RECIPE Stakeholder Workshop #1 - 15 May 2025

Building a resilient energy transition for Switzerland – How do we get there?

WORKSHOP SUMMARY

The **first open workshop** of the SWEET RECIPE consortium successfully engaged approximately **60 key stakeholders** from Swiss energy utilities, authorities, businesses, and solution providers. The workshop's objective was to onboard a broad spectrum of relevant stakeholders to the 6-year RECIPE project and gather their insights on building a resilient energy transition for Switzerland.

Ensuring reliable energy supply is of utmost importance for Switzerland's economy and society

A **key message** from the workshop was the critical importance of ensuring a reliable energy supply for Switzerland's GDP, business attractiveness, and quality of life. Participants emphasized that energy system disturbances—such as power outages, supply interruptions, or excessively high energy prices—can severely impact the economy, vital services (e.g. water, hospitals, communications), and public well-being. Such disruptions may also lead to social dissatisfaction and undermine public support for the energy transition.

Switzerland hosts many internationally active companies, for which energy reliability is a key factor in maintaining operations. Interruptions in energy supply directly threaten economic prosperity and Switzerland's reputation as a stable business location.

Energy is also fundamental to essential public services. Water provision relies on electrically powered pumps and treatment systems; hospitals and pharmaceutical logistics depend on uninterrupted power; and agricultural processes are increasingly electrified. Power outages that extend beyond a certain duration threshold can also disrupt communication networks, leading to compound disruptions that paralyze everyday life.

Participants agreed that it is not only crucial to avoid energy supply disturbances, but also to prepare for them, ensuring that provision of critical services can continue even in the face of disruptions.

Key emerging hazards for the Swiss energy system

A wide range of hazards threatening the Swiss energy system were identified during the workshop, spanning natural, technical, socio-economic, and policy-related risks. In addition to well-known threats like infrastructure failures and damages from localized extreme weather (e.g. strong winds, landslides, etc.), participants emphasized emerging hazards driven by the energy transition, climate change, and broader trends. Key future hazards include:

1. **System complexity**: The rise of distributed resources and diverse actors increases the risk of system instabilities, forecasting challenges, and underinvestment in infrastructure.
2. **Large-scale weather events**: Prolonged heat, drought, or low solar/wind conditions—especially across regions—could cause major supply shortfalls if not anticipated during infrastructure planning.
3. **Cybersecurity risks**: The growing number of digital components outside operator control raises the threat of cyber-attacks, including AI-driven intrusions, DDoS attacks, and legacy system weaknesses.

The importance of studying compound hazards and those stemming from a common source was emphasized. For example, after a natural event that damages significant energy infrastructure, restoration efforts may be delayed due to supply chain bottlenecks. Similarly, geopolitical tensions can reduce fuel supply across the continent, increasing system vulnerability and making energy adequacy more difficult to ensure.

Additionally, participants highlighted the need to consider interdependencies among different systems—such as electricity, gas, and communication—when analyzing hazard propagation. Each of these systems ultimately depends on the others for reliable operations.

Valuing and allocating the costs of resilience measures: A key challenge

Challenges that were identified during the workshop discussions and to be addressed by the RECIPE consortium are the inherent difficulty in estimating the economic value of resilience enhancement measures and identifying how the cost of resilience measures is split among the involved stakeholders, especially because the benefits of increased resilience might not be materialized over long periods of time.

How to enhance energy system resilience?

Workshop participants identified four categories of measures to enhance the resilience of energy users to hazards affecting the energy system:

1. **Infrastructure investments**: Build redundant backup generation and storage in Switzerland, expand electricity networks, install hail-resistant PV panels, increase the share of multi-fuel plants, and develop domestic hydrogen production and storage. These capital-intensive measures boost the system's capacity to meet demand under extreme conditions.
2. **Operational measures**: Deploy preventive maintenance, design markets to engage distributed flexibility and demand-side management, integrate with European electricity markets, and retain ownership of key infrastructure (e.g. the north-south gas pipeline). These typically lower-cost measures improve flexibility and hazard response.
3. **User-side resilience**: Encourage users (e.g. hospitals, telecom providers) to invest in backup generation, hedge energy price risks with long-term contracts, and plan for disruptions (e.g. blackout kits, emergency protocols). These actions complement system-level resilience.
4. **Policy and regulation**: Create incentives for resilience enhancement investments, support coordination among stakeholders, and enforce timely standards (e.g. cybersecurity, remote control, hail resistance).

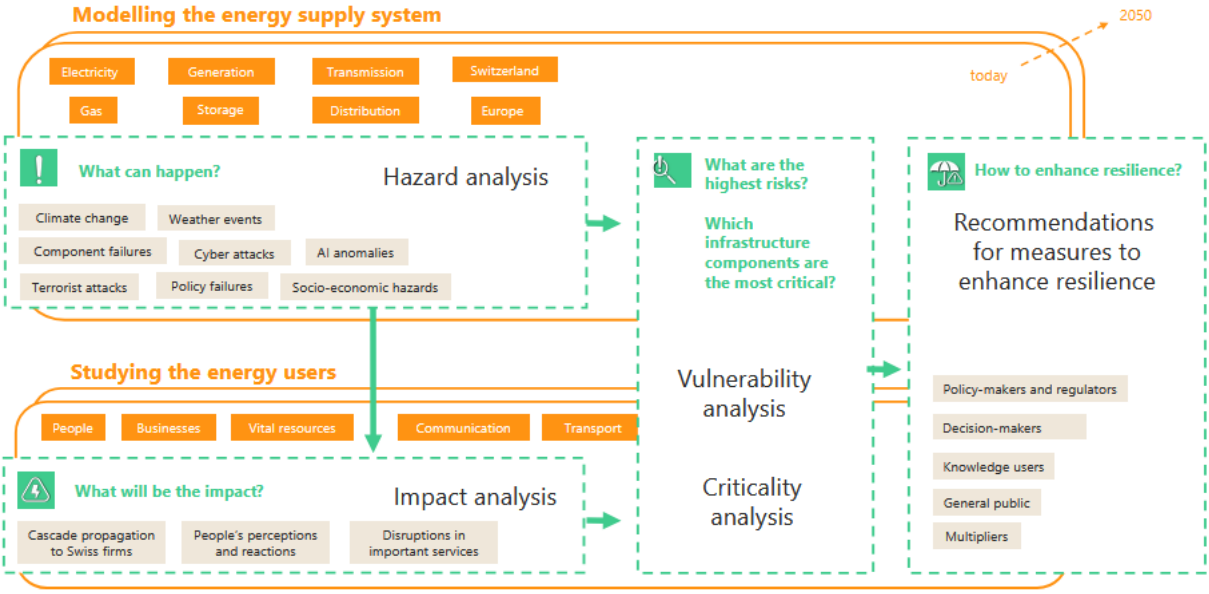
A somewhat more detailed itemization of the inputs collected during the workshop is provided in the sequel of this document, with objective to act as a workshop documentation and a future reference.

RECIPE Consortium's next steps

The RECIPE Consortium will process the inputs of the workshop and, within the limits of the project budget and the consortium members' expertise, incorporate them in its workplan, interacting bilaterally with the various stakeholders. First priorities, addressed during the coming year, are:

1. An identification of a set of "hazard storylines" will be performed, i.e. the sequence and combination of events that can lead to a propagation of hazard throughout the Swiss energy system will be qualitatively identified and assessed. Following, a prioritization of the hazards to be considered for more detailed quantitative analysis.
2. Development of appropriate energy-system and weather models, collection of required data and setting up of relevant socio-economic studies will be performed allowing to build up the bricks needed in order to, later on, perform vulnerability and resilience-enhancement analysis.

The next RECIPE open workshop will take pale in June 2026. Its focus will be the presentation of the "hazard storylines" and the selection of hazards for further analysis.



RECIPE Approach

From risks to resilience – Inputs by workshop participants

Impacts of energy system disturbances

This section compiles the input from the workshop participants related to the impact of energy disturbances on the following sectors and vital resources.

Economy

- GDP loss due to blackout
- High electricity / energy prices

Society

- Short term: Fear, panic, and irrational behavior
- Medium to long term: Loss of trust in politics and institutions, and reduced acceptance of the energy transition
- Inequality: Varying levels of impact depending on societal vulnerability
- Communication failures and lack of awareness can lead to irrational responses
- Decline in social cohesion and organization

Water

- Reduced drinking water availability (pumping/treatment disrupted)
- Sanitary issues as (household/industrial) wastewater may remain untreated
- Disruptions in industry due to limited availability of water for cooling/steam generation (with lack of electricity likely the primary factor for disruption)
- Cross-sectoral impact in farming if water is not available for a longer period of time

Food

- Various disruptions in farming (e.g., milking), food processing (e.g., bakeries, however, gas is also important), food logistics (e.g., storage/cooling) and retail (e.g., payment processes)
- Disruptions in households, as cooking and food preparation is affected

Medical products / services

- Impairment of hospital operations (depending on emergency power supply)
- Interruption of storage and distribution of medical/pharmaceutical products (e.g., due to disrupted cooling)

- Across all vital resources, dependencies with ICT systems are critical

Hazards to the energy system/infrastructure

This section compiles the input from the workshop participants related to the hazards that loom over the energy infrastructure belonging to the natural, technology, and societal domains.

General considerations

- Pay attention to large-scale hazards driven by a common source
- Differentiate between multi-cause failures and common cause failures

Nature

- Natural hazards (strong winds, hail, landslides, avalanches, etc.)
- Climatic large-scale events over large geographic areas (e.g. Dunkelflaute, droughts, very high temperatures, cold spells)
- Large errors in weather-related forecasts (especially at a wider scale) – overreliance on a central service for weather prediction
- River temperature increase (impact on cooling)

Technology

- Failures of critical components (component ageing, longer replacement periods)
- Cyber-attacks (e.g., to SCADA/EMS, controllers, distributed resources)
- Manipulation of (measurement / forecast) data
- ICT system updates
- Increasing complexity might lead to more difficult to tune protection settings
- Global interruption of gas supply
- Changing demand structure and/or generation mix
- Lack of enough diversification of technologies Europe-wide
- Lack of appropriate standardization (in power and ICT systems)
- Energy consumption of data centers

Society / Economy / Policy

- Supply chain bottlenecks
- Energy market failures, lack of appropriate price signals (e.g., negative prices)
- Fuel supply inadequacy (e.g. from Russia or outside Europe)
- Monopoly / regulatory framework might not motivate change
- Grid adaptation (planning, permit, investment) might not be able to follow the rate of technology and climate changes
- Lack of coherence in energy policy and suboptimal technology decisions
- Policies / regulations forbidding specific technologies
- Investment uncertainty
- Resistance of population to rising costs, especially higher electricity prices

- Lack of acceptance of energy transition measures or decentralized expansion
- Terrorist attack

Criticalities and vulnerabilities of the energy system

This section compiles the input from the workshop participants related to the criticalities and vulnerabilities of the energy system.

- Impact of large-scale events
- Large-scale blackout
- Supply chain bottlenecks – longer replacement time (e.g., availability of transformers)
- Conflicts between decentralized decision-making and large-scale infrastructure decisions
- Interdependency between global system for mobile communications (GSM) networks and power system
- Abundance of low-level actors at gas and electricity systems slows down progress
- "Imported risk" from technical failures across Europe
- De-industrialization due to high energy prices
- Timing of investments

Resilience enhancement measures

This section compiles the input from the workshop participants related to the measures that can enhance the resilience of the Swiss society, economy, and vital resources in connection with the Swiss energy infrastructure.

- Redundant / backup generation and storage located in Switzerland
- H_2-ready gas storage, H_2-ready and/or multi-fuel power plants in Switzerland
- Hail-resistant solar panels (will be the standard)
- Convert the overhead lines in distribution to underground cables
- Preventive maintenance & asset risk monitoring
- Appropriate replacement / repair strategies
- System flexibility, (fast) demand-side management
- Increase time resolution of market clearings
- Studies to define system stability boundaries
- Cyber-resilience of PV and EV
- Cyber-security standards
- Appropriate regulatory / market structure to enable distributed resources (e.g., EV charging infrastructure) to offer grid stabilization services
- Coordination (across policy- and decision-makers, owners of the various infrastructures, network levels, etc.)
- Target subsidies to specific actual needs, such as winter capacity or grid reinforcement
- Political incentives and regulations, e.g., financial incentives for consumption reduction or clear regulatory frameworks
- Price the value of resilience into the market design
- Strengthen international agreements
- Better understand industry sensitivity to energy prices
- Household level: Promotion of emergency preparedness and self-care (e.g., blackout kits)
- Strengthening trust and transparency through better information and communication
- Involvement of society in decision-making processes
- New mindset: More awareness, preparedness, and strategic decisions at all levels

Knowledge gaps and expectations from RECIPE - Inputs by workshop participants

This section compiles the input from the workshop participants related to the expectations and suggestions to RECIPE about the possible development of tools, methods, and knowledge pertaining to the resilience of the Swiss energy transition.

Tools / methods

- Develop energy system models capable of capturing many years of climate variability
- Consider scenarios involving different roles / responsibilities for energy suppliers and users
- Involve societal actors and take political needs into account
- Develop appropriate metrics to measure reliability and the value of resilience
- Develop system models corresponding to different scenarios and different resilience levels
- Develop "how to" toolkit for small actors (such as small utilities)
- Develop tool to assimilate cyber security knowledge base into specific actions / decisions
- Explore the value of diversifying energy sources and energy storage

Knowledge generation

- Make a list with the most critical components of the future energy system
- Investigate risk propagation through interdependent systems (electricity-gas-ICT, Europe-Switzerland, transmission-distribution, energy-economy, energy-society)
- Gain a clear understanding of the dependencies between energy and ICT systems
- Improve understanding of the role of AI in energy systems and energy consumption
- Make a list of the mechanisms through which a hacker can gain access to important energy system components; are specific standards required?
- Enhance understanding of the capabilities of different flexibility options (e.g. batteries, demand shedding) -> Quantify the value of different flexibility options (e.g., demand-side management, batteries) in enhancing resilience
- Investigate potential market designs in terms of system operation; clarify roles
- Quantify trade-offs between different levels of integration and local independence in terms of cost, resilience, other risks, etc.
- How can the market better integrate and value solar and flexible distributed resources?
- Identify opportunities to incorporate resilience measures for economic actors
- Assess the impact of policies and regulatory incentives in enhancing resilience
- Better understand the effects of a decreasing sense of community in Switzerland, and explore how informal and community support systems can be strengthened
- Improve understanding of end-user expectations and their willingness to contribute to a system shift

About RECIPE

The RECIPE consortium aims to foster a sustainable and resilient energy future for Switzerland, in alignment with the country's energy and climate policy goals. It studies the risks associated with the energy transition and climate change that Switzerland may face over the next 25 to 30 years and proposes measures to enhance resilience.

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