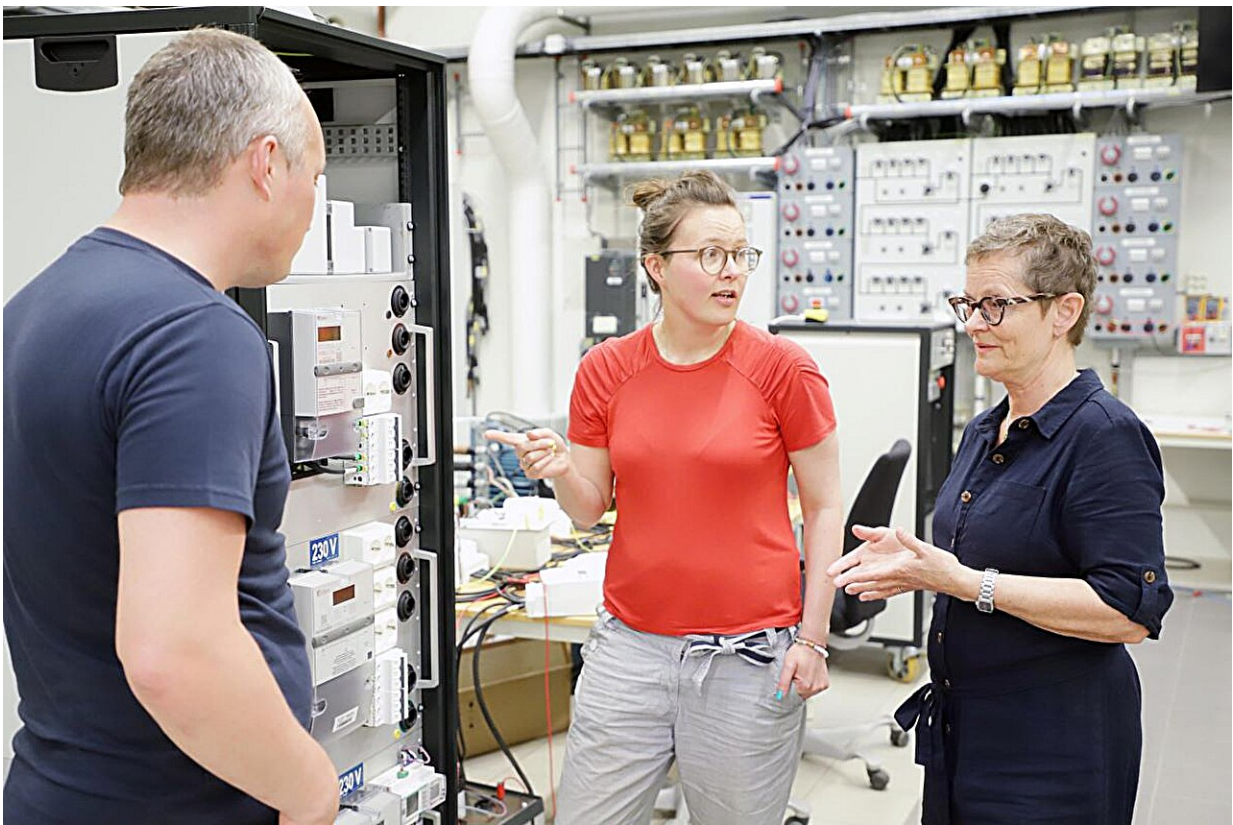


Electrification of society is putting major demands on supply security, say researchers

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There's not a lot you can do when the internet goes down, and your panel heaters and electric hob suddenly go cold. Fortunately, power cuts don't happen very often. But, according to Chief Research Scientist Gerd Kjølle (right), the electrification of society is putting major demands on supply security. Kjølle is pictured here with her colleagues Henning Taxt and Maren Istad. Credit: Daniel Albert

Power cuts can be caused by heavy snow and icing, as well as lightning strikes and strong winds bringing down power lines. Together with more extreme weather events, Norway is also facing a major power supply deficit. So what can we do to avoid a total electricity crisis?

"Luckily, we don't experience power cuts very often," says Gerd Kjølle, who is a Chief Research Scientist at SINTEF Energy Research. "But our supply security is facing major challenges," she says.

In Norway, we have electricity on tap for 99.98% of the time, experiencing blackouts for only two to three hours a year on average.

"There are some big regional differences," says Kjølle. "Many people never experience a power cut. The majority occur in northern Norway, along the coast, and in the south when major snowstorms are accompanied by high winds, such as we've seen this winter. The majority of outages are caused by the weather," she says.

The most common causes of power cuts are heavy snow and icing, as well as lightning strikes and strong winds bringing down power lines.

"There's nothing we can do about the weather," says Kjølle. "We know that climate change and more [extreme weather events](#) can lead to freak accidents and an increased risk of power cuts. The challenge is to make sure that our electricity supply system is as resilient as possible in the face of harsh weather conditions and all other threats," she says.

Supply security under pressure

The current national target to reduce CO₂ emissions by 55% by the year 2030, combined with achieving a zero-emission society by 2050, means that Norway has to implement a major electrification of its societal infrastructure. The country now has a great need to expand both its

electricity generating capacity and its distribution grid.

"More and more of our infrastructure is being connected to the grid," says Kjølle. "The transport and oil and gas sectors are in the process of being electrified, and the business community is demanding that a lot more power be made available. Existing industries are also aiming to achieve electrification, and there are big plans to build power-hungry facilities such as data centers and battery factories" she says.

"In many areas, we're talking about multifold increases in supply needs," she adds. "The Norwegian Water Resources and Energy Directorate (NVE) reckons that Norway will be facing a power supply deficit in the years 2027 to 2030. Capacity in the grid and supply needs vary from region to region, but overall, we're in dire need of a massive expansion of the grid," says Kjølle.

It seems that some of the plans for these gigantic battery factories are in fact a little fanciful?

"I can agree with you there," says Kjølle. "But we must also remember that not all of these projects have been fully matured. Everything indicates that there will be significant growth in these new, power-demanding industries," she says.

Will we be able to meet the demand for electrification fast enough?

"Well, not if we have to rely on major new hydropower plants and wind farms," says Kjølle. "The licensing bureaucracies can take years to approve such projects. Some may take anything from seven to 10 years before they get built. There are some projects in the pipeline, but these are far too few to meet the need that we see coming. A centralized

electricity grid can't be built in a day. It may take as many as 10 to 15 years to install a new power line," she says.

"If processes are speeded up a bit we can achieve upgrades and the expansion of existing hydropower plants that will offer additional electricity generation. There is also a major potential to increase output from existing plants," she adds. "If electrification is to take place at the rate needed for Norway to meet its climate change mitigation targets, we have to be looking at [alternative energy sources](#) and systems," says Kjølle.

Solar power can deliver

Wind farm construction onshore has faced stiff opposition, and new developments have been put on hold for several years. The exception is in Finnmark, where plans appear to be advancing. Offshore wind will not be making a significant contribution before 2030.

"I believe that solar energy is the fastest way of producing more electricity locally," says Kjølle. "But simply covering our house roofs with solar panels won't be enough. Norway will have to start building some big solar energy farms. It remains to be seen how people will react to that, and it's far from certain that such farms will be met with universal approval," she says.

Better management and utilization

Gerd Kjølle is in no doubt that while Norway is waiting for the construction of a new distribution grid and greater volumes of electricity generation, the country can make better use of its current system of power production and the grid.

"There is in fact a lot we don't know about the condition of the grid," she says. "This is why we impose static limits that are conservatively stipulated to ensure safety. Digitalization and sensors enable us to obtain a much clearer picture not only of the electricity being generated and consumed, but also of the power flowing in the grid," says Kjølle.

"Digital tools, combined with self-regulation, provide us with better and more flexible management and control of power flows," she adds. "The sun may be shining on days when we need very little power. But instead of automatically sending unregulated solar energy out into the grid, perhaps this can be better utilized to charge batteries or to supply EV charging stations," she says.

This approach will enable Norway to save some of the electricity provided by regulated hydropower and better utilize the current grid. We know of one EV charging company that has already installed a station that utilizes a battery and solar panels to help charge electric cars, while at the same time receiving supplies from the main grid.

Do we know how much capacity there is in the grid?

"Not really," says Kjølle. "We know very little about the actual capacity in the grid at any given time, although we do know that there is free capacity that can come to our aid. The grid may be more resilient than we think. If so, the issue then arises as to whether greater utilization will exceed the limits stipulated to ensure supply security. We need to look into this in more detail," she says.

Gerd Kjølle highlights the fact that we have much to gain by so-called peak shaving, for example by charging our cars during the night when levels of consumption are low. Intelligent use of electricity can make a significant contribution to savings. To prepare for periods when there are power shortages and limited capacity in the grid, it may be advisable for

grid companies to enter into contracts with businesses who agree to reduce consumption or transfer it to other times.

"We can't get away from the fact that politicians, the general public and the grid companies all need to be made more aware of how the grid will have to handle the massive changes and challenges that will result from electrification, climate change and other threats," says Kjølle.

Are you saying that electrification for the sole purpose of meeting climate change mitigation targets may be putting supply security at risk?

"Yes, I am," says Kjølle. "Greater supply vulnerability is the other side of the coin. The bigger the demands we place on the power system, by increasing complexity and driving it closer to its limits, the greater the risk of new vulnerabilities arising. This is compounded by the fact that society as a whole will become more vulnerable because 'everything' is now entirely dependent on electricity. If we fail to manage the new opportunities we have created, we simply increase the risk of bigger unwanted incidents," she says.

Making coffee using your Tesla?

Hospitals, fire alarm systems and other functions critical to society are equipped with their own emergency electricity supplies to cover their most essential needs in the event of power outages. Businesses will have to ensure that they have back-up systems in place, especially if they are responsible for key functions that cannot be subject to downtime. However, things are not so straightforward for the ordinary consumer, and the DSB is ready with some advice (see the fact box above).

"A battery pack to help make meals or heat the home is hardly a

practical alternative," says Kjølle. "But when we get a system for utilizing the power from our EVs, that will really make a difference," she says.

A more local focus is a smart focus

Gerd Kjølle believes we will see a more decentralized electricity supply system in the future.

"Our supply security is currently rooted in a highly centralized power system involving more than 300,000 kilometers of transfer connections," says Kjølle. "I believe that trends are progressing in the direction of a society in which electricity use is more locally focused. For example, a residential area may organize to develop a local energy system that is less dependent on the centralized grid. This may help to boost supply security and provide us with greater resilience in the event of grid outages," she says.

A more flexible power supply system

"If Norway is to meet its climate change mitigation targets and safeguard supply security at an acceptable price, there are many things we have to do," says Kjølle. "In addition to digitalization and obtaining an awareness of the condition of the grid, we have to promote more flexible power generation and consumption, as well as the use of energy storage systems such as batteries. These actions will also offer us new opportunities for utilization of the grid," she says.

Kjølle believes that it may be better from a socio-economic perspective to become more locally self-sufficient and less reliant on the centralized distribution grid. If local consumer communities become more self-sufficient, this will also help to smooth out the output peaks.

"Consumption can be differentiated. Not everything is equally critical," says Kjølle. "You don't have to wash your clothes, charge the car and cook your dinner all at the same time," she says.

Far from remote threats

The war in Ukraine has demonstrated that a nation's electricity system can be an attractive target for attack. In 2022, we became aware that acts of war against power facilities can also happen in Europe. Here in Norway, war is no longer as remote as it once seemed to be.

"Greater geopolitical tensions mean that we have to be on our guard—even against the unthinkable," says Kjølle. "Cyberattacks have increased in scope. As an energy system becomes more digitalized and complex, its vulnerability to such attacks only increases. This means that our efforts to boost resilience must be even greater. We must do everything we can to ensure that our efforts to combat [climate change](#) do not also pose a threat to our supply security. To achieve this, we need more research," says Kjølle.

Provided by Norwegian University of Science and Technology

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