CIGRE Study committe C6

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG C6.51

NAME OF THE CONVENOR
Yu James (UNITED KINGDOM)

TITLE
The role of Distribution Systems in supporting Resilience and Restoration

THE WG APPLIES TO DISTRIBUTION NETWORKS: YES

ENERGY TRANSITION
1 / Storage
3 / Digitalization
5 / Grids and Flexibility
6 / Solar PV and Wind
7 / Consumers, Prosumers and Electrical Vehicles
8 / Sector Integration

POTENTIAL BENEFIT OF WG WORK
1 / commercial, business, social, economic benefits
2 / potential interest from a wide range of stakeholders
3 / likely to contribute to new or revised industry standards
4 / state-of-the-art or innovative solutions or directions

STRATEGIC DIRECTION
1 / The electrical power system of the future reinforcing the End-to-End nature of CIGRE: respond to speed of changes in the industry by preparing and disseminating state-ofthe-art technological advances

SUSTAINABLE DEVELOPMENT GOAL
9 / Industry, innovation and infrastructure

BACKGROUND :
This WG aims to investigate over the course on the next 2 years the engineering, digital and commercial challenges and opportunities to treating the electricity distribution and transmission network as a whole, and converting distribution network (DN) as the key player in network resilience and restoration - a role has always been retained at transmission level. This WG has clear mission to bridge the gap between theory and practices so that our members can use it in their strategic development and daily operation. This WG is to be driven and owned by the industry partners, leverage- verify the latest findings and developments in the electricity sector and CIGRE (such as C2.26, C2/C6.36, C6.45 and more), with a focus on theorical and technology advancement. This will inform the specific opportunities for distribution systems to aggregate both the demand and resources to provide dynamic support for a safe operation of transmission network. It proposes:

- to break the silos of ownership and identify the regulatory and commercial barriers;
- to best capture the value of the application of system thinking;
- to pursue a clear purpose to enhance the internal collaboration

The Evolving Role of Distribution Networks in the Electricity System

Traditionally, electricity distribution networks—defined in the UK as systems operating at voltages of 132kV and below, and at 110kV in many parts of Asia and <35kV in the USA—have been viewed as passive infrastructures. Their primary function was to deliver electricity from the transmission system to end-users, with minimal

operational complexity or dynamic interaction. Planning and operation were largely centralized, with distribution networks playing a subordinate role in the overall energy ecosystem.

However, this paradigm is rapidly changing. Distribution networks are now at the forefront of the energy transition, driven by the proliferation of distributed energy resources (DERs), particularly renewable generation such as solar PV and wind. These resources are increasingly being connected at the distribution level, transforming the network from a passive conduit into an active participant in system balancing, flexibility provision, and decarbonization.

Technological advancements are accelerating this shift. Innovations such as Virtual Power Plants (VPPs)—which aggregate and coordinate DERs to act as a single dispatchable entity—are redefining the operational and theoretical frameworks of distribution systems. These technologies enable real-time optimization, enhance grid resilience, and unlock new value streams for consumers and operators alike.

As a result, the distribution network is evolving into a dynamic, decentralized platform that supports bi-directional power flows, active system management, and market participation - an active distribution network. This transformation necessitates a rethinking of regulatory models, planning methodologies, and operational strategies to fully harness the potential of distribution-level innovation.

PURPOSE / OBJECTIVE / BENEFIT OF THIS WORK :

The group aims to redefine the role of (active) distribution networks as supporting modules and active contributors to system-wide stability and resilience. This group acknowledges the ongoing efforts of other CIGRE working groups or technical brochures:

- TB 911 (WG C2.26) focuses on individual DER black start capabilities and feasibility studies, but lacks a system-level DN perspective, practical requirements, and engineering validation.
- TB 733 (JWG C2/C6.36) addresses DSO-TSO coordination in restoration but only for top-down approaches, without a framework for bottom-up DSO-led coordination.
- JWG C1/C4.46 on Optimising power system resilience in future grid design
- WG C4.47 on Power System Resilience
- WG C6.45 improves DN resilience through internal DER coordination, but does not consider external grid support and lacks validation in real-world engineering projects.
- WG C6.48 studies DN energy management and flexibility enhancement but does not provide a clear pathway for how DN flexibility can support resilience and restoration at both local and national levels.
- WG C6.49 focuses on the structure, control, and operation of individual VPPs within DN but does not address their role in supporting transmission (national-level) resilience and restoration needs.

This group will address these gaps by leveraging DN flexibility for multi-objective optimized support at both local and national level, defining practical engineering requirements, and validating solutions through flagship demonstration projects.

Objectives

- To assess the evolving technical and operational capabilities of distribution networks, including their potential to support transmission-level services such as inertia, frequency response, voltage stability, and black start.
- To identify practical requirements and effective response strategies for distribution networks in term of system-wide resilience enhancement.
- To propose a structured roadmap for the development of a modern theoretical framework that reflects the active role of distribution systems in the restoration of wider electricity system.
- To review major blackout events and extract lessons for future development. And to identify gaps in current planning, operational, and regulatory approaches that may hinder the full utilization of distribution-level capabilities.
- To foster collaboration across disciplines and geographies, ensuring the framework is robust, inclusive, and adaptable to different system contexts.

The forum would design mainly for the benefit of electricity transmission and distribution network operators and their customers. It aims to bring together a diverse group of stakeholders who are actively involved in shaping the future of the industry.

A secondary benefit would be that this forum would create a platform for knowledge sharing, networking, and collaboration among these stakeholders that would not typically be engaged by technical working groups, fostering meaningful discussions and driving positive change.

There are a number of working groups across CIGRE supporting various elements on black-start and this forum aims to draw on some of the outputs of these forums to take a holistic view of the Whole System and associated opportunities.

SCOPE :

This working group focuses on the resilience and restoration of the wide electricity system, with particular attention to the capabilities and contributions of (active) distribution networks. The working group will include a definition of a(n) (active) distribution network in the report. The working group would investigate and report on:

1. Existing activities and findings within CIGRE related to electricity distribution networks, power electronic capability, and the vectors by which they are connected to determine areas of commonality.

2. Identify global practices and developments for enhancing DN resilience and black start capability, with a focus on associated requirements such as market rules and business operations.
3. System-level flexibility utilization of DN for resilience and restoration, including:
a. Approaches for evaluating and coordinating distributed resources to support both internal distribution network operation and the external grid (i.e., at transmission level).
b. Methods for applying multi-objective optimization to balance resilience between local and national level.
4. Practical implementation requirements for real-world applicability, including:
a. Development of operational rules and specifications based on actual engineering projects (the working group aims to include requirements on data and information exchange).
b. Definition of infrastructure requirements for hardware (e.g., PMUs, communication facilities, smart switchgear, mobile generators) and software (e.g., real-time simulation, forecasting tools, smart control strategies) to ensure operational feasibility.
5. Real-world engineering validation of distribution-enabled resilience and restoration, including:
a. Verification of proposed approaches through practical projects in distributed black start, rapid frequency/voltage support, and overall grid resilience.
b. Incorporation of latest global innovation practices and flagship demonstrations (e.g., Distributed ReStart and BLADE projects in UK, Baochi ES project in China) to bridge the gap between simulation and engineering implementation.
6. Identify a technical framework for distribution networks' contribution to system resilience and present the latest examples.
7. Report the tool available, lessons from demonstration projects to inform a Technical Brochure.

DELIVERABLES AND EVENTS

Deliverables Types

CSE
Technical Brochure and Executive Summary in Electra
Tutorial
Webinar

Deliverables schedule

Webinar	Q3	2028	Webinar
Tutorial	Q3	2028	Tutorial
Technical Brochure	Q4	2027	Final TB
Technical Brochure	Q2	2027	Draft TB

Time schedule

Q1	2026	Recruit members
Q2	2026	Develop final work plan

APPROVAL BY TECHNICAL COUNCIL CHAIRMAN:

Rannveig Loken
May 18th, 2026