Snow-repelling solar cell panels could help Norway generate more electricity

Norway has seen an increase in solar power capacity in recent years, but in winter solar panels face a big problem: snow. Researchers at NTNU modelled how much extra electricity could be generated if solar panel surfaces were designed to repel snow and ice.

Norway has been slow to exploit solar energy, but over the last few years interest in the technology has been rapidly increasing: between 2015 and 2021, the country saw a 15-fold increase in its capacity for solar power generation.

"It's a classical misunderstanding that there is not enough solar radiation in Norway," says Professor Bjørn Petter Jelle at Department of Civil and Environmental Engineering at NTNU. "In one way, it's partly true: we don't have so much sun in the darkest winter months. But on the other hand, the sun we *do have* in winter is very valuable. In addition there is, of course, midnight sun or sunshine large parts of the night during summer."

There is one significant challenge to overcome, however: snow on solar cells can reduce the amount of electricity they generate at the time of year when it is needed the most. "A thin layer of snow and you have no electricity production," says Jelle.

Preventing snow and ice from sticking to a solar panel is a more complex problem than it might first appear. Depending on many variables and their interactions, snow may at times easily slide off and at other times stick to the solar cell panel surfaces.

The solar cell panels on the roof of NTNU's ZEB Living Lab in Trondheim were used as a case study to model how much solar electricity is lost due to snow cover during the winter months.
Photo: Clara Good

To understand the impact of the snow problem on Norway's solar power generation, Jelle and colleagues at NTNU modelled how much extra electricity could be generated in three Norwegian cities if solar cells featured icephobic surfaces or coatings that reduced the amount of snow accumulating on panels.

Using NTNU's ZEB Living Lab in Trondheim as their case study, Jelle and colleagues estimated how much solar radiation would be reaching the surface of the building's solar cells throughout the winter months – and how much solar electricity would have been lost due to snow coverage over the last four years. Then, using data on the efficiency of icephobic coatings available commercially for other applications, the researchers simulated how much of the electricity lost due to snow coverage could be recovered if those solar panels had had an icephobic surface. The researchers then repeated the same analysis for two other cities, Oslo and Bergen, using local climate and latitude data.

They found that icephobic coatings could reduce the amount of electricity lost over the winter months by 65% in Oslo, 60% in Trondheim, and 45% in Bergen. The work was funded by the Research Council of Norway and published in the journal *Solar Energy*.

The research also showed that the coatings would be most effective between January and April, rather than November and December, at all three locations. This makes sense when you consider the difference in the amount of solar radiation over those months, says Jelle. In Trondheim, the city at the highest latitude in the study, there are approximately four to five hours of daylight during the dark months of December and January. "Then as you get into February and March, you get more and more sun," says Jelle. That extra solar radiation would also start to melt snow that's accumulated on a solar panel, thus giving an icephobic coating a helping hand.

As yet, though, the icephobic coatings simulated in the study are not yet available commercially for solar cells. Those designed for other applications, such as coatings based on silicones used on aircraft, tend to be opaque – something that would defeat the purpose of using it on a solar panel. "If you add a coating on the surface for a purpose other than trapping solar radiation, then you're often reducing the solar radiation harvesting," says Jelle.

However, researchers are currently developing nanostructured surfaces that could repel ice and snow without the need for an additional coating. Often, these are designed so that any water hitting the surface is repelled before it freezes, preventing the formation of a layer of ice that snow can more easily stick to. But whether it's possible to create a surface that fully prevents ice or snow accumulation is still an open question. "It is possible to delay it, but if you can delay it and then at the same time manage to keep the snow off for a long time, that's much more difficult," says Jelle. "Even if the surface is very smooth, snow can still stick."

If researchers do manage to create such a surface, it would be useful across many industries. Given the right conditions, snow and ice can accumulate on airborne power lines, aircraft hulls and wings, ship hulls, road signs and a lot of other surfaces, causing a whole host of problems. "Driving a car in Norway in winter, often you cannot see what's on the signs because they're covered by snow or ice," says Jelle.

Reference: Mattia Manni, Maria Chiara Failla, Alessandro Nocente, Gabriele Lobaccaro, Bjørn Petter Jelle. The influence of icephobic nanomaterial coatings on solar cell panels at high latitudes, Solar Energy, 248, 76-87 (2022). https://doi.org/10.1016/j.solener.2022.11.005

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