DISCUSSION MEETING SUMMARY

Group C6

(Distribution Systems and Dispersed Generation)

Tuesday, 30th August 2022

Chair: **Christine Schwaegerl (Germany) (outgoing)**
Kurt Dedekind (South Africa) (incoming)

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

Special Reporters: Ursula Krisper (PS1), Yasuo Matsuura (PS2), Thomas Strasser (PS3)

1. INTRODUCTION

The 2022 discussion meeting of Study Committee C6 was held on 30th August 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 co-chaired by the Study Committee Chair, *Christine Schwaegerl and Kurt Dedekind*, with the individual Preferential Subjects hosted by the respective Special Reporters.

3. CONTRIBUTIONS TO PREFERENTIAL SUBJECT 1

DER Solutions and Experiences for Energy Transition and Decarbonisation

The session consisted of **2 prepared presentations** and one invited contribution by Joao Pecas Lopes, convenor of WG C6.40 on Electric Vehicles. It answered 4 questions, and was structured with four sub-topics to discuss important issues that were identified in the paper contributions for this session:

PS1 received 6 papers, which were assigned to four sub-topics: Important conclusions from the discussions were as follows:

1. *Electric vehicle (EV) recharging and their impact on low voltage (LV) grid operation.* Two papers were reviewed under this topic, namely papers 10920 and 11083.
2. *Renewable energy sources (RES) and DER operation in distribution grids*. Two papers were received and reviewed under this topic, namely papers 10712 and 10768.
3. The third sub-topic unpacked the topic of Photovoltaic *(PV) management for energy savings*, which was reviewed by one paper, number 10311. This article also provides the basis for some additional food for thought and raises the following potential elements.

- The proposal of PV managementis also possible to use in grids with big penetration of PVs and where the heating pumps are the predominant load.
- The methodology for saving energy would work also in differing climates as in winter the voltage adjustment is done by tap changer adjustments. For LV networks a sufficient voltage margin is secured to achieve an energy reduction.

4. The fourth sub-topic considered the *electrification and the power supply of transportation systems.* The following considerations could be drawn from the contribution of paper 10683:

- Static Frequency Converters (SFC) can contribute to optimizing railway supply systems.
- Use of back-to-back converters may provide additional consideration for three-phase common coupling:
  - the converter is seen as a perfect balanced load from the supplying grid.
  - Power factor can be controlled
  - The converter interfaces the grid independently from the harmonics produced in the railway system
- In similar vein, on the single-phase catenary side:
  - The converter current limitation is an advantage in cases where the short-circuit power level is at its limit, but where the supply power needs to be increased.
  - Reactive power, and therefore catenary voltage can be controlled independently from the actual three-phase voltage level.
  - Distance between feeding substations can be increased.
  - Neutral sections can be avoided.
  - Several converters can be interconnected to the same line and share the traction load. Braking energy can be recovered and kept within the railway system.
- Finally, there is relation between speed of the train and the energy consumption,

4. CONTRIBUTIONS TO PREFERENTIAL SUBJECT 2

Innovative Planning and Operation of Active Distribution Systems

11 questions were asked, relating to 25 papers about "Energy Storage in Distribution Systems", structured around three primary subtopics:

1. Aggregation and management platforms for active distribution systems with DER (questions 2.1 – 2.3); Papers 10175, 10268, 10281, 10298, 10393, 10525, 10596, 10858, and 11108.

2. Strategies and tools for DER integration, hosting capacity, congestion management and system service provision by DER (questions 2.4 – 2.9): Papers 10206, 10280, 10496, 10508, 10523, 10524, 10593, 10595, 10826, 10827, 11044, 11106, and 11158

3.*Greening rural and green-field electrification, off-grid distribution and zero emission industrial systems (question 2.11);* Papers 10594, 11130, and 11131.

There were 28 prepared contributions submitted in advance, one invited contribution by Alexandre Oudalov, convenor of WG C6.35, and one presentation by a NGN CIGRE member on "Behind-the-Meter PV Estimation for Grid Awareness and Enhanced Visibility". Additionally, James Yu, provided an overview of the outcomes of the recently completed JWG C6/ B4.37 activities on MV DC systems.

Highlights of the notable discussions and conclusions, based on prepared contributions and several spontaneous contributions, are described below. The papers originated from thirteen (13) countries reflecting a wide and international interest in the topics. The papers presented concepts and results that broadly align with the three subgroups as defined above. The conclusions from the presentation and discussions might be briefly summarized as follows:

- The aggregation and integration of RES/DER to the power system may result in various challenges, such as voltage issues, congestion, the role definition between the TSO and DSO. The TSO, DSO and customer resources could be layered as structured compositions, which could solve related issues and bring other challenges as well.
- Current practices defines that the TSO sets the requirements at the Point of Connection and that the DSO should comply with them. The mass deployment of RES/DER would however bring challenges to the system operation and coordination at the point and may thus require a re-think as to how this should be coordinated. DSO's may also have to look at means of improving the controllability and visibility of network and customer related operations under their control.
- The flexibility that DER could provide to the power system against the uncertainty and variability of RES/DER was discussed.
- Countermeasures against the voltage related challenges caused by the mass deployment of RES/DER in the power system, various methods to control reactive power using the control of inverters of RES/DER, (which are DC power sources), were discussed. The reactive power control by smart inverters has altered the grid connection rules and influenced the concept of voltage control.
- Simulation tools would be required to test and evaluate the behaviour of various types of RES/DER, and the power grid condition. Discussion covered the effectiveness and benefits provided by detailed and varied simulation methods, the associated modelling tools and where the foundational importance of data management for such simulation, was unpacked.
- Several discussions about LV grid visibility and their associated controllability by utilizing the state-of-the-art technologies, were shared. LV STATCOMS and the use of smart meters were some of the methods used in the shared contributions. Challenges surrounding the real-time controllability, data updates and the actual system status appear to exist in many countries where this transition to greater visibility and controllability of distribution networks has taken place.
- The discussion about electrification, and the countermeasure against non-technical losses and off-grid solution were covered in the contributions. The economic and societal issues reflected some unique applications in certain parts of the world, - notably where remote communities are served by DER applications. Regulatory and political factors also influenced designs and practices around the globe.

5. CONTRIBUTIONS TO PREFERENTIAL SUBJECT 3

Aggregated DER for Enhancing Resilience, Reliability and Energy Security of Distribution Systems

The 19 papers that were received in the PS3 category came from 15 countries and four continents, with the majority of the papers from Asian and European authors. They have been written by researchers and engineers from utilities, manufacturers, consultants, and academic institutions and they address different integration topics of distributed energy resources (DER) into power distribution systems and microgrids. These papers were grouped into the following four subtopics:

1. *Characterisation of DER units and their integration into distribution grids*
   (Papers C6-10238, C6-10271, C6-10855, C6-11026, and C6-11047)
2. *Rural electrification and islanded systems in the context of renewable generation*
   (Papers C6-10497, C6-10700, C6-10859, and C6-11119)
3. *Planning, protection, and control of microgrids and virtual power plants*
   (Papers C6-10331, C6-10333, C6-10417, C6-10652, C6-10653, C6-10825, and C6-10971)

4. *Experience and lessons learned from microgrid projects and testbeds*
   (Papers C6-10237, C6-10396, and C6-10806)

A total of 11 contributions were received, covering a range of 10 questions that were posed in the Special Report. An additional invited presentation by Nikos Hatziargyriou on the BESS WG C6.43 activities was included in the session.

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

- The integration of renewable energy resources (RES) in the form of DER is still key for the transition to a sustainable electricity supply. DER can also contribute to enhancing the resilience, reliability as well as security of the electricity supply in power distribution systems and microgrids.
- The integration of battery energy storage systems (BESS) and electric vehicle supply equipment (EVSE) into power distribution grids are key to coping with the intermittent behaviour of renewables. However, there is still a lack in the design and deployment as well as in the interconnection and integration requirements of BESS. Also, tweaks to regulatory rules need to be adopted and adapted.
- Even if there is a big potential in using BESS in power distribution grids, there is currently a lack of experience with relatively few use cases about the lessons learned about their integration and aggregation; This is an area of potential advancement
- Islanded microgrids and off-grid applications play still an important role in rural electrification; especially in developing countries. Unique solutions are however key to the successful operation of such installations.
- DC technology is becoming increasingly important for the integration and aggregation of DER. DC and hybrid AC-DC grids will become more popular in the future.
- Collecting and sharing experiences and lessons learned about realized projects from all over the world with different requirements and needs related to active distribution grids and microgrids is very important. Meetings and events like the CIGRE Session are the perfect places to inform and discuss lessons learned between the participants.

6. CONCLUSION

Several relevant prepared and related spontaneous contributions, four invited presentations as well as an inspiring presentation by a young member 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, invertor 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 and energy-secured future.