Floating solar farms could cool down lakes threatened by climate change

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The future of solar energy? Credit: Giles Exley, Author provided

Solar power is now the cheapest source of electricity in history, according to a 2020 report by the International Energy Agency. But there's something holding this clean energy powerhouse back: space. Unlike fossil fuel power stations, solar farms need a lot of room to generate enough electricity to keep up with demand. Most solar farms are composed of ground-mounted panels that take up land that could be used to grow food or provide habitat for wildlife.

Although electricity and water don't usually mix, a growing number of floating solar farms are being deployed worldwide. Floating solar panels on a lake or reservoir might sound like an accident waiting to happen, but recent studies have shown the technology generates more electricity compared with rooftop or ground-mounted solar installations. This is thanks to the cooling effect of the water beneath the panels, which can boost how efficiently these systems generate electricity by as much as 12.5%.

That said, lakes and reservoirs are already very important for people and the planet. While these freshwater bodies cover less than 1% of Earth's surface, they nurture almost 6% of its biodiversity and provide drinking water and crop irrigation that's vital to billions of people. Worryingly, climate change has raised the surface temperatures of lakes globally by an average of 0.34°C per decade since 1985, encouraging toxic algal blooms, lowering water levels and preventing water mixing between the distinct layers which naturally form in larger and deeper lakes, starving the depths of oxygen.

In the rush to decarbonise energy in order to slow global warming, might turning to floating solar farms simply add to the strain on the world's precious freshwater reserves? Remarkably, in new research, we found that carefully designed floating solar farms could actually reduce the threats posed by climate change to lakes and reservoirs.

A buffer against warming

Along with colleagues, I used a computer model to simulate how floating solar farms are likely to affect lake water temperatures. Our simulations are based on Windermere, the largest lake in England and one of the most well-studied lakes in the world.

Floating solar farms reduce how much wind and sunlight reaches the

lake's surface, changing many of the processes that occur within. As each floating solar farm has a different design, we ran simulations to see how lake temperatures changed with over 10,000 unique combinations of wind speed and solar radiation.

A floating solar farm generating electricity for a water treatment works at a reservoir in north-west England. Credit: Giles Exley, Author provided

Our results suggest that the changes to water temperatures caused by floating solar farms could be as big as climate change itself, only in the opposite direction.

A floating solar farm that reduces wind speed and solar radiation by 10% across the entire lake could offset a decade of warming from climate change. Designs that shaded the lake more than sheltered it, by reducing sunlight more than wind, had the greatest cooling effect. Evaporation fell and the lake was mixed more frequently, which helps oxygenate the deeper water.

These effects might vary depending on a lake's depth, surface area and location. But ecological processes in lakes are most affected by wind speed and sunlight, which is what our simulations focused on.

Global potential

While most of our simulations indicated a win-win for lakes and floating solar farms, some suggested undesirable side effects. In a small number of simulations, we found that floating solar farms that reduced wind speed at the lake's surface more than they reduced sunlight might actually mimic or amplify the effects of climate change, increasing how long deeper lakes remain stratified. Thankfully, we think the careful design of floating solar farms should reduce these risks.

Floating solar power has grown more than a hundredfold in the past five years, reaching 2.6 gigawatts of installed capacity across 35 countries. If just 1% of the surface area of all human-made water bodies (which are easier to access and typically less ecologically sensitive than natural lakes) was covered by floating solar panels, it could generate 400 gigawatts—enough electricity to power 44 billion LED light bulbs for a year.

Floating solar is likely to make an important contribution to the decarbonisation of the world's energy supplies. In a stroke of serendipity, our research suggests this could have the added benefit of offsetting part of the damage to lakes caused by rising temperatures.

Still, our simulations only covered the physical effects of floating solar, while other questions remain unresolved. How would floating solar farms interact with other lake uses, such as sport or aquaculture? How would the wildlife sharing the lake fare? And which lakes are best suited to hosting a floating solar farm? The work to fully understand the potential of this technology is only just beginning.

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