Statnett

Long-term Market Analysis

Nordics and Europe 2018–2040

Executive summary

December 2018

Europe is set to develop a low carbon power system with significant contribution from renewable energy sources. By 2040, solar and wind power will probably be the dominating source of generation. Meanwhile, use of electricity for transportation, heat and other purposes increase. This global trend is even more evident now than it was when we published our last market analysis in 2016. The climate challenge, political targets and instruments to achieve those are still important, while lower cost of wind power, solar power and batteries are becoming more important contributors.

There has been a sharp rise in coal, gas, CO_2 and power prices over the last two years. However, the long-term price is less changed. With our updated forecast, average prices remain roughly at current levels until 2030. They then decline to 2040 by adding even more solar and wind power. At the same time, prices become much more volatile, even with access to large volumes of new flexibility.

Higher prices and lower costs make it profitable to build wind power without subsidies in Norway in the first ten years. That is why we expect much more wind power in Norway than we did in our previous analysis. Power surplus and low prices in summer mean that prices on average are somewhat lower in Norway than on the continent. We expect larger internal price differences, especially between northern and southern Norway.

Transformation of the European power system is more technology and market driven

The costs of solar power, wind power and batteries have fallen a lot over many years. For solar power, the entire value chain from silicon to installed panels has become more efficient and less costly. Continuous improvements allow less material usage, higher efficiency, and cheaper power electronics. Due to this, we expect that LCOE for both large-scale and small-scale solar power will be halved by 2040. For wind power, the development of taller turbines is contributing to lower costs. Most new wind power projects in Norway have a LCOE of 30-35 €/MWh, while projects with particularly good wind conditions can achieve below 30 €/MWh. With further declining costs both we and others expect it will be possible to build wind power plants at 25 €/MWh within ten years.

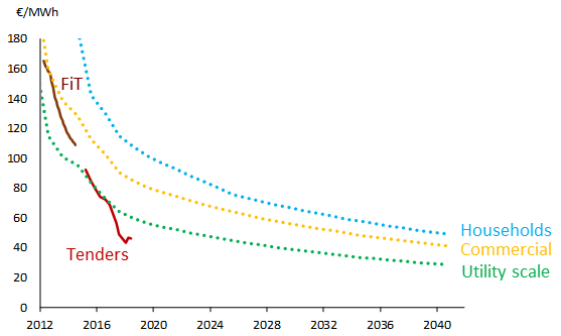

Figure 1: Development in LCOE for German solar power 2012-2018, auction prices and our forecast 2018-2040

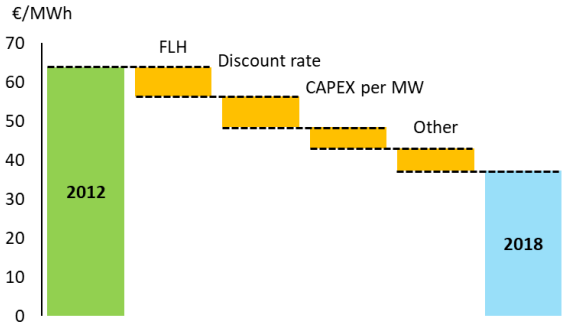

Figure 2: Underlying causes of reduction in LCOE for Norwegian wind power 2012-2018

In light of lower costs, the development of a renewable European power system seems more likely. It also reduces the need for subsidies. However, policy still plays a key role in meeting the climate goals from the Paris agreement. The transition needs to happen much faster than today to reach the targets. To achieve this, more incentives are required to cut greenhouse gas emissions. This is even more important outside the power sector where the abatement measures are more expensive.

In our analysis, we assume that Europe reach its climate targets by 2030 and that the speed at which the system changes toward a renewable system will increase after 2030. The share of renewable generation increases from 35% today to around 75% in 2040 in the area covered by our market

models[1]. The main reason being the increase in solar and wind power from almost 20% to over 55% of total generation. The proportion of coal, lignite and nuclear power drops significantly. We expect growth in power consumption, although total energy consumption is reduced due to electrification of transportation and heating. This is the same main message as in our 2016 analysis. The biggest difference is that we now assume an even greater market share for solar and wind power measured to 2040.

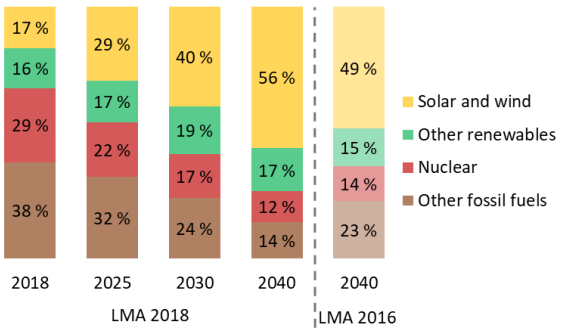

Figure 3: Distribution of power generation in our simulated areas until 2040, and compared to the previous LMA

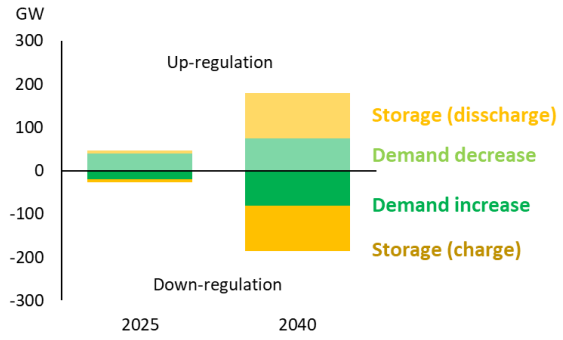

Figure 4: New flexible capacity in Europe until 2040 from consumption and storage

The transition to an energy system where solar and wind power dominates is dependent on new flexibility from storage and demand response. Without this, our simulations show that the amount of curtailment increases sharply when the proportion of solar and wind power passes 40-50% of annual generation. It is essential to have large amounts of flexible capacity responding to periods of both low and high power prices to sustain the value of the power and ensure continued emissions cuts.

The EU ETS carbon market is a key instrument in the climate policy of EU, and power prices in both Europe and Norway are sensitive to the carbon price. At the same time, a large surplus on quotas and lack of political agreement to tighten the market has resulted in prices around 5 €/t over many years. However, during the past year, prices have risen to over 20 €/t. Some of the explanation might be the final decision to tighten the annual cap and the creation of a market stability reserve (MSR). The upswing has nevertheless been unexpected. Several external analyzes indicate that the development has been driven by short-term conditions, and that price developments will continue to be more moderate. At the same time, development indicates increased confidence in the system. We have upgraded our carbon price forecast from 25 €/t to 35 €/t in 2040. Our price range between 15 and 50 €/t in 2040 is similar to our 2016 analysis.

Although we anticipate a substantial restructuring and a significant reduction in emissions from the power sector, it is probably not enough to reach the overall climate targets from the Paris Agreement by 2050. First, most experts believe that the 2030 targets does not by far put Europe in a position to reach the 2050 goals. Secondly, although the power sector both reduces its own emissions a lot and contributes to cuts in other sectors, it is very difficult to cut the total emissions enough with the technologies available today.

[1] Norway, Sweden, Finland, Denmark, the Baltic states, United Kingdom, Belgium, Netherlands, Germany, Poland, France, Switzerland, Czech Republic, Slovakia, Austria and Italy.

Solar and wind power push European prices downward by 2040 – many possible outcomes

Prices in the European power market have risen from less than 30 €/MWh when we made our last analysis in 2016 to over 40 €/MWh now. The reason behind the change is major growth in coal, gas and EU ETS prices. However, the long-term price forecasts we use for coal and gas are just slightly changed. Our updated assumptions entail a moderate decline in coal and gas prices from today's level.

Stable marginal costs for thermal power plants mean that we expect power prices in Europe to remain at current levels until 2030. From 2030 to 2040 the price falls as a result of continued high growth in solar and wind power. Compared to our 2016 analysis, we now have higher prices in 2025, marginally lower in 2030 and around 5 €/MWh lower in 2040. The prices are lower in 2040 because we have increased the proportion of solar and wind power from around 50 to above 55%. We see that the effect of renewables on price becomes stronger when the proportion is larger, as the number of hours of low power prices increases significantly.

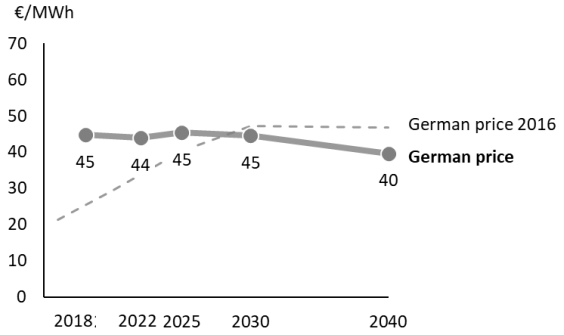

Figure 5: German power price in the Base scenario compared to LMA 2016

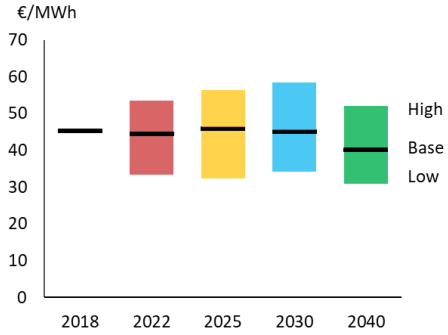

Figure 6: German power price with price range of our three scenarios

The revenues of solar and wind power is reduced more than the average power prices. By 2040, we expect the prices received by these technologies to be 25-40% below the average power price. This happens despite the fact that we have massive new flexible capacity that raise the price in hours where renewable production is high. Combined with great uncertainty surrounding key drivers for power prices, this means there is still a need for support and guarantee schemes in most places.

An important uncertainty factor for long-term power prices is how fast the share of solar and wind power increases. However, gas and CO_2 prices are still most important. Although gas power accounts for only 10% of annual generation, short-run marginal costs of gas-fueled plants determine power prices at almost 50% of the hours in 2040. In our two alternative scenarios, High and Low, it is mainly alternative estimates of gas and CO_2 prices which define the price uncertainty. These scenarios provide a range for continental prices of 30 to 55 €/MWh from 2025 onwards. Compared to our previous analysis, we have about the same downside, but the upside is somewhat reduced due to lower costs for wind and solar power. Sustained high prices will increase the expansion of solar and wind power, thus reducing prices.

European power prices are becoming more volatile, despite much more flexibility

A trend we see irrespective of scenario is that price volatility increases a lot, although the increase is most evident in the high scenario. The reason is more hours with either overcapacity or scarcity as solar and wind power replaces thermal generation. More flexibility from both storage and demand side which respond to low prices can mitigate the volatility to a certain extent, but because the intermittent generation can be high over many days, it is practically impossible to prevent the share of very low prices from rising. In times of scarcity, price dependent consumption will play a key role. However, this must not be confused with loss of load.

Wind power becomes dominant in the Nordics – electrification and industry increase consumption

Due to lower costs and higher power prices, building wind power in Norway is now profitable without support. As we have indicated in our interim report to NVE's work on "National framework for wind power"[2], we see that even for large increases of wind power, the power price stays fairly unchanged in southern Norway. This makes wind power profitable for the next 10-15 years if prices on the continent follow our Base scenario. Because of this and the many investment decisions over the past two years, we have increased the amount of wind power a lot throughout the analysis period. In Norway, we assume more than 30 TWh in 2040, which is twice the amount from our last analysis. Concern over encroachment on nature will probably be important for the amount of new capacity. Toward 2040 the profitability of new wind power is more uncertain, as wind power becomes dominant in the Nordics and Europe in general.

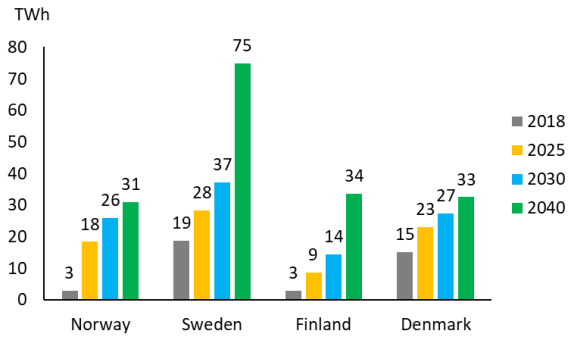

Figure 7: Wind power generation in the Nordic countries in the Base scenario

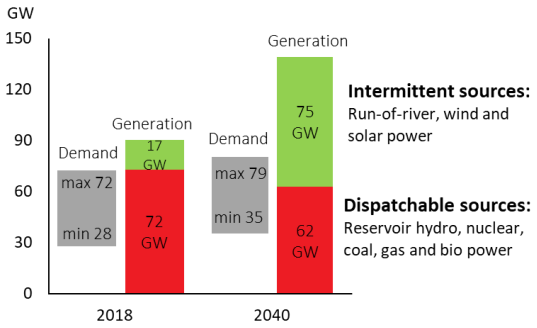

Figure 8: Maximum capacity from intermittent and dispatchable sources and variation in Nordic demand

We expect a large increase in wind power in the rest of the Nordic countries as well, especially in Sweden, where wind power is replacing nuclear power. We have now removed all Swedish nuclear capacity in 2040. This is an assumption taken from the common Nordic scenario prepared in for the Nordic Network Development Plan 2019. The lifetime of the last reactors expires in the mid-2040s and it is uncertain whether these will be extended. Uncertainty about the phase-out of Swedish nuclear power is something we consider in all projects where this is relevant. In Denmark and Finland, wind power continues to grow and replace thermal power. Eventually, solar power plays a greater role in the Nordic system as well. This contributes to increased generation in the summer months when there already is a large surplus from intermittent energy sources.

At the Nordic level, we expect a growth in consumption of just under 20% to 2040. In energy this amounts to 60 TWh, where 20 TWh is in Norway. This is about the same as in our last analysis. Growth is driven by industrial growth and electrification, while we expect small changes in non-industrial demand. In Norway, announced expansion plans give high growth in industrial consumption over the next ten years. In the long term, overall consumption growth is driven more by electrification. At the same time, we see a potential for more growth than we have assumed in our baseline scenario, including more data centers.

In summary, this leads to a growth in Norwegian power surplus from around 10 TWh to almost 30 TWh in 2040. The Nordic annual power balance is weakly positive throughout the period. However, our analysis show that the power balance from hour to hour becomes much more important when intermittent power generation becomes dominant in the Nordic countries. Large fluctuations in generation from ever-changing weather have consequences in the power market, for the system operation and for the need for exchange between regions.

[2] "Nasjonal ramme for vindkraft"

Norwegian power prices are lower and more dominated by wind power, especially in the north

In our Base scenario, power prices in southern Norway are roughly at current levels until 2030, around 40 €/MWh. This is slightly below the average level on the continent, and is due to the fact that we have a power surplus. By 2040, the decline in continental and British prices reduces the price to below 35 €/MWh in southern Norway. In the summer the prices are particularly low, partly because of more solar power throughout Europe which decreases the average price. Our two alternative scenarios provide a price range of 28 to 45 €/MWh in southern Norway. The reason why power prices are significantly lower than in Europe in the high scenario is due to the fact that profitable wind power in Norway limits the upside of power prices.

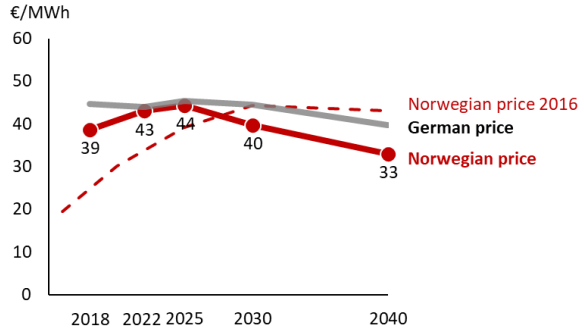

Figure 9: Average power prices of Southern Norway in the Base scenario

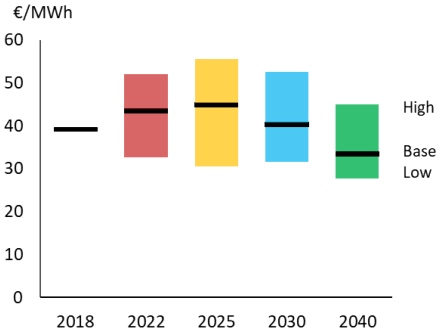

Figure 10: Average prices of Southern Norway in Base, High and Low scenarios

Our analyses show that prices in the north of the Nordic region will be lower than further south more often than before. Closing Swedish nuclear power and new interconnectors raises the price in the south more than in the north, while more wind power lowers the price in the north more than in the south. The latter is especially true for Northern Norway. Our simulations show that expected wind power projects will result in more hours of congestion out of the area and thus lower area prices. More consumption and gradually more transmission out of the area will reduce price differentials, but might lead to even more wind power. Combined with the fact that it takes a long time to build new lines, this means that prices in northern Norway are likely to be below prices in the south, and close to the cost of building wind power.

The overall market trend will likely lead to greater changes in Norway than we assume

Our model simulations indicate that price volatility in Norway increase, although this is still lower than in the neighboring countries. This is primarily due to more volatile prices in all markets around us, especially in Sweden. Additionally, the proportion of dispatchable generation in Norway falls as new capacity is primarily wind power. This means that we will have more hours where export, import or intermittent Norwegian generation sets the price, while large hydro loses market share. This implies more and higher price spikes in the winter when the Norwegian surplus is low and prices around us are high. At the same time, we get many more hours with very low prices throughout the year, but mostly in the summer when consumption is low and intermittent generation is high.

These developments will in sum likely lead to more changes on the Norwegian side than we have assumed. For example, it is likely that we will see more demand response from industry during short periods with high prices. It is also more likely with demand which exploit long-term variations in power prices. We are also likely to get more battery storage, but less than other countries since it is less profitable here. In addition, increased capacity in hydro plants are likely to be profitable, and perhaps also new hydro pumping plants. We are also seeing increasing benefit from new transmission capacity investments beyond those that are under construction.

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