

Annual Report

Mission

As the national grid company, Swissgrid ensures the secure transport of electricity via both the national grid and the transmission grid connected to the European electricity system. This electricity forms the basis for the high quality of life and prosperity in Switzerland and Europe. Thanks to the central role it plays in the energy system, Swissgrid is actively shaping its sustainable transformation.

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Relevant contribution to the transformation of the energy system

The energy industry is facing major changes: decisions at the global, European and Swiss levels are making provision for a change in energy production, away from CO₂-intensive towards CO₂-neutral energy sources. With its long-term climate strategy, Switzerland has set itself the goal of achieving net-zero greenhouse gas emissions by 2050. At the same time, following the adoption of the Energy Strategy 2050 by the Swiss electorate, the decision has been made to gradually phase out nuclear energy and promote renewable energies. The power plant park in Switzerland will therefore undergo significant changes. In order to achieve the climate targets, electrification of mobility, heating and industry is also necessary, leading to an increase in the consumption of electrical energy.

This comprehensive transformation of the energy system is already a mammoth task in itself. In addition, Switzerland's security of supply – particularly in the winter months – must be guaranteed in the long term. This challenge, which has long been discussed in the industry, has moved to the top of the political agenda in recent years, resulting in changes to the legal framework.

A challenge and an opportunity

Transmission system operators, as the link between production and consumption, are significantly affected by these changes. The rise in decentralised and renewable electricity generation, such as wind and photovoltaics, and the elimination of power plants with guaranteed power, are increasing the volatility and complexity of the energy system, and hence the demands placed on grid operators. However, these changes are both a challenge and an opportunity, giving transmission system operators the chance to make an important contribution to the transformation of the energy system.

It is crucial for the grid infrastructure to keep pace with the ambitions of the energy transition. Swissgrid aims to use, manage, modernise and expand its transmission system more efficiently so that the secure transport of electrical energy can continue to be guaranteed in the future. Digitalisation is one of the aspects the company is relying on in order to increase the efficiency of grid operations and of the planning, expansion and maintenance of the grid infrastructure. Swissgrid is tackling the higher volatility of renewable electricity generation by improving its

forecasting capabilities, for example. On the market side, new market platforms and products are being developed so that the growing potential of decentralised flexibility, such as batteries and heat pumping technology, can be used in a way that benefits the system.

Swissgrid is committed to a climate-neutral society by 2050, a successful energy transition and the continuous development of the grid – as the backbone of a more sustainable energy system. Swissgrid has reaffirmed its commitment with its Strategy 2027 (see chapter «2027 Strategy») and the decision to anchor sustainability even more firmly within the company. The company is also part of the initiative to support the energy system to reach carbon neutrality.

Swissgrid sets various priorities in order to fulfil its legal mandate and to assume its important contribution to ensuring a secure supply of electricity. These priorities are also part of the Strategy 2027 and correspond to sustainability topics that have been integrated into Swissgrid's materiality matrix.

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Security of supply

As a transmission system operator, Swissgrid is responsible for a critical infrastructure. Secure and efficient grids are of vital importance in order to guarantee the supply of electricity. In Switzerland, other sectors such as transport, finance, health and IT also count as critical infrastructures. However, they are all dependent on the energy sector, and therefore rely on a secure supply of electricity, which the transmission system plays an important role in providing. The Federal Office for Civil Protection considers an electricity shortage to be the greatest financial risk for Switzerland. A major, nationwide power failure also ranks in the top ten¹ in the expected damage category.

The Swiss transmission grid is closely interlinked with the European interconnected grid and, due to its central location in Europe, plays a key role in the exchange of electrical energy in Europe. An outage or disruption to the grid can therefore have far-reaching consequences that extend beyond Switzerland's borders.

¹Federal Office for Civil Protection, report on the national risk analysis (disasters and emergencies in Switzerland 2020)

Grid-related security of supply – the sum of various components

In order to ensure a high level of grid-related security of supply and to protect the grid from an outage, Swissgrid takes action at various points:

Ensuring grid operations – around the clock

In Swissgrid's capacity as Coordination Centre South, its grid control rooms are responsible for ensuring the permanent balance between electricity generation and consumption to maintain a constant system frequency of 50 hertz – not only for Switzerland, but also for Europe. The grid control rooms also monitor the capacity utilisation of the transmission system and intervene in the event of congestion, impending line overloads or failures of grid elements. When operating their grids, the transmission system operators follow the n-1 principle, which is an essential rule for ensuring secure transmission system operation. This principle states that if any one grid element fails, no other element may be overloaded.

Long-term planning is necessary for secure grid operation: this takes into account aspects such as the decommissioning of lines and power plants, as well as the schedules of power plant operators and electricity traders, which include all electricity exchange transactions in Switzerland and abroad. Swissgrid continuously coordinates its planning and real-time operations with European transmission system operators.

Helping to shape and develop markets – in Switzerland and Europe

Another prerequisite for a high level of grid-related security of supply is the availability of control power to compensate for short-term deviations between production and consumption (balancing measures) and to manage grid congestion. That is why Swissgrid is continuously optimising the Swiss market for control power and cooperating with European transmission system operators.

The transmission system operators are also tasked with providing sufficient capacity on cross-border lines for international electricity trading. In order to avoid grid congestion and to ensure non-discriminatory access, Swissgrid allocates capacity at the Swiss border by means of auctions. These processes are carried out in close coordination with the neighbouring transmission system operators.

Cooperation with Europe – in all areas

Swissgrid and European transmission system operators cooperate closely in areas such as grid operations, control power markets and congestion management. To ensure that all grid operators adhere to the same rules in the interconnected grid, the EU regulatory requirements for system operation are implemented. Cooperation across Europe is also crucial for the successful integration of increasingly decentralised energy sources into the overall system.

Due to the lack of an electricity agreement between Switzerland and the EU, it is becoming increasingly difficult for Swissgrid to help shape these pan-European developments. This has a negative impact on grid security, and hence on Switzerland's security of supply. The exclusion of Swissgrid from European platforms and coordination processes increases the risk of unplanned load flows in the Swiss transmission grid. Swissgrid is therefore taking various measures to counteract Switzerland's growing isolation (see chapter «Stakeholder engagement»).

Ensuring safety – at all levels

Important prerequisites for grid-related security of supply include a resilient grid infrastructure and the availability of IT and communication systems. To ensure the safe and reliable operation of the Swiss transmission grid, Swissgrid pursues an integral security policy. This defines the objectives and framework for action for implementing precautions in a consistent and coordinated way according to standardised rules.

The purpose of integral security management is, on the one hand, to protect people and the environment from negative influences caused by Swissgrid's activities and, on the other hand, to protect Swissgrid's employees, installations, systems and information from adverse effects.

Swissgrid's integral safety policy

Swissgrid's integral approach to safety management comprises seven security domains: operational security, physical security, information security, integral risk management, crisis management and business continuity management, as well as health protection, occupational safety and environmental protection. The integral safety policy sets out Swissgrid's safety objectives and regulates the essential aspects required for the effective implementation of company-wide integral safety management. These include the principles, the overarching framework conditions and domain-specific requirements, and security organisation.

Operational security

The aim of operational security is to ensure that Swissgrid provides a secure service in every grid state. It is based on the processes and elements of safety risk management, such as the reporting system, event investigation, safety risk analysis, safety culture and clearly defined roles and responsibilities.

In particular, operational security aims to ensure that work can be carried out reliably in complex grid and system operations, and that the corresponding processes and instructions function properly. The following specific methods and processes are used, among others:

- Independent, continuous observation of operations with the aim of identifying instructions that are inappropriate or prone to errors, or procedures that deviate from the instructions, and improving them by means of incident analyses.
- The principles of «human factors» for designing a robust working environment that is tailored to people's characteristics.

A competence management system that consistently ensures and documents basic training, the retention of knowledge and skills, the further training of employees (especially in grid and system operations), and the building up of experience.

Physical security

The aim of this security domain is to ensure the physical security of employees, of third parties and of the Swissgrid infrastructure.

Swissgrid has developed its own company-wide standards based on best practice in order to meet the requirements of a critical infrastructure. Among other things, they take into account the ISO/IEC 27002 standard, the industry recommendation of the Association of Swiss Electricity Companies (VSE) and the regulations of the Federal Inspectorate for Heavy Current Installations (ESTI).

Information security

The aim of the «information security» domain is to guarantee the confidentiality, availability and integrity of data and information in physical form or based on Information and Communication Technology (ICT) systems for business and operating technology.

A risk-based information security management system built according to international standards, such as those of the ISO/IEC 27000 family, defines the regulations and measures to be applied. This management system supports the entire implementation process from implementation through to review and further development. The basic measures to be applied and measures specific to the energy sector are derived and implemented from the same family of standards.

Crisis management and business continuity management

Swissgrid's crisis management and business continuity management (BCM) have the common goal of ensuring flexible incident management that is adapted to the situation so that the continuity of critical processes required for Swissgrid's key responsibility can be guaranteed in the event of an incident. Crisis management and BCM serve to continue Swissgrid's mission in accordance with the defined framework conditions, subject to certain restrictions, in the event of deviations from the normal situation. They are based on Swissgrid's mandate in accordance with Art. 20 StromVG and Art. 5 StromVV, ENTSO-E requirements in accordance with the Synchronous Area Framework Agreement, Transmission Code and VSE industry document, and the requirements of the Federal Office for Civil Protection.

The existence and proper functioning of crisis management and BCM correspond to the necessary level of basic protection. Swissgrid's business continuity management system, based on the ISO 223xx series, is being continuously developed for this purpose within the framework of a roadmap approved by the Executive Board, including annual targets. Among other things, it describes the creation of BCM specifications, the regular verification of BCM scenarios, and the development, testing and practising of risk-based business continuity plans. Business impact analysis is used to identify the critical processes required for Swissgrid's key responsibility and the requirements for restoring process performance, which are to be taken into account within the BCM framework. At the same time, this determines the corresponding level of protection. This analysis is repeated as necessary and reviewed on a regular basis. In addition, Swissgrid employees are trained to apply the correct conduct in the event of an incident as part of crisis exercises, and the functionality of existing systems and processes is checked. The implemented BCM processes are tested on an ongoing basis.

Every year, additional exercises lasting several days are conducted at the simulation centres in Prilly and Aarau. The aim of these exercises is to simulate a major disturbance or blackout and to practise grid restoration. Swissgrid, all distribution system and power plant operators connected to the transmission system, and the operators of restoration cells participate in these exercises. Swissgrid envisages that, in the event of a major event, personnel will be gathered at decentralised sites in Switzerland in order to carry out the necessary work on site. This procedure

is repeated and practised with the involvement of external partners.

The status of BCM implementation and the company's business continuity capability are regularly reported to the Executive Board and the Board of Directors.

The topics of occupational health and safety and environmental protection are explored in greater detail in the «Occupational health and safety» section.

Continuing to ensure grid-related security of supply in the future

The transformation of the energy system is bringing new challenges for ensuring grid-related security of supply. Swissgrid addresses these challenges in its Strategy 2027 (see chapter «2027 Strategy»). The «Security of supply» priority focuses on measures to ensure grid-related security of supply in the long term, regardless of the degree of integration into EU processes, while at the same time supporting the federal government's «Energy Strategy 2050». To increase the controllability of the grid, Swissgrid is taking structural measures, changing operational processes and using digital solutions in system operation. These approaches are also key to promoting the integration of renewable energy sources into the energy system.

	2023	2022
Number of supply failures in the meshed grid	1	0
Average duration of interruption	40 minutes	0
Energy not supplied in the meshed grid	113 MWh	0

in GWh	2023	2022
Transported energy	74,134	74,414
Imported energy	27,017	32,695
Exported energy	32,888	28,762
Transit energy	21,591	23,134
Active power losses absolute	919	987
Positive control energy	1,033	1,118
Negative control energy	694	754

Active power losses of transported energy	1.24%	1.33%
Ratio of «energy not supplied» to transported energy	0.0015	0

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Grid transfer capacity

Swissgrid's aim is to provide a grid infrastructure that offers high availability and capacities, and that meets the requirements of the future energy system. This requires long-term planning, modernisation and optimisation of the grid, as well as ongoing inspection, maintenance and servicing. To support the

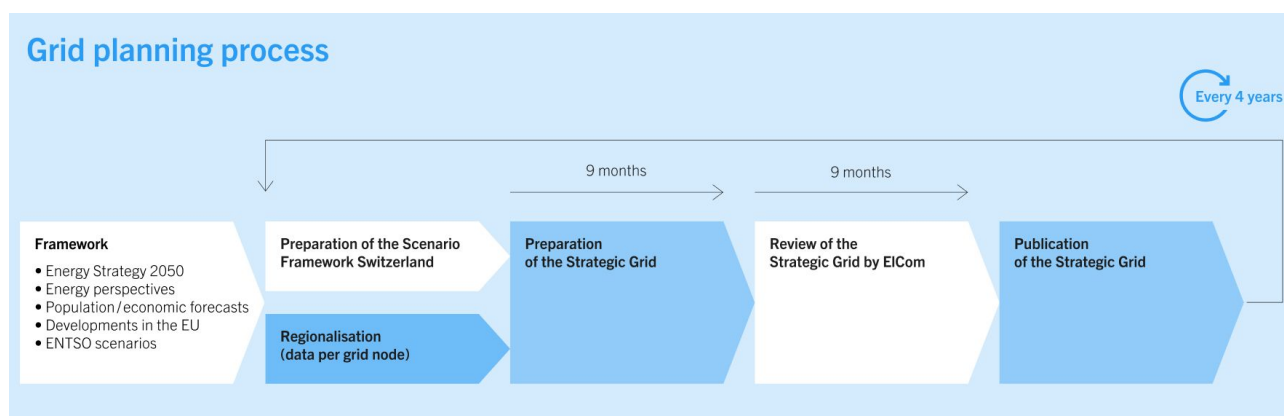
transformation of the energy system, Swissgrid invests over CHF 200 million every year.

Planning the grid – the Strategic Grid

The requirements placed on the grid have changed significantly in recent years. This trend will intensify in the coming decades as part of the energy transition. The Swiss Federal Office of Energy has set out these changes in the scenario framework for Switzerland, which contains national target values for each generation technology and consumer group for the years 2030 and 2040.

Swissgrid is developing the Strategic Grid 2040 on the basis of this scenario framework. In addition, Swissgrid receives information on the regional development of production and consumption within Switzerland from SBB and from the distribution system and power plant operators that are directly connected to the transmission system. Swissgrid uses this data to determine grid development requirements.

The process for the Strategic Grid 2040 is already well advanced. In 2024, Swissgrid will finalise the planning and submit it to the Federal Electricity Commission (EiCom) for review. Swissgrid will then publish the new strategic grid. For the first time, this planning is based on the legal basis established in the «Electricity Network Strategy». It will be repeated every four years in the future.



Investment in the grid infrastructure – modernisation in line with demand

Swissgrid continuously invests in its grid infrastructure to ensure a secure, efficient grid in line with demand. The current modernisation projects are set out in the Strategic Grid 2025 and represent an investment volume of around CHF 2.5 billion. The grid projects included in the Strategic Grid 2025 are designed to eliminate existing congestion, ensure the transport of energy from large power plants in the Alps to urban centres, and strengthen the connection to the European grid.

Swissgrid has already been able to complete some of the projects from the «Strategic Grid 2025», while others are in the project planning or implementation phase.

Maintenance of a grid that is permanently in use

The Swiss transmission grid is one of the most reliable power grids in the world. To ensure that the grid functions perfectly at all times, it not only needs to be converted and expanded, but must also be continuously inspected, maintained and repaired. Maintenance includes regular cleaning and adjustment of technical systems. If installations are damaged after a storm or avalanche, they must be repaired quickly. Swissgrid also carries out planned repair work, such as the replacement of conductors and insulators, protection against corrosion, the revision of circuit-breakers and deforestation. Two-

thirds of the Swiss transmission grid, which is over 6,700 kilometres long overall, dates from before 1980. This work is therefore of great importance.

The right grid infrastructure for the transformation of the energy system

The modernisation of the transmission system lays the foundations for a sustainable energy future. At present, however, the expansion of the grid cannot keep pace with the growth of renewable energy installations. Objections and legal proceedings lead to significant delays in the realisation of grid projects. Swissgrid is committed to ensuring that approval processes are made more efficient and that grid expansion can be driven forward. In the «Grid Transfer Capacity» priority of its Strategy 2027 (see chapter «2027 Strategy»), Swissgrid also defines measures to increase the capacity of the grid in line with demand and to implement and operate the grid even more efficiently in the future. Digital solutions play a key role in addition to the Strategic Grid 2040. A completely digitalised grid image provides the basis for establishing data-driven system management.

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Innovation and digitalisation

Swissgrid is driving forward digitalisation within the company in order to tackle the challenges associated with the transformation of the energy system. Digitalisation can also be seen as a catalyst for the energy transition because it leads to increased efficiency in all areas of responsibility and opens up new opportunities.

More efficiency in grid planning

Use of 3D visualisations

Swissgrid has developed a 3D Decision Support System in collaboration with ETH Zurich. This system analyses and maps all the factors that are relevant to the line route, such as environmental protection, regional planning, economic efficiency and technology. The resulting 3D models assist decision-makers, lead to greater transparency, and simplify communication with residents and stakeholders.

Greater efficiency in grid management and expansion

A digital twin of the grid

A completely digitalised grid image – a digital twin of the physical grid – provides the basis for establishing data-driven plant management. This allows the status of plants to be monitored more precisely over the entire life cycle and enables the grid to be operated in a more efficient manner.

Use of drones and artificial intelligence

In 2022, Swissgrid carried out a pilot project to test the use of drones. They flew over around 1,000 pylons to assess their condition and identify any damage. These drones can deliver high-resolution images thanks to modern sensors and cameras. Using artificial intelligence algorithms, the images were then evaluated according to the damage catalogue defined by Swissgrid. Following the successful completion of the pilot project, Swissgrid commissioned service providers to fly over all 12,000 pylons in the transmission system by 2025. Swissgrid is also considering the use of drones for other scopes of application.

Building Information Modelling

In order to expand the transmission system more efficiently, Swissgrid uses digital working methods such as Building Information Modelling (BIM). This allows interdisciplinary collaboration over the life cycle phase of systems, including model-based planning and the realisation of grid infrastructure. The first pilot projects are currently underway, such as the replacement construction at the Botterens substation.

Internet-of-Things sensors on pylons

In 2021, Swissgrid launched the «Pylonian» innovation project, which involved placing Internet-of-Things sensors on pylons to measure variables such as pylon vibrations, pylon inclination, temperature and solar radiation. Swissgrid's aim is to monitor the condition of the pylons over their entire life cycle in order to carry out maintenance work in a more targeted manner.

More efficiency in grid operations

Forecast of production from photovoltaics

Swissgrid's «PV Forecasts» project aims to significantly improve Swissgrid's internal data basis for feeding photovoltaic energy into the grid. This should make forecasts with a high regional and temporal resolution possible in the future. This aids system operation with regard to grid monitoring and is intended to assist the industry with the secure integration of large volumes of photovoltaic energy.

Outage planning

The aim of Swissgrid's «Compose» research and development project is to automate and optimise the outage planning of grid elements with the help of mathematical optimisation and algorithms. This facilitates the highly complex planning of grid operations.

Closer cooperation between transmission and distribution system operators

The expansion of photovoltaics, heat pumping technology and electric vehicles requires closer coordination between grid operators in order to ensure secure grid operation. In association with Equigy, Swissgrid and ewz carried out a pilot project to distribute the use of decentralised energy resources in a coordinated manner in order to provide ancillary services. Phase B, which was launched in 2023, aims to win over additional industry partners for the project.

Swissgrid is also seeking closer cooperation with distribution system operators in the future with the «OPTESO» project, which aims to develop a decentralised mechanism for carrying out joint grid security calculations.

Innovation and digitalisation as a new priority in Strategy 2027

The new «Innovation and Digitalisation» priority was included in Strategy 2027 (see chapter «2027 Strategy») in order to develop Swissgrid into an innovative, highly digitalised company. A comprehensive package of measures creates the prerequisites at the data, technological and personnel levels so that the desired digital transformation can be successfully implemented in the company. The focus is also on developing a culture of innovation. To this end, Swissgrid organised events such as Innovation Days, during which employees were able to explore exciting topics for the future and receive incentives, and where ideas and interaction were promoted (see chapter «Attracting, retaining and developing skilled workers»).