Axpo Energy Reports

Wind energy

Introduction

A secure, affordable and sustainable electricity supply is fundamental to the functioning of Swiss society and the economy. Today, Switzerland benefits from very good conditions for a reliable supply thanks to hydropower, nuclear power, new renewable energies and its central location in the European power grid.

However, without appropriate measures, this position will come under pressure in the coming decades. The electrification of mobility and heating, in addition to population growth, are likely to significantly increase the demand for electricity. Rising energy demand of data centres, cloud services and generative AI further contribute to this trend. At the same time, the planned phase-out of nuclear power will eliminate part of domestic electricity production in the long term.

The focus is increasingly on the winter half-year. Switzerland already consumes more electricity in winter than it produces. In the darker months of the year, the demand for heat is higher and people generally spend more time indoors, which increases the power consumption of electronic devices and lighting. In addition, hydropower produces less electricity due to the seasonal runoff profile with a high proportion of run-of-river water. The current expansion of renewable energies in Switzerland and neighbouring countries is also largely based on solar energy, which generates most of its yield in the summer half-year. The seasonal difference between summer surpluses and winter deficits is increasing, making a secure winter supply increasingly difficult.

In addition to close cooperation with neighbouring countries and the EU, the development of reliable, affordable and sustainable domestic electricity production is needed to secure the electricity supply in the future. In the Axpo Energy Reports, we look at four technologies that could substantially increase domestic electricity production in the winter half-year: Wind energy, new nuclear power plants, solar energy and gas-fired power plants.

This report outlines the regulatory and social framework conditions that can accelerate the expansion of wind energy. It is not intended as a position paper: it does not assess whether wind energy should be expanded, but rather describes the conditions that must be met for wind energy to make a substantial contribution to winter electricity generation by 2050.

This report deals with the Expansion of wind energy in Switzerland by 2050.

Disclaimer: This report was originally drafted in German and has been carefully reviewed by experts, particularly with regard to terminology and content accuracy. The translations are intended to make the report more accessible to a nationwide and international audience and have been produced with the utmost care. In the event of any questions regarding interpretation, the original German version is considered authoritative.

Table of contents

01

Summary

The use of wind energy for electricity production is a mature technology, but it has only been used marginally in Switzerland to date. At the end of 2025, 50 wind turbines at 13 locations contributed around 0.2 percent (180 GWh) to Swiss electricity production. Wind energy offers a particular advantage here: Two-thirds of electricity production occurs in the winter half-year. The Swiss Federal Office of Energy estimates the theoretical wind energy potential in Switzerland at 29.5 TWh per year – which corresponds to around half of the total Swiss electricity consumption in 2025.

Modern wind turbines are significantly more efficient than earlier models and can operate across a wider wind-speed spectrum. These developments mean that wind turbines can now be operated economically in Switzerland with today's subsidies, despite moderate wind speeds. Modern systems are also quieter than older models and can be switched off when necessary to protect birds and bats.

The current Electricity Act (EnG) provides for an expansion of renewable energy generation of 45 TWh by 2050[1]. The Federal Council specified this target in November 2025: The interim target for 2030 for the expansion of wind turbines has been set at 2.3 TWh. This requires the addition of around 250–300 additional wind turbines by 2030[2].

At a national level, surveys indicate generally strong public support for the construction of wind turbines, with approximately 60 percent of respondents expressing permitting[3]. In contrast, assessing permitting and acceptance at the local level is more difficult. However, the delays resulting from objections in practice indicate increased scepticism at the local level: Wind projects that are currently in the permitting process are delayed in 60 percent of cases due to objections from associations. The remaining 40 percent are delayed by objections from private individuals. At the same time, around 60 percent of the referendums held in the local communities on wind projects in later and thus specific project phases are positive. However, many projects never reach this stage or have already undergone major adjustments. Lack of local acceptance is the biggest challenge for wind energy projects in Switzerland.

The current procedural and authorisation processes allow for objections to the same project at multiple stages, often resulting in lengthy processes and significant delays. Depending on the canton, an objection to communal land-use planning can first be appealed to two cantonal instances and then to the Federal Supreme Court. The same applies to the subsequent building permit procedure. It is also possible that a higher authority will not make a final decision on the objection, but will instead refer the matter back to the lower authorities for further clarification and a new decision. As a result, previous planning and

[1] Federal Act on a Secure Supply of Electricity with Renewable Energies, 2023, Art. 2 (2) of the Energy Act
[2] Taking into account a typical plant with 8 GWh and the current expansion (50 plants).
[3] gfs.bern, 2025, Final report – Wave 4 energy supply security study

approval procedures for wind turbines in Switzerland took an average of 15 years. Current projects are already 9.5 years old on average. The combination of low local acceptance and the extensive opportunities for objections within the current authorisation process is the main reason why so few wind turbines have been built in Switzerland to date.

The Acceleration Decree adopted by Parliament in the 2025 autumn session and coming into force in stages from 1 January 2026 provides for the Consolidate the planning and approval process in a cantonal planning approval procedure. If these simplifications are consistently implemented and the scope for appeals is limited, the duration of approval may be shortened. Some cantons (e.g. LU, SG) have already incorporated some or all of the requirements into cantonal corporate law. In addition, cantonal suitability areas for wind turbines are decisive as a basic requirement in the planning and authorisation process. Due to their location in a suitable area, plants above a certain size are also attributed to the "basically overriding national interest" in accordance with the revised Energy Act. There are major differences between the cantons: Some cantons (such as Lucerne or SG) already have some areas of suitability, while others are only at the beginning of work on the necessary structural plan adjustments. The cantons have identified suitable areas with a theoretical potential of 6.9 TWh in their structure plan (as of June 2025). However, once projects are realised, the achievable energy yield is usually considerably lower.

To accelerate the expansion of wind energy in the future, it is therefore crucial that the cantons designate additional suitable areas and consistently implement the federal requirements for speeding up the permitting process.

Wind turbines in Switzerland, like any other electricity generation technology, cannot be operated economically without subsidies. The cost of generating electricity is between 75 and 124 Swiss francs per megawatt hour. This applies to locations that are well suited for wind turbines due to their full load hours. Locations that are not suitable for wind turbines due to very low full load hours are not considered in this report. These are not considered here. However, it is possible that locations in potential areas fall into this category, i.e. despite the potential area, the wind speed is not sufficient for wind turbines. Based on the electricity market simulation used here, and taking into account possible revenues from green electricity certificates, income from the sale of wind-generated electricity over the next 25 years is expected to average around 40 to 70 Swiss francs per megawatt. This difference reflects the subsidy requirements for wind turbines in Switzerland.

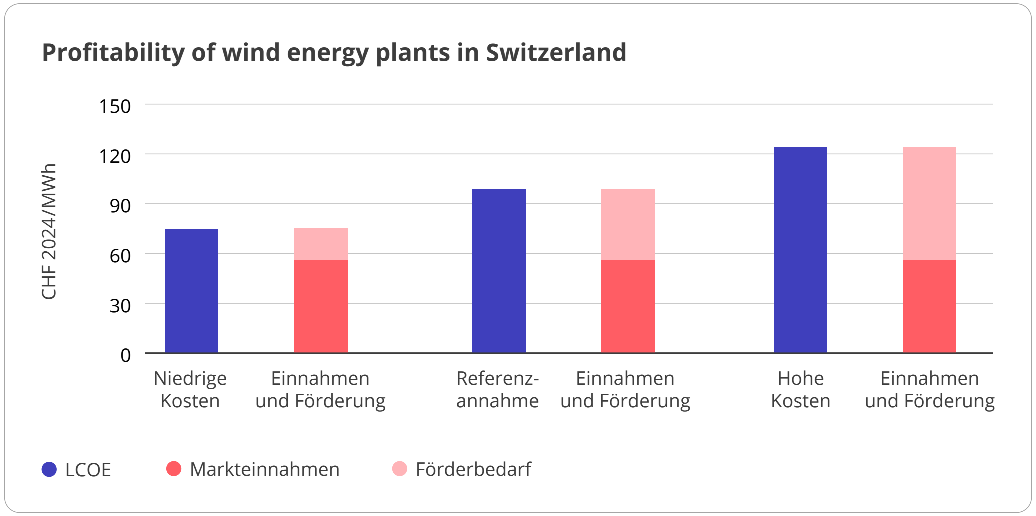


Figure 1: Comparison of production costs, average market revenues and green electricity certificates in CHF, real 2024. The subsidy requirement is calculated from the difference.

Costs and income are influenced by various factors:

- **Location:** The wind conditions at the chosen location have a direct impact on profitability, as they determine how much electricity can be generated. The costs, for example for transport or grid connection, also depend heavily on the location.

- **Regulatory framework:** The duration of the permitting process and regulatory requirements increase production costs.

- **Differences to other countries and Swiss finish:** Higher construction and labour costs, geography (Alps, no economies of scale due to large wind farms) and land availability as well as regulatory requirements (wind measurement) make Swiss projects more expensive than abroad.

The federal government supports wind projects financially through investment contributions or sliding market premiums and project planning contributions. In the case of investment contributions, wind projects can receive subsidy of up to 1650 Swiss francs per kWh, depending on the type of system, in accordance with the current ordinance. Legally, a maximum of 60 percent of the total investment can be subsidised. Under the current reference assumptions, wind projects with state subsidies would be able to cover their costs today. The average electricity generation costs of 99 Swiss francs per MWh consist of an investment share of 80 percent of the investment, corresponding to around 79 Swiss francs per MWh. Based on the average revenue assumed here, the resulting subsidy requirement amounts to 38 Swiss francs per MWh, or roughly 48 percent of the investment. A typical wind turbine generates two thirds of its energy in winter. To analyse the subsidy efficiency in terms of winter contributions, the subsidy requirement of 14 to 63 Swiss francs per MWh is allocated to the electricity produced in winter. This results in a winter-specific subsidy requirement of between 21 and 95 Swiss francs per MWh.

The construction and operation of wind turbines in Switzerland generate both macroeconomic and economic effects. The resulting added value and impact on jobs occurs at various stages in the value chain, each with a different domestic share. In the case of a typical system, around 40 percent of the total costs are attributable to production. Around 80 percent of this is imported. Over the entire life cycle, the domestic value-added share amounts to 69 percent of the total costs. In other words, for every Swiss franc spent on wind energy, 0.69 Swiss francs of added value is generated in Switzerland. A typical wind turbine employs around 2.7 people full-time across construction, operation, maintenance, and dismantling. Measured per unit of electricity, this corresponds to around 323 full-time jobs per TWh generated.

The expansion of wind energy in Switzerland faces challenges that are primarily structural rather than technological in nature. The analysis shows several interacting factors that have made expansion very difficult in the past. Achieving a substantial expansion of wind energy requires coordinated action at several levels. Consistent acceleration of procedures, ambitious structure plan by the cantons and at least maintaining the state subsidy scheme at its current level are key prerequisites for achieving the federal government's expansion goals.

Another key factor for the further expansion of wind turbines is the improvement of acceptance at the local level: Without the support of the affected population and municipalities, even optimised procedures with fewer opportunities for objections and sufficient subsidy will not lead to the desired expansion. Acceptance must therefore be actively addressed.

02 Technology

Wind energy is a mature technology, generating two-thirds of its output in winter, but it is not widely developed in Switzerland.

In brief

- Horizontal axis wind turbines have established themselves worldwide and are technologically mature.
- Wind energy currently makes only a small contribution (0.17 GWh/ 0.2 percent) to electricity production in Switzerland, but has an expansion potential of up to 30 TWh.
- A large proportion of Swiss wind production, around two thirds, occurs in the winter half-year.
- The historical expansion of wind energy in Switzerland was characterised by long implementation periods due to delays in the permitting processes. Until now, wind projects in Switzerland have taken an average of around 15 years to be built.

2.1 Technological development

The average output of onshore wind turbines has multiplied over the last 20 years. While turbines in the early 2000s usually had an output of around 1 MW, modern turbines can often reach 5 MW or more. This makes it possible to generate more energy with fewer systems, which reduces both specific costs and the space required. The increase in performance is mainly due to the increase in hub heights (the distance from the ground to the centre of the rotor) and larger rotor diameters. Higher turbines make it possible to use stronger and more constant wind flows at higher altitudes, which increases the full-load hours[4] and output, resulting in a higher energy yield per turbine. These developments have significantly improved the profitability of wind turbines in Switzerland, despite moderate wind speeds in some locations.

Rotor blades twice as large > 4 times as much wind energy

+ grössere Nabenhöhe und dadurch höhere durchschnittliche Windgeschwindigkeiten

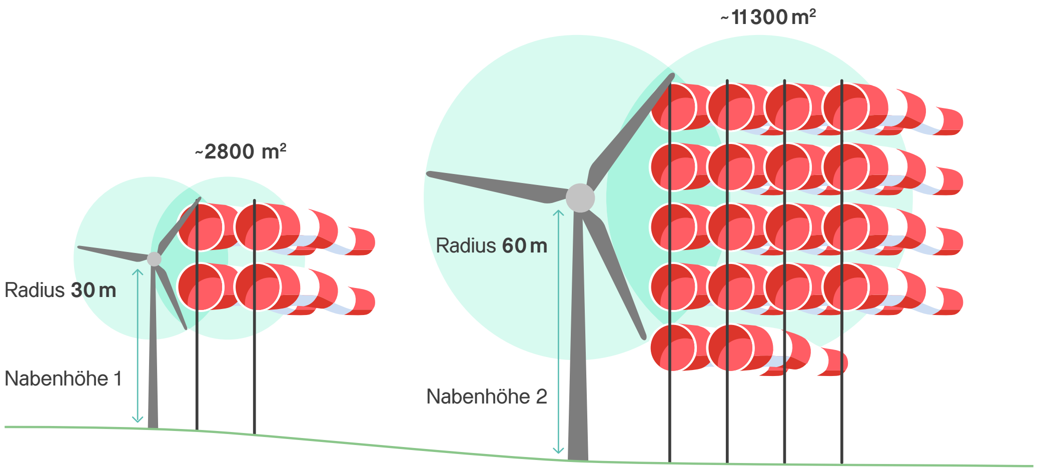


Figure 2: The effect of rotor blade length and hub height on the power output of wind turbines.[5]

Developments in achievable hub heights and rotor diameters have been driven by significant advances in the materials used. Today, rotor blades are predominantly made of glass or carbon fibre reinforced plastic. These composite materials are both lightweight and robust, enabling the blades to withstand the wind and weather stresses effectively.

[4] Full load hours describe the degree of utilization of a technical system: VLS = annual energy yield (MWh)/installed capacity (MW).
[5] Axpo Holding AG, 2025, Role and potential of wind energy in Switzerland

The generators and power electronics in wind turbines have also undergone significant development. In the past, predominantly asynchronous generators were used. While these are robust, they are less efficient. Today, modern wind turbines increasingly use synchronised permanent magnet generators, which have lower energy losses but higher material costs. They can also be driven directly and do not require a maintenance-intensive gearbox.[6]

Despite technological advances, wind turbines still have some impact on their immediate environment. However, technical solutions are available for three key aspects that can minimise these effects:

- **Modern systems can be quieter than a conversation:** Modern turbines are significantly quieter than older models. Aerodynamically optimised rotor blades and sound-insulated generators reduce noise emissions below the legally prescribed limits that are required in Switzerland for 40–55 dB(A) in residential areas[7]. By way of comparison: A normal call generates about 60 dB(A). However, even if the actual load is low, the noise immission of wind turbines is often perceived as more disturbing than the same loud background noise, since the noise caused by the movement of the rotors has a cyclical character.[8]

- **Intelligent control systems minimise the casting of shadows:** The movement of the rotor blades creates shadows that can be effectively minimized with modern control systems, but not completely prevented. These systems temporarily interrupt the operation of the turbines when the sun is at certain positions or during critical periods. In contrast to Germany, where the maximum duration of dynamic shadow casting is limited to 30 minutes per day and 8 hours per year[10], there is no corresponding public law regulation and / or case law in Switzerland. As a result, affected parties must assert their claims in advance under the civil regulations of neighbouring law, where they are subsequently assessed by the courts.

- **Automatic switch-off and early detection provide effective protection for living organisms:** The impact of wind turbines on wildlife, especially birds and bats, is significantly

Comparison of Noise Levels from Wind Power Plant

Direkt unter einer laufenden Windenergieanlage ist eine Unterhaltung im normalen Plauderton jederzeit möglich.

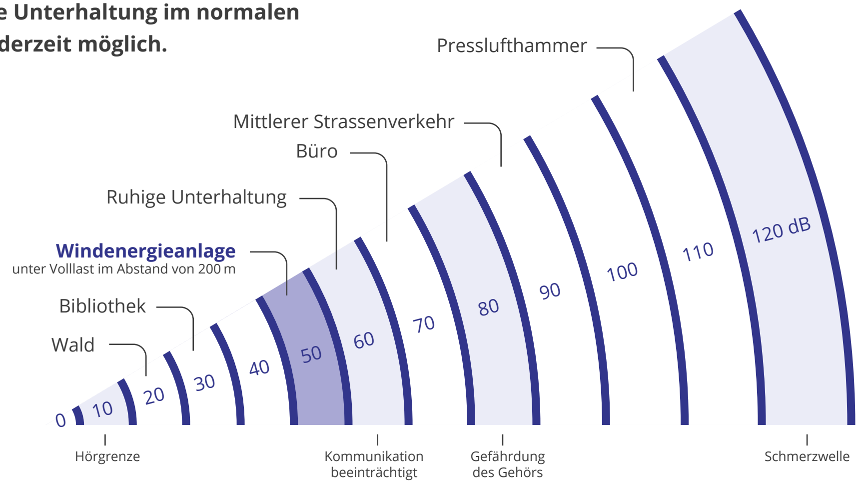


Figure 3: Noise levels in various everyday situations vs. wind power plants[9]

[6] Nejad, Keller, & Guo, 2022, Wind turbine drivetrains: state-of-the-art technologies and future development trends
[7] Eggenschwiler, Heutschi, & Schäffer, 2016, Auswirkungen und Beurteilung des Lärms von Windenergieanlagen – aktuell Beiträge aus der Schweiz
[8] Attya, Dominguez-Garcia, & Anaya-Lara, 2018, A review of frequency support provision by wind power plants: Current and future challenges
[9] Suisse Eole, 2025, Suisse Eole – Swiss wind farms and projects
[10] Landes-Arbeitsgemeinschaft Immissionschutz, 2020, Notes on determining and assessing the optical immissions of wind power plants, 2019 update

reduced through modern measures. Site-specific surveys are carried out as early as the planning phase to identify potential risks. Measures such as shutting down facilities during sensitive times (e.g. during migratory bird migration) or installing detection systems with radar to detect birds and bats help to minimise the impact.[11]

However, switching off wind turbines to reduce shadow flicker or protect wildlife reduces the energy yield. This directly affects revenue and therefore the profitability of wind turbines.

2.2 Buildout of wind energy in Switzerland

Wind energy contributed around 0.25 percent to annual electricity production in Switzerland in 2025[12]. By the end of 2025, 50 wind turbines are expected be in operation at 13 locations across the country, with a forecasted total installed capacity of 109 MW and producing around 180 GWh of electricity per year. More than half of this production is accounted for by the two largest wind farms Mont-Crosin in the canton of Bern (16 turbines, 78 GWh) and Sainte-Croix in the canton of Vaud (6 turbines, 20 GWh)[13].

The winter electricity share of Swiss wind production has averaged 62 percent over the last five years.

The wind turbines used in Switzerland are exclusively three-blade drive rotors with a horizontal axis that are adapted to inland conditions. The turbines installed today have a typical output of 2–3 MW.

A wind farm with six turbines and an annual production of around 45 GWh is currently being built. The portfolio of wind turbines is offset by an extensive projectproject pipeline. At the end of September 2025, 21 projects (137 plants, 836 GWh) were in the permitting process. The projects have already been in the permitting process for an average of 9.5 years[14] and show significant delays compared with the original project planning. The average permitting period for wind projects in Switzerland was 15 years for the turbines built today.[15] However, the regulatory basis has improved significantly in recent years, meaning that the average duration for new projects is only of limited informative value and is likely

Overview of existing wind power plants in Switzerland

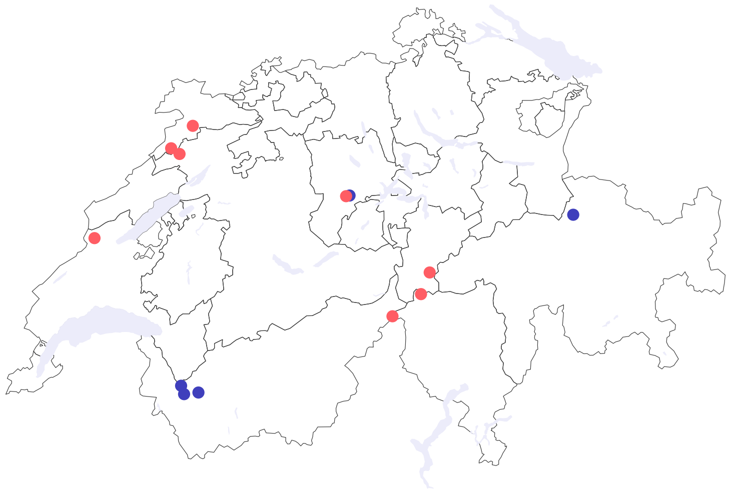


Figure 4: Map showing existing wind power plants in Switzerland (as of 2025). Red: Wind farms with multiple turbines; Blue: Large individual turbines >1 MW.

[11] Suisse Eole, 2025, Suisse Eole – Swiss wind farms and projects
[12] Swiss Federal Office of Energy, SFOE, 2025, Swiss electricity balance – monthly values
[13] Suisse Eole, 2025, Suisse Eole – Swiss wind farms and projects
[14] Schmid, 2024, Swiss wind energy projects in the federal state structure
[15] Suisse Eole, 2025, Suisse Eole – Swiss wind farms and projects

to be shorter in the future (more on this in Section 3.4).

2.3
Potential of wind energy in Switzerland

Switzerland has considerable potential to use wind energy. Although wind speeds inland are moderate compared to coastal regions, numerous locations in Switzerland offer favourable conditions for the construction of wind turbines.

In its final report on Switzerland's wind potential from 2022, the Swiss Federal Office of Energy (SFOE) reports a national potential of 29.5 TWh/a[16] (compared to: Electricity consumption in Switzerland in 2024: 57.5 TWh). This estimate is a significant increase over the previous estimate of 3.7 TWh/year from 2012[17]. The main reasons for the increase are technological advances and political changes, such as a stronger focus on domestic electricity production. The realisation of large-scale renewable energy plants is now considered a matter of national interest. Authorities and courts are therefore required to assess the projects as equivalent to other national interests when weighing up considerations during planning and authorisation procedures, or in the event of complaints (see Chapter 3.3 for more details).

The calculation of the potential is based on a detailed analysis of wind resources, subdivided according to the specific natural areas of Switzerland: Central Plateau, Jura and wide Alpine valleys as well as the Alpine region. For each region, specific turbine types were adapted to the respective wind conditions and topographical characteristics. The methodology also incorporates exclusion criteria to account for technical, economic, ecological and social restrictions. Around half of the identified potential is in forest areas (14.8 TWh/year).

Another exclusion criterion in the study of wind potential is that systems located in industrial zones were not considered. However, wind turbines built in industrial zones can be of interest to large energy consumers, especially if the area cannot be used for other purposes. Grid connections are often already available or nearby, which can save some of the connection costs. There are no studies or more detailed analyses of the potential of wind energy in industrial zones in Switzerland[18].

Wind energy potential of the cantons according to the SFOE's potential study

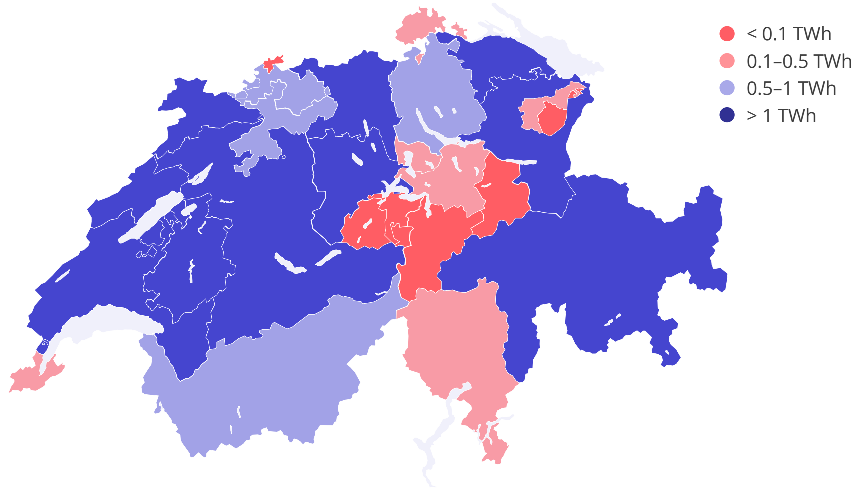


Figure 5: Areas with wind energy potential according to the SFOE: The areas marked in blue indicate potential sites for wind power plants.

[16] Swiss Federal Office of Energy, SFOE, 2022, Wind potential Switzerland 2022
[17] Federal Office for the Environment, FOEN, 2012, Energy Strategy 2050 – Potential for Wind and Solar Energy
[18] Potential according to Suisse-Eole approx. 2 TWh per year

2.4
Technological innovations

Horizontal axis wind turbines in the megawatt range have established themselves as the leading technology in the wind energy sector. Unconventional designs and small wind turbines appear to have inherent performance limits, making widespread implementation in Switzerland by 2050 rather unlikely.

Airborne wind energy systems offer promising potential, particularly in alpine regions, where they could open new opportunities for wind utilisation and deliver more stable load profiles than conventional systems. Over the past decade, however, the technology has faced significant technical challenges and attracted only limited investment. Broad implementation by 2050 therefore seems unlikely (lower TRL than small wind turbines).

There are no new innovative turbines as an alternative to today's wind turbines to meet the challenge of Switzerland's energy supply by 2050.

Alternative Wind Systems

Category	Unconventional Designs	Small wind systems	Flying Wind Energy Systems
Technology	Vertical-axis wind turbines and other designs in the MW range	1–100 kW wind turbines for installation in urban or built-up areas or in locations unsuitable for large turbines	Flying, tethered device (kite or aircraft) that utilizes atmospheric winds at 250–750 meter altitude
TRL*	1–6	6–8	4–5
Potential	• Possible efficiency improvements overall or in weak winds, depeding on geometry, reduction of noise, bird and bat strikes. etc.	• Application in built-up areas with minimal impact on landscape and biodiversity, simplified grid connection and local usage • Lower project costs and better integration possible	• Utilization of stronger, more stable high-altitude winds • Requires 90 percent less material than conventional wind turbines • Use in regions unsuitable for conventional turbines (e.g. alpine regions) possible
Challenges	• Conventional MW turbines are scientifically considered optimal for accessible wind conditions – new more efficient designs very unlikely • Claims regarding noise, biodiversity etc. not commercially proven	• Small systems have significantly lower capacity factors than large turbines • Strong dependence on site structure (vibration, noise, etc.) • Limited reliability of technology • No suitable regulation	• Early development stage with major hurdles in take-off/landing and automated flight in variable conditions – no commercial product before 2030 • Hardly any investments worldwide • No suitable regulation and competition for airspace usage
Chances for large-scale deployment	insignificant	insignificant	insignificant
Impact on energy system	insignificant	insignificant	insignificant

Table 1: Potential and Challenges of Alternative Wind Systems

*TRL: Technology Readiness Level, scale from 1 – conceptual to 9 – implemented

03 Planning and permitting of projects

The situation regarding permitting projects has recently improved significantly; cantons must take a more active role and consistently implement the legislation on accelerated procedures.

In brief:

- The new Acceleration Order provides for the creation of a cantonal planning permitting process, bundles land-use planning and building permit, shortens the right of appeal to a cantonal authority plus the Federal Supreme Court and creates the framework for reducing the duration of the authorisation procedures to ideally up to five years – if the cantons implement the proposal consistently and with sufficient resources.

- The designation of suitable areas is an essential prerequisite for the expansion of wind energy. As of June 2025, suitable areas with an annual yield of 6.9 TWh had been designated in the cantonal structure plans at 217 locations. The implementation status varies in the cantons: While some cantons are in the process of adapting their structure plans to new findings and, in some cases, to their own development goals, others have yet to do this work.

- Some cantons already have simplified and concentrated permitting processes, while other cantons still have this work to do with the implementation of the Acceleration Decree. The Acceleration Decree will now rectify these inequalities.

- Another way of promoting the achievement of the expansion targets for wind energy is to consider strengthening planning from a national perspective, e.g. in the form of a wind round table.

3.1 Cantonal suitable regions

Space in Switzerland is limited and subject to competing interests. The cantons' central instrument for managing spatial development is the cantonal structure plan. This forms an essential basis for the further planning and permitting processes for wind turbines. With the adoption of the Energy Strategy 2050 in 2017, the electorate mandated the cantons to create the planning conditions necessary for the use of wind energy. In practice, this means the cantons are required to define suitable regions for wind energy production in their cantonal structure plans. Identifying these

Achievement of the objectives of the structure plan amendment for wind energy

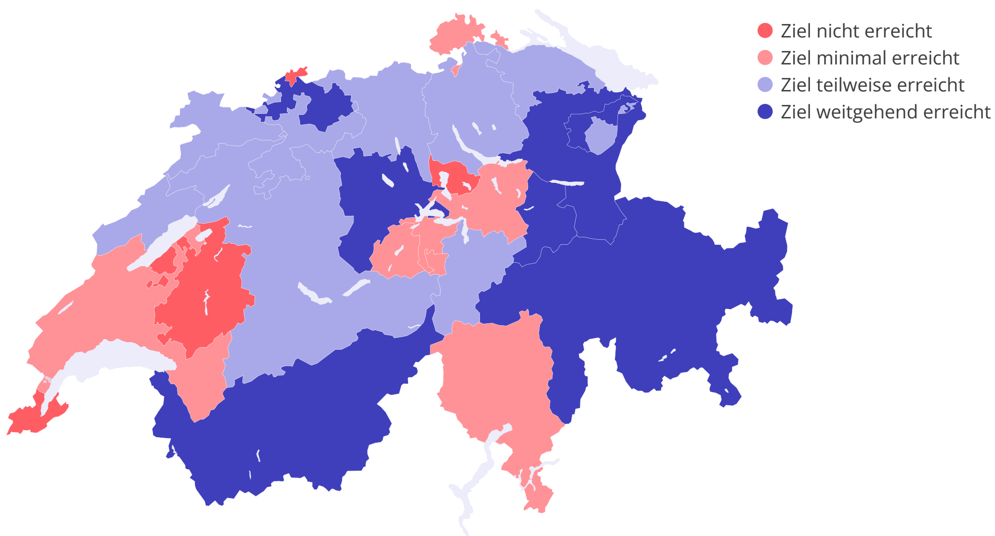


Figure 6: Target achievement by the cantons in terms of adapting the structure plans with suitable areas for wind turbines. Status June 2025.

suitability areas involves weighing up the interests concerned and provides a central foundation for further planning. In this way, the definition contributes to planning security for investors and ensures transparency. The designation of a suitable area in the structure plan significantly increases a wind project's chances of success during the land use planning and authorisation process. It should be noted, however, that the authoritative requirement for the authorities when drawing up and for the Federal Council when approving cantonal reference plans continues to be the wind energy concept from 2020[19] and does not take into account the revised potential of the SFOE from 2022[20].

A detailed analysis of the cantons shows: There are sometimes major differences between the individual cantons in the implementation of the requirements of federal law and in the determination of the areas of suitability. While some cantons have already defined the required areas of suitability and included them in the structure plans, others have not yet planned any changes or are only in the planning and development process. In order to be able to compare the cantons with each other, this report examines the achievement of the objectives set out in federal law and assesses them qualitatively on the basis of three criteria:[21]

- **Process status:** What is the current status regarding the revision of the "wind energy" structure plan? (draft, decision, plan permitting, legal force)
- **Coordination status:** Comparison of Areas of suitability in the structure plan (pre-orientation, interim result, determination).
- **Reported income:** If the Cantons Suitable areas based on the potential recommended by the SFOE 2022?

[19] Federal Office for Spatial Development ARE, 2020, Wind energy concept
[20] Swiss Federal Office of Energy, SFOE, 2022, Wind potential Switzerland 2022
[21] Basler & Hofmann, 2025, Analysis of cantonal guidelines for wind energy in Switzerland carried out by Axpo

Cantonal suitable regions, potential and goals for wind energy

Stand Juni 2025		Im kantonalen Richtplan	Potenzial BFE	Kantonale Ziele
Projektierungsgrad per 1.7.25	**Gebiete**	**GWh/a**	**GWh/a**	**GWh/a**
Aargau	5	50	1218	50
Appenzell Ausserrhoden	6	203	168	120
Appenzell Innerrhoden	4	23	81	10
Basel-Landschaft	14	500	597	500
Basel-Stadt	0	0	0	k.A.
Bern	15	600	7030	600
Freiburg	7	260	1803	160
Genf	4	112	437	40
Glarus	3	110	24	80
Graubünden	25	980	1315	400
Jura	5	330	1908	180
Luzern	22	440	1090	250
Neuenburg	5	200	1147	200
Nidwalden	7	0	11	100
Obwalden	0	0	0	k.A.
Schaffhausen	3	92	464	53
Schwyz	3	65	437	65
Solothurn	8	160	956	160
St. Gallen	17	600	1515	300
Tessin	1	16	104	30
Thurgau	6	216	1439	70
Uri	2	40	77	40
Waadt	11	1250	5929	1000
Wallis	9	233	632	310
Zug	0	0	189	k.A.
Zürich	35	420	883	735
Total	**217**	**6900**	**29 454**	**5453**

Table 2: Cantonal distribution of areas identified in the structural plan as suitable for wind energy, compared to the SFOE's potential estimates and the cantons' targets for wind energy expansion.

Cantonal suitable regions, potential and goals for wind energy

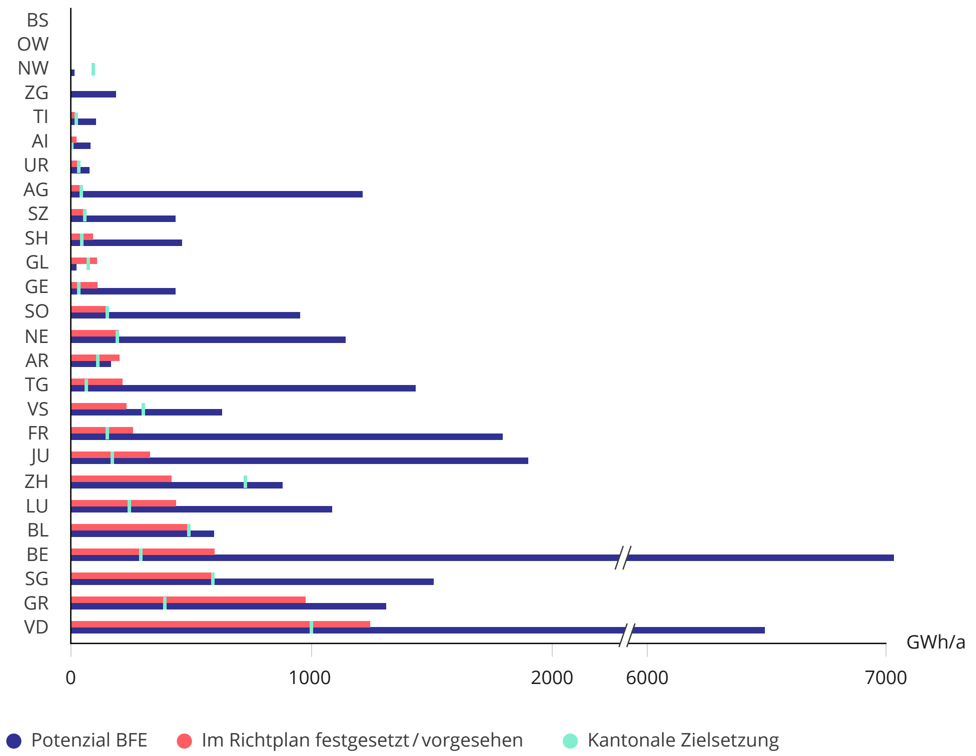


Figure 7: Energy yield potential of the areas designated as suitable for wind energy in current land-use plans (red) compared to the SFOE 2050 potential (blue) and the cantonal target (turquoise).

The map shows that there are certain regional differences. Some cantons, such as Lucerne, are acting as pioneers and have already updated their structure plan in relation to wind suitability areas or are in the process of updating it. Other cantons, such as Zug or Basel-Stadt, have not yet done this and have not designated any suitable areas. As of June 2025, the cantons have collectively identified 217 suitable sites with an estimated annual wind energy generation potential of 6.9 TWh. Although the potential of the suitability areas exceeds the national expansion target for 2030 (2.3 TWh) by a factor of three – and in some cantons also surpasses the cantonal expansion target – it is important to note that the potential only represents an initial optimal estimate. During implementation, the possible energy yield is usually reduced considerably, as, for example, the entire area cannot be used optimally (fewer wind turbines), the maximum possible number of turbines according to the structure plan cannot be built, or the precise wind measurement at the specific location deviates from the potential.

3.2 Land-use planning and building permit procedure

Land-use planning

The designation of a suitable area for wind turbines in the cantonal structure plan must be further detailed in terms of planning law and made binding for landowners. As the planning authorities, municipalities carry out this task through land-use planning. On the basis of the provisions in the cantonal structure plan, the affected land areas are allocated to the building zone and the other planning legal framework conditions are specified and specified (e.g. dimensions, heights, distances, etc.). Municipalities must also weigh up the different interests at the various levels. In some cantons (VD, LU, SG, SH), responsibility for planning the use of wind turbines already lies at the cantonal level and not at the municipal level.

Affected parties – including environmental protection organisations – can lodge objections and appeal (possibly through several cantonal instances up to the Federal Supreme Court) against the stipulations contained in the land use plan. Once these stipulations enter into legal force, the planning requirements relevant to the project become binding on the landowner and specific to the parcel. This increases planning security for investors.

Building permit procedure

Once utilisation planning has been completed, the building permit or planning application process begins. In principle, the municipal building authority is responsible for issuing the building permit; in certain cases, e.g. in the case of projects outside the building zone, this responsibility may lie with the cantonal authorities. In most cases, coordination between the different departments is required. The purpose of the building permit procedure is to check whether the building project complies with all rules and standards and whether the building can therefore be authorised. To this end, the project must submit all documents in full and provide the evidence required by law. The drafting and preparation of planning application documents is generally complex and time-consuming. For a wind farm, an environmental impact assessment is typically required, as well as evidence or statements on site development, noise protection, shadow impact and species protection, and any necessary replacement measures.

After being checked for completeness by the administration, the planning application is made public for a certain period. During this time, objections must be lodged – in many cantons, they are decided in the first instance together with the building permit. If the decision is favourable, the objectors are free to appeal against the building permit. This also applies to environmental associations and organisations, provided they are entitled to lodge objections and complaints. Most cantons provide one or two levels of appeal before the appellants can take the appeal to the Federal Supreme Court.

3.3 National interest

To obtain a licence, wind energy projects must be weighed up against other interests. In order to increase the chances of permitting, the legislator has defined in the Energy Act that installations for the use of renewable energies above a certain size and importance are of national interest for wind projects above 20 GWh per year.[22] At the same time, the cantons are obliged to exclude suitable areas for wind power in their framework plans[23]. This is intended to provide a basis for planning specific wind power projects located in these areas and helps to give such a project appropriate weight in the balancing of interests. Through earlier legislative revisions, and particularly the most recent partial revision of the EnG, the legislator has sought to give greater weighting to renewable energy production sources – including wind turbines – in the weighing up of interests process. With a view to the expansion target of 6 TWh of winter electricity, wind turbines in suitable areas and outside biotopes will now be given "basically overriding" national interest[24]. In these areas, a wind turbine therefore has a good chance of obtaining permitting, at least from a legal point of view.

However, two significant challenges remain in the future. Firstly, the cantons must identify suitable areas to a sufficient extent (see Section 4.1). Secondly, even the overriding national interest does not prevent projects from being opposed or rejected in a vote by the local population due to other considerations. In this respect, it remains to be seen in practice what effect the amendment to the Electricity Act – particularly in combination with the Acceleration Decree – will have.

[22] Art. 12 Energy Act
[23] Art. 10 Energy Act
[24] Art. 9a Electricity Supply Act

Right of associations to appeal

Under certain conditions, specific associations and organisations are legally entitled to register their interests during permitting process for wind turbines. They must do so by submitting objections and appeals to ensure that their interests are protected and respected. These are primarily environmental protection and nature conservation organisations, which – depending on the legal structure – can participate at all levels (federal, cantonal, municipal). The large number of potentially involved associations, and their sometimes diverging interests, makes it challenging for project planners to recognise all concerns and to develop feasible solutions to avoid complaints and the resulting delays.

3.4 Legislation on accelerated procedures

The framework conditions at the various stages of the authorisation process are particularly decisive for the realisation of wind turbines. In particular, the complexity and length of proceedings under current corporate law represent a significant Hurdle. The above explanations result in the following decisive steps in the planning and authorisation process for the current status (2025):

- **Cantonal structural planning:** Projects with a significant impact on the area and the environment need a basis in the cantonal structure plans. The cantons determine the structure plan and have it reviewed and approved by the Confederation.

- **Municipal land use planning:** At the municipal level, more detailed zoning is carried out on the basis of the specifications in the cantonal structure plan. A municipal vote is usually required to determine these. Objections may be lodged against the determinations, and appeals may subsequently be lodged.

- **Building permit:** As part of the building permit procedure, the developed building project is checked for compliance with the overarching (planning and use planning and other) specifications. At the latest in this procedure, the developers must also submit a comprehensive environmental impact assessment, among other things. During the public consultation period, directly affected parties as well as authorised associations and organisations may lodge objections. Once the building permit has been granted, objectors are entitled to appeal.

Each of these steps – up to the determination or granting of the building permit – can take different lengths of time.

If land-use planning already exists for a suitable area, in accordance with the cantonal

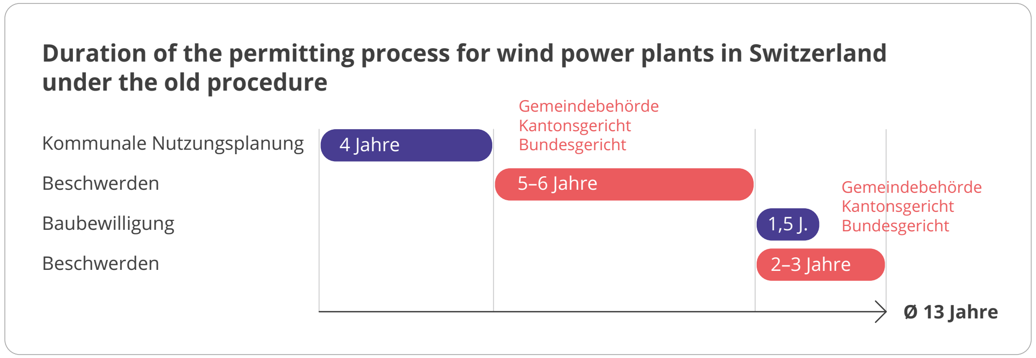


Figure 8: Visualization of the project timeline for wind power plants in Switzerland under the current procedure (2025). The process allows for multiple rounds of appeals through municipal, cantonal, and national authorities. Not shown is the preceding land-use planning phase, which is omitted for existing designated areas.

structure plan, and the project largely complies with these specifications, the chances of obtaining a building permit are favourable. The increased recognition of the (national) public interest by law has also increased the chances of translating the specifications in the directional and land-use planning into specific projects.

It should be noted that there are only limited possibilities for appealing and appealing against provisions in the cantonal structure plan (e.g. affected municipalities can only appeal directly against the determination decision under certain conditions, while private appeals are not possible).

Under the current system, legal action can usually be taken against both the planning of use and the granting of a building permit through several courts (at least one cantonal court and one federal court; in some cases, the cantons also provide for two appeal courts, e.g. Zurich or Bern). Estimating the duration of these appeal and court proceedings is difficult and depends on the case; however, it is not uncommon for wind energy projects to take three to five years per appeal instance.

As a result, proceedings lasting over 13 years until a final court judgement is reached are often the rule rather than the exception.

This situation has been recognised and addressed at federal level. The Acceleration Decree, which was finalized in the 2025 autumn session, provides for various amendments to the Energy Act (EnA). This provides the cantons with the framework conditions for implementation in cantonal legal framework. The main elements of the Acceleration Decree are:

- **Planning permitting process:** Creation of a uniform cantonal planning permitting process also for wind turbines, which as a rule combines the steps of use planning and building permit. In future, both must be appealed against to the cantonal appeal body at the same time.
- **Responsibility at canton:** In principle, the cantonal authorities should be responsible for the cantonal planning permitting process.

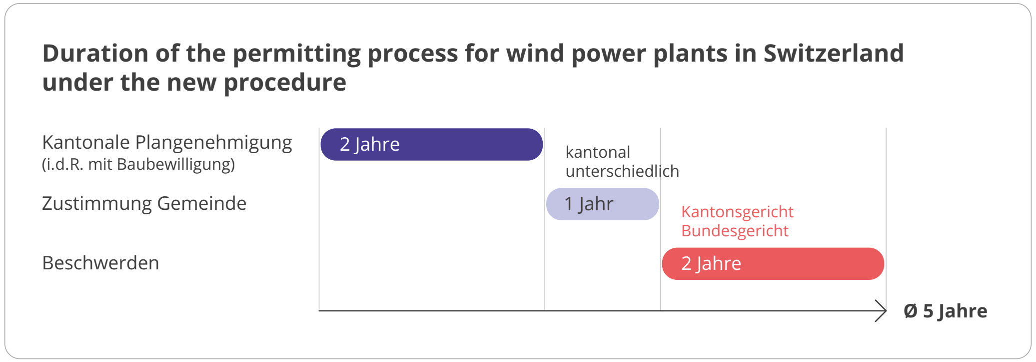


Figure 9: Visualization of the permitting timeline for wind turbines in Switzerland following the adoption of the legislation on acceleration decree (2025). The consolidated planning approval process significantly reduces the permitting timeline. Not shown is the preceding structure planning, which is omitted for existing suitable areas.

- **Shortening of appeal proceedings:** Appeal proceedings are limited to the highest cantonal instance and the Federal Supreme Court.
- **Approval from the local municipality:** The Acceleration Decree leaves the cantons decide whether to waive the formal consent of the local municipality during the planning approval process.

Based on the experience gained and to achieve the acceleration envisaged by the federal legislator, it is essential that the land-use planning and building permit procedures are handled exclusively at cantonal level. Municipal referendums should be dispensed with, as was recently implemented in some cantons and was supported by a majority in corresponding referendums. Furthermore, when implementing the federal requirements, attention must be paid to lean and efficient processes and sufficient (human) resources must

Current projects in the permitting process

Projektierungsgrad per 1.7.25	Projekte	Anlagen	MW	GWh
Bewilligte Projekte	1	6	12	28
Baubewilligung	7	54	182.5	344
Beschwerde gegen Nutzungsplan	3	13	51.9	58
Kommunaler Nutzungsplan	11	70	246.75	434.2
Total	**22**	**143**	**493.15**	**862.2**

Table 3: Current projects in the permitting process as of the end of 2025.

be allocated. This can significantly shorten the duration of the authorisation process.

By consolidating the procedure in line with the revised Energy Act (Acceleration Decree), it appears possible to reduce the average authorisation period to around five years in the best-case scenario. Upstream of these five years – and therefore not included in this duration – is the prior adjustment of the structure plan and the determination of the suitability area for wind energy. The cantons can further support these acceleration efforts by consistently implementing suitable areas in their cantonal structure planning. This is particularly in view of the fact that, following the 2017 mandate to designate suitable areas[25], the cantons, as described in Section 4.1, have only complied with this mandate to a limited extent.

It should not be forgotten that there is currently legal uncertainty about the potential that the cantons have to base their plans: The wind energy concept (4.3 TWh) defined by the Federal Council in 2020 must be updated in accordance with the potential study conducted by the SFOE in 2022 (30 TWh) and used by the cantons as a guideline. A legal clarification of which document the structure plan adjustments must reference is necessary, even if in practice the cantons already refer to the updated potential.

In 2025, 21 projects across Switzerland are undergoing the described permitting process. The projects are spread over the various stages of the process and are delayed due to protracted permitting, objection and court proceedings. It can be assumed that all these existing projects will pass through the above-mentioned (current, i.e. 2025) permitting and procedural steps in full.

In around 60 percent of the projects, the objections were partly or exclusively lodged by organisations with the right of appeal. Apart from one project, the remaining 40 percent have been delayed by objections from private individuals. For the project developers, this leads to the impression that wind energy projects are being tackled in an organised and systematic manner.

3.5 Further action: Strengthening pan-Swiss planning

Switzerland's decentralised planning structure poses a challenge when it comes to achieving overarching, nationwide goals. The public good of security of energy supply (in this case, electricity supplier in the winter half-year) is difficult to achieve due to the federalist structures and the resulting lack of overview and coordination throughout Switzerland[26]. This is particularly true for technologies such as wind energy, which often face local opposition.

[25] Through the Energy Strategy 2050 in the Energy Act

[26] According to economic theory, a public good (non-rivalry and non-exclusibility) requires an overarching coordination process to ensure that it is adequately supplied. This enables a welfare-maximising weighing up of the overall economic benefit against the sum of individual interests/costs.

Today, the federal government supports cantonal and communal planning primarily by providing conceptual foundations, such as the Wind Energy Concept or the SFOE's potential study. To date, these instruments have primarily focused on the identification and labelling of potential – such as the designation of spatially suitable areas for wind energy use. On the whole, they can be assessed as not very binding and thus, at best, have little coordination effect. Strengthening overarching planning, control and coordination at federal level – and thus across cantonal borders – could counteract these challenges and strengthen the expansion of wind power.

The conceptual work of the Confederation could be made more binding.[27] The Wind Energy Concept should not merely serve as a recommendation, but should exert stronger influence on cantonal planning and assign the national expansion targets to the cantons with greater binding force. The status of cantonal implementation should also be more closely monitored, assessed and presented in a comparable manner at the federal level. Specifically, the potential could be allocated to the cantons as described in Chapter 3.1 and periodically compared with the already designated suitability areas and cantonal targets within a monitoring programme. Such monitoring would create transparency regarding the status of cantonal plans and projects and also increase comparability. This would encourage the cantons to periodically review their plans and identify additional areas of suitability.

In addition, strategically important wind energy projects could be included in the federal concept, which would enable explicit, national prioritisation. This would send a clear national signal in favour of these projects and give them stronger political and planning backing. Greater legitimisation of the selected projects could lead to greater acceptance and fewer objections. For these prioritised projects, the cantons could also be given the option of amending the structure plan only after permitting has been granted, provided the planned wind turbine is already included in the federal concept. This could speed up the authorisation process.

To implement this, a "Wind Round Table" could be established at which the federal government, cantons, project planners and other relevant stakeholders regularly exchange and coordinate information on the status of planning, the overall national situation, and specific projects. A similar round table approach has already been used in Switzerland in the hydropower sector (see the Axpo Energy Report on hydropower). At the same time, such an exchange can promote acceptance by the cantons of a stronger coordinating role for the Confederation.

If more binding concepts and additional dialogue tools – for example through a round table – do not have the necessary effect on the expansion of wind power, the next measure to be considered would be even stronger nationwide planning and, consequently, a shift in responsibilities from the cantons to the federal government. A national sectoral plan for wind (or renewables in general) would then be conceivable, for example, which would enable the Confederation to define wind energy projects (possibly limited to those of national importance) directly at the structural planning level – with the result that planning authority for wind turbines is transferred to the Confederation in this respect. The obligation to reconcile cantonal and national interests and the cantons also have the option of participating in the corresponding planning and permitting processes remain in place. Sectoral plans already exist in other areas such as transport (motorways and railways), asylum and the military. As this approach would involve a significant shift in competences and require a constitutional amendment, it would need to be carefully considered and politically desirable.

[27] The liability could also be strengthened by amending the relevant article of the law (Art. 11 of the Energy Act), which defines the tasks of the Confederation with regard to supporting the cantons in the expansion of renewable energies.

04 Acceptance

Local acceptance remains the biggest source of uncertainty regarding the expansion.

In brief:

- Social and – above all local – acceptance is the decisive factor for the success of wind energy projects in Switzerland. Resistance from the local population and associations may take the form of legal Objection, making implementation more difficult and delaying or even preventing projects.
- Approval for wind energy projects depends on the nature and timing of the votes: Binding votes in late project phases achieve higher approval than consultative votes in early phases, as there are still many uncertainties and conflicts at these points in time.
- Except for one project, all projects currently in the permitting process are behind schedule due to objections. Of these, 60 percent face objections from associations and 40 percent from private individuals.
- Various measures to increase local acceptance are already being implemented in Switzerland and neighbouring countries. However, it is difficult to measure the extent to which these directly increase acceptance and improve project success rates.

4.1 National and local acceptance

The Energy Strategy 2050, approved by 58.2 percent of voters, was adopted in May 2017 and forms the basis of Switzerland's energy policy. A key component of this strategy is the expansion of wind energy production by 2050. The Energy Act provides for the expansion of renewable energies (excluding hydropower) by 45 TWh by 2050, but does not specify which technology should contribute to this and how much.[28] This clarification was carried out by the Federal Council in November 2025 when it amended the Energy Ordinance: The interim target for 2030 for the expansion of wind turbines is set at 2.3 TWh. Specifically, this means the expansion of around 250–300 new wind turbines by 2030[29].

Despite these ambitious targets and the urgent climate policy, the expansion is proving to be difficult. Objections from associations or private individuals as well as a lack of public acceptance make realisation more difficult and contribute significantly to project delays. The planning and permitting process for today's wind energy projects are characterised by their exceptionally long duration of 15 years on average.[30]

At a national level, surveys repeatedly show that there is fundamental support for the construction of new wind energy. A relatively constant 60 percent of the population supports the construction of wind turbines. This value is clearly below the approval rates for new hydropower or PV on roofs and facades (90 percent), but above the approval rate for PV on open spaces (50 percent).[31]

At a local level, and therefore for specific wind energy projects, acceptance varies considerably. It is also difficult to draw firm conclusions on acceptance levels due to the low number of projects and strong regional differences. It is evident that: Whether a decision is positive depends on the type and tim-

[28] Federal Act on a Secure Electricity Supply with Renewable Energies, 2023
[29] Taking into account a typical plant with 8 GWh and the current expansion (50 plants).
[30] Schmid, 2024, Swiss wind energy projects in the federal state structure
[31] gfs.bern, 2025, Final report – Wave 4 energy supply security study

ing of the coordination during the course of the project. Binding votes, which are often only carried out in later and thus more specific project phases, achieve a significantly higher approval rate with a median of 60 percent than consultative votes, which take place early in the planning phase and reflect groundbreaking or fundamental decisions (median 33 percent).[32] This difference can be explained partly by the fact that consultative votes typically take place early on, when there are still many uncertainties and potential conflicts have not yet been sufficiently addressed. By contrast, projects in later phases have usually already undergone considerable adjustments and downsizing with the aim of increasing acceptance.

In principle, the concerns of the population and of organisations opposing wind energy projects are driven by many different factors and are difficult to record conclusively. Important main aspects are (not exhaustive): [33, 34, 35, 36, 37]

- Socio-economic aspects such as effects on property values, loss of attractiveness of the area (e.g. for tourism and the local population), devaluation of local recreation areas, and the impacts of construction and development.
- Visual change and threat to the sense of place through landscape integration.
- Noise and shadow pollution during operation and construction,
- Concerns about the impacts on nature and the environment – particularly regarding bird and species protection.
- Perception of fairness towards the affected population in the planning process and a lack of trust.
- Distribution of financial income from the business perceived as being unfair.
- Unequal burden on rural areas compared to cities, caused by the high electricity demand of industry and conurbations, for which the local population is not sufficiently compensated.

60 percent of the projects currently in the permitting process are faced with objections from associations that exercise their right to lodge a complaint in accordance with their association's purpose. The remaining 40 percent of projects are subject to objections from private individuals. As a result, all current projects – except one project in Chroobach, Schaffhausen – are facing objections and delays. As a result of the adopted acceleration decree (see Section 4.4), the number of possible appeals will be reduced in the future, giving associations and private individuals feweropportunities to file complaints.

Long procedures and the associated uncertainties are both a cause and the result of low local acceptance. Delays are often driven by extensive, and sometimes supplementary, clarifications and investigations, but especially by objections or legal complaints lodged by both individuals and associations. On average, the planning and permitting process for wind turbines in Switzerland took 15 years to complete – today's projects range from 4 months to 24 years[38].

[32] Suisse Eole, 2025, Suisse Eole – Swiss wind farms and projects
[33] Rand & Hoen, 2017, Thirty years of North American wind energy acceptance research: What have we learned?
[34] Ruddat, 2022, Public acceptance of wind energy – concepts, empirical drivers and some open questions
[35] Devine-Wright, 2005, Beyond NIMBYism: towards an Integrated Framework for Understanding Public Perceptions of Wind Energy
[36] Petrova, 2013, NIMBYism revisited: public acceptance of wind energy in the United States
[37] Frisch & Sokic, 2018, Local acceptance and wind energy
[38] Schmid, 2024, Swiss Wind Energy Projects in the Federal State Structure, Example: Tramelan wind farm in the Jura, approval procedure 4 years, complaint 7 years

4.2
Measures to increase local acceptance

In neighbouring countries, where wind energy is more prevalent than in Switzerland, numerous measures have already been implemented to increase local acceptance. These measures concern, among others, the following aspects [39, 40, 41]:

- **Local added value:** Creating local benefits is an important starting point. Projects should be designed in such a way that they generate direct added value for the communities concerned – for example through local value creation, direct payments or participation opportunities.

- **Additional local capacities:** Building up skills in the communities is also crucial. By providing additional personnel resources, municipalities could support procedures more professionally and organise them more efficiently.

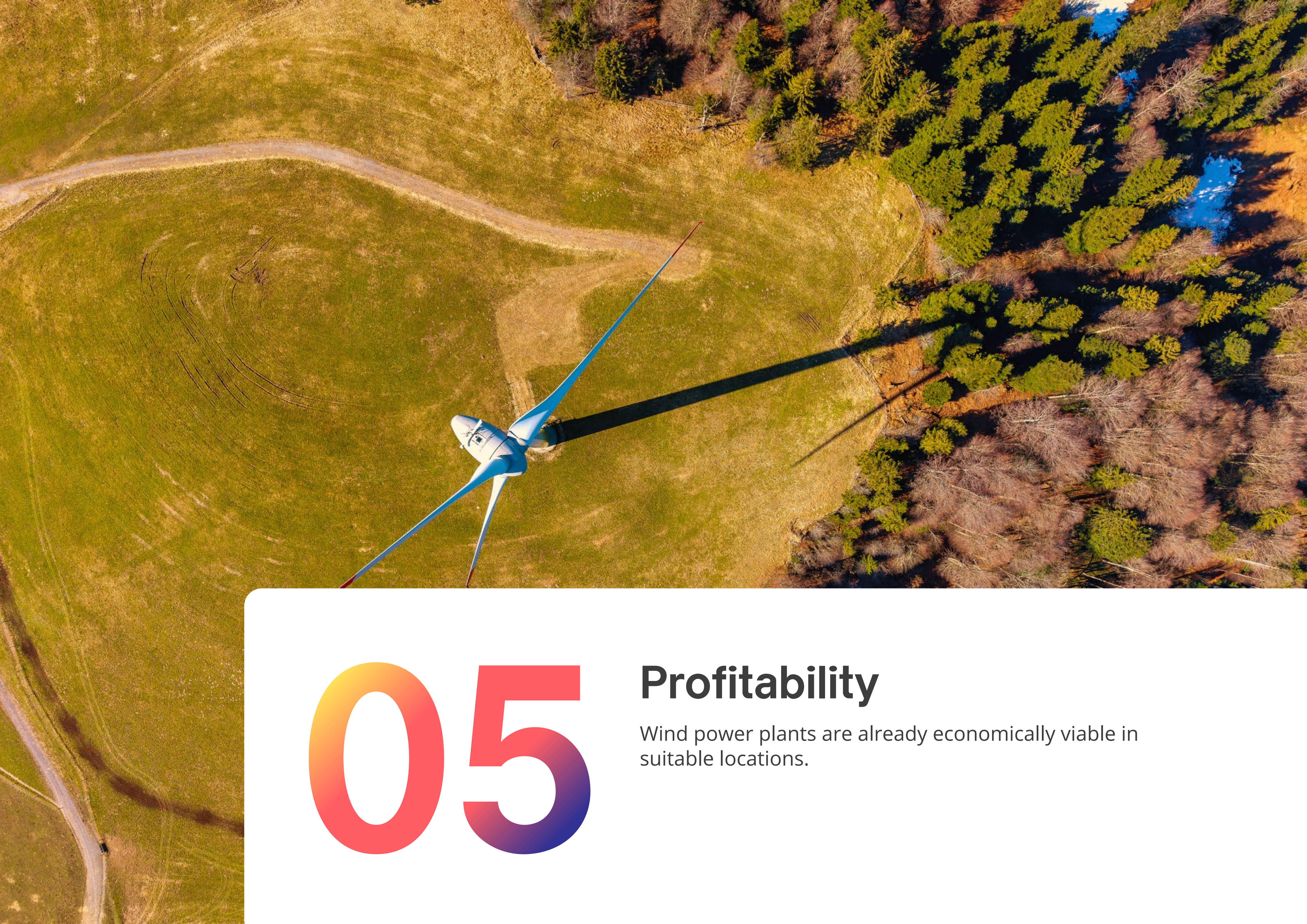
- **Information transparency and communication:** Targeted information work and transparent communication can increase the acceptance of local projects. Disclosing financing structures and openly communicating the project details can help to build trust. Regular information events and the use of digital platforms – such as project websites – can increase public involvement and provide timely information about progress and challenges.

- **Community engagement:** Strong public involvement in decision-making processes can help to increase local acceptance. Early and active participation opportunities enable the affected communities to voice their interests and concerns and can help to resolve conflicts at an early stage. Financial participation can also lead to fewer objections and greater acceptance, as demonstrated by public participation programmes in Germany.

Some aspects that influence acceptance are fundamentally or partially unavoidable – such as landscape change, construction noise, noise emissions, and impact on nature – and are therefore subject to a social weighing of interests. These concerns cannot be addressed with direct measures alone and instead require a broader fundamental discussion about the willingness to prioritise social benefits over local impacts.

Other aspects such as perceived fairness, trust in project developers or effects on health can very well be addressed, and it is the responsibility of project development to clarify these issues.

[39] Vuichard, Stauch & Dälle, 2019, Individual or collective? Community investment, local taxes, and the social acceptance of wind energy in Switzerland
[40] Stadelmann-Steffen & Dermont, 2021, Acceptance through inclusion? Political and economic participation and the acceptance of local renewable energy projects in Switzerland
[41] Hinisch, 2020, WinWind, the handbook for socially inclusive wind energy



05

Profitability

Wind power plants are already economically viable in suitable locations.

In brief:

- The costs and revenues of a wind turbine are largely dependent on the choice of location.
- In Switzerland, wind energy projects are subsidised with investment contributions, sliding market premiums, and a partial assumption of project risks (project planning contributions).
- The production costs of a wind turbine in Switzerland are between around CHF 75 and 125 per MWh in 2024 in 2035 (assumption: Planning will start today), while the expected income over the life of the plant is around CHF 60/MWh in real terms in 2024. This results in a subsidy gap of CHF 15–65/MWh. For a plant in 2050, the costs are between 60 and 100 Swiss francs per MWh (real 2024), and the revenues around 50 Swiss francs per MWh (real 2024), leading to a gap of roughly 10 to 50 Swiss francs per MWh (real 2024).
- The subsidy requirement per MWh produced in the winter half-year is between 20 and 95 Swiss francs per MWh, on average 60 Swiss francs per MWh, for plants commissioned from 2035 onwards.
- In good locations, subsidies are currently sufficient to ensure the profitability of wind turbines.
- Project delays have a negative impact on the prime costs. A delay of five years can increase the production costs by up to 2 Swiss francs per MWh.

5.1 Costs and revenue of wind turbines

5.1.1 Costs and influencing factors

The costs of wind turbines in Switzerland are influenced by various factors. The following are key considerations, although not an exhaustive list:

- **Choice of location:** The location of a wind turbine is the biggest factor influencing costs, as it affects various aspects of implementation: the transport of turbine components, the site and site preparation (earthing work, road construction, crane sites, soil improvement measures, foundations) and the grid connection including the transformation station. Locations with limited and more complex accessibility, such as in alpine terrain for example, are typically associated with higher costs.
- **Regulatory framework:** The permitting process and regulatory requirements have an impact on the costs of wind energy projects. Long and complex permitting processes, e.g. due to delays caused by appeals, increase costs and project risk. Regulatory requirements such as automatic switch-off, shadow impact limitation, or equalisation measures can also increase the costs. However, this impact is relatively small compared to the system costs.

Swiss Finish and why wind turbines are more expensive in Switzerland than abroad
Wind turbines in Switzerland face higher costs than comparable turbines abroad. This difference, or its cause, is colloquially referred to as the “Swiss finish”. This refers to Swiss rules and framework conditions that increase the costs of wind energy projects compared to other countries. These effects are subject to complicated interactions. At the same time, the Swiss finish cannot be seen exclusively as a disadvantage, as some of the requirements serve important public interests, such as protecting people, nature and the landscape, ensuring quality standards, or supporting social acceptance. Careful environmental assessments, transparent author-

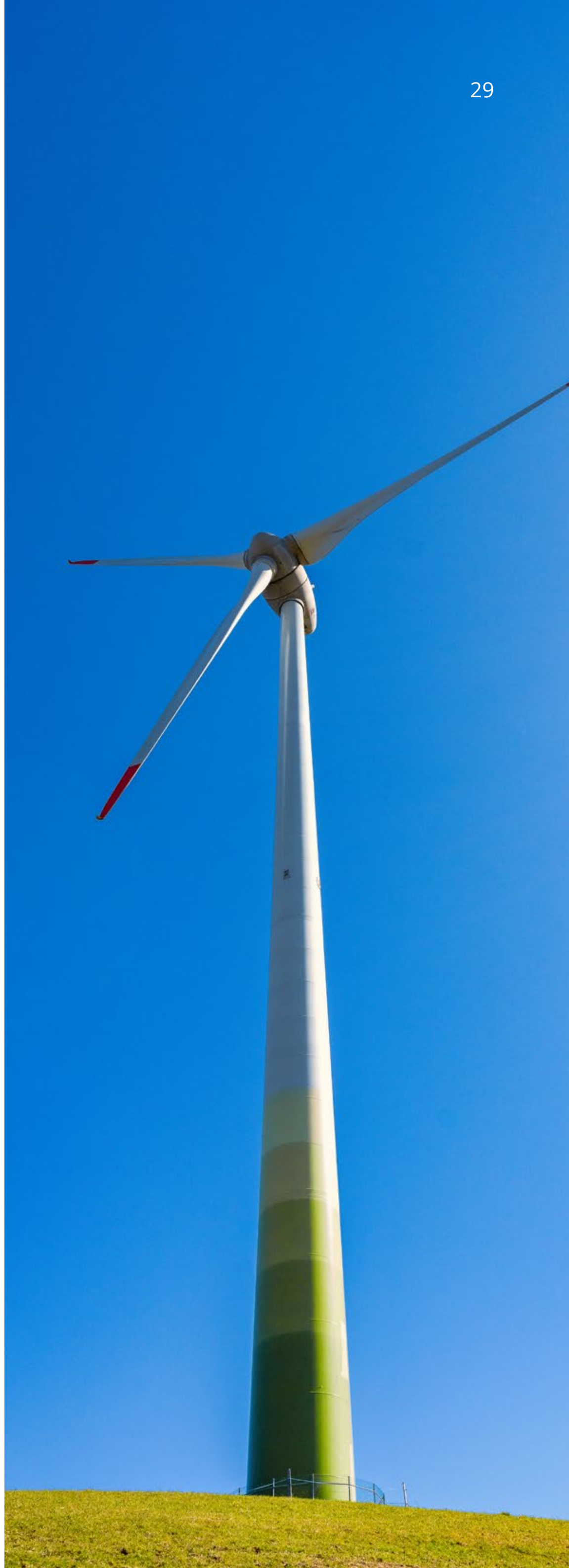
isation procedures, stringent noise and species protection thresholds, and strict construction and occupational safety standards can reduce project risks in the medium and long term and generate added value, even if they also increase costs. Nevertheless, from a project perspective, these differences result in additional costs compared with other countries – some of which can be attributed to the Swiss finish:

- **Labour costs and general price levels are higher in Switzerland:** Compared to neighbouring countries, Switzerland has higher salaries across many occupational groups. At around 55.6 euros, average labour costs in Switzerland in 2016 were almost twice as high as the EU-15 average of 30.30 euros.[42]

This directly impacts the construction, logistics, assembly and operating expenses of wind projects.

- **Geography and land availability make it difficult to exploit economies of scale:** The construction and operation of plants in alpine locations tends to be more expensive than in the lowlands (accessibility, logistics, foundations, winter conditions). In addition, large wind farms with several dozen turbines – for example, those in Germany – are practically impossible in Switzerland due to geographical constraints. This eliminates cost advantages associated with economies of scale in the construction of large wind farms. Manufacturing processes and supply chains also benefit from economies of scale: At the end of 2024, 28 766 onshore wind turbines had been installed in Germany and 50 in Switzerland[43].

- **Regulatory requirements increase costs:** In the past, the lengthy permitting process in Switzerland in particular has led to considerable additional costs. We assume that additional costs of up to CHF 200 000 per delayed year may be incurred in a wind project. This is due to legal costs as well as personnel and project related costs. Regulatory requirements regarding wind measurement, clarifications, investigations or compensation measures also influence the costs.



[42] Swiss Federal Statistical Office, 2020, Labour costs per hour worked in the manufacturing and service sector – comparison between Switzerland and European Union (EU)
[43] Bundesverband Windenergie, 2025, Status of onshore wind energy expansion – half-year 2025

cations are not suitable for the erection of wind turbines due to poor wind conditions. Site-specific wind measurements are required to determine this. For example, at Flumserberg, an Axpo wind measurement showed that wind speeds were not sufficient to erect a plant.

Table 4 shows the cost assumptions for systems commissioned in 2035 and 2050, which are used for the following invoices. In view of the small number of systems that have been installed in Switzerland to date, the validity of empirical values is limited.

Looking at the costs of a wind energy project in isolation does not allow for the comparison of different wind turbines with each other or with other electricity generation plants. For this reason, the levelised cost of electricity (LCOE) is calculated. The LCOE indicates the average cost of generating one megawatt hour of electricity over the entire service life of a system. All costs relevant to the project are taken into account: from investment, operation and maintenance to fuel costs (there is no longer the latter in the case of wind energy) and decommissioning[44]. However, any general system costs that may arise – such as those associated with further grid expansion or additional balancing energy – are excluded.

The calculations of the prime costs are based on the assumptions regarding investments, operating costs and full load hours defined in Table 4. The results show that, depending on the scenario, the production costs for wind turbines in Switzerland are between approximately 75 and 124 Swiss francs per MWh for projects that are planned today and will therefore go into operation in the mid-2030s. The main drivers for this range are the different system costs and the variation in full load hours – both of which depend on the location. Higher investment costs and lower full-load hours lead to higher production costs, while more favourable turbines and better wind conditions reduce the costs per kWh generated.

As shown in Figures 10 and 11, around 80 percent of the prime costs in 2035 and 2050 are dependent on plant costs and 20 percent on operating costs. The figure also shows an assumed learning curve for the technology and a slight cost degression up to 2050. This results in production costs of between around 60 and 100 Swiss francs per MWh in 2050.

[44] The dismantling costs are estimated to amount to approx. 30 000 CHF/MW and are very low over the entire service life of the system.

Costs of wind energy projects in the Switzerland in 2035 vs. 2050

Parameter	2035 Reference assumption	2035 High Costs	2035 Low Costs	2050 Reference assumption	2050 High Costs	2050 Low Costs
Production Full load hours (per year) MWh/MW	1700	1500	2000	1975	1740	2270
Costs Investment costs, real 2024 (CHF million/MV)	2.1	2.3	1.9	2.0	2.2	1.7
Operating costs (OPEX), real 2024 (CHF/MWh)	20	24	15	16	20	13
WACC[45], real (%/a)	4%	4%	4%	4%	4%	4%
Operating time (years)	25	25	25	25	25	25
Total project duration[46] (years)	8	13	6	8	13	6
of which planning	2	2	2	2	2	2
of which authorisation	5	10	3	5	10	3
of which construction	1	1	1	1	1	1
of which process delay (years)	No delay	5 years longer	2 years faster	None Delay	5 years longer	2 years faster
Additional costs delay, real 2024 (CHF/MW)	0	Approx. 45 000 more	Approx. 26 000 less	0	Approx. 45 000 more	Approx. 26 000 less

Table 4: Costs of wind energy projects in Switzerland with reference assumptions and high and low costs with commissioning 2035 vs. 2050, all values in real 2024.

[45] WACC = Weighted Average Cost of Capital, Imputed Interest Rate. The assumed WACC of 4 percent is derived from the SFOE's imputed interest rate for the subsidy instruments for renewable Energies (SFOE, 2025). The nominal assumption is rounded to 5 percent, which has been converted into a real interest rate of 4 percent.
[46] For the derivation of the permitting period and potential delays, see Section 3.4 Overview and estimated time requirements today and in the future

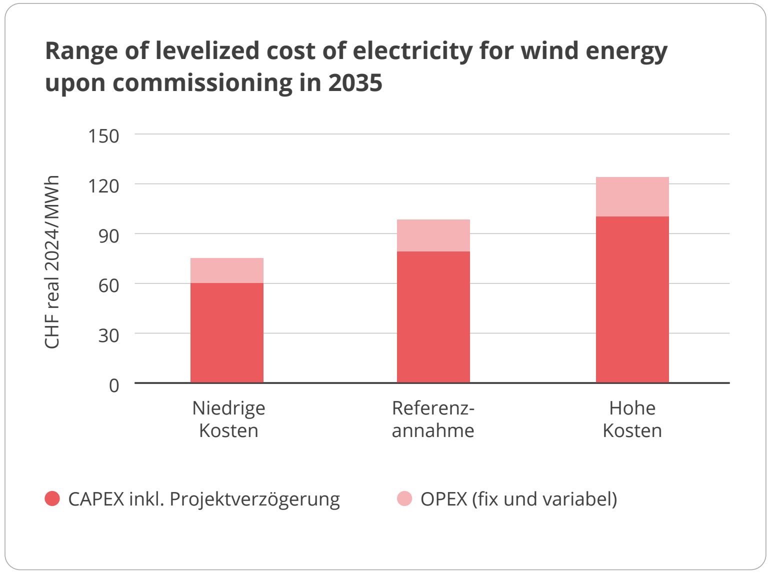


Figure 10: Reference assumption in the middle compared to high and low cost assumptions, divided into construction costs (CAPEX), fixed and variable maintenance costs (OPEX).

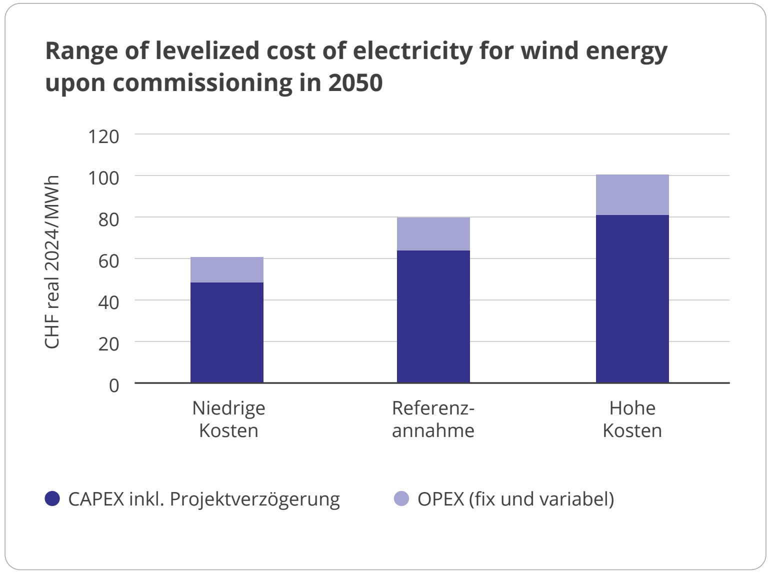


Figure 11: Reference assumption in the middle compared to high and low cost assumptions, divided into construction costs (CAPEX), fixed and variable maintenance costs (OPEX).

5.1.3 Market revenue

The income of a wind turbine in Switzerland depends primarily on two aspects:

- **Energy yield:** The wind conditions prevailing at the selected location have a direct impact on the full-load hours, but also on the size and type of the system used and thus on the achievable annual production of the system. In addition, a larger system, i.e. higher output, typically has lower specific costs than a smaller one.
- **Revenue generated on the electricity market:** The capture price determines how much revenue a system can generate per kilowatt hour of electricity generated. To calculate future electricity prices, detailed Europe-wide fundamental market simulations were carried out (see information box).

Revenues for wind turbines in Switzerland can vary significantly. This can be seen simply by looking at the full load hours, i.e. the annual amount of electricity produced per plant. While we expect up to 2200 MWh per MW of installed capacity to be produced in the Jura region per year, full-load hours in Alpine regions are expected to be just 1400 MWh per MW of installed capacity[47].

The electricity price is subject to hourly fluctuations, depending on supply and demand. Comprehensive fundamental market simulations were carried out to calculate future electricity prices.

[47] Swiss Federal Office of Energy, 2020, Wind Atlas Switzerland: Annual average of the modelled wind speed and wind direction

Where do electricity prices come from?

Nobody knows future electricity prices. To get an idea of them, we work with various scenarios that each span a world showing how markets can develop. For the long-term view, fundamental models are generally used – they are not based on historical data, but explicitly model future power plants and load development, and replicate today's market mechanisms and price formation. Since we do not know the future, we work with various scenarios and estimate a range of possible developments, prices and therefore also revenues.

Our fundamental model simulates the electricity market of the European countries including Switzerland for the period 2025–2060. In doing so, the development of renewable energies, demand, cross-border import and export opportunities and other important market factors such as future prices for gas and CO_2 emissions are taken into account. From this, hourly future electricity price scenarios can be derived, as well as power plant utilization and hourly imports and exports per country.

For the European market, two scenarios are considered. From these we derive a range of possible revenues. The median revenues are the midpoint between the results. The two scenarios differ as follows:

- In the first scenario, the decarbonization of the global economy makes progress, but is not yet fully achieved. The electricity sector in Europe reaches a decarbonization of 90 percent by 2050. Thermal power plants serve as backup. Carbon Capture and Storage and hydrogen come into use, but only to a limited extent. Electricity demand grows moderately.
- In the second scenario, global climate policy follows a new pragmatism and reaches a decarbonization of 80 percent by 2050. Renewable energies dominate electricity generation; gas is the most important backup electricity source. Electricity demand grows less than in Scenario 1, which is attributable to lower demand from water electrolysis.

For Switzerland, a Net-Zero scenario is assumed, in which decarbonization allows demand to rise; for gas power plants, various options for decarbonization are available. Details can be found in the Gas Report and the Synthesis Report.

The prices for gas, CO_2 emissions and other primary energy are based on the Announced Pledges (AP) and Stated Policies (SP) of the IEA World Energy Outlook.

A validation was carried out in a study together with FEN – the Energy Networks Research Centre at ETH Zurich.

Range of expected revenue from wind power plants

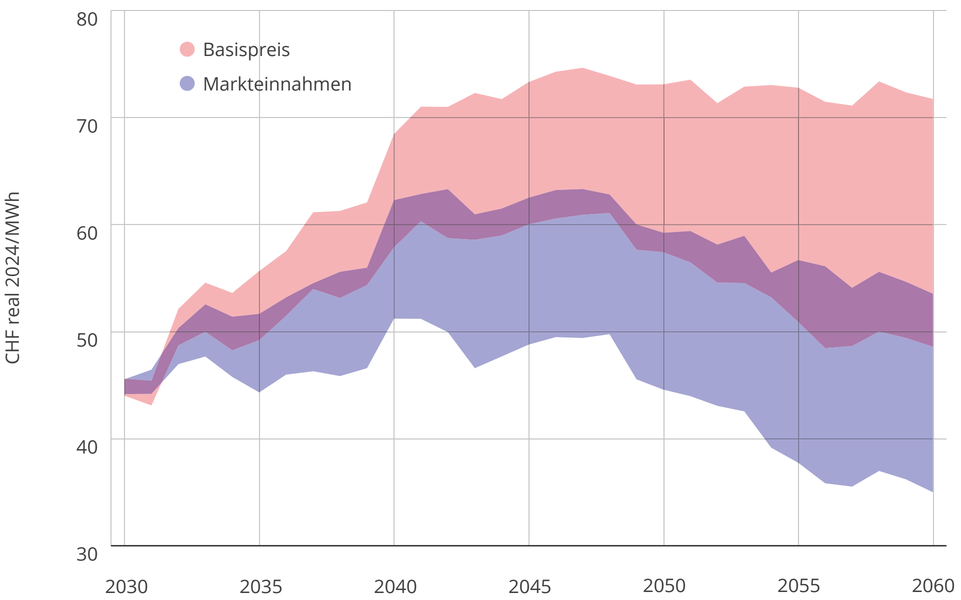


Figure 12: Range of expected market revenues from wind power plants and the base price for the two scenarios analyzed.

Figure 12 shows the development of wind energy revenues on the electricity market in Switzerland based on the simulation results. It demonstrates that the annual revenue for wind power plants in the 2030s will be between 40 and 50 euros per MWh. In the 2040s, market prices and revenues will be above 50 euros per MWh before falling again slightly at the end of the 2040s.

Income is below the base price, i.e. the annual average of electricity prices. This effect is already evident today, despite the low penetration of wind energy in Switzerland. This is because penetration in the surrounding countries is already high. In Germany, for example, wind energy now accounts for over 30 percent of electricity production. Due to the strong interconnectedness of the Swiss electricity system, low prices are already having an impact on the Swiss electricity market in times of high wind feed-in from Germany or France, for example. This effect therefore also applies to Swiss wind turbines.

Wind turbines may also generate additional income through green electricity certificates. However, the market for these certificates is very illiquid, which makes future revenue estimates highly uncertain. For further analyses, revenues for these certificates are set at a maximum of 10 Swiss francs per MWh.

5.2
Regulatory influence through subsidy mechanisms and grid connection

5.2.1
Investment contribution, rolling market premium and project contribution

According to the Energy Act (EnG), wind energy plants can choose between two types of direct subsidy instruments. Firstly, they are entitled to investment contributions of up to 60 percent of the investment costs if they exceed an output of 2 MW.[48] Secondly, they can alternatively also receive a floating market premium.[49] With the sliding market premium, the operator is guaranteed a certain remuneration rate and the difference to the market price is paid out as a subsidy on an ongoing basis over 20 years. If the market price is higher than the remuneration rate, repayments are due.

[48] Art. 27a Energy Act
[49] Art. 29a Energy Act

The law does not provide for tenders for allocation of subsidies for wind power plants. It is subsequently the Federal Council that determines the amount of the subsidy and the other conditions for obtaining the receivables. It does this on the basis of the Energy Promotion Ordinance and other implementing provisions. However, the administrative determination and allocation pose various challenges for project developers. They depend on the Federal Council's assumptions regarding the amount of subsidy. If the Confederation's price assumptions are too optimistic and the regulatory weight average cost of capital (WACC) is too low relative to project risks, there is no economic business case for developers. In addition, further uncertainties and one-sided risks of loss exist. For example, project developers must conduct an expensive wind measurement before even applying for subsidy. There is also the risk that the real costs incurred – such as legal fees for appeal proceedings – are not included in the determination of subsidy.

For the investment contributions, the Federal Council has currently (as of 2025) foreseen flat-rate contributions of CHF 1300–1650 per kW depending on the installation category[50, 51]. The plant categories differ according to the altitude at which the plant is built. The system categories differ according to the altitude at which the system is erected. The remuneration from the sliding market premium currently amounts to 12 to 16 Rappen per kWh per category in the first five years. This is followed by a reduction to 7–9 cents/kWh if the effective production is lower than the reference production.[52]

In addition to the direct subsidy instruments, wind power plants can also apply for project contributions of up to 40 percent (up to CHF 1 million) of the project costs.[53] These contributions would be partially credited to the project developers if the permitting is not granted. If a project is successful, the amount received is then deducted from the investment contribution or the sliding market pre-

[50] Divided into facilities <1000 m, 1000 m–1700 m und >1700 m above sea level
[51] Art. 87a Energy Promotion Ordinance
[52] Art. 30d Energy Promotion Ordinance
[53] Art. 27a Energy Act

mium. The project planning contribution should therefore not to be seen as direct subsidy, but rather as a form of risk sharing to mitigate potential losses if a project fails.

5.2.2 Grid connection

As with all production plants, the costs for the grid connection (i.e. access lines and transformation costs) are borne by the respective project. Wind power plants usually require additional lines and connection points (substations) to the (supra-regional) distribution grid. They may also require additional reinforcements of existing grid structures, as the available grid capacity is not always sufficient. This can lead to delays in grid connection or even capacity restrictions, particularly if demand increases.

For some time now, distribution grid operators have been able to share the costs of such grid reinforcements across Switzerland via the transmission grid company, Swissgrid AG. A further revision of the Electricity Act has added a provision whereby the costs of reinforcing an existing grid connection, which in principle would have to be borne by the project developers, can also be partially solidarity with each other. Specifically, renewable systems greater than 50kW receive a subsidy

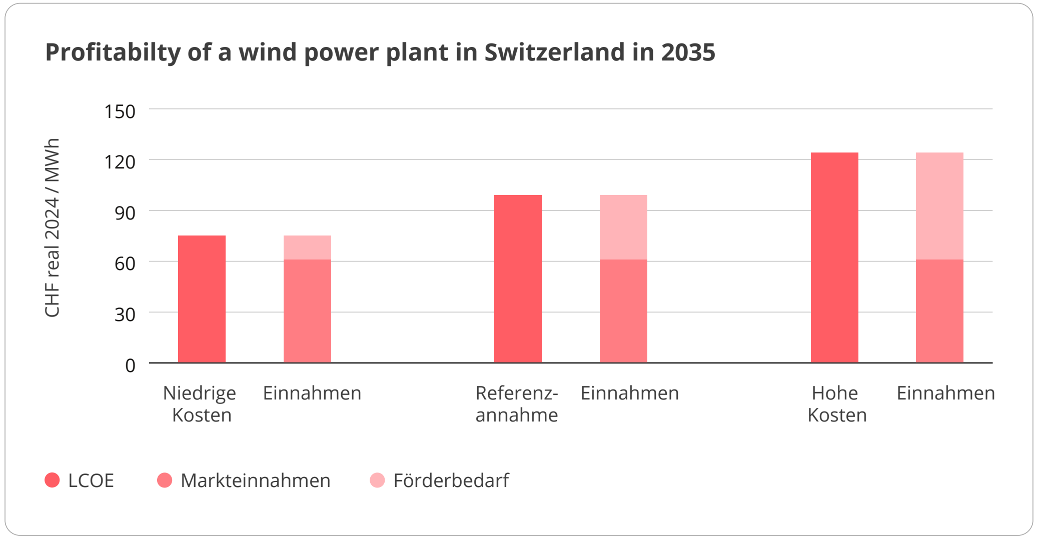


Figure 13: Profitability of wind turbines 2035 in CHF/MWh, real 2024 in Switzerland: Comparison of production costs, average market revenues and green power certificates. The funding requirement is calculated from the difference.

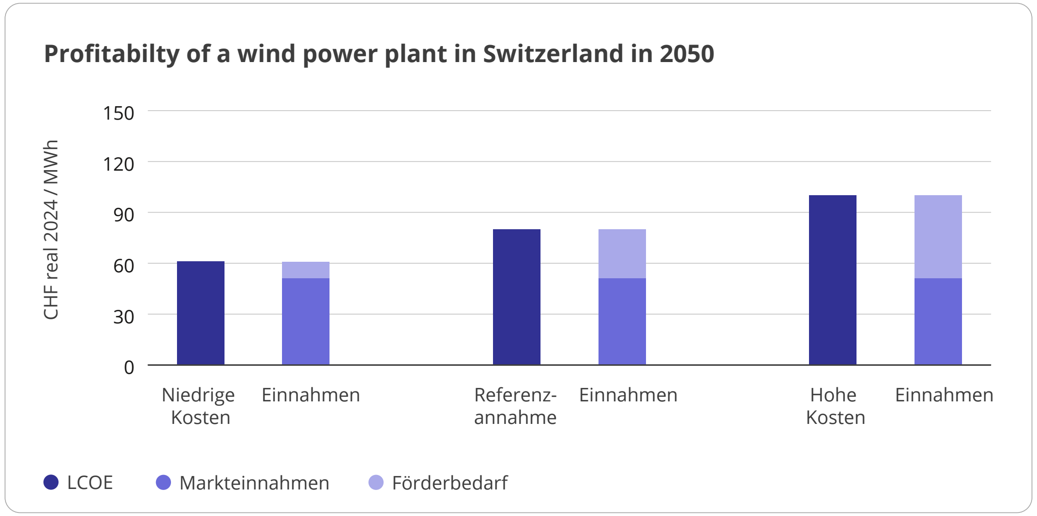


Figure 14: Profitability of wind turbines 2050 in CHF/MWh, real 2024 in Switzerland: Comparison of production costs, average market revenues and green power certificates. The subsidy requirement is calculated from the difference.

of 50 Swiss francs per kW. However, these contributions are low and apply only to existing grid connection lines. Extending this solidarity mechanism to new grid connections could further strengthen the economic efficiency of production facilities.

5.3
Subsidy requirements

To check whether a wind turbine is financially viable, the expenses for construction, maintenance and operation are compared with the income from the sale of the electricity generated.

With market revenues and costs as shown in Chapter 5.1 for the year 2035, it is clear that in all cases – from low to high costs – the revenues from electricity sales are not sufficient to cover all costs. State subsidies are necessary in all calculated scenarios. Figures 13 and 14 show this clearly: The costs are always higher than the market revenues[54] shown beside.

Based on the assumptions made here, the production demand for wind turbines in Switzerland in 2035 is CHF 14–63 / MWh. Under the reference assumptions, wind projects can breakeven with the current state subsidies. The electricity production costs of 99 Swiss francs per MWh consist of 80 percent of the investment (around 79 Swiss francs per MWh). Based on the market revenue assumed here, the required receivable amounts to CHF 38 / MWh, i.e. around 48 percent of the investment or around CHF 1100 / kW. This means that the statutory investment contribution of up to 60 percent of the investment can ensure the profitability of the system. Even under the "high costs" assumptions, the subsidy in our calculation is just sufficient. However, in the case of individual projects, the receivables may still not be sufficient due to slightly poorer wind conditions, higher construction costs or other poorer conditions[55]. There are also locations that are generally unsuitable for wind turbines because they do not meet certain minimum requirements, such as wind speeds. Such locations are not covered in the profitability analysis shown here.

For the year 2050, it is clear that subsidies will remain essential in almost all cases. The necessary subsidy is between 10 and 50 Swiss francs per MWh, with an average of around 30 Swiss francs per MWh under the reference assumption.

Reviewing the existing subsidy mechanisms shows that the statutory investment contribution and the sliding market premium are adequate to ensure profitability of wind projects. However, the administrative determination of the subsidy rates continues to be a major hurdle remains, as these assumptions do not necessarily match the reality of the project applicants or take sufficient account of their heterogeneity. It would be better to award subsidy via auctions, allowing projects to state their specific subsidy requirements and compete with other projects. However,

[54] In all illustrations, the following assumes: Average market revenue of both scenarios from section 5.1.3 as well as CHF 5 / MWh Green electricity certificates
[55] Alternatively, the floating market premium instrument could be used for such projects. This is not capped by law.

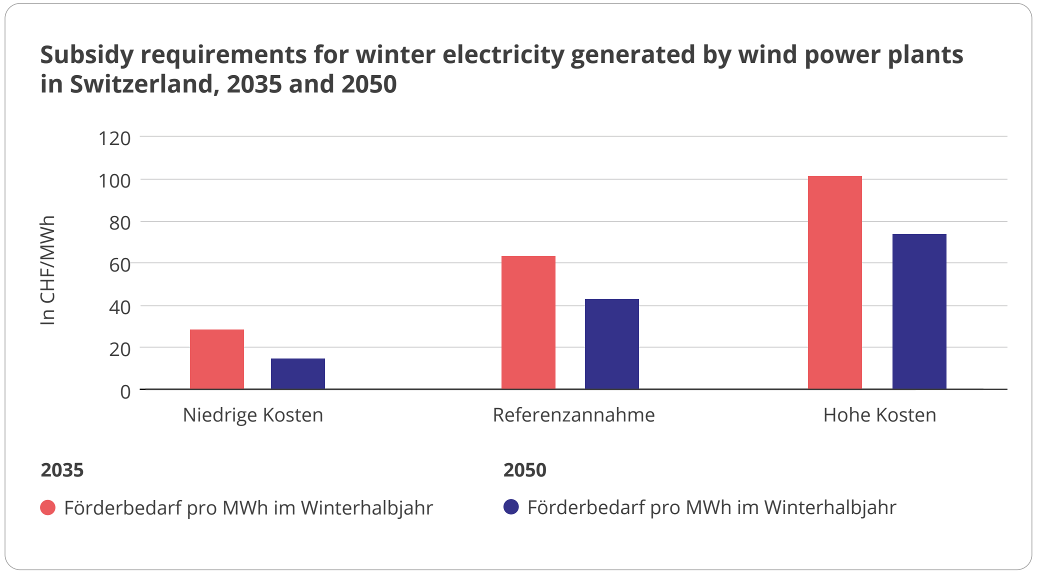


Figure 15: Production requirement in CHF real 2024/MWh Winter electricity from wind turbines for the years 2035 and 2050 under reference assumption, low and high costs – required Amounts receivable will be allocated to winter power generation.

this approach would require sufficient projects to create the necessary competition – something that would only be achievable if acceptance and permitting rates improve.

5.4 Subsidy requirements for the Winter half-year

In addition to the basic profitability, it is particularly interesting to see how a technology can make a meaningful contribution to the electricity supply in the winter half-year. It is crucial to understand how expensive a technology is and, how strongly it is subsidised, relative to the energy it produces in the winter half-year. For this purpose, the required subsidy per winter electricity from wind energy is considered. As two-thirds of wind energy generation in Switzerland occurs in the winter half of the year, the production requirement per winter electricity is between around CHF 20 and 95 per MWh, depending on the location. The production requirement is determined by referring the year-round production requirement (see Figure 15) not to the year-round electricity generation as above, but only to the amount of electricity produced in the winter half-year. The demand for electricity thus increases in line with the ratio of winter and summer electricity production[56]. On average, the subsidy requirement is just under 60 Swiss francs per MWh for plants commissioned from 2035 onwards.

The picture is similar in 2050. The production requirement per MWh of winter electricity is on average around CHF 45/MWh and in total between around CHF 15 and CHF 75/MWh, based on the assumptions in Section 5.1.

[56] As a formula: Production requirement/share of winter electricity=winter production requirement. For example, for the reference assumption 2035 according to Figure 13: CHF 38/MWh/0.66 = CHF 58/MWh

06 Macroeconomic impacts

Investments in wind turbines lead to a 69 percent share of domestic value creation and create 323 full-time jobs per TWh.

In brief:

- Investments in power plant components such as the tower or nacelle account for around 20 percent of the costs and account for 80 percent of the costs abroad; however, the remaining expenses are almost exclusively incurred in Switzerland.
- For a wind turbine in Switzerland, the Service life accounts for around 69 percent of total costs in Switzerland.
- A wind turbine creates 2.7 full-time equivalents per year and 323 full-time equivalents per TWh.

6.1 Value chain

The value chain of a wind turbine can be divided into planning, Financing, manufacturing, construction/installation and operation (see Table 5). For each of these steps, the respective share of costs can be recorded and translated into domestic and imported The following shares are allocated: Planning, financing, construction/installation and operation take place predominantly in Switzerland and account for around 80 percent of the costs. Components such as rotor blades, towers and nacelles are primarily manufactured abroad by specialised European manufacturers and account for around 20 percent of the costs. As wind energy production expands in Switzerland, it is possible that some of these production steps could be performed domestically in future.

Within the value chain, dependence on individual countries is relatively limited. Only the neodymium magnets used in the generators have a high concentration of origin (95 percent China).

6.2 Value creation from wind turbines in Switzerland

To calculate domestic value added, all costs incurred within Switzerland are assigned an appropriate multiplier depending on the value creation step. This makes it possible to determine how much added value is generated from an expenditure. The multiplier is used to deduct the expected foreign inputs of a company in the corresponding sector. Depending on how many foreign inputs are required in a sector, a given amount of Swiss-franc expenditure results in more – or less – added value. Consequently, the same expenditure in different value chains does not generate the same added value.

As shown in Figure 16, the added value is distributed over the various life cycle phases of the system. For simplicity, it is assumed that all expenses for planning, production of power plant components, construction and installation are incurred during a one-year construction phase. The 25-year operating phase then begins, during which the operating and

Methodological note

The macroeconomic aspects of the generation technologies considered in the Axpo Energy Reports were analysed and processed by Swiss Economics. For detailed information, please refer to the separate analysis.

For the analysis, we consider a reference wind turbine with an installed capacity of 5 MW and an annual production of 8.5 GWh. The costs of this system correspond to the assumptions of a reference system described in Chapter 5.

The value chain of wind power plants in Switzerland

	Planning	Financing	Production	Construction/ installation	Operation
Value-added steps	• Planning • Engineering • Feasibility and environmental studies	• Financing (Own and Liabilities) • Depreciation and amortisation*	• Rotor blades • Tower • Gondola	• Foundation • Transport • Assembly • Mains connection	• Lease • Operation • maintenance • Insurance • Marketing
Cost share	4%	53%	23%	9%	14%
of which national	92%	99%	20%	86%	71%
Provider	Predominantly Swiss engineers and planning offices, operators	Financing by Swiss banks and operators (50:50%)	Specialised European suppliers (rotor blades, tower and nacelle), possibly also with sites in Switzerland in the future	Mostly Swiss construction companies and installers, some European providers for specialised tasks	Maintenance, operation and marketing by operators, repairs by Swiss companies, spare parts from abroad, low energy share
Significant Dependencies Abroad			Nacelles and rotor blades from various European manufacturers, 95% neodymium magnets from China		Spare parts from China

● Local ● Abroad

ZHAW (2021), IEA (2012), IEA (2021), Goers et al. (2020), IRENA (2014), SFOE (2020), SFOE (2023), SFOE (2025)
* To be allocated to operating costs for accounting purposes, but to the cost of capital when calculating

Table 5: Value chain and the associated cost shares in Switzerland and abroad of wind turbines in Switzerland.

financing costs (capital costs and depreciation) are incurred. The distribution of value added over the service life is uneven. A high value added in the first year is followed by lower value added from the business operation. In terms of value added, the domestic share of investments is initially rather small, as the majority of key components are imported. In operations, the domestic value-added share is high because maintenance and operation services are predominantly provided in Switzerland. Over the life cycle of a wind turbine, domestic value added accounts for 69 percent of the total costs. At 92 percent, the company has a larger domestic share than construction in the first year (31 percent). Based on the total costs of 32 million Swiss francs, the reference wind turbine with an installed capacity of 5 MW would generate domestic added value of 22.3 million Swiss francs – divided into 3.8 million Swiss francs during construction and 18.5 million Swiss francs during operation.

Annual value added by a typical wind power plant in Switzerland

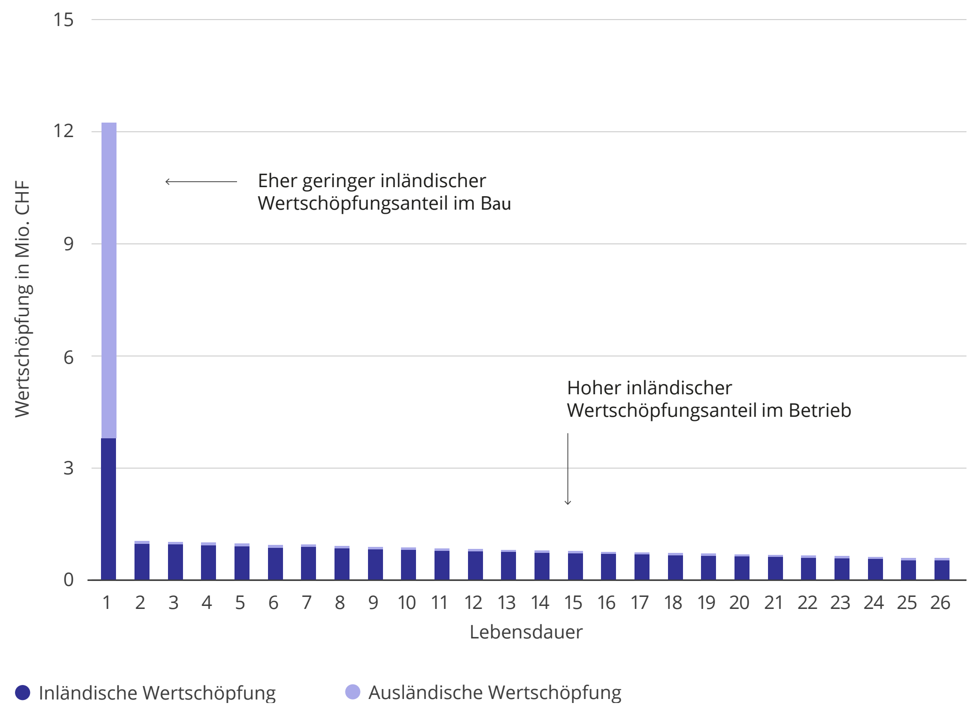


Figure 16: Value added of a typical wind turbine over 25 years, divided into domestic and foreign shares.

6.3 Employment from wind turbines in Switzerland

Investment in a wind turbine creates jobs – measured in full-time equivalents (FTEs) – across the entire life cycle of the turbine. A reference wind turbine in Switzerland generates a total of around 69 FTEs over its lifetime, which corresponds to 2.7 FTEs per year or 323 FTEs per TWh. Employment is unevenly distributed across construction and operation. During the one-year construction phase, an average of 3.7 FTEs per year are required, compared with 1.7 FTEs per year during operation.

Value creation and promotion

In Switzerland, state subsidies typically cover a significant proportion of the costs of electricity generation. If the necessary subsidies are subtracted from the reported value added, the effective market-driven share of value added is correspondingly lower. In other words: A significant part of value creation is made possible only by government subsidy. If the corresponding subsidy is deducted from the value added, the domestic value added for the reference plant analysed is reduced from around 22.3 million Swiss francs to 7 million Swiss francs.

07 Environmental impact

Wind power plants have the lowest environmental impact compared to other technologies.

In brief:

- Wind turbines in Switzerland have a particularly low environmental impact compared to other technologies.
- A typical wind turbine with an installed capacity of 5 MW and a lifespan of 25 years is compared with other types of electricity generation such as nuclear, solar and gas in terms of six environmental indicators.
- The analysis shows that wind turbines generate a high proportion of value added and employment in Switzerland over their entire life cycle, while key components are often imported and the environmental impact is largely low.

7.1 Environmental impact compared to other technologies

To assess the environmental impact, a prospective life cycle assessment[57] is used, which records the environmental impact of power plants over their entire life cycle. All phases are considered – from the extraction of raw materials, plant construction and operation to dismantling and recycling. The analysis comprises six environmental indicators: Greenhouse gases, land requirements, damage to ecosystems, hazardous waste, radioactive waste and the need for critical metals.

The environmental impacts recorded in this way occur both in Switzerland and abroad. This geographical distribution differs from the cost allocation on which the value-added analysis is based. Environmental impacts along the supply chain are also included, such as those arising from the extraction of raw materials used in the power plant components. The prospective design of the LCA makes it possible to account for future developments up to 2050. The expected decarbonisation of the Swiss and global economy is also incorporated, so that, for example, the future electricity mix – with an increasing share of renewable energies – is reflected in the calculations.

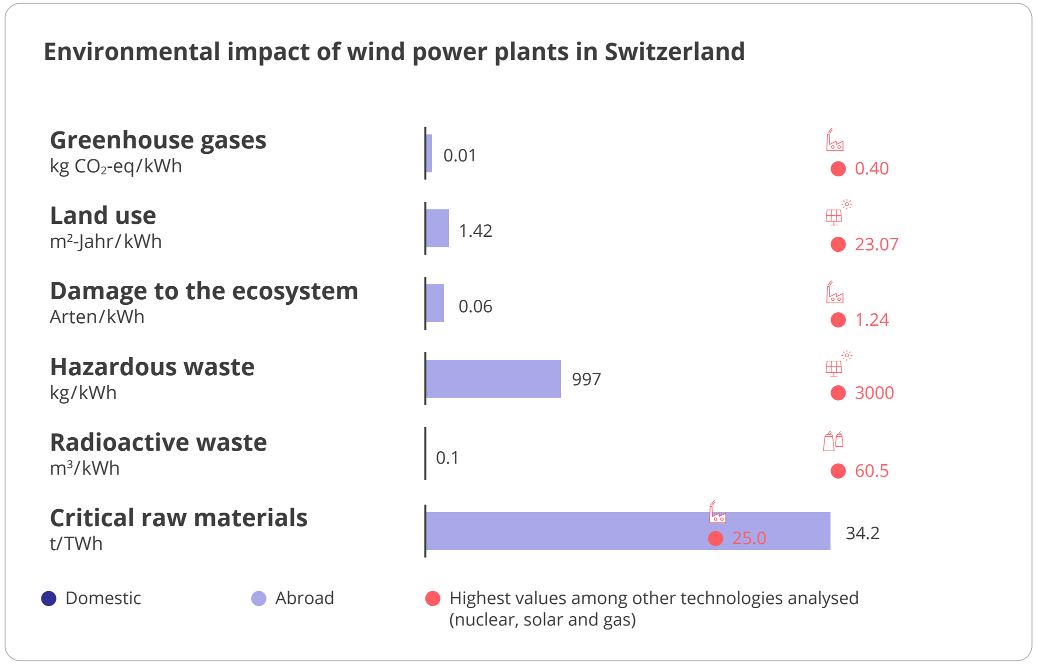


Figure 17: Environmental impacts of wind power plants in 2035, compared to the highest value recorded for each of the other technologies considered.

[57] A prospective life cycle assessment (LCA) is a life cycle analysis that does not assess environmental impacts retrospectively with current data, but rather with a forward-looking approach under future conditions. It combines classic LCA methodology with scenarios or projections to assess how the environmental footprint of a product or process will develop in the future.

Methodological note

The environmental impact of the generation technologies under consideration was analysed and processed by the Paul Scherrer Institute (PSI). For detailed information, please refer to the separate analysis. The environmental impact is calculated over the entire life cycle of the power plants using LCA methodology.

A reference wind turbine with an installed capacity of 5 MW, and an annual production of 8.5 GWh, is considered for the analysis. The assumed service life of the system is 25 years and the average full load is 1700 hours.

Figure 17 shows the environmental impact of a wind turbine in 2035. For better comparability, the respective peak values of the other investigated technologies (nuclear power plants, roof-mounted photovoltaics, ground-mounted photovoltaics and gas-fired power plants) are also presented.

Important findings:

- The environmental impacts of wind turbines in Switzerland occur almost exclusively in the upstream stages of the life cycle, i.e. abroad.

- Consider greenhouse gases CO_2-Emissions over the entire life cycle of a technology, from the extraction of raw materials, construction and operation to dismantling and recycling. As such, greenhouse gas emissions from wind turbines are very low, but not zero.

- Land use describes the total area that a technology requires directly on site or in its upstream supply chains. Ground-mounted PV systems require the most space. Wind requires little land. Landscape protection aspects – such as the visibility or visual impact of wind turbines – are not taken into account.

- Damage to ecosystems covers the loss of species caused by emissions, land use, resource extraction, water consumption and climate impact. Gas-fired power plants fuelled by natural gas are at the upper end – driven primarily by high greenhouse gas emissions. The impact of wind turbines on ecosystems is low in this comparison.

- Hazardous waste includes non-radioactive waste that, due to its hazardous properties, must be disposed of in underground landfills and cannot be disposed of via, for example, waste incineration plants. Ground-mounted PV systems perform worst on this indicator, due to the high proportion of copper used in the production of modules and system components. Wind energy causes moderate quantities of hazardous waste, mostly along the upstream stages of the life cycle. Although it is well known that the rotor blades are difficult to recy-

cle, they do not constitute hazardous waste. They are made of fibre composites, which can typically be thermally recycled. While recycling processes for such composite materials exist, they are complex, very expensive, and not designed for the size of wind turbines. There are various research projects and initiativesthat look at how composites can be recycled more intensively.[58]

- Radioactive waste refers to highly radioactive residues that must be stored in deep geological repositories. Nuclear power is the only technology that produces such waste. For the other technologies – including wind – the radioactive waste is generated in the upstream stages of the life cycle by the electricity mix used in other countries.

- Wind energy has the second highest demand for critical raw materials, particularly due to the use of neodymium as a key component in permanent magnet generators of modern wind power plants.

[58] EnBW, 2025, Wind turbine recycling

08

Politics

Political decisions will determine the success of the expansion.

In brief:

- The Acceleration Order will simplify the permitting process for wind energy projects in the cantons by, among other things, bundling the procedures for planning use and building permits and limiting the possibilities of appeal. Parliament adopted the corresponding revision of the Energy Act (EnG) in the 2025 autumn session.
- Two new popular initiatives – the Forest Protection Initiative and the Municipal Protection Initiative – could effectively make it impossible to expand wind energy in Switzerland by calling for stricter requirements for minimum distances from forests and more local authorities to have a say.

8.1 Legislation on accelerated procedures

The Acceleration Decree was passed by Parliament in the 2025 autumn session. Following the necessary amendments to the decree, the acceleration order can be expected to enter into force on a phased basis from 1 January 2026.

As described in Section 3, the Acceleration decree fundamentally streamlines the processes for wind power plants and wind turbines. A high risk of appeals and complaints remains, but the chances of success in obtaining a building permit for projects of national interest in Eligible Areas are expected to improve. However, depending on the cantonal design, municipal elections may still be held in the course of land-use planning, which may lead to a negative result for the specific wind project. This does not affect cantons, such as Lucerne, which have already ruled out this option.

Individual cantons such as LU, VS, SG or SH have already included various points of the Acceleration Decree as part of the revision of their legal bases. Specifically, the Canton of Lucerne has enshrined in law a cantonal planning permitting process as provided for in the Acceleration Order: In the canton of Lucerne, a cantonal authority is responsible for conducting the planning permitting process and making the planning permitting decision. This includes both the land-use planning specifications and the actual building permit. Consequently, all related objections must also be submitted in full to the cantonal authority, which rules on them as part of the unified cantonal planning permitting decision. This creates the conditions for the other (judicial) bodies (limited to the Cantonal Administrative Court and the Federal Supreme Court in Lausanne) to be able to rule on both aspects of planning permitting at the same time: land-use planning and building permit.

8.2 Popular initiatives

At the end of June 2025, two federal popular initiatives were submitted that could slow down the expansion of wind energy in Switzerland:

- **Forest conservation initiative:** Popular initiative “Against the destruction of our forests by wind turbines”[59] requires a minimum distance of 150 metres from forests and forest pastures.
- **Community protection initiative:** “For the protection of direct democracy in wind farms”[60] aims to define the municipalities’ right to have a say at the constitutional level.

The two popular initiatives submitted at the end of June 2025 could effectively make the expansion of wind energy in Switzerland im-

[59] Forest conservation initiative, 2026, initiative
[60] Municipal Protection Initiative, 2026, Initiative

possible. The Forest Protection Initiative demands a minimum distance of 150 metres between wind turbines and forests or wooded pastures. This new distance rule would further restrict the scope for site selection and could make numerous planned projects more difficult or even impossible. This has a direct impact on the wind potential determined by the SFOE, where around half (14.8 TWh) is attributable to forest areas.

The municipal protection initiative, on the other hand, aims to enshrine the municipalities' right to have a say in wind farm projects in the Federal Constitution. This would strengthen the corporate legal rights of the local population by giving them more influence over the planning and implementation of wind turbines. This could lead to procedures becoming even more dependent on municipal votes and individual municipalities delaying or preventing projects.

Both initiatives could therefore significantly increase the hurdles for the expansion of wind energy, or in fact make it impossible. For future wind energy projects in Switzerland, this would introduce an additional uncertainty factor and could lead to longer realisation times.

In principle, popular initiatives in Switzerland have a very low chance of success[61]. In addition, the population has consistently supported the current course of national energy policy in recent votes (Electricity Act, Energy Strategy 2050).

[61] FSO Last updated September 2025: Twenty-six of the 236 popular initiatives were adopted. This corresponds to a chance of success of around 11 percent.

09 Conclusion

A substantial expansion of wind energy is possible,
but it requires public acceptance, clear political commitment,
and consistent spatial planning.

The expansion of wind energy in Switzerland has so far been very limited. This is primarily due to planning and social challenges in the realisation of wind energy projects, less so to technological or economic restrictions. Substantial expansion is only possible if public acceptance, authorisation procedures, spatial planning and subsidy instruments work together effectively.

Wind energy generates a high level of electricity in the winter half-year and has a great deal of untapped potential, but has hardly been expanded in Switzerland to date.

Wind energy generates a high amount of electricity in the winter half of the year: Around two-thirds of annual production occurs between October and March. At the same time, Switzerland has considerable potential that can be used. Although wind speeds inland are moderate compared to coastal regions, numerous locations in Switzerland offer favourable conditions for the construction of wind turbines. The SFOE estimates the usable potential at around 30 TWh per year. However, this potential is barely being utilised today – only 50 wind turbines with a total annual production of around 0.2 TWh have been built in Switzerland to date.

State subsidies are necessary, but are generally sufficient today, wind energy has low demand for subsidies for winter electricity.

Like all other power generation technologies, wind turbines cannot cover their costs without state subsidies. In Switzerland, wind turbines are subsidised with a flat-rate investment contribution (or alternatively a sliding market premium) and a project planning contribution. The current subsidies for wind energy are generally sufficient for economic operation, provided sites fulfil certain minimum requirements – such as achieving around 1500 full load hours. In individual cases, however, this may differ, for example when construction costs are higher due to challenging topographical conditions. Overall, wind energy has a comparatively low subsidy requirement for electricity production in the winter half-year compared to other technologies.

Accelerated permitting processes are an important improvement, but they only have an impact when combined with suitability areas.

At the federal level, the Acceleration decree laid the foundations for significantly shortening the processing time for wind energy projects: The permitting process is simplified and consolidated by means of a cantonal planning permitting process, which is intended to speed up the processes and the duration of the procedure. These requirements must be implemented by the cantons as consistently as possible in cantonal law in accordance with their purpose. However, the Acceleration Decree only takes full effect when combined with the cantons' obligation to designate cantonal suitability areas for wind turbines and wind farms in their structure and land use planning. By doing so, the cantons fulfil their planning obligations and proactively determine where wind projects can be realised. This strengthens planning security and reduces project risks. At the same time, it provides the legal planning prerequisites necessary for implementing the desired acceleration of authorisation procedures.

The cantons have already designated suitable areas with a theoretical potential of around 7 TWh per year (see Chapter 3.1). However, practical experience shows that the actual yield of specific projects is generally lower than the potential identified in the suitability areas. The main reason for this is the strong local variation in wind speeds and the associated uncertainties in their modelling. As such, wind measurements are typically carried out on site for specific projects, enabling a more precise assessment of the local potential. Against this backdrop, it is crucial for the substantial expansion of wind energy that the cantons have a sufficiently broad and robust number of suitable areas to secure the overall expansion potential despite project-related deviations.

Local acceptance is the key Success factor for the expansion of wind energy, without the consent of the municipality.

At a national level, surveys repeatedly show that there is fundamental support for the construction of wind turbines. A relatively constant 60 percent of the population supports the construction of wind turbines. At the local level – i.e. for specific wind projects – approval is lower, at least in the early stages of the project. A lack of local acceptance is the biggest obstacle to wind energy projects in Switzerland. Without the broad support of the local population and communities, projects are difficult to realise – even if the legal framework of the Acceleration Decree is optimised. In principle, the concerns expressed by the public and organisations against wind projects are motivated by a variety of factors and are difficult to record conclusively. Of the projects currently in the permitting process, 60 percent are confronted with objections from associations and the remaining 40 percent with objections from private individuals. Historically, the average authorisation procedure for wind turbines in Switzerland has taken around 15 years.

The Acceleration Decree has improved the initial situation. As a result, the average duration of permitting for wind projects within eligible areas is likely to fall from 15 on an estimated and best-case basis 5 years. This is possible because a consolidated plan permitting process is being introduced in which appeals can only be lodged once at cantonal level and once at national level. This should help reduce delays to wind projects caused by appeals in the future. It could also reduce the number of appeals with low prospects of success. However, one key challenge remains: The Acceleration Order leaves it up to the cantons to decide whether to waive the formal consent of the local municipality in the new planning approval procedure. In order to prevent projects of national interest and within a suitable area defined in the cantonal structure plan from failing due to local resistance, the cantons should refrain from obtaining the consent of the local municipalities when implementing the Acceleration Order.

Future initiatives against wind power would effectively prevent further expansion and should therefore be rejected.

In mid-2025 two federal popular initiatives were submitted that could prevent the expansion of wind energy in Switzerland: The forest conservation initiative requires a minimum distance of 150 metres from the forest, while the community conservation initiative aims to anchor the municipality’s right to have a say in wind projects at constitutional level. These initiatives illustrate that, despite broad national support, the expansion of wind energy remains politically fragile. Both the Forest Conservation Initiative and the Community Conservation Initiative aim to tighten existing framework conditions and would limit the scope for action for new projects: Fixed minimum distances to forest areas would significantly reduce the potential for suitable areas. Incorporating the municipality’s right to have a say in the constitution would deprive the cantons of the option of waiving the municipality’s consent as part of the acceleration order. Both popular initiatives must be rejected to enable the expansion of wind energy.

Strategic coordination by strengthening national planning can further drive expansion.

Switzerland's decentralised planning structure poses a challenge when it comes to achieving overarching, nationwide goals. This is particularly true for technologies such as wind energy, which often face local opposition. Today, the federal government supports cantonal and municipal planning for wind energy by providing conceptual guidance and principles. To date, these have primarily focused on the identification and designation of potential (i.e. the designation of spatially suitable areas for wind energy use). Overall, they are not binding and therefore have little coordination effect at best. These challenges could be addressed by strengthening the binding nature of the federal government's conceptual principles on the cantons, by improving coordination between the federal government and the cantons, and by setting up a monitoring system at federal level to accompany and assess implementation in the cantons. This could motivate the cantons to designate additional suitability areas, contribute to greater coordination between the Confederation and the cantons and among the cantons (with a view to the national perspective), and strengthen the implementation and comparability of cantonal planning. In addition, strategically important wind energy projects could be included in the federal concept, which would enable explicit, national prioritisation. This would send a clear national signal in favour of these projects and give them stronger political and planning backing. Greater legitimisation of the selected projects could lead to greater acceptance and fewer objections.

To implement this, a "Wind Round Table" could be established at which the federal government, cantons, project planners and other relevant stakeholders regularly exchange and coordinate information on the status of planning, the overall national situation, and specific projects. At the same time, such an exchange promotes the cantons' acceptance of a stronger coordinating role for the federal government. If the expansion targets set by the federal government cannot be achieved even with increased nationwide planning and coordination, further measures should be examined, such as the creation of a national wind energy sectoral plan.

Disclaimer and bibliography

Publication details
Initial publication: 24 March 2026

Main authors:
Cédric Aubert, Clemens Bolli, Fabian Feger, Roland Kübler, Lara Lück, Paul Letainturier, Thomas Porchet, Mia Pfuderer, Leo Zimmermann

Experts and Contributors:
Martin Koller, Silvia Milan, Lena Schneider, Jeanette Schranz, Marius Schwarz, Stephan Weber

Design and production:
Aorta Design GmbH, Baden

Disclaimer

This publication was produced as part of the Axpo Energy Reports project to provide an overview of the role and potential of wind energy in Switzerland and is for information purposes only. The opinions expressed in this document reflect Axpo's thoughts and endeavours at the time of publication. These may change due to regulatory or macroeconomic developments. We cannot accept any liability, either expressly or implicitly, for the information contained in this document. This document contains statements that relate to future events and are purely speculative in nature. Such statements merely reflect our assessment of the situation at a particular point in time. Actions based on this document are the sole responsibility of the actors. We accept no liability for damages that may arise directly or indirectly from the use of this document.

Attya, A., Dominguez-Garcia, J., & Anaya-Lara, O. (2018). A review on frequency support provision by wind power plants: Current and future challenges. *Renewable and Sustainable Energy Reviews, Volume 81, Part 2*, 2071–2087.

Axpo Holding AG. (2025). *Rolle und Potenzial der Windenergie in der Schweiz.* Baden.

Basler & Hofmann, raumwirksam. (2025). *Analyse kantonaler Richtplanung für Windenergie in der Schweiz.* Baden.

Bundesamt für Statistik, BFS, B. f. (2020). *Arbeitskosten je geleistete Stunde im Produktions- und Dienstleistungssektor – Vergleich Schweiz – Europäische Union (EU).*

Bundesamt für Energie, BFE. (2020). *Windatlas Schweiz: Jahresmittel der modellierten Windgeschwindigkeit und Windrichtung.*

Bundesamt für Energie, BFE. (2022). *Windpotenzial Schweiz 2022.* Bern, Schweiz.

Bundesamt für Energie, BFE. (30. Juni 2025). *Elektrizitätsbilanz der Schweiz – Monatswerte.* Von www.bfe.admin.ch/ogd62.

Bundesamt für Energie, BFE. (2025). Von WACC – Kalkulatorischer Zinssatz: www.bfe.admin.ch/bfe/de/home/foerderung/erneuerbare-energien/wacc-kalkulatorischer-zinssatz.html.

Bundesamt für Raumentwicklung ARE. (2020). *Konzept Windenergie.*

Bundesamt für Umwelt, BAFU. (2012). *Energiestrategie 2050 – Potenziale Wind- und Sonnenenergie.* Von www.aramis.admin.ch/Default?DocumentID=47323&Load=true.

Bundesverband WindEnergie, BWE. (2025). *Status des Windenergieausbaus an Land – Halbjahr 2025.* www.wind-energie.de/themen/zahlen-und-fakten/deutschland/.

Devine-Wright, P. (2005). *Beyond NIMBYism: towards an Integrated Framework for Understanding Public Perceptions of Wind Energy.*

Eggenschwiler, K., Heutschi, K., & Schäffer, B. (2016). *Wirkung und Beurteilung des Lärms von Windenergieanlagen – aktuelle Beiträge aus der Schweiz.*

EnBW, 2025. *Recycling von Windrädern* mit Link: www.enbw.com/unternehmen/themen/windkraft/windrad-recycling.html.

Frisch, E., & Sokic, N. (2018). *Lokale Akzeptanz und Windenergie.*

Gemeindeschutz-Initiative. Von Initiative: www.gemeindeschutz-ja.ch/#initiative.

gfs.bern. (2025). *Schlussbericht – Studie Versorgungssicherheit Welle 4.* Bern.

Hinisch, A. (2020). *WinWind, das Handbuch für sozial inklusive Windenergie.*

Länder-Arbeitsgemeinschaft Immissionsschutz, 2020. *Hinweise zur Ermittlung und Beurteilung der optischen Immissionen von Windkraftanlagen.* Aktualisierung 2019.

Nejad, A. R., Keller, J., & Guo, Y. (2022). *Wind turbine drivetrains: state-of-the-art technologies and and future development trends.*

Petrova, M. A. (2013). *NIMBYism revisited: public acceptance of wind energy in the United States.*

Rand, J., & Hoen, B. (2017). *Thirty years of North American wind energy acceptance research: What have we learned?*

Ruddat, M. (2022). *Public acceptance of wind energy – concepts, empirical drivers and some open questions.* Stuttgart, Deutschland.

Schmid, J. (2024). *Schweizer Windenergieprojekte im föderalen Staatsgefüge.* Bern.

Stadelmann-Steffen, I., & Dermont, C. (2021). *Acceptance through inclusion? Political and economic participation and the acceptance of local renewable energy projects in Switzerland.*

Suisse Eole. (2025). *Suisse Eole – Bewilligungsprozess*. Von www.suisse-eole.ch/de/windenergie/bewilligungsprozess/.

Suisse Eole. (2025). *Suisse Eole – Schweizer Windparks und Projekte*. Von www.suisse-eole.ch/de/windenergie/windparks/.

Vuichard, P., Stauch, A., & Dälle, N. (2019). *Individual or collective? Community investment, local taxes, and the social.* St. Gallen, Schweiz.

Waldschutz-Initiative. Von Initiative: www.waldschutz-ja.ch/#initiative.