CIGRE UK Webinar

Researches and Activities of SC C6 on Active Distribution Systems and Distributed Energy Resources

Prof. Jun Liang

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Jun Liang

Jun Liang is a **Professor** at Cardiff University, Leading researches on DC transmission/distribution, power system operation, power electronic converter control, offshore wind, and electrified transport.

Research funding over £20M in 30+ projects. The **Coordinator and Scientist-in-Charge** of 3 EC Marie-Curie Action ITN/ETN/DN projects (total €12M, 2013-2026). Leads a major EPSRC-China NSF project (total £1.1M) on intelligent control of AC/DC network for clean energy supply in urban areas, and a major EPSRC UK-Australia project on cyber security on grid integration of EV.

He has published over 260 papers including 160 journal papers, 1 book in IEEE/Wiley, and 4 book chapters. He has supervised 35 PhD students, and 12 post-doctoral researchers.

An Associate Editor of IEEE Transactions on Sustainable Energy, an Editorial Board member of CSEE JPES, a Guest Editor of IEEE Transactions on Power Delivery, and technical committee members of several international Conferences.

CIGRE C6 UK Regular Member, an IEEE Fellow, an IET Fellow, the **Chair** of UK&RI Chapter of IEEE Power Electronics Society, an Organising Committee member of the IET ACDC conferences, a committee member of CIGRE Working Groups, Committee member of the British Standards Institution (**BSI**), the Committee member of International Electrotechnical Commission (**IEC**) SC 8A,

STUDY COMMITTEE SC C6

Active Distribution Systems and Distributed Energy Resources

- **SC Chair:** Kurt Dedekind
- **SC Secretary:** Evert de Haan
- **Communications Officer**: Harry Evans

Mission:

Assessment of the technical impacts resulting from a more widespread adoption of DER applications on planning and operation and on approaches, and of enabling technologies and innovative solutions for DER integration in active distribution systems.

STUDY COMMITTEE SC C6

Active Distribution Systems and Distributed Energy Resources

Areas of attentions:

- Enabling technologies for **renewable and distributed energy resource** integration and application: active network management, microgrids, virtual power plants, distribution management systems (DMS, ADMS, DERMS), DER monitoring and control, aggregation systems and platforms, block-chain applications.
- Innovative solutions for **DER and distribution technology deployment**: smart inverters and power electronic interfaces, interconnection and integration requirements, MV/LV DC supply systems, distribution system modernization.
- **Storage technologies**: deployment of various storage technologies such as electrochemical electric battery energy storage systems, flywheels, flow batteries, and new storage
- **Multi-energy** solutions (including thermal storage), **Power2X** applications (including power to heat, power to gas), **electric vehicles**.

STUDY COMMITTEE SC C6

Active Distribution Systems and Distributed Energy Resources

Areas of attentions:

- New approaches to configure new distribution systems for **enhanced reliability and resilience**: islandable grid connected microgrids, power exchange between microgrids.
- New approaches to determine the impact and plan and operate distribution systems in the context of a wide deployment of **DER, including the analysis of hosting capacity and protection**
- Consumer integration and empowerment: **demand side integration** and participation, demand response, load management, smart load, new customer sectors such as electric vehicles, smart home and smart meter applications with impact on distribution systems.
- **Smart cities**: integrated distribution system technologies, power, control, and information and communication technology deployment for flexibility, integration of multi-energy systems.
- **Rural Electrification**: islanded power systems and individual customer off-grid systems, new solutions, weak grid connected systems

Preferential Subjects (CIGRE Paris Session 2024)

Preferential Subject 1: *Flexibility Management in Distribution Networks*

- Energy storage systems with the associated provision of their grid services
- Evolving planning and operational objectives and criteria with increased electrification, coupled with the changes in end-to-end technology behaviours
- Electric Vehicle integration and impacts

Preferential Subject 2: *Power electronic based solutions for Smart Distribution Systems*

- Evaluating and quantifying the added value of smart inverter and converter functions and their integration into Distribution Networks.
- Case Studies of DC and DC/ AC hybrid grid solutions for the future
- Provision of ancillary services for Distribution and upstream networks

Preferential Subject 3: Rural, islanded and industrial electrification standards, practices and technology options.

- Microgrid and multi-microgrid installations
- Off-grid and island DER applications including appropriate resilience measures
- Applications highlighting the interface between technical and non-technical aspects for rural electrification

Preferential Subjects (CIGRE Paris Session 2024)

- Receiving a record number of abstracts submitted to SC C6 (**94** in total)
- A very high percentage of abstracts have been accepted.
- The final paper submission deadline is the **6th February 2024**.

C6 Working Groups and UK Members

Number	Title	UK Member
JWG C6/C2.34	"Flexibility provision from distributed energy resources"	Milana Plecas (SP Energy Networks)
WG C6.35	"DER aggregation platforms for the provision of flexibility services"	Geev Mokryani (University of Bradford)
WG C6.39	"Customer empowerment"	
WG C6.40	Electric Vehicles as Distributed Energy Resource (DER) systems	Adam Maloyd, WSP
WG C6.42	Electric Transportation Energy Supply Systems	Maurizio Albano (new Convenor), Liana Cipcigan, Jhan Chan, Preye Ivry, Harry Evans (NGN),
WG C6.43	Aggregation of battery energy storage and distributed energy resources (DER), including solar PV	
WG C6.44	Nodal Value of Distributed Renewable Energy Generation	Geev Mokryani (University of Bradford)
WG C6.45	The Impact of Distributed Energy Resources (DER) on the Resilience of Distribution Networks	Shota Omi, Daniel Donaldson (NGN)
WG C6.46	Energy Efficiency in Distribution systems	
WG C6.47	DSO-customer interfaces for efficient system operation	
JWG D2/C6.47	"Advanced consumer side energy resource management systems"	James King (Nortech Management Limited)

Ongoing Working Groups

- 17 working groups are currently active
- 7 of these are joint working groups
- Full details can be found at: https://c6.cigre.org/GB/technical-activities/working-groups-list

- Call for active participation:
  - WG C6.47-DSO-customer interfaces for efficient system operation
  - WG C6.46 -Energy Efficiency in Distribution systems
  - WG C6.39 -Customer Empowerment
  - WG C6.42 -Electric Transportation Energy Supply Systems
  - WG C6.45 -The Impact of DER on the Resilience of Distribution Networks
  - JWG D2/C6.47 -Advanced consumer side energy resource management systems
  - JWG C5/C6.29 -New markets, Local Energy Communities

WG C6.47 DSO-customer interfaces for efficient system operation

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CIGRE Study Committee C6

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

(J)WG [1]N° C6.47	Name of Convenor: Daniel Eghbal (Australia) E-mail address: daniel.eghbal@ieee.org
Strategic Directions #[2]: 1,2,3	Sustainable Development Goal #[3]: 7,9,13
The WG applies to distribution networks: ☒ Yes / ☐ No	
Potential Benefit of WG work #[4]: 1,2,3,4	
Title of the Group: DSO-customer interfaces for efficient system operation	

Scope, deliverables, and proposed time schedule of the WG:

Background:

Where DSOs used to design their networks for rather predictable loads and have the required reinforcements in place on time, the world could not be(come) more different. The climate issues (and transition to renewables) force customers to go about their energy use in a different manner, resulting in (rapid) increases in electrical loads (e.g. electric heating and mobility) and generation (e.g. solar and wind) on the distribution networks.

The natural reflex for DSOs might be to ramp up their grid reinforcement efforts to support the electrification. However, shortages in staff and materials do not always allow for timely reinforcement and significant grid reinforcement increases the electricity price for customers. Furthermore, low-capacity factors for certain use cases (e.g. for PV) raises the question whether all reinforcements would be cost effective. These developments require the DSOs to grow into their system operator role. Increasingly, the DSO can (due to increased integration of DERs) and needs to (due to capacity constraints) unlock and orchestrate the customer-side flexibility capabilities. It requires increased communication with the customers on the state of the grid and the behaviour that is expected from the customer. This will require some sort of DSO-customer interface(s).

Purpose/Objective/Benefit of this work:

Communication between the DSO and the customer requires a defined interface – an interface that goes beyond the capabilities of the regular (smart) energy meter. The working group is to investigate the requirements for communication, data exchange, visibility and controllability between a customer and its DSO. These requirements will be translated to (high level) design considerations for such an interface. Note that different design choices may be made for different types of customers and include the role of aggregators. These design considerations will help move towards international best practices and standards for information exchange between DSOs and customers.

Scope:

Customers include all customers connected to the DSO grid (residential, commercial, and industrial; generators and loads; on MV and LV). Also, the role of the aggregator is to be taken into consideration

The working group would investigate and report on:

1. definitions relating to the DSO-customer interface(s).

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2. current and future use cases requiring DSO-customer cyber-secure communication, illustrating the purpose of/need for more extensive information exchange and interoperability.
3. levels of controllability and visibility required by the DSO linked to the use cases.
4. use cases for which a new/improved interface is needed/helpful.
5. what data needs to be exchanged to support the identified use cases requiring a DSO-customer interface (e.g., P, Q, I, U, E, instantaneous vs. averages vs. min/max, grid status, setpoints, maintenance schedules, emergency conditions, frequency of data-e.g. 5 minutes or 15 minutes).
6. what moment in time the data needs to be exchanged (e.g., day(s) ahead, intraday, real-time, after the fact).
7. the role of aggregators in the use cases.
8. current standards pertaining to DSO-customer interfaces.
9. past and current DSO-customer interface implementations (hardware and software) and their pros and cons in relation to the current and future use cases.
10. potential novel ways for interface implementations (smart meter, new hardware interface, new software interface, ...)
11. design recommendations for a DSO-customer interface, potentially differentiated for different types of customers, considering the roles of the aggregator and retailer, including the physical interface.
12. conclusions, future perspectives, and emerging technologies.

Remarks: The work will be carried out in collaboration with experts from SC's B5, C2, C5, and D2.

Deliverables:

☒ Annual Progress and Activity Report to Study Committee
☒ Technical Brochure and Executive Summary in Electra
☒ Electra Report
☐ Future Connections
☐ CIGRE Science & Engineering (CSE) Journal
☒ Tutorial
☐ Webinar

Time Schedule:

• Recruit members (National Committees)	Q3 2023
• Develop final work plan	Q4 2023
• Draft TB for Study Committee Review	Q4 2025
• Final TB	Q4 2025
• Tutorial	Q1 2026

Approval by Technical Council Chairman:

Date: July 11th, 2023

WG C6.47 DSO-customer interfaces for efficient system operation

- Background:

- Where DSOs used to design their networks for rather predictable loads and have the required reinforcements in place on time, the world could not be(come) more different. The climate issues (and transition to renewables) force customers to go about their energy use in a different manner, resulting in (rapid) increases in electrical loads (e.g. electric heating and mobility) and generation (e.g. solar and wind) on the distribution networks.
- The natural reflex for DSOs might be to ramp up their grid reinforcement efforts to support the electrification. However, shortages in staff and materials do not always allow for timely reinforcement and significant grid reinforcement increases the electricity price for customers. Furthermore, low-capacity factors for certain use cases (e.g. for PV) raises the question whether all reinforcements would be cost effective. These developments require the DSOs to grow into their system operator role. Increasingly, the DSO can (due to increased integration of DERs) and needs to (due to capacity constraints) unlock and orchestrate the customer-side flexibility capabilities. It requires increased communication with the customers on the state of the grid and the behaviour that is expected from the customer. This will require some sort of DSO-customer interface(s).

WG C6.47 DSO-customer interfaces for efficient system operation

Key Objectives:

1) To investigate the requirements for communication, data exchange, visibility and controllability between a customer and its DSO.

2) Translate the identified requirements high-level design considerations for such a DSO-customer interface, to help move towards international best practices and standards for information exchange between DSOs and customers.

WG C6.47 DSO-customer interfaces for efficient system operation

- Scope:

All customers connected to the DSO grid (residential, commercial, and industrial; generators and loads; on MV and LV), and the role of the aggregator to be taken into consideration:

1. definitions relating to the DSO-customer interface(s).
2. current and future use cases requiring DSO-customer cyber-secure communication, illustrating the purpose of/need for more extensive information exchange and interoperability.
3. levels of controllability and visibility required by the DSO linked to the use cases.
4. use cases for which a new/improved interface is needed/helpful.
5. what data needs to be exchanged to support the identified use cases requiring a DSO customer interface (e.g., P, Q, I, U, E, instantaneous vs. averages vs. min/max, grid status, setpoints, maintenance schedules, emergency conditions, frequency of data e.g. 5 minutes or 15 minutes).
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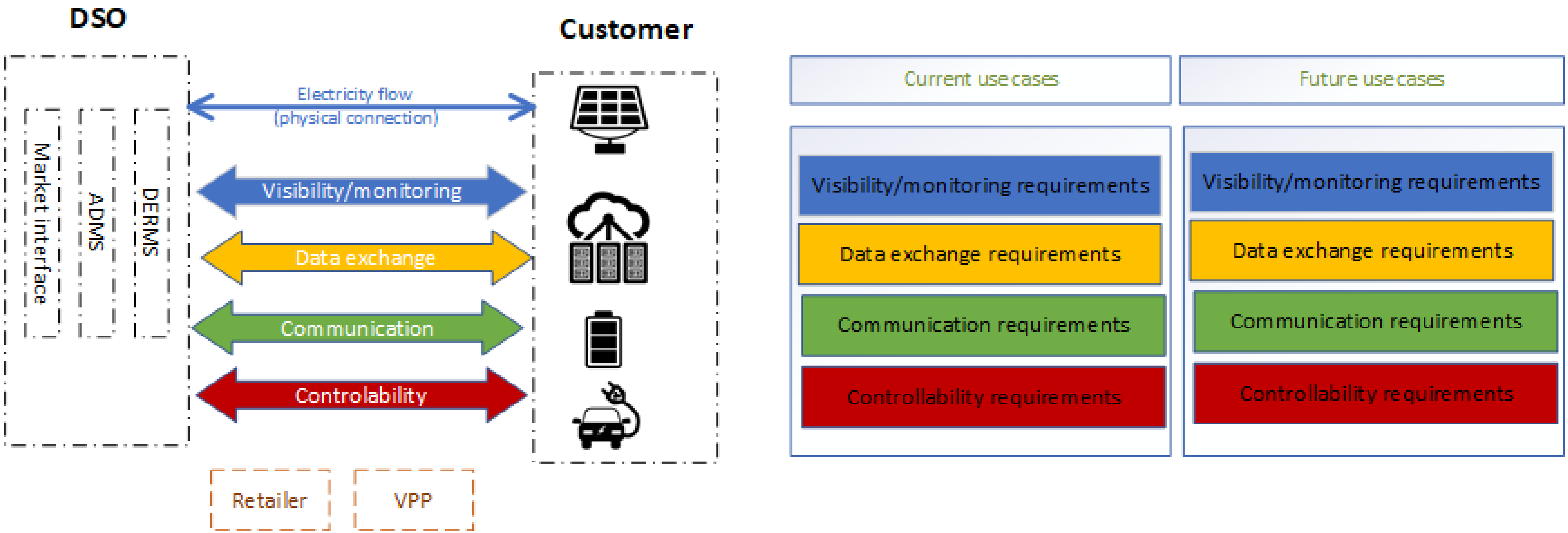
WG C6.47 DSO-customer interfaces for efficient system operation



WG C6.47 DSO-customer interfaces for efficient system operation

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- ☒ Tutorial
- ☐ Webinar
- Time Schedule:
- Recruit members (National Committees) Q3 2023
- Develop final work plan Q4 2023
- Draft TB for Study Committee Review Q4 2025
- Final TB Q4 2025
- Tutorial Q1 2026

19 member so far, none from UK, meeting twice, next on 31st January and also in Paris.

To convene and run a WG

- Application: topic within SC and ToR
- Convenor: relevant experience, management skill, strong networks, with existing materials
- Secretary: complementary, group management and meeting organisation, material collection and edit, use of KMS and other file exchange platform (act as a Convenor to some extent)
- Members: two formal members maximum from each country, not preventing more to attend as specialists
- Running WG: Regular meetings (in-person and online), Convenor/Secretary to have TB backbone and structure, not relying too much on members
- Deliverables: on time, 2 years, Annual reports, Technical Brochure (editorial and approval), workshop, webinar.

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THANKS FOR YOUR ATTENTION !

Presented by Prof. Jun Liang
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18/01/2024