Long-term Market Analysis 2020-2050

- Update Spring 2021

Statnett

Update Spring 2021

Statnett prepares a Long-Term Market Analysis (LMA) every two years. The analysis is compiled to keep track of and analyze the long-term development in the power market, among other things. The developments in the Nordic region and Europe are of great importance to Norway and to Statnett's decision-making. We make the report public to give insight into our thinking and assumptions.

We published our latest Long-term Market Analysis for the period 2020-2050 in October 2020 (LMA20). This analysis focused particularly on the road to zero emissions in 2050, both in the existing power sector and the entire European energy system.

Since we published the LMA20 in October, there have been developments in several significant factors that affect the long-term picture. It is important for us to follow market developments closely, as they occur, in order to better understand the future.

In this update of LMA20, we discuss the developments over the last period, focusing on the consequences for the market development the next 10-15 years. We prepare such updates of the LMA in "middle years" from time to time, when major changes occur. This update of the LMA20 is to be read as a supplement to the complete report.

The updated analysis is based on revised data sets for 2025 and 2030 from the full Long-term Market Analysis 2020-2050.

The report is prepared by Julie Gunnerød, Eirik Bøhnsdalen, Dalibor Vagner, Lars Martin Hytten og Lasse Christiansen

Statnett

Key Takeaways

The main assumptions of the LMA20 are strengthened since we published the report in October last year. The direction towards zero emissions in the entire energy system is now even clearer. Among other things, the EU has adopted, and is now in the process of legislating, a stricter target for emission reduction by 2030 and has also set ambitious targets for the development of offshore wind. In addition, the green wave in finance, industry and business has further intensified. Climate policy has also been tightened outside Europe since the autumn last year. The US and China have launched their own zero-emission targets. In LMA 2020, we assumed that Europe would reach the emission targets by 2050 and we now believe that the latest developments has made this more likely.

The final decision to cut emissions by 55% by 2030 has contributed to a doubling of the price of CO_2 in the EU ETS between November 2020 and May 2021. This increase in price is also an expression of greater confidence in both the emission trading system and the climate policy in general, and a manifestation of the fact that others measures, such as legislated phase-out of coal power and subsidies of renewables, to a lesser extent than before compete with the market for emissions permits. The increase in the price of CO_2 is expected to continue and we have updated our assumptions for 2030 to 70 €/t, up from 35 €/t. A higher price of CO_2 result in higher marginal costs in fossil power plants and thus also higher power prices both in Continental Europe and in Norway. Thus, the market outlook is now more in line with our "High Power Price" scenario from LMA20 in the coming decade.

Higher power prices increase the profitability of all renewable production. In combination with rapidly falling technology costs, this reduces particularly the need for subsidies for bottom-fixed offshore wind. In our new "Basis" scenario for 2030, bottom-fixed offshore wind in the North Sea is profitable based on the price of power alone. If building of bottom-fixed offshore wind can be done without large subsidies in Norway, it could lead to more power consumption, since new production is a significant factor for the price-sensitive consumption.

In Norway, developments over the past six months have strengthened our main forecast for power consumption, especially in the coming decade. The new 2030 target for emission reduction and an increase in the Norwegian CO_2 tax will provide stronger incentives for emission cuts and electrification. Power prices in Norway are also less affected by the higher price of CO_2, especially in the two northernmost price areas, NO3 and NO4. This increases the relative competitiveness in Norway. In addition, several major plans for new consumption has moved further towards concretization. The growth in power consumption from petroleum activities will probably continue to depend on political targets. In the longer term, the sample space for Norwegian consumption development is more wide-ranging, as the plans for new consumption are less specific. The opportunities for further industrial growth related to the green transition is large, while also it is likely that large consumption growth depends on new power production. The development also depends on how much the activity in the petroleum sector is reduced in the long run. A consumption growth corresponding to what we have in our "High" scenario will be central in our further analysis.

Power prices in southern Norway will increase on average by around 10 €/MWh in 2025 and 5 €/MWh in 2030, compared with LMA20. Power prices in Norway do not increase as much as in Europe, and the increase is also smaller both in northern and central Norway, and in northern Sweden. Initially, this reinforces the price differences between the north and the south in the two countries. This in turn increases the value of upgrading the transmission channels. In the long run, this development can be counteracted by the fact that consumption in the northernmost areas in the Nordic region is increasing at a faster pace than we have assumed in the baseline scenario in the LMA20. Increased prices in Europe also mean increased price volatility. This increases the value of the flexibility in Norwegian hydropower, as well as the value of cross boarder trade.

This update is based on a slight revision of our datasets for 2025 and 2030 from the LMA20. The Updated LMA must be read as a supplement to the complete report, the Long-term Market Analysis 2020-2050. Specifically, the update involves: (1) updated assumptions for CO_2 prices until 2030, (2) minor adjustments to installed renewable capacity and installed capacity in fossil power plants, and (3) an additional assessment of the technology costs for offshore wind. The analysis is not complete, and we will continue to work with the dynamic effects, such as the indirect effects of increased price of CO_2 on hydrogen production. This is a topic for further analysis, but we will touch upon these points in the following text.

Tighter Policy Measures

In sum, the direction towards zero emissions is even clearer now, than in the autumn of 2020. Climate policy has been tightened globally, in the EU and nationally through, among other things objectives for emission reductions and renewable power production.

Statnett

The EU legislates a target of -55% emission reduction by 2030

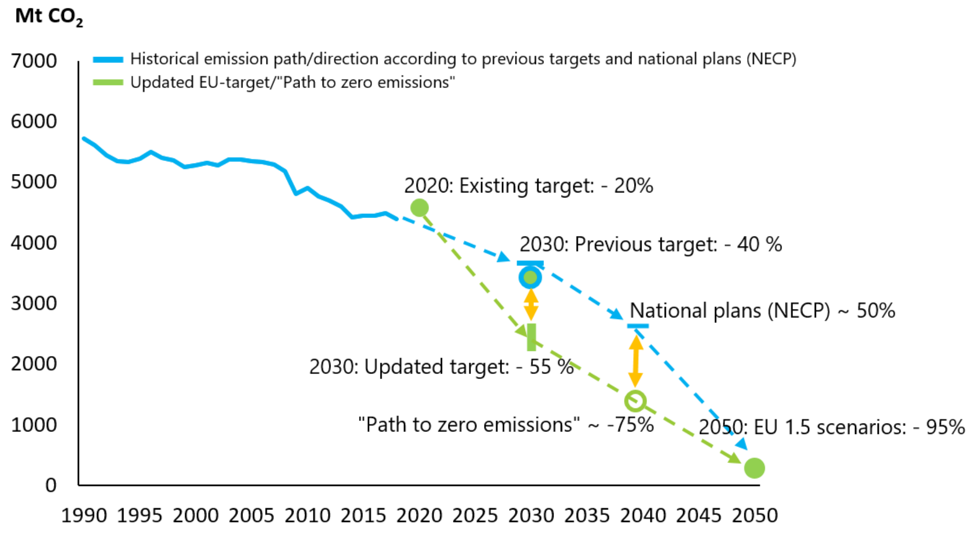
The EU has long been in the process of tightening the emission target for 2030 so that it will be possible to reach the statutory zero emission target in 2050. Through the autumn of 2020 and the spring of 2021, the EU has instigated the process of adopting a 55% emission reduction. The bill has now been written and is expected to be enacted in June 2021.

When working with the scenarios in the LMA2020, we emphasized the 2050 target and assumed that the proposal for a 55% emission cut would be adopted. Because of this, the tightening of the 2030 target does not entail any direct changes to our assumptions - but it strengthens our baseline scenario from LMA20.

Although the tightening of the target was expected, the tightening has created reactions in the carbon market. The price of CO_2 doubled between November 2020 and March 2021 and has increased further throughout May. The price increase was primarily driven by the expectation that the supply side of the EU ETS will be tightened as a result of the new 2030 target, in addition to the market perceiving the credibility of the EU's target of zero emissions as strengthened.

As a result of the increase in price, other analysts have raised their CO_2 forecasts considerably. We return to our updated forecast for the price of CO_2 further on in the analysis.

Illustration of emission paths towards 2050



Statnett

60 GW offshore wind in the EU by 2030

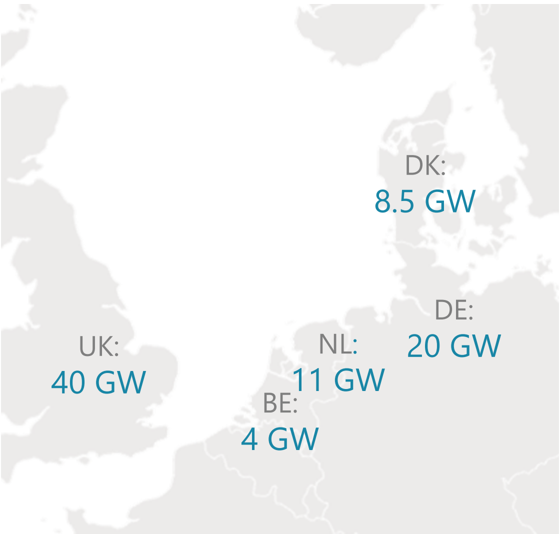
In November, the EU launched its strategy for the development of offshore wind, which sets a target for at least 60 GW of offshore wind by 2030. In 2050, the target is 300 GW of offshore wind, as well as 40 GW from wave and tidal power.

After Brexit, the United Kingdom is no longer included in the EU targets but has set its own ambitious goals for offshore wind development. Originally, the United Kingdom had a target of 30 GW offshore wind by 2030, but in October 2020, they increased the target to 40 GW.

Many other EU countries have, like the United Kingdom, set national targets for development by 2030, as shown in the figure on the right.

In sum, the concretisation of goals at EU and national level helps to reduce the risk for offshore wind developers. This in turn can lead to lower development costs. We will return to this in the next chapter.

The individual countries offshore wind goals by 2030



EU Offshore Renewable Strategy

	1991*	2010**	Today	2030	2050
Average power capacity of offshore wind turbine	0,45 MW	3MW	7,8MW	↗	↗
EU offshore wind energy capacity	5MW	3GW	12GW	≥60GW	300GW
Ocean energy capacity (e.g. wave, tidal)		3,8MW	13MW	≥1GW	40GW

* First offshore wind farm: Vindeby, Denmark.
** Including UK

Statnett

Zero emissions in the US and China by 2050 and 2060

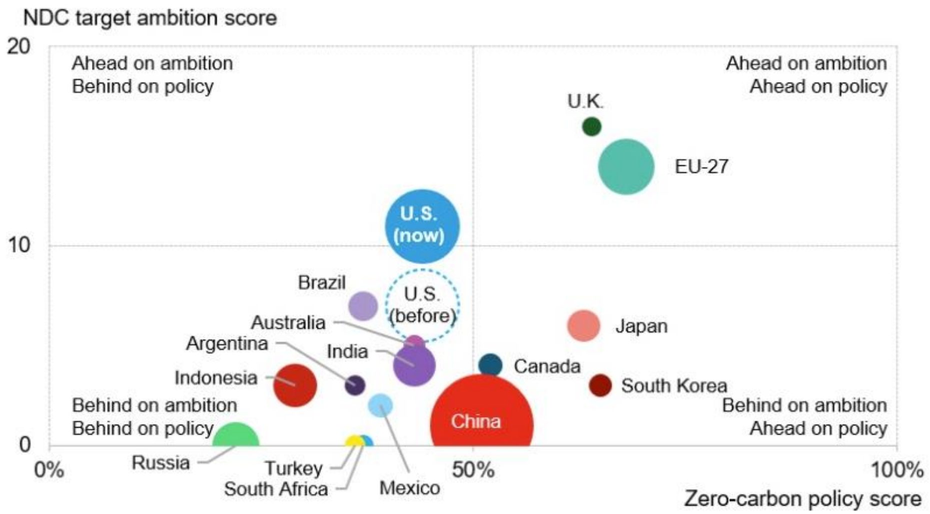
Globally, climate policy has been tightened since last autumn. China and the United States, which are the two countries with the highest CO_2-emissions, have recently set zero emission targets.

President Biden has re-entered the United States into the Paris Agreement and set targets for halving greenhouse gas emissions by 2030 and a zero emissions target by 2050. The new emissions targets place the United States in almost the same league as the EU and the UK in terms of reducing emissions. However, European countries have come further with regards to linking emissions targets with legislation and specific measures to reduce emissions. The United States must deliver more in this respect, in order to take a leading position in the fight against greenhouse gas emissions.

In the autumn of 2020, China launched its goal of zero emissions by 2060 and has a goal of reaching the peak of emissions by 2030. China currently accounts for 28% of global emissions, which makes its goal for zero emissions central to global climate policy. China also plays a key role in technology development, as the largest investor, producer, and consumer of renewable energy in the world.

Several studies and forecasts show that it is unlikely that we will have zero emissions globally in 30 years. Still, a global development towards zero emissions will provide important impetus for the European transition, especially when it comes to development of new or better technology.

BNEF ratings for selected countries' NDC target and zero-carbon policies



Source: BloombergNEF

Note: NDC = Nationally Determined Contribution

The green transition accelerates

Europe

The tightening of the climate targets in the EU provides an even clearer direction towards zero emissions, which has quickly been priced into the market.

With the price of CO_2 twice as high, the power price in the next ten-year period is most comparable to our "High power price" scenario from LMA20. This enables a faster transition to a power system based on renewables.

Statnett

Doubling of the price of CO_2 – expecting growth towards 2030

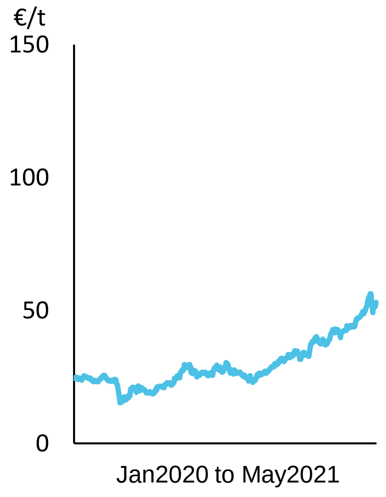
The price of CO_2 in the EU ETS was on average just over 50 € / t CO_2 in May 2020. This is more than double the price in the beginning of November 2020. The increase has primarily been driven by the EU's new target of a 55% emission cut by 2030, but also by the fact that there is increased confidence in the emission trading system in general, and more certainty in that the EU's goals are upheld and possibly further tightened. Furthermore, the annual settlement period for emissions, as well as the withdrawal of allowances via the Market Stabilization Reserve (MSR) has contributed. In addition, there are an increased number of financial players in the market. The price of CO_2 has been expected to rise, but this price increase happened earlier in the 2020s than most analysts expected.

Since most external analyst have adjusted their forecasts for the price of CO_2 considerably; we have updated our assumptions. We expect an increase in the price of CO_2 to around 70 €/t CO_2 in 2030, in our Updated LMA. In 2030, we operate with a range of between 50 €/t to 100 €/t.

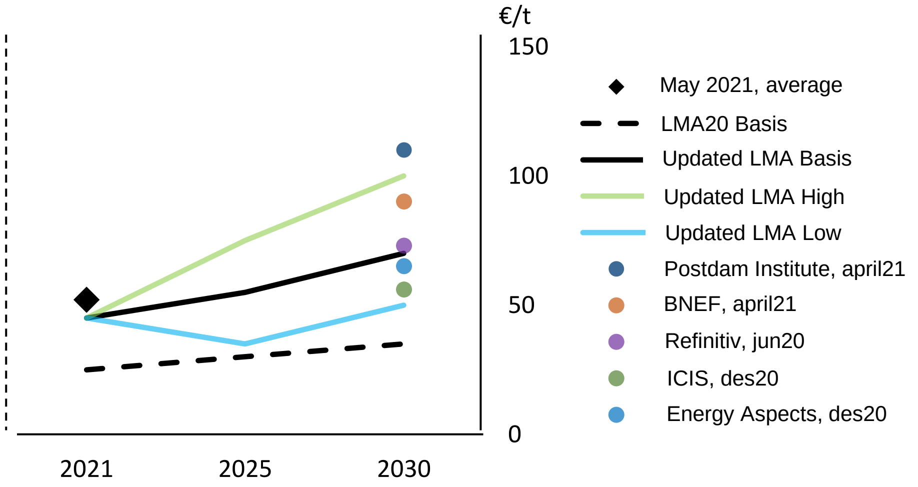
The price of CO_2 has the most impact on the power price when fossil power production sets the price. Thus, the price of CO_2 will have the most impact on the power price in the next few years, and the effect will somewhat decrease with the phase-out of fossil power production, especially coal power. After 2030, the price of CO_2 will increasingly affect the power price indirectly through use of electricity for hydrogen production. A high price of CO_2 will make it more profitable to switch to hydrogen in various industrial processes, which in turn provides more electrolysis capacity and supports the price of hydrogen. This will contribute to an increase in the power price in hours with a high share of solar and wind power, which increases and stabilizes the average power prices. In turn, this provides incentives to invest in additional wind and solar power production.

The UK left the EU ETS after Brexit and started their own emission permits market (UK ETS) from 1 January 2021. There is considerable uncertainty associated with the price on emissions in the UK ETS in the short term, but there is little doubt that carbon pricing and quota trading will play an important role in the transition to an emission-free energy system in both the UK and the EU. In the longer term, we therefore assume that the necessary adjustments will be made in the British emission permit market so that the UK ETS fulfills this function.

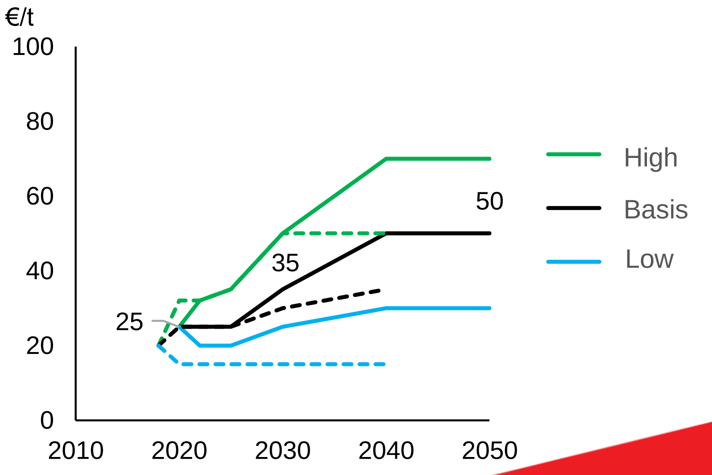
Historical price of CO_2



Assumptions for the price of CO_2 in Updated LMA



Assumptions for the price of CO_2 in LMA20

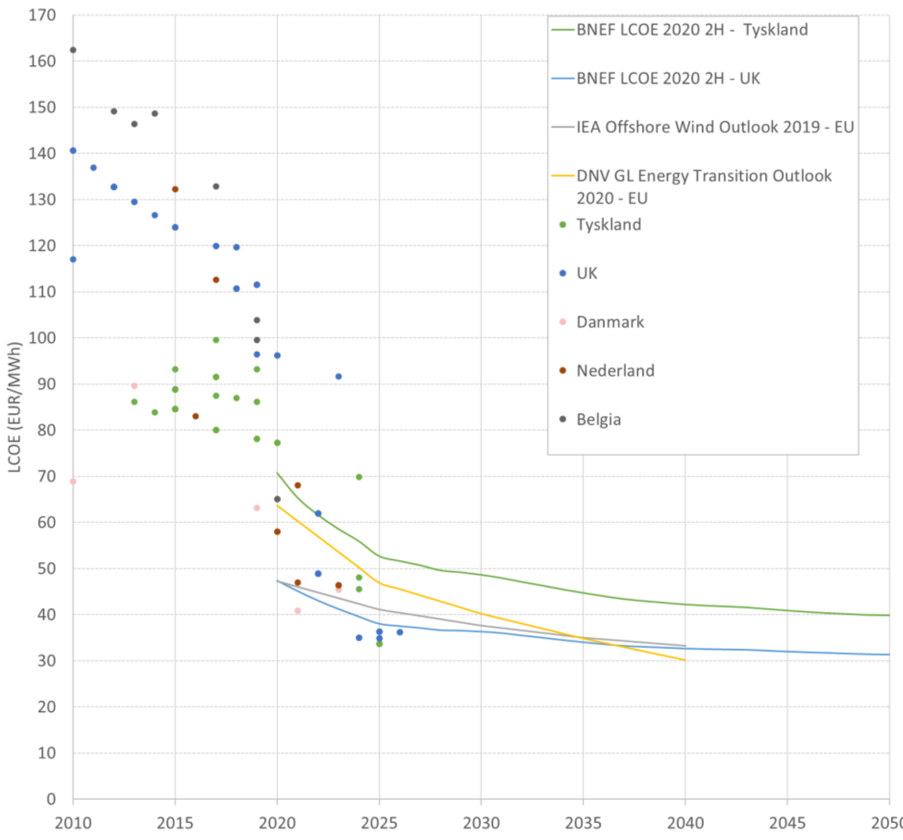


The cost of bottom-fixed offshore wind is rapidly declining

Since LMA 2020 was published, the EU and several individual countries have introduced more ambitious targets for emission reductions and offshore wind development. In external analyzes and forecasts, there is a consensus that the large volumes of offshore wind will lead to further decrease in technology costs. Our updated cost figures, which we compile from external sources and use as a reference to assess subsidy needs, are therefore around 10% lower in our update, compared to LMA20.

The cost of offshore wind has dropped sharply in recent years. The main drivers are larger turbines, larger projects, more specialization in the entire value chain, as well as lower financing costs.

We expect costs to continue to decline, as the pace of development in offshore wind will increase sharply in the coming years. Larger turbines, new specialized installation vessels and cheaper transmission solutions will be some of the most important factors for cost reduction in the future. Increasing sea depths and increasing distances from land will offset some of this, but both we and the rest of the energy industry still expect costs to continue to fall.



* Punktene i scatter-plotet viser såkalt "levelized tariff" for investeringsbesluttede havvindprosjekter. Denne størrelsen viser forventet gjennomsnittlig oppnådd kraftpris over levetiden til det aktuelle prosjektet, og er sammenliknbart med LCOE for prosjektet (kilde BNEF)

Could have subsidy free offshore wind before 2030

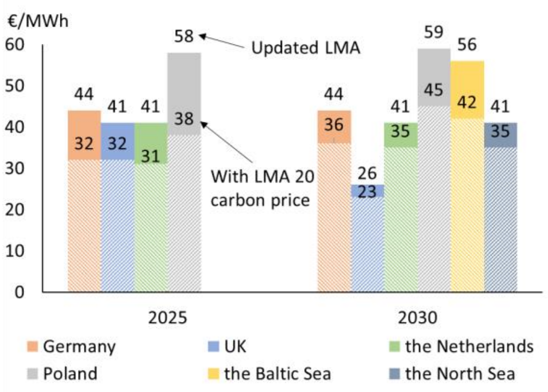
Significantly higher price of CO_2 result in higher capture prices for renewable energy production. In our updated simulations, the capture price increases by around 10 and 7 € / MWh in 2025 and 2030 respectively, as a result of increased costs of emitting CO_2. This results in a much lower need for subsidies for both offshore wind and solar power in our Updated LMA, compared with LMA20.

If we compare the expected capture price with the expected LCOE for offshore wind, we see that there will still be a need to subsidies many of the offshore wind projects, also in 2030. However, we see that an increasing proportion of the projects will be profitable without other support than the grid costs. Increased willingness to pay for renewable energy and greater demand for corporate PPAs can further reduce the need for subsidies.

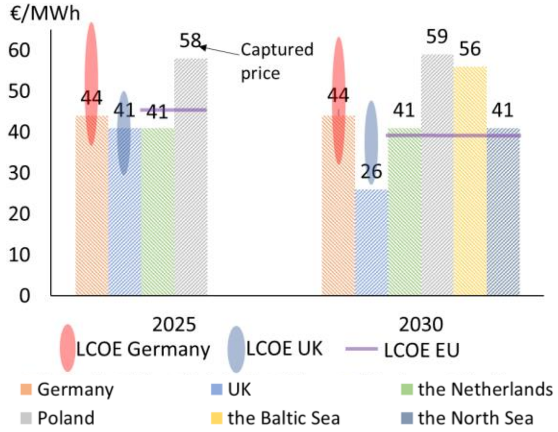
Towards 2030, the cannibalization effect will increase, and the power price will decrease in the hours with high wind power production. This effect is most evident in the countries with the highest share of wind power. In the UK, which shall develop as much as 40 GW of offshore wind power by 2030, the capture price for wind power in our Updated LMA is around 30 €/MWh in 2025 and only around 25 €/MWh in 2030. The corresponding figure for Germany is around 45 €/MWh in both 2025 and 2030. However, we expect that rapid technology development will help reduce costs and thus continue to keep the need for subsidies low.

The political goals in the EU of 60 GW of offshore wind by 2030 and 300 GW by 2050, strengthens the assumption that there will be a lot of offshore wind development in the coming years. This will probably also be the case even if the development is such that offshore wind is not profitable based solely on the power price. Similar political targets have also been set in the USA and Asia, which are central to the development of technology and thus decreasing costs.

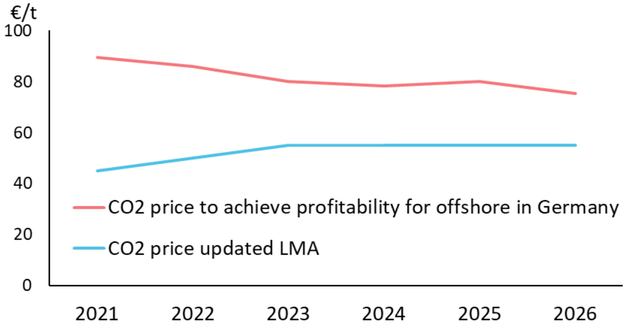
Change in captured price for offshore



Captured price and LCOE for offshore



CO_2 price needed to achieve profitability for offshore in Germany



The High Power Price scenario from LMA20 is the most likely

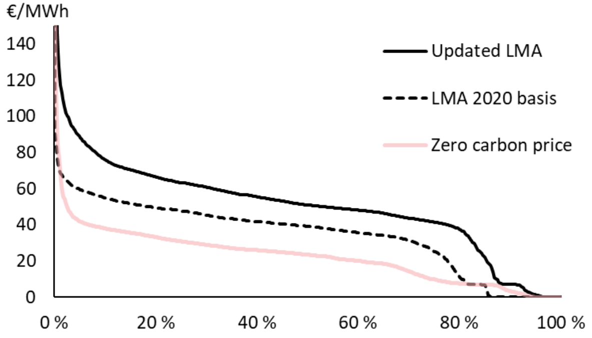
In the Updated LMA20, the simulated average power price over the year on the Continent increases by around 15 €/MWh in both 2025 and 2030, compared to LMA20. This is primarily due to the increase in price of CO_2. The minor adjustments we have made to the capacity of fossil and renewable power production will roughly balance each other on the average price. Because of this, the average price increases the most in the countries with the highest share of carbon-intensive power production, such as Poland, and less in e.g., Britain that has phased out almost all coal power. In general, the average prices for 2030 in the Updated LMA are very similar to the average prices in our High Price scenario from LMA20.

The increase in carbon prices has a direct effect on power prices by increasing the marginal costs of fossil power production. This is clearly shown in the change in the duration curve for the German power price in 2025 and 2030. In the duration curve for Germany in 2030, we also see how there will be far more prices above 150 € / MWh. This is due to fewer fossil power plants, which means that the power price is more often set by flexible demand, who chose to stop consuming at a certain price level. At the same time, more renewable capacity increases the share of low prices. In sum, the Updated Basis scenario gives significantly higher price variation than the Basis scenario from LMA20, and almost the same price variation as in the High Price scenario from LMA20. The pink curve in the figures shows what the power price would be if the price of CO_2 was 0 € / t, which illustrates how much the carbon price affects the power price.

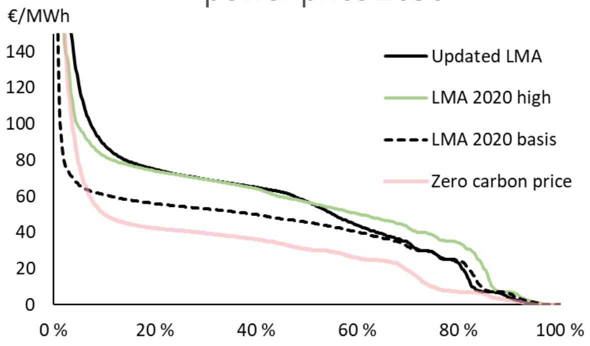
The carbon price also has an indirect effect on the price of power by making emission-free energy relatively more profitable. In part, we capture this dynamic effect in these simulations by having somewhat more renewables and somewhat less fossil power production in the Updated LMA20, compared with the Basis scenario from LMA20. However, we do not capture the indirect effect the carbon price has on stimulating more hydrogen production, which in turn will lead to increased investment in renewables. This means that the effect that increased carbon prices, and increased power demand, have on power prices can be even stronger than shown here. These dynamic effects will be subject for further analysis.

In sum, the simulated prices in our Updated LMA is closer to the scenario High Power Price from LMA20, than the Basis scenario. The upside in power prices in the Updated LMA will thus be an "Extra High Price" scenario, which we will continue to develop in our further analysis. In other analyzes, we use sensitivities on a combination of different factors that in practice correspond to an "Extra high" scenario.

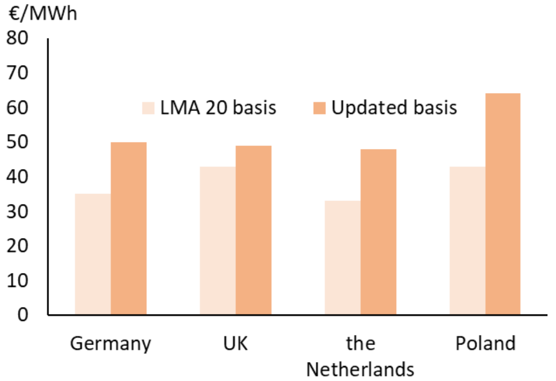
Duration curve for simulated German power price 2025



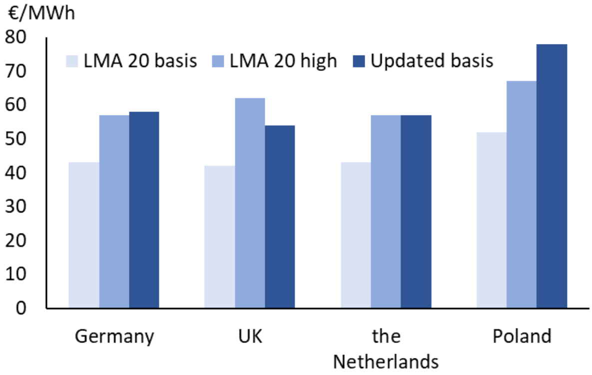
Duration curve for simulated German power price 2030



Average simulated power price 2025



Average simulated power price 2030



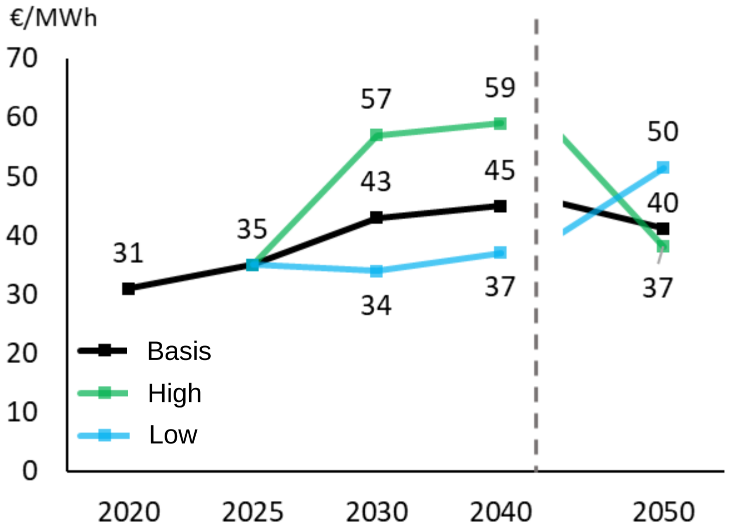
The Power Price might decrease towards 2040

A key point in LMA20 was that a development towards higher power prices in the first 10-20 years can contribute to lower prices later in time. The reason for this is that a higher price of CO_2 provides a foundation for a faster transition to a renewable power system and faster technology development, both of which will contribute to reduced power prices in the long run. This is one of the reasons why it is difficult to establish scenarios that give a consistently high average price throughout the analysis period, until 2050. We illustrate this point in LMA20 with our High Price scenario having high prices until 2040, and then the lowest prices in 2050.

The Updated LMA, with a significantly higher carbon price compared to LMA20, indicates that we probably are on a path in line with the High Price scenario from LMA20. The next ten years, the price of emission allowances will greatly affect the price level. Thereafter, the impact of the carbon price will decrease, as fossil power plants phase out and set the power price for fewer hours. After 2030, the price is more dependent on the amount of renewable production developed by 2030 and how much this puts a downward pressure on the power prices. In addition, the amount of green hydrogen production in the market affects the price and how much this contributes to increase the prices from zero and reducing the cannibalizing effect.

If the cost decrease of these technologies is sufficiently, driven by high renewables investment in Europe as well as globally, it is likely that power prices will approach a lower equilibrium level at an earlier stage than anticipated in LMA20.

Power price scenario from LMA20



Emission cuts must be made with more expensive technology
→ The price path goes from low to high

Faster transition and lower technology costs
→ The price path goes from high to low

The green transition accelerates

The Nordics

Higher power prices and a faster, pace of the green transition on the continent also affects Norway and the Nordic countries.

Developments since last autumn have strengthened our Basis for the Norwegian power consumption until 2030, driven by more specific consumption plans and higher incentives for electrification.

Statnett

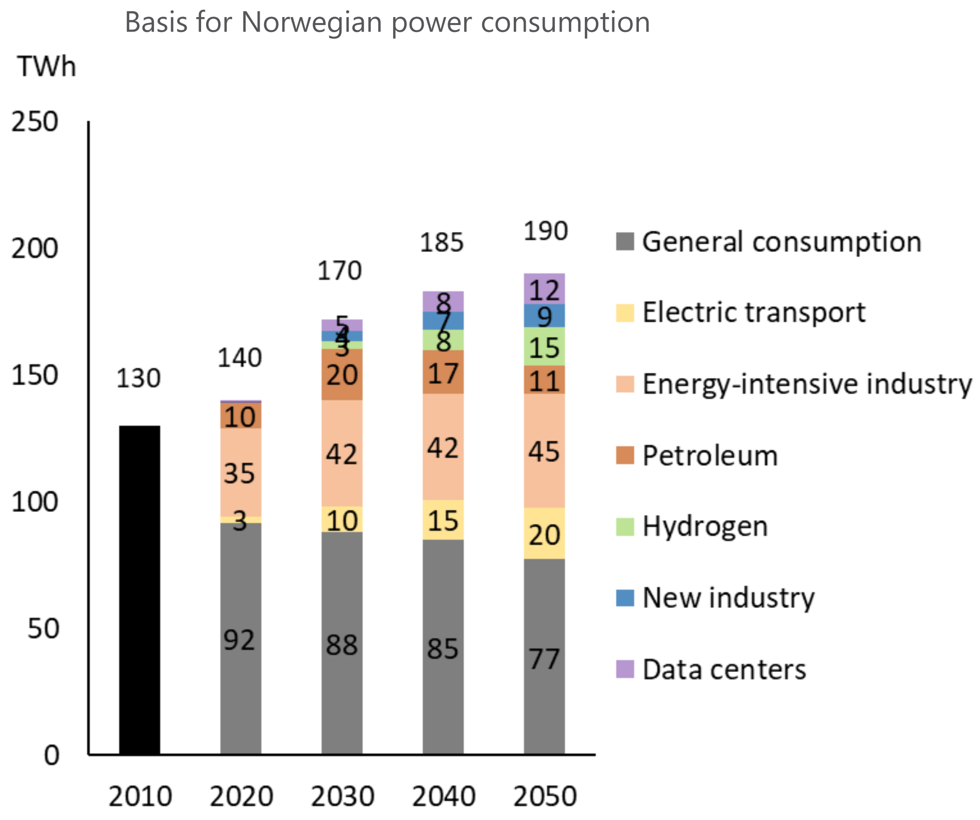
Our Basis Scenario for Norwegian Consumption is More Likely

Since LMA20 was published, several key developments have strengthened our Basis scenario for consumption up until 2030. In the longer term, there is still considerable room for deviation, although the political direction seems even clearer now than in the autumn of 2020.

Several well-known plans for industrial and electrification already included in our Basis for 2030 have become more certain during the last six months. In addition, the EU's new emission target for 2030 contribute to an increased pressure on electrification and clearer investment signal for green industries. This reduces the uncertainty associated with increased power consumption in petroleum activities and existing industry, through hydrogen production. There is still uncertainty in the consumption development towards 2030, e.g. with regards to data centers, fish farming on land, business parks etc. However, in sum, our Basis scenario seems significantly more certain compared to this autumn.

The prospect of profitable bottom-fixed offshore wind without subsidies in the Southern North Sea, and possibly floating offshore wind in the long term, also reduces the uncertainty related to the price-sensitive consumption categories our Basis scenario. This becomes increasingly important as the current power surplus is absorbed by higher consumption. A political decision to open for more onshore wind power and / or a political will to subsidize new power production will also contribute to this.

In the long term, the sample space is larger. The consumption plans are less specific, while at the same time, there are great opportunities for further industrial growth linked to the European green transition. Another significant uncertainty is how quickly the consumption in the petroleum sector will decline in line with lower global demand. In addition, some consumption categories are more sensitive to power prices than others, and consequently more closely linked to the development of new power production. For the realization of these consumptions categories a low need for subsidies for offshore wind will be key, given that both onshore wind and subsidization of new power production is politically contested.



* The figure is rounded off to the nearest 5

Higher Incentives for Electrification of Petroleum Activities

Much of the fossil energy use in Norway is related to the extraction and processing of oil and gas. To cut emissions in this sector, electrification is the most important measure. Higher carbon prices in the EU ETS and an increase in the Norwegian CO_2 emissions tax will provide a stronger incentive for electrification of petroleum extraction in the short term.

In January, the government presented its proposal for a climate plan for the period 2021-2030, where a key instrument was to increase the CO_2 emission tax, which is around NOK 600 per ton today, up to NOK 2,000 per ton in 2030. The increase in the CO_2 emission tax was not approved by the Parliament in March, but the CO_2 emission tax is expected to be a topic in the national budget again in the autumn and is expected to increase gradually in the coming national budgets. In the Basis scenario in LMA20, we assumed an increase in power consumption from the petroleum sector of around 10 TWh until 2030, which is a doubling of the current consumption in the sector. With greater pressure on emission cuts, we now believe this increase in consumption to be more likely, even though there is still considerable uncertainty about the number of platforms that will be electrified and how this affects the overall power consumption.

In the longer term, the uncertainty remains, but at the same time the climate goals provides a strong indicative of the direction. In LMA20, we assumed that the power consumption in the petroleum sector would fall in line with lower demand for oil and gas globally. Tighter climate targets in the EU and globally suggest that lower power consumption in the Norwegian petroleum sector is likely towards 2050, as in Basis in LMA20. But the development is uncertain and depends, among other things, on competition with other oil and gas suppliers globally, and whether one succeeds with hydrogen production based on natural gas with CCS.

The long-term picture may also affect actions in the short term. If it becomes consensus that demand for Norwegian oil and gas products will fall sharply in the long run, electrification of petroleum activities will naturally appear less profitable. This can reduce the power consumption from petroleum activities as early as 2030. Considering this, a power consumption from petroleum activities as in our high consumption scenario, of up to 30 TWh, is now somewhat less realistic than when LMA20 was published. However, more mature CCS technology pulls in the opposite direction.

Statnett

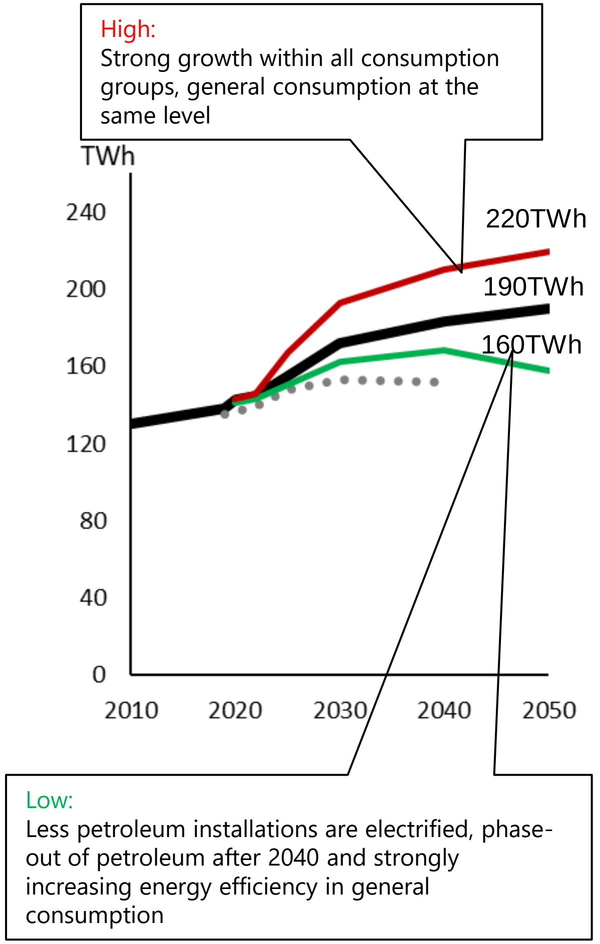
Increase in Consumption depends on Production growth

A significant part of the expected consumption growth is power-intensive industry that is sensitive to the power prices. This applies to, among other things, hydrogen production, production of batteries and data centers. Increased industrial consumption without corresponding new power production will result in higher power prices in Norway. This in turn can lead to a halt in consumption growth in industries that are sensitive to power prices.

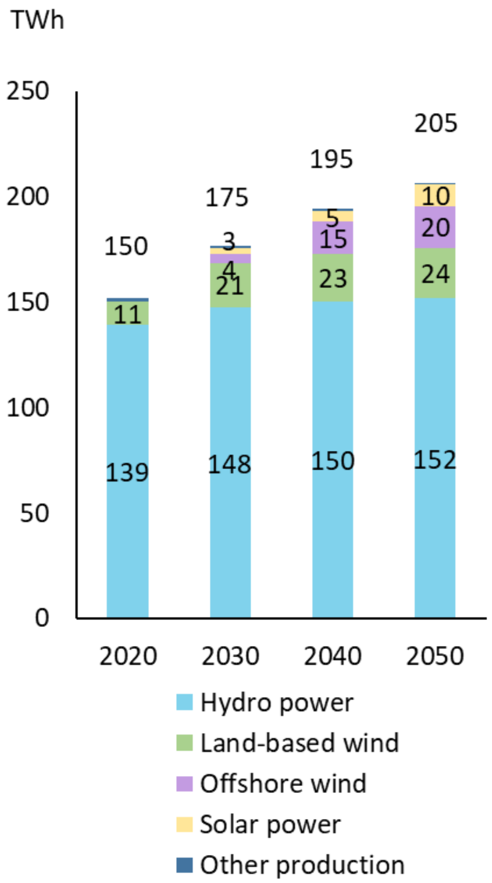
Our Basis scenario for the Norwegian power consumption is therefore closely linked to our Basis scenario for Norwegian power production. Offshore wind appears to be the most realistic source of power production in the long run, due to the opposition to onshore wind power development and limited potential for increase in hydropower and solar power production. Offshore wind in Norway also appears more realistic as a result of a rapidly declining need for subsidies, described more in the following.

Due to current restrictions on onshore wind power and longer lead times for offshore wind development, we consider our high scenario for consumption development to be somewhat less likely in the short term, towards 2030. In the case of a political opening of new power production, either through onshore or offshore wind development, our high consumption scenario will still be possible, but probably somewhat delayed. Towards 2050, the High scenario for Norwegian consumption development is entirely possible, but still dependent on new power production.

Scenarios for Norwegian power demand



Basis for Norwegian power production



* The figure is rounded off to the nearest 5

Statnett

Offshore Wind Will Probably be Profitable Without Subsidies

A higher carbon price in Updated LMA results in higher power prices in Norway, resulting in higher earnings for the renewable power production. Combined with the expected higher pace in cost reductions for bottom-fixed offshore wind, this implies a decreasing need for subsidies for bottom-fixed offshore wind in Norway, as on the continent.

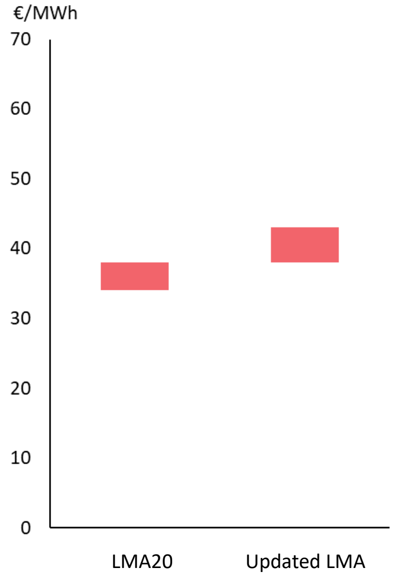
We have not prepared our own assessments of costs for Norwegian offshore wind projects, due to little available data. However, we assume that the costs for bottom-fixed offshore wind in the Norwegian sector will be among the more costly for European offshore wind projects. This since great sea depths and long distances from land increase the costs. At the same time, larger projects and economies of scale pull in the opposite direction. Based on this, we assume that the LCOE for bottom-fixed offshore wind on the Norwegian shelf in 2030 will be somewhere around 40-50 € / MWh without grid connection and just over 50-60 € / MWh including grid connection.

In the Updated LMA, the capture power price for offshore wind increases by around 5 € / MWh, from an interval of around 35 € / MWh in LMA20, to an interval of around 40 € / MWh. If we exempt costs for grid connection, the costs are approximately on a par with the capture power price for bottom-fixed offshore wind in the Southern North Sea around 2030, with our assumptions from the Updated LMA. With full grid costs, projects will still be unprofitable based on the power price alone.

Several of the areas designated as relevant for offshore wind power on the Norwegian shelf will only be relevant for floating turbines due to the sea depth. The potential for floating wind power on the Norwegian shelf is enormous, but it is uncertain whether and when this will be profitable based on the power price alone.

Floating wind power is today an immature technology, with only a few test projects in operation. Forecasts for the cost development are therefore very uncertain. If costs fall significantly, large-scale development of floating wind power along the Norwegian coast might be possible.

Simulated captured price for offshore wind in Norway in 2030



Consumption in the Nordics Could Increase More

The trend towards zero emissions applies to the entire Nordic region, which means increased consumption due to electrification in all the Nordic countries. From 2030, consumption related to production of hydrogen, to decarbonize the industrial sector, among other things, is the major driver for consumption growth.

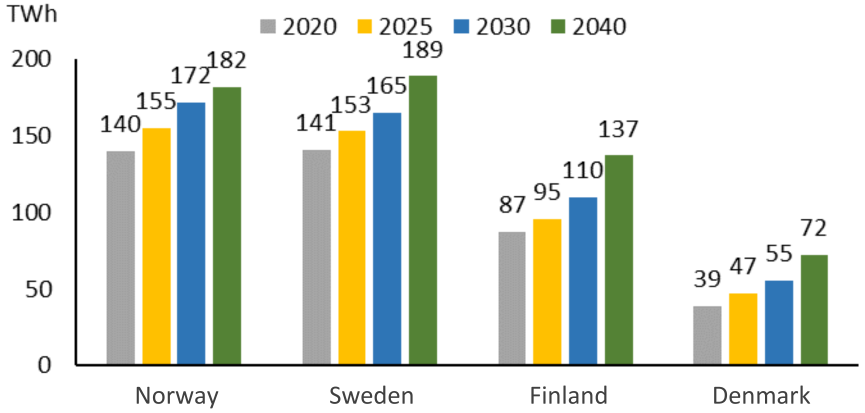
Since LMA20 was published, the consumption plans in Sweden, related to the iron and steel industry, have become more specific. Production of green hydrogen to replace coke will increase the need for power. We assumed 20 TWh of hydrogen production in Sweden by 2040 in LMA20. However, in the most ambitious scenarios for the individual project HYBRIT, it is now assumed up to 45 TWh in 2040. This consumption will probably be established in SE1.

There is still a large sample space for the power consumption from hydrogen production, but the significant upside is now clearer. In our other analyzes, we analyze sensitivities with different levels of hydrogen production in northern Sweden.

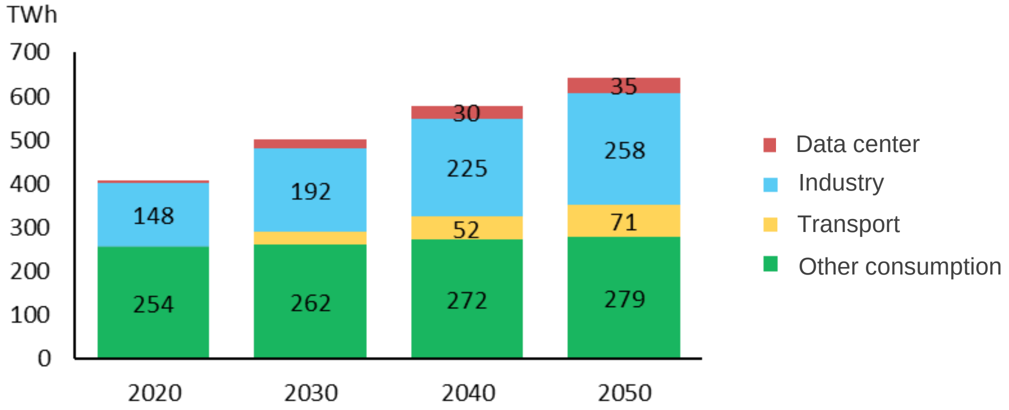
Higher consumption growth in northern Sweden than we assumed in LMA20 is likely to diminish the power surplus in this region. A smaller power surplus in northern Sweden will lead to reduced differences in average power prices in north and south of the Nordic region.

It is likely that the hydrogen is produced during periods of relatively low power prices, although the capacity factor and cut-off price for green hydrogen production is still very uncertain. Storage is central to reducing the cut-off prices.

Power consumption in the Nordics per country, LMA20



Power consumption in the Nordics per consumption group, LMA20



Prices in Norway Increases, but Relatively Less Than in the EU

In Norway, the simulated average power price in the Updated LMA will increase by around 10 € / MWh in 2025 and around 5 € / MWh in 2030, compared with LMA20. Power prices are rising as a result of increased carbon prices, as Norway are "importing" power prices from the continent. Since the interconnector capacity is higher in Southern Norway the prices increase relatively more in the south, then in the north. Towards 2030, the direct effect of the carbon price on power prices is declining, like on the continent.

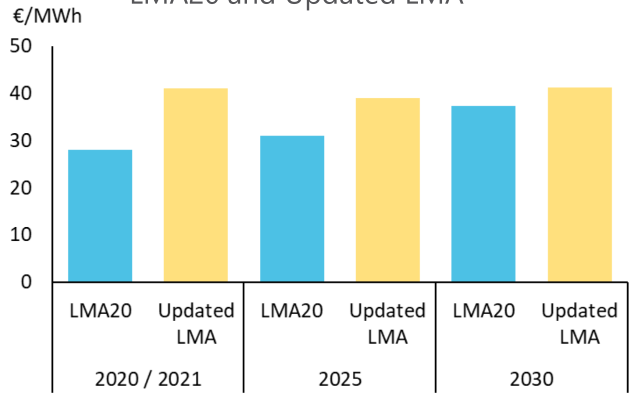
The price variation in Norway is also higher in the Updated LMA. As in LMA20, the Norwegian power price will increasingly alternate between being set by thermal power plants on the continent and by solar and wind power with zero marginal cost. Higher marginal costs in the fossil power plants, due to increased carbon price, increases the variation in the Norwegian power price.

Higher power prices in Norway are a result of increased value of Norwegian hydropower and higher water values. Increased carbon prices thus lead to a significant redistributive effect to Norway from our trading partners, as long as we have a power surplus. In addition, there is a redistributive effect internally in the Norwegian power market. We estimate that in 2021, producer surpluses will increase by just under NOK 19 billion and consumer surpluses will decrease by approximately NOK 16 billion due to the increased carbon price.

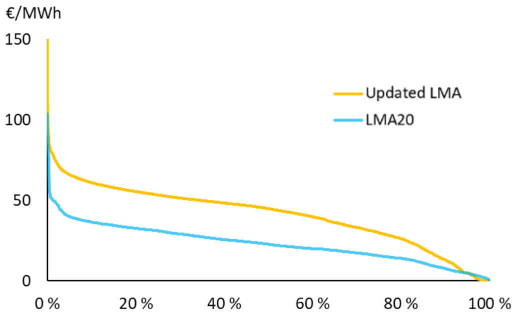
Norwegian power prices do not increase as much as power prices on the continent, given a set increase in carbon prices. Thus, Norway gets relatively lower power prices than the continent and the price difference between Norway and the continent increases when the carbon price increases. As a result, Norway will become relatively more competitive in terms of attracting industry. The benefits of trading in the power market with other countries will also increase.

These prices, which is most comparable to our high-price scenario from LMA20, will probably persist over the coming decade. In the long run, the power price in Norway, like that on the continent, will probably be driven down to a lower equilibrium as a result of decreasing costs for technology.

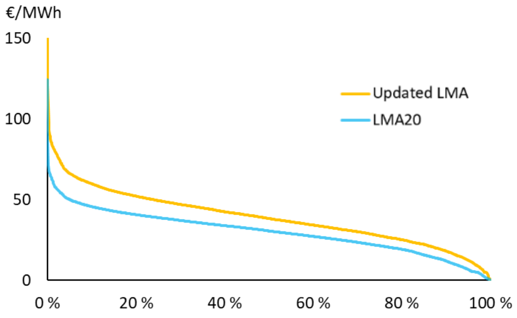
Simulated Norwegian average price LMA20 and Updated LMA



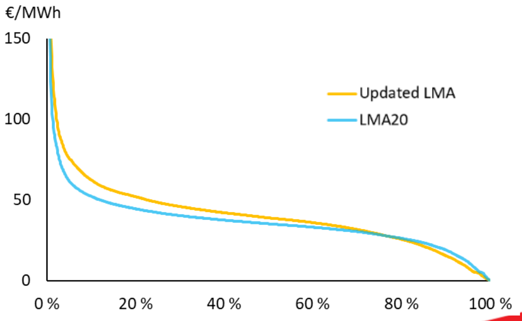
Duration curve for simulated Norwegian power price 2020 and 2021



Duration curve for simulated Norwegian power price 2025



Duration curve for simulated Norwegian power price 2030



Increased Price Differences North-South in the Nordics

In LMA20, we illustrated how the differences in average power prices between the south and the north of the Nordic region will increase in the future. Higher power prices on the continent in the Basis scenario of the Updated LMA, compared to in LMA20, will amplify the differences.

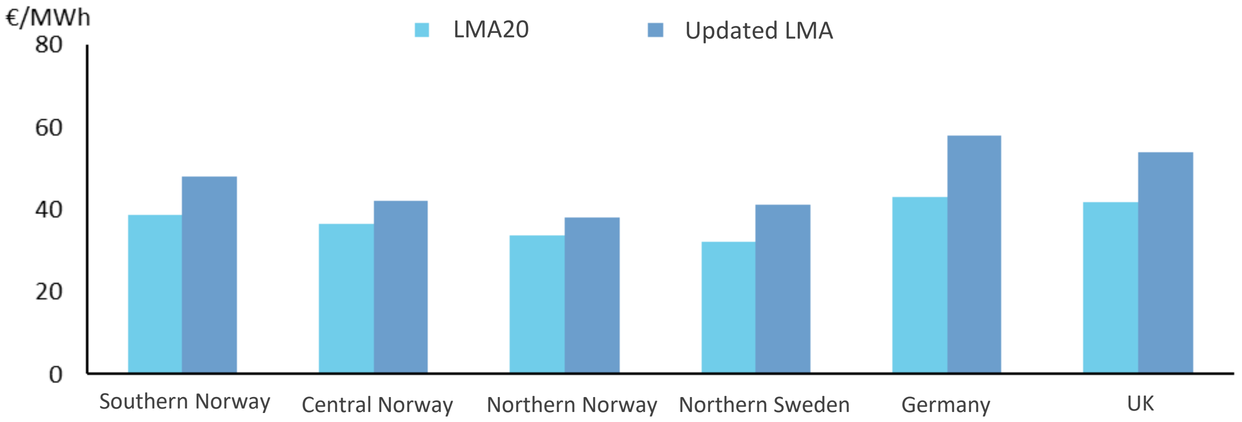
How long the price difference between north and south will remain in place depends on several factors. In LMA20, we expected that the difference in average price would be evened out towards 2040, as a result of more consumption in the north and grid reinforcements between the north and the south in the Nordic region. As the average price differences are even higher in the Updated LMA20, the price signals also become stronger.

In the south, the relatively high price will provide a strong incentive for increased power production, while in the north, the incentive for establishing more consumption will increase. At the same time, the current political will limits the possibilities for the development of additional onshore wind power in Norway, while bottom-fixed offshore wind is not yet profitable with the power price alone. Development of new power production in Norway is therefore also a political issue.

Even so, the leveling of these price differences can still happen earlier than forecasted in the LMA20, but if so, primarily driven by development of new consumption in the north, combined with transmission grid reinforcements (see also the next slide). The likelihood of increased consumption is especially relevant in northern Sweden, where, among other things, there are large-scale plans related to the decarbonization of the steel industry.

Finally, it is important to mention that even if average prices become more similar, this does not necessarily mean that the hourly price differences decrease. In LMA 20, we showed how the average price difference hour by hour between the north and the south in Norway increased towards 2040, even though prices on average levelled out.

Simulated annual average prices in 2030



Statnett

Uncertainty Regarding Grid Capacity in and Towards Sweden

Until 2021 and ongoing, there has been significant reduced capacity in the power grid internally in Sweden and from SE3 and NO1. This has happened before, but not to such an extent. Part of this is due to disconnections, but the effect has also been reinforced by changed flow patterns at the Nordic level. These changes in the flow has to a large extent been expected but have been amplified by the rapid development of new wind power production in Sweden.

In our simulations, we assume somewhat reduced capacity, but in general we assume capacities close to what has been the limits historically with an intact grid. This means that our simulations underestimate bottlenecks and price differences. This is something we include in, for example, specific analyzes of various grid expansions. At the same time, it is very difficult to give an unbiased estimate of the future grid capacity. Through sensitivities where we reduce capacity more permanently, we try to shed more light on this.

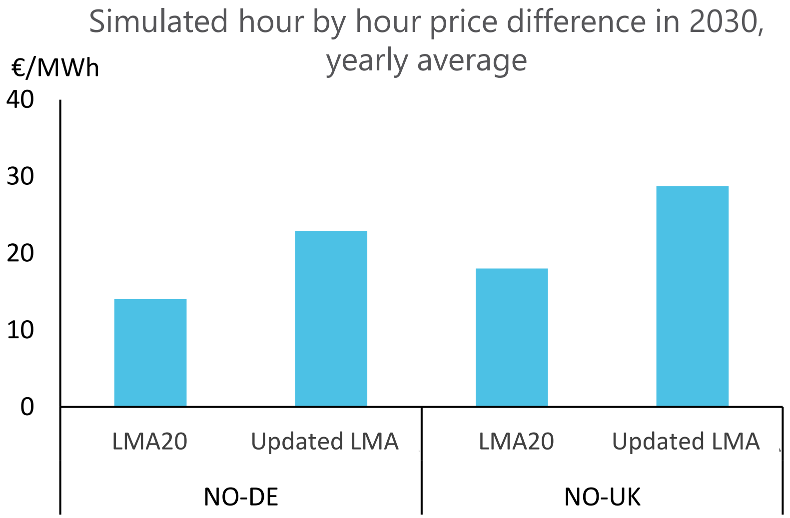
We consider that there is a high probability that the capacity, especially between SE2 and SE3 and SE3 and NO1, will be significantly lower than what we have assumed here, especially in the next few years. If so, this will contribute to higher prices in NO1, NO2, NO5 than what we have shown earlier in this Updated LMA. At the same time, prices in NO3 and NO4 will be somewhat reduced.

In the long term, grid reinforcements in Sweden will increase capacity both between SE2 and SE3 and towards NO1. The latter happens because part of the reductions in capacity between Sweden and Norway is due to restrictions on the north-south axis in Sweden. In Norway, grid capacity increases between NO3 and NO5 due to the upgrade of Sogndal-Aurland (2025) and Sogndal-Modalen (before 2030). All these reinforcements help to reduce the price differences. In the long run, the location of new consumption and production can, as discussed earlier, also dampen the differences in average prices.

Higher Hourly Price Differences to Continental Europe/UK

The high carbon price in 2030 in Updated LMA increases power the average price and price volatility more on the continent/UK than in Norway. As a result, there is a significant increase in the price differences hour by hour between Norway and Germany, and Norway and UK. The economic gain from trade is strongly linked to these price differences as they say something about the production costs on the margin in the various markets. Much of the increased economic gain comes in the form of congestion rent. The price difference is highest between Norway and UK, compared to mainland Europe. This is due to a higher proportion of wind power in UK, which implies a larger proportion of hours with very low power prices. This is a recent market development, as in the past high price difference between Norway and UK has been driven by the higher marginal costs in thermal power plants in UK in general. An uncertainty is what the price of CO_2 will be in the British market in the future - in 2030 this is the same as in the EU in our Basis scenario.

In the long run, typically after 2030, we believe that technology costs for offshore wind, hydrogen and batteries increasingly will be the driver of power prices and price differences. In sum, we believe that the development towards 2040 will reduce the price differences compared to the very high level we have in our Updated Basis scenario till 2030 (see also page 13 for a more detailed explanation of the logic behind this).



Appendix

Statnett

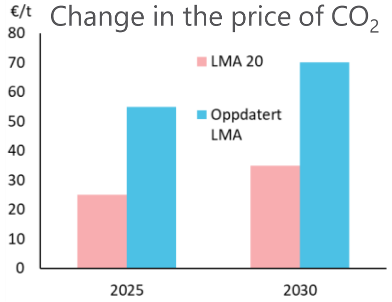
Changes in the datasets

Changes in the datasets for 2025 and 2030:

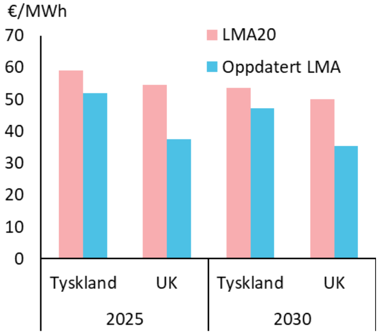
Overall:
- Assumptions for the price of CO_2 is increased from 25 €/t to 55 €/t in 2025 and from 35€/t to 70€/t in 2030
- Uppdated assessment of the LCOE for bottom-fixed offshore wind

Minor adjustments of our assumptions for Europe (EU11) and the Nordics:
- Increased innstalled capacity of solar and wind with 14 GW in 2025 and 11 GW in 2030, i EU11
- Faster phase-out of coal and lignite in Germany in 2025, reduced with 3GW
- Minor increase in consumption in EU11, 21 TWh in 2025
- Increased installed capasity from solar and wind with 2,6 GW in the Nordics in 2025 (0,4 GW in Norway, 0,9 in Sweden, 0,3 in Denmark and 1,1 GW in Finland)

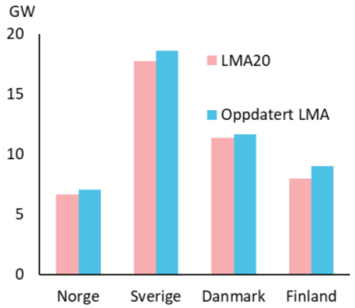
Change in the price of CO_2



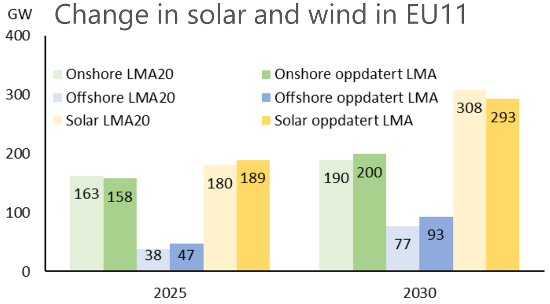
Change in LCOE for offshore



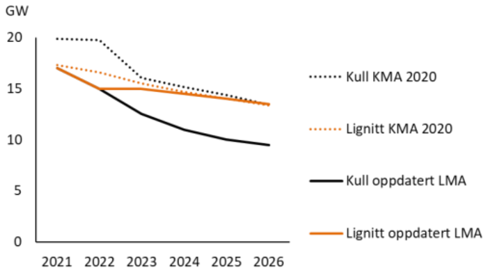
Change in solar and wind in the nordics in 2025



Change in solar and wind in EU11



Change in capacity in Germany



Change in capacity in Germany