GREEN POWERED FUTURE
MISSION

MI Green Powered Future Mission Workshop *"Policy and Technology for Grid Digitalisation"*: Summary Report

18-19 February 2025

Mission Innovation
Green Powered Future Mission Workshop
Policy and Technology for Grid Digitalisation
February 18 (Tuesday) & 19 (Wednesday), 2025

Program (time: CET)

Day 1 – February 18 (Tuesday)

7:00-9:20 US (EST) / 12:00-14:20 UK (UTC) / 13:00-15:20 Europe (CET) / 17:30-19:50 India / 20:00-22:20 China / 21:00-23:20 Japan / 23:00-01:20(+1) Australia (AEDT)

13:00-13:05 Meeting Protocol

MARUTA Akiteru – Moderator

13:05-13:10 Host's Welcome

UEJIMA Hiroki
Mission Innovation Steering Committee Member
Director, International Affairs Office
Innovation and Environment Policy Bureau
Ministry of Economy, Trade and Industry (METI), Japan

13:10-13:20 Opening Statement

MARTINI Luciano
Director, **Mission Innovation "Green Powered Future Mission"**
Director, Materials and Generation Technologies Department
Ricerca sul Sistema Energetico (RSE), Italy

13:20-13:50 International Initiatives

Scaling power system digitalisation in the age of urban growth and AI
REIDENBACH Brendan
Energy Policy Analyst
International Energy Agency (IEA)

Reimagining grid planning practices for rapid energy system decarbonization – Insights from ISGAN's Lighthouse Project on smart distribution grids
LINDQUIST Helena
Lighthouse Project Manager
International Smart Grid Action Network (ISGAN)

13:50-15:05 Countries and Utilities Perspective

Digitalization in the Strategic Energy and Climate Framework of Spain
PALOP Enrique
Deputy Assistant Director General for Energy Foresight and Statistics
Ministry for the Ecological Transition and the Demographic Challenge, Spain

Policy and Technology for Grid Digitalization – Canadian Perspectives
REBELLO Eldrich/ IVALL Jason
Science and Technology Advisor, Office of Energy Research and Development
Natural Resources Canada (NRCan)

TEPCO's DX Initiatives and Case Studies
YAMAKI Koichiro
Producer, Engineering Management Office, Engineering Strategy Unit,
TEPCO Holdings
Chair of CIGRE Japan National Committee for SC C1 (Power System Development and Economics)

OBA Ryosuke
Team Leader, DX Promotion Group, Innovation Promotion Office,
TEPCO Power Grid, Japan

Enel's commitment towards grid digitalization
BARON Marco
Network Engineering and Development
ENEL Grids, Italy

Delivering energy sector digitalisation
EVANS Simon
Programme Director, Virtual Energy System
National Energy System Operator (NESO), UK

15:05-15:20 **Discussion with key questions**

15:20 **End of Day 1**

Day 2 – February 19 (Wednesday)

7:00-9:20 US (EDT) / 12:00-14:20 UK (UTC) / 13:00-15:20 Europe (CET) / 17:30-19:50 India / 20:00-22:20 China / 21:00-23:20 Japan / 23:00-01:20(+1) Australia (AEDT)

13:00 **Meeting Protocol**

MARUTA Akiteru – Moderator

13:00-14:00 **System Providers / Communication / System Integrators / Aggregators**

Lessons learnt from digitizing distribution grids for physics-based analytics
GETH Fred
Principal Power System Engineer
GridQube, Australia

Overview of ADMS operation in ROK
BYUN KyungHwan
Senior Manager
Korea Electric Power Corporation (KEPCO), Korea

Effective Use of Surplus Regenerative Energy on Railways to Save Energy
SPECE James
Manager, Development Dept., ITAMI Works
Mitsubishi Electric, Japan

The Grid Innovation Path of Areti: from Automation to Flexibility
DE LUCA Ercole
Head of Regulatory and Public Finance
ARETI, Italy

14:00-15:00 Research Institute / National Project

Information Technologies Applied to Power Grids
NODA Taku
Senior Research Scientist, Grid Innovation Research Laboratory,
Central Research Institute of Electric Power Industry, Japan

Exploring Digital Urban Energy Platforms: Harnessing Realistic 3D and GIS
YAN Jerry
Chair Professor and Director, International Centre of Urban Energy Nexus,
Hong Kong Polytechnic University
Member, **European Academy of Sciences and Arts**
Fellow, **Hong Kong Academy of Engineering**

Interoperable Domestic Flexibility: Standards and Innovation
SHUTT Rebecca
Energy Engineer
Department for Energy Security and Net Zero (DESNZ), UK

Interoperability challenges for distributed flexibility integration with grid operations
MCGRANAGHAN Mark
EPRI Fellow
EPRI Europe, Ireland

15:00-15:15 Discussion with key questions

15:15-15:20 Closing remarks

HASHIMOTO Jun
Team Leader
Energy Network Team, Renewable Energy Research Center,
National Institute of Advanced Industrial Science and Technology (AIST), Japan

15:20 End of Day 2

Registration: https://project.webex.com/webappng/sites/project/webinar/webinarSeries/register/f5649b206ed94048bc4189332764a662

Registration close: February 18 at 09:00 GMT
(Recording is available for a limited period upon registration)

Language: English
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Platform: WebEx

Host: Ministry of Economy, Trade and Industry (METI), Japan

Contact: For questions on webinar program: Technova Inc. maruta@technova.co.jp
For questions on registration and webinar: admin@mi-office.tokyo

Workshop Summary

Day 1 – February 18 (Tuesday)

Opening address

Hiroki UEJIMA
Mission Innovation Steering Committee Member,
Director, International Affairs Office,
Innovation and Environment Policy Bureau,
Ministry of Economy, Trade and Industry (Japan)

We acknowledge the efforts of key collaborators, particularly Mr. Luciano MARTINI, the GPFM Director, and his team, for their role in organizing these impactful workshops. These efforts have enabled Japan to facilitate three workshops that comprehensively address all three research and innovation pillars identified by GPFM as the 50 most urgent areas for research and innovation. He expresses gratitude to UK colleagues for their support in securing distinguished speakers, who will provide diverse perspectives and insights.
We encourage participants to remain engaged throughout the event, which aims to cover the critical role of grid digitalization and hope the workshop will be both informative and inspiring.

Opening address

Luciano MARTINI
Director, Mission Innovation "Green Powered Future Mission"
Director, Materials and Generation Technologies Department
Ricerca sul Sistema Energetico (RSE), Italy

2025 is a crucial year, marking the 10th anniversary of Mission Innovation. In the second phase, launched in 2021, new missions were introduced, such as the Green Powered Future Mission (GPFM), which is focused on integrating renewable energy into power systems. The GPFM aims to demonstrate the feasibility of integrating up to 100% variable renewable energy into power grids by 2030, ensuring that power systems remain cost-efficient, secure, and resilient. To achieve this, we are not only exploring technical solutions but also innovative approaches related to market design, regulatory frameworks, and business cases for clean energy transition. We have created a platform, the GPFM Toolbox, to share information and resources on our activities with the broader public.
Our coalition includes key countries like China, Italy, the UK, and Japan, as well as international organizations and private sector stakeholders. These partnerships allow us to launch pilot projects and explore real-world applications of clean energy technologies. The mission is structured around 3 main Pillars: Affordable and Reliable VRE, System Flexibility and Market Design, and Data/Digitalization for System Integration, which is the focus of this workshop. Through this event, we aim to share knowledge and best practices to accelerate innovation in digitalization and system integration. Ultimately, we see digitalization as a critical enabler for modernizing power systems, reducing costs, and enhancing resilience.

International initiatives

Scaling power system digitalisation in the age of urban growth and AI

Brendan REIDENBACH
Energy Policy Analyst
International Energy Agency (IEA)

I work within the IEA's Energy Efficiency and Inclusive Transitions office, leading the Digital Demand-Driven Electricity Networks Initiative (3DEN), a five-year project supported by the Italian government. Our focus is on understanding power system digitalization, examining both grid-side and demand-side changes, and analyzing technologies at the grid edge.
The global demand for electricity is rising due to factors like population growth and improved living standards, particularly in developing economies in Africa and Asia. Even in advanced economies,

electricity demand is expected to grow, albeit more slowly. Alongside this, digitalization is rapidly expanding, with the demand for data growing exponentially—data consumption has increased 25-fold in the last decade. Data centers, responsible for processing this data, have traditionally consumed around 1-1.5% of global electricity. However, this is changing due to the rise of AI, cloud computing, and online platforms.

Although AI's direct electricity demand remains small, its role is increasing, especially as industries aim to decarbonize and electrify their processes. The growth of electric vehicles, air conditioning demand in hotter regions, and increasing industrial electrification all contribute to future electricity demand.

While digitalization is creating new challenges, it remains important in shaping future energy demand. We anticipate significant regional and local variations in electricity consumption, with data centers in places like the U.S. and Ireland consuming large portions of local electricity. These changes will require careful management, especially as power grid expansions struggle to keep pace with growing demand.

Q&A

Q: Regarding forecasts on the energy demands toward the 2030 or beyond, we see the big gap among the predictions. What are the reasons for such huge gap and the differences?

A: It is due to the limited availability on data center energy consumption. While some countries like Ireland and the US report figures, others don't, leading to unreliable estimates. The EU's new Energy Efficiency directive mandates large data centers to report their annual energy use, improving data collection and helping to better plan future grid capacity.

Q: Can you please comment on the data center load growth relative to the total electricity demand: Is a fraction of the data center demand of the data center load growing faster?

A: The demand for data centers is growing rapidly, especially with the rise of AI. While data centers are taking up a larger share of electricity demand, their overall proportion is still smaller compared to other sectors.

Reimagining grid planning practices for rapid energy system decarbonization – Insights from ISGAN's Lighthouse Project on smart distribution grids

Helena LINDQUIST
Lighthouse Project Manager
International Smart Grid Action Network (ISGAN)

ISGAN, a technology collaboration program under the International Energy Agency, brings together 25 countries to foster knowledge sharing on smart grids. Our Lighthouse Project, launched in 2023, focuses on long-term planning and implementation of smart distribution grids.

The project aims to address the increasing importance of distribution grids in the global energy transition. The urgency is driven by the need to modernize grids at the low and medium voltage levels, ensuring they can handle new energy demands, such as those driven by climate change and renewable energy. Traditional grid planning approaches are no longer sufficient, as they are reactive and rigid. Instead, we advocate for a forward-looking, adaptive planning approach that uses strategic intelligence, real-time data, and scenario-based modelling to manage uncertainties and complexities.

The project's key achievements so far include the development of a new framework for smart distribution grid planning and a policy brief released at the Clean Energy Ministerial in Brazil in October 2024. The framework outlines five key phases, from foresight through to implementation, and emphasizes the need for robust legal and regulatory frameworks, coordinated actor collaboration, agile planning processes, and critical knowledge infrastructure.

The policy brief highlights four main messages for policymakers: 1) the need for clear legal and regulatory frameworks for grid investments, 2) fostering collaboration among all involved actors, 3) shifting to agile planning methods, and 4) building the knowledge and data-sharing infrastructure necessary for resilient planning processes.

Q&A

Q: Are AI and grid digitalization really topics for the policy belief or are we still at the early stage to discuss these topics in the policy belief?

A: In our Lighthouse Project, we cover a broad theme of planning and implementation, with AI being a tool for utilities. It also raises questions about local and regional capacity needs. Within ISGAN, there's ongoing discussion about AI, flexibility, and regulation for deploying smart grids essential for the energy transition. The policy brief and framework will guide our project's next two years, exploring deeper into related topics.

Country and Utilities Perspectives

Digitalization in the Strategic Energy and Climate Framework of Spain

Enrique PALOP
Deputy Assistant Director General for Energy Foresight and Statistics
Ministry for the Ecological Transition and the Demographic Challenge, Spain

Spain is aligning with the global shift toward a climate-neutral energy system, structured around four core principles: decarbonization, strategic autonomy, decentralization, and democratization of energy access. Key drivers include expanded renewables, electrification of end-uses, energy flexibility (e.g., storage and demand-side management), digitalization, and improved energy efficiency across all sectors.

To guide this transition, Spain relies on two strategic planning tools: the National Integrated Energy and Climate Plan (NECP) for the medium term (2023–2030) and a long-term decarbonization strategy targeting climate neutrality by 2050. Under the NECP, Spain aims to:

- Cut greenhouse gas emissions by 32% (vs. 1990)
- Achieve 48% renewable energy share in final use
- Improve energy efficiency by 43%
- Reach 81% renewable electricity
- Manage a 34% rise in electricity demand (vs. 2019)

The NECP includes five pillars: decarbonization, energy efficiency, energy security, internal energy market, and research/innovation—plus a cross-cutting chapter on climate adaptation, environmental justice, and gender.

Digitalization is embedded in over 30 of 110 measures, impacting areas like renewable integration, grid modernization, energy market design, cybersecurity, and consumer data access. Regulatory sandboxes also support testing new technologies in the electricity sector.

Public funding for this transition is delivered via Spain's Recovery, Transformation, and Resilience Plan, which channels EU recovery funds. Around 40% goes to green projects and 30% to digital transformation. Two key investments are:

- €525M for network digitalization and EV infrastructure
- €156M for new business models, such as smart energy management and cybersecurity.

Q&A

Q: Do you have any thinkings or measures to cope with the cyber potential cyber security in term of the grid digitalization in the future?

A: At the national level, we're developing a new strategy focused on energy and climate security, addressing risks from climate change. Cybersecurity will be a key component, given the growing threat of attacks on critical energy infrastructures. This is a shared concern among us all.

Policy and Technology for Grid Digitalization – Canadian Perspectives

Eldrich REBELLO / Jason IVALL
Science and Technology Advisor, Office of Energy Research and Development
Natural Resources Canada (NRCan)

Natural Resources Canada supports technology demonstration through funding programs and other activities that bridge the gap between university research and market-ready innovations. Canada's electricity sector faces unique challenges due to the country's vast geography and 13 different electricity markets, each with distinct needs.

The Smart Grid Program, which ran between 2018-2024, aims to demonstrate innovative technologies like demand response, microgrids, distributed energy resources (DERs) and new electricity market and rate structures. These projects primarily involve electricity utilities and

electricity system operators and focus on integrating DERs and advancing grid capabilities. The program's goal is to help utilities transition from exploring digital technologies to fully embracing them, supporting the growth of electricity systems that can handle more decentralized and diverse energy sources.
Several Smart Grid Program projects showcased the roles of artificial intelligence (AI) and data analytics, enabling utilities to optimize operations, forecast demand, and identify opportunities for digital solutions. However, despite proven technological advancements, regulatory frameworks in Canada have struggled to keep pace. We renewed the Smart Grid Program in 2023, and it now includes a focus on building regulatory capacity to address these gaps.
In addition, we see several Canadian innovators leading the way, such as Saint John Energy in New Brunswick and Hydro One in Ontario, who are partnering with international technology developers to explore AI and other digital solutions in the energy sector. Ultimately, while technology plays a crucial role, effective regulations and policy adjustments are necessary to drive comprehensive system change.

Q&A

Q: To manage digital systems, which is better and effective, a nationwide digitalized grid system or small and localized mini-grids?

A: Canada's east-to-west interconnected system offers benefits, but due to the vast size (5,000 kilometres), each province shares more similarities with nearby U.S. states. In my opinion, regional coordination is more practical than a national system.

Q: Since Canada's grid is connected to the U.S., balancing the grid and digitalization across borders presents additional challenges.

A: Unlike the U.S. which has the Federal Electricity Regulatory Commission. This makes coordination more challenging, but provinces may align with neighbouring U.S. states.

TEPCO's DX Initiatives and Case Studies

Koichiro YAMAKI
Producer, Engineering Management Office, Engineering Strategy Unit,
TEPCO Holdings
Chair of CIGRE Japan National Committee for SC C1
(Power System Development and Economics)

Ryosuke OBA
Team Leader, DX Promotion Group, Innovation Promotion Office,
TEPCO Power Grid, Japan

TEPCO's DX strategy aims to drive business transformation and contribute to a zero-carbon energy society. Our DX strategy seeks to move from traditional operations to data-driven processes, refining our One-Stop electricity business model and developing a zero-carbon energy data hub to support carbon reduction efforts. We integrate AI, IoT, and real-time data analytics to optimize energy management and enhance efficiency.
Digital transformation benefits us in six main areas: ensuring reliable energy supply, optimizing operations, enhancing customer well-being with sustainable energy, improving decision-making, boosting safety and disaster response, and fostering collaboration with industry partners to co-create innovative business models. For example, AI-driven failure prediction helps reduce downtime, while real-time data analytics shift resources to high-value areas.
To drive this change, we have established five action guidelines for employees: believing in the power of data, using data for decision-making, collaborating across teams, ensuring transparency, and empowering employees to unlock innovation. These principles enable active participation in our DX journey. By 2030, we aim to reduce CO2 emissions by 50%, and by 2050, we target net-zero emissions.
Two key initiatives include AI and drone-based facility maintenance, improving efficiency by detecting issues like overheating or leakage, and the digitalization of substations. As renewable energy expands, we are integrating AI, 3D modelling, and sensing technologies to improve reliability and predictive maintenance. Our goal is to establish fully digital substations to reduce maintenance costs and enhance system efficiency.

Q&A

Q: *What is the next stage in which TEPCO utilizes its digitalization technology such as drone-based facility maintenance?*

A: In Japan we have the 10 power utility companies, all of which are working to together. We try to promote this drone-based facility maintenance idea with other utility companies.

Enel's commitment towards grid digitalization

Marco BARON
Network Engineering and Development
ENEL Grids, Italy

ENEL manages a vast network of about 2 million kilometres, serving over 70 million users globally. Our main goal is to leverage subsidized funding to drive digitalization, improve network efficiency, and accelerate the energy transition.

Over the past 20 years, subsidized finance has been crucial for ENEL's digitalization efforts, enabling flexibility, renewable integration, and better network monitoring. Recently, however, identifying tailored funding for distribution networks has been challenging, as most funding focuses on generation and storage rather than distribution needs. Despite this, we continue to push for innovation in network investments and integrate electrification, flexibility, and renewable energy.

ENEL has developed several projects focusing on flexibility, such as "BE-FLEXIBLE," which integrates balance service providers with users to allow flexibility services. Additionally, we are working on projects like Digital Twin technology and artificial intelligence (AI) for network management. In the "Twin EU" project, ENEL is collaborating to federate digital twin developments across Europe, helping improve network planning and defence strategies. We are also testing AI for congestion management in distribution networks, especially in areas with high distributed generation.

Looking ahead, we see four main challenges for distribution network operators: activating flexibility, integrating processes like operation planning and maintenance, making networks resilient to extreme weather, and continuing to support third-party services. We believe that focusing on tailored solutions, rather than just research and development, is crucial to efficiently operate and enhance distribution networks, supporting the urgent decarbonization and energy transition goals.

Q&A

Q: *Usually, grid digitalization is something for the developed countries but, you mentioned that ENEL is trying to contribute to countries like Colombia. Do you think digitalization technology can contribute to the development in the developing countries, and EU and Italy are helping them?*

A: We led the transfer of our European expertise to Colombia, focusing on practical solutions rather than theoretical concepts. We addressed congestion in northern Bogota by implementing a flexibility mechanism, and while digitalization needs further steps, this project helped engage regulators.

Delivering energy sector digitalization

Simon EVANS
Programme Director, Virtual Energy System
National Energy System Operator (NESO), UK

Our project aims to drive digitalization in the energy sector by creating a shared data infrastructure for the UK's energy system. This infrastructure will connect digital assets and create an ecosystem of digital twins, which will allow us to tackle system-wide challenges and accelerate the transition to net zero.

The first step is addressing the barriers to large-scale data sharing. We're focusing on building a decentralized, secure, and scalable data-sharing system that enables any sector actor to share data efficiently. This system will rely on three components: data preparation, trust, and sharing. The "prepare" function acts as a gateway at an organization's boundary, allowing secure data sharing with the broader system. The "trust" and "share" components manage governance, security, and data catalogues.

We're currently in the pilot phase, testing a use case involving data exchange between transmission, distribution, and system operators to improve operational planning and outage management. This is expected to reduce manual work, enhance situational awareness, and minimize system risks.

Our goal is to deploy this infrastructure progressively, starting with the pilot phase that concludes in April 2025. We then move onto our MVP phase for the following 12-18 months, where we will be iteratively expanding its functionality based on the requirements and use cases of the sector. Throughout the next phases we'll be scaling the participants, targeting widespread adoption and market penetration across the entire energy value chain in advance of 2030. The project holds significant potential for improving data exchange in the energy sector and is an exciting opportunity for collaboration across the industry. We're eager to share results and insights from the trial, and we invite industry partners to get involved.

Q&A

Q: What do you think about the international collaboration of your technology or your concept of data sharing?

A: There's a huge opportunity to collaborate internationally, particularly with organizations like the Australia and the EU. By applying universal design principles, we can connect energy systems globally, with country-specific implementations. This cross-country interconnectivity is vital for global energy sector integration.

Q: When you are sharing data, what do you think about data security and cyber security?

A: Ensuring data security and trust is critical. We're collaborating with cybersecurity agencies to safeguard data sharing, focusing on policies, controls, and trust frameworks. Managing trust across stakeholders, both technically and through policy, is essential for successful data exchange.

Discussion with key questions

Q: What do you think are the biggest barriers or gaps to advancing power system digitalization? What solutions do you think are most promising?

Eldrich REBELLO, Natural Resources Canada (NRCan)

While digital technologies evolve rapidly, with updates every 6-12 months, electricity systems have planning cycles that last 4-6 years. This causes a gap, as technologies become outdated by the time they are implemented. The electricity system isn't designed to adapt quickly enough to this pace of change.

Marco BARON, ENEL Grids, Italy

The key challenge lies in transitioning technology into the network. While the technology is ready, regulatory steps are necessary for its implementation. In the past, stakeholders in the electricity value chain worked independently, but now, with increasing data and information exchange, collaboration is essential. Interconnected systems between TSOs and DSOs require standardized interfaces and data sharing to ensure smooth integration, with cybersecurity becoming a shared responsibility.

Enrique PALOP, Ministry for the Ecological Transition and the Demographic Challenge, Spain

From a regulator's perspective, I feel that technology is progressing too quickly for the power sector. The existing regulations need to evolve to accommodate these innovations. Regulatory sandboxes are useful for testing new tools, like AI or flexibility mechanisms, in controlled environments. These tools must be incorporated into the system without compromising energy security, supply, or accessibility for all consumers.

Simon EVANS, National Energy System Operator (NESO), UK

The focus should not only be on technology but also on the socio-technical aspects. While deploying the right technology is important, solving policy, regulatory, legal, and skills-related challenges is even harder.

Helena LINDQUIST, International Smart Grid Action Network (ISGAN)

Digitalization isn't just about technology; it’s about people working together across various sectors. The key is fostering seamless collaboration between utilities, regulators, and policymakers. With global decarbonization goals, we need to move from fragmented, self-interested systems to more integrated ecosystems. Enhancing collaboration and understanding each other's roles is essential for driving effective digital transformation.

Day 2 – February 19 (Wednesday)

System Providers/ Communication/ System Integrators/ Aggregators

Lessons learnt from digitizing distribution grids for physics-based analytics

Fred GETH
Principal Power System Engineer
GridQube, Australia

With a high adoption of solar systems—one in three homes in Australia—our goal is to enable better visibility and control in networks, which requires digitizing electrical models to improve power system management.

The challenges we face include reconciling sensor data with network models, performing state estimation, and identifying congestion in real-time. By developing dynamic operating envelopes, we aim to allow more flexible export limits, optimizing energy use. The shift from static to dynamic limits, informed by real-time data, helps manage congestion effectively.

We believe in the value of physics-based digital twins, which offer reliable, auditable, and explainable results. However, utilities face significant challenges, such as inconsistent network models and data quality issues. For example, phase connectivity, smart meter accuracy, and data granularity all need to be addressed for improved network performance.

To overcome these issues, we need better collaboration between research and industry to refine data-driven approaches and improve the quality of network models. Additionally, we advocate for public data sets to aid research, allowing for more accurate methodologies and solutions.

Ultimately, failing to digitize networks effectively could hinder the integration of renewables, delay EV charging infrastructure development, and complicate the creation of flexibility markets. Thus, network digitalization is crucial for enabling a successful energy transition.

Q&A

Q: The attempt to digitalize the distribution system is currently limited to Queensland, but do you have plans to roll it out in other part of Australia and also globally?

A: We are working on network modeling in the Northern Territory. Our platform is adaptable to various electrical systems worldwide, including split-phase and three-phase systems, and we hope it will be widely adopted.

Q: If customers with solar panels are limited in what they can sell to the grid due to those constraints, is there an opportunity for storage to feed the grid when the sun isn't shining?

A: Dynamic operating envelopes in Australia apply at the point of connection, allowing customization.

Overview of ADMS operation in ROK

KyungHwan BYUN
Senior Manager
Korea Electric Power Corporation (KEPCO), Korea

KEPCO has developed ADMS (Advanced Distribution Management System) to enhance the management of the rapidly increasing distributed energy resources (DERs). The system integrates functionalities of the previous DMS, including power operation, EMS, and distribution automation. ADMS aims to provide intelligent control systems for energy conversion and digital transformation, supporting energy system stability and safety. The system is divided into three main components: applications, platform, and simulator.

ADMS includes 13 applications that enable real-time monitoring and control, such as online power flow analysis, voltage control, power quality management, and fault detection and isolation (FISR). The platform ensures data exchange and system integration. ADMS also uses a simulator for testing and training operators. Additionally, it provides essential functions like voltage regulation, optimal grid reconfiguration, and management of unmeasured power generation. OMS (Outage Management System) is integrated to improve work safety and efficiency during power outages.

The system aims to improve convenience for operators, reduce maintenance costs, and enhance system stability, making it a key tool for managing complex, modern energy networks.

Q&A

Q: ***You mentioned that you have already implemented the DRMS to control DER but what kind of remote control of the DER have you already implemented?***

A: We control the generation output through ADMS and also manage inverter parameters remotely. However, this requires agreements with TR owners, which can be a bit challenging.

Effective Use of Surplus Regenerative Energy on Railways to Save Energy

James SPECE
Manager, Development Dept., ITAMI Works
Mitsubishi Electric, Japan

We offer Railway Energy Solutions, particularly focusing on the underutilized regenerative braking power. When trains slow down, their motors switch to generating power, which is either consumed by the train or fed back into the electric catenary system. However, if no other trains are nearby, this power often goes unused, causing inefficiencies. Mitsubishi's goal is to capture and reuse this regenerative energy, which could reduce CO2 emissions by up to 17% in Japan's rail systems, equivalent to powering 400,000 households.

We explored methods to capture this energy, including moving trains closer together for shared power use and installing storage devices at substations or on trains. These systems would allow for peak shaving, DC grid voltage stabilization, and better use of the available energy. Additionally, energy could be repurposed for other systems, like station lighting or EV charging.

Our platform analyzes data from various sources to identify areas where regenerative power exceeds local demand and recommends improvements to grid operations. Our next-generation storage devices, designed for short, high-power durations, can store excess regenerative energy and ensure efficient power use, even directly on the trains.

However, challenges exist, such as high implementation costs, the need for improved understanding of digital solutions, and the lack of official recognition of surplus power as green energy. Addressing these challenges requires collaboration and the adoption of comprehensive digital solutions for efficient energy reuse, which we hope will shape future energy policies.

Q&A

Q: ***In your comparison of EDLC and LIB, where do super capacitors fit, and do you see the super capacitors are feasible storage options in EDLC category?***

A: Super capacitors have a high cycle life but lower energy density, requiring more units to store enough energy for regenerative energy capture.

Q: ***Your system was developed for Japan's heavy train traffic, but can it also be applied to other regions of the world?***

A: Our system is already running in Hong Kong and we're exploring expansion to other regions. However, the challenge lies in understanding who benefits from the equipment's power savings, especially in places like Europe where operators and authorities have separate responsibilities.

The Grid Innovation Path of Areti: from Automation to Flexibility

Ercole DE LUCA
Head of Regulatory and Public Finance
ARETI, Italy

Our company, a Distribution System Operator (DSO) in Italy, has developed a system called RomeFlex to modernize our energy grid. Serving 1.6 million connections in Rome, we manage a wide range of responsibilities, including public lighting for Rome's monuments. Our operations align with the European Green Deal's goal of creating interconnected, stable energy networks.

Our grid faces challenges due to its age—40% of it is over 40 years old—and the increased energy demand, which necessitates over €500 billion in investment over the next decade. To address these challenges, we focus on energy transition strategies, emphasizing the optimization of infrastructure through flexibility and customer participation. This involves developing forecasting models for consumption, generation, and enabling demand response. Digitalization is another priority, as we aim to enhance the grid's observability and controllability to improve its resiliency

and flexibility. We plan to fully remote-control 100% of the medium-voltage grid and 40% of the low-voltage grid by 2028, with significant investments in smart meters, automation, and grid upgrades. We are also working to manage peak consumption, which is expected to rise in the coming years, particularly during winter evenings. To balance this, we are investing in flexibility solutions rather than overspending on infrastructure. We have developed a platform, R Flex, to enable grid operators to access flexibility services, which are certified using blockchain to ensure transparency and accuracy in data and transactions.
By collaborating with other European DSOs, we share our platform, enabling them to access flexibility services and benefit from our technology.

Q&A

Q: Especially when discussing the flexibility market, the electricity market in Italy is divided into four or five regions, and are there any concerns for this market?

A: DSO has five large regions in Italy. The challenge is granularity—each substation is unique, with over 13,000 in Rome alone. Therefore, DSOs face more localized issues.

Research Institute / National Project

Information Technologies Applied to Power Grids

Taku NODA
Senior Research Scientist, Grid Innovation Research Laboratory,
Central Research Institute of Electric Power Industry, Japan

At the Central Research Institute of Electric Power Industry, we focus on developing advanced simulation technologies to help achieve GX (Green Transformation). One key development is the Web Simulation Framework (WSF), a web-based simulation tool for power systems. Unlike traditional Windows applications, WSF doesn't require installation and is accessible via any web browser. It allows users to run simulations remotely, on any device, improving accessibility and reducing the need for powerful local PCs. The WSF has been rolled out to Japan's transmission and distribution (T&D) companies in 2024.
We also developed an automatic data case generation system for power system simulations. Traditionally, preparing the data for these simulations was time-consuming, taking weeks or months. The system, called Grien, automates this process, creating data for voltage, electromagnetic, and lightning outage simulations. This system is already in use at several electric power companies in Japan.
In addition to these tools, we are creating an optimization system for microgrid businesses, which automatically calculates the optimal capacity for renewable generation and energy storage. We're also working on a cloud system to gather electric vehicle (EV) information to support the electric power industry and developing AI and data science applications to support utilities.

Exploring Digital Urban Energy Platforms: Harnessing Realistic 3D and GIS

Jerry YAN
Chair Professor and Director, International Centre of Urban Energy Nexus,
Hong Kong Polytechnic University
Member, European Academy of Sciences and Arts
Fellow, Hong Kong Academy of Engineering

Hong Kong, aiming for carbon neutrality by 2050, heavily relies on natural gas and coal for its energy, with over 72% of its electricity coming from these sources. Buildings and transport sectors contribute significantly to energy consumption and carbon emissions, making it essential to focus on these areas for carbon reduction.
At the International Center of Urban Energy Nexus, which I lead, we focus on using digital technologies to link energy systems with urban demand, particularly in buildings and transport. We've developed a Smart Energy and Buildings platform that integrates geographic, time-based, and user behavior data with energy systems to optimize energy consumption and generation. We also use 3D urban models, created from satellite and remote sensing data, to assess solar potential

on rooftops and building facades, enabling simulations of energy production and demand. Currently, we're working on these models in over 100 cities worldwide.

Our platform also links building energy use with electric vehicle (EV) data to optimize charging stations and their integration with the power grid. We're working on case studies in cities like Hong Kong, Shanghai, and Shenzhen, exploring how mobility data and energy storage can be synchronized with the grid to optimize energy systems. We're also expanding our work into other areas like water and infrastructure resilience, using our urban 3D models to improve adaptability.

We believe that energy, resilience, and sustainability must be tackled through interdisciplinary research, which is why we launched the Nexus journal to foster collaboration in these areas.

Q&A

Q: The difficult part is predicting human behavior and transportation, as they are strongly influenced by factors such as weather, temperature, local events, and other variables. How do you integrate these aspects into the model?

A: We are developing a framework that integrates various layers, such as energy and weather data, to simplify the process. By using this platform, we aim to collaborate across sectors like energy, water, and electricity, initially testing in Hong Kong and expanding to other cities with sufficient data and computational power.

Interoperable Domestic Flexibility: Standards and Innovation

Rebecca SHUTT
Energy Engineer
Department for Energy Security and Net Zero (DESNZ), UK

The UK's Department for Energy Security and Net Zero has recognized that increasing system flexibility can significantly reduce costs, with the potential to save up to £10 billion annually by 2050. To promote this, the government introduced the Smart Systems and Flexibility Plan, emphasizing the need for data and digitalization to optimize low-carbon sources.

The Net Zero Innovation Portfolio includes a £1 billion fund aimed at developing low-cost, low-carbon technologies. One key program within this portfolio is the interoperable demand-side response (iDSR) program, which sets standards to integrate energy-smart appliances and grids seamlessly.

In 2021, the British Standards Institution developed two key standards—PAS 1878 and PAS 1879—aimed at standardizing domestic demand-side response appliances and grid operations. These standards ensure interoperability, data privacy, grid stability, and cybersecurity across five appliance types: heating, ventilation, air conditioning, wet appliances (such as washing machines), cold appliances (such as fridges), home battery storage, and electric vehicle charge points. The program uses an intermediary logical entity called the Consumer Energy Manager (CEM) to facilitate communication between devices that use different protocols and the DSR service providers who are aggregating response across a cohort of many appliances to provide flexibility to the grid, ensuring they work together interoperably.

The standards also define demand-side response service types: routine (based on incentives set in advance) and response (real-time requests to help balance supply and demand). These services are designed to prioritize consumer preferences while offering flexibility in energy usage.

As a result of the iDSR innovation programme, there is now industry experience in using the PAS 1878 standard to build ESA (Energy Smart Appliance) and Demand Side Response (DSR) systems. This industry feedback from the iDSR programme and elsewhere has identified areas within the standard that would merit clarification and amendment to reflect technological developments, as well as to bring the standard into alignment with other standards in the field. The PAS 1878 revision is now underway, targeting publication of a revised standard at the end of 2025. International feedback on the standard is welcomed at the public consultation on the standard, run by the British Standards Institution, and expected to run for 6 weeks during May/June 2025.

Q&A

Q: How many devices available today to comply with the UK Pas standards for the demand response?

A: Currently, only appliances developed through the IDSR program comply, and the revisions will improve the standards, making them more robust and manufacturer-friendly.

Interoperability challenges for distributed flexibility integration with grid operations

Mark MCGRANAGHAN
EPRI Fellow
EPRI Europe, Ireland

As the world integrates more renewable energy, the need for grid flexibility becomes essential. This flexibility can be sourced from various parts of the grid, including distributed resources like residential appliances, which can provide crucial grid services. My focus is on the interoperability challenges of integrating customer resources with grid operations.

I'll discuss two key initiatives: the Flexible Interactive Technologies Initiative (FlexIT) and the Mercury Enabled Consortium. FlexIT addresses the interfaces between utilities, aggregators, and energy management systems for buildings or homes. It aims to develop business frameworks, protocols, and service definitions, using OpenADR as one of the communication protocols.

Meanwhile, the Mercury initiative focuses on device-level standards. These standards ensure that appliances like heat pumps and electric vehicle chargers can seamlessly integrate into grid services, with testing protocols for certification. Our goal is to create basic device requirements, ensuring seamless operation for consumers, and to establish a certification process that verifies devices can perform grid services.

Ultimately, flexibility is a critical component of a future-proof energy system, but integrating distributed resources is complex. The success of these initiatives hinges on developing robust interoperability standards that manufacturers can confidently implement, allowing us to efficiently use these resources for the grid.

Discussion with key questions

Q: What do you think are the biggest technical and non-technical challenges your organization or project, which you are facing in the digitalization of electricity systems?

Ercole DE LUCA, ARETI, Italy

Smooth communication between platforms, from TSO to DSO to customers, is crucial. Standardization ensures everyone agrees on protocols, and while it's a technical issue, the real challenge lies in the willingness to adopt these standards.

Mark MCGRANAGHAN, EPRI Europe, Ireland

I believe standardization and interoperability are crucial, but it's important to balance setting the minimum requirements while leaving space for future innovation and developments.

Rebecca SHUTT, Department for Energy Security and Net Zero (DESNZ), UK

For domestic DSR, there's a balance between being device-agnostic and allowing enough flexibility for appliances to optimize their smart functionality.

Jerry YAN, Hong Kong Polytechnic University

Data is critical, especially when scaling up to larger systems and involving consumers. Challenges include data sharing, quality, and accessibility, even if the data is available. Big data and AI offer potential solutions, though they aren't perfect yet.

Taku NODA, Central Research Institute of Electric Power Industry, Japan

There's a social aspect to consider, particularly in Japan's electrical power industry, which tends to be more conservative compared to other sectors. People in the industry can be hesitant to embrace new IT technologies, even though these technologies could significantly benefit them. People understand the concepts well and are capable of implementing the technologies. If we encourage them, they'll start taking action.

James SPECE, Mitsubishi Electric, Japan

The rail industry is similarly traditional. Many people say, "we've been doing it this way for a hundred years, why change?" Convincing them to adopt data systems and visualization tools is challenging and motivating them commercially is not easy either.

Closing remarks

Jun HASHIMOTO
Team Leader
Energy Network Team, Fukushima Renewable Energy Institute (FREA),
National Institute of Advanced Industrial Science and Technology (AIST), Japan

The Workshop has provided a unique platform for sharing insights, addressing key challenges, and exploring innovative solutions for the future energy system.

On Day 1, we discussed international initiatives and country-level strategies for grid digitalization. We focused on scaling power system digitalization amidst rapid urbanization, AI integration, and the need for more efficient grid planning to accelerate energy system decarbonization. Presentations from organizations like the International Energy Agency (IEA) and the International Smart Grid Action Network (ISGAN) emphasized the importance of flexible and adaptive approaches to modern grid development. We also heard from countries such as Spain, Canada, Japan, Italy, and the UK, which shared their national policies and utility-driven digitalization initiatives. A case study on the digital transformation of power utilities demonstrated how technology is integrated into operations to improve efficiency, reliability, and sustainability. This reinforced the need for tailored digitalization strategies that adapt to local conditions while fostering global collaboration.

On Day 2, we focused on technological innovations and real-world applications shaping the future of grid systems. Presentations from key industry players, including GridQube and Mitsubishi Electric, provided insights into advanced distribution management systems, surplus energy utilization, and automation for increased grid flexibility. Research discussions highlighted advancements in information technology, including real-time data, AI, interoperability, and standardization, all contributing to enhanced grid reliability.

This workshop reinforced the notion that grid digitalization requires a collective effort involving technology, policy frameworks, standardization, and international collaboration. The shared knowledge here will strengthen the transition to more sustainable, flexible, and intelligent energy systems.

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