Energy Strategy 2050: The potential of millions of Swiss rooftops

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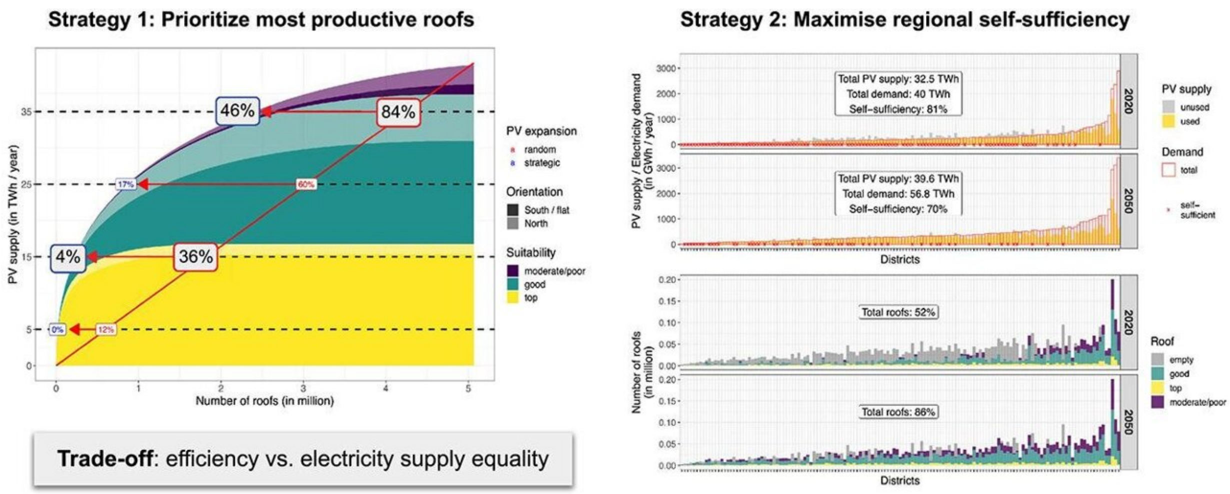

Graphs presenting the two strategies studied. Number of roofs needed to achieve a PV expansion target. Credit: 2023 EPFL / Alina Walch Martin Rüdisüli - CC-BY-SA 4.0

Five million rooftops in Switzerland—more than half of the nationwide total—are suitable for generating power. A review of two solar photovoltaic development strategies has shown that combining the two approaches could cause over two-thirds of Swiss towns and cities to become energy self-sufficient.

As part of its Energy Strategy 2050, the Swiss federal government is targeting a rapid expansion of the country's solar photovoltaic installed base, with the aim of generating 35 terawatt-hours (TWh) of power from renewables (excluding hydropower) in 2035 and 45 TWh in 2050. How can these goals be achieved in a way that's both efficient and fair to individual towns and cities?

It's widely accepted that solar power will play a key role in decarbonizing Switzerland's energy mix—which is why rooftop energy potential has long been a research topic for scientists at the Solar Energy and Building Physics Laboratory (LESO-PB) within EPFL's School of Architecture, Civil and Environmental Engineering (ENAC).

For her Ph.D. thesis, Alina Walch assessed the potential of renewable energy systems, taking a cross-disciplinary approach that combines big data with machine learning (often referred to generically as artificial intelligence or AI).

She developed and then compared two scenarios for expanding Switzerland's solar photovoltaic installed base so as to achieve—or even exceed—the Energy Strategy 2050 targets, working in conjunction with Dr. Martin Rüdisüli, an expert in energy-system modeling at the Swiss Federal Laboratories for Materials Science and Technology (Empa) in Dübendorf.

"We carried out the research together, drawing on my knowledge of solar photovoltaic modeling and Martin's experience in assessing different scenarios for expanding this form of power as part of the energy transition," says Walch.

North-facing roofs

Before she could generate forecasts of Swiss rooftops' solar-power potential in 2050, Walch first had to establish a basis for her estimates and make some assumptions. Which kinds of rooftops should she consider for her model? Should she take a flexible approach and also include rooftops that receive less sunlight or that are oriented north? To begin with, she decided to include only rooftops that were entirely or mainly south-facing.

"But we eventually discovered that north-facing rooftops with a pitch angle of less than 20 degrees could also be candidates for highly productive solar-power installations," explains Walch. She, therefore, added these rooftops to her model as well—and her estimate of Switzerland's total solar-power potential jumped by 25%. "We calculated the maximum potential of all Swiss rooftops," says Walch.

"But, with the clock ticking, there's a more pressing question: what strategies are needed to meet the federal government's targets as quickly as possible?"

Strategy 1. Prioritize large, flat roofs

The key to efficient power generation is to make the best use of available roof space. Large, gently sloping roofs—such as those found on industrial and agricultural buildings—clearly offer the highest solar potential. Crucially, these roofs have few skylights, chimney stacks, and other superstructures, and the buildings themselves tend to be located away from built-up areas, meaning the solar panels are less of an eyesore.

According to Walch's calculations, fitting solar photovoltaic systems onto just 4% of such rooftops would raise annual output to 15 TWh. Moreover, this approach would keep the number of separate installations to a minimum, helping to reduce both costs and carbon emissions.

Equipping a further 2.5 million rooftops with solar panels would be a quick and easy way to achieve the 2050 target of 45 TWh. But, as with all things, there's a drawback: urban areas lack the necessary rooftop real estate to meet their power needs under this approach, meaning the benefits would be unevenly distributed.

Strategy 2. Balance electricity production

Walch then considered how this first strategy could be tweaked to make solar power generation more regionally balanced. For instance, she considered what would happen if solar panels were fitted to the rooftops of all residential buildings. "We ran simulations to find out how much power each district would need to generate in order to become self-sufficient," she says. "Rural towns could easily cover their power needs—without even having to tap into their full potential.

But for cities, self-sufficiency is a near-impossible goal, so there's an imbalance that we can't correct for." While this second strategy would better meet power demand on a regional level, solar panels would have to be installed on 4 million rooftops in order to achieve the federal government's targets.

In today's perfect storm of climate change, geopolitical uncertainty, and other global pressures, energy security has become a major concern.

Walch believes that the answer lies in generating power close to where it's needed, "Our latest analysis shows that the best option is a compromise between the two strategies—one that harnesses the potential of both industrial and residential rooftops. The ideal approach is to start by fitting solar panels onto the biggest roofs in each city until the targets are met. After this point, once a city's energy needs are covered by renewables, limits should be placed on any new installations."

The study is published in the *Journal of Physics: Conference Series*.

More information: Alina Walch et al, A critical comparison of methods to estimate solar rooftop photovoltaic potential in Switzerland, *Journal of Physics: Conference Series* (2019). DOI: 10.1088/1742-6596/1343/1/012035

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