Q&A: Is air conditioning a threat to Switzerland's power grid?

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The elevated temperatures this summer prompted many of us to crank up the air conditioning. In Switzerland, the energy used for cooling is approaching that for heating. What does that mean for power grids?

Official figures from the Swiss weather office are striking: temperatures this summer were 1.6°C above the national average for 1991–2020, and there was an intense heat wave with peaks reaching or exceeding the 2003 records in several cantons.

Planet-wide, this was the second hottest summer (after 2023) since records began. And as the temperature rises, the need for air conditioning is surging. According to Switzerland's Federal Office of Energy, cooling systems now account for nearly 11% of the country's electricity use—not far from the 14% figure for heating.

Air conditioning saves lives, but it also contributes to urban heat islands (thus aggravating global warming), adds to the pressure on power plants and increases the load on power grids. Will Switzerland's grid be able to handle the additional demand? We spoke with Prof. Mario Paolone from EPFL's Distributed Electrical Systems Laboratory to find out.

The heightened use of air conditioning means that peak load on our grid will soon occur in the summer rather than the winter. Is that cause for concern?

As far as the grid is concerned, managing demand for cooling systems isn't that different from managing demand for heating systems. But the challenge is that the need for electricity is growing overall, not just because of air conditioning, since a growing number of processes are going electric.

That's true for businesses as well as consumers. Heat pumps and electric vehicles are more efficient than gas-fired boilers and combustion engines, for example. It's this electrification of processes that's driving the change.

Prof. Mario Paolone. Credit: EPFL/Alain Herzog

How?

The additional demand is impacting local power grids, which were already congested. Existing power lines and transformers weren't sized for the kind of load they're now experiencing. Power plants are also under greater pressure as they must supply the additional electricity and keep enough reserves to accommodate the often-unpredictable spikes in demand.

If we want to fill the gap with renewable energy, an estimated 40 GW of additional solar power will be needed to meet Switzerland's demand for electricity, including electricity for heating systems, cooling systems and electric vehicles. But that will make local power grids even more congested and increase the required reserves.

Can some of the pressure be mitigated by the fact that demand for air conditioning occurs when solar energy is at its peak?

That's definitely a positive aspect of air conditioning: its use is naturally synchronized with periods of intense sunlight. If Switzerland shifts more of its energy mix to solar power, that will alleviate some of the grid problems I mentioned.

Property owners will want to install solar panels at the same time as air conditioners in order to lower their operating costs. That will also reduce the need for energy storage, since the power can be consumed right as it's produced.

Given that Switzerland has a power surplus in the summer, could we meet the additional demand with solar energy and therefore 'break even?'

That's what a lot of people think because most of us reason in terms of net energy. But power demand and supply systems don't work on an aggregate level. Enough electricity must be available to meet demand instantaneously or else we'll experience power outages.

That's why grid operators have to use either a demand management system or an energy storage system to handle swings in supply and demand. For now, grid operators manage demand with what are known as primary, secondary and tertiary reserves.

Could the answer be to decentralize more of Switzerland's power network?

Absolutely. The aim of the Federal Act on a Secure Electricity Supply (Mantelerlass) that was adopted on 9 June is to create "energy communities" in which buildings share the power they generate with each other as needed, potentially meeting all of their own demand.

Technology already exists to address issues with synchronizing supply and demand while meeting the grid constraints I described earlier. We'll undoubtedly see energy communities being created all around Switzerland to produce and manage their own electricity—for not just air conditioning but also heating and electric vehicles—and ease congestion on the national grid.

More broadly, however, we'll need to manage demand for power in general more effectively if we want to mitigate the impact on our grid and energy reserves.

There's also the issue of how costs are distributed among power producers, power consumers and power grid operators.

We now have the technology to calculate the load factor of a grid based on power flow. This can be done with locational marginal pricing, for instance. We're working on a project with the Lausanne power utility to use this form of pricing to maximize the benefits for all participants in a given market while also enhancing the performance of the power grid. The idea is to find the best way to reduce the investment and operating costs for an entire community.

We have the answers in theory, but we're missing the right legal framework to implement them. A project with the Lausanne power utility is intended to test one option under real-world conditions.

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