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ISGAN
INTERNATIONAL SMART GRID ACTION NETWORK

International Energy Agency (IEA)
Technology Cooperation Programme (TCP)

International Smart Grid Action Network (ISGAN)

Annual Report 2024

for the period from 1 March 2024 - 28 February 2025

Technology Collaboration Programme
by iea

Disclaimer

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June 2025

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1. Letter from the Chair

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It is with great pleasure that I introduce to you the fourteenth Annual Report of the International Smart Grid Action Network (ISGAN).

Building on its successful track record, ISGAN effectively combines at best its **dual roles** as an International Energy Agency (IEA) Technology Collaboration Programme (TCP) and a Clean Energy Ministerial (CEM) initiative to provide an international platform and vital community of grid experts from Ministries, Energy Agencies, System Operators, Research Centers and Academia. This unique positioning allows ISGAN to focus on the development and dissemination of knowledge and best practices on **smarter, cleaner, and more flexible electricity networks** worldwide. In particular, ISGAN provides an important channel for the dissemination of smart energy-related knowledge, trends, and lessons learned in support of national, regional, and global climate and clean energy objectives, thereby empowering decision makers and key stakeholders.

ISGAN network comprises **27 committed members** (26 Countries and the European Commission) spanning **five continents**, engaging both developed and emerging economies, who actively collaborate in six dynamic Working Groups. The ISGAN broad community includes the Vice-Chairs, Presidium and ExCo members, the Co-Secretariat, Working Group Managers, Technical Leads, National Experts and the invaluable contributions by the IEA and CEM desk officers. Moreover, the true value of ISGAN lies in its ability to convene key grid stakeholders, providing a unique opportunity to keep policymakers up-to-date on global energy trends and on the most cutting-edge solutions, tools, and technologies essential for power system transformation and decarbonization.

International collaboration remains at the heart of ISGAN's core. Its diverse membership represents a truly collaborative environment where knowledge, strategies, and best practices are efficiently exchanged across the globe. In particular, ISGAN has

strengthened its outreach and nurtured long-standing, fruitful collaborations with key power sector initiatives, including the MI Green Powered Future Mission (GPFM), the CEM's 21st Century Power Partnership (21CPP), and the Global Smart Energy Federation (GSEF) in the framework of the annual ISGAN Awards of Excellence.

In the past year, ISGAN, in close partnership with GPFM and 21CPP, organized impactful joint side events at key Ministerial meetings, aimed to amplify key messages and underscore the crucial role of smart grids in the clean energy transition, underlining the need for joint efforts and concrete actions towards development and deployment of innovative solutions for grid modernization.

A significant highlight of the past year activity is the strong ISGAN, 21CPP, and GPFM engagement at the CEM15/MI-9 Ministerial meeting in Foz do Iguaçu, thus demonstrating their commitment to the CEM-MI emblematic deliverable, the **"Agenda for Action on Power Systems Solutions"**, aimed to support the achievement of the shared commitments established at COP28 in Dubai and in particular the COP28 pledge of tripling by 2030 the current renewable capacity installed globally.

I'm also very proud of the successful completion of phase 1 of the **ISGAN Lighthouse Project** on "Electricity Network Planning and Implementation under Uncertainty for the Clean Energy Transition: The Roles of Smart Distribution Grids in Energy Systems". Looking ahead, ISGAN is pleased to announce the launch of the second, highly anticipated phase of its Lighthouse Project, seeking to collaborate with key CEM & MI initiatives. This ambitious activity will benefit from the collective expertise and active participation of all six ISGAN Working Groups, strengthening ISGAN commitment to addressing critical challenges of the energy transition.

I extend my deepest gratitude to the entire **ISGAN community** for its unwavering commitment and active collaboration over the past year. It is a privilege to serve this community as Chair and I strongly believe that your contributions are the cornerstone of ISGAN's continued success.

Despite the evolving and increasingly dynamic international landscape, with multiple regional and global initiatives focused on modernizing and decarbonising the power sector, I firmly believe that ISGAN remains a pivotal and powerful global platform, promoting the effective coordination and international collaboration needed to accelerate progress towards the development and deployment of the smart energy systems that are an enabler of the **clean energy transition.**

I warmly invite you to delve into this year's report and discover the key recent achievements and ongoing work of the ISGAN. I sincerely hope that this report will inspire you to actively engage with ISGAN, contributing to our shared global endeavour of advancing clean energy through smart grids.

Yours sincerely,

Luciano Martini
Chair, International Smart Grid Action Network (ISGAN)

2. International Smart Grid Action Network

2.1. Overview

As the global energy landscape transitions towards sustainability, the concept of smart electricity grids has emerged as a cornerstone of modern energy systems. Smart grids integrate advanced technologies, such as sensors, automation, and communication networks, to enhance the efficiency, reliability, and flexibility of electricity delivery. However, the development and implementation of these systems require a collaborative, international approach. The International Smart Grid Action Network (ISGAN) plays a pivotal role in fostering this global cooperation.

2.1.1. The Need for International Collaboration

Smart grids are complex, integrating multiple disciplines, technologies, and stakeholders. The transition to these advanced systems presents challenges that transcend national borders, including:

1. **Standardization:** Ensuring interoperability between technologies developed in different countries.
2. **Knowledge Sharing:** Accelerating innovation by sharing research findings, best practices, and lessons learned.
3. **Economic Efficiency:** Reducing duplication of efforts and leveraging resources across nations.
4. **Global Challenges:** Addressing universal issues like climate change, cybersecurity threats, and energy equity.

No single country possesses all the expertise, resources, or solutions needed to address these challenges comprehensively. International collaboration provides a platform to pool resources, align strategies, and establish a shared vision for the future of energy systems.

2.1.2. ISGAN: A Catalyst for Cooperation

The International Smart Grid Action Network (ISGAN) is a multilateral initiative under the framework of the Clean Energy Ministerial (CEM) and the International Energy Agency (IEA). Since its inception in 2010, ISGAN has worked to accelerate the development and deployment of smart grids worldwide by facilitating international collaboration.

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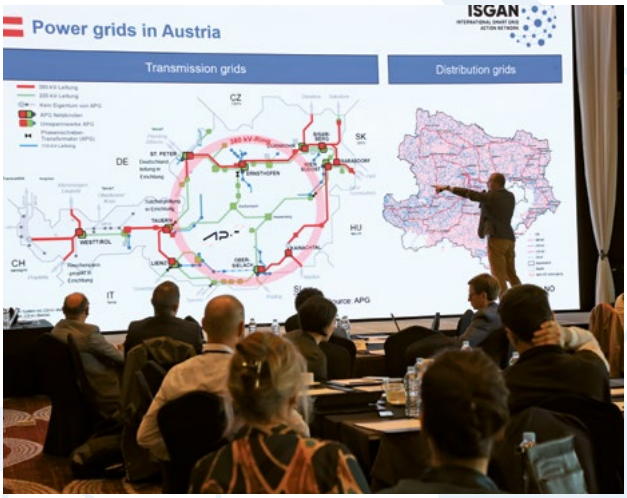
World Cafe



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Audience ExCo 28

2.1.3. Key Contributions of ISGAN

1. **Policy and Regulatory Frameworks:** ISGAN provides a platform for governments to exchange policy insights, regulatory approaches, and strategies to foster smart grid adoption. By harmonizing these frameworks, ISGAN helps reduce barriers to enable innovation and deployment.
2. **Knowledge Sharing and Capacity Building:** ISGAN organizes workshops, webinars, and expert meetings to disseminate cutting-edge knowledge. These activities equip stakeholders with the tools and understanding needed to implement smart grid solutions effectively.
3. **Innovation and Research Collaboration:** Through its various Working Groups, ISGAN promotes joint research projects, pilot programs, and innovation exchanges. This enables nations to collectively tackle technical and systemic challenges.
4. **Global Benchmarks and Metrics:** ISGAN develops performance metrics and benchmarks that allow countries to evaluate their progress and identify areas for improvement in their smart grid initiatives.
5. **Outreach and Engagement:** By fostering dialogue among diverse stakeholders, including policy makers, academia, and non-governmental organizations, ISGAN ensures that a wide range of perspectives informs global smart grid strategies.

The Co-Secretariat at AIT is responsible for managing ISGAN and its daily activities, the common fund, and reporting to the IEA.

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Presidium

The ExCo is led by the Chair and three Vice-Chairs and together they form the Presidium.
Each member of the Presidium is elected for a period of two years, with possible re-election.

Luciano Martini
Chair of ISGAN
Ricerca sul Sistema Energetico - RSE S.p.A., Italy
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Each Contracting Party appoints a delegate and an altemate to the Executive Committee. This is ISGAN's decision-making body, which meets regularly and convenes twice a year. lts main aims are to discuss new developments, identify knowledge gaps end implementation barriers, and shape ISGAN's Programme of Work accordingly.

ExCo and Member Countries

Australia, Austria, Belgium, Canada, China, Denmark, European Commission, Finland, France, Germany, India, Ireland, Israel

2.2. Structure of ISGAN

ISGAN is both a initiative of the Clean Energy Ministerial (CEM) and a Technology Collaboration Programme (TCP) under the International Energy Agency (IEA). While it reports to both organizations, its formal operations are governed within the IEA framework. Unlike traditional CEM workstreams, ISGAN operates under a legally binding Implementing Agreement (IA), which defines the obligations of its official participants. These participants, nominated by their respective countries, are referred to as "Contracting Parties" and serve as signatories to the agreement. Together, they form the Executive Committee (ExCo), which oversees ISGAN's strategic operations. The ExCo is supported by the Presidium, comprising a chair, four vice chairs, two co-secretariats, and ISGAN's Operating Agent.

During the 27th ISGAN ExCo meeting (March 2024), Atul Kumar Bali was elected as the fourth Vice-Chair of ISGAN following Arun Kumar Mishra, who stepped back at the end of 2023. For ISGAN, it is very important to have Chairs and Vice-Chairs from multiple continents to bring the specific interests and priorities of different regions into the discussions of the Presidium.

The Presidium is supported by the Budget Review Group, who prepare budget proposals for the meetings with the strong support of the Secretariat and executes the Budget decisions as decided during ExCo meetings.
ISGAN has one Limited Sponsor, Flux50 (Belgium)

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The Co-Secretariat KSGI is responsible for the support of ISGAN contributions to the Clean Energy Ministerial, the ISGAN Award of Excellence, and coordination and contact activities within Asia.

Italy · Japan · Korea · Mexico (inactive) · Norway · Singapore · South Africa · Spain · Sweden · Switzerland · The Netherlands · United Kingdom · United States of America

2.3. ISGAN Collaboration with Partner Organizations

ISGAN actively collaborates with various organizations to foster innovation, knowledge exchange, and strategic alignment in the global energy transition. The figure below outlines key partnerships and their specific areas of cooperation:

1. **Global Smart Energy Federation (GSEF):**
   - **Primary Contact:** Reji Kumar Pillai (Chair)
   - **ISGAN Liaison Person:** Chloe Yoon
   - **Pending Action:** Collaboration plans are under discussion.
2. **IEA 3DEN:**
   - **Primary Contact:** Vida Rozite (Contact Point)
   - **ISGAN Liaison Person:** Luciano Martini
   - **Pending Action:** A joint workshop is planned to enhance cooperation and knowledge sharing.
3. **MI Green Powered Future Mission:**
   - **ISGAN Liaison Person:** Alexandre Prieur
   - **Alternate ISGAN Contact:** Ralf Eickhoff
   - **Achievements:** Memorandum of Understanding (MOU) signed at CEM 13 to formalize cooperation.
4. **ETIP SNET (European Technology and Innovation Platform Smart Networks for Energy Transition):**
   - **ISGAN Liaison Person:** Antonio Iliceto
   - **Alternate ISGAN Contact:** Ralf Eickhoff
   - **Achievements:** MOU signed in July 2023, establishing a framework for collaboration.
5. **Global Power System Transformation Consortium:**
   - **Primary Contacts:** Sadie Cox (Contact Point) and Karin Wadsack (Secretariat)
   - **ISGAN Liaison Person:** Russ Conklin
   - **Pending Action:** Areas of collaboration are under consideration.
6. **Hydrogen TCP:**
   - **Primary Contacts:** Paul Lucchese (Chair) and Marina Holgado (Secretariat)
   - **ISGAN Liaison Person:** Antonio Iliceto
   - **Alternate ISGAN Contact:** Josef Ayoub
   - **Pending Action:** Cooperative activities at the Working Group (WG) level are ongoing, with an invitation extended to attend ExCo 26.
7. **PVPS TCP (Photovoltaic Power Systems):**
   - **Primary Contacts:** Daniel Mugnier (Chair) and Emily Mitchell (Secretariat)
   - **ISGAN Liaison Person:** Josef Ayoub
   - **Alternate ISGAN Contact:** Roland Bründlinger
   - **Achievements:** A presentation was delivered during ExCo 25 to strengthen engagement.
8. **IETS TCP (Industrial Energy-Related Technologies and Systems):**
   - **Primary Contacts:** Thore Berntsson (Chair) and Heléne Johansso (Secretariat)
   - **Pending Action:** Potential collaboration opportunities are being explored.
9. **User's TCP:**
   - **Primary Contact:** David Shipworth (Chair)
   - **ISGAN Liaison Person:** Nicole Kerkhof Damen
   - **Alternate ISGAN Contact:** Klaus Kubeczko
   - **Pending Action:** Collaboration at the Working Group 7 level is underway.

These collaborations highlight ISGAN's commitment to building strong partnerships across sectors and regions to accelerate smart grid development and the global energy transition.

3. ISGAN's Vision for a Sustainable Future

3.1. What is a Smart Grid?

A smart grid represents a transformative leap in electrical system design, blending advanced technology and innovation to redefine the conventional model of electricity distribution. Unlike traditional power grids, which operate on a one-way flow of electricity and limited data communication, a smart grid integrates cutting-edge digital communication and sensing technologies to establish a dynamic, two-way exchange of information and power between consumers and utility providers.

This intelligent infrastructure relies on an interconnected network of sensors, smart meters, and automated control systems to collect and analyze real-time data on electricity consumption patterns, grid performance metrics, and the operational status of equipment. By leveraging this comprehensive data, the smart grid enables precise monitoring, predictive maintenance, and optimization of the entire electricity supply chain, enhancing operational efficiency and minimizing downtime.

One of the most significant benefits of a smart grid is its ability to seamlessly incorporate renewable energy sources, such as solar and wind power, into the electricity network. This integration supports decarbonization efforts while ensuring grid stability even with fluctuating energy inputs. Additionally, the smart grid promotes energy efficiency by enabling demand-response mechanisms, empowering consumers with real-time insights into their energy usage, and encouraging informed decisions to reduce consumption or shift it to off-peak times.

The infrastructure is also designed to accommodate the growing adoption of electric vehicles (EVs), providing the necessary flexibility and scalability to support widespread EV charging without overwhelming the grid. Its adaptive and resilient nature ensures a robust response to challenges such as power outages, cyber threats, and natural disasters, enhancing the reliability of electricity supply.

Ultimately, the smart grid is more than a technological upgrade—it is a cornerstone of the transition to a sustainable, interconnected energy future. By fostering collaboration between consumers, utility providers, and renewable energy systems, the smart grid paves the way for an efficient, resilient, and environmentally conscious electricity ecosystem that meets the evolving needs of modern society.

3.2. What's New in the World of Smart Grids in 2024?

3.2.1. Technological Innovations

The smart grid landscape has undergone significant transformation, with advanced digital technologies playing a central role in enhancing grid reliability, flexibility, and responsiveness. A key development is the increasing deployment of artificial intelligence (AI), machine learning, and edge computing for grid optimization. These tools enable real-time monitoring, fault prediction, dynamic load balancing, and self-healing capabilities, particularly in distribution networks.

The International Energy Agency emphasizes that digital technologies can extend the operational lifespan of existing assets and defer up to USD 1.8 trillion in global investment needs by 2050 through smarter asset

management and system optimization. Smart meters and intelligent sensors are now widely used to enable bi-directional power flows, which are vital for integrating distributed energy resources (DERs) such as rooftop solar, residential battery storage, and electric vehicle (EV) infrastructure[1].

The increase of digital twin concepts (virtual replicas of physical grid components), is also gaining traction, allowing utilities to simulate grid behavior under various scenarios and plan investments more efficiently[2]. Additionally, the integration of advanced sensors and Internet of Things (IoT) devices enables real-time monitoring of grid conditions, enhancing stability and efficiency. For instance, Spain's Naturgy is investing EUR 1.45 billion to digitalize its grid[3], focusing on remote sensing and smart metering technologies to better manage renewable energy integration and local consumption. Artificial intelligence and machine learning are also increasingly being utilized to analyze vast amounts of grid data, enabling predictive maintenance and optimization. The integration of distributed energy resources like solar panels, wind turbines, and battery storage systems is accelerating. As an example, Germany's smart grid plays a pivotal role in balancing the grid by regulating the output from traditional power plants and utilizing advanced energy storage solutions[4]. Furthermore, microgrids, which are small, localized networks of energy production and consumption, are becoming more advanced. These microgrids can operate independently from the main grid, providing energy security in the event of a power outage. With new control systems, microgrids can seamlessly integrate with the main grid, helping to balance supply and demand while enhancing overall grid resilience. The deployment of 5G networks is enhancing real-time communication within smart grids. The ultra-low latency and high-speed communication provided by 5G enable near-instantaneous data exchange between grid components, ensuring more precise control and monitoring. Lastly, advances in energy storage technologies, such as solid-state batteries and grid-scale storage solutions, are improving the ability of the grid to store excess energy. With enhanced storage capacity, utilities can better integrate intermittent renewable energy sources like wind and solar, smooth out fluctuations in supply and demand, and improve overall grid stability.

3.2.2. Regulatory and Policy Developments

Regulatory innovation is proving to be as critical as technical advancement. As smart grids become increasingly complex, flexible, and decentralized, regulatory frameworks are evolving to address issues around data privacy, interoperability, market access, and cybersecurity.

In the European Union, the Commission has committed to investing EUR 584 billion in electricity grids by 2030, of which EUR 170 billion is specifically dedicated to digitalization efforts such as automated control systems, smart metering infrastructure, and grid-responsive pricing mechanisms[5]. These efforts are supported by updated Network Codes and the Clean Energy Package, which mandate consumer data access, demand response participation, and non-discriminatory access for DERs.

The European Distribution System Operators[6] advocate for the establishment of harmonized technical standards, grid code modernization, and digital infrastructure guidelines to ensure scalable, secure, and interoperable deployment across member states. Additionally, regulatory sandboxes are being used to test innovative grid solutions in real-world environments without immediate compliance burdens, fostering a more dynamic innovation ecosystem.

1 IEA, Unlocking Smart Grid Opportunities in Emerging Markets and developing Economies, 2023 https://iea.blob.core.windows.net/assets/5d97b28a-ca5f-46a5-a194-2c13fd6e4aad/UnlockingSmartGridOpportunitiesinEmergingMarketsandDevelopingEconomies.pdf
2 EDSO, Digital twins: challenges and opportunities for the future of the energy system, https://www.edsoforsmartgrids.eu/edso-publications/digital-twins-challenges-and-opportunities-for-the-future-of-the-energy-system/
3 Reuters 2024, https://www.reuters.com/business/energy/spains-naturgy-invest-145-bln-boost-electric-grid-2024-06-03/
4 EnergyEvolution, 2024 The Future of Smart Grid Technology: Trends to Watch https://energyevolutionconference.com/smart-grid-technology-trends-to-watch/
5 IEA, Smart Grids, 2023 https://prod.iea.org/energy-system/electricity/smart-grids
6 E.DSO Smart Grid Regulation and System Flexibility, 2023 https://www.edsoforsmartgrids.eu

3.2.3. Trends in Economic and Strategic Investment

Strategic investments in smart grids are accelerating globally, not only in developed economies but also across emerging markets and developing economies (EMDEs). The IEA's 2023 report warns that electricity demand in EMDEs is projected to grow by 2,500 TWh by 2030, equivalent to five times Germany's current demand. Without proactive digitalization and smart grid deployment, this could result in economic losses of up to USD 1.3 trillion due to inefficiencies and system disruptions. To address this, the IEA recommends targeted public-private partnerships, cost-reflective tariffs, and supportive regulatory environments to unlock the potential of smart grid solutions in these regions. Meanwhile, IRENA's "Smart Electrification"[7] initiative outlines over 100 technological and policy innovations aimed at decarbonizing end-use sectors such as transport, buildings, and industry through smart grid-enabled electrification. IRENA notes that smart operations of technologies like heat pumps, EVs, and decentralized PV systems can significantly reduce the need for expensive grid reinforcements, translating into long-term savings for utilities and consumers alike[8].

3.2.4. Current Progress in Smart Grid Deployment

Several major economies have announced substantial new funding to modernize and digitalize their electricity grids. Notable progress in deploying smart grids is being made by the following countries and regions[9]:

- The European Commission presented the EU action plan "Digitalisation of the energy system" at the end of 2022. The Commission expects about EUR 584 billion (USD 633 billion) of investments in the European electricity grid by 2030, of which EUR 170 billion (USD 184 billion) would be for digitalization (smart meters, automated grid management, digital technologies for metering and improvement on the field operations).
- China plans to modernize and expand its power grids with USD 442 billion in investments over the period 2021-2025.
- Japan announced in 2022 a funding programme of USD 155 billion to promote investments in smart power grids.
- India launched in 2022 an INR 3.03 trillion (Indian rupees) (~USD 38 billion) scheme to support power distribution companies and improve distribution infrastructure.
- The United States announced in 2022 the Grid Resilience Innovative Partnership (GRIP) Program, with a funding opportunity of USD 10.5 billion to support the upgrade and expansion of US electric grids.
- Canada is investing USD 100 million through its Smart Grid Program to support the deployment of smart grid technologies and smart integrated systems.

7 IRENASmart Electrification of End-Use Sectors: Benefits for Distribution Gridss, 2024, https://www.irena.org/Publications/2024/Sep/Smart-electrification-of-end-use-sectors-Benefits-for-distribution-grids
8 IRENA Smart Electrification of End-Use Sectors: Benefits for Distribution Grids, 2024 https://www.irena.org/Publications/2024/Sep/Smart-electrification-of-end-use-sectors-Benefits-for-distribution-grids
9 IEA, Smart Grids https://www.iea.org/energy-system/electricity/smart-grids

3.3. ISGAN's Operational Priorities and Focus Areas

ISGAN is dedicated to advancing the global understanding of smart grid development, deployment, and operation while addressing critical knowledge gaps and fostering innovation. Its initiatives aim to identify and promote emerging solutions, facilitate technical collaboration, and recognize exemplary projects to encourage widespread replication. By emphasizing the integration of smart grid concepts into governmental policies and regulatory frameworks, ISGAN plays a vital role in shaping the energy sector's evolution.

To achieve these objectives, ISGAN engages in six Working Groups designed to enhance global knowledge and collaboration. These efforts include identifying innovative tools and practices, enabling peer-to-peer knowledge sharing, and fostering international cooperation within the smart grid community. ISGAN supports these goals through various activities, such as case books, discussion papers, workshops, webinars, fact sheets, and policy briefs, which provide actionable insights and technical guidance.

Moreover, ISGAN acknowledges exceptional projects and initiatives through its award program, promoting their replication and broader adoption. This recognition highlights best practices and reinforces the importance of innovation in advancing smart grid technologies. By focusing on these strategic areas, ISGAN not only bridges knowledge gaps but also strengthens global efforts to create resilient, efficient, and sustainable energy systems.

3.4. ISGAN Themes

At the core of ISGAN's efforts lie four key strategic themes: **flexibility, digitalization, interoperability, and resilience.** These pillars are not only vital to the modernization of electricity grids but also essential for achieving a sustainable, reliable, and future-ready energy ecosystem.

3.4.1. Flexibility

Flexibility in the energy grid ensures that supply and demand can adapt dynamically to fluctuations, whether caused by changing consumer patterns or the integration of renewable energy sources like solar and wind. This adaptability allows grids to manage peak loads, mitigate outages, and enhance overall efficiency. ISGAN promotes innovations that enable both physical infrastructure and operational strategies to respond effectively to changing conditions.

3.4.2. Digitalization

Digitalization is revolutionizing the way energy systems operate. By integrating advanced digital technologies such as sensors, data analytics, and artificial intelligence, grids can monitor performance in real time, predict maintenance needs, and optimize resource allocation. ISGAN focuses on harnessing digital tools to enhance grid intelligence, making energy systems smarter and more responsive to user needs.

3.4.3. Interoperability

Interoperability ensures that different components of the energy system, including devices, networks, and software platforms, can communicate and function seamlessly together. Standardization and collaboration across industries and borders are key to achieving this.

3.4.4. Resilience

Resilience is about creating energy systems that can withstand and recover from disruptions, whether caused by natural disasters, cyberattacks, or equipment failures. Resilience of the Energy Grid emphasizes strategies and technologies that bolster the grid's ability to absorb shocks, minimize downtimes, and ensure reliable energy delivery even under challenging circumstances.

These themes capture the essential dimensions of future energy systems, addressing the shifting demands and challenges encountered by utilities, grid operators, end users, technology developers, policymakers, and other key stakeholders as well as their advancements in interaction with each other. They also act as foundational principles for steering priorities for ISGAN activities.

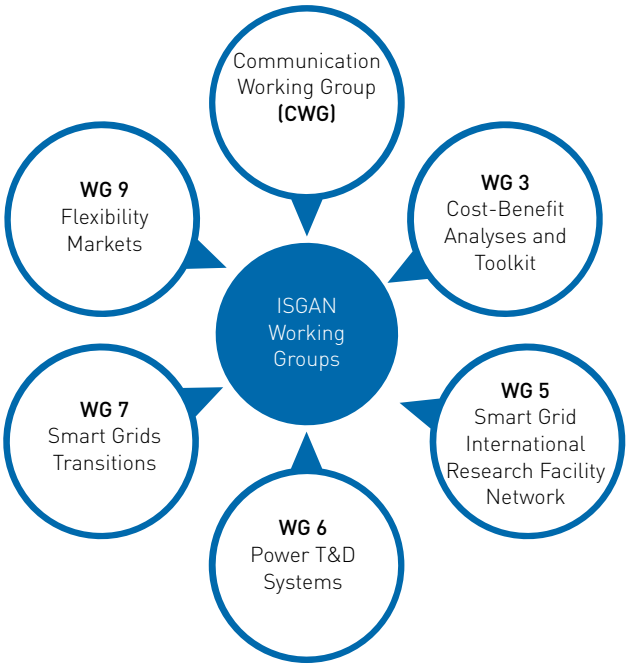
By adopting a thematic approach, ISGAN, in collaboration with its partners, can strategically navigate the complex and evolving smart grid landscape. This approach fosters synergy and innovation, paving the way for the development of energy systems that are more resilient, efficient, and sustainable, meeting the needs of a rapidly transforming global energy ecosystem.

Together, ISGAN's themes of flexibility, digitalization, interoperability, and resilience form a comprehensive strategy to address the evolving challenges of modern energy systems. By fostering international collaboration and knowledge-sharing, ISGAN is driving the transition toward smarter, cleaner, and more resilient grids that can support a sustainable energy future.

3.5. ISGAN Working Groups

ISGAN organizes its activities under standing Working Groups, each operating under its own manager and with its own set of national experts, appointed by member countries. The activities in the Working Groups are planned every year and presented as the individual Programmes of Work by the Working Group Manager and are approved by the Executive Committee. Currently, ISGAN has six Working Groups:

- Communications Working Group
- WG 3: Cost-Benefit Analyses and Toolkit
- WG 5: Smart Grid International Research Facility Network
- WG 6: Power Transmission & Distribution Systems
- WG 7: Smart Grids Transitions
- WG 9: Flexibility Markets – Development and Implementation



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ISGAN Working Group Managers

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4. Highlights in 2024

4.1. ISGAN Lighthouse Project

4.1.1. Summary of the Lighthouse Project 2024

The Lighthouse Project focuses on increasing ISGAN's impact by promoting a deeper understanding and dynamic international dialogue on smart distribution grids. This initiative aligns with global energy transition goals, particularly the COP28 pledge to enhance renewable energy capacity and energy efficiency. The first Lighthouse prototype has involved extensive inter-Working Group (WG) collaboration and stakeholder engagement to develop policy recommendations and tools for long-term grid planning and implementation.

The **vision of the lighthouse project** was to facilitate a unified ISGAN focus on one overarching theme—smart distribution grids—to increase impact, promote knowledge sharing, and engage stakeholders effectively. The **key objectives** were to improve the collaboration across ISGAN Working Groups, and to produce impactful external communications, including a Policy Brief and Knowledge Hub. Furthermore, it was planned to engage diverse stakeholders in discussions around smart grid challenges.

4.1.2. Activities and Outcomes

The Knowledge Sharing Process (KSP) involved several key activities aimed at enhancing collaboration and producing actionable insights. Six workshops were conducted between January and September 2024, including five virtual sessions and one in-person meeting. These workshops facilitated knowledge exchange and co-creation on the theme of smart grid transformation. A significant outcome of the KSP was the development of the "ISGAN Knowledge Hub," a pilot online resource designed to guide key stakeholders in planning and implementing smart distribution grids. Additionally, the process led to the publication of a comprehensive Policy Brief on long-term grid planning and implementation, which was presented at the CEM15 event.

The Global Workshops series took place from May to September 2024 and featured five regional workshops. These events provided a platform to explore the unique challenges and opportunities associated with distribution grid development across different global regions.

Collaborations and outputs were central to the success of the Lighthouse Project. ISGAN experts and stakeholders were actively mobilized to participate in co-creation processes, fostering a collaborative environment for addressing smart grid challenges. External stakeholders were also engaged through public workshops and virtual webinars, broadening the project's reach and impact. To further inform policy and planning discussions, survey results from 20

countries were analyzed and disseminated, offering valuable insights into the state of smart grid development worldwide.

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Helena Lindquist, Manager of the Lighthouse Project

4.1.3. Key Deliverables:

Policy Brief for CEM15: Highlights the critical need for policy attention to low- and medium-voltage grids and advocates for de-risking investment through better planning frameworks.

ISGAN Knowledge Hub: Provides a structured framework and library of resources for stakeholders.

4.1.4. Report on Lighthouse Global Workshops

ISGAN's Lighthouse Project on Smart Distribution Grids has initiated a global workshop series to explore the essential preconditions, challenges, and opportunities for transforming grid systems across various global regions. This effort comes at a critical time when international energy goals, such as the COP28 pledge to triple renewable energy capacity and double energy efficiency improvements by 2030, demand innovative and effective solutions for grid modernization. The series comprised five workshops, each dedicated to the unique contexts and advancements within specific regions worldwide. These workshops served as a platform for international collaboration, fostering the exchange of knowledge and strategies to address the shared and region-specific challenges of smart grid implementation.

The workshops aimed to:

1. **Examine Prerequisites:** Define the fundamental requirements for successful grid development and identify barriers to progress.
2. **Understand Uncertainties:** Analyze how uncertainties—such as policy changes, market dynamics, and technology adoption—impact the planning and implementation capabilities of grid stakeholders.
3. **Promote Collaboration:** Develop strategies for fostering cooperation among stakeholders to accelerate the transformation of distribution grids.

The discussions focused on addressing critical questions that are essential for shaping the future of energy systems. Participants explored the fundamental prerequisites required for successful grid development, analyzed how uncertainties impact the planning and implementation capabilities of grid actors, and examined strategies for fostering collaboration among stakeholders to accelerate the transformation of distribution grids.

By emphasizing adaptive long-term planning and innovative policies, the Lighthouse Project has established a strong foundation for a unified ISGAN approach to smart distribution grid challenges. The Lighthouse Global Workshops have demonstrated their relevance in addressing the urgent need for grid modernization to support global energy transitions. Gained knowledge from the Lighthouse process was shared with other TCPs to improve their collaboration activities. To ensure continued progress and alignment with available resources, a "Lighthouse Task Force" is proposed to evaluate and refine the project's strategies and objectives for future success.

4.2. 15th Clean Energy Ministerial

ISGAN contributed to the 15th meeting of the Clean Energy Ministerial in three Side-Events. More details can be found in the Chapter on Events of the Clean Energy Ministerial 2024

4.2.1. 21CPP-ISGAN-GPFM event

"Power Systems for a Sustainable Future: A Joint CEM and MI Framework for Action"
1 October 2024

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21CPP ISGAN GPFM Side event at the 15th Clean Energy Ministerial.

- Opening Remarks by **Julie Cerqueira**, MI Steering Committee Chair and **Jean-Francois Gagné,** Head of the CEM Secretariat, on the importance of translating ambitions to actions and corresponding need for close **MI-CEM collaboration**
- Overview of 21CPP, ISGAN and GPFM as CEM and MI Power Sector Leading Initiatives and highlights of their commitment towards the joint CEM-MI **"Agenda for Action on Power Systems Solutions"**
- Spotlight on the ISGAN Lighthouse Project **"Long-Term Planning and Implementation of Smart Distribution Grids"**
- High-level roundtable discussion among Representatives from **CEM Workstreams** and **MI Missions** on key challenges and opportunities for **power sector solutions** and related commitment towards the **Joint CEM-MI Agenda for Action**
- Presentation of approach and objectives of the objectives of the Joint CEM-MI Deliverable **"CEM-MI Agenda for Action on Power Systems Solutions"** that was then endorsed by CEM and MI members' countries HoDs at the Minister-CEO roundtable on power sector. This CEM-MI Deliverable represents a collective effort in identifying **key implementation actions** to be undertaken to make power systems the enablers of the clean energy transition.

The Agenda for Action is in line with the **COP28, G7** and **G20** goals thus reaffirming the CEM-MI mutual support to work together in order to help advance power system solutions and attain ambitious clean energy objectives.

4.2.2. 21CPP event

"Status of Power System Transformation 2024: Where We've Been and Where We're Going" **1 October 2024**

- Opening Remarks by Lord **Adair Turner,** Energy Transitions Commission Chair
- Introduction to the **21st Century Power Partnership,** Power Sector Transformation Video and presentation of key findings from the "Status of Power System Transformation 2024" report that ISGAN contributed to.
- Panel discussion, moderated by **Luciano Martini,** on how **power system transformation** efforts and considerations have evolved in recent years, reflecting on lessons learned and successes, involving key international panelists renowned in the energy landscape, e.g., **IEA, IRENA, WEF, LDES.**
- Signature of the **ISGAN and 21CPP MOU** regarding "Cooperation on Innovative Power System Transformation Solutions"

ISGAN honourees presentation

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21CPP Side event at the 15th Clean energy Ministerial

During the 21CPP event on 1 October, ISGAN and 21CPP have formalized their will to collaborate and signed a **Memorandum of Understanding** on **"Innovative Power System Transformation Solutions",** witnessed by Jean-Francois Gagné, aiming to accelerate the development and widespread deployment of innovative solutions to make power systems more efficient, reliable, and sustainable.

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Signature of the Memoprandum of Understanding between 21CPP and ISGAN at the 15th Clean Energy Ministerial (From left) Luciano Martini/ISGAN Chair, Jean-Francois Gagne/Head of CEM Secretariat, Doug Arent/Operating Agent of 21CPP

4.2.3. 10th ISGAN Awards

The 10th ISGAN Awards of Excellence on the theme of *"Flexibility for Grid Resilience"*

2 October 2024

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Group photo with the Awardees of the ISGAN Award of Excellence, witnessed by Jean-Francois Gagné, Head of the CEM Secretariat

- Introductions of the 10th ISGAN Awards on the theme of **"Flexibility for Grid Resilience"**
- Announcement of the awards honorees and in particular:
  - ISGAN Winner: **Korea Power Exchange**
  - ISGAN Runner-up: **Ecole Centrale de Nantes**
  - ISGAN Honorable Mention: **Sumitomo Electric Industries, Ltd**

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5. Insights from ISGAN Working Groups

This section highlights the invaluable insights and progress achieved by ISGAN's Working Groups over the past year. These collaborative efforts have played a key role in advancing ISGAN's understanding of smart grid technologies and their integration into operational frameworks. By sharing knowledge and expertise, the Working Groups have utilized these insights to improve efficiency, sustainability, and resilience across power system networks. ISGAN Working Groups examine the topic of smart grids from diverse perspectives using a variety of methodologies. In doing so, they complement one another not only through their distinct viewpoints but also through the different approaches they employ to generate knowledge.

5.1. Communication Working Group

The ISGAN Communication Working Group (CWG) serves as a central hub for knowledge management and outreach within the International Smart Grid Action Network, with the core mission of collecting, summarizing, and effectively disseminating information related to ISGAN's diverse array of activities. As a cross-cutting entity, the CWG collaborates closely with all other ISGAN Working Groups to support their communication needs and amplify their findings. The group's work is structured around six key tasks, encompassing the synthesis of findings into accessible formats for various stakeholders, the identification and promotion of national priorities and best practices through casebooks and workshops, the facilitation of structured knowledge exchange initiatives such as the Lighthouse Project and Knowledge Sharing Projects, the organization of virtual learning opportunities like ISGAN webinars, the execution of outreach and liaison functions with other organizations, and the creation of public media content.

A key function of the CWG is dissemination and outreach. Recognizing that the implementation of smart grids, technologies, and systems requires engagement from diverse stakeholders—including policymakers, governing bodies, Transmission System Operators (TSOs), Distribution System Operators (DSOs), and Non-Governmental Organizations (NGOs)—the CWG produces and shares resources such as publications, webinars, and workshops. These activities promote knowledge exchange, highlight emerging trends, and anticipate future developments. While the materials are primarily policy-focused, they are designed to engage a variety of audiences and advance national, regional, and global clean energy objectives.

Create and curate knowledge that relates and reinforces the vital role of smart grids in the energy transition and ISGAN activities.

Maximize the impact of ISGAN's various activities by engaging with diverse stakeholders, both internally and externally.

Maintain current members and increase the audience for ISGAN activities.

5.1.1. Achievements in 2024

In 2024 the main focus of the Communication Working Group lay with the ISGAN Lighthouse project. The most visible result was the presentation at the 15th Clean Energy Ministerial (CEM 15) held in Foz do Iguaçu, Brazil from 30 September to 4 October 2024.

For this purpose, the most important results were summarized in the Policy Brief ISGAN Policy Brief on Long-Term Planning and Implementation of Smart Distribution Grids[10]

Furthermore, a series of international workshops on the topic of the Lighthouse project were conducted. More details can be found on the ISGAN Website: ISGAN. All Rights Reserved. - Global workshop series: Lighthouse experts explore distribution grid transformation worldwide[11]

Another very important communication product of ISGAN is its highly attended webinars. The webinars attract a significant number of live attendees and are subsequently viewed by hundreds of online visitors. The following webinars took place in the fiscal year 2024:

Date	Title	Speakers
11.3.2024	Aggregator in digitalized power systems	Sebastian Lehnhoff; Marcel Otte; Jirapa Kamsamrong; Annike Abromeit; Christian Kunze; José Pablo Chaves Ávila
21.5.2024	Revolutionising Renewable Energy: Exploring the Biomass-fired Top Cycle (BTC) Plant	Henrik Båge; Michael Bartlett
22.5.2024	Storage technologies in multi-energy carriers and industrial environments in the SINNOGENES project	Ilias Zafeiropoulos; Rushit Amishbhai Kansar; Ricardo Silva; Hernandez Jimenez Angel
25.6.2024	How to Integrate Energy Communities into the Electricity System	Seyed Amir Mansouri; Albert Farriol Salas
3.7.2024	Storage technologies for transport and insular systems in the SINNOGENES project	Nikos Andriopoulos; Quentin Matthewson; Georgios Spanos; Grégoire Thillaye du Boullay
23.10.2024	Biomass-fired Top Cycle (BTC) Technology: A Deep Dive into the Innovations Redefining Biomass Power Generation	Michael Bartlett; Jens Pålsson; Chunguang Zhou; Felix Guethe
28.11.2024	Flexible Operation of Energy Communities under Uncertainty in Energy Markets	Albert Solà Vilalta; Llorenç Burgas Nadal
3.12.2024	Long-Term Planning & Implementation of Smart Distribution Grids	Helena Lindquist; Susanne Ackeby; Klaus Kubeczko

10 https://www.iea-isgan.org/wp-content/uploads/2024/09/ISGAN_Policy-Brief_LT_Planning_and_Implementation_of_Smart_Distribution_Grids_2024.pdf
11 ISGAN. All Rights Reserved. - Global workshop series: Lighthouse experts explore distribution grid transformation worldwide

5.2. WG 3: Cost-Benefit Analysis & Toolkits

Developing an effective plan for the power system in order to reach the targets set for 2030 and 2050 requires modern planning and decision-making methodologies capable of addressing future challenges.

ISGAN Working Group 3 focuses on developing tools to help electrical system stakeholders identify investment requirements and priorities for smart grid systems and regulatory advancements. These tools enable the creation of tailored business cases by factoring in existing regulatory and market frameworks, the current state of the system, available resources, generation assets, and demand profiles. Additionally, Working Group 3 seeks to create a global framework and analytical methods to standardize the identification, definition, and quantification of benefits derived from the demonstration and deployment of smart grid technologies. Sharing knowledge and experiences from participating countries serves as a solid foundation for this work.

The flagship product of Working Group 3 is the **Smart Grid Evaluation Toolkit** (SmartGridEval), a web-based software offering a novel decision-support tool for strategic smart distribution system planning. It integrates Multi-Criteria Analysis (MCA) and Cost-Benefit Analysis (CBA) to guide decision-making. Currently, the tool is being enhanced to expand its scope to include projects that emphasize flexibility in system development and sector coupling, as well as to incorporate uncertainty management into its framework.

Development of tools to help analysts, regulators, utilities and other electricity system stakeholders to define and decide on system needs and priorities for smart grid system investment and regulatory changes.

Creation of 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 grids technologies and practices in an electricity system.

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.

5.2.1. Achievements in 2024

In 2024 the following achievements have been accomplished:

- A paper titled "Techno-Economics Evaluation of Electrolyser Technologies: Multicriteria Decision Making with SmartgridEval" has been presented at the 2024 CIRED Vienna Workshop.
- A new analysis comparing AC and DC systems at the distribution level has been initiated, focusing on a detailed literature review and preliminary research.
- A detailed Flexibility Market Questionnaire on the implementation and development of flexibility markets has been designed and shared with members of WG 3 and WG 9. This survey includes approximately 40 questions – both open-ended and multiple-choice – spread across seven sections. The topics cover market structure, stakeholders, products, implementation challenges, and regional insights. The questionnaire is currently active, and initial responses are being analyzed.

- Collaboration with WG 7 is underway to identify participatory processes that ensure investments in distributed energy resources are robust, technically viable, and socially acceptable.

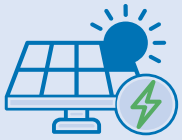
Looking into the future, the following key areas for improvement of the online tool, were identified:

- Integration of Cost-Benefit Analysis (CBA) and uncertainty modelling through scenario analysis.
- The identification of new Key Performance Indicators (KPIs).
- Enhancements to the user interface and overall user experience.

5.3. WG 5: Smart Grid International Research Facility Network

The Smart Grid International Research Facility Network (SIRFN) is a network of smart grid research and test-bed facilities in countries participating in ISGAN. The Working Group 5 participants coordinate joint testing-related activities relevant to modern, "smart" electricity grids, broadly defined.

Working Group 5's collaborative testing and evaluation capabilities are meant to be leveraged by the international community to enable improved design, implementation, and testing of smart grids and their functionalities, including the reliable integration of clean energy technologies.



Research and testing facilities, test beds, testing projects: identification of collaboration opportunities among test facilities, state-of-the-art testing practices, identification of testing protocols needing attention.

Strong and active community of researchers engaging in applied research and impactful work on Smart Grids testing: DER, power systems, microgrids, protocols for advanced inverter functions for PV and storage integration etc.

Smart Grid Modelling: Server and interfaces to use these systems and topologies. SunSpec Alliance System Validation Platform, to reduce barriers to testing in emerging / developing economies.

Open source software tools, test cases and procedures to be used by DER vendors, universities, research institutions, certification laboratories, standards organizations, etc.

5.3.1. Achievements in 2024

The work in Working Group 5 is organized in Joint Research Activities (JRA). The following JRAs were active in 2024:

Research Infrastructure Dataspace Showcase (RIDS)

Jawad Kazmi, AIT, Austria

This JRA focuses on developing and demonstrating a data collaboration platform based on a federated dataspace. The project aims to showcase a prototype comprising interconnected nodes at participating institutions, linked via a virtual private network (VPN). Several use cases will demonstrate how the platform integrates with existing research infrastructure, enabling seamless data sharing and collaboration. Significant progress has been made in advancing the project's objectives: PV Ontology Development, Meta-Data Representation Model, Knowledge Representation Model, Data Publishing user interface, Dataspace Agent Software Stack and IT Infrastructure Setup.

Development of PHIL Interfacing Methods to Facilitate Black-Start Testing of Grid-Forming Converters

Zhiwang Feng, UoS, UK

This JRA focuses on enhancing power hardware-in-the-loop (PHIL) interfacing methods for testing grid-forming converters, with particular emphasis on their black-start applications. The first four tasks, which involved analyzing and assessing PHIL interfaces in Simulink, have been completed. These assessments have theoretically evaluated the feasibility and applicability of these interfaces for grid-forming converter testing. Currently, the main focus is on the experimental validation of various interfaces for integrating grid-forming converters into PHIL setups, as well as post-experimental data processing.

OpenSVP for EN50549 and VDE 4105 Testing

Terence O'Donnell, UCD, Ireland

This JRA focuses on enhancing the automated test platform OpenSVP, originally developed by SunSpec, Sandia, and CanmetENERGY, to support smart inverter testing based on EN 50549 and VDE 4105 standards. The platform is being deployed in several new research laboratories within the SIRFN network, driven by the need for greater flexibility from distributed energy resources (DERs) and rigorous testing to ensure interoperability and performance consistency.

FAIR Data for Power System Testing

Kai Heussen, DTU, Denmark

Reproducibility is a key requirement in validation and interoperability; however, power system experiments remain complex and difficult to reproduce and analyse. Meaningful data structures and metadata annotations can enhance interoperability and provide a foundation for the automation of testing processes. This JRA builds on the concept of structured dataset annotations, inspired by the FAIR principles, ensuring that metadata is (F)indable, (A)ccessible, (I)nteroperable, and (R)eusable. Since findability and accessibility are already addressed by data exchange mechanisms such as data spaces, this initiative focuses on the interoperability and reusability requirements.

This JRA develops meaningful metadata structures to improve the reporting and interoperability of test data. By focusing on the reproducibility of practical test data sharing cases, the relevant metadata requirements are identified.

Open/Closed Loop testing of grid-forming inverter

Tobias Erckrath, FH-IEE, Germany

The project aims to identify the advantages of closed-loop (PHIL-based) testing over traditional open-loop testing, with a particular focus on its ability to capture network interactions. This approach enables a broader range of test cases, allowing for more realistic and comprehensive test scenarios. One of the key objectives is to evaluate how these enhanced testing capabilities can provide significant benefits in

real-world applications. The project will also review the current state of closed-loop testing in guidelines and identify potential improvements over traditional testing methods.

Additionally, the project will focus on defining requirements for the overall PHIL system. As a key milestone, a unique test case has been identified, which will serve as the first demonstrator case during the JRA.

Event	Involved	Date/ Location
Public WS on "Grid-forming inverters- validation and testing challenges" WG 5 and AIT organized a public workshop including lab-tour and demonstration	AIT & WG 5	March 24, Austria
Ireland National TCP Day Presentation of WG 5 activities	UCD & WG 5	June 24, Ireland
CIRED Vienne WS "Qualification & Validation of Grid Services from the GFI of Hybrid & Renewable Energy Plants" WG 5 experts supported the workshop activities including a lab-tour	ERIGrid, AIT & WG 5	June 24, Austria
IEEE Student Summit WS on "Power electronic testing & developing" WG 5 organized and held a workshop for students to train and presented grid-tied power electronics, including an active training session, presentations and a lab-tour and demonstration	DERlab, FH-IEE & WG 5	Aug 24, Germany
Public WS on "Research infrastructure automation" JRA presentation of several WG 5 members	ERIGrid, DTU & WG 5	Sept 24, Denmark
RD20 Tokyo Symposium 2024 Presentation of WG 5 activities	AIST & WG 5	Oct 24, J apan
Guest Lecture "P/HiL testing infrastructures and praxis-relevant applications" Presentation of ISGAN + WG 5. Panel Session of research infrastructures and laboratories	TU Dortmund, DERlab, Fraunhofer & WG 5	Jan 25, Germany
MI – GPFM WS: "Policy & Technology for Grid Digitalization" Presentation of WG 5 activities	AIST & WG 5	Feb 25, Online

5.4. WG 6: Power Transmission & Distribution Systems

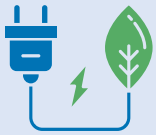
Working Group 6: Power Transmission and Distribution (T&D) Systems focuses on the potential system-related challenges in the development of future smarter grids. The Working Group works through knowledge sharing to facilitate the application of advanced technologies needed for power grids to contribute in the best way to the attainment of clean energy, climate goals and sustainable energy access to all.

The Working Group promotes solutions that enable power grids to maintain and improve the security, reliability, and quality of electric power supply while facing challenges related to significant trends in the industry, like expanding electrification of the energy system to unserved areas, integration of large-scale renewable energy sources and distributed generation, electrification of industries, heat and transport, increased customer participation, replacing aging infrastructure and integration of emerging, real-time information technology systems.

The main objective of Working Group 6 is to establish a long-term vision for the development of future sustainable power systems. The Working Group shall consist of efforts to improve understanding of Smart Grid technologies applicable to or influencing power system performance and efficiency, accelerate their development and deployment and promote the adoption of related enabling policies.

By focusing on power system-related challenges and solutions, Working Group 6 provides ISGAN with a discussion base for dedicated scientific input on technology, market, or regulatory aspects of transmission and distribution systems. The work is based on collecting, integrating, synthesizing, and distributing information on Smart Grid technologies, practices, policies, and systems through discussion papers, webinars, papers, and presentations at relevant seminars, conferences, and workshops. The importance is to process this information and deliver important conclusions for the complete system.

Knowledge sharing is essential within Working Group 6 and experts come from the majority of ISGAN member countries and are a mix of system operators, policy makers, academia and research institutes.



Facilitate the application of advanced technologies needed for power grids to contribute in the best way to the attainment of clean energy, climate goals and sustainable energy access to all.

Solutions that enable power grids to maintain and improve the security, reliability and quality of electric power supply while facing challenges related to significant trends in the electricity sector.

Condense to conclusions and recommendations for policy makers: case books, discussion papers, workshops and collaboration with other initiatives.

5.4.1. Achievements in 2024

FY2024 was a year where the ISGAN WG 6 focus has been highly relevant and important. The work has been performed in activities, where three activities continued from FY2023, three new activities were started and four activities were in the finalizing phase. Monthly coordination calls have been arranged, discussing the ongoing WG activities but also including presentations from national experts and other relevant parties like IEA.

Discussion papers

WG 6 has published four new discussion papers:

- 2020.02: FlexPlan project view
- 2022.02: Network decision-making under uncertain scenarios
- 2022.03: Aggregator roles in digitalized energy systems (report + policy brief)
- 2022.04: Energy community embedment (cooperation with ETIP-SNET) (report)
- 2023.01 Active system management by DSOs (report + Executive summary)

Policy briefs

One policy brief has been published on *Aggregator roles in digitalized energy systems* (activity 2022.03). WG 6 was also involved in developing the policy brief on the topic on Long-Term Planning and Implementation of Smart Distribution Grids, which was produced within the Lighthouse project and launched at a side event at CEM 15 at Foz do Iguaçu, Brazil.

Upcoming publications

One additional discussion paper was finalized and is to be uploaded for official approval. The discussion paper is related to the activity *Exploring the interaction between power system stakeholders: Insights from Pilot Projects.*

Extended outreach

- An ISGAN ETIP-SNET side event was arranged at Cigré in Paris, on August 27th, 2024 on Energy Communities´ impact on power grids (2022.04). The event was well attended by approximately 90 experts.
- A presentation of the ISGAN WG 6 activity on Exploring the interaction between power system stakeholders: Insights from Pilot Projects (2023.03) was selected for presentation at „Klimafitte Industrie: Forschung und Entwicklung für die Industrie der Zukunft" (Eng. Climate-Fit Industry: Research and Development for the Industry of the Future). This is a yearly event where participants active in all IEA TCPs from Austria have to participate. The meeting is one of the most important forums in Austria to share information on IEA projects.

Progress in activities

During FY 2024, Working Group 6 has delivered in the following ongoing activities

- Activity 2023.02: Deploying flexibility for resilience - best practice sharing (Lead: Norway)
- Activity 6 2023.03: Exploring the interaction between power system stakeholders: Insights from Pilot Projects (Lead: Austria)
- Activity 2024.01 Hydrogen sector impact on power grid: production/storage/transport

Finalised activities

During FY 2024, Working Group 6 has finalized the following activities:

Flexibility and storage as an alternative to building new grid infrastructure: the FlexPlan view

This activity aimed to share lessons from the FlexPlan Horizon 2020 project with the ISGAN community. The project developed a new grid-planning methodology incorporating storage and flexibility resources as alternatives to building new grid elements. It also created an innovative planning tool to advance current methodologies. WG 6 followed the project's progress, including participation in Advisory Board meetings. A summary report was created, focusing on the final regulatory reflections and guidelines. The ISGAN report was approved and published on the ISGAN website in FY2024.

Network decision making under uncertain scenarios (cooperation with KTP).

The activity focused on developing power grids to meet global sustainable development goals, organized as a Knowledge Sharing Project with ISGAN CWG. 11 countries and IRENA participated, with key work done in workshops, including one in Berlin at ExCo 26. The main output was a policy brief with seven key messages, launched at CEM 14, and a detailed report finalized in 2023, published on the ISGAN website in FY2024.

Aggregator Roles in Digitalized Energy Systems

This activity explored how aggregators can improve TSO-DSO-Customer coordination, enabling improved flexibility management in digitalized energy systems. The final discussion paper was published on the ISGAN website in FY2024.

Energy Community Embedment (Cooperation with ETIP-SNET)

The activity examined how local energy communities impact the electricity grid, support flexibility, and affect electricity markets. It involved knowledge transfer between stakeholders and countries and culminated in a joint report published in FY2024.

Active System Management by DSOs - Online Workshop Series

This series of workshops focused on DSOs' role in integrating renewables and managing electrification. The resulting report explored active system management and its potential to optimize investments and enable the energy transition.

Challenges Related to PV and EV Integration

Launched to share best practices on integrating PV and EV in distribution systems, the activity has been refocused to address the integration of EVs and heat pumps, leading to the 2025.02 activity on long-term planning for residential grids.

Lighthouse WG 6 Contribution

This activity served as a framework for WG 6's input to the ISGAN Lighthouse project, with participation in workshops and analysis groups. A similar activity, 2025.04, is suggested for FY2025.

5.5. WG 7: Smart Grid Transitions and Institutional Change

Working Group 7 aims to support policymakers in the field of electricity grids related to issues of the transition from the established institutional structures and governance processes towards a smart grid in the context of the energy system transition. Working Group 7 complements other ISGAN Working Groups, regarding non-technical aspects and framework conditions conducive to smart grid deployment. Its focus is on institutional change, including governance of the electricity system, policies and stakeholder processes, regulatory aspects and human behavior; topics, which are dealt with by social sciences and humanities (SSH) disciplines and transdisciplinary researchers linking the expertise from SSH and engineering.

The overall approach of the WG 7 is to investigate socio-technical transition and governance issues associated with smart grid deployment using two related frameworks: sustainability transitions and reflexive governance. Future development is understood to be a socio-technical transition process. The scope is determined by institutional change processes with electricity grids as the central infrastructure element. The work is allocated within three thematic areas tailored to the needs of the target groups. It spans the range from the understanding of the underlying conditions (systemic knowledge) over questioning the current models or relationships (reflective knowledge) to the development of processes and possible pathways (transformative knowledge).

Socio-technical transition

Institutional change to a sustainable energy system with smart grids as a central infrastructure element

Task 3	Task 2	Task 1
Structures of institutional change	Future models and translation function	Transition processes and pathways
What are the conditions?	What matters? What counts?	What works?
Understand institutions as structural conditions (incl. regulation, tariffing,actor constellations) *Aims to build a basis for the discourse of the actors in the future energy system*	Development of future models and translation function within and between domains - policy areas, public service sector & economy, R&D *Targets the Stakeholders in the transition*	Transformative policy instruments and processes such as living labs, regulatory sandboxes and other forms of regulatory experimenting *Targets CEM and ExCo*
System knowledge	Reflective knowledge	Transformative knowledge

Future models and translation function: between domains role and implantation of the public sector in security of supply and operation of critical infrastructures.

Structures in institutional change: regulation, tariff setting and incentives in smart grids.

Transition processes: Policy instruments and governance processes including regulatory experimentation as a policy instrument of regulatory learning.

5.5.1. Achievements in 2024

Working Group 7 was key in the foundation of the Lighthouse Project. The main structure and approach were developed in close cooperation with the WG 7 expert, Klaus Kubeczko and the Lighthouse Project Manager, Helena Lindquist.

Working Group 7 contributed to the following events:

Technology Platform Smart Grids Austria
Presentation of the Lighthouse and the WG 7
October 2024, Austria
~ 70 participants (industry)

Mission Innovation Austria 2024
Organisation of a discussion session with keynote
October 2024, Austria
~ 50 participants (policy)

Global Smart Grids Seminar
Presentation of transition management for smart grids
November 2024, Korea
~ 100 participants (diverse)

ISGAN Sandbox CoP
Presentation & discussion of a practical example of regulatory sandbox
September 2024, online

Working Group 7 is also very active in scientific publishing. In 2024, the following papers were published:

- Bauknecht, Dierk, and Klaus Kubeczko. 2024. "Regulatory Experiments and Their Impacts on Sustainability Transformations." *GAIA – Ecological Perspectives for Science and Society Special Issue. 44–50.* https://https://doi.org/10.14512/gaia.33.S1.7

- Wieczorek, Anna J., Harald Rohracher, Dierk Bauknecht, Klaus Kubeczko, Simon Bolwig, Pieter Valkering, Regine Belhomme, and Simone Maggiore. 2024. "Citizen-Led Decentralised Energy Futures: Emerging Rationales of Energy System Organisation." Energy Research & Social Science 113 (July): 103557. https://doi.org/10.1016/j.erss.2024.103557.

Further results of the Working Group were

- The first version of the Wiki for internal use and editorial guide.
- This dictionary for smart grids related terms has been started because many terms are understood in different ways and a common language is crucial for the communication of any technical results. It is continuously being expanded.
- Comparative analysis of different grid pricing mechanisms.

5.6. WG 9: Flexibility Markets – Development and Implementation

Working Group 9 focuses on the critical role of flexibility in smart grid development and operation. The objectives are pursued across four key tasks:

- Task 1, "Flexibility-aware long-term system planning," aims to deepen the understanding and application of flexible resources in distribution network planning. This involves reviewing emerging local flexibility market concepts, evaluating these markets alongside traditional network reinforcement solutions, and assessing the role of capacity market mechanisms in ensuring supply security amidst increasing renewable energy penetration.
- Task 2, "Price Signals and Tariffs for Consumer Flexibility," is dedicated to exploring the evolving landscape of tariffs and price signals designed to incentivize consumer participation in grid flexibility. This includes analyzing existing tariffs, their impact on consumption, identifying best practices, and understanding the underlying market drivers.
- Task 3, "Mechanisms for DSO remuneration with consideration of flexibility solutions," centers on gathering international insights into electricity distribution remuneration schemes to pinpoint and address regulatory barriers hindering the growth of local flexibility markets and to propose effective incentives.
- Task 4, "Flexibility Market Definition," aims to establish a shared understanding and definition of flexibility markets within the Working Group by examining various national implementations and characteristics, with the goal of documenting this on the ISGAN Wiki.

Flexibility-aware distribution network planning integrates flexible resources such as demand response and energy storage into grid planning to manage constraints more efficiently. It reduces the need for costly infrastructure upgrades and supports the integration of renewables.

Price signals and tariffs for flexibility can encourage consumers and providers to adjust their energy use based on grid needs. These financial incentives help unlock and direct flexibility where it's most valuable.

Coordination and interplay of different flexibility markets ensures efficient use of resources and avoids conflicting signals. Aligning these markets supports overall grid reliability and economic performance.

5.6.1. Achievements in 2024

Working Group 9 focused on exploring various possibilities for long-term planning of distribution grids and analyzing the coordination and interaction between different flexibility markets. This effort aimed to enhance the efficiency and resilience of energy distribution systems.

- To gather insights on flexibility mechanisms across different member countries, Task 1 and Task 3 conducted several surveys. Additionally, Task 3 collaborated closely with the Bridge initiative and the BeFlexible Project, strengthening the exchange of knowledge and best practices.
- A key milestone was the initiation of discussions to establish a clear definition of flexibility markets. This effort was carried out in partnership with Working Group 7 (WG 7), with the goal of creating a Wiki as a shared knowledge resource. Furthermore, Task 2 was repurposed as a joint task to align with WG 7's focus areas, ensuring a more integrated approach.
- As a result of these activities, several key publications were produced
- Factsheet: Taxonomy to Quantify Flexibility Potential
- Brochure: Integrating Flexible Resources into Distribution Network Planning
- Case Studies: Data and Digitalisation as an Enabler for Energy Flexibility

These publications contribute valuable insights into energy flexibility and support ongoing efforts to optimize distribution networks.

6. ISGAN Awards

Since 2014 ISGAN, in partnership with the Global Smart Energy Federation (GSEF), recognizes and showcases leadership and innovation through an annual ISGAN Award of Excellence competition.
The international jury panel recognizes excellence in innovation, integration, and transformation of smart grid systems, by selecting winning projects based on their potential impact, economic rationale, potential for replication or adaptation, innovation and other benefits.

7. Dissemination Activities of ISGAN

As part of the development of the ISGAN communication strategy in cooperation with an external consultant, ISGAN members analyzed and classified their stakeholders. A distinction is now made between ISGAN's internal and external stakeholders and between experts and non-experts. During this process, it was analysed which communication channels and methods are best suited for which of the stakeholder groups in order to achieve maximum impact.
In line with this analysis, ISGAN publishes its results in different communication products in order to make the information available on different levels of detail:

- Policy briefs for policy makers.
- Discussion papers for researchers.
- Videos for the general public.
- Webinars for researchers and application experts.

Information about these publications is shared via different channels like LinkedIn, the ISGAN Website, and is also promoted at several events with stakeholders. The dissemination on national level takes place in many different ways. In some cases, there are national mirror groups or national IEA TCP days, where results can be highlighted.

Dissemination channels and their impact:
Website: The ISGAN TCP website serves as the primary hub for all publications and event information. It has seen a significant increase in visits, with over 31 000 unique visitors in 2024.

Newsletter: Monthly newsletters are distributed to subscribers, featuring updates on recent publications and upcoming events. The newsletter has an open rate of 35%.

Social Media: Active presence on LinkedIn with posts generating 47 752 impressions, 1 606 reactions, 28 comments, and 87 reposts.

7.1. ISGAN ExCo Meetings 2024

The ISGAN Executive Committee convenes twice a year for ExCo meetings, bringing together its members, Working Group Managers, Task Leads, and Secretariats. These meetings are typically attended in person by representatives from nearly all ISGAN member countries.
The agenda features updates on the activities of the Working Groups, strategic discussions, and workshops, along with presentations from the IEA, CEM, and guest organizations. Countries considering future membership in ISGAN are invited to participate as observers.

In addition to the three-day ExCo meetings, the ISGAN community organizes workshops, conferences, and related events to foster collaboration and knowledge exchange.

7.1.1. ISGAN ExCo 27, Copenhagen, Denmark

The 27th meeting of the ISGAN Executive Committee took place from 19th to 21st March, 2024 (side-events on 18th and 22nd March) in Copenhagen, Denmark.

© ISGAN

27th ISGAN ExCo Meeting

The meeting began with an engaging keynote speech delivered by Anders Hoffmann, Deputy Permanent Secretary at the Ministry of Climate, Energy, and Utilities in Denmark, and Chair of the IEA Governing Board. His address set the tone for the discussions by emphasizing Denmark's leadership in green energy initiatives and the critical role of international collaboration in achieving global climate goals.

The participants engaged in strategic discussions about planning for future budgetary requirements. In particular, discussions were held on the financial aspects of the Lighthouse Project as well as securing funding for the Project Manager position.

The tendering team presented their findings and shared a detailed roadmap for the upcoming tendering process for the ISGAN Secretariats. This preparation was expected to ensure a smooth and efficient process.

7.1.1.1. Cooperation with Other Organizations

The meeting explored opportunities for collaboration with the 21CPP initiative. Proposed terms for a Memorandum of Understanding were discussed, with a focus on identifying shared objectives and ensuring mutual benefits for both organizations.

Participants developed a comprehensive plan for a side event at the upcoming CEM 15, where key topics were identified, and potential speakers were proposed to ensure the event's success and impact. Exciting updates and new results from the ISGAN Working Groups were presented during the meeting. These developments were discussed in detail, with a focus on finalizing and accepting the individual programs of work.

© KPX

Discussions during ExCo 27 World Cafe

© Mihai Calin

27th ISGAN ExCo meeting

7.1.1.2. Side Event: National strategies and priorities

On the day before this ExCo meeting the workshop: **2024 – The Year of the Grid National priorities and programmes in smart grids; How can they lead to a global pledge on grid development** took place. ISGAN countries presented their national priorities and strategies for smart grid implementation. During a presentation by the European Commission the new Grid Action Plan was presented. The aim of this workshop was to share the national priorities and consider them in future work.

Workshop on national strategies and priorities

7.1.1.3. Lighthouse Project

During the ExCo, several sessions and a full-day workshop which concentrated on the Lighthouse Project took place. An update on the current status of the Lighthouse Project was provided, outlining the key milestones achieved and the challenges faced. The next steps were proposed and discussed. Furthermore, an interactive session took place to foster collaboration among participants and gather valuable insights to guide the project.

Lighthouse Project workshop

In addition to the sessions during the ExCo meeting, a full-day workshop took place on Friday, March 22, 2024. This workshop allowed participants to engage deeply with the project and contribute to its ongoing development.

Site Visit to DTU

A site visit to the Technical University of Denmark (DTU) took place on March 21, 2024. During this visit, participants had the opportunity to explore cutting-edge research and innovations taking place at the university.

Luciano Martini, Chair of ISGAN at ExCo27

7.1.2. ISGAN ExCo 28 Incheon, Republic of Korea

The 28th Meeting of the Executive Committee of ISGAN took place in Incheon, Korea from 29th to 31st October, 2024 with an open workshop on November 1st, 2024.

A keynote speech was held by Sanghee Park, Director for Innovative Energy Industry & Distributed Energy Division, Ministry of Trade, Industry, and Energy (MOTIE) of Republic of Korea. Sanghee Park reported on Korea's 2024 energy plan with initiatives like a pilot program for Vehicle-to-Grid (V2G) technology and expanding smart meter networks to improve energy efficiency. In June 2023, he reported that the government enacted a special act to accelerate distributed energy resource (DER) adoption, easing grid congestion and enhancing resilience. Korea is also leading standardization efforts and fostering industry

collaboration for smooth DER integration. Partnering with the IEA, KPX signed a declaration to advance clean energy, reaffirmed at COP28 with commitments to renewables, net-zero goals, clean hydrogen, and carbon storage. As ISGAN's co-secretariat since 2011, Korea promotes smart grid knowledge exchange and collaborates internationally to build a resilient, sustainable energy future with strong government and stakeholder support.

Michele DeNigris, former chair of ISGAN, sent a video message on the origins of ISGAN. He highlighted the excellent work of Russell Conklin and all other Vice-Chairs as well as the chair Luciano Martini. He reminded the audience of key milestones in ISGAN. He thanked Luciano Martini for his work as chair of ISGAN and wished the delegates a fruitful meeting.
A significant discussion took place during the meeting regarding Limited Sponsors. The potential to involve sponsors in the ISGAN Executive Committee was explored. Flux50 has expressed its willingness to contribute to ISGAN as a limited sponsor. In order to avoid misunderstandings, the role of limited sponsors is named limited participating parties (LPPs). These entities may be invited to join ISGAN in accordance with the provisions of the Implementing Agreement, as outlined below:

- LPPs must join a Working Group
- Their participation requires approval from the members of the respective Working Group.They may attend ExCo meetings as observers but do not hold voting rights.

Flux50 has been invited to join as a Limited Participating Party (LPP) effective from 2025.

The meeting featured a World Café session, during which the Working Groups presented their progress. The session was marked by lively discussions and active knowledge exchange, contributing to its overall success.

During the second ISGAN Executive Committee meeting of the calendar year, there is no requirement for votes on Programmes of Work. Instead, this meeting is structured to facilitate more in-depth discussions through the World Café format. . Working Group managers also used this opportunity to seek input from participating countries to ensure their activities align with national priorities and effectively contribute to achieving net-zero and other strategic goals.

© KPX

World Cafe Session

The primary purpose of the World Café session is to foster direct interaction between Working Group Managers and ExCo members. To facilitate these discussions, updates from each Working Group are included into the document package in the form of summarized handouts. By organizing discussions in small discussion groups, the session promotes more personalize, two-way communication, moving beyond standard reporting.

The strategic goal of this approach is to maximize the impact of the work carried out by the Working Groups. Through active engagement and guidance, ExCo members can help steer these activities to ensure alignment with their respective national agendas and policy objectives.

A day following the World Café, all Working Group managers presented key highlights from the table discussions providing recommendations by the ExCo and the Presidium.

Further highlights included the workshops organized by the Working Groups, which provided valuable opportunities for deep dives into specific topics,

hands-on collaboration, and the sharing of best practices among participants:

- A workshop organized by the Communication Working Group focused on the Lighthouse Project and its future direction.
- A joint workshop by Working Groups 3 and 7 explored participatory processes for improving DER investment planning and gathered input from ExCo members.

Key decisions were made during the meeting including the selection of the topic for ISGAN's next Awards of Excellence and the finalization of dates and locations for future ExCo meetings.

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Terijo Lovasz, Australia, CWG Manager

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Simona Ruggeri, Italy, WG 3 Manager

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Ron Brandl, Germany, WG 5 Manager

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Susanne Ackeby, Sweden, WG 6 Manager

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Branislav Iglar, Austria, WG 7 Manager

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Charmalee Jayamaha, UK, WG 9 Manager

7.2. Events of the Clean Energy Ministerial 202

7.2.1. CEM Senior Officials Meeting (SOM) 2024 in Nusa Dua, Bali: Side Event

Smart Distribution Grids Powering the Energy Transition: ISGAN's *"Lighthouse Project" and its contribution to CEM goals*

The International Smart Grid Action Network (ISGAN) launched its first-ever "Lighthouse Project" to shine a beacon on distribution network planning and implementation under uncertainty. The aim of this side event was to support countries' attainment of their COP28 goals and also feed into the development of a CEM15/MI-9 joint deliverable on power systems infrastructure through the Lighthouse Project.
ISGAN sought to highlight the critical questions that must be adressed for distribution grids to serve as enablers, rather than barriers, to clean energy transition. It showcased how ISGAN is bringing together its Working Groups and global network of experts to tackle this challenge. This session included a short interactive exercise, demonstrating one of the approaches employed by ISGAN's proven "Knowledge Sharing Projects" framework.

During the event, ISGAN highlighted key insights from regional experts and fostered further collaboration, especially with Indonesia and other ASEAN countries. Senior officials from CEM and MI were encouraged to attend, alongside experts engaged in power systems-related or -adjacent sectors, as well as government, and power system officials in attendance from Southeast Asia and beyond.



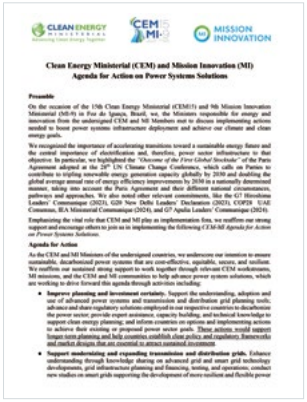

© CEM (4)

Side event at CEM

7.2.2. 15th Clean Energy Ministerial - 9th Mission Innovation (CEM15/MI-9) Ministerial meeting in Foz do Iguaçu, Brazil: Side Events

Power Systems for a Sustainable Future: A Joint CEM and MI Framework for Action

Clean Energy Ministerial's (CEM's) International Smart Grid Action Network (ISGAN), 21st Century Power Partnership (21CPP) and the Mission Innovation's (MI's) Green Powered Future Mission (GPFM) jointly organized a side event to launch the **'Agenda for Action for Power Systems Solutions'**.This agenda outlines both forums' commitment to advancing power system solutions, as well as concrete actions and goals that the CEM power workstreams and the MI Green Powered Future Mission can implement to support investments in a sustainable, secure, and resilient power sector infrastructure and system. The Agenda for Action aims to advance progress toward the global goals of tripling renewable energy and doubling energy efficiency by 2030. The Agenda for Action was officially launched at the Ministerial Round Table for Power Sector Transformation, with 28 CEM and MI member signatories in attendance.


Clean Energy Ministerial (CEM) and Mission Innovation (MI)
Agenda for Action on Power Systems Solutions

Furthermore, an ISGAN Policy Brief on *Long-Term Planning & Implementation of Smart Distribution Grids*, developed by the ISGAN Lighthouse Project, was officially released at this event.

This policy brief outlines strategies for policymakers to reduce uncertainties and help grid actors manage risks in the long-term planning and implementation of smart distribution grids, which are essential for achieving global goals, such as the COP28 objectives to triple global renewable energy capacity by 2030. It emphasizes the need for increased policy attention towards the importance of low- and medium-voltage grids and highlights how policymakers can create favourable frameworks to enable more agile, forward-looking approaches to long-term grid planning and distribution grid modernization. The brief is an initial outcome of the inaugural ISGAN Lighthouse Project, a new interdisciplinary ISGAN initiative, developed by ISGAN experts through interactive stakeholder workshops and analytical activities conducted throughout 2024.

Status of Power System Transformation 2024: Where We have Been and Where We are Going

Clean Energy Ministerial's (CEM's) International Smart Grid Action Network (ISGAN), the 21st Century Power Partnership (21CPP) jointly organized a side event to launch and release a thought leadership report on the state of global power sector decarbonization. This report tracks trends in the transition to clean energy within the power system and highlights that further progress is needed to reach energy sector emissions reduction targets. It provides an overview of key topics related to power sector transformation that are essential for achieving global decarbonization and net zero goals and includes examples of strategies to accelerate power system decarbonization and facilitate clean energy deployment.

During the event, ISGAN and 21CPP signed a MoU, regarding "Cooperation on Innovative Power System Transformation Solutions", that underscores their longstanding engagement and establishes a framework for sustained cooperation in implementing activities to advance innovative power system transformation solutions.

The Winners of the 10th ISGAN Award of excellence were announced in a dedicated session for awards in several CEM initiatives. The winners had the opportunity to share a brief overview of their winning projects and discuss the significance of their participation in the ISGAN Awards. The Honourees also participated in sessions during the CEM events.

©21CPP

Report on the state of the global power sector decarbonization

© KSGI

(From the left) Luciano Martini/ISGAN Chair, Jean-Francois Gagne/Head of CEM Secretariat, Doug Arent/Operating Agent of 21CPP

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Woo-Duk CHUNG, Senior Manager of Korea Power Exchange (KPX)

© KSGI

Riichi Kitano, Redox Flow Battery System Division Sumitomo Electric Industries, Ltd.

7.3. Other Events involving ISGAN Representatives

7.3.1. ISGAN Lighthouse Project at the IEA Inter-TCP Meeting

Presentation on TCP mechanics of collaboration

A further dissemination activity of the Lighthouse Project was the presentation of Helena Lindquist at the IEA inter-TCP meeting. She focused her presentation on the mechanics of collaboration within the International Energy Agency (IEA) Technology Collaboration Programme (TCP) and highlighted the ISGAN Lighthouse Project as an example. Collaboration involves balancing **task-oriented goals ("What")** with interpersonal and **cultural aspects ("How")**. Success depends on integrating these dimensions:

- **"What":** Organizational strategies, hierarchies, tools, and processes.
- **"How":** Communication styles, trust, inclusivity, and psychological safety.

Neglecting the "How" can lead to misunderstandings, conflicts, and inefficiencies, especially in cross-border collaborations.

Challenges in Cross-Organizational Collaboration include differences in roles, methods, and cultures between organizations complicate the "How" dimension. Lack of standardized processes, clear responsibilities, and a cohesive culture exacerbates these challenges.

As a successful example the ISGAN Lighthouse Project was presented and the key takeaways deduced from it.

- Success requires addressing both the "What" (tasks and structure) and the "How" (culture and relationships).
- Reflection is needed to identify overlooked aspects and opportunities for improvement.
- Questions posed encourage participants to explore how to optimize their approaches for greater impact.

7.3.2. Mission Innovation Austria Week

An example for the dissemination of ISGAN results on national level is the session, that was held during the Mission Innovation Austria week, which took place October 8th-10th, 2024, in Stegersbach, Austria.

The workshop *"Living Labs as Instruments of Energy Policy"* provided a platform to discuss how energy policy challenges can be addressed through experimentation in living labs and how their findings can influence political decisions. Key topics included governance, upscaling, and the dissemination of successful approaches beyond regional boundaries. The importance of structured communication of common themes was emphasized to increase the visibility of results.

The workshop also explored opportunities for international networking to achieve greater impact and accelerate the energy transition. Branislav Iglár (AIT Center for Energy) highlighted the importance of living labs as testing grounds for innovative energy solutions. He emphasized their role in generating valuable insights for evidence-based energy policy.
In a Keynote speech, Klaus Kubeczko (AIT Center for Innovation Systems & Policy) discussed the topic *"Living Labs as Instruments of Mission-Oriented Innovation Policy or Transformative Climate and Energy Policy?"*

Key points in his presentation were a Mission-Oriented Innovation Policy, Transformative Energy Policy and the importance of effective governance structures in order to ensure successful models and transfer to other regions.
The following panel discussion was conducted with several stakeholders from the Austrian energy industry and research under the moderation of Branislav Iglár. The panelists (Klaus Kubeczko (AIT Center for Innovation Systems & Policy), Angela Berger (CETP - Clean Energy Transition Partnership), Tara Esterl (AIT Center for Energy), Ewald Selvicka (AEE INTEC - Institute for Sustainable Technologies) and Albert Treytl (University for Continuing Education Krems)) discussed Best Practices and Challenges: learned from ongoing living lab projects, with emphasis on integration into existing infrastructures. Governance and Policy-Making and International Networking including Cross-border cooperation enhances the impact of living labs. A further discussion topic was the Scaling and Dissemination: Successful models should be systematically documented and shared for wider application.

The workshop was a successful step towards enhancing the role of living labs in energy policy and underscored their potential to drive transformative change.

© Branislav Iglar

Klaus Kubecko presenting at Mission Innovation Austria Week

© Branislav Iglar

Fishbowl Discussion at the Mission Innovation Austria Week

7.3.3. ISGAN ETIP-SNET side event at Cigré in Paris

The event took place on August 27th, 2024 on the topic of Energy Communities´ impact on power grids (2022.04)

ETIP SNET and ISGAN hosted a highly engaging event at CIGRE 2024, bringing together global energy experts to discuss the evolving role of energy communities in power grids. As part of CIGRE's renowned knowledge-sharing platform, the event centered around the paper **"Energy Communities' Impact on Grids",** authored by ETIP SNET's Working Group 1 in collaboration with ISGAN. This paper explored the pivotal role of energy communities in supporting **Distribution System Operators (DSOs) and Transmission System Operators (TSOs)** in integrating renewable resources and advancing the energy transition.

The event delved into the following topics:

1. **The role of Energy Communities as reliable stakeholders** in the evolving energy market.
2. **DSOs as facilitators** between TSOs and Energy Communities in the transition towards decentralized energy systems.
3. **Market development trends** that will drive the promotion of Energy Communities and accelerate the energy transition, including:
   - Adaptation of market structures through new platforms and tariff mechanisms.
   - The emergence of local markets as a fundamental shift in market design.
4. **The necessity of reassessing smart grid concepts** to streamline efforts and optimize resources for a more efficient transition.

The event also featured an interactive Q&A session, allowing participants to pose critical questions and engage with leading experts on the implications of Energy Communities. Attendees expressed strong interest in the potential for localized energy markets and the role of digital innovations in enhancing grid resilience.

© ISGAN

Nuno de Souza e Silva (ETIP SNET and R&D Nester), **Janka Vanschoenwinkel** (ISGAN and VITO), **Luciano Martini** (ISGAN and RSE Spa), **Albana Ilo** (ETIP SNET and TU Wien), **Irina Oleinikova** (ISGAN and NTNU)

The CIGRE 2024 event successfully showcased the growing influence of Energy Communities in shaping modern power systems. The participation of ISGAN Chair, Luciano Martini, added significant value to the discussions, emphasizing international collaboration as a cornerstone of the energy transition. The insights gained from this event will contribute to ongoing initiatives aimed at accelerating the deployment of smart, consumer-centric energy solutions globally.

MI GPFM Workshop on "Policy and Technology for Grid Digitalisation": ISGAN Contribution

The international online Workshop "Policy and Technology for Grid Digitalisation", organized by the MI Green Powered Future Mission with the support of the GPFM members from the Ministry of Economy, Trade and Industry/METI (Japan), took place on 18/19 February 2025.

This 2-day event featured contributions from 18 international experts from 9 different countries, providing a valuable platform to bring together representatives from the GPFM coalition and experts from governments, the private sector, research centres, and international organisations, to showcase

and discuss grid digitalisation policies and strategies, as well as the implementation of digital technologies and related innovations. International experts took the floor to showcase countries' policy, scenarios & trends, and to share best practices and innovative solutions in the field of grid digitalisation. Luciano Martini, ISGAN Chair, and in his quality of GPFM Director, contributed to the event and spoke in the opening session of this workshop, presenting GPFM activity and main objectives. Moreover, Helena Lindquist, Lighthouse Project Manager, gave a presentation entitled "Reimagining grid planning practices for rapid energy system decarbonization – Insights from ISGAN's Lighthouse Project on smart distribution grids", presenting ISGAN main objectives and highlighting the ISGAN Lighthouse Project. In particular, the presentation focused on reimagining grid planning for rapid energy system decarbonization, highlighting the increasing importance of modernizing low and medium voltage distribution grids to handle new energy demands driven by climate change and renewable energy. Moreover, it has been clarified that while the Lighthouse Project's policy brief focuses broadly on planning and implementation, AI is considered a relevant tool for utilities within this scope. Furthermore, AI, flexibility, and regulation for smart grid deployment are actively being discussed within ISGAN as key elements for the energy transition.

7.3.4. Representation of ISGAN at International Events

At several events, the Chair, Vice-Chairs and the Operating Agent of ISGAN presented the TCP and gave information about results, best practices and strategies in ISGAN. The Operating Agent took part in the following events:

- IEA TCP collaboration and its mechanics 19.11.2024
- IEA TCP Communication Plan 10.12.2024
- Building coordination group meeting 24.01.2025
- TCP Day in Prague 6.02.2025

7.4. ISGAN Virtual Learning Webinars 2024

The objective of ISGAN Virtual Learning is to provide the energy community — which includes the energy industry, high-level engineers, decision-makers, students, and the general public — with an efficient and effective way to continuously enhance and update their technical skills in the field of smart grids.

ISGAN Virtual Learning offers the latest information on emerging topics and challenges, recent advancements, best practices, and innovative methodologies, as well as the theory, applications, and deployments related to smart grids. It also highlights events connected to ISGAN activities. Through the webinars, smart grid experts from over 150 countries worldwide were reached.

Recordings of past webinars are available on the ISGAN Virtual Learning YouTube Channel Playlist. https://www.youtube.com/playlist?list=PLVQFc2zOj3J8fiUk-bR-9aD-ko1un8L-Gh

Date	Title
March 11, 2024	Aggregator in digitalized power systems
May 21, 2024	Revolutionising Renewable Energy: Exploring the Biomass-fired Top Cycle (BTC) Plant
May 22, 2024	Storage technologies in multi-energy carriers and industrial environments in the SINNOGENES project
June 25, 2024	How to Integrate Energy Communities into the Electricity System
July 03, 2024	Storage technologies for transport and insular systems in the SINNOGENES project
October 23, 2024	Biomass-fired Top Cycle (BTC) Technology: A Deep Dive into the Innovations Redefining Biomass Power Generation
November 28, 2024	Flexible Operation of Energy Communities under Uncertainty in Energy Markets
December 3, 2024	Long-Term Planning & Implementation of Smart Distribution Grids

7.5. ISGAN Publications 2024

ISGAN's Working Groups were very productive in 2024, having produced numerous publications. In the following chapters the publications of ISGAN working groups are listed:

7.5.1. ReFlex Guidebook

January 31, 2024

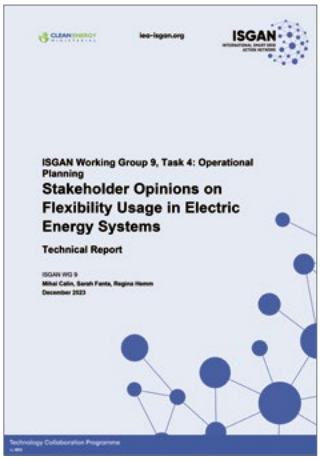
ReFlex Guidebook

The ReFlex Guidebook for the replication of use-cases tackling the flexibility challenge in smart energy systems is based on the ReFlex project, which aimed to develop a replicability guideline for the deployment of technologically feasible, market-based and user-friendly solutions for smart grids with a high level of flexibility.

The focus was put on grids with an expectedly high level of renewable energy production which is effectively and efficiently used locally through mixes of measures from voltage regulation, demand response, energy management, and storage. In eight demo sites in Austria (AT), Germany (DE), Sweden (SE) and Switzerland (CH). Four of them – Salzburg-Köstendorf (AT), Island of Gotland (SE) and Malmö-Hyllie (SE), Lausanne-Rolle (CH) – involved demo sites situated in larger areas with a distribution system operator (DSO) as the main project partner. The other four – Biel-Benken (CH), Güssing (AT), Hartberg (AT) and Wüstenrot (DE) – are situated in smaller areas with less than 15,000 inhabitants involving private and public owned energy utilities, which did not have to unbundle grid operation from energy supply.

7.5.2. Stakeholder Opinions on Flexibility Usage in Electric Energy Systems – Technical Report

February 15, 2024



Stakeholder Opinions on Flexibility Usage in Electric Energy Systems – Technical Report

The global energy landscape is in the midst of a profound shift towards flexibility markets and distributed solutions, necessitating a nuanced understanding of their impact on operational planning. This research, conducted under the International Smart Grid Action Network's Working Group 9, delves into the intricacies of flexibility within the Austrian, Canadian, and Korean electricity systems. Leveraging prior research, the collaborative effort sets the stage for a comprehensive exploration of flexibility markets across diverse regions.

Employing a multi-faceted methodology, the work was initiated with a thorough review of electricity systems in the participating countries. Based on this review, a targeted stakeholder questionnaire, complemented by in-depth interviews with system operators, aggregators, and consumer associations, facilitated not only insights extraction but also a comparative synthesis of stakeholder views.

It can be acknowledged that barriers to distributed flexibility use range from technical constraints to regulatory hurdles, highlighting the absence of a comprehensive regulatory framework. Smart meters, while ubiquitous, still face technical challenges and regulatory barriers that impede Distribution System Operators (DSOs) from accessing flexibility resources, necessitating further clarification.

Globally, a consensus emerges on the imperative for refined regulatory frameworks and clarified roles. Challenges persist in technology and infrastructure for measurement and verification, hindering seamless flexibility integration. It could be demonstrated that flexibility potential as a network reinforcement tool faces unpredictability, mitigated by advancements in predictability and regulatory evolution. European perspectives underscore grid topology's significance in leveraging local flexibilities.

Distinct business models surface across regions, with Austrian Flexibility Service Providers focusing on ancillary services, short-term markets, and Virtual Power Plant (VPP) solutions. Persistent customer engagement challenges highlight the need for education and financial incentives.

In conclusion, the diverse designs of global electricity markets necessitate tailored approaches for the successful implementation of flexibility markets in operational planning. Regulatory clarity and continuous stakeholder engagement emerge as pivotal factors in navigating this evolving energy landscape.

7.5.3. Barriers to incorporate distributed flexibility in operational and long-term planning – A Factsheet

February 15, 2024

Barriers to incorporate distributed flexibility in operational and long-term planning – A Factsheet

Energy systems around the world are undergoing a paradigm shift, driven by the need for decarbonization and the rapid growth of decentralized, variable renewable energy sources. A key element for the effective integration of renewable and decentralized energy sources into the power system is the use of flexibility from distributed resources, e.g., for market participation or the provision of grid services.

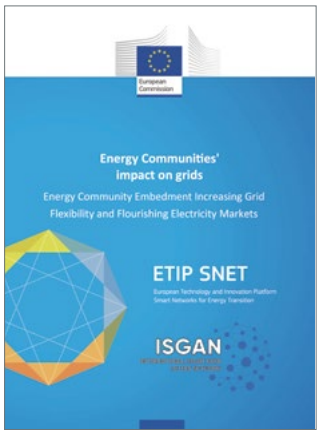
As part of the IEA TCP for a Co-operative Programme on Smart Grids (ISGAN) Working Group 9, we access insights from existing European and non-European power systems, markets, and pilots to understand the issues and implications of flexibility market design.

The main barriers to using distributed flexibility can be grouped into three sub-categories:

- technical barriers
- consumer engagement
- regulatory barriers

7.5.4. Energy communities' impact on grids – Energy community embedment increasing grid flexibility and flourishing electricity markets

June 7, 2024



Energy communities' impact on grids – Energy community embedment increasing grid flexibility and flourishing electricity markets

The new role of energy communities represents both an opportunity and a challenge for DSOs and, consequently, for TSOs. They can unlock active consumers' flexibility potential and more effectively integrate distributed renewable resources and new technologies, such as rooftop photovoltaic facilities, electric vehicles or batteries, etc. In contrast, energy communities must fulfill all related duties and responsibilities when acting as suppliers, active customers, or any other existing market role. They must act on equal terms with other market players.

Each country offers a wide choice of different legal forms of organizations for a newly created energy community entity, which leads to a wildly grown landscape. They are actually generally limited to a certain redistribution of cash flow. Their upgrade to fully integrated supporting the demand response process in distribution and transmission levels will require solid organization forms and business cases. In the technical aspect, remarkable scientific works are being done to improve the load matching of individual customers and at the community level. However, none of these studies considers the grid, constraints, challenges, and coordinated operation, so the solutions are not directly practicable on a large scale.

This paper first gives a brief overview of the development of energy communities, followed by an analysis of the impact of large-scale implementation of energy communities on the power grids. This is pursued by discussing economic processing in the power industry and business organization, as both are crucial for promoting viable energy communities. The paper finalizes conclusions and recommendations on innovation and research activities.

7.5.5. How can Aggregators Improve the TSO-DSO-Customer Coordination in Digitalised Power Systems? – Discussion Paper and Policy Brief

July 4, 2024

How can Aggregators Improve the TSO-DSO-Customer Coordination in Digitalised Power Systems? – Discussion Paper and Policy Brief

Utilizing untapped Distributed Energy Resources (DERs) potential from customers in the distribution grid necessitates TSO-DSO-Customer coordination. Customers still face challenges how to manage and market their flexibility in the energy market and how they can become active customers. Aggregators can facilitate these flexibilities as an intermediary by providing services to different power systems participants.

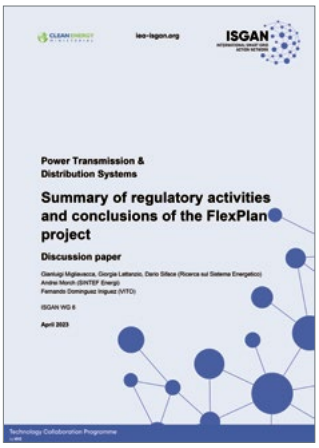
The EU regulation has identified the independent aggregator, who is not affiliated with the customer's supplier. However, the independent aggregator has not been fully implemented yet. There are existing aggregator

services, but the challenges arise on how to accommodate diverse solutions from aggregator to support TSO-DSO coordination and enhance active customer participation.

This work investigated how aggregators can improve the TSO-DSO-Customer coordination in a digitalized power system by analyzing existing policies, their role, possible coordination approaches, and addressing (non-) technical challenges.

7.5.6. Summary of regulatory activities and conclusions of the FlexPlan project

July 4, 2024



Summary of regulatory activities and conclusions of the FlexPlan project

The FlexPlan Horizon 2020 project aimed at establishing a new grid-planning methodology which considers the opportunity to introduce new storage and flexibility resources in electricity transmission and distribution grids as an alternative to building new grid elements, in accordance with the intentions of the Clean Energy for all Europeans regulatory package of the European Commission.

FlexPlan created a new innovative grid-planning tool whose ambition is to go beyond the state of the art of planning methodologies by including the following innovative features:

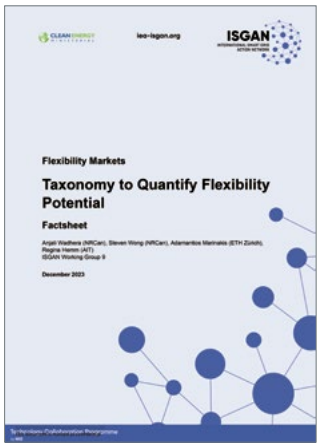
- assessment of the best planning strategy by analyzing in one shot a high number of candidate expansion options provided by a pre-processor tool,
- simultaneous mid- and long-term planning assessment over three grid years (2030, 2040, 2050),
- incorporation of a full range of cost–benefit analysis criteria into the target function,
- integrated transmission and distribution planning,
- embedded environmental analysis (air quality, carbon footprint, landscape constraints),
- probabilistic contingency methodologies in replacement of the traditional N-1 criterion,
- application of numerical decomposition techniques to reduce calculation efforts,
- analysis of variability of yearly renewable energy sources (RES) and load time series through a stochastic optimization approach.

Six regional cases covering nearly the whole European continent were developed in order to cast a view on grid planning in Europe till 2050.

FlexPlan ended up by formulating guidelines for regulators and planning offices of system operators by indicating to what extent system flexibility can contribute to the reduction of overall system costs (operational + investment) yet maintaining current system security levels and which regulatory provisions could foster such process. After presenting a short overview of the project motivation and goals, the present report concentrates on the final regulatory reflections and the elaboration of the final regulatory guidelines.

7.5.7. Taxonomy to Quantify Flexibility Potential

August 8, 2024

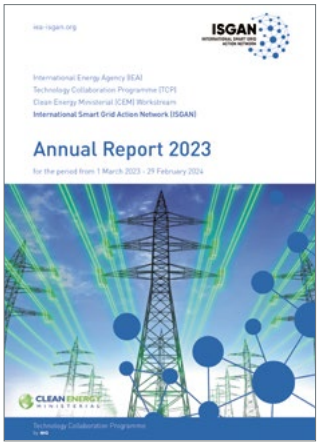


Taxonomy to Quantify Flexibility Potential

To make net zero technically and economically feasible, the future power system will need to capture flexibility from various resources (i.e., generation, storage, and loads) across various segments of the power system (i.e., generation, transmission, distribution, and end-use loads). The uptake of digitalization, the adoption of distributed energy resources and the push for cross-sectoral electrification are transforming traditional grid operation; resources with flexibility potential in distribution grids can be a key solution to support grid reliability, resiliency, and optimized system utilization via flexibility markets.

7.5.8. 2023 ISGAN Annual Report

September 3, 2024



2023 ISGAN Annual Report

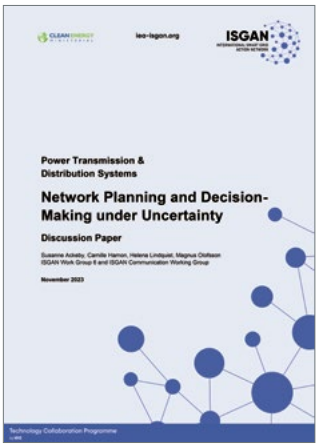
The 2023 Annual Report of ISGAN offers a comprehensive overview of its activities and progress over the past year. With a strong emphasis on collaboration, ISGAN brings together countries from five continents, encompassing both developed and emerging economies. This diverse membership creates a rich environment for sharing knowledge, strategies, and best practices that inform policymakers at regional, national, and international levels.

Key highlights of the report include detailed insights into the activities and events conducted by each of the working groups. Among the flagship initiatives is ISGAN's lighthouse project, "Electricity Network Planning and Implementation under Uncertainty for the Clean Energy Transition", which focuses on strategic planning for intelligent distribution grids.

The report also reports significant events such as the ISGAN ExCo25 meeting in Berlin, Germany, and the ExCo26 meeting in Utrecht, the Netherlands, along with other key events such as the ISGAN Award and the CEM 14/MI-8 meeting in Goa, India. Additionally, it provides a summary of the ISGAN virtual learning webinars hosted in 2023 and includes a comprehensive list of publications released during the year.

7.5.9. Network Planning and Decision-Making under Uncertainty – Discussion Paper and Policy Brief

August 29, 2024



Network Planning and Decision-Making under Uncertainty – Discussion Paper and Policy Brief

Recognizing the pivotal role of electrical grids in achieving net-zero emissions and addressing a wide spectrum of ecological, social, and economic aspects of sustainable development, ISGAN Working Group 6 joined forces with the ISGAN Communication Working Group, to spearhead a collaborative knowledge sharing project (KSP) on Network Planning and Decision-Making under Uncertainty.

This initiative aimed to collate global insights on challenges and solutions in grid planning, ensuring that power grids can effectively contribute to the SDGs. The project involved researchers, policy makers and representatives from both transmission and distribution system operators and the focal question encapsulated the overarching objective: How can power grids be strategically developed to align with, and contribute to the global sustainable development goals?

The project explored diverse long-term considerations in grid planning, addressing effective management of inherent uncertainty and complexity, the co-evolution of regulatory frameworks, workforce development, and heightened stakeholder coordination throughout the planning process. This report provides a detailed account of the collaborative process, the methodologies applied, and the outcomes achieved at each stage, with a focus on explaining the meaning and context surrounding the synthesized policy messages that were the main outcome of the project.

7.5.10. ISGAN Policy Brief on Long-Term Planning of Smart Distribution Grids

October 1, 2024

ISGAN Policy Brief on Long-Term Planning of Smart Distribution Grids

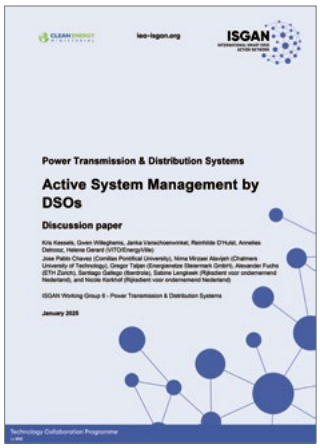
To spotlight the importance of low- and medium-voltage grids and their key role in clean energy transitions, ISGAN is publishing a new Policy Brief on Long-Term Planning and Implementation of Smart Distribution Grids.

Thousands of distribution grids worldwide are in urgent need of modernization to accommodate growing shares of renewable energy sources (RES) and changing patterns of generation and consumption. However, the much-needed investments are hampered by the growing complexity and multiple uncertainties facing key actor groups with responsibilities for grid development and operation.

As a major milestone, policymakers have a key role to play by creating favorable framework conditions for agile and forward-looking planning processes, thus de-risking and accelerating investments.

7.5.11. Active System Management by DSOs – Discussion Paper

February 5, 2025



Active System Management by DSOs – Discussion Paper

This discussion paper provides valuable insights into how Distribution System Operators (DSOs) can leverage active system management to enhance the cost-efficiency and security of their grid operations. These insights are derived from a series of interactive workshops conducted with members of the ISGAN Working Group 6 (WG 6) and other key stakeholders, including industry experts, policymakers, and researchers. The paper delves deeply into three critical topics that are central to the future of DSO operations:

- **Market-Based Flexibility Procurement by DSOs** – Examining how DSOs can engage in market-based mechanisms to procure flexibility services, ensuring optimal grid performance while maintaining regulatory compliance and economic viability.
- **Supporting Grid Tools for Active System Management** – Exploring advanced digital tools, automation strategies, and innovative grid management solutions that facilitate real-time decision-making and improve operational resilience.
- **Applicability of Flexibility Mechanisms and Their Trade-Off with Investments** – Analyzing the practical implementation of flexibility options, assessing their benefits and limitations, and evaluating how they compare to traditional grid reinforcements and investments.

Beyond outlining these key topics, the paper also identifies a range of challenges that DSOs face when implementing active system management strategies. These challenges include regulatory barriers, market design complexities, technological constraints, and stakeholder coordination issues. To address these obstacles, the discussion paper presents a set of potential solutions and best practices that can help DSOs navigate the evolving energy landscape effectively.

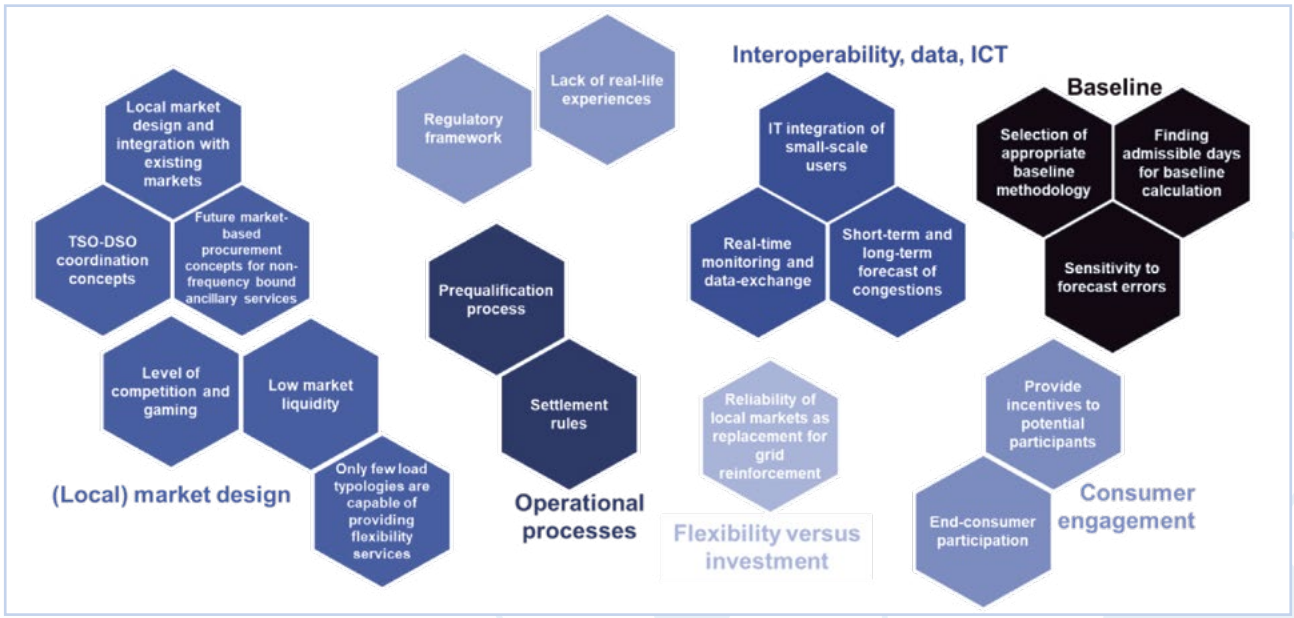


Illustration of the main challenges for market-based flexibility procurement by DSOs considering the participation of demand-side flexibility

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8. Outlook

During 2025, ISGAN's Working Groups (WGs) will continue to advance global smart grid innovation by focusing on key priorities. The second phase of the Lighthouse Project will coordinate across all Working Groups, consolidating their results to produce concrete communication products tailored to different knowledge levels and stakeholder groups. The ISGAN Lighthouse Project will continue with a focus on the long-term planning of distribution grids. In 2025, the project will begin with a scoping phase to define the key activities, set clear objectives and ensure the active engagement of ISGAN experts. By 2026, one of the key deliverables of the Lighthouse project will be a comprehensive Case Book. Some results of the Working Groups will contribute to the Lighthouse Project, while others will remain as independent, serving separate objectivesor areas of focus. The main tasks of the Working Groups for 2025 and 2026 will be focused on:

1. Communication Working Group (CWG):
The tasks of the Communication Working Group will include refining communication strategies to effectively reach technical and non-technical audiences. This will involve focusing on stakeholder engagement, crafting policy messaging, hosting webinars, and enhancing public outreach efforts. Key outputs will include policy briefs, casebooks, expanded social media presence, and the development of virtual learning opportunities.

2. Cost-Benefit Analysis & Toolkits (WG 3):
Delivering analytical frameworks for evaluating smart grid impacts, with tasks on AC/DC systems, hosting capacity, hydrogen integration, and collaborative KPIs for decision support.

3. Smart Grid Research Facility Network (WG 5):
Driving international collaboration through shared data spaces, testing grid-forming inverters, and advancing testing automation via openSVP enhancements.

4. Power Transmission & Distribution Systems (WG 6):
Addressing hydrogen's impact on grids, the role of grid-forming units, and fostering insights through discussion papers and pilot projects on active system management.

5. Power System Transitions (WG 7):
Exploring pathways for modernizing energy systems, including regulatory experimentation, governance processes, institutional readiness, and equitable energy service frameworks.

6. Flexibility Markets (WG 9):
Developing innovative market mechanisms and strategies for flexibility, operational planning, and consumer engagement through price signals and spatial/temporal analyses.

The current term of ISGAN is scheduled to conclude in February 2027. In anticipation of this, a comprehensive strategy process will be undertaken within the next year. The primary objective of this process is to develop a forward-looking strategic plan that will guide ISGAN's future activities and initiatives. This strategic plan aims to enhance ISGAN's capacity to make a significant impact in the fields of knowledge sharing and policy advice related to Smart Grids. By formulating a well-defined and visionary strategy, ISGAN seeks to continue playing a pivotal role in advancing Smart Grid technologies and policies on a global scale.

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ISGAN
INTERNATIONAL SMART GRID ACTION NETWORK

Technology Collaboration Programme
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