Fundamental Power

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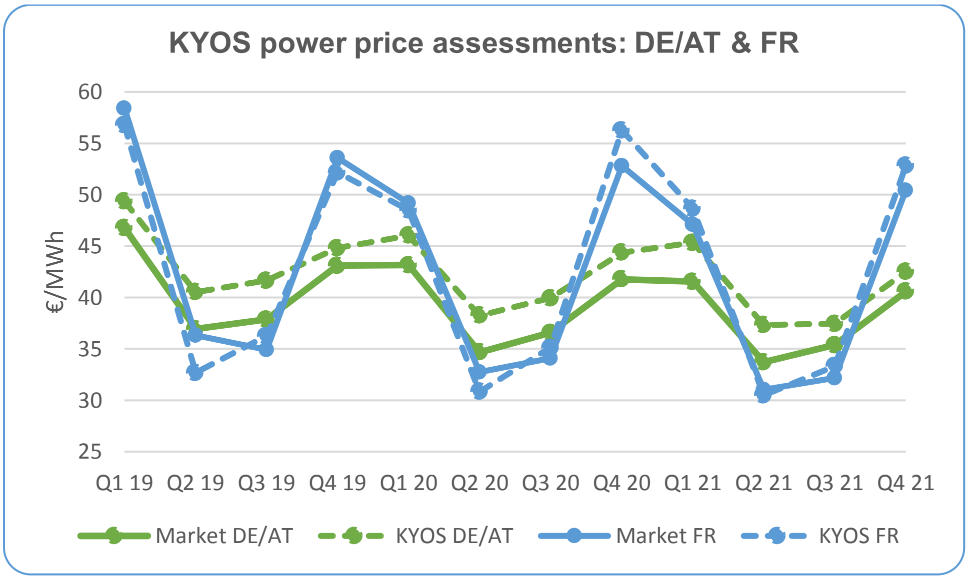
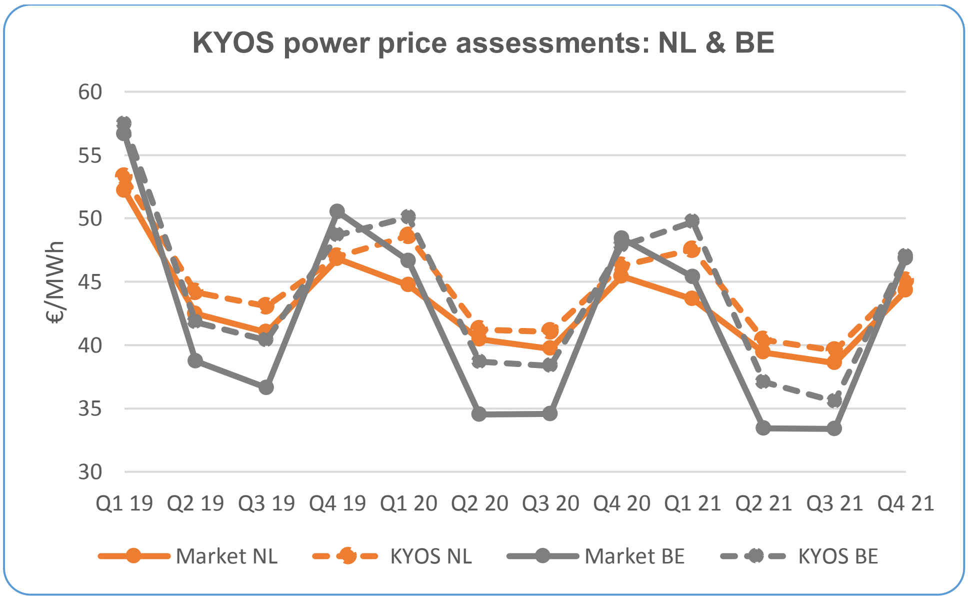
KYOS Fundamental Power Market Analysis

Power price assessments:





Remarks:

The trading date of the analysis is 11 June 2018. End-of-day closing prices from the relevant exchanges were used for all market prices. The KYOS power price assessments have been calculated with the fundamental power market model, KyPF.

This model allows for a very detailed hourly optimization of all individual flexible power assets in the market, including gas, coal, lignite, nuclear, hydro power, batteries and other storage assets. The true flexibility of the assets is captured, optimizing between minimum and maximum load, using efficiency curves or energy losses, and taking into account start costs.

This leads to a very realistic behavior of the individual assets, close to real market behavior. The model also optimizes the inter-connection flows between the countries.

KyPowerFundamentals (KyPF)

With KyPF you can create hourly power price forecasts and analyze a range of scenarios. It is provided with relevant data sets and integrated in our web-based Analytical Platform for ease of use. Let these forecasts assess the impact of policy changes, assist you with strategic investment decisions and support your trading activities.

For more information about the analysis, please contact us on info@kyos.com.

KYOS

Study: Germany – The discount for wind power

Wind produces at a discount….

As the energy transition progresses, costs continue to decline for various renewable energy sources, in particular solar and wind. The International Energy Agency (IEA) anticipates that within the next five years costs for solar will fall by 25%, for onshore wind by 15%, and for offshore wind by almost a third. A further cost decline is expected towards 2030 and beyond. In combination with the increasing competition to develop new projects, government support is reduced and for some offshore wind projects even zero. Now more than ever, developers depend on future power prices for the viability of their business cases.

This study focuses on wind power generation in Germany. It quantifies at what discount an average wind power generator produces, comparing the average realized spot price of a wind turbine with the baseload spot price. What will this discount be in the future? This is one of the big unknowns for project developers and investors, and one of the key parameters in long-term Power Purchase Agreements (PPA's).

Why is there a discount?

On windy days, wind turbines generate a lot of electricity, but prices tend to be low. And on windless days, especially when there is limited solar production, prices tend to be high. This negative correlation between wind power production and power prices leads to the mentioned discount.

A small example may be helpful. Suppose that there are three possible wind conditions: strong, average and weak, leading to the following revenue streams:

	Strong	Average	Weak
Power Price in €/MWh	10	40	70
Production in MWh	10	5	0
Revenue in €	100	200	0

If each outcome is equally likely, the average (baseload) power price is 40 €/MWh (10, 40 or 70). However, the average revenue for the wind power generator is just 100 € (100, 200 or 0). With an average production of 5 MWh, the weighted-average price is 100/5 = 20 €/MWh. Hence, the power is produced at a discount of 40-20 = 20 €/MWh.

What was the discount in '16/'17?

To quantify the size of the discount in reality, our study first takes hourly renewable production data (from ENTSO-E) and day-ahead power prices (from EPEX) of 2016 and 2017 in Germany.

Note that the 'German' (DE) calculations in this report are actually for the combined zone of Germany, Austria and Luxemburg, in line with the current market situation, so before the split-off of Austria in its own zone later this year.

We calculate the average power price across all hours (baseload), as well as the weighted average price earned by wind power generators. In the dataset with historical prices, there are 246 negative prices, 1.4% of the total. For the purpose of this analysis, we believe it is better to replace them by 0. One reason is that wind power generators can curtail their production and hence avoid the negative prices. Another reason is that we believe that negative prices are generally hard to explain on economic grounds. They are mostly an artefact of the imperfect regulatory regime and of other market imperfections, which may be expected to disappear, or at least become less prominent, in the future.

Figure 1: Average prices per month

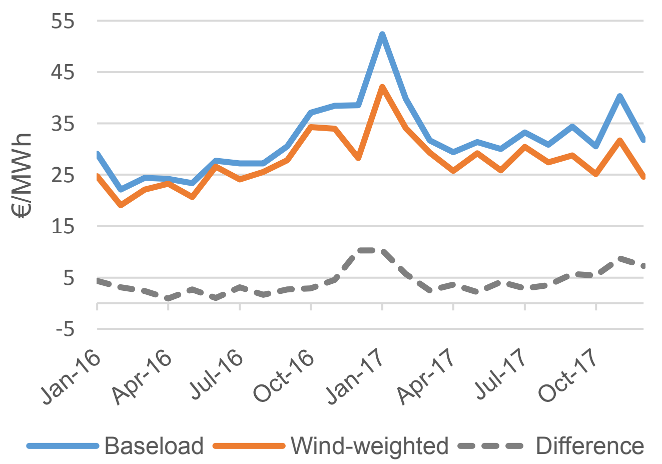


Figure 1 shows the monthly averages of the baseload price and the wind production weighted price, combining both onshore and offshore. Prices have been higher in the winter on average, but wind power producers could not fully benefit: especially when it was very windy, prices were low. In total, over both 2016 and 2017, wind producers realized a 4.04 €/MWh lower income than the baseload price. Note that with the negative prices included, the discount was 4.72 €/MWh.

An evolving energy landscape

The calculation of a historical discount (or premium) is rather straightforward, but what will the discount be in the future?

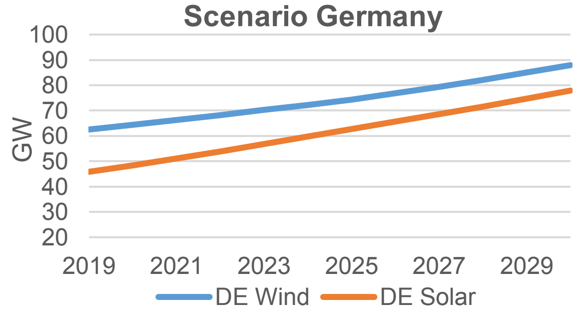
A couple of developments plays a role. To begin with, the further expansion of wind power generation will lead to even more depressed prices on windy days and push the discount up. However, in tandem with the expansion of wind capacities, solar will grow too, in Germany and in surrounding countries.

Very often, this may lead to abundant electricity in the summer, but a tighter supply situation in the winter. The electrification of the heat supply, away from gas, may further boost power prices in winter. Because turbines produce more power in winter, this is positive for wind power generators and reduces the discount.

Finally, and most importantly, the future discount for wind is largely dependent on the flexibility of supply (and demand) to deal with periods of high and low supply. This means that also the development of storage, the flexibility of demand and the flexibility of conventional generation play a role.

Our assumptions of renewable capacity growth are derived from the Sustainable Transition 2030 scenario in the ENSTO-E's Midterm Adequacy Forecast (MAF). The exact annual expansion of the renewable generation capacities is shown in Figure 2. It shows that the German (including Austria and Luxemburg) wind capacities grow from about 60 GW currently to 88 GW in 2030, and solar from about 45 to 78 GW. Of the total energy production, solar and wind account for 26%, and this will grow to 37% in 2030. These growth rates are projected on historical renewable production patterns to generate future hourly wind and solar production.

Figure 2: KYOS Wind & Solar Scenario Germany



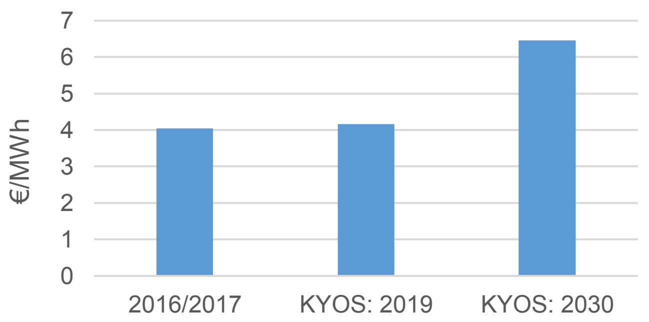
In the KyPF fundamental power market model, this is combined with detailed information about the existing and future fleet of power generation and energy storage assets, as well as hourly demand, fuel cost and transmission capacity forecasts. The German-Austrian price zone is not modelled as an island, but jointly with its neighbouring markets. The complete input dataset is available on demand, as a paid service.

The discount in 2030

Our detailed modelling of future hourly power prices shows that discounts will be almost the same in 2019 as they were in 2016/2017. More importantly, it will grow steadily towards 2030, from 4.16 €/MWh in 2019 to 6.46 €/MWh in 2030.

The flexibility of the energy system plays an important role in stabilizing future market prices. With enough flexibility, prices will not be so low on windy days. First of all, as long as renewable generation produces less than 100% of demand, still some conventional asset, in Germany or abroad, needs to produce. And this conventional asset will set the market price to a level above zero.

Figure 3: German wind discount



Secondly, there is a fast-growing awareness that the future energy system will need various forms of storage, ranging from short-term battery storage to more long-term storage from compressed air, hydrogen or other technologies. Just like current natural gas markets, where gas storage stabilizes price levels over time, power market prices will often be set by the marginal cost of storing an extra unit of energy.

The robustness of the presented results can be assessed with various sensitivity tests. The discount for solar and wind power generation depends on the penetration levels of solar and wind, as well as the overall flexibility of the system to smoothly absorb intermittent electricity generation. A major added value of the KYOS fundamental power market model KyPF, is the ability to easily perform sensitivity analysis and assess the major risk factors of power generation projects.

For example, if the growth of energy storage does not keep up with the growth of renewable generation, prices may become more extreme than our analysis suggests, and the discount for wind larger. Or as an alternative example, local network constraints could support the growth of more baseload generation patterns via curtailment, local storage or other forms of renewable generation (biomass, tidal energy).

Conclusion: investment in wind power still worthwhile despite higher discount

Having said all this, what does it mean for investors of wind parks? Solar and wind generation capacities are expected to grow and thereby reduce the effective market price for wind and solar. The weighted average price at which they produce, can be expressed as a discount to the baseload price. In the German/Austrian pricing zone, this discount has slowly grown to a level of more than 4 €/MWh in 2016 and 2017.

According to popular belief, due to the increase in wind generation capacities, future wind production will be dumped on the market at very low prices. Our analysis comes to a different conclusion. Although a higher discount for wind power, from 4 €/MWh now to 6.5 €/MWh in 2030, does not sound like good news, it is probably small enough for most projects to remain attractive.