Report 2021

Switzerland

Slackline on Peuchapatte Wind Farm. *Photo: Suisse Eole*

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By the end of 2021, Switzerland had 42 large wind turbines in operation with a total rated power of 87 MW. These turbines produced 146 GWh of electricity in 2021.

The construction of a new wind farm with a capacity of 14 MW began in 2021; it will be operational by the end of 2022, increasing the total wind power capacity by 16%. A cost-covering feed-in tariff (FIT) for renewable energy in Switzerland has been in place since 2009 [1]. This policy promotes wind energy, and despite the long authorisation process, many projects are still in development. Financing is currently requested for an additional 3.2 TWh under the FIT scheme.

Internationally cross-linked research activities in 2021 focused on cold climates, complex terrain, aviation cohabitation, and social acceptance.

Table 1. Key National Statistics 2021: Switzerland

Total (net) installed wind power capacity	87 MW
Total offshore capacity	0 MW
New wind power capacity installed	0 MW
Decommissioned capacity (in 2020)	0 MW
Total electrical energy output from wind	146 GWh
Wind-generated electricity as percent of national electricity demand	0.2%
Average national capacity factor	19.2%
Target (2050)	4.3 TWh/yr
National wind energy R&D budget	7.45 mio CHF (2020 most recent)

Highlight(s)

- One project is under construction, and 2 positive decisions from the federal court were issued in 2021, opening up more deployment.

Market Development

Targets and Policy

The Energy Strategy foresees an additional 22.6 TWh/yr from renewable energy by 2050. Wind energy should contribute 4.3 TWh/yr to this target (with intermediate goals of 0.3 TWh in 2025 and 1.2 TWh in 2035).

Since the introduction of the FIT in 2009, wind projects with an estimated energy yield of 120.8 GWh are in operation and being supported under the scheme in 2021; additional projects with a potential energy yield of 1,737 GWh have been registered, and 1,507 GWh are on the waiting list. This FIT scheme is now over, and a new scheme based on investment subsidies will support wind energy deployment from 2022 (investment subsidies up to 60%). This scheme has the disadvantage of not covering the market price risks on the long terms, and is, therefore, not appropriate for wind energy projects. This scheme could be interesting for community-owned wind turbines, but the authorisation process for such smaller project has to be defined.

The cost of the FIT is financed by a levy on electricity consumption. The maximum levy is of 23 CHF/MWh (around 21.2 EUR/MWh; 23.8 USD/MWh) and a fund to support renewable energies in Switzerland is financed. The FIT for newly installed wind turbines in 2021 was between 130 CHF/MWh and 230 CHF/MWh. Wind turbines built on locations 1,700 m above sea level or higher receive an altitude bonus of 25 CHF/MWh (23 EUR/MWh; 25.8 USD/MWh) in addition to the standard retribution [3]. The payment period expands over 15 years. This price is a contract for difference, with the market price being at the very high end of 2021, wind turbine operators under this scheme have to give money back to the fund.

Progress and Operational Details

Approximately 59% of Switzerland's overall electricity production comes from renewable sources, with hydropower by far the biggest contributor (95%). Wind power generation currently provides 0.2% of Swiss electricity consumption. End of 2020, new turbines were installed, but these turbines were not fully commissioned in 2021. Projects that are already in the advanced planning stages represent an additional 360 MW, while early-stage projects represent roughly 600 MW.

Matters Affecting Growth and Work to Remove Barriers

Lengthy planning procedures (15 to 20 years) are the greatest hindrance to Swiss wind energy growth. Stakeholders at different authority levels must first give their authorisation, and specific projects must also be approved by voters in the local population.

In general, the Swiss population is favourable to wind energy as confirmed by votes at national and local levels. However, the opposition is very well organised, manages to polarise discussions on specific topics, and systematically uses every possi-

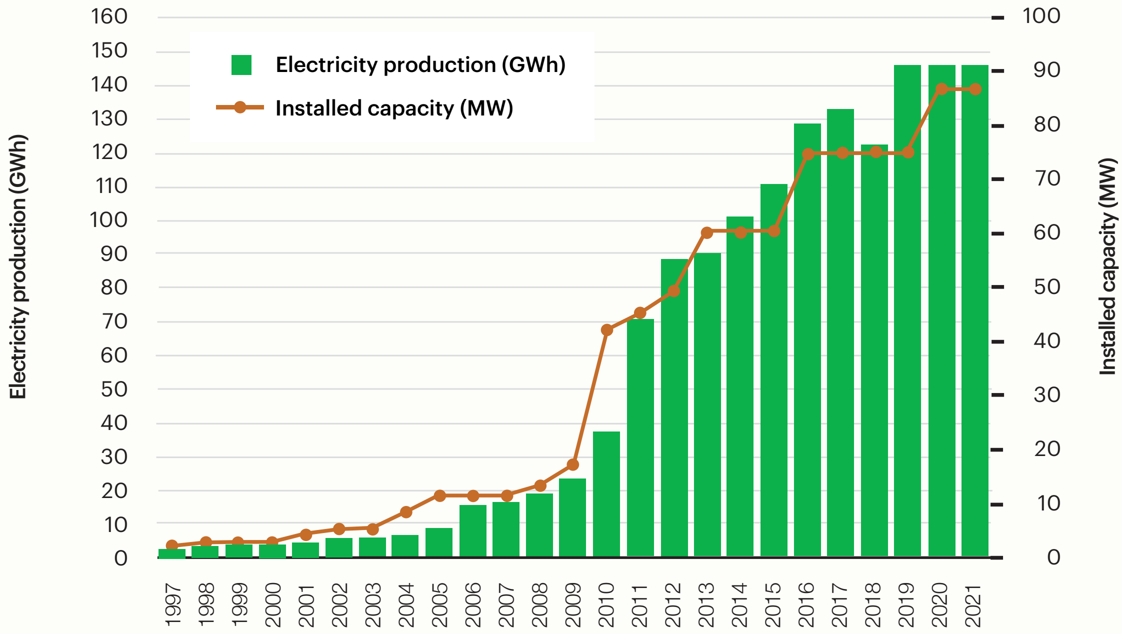

Figure 1. Installed and cumulative wind power capacities and share of electricity demand met by wind energy

ble channel of appeal, which slows down the planning procedures.

Some Cantons (provinces) opened a combined procedure for land use planning and build permitting. Two to three wind farm projects followed the new simplified process in 2021. Moreover, the role of the cantonal authorities in the planning process is now better defined, and they are more able to assist project developers and communes with a project on their territory.

RD&D Activities

National RD&D Priorities and Budget

The priorities of the research term 2017 to 2022 remain valid for 2021 [4]. These priorities are:

- Performance optimisation per turbine and farm via turbine optimisation, control optimisation, and wind farm design;
- Reduction of turbine downtimes through technical optimisation, icing protection, wind forecasts, and understanding of avifauna behaviour; and
- Acceptance of wind power. This includes accelerating research between wind power and other fields (such as ornithology or noise research) and promoting stronger cooperation between federal offices and institutes.

In 2021, the budget for wind energy-related R&D and demonstration projects from the Swiss Federal Office of Energy was approximately 0.5 million CHF (0.44 million EUR; 0.53 million USD). Within the national Swiss Energy program, approximately 0.4 million CHF (0.37 million EUR; 0.45 million USD) were allocated to the wind energy sector for information activities, quality assurance measures, and the support of regional and communal planning authorities [4]. Budget-wise, the 2022 trend is the same as for 2021.

National Research Initiatives and Results

The Comparison metrics simulation challenge (COMESI) project of the Ostschweizer Fachhochschule is ongoing. Its purpose is to help modellers to choose the best suitable model for a given wind energy project in complex terrain.

Due to the complex nature of the weather and the wind flow over the earth's surface, it can be very challenging to measure and model the wind resource correctly. For a given project, the modeler is faced with a difficult choice of a wide range of simulation tools with varying accuracies and costs. In this project, a public "simulation challenge" for wind energy sites in complex terrain is being implemented in collaboration with IEA Wind Task 31, in which participants submit their simulation data and results in a pre-defined template.

The influence of site complexity on the skill versus cost score plots was briefly explored by comparing three different models for four sites with increasing complexity. It was shown that for increasing site complexity, the "before" skill scores decreased, and the gaps between the skill scores of each model increased dependent on its sophistication, i.e., LES outper-

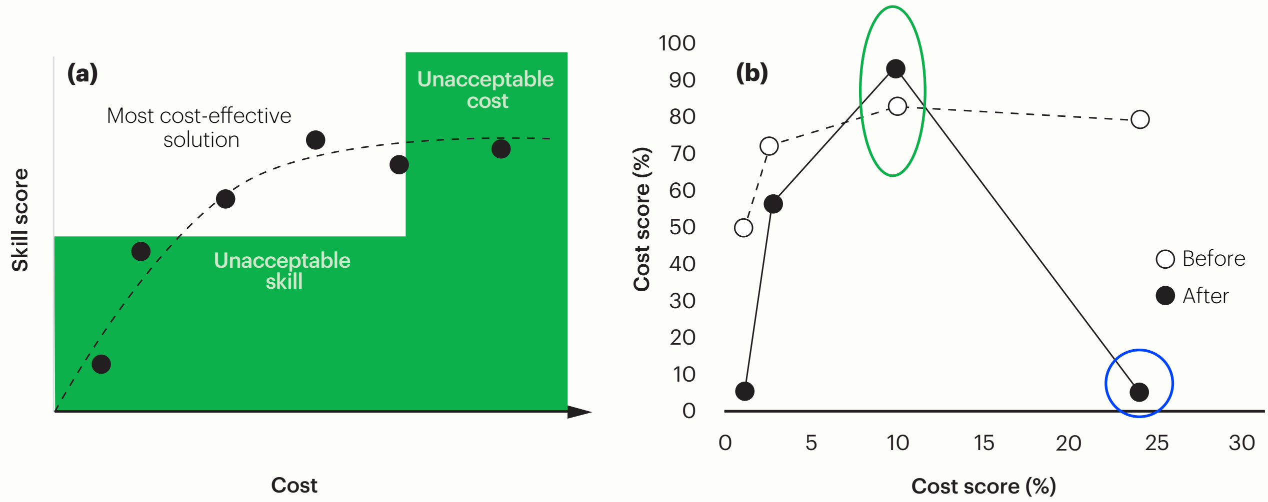

Figure 2. (a) Theoretical cost vs. - skill score; (b) Results of the initial study.

formed RANS and WAsP simulations. In turn, for less complex sites, RANS and WAsP simulations performed similarly to the LES case but had significantly better cost scores. [5]

Understanding the wind potential of the Alps is also a focus of research. The objective of the MaxWEP project is to explore the potential of the wind over complex terrain as an energy source during wintertime in Switzerland. A wind assessment method is developed to assist and promote the transition of the Swiss electricity supply system towards renewable energy resources. Driving a high-resolution numerical weather model (WRF) with the COSMO model as an input, the researchers create a map of the spatial pattern of the local wind speed potential. They further provide predictions of a vertical profile of wind speed by using a machine learning algorithm driven by a combination of ground-based scanning LIDAR measurements, 3D ultra-sonic anemometer data, and data from the surrounding operational weather station network of MeteoSwiss.

In order to bring together the wind energy research community of Switzerland, an initiative by HSR was concretised in 2019 with the launch of The Swiss Wind Energy R&D Network at a dedicated national Forum which gathered 162 members end of 2021. The concept developed is the first central collaboration platform in the wind energy industry that provides real incentives for participation. The network offers a platform to initiate and coordinate new collaborative wind energy projects in the areas of R&D, learning, and teaching, ultimately aiming to foster excellence in Swiss wind energy R&D and to promote the export of Swiss know-how in products and services to the international wind energy market (https://www.wedowind.ch/).

Collaborative Research

Switzerland is involved in the following IEA Wind TCP Tasks:

- Task 11 Base Technology Information Exchange Wind SCOUT (Operating Agent)
- Task 19 Wind Energy in Cold Climates (with the particularly active participation of Meteotest)
- Task 28 Social Acceptance of Wind Energy Projects
- Task 31 International Wind Farm Flow Modeling WAKEBENCH
- Task 32 LIDAR: Wind Lidar Systems for Wind Energy Deployment LiDAR
- Task 34 Working Together to Resolve Environmental Effects of Wind Energy (WREN)
- Task 48 Airborne Wind Energy

Impact of Wind Energy

Environmental Impact

With Carbowind study results mentioned above, the impact on carbon reduction with newly installed wind power plants is promising, with 378 g CO_2/kWh saved based on an hourly analysis of the Swiss energy electricity system. Wind power generation, combined with solar power, is expected to replace power generated at nuclear power plants, which are expected to be shut down at the end of their lifetime until 2035.

The Federal Council has developed the Energy Strategy 2050. This should enable Switzerland to make advantageous use of the new starting position and maintain its high supply standard. At the same time, the strategy contributes to reducing Switzerland's energy-related environmental impact.

Photo: Peter Wormstetter/Unsplash

Economic Benefits and Industry Development

A study estimated that the total turnover in wind energy in Switzerland in 2010 was about 38.9 million EUR (47.6 million USD) and that the wind industry employed about 290 people [6]. Another study from 2009 estimated the worldwide turnover of Swiss companies in wind energy is 8.6 billion EUR (10.5 billion USD) by 2020.

The Swiss industry is active in several wind energy fields:

- Development and production of chemical products for rotor blades, such as resins or adhesives (Gurit Heberlein, SIKA, Huntsman, Clariant)
- Grid connection (ABB)
- Development and production of power electronics such as inverters (ABB, VonRoll)
- Services in the field of site assessments and project development (Meteotest, Interwind, NEK, Basler & Hofmann, etc.)

Next Term

In terms of deployment, the construction of the Saint Croix wind farm project started in 2021, and 14 MW should be added to the total capacity end of 2022.

ETHZ and TU Delft are working on the WindSpores project. In this project, hundreds of different technically and economically feasible spatial configurations for Swiss wind deployment will be analysed.

The project RAST Radarsimulations should develop better planning for wind turbines due to knowing the influence on a radar beforehand.

References

[1] Swiss Federal Office of Energy (2018).
Système de rétribution de l'injection.
https://www.bfe.admin.ch/bfe/en/home/foerderung/renewable-energy/feed-in-remuneration-at-cost.html

[2] Swiss Federal Office of Energy (n.d.).
Energy strategy 2050.
https://www.bfe.admin.ch/bfe/en/home/policy/energy-strategy-2050.html

[3] Swiss Confederation (2017).
Ordonnance sur l'encouragement de la production d'électricité issue d'énergies renouvelables OEneR.
https://www.admin.ch/opc/fr/classified-compilation/20162947/201904010000/730.03.pdf

[4] Swiss Federal Office of Energy (n.d.).
Wind Energy Research Program.
https://www.bfe.admin.ch/bfe/en/home/research-and-cleantech/research-programmes/wind-energy.html

[5] S Barber, A Schubiger, S Koller, A Rumpf, H Knaus and H Nordborg (2020)
Actual Total Cost reduction of commercial CFD modelling tools for Wind Resource Assessment in complex terrain. J. Phys.: Conf. Ser. 1618 062012,
https://doi.org/10.1088/1742-6596/1618/6/062012

[6] Rutter & Partner (2013).
Volkswirtschaftliche Bedeutung Erneuerbarer Energien in der Schweiz.