ENERGY **Can Switzerland ever be 'renewable'?** Switzerland has abundant renewable energy resources: sun in the Alps, wind in the Jura and biomass in the forest and on farms. Researchers at WSL are investigating how the Swiss can – and want to – use them.

Photovoltaic systems in the mountains could significantly improve the electricity supply in winter.

Photo: Jérôme Dujardin, WSL

11 March 2011: The reactor disaster in Fukushima in Japan contaminates wide areas of air, soil and water and exposes people to radioactive radiation. The shock leads the Federal Council to decide to gradually phase out nuclear power. In 2017, the electorate approved the Energy Strategy 2050 with its three

pillars: to have no new nuclear power plants, to expand renewable energy and to reduce consumption through improved energy efficiency.

According to the Swiss Federal Office of Energy, the Swiss currently consume around 220 terawatt hours (TWh) of energy per year. Almost half of this comes from petroleum products and about a quarter is in the form of electricity, which is mainly produced from nuclear and hydroelectric power. Gas, coal and waste heat make up the rest. Is it possible to generate this quantity of energy and still ensure that it is in line with the UN's Sustainable Development Goals, i.e. clean and affordable? To find out, the federal government invested 250 million Swiss francs in Innosuisse's Energy Funding Programme. For the so-called 'energy transition', 1300 researchers and other experts explored technical, social and political solutions between 2014 and 2021.

The resources are there

WSL also participated in the Programme. For many years, WSL researchers have been collecting data on the development of forests, glaciers, snow and other environmental parameters. They use this data to develop simulation models to estimate the availability of natural sources of renewable energy, namely biomass, water, wind and sun.

Their findings show that one potentially quite large source of energy is stored in biomass, i.e. organic substances such as wood, cuttings and solid and liquid manure. "Biomass is a valuable substitute for fossil fuels. It is available everywhere and can be efficiently converted into energy," says Oliver Thees, a forest scientist and economist at WSL. His team explored the energy potential of woody and non-woody biomass as one part of the Energy Funding Programme and found it could contribute as much as 27 TWh of energy per year.

Wood in the form of forest and woodland wood, industrial residues and waste wood is already being used intensively, especially for heating. However, the researchers showed that about one third more, amounting to 13.9 TWh per year, could potentially be used sustainably.

Manure heaps and liquid manure pits have considerable energy potential, and could provide around 6.6 TWh. Much of this potential is currently unused according to a WSL study on biogas production from solid and liquid manure. A further bonus of using farmyard manure for energy is that less would be spread on fields and meadows, which would reduce not only greenhouse gas emissions, but also overfertilisation.

Filling the winter electricity gap

Hydropower will continue in future to supply a lion's share of the electricity in Switzerland. But winters present a problem. When water is bound up as snow and ice, the water levels in the reservoirs fall, and with them, the electricity production. Climate models predict that, in future, there will be less rain in summer and more in winter. "In this case, climate change would help the energy transition," says Michael Lehning, head of the Snow Processes Group at the WSL Institute for Snow and Avalanche Research SLF. But this would not be enough to close the so-called 'winter gap'.

Switzerland relies on electricity imports in winter. But what will happen if neighbouring countries no longer can or no longer want to supply it and if

nuclear power production one day stops? Huge storage facilities would be needed to store the electricity generated in summer. This would require, for example, constructing new and higher dams and additional pump storage power plants, which would be highly questionable from an ecological point of view.

A simulation study at SLF and ETH Lausanne explored how much potential renewable energy in Switzerland has to fill the winter gap. It showed that, if wind and solar energy were expanded considerably, they could, together with today's hydropower production, reduce the amount of energy Switzerland would have to import in winter without nuclear power by 80 per cent.

Solar power in the mountains is very promising. Solar plants on dam walls and avalanche barriers work much more efficiently, especially in winter, than those in the foggy lowlands, says Annelen Kahl. She is a solar researcher at SLF and co-managing director of the solar company SUNWELL. In the mountains sunny days are more frequent, the snow reflects the sunlight, and the solar panels can be optimally aligned with the winter sun, unlike on the roofs of buildings. According to the simulation, installing roughly 100 km^2 of new solar panels, with half in the Alps, would be realistic. The rest of the winter gap would have to be filled by about a thousand new wind turbines.

Together, these plants would produce around 25 TWh of electricity, which is considerably more than that produced today with solar (3 TWh) and wind power (0.15 TWh). "You would still need to have additional storage for summer electricity, but much less," says Michael Lehning. "So the energy transition in Switzerland would be feasible from a technical point of view."

Wind power as a stumbling block

Administrative hurdles such as building permits pose difficulties, while social acceptance is even more of a problem. In unspoilt areas with great wind potential, the public tend not to want energy plants, as WSL's Energyscape project showed. Several wind-farm projects remain blocked by local opposition even in well-populated regions. "It's not about the lack of technology, but the lack of communication and acceptance," says Boris Salak, a social scientist who participated in the project. Various studies have shown that the public tend to be more positive about energy plants if they are involved in the planning process at an early stage.

To encourage local participation, energy cooperatives could provide a role model. Around three hundred such cooperatives already exist in Switzerland. They mostly operate small, jointly financed photovoltaic or woodchip plants, especially in rural areas. A WSL survey in 2016 concluded that the advantages of cooperatives are their local roots, broadly based financial participation and close cooperation with the local communities. However, promoting this form of organisation would require a cost-covering purchase guarantee for the energy produced that lasts for the lifetime of the plants.

According to Boris Salak, the energy transition will only have a chance if the authorities and energy producers take socio-political aspects into account. These include social values such as people's attitudes towards 'their' landscape, as well as such ecological costs as a possible loss of biodiversity. "Selecting the sites for energy plants on the basis of technical-economic principles alone will not be sustainable." *(bki)*