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1 Introduction

The International Smart Grid Action Network (ISGAN) strives for the accelerated development and deployment around the world of smarter, cleaner electricity grids—as in **smart grids**. ISGAN's national experts come from 26 countries and the European Commission and include engineers, analysts, academics, industry executives, government officials, project managers, policymakers, technology providers, and utility planners. In coordination with the International Energy Agency (IEA), Clean Energy Ministerial (CEM), and other strategic partners, ISGAN is committed to identifying emerging advances, sharing best practices, and raising high-level government awareness on the value and impact of smarter grids.

ISGAN facilitates dynamic knowledge exchange, technical assistance, peer review, and activity coordination among its participants and stakeholders. Policy analysis and recommendations are a top priority for ISGAN. Unbiased technical expertise and direct interaction with policymakers are two major assets on which ISGAN can base its leadership.

1.1 Background of ISGAN

2010, ISGAN is launched in Washington D.C. at the first Clean Energy Ministerial (CEM) meeting. The initiative evolves from CEM's commitment to policies and programs that accelerate the global transition to clean energy.

2011, ISGAN is formally established as the International Energy Agency (IEA) Implementing Agreement for a Co-operative Programme on Smart Grids, operating as a "Technology Collaboration Programme" under the IEA Framework for International Energy Technology Co-operation.

2013, ISGAN membership expands across five continents and includes 24 participating countries and the European Commission.

2014, ISGAN expands to include Annex 5: Smart Grid International Research Facility Network (SIRFN), bringing together a diverse array of research and testing facilities.

2015, The first annual ISGAN Award of Excellence is launched to celebrate exemplars in smart grid projects and promote the adaptation of their proven best practices in other countries and jurisdictions.

2016, Launch of the ISGAN Knowledge Transfer Platform (KTP). The KTPs offer dynamic spaces where interdisciplinary groups of participants with complementary competencies contribute to the development of joint ISGAN knowledge products, policy messages, and targeted technical assistance. ISGAN will complete its 9th KTP project in 2023.

2016, Beginning of ISGAN Virtual Learning webinars. Every year, ISGAN hosts dozens of webinars where participants from academia, government, non-profits, and industry gather to demonstrate and share best practices and the latest smart grid research.

2018, ISGAN continues to expand its international reach and to serve as a partner for domestic and international efforts including the Global Smart Energy Federation, and the India Smart Grid Forum.

2019, ISGAN Annex 3 releases the smart grid evaluation toolkit, which integrates Cost-Benefit Analysis (CBA) within a Multi-Criteria Analysis (MCA) framework.

2021, The Annexes are transformed into Working Groups (WGs) with WG 3-Cost Benefit Analysis Toolkit, WG 5-International Research Network-SIRFN, WG 6-Power T&D Systems, WG 7-Smart Grid Transitions, WG 9-Flexibility Markets, and a cross-cutting Communications Working Group (focused also on deep knowledge exchange).

2022, ISGAN signs a Memorandum of Understanding with the Global Smart Energy Federation and a letter of intent with the Mission Innovation: Green Powered Future Mission at the Global Clean Energy Action Forum in Pittsburgh, Pennsylvania.

2022, A new strategy and structure process is completed, and Request for Extension (RfE) is finalized.

2 Goal of Project

According to the Energy Act of January 2018 and the Swiss Federal Council decision of August 2019, the general goals for the Swiss energy system is to phase-out the nuclear power and reach zero net greenhouse gas (GHG) emissions by 2050. According to the energy perspectives of the Swiss Federal Office of Energy (SFOE), this will be achieved by increasing the share of renewable energy generation sources and electrification of heating and mobility, while increasing the energy efficiency.

The implementation of this strategy drives the following trends: (i) increasing proliferation of variable renewable energy sources (VRES), such as wind farms and solar PVs, mainly in a distributed fashion, (ii) increasing electrification of energy demand, i.e., heating and transportation, which leads to a significant increase in both peak demand and total electricity demand, and (iii) as a result of (i) and (ii), increasing need in techno-economically feasible ways to utilize the available sources of flexibility so that the costs of the energy supply as well as infrastructure investments are optimized.

These developments introduce tremendous stress on the energy suppliers and system operators that are responsible for balancing the supply and the demand and this phenomena are unprecedented. As such, they require massive and costly adaptations to the energy infrastructure. The transition also brings along the need for new planning, operation, market and ownership models, as well as the need for new regulations to facilitate these complex models.

FEN, acting as a bridge between academia and the industry, has been performing several research activities in this direction. Some of these activities have been performed as an integral part of Swiss participation in the ISGAN activities in the period of 2022-present. FEN represented the SFOE actively in the following working groups that are focusing on the activities of interest:

- **Working Group 3** on **Cost-Benefit Analysis and Toolkits** (link)
- **Working Group 6** on **Power Transmission & Distribution Systems** (link)
- **Working Group 9** on **Flexibility Markets** (link)

By exploiting international experiences and insights, the results of the participation in these working groups and the associated activities will continue to provide useful insights to Swiss policymakers and energy stakeholders for (i) devising future grid investment and operational strategies leveraging the value of flexibility, (ii) decreasing the cost of the ownership of distributed energy resources as a result of new potentials of revenue streams by providing flexibility services, and (iii) devising appropriate (intermediate) targets and regulations towards achieving the targets of the Energy Strategy 2050 in the most economic and environmentally friendly manner.

3 Summary of Work Performed in 2024 and Achieved Results

3.1 Working Group 3: Cost-Benefit Analysis and Toolkits

The primary objective of Working Group 3 (WG3) is to develop a global framework and related analyses that can identify, define, and quantify in a standardized way the benefits that can be realized from the demonstration and deployment of smart grid technologies and practices in an electricity system. More specifically, WG3 develops tools used by analysts, regulators, utilities, and other electricity system stakeholders. These tools help define and decide on system needs and priorities for smart grid system investment and regulatory changes. Results help develop specific business cases, considering specific regulatory and market structures, current system status, demand profiles, and available generation assets and resources. In their analysis, different ISGAN countries are likely to prioritize distinct domains within the power sector. Therefore, in developing methodological frameworks and tools, a broad definition of smart grid is adopted to encompass the full range of technologies and activities from centralized power generation to transmission and distribution networks end uses and distributed generation, and different energy vectors. The CBA-MCA tool is also used for sector coupling and evaluating various integrated energy systems. WG 3 continues to leverage existing knowledge and experience gained in different participating countries, as well as current international efforts underway and cooperation among major smart grids stakeholders globally. Two tasks are identified to achieve the objectives: (1) online tool improvement and dissemination and (2) identification of suitable regulatory frameworks to foster flexibility.

3.1.1 WG activities as officially reported to ISGAN

A significant focus was devoted to the discussion of possible flexibility market models and methodologies for defining and quantifying flexibility. These discussions led to the definition of a form to be filled out (initially) by the National Experts of WG3 and WG9. The choice of the form is linked to the possibility of encouraging collaboration and participation in its development by the WG3 National Experts. Furthermore, the form facilitates the collection of complete and standardised data, improving the efficiency and effectiveness of the analysis process. Sharing this information with other Working Groups could stimulate further collaboration and insights, contributing to the analysis and development of flexibility markets. The form, consisting of about 40 questions, both open-ended and multiple-choice to ensure comprehensive answers but quick completion, is divided into seven main sections:

1. **Respondent's background**: questions on the country of operation, sector of work and level of experience in the sector.
2. **Overview of the flexibility market**: information on the country and year of development, type of market (study, pilot, active), area covered by the market (local or national) and motivation behind its creation.
3. **Entities involved**: details of the flexibility providers and the presence of the TSO.
4. **Products and services**: questions on the characteristics and types of products and services offered.
5. **Market details**: enquiries about the name of the market, timing and coordination with the TSO.
6. **Implementation aspects**: questions on the difficulties faced, data exchanged between the parties, inclusion of uncertainty in the studies carried out, type of studies carried out, tools used, value associated with flexibility, estimation of flexibility exchanged and modelling of the parties involved.

7. **Additional details**: website requests, additional documents and lessons learnt.

Participation in the Development of the Lighthouse Project Active involvement in the development of the Lighthouse Project, a high-level initiative involving all of ISGAN's WGs, with a focus on 'Electricity Network Planning and Implementation under Uncertainty for the Clean Energy Transition' starting in 2024. In particular, a specific activity focused on identifying participatory processes to identify robust and socially acceptable investments in distributed energy resources. The activity aims to identify participatory processes at the national level to facilitate investments that take into account investors' interests, grid conditions, uncertainties and public acceptance. The idea is to define a questionnaire to be sent to National Experts to learn more about participatory processes (including rules and procedures, cooperation agreements, informal and formal institutions, etc.). The activity is carried out with WG7- Transition-, the WG dedicated to the study of institutional and social changes associated with the deployment of Smart Grids.

A set of questions were identified on 'Social Acceptability', i.e., how social acceptability is assessed and achieved, technical aspects (implementation and models adopted), good practices and barriers. Some aspects are still being defined. Indeed, not all investments are equal: investing in the installation of a wind power plant is different from investing in charging stations for electric vehicles. Therefore, it may be necessary to divide the questionnaire into several sections, each dedicated to a specific type of DER. Furthermore, planning approaches may vary depending on the technology considered. For example, approaches for renewable generators are more established than those for electric vehicle charging points. The activity was presented at the EXCO meeting 28, and received positive feedback. Future steps will be to involve those countries that have expressed an interest in participating and contributing to the activity. The working paper can be accessed here.

3.1.2 ETHZ-FEN Participation in meetings and contributions to the activities

In 2024, ETHZ-FEN participated in the following tasks in addition to participation in montly 1-hour-long meetings:

- Preparation of a survey on flexibility market models
- Identification of participatory processes for determining robust, technically feasible and socially acceptable investments in distributed energy resources

As part of the first task, the survey can be found online and contains 40 questions on the piloting, demonstrating or deployment of flexibility markets. A shortened list of questions are provided below:

- Motivation
- Location (country)
- Implementation type
- Is it still active?
- Which voltage level does it cover?
- Who buys the flexibility services?
- Who are the flexibility providers?
- Which services are traded?

- Which products are traded?
- Product specifications
- Market platform name (e.g., picloflex)
- Pricing method
- Availability time of the service procured
- Trading time
- Activation time
- Integration with other markets
- Coordination with TSO
- Which challenges did you face during the market implementation/studies?
- Which data are exchanged by the DSO to flexibility providers?
- Is there a penalty scheme for not providing the committed flexibility?
- Which studies were carried out to verify the validity of the market model implementation? Network studies? Market simulations?
- What tools were used to verify the criticalities in the network?
- Was there a minimum price assigned to the flexibility product provided?
- Is the impact on the CO2 emissions of the service taken into account?
- In some cases to be detailed, can the value of a given service include a fixed amount to ensure that the service is still available and a variable part for the curtailment provided?
- Once several flexibility services are contracted, how do you choose which service to be used compared to other standard solutions (e.g., power generator installation, customers without power supply, etc.)?
- How is the customer participation model been implemented? Is it assumed that all users in the area will participate? A certain percentage? Are active users (producers) and loads modelled?
- Was uncertainty integrated in the studies? Which aspects are considered uncertain? (e.g., service provided by the flexibility service provider, renewable energy sources, demand)
- Which is the extension of connection area for flexibility resources to be candidates for providing the service?
- Estimated volume of the contracted flexibility: In comparison to maximum peak demand, what is the average estimated volume of the contracted flexibility over a year (or a day, etc.)
- Number of flexibility providers involved
- Customers: Residential, commercial, industrial
- Generators
- Energy storage systems
- EV charging stations

The objectives of the second task are (i) to identify processes at the national elvel for facilitating investments that consider investors' interestes, grid conditions, uncertainties, and citizens' interests and acceptance, and (ii) to identify good practices that can be recommended by ISGAN which can serve as a suggestion for planning and carying out their investments. As part of this task, the following projects (canceled and approved) as a result of direct votes at municipality level or cantonal level in Switzerland are collected and shared:

- Terminated/canceled/voted down projects for solar farm in the mountains:
  1. Solar PV project bz ewz in Splügen-Tambo, location in the mountains, known for winter sports
  2. Solar PV project by ewz in Val Nandro, location in the mountainous
  3. Solar PV in Lauterbrunnen, touristic location in the mountains
  4. Solar PV in Saanen, location in the mountains
  5. Solar PV in Hasliberg, location in the mountains, known for winter sports
  6. Solar PV in Oberiberg, location in the mountains
- The referendum in one state that resulted in disapproval of an accelerated procedure for the construction of large solar PVs in the mountains:
  1. Canton Wallis
- Successful/approved projects for solar farms in the mountains:
  1. Solar PV by ewz in Albigna-Staumauer
  2. Solar PV by ewz on the wall of the dam of Lago di Lei
  3. Gondo in the canton of Wallis
  4. Grengiols in the canton of Wallis
- Successful/approved projects for wind farms:
  1. Downscaled but approved in Grenchenberg
  2. Since 2012, 30 out of 36 votes in municipalities and cantons ended in favor of wind parks
  3. Andermatt

3.2 Working Group 6: Power Transmission and Distribution Systems

The main objective of Working Group 6 is to establish long-term visions for the development of the future sustainable power systems. To create and project such visions, WG6 clarifies system-related challenges, with emphasis on the technologies, market solutions, and policies which contribute to the development of system solutions. WG6 facilitates knowledge sharing related to the application of advanced technologies for power grids and their contributions to clean energy, climate goals, and sustainable energy access for all. WG6's results are disseminated at different strategic levels. WG6 maintains a critical view on evolutions for smarter, cleaner power transmission and distribution systems based on four Focus Areas. While WG6's annual Program of Work includes more defined activities and tasks, the Focus Areas below illustrate and support the continuity and long-term plans of the Working Group. There are four focus areas: (1) expansion planning and market analysis, (2) technology trends and deployment, (3) system operation and security, and (4) transmission and distribution system interaction.

3.2.1 Participation in meetings and contributions to the activities

ETHZ-FEN contributed to discussions, collected information for ongoing projects and forwarded ideas, concepts and interesting project reports to other project partners within Switzerland.

This year, the interactions and contributions include the following:

- **Monthly coordination calls**. In general ETHZ-FEN aims to play an active role, whereever suitable, by
  - contributing to surveys for ISGAN
  - reviewing ISGAN reports and white papers
  - establishing contacts with experts from the Swiss transmission and distribution industry
- Contributions to the three-part **workshop series "active system management by DSOs"**. This includes the participation and circulation of a survey on the "Applicability of different flexibility mechanisms for DSOs and their trade off with investments" and the participation and discussion in all workshops. In the third workshop, ETHZ-FEN gave a **short presentation on lessons learned** from recent Swiss research projects related to flexibility.
- Contributions to a **report on "Active System Management by DSOs"** ETHZ-FEN contributed quantitative insights from multiple projects on the value of flexibility from the perspective of Swiss distribution grid expansions. The section highlights the trade-off between flexibility and investments for different Swiss distribution grids.
- Contributions to the **report "Exploring the interaction between power system stakeholders: Insights from Pilot Projects"** (link). ETHZ-FEN used the opportunity to disseminate the results of the DFLEX project, providing a **synthesis on stakeholder interaction, flexibility modeling, economic and market aspects**.
- Start of an **activity on hydrogen developments**. A report on **Hydrogen production impacts on grids** will be published by ISGAN WG6 in 2025. ETHZ leads a chapter on "grid operation and national experiences" and contributes results from recent projects on hydrogen markets and sector coupling.

3.3 Working Group 9: Flexibility Markets

Working Group 9 (WG9) addresses all aspects of market design for power system flexibility. This includes the whole range of market timescales, from long term investment signals to second-to-second balancing and response. It also extends to cover the whole physical system from large centralised generation to behind the meter sources of flexibility within domestic settings and interfaces. WG9 considers all sources of value that flexibility conceivably could capture, going beyond MWh to include physical grid characteristics like voltage control, repeatability, inertia, locational constraint alleviation, in addition to various aspects of the market that goes beyond the trading rules such as consumer support, or how obligations (such as with respect to grid stability) are understood and checked. The objective of the combined impact of the Working Group's activities will be (i) to enrich and disseminate participant's understanding of flexibility market design, (ii) to create and curate an evidence base all can draw upon to support decision making in the flexibility market space, and (iii) to further the debate on best practice in market design. Three tasks/activities were identified for 2023-2024: (1) end-use flexibility characterisation and grid utilisation, (2) interoperability, and (3) operational and long-term planning.

3.3.1 Participation in meetings and contributions to the activities

FEN participates in the regular WG9 monthly meetings, as well as in ad-hoc meetings to synchronize the WG activities. FEN contributed to the **development of WP9's Program of Work (PoW)** for the year 2024-2025. Within the PoW, FEN **co-leads Task 1 "Flexibility-aware distribution network planning"**, actively contributed to and coordinating activities in all three subtasks, namely Subtask 1.1 "Long-term distribution network planning", Subtask 1.2 "Overview of local flexibility market concepts" and Subtask 1.3 "Evaluation of local flexibility markets and network reinforcement solutions". The activities will lead to comprehensive factsheets.

As part of the interactions and exchange performed within WG9, FEN has been actively sharing information from the **AISOP** and **PATHFDNR** projects, which are extremely relevant to the scope of WG9, as these projects cover topics such as "dynamic network tariffs", "design of local flexibility markets" and "flexibility-aware distribution grid planning".

In addition, FEN participated in the brainstorming and first interactions that led to a selection of **Lighthouse projects**, i.e., activities that will combine work performed in the various WGs with the objective to address a specific topic.

4 Collaboration

4.1 National Collaboration

ETHZ-FEN actively collaborates with Swissgrid on the topic of TSO-DSO interactions and integrated market modeling.

4.2 International Collaboration

Not available.

5 Publications

Not available.