SAIFI/SAIDI indicators and the growing RES penetration

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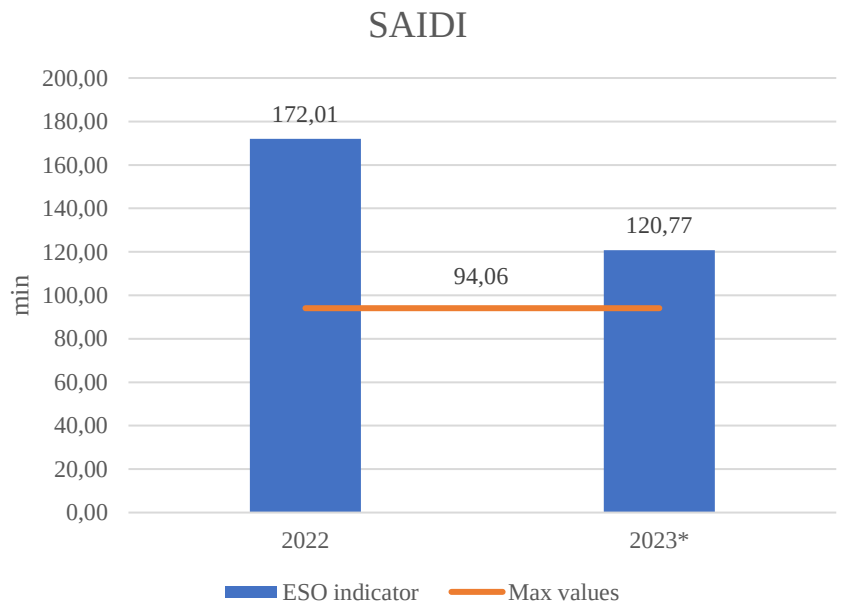
ERRA EMER Committee Meeting
September 12, 2024 | Online meeting

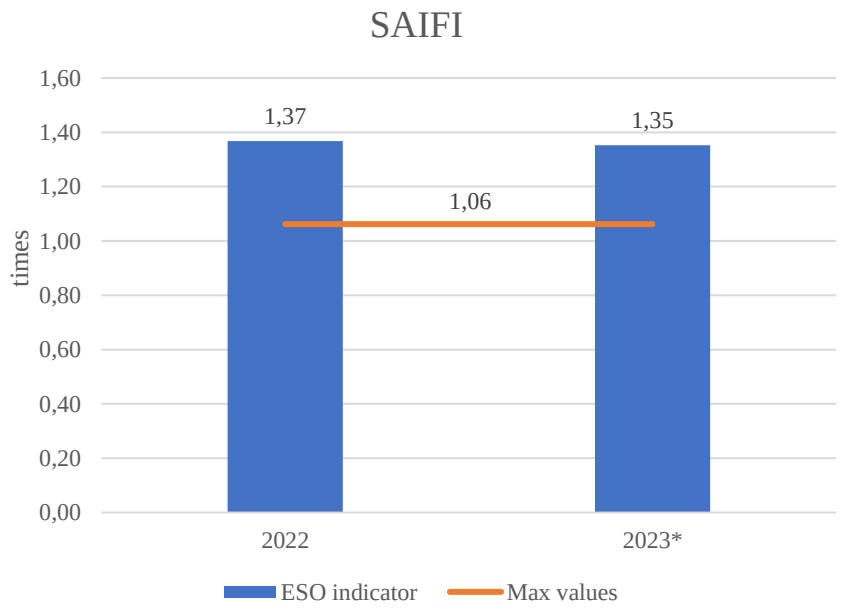
Background

Large shares of intermittent renewable generation (wind and photovoltaic) cause additional stress on the system and can affect the network reliability. In order to keep stability network management requires inter alia increased flexibility where flexibility sources may include flexible capacities within the electricity generation mix, interconnection capacity, energy storage or improved load control.

Did you <u>experience</u> any changes in the network reliability performance (SAIDI / SAIFI) in the last years?

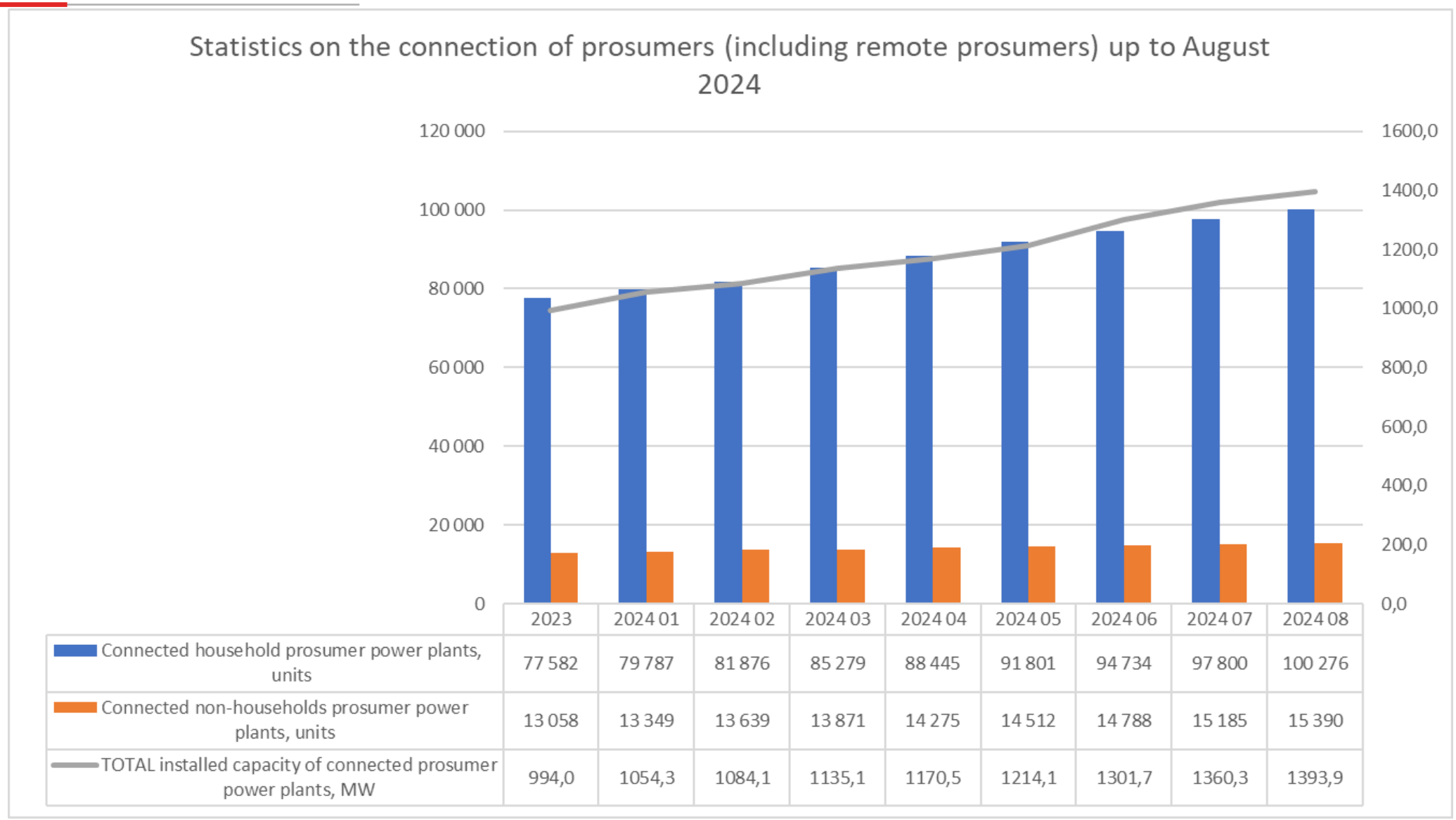
The network reliability performance (SAIDI/SAIFI) has changed in last years. Adverse weather conditions (such as high winds and high rainfall) have had the greatest impact. Indicators are assessed annually. The assessment of indicators may exclude exceptional cases of transmission interruptions caused by natural phenomena and external effects.





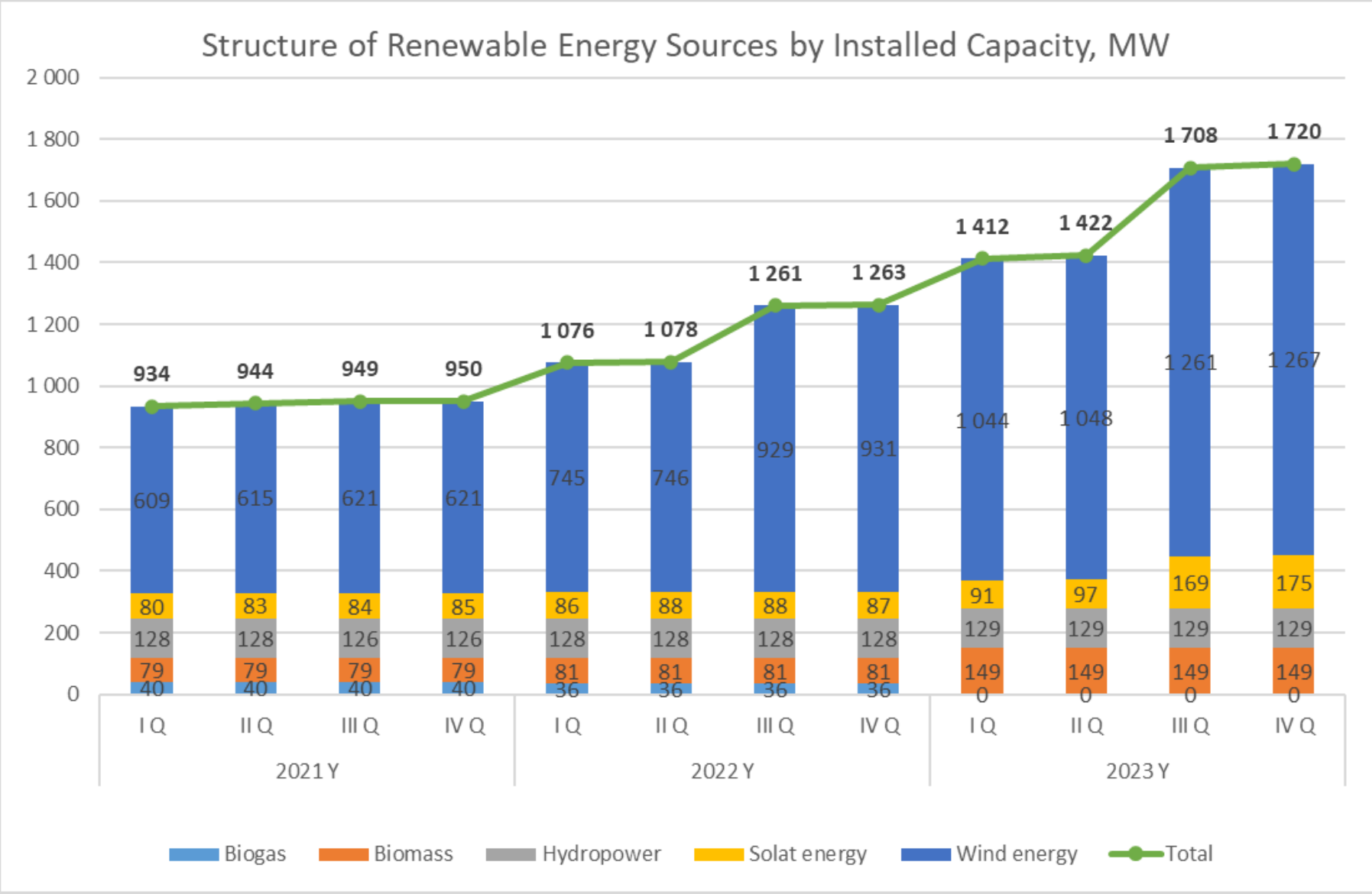
**The values for 2023 are preliminary.*

What are the major reasons and can you causally connect such changes with the increasing share of intermittent renewable generation?



	2023	2024 01	2024 02	2024 03	2024 04	2024 05	2024 06	2024 07	2024 08
Connected household prosumer power plants, units	77 582	79 787	81 876	85 279	88 445	91 801	94 734	97 800	100 276
Connected non-households prosumer power plants, units	13 058	13 349	13 639	13 871	14 275	14 512	14 788	15 185	15 390
TOTAL installed capacity of connected prosumer power plants, MW	994,0	1054,3	1084,1	1135,1	1170,5	1214,1	1301,7	1360,3	1393,9

What are the major reasons and can you causally connect such changes with the increasing share of intermittent renewable generation?



What are the major reasons and can you causally connect such changes with the increasing share of intermittent renewable generation?

1. **Integration of Intermittent Renewables**:
   - **Variability**: Renewable energy sources such as wind and solar are intermittent by nature. Their output fluctuates based on weather conditions, which can lead to grid instability if not properly managed.
   - **Grid Congestion**: High penetration of renewables can cause congestion in certain parts of the grid, leading to more frequent and prolonged outages.
   - **Need for Ancillary Services**: Higher levels of renewable energy increase the need for ancillary services to maintain grid stability, including frequency regulation, voltage control, and reserves. If these are inadequate, reliability can suffer.
2. **Inadequate Infrastructure**:
   - **Aging Infrastructure**: As the grid is adapted to accommodate more renewables, older infrastructure may not be able to handle the new stresses, leading to increased failures.
   - **Delayed Upgrades**: If upgrades to transmission and distribution networks lag behind the rate of renewable adoption, the grid may experience more faults and outages.

What are the major reasons and can you causally connect such changes with the increasing share of intermittent renewable generation?

3. Operational Challenges:

- **Forecasting Errors**: Inaccuracies in predicting renewable generation can lead to supply-demand mismatches, causing outages or requiring more frequent use of non-renewable peaking plants, which may be less reliable.
- **Increased Complexity**: Managing a grid with a higher share of renewables adds complexity to grid operations, including balancing supply and demand, which can lead to more frequent errors and outages.
- **Grid Wear:** The current electrical grid infrastructure is often not adapted to the variability of renewable energy sources like solar and wind power. This requires substantial investments in grid modernization to ensure stable and reliable energy supply.
- **Vulnerability to Natural Phenomena:** Renewable energy sources, especially wind and solar power plants, are sensitive to extreme natural phenomena such as storms, floods, or droughts. This can cause disruptions in energy supply and requires additional protective measures.

Did you design / implement measures to prevent from potential deterioration of network reliability performance related that the increasing share of intermittent renewable generation?

The laws stipulate that the system balancing limits and their capacities must be assessed. These capacities are evaluated based on the 110 kV transmission network sections, which include the Operator's 110/10 kV and 110/35/10 kV transformer substations connected to the respective section.

Available capacities can be monitored on the map prepared by the operator according to the 110 kV transmission network sections, which include the Operator's 110/10 kV, 110/6 kV, and 110/35/10 kV transformer substations connected to the respective section.

This information is updated periodically, at least every 10 working days.

Did you design / implement measures to prevent from potential deterioration of network reliability performance related that the increasing share of intermittent renewable generation?

- Operators must evaluate technical grid capacity and system balance capabilities to transfer electricity at grid-safe level to avoid overloads. Due to production heterogeneity, solar and wind generation profiles are evaluated separately.
- Technical capacity assigned for the solar power plants are in the 110 kV transmission network section and allocated for different priority groups.
- The available technical capacities for wind power plants in a specific 110 kV transmission network section are indicated on the map of available capacities without assigning them to a specific priority group. However, when reserving grid for wind power plants, the Operator must take into account the overall capacity assigned to the priority group, which cannot be exceeded.
- The restriction on the allowable generation capacity, related to the technical capacity of the distribution electrical networks, is not established if the network user performs such reconstruction of the Operator’s electrical networks and transmission electrical networks, which ensures that the capacity of these electrical networks in emergency mode, connection of new network users’ electrical equipment, maintenance work of the Operator’s electrical networks or the transmission system operator’s electrical networks, including modernization, repair, preventive maintenance, testing, or implementation of projects of special national importance, would be sufficient to transmit the allowable generation capacity of the power plant or storage device.

Did you design / implement measures to prevent from potential deterioration of network reliability performance related that the increasing share of intermittent renewable generation?

- When connecting all power plants, hybrid power plants, or storage devices, restrictions on allowable generation capacity related to the technical capacity of the transmission electrical networks apply. If the network user disagrees with these restrictions, their power plant and storage device can only be connected to the electrical networks after the reconstruction of the transmission electrical networks. This specified restriction applies to the combined allowable generation capacity of the hybrid power plant and the power plant connected at the same connection point with the storage device, considering the power generation source or storage device operating during the restriction period. When a hybrid power plant is formed based on an already connected power plant, or when a storage device is connected to an already connected power plant, or a power plant is connected to a storage device, the specified restrictions apply to the additionally connected power generation or storage device, except when restrictions were already established for the power plant or storage device at the time of its connection.

Did you design / implement measures to prevent from potential deterioration of network reliability performance related that the increasing share of intermittent renewable generation?

Restrictions on allowable generation capacity when connecting power plants or storage devices (Pmax > 100 kW):

System balance restrictions:

- If the network user wants to reserve a higher allowable generation capacity than assigned to their priority group, regardless of the Operator's electrical network capacity.

Hybrid power plant restrictions:

- If a hybrid power plant is connected or a hybrid power plant is formed based on an already connected power plant and at least one generation source is not assigned capacities that are exempt from system balance restrictions.
- Restrictions apply to the combined allowable generation capacity of the hybrid power plant and the power plant connected at the same point with the storage device, considering the operating sources during the restriction period.
- If a hybrid power plant is formed based on an already connected power plant or a storage device is connected, restrictions apply to the additionally connected power generation or storage device, except when restrictions were already established for the power plant or storage device at the time of its connection.

What is the role & potential of network flexibility in this context?

General network flexibility is a crucial factor in ensuring the efficient and reliable operation of electricity network. Here are some key aspects of network flexibility:

- **Avoiding Overloads**: Network flexibility allows for efficient management of electrical flows, thus avoiding network overloads. This is especially important during high generation or consumption peaks.
- **Optimal Network Utilization**: A flexible network can dynamically distribute electricity where it is most needed, ensuring optimal network utilization.
- **Managing Generation and Consumption Peaks**: Network flexibility allows for better management of generation and consumption peaks, ensuring stable and reliable electricity supply.
- **Resilience to Disruptions**: A flexible network can quickly adapt to various disruptions, such as natural disasters or technical failures, ensuring uninterrupted electricity supply.
- **Integration with Renewable Energy Sources**: Network flexibility is essential for integrating renewable energy sources, such as solar and wind power, which are variable and dependent on weather conditions.

In summary, general network flexibility is essential for ensuring efficient, reliable, and sustainable operation of electrical networks, especially when integrating renewable energy sources and managing generation and consumption peaks.

What are the major challenges encountered so far?

- Renewable energy sources like solar and wind are intermittent, meaning they don’t produce energy consistently. This can lead to reliability issues in the power supply;
- Efficient and cost-effective energy storage solutions are still under development. Storing energy for use when renewable sources aren’t generating power is crucial for a stable energy supply;
- Integrating renewable energy into existing power grids can be complex and costly. The grids need to be upgraded to handle the variable nature of renewable energy;
- Large-scale renewable energy projects can require significant land and resources, which can lead to conflicts over land use and environmental concerns;
- There can be resistance from local communities regarding the installation of renewable energy projects due to aesthetic concerns, noise, and potential impacts on local wildlife.

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