

# DISCUSSION MEETING SUMMARY

## Study Committee C6

### ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES

**30 August 2024**

**Chair:** Kurt DEDEKIND (South Africa)

**Secretary:** Evert de HAAN (Netherlands)

**Special Reporters:** Barbara HERNDLER (Austria – PS1), Istvan VOKONY (Hungary – PS2) and Ray BROWN (Australia – PS3)

#### 1. INTRODUCTION

The 2024 discussion meeting of Study Committee C6 was held on 28 August 2024, in the Amphitheatre Bleu at the Palais des Congrès in a morning and afternoon session.

#### 2. RUNNING OF THE MEETING

The Discussion Group Meeting was chaired by the Study Committee Chair, *Kurt Dedekind*, with the individual Preferential Subjects hosted by the respective Special Reporters. Additionally, the SparkUp sessions were facilitated by the Study Committee C6 Secretary, *Evert de Haan*.

A total of 72 papers were selected for presentation and discussion at the CIGRE Session 2024 - 44 for PS1, 12 for PS2 and 16 for PS3, distributed among the Preferential Subjects to provide a comprehensive view of current research and development efforts. The insights from these papers were crucial for fostering a robust discussion and formed the basis for the questions and dialogues during the Group Discussion Meeting (GDM). **37 prepared contributions** were received for the GDM which formed the basis of the discussion and knowledge sharing that took place on the day of the meeting.

#### 3. CONTRIBUTIONS TO PREFERENTIAL SUBJECT 1

##### Flexibility Management in Distribution Networks

The session consisted of **two presentations from our NGN members** and one invited contribution by **Pierluigi Mancarella, convenor of WG C6.34 on Flexibility**. It was structured with five sub-topics to discuss important issues that were identified in the papers contributing for this session. **18 Contributions** were received for the session, with several spontaneous contributions from the floor to support the topics that were presented.

The following main topics were addressed in Preferential Subject 1 (PS1):

- Strategies to ensure uninterrupted power supply, manage DERs, and enhance resilience in distribution networks.
- Integration, optimization, and economic viability of battery energy storage systems (BESS) and renewable energy sources across different regions and sectors, environmental factors, total cost of ownership (TCO) optimization, and overcoming integration barriers.
- Development of innovative energy management and grid optimization solutions, including local ancillary service markets (LASM), energy communities, electric vehicle (EV) integration, flexible

resource mobilization, blockchain for peer-to-peer trading, gravity energy storage systems (GESS), and demand response strategies.

- Modernizing grid infrastructure and enhancing flexibility through the integration DERs and demand-side management, covering terminology standardization, DER valuation, congestion management, operational planning for DSOs, EV charging infrastructure, hosting capacity, control strategies, and load forecasting for microgrid design.
- Proactive controls, automated switching, Distributed Energy Resource Management Systems (DERMS), flexibility utilization, energy routers, non-wire alternatives (NWA), and other advanced technologies.

A total number of 44 papers were received with representation from 24 countries and 4 continents, and where most of the authors came from Europe.

The papers were grouped into the following subtopics:

- **Analysis and Management of Flexibility and Resilience in Distribution Systems**
- **Innovations in Energy Storage Integration and Utilization**
- **Innovations in Local Energy Market Models and Ancillary Services Provision**
- **Advanced Distribution Grid Planning and Management**
- **Advanced Grid Technologies and Analytics**

The key points from the presentations and discussions that followed from the were as follows:

- **Balancing Grid Flexibility and network reinforcements/Upgrades:** Balancing the use of DERS alongside necessary grid upgrades is crucial for sustainable and reliable energy management.
- **Advanced Control and Data-Driven Solutions:** the use of data-driven tools and robust control systems to optimize flexibility and stability, ensures effective integration of new technologies and improved resilience during extreme events.
- **Role and Challenges of BESS:** BESS is essential for optimizing self-consumption, managing peak demand, and ensuring continuity during emergencies. However, financial challenges and integration complexity must be addressed to fully realize the potential of these smart green ports and support European decarbonization targets.
- **Advanced Coordination for System Restoration:** The use of multiple smaller Distributed Energy Resources (DERs) for system restoration depends on sophisticated coordination systems. Key elements include resilient communication networks and robust network switching capabilities.
- **Transformative Potential of Inland Ports:** Ports, despite their energy reliability challenges due to remote locations, can harness local renewable resources such as solar and wind.
- **Demand Shifting and Grid Management:** Strategies such as dynamic tariffs, advanced control systems, and the integration of flexible loads like electric vehicles can optimize energy consumption, enhance grid balance, and support decarbonization efforts.
- **Alternative incentive:** The use of alternative incentives (in contrast to monetised incentives) should be considered to encourage demand response. Examples include, reliable supply, premium power programs etc.
- **High-Quality Flexibility in Energy Systems:** Optimizing flexibility involves balancing internal factors (e.g., DER types and management applications) with external constraints (e.g., utility tariffs and regulations). Adopting advanced energy management standards and value-stacking strategies can enhance grid efficiency and operation.

- **Advanced testing:** While simulator testing and HIL testing provide valuable insights into software logic and local control accuracy, Injection-Based HIL testing offers the most comprehensive evaluation by simulating realistic network faults.
- **Value staking of flexibilities:** The focus of flexibility from a single service to a multi service provider should be considered to continue to add value.

#### 4. CONTRIBUTIONS TO PREFERENTIAL SUBJECT 2

##### **Power Electronic based Solutions for Smart Distribution Systems**

PS2 received and evaluated to present 12 papers. Authors came from 11 different countries and four continents. Papers in the subtopic were grouped as follows:

- **Grid Systems and Converters**
- **Renewable Energy Integration and Management**
- **Energy Distribution and Control Systems**

These groupings aligned the papers with their overarching focus on grid systems and technology, renewable energy management, and specialized distribution and control systems within the broader context of electric power systems.

There were **10 contributions submitted** in advance, and one invited contribution by **Aradhna Pandarum, convener of WG C6.46, on Energy Efficiency in Distribution Systems**. In addition, several spontaneous contributions from the floor were received during the session.

During the GDM in PS2 various technological solutions for enhancing the flexibility and security of power supply in active distribution networks were introduced. These solutions include dynamic operating envelopes, soft open points, and dynamic pricing mechanisms, all aimed at addressing the challenges of integrating Distributed Energy Resources (DERs) and managing grid dynamics.

- **Flexibility and security of supply:** These are highlighted as inherently controversial due to conflicting objectives between ensuring grid stability and accommodating consumer energy generation goals. Technological advancements like dynamic operating envelopes and grid-forming converters are proposed to optimize grid operations under varying conditions. However, their success is influenced by specific contexts and goals.
- **Energy communities as a technological solution:** The concept of energy communities is presented as a new approach to managing local energy resources, fostering a decentralized and flexible grid infrastructure. This model allows for more localized control and optimization, potentially enhancing both security and flexibility while supporting sustainability goals.
- **Emerging indirect control methods:** Dynamic pricing, which adjusts electricity prices in real-time based on demand and supply conditions, is emerging as a non-direct control method. It encourages consumers to shift their energy usage patterns, helping balance grid loads without the need for direct intervention.

The overall message is that while technological solutions offer promising ways to enhance grid flexibility and security, their effectiveness depends heavily on the broader application environment, including legal frameworks, economic conditions, and sustainability goals.

#### 5. CONTRIBUTIONS TO PREFERENTIAL SUBJECT 3

##### **Rural, Islanded and Industrial Electrification Standards, Practices and Technology Options**

PS3 received and evaluated to present 16 papers. Authors came from 8 different countries and five continents. Papers in the sub-topics were grouped as follows:

- **Off-grid and island DER applications including appropriate resilience measures.**

- **Microgrid and multi-microgrid installations**
- **Protection Issues in Distribution Systems with High Levels of DER**

Applications highlighted the interface between technical and non-technical aspects for rural electrification.

A total of **9 contributions** were received, covering a range of questions that were posed in the Special Report. An additional invited presentation by an **NGN member** was included in the session.

The conclusions from the contributions and ensuing discussions may be briefly summarized as follows:

### **Off-grid and Island DER Applications Including Appropriate Resilience Measures**

One prepared contribution was received on the topic of community engagement. In addition, spontaneous contributions were received on the need for transparency, particularly about the cost of electricity that would be provided by a project, and on the requirements for standards.

### **Microgrid and Multi-microgrid Installations**

Five prepared contributions were received on various aspects of microgrids. These included presentations on the possibility of fast mode changes from grid-tied to islanded mode in the event of an outage of the grid, with the general view that this was technically possible. Interestingly, in at least one country, regulations only allowed a transition to islanded mode in the event of an extended outage. A presentation was given on a BESS-based microgrid picking up step-load on transition to islanded mode. Two presentations were given on the range of applications for microgrids. In addition to traditional application to serve process critical industries such as semiconductor manufacturing, it is expected that microgrids will be increasingly used to provide resiliency in distribution networks.

### **Protection Issues in Distribution Systems with High Levels of DER**

Two prepared contributions were received, one on the protection of DC distribution systems and the other on the detection of broken conductor faults in distribution systems with high levels of penetration of DER.

## **6. CONCLUSION**

Several relevant prepared and related spontaneous contributions, two invited presentations as well as three inspiring presentations by NGN members were made and discussed during the day, covering key topics of SC C6 activities. It was shown that ...

- There is a need to develop an appreciation of the integration of new technologies. Applications such as Battery Storage solutions, inverter management and DC applications are avenues that will have to be explored further.
- New customer behaviour patterns are shaping the technology options, information exchange platforms and network operations of the future. Energy Efficiency measures, EV adoption and Demand Response options are shaping the discourse of such a future engagement.
- Electrification growth will spurn a range of challenges to existing network capacity, notably in dense urban environments.
- Energy security will play an increasingly important role, as both resilience and reliability measures will become key focus areas for the sustainability of the industry.
- The move towards the decarbonisation net-zero targets will require greater flexibility management to cope with the uncertainties of existing energy supplies, and the variability associated with renewable energy integration.

Technologies and solutions are available especially in the form of different storage and intelligent electrification systems, including MVDC systems, and increased consumer integration, coupled with conventional infrastructure strengthening measures can cater for the expected energy transition. Its application will however mainly be driven by the cost or the value of the benefits they provide for

different stakeholders. The benefits realised are also dependant on the regulatory regimes and associated political to move towards a de-carbonised and sustainable future.

The key impact will be the ability to learn from the lessons from across the globe, and to ensure that the collaboration within platforms such as CIGRE, in fact enable such a transition towards an energy-secured future.