

An aerial night photograph of a snowy mountain landscape. A road with streetlights winds through the snow-covered terrain. Several small buildings with warm interior lights are visible. In the background, a large, dark body of water is partially covered with ice. The overall scene is illuminated by a cool blue light, with the warm lights from the buildings providing a contrast.

**Statnett**

Executive Summary  
Grid Development Plan  
**2019**

Short version

# Executive Summary

Planning and expanding the transmission grid is one of Statnett's main tasks. In 2009, Statnett launched a plan for the next generation central grid. The measures set out in the 2009 plan have largely been implemented, and now form the backbone of the power system that will facilitate Norway's electric future. In 2019, it is clear that the future is electric and that we are moving towards that future at an ever faster pace.

The power supply makes an important contribution to the competitiveness of Norwegian society. The Norwegian power system, which is based on almost 100 per cent renewable sources, is efficient and highly utilised, with some of the most affordable power transmission per megawatt hour in Europe. Statnett's mission is clear – we must ensure Norway's continued competitiveness, while guaranteeing continued high security of supply.

This mission is challenging. Increasing electrification needs, more renewable power generation, new industries, changing consumption patterns and expanding cities are all increasing the pressure on the power system. At the same time, the grid costs should be supported by users in a way that ensures broad understanding for the required development. There may also be cases where it is challenging to gain acceptance of necessary solutions.

We should and must develop the power grid in close dialogue with society and users. There are a number of stakeholders involved in developing projects that have needs which must be resolved faster than Statnett can realistically develop projects. At the same time, it is important that consumption and production can make the most of grid investments that have already been realised. This requires balanced development and accurate information about needs and developments in society.

Statnett's Grid Development Plan 2019 has four key messages:

- We are strengthening supply to several regions and to the larger cities
- We are investing NOK 4–6 billion annually to facilitate increased electrification

- We have a strong existing grid structure that will facilitate balanced grid development in the future
- In order to achieve our social mission in a world of rapid change, we must work efficiently, digitalise the power system and focus on green solutions within the industry

In summary, the plans and measures set out in the Grid Development Plan 2019 provide for balanced and efficient grid development that will facilitate restructuring and competitiveness in a fully electric society.

## Climate and data are changing the power system – and we are capable of handling it

The transition to a green energy system has become clearer and is happening faster than we expected when we published the Grid Development Plan 2017. Political goals and instruments for dealing with climate challenges also increase our confidence that this trend will continue. Solar and wind power are becoming more competitive, and onshore wind power is now profitable without subsidies in Norway. Electrification is a cost-effective way of replacing fossil energy use, thus reducing greenhouse gas emissions. Digitalisation and technology development are also opening up new industries in need of electricity. Consequently, we expect both electricity consumption and production to increase significantly over the next 20 years.

Since 2009, Statnett has made major improvements to the grid, which has consistently provided better status and capacity in the transmission grid throughout the country. We have completed several major projects, including more than 1,300 km of newly constructed cables and over 900 km of upgraded cables. In 2018, we passed our investment peak, and we are the Nordic grid company that has made the most investments in recent years. We have improved security of supply in vulnerable areas such as Northern Norway, Greater Oslo, Hordaland and the Stavanger region, boosted capacity for new consumption and production and constructed two new interconnectors to respectively Germany and the UK. Together, these investments create significant value for society. The grid improvements

behind us put us in a better position to deal with the major changes in the power system going forward, through balanced continued development of today's transmission grid.

In our analysis report "An electric Norway – from fossil fuel to electricity", we outline a scenario with a higher degree of electrification than we included in the scenarios in our long-term market analysis (LMA 2018), where we show that increased annual power consumption of 30–50 TWh is possible with proper localisation and gradual development of the existing power grid. In order for the conversion from fossil fuels to electricity to produce the desired reduction in greenhouse gas emissions, it is essential to have a balanced development between consumption and production. Wind power on land is currently competitive without subsidies, but further development may lead to conflicts with outdoor activities and natural assets. At the same time, it will take time for the costs of offshore wind along the Norwegian coast to fall to a competitive level. In our documentation for the National Framework for Wind Power, we demonstrated that the major transmission channels have capacity to handle large volumes of new production if they are correctly located in the grid. In several cases, grid capacity was taken into account in the Norwegian Water Resources and Energy Directorate's proposal for a national framework, while there is also a strong focus on environmental interests.

In the short term, we can clearly see that the reinforcements we have made in recent years have the potential for significant value creation. From January 2018 to the summer of 2019, we allocated capacity to around 3,000 MW of consumption and around 3,000 MW of production within current grid capacity. In total, we have processed applications for new consumption of about 11,000 MW over the past two years. There is a great deal of uncertainty about how much will actually be implemented, and there will be a need for grid investments to connect the rest of the volume. The large number of new connection cases is one change since the previous Grid Development Plan, and this affects grid development overall. Increased investments to connect more consumption have less of an impact on grid tariffs than renovations of facilities and connecting production, partly because the volume increases and partly because some of it is financed through construction grants.

### **Balanced grid development is necessary to prioritise between several different considerations**

The power system is changing and becoming more and more complex, where Statnett's role is to be a neutral societal actor with a responsibility to weigh many considerations, which often pull in opposite directions. Although the existing transmission grid can handle a large increase in volume with proper placement, in the future it will be necessary to maintain a steady level of

investment, based on a gradual strengthening of existing main grids. Grid investments facilitate value creation, secure the power supply and reduce greenhouse gas emissions, but also entail high costs. Accordingly, we make careful assessments of costs and benefits when proposing solutions for projected needs, to ensure that solutions are in the best interests of society.

The growth we see moving forward will affect the need for grid reinforcements in several ways:

- Long-distance transmission capacity
- Capacity to rural areas and to larger cities
- Maintenance and renovations to maintain system functions
- Transformer capacity between the transmission grid and the regional grid

Completed and ongoing grid reinforcements are helping reduce congestion in the grid. The same applies to projects intended to improve utilisation of existing grid capacity in system operations, such as the introduction of a flow-based market algorithm. Despite this, we will probably see greater congestion internally in Norway, driven by various factors, including higher levels of unregulated renewable power generation. This is especially true for the north–south direction. Nevertheless, the socio-economic benefits that are generated in the power market by reducing congestion will, in many cases, cover only a small part of the investment costs for vital projects. As such, there is currently little evidence that it would be socially economically profitable to develop the power grid in a fundamentally different way so as to facilitate the transmission of large surpluses over long distances. A rational approach would be to gradually strengthen our current main grid structure in connection with renovations of existing power lines. Proper placement and balancing of production and consumption will help save costs by allowing us to postpone or avoid grid investments. Consequently, efficient price signals through grid tariffs and the power market, in addition to more accessible information on favourable placement within the grid, are a crucial aspect of rational grid development. At the same time, we must safeguard our neutral role in the development of the power system.

The greatest need to strengthen capacity going forward will be out to rural areas and in to larger cities. In addition to the fact that grid capacity will soon be fully utilised in a number of areas, there are plans for a significant increase in consumption from industry, the petroleum sector and commercial interests in Haugalandet, the Bergen area, the northern region of Western Norway, in Trondheim, in Lofoten/Vesterålen and in Finnmark. Renovation requirements, population growth and general electrification, including electrification of the transport sector, are also contributing factors as we implement or

plan increased capacity towards larger cities such as Oslo, Stavanger and Bergen. We are currently conducting several analyses in these areas. To ensure that we are sufficiently ahead of these developments and in a position to find the best end-to-end solutions, we are increasing our focus on close dialogue with stakeholders, businesses and decision-makers. In this collaboration, we will also emphasise the proper distribution of projects in the transmission grid and the regional grid in order to solve the need effectively at the right level.

In order for the current transmission grid to provide a secure power supply for both existing and new production and consumption, there will be a continuous need for maintenance, renovations and measures aimed at extending the service life of existing facilities. This is due to aging facilities as well as the implementation of EU energy market legislation, known as the “third energy package”, into Norwegian legislation, which required Statnett to take over a larger number of older substation facilities with a major need for renovations. Statnett therefore plans to perform a large volume of renovations in the coming years, and it will be crucial to coordinate plans and implementation for capacity and renovation projects in the future. This also includes weighing the trade-offs between the costs of measures aimed at extending the service life of facilities measures against major renovations.

In many places, minor measures such as the expansion of existing substations are also needed to increase transformation capacity, temperature upgrading of power lines or smaller operational projects designed to connect new customers to the grid, while also ensuring security of supply.

Many of our investments have an environmental cost, where the benefits of reducing land use and our environmental footprint can be high. Mitigating measures can also be very costly. Cabling in the transmission grid is one example of a mitigating measure that would entail far higher costs than overhead lines. In the white paper on the power grid (Report to the Storting No. 14, 2011–2012), the government considered that, in most cases, the most socially rational approach would be to have overhead lines at the highest voltage levels, but that cabling may be appropriate in exceptional cases.

### **The planned investment level will facilitate our electric future**

We expect to invest NOK 4–6 billion annually over the next five years (2020–2024). The total investment level is significantly lower compared to the period 2019–2023 from our updated 2018 investment plan.

In the longer term (2025–2030), uncertainty increases, but we expect that investments in new grid facilities and major renovation projects will continue to be around NOK 4–6 billion annually. This means that, in practice, we will continue at the same domestic investment level seen in recent years. This is roughly within the sample space we outlined in the previous Grid Development Plan for this period, but at the same time in the upper range of the sample space.

The need to renew aging facilities indicates a firm base for investments well into the future. Consequently, from the start of the 2030s, annual grid investments could still be in the range NOK 4–6 billion, but uncertainty is high. Between 2030 and 2040, several of the central power lines in the transmission grid will reach the end of their expected service life. We have little experience with actual service life, and this contributes to an increased sample space after 2030. Combined with a balanced approach to the management of our obligation to provide connections to the power grid and needs for renovations, the benefits we expect to realise from our efficiency initiatives and development work should be able to reduce investments. Major individual projects, such as more interconnectors or large-scale restructuring of congestion points internally in Norway, will contribute to increased investment levels.

Considering Statnett's obligation to provide connections to the power grid for new consumption and production, security of supply and rational asset management, we have little flexibility in relation to a large proportion of our future investments. Equalising and reducing grid investments and grid tariffs will require a long-term effort. We are proposing equalising the tariff level going forward, with a tariff rate for consumption of around NOK 400/kWh, which, adjusted for the consumer price index, entails a real reduction in tariff load. At the same time, we estimate that there will be considerable growth in trade revenues over our interconnectors, and fluctuations in these revenues represent the greatest uncertainty for tariff levels.

Based on the development projects that have been completed since 2010 and a steady pace of future renovation and capacity projects, Statnett is facilitating both the realisation of climate targets and strengthened national competitiveness in relation to other countries that do not have Norway's renewable resources and are facing a more demanding restructuring of the energy sector. This advantage will also provide the best starting point for competitive industries in the future.

A high level of investment makes it even more important to consider cost-reducing initiatives and develop the transmission grid effectively. Statnett is working to achieve increased cost awareness and improved efficiency throughout the value chain,

from choosing the right solutions to increased system utilisation and lower unit and development costs.

### **Northern region: Faster progress to facilitate consumption growth**

We are well underway with major grid investments that will strengthen security of supply and increase transmission capacity to Troms and Finnmark. The new 420 kV Ofoten–Balsfjord line has been in operation for two years, and we are making good progress with the construction of a new 420 kV line from Balsfjord to Skaidi in Finnmark. When these are completed, however, there will still be little available capacity in the transmission grid, especially in Eastern Finnmark.

Through the project “Business and grid in the north”, Statnett has worked more closely than usual with various industrial players to understand their needs. In the Hammerfest area, we expect growth in consumption which will provide a basis for strengthening the grid from Skaidi to Hammerfest. We have recently entered into an agreement with Equinor to study projects that will facilitate the full or partial electrification of Snøhvit, and we have asked the Ministry of Petroleum and Energy to resume its appeal processing of the Skaidi–Hammerfest licence application. Reinforcement eastward from Skaidi to Adamselv will provide increased security of supply and facilitate some consumption growth, and we plan to apply for a licence for upgrading from 132 kV to 420 kV in 2020. We have also entered into an agreement with Finnmark Kraft and Varanger Kraft on a study of further reinforcement towards Varangerbotn to facilitate new wind power. Work on the licence application for Adamselv–Varangerbotn will start in the near future.

In “Sørnettet”, the grid that supplies Lofoten, Vesterålen and the Harstad area, we have applied for a licence to renovate the 132 kV Kvandal–Kanstadbotn connection. This renewal is the first step in a joint long-term strategy for further development of 132 kV, prepared in collaboration with the grid operators in Sørnettet.

Nordland, Troms and Finnmark are a surplus area as a whole. More wind and hydropower, not only in Finnmark, but throughout Northern Norway, therefore results in increased flow to Central Norway and Sweden. Grid restrictions out of the area mean that an increased volume of production is resulting in lower prices in Northern Norway than in Southern Norway. Major investments will be needed to remove this congestion, partly because it will also be necessary to reinforce the grid towards Sweden and internally in Sweden. New consumption affects grid needs to a varying degree depending on location, but will mainly have a favourable effect on transmission restrictions out of Northern Norway.

### **Central region: More wind power and increased consumption is affecting further development**

The new 420 kV lines on the north and south sides of the Trondheimfjord were commissioned during the summer of 2019. The connections will facilitate 880 MW of new wind power at Fosen and at least 250 MW of wind power south of the Trondheimfjord. The volumes that are connected or awaiting connection are currently higher than this. Next step of the Namsos–Surna grid reinforcement process is to link these with a new Åfjord–Snilldal 420 kV connection no later than 2028. More production both north and south of the Trondheimfjord means that we expect increased flow through the area, and thus increased profitability from building this connection. We must also reinforce Surna–Aura/Viklandet in order to reduce congestion and to be able to connect new wind power. New wind power in Central Norway will push down power prices in the area, even with these measures in place. We will resume project development with the goal of commissioning by 2028.

There will soon be too little capacity in Trønderenergi Nett's 66 kV grid to handle the expected growth in consumption. To better understand the development of consumption patterns and find the best overall measures to facilitate increased consumption, Statnett, in collaboration with Tensio (company formed by the recent merger of Trønderenergi Nett and NTE Nett), plans to start conducting analyses in the Trondheim area in the autumn of 2019.

Towards the coast of Nordmøre and in Romsdal, there are plans for new industrial consumption and electrification of the existing industry and the petroleum sector, in addition to a general increase in consumption. Since 2017, consumption at the gas processing plant at Nyhamna has increased, and in practice the grid capacity for consumption in the area is fully utilised. In the autumn of 2019, we will begin conducting analyses of future grid development in collaboration with Istad Nett and Nordmøre Energiverk. These analyses will build on knowledge from previous concept evaluations for increased reliability of supply at Nyhamna from 2015.

### **Western region: Consumption growth will trigger grid investments in Bergen and Haugalandet**

The need to strengthen the grid to ensure security of supply to cities and keep in step with the electrification of the petroleum sector and planned industrial consumption increases is affecting grid development throughout the region. In the Bergen area, BKK Nett will complete a new 300 kV connection from Modalen to Kollsnes in 2019. The connection will improve the security of supply to the Bergen region by providing a continuous connection, “Ytre Ring”, around the City of Bergen. However, the combination of a demanding operating situation and Equinor's plans to discontinue production at Energiverk Mongstad make it

necessary to look at further measures to maintain a secure power supply. At the same time as the grid capacity for consumption is in practice fully utilised, there are plans for large consumption increases from the offshore petroleum sector in addition to general consumption growth around the City of Bergen. Statnett is therefore conducting a concept evaluation for Bergen and the surrounding area in collaboration with relevant stakeholders. The measures we will take will strengthen security of supply and facilitate the increase in consumption.

In Haugalandet, we have completed some smaller projects and have sufficient capacity to supply current industrial consumption. For the past year, Statnett has worked closely with relevant consumption stakeholders and Haugaland Kraft Nett to identify all consumption plans in the area. Moving forward, we expect to see increased consumption from both the Utsira High, possible expansions at Hydro's plants in Karmøy and Husnes, Gassco's plant at Kårstø and a possible overall major increase in consumption from several customers connected to Haugaland Industrial Park. Consumption growth makes it more demanding to implement necessary disconnections in conjunction with renovation and maintenance work, while still maintaining an acceptable security of supply. A new power line to Haugalandet is the next step in the planned grid development in the area. We are continuing to enter into evaluation agreements with the consumer stakeholders in order to secure a basis for continuing the power line project.

Plans for production growth north of the Sognefjord and two new interconnectors will increase flow and thus congestion on the Sogndal–Aurland connection. In the spring of 2019 we therefore applied for a licence to reinforce this connection. Expected consumption growth in the Bergen area will increase congestion on the second connection from Sogndal and southwards, towards Samnanger, amplifying the need for increased capacity here as well. At the same time, we see limited socio-economic benefits from upgrading to 420 kV on this connection now. Expected consumption growth in the Bergen area will result in less flow further south, reducing congestion between Samnanger and Sauda.

### **Southern and Eastern region: Plans for large increases in consumption**

During 2018 and 2019, we commissioned several sections and stations within the major Western Corridor project. There is now a continuous 420 kV line all the way from Kristiansand, via Feda and up to Sauda. The Western Corridor will facilitate high utilisation of existing and new interconnectors, as well as provide for greater security of supply and the opportunity to connect new production.

Security of supply to Nord-Jæren is inadequate. We have therefore applied for a licence for a new connection from Lyse to Fagrafjell, which will provide a third transmission grid connection to the area. We received a licence for this connection from the Ministry of Petroleum and Energy in September 2019, and will start construction in the near future. In collaboration with Lyse Elnett, we are also in the process of clarifying a concept for step-by-step development of the power system north of the current Stokkeland substation (which will be replaced by the new Fagrafjell substation). This will be presented in the autumn of 2019. Further project development and choice of solution will take place in consultation with local stakeholders and authorities in line with how needs develop moving forward.

We are in the process of renovating central parts of the transmission grid that supplies the City of Oslo. The Smestad–Sogn renovation projects, with new underground cabling in a tunnel, and the Smestad and Sogn transformer substations are under construction. We have obtained a licence and made an investment decision on the new Hamang substation to replace the old one. We have also applied for licences for the new Liåsen substation, renovations to the cable connection between Sogn and Ulven and renovations to the connection between Hamang and Smestad. The latter will increase capacity towards the capital and improve security of supply. The measures are part of the Greater Oslo Grid Plan where we, in line with the development of needs, are renovating the grid and upgrading to operation at 420 kV.

Between Fåberg and Oslo, we expect increased power flow from north to south as a result of new interconnectors and construction of wind power in Central Norway. This could result in more hours of restrictions in the grid than we see today. In addition, the oldest line between Ulven and Fåberg is in poor condition. The plan for the development of the Greater Oslo transmission grid outlined the possibility of a new 420 kV line replacing the two existing lines west of Mjøsa. This will result in a significant increase in capacity compared to the existing grid. In the autumn of 2019, we will assess whether the initially recommended grid structure is still correct based on expected development in the area.

There are several plans for the establishment of large data centres in the south and east. Preliminary analyses show that major consumption is possible at certain points without reinforcing the power lines along the major transmission channels towards the southern and eastern parts of the country. However, there will need to be some large local investments in transformation capacity and some minor power line projects if any of the larger plans are implemented. Before the summer of 2019, Statnett studied projects that would be necessary in

the transmission grid to connect two planned data centres in Vestfold and Telemark. We are in dialogue with several players developing data centre projects, and expect to conduct similar studies again in the coming years.

### Interconnectors

Statnett is in the process of developing NordLink to Germany and North Sea Link to the UK. Both have a capacity of 1,400 MW and are scheduled to be operational in 2020 and 2021, respectively. The connections will provide greater value for Norwegian power generation, increased congestion revenues and periods of cheaper imports and, overall, improved energy security.

Apart from NordLink and North Sea Link, we have no specific plans for further development of interconnectors to the continent and the UK. This is in line with what we signalled in the Grid Development Plan 2017 and in our consultation response to the Norwegian Water Resources and Energy Directorate (NVE) on the NorthConnect licence application in June 2018. We expect a market development where, among other things, increasing amounts of solar and wind power will give rise to price differences both internally and towards our neighbouring countries, combined with a potentially sharply increasing need for power in Norway. All in all, this can increase the socio-economic benefit of any new transmission capacity, and thus the potential for further investments. However, there is uncertainty related to future market developments and thus also the benefit of interconnectors. In addition, we see several other arguments that, combined, entail that we are not initiating any new projects at this time:

- Systems and market solutions for efficient utilisation of interconnectors should be in place
- We need to have more clarity on the scope of future congestion in Germany and how this will be managed
- There is uncertainty about the consequences of Brexit on the market
- Licence processing for NorthConnect is ongoing, and it is sensible to wait for the completion of this process

Increasingly unregulated production and significantly greater exchange capacity out of the Nordic synchronous area make transmission system operation more challenging. Therefore, in order to maintain secure transmission system operation and ensure high utilisation of our interconnectors, Statnett and the other Nordic TSOs are implementing a number of improvement measures. This includes the introduction of a new Nordic balancing model with more granular time resolution. In addition, we must reduce today's strict ramping restrictions through the establishment of flow-based market coupling and more automated regulation.

Statnett believes it is important to have these measures in place before we can further increase capacity out of the synchronous area. Otherwise, it may be necessary to reduce the capacity of both new and existing interconnectors. It could also be more challenging to comply with European rules for utilising technical capacity in the grid. In light of this, we need operational experience to better assess how we can make better use of the connections so that we can realise the potential socio-economic benefits indicated by the market analysis.

The extent of internal congestion in Germany and how this will be managed is an important uncertainty factor. North-south transmission needs in Germany are increasing and will continue to see significant growth over the next 20 years. At the same time, there are delays of unknown scope in current grid development, and at this time, it is unclear how further transmission needs beyond current plans will be met. In addition, it is uncertain how the internal congestion will be managed. All this means that we need to await any further development of new capacity, not only to Germany but also to Jutland and other parts of the continent.

When it comes to the possibility of constructing an interconnector to the UK, we believe that a rational approach would be to start by clarifying how Brexit will affect rules and solutions for power trading. Furthermore, NorthConnect's licence application is still being processed.

While working on the Nordic Grid Development Plan 2019, Statnett, in collaboration with Energinet, Svenska Kraftnät (Svk) and Fingrid, has explored the need and opportunities for increased grid capacity across certain national borders internally in the Nordic region. Against this background, we agree with Fingrid that we should continue the analysis process to find potential measures that will facilitate better use of the existing power line between Finnmark and Finland. Between South Norway and Sweden, we see increasing socio-economic benefits from increased capacity, mostly driven by the plans to phase out all Swedish nuclear power plants. Initially, however, there is a lower need, and we therefore agree with Svk that it is wise to put further investments on hold in this corridor. Analyses carried out on the Skagerrak connection indicate that it will be profitable to maintain current capacity. Here, however, we see a clear need to await the outcome of delays in the development of the German grid, the handling of internal congestion in Germany, developments in Denmark and the utilisation of the existing interconnectors. We agree with Energinet that we should wait before making any new investments.

<sup>1</sup> NorthConnect is a company that wants to build a new 1,400 MW interconnector between Sima and Scotland.

**Statnett SF**

Nydalen Allé 33  
0484 Oslo

**T** +47 23 90 30 00

**F** +47 23 90 30 01

**Statnett**