Price and volume risks are evaluated under different scenarios
- PPA price distribution for individual risk assessment and valuation of liquidity premium

Market calibration with real quotes

- PPA valuation is calibrated to market quotes on a country- and technology-specific basis
- Aurora's database includes over 220 PPA quotes for several European markets

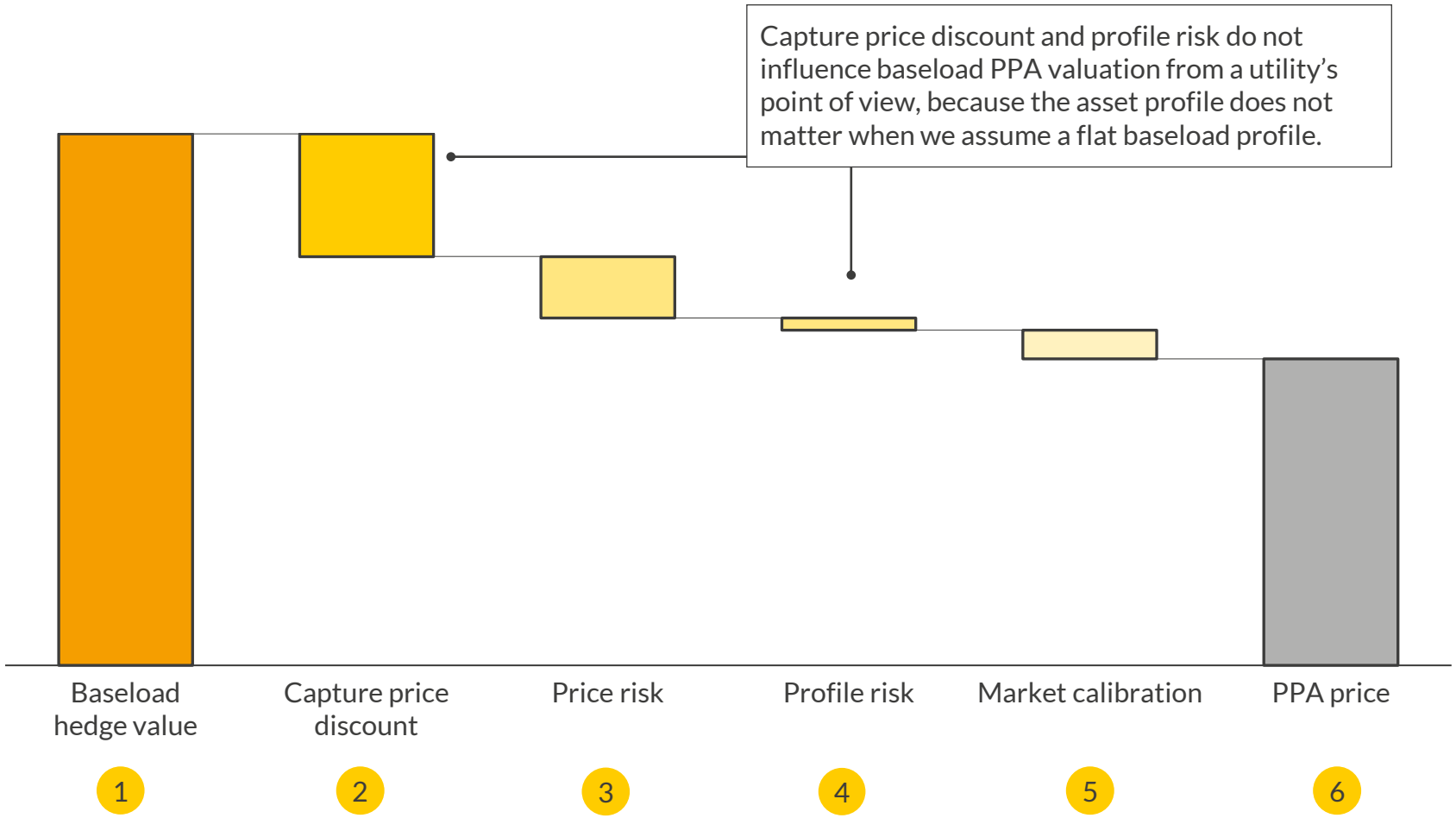
Don't hesitate to learn more about our PPA valuations from **Josephine Gunnehed, Senior Commercial Associate**

✉ **josephine.gunnehed@auroraer.com**

Source: Aurora Energy Research

Starting point of the PPA valuation is the value of the baseload hedge, adjusted by different risk and cost components

PPA price calculation: waterfall components
€/MWh



Source: Aurora Energy Research

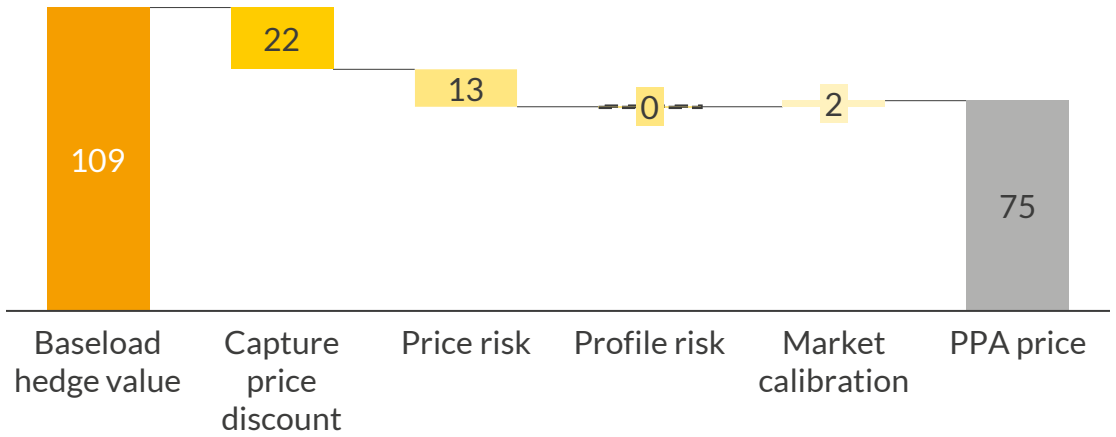
Comments

1. Expected revenues from selling/ buying baseload futures following stack and roll strategy, incl. rolling losses
2. Difference in value of asset-specific generation profile vs. baseload profile
3. Risk discount reflecting uncertainty in baseload price realisation. Offtakers choose confidence level P(X) > 50
4. Risk discount reflecting uncertainty in realised production and capture prices
5. Risk discount reflecting other risk factors not explicitly priced into risk factors above, calibrated with market price quotes
6. PPA price result

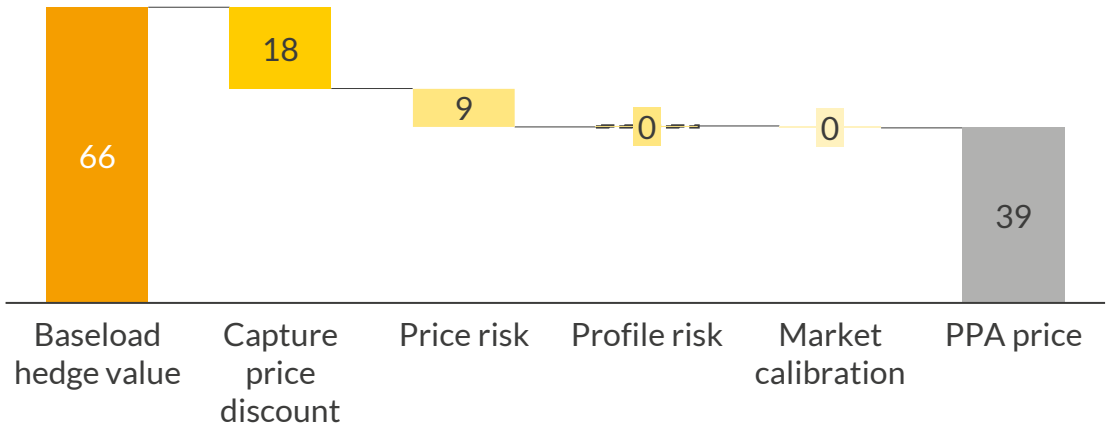
note: balancing costs and Guarantees of Origin value may be added dependent on contract specifications

Pay-as-produced PPA for onshore wind is valued at 33-39 €/MWh in SE2 and Finland; solar in DK1 at 75 €/MWh

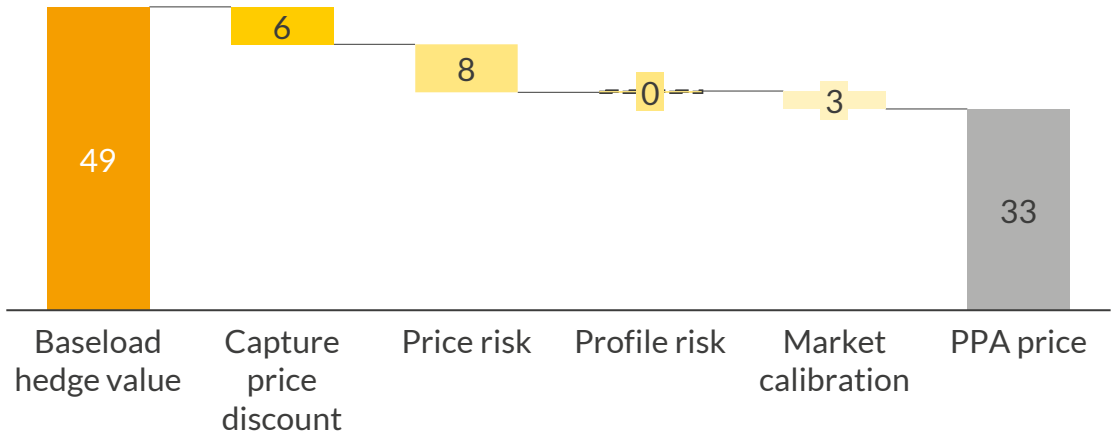
10-year solar pay-as-produced PPA in DK1 starting in 2024
€/MWh, nominal



10-year onshore wind pay-as-produced PPA in Finland starting in 2024
€/MWh, nominal



10-year onshore wind pay-as-produced PPA in SE2 starting in 2024
€/MWh, nominal



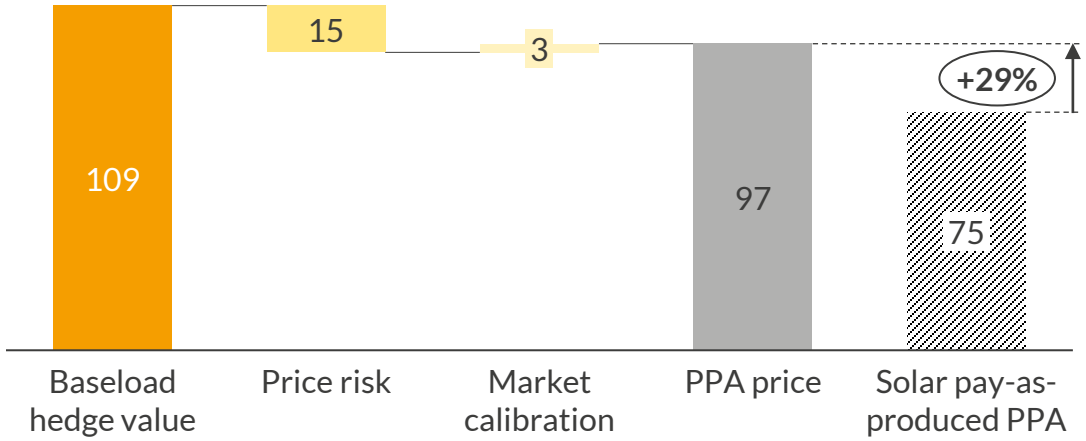
Comments

- The largest factors driving the price of a pay-as-produced PPA are baseload prices and the capture rate of the contracted technology.
- Price risk reduces the value further but is dependent on the baseload hedge value, which is higher in DK1 than in SE2 and Finland, resulting in a higher price risk in DK1.
- Capture price discount is driven by both the price level and the capture rate of the given technology; Danish solar is highly cannibalized in a high-price environment, while wind in SE2 is moderately cannibalized in a low-price environment.
- Profile risk has only a limited impact because of low average deviation in weather years.

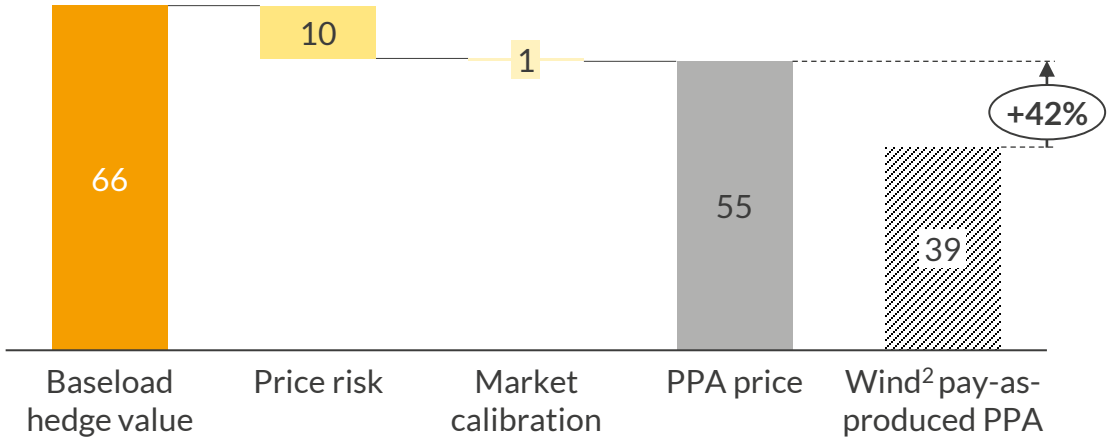
Sources : Aurora Energy Research

Baseload PPAs for are valued at 38-97 €/MWh in the focus regions, with the valuation in DK1 much higher than in the other regions

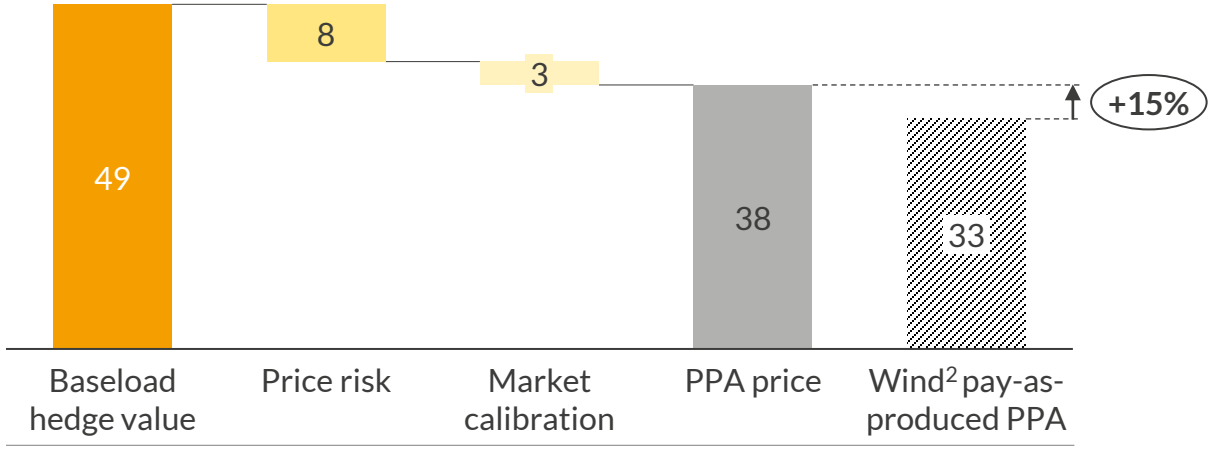
10-year baseload[1] PPA in DK1 starting in 2024
€/MWh, nominal



10-year baseload[1] PPA in PPA in Finland starting in 2024
€/MWh, nominal



10-year baseload[1] PPA in SE2 starting in 2024
€/MWh, nominal



1) We assume a flat baseload profile over the year. 2) Onshore wind.

Sources: Aurora Energy Research

Comments

- In our pricing method, the technology does not impact baseload PPA valuation because regardless of the asset profile, the offtaker gets the same flat baseload profile.
- For a baseload PPA, the value of the baseload hedge and the associated price risk largely determine the value of a PPA from an offtaker's perspective.
- The discount of a pay-as-produced onshore wind PPA to a baseload PPA is larger in Finland than in SE2 because of higher capture price discount in Finland.

Discuss how our pricing method works with Josephine Gunnehed, Senior Commercial Associate
josephine.gunnehed@auroraer.com

We offer tailored PPA advisory support ranging from end-to-end transaction support to strategic advisory

1 Decarbonisation, power procurement and PPA strategy	▪ Strategic assessment of options on corporate decarbonisation and scope 2 emissions reduction pathways, including PPAs, direct renewable investments ▪ Supporting utilities and corporates defining European PPA strategy and implementation plan
2 PPA tendering and market outreach support	▪ End-to-end PPA advisory, including preparation of tender documents and teasers ▪ Organisation of tenders or participation in tenders or direct market approach ▪ Assessment of offers and short listing
3 Commercial negotiation support and risk assessment	▪ Advisory support in the context of PPA negotiation, including Fair Value PPA pricing, and additional cost components (balancing costs, Guarantees of Origin) ▪ Assessment and mitigation of commercial PPA risks
4 PPA Valuation	▪ PPA transactions: Evaluation of offers and pricing proposals ▪ Portfolio strategies: Assessment of combination of different renewable production profiles, combined pricing and risk assessment ▪ Re-evaluation of PPA contract values (e.g. for accounting purposed)

We are supporting different client groups:

Utilities

- Strategic support for utilities on their European PPA, portfolio and hedging strategies
- Main contact points: Strategy, Analytics, Trading and Origination

Renewable Developers

- PPA pricing and commercial risk assessments
- Portfolio strategies
- PPA tendering and negotiation support

Corporates / Industrial offtakers

- Strategic advice on decarbonisation pathways (early-stage support)
- End-to-end PPA transaction advisory
- Re-evaluation and negotiation of PPAs

Banks / Lenders

- PPA pricing and commercial risk assessments (debt financing)

We have extensive experience in supporting our clients on PPA related projects and transactions

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PPA Transactions

20
PPA-transactions supported since 2020

> 1000 MW
PPA-Transaction Volume

Renewable Transactions

> 1000
Clients Worldwide

300+
Transactions Worldwide

Our industrial clients trust us

BASF We create chemistry, adidas, SNCF, DB, umicore, SIEMENS, Solvay, GLENCORE, Google, Unilever, CABOT, BOREALIS, SIMEC, INEOS, EVONIK, MITSUBISHI POWER, colt Data Centre Services, AlzChem, wieland, bp, DOW, Heineken, hynamics GROUPE EDF, orange, BOC Member of The Linde Group, Hydro

*"We have been working with **Aurora** to define and execute on our renewables strategy since 2018 and value Aurora's in-depth energy market expertise and analytic approach"*

Horatio Evers, Managing Director, BASF Renewables Energy

"The tender process was run efficiently by Aurora. Tendering documents were well structured and of high quality. Aurora helped us to get substantially more offers than going on our own."

Bernd Fuchs, CEO, Greenovative (Renewable Developer, Germany)

"Auroras PPA pricing methodology helped us to validate and assess PPA offers and understand our negotiation position. In a market with little price transparency, this is a key success factor."

Lucas Fabre, Head Climate & Energy Transition, Solvay

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Three Group Meeting roundtable events **in Stockholm** with key market participants such as developers, investors, financiers, utilities, grid operators, and government officials

Analyst Support

Biannual workshops and support from our bank of analysts, including native speakers and on-the-ground experts

For more information about our Nordic Power & Renewable Market Service, please contact Josephine Gunnehed, Senior Commercial Associate

✉ **josephine.gunnehed@auroraer.com**


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