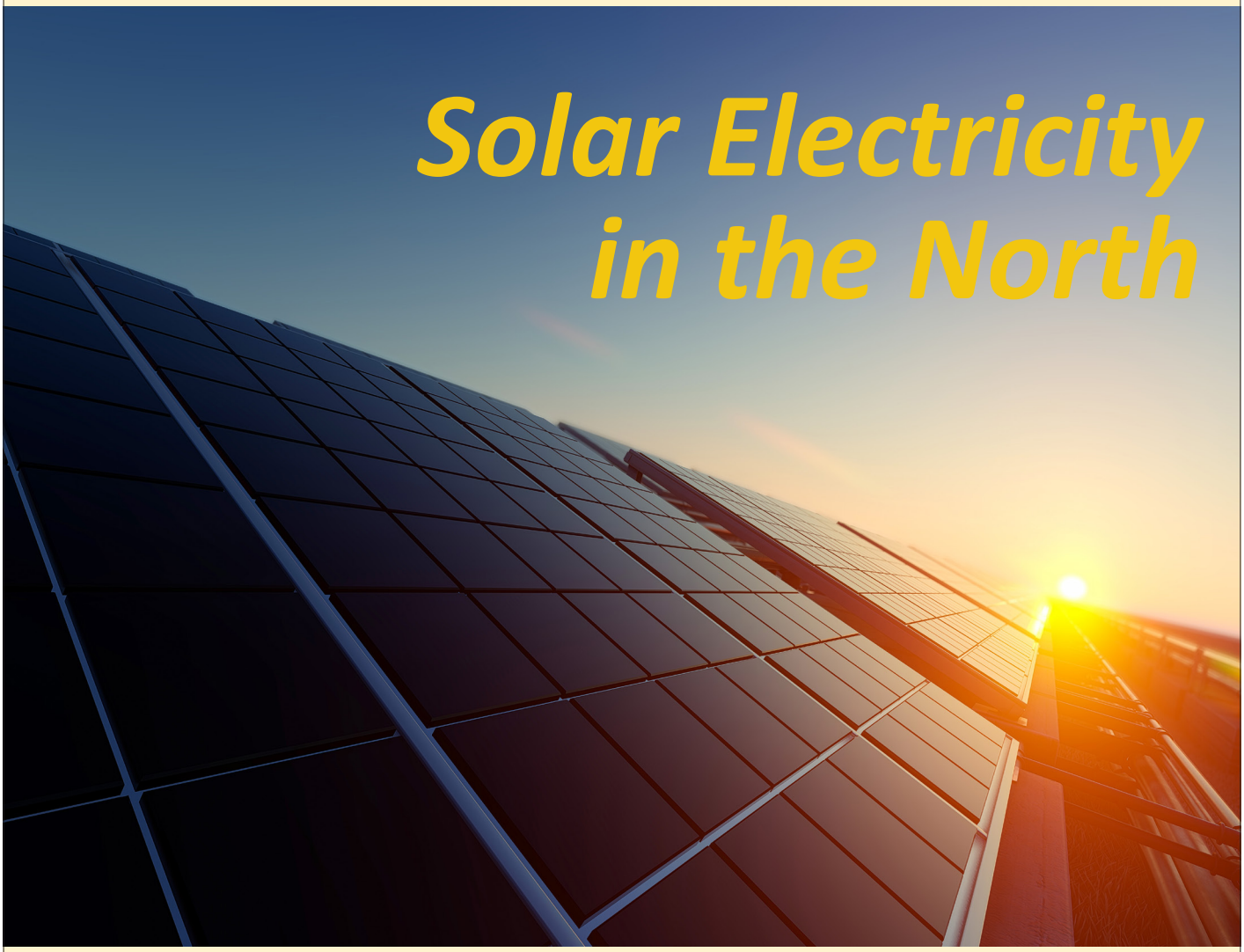
SOLIGA LANTBRUK I NORR

Solar Electricity in the North



LANTBRUKARNAS RIKSFÖRBUND

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Europeiska jordbruksfonden för landsbygdsutveckling: Europa investerar i landsbygdsområden

REGION NORRBOTTEN

Länsstyrelsen Norrbotten

Längmanska Företagarfonden

region västerbotten

Länsstyrelsen Västerbotten

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Introduction

Solar energy is by far the largest potential energy source available on earth. Traditionally, most of this energy has been exploited in the form of solar heat, but in recent decades the costs of producing solar electricity have fallen dramatically. At first glance, solar electricity may not seem like a clear choice for areas like the north of Sweden but with a good understanding of how to adapt the technology, it is an energy source that could make a substantial contribution to covering our energy requirements. This leaflet aims to explain the differences between solar energy potential in northern locations compared with those further south.

What are the differences?

Solar radiation

The amount of solar radiation that reaches the surface of the Earth decreases the further north one goes. In the north, the sun follows a lower path in the sky which means that sunlight strikes the Earth at a lower angle with and with lower intensity and energy density. This lower sun path also forces sunlight to travel further in the atmosphere where atmospheric gases and particles absorb or deflect some of the sunlight before it is able to reach the surface of the Earth. Both of these effects contribute to solar irradiance being lower overall in northern regions than in southern regions.

The effect of a lower angle of incidence as well as greater atmospheric travel distance is illustrated in the figure below. Air mass (AM) is a value that indicates the impact traveling through the atmosphere has on solar radiation. Higher AM means that sunlight travels further and that a greater proportion of it is absorbed or scattered in the atmosphere before reaching the Earth's surface. In central Europe AM tends to be between 2 and 3, while in Nordic regions AM is closer to 1.5.

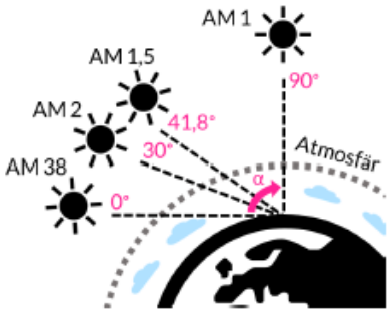

Figure 1. Visualization of how a lower solar path affects angle of incidence and atmospheric traveling distance of solar radiation.

Time distribution

In northern regions, there are significantly more daylight hours in summer and significantly fewer in winter. Because of this, the potential for producing solar energy in northern Sweden, for example, is often similar in summer to that of central Europe. In winter, autumn and spring, however, differences in solar irradiance between the two regions are more substantial mainly due to shorter days and a lower solar path in the north. The figure below shows solar irradiance for each month for four different cities ranging from Munich in southern Germany to Kiruna in northern Sweden. The average annual irradiance for these locations varies from 1150 kWh/m^2 per year in Munich to 800 kWh/m^2 per year in Kiruna and the biggest differences are seen between September and March.

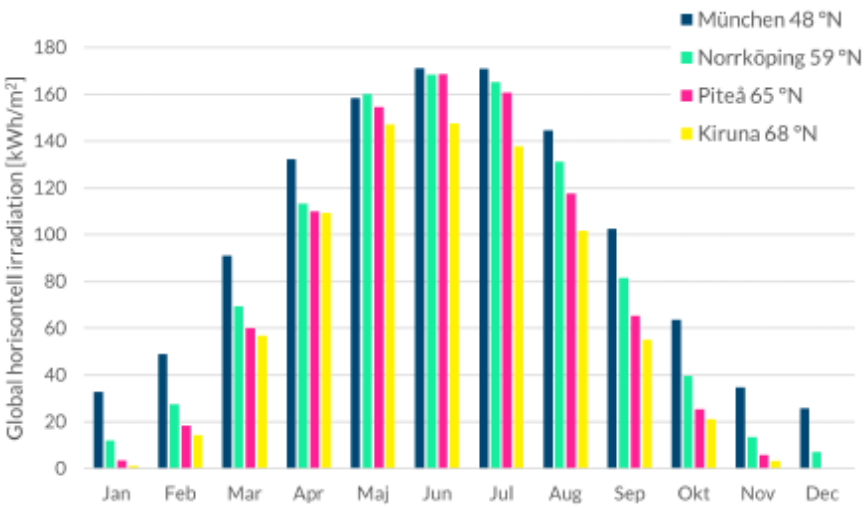

Figure 2. Annual average solar irradiance for four European cities by month.

The effect of snow and lower temperatures

Snow is a common feature of northern winters and can cover solar power plants leading to losses in energy production. The amount of solar energy lost due to ”snow shading” varies between different solar power plants but in northern Sweden it is generally estimated to fall between 3-10 % per year if no snow removal is carried out. In addition, solar modules that are exposed to pressure from high snow loads may be damaged or even destroyed, resulting in a need for maintenance or replacement that would not otherwise be necessary.

The lower temperatures that are also a common feature of northern winters are, on the other hand, mostly beneficial for solar energy production. Solar cell components are able to produce more energy at lower temperatures and systems experience fewer electrical losses resulting in a higher overall energy yield.

How to adapt solar installations for northern regions

Mounting with higher module inclination

Installing solar energy modules in northern regions can be challenging since it must be adapted to the harsher climate. One important adaptation is that solar modules in northern regions need to be installed with a higher tilt or inclination. A higher tilt allows the solar module to better accommodate the lower solar path experienced in the north and leads to higher annual energy production. A higher incline also makes it more likely that any snow will slide off the module which prevents loss of

energy production and decreases the risk of modules being damaged by high snow loads. Optimal module inclination in Munich is between 30-40 degrees south, while in northern Sweden it is closer to 50 degrees south.

Vertically mounting modules on the exterior walls of buildings is an excellent mounting solution that is often overlooked in northern regions. As well as adapting to the lower sun path, vertically mounted solar modules, are able to capture sunlight reflected from snow-covered ground. A solar installations on an exterior wall in northern Sweden is able to produce as well, and in some cases even better, than a roof-mounted installation tilted 10 degrees south.

Bifacial modules

Another adaption that functions well in a northern climate is using bifacial modules. These are modules that can generate power by absorbing light from both sides. Bifacial modules are able to exploit the greater reflectivity of snow-covered ground in northern winters and according to software simulations have the capacity to improve total annual yield by as much as 15-20 % compared with one-sided modules. The market for bifacial modules is growing and, according to some projections, market share is expected to increase to around one third of the total module market by 2030. The cost of bifacial modules remains higher but the price gap between one-sided and bifacial modules is shrinking. To ensure that a bi-facial module adds value to an installation, it is important that the mounted module is heavily tilted or mounted some distance above the ground so that reflected and scattered light is able to reach the bottom of the module.

Financial aspects

The overall return on investment for solar power plant installations is generally lower in northern Sweden for a variety of reasons. Lower annual solar radiation means that solar plants in the north produce less electricity. The cost of electricity on the Nordic spot-market is also currently lower in northern Sweden (SE1 & SE2) than it is in the south (SE3 & SE4). This is, however, expected to change in the future due to the continued electrification of industries in the north with one analysis from the Swedish authorities suggesting that electricity prices in the north are likely to equal or even exceed those in the south by 2035. Lower energy taxes in many regions in northern Sweden also contribute to making the net value of a produced kWh from a solar plant lower than an equivalent purchase from the national grid.

It appears that the cost of establishing solar power installations is often higher in the north than in the south. Traveling distances for installers are generally longer and there are currently fewer installers operating on the market. Additionally, the freight cost of solar hardware from distributors located in southern Sweden and central Europe is presumably higher which impacts the overall cost of installation.

In Sweden there are some state-funded incentives designed to encourage the installation of solar energy. Most of these are currently directed at private citizens rather than companies. For example, a person installing solar modules may receive a subsidy of up to 30 % the labour costs associated with the installation. The state also offers a tax reduction of 0.6 SEK/kWh on any electricity sold to the national grid.

About the project

This information is produced by the project *"Soliga lantbruk i norr"* (Sunny Farms in the North). It aims to increase knowledge about solar electricity production and related financial aspects among farmers in the counties of Norrbotten and Västerbotten, to increase the proportion of solar electricity generated in the region and to work toward energy self-sufficiency. In addition to increasing knowledge, the project has provided procurement support for farmers and has also helped some farmers to learn more about the conditions for larger scale solar electricity fields.

The project is led by the Federation of Swedish Farmers (LRF) and implemented together with Energikontor Norr (North Sweden Energy Agency), RISE ETC, Ludvig & Co and The Rural Economy and Agricultural Societies.

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