POLICY BRIEF

Decarbonizing the Nordic power system

Source: Flickr 2013.

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Introduction

This policy brief is based on presentations made by Asbjørn Torvanger from CICERO Center for International Climate Research, Jan Bråten from Statnett (the system operator of the Norwegian power system), Kristin Linnerud and Eirik Ogner Jåstad from the Norwegian University of Life Sciences and Terje Kronen from Naturvernforbundet (Friends of the Earth Norway) during a webinar on decarbonization of the Nordic power system that took place on September 29th, 2023.

The policy brief discusses challenges and opportunities for the Nordic power system given ambitious climate policy targets, broad electrification, and the fast growth of renewable power production. Decarbonization of the power system is a necessity for all Nordic countries to meet their climate neutrality goals. The Nordic power system must work well with the other European countries, given many grid connections to the continent and the UK. On this background the opportunities for developing renewable energy sources and balancing power in the Nordics, as well as energy efficiency, flexibility, and storage improvements were discussed. Due to the differences in energy resources across the Nordics, there is an underdeveloped potential to secure power supply, increase efficiency, constrain electricity prices, and reduce the risk for unwanted distributional effects and consequences for nature through strengthened Nordic collaboration.

Context of this policy brief

To support the 'Nordic Vision 2030' and 'Climate transition in the Nordics', CONCITO, CICERO, IVL Swedish Environmental Research Institute, University of Iceland, Reykjavik University, and Tyrsky Consulting have carried out an assessment of decarbonization in the Nordics for the Nordic Council of Ministers. The consortium has taken stock of greenhouse gas emissions in the Nordic countries and described and assessed the national pathways towards climate neutrality in the Nordic region.

The project is a part of the initiative "Climate transition in the Nordics" to support the Nordic Vision 2030. The overall aim of the Nordic Vision is to become the most sustainable and integrated region in the world by 2030.

As a part of the "Nordic Stocktake and Visions – Pathways to climate neutrality" project, the consortium held five webinars on topics of special relevance for reaching climate neutrality in the Nordic region. The webinars can be viewed on Norden.org.

Source: Flickr, 2015.

Status and challenges for power balance and nature conservation

The Nordic countries have ambitious climate policy targets, and broad electrification is a dominating strategy. This will increase the demand for electricity, and the decarbonization of the power system implies fast growth of renewable energy production from wind, solar power, and bioenergy. As the decarbonization of the European power system proceeds, electrification based on wind and solar power will create challenges in balancing the power system with more power that can be regulated, as periods of high consumption, e. g. cold periods, often coincide with periods of low wind and solar production. A larger share of intermittent power production means increased demand for non- or low-carbon balancing power from hydropower, pumped-storage hydropower, bioenergy, nuclear power or gas-fired power stations with carbon capture and storage. Important supplemental solutions are increased energy efficiency and flexibility in production and use of power, improved grid connections, and energy storage to be used in periods with strained power production.

Looking at Norway as an example, in 2021, 88 percent of power production in Norway was based on hydropower, and 9 percent on wind power, see Figure 1 (NVE, 2023). This contrasts with EU power production, of which 42 percent of new electricity generation was based on combustible fuels in 2020 (Eurostat, 2023). Norway's magazine-based hydropower production acts as a valuable green battery, adding some flexibility, and there is also a potential for refurbishing hydropower plants, with an estimated potential for increasing production from existing plants between 6 and 23 TWh (NVE, 2021; Vilberg et al., 2023)

Figure 1. Declaration on physical power to consumers in Norway, 2021. Source: NVE, 2023.

There is potential for increasing production from wind power in Norway, but wind power projects on land have recently been met by opposition from local communities due to impacts on nature and reduced recreational values, etc., and there have also been conflicts with wind power projects and land use rights of the indigenous people of Norway. Although there is less opposition towards sea-based wind power, there are cost- and efficiency challenges that need to be solved. Importantly, Norway has committed to conserving 30 percent of land and sea, and to restore 30 percent of affected nature areas through the Global Biodiversity Framework. Combining increased renewable power production with more nature conservation will be a challenge.

Similar challenges exist in the other Nordic countries, although the expected consumption growth, the technological mix and the potential for future renewable energy production vary across the countries, see Figure 2. In theory, there is a substantial potential for increasing renewable power production across Norway, Denmark, Finland, and Sweden. The most important constraints may be the social acceptance of costs and land use impacts from increased investments in both power production and grid capacity.

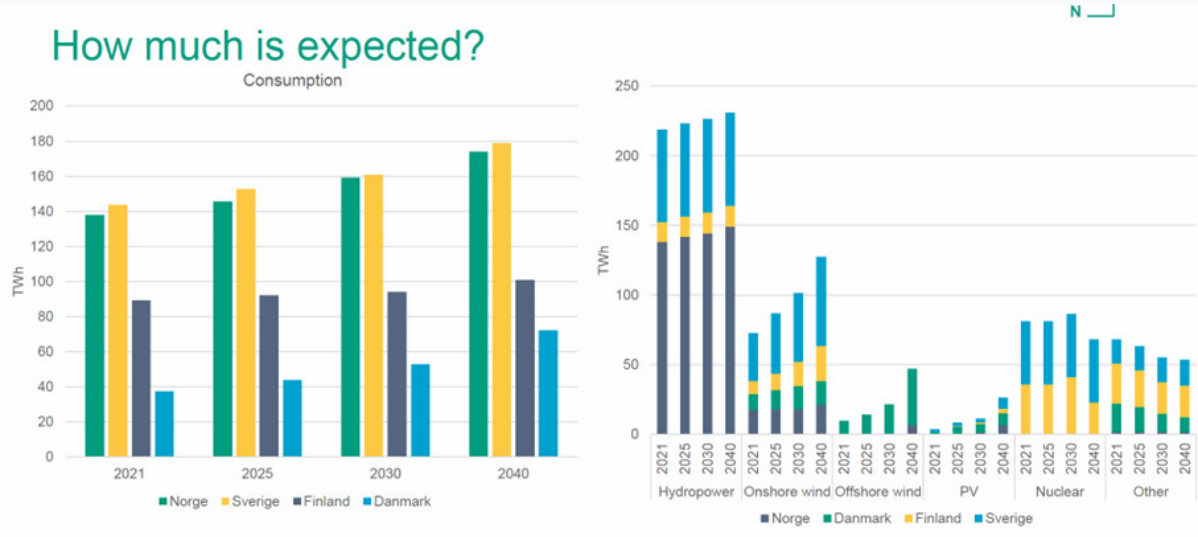

Figure 2. Expected consumption and production of various power sources for Norway, Sweden, Finland, and Denmark until 2040. Source: Jåstad, 2023.

A main challenge facing the Nordic countries is securing power supply while reducing negative impacts on nature from increased power production. To use scarce resources more efficiently while securing power supply, collaboration between the Nordic countries on grid development, flexibility, energy storage and improved energy efficiency, are important measures. Norway recently signed the UN Global Biodiversity Framework, where the goal is 30% nature protection and 30% restoration of affected land. Currently, Norway is protecting

Source: Flickr, 2021.

An efficient and acceptable decarbonization of the power system

18% of its land area. New renewable energy should come from sources with the least negative impact on vulnerable nature, such as using land with existing buildings and infrastructure, so-called 'grey' areas.

Increased demand flexibility will be important to promote faster emission reductions, lower system costs and a more robust power system. In Denmark, Sweden and Finland, there is potential for flexibility through taking advantage of the large district heating systems for combined heat and power production. In general, there is great potential for flexible demand in the heating sector, through using electricity when it is abundant and prices are low, and other energy carriers, such as biomass or stored heat, when electricity is scarce. Other opportunities to increase flexibility are new business models for sharing services and replacing products since this will contribute to the low carbon society.

Increased power production is required to supply increased demand. There is a potential to develop more onshore and offshore wind power, but with challenges regarding costs, negative impacts on nature and acceptance in local communities. High cost for (floating) offshore wind power may mean a need for public support for many years. Pumped hydropower may have a significant potential in Norway, whereas biomass-waste based district heating has a significant potential in Sweden and Finland.

Improved energy efficiency will reduce the need for new grid infrastructure and new power production. Meeting the Paris agreement climate policy goal and protecting and restoring nature in line with the Global Biodiversity Framework means that energy must be used as efficiently as possible. A circular economy, e. g. encompassing a sharing economy, can substantially improve energy and resource use efficiency.

Storing energy in the form of hydrogen or ammonia when the power price is low may become important. Sizeable hydrogen production is planned in some Nordic countries. In periods of abundant wind power production and a low power price, energy can be stored as hydrogen, but with a substantial energy loss and large investment requirements in hydrogen production, storage, and distribution infrastructure.

Social acceptance of wind and solar power investments depends on social-political and community acceptance. Offshore wind and solar power in 'grey' areas, such as industrial areas, road, and railroad shoulders for solar power production, likely have higher acceptance than onshore wind and power, but people are more skeptical towards exporting power. This means that national control of energy and profit sharing with local inhabitants are important. Communicating the benefits of an interlinked power system for improving energy security, and the importance of energy efficiency measures to reduce negative impacts on nature, can be important tools to promote social acceptance during the green transition.

: Source: Flickr, 2009.

Recommendations for Nordic collaboration

1 **Increase Nordic power system flexibility.**
There is great potential for collaboration in the Nordics to exploit opportunities for increasing flexibility in the power system and using resources more efficiently. Increased flexibility in one country can help to balance the power system of other countries, e. g. more production flexibility in Norway through refurbished hydropower and pumped storage of hydropower. One example is an efficient CCS value chain, with major industrial CO_2 point sources in Denmark, Finland, Norway, and Sweden, and where Norway is building an infrastructure for CO_2 transportation and storage under the North Sea seabed.

2 **Increased transmission (grid) capacity** within and between countries can secure power supply since there is lower correlation between wind, sun, and hydro power production with increasing distance. Another benefit of increasing the transmission capacity between the Nordic countries is that the technology mix, and to some extent, the consumption pattern, varies across the countries, which adds to the flexibility of the power system.

3 **Utilize different opportunities.**
With an increasing share of power from intermittent power production from solar and wind, creating a stronger grid and strengthening the different production and storage opportunities in each of the Nordic countries will strengthen flexibility and enhance efficiency in the Nordic power system.

4 **Share experiences.**
Using energy more efficiently is key to reducing negative impacts on nature from new energy production and transmission lines and enabling an efficient green transition. Nordic collaboration can reduce energy consumption through sharing experiences with different measures to increase energy efficiency in production, transmission, and consumption, as well as measures to reduce waste and impacts on nature in general.

Source: Flickr, 2012.

References

Eurostat, 2023. Electricity production, consumption and market overview. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Electricity_production,_consumption_and_market_overview#Electricity_generation

NVE, 2023. Hvor kommer strømmen fra? https://www.nve.no/energi/energisystem/kraftproduksjon/hvor-kommer-stroemmen-fra/

NVE, 2021. Opprusting og utvidelse. https://www.nve.no/konsesjon/konsesjonsbehandling-av-vannkraft/opprusting-og-utvidelse/

Vilberg, I., L. Lia, T. Aronsen, M.-P. Gosselin, A. Harby, M. Belsnes, 2023. Potensial for opprusting og utvidelse av vannkraft med miljødesign. Hydrocen rapport nr. 35. https://hydrocen.nina.no/Portals/Hydrocen/PotOUt-rapport.pdf