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Fact sheet

Voltage control

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1 Voltage control – a key responsibility for Swissgrid

In addition to frequency control and grid security, voltage is also monitored in real time in Swissgrid's grid control centre. Electrical energy with a voltage of 220 kilovolts (220,000 volts) or 380 kilovolts (380,000 volts) flows from power plants and from abroad into the Swiss transmission grid. The voltage values must be kept within certain limits to ensure secure grid operation. This requires reactive power.

Reactive power is power that is generated and absorbed but that cannot be used, for example, to operate machines and appliances or for lighting. However, reactive power is not useless; it enables the voltage in the grid to be kept within the allowed limits. When the grid load is high (especially in the winter months), the voltage tends to drop. More reactive power must therefore be generated to maintain the voltage. When the grid load is low (especially in the summer months), the voltage tends to increase. In this case, more reactive power needs to be absorbed or drawn from the grid.

Power plants can use their generators to produce or absorb reactive power to influence the voltage in this way. Swissgrid continually informs power plant operators which voltage is required where and when, and remunerates power plant operators for the supply of reactive energy.

Some distribution grids can control their reactive energy exchange and thus actively influence the voltage. Like the power plant operators, distribution system operators are remunerated by Swissgrid for the supply of reactive energy.

Swissgrid has the option of staging transformers between the 220 kV and 380 kV voltage levels in order to control the flow of reactive energy and influence the voltage.

Voltage variations can lead to critical situations: overvoltage can damage operating facilities, while undervoltage can cause a power failure. Voltage control is therefore important for the supply of electricity, and it ensures secure grid operation.

Voltage control is a key responsibility for Swissgrid and must therefore be guaranteed in the medium and long term.

2 Main challenges

Swissgrid faces the following current and future challenges that affect voltage control:

- **Power plants with exhausted resources:** There are periods during which all reasonable options have been exhausted and power plants (especially storage power plants at times when the reservoirs are empty) cannot provide sufficient reactive power.

- **Swissgrid's own requirements:** Swissgrid has its own high demand for reactive power. Its transmission grid (overhead lines and underground cables) requires reactive power to magnetise and demagnetise magnetic fields. This demand is constantly rising due to grid expansion and voltage increases.
- **Energy transition and decentralisation:** The expansion of renewable electricity generation presents both opportunities and challenges for voltage control. Hydropower plants are essential for voltage control in Switzerland, and wind power plants can also be used for voltage control. However, the decentralised feed-in of electricity negatively impacts voltage control. The increased cabling of distribution grids and greater meshing can also lead to higher voltages.
- **Voltage control at a European level:** Neighbouring transmission system operators play a role in voltage control in Switzerland due to the large number of international interconnection lines and the country's central location in Europe. The aim is to minimise the exchange of reactive energy between Switzerland and other countries in order to make the lines available for the exchange of active energy (energy that actually reaches consumers).

The challenge for Swissgrid is to keep the reactive power at the right level. As a result of the energy transition, there is an increased risk that too few resources will be available for voltage control.

3 Possible measures

Voltage control measures must be taken on a regional scale, as reactive power is not well-suited to transportation over long distances and therefore cannot be imported in large volumes.

Consequently, Swissgrid and power plant and distribution system operators need to implement measures to guarantee voltage control in the medium and long term. The following measures are key to overcoming the current and future challenges:

- **Replacement and/or tap-changing of coupling transformers (in progress):** Swissgrid has the option of staging transformers between the 220 kV and 380 kV voltage levels in order to control the flow of reactive energy. This affects the voltage. Swissgrid would like to increase the degrees of freedom and controllability of its transformers whose voltage ratio cannot be influenced or can only be influenced according to the active power flow. To achieve this, it makes sense to replace the affected transformers.
- **Continued operation of generators as synchronous condensers (under review):** Nuclear power plants provide significant local resources for voltage control. In the event of a shutdown, a solution must be found to compensate for the reactive power resource that is lost. One possibility is to continue operating the generators of the nuclear power plants as synchronous condensers. In this operating mode, the generators provide reactive power for the extra-high-voltage grid, i.e. for Swissgrid.
- **Construction of compensation systems (under review):** Compensation systems use reactive power to assist with voltage control. In this way, grid operations can even compensate for a high voltage at night and at the weekend, when less electricity flows through the lines. The installation of reactive power compensation systems can make a significant contribution to voltage control.

4 Conclusion

Swissgrid needs external and/or its own resources for sustainable voltage control. To achieve this, it is reliant on the support and commitment of relevant partners.