Untapped solar and wind potential in Swiss mountains

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Scientists at EPFL and the WSL Institute for Snow and Avalanche Research SLF have issued recommendations for what type of renewable energy should be produced in Switzerland's various regions, to help achieve the country's goals of carbon neutrality and energy self-

sufficiency.

According to a new study, the most effective way for Switzerland to become carbon-neutral and energy self-sufficient is to install a combination of wind turbines and solar panels in its Alpine regions. The study's "optimal scenario" suggests adding new capacity in a ratio of 75% wind power and 25% solar power to supplement the country's existing hydropower facilities. The research was conducted jointly by scientists at EPFL's Laboratory of Cryospheric Sciences (CRYOS) and WSL Institute for Snow and Avalanche Research SLF, with the backing of the Swiss National Science Foundation and the Swiss Federal Office of Energy. Their findings have just been published in *Environmental Research Letters*.

"We know our optimal scenario is provocative, but we wanted to map out a full strategy and suggest the most effective path to take, even if it seems radical," says Jérôme Dujardin, the study's lead author and a Ph.D. student in environmental science and engineering at CRYOS. "Policymakers will surely choose a middle-ground option between our optimal scenario and the status quo."

Switzerland's renewable-energy advantages

The study employs a new method for determining what kind of renewable energy is best suited for specific regions, taking into account their topographies, microclimates, hydropower storage potential, and how electricity can be traded with neighboring countries. The scientists based their calculations on meteorological data (e.g., wind speed and amount of sunlight) and satellite data, and factored in Switzerland's current hydropower infrastructure.

To develop their recommendations, they conducted a granular analysis of Switzerland's landscape and configured their model to maintain a

distance of at least 500 meters between newly built wind turbines and homes, while steering clear of glaciers, steep slopes, forests, and national parks. For solar panels, the model was configured to exclude northern orientations. The scientists designed their model for Switzerland's planned power grid in 2025, to make sure that the country's entire power system remains operational.

Jura best suited for wind power

The study shows that Jura is the region with the most potential for wind-power generation, especially in its uninhabited areas. The model suggests locating 40% of the country's new wind turbines in this region, followed by the Alps and pre-Alps. Furthermore, the study also finds that installing rooftop solar panels in the low lands is not an effective solution, due to persistent cloud cover in winter.

Solar panels a good choice for the Alps

Another of the scientists' findings is worth investigating further. "We saw that installing solar panels in the Alps could bring real benefits, including from an economic perspective," says Michael Lehning, a coauthor of the study and full professor at EPFL, and the head of CRYOS. "The Alps get a lot of sunshine in the winter, and the hydropower infrastructure that's already in place could be used to transmit solar energy to the main grid. That's also true for wind energy, whose considerable potential in the Alps is still largely untapped, and partially unknown due to the mountains' complex topography."

Lehning believes his team's findings should spur policymakers to explore these opportunities. "Switzerland has abundant hydropower in the summer, but that's not the season when it's needed most—especially given the growing number of people who are installing solar panels on

rooftops. Our study shows that adding solar capacity in the Alps to capture winter sunlight, and combining that with the hydropower already being generated, could cut the amount of energy Switzerland has to import in the winter by some 80%," he says.

Case study

Switzerland served as a case study for the scientists, whose method employs an "evolution strategy" inspired by the natural evolution of species. It involves running different scenarios in order to find the optimal breakdown among the different types of renewable energy. Their model is the first to factor in so many different variables and calculate the best kind of renewable energy generation for each region within a country. The ability to identify the most effective strategies for becoming carbon neutral could be a real boon for policymakers in Switzerland and beyond.

"Synergistic optimization of renewable energy installations through evolution strategy," was published in *Environmental Research Letters*, 20 May 2021.

More information: Jérôme Dujardin et al, Synergistic optimization of renewable energy installations through evolution strategy, *Environmental Research Letters* (2021). DOI: 10.1088/1748-9326/abfc75

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