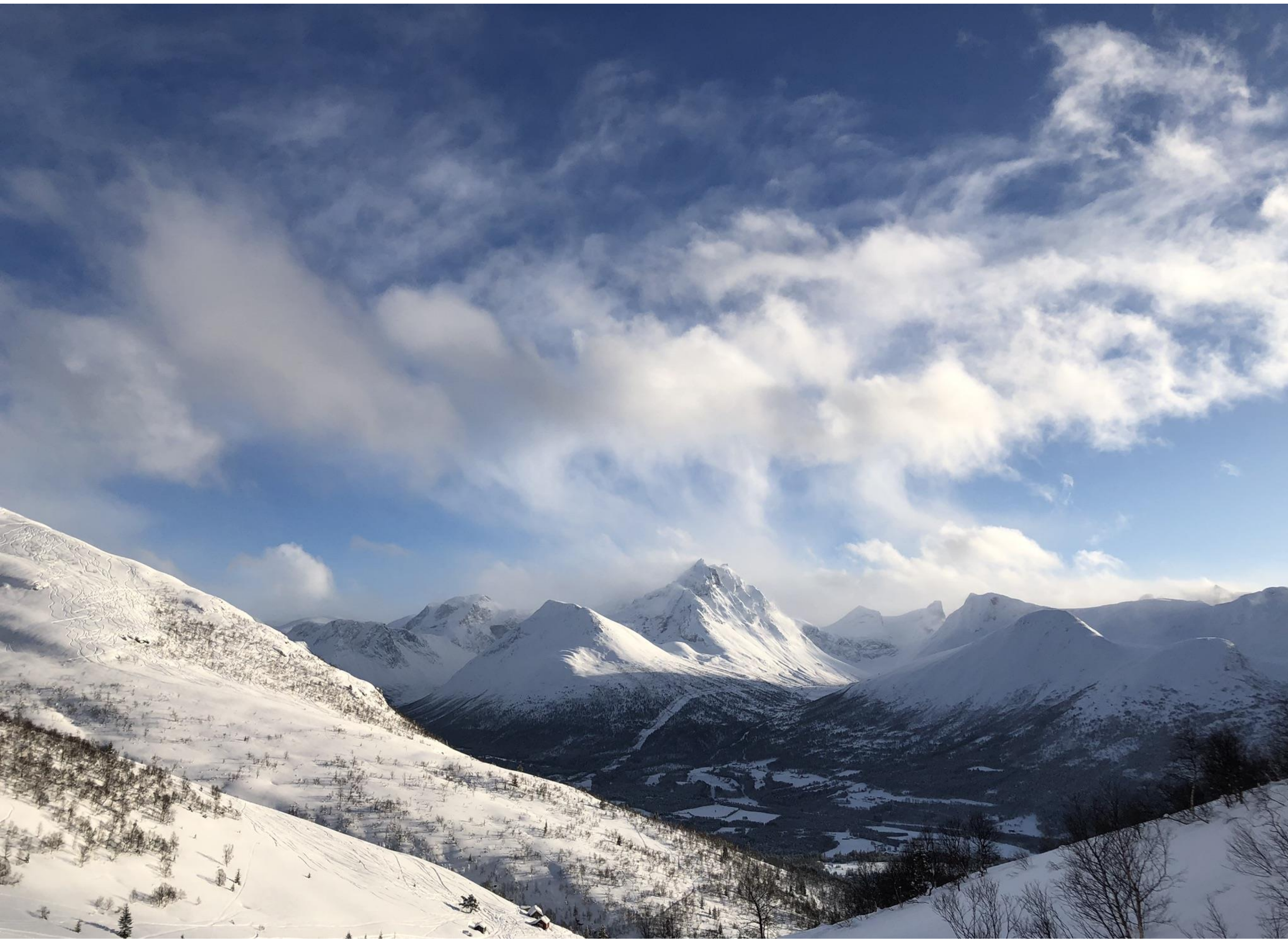
Statnett

Long-term Market Analysis

Norway, the Nordic region and Europe 2024-2050



February 2025

Executive summary

The European and Norwegian power markets are undergoing significant changes with increasing solar and wind power, numerous projects under development, and more variable electricity prices. Over the next 25 years, the transition to emission-free energy will continue to bring significant changes. At the same time, there is a lot of uncertainty, driven by increased competition from China and the USA, political uncertainty, and still high costs for key technologies. The following five factors in the development of the power market are particularly central to Norway and Statnett's responsibilities:

- The expansion of solar and wind power continues in all scenarios.
- There is insufficient flexibility being built to smooth out renewable production.
- European electricity prices continue to vary greatly hour by hour, possibly until 2050.
- Consumption in Norway may increase a lot – industrial competition and not as much production may dampen growth.
- Prices in Norway are gradually becoming more similar on average – internally and with neighboring countries.

The analysis confirms the need for Statnett's planned grid reinforcements. This is particularly true for those that increase transmission capacity between regions in Norway. In addition, the analysis shows great price differences and high benefits from exchanges with other countries until 2050, even though net exports will be smaller.

The development in Norway must be viewed in conjunction with the European market development

The development of electricity prices and power flow in Norway is influenced by both consumption and production in Norway, and by how the market and system develop in the Nordic region and Europe. In addition, the development in Europe has a significant impact on technology costs and the development of Norwegian industry and business activities. Therefore, Statnett analyze the Norwegian and European markets, among other things, to clarify grid needs and possible challenges in system operations. To provide a significant range of possible results, we use a certain set of scenarios:

- 3 scenarios for market development in Europe and Norway: Low Price, Base, and High Price
- 3 scenarios for development of consumption and production in Norway: Low, Medium, High

In the Base and Low Price scenarios, technology costs fall, resulting in lower and more stable electricity prices. This also brings us closer to the goal of net-zero emissions in energy by 2050. The High Price scenario shows a development where higher technology costs lead to higher and more variable electricity prices, and where the goal of zero emissions is less likely to be achieved. In this scenario, the industry is also more likely to be outcompeted.

Europe – energy transition, security, and cost focus shape energy policy

War, geopolitical rivalry, and prospects of trade wars increase uncertainty and are likely to affect goals and measures in energy, climate, and industrial policy. At the same time, this is likely to reinforce the transition to emission-free energy. European countries are nowhere near being able to meet their energy needs with domestically produced fossil energy at competitive costs. Security of supply and competitiveness considerations are therefore a central part of the rationale for the expansion of solar, wind, and nuclear power, as this provides both lower electricity prices and increased self-sufficiency in energy. Greater emphasis on security of supply and competition is also likely to result in more measures to maintain and develop the industry. It is also likely that there will be less detailed regulations in the EU. At the same time, increased focus on costs may delay the transition where costs are highest.

Countries in the EU have adopted several intermediate objectives, strategies, and instruments to achieve the target of a 55 % reduction in greenhouse gas emissions by 2030. To ensure development in line with the target of climate neutrality by 2050, the EU Commission has provisionally proposed a target of a 90 % emission cut by 2040. This is a key driver for high CO_2 prices, more emission-free electricity production, and increased consumption through electrification.

The quota market (EU ETS) ensures that emissions decrease in accordance with the stated target. In addition, revenues from the sales of quotas help finance the support for renewable production, energy efficiency, and hydrogen. With current regulations and a target of a 90 % emission cut, the prices of quotas beyond the 2030s are likely to be higher than today. This has a significant impact on electricity prices – especially the first fifteen years from today.

The ability and willingness to execute the energy transition will be greatest where technologies are mature, and where costs are successfully reduced. We assume that the EU and national authorities provide financial support for investments to technologies that currently have high costs. From around 2040, we assume less financial support, either because costs and the need of support are reduced or because ambitions are lowered. Achieving the climate goals may be postponed in the event of major political, as well as less support for renewable expansion, and possibly the removal of the quota market. This would have a significant impact on the market and electricity prices.

Technology costs and global transition affect developments in Europe
External forecasts show that the costs for emission-free production, energy storage, and various forms of flexibility will continue to decrease. This reinforces the transition and generally leads to lower electricity prices over time. For offshore wind, electrolysis plants, and nuclear power, however, economic support is a prerequisite for building large enough volumes so that learning and standardization can reduce costs.

The global energy transition is accelerating, particularly in the expansion of emission-free electricity production. China is leading the way by building significantly more emission-free energy production than anyone else and as a dominant producer of solar panels, wind turbines, heat pumps, electrolysis plants, batteries, and electric cars. This lowers technology costs and helps accelerate the transition in Europe. However, industrial competition increases uncertainty about energy consumption in the European industry.

The shift in the presidency in the United States is likely to involve a political focus on the production and use of fossil energy. Most likely, this will also slow down the development and production of electric cars, hydrogen, and renewable electricity production in the United States. These developments can both strengthen and slow down the transition in Europe.

Europe's electricity production becomes nearly emission-free
Renewables already account for just under 50 % of electricity production in Europe, and further to 2050, there is broad agreement that production growth will mainly come from solar and wind power. There are some uncertainties about whether zero-prices and low profitability may slow down the expansion the first years. However, there is no doubt that much more wind and solar power will be built regardless. Together with nuclear power, this provides nearly emission-free electricity production beyond the 2030s.

Phasing out coal power and increasing consumption create a deficit in capacity during hours with little solar and wind power. This creates a necessity to build new dispatchable capacity. Batteries and more flexible consumption will contribute, but dispatchable power plants must be built as well. Many of these power plants will have low and uncertain profitability. Most countries therefore have support schemes to ensure sufficient capacity in the market. There is a risk that the expansion of capacity will be too slow. This could lead to a transitional period with an extra tight capacity balance and high price peaks.

Nuclear power provides both emission-free energy and capacity, with little use of land area. The disadvantages are high and uncertain costs, long lead times, and competition from solar and wind power, which in practice reduces time of production throughout the year. Therefore, investments in nuclear power occur in countries that support this economically. In the Base scenario, we assume that today's capacity is maintained. Should costs decrease, there may be a higher expansion from 2035-40. However, simulations from our model show that more nuclear power will have little impact on electricity prices.

Europe's electricity consumption will increase – but less than expected the first few years

There is a broad agreement that the transition from fossil to emission-free energy use, more data centers, and new industry will lead to increased electricity consumption in Europe in the coming years. At the same time, we observe a clear trend that electrification is progressing more slowly than anticipated. In addition, it has become more uncertain whether the European industry will be able to compete with China and the United States. In sum, the range of consumption development increases towards 2050.

Production and use of green hydrogen will be central to reduce emissions in parts of the industry and transport sector. Flexible hydrogen production, where production only occurs when electricity prices are low, can also provide large amounts of flexibility to the electricity market. The development of usage of hydrogen and production is simultaneously one of the most central uncertainties for electricity prices, climate targets, and the industry. The main challenge today entails that electrolysis plants are too expensive, and that storage and infrastructure are lacking. This leads to an excessively high price of hydrogen for consumers, and many projects are postponed. With financial support and technological development, it can still succeed, but the progress can also come to a halt.

In the Base scenario, we assume that total consumption increases to almost double today's level by 2050. The growth is relatively moderate until 2040. In the Low Price scenario, growth is further strengthened, driven by even lower costs and increased competitiveness. In the High Price scenario, growth in consumption is significantly lower due to higher costs, less hydrogen production, and the relocation of heavy industry to other parts of the world.

Significant growth in flexibility – but not enough to absorb all renewable production

There will eventually be a significant need for flexibility and energy storage to utilize the potential surplus when there is a lot of solar and wind power. Parts of this will be covered by batteries, which are now being built at a rapid pace. More flexible use of electric boilers that use most electricity when prices are low, investments in pumped storage, and more grid capacity will also contribute. However, it is only with flexible hydrogen production that it will be possible to build a volume large enough to utilize most of the variable solar and wind power production. Whether this happens is uncertain, and it will in any case not happen until 10-15 years from now, and contingent on reduced costs of electrolysis plants and hydrogen storage.

Considering this, growth in energy storage and flexibility is much lower than the growth in solar and wind power until 2040 in our Base scenario. This contributes to a lot of prices around zero and spill of energy during this period. Towards 2050 we assume that lower technology costs will provide more storage and flexibility, but this is uncertain.

Gradually lower and more uniform average prices across Europe, but high price variation

On the continent and in the UK, average electricity prices in the Base scenario decrease from today's level of around 80-85 €/MWh to around 65 €/MWh in 2030, and further to around 50 €/MWh in 2050. Lower costs for renewables and flexibility are the main reasons for the decline in prices. Average prices also become more uniform across the various European countries, largely driven by the power systems becoming more similar over time.

Towards 2040, lower growth in consumption and flexibility compared to wind and solar power results in a price around zero a large portion of the time. At the same time, high CO_2 prices lead to relatively high electricity prices when gas power is setting the price. In sum, this results in high short-term price variation. Towards 2050, even more renewables and cheaper flexibility gradually lead to more stable electricity prices. However, price variation remains higher than it has up until today.

The High Price and Low Price scenarios provide a range of average prices on the continent from 40 to 70 €/MWh in 2040/50. In the High Price scenario, price variation is higher, while the opposite occurs in the Low Price scenario. Major political changes can lead to even greater impact on the price. For example, our simulations show that a hypothetical shutdown of the quota market (EU ETS) with a zero CO_2 price would halve the price in Europa in the 2035 Base scenario. As time goes on, less gas power has a more muted effect on the power price. Such a scenario would slow down the entire energy transition.

Norway – consumption growth will depend on more production

Electrification and increased activity in industry and data centers are strong drivers for increased electricity consumption in Norway. We assume that Norway maintains the target of becoming a low-emission society, and together with many plans of electricity consumption, this provides potential for high growth in the Norwegian consumption. However, growth assumes that electricity prices are low enough. Without new Norwegian electricity production, excluding the projects that are currently under development, high electricity prices will practically limit consumption growth to an estimated 25-30 TWh.

The three main scenarios for Norwegian consumption and production show an increase in consumption from 140 TWh today to between 180 and 260 TWh in 2050. In the Low scenario, more energy efficiency and little new production result in lower demand. In the High scenario, much new production provides a basis for high industrial growth. Compared to the previous analysis we have done; the growth has shifted to occur after 2040. This particularly applies to the High scenario, which requires a lot of new production.

We assume a balanced growth in consumption and production in all main scenarios. A lasting larger deficit in the Norwegian energy balance is unlikely as this will lead to high electricity prices and thus less new industry. Similarly, a larger surplus will quickly be offset by more consumption. At the same time, it is likely that new industry can outcompete existing ones – if there is not enough new production.

Electricity prices within Norway are likely to become more uniform

The analysis shows the following four main trends for the development of electricity prices in Norway:

- The average prices in each price area become more similar.
- Prices remain lower than in Europe, but a dry year can lead to higher prices.
- There is still significant seasonal variation - with lower prices in the summer, higher in winter.
- Prices vary greatly between days and weeks, but much less than in other countries.

The two most important factors for Norwegian electricity prices on average over time are the prices in our neighboring countries and the energy balance in Norway. This results in average prices throughout the year of 50-55 €/MWh in the Base scenario in all Norwegian price areas from 2040 and onwards, with a range of 35-70 €/MWh. The convergence of the average prices between the Norwegian price areas is due to less surplus in the energy balance in northern Sweden and Norway, as well as grid reinforcements in Norway and Sweden. If consumption growth is lower or grid expansion is delayed, today's differences in price will last longer.

Our simulations show that the differences in electricity prices between summer and winter are increasing. A consequence of this is that regulated hydropower with reservoirs achieves almost twice as high prices as solar power throughout the analysis period.

With the electricity prices in the Base scenario and a Norwegian energy balance around zero, our calculations show that onshore wind power can be developed without support in Norway. Solar power and fixed-bottom offshore wind have low calculated profitability if the development is to be based on electricity sales alone. Without significant cost reductions, any development of nuclear power in Norway will likely require financial support with the electricity prices in the Base scenario.

Periods of tight capacity balance will lead to more high price peaks – also in Norway
In the Medium scenario, the maximum Norwegian capacity consumption increases by about 6 GW by 2035. The analysis assumes that 5 GW more capacity is developed in existing regulated hydropower towards 2050. Without these uncertain investments in new capacity, Norway will have a negative capacity balance within a few years.

Even if Norway has a positive capacity balance, there will likely be more hours in Norway, such as we experienced on December 12, 2024. This is because there are periods when there is not enough capacity in hydropower to cover Norwegian consumption and simultaneously have full export. With increased consumption in Norway, this will happen more frequently than today. Delays in the development of dispatchable power plants, both on the continent and in our Nordic neighboring countries, can lead to a period of extra high price peaks during the next decade.

Significant need for planned grid in Norway – and high benefit from exchanges with other countries
Today, we have large price differences and a clear need for planned grid reinforcements in Norway. Market developments ahead reinforce the need for grid reinforcements. More variable prices and production result in high and variable flow in much of the grid. In addition, high growth in consumption and production can create further needs.

A lot of flexible hydropower results in significantly lower short-term price variation in Norway than elsewhere in Europe. Fluctuations in inflow also result in large variations in prices between wet and dry periods. Together with high short-term price variation in our neighboring countries, this results in large price differences hour by hour on average between Norway and abroad until 2050 in our market scenarios. The benefits of electricity exchanges with abroad therefore remain at a historically high level, even though today's net exports are reduced to around zero. Hourly price differences result in high congestion revenues. In addition, Norway will earn a lot over time by exporting more at higher electricity prices while also importing larger volumes at lower prices. The reason is that regulated hydropower shuts down production during hours of import and relatively low prices and shifts production to hours of higher prices where Norway normally exports.

Revenues from electricity exchanges with other countries will vary with the Norwegian energy balance, foreign prices, and across weather years. In the Base scenario, the net present value of Norway's total, average revenues from electricity exchanges with other countries are around NOK 210 billion until 2050. The range is around NOK 180 to 300 billion depending on foreign electricity prices and weather variations. Of this, congestion revenues for exchanges with other countries amount to around NOK 125 billion in net present value in the Base scenario, with a range of NOK 110-140 billion[1].

[1] We have used a 4 % interest rate in the net present value calculation. The calculation is based on the annual revenues, averaged over 29 weather years. Since we do not model every year up to 2050, we have linearly interpolated between the years 2030, 2035, 2040, and 2050.