StormGeo
Nena Analysis

NORDIC RENEWABLES

Outlook 2023-2050

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Solar Power: Potential, Costs and Expectations

Despite a notable cost increase over the past two years, the demand for solar energy remains at a record high, largely driven by soaring electricity prices. The Nordics and Europe are witnessing the emergence of increasingly large utility-scale solar projects, with several boasting well over 100 MW of installed capacity. As costs are expected to decline going forward, everything points to the fact that investments in solar power will remain extremely high in the coming years.

The main driver in the Nordic region have been high electricity prices, especially in southern Sweden. Combined with a tax rebate in Sweden and the ability to receive spot prices for the solar energy they generate, the repayment period for households has been considerably reduced. Furthermore, it has become a popular choice for small to medium-sized companies to establish utility-scale solar facilities, particularly on farmland. These businesses are using the generated power to meet their own electricity needs or to enter power purchase agreements with other local companies, a business model commonly adopted in Denmark for utility-scale solar.

Although solar power still constitutes a small fraction of total power production in the Nordics, it holds significant potential. The type of installation, whether rooftop or utility-scale, varies significantly from one country to another. In Sweden, rooftop solar installations are the predominant choice, whereas in Denmark, utility-scale solar takes the lead. While there are no direct subsidy programs for utility-scale solar in the Nordics, there have been developments. In Finland, companies involved in energy-intensive production processes can now apply for a green electrification grant. In Sweden, a green tax deduction of up to 15% can be claimed for the installation costs of rooftop solar panels, and this deduction can extend to cover up to 50% of the expenses for installing a home battery. In Norway, Enova offers support of up to 47,500 NOK for the installation of rooftop solar panels. Denmark's TSO, Energinet, is set to introduce a geographically differentiated production tariff in 2023 in response to the growing renewable production, particularly utility-scale solar, which has created challenges in managing the local grid in certain areas. Under this new scheme, localities with a production surplus will be charged a production tariff of 10.6 DKK/MWh, while areas with excess consumption will benefit from a lower tariff of 4.6 DKK/MWh.

There are numerous large utility-scale solar projects in various stages of development across the Nordics. In Denmark, Luxcara and BeGreen have completed a 400 MW utility-scale solar farm this year in Faxe, Vordingborg, and Herning. Last December, 300 MW solar farms in Aabenraa and Kassø became operational. In total, approximately 1.3 GW of solar power capacity is under construction or with FID in Denmark. In Sweden, Ilmatar Solar is planning a 450 MW solar park outside Halmstad in the SE4 bidding zone. In September last year, they also announced a 550 MW solar park outside Motala. European Energy had initially proposed a 129 MW solar park outside Helsingborg in Svedberga. However, the provincial government chose not to approve the project, and the matter is currently under consideration in the land and environmental court. Additionally, Finland is also witnessing several large-scale solar projects in the planning stages, including an 80-100 MW solar park in Lapua developed by EPV Energy and ATP Palloneva's 250-500 MW solar farm in Kauhajoki. The potential for solar photovoltaic (PV) energy in the Nordics is vast. If all building facades were fully utilized, the potential could be around 150 TWh. When ground-mounted systems are considered, this number multiplies. Surprisingly, even in northern Scandinavia, solar conditions are favourable. However, the already low electricity prices in this region do not justify extensive deployment of commercial solar PV installations. Currently, there are only a few large rooftop solar installations outside Umeå and Piteå in northern Sweden.

Solar power under construction or with FID

Owner / Developer	Name	County	Area	Cap. Fac. %	GWh	FLH	MW	LRMC €/MWh	Status	Comm-issioned	Date of FID
Luxcara/BeGreen	Barmosen	Zealand	DK2	9,11	143	1 040	137	51,68	FID	06/25	02/22
Luxcara/BeGreen	Bregentved	Faxe	DK2	9,11	116	1 040	112	51,82	FID	06/25	02/22
Nordic Solar	Portfolio of solar plants	N.a.	DK	11,56	330	1 320	250	42,14	Under construc	06/27	N.a.
Hydro Rein/GreenGo	A	Jutland	DK1	11,15	145	1 273	114	43,17	Pre-constructic	06/26	N.A
Hydro Rein/GreenGo	B	Jutland	DK1	11,15	377	1 273	296	43,17	Pre-constructic	06/27	N.A
Better Energy	Viuf	Viuf, Håstrup	DK2	8,76	228	1 000	228	53,63	FID	11/24	06/23
Sum Denmark					1 339		1 137				
Skarta Energy	Utajärvi 1	Utajärvi	FI	8,76	80	1 000	80	53,63	Under construc	06/24	09/22
Neoen	Joensuu	Joensuu	FI	8,76	100	1 000	100	53,63	FID	06/24	03/23
3Flash	Lappeenranta	Lappeenranta	FI	8,76	600	1 000	600	53,63	Planned	06/26	03/24
Skarta Energy, Solarigo	The Callio-Hitura solar farm projec	Nivala, Pyhäjärvi	FI	7,59	65	867	75	61,12	Development	n.a.	05/24
Sum Finland					845		855				
Ilmatar Solar	Tönnersjö	Halmstad	SE4	8,76	450	1 000	450	53,63	FID	03/24	08/22
Ilmatar Solar	Olivehult	Motala, Olivehult	SE3	8,76	550	1 000	550	53,63	Planning	01/25	06/22
Ilmatar Solar	Åskya	Älmhults	SE4	8,76	340	1 000	340	53,63	Planning	01/25	06/22
European Energy	Svedberga	Helsingborg	SE4	11,93	175	1 362	129	41,00	Under Construc	06/24	12/22
Sum Sweden					1 515		1 469				
Green Genius / RGREEN INVES	Portfolio (8 projects)	N.a.	LT	10,99	82	1 254	66	43,75	Under construc	01/24	01/23
UAB Saulės grąža	Spilve Meadows, Port of Riga	Riga	LV	8,76	100	1 000	100	53,63	Tender	01/27	11/22
Sum Baltic					182		166				

Source: StormGeo Nena Analysis

On land use of solar PV

Conflicts related to land use are increasingly posing challenges to the expanded adoption of renewable energy sources. While onshore wind power has received significant attention in this context, solar power is not exempt from such concerns. For instance, the Svedberga Solar Park in southern Sweden faced opposition due to worries about constructing it on agricultural land. In 2021, a study conducted by the Swedish research institute RISE highlighted land use issues associated with utility-scale solar installations. The study revealed that in Sweden, such installations are predominantly situated on existing or former farmland. However, the study's key insight is that the land can be restored to its natural state at the end of a solar installation's life. Furthermore, many solar developers are proactively incorporating practices to enhance biodiversity, such as utilizing grazing animals or cultivating plants between solar panels.

To gauge the efficiency of several of Sweden's largest solar farms, we evaluated their power density, defined as the installed capacity in relation to the installation's size. On average, these solar farms provided 69 ± 7 MW per square kilometer. Considering the required land use for our projected solar energy output in 2050, which amounts to approximately 730 square kilometers, it equates to about 2% of the total land area designated for farming in Sweden. This land use requirement is well within reasonable limits.

CAPEX

According to the IRENA report titled "Renewable Power Generation Costs in 2021," the average CAPEX for utility-scale solar power projects in Germany was $700 per kilowatt (kW) in 2021. However, the report also highlights a notable increase in solar PV costs, with a rise of 10-25 percent since 2020. This increase is primarily attributed to elevated raw material costs, especially for polysilicon, copper, and steel.

Despite the ongoing maturation of solar PV technology, regional cost disparities persist. A comprehensive cost breakdown of utility-scale solar power reveals that all CAPEX components are subject to regional variations. In our assessment of cost reduction potential in Europe, we adhere to the current global best practices for hard costs, encompassing modules, inverters, balance-of-system (BoS) hardware, installation, and development.

IRENA reported that in 2021, underlying prices of raw materials and components used in solar power increased due to developments in the global commodity and freight markets. While we have not conducted a detailed analysis of the impact on solar power CAPEX, it remains uncertain how increased costs affected developers' CAPEX in 2022 and 2023. Nonetheless, it seems reasonable to anticipate that the cost increases observed in 2021 and 2022 will decelerate before resuming a downward trajectory from 2023 onwards.

For utility-scale solar power, we project a total CAPEX of 0.67 million euros per megawatt (MEUR/MW) in 2023, with an assumed decrease to 0.55 MEUR/MW by 2028. From 2029 to 2035, we expect a 1% decline in module costs while keeping all other CAPEX components constant, followed by a 2% inflation rate.

This document is part of the Nena Nordic Renewables Outlook, which was published in fall 2023.

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