



TECHNICAL COMMITTEE REPORT

2024

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1 Introduction

This report summarises CIGRE UK Technical Committee (UK TC) related work conducted over 2024 and its intended recipients are the CIGRE UK members.

The report provides information on the structure of CIGRE UK TC, updated information from the lead areas within the remit of CIGRE UK TC, i.e. Technical Panels, Technical Events, Liaison activities and Session Papers. Since the concept for CIGRE UK for Technical Panels was introduced a few years ago, progress has been made in establishing a number of panels. Information with respect to the composition of these are given in the individual SC RM reports sections.

The report also contains statistical information courtesy of the Central Office with respect to the WG and their composition and outputs.

Finally, the report includes a brief update from each Regular Member (RM) representing UK in the international Study Committees.

CIGRE UK TC has a dedicated website and KMS webpage and relevant information relating to TC work is uploaded onto the KMS site. CIGRE UK membership can request access to the public parts of the KMS in order to keep informed on aspects of various TC works.

2 CIGRE UK Technical Committee

CIGRE UK Technical Committee mirrors the international CIGRE Technical Council with the specific aim of serving the technical requirements of CIGRE UK. In doing so CIGRE UK TC aims:

- 1 to be the technical thought leader for the UK electricity supply industry
- 2 to support the active participation in and access into the critical technical working groups of CIGRE,
- 3 to provide a staircase of new talent into technical study committees and working groups as the core of future expertise for the UK electricity supply industry,
- 4 to leverage overall CIGRE organization by providing greater depth of technical knowledge from the UK electrical supply industry.

CIGRE UK TC works towards the achievement of the above objectives by:

- 1 providing leadership in the practical development of the UK transmission and distribution networks,
- 2 ensuring CIGRE technical activities reflect the issues of interest/concern to UK,
- 3 establishing closer links between UK Regular Members and all UK members using adopted communication techniques in the form of Technical Panels,
- 4 establishing responsibilities expected from UK Regular Members in terms of representing the UK,
- 5 introducing review and selection process/methods for UK papers to maximize the number and quality of papers accepted by CIGRE Technical Council,
- 6 ensuring UK Regular Members gain clear view of technical topics of interest/concern to UK members,
- 7 promoting exchange of technical information to all UK members without commercial constraints.
- 8 promoting joint activities across TPs/SCs, providing further support to the TPs/SCs with smaller UK members/communities.

2.1 CIGRE UK TC Structure

CIGRE UK TC is structured as shown in Figure 1. Roles and responsibilities attached to each position can be found on CIGRE UK TC KMS webpage (<https://cigregrroups.org/x/EAX6>). In addition to the assigned roles the UK TC invites CIGRE UK Chair and Vice Chair as well as the NGN and Women’s Network representatives to the UK TC meetings. CIGRE UK TC normally meets 4 times annually and teleconference in the meantime as necessary.

In the past year, Ray Zhang stepped down and James Yu took over and became the new TC chair. Also, A1, B3, B4, C3, C5 and D2 had new RMs stepping up. We would like to thank all the outgoing members for their hardworking and contributions in serving their terms of office over the years, and wish all the new members every success in taking up the roles.

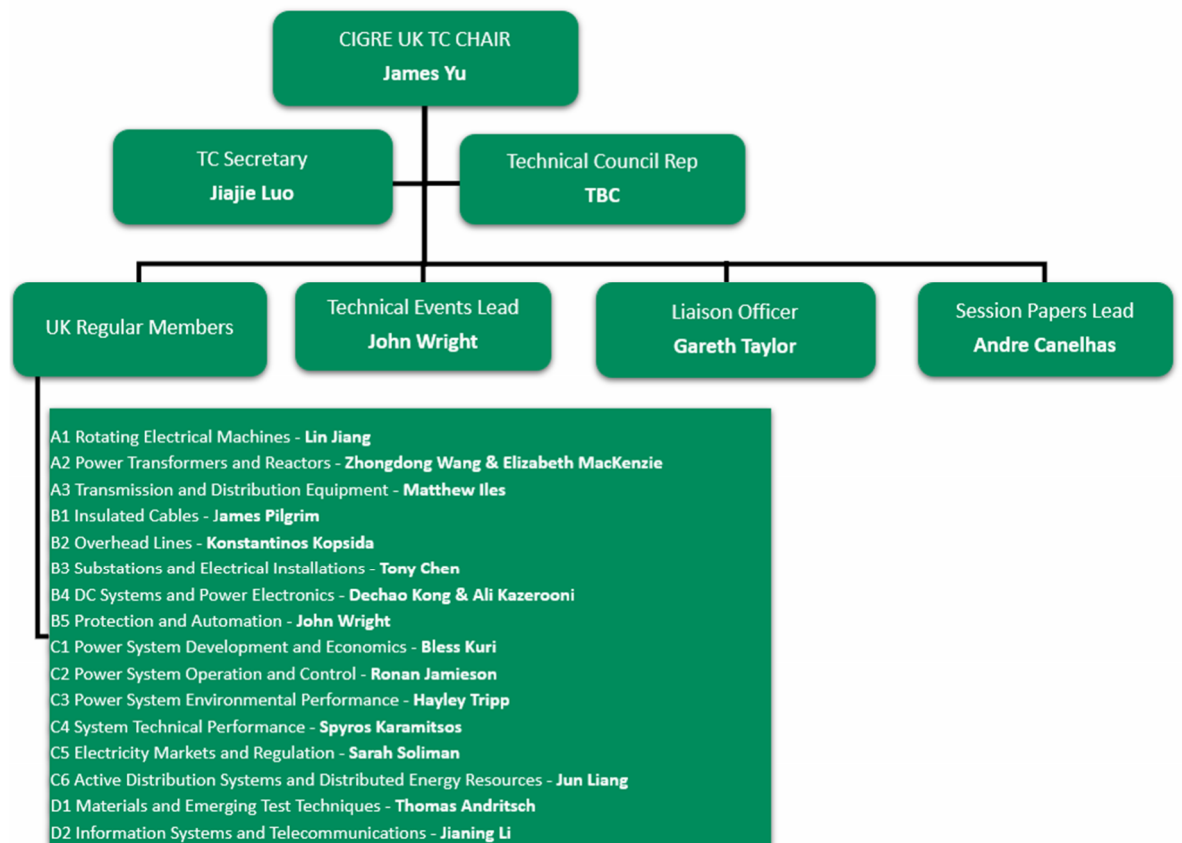


Figure 1: CIGRE UK TC structure

2.2 CIGRE UK Regular Members

The following table shows the current UK RMs serving in Study Committees along with their contact details.

Study Committee	Regular Member/Additional Regular Member	Email
A1	Lin Jiang	ljiang@liverpool.ac.uk
A2	Zhongdong Wang	zhongdong.wang@manchester.ac.uk
A2	Elizabeth Mackenzie	elizabeth.a.mackenzie@btinternet.com
A3	Matthew Iles	matthew.iles@nationalgrid.com
B1	James Pilgrim	japil@orsted.co.uk
B2	Konstantinos Kopsida	K.Kopsidas@manchester.ac.uk
B3	Tony Chen	lujia.chen@manchester.ac.uk
B4	Dechao Kong	Dechao.Kong.DIPS120@said.oxford.edu
B4	Ali Kazerooni	ali.kazerooni@gmail.com
B5	John Wright	john.w.wright@ge.com
C1	Bless Kuri	bless.kuri@sse.com
C2	Ronan Jamieson	ronan_jam@hotmail.com
C3	Hayley Tripp	Hayley.Tripp@nationalgrid.com
C4	Spyros Karamitsos	spyros.karamitsos@ieee.org
C5	Sarah Soliman	sarah.soliman54@gmail.com
C6	Jun Liang	liangj1@cardiff.ac.uk
D1	Thomas Andritsch	t.andritsch@soton.ac.uk
D2	Jianing Li	jianing.li@wsp.com

3 CIGRE-UK Technical Events

3.1 Introduction

CIGRE-UK has organised Technical Liaison Meetings, webinars, and many other events in this year. The active support of RM's, NGN and the wider CIGRE community has been greatly appreciated. For more details, please visit the CIGRE UK website, and follow the CIGRE UK LinkedIn account.

CIGRE UK Website:

<https://cigre.org.uk/category/events/>

LinkedIn:

<https://www.linkedin.com/company/cigre-uk/posts/?feedView=all>

3.2 Event Highlight and Summary

Event	Time	Type
A2/D1 Liaison Meeting	27-28 Nov	In-person*, Manchester
CIGRE UK AGM and Post Paris Session 2024 Technical Conference	13-14 Nov	In-person, Birmingham
A2-NGN BRUSH Transformer site visit	07 Nov	In-person, Loughborough
Uniting Academia and Industry for Net Zero Ambitions	29 Oct	In-person, London
Digitalisation and Data Science Conference – Enabler for Net Zero	27 Sep	In-person, London
Paris Session 2024	Aug	In-person, Paris
TC-NGN Birmingham Decarbonisation Summer School	June	In-person, Birmingham
Artificial Intelligence in the Energy Sector & Understanding Neurodiversity	21 May	In-person, Birmingham
CIGRE NGN Training Session on Substation Fundamentals	12 Mar	In-person, Stafford
A3/B3 Liaison Meeting	07 Feb	In-person, Manchester
NGN Young Member Showcase	24 Jan	In-person, Cardiff
A3/B3 Liaison Meeting	07 Feb	In-person, Stafford
A2/D1 Liaison Meeting	09 Jan	In-person, Manchester

*most in-person events provided remote joining capability.

3.3 CIGRE-UK Webinars

Webinar Programme

Date	Title	Presenter
Jan	<u><i>How to convene & effectively participate in CIGRE Technical Working Groups</i></u>	Jun Liang, Charlotte Higgins
Feb	<u><i>Whole Energy System Accelerator</i></u>	Joseph Melone, Priya Bhagavathy, David Wyatt

Mar	<u><i>The importance of transformer specification and supplier selection in managing equipment, network and project delivery risks</i></u>	Jose Quintana
Apr	<u><i>Utilities to Better Understand Weather Related Outages in a Changing Climate</i></u>	Daniel Donaldson
May	<u><i>Dynamic Power Cable Installation for Floating Wind Farms: An Operational Perspective on Future Challenges</i></u>	Daniele Caruso
June	<u><i>The advantages of voltage control on a Smart Distribution Network</i></u>	Jon Hiscock
July	<u><i>Addressing Electromagnetic Interference Issues for Safe Transition to Net Zero Transmission Network and Clean Energy</i></u>	Himanshu Negi
Sep	<u><i>Monitoring of Circuit Breakers Switching Shunt Reactors</i></u>	Phil Moore
Oct	<u><i>Centralization of Cybersecurity system meeting Standards & Regulation</i></u>	Prasad Balasubramani

4 CIGRE-UK Technical Panels

More information on the UK Technical Panels is available on individual Regular Member reports of this document.

5 Information from Paris Central Office

The following statistical information is based on data from the Paris Central Office relating to technical activities within CIGRE for the year 2023. Data related to 2024 will be available in 2025.

Normally we receive updates from the Central Office about information of active working groups and working group membership. However this year a working group management tool is under development and such information is not passed to us at the time of writing this report.

5.1 Working Group Publications

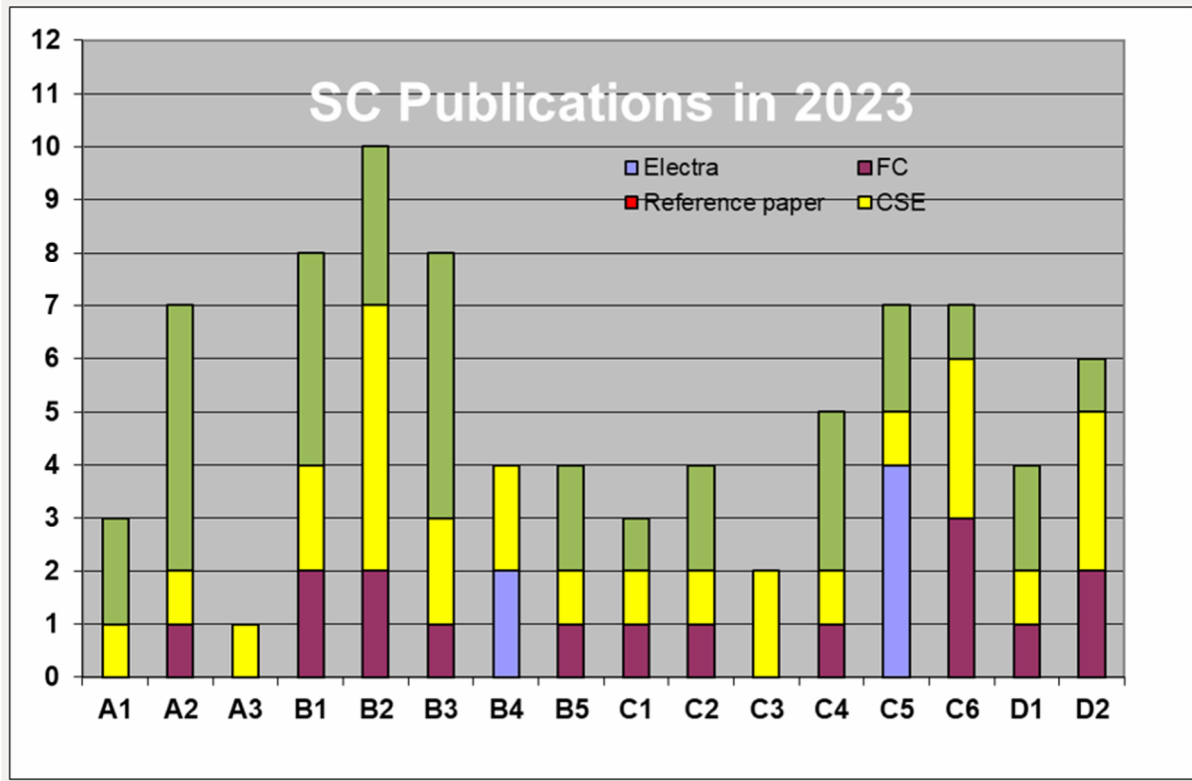


Figure 2: Study Committee Publications

- B2 has the most publications in the past year combining all categories.
- As shown in Figure 2, A3 has produced the least publication in the past year.

6 RM Report on SC A1 Rotating Electrical Machines

6.1 Study Committee Scope

SC Chair: Howard SEDDING
 SC Secretary: P. WIEHE

In 2024, the SC changed its name from “Rotating Electrical Machines” to “Power generation and electromechanical energy conversion” to better serve the evolving landscape driven by the energy transition.

The SC covers the full equipment lifecycle, from research, development, design, manufacture, and testing of power generation and electromechanical energy conversion equipment and their associated auxiliaries to commissioning, operation, condition assessment, maintenance, life extension, refurbishment, upgrades, efficiency improvement, conversion (e.g., from power generation duty to synchronous condenser/compensator duty), storage, and de-commissioning.

Within these fields, SCA1 promotes the international exchange of information, knowledge, practice, and experience and adds value by synthesizing state-of-the-art practices to develop guidelines and recommendations.

6.2 SC-A1 Advisory Groups

- AG A1.01: Turbogenerators
- AG A1.02: Hydro-Generators
- AG A1.05: Wind Generators and New Technologies
- AG A1.06: Large and High-Efficiency Motors

- Details of the Advisory Group Coordinators:

Advisory Group		Convener	
No	Name	Name	email address
AG01	Turbogenerators	Monique Krieg (Netherlands)	m.g.krieg@eic-highenergy.com
AG02	Hydro-Generators	Johnny Rocha (Brazil)	johnny.rocha1959@gmail.com
AG05	Wind Generators and New Technologies	Luis Rouco (Spain)	rouco@comillas.edu
AG06	Large and High Efficiency Motors	Erli Figueriedo (Brazil)	erliff@uol.com.br

6.3 2024 Preferential Subjects

For the 2024 Group Discussion Session, three preferential subjects were proposed to stimulate discussion considering the strategic directions.

- PS1 - Rotating Electrical Machines and the Energy Transition
- PS2 - Evolution and Development

- PS3 - Keeping the Lights On

A total of 29 papers have been accepted and published.

a) Preferential Subject 1: Rotating Electrical Machines and the Energy Transition

The preferential subject covers:

- Impact of the energy transition on the role, duty, and flexible operation of rotating electrical machines,
- Changing requirements on rotating machines to support the evolution of smart grids,
- Update of international standards for electrical machine requirements to reflect future applications.

Nine papers were accepted under PS1.

b) Preferential Subject 2: Evolution and Development

The preferential subject covers:

- Developments in the design of generators for new applications such as wind turbines, synchronous compensators, and variable speed pump storage,
- Improvements in design, manufacture, efficiency, insulation, cooling, bearings, and materials,
- Enhancements in the performance, reliability, and control of rotating electrical machines,
- Design evolution of rotating electrical machines based on operational experience

c) Preferential Subject 3: Keeping the Lights On

The preferential subject covers:

- Condition monitoring, diagnosis, and prognosis of rotating electrical machines, including the use of artificial intelligence, deep learning techniques and digital twin concepts,
- Ensuring power supply reliability by asset management of installed base and maintenance practices,
- Improving performance and extending the operational service life of installed base through refurbishment, replacement, and power up-rating, and methodologies to establish the sequence of machines to be refurbished/replaced.

6.4 Technical Panel Meetings, Seminars &Tutorials

Two SC A1 Tutorials were given in the Paris Session on Tuesday morning, 27th of August 2024.

1. “Survey of Partial Discharge Monitoring in Large Rotating Machines”.

This tutorial presents the highlights from the survey carried out by WG A1.63 on discharge monitoring of large motors and was presented by Andre T. Carvalho (Brazil).

2. “Challenges in designing salient pole synchronous condensers equipped with negative excitation systems”.

Due to the challenges resulting from the energy transition, synchronous compensators/condensers are widely used in many countries to support grid power quality and operational performance. This tutorial explains their design principles, how their operation differs from traditional machines used for power generation and design challenges. It will also give an example of how negative excitation can be used to extend the MVAR capability. Johnny Rocha (Brazil) presented the tutorial.

6.5 Current Working Group Status (March 2024) and UK member (Bold)

WG Nr.	ADVISOR Y GROUP	WG TITLE	CONVENOR	STATUS
A1.42	AG-02	Influence of key requirements to optimize the value of hydro generators	Eduardo Guerra	TB prepared. Final check before review under 6-week rule.
A1.43	AG-02	State of the art of rotor temperature measurement	Stjepan Tvoric	The work is complete and reviewed; a report will be published in 2024.
A1.45	AG-06	Guide for Determining the Health Index of Large Electric Motors	Dr Zhang Pinjia	The responses to the distributed questionnaire have been insufficient so far to complete the work. The SC will assess how to continue with this working group.
A1-C4.52	AG-05	Wind generators and frequency-active power control of power systems	Nick Miller	TB in preparation.
A1.53	AG-06	Guide on Design Requirements of Motors for Variable Speed Drive Application	AK Gupta	Needs revision following 6-week rule feedback. Work to be reallocated as Mr. Gupta has retired.

A1.55	AG-02	Survey on Split Core Stators	Sun Yutian	Draft report available. Will be rechecked before submitting for review under the 6-week rule.
A1.56	AG-02	Survey on Lap and Wave Winding and their Consequences on Maintenance and Performance	Richard Perers	TB prepared. Final check before review under 6-week rule.
A1.58	AG-06	Selection of Copper Versus Aluminium Rotors for Induction Motors	Fredemar Rüncos	TB prepared. To be circulated for review under the 6-week rule.
A1.60	AG-02	Guide on economic evaluation for refurbishment or replacement decisions on hydro generators	Mark Bruintjies	Questionnaire responses are being analysed.
A1.61	AG-06	Survey of Partial Discharge Monitoring in Large Motors	André Tomaz de Carvalho	TB in preparation.
A1.62	AG-02	Thrust Bearings for Hydropower - A Survey of Known Problems and Root Causes	Daniel Langmayr	Limited responses were received from the questionnaire making it difficult to compile a globally representative report. The SC will review how to conclude this working group.
A1.63	AG-01	Turbo Generator Stator Winding Bushings and Lead Connections – Field Experience, Failures and Design Improvements	Jabulani Bembe	Questionnaire responses are being analysed.
A1.64	AG-06	Guide for Evaluating the Repair / Replacement of Standard Efficiency Motors	Erli Ferreira Figueiredo	Report in preparation.
A1.67	AG-02	State of the Art in methods, experience and limits in end winding corona testing for Hydro Generators	(Hélio de Paiva Amorim Junior)	New convenor required.
A1.69	AG-02	Hydro-Generator Excitation Current Anomalies	J. Johnny Rocha E.	Team assembled.
A1.70	AG-01	Dielectric Dissipation Factor Measurements on Stator Windings	Monique Krieg-Wezelenburg	To be issued in several parts due to volume of content. > TB 918 “DDF Measurements on Stator Windings – Part 1

				<p>Survey Answers” issued.</p> <ul style="list-style-type: none"> > Part 2 in progress. > > UK Member > Richard Ludlow (member) > Ian Simmonds (member)
A1.71	AG-02	Survey on damper-winding Concepts and its operational experience on hydro generators and motor-generators	Thomas Hildinger	Questionnaire is being prepared.
A1.72	AG-02	Survey on multi-turn coils with dedicated turn insulation versus coils without dedicated turn insulation	Yoon Duk Seol	Questionnaire is being prepared.
A1.73	AG-02	Customer Requirements for Qualification of Form Wound Stator Insulation Systems for Hydro Generators	Dr. Marcelo Jacob da Silva	Questionnaire completed and circulated on 13 March 2024.
A1.74	AG-06	Evaluating quality of electric motors (previously WG A1.68)	Kondra Nagesh	Questionnaire being prepared. Need to review WG status & schedule.
A1.75	AG-01	Large air-cooled turbo-generator – state of the art, limits and perspectives for Small Modular Reactors	Vincent Fernagut	Questionnaire is being prepared
A1.76	AG-01	Study on Eco-Design, Circular economy and impacts on generator production process	Raül Morales Garcia	Questionnaire is being prepared
A1.77	AG-06	Survey on Insulation Reliability of Induction and Synchronous Motors	Fernando Spezia	Planning of work. Need more WG members. Request for WG members to be recirculated.

7 RM Report on SC A2 Transformers

7.1 Study Committee Scope

SC Chair: Pascal Müller

SC Secretary: Mark Foata

7.2 Mission

To facilitate and promote the progress of engineering and the international exchange of information and knowledge in the field of Power Transformers and Reactors. To add value to this information and knowledge by means of synthesizing state-of-the-art practices and developing recommendations.

The scope of SC A2 includes:

- Theory, principles and concepts, functionality, technological development, design, performance and application of materials, efficiency;
- Manufacturing, quality assurance, application guidance, planning, routing and location, construction, erection, installation;
- Reliability, availability, dependability, maintainability and maintenance, service, condition monitoring, diagnostics, restoration, repair, loading, upgrading, uprating;
- Refurbishment, re-use/re-deployment, deterioration, dismantling, disposal.

Study Committee A2 pursues mainly two strategic directions (SD) based on the needs and requirements of their customers. The first addresses business and commercial considerations and concerns and is labelled "Services to Customers", while the second is related to "Technology Issues".

Services to Customers includes

- Life management of transformers and reactors includes:
- Economic issues;
- Reliability and availability information on power transformers in service;
- Impact of accessories on transformer reliability;
- Promotion and dissemination of Study Committee A2 work.

Technology Issues includes:

- Application of new materials;
- Better energy efficiency and lower environmental impact;
- New concepts.

UK representation on the committee is Prof. Zhongdong Wang (RM) and Elizabeth MacKenzie (ARM).

The scope of SC A2 covers:

- All kinds of power transformers, including HVDC transformers converter and phase-shifting Transformers;

- All kinds of reactors, including shunt reactors, series reactors, and HVDC smoothing reactors;
- All transformer components, including bushings, tap-changers, and other transformer accessories.

The key activities of SC A2, which cover the life cycle of a transformer, are related to the four following key domains:

- Specification, procurement and economics
- Design, manufacturing and testing
- Operation, reliability, safety and environmental impact
- Maintenance, diagnostics, monitoring and repair

Key domains (1) and (2) are associated with transformer technology, while key domains (3) and (4) are associated with transformer utilization. SC A2 will normally have activities in order to continuously cover the four key domains.

SC A2 is also moving to consider MV/LV issues.

UK representation on the committee is Prof. Zhongdong Wang (RM) and Elizabeth MacKenzie (ARM).

7.3 Strategic Advisory Groups

AG 2.1 Strategic – Pascal Mueller;
 AG 2.2 Knowledge Transfer – Tara-Lee McArthur;
 AG 2.3 Transformer Technology – Khayakazi Dioka;
 AG 2.4 Utilisation/operation - Brendan Diggin;
 AG 2.6 Green Book – Simon Ryder;
 AG 2.7 Transformer Digitalisation – Patrick Picher;
 AG 2.8 Lower Voltage Applications – Peter Werle.

7.4 Preferential Subjects

The Preferential Subjects for 2024 Paris Session were:

PS 1: Design of resilient transformers
 PS 2: Advances in transformer analytics
 PS 3: Reliability of transformers for renewable energy
 Eight papers with UK input were published.

7.5 New Working Groups

B3/A2/A3/C3/D1.66	Guidelines for life cycle assessment in substations considering the carbon footprint evaluation	UK Member: Hang XU
Task force	Silver Corrosion in Transformer	
A2.73	Enhancing the exchange of Transformer information through digitalisation	
A2/D1.74	Online moisture monitoring of transformers for ageing assessment	

In preparation	Tap Changer Specification, Condition Assessment, Testing and Maintenance Guidelines	
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7.6 Technical Panel Meetings, Seminars & Tutorials

The last UK A2 technical panel and A2/D1 liaison meeting were held in person on 9th January 2023. 58 individuals registered to attend.

The next technical panel and liaison meetings are scheduled on 27th-28th November 2024 at the University of Manchester, with one day for the liaison meeting and technical panel meeting, and one day for a transformer research dissemination meeting.

For the CIGRE UK monthly webinars, A2 has contributed two webinars this year: “The Importance of Transformer Specification and Supplier Selection in Managing Equipment, Network and Project Delivery” by Jose Quintana, and “The Critical Role of Online DGA in Preventing Transformer Failures: a Case Study Approach” by Michelle Fiddis and Shuhang Shen.

A2 has also arranged a visit to the Brush Transformers factory in Loughborough, in conjunction with NGN, on 7th November 2024, and is planning a presentation competition event early in 2025.

7.7 Technical Brochures published in 2024

Three technical brochures have been published recently, and three documents are under final review and due for publication this year (dates as of CIGRE Session in August):

WG	Title	Status
A2.62	Analysis of Power Transformers Reliability	Published, TB939
A2.64	Condition of cellulose insulation in oil immersed transformers after factory acceptance test	Published, TB937
A2.57	Effects of DC Bias on Power Transformers	Publication October
A2.54	Power Transformer Audible Sound Requirements	Published, TB940
A2.56	Power Transformer Efficiency	Final draft under comments resolution
TF	Power Transformers Sound Levels on Site	Final draft under review

A paper on “Mitigation of fire due to high energy internal arc in bushing turrets” (EDF, Siemens) was published in CIGRE Science and Engineering (CSE) in February 2024.

7.8 Current Working Groups and UK Members

WG	Title	UK Member	Organisation
A2.58	Installation and Pre-Commissioning of Transformers and Shunt Reactors	John Lapworth Ian Hunter	Doble Polaris
A2.59	On-Site Assembly, On-Site Rebuild, and On-Site High Voltage Testing of Power Transformers	Simon Ryder	Doble
A2.60	Dynamic Thermal Behaviour of Transformers	Muhammad Daghrah Jose Quintana Xiang Zhang	M&I Materials SPEN MMU

A2.63	Transformer Impulse Testing	Qiang Liu	Manchester Univ.
A2/D2.65	Transformer Digital Twin – concept and future perspectives	Zhongdong Wang Tim Zhao	Manchester Univ.
A2/D1.66	Breathing systems of liquid filled transformers and reactors	Russel Martin	M&I Materials
A2/D1.67	Guideline for Online Dissolved Gas Analysis Monitoring	Michelle Fiddis Shuhang Shen	GE Exeter Univ.
A2.68	Failure Survey of Lower Voltage Generator Step Up Transformers installed in Wind farms and Photovoltaic Parks	Elizabeth MacKenzie Denis Nesbitt Florian Marpoux Muhammed Dagrah	Consultant Doble EdF M&I
A2.69	Guide for transformer maintenance – update	Allan Holton Paul Jarman	SPEN Manchester Univ
D1/A2.77	Liquid tests for Electrical Equipment	Atitila Gyore Qiang Liu Russel Martin David Walker Gordon Wilson	M&I Materials Man Univ. M&I Materials SPEN NG
A2/C3.70	Life Cycle Assessment (LCA) of Transformers	Hang Xu	Man Univ.
A2/D1.71	Modern insulating liquids qualification for OLTC, bushings and other accessories	None	
A2/D1.72	Retrofill of mineral oil in transformers – Motivations, considerations and guidance	Paul Dyer Caleb Walker	UKPN SPEN
A2.73	Enhancing the exchange of transformer information through digitalization	New	
A2/D1.74	Online moisture assessment of transformers for ageing assessment	New	
D1/A2.79	Improved understanding of dynamic behaviour of winding insulating materials in liquid insulated power transformers		
D1/A2.80	Functional properties of non-metallic solid materials for liquid filled transformers and reactors and their compatibility with insulating liquids		

Due to considerable interest from UK members, A2 has also set up a UK mirror group for JWG A2/C3.70, Life Cycle Assessment (LCA) of Transformers. This group will shadow the working group, with the UK WG member liaising between the WG and the mirror group.

7.9 Working Group Updates

A2.54 Update

The purpose of the Working Group was to provide clear, up-to date guidance to help users specify sound levels for power transformer applications. The Working Group produced graphs showing high, low and average sound levels for transformers of different rated power for no-load, load and cooling

system sound, which can be used to specify sound levels for new transformer purchases. Best practice guidance was produced for transformer sound level specification, along with practical examples of how to use the graphs when specifying sound levels. An overview of factory installed and site installed noise mitigation methods was provided. The work is now complete and the technical brochure (TB 940) was published in September 2024.

A2.57 Update

The purpose of the working group is to look at the effects of DC bias on power transformers. The TB has been completed and should be published this year.

A2.58 Update

The purpose of the working group is to look Site Installation and Pre-commissioning of Transformers and Shunt Reactors. The TB is almost complete and expected to be published in 2025.

A2.60 Update

Working group A2.60 (dynamic thermal behaviour of power transformers) focuses on reviewing and improving Dynamic Transformer Thermal Modelling (DTTM), particularly enhancing the IEC standard model with considerations for cooling systems, new insulating liquids, and sub-zero temperatures. The group includes five UK members. Since its start in September 2019, the group has made significant progress, notably developing and publishing the DTTM Benchmarking Platform (DTTM-BP). The Technical Brochure is approximately 70% complete. Currently, the group is focusing on expanding the Transformer Thermal Scenario database and integrating proprietary DTTMs into the benchmarking platform. The working group is expected to deliver the Technical Brochure in September 2025.

A2.63 Update

The purpose of the working group is to look Transformer impulse testing. The WG is planning to publish three technical brochures, two by end of 2024 and one in 2025. TB is almost complete and expected to be published in 2025.

A2/D2.65 update

The purpose of the WG A2/D2.65 is to define the concept and future perspectives for transformer digital twins. There have been two UK members in this working group. In 2024, there have been two meetings held. A draft of the technical brochure was initiated and discussed in Paris. Moreover, a questionnaire was conducted on applications and benefits of transformer digital twins, and hence help the WG understand the present status of transformer digital twins, as well as the expectations around the world. Most of the TFs are completed over 50%. There will be two meetings held next year in Feb and Oct, respectively. The final draft of the TB will be completed by the end of 2025!

A2/D1.66 Update

The scope of the WG is Breathing systems of liquid filled transformers and reactors. A questionnaire has been distributed and the ta group is split into task forces to look at various aspects. The plan is to have a draft brochure completed in 2025.

A2/D1.67 Update

The purpose of the WG is to develop guidelines for the interpretation, acceptable limits and trends for online DGA monitoring equipment, alarm response strategy, DGA system specification, and maintenance requirements, and to provide examples of the different use cases for online DGA systems. The UK has two members in this working group, one from manufacturer and one from university. There have been two online meetings and one in-person meeting during CIGRE Paris Session in 2024 for the whole working group. There have been multiple individual meetings held in 2024 within each of the six Task Forces.

The outline of the technical brochure has been drafted. Chapters including alarm response, monitor specifications and maintenance have started drafting. Data collection template on online DGA monitoring results has been produced and data collection and analysis are ongoing. Two surveys on maintenance have been drafted and spread out. OEM survey has been closed and analysis on the survey is ongoing. User survey has been circulated and collection is ongoing. In addition, case studies on alarm response strategies have been collected from utilities and literature. Next steps including

analysis of the collected data, OEM/User surveys and technical brochure write-up. The WG is due to end in 2025.

A2.68 update

The purpose of the WG is to validate by use of a survey whether or not there is a higher failure rate of windfarm and solar park transformer than the general population, and if there are common failure causes. The UK has five members in this working group. There have been seven online meetings of this working group and one in-person meeting in 2024. The outline of the technical brochure has been drafted, with names allocated to chapters. The simple survey has been produced. Data has been received, with more than 2000 transformers added to the database so far. The WG is due to end in Q1/2026.

A2/C3.70 update

This WG is looking at LCA for Transformers. There is a mirror group for UK participants. The data should be collected and the TB published in 2025.

A2/D1.71 update

This WG is looking at Modern Insulating Liquids Qualification for OLTC, Bushings and other accessories. There is no UK member of the WG. The TB is expected to be published in 2026.

A2/D1.72 update

This WG is looking at Retrofill of mineral oil in transformers motivations, considerations and guidance. The TB is expected to be published in 2026.

A2/D1.74 update

This is a new WG looking at Online moisture monitoring of transformers for ageing assessment. Members are currently being recruited and it hopes to complete work by 2028.

JWG D1/A2.66 update

The purpose of this group is to improve and to extend the current knowledge on transformer breather and sealed expansion systems. It has 18 members, 1 from the UK. The work of the group has been split between a number of TF, to enable many topics to be developed simultaneously. The draft brochure is being developed on KMS. The group started its work in 2022 and is expected to complete its work by the end of 2025.

JWG D1/A2.77 update

The purpose of this group is to improve and to extend the current knowledge on chemical and electrical tests applicable to electrical equipment to other liquids than mineral oil. It is a large group with approximately 70 members, 5 from the UK, headed by Fabio Scatiggio as convenor. The group started its work in 2020 and is expected to complete its work by the end of 2024, with publication of the technical brochure soon after.

The work of the group has been split between 3 TF, to enable many topics to be developed simultaneously. Currently, the draft brochure (on KMS) is up to version 16.

TF A2.01 Update

The purpose of the Task Force was to consider why the sound levels of power transformers often differ when measured on site compared to when measured in the factory. The Task Force identified differences between factory and site noise measurements and effects on sound levels, produced best practice guidance to reduce these differences and made recommendations for a future working group to research further. The Task Force met 6 times in person and 6 times virtually and was made up of utilities, manufacturers and consultants. The UK had one member. The brochure has been drafted and submitted to Cigre for review. Cigre have requested a Working Group be set up to research further the findings of the Task Force. A ToR is due to be produced to define the scope of the Working Group.

7.10 UK Members of the Technical Panel

Name	Organisation	Role	WG
Zhongdong Wang	Manchester University	Chairman	65, 73
Elizabeth MacKenzie	TCL	Vice-Chairman	68
Jose Quintana	SP Energy Networks	Secretary	60
ShengJi Tee	SP Energy Networks	Events	62
Paul Jarman	Manchester University	Member	57, 60, 69
Paul Dyer	UK Power Networks	Member	74
Steve Blanche	Hyosung	Member	
Wenhui Deng	SSE	Member	
Tom Breckenridge	TB TCS	Member	
Ian Hunter	Polaris	Member	
Qiang Liu	Manchester University	Member	63
Simon Ryder	Doble	Member	58
Ruth Hooton	National Grid	Member	
Andrew Reynolds	National Grid	Member	
David Walker	SP Energy Networks	Member	77
Dave Fishman	Btrac	Member	
Jonathan Walmsley	GE	Member	
Hari Maletapi	Wilson Power Solutions	Member	
Prakash Dahi	Brush Transformers	Member	
Partha Subramanian	Winder Power	Member	
Jim Butler	Rosh Engineering	Member	
Mike Munro	Polaris Diagnostics	WG Member	64
Kevin Wilson	Wilson Power Solutions	WG Member	56
Dongsheng Guo	National Grid	WG Member	57
John Lapworth	Doble	WG Member	58
Muhammad Daghrah	Midel & Mivolt Fluids	WG Member	60, 68
Stefan Dragostinov	Doble	WG Member	63
Sicheng Zhao	Manchester Power Solutions Ltd	WG Member	65
Janine Dickinson	National Grid	WG Member	54, TF1
Xiang Zhang	Manchester Met University	WG Member	60
Allan Holton	SP Energy Networks	WG Member	69

Michelle Fiddis	GE	WG Member	67
Shuhang Shen	Exeter University	WG Member	67
Florian Marpoux	EDF Renewables	WG Member	68
Dennis Nesbitt	Doble	WG Member	68
Hang Xu	Exeter University	WG Member	70
Steven Vallance	SP Energy Networks	WG Member	70
Caleb Walker	SP Energy Networks	WG Member	74
Jamie Beardsall	Drax Power	WG Member	65
Fraser Cook	Qualitrol DMS	WG Member	66
Russell Martin	Midel & Mivolt Fluids	WG Member	66
Attila Gyore	Midel & Mivolt Fluids	WG Member	72

8 RM Report on SC A3 Transmission and Distribution Equipment

8.1 Study Committee Scope

Outgoing SC Chair: Nenad Uzelac

Incoming SC Chair: Nicola Gariboldi

SC Secretary: Frank Richter & Paolo Mazza

The scope of SC A3 covers all kinds of transmission and distribution equipment above 1kV, including:

- All kinds switching devices, including AC and DC at the MV, HV and UHV ranges;
- All kinds of instrument transformers, including non-conventional instrument transformers for AC and DC applications;
- Surge Arresters for AC and DC applications.
- Digitization and the implications of new and emerging technologies such as digital twins, machine learning, virtual and augmented reality and new substation functions.

The key activities of SC A3 address topics throughout all life-cycle phases; from conception, through research, development, design, production, deployment, operation, and end-of life.

At all stages the, technical, safety, economic, environmental and social aspects are addressed as well as interactions with, and integration into, the evolving power system and the environment. Technical aspects such as performance, specification, testing and the application of testing techniques are covered as well as asset management topics such as life cycle assessment techniques, safety and risk management techniques, education and training. Some of the key topics include:

- Theory, principles and concepts, functionality, technological development, design, performance and application of materials, efficiency.
- Manufacturing, quality assurance, application guidance, planning, routing and location, construction, erection, installation.
- Reliability, availability, dependability, maintainability and maintenance, service, impacts of harmonics, condition monitoring, diagnostics, restoration, repair, loading, upgrading, uprating.
- Environmental considerations, both of the equipment impact on the environment and the natural environment (and its changes) impact on the equipment.
- Increasing asset intelligence or capability enhancement through intelligent or advanced control and protection, use of integrated sensors, interaction with future networks and the impact of increased distributed and renewable generation.
- Refurbishment, re-use/re-deployment, deterioration, dismantling, disposal.

UK representation on the committee is Matthew Iles (RM).

8.2 Strategic Advisory Groups

AG 3.01 strategic planning – Nenad Uzelac;

AG 3.02 Utility Advisory board – Robert Le Roux;

AG 3.03 Green Book – Hiroki Ito;

8.3 Preferential Subjects

The Preferential Subjects during the 2024 Paris session were:

1. PS 1: Energy transition involving T&D equipment

- Innovative technologies to reduce total cost of ownership and to foster the energy transition.
- Novel applications especially DC and increased duties on equipment due to DER.
- Improvement of grid resilience due to climate change: the impact on equipment requirements.

2. PS 2: Lowering the carbon footprint of T&D equipment:

- Performance & maturity of SF6 alternatives – report on industry experience.
- Life cycle assessment of T&D Equipment.
- Life cycle management and life extension of existing equipment.

3. PS 3: Maintaining and management T&D assets:

- Smart sensors, low power instrument transformers, monitoring, condition assessment and application of IoT.
- Digital twin and equipment reliability modelling also covering new / higher load profiles.
- Big data management and data ownership, with respect to equipment condition assessment.
What are the future needs and requirements of an end-to-end power system?

In all 78 reports were accepted, 2 of which were from the UK.

8.4 New Working Groups

New WGs:

- JWG B3/A2/A3C3/D1.66 Guidelines for Life Cycle Assessment in Substations considering the carbon footprint evaluation
- JWG B3/A3.67 Operational safety of Medium Voltage GIS in case of abnormal leakage
- JWG C4/A3/B2/B4.75 Guide to procedures for the creation of contamination maps required for outdoor insulation coordination

WGs Disbanded:

Three working group finished their work.

- JWG C4/A3.53 (TB 921).
- JWG B3/A3.59 (TB 914).
- WG A3.40 (TB 931)

8.5 Technical Meetings, Seminars & Tutorials

The last meeting of the A3 Study Committee met on the 29th August 2024 at the CIGRE Paris Session. The meeting took place in person.

There has been a meeting of the strategic advisory group in Milan in March 2024. The main SC has last met at the Cairns symposium 2023.

The next meeting of the A3 SC will be at the Montreal Symposium in September 2025.

There will be 2 further events in 2025. CIGRE B3/A3 Forum, Klingenberg, Germany in March. Symposium, Trondheim, Norway in May.

8.6 Technical Brochures and Publications

As working group activity has been limited, technical brochures and Electra articles are still outstanding. The following table details the most recent publications, and pending publications related to SC A3.

Ref.	WG	Title
TB 921	JWG C4/A3.53	Applying Low-Residual-Voltage Surge Arresters to Suppress Overvoltages in UHV AC Systems
WBN053	CZC	1. Fundamentals of Current Interruption in (High-Voltage) Vacuum
TB 914	JWG B3/A3.59	Guidelines for SF6 end-of-life treatment of T&D equipment (>1kV) in Substations
WBN041	CZC	The fundamentals of current interruption in SF6 and its alternatives
TB 873	JWG B4/A3.80	Design, test and application of HVDC circuit breakers
TB 871	A3.41	Current interrupting in SF ₆ -free switchgear
TB 830	A3.36	Application and benchmark of multi-physics simulation tools and
TB 817	A3.38	Shunt capacitor switching in distribution and transmission systems
TB 816	A3.30	Substation equipment overstress management
TB 757	A3.35	Guidelines and best practices for the commissioning and operation of controlled switching projects
TB 737	JWG A3.32/CIREDA	Non-intrusive methods for condition assessment of distribution and transmission switchgear
TB 725	A3.29	Ageing high voltage substation equipment and possible mitigation
TB 716	A3/B5/ C4.37	System conditions for and probability of out-of-phase
Electra Paper	A3.31	Instrument transformers with digital output
TB to be published soon	A3.39	Application and field experience with metal oxide surge arresters

8.7 Last Study Committee Meeting (Highlights)

Study Committee A3 met during the 2024 Paris session on the 29th August 2024. It was chaired by Nenad Uzelac who welcomed all attendees.

The meeting agenda was reviewed and approved along with the minutes of the last meeting in 2023. There was a round of introductions to welcome new regular members.

Nenad talks about the progress made in the equipment sector, in connections with other organisation, in the involvement of NGN, also in assuring the communication and the impact of SC activities. LinkedIn SC A3 channel is very important for promoting SC A3 activities and all SC A3 Members are kindly invited to “like” and to repost the posts.

Following the new strategy launched by CIGRE identifying 8 areas important for energy transition new subjects have been identified in SC A3 and new Experts are needed to properly cover them.

Robert Le Roux presented an update from the Utilities Advisory Board including an update on the last meeting held earlier in the Paris session.

Branislav Pilat presented himself as the official NGN representative in A3. The goal is to be more active to improve awareness of NGN, especially in countries with no active NGN network. With publications on ELECTRA, followers in Cigre NGN are not only coming from engineering but from a lot of different professions.

A question as asked about engagement of the 35-45 range. Branislav pointed out that 35 years is the threshold for reduced fee. Nenad pointed out that it's important to be inclusive: the same would apply also for older, retired Members. It was highlighted that CIGRE Australia promotes NGN through local mirror panels.

Hiroki presented an updated on the progress of updating the Green Book. The first draft is due in December 2024.

Following updates from active working groups Nenad opened the floor to invitations about plans for new webinars or tutorial or requests from National Committees. New proposals were presented for new working groups and liaison activities with other organizations. Several topics were discussed including temperature rise limits, the next reliability survey, manufacturer capability assessment and on site test requirements (specifically focused on PD). There was considerable discussion on digital twin.

The preferential subjects for Paris 2026 were discussed and agreed. These are going to be:

- PS1 Transformation of T&D Assets for Evolving Grid conditions
- PS2 Sustainability and Circuit Economy of T&D Equipment
- PS3 Asset Management strategies for T&D Equipment

The future meetings in Klingenberg, Trondheim and Montreal were presented.

Updates were then given from TC38, TC17, IEEE and Current Zero Club on their current and future activities. Liaison updates from B3 and D1 were also presented.

Lastly the new Chair Nicola was introduced along with the second Secretary Paolo.

8.8 Current Working Groups and UK Members

WG/JWG	Title	Convener	Secretary	UK Participation
WG A3.39	Application and field experience with Metal Oxide Surge Arresters	R. le Roux (IE)	F. Richter (DE)	
WG A3.40	Technical requirements and field experiences with MV DC switching equipment	C. Heinrich (DE)	T. Miyamoto (JP)	
WG A3.42	Failure analysis of recent AIS instrument transformer incidents	Z. Roman (US)	Fernando Lagos (BR)	
JWG A3.43 /CIRED	Tools for lifecycle management of T&D switchgear based on data from condition monitoring systems	N. Gariboldi (CH)	J. Mantilla (CH)	
JWG A3/A2/ A1/B1.44	Limitations in Operation of High Voltage Equipment Resulting of Frequent Temporary Overvoltages	B. Rusek (DE)	-	
WG A3.45	Methods for identification of frequency response characteristic of voltage measurement systems	E. Sperling (CH)	M. Freiburg (DE)	
WG A3.46	Generator Circuit-Breakers: review of application requirements, practices. In-service experience and future trends	P. Novak (DE)	-	
JWG B4/A3.86	Fault Current Limiting Technologies for DC Grids	Z. He (CN)	-	
JWG B3/A3.60	User guide for non-SF6 gases and gas mixtures in Substations	K.P. (Piet) Knol (NL)	-	

WG A3.47	Lifetime Management of Medium Voltage Indoor Switchgear	A. Maheshwari (AU)	Matthew Ridgley	Ian Naylor
WG A3.48	4th CIGRE reliability survey on transmission and distribution equipment	H.Ito (JP)		Matthew Iles
WG A3.49	Aging effects on accuracy class of Instrument Transformers	Roberto Tinarelli (IT)		Philip Orr
WG A3.50	On-site calibration and verification of the accuracy of instrument transformers	Paolo Mazza (Italy)	Christoph Datz	Rui Zhang
WG A3.51	Requirements for HV T&D Equipment operating under Abnormal Weather Conditions	Dr. Santosh Kumar Annadurai (IN)	Sasi Vettayappan (IN)	Peter Curtis
JWG B3/A2/A3C3/D1.66	Guidelines for Life Cycle Assessment in Substations considering the carbon footprint evaluation	Akshaya Prabaker (NL)	Dennis van der Born (NL)	Mark Waldron
JWG B3/A3.67	Operational safety of Medium Voltage GIS in case of abnormal leakage	Maik Hyrenbach (DE)		Tony Chen
JWG C4/A3/B2/B4.75	Guide to procedures for the creation of contamination maps required for outdoor insulation coordination	Massimi Marzinotto (IT)		
WG C4.76	Overvoltage protection in switching inductive devices with vacuum circuit breaker	Q. Yang (CN)	Q. Sun (CN)	G. Dakin

Updates on working groups:

A3.39 Update

The draft TB is to be circulated for final review of all members followed by review by the SC planned in October 2024. The final technical brochure is planned to be published in March 2025 with a tutorial and Electra article planned for February 2025.

A3.40 Update

The Technical Brochure 931 has been published and the working group has been disbanded.

A3.42 Update

Both the convenor and secretary resigned in 2020 so a new convener and secretary took up position. The last meeting of the WG was held in Croatia in November 2022. A second draft was issue in November 2023.

A3.43 Update

The draft Technical Brochure has been circulated around SC A3 members with feedback due 9th September.

A3.45 Update

The draft Technical Brochure has been circulated around SC A3 members with feedback due 23rd September. A final meeting is expect to review the comments and prepare the final draft for October 2024 with the aim of publishing at the end of 2024 or early 2025. A tutorial was held in Cairns with a second tutorial planned for either Trondheim or Montreal. An Eletra article is being prepared.

A3.46 Update

Since starting in 2020 there have been multiple remote meetings with on 2 in person meetings held recently. There has been good discussion with examples of considerably higher than 1PU peak currents with degrees of asymmetry approaching 200% depending on the power factor. A tutorial was presented during the Paris 2024 session. A final meeting is expected in Trondheim. The work is expected to be finalised in 2024 with the Technical Brochure planned for the end of Jan 2025.

A3.47 Update

Work has just started with a kick-off workshop taking place at Palais des Congrès on 20 August 2022. Despite initially having a small membership the working group report good progress over the last 12 months, although they would prefer to have greater membership. There are currently 12 active members. The first internal draft is planned for August 2025 with a SC draft intended for December 2025. The Technical Brochure is being targeted to April 2026 along with an Eletra article and a tutorial in August 2026

A3.48 Update

Created in 2022 the inaugural meeting was held during the Paris 2022 session with numerous in person and virtual meetings since. This is the 4th survey to collect reliability data from equipment in service in 2014-2017 including performance of ageing equipment which has been in service for more than 35 years. The UK submitted a late response to the survey and the results are being included, nevertheless a huge amount of analysis of the survey results returned has already been completed. 6 Technical Brochures are being proposed, the first on general results has been reviewed by A3 and has been submitted for publication. A second draft of the TBs on circuit breakers and GIS are being prepared. First drafts for disconnector and earth switches, instrument transformers and surge arresters, and for Vacuum circuit breaker and generator circuit breakers are being prepared.

The next planned reliability survey will be on equipment in service from 2024 to 2027 and a ToR has been submitted.

A3.49 Update

Created in 2023, the call for members went out in January 2023. The WG is running behind schedule with the development of a final work plan 6 months late. There has been discussions with A3.50 about collaboration to help cross dissemination and avoid overlap. The next meeting (#11) was scheduled for the end of September 2024.

A3.50 Update

Created in 2023, the call for members went out in October 2023. There have been 2 in person meetings with a joint meeting with A3.49 in August 2024. The WG has 30 regular members from 16 countries. Representation consists of 17 manufacturers, 7 system operators and 6 from academia. Following a timetable revision a final work plan has been completed with a Tutorial and webinar planned for 2Q2 2025 and the TB due in Q3 2026.

A3.51 Update

Created in 2023, the call for members went out in October 2023. There are 17 regular members and 3 NGN members. The kick off meeting was held on 24th November 2023 with 2 virtual meetings held since.

WG A3/A2/A1/B1.44 Update

TB is under Revision in the SC. In the meantime the Eletra article and the abstract of TB will be prepared.

B3/A3.60 Update

The first meeting was on 10th September 2021 with further web meetings in November, March 2022 and August (during Paris session). The TB will provide guidance on handling, with a focus on achievable filling accuracy and maintainability, gas measurement guide according to TB 723, tightness guide and requirements, and environmental, health and safety aspects. A poster was presented at the Paris 2024 session. Publication is planned in 2024.

JWG B3/A2/A3/C3/D1.66 Update

There are currently 45 participants with further notification of interest so the membership is currently capped. The kick off meeting was held in early May where the chapter structure was agreed.

WG C4.76 Update

A draft Technical Brochure has been prepared and is being circulated for comment.

8.9 New Working Group Proposals

New WGs were proposed during the SC meeting at the Paris 2024 session.

- Digital Twin

A ToR was presented on the Application of Digital Twin for Switchgear. There was significant discussion on the scope of a digital twin and its potential applications. It was concluded that there needs to be a clear definition of the digital twin according to the application. IT was requested to revise the TOR by defining Digital Twin and introducing MV and that it would be beneficial to discuss with SC B3

- Working group for Green Book maintenance activities
- 5th Reliability survey
- Onsite testing

After review it was stated that the existing scope was too wide and should be limited to PD during on site dielectric tests. It was further suggested it should take into account IEEE testing guide and that SC D1 could be involved. IT was identified that it would be beneficial to harmonise the HV test levels between switchgear and cables.

- Temperature rise limits

B3 is not leading the WG. Limits have been increased quite recently. It was identified that the scope is too broad. IT was conclude that A whitepaper should be created first. An ad hoc WG should be established.

- Distance to Transmission lines
- Capability Assessment

Recognising there is a big push to standardise everything, any such WG should only look at the technical capability and not QMS. ToR requires re-scoping to be clearer and draw parallels to A2 equivalent and existing TB.

9 RM Report on SC B1 Insulated Cables

9.1 Study Committee Scope

SC Chair: Geir Clasen, NO
SC Secretary: Matthieu Cabau, FR

9.2 Strategic Advisory Groups

There are now four advisory groups in the B1 SC

- Strategic Advisory Group (Chair: Geir Clasen, NO).
- Tutorial Advisory Group (Chair: Luigi Colla, IT)
- Customer Advisory Group (Chair: Carla Damasceno)
- Reliability Advisory Group (Chair: Russell Wheatland, AU)

The Reliability Advisory Group was launched with effect from September 2022 on the topic of Cable System Statistics (Every Two Years). The Advisory Group was created based on the recommendations of TF B1.81 (How to have statistics every two years) and is focused on capturing the service experience of insulated cable systems on a more frequent basis. The introduction of a permanent Advisory Group (rather than ad-hoc Working Groups) will provide more stability to the process of collecting the service experience data, which is very widely used across the industry. The new Advisory Group will implement a revised data collection process which, it is hoped, will improve the range of information collected. Although some data has been contributed from the UK, the large number of organisations owning cable assets has made it difficult to ensure a full contribution.

9.3 Draft Preferential Subjects

The Draft Preferential Subjects for 2026 Paris Session are shown below. These should not be treated as final, although the broad categories for the subjects (Future systems, experience and sustainability) are very similar to previous years.

PS 1: Future cable systems and innovative cable applications

- Cable systems challenges and solutions such as floating applications/deep water, meshed DC grids, overhead-line/substation interfaces
- New developments on materials, design and construction challenges such as super-conducting solutions, hydrogen inclusion, high temperature / electric stress, very large conductors and cost-effectiveness
- Intelligence into cables. Integration of sensor technologies, real-time use of data, predictive maintenance, use of robotics, dynamic management of load demands, digital twins, data use for Building Information Methodology implementation

PS 2: Recent experience with AC and DC cables, both land and submarine

- Quality, monitoring, condition assessment, diagnostic testing, After Installation Testing, fault location, upgrading and uprating methodologies and relevant management
- Lessons learned from permitting, consent, interface management cables to other equipment/device/substations and safety issues
- Experiences with new test requirements and new tools for cable ratings calculation

PS 3: Environmental Impact and Cable Lifecycle

- Development in more sustainable materials and production methods, recover, recycle, reuse of cable materials and SF6 alternatives
- Best practices in Life Cycle Assessment and Environmental Certification
- Environmental impact of cable systems with regards to climate change

9.4 New Working Groups

Working Groups (WG) normally take 3 years to complete and the deliverable is a Technical Brochure with recommendations based on Terms of Reference (ToRs) developed by a Task Force. At the time of writing, the formal ToR for these groups has not been approved by the Technical Council but the activities were approved by the B1 Study Committee.

Number	Title	UK Member
B1.92	Mechanical performance and limits of submarine power cable systems (Conv: TBC. Convener of TF was Soren Kruger Olsen, DK)	TBC

TF B1.94 “Grid operations (switching etc) and transient voltages in XLPE insulated cable systems possibly causing accelerated failure modes” was unable to complete its work prior to the Study Committee meeting. On that basis, it is now due to report in 2025. It can be re-submitted for the vote at the 2025 SC meeting to determine if it should proceed to a WG.

New Task Forces are shown below. The UK intends to appoint a member to TF B1.96, B1.97 and B1.98. B1.99 will initially proceed without a UK member. Note that the appointments to B1.97 will be handled by the B1 Strategic Advisory Group; nominations will be sent, but the final decision on who to appoint will be approved by SAG instead of the convener. This is due to the need to carefully balance supplier and customer participation in this TF.

Number	Title	UK Member
B1.96	Cable accessory failure hazard mitigation	TBC
B1.97	Improvements of Range of Approval criteria for HV and EHV power cables	TBC
B1.98	Test Recommendations for Earth Screen Power Cable Connections in Wind Farm Array Cabling	TBC
B1.99	Evaluation of sustainable Power cables	TBC

9.5 Technical Panel Meetings, Seminars & Tutorials

A hybrid Technical Liaison meeting will be held on 17th October 2024, with expected attendance of approximately 30 persons in person and around 35 online. The meeting will again be held jointly with

the D1 UK group, and the D1 RM Thomas Andritsch presented a summary of B1-relevant material to the group.

9.6 Technical Brochures

The following TBs have been published since November 2023:

TB924 Condition Assessment and Diagnostic Methods to Support Asset Management of MV Cable Networks

There is a significant backlog of late running TBs (due to delays in the respective WGs circulating a draft). A further 4 TBs have been commented on by the UK since November 2023 and are in the finalization stage, 2 others are expected to be released for commenting imminently.

9.7 Last Study Committee Meeting (Highlights)

The B1 Study Committee meeting was held in connection with the Paris and was primarily an in person meeting with the exception of a small number of participants who were unable to travel.

The new WG and Task Forces were the subject of spirited discussion. Around 30 ideas were put forward on to the long list, which was then reduced down to a shorter list for discussion in the meeting. The UK chose not to submit a request for new work, other than to request the continuation of B1.95 from a Task Force to a full Working Group. This request was granted. The UK was also keen to see NWI 345/349 (now TF B1.97) and NWI346 (now TF B1.98) proceed on the basis of strong UK interest, especially in the submarine cables areas.

Many WG have been delayed due to the impact of the COVID pandemic and restrictions on physical meetings. It is notable that many of the delayed groups are now struggling to make progress even though there have been no COVID related restrictions for quite some time. Of the 13 WGs which could have been expected to have a draft TB available in the year prior to the Session, only 3 were able to deliver (of which 2 were later than originally planned and 1 was on time per the original schedule).

9.8 Current Working Groups and UK Members

Note: although the final publications of B1.54 and B1.58 are not yet available, the work is understood to be completed and the WG are effectively closing – hence they are not mentioned here.

Number	Title	UK Member (only B1)
WG B1.67	Loading pattern on cables connected to windfarms	Ross Wilson (UK)
JWG B1/C4.69	Recommendations for the insulation coordination on AC cable systems	Francis Waite (UK)
WG B1.70	Recommendations for the use and the testing of optical fibres in submarine cable systems	Roman Svoma (UK, Convener), Phil Miller (UK), Jingyi Wan (NGN)
WG B1.72	Current rating verification (Part 2)	James Pilgrim (UK), Kenneth Benton (NGN)
JWG B4/B1/C4.73	Surge and extended overvoltage testing in HVDC cable systems	None
JWG B1/B3.74	Recommendations for a performance standard of insulated bus-bars	None
JWG B1/D1.75	Interaction between cable and accessory materials in HVAC and HVDC application	Thomas Andritsch (UK)
JWG D1/B1.75	Mechanism for corrosion and how to monitor it	None
WG B1.76	Increasing the role of quality assurance and quality control to reduce the cable failure possibility	Roman Svoma (UK)
JWG B1/B3/D1.79	Recommendations for dielectric testing of HVDC gas insulated system cable sealing ends	Drew Boa (UK), Jack Stride (NGN)

WG B1.80	Guidelines for Site Acceptance Tests of DTS and DAS Systems used for Cable Systems Monitoring	Vacant
WG B1.82	MVDC Cable system requirements	Leigh Williams
WG B1.83	Grounding aspects for long HVDC land cable connections	Dongsheng Guo
JWG B1/C3.85	Environmental issues of decommissioning	None
WG B1.86	Assessment, Prevention and Mitigation of Safety Risk in Cable Systems	Christopher Donaghy-Spargo
WG B1.87	Finite Element Analysis for Cable Rating Calculations	James Pilgrim (Conv), Venkata Chalapathi (UK), Hugo Hui (NGN)
WG B1.88	Recommendations regarding the use of non SF6 gases in cable systems	Manu Haddad (UK)
JTF B4/B1.88	Insulation coordination procedure for DC cable systems in HVDC stations with Voltage Source Converters (VSC)	Rosemary Urban (UK)
WG B1.89	Guidance for conducting cable systems failure analysis	Ross Wilson (Conv), Raed Ayoob (UK)
WG B1.90	Cable systems electrical characteristics (Update to TB 531)	Tanmay Joshi (UK), Sara Anild (NGN)
WG B1.91	Transient thermal modelling of power cables	Ahmed Badawi (UK)
TF B1.92	Qualification of Lead Free Submarine Cables at 72.5kV <math>U_m < 170 \text{ kV}</math>	James Pilgrim (Conv), Phil Miller (UK)
TF B1.94	Grid operations (switching etc ...) and Transient voltages in XLPE insulated cable systems possibly causing accelerated failure modes	Laurence Trim (UK)
TF B1.95	Mechanical performance and limits of submarine cables - modelling and testing	David Young (UK)

NOTE: UK denotes the UK member, IE denotes Invited Expert, NGN denotes Next Generation Network member.

9.9 UK Members of the Technical Panel

As the B1 liaison meetings are quite popular (40+ applications/attendees) it would be difficult to have this number of people in the panel.

In the past there has been one meeting per year in the summer before the SC B1 meeting. No meeting has yet been held in 2023/24 due to the need to revise the panel membership, and the lack of volunteers to date. The intention is to set up a panel with representation for the following sectors:

- Panel Chair (Regular Member)
- Panel Secretary
- Member from TSO
- Member from DNO
- Member from Manufacturer
- Member from Offshore Wind
- Member from Consultancy
- Member from Academia

- Previous Regular Member

Volunteers will be sought to start the panel from late 2024, anyone interested should contact James Pilgrim via japil@orsted.com

10RM Report on SC B3 Substations and Electrical Installations

10.1 Study Committee Scope

SC Chair: Mark McVey (US)
SC Secretary: Samuel Nguefeu (FR)

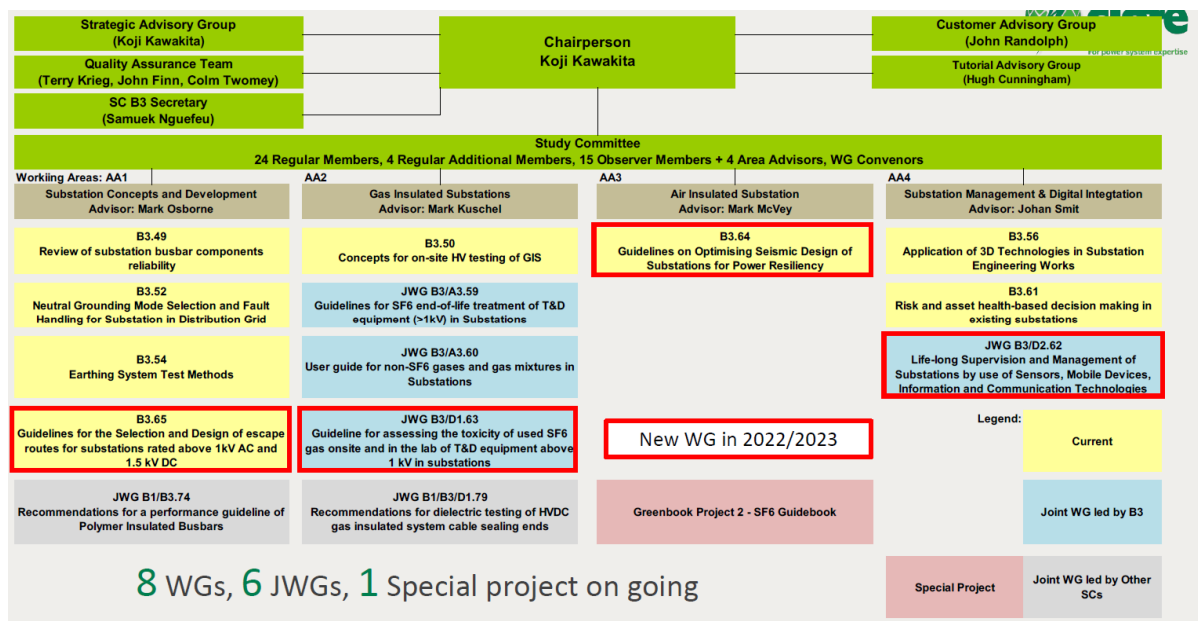
The scope of Study Committee (SC) B3 addresses topics throughout the asset management life-cycle phases; from conception, through research, development, design, production, deployment, operation, and end-of life. At all stages, technical, safety, economic, environmental and social aspects are addressed as well as interactions with, and integration into, the evolving power system and the environment. All aspects of performance, specification, testing and the application of testing techniques are within scope, with a specific focus on the impact of changing interactions and demands due to evolution of the power system. Life cycle assessment techniques, risk management techniques, education and training are also important aspects.

Within this framework additional specific areas of attention include:

- Theory, principles and concepts, functionality, technological development, design, performance and application of materials, efficiency.
- Manufacturing, quality assurance, application guidance, planning, routing and location, construction, erection, installation.
- Reliability, availability, dependability, maintainability and maintenance, service, condition monitoring, diagnostics, restoration, repair, loading, upgrading, uprating.
- Refurbishment, re-use/re-deployment, deterioration, dismantling, disposal.

Key strategic directions

- New substation concepts
- Substation ownership issues
- Life-cycle management
- Integration of intelligence for digitalization on substations



10.2 Strategic Advisory Groups

- Strategic Advisory Group (SAG) – Mark McVey (JP)

- Customer Advisory Group (CAG) – John Randolph (US)
- Tutorial Advisory Group – Hugh Cunningham (IE)
- AA1 - Substation concepts & developments – Mark Osborne (UK)
- AA2- Gas Insulated Switchgear (GIS) Substations – Mark Kuschel (GE)
- AA3 - Air Insulated Switchgear (AIS) – Mark McVey (US)
- AA4 - Substation Management – Johan Smit (NE)

10.3 Draft Preferential Subjects

2024 Paris Session B3:

PS1 Challenges & new solutions in T&D substation design and construction for energy transition:

- Design impacts on substations from on-offshore wind, PV, hydrogen, small modular reactors, EV charging infrastructure etc.
- New functions in substations (energy storage, synchronous compensators, etc.).
- HV-MV DC substation and GIS/GIL application for a DC network.

PS2: Return on operational experiences for substation management:

- Challenges of managing assets: Initiatives to strengthen resilience, reliability and security, best practice and end-of-life management considering sustainability aspects.
- Lessons learned from operational experience from SF6 alternatives solutions, digital transformation solutions and digital substation.
- New competencies for new technologies, knowledge transfer methods and high standards of education in engineering skills.

2025 Colloquium – Kyoto, May 2025 Draft

- Carbon Neutrality
- Energy Transitions
- Digital Transformation

2025 Symposium – Trondheim, Norway

NRCC Symposium - led by B5, Sept 2025. Focus on changes required in the power system for the energy transition – Preferential subjects still under agreement, likely to focus on system dynamics, AC onshore and Offshore, Power to X.

10.4 New Working Groups

Number	Title	UK Member
B3.68	Return on experience for Offshore Substations	Simon Waddington (convenor)

B3.64	Guidelines on Optimising Seismic Design of Substations for Power Resiliency	TBC
B3.65	Guidelines for the Selection and Design of escape routes for substations rated above 1kV AC and 1.5 kV DC	TBC
JWG B3/A2/A3/C3/D1.66	Guidelines for Life Cycle Assessment in Substations considering the carbon footprint evaluation	Mark Waldron

10.5 Technical Panel Meetings, Seminars & Tutorials

Cigre Strategic Advisory Meeting B3 14th May 2024, Richmond, Virginia, US

CIGRE General Discussion Meeting – Paris 27th August 2024

10.6 Technical Brochures Published 2023-24

TB number	Title	WG
TB 914	Guidelines for SF6 end-of-life treatment of T&D equipment (>1kV) in Substation.	B3/A3.59
TB 907	Mobile Substations Incorporating HV GIS – <i>(UK WG Convenor Paul Fletcher)</i>	B3.41
TB 898	Knowledge transfer of substation engineering and experiences <i>(Dedicated to John Nixon, was the original WG convenor, who unfortunately we lost in 2022)</i>	B3.58
TB 895	Impact on Engineering and Lifetime management of Outdoor GIS	B3.57
TB 886	Guidelines for Fire Risk Management in Substations	B3.53

10.7 Last Study Committee Meeting (Highlights)

The 2023 Study Committee B3 meeting was held in Cairns on 05/09/2023.

- The B3 Annual report is published in the June 2023 edition of Electra (#328)
- New Strategic Plan towards 2030 (led by Marcio Szechtman—TC Chair) “Energy Transition”: reviewed Short-Term Actions, Medium/Long Term Actions, and Next Steps
- CIGRE Women in Energy. CIGRE is looking to expand opportunities to combine activities in the substation arena. Please contact me with any ideas.
- Ambition for expansion of Global CIGRE Active membership
- Evolving cooperation with International Energy Authority (IEA) as the energy transition grows
- Adapting names of A1, C3 and D2 to reflect more

- Longer term coordination with End to End Energy Transition work

New B3 WG Terms of Reference under development;

AA1– Substation Concepts

- Guidelines for Managing Black Start Resilience in substations (possible Crina Costan)
- Offshore Substation Operational Experience (proposal Simon Waddington)
- Earthing system design guidelines for high voltage systems (possible Stephen Palmer)
- Harmonization of voltage designations and definitions across different HVDC component technologies (convenor Bruno Bisewski)

AA2– GIS, GIL, SF6 and Alternative Gases (Mark Kuschel)

- Operational safety of Medium Voltage GIS in case of abnormal leakage (Maik Hyrenbach)
- Temperature rise limits increase for lighter products (proposal Sergio Feitoza Costa)
- Guidelines for end-of-life treatment for substations > 1 kV (by JWG B3/A3.59 done)
- Return of operational experiences of SF6 free equipment (after JWG B3/A3.60)
- SF6 Green Book – Daniel Staiger; draft expected 2024

AA3– Air Insulated Substations (Mark McVey)

- Process Requirements for Commissioning and Inspecting Substations

AA4– Substation Management (Johan Smit)

- Guidelines for Life Cycle Assessment in Substations considering the carbon footprint evaluation (proposal new ToR—Akshaya Prabakar)

B3 recognition for contributions to CIGRE

The Outstanding service Award (used to be called distinguished award) for contribution in various ways to the success of CIGRE;

- Jeff Camden (US)
- Tony Lujia Chen (UK)

Next SC meeting will be on the 22 August 2024, in Paris.

10.8 Current Working Groups and UK Members

Number	Title	UK Member
B3.49	Review of substation busbar component reliability	Sadiq Siddiqui
D1/B3.57	Di-electric testing of gas insulated HVDC system	TBC
B3.50	On-site testing of HV GIS after installation, extension, repair or maintenance	TBC
B3.51	Service continuity guide for maintenance repair and extension of HV GIS	TBC

B3.52	Neutral grounding method selection and fault handling for substations in the distributed grid	Tony Yip (Secretary)
B3.54	Earthing System Test methods	Stephen Tucker, Dongsheng Guo, Mark Osborne AA1 advisor
B3.56	Application of 3D technologies in substation engineering works	Marcin Mroz
JWG B1/B3/D1.79	Recommendations for dielectric testing of HVDC GIS cable sealing ends	TBC
B3/A3.59	Guidelines for SF6 end of life treatment and T&D equipment (>1kV) in Substations	Adam Green
B3/A3.60	User guide for non SF6 gases and gas mixtures in substations	Mark Waldron
B3.61	Risk & Asset Health based decision making in existing substations	Dawn O'Brien
B3/D2.62	Life-long Supervision and Management of Substations by use of Sensors, Mobile Devices, Information and Communication Technologies	Call out
B3/D1.63	Guideline for assessing the toxicity of used SF6 gas onsite and in the lab of T&D equipment above 1 kV in substations.	Tony Chen
B3.64	Guidelines on Optimising Seismic Design of Substations for Power Resiliency.	Call out
B3.65	Escape routes from Substation rated above 1kV AC and 1.5 kV DC. (Draft TOR)	TBC

10.9 UK Members of the Technical Panel

Delivered Technical Webinar

July Webinar - Mat Iles, presented a summary of the UK Colloquium 'The Role and Impact for Electricity Transmission & Distribution (T&D) Substations and Equipment in Delivering a Net Zero Carbon Future' held the previous month.

The UK liaison meeting

The B3 meeting will be jointly held with A3 on the 7/8th February 2024, in Manchester. We will aim to have presentations on UK specific issues regarding the SF6 and wider Net zero challenges affecting B3 and A3 activities.

11RM Report on SC B4 HVDC and Power Electronics

11.1 B4 Study Committee

Mission

To facilitate and promote the progress of engineering and the international exchange of information and knowledge in the field of Direct Current (DC) equipment/systems and power electronics applications. To add value to this information and knowledge by means of synthesizing state-of-the-art practices and developing recommendations.

Technological Field of Activities

- Direct Current equipment and systems including converter technologies and semi-conductor devices.
- Power electronics for AC systems and power quality improvement, advanced power electronics and applications.

Scope

Within its technical field of activity, [Study Committee B4](#) addresses DC systems and Power Electronics (PE) equipment in both transmission and distribution systems. The study committee also addresses DC Converters for the integration of distributed renewable (PVs) and energy storage as well as power quality control. SC B4 covers the full spectrum of DC systems and PE devices including technology, specification, design, implementation, operation, maintenance, refurbishment of DC systems and Flexible AC Transmission System (FACTS) devices.

Within this framework additional specific areas of attention include:

- Theory, technologies, design, performance, operation & maintenance, and application of DC converters and systems.
- Theory, technologies, design, performance, operation & maintenance, and application of FACTS devices.
- DC interconnectors and establishment of DC grid(s)/multi-terminal HVDC systems to increase power transmission capacities and to reduce existing network congestions (AC network overlay), to enable power trading, to share spinning reserve, and to reduce energy costs.
- Technologies of inverters with grid-forming control capabilities to improve and enhance the reliability and stability of the PE dominated power system with integration of growing renewable generations and battery storage resources.
- Standardization and digitalization of Offshore DC platforms.
- Implementation of Interoperability of HVDC systems constructed by various HVDC OEMs for flexible and reliable operation and control of largely interconnected power system through HVDC system;
- Application of DC technologies and PE in distribution system for better power quality control;
- MVDC applications such as connection of large solar parks.
- Refurbish and upgrade of HVDC systems and FACTS devices.
- Inverter based energy storage.

11.2 CIGRE B4 SC - Strategic Advisory Groups

SC B4 Chair: Joanne Hu (Canada); SC B4 Secretary: Rebecca Ostash (Canada)

Number	Title	Convenor	Secretary
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AG01	Strategic Advisory Group	Joanna Hu	Rebecca Ostash
AG02	B4 Newsletter	Hani Saad	
AG03	Communication and Website	Silvia Sanz Verdugo	
AG04	HVDC/FACTS System Performance	Josh Burroughs	Phaedra Tairorl
NGN	B4 NGN Group	Yuebin Zhou	
WiE	B4 Women in Energy	Rebecca Ostash	

11.3 CIGRE B4 UK Members

Dechao KONG	Chair and Regular Member	Developer
Ali Kazerooni (New)	Additional Regular Member	TSO

Thanks for valuable contributions from Prof. James Yu (SP Energy Networks) – previous CIGRE UK B4 Additional Regular Member.

11.4 2024 Paris Session – B4 SC

- The Preferential Subjects for 2024 Paris Session:
 1. PS 1 DC Equipment and Systems
 - PS1.1: Planning, design, performance, testing and commissioning of DC equipment and systems including point to point, multiterminal and DC grids, especially offshore DC systems.
 - PS1.1-1: LCC & Hybrid HVDC
 - PS1.1-2: VSC HVDC
 - PS1.1-3: Offshore HVDC
 - PS1.1-4: Multi-Terminal & DC Grids
 - PS1.2: Refurbishment and upgrade of existing DC systems.
 - PS1.3: Service and operating experience of DC converter stations and systems, especially VSC based DC systems and offshore DC systems.
 2. PS 2 FACTS and Power Electronics
 - PS2.1: Planning, design, performance, testing and commissioning of FACTS and other PE devices including inverter-based generation.
 - PS2.1-2: STATCOM & SVC
 - PS2.1-2: Other Power Electronic Devices
 - PS2.2: Refurbishment and upgrade of existing FACTS and other PE devices.
 - PS2.3: Service and operating experience.
 3. PS 3 New Technologies and Concepts of DC and FACTS Enabling Energy Transition
 - PS3.1: New technologies/concepts to address network issues associated with green energy transition such as application of grid-forming converters, multi-vendor interoperability.
 - PS3.1-1: Modelling & Analysis
 - PS3.1-2: Network Integration & Application •
 - PS3.2: New Concepts, Technologies and design of DC converters and PE devices for both transmission and distribution systems including interfacing generation and storage to the network, energy hubs/islands, etc.

The following B4 papers for PS1-3 of Cigre 2024 Paris Session were contributed from co-authors in the UK:

1. Dynamic demand control applied to synchronous grid forming controlled HVDC.
2. Assessment of Operational Challenges of HVDC Multi-Purpose Interconnectors with Low Short Circuit Levels.
3. A Novel Methodology to Derisk HVDC and Offshore Wind Connections to A Network.
4. Software-In-the-Loop Real-Time Simulation of a HVDC Terminal.
5. Application of Harmonic Loci-Based Control Design in Frequency and Time Domain for a Consistent Design of VSC HVDC Harmonic Active Solutions.

For more details, please see URL: https://session.cigre.org/fileadmin/cru-1725973228/user_upload/2024_TECHNICAL_PROGRAMME_JULY_2024.pdf

- Special Reporter for B4 SC by:

1. J. Dorn
2. V. Pathirana
3. S. Xu
4. C. Winter

For more details of CIGRE 2024 Special Report for B4 SC, pls see the URL:

https://session.cigre.org/fileadmin/cru-1725973228/user_upload/B4_2024_Special_Report.pdf

- Tutorial B4: Hybrid LCC/VSC HVDC Systems on 26th October 2024.

Speakers:

- Y. Zhou
- Z. Wang
- E. Berne
- P. Max
- M. Portugal

For more details, please see URL: <https://session.cigre.org/programme/general-programme/event/sc-b4-tutorial-new65816cedc79a9425084046.html>

- Workshop B4: Interoperable Multi-terminal HVDC Systems: from dream to reality on 28th August 2024.
 - P1: Multi-terminal Hubs – a large step towards the energy grid of the future
 - P2: Project Aquila – GB HVDC Hub and Interoperability Demonstration Development Progress
 - P3: Multi-Vendor Interoperability from China
 - P4: InterOPERA Project – Part 1 (Objectives and General Approach – Proposed Demonstrator)
 - P5: InterOPERA Project – Part 2(Multi-Vendor Interoperability by Design – Functional Framework including Grid Forming)
 - P6: North American Initiatives on Standardisation to Enable Multi-terminal HVDC Systems
 - P7: IEC Technical Specification on HVDC Systems

For more details, please see URL: For more details, please see URL: <https://session.cigre.org/programme/general-programme/event/interoperable-multi-terminal-hvdc-systems-from-dream-to-reality-57.html> For event materials, please see <https://cigre.org.uk/category/b4-zone/>

11.5 2024 B4 SC AGM Meeting (Highlights)

- The physical B4 SC AGM meeting was held on 27th September, 2024 (Tue) during Cigre Paris Session. It was chaired by Joanne Hu and attended by B4 SC national regular members, working group convenors and guests.
- Key updates of Advisory Groups from Joanna Hu (AG01), Hani Saad (AG02), Silvia Sanz (AG03), Josh Burroughs (AG04), Sergio Santo (AG04:TF4), Yuebin Zhou (NGN).

- Introduction of the B4 Green Book on HVDC.
- Introduction of B4 WiE Group.
- Working group reports were presented by Working Group (WG) convenors or representatives (See Table 1 within this report for current WGs and Task Forces (TFs).
- DC and FACTS Schemes Under Construction or Planned.
- Operational Experiences of Existing HVDC and FACTS Schemes.
- Future Meetings in 2025:
 - 12-15 May, 2025: Symposium in Trondheim, Norway
For more details, see URL: <https://cigrenrccsymposium2025.com>
 - 29 Sept to 01 Oct, 2025: Symposium (B2/B4-led) in Montreal, Canada
For more details, see URL: <https://www.cigre.org/article/GB/events/cigre-symposia/cigre-2025-international-symposium-in-canada-2025>

11.6 CIGRE UK Events with B4's Inputs and Contributions in 2023-24

- The 2023 Cigre UK B4 Liaison Meeting was held on 4th Oct 2023 (Virtual Event). For more details, see URL: <https://cigre.org.uk/blog/cigre-b4-liaison-meeting-4th-october-hybrid-event-london-webex/>.
- The 2024 Cigre UK B4 Liaison Meeting was rescheduled in Jan, 2025 (TBA for specific date).
- CIGRE UK NGN Distinguished Industrial Lecture: Power Electronics aiding the electrical transmission system: FACTS and HVDC was held on 4th March, 2024. For more details, see URL: <https://cigre.org.uk/ngn-events/cigre-uk-ngn-university-birmingham-hub-hvdc-facts-lecture-report-2/>
- CIGRE UK NGN Distinguished Industrial Lecture: New Power Electronics Technologies and Applications to Facilitate Global Net Zero Energy Transitions – Good Practices from CIGRE B4 Study Committee was held on 26th April, 2024. For more details, see URL: <https://drive.google.com/file/d/1B1Mx-rqRGvrm6FvPq77BqFH0t76GDcxF/view>
- CIGRE UK WiE Event - Uniting Academia and Industry for Net Zero Ambitions on 29th October 2024. For more details, see URL: <https://cigre.org.uk/uk-news/uniting-academia-industry-net-zero-ambitions/>
- CIGRE UK Webinar – LV Engine: Hybrid AC-DC Networks on 30th August 2023. For more details, see URL: <https://cigre.org.uk/blog/lv-engine-smart-energy-hub-providing-hybrid-lvdc-lvac-networks-30th-august/>
- CIGRE UK Webinar – An introduction of SSEN's HVDC Project Aquila and its Concepts on 25th October 2023: For more details, see URL: <https://cigre.org.uk/blog/introduction-ssens-hvdc-project-aquila-concepts/>
- The Technical Zone for Cigre UK B4. For more details, see URL: <https://cigre.org.uk/category/b4-zone/>

11.7 Working Groups with UK Members' Engagement and Contribution

• Current Working Groups

		Convenor
B4.64	Impact of AC System Characteristics on the Performance of HVDC schemes	Jef Beerten
B4.69	Minimizing loss of transmitted power by VSC during	Dennis Woodford
B4.82	Guidelines for Use of Real-Code in EMT Models for HVDC, FACTS and Inverter based generators in Power Systems Analysis	Garth Irwin

B4.85	Interoperability in HVDC systems based on partially open-source software	Staffan Norrga
B4/A3.86	Fault Current Limiting Technologies for DC Grids	Zhiyuan He
B4.87	Voltage Source Converter (VSC) HVDC responses to disturbances and faults in AC systems which have low synchronous generation	Carl Barker (UK)
TF B4/B1 88	Insulation coordination procedure for DC cable systems in HVDC stations with Voltage Source Converters (VSC)	Kees Koreman / Tanumay Karmokar
B4.89	Condition Health Monitoring and predictive maintenance of HVDC Converter Stations	Nadine Chapalain
B4.90	Operation and maintenance of HVDC and FACTS Facilities	Les Brand
B4.91	Power-electronics-based transformer technology, design, grid integration and services provision to the distribution grid	Marco Liserre
B4.92	STATCOMs at Distribution Voltages	John Wright-Smith
B4.93	Development of Grid Forming Converters for Secure and Reliable Operation of Future Electricity Systems	Dechao Kong (UK)
C2/B4.43	The impact of Offshore Wind power hybrid AC/DC connections on System Operations and System design	Christer Norlander
B4.94	Application of grid-forming VSC-HVDC system in black start restoration	Arash Fazel Darbandi
TF B1B3B4 C4D1.95	Harmonization of voltage designations and definitions across different HVDC component technologies	Bruno Bisewski
C4/B4.72	Lightning and Switching Induced Electromagnetic Compatibility (EMC) issues in DC power systems and new emerging power electronics-based DC equipment	Qingmin Li
B4.95	Developments in Power Semiconductor Technologies and Applications in HVDC/FACTS	Joerg Dorn
B4.96	HVDC connection of power system with high proportion of photovoltaic (PV) generation	Qi Guo

	C4/A3/B2/ B4.75	Guide to procedures for the creation of contamination maps required for outdoor insulation coordination	Massimo Marzinotto
	B4/C4.97	Benchmarking of simulations models for control interaction in meshed AC networks with multiple converters	Arash Fazel Darbandi
	C1/B4.49	Offshore transmission planning	Cornelis Plet
NEW	B4.98	Design considerations in integration of DC systems to meshed DC/AC Transmission networks	Afshin Pashaei (UK)
NEW	B4.99	Design and Construction of offshore Voltage Sourced Converter (VSC) Stations	Sofie Nilsson
NEW	B4.100	Dynamic Active and Reactive Power Supporting Devices for VSC HVDC Systems	Chandana Karawita
NEW	B4.101	Industrial Implementation and Application of Grid Forming Energy Storage Systems (GFM ESS)	Changjiang Zhan
NEW	B4.102	Technical Requirements and Scenario Considerations on Grid-Forming Capabilities of VSC-HVDC Systems	Zhiyong Yuan
NEW	B4/C4.103	AC Network Equivalents for HVDC and FACTS Project Studies	Hiranya Suriyaarachchi
NEW	B4.104	HVDC Digital Twin – concepts and roadmap	Arkadiusz Burek

Completed Working Groups and UK Members for Contribution

Completed working groups with TB as published or under review in 2023-24 and UK members for contribution

Number	Title	UK Member for Contribution
JWG	Guidelines for Subsynchronous Oscillation Studies in	1. A. Pashaei
C4/B4/52 (TB 909)	Power Electronics Dominated Power Systems	2. E. Lavopa

<p>WG B4.81 (TB 934)</p>	<p>Interaction between nearby VSCHVDC converters, FACTs devices, HV power electronic devices and conventional AC equipment</p>	<p>3. A. Pashaei 4. B. Marshall 5. B. Ponnalagan 6. O. Adeuyi 7. O. Jasim</p>
<p>WG B4.84 (TB935)</p>	<p>Feasibility study and application of electric energy storage systems embedded in HVDC and STATCOM systems</p>	<p>1. D. JOVCIC 2. A. Egea 3. P. Judge</p>

12RM Report on SC B5 Protection and Automation

12.1 Study Committee Scope

SC B5 Chair: Rannveig Løken (Norway) – Handover to Volker Leitloff (France) 2024
 SC B5 Secretary: Richard Adams (UK) – Handover to Peter Bishop (NZ) 2024

The scope of SC B5 is to facilitate and promote engineering development and knowledge exchange in the field of protection and automation by means of “synthesizing” the best practices and recommendations. It covers principles, design, applications, coordination, performance, and asset management of “Light Current” systems and equipment. All technical, organisational, and economical aspects are considered including staff education and training.

12.2 Strategic Advisory Groups

SAG Convenor, Rannveig Løken (Norway)
 Substation Automation (TG.51), Volker Leitloff (France) – Handover to Casale Emiliano (Italy) 2024
 Protection & Monitoring (TG.52), Cedric Moors (BE)
 New Network Requirements (TG.53), Nirmal Nair (NZ)
 Tutorial/IEC Liaison, Anita Oommen (ZA)
 IEEE Liaison, Jonathan Sykes (US)
 Communication Officer, A. Apostolov (US)

12.3 B5 2024 Paris Session - 25th to 30th Aug 2024

Two Preferential Subjects:

1.1 PS1 - Practical experiences and new developments of process bus: Rene Troost Stedin

<p>45 papers from 22 Different Countries</p> <p>Roughly half of the papers focus on real-world implementations, while the remaining half present findings from laboratory or university studies.</p> <p>Discussions surrounding centralized, virtualized, and wide-area Protection, Automation and Control (PAC) applications indicated a significant trend. Specifically, the adoption of the IEC 61850 standard played in enabling these applications.</p> <p>The papers were grouped as follows:</p> <ol style="list-style-type: none"> 1. Reference projects (18 papers) 2. Centralized (CPC) and virtualized (VPC) PAC (11 papers) 3. Wide area process bus applications (5 papers) 4. Time synchronization (4 papers) 5. Process level data acquisition (7 papers) 	<p>Highlights:</p> <p>Increase in fully digital substation being commissioned (utilizing process bus)</p> <p>Increase in commercial availability of IED’s, Process Interface Units etc. supports this trend.</p> <p>Focus on TSO – However, was a notable increase at DSO level.</p> <p>CPC and VPC is the latest trend – many suggesting is the only way to leverage the maximum benefits from IEC61850 process bus.</p> <p>Use Wide Area process bus to drive vendor independent solutions – Diff Protection.</p> <p>Concerns over reliance of high precision time sync as process bus increases – best architectures etc.</p> <p>Standards and process bus architectures critical – redundancy etc.</p>
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1.2 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems – Pablo Flores – Electrobras

<p>59 papers from 25 Different Countries</p> <p>In the last decade PAC systems have evolved technologically, driven by the IEC 61850 standard and the evolution of electronics and communication networks, WANPAC solutions and virtualization. This evolution requires a new testing strategy, especially software, virtualized environments, and real time simulator for WAMPAC. Testing is a fundamental part of the implementation, operation, and maintenance process.</p> <p>The papers were grouped as follows:</p> <ol style="list-style-type: none"> 1. Engineering process and tools in Digital Substation (15 papers) 2. Application Tests in Digital Substation (10 papers) 3. Tests associated with inverter-based generation sources - IBR (7 papers) 4. Wide Area Monitoring, Protection, and Control (WAMPAC), including Travelling Waves (TW) and Synchrophasor (20 papers) 5. General testing applications (7 papers) 	<p>Highlights:</p> <p>Engineering Tools and Processes at all stages to guarantee security, scalability, and cost improvements.</p> <p>Testing is essential – however, testing alone is not sufficient – require procedures and correct tools – experience from projects is refining this.</p> <p>Distance protection challenges with IBR`s.</p> <p>WAMPAC as a system protection strategy advances due to the increase in the complexity of the power system and the difficulty of adequate performance without this vision.</p> <p>Hydro Power, Retrofit, and LPIT that also have an implementation and testing process. Some of them are technologically new, and these procedures still need to mature.</p>
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12.4 Proposed New Working Groups and PS for Paris 2026

New Working Groups for 2024

- Digital Transformation of PACS: beyond the Application of IEC 61850
- Implementation guide for fully digital IEC 61850 based PACS
- Challenges and solutions for backup protections in modern power systems

New Preferential Subjects for 2026

- Knowledge management in the field of Protection, Automation, Control, Metering and Monitoring (including Education and Training of PACS engineers)
- New requirements, developments and experience of network protection and control for non-conventional sources

12.5 Future Events

- CIGRE Symposium 2025 in Trondheim, Norway – May 12 – 15 2025
- SC B5 Osaka Colloquium – Japan 30th June – 6th July 2025

12.6 New Working Groups Started in 2024

Number	Title	UK Member
B5.84	Recommendations and constraints for development and interfacing of virtual Intelligent Electronic Device	RM: Thomas Charton CM: Daniel Otto CM: Ali Abdulla

	implemented in Protection, Automation and Control Systems	
B5.85	Protection, Control and Supervision principles of “Grid Stabilizing	CM: Ryan Sims CM: Liang Wuxing CM: Li Ding CM: Roshini Shaik (NGN)
B5.86	Protection Automation and Control System interfaced asset	RM: Ben Haines CM: Sihui Chen
C2/B5.46	System Integrity Protection Schemes and the (N-1) criteria	CM: Sean Norris CM: Vladimir Terzija CM: Venkatesh Chakrapani CM: Adam Dysko CM: Ryan Young

12.7 Technical Panel Meetings, Seminars & Tutorials

IET DPSP March 2024.
 Cigre B5 UK Technical Panel Meeting – September 21
 B5 Liaison Meeting Nov 21– combined with D2

12.8 Technical Brochures

Reference	Working Group	Title
926	WG B5.64	Methods for specification of functional requirements of protection, automation, and control

This brochure presents the main treats of an informal or near-formal definition of a simplified Domain-Specific Language (DSL), informally called PacDSL, intended for the formal specification of functional requirements of Protection, Automation and Control of electrical power systems. The definition covers the basic aspects of the lexicon, syntax, semantics, and pragmatics of a typical DSL for this objective, that is agnostic to technology and proprietary solutions, aiming the needs of utilities, academics, manufacturers, and consultants. The brochure intends to document the need for this formalization, based on a survey among utility stakeholders, and to exemplify some possible constructs and Use Cases for this proposed language. It mainly shows its insertion in the engineering cycle during the requirement specification to be deployed on IEC 61850 and other implementation standards.

12.9 Awards

No UK Awards for B5 this year.

12.10 Current Working Groups and UK Members

Country Member	Type	WG Member (WG-__(R)/(C) (R) - regular (C) – corresponding
Ray Zhang	Consultant	JWG B5/C4.61 Convener
V. Terzija	Other	JWG B5/C4.61 WG B5.57 WG C2/B5.46
Zoran Gajic	University	WG B5.57
Peter Crossley,	University	WG B5.55 Convener WB B5.82 (R)
Peter Watson	Consultant	WG B5.56 (R) WG B5.72 (R)
John Wright	Vendor	WG B5.59 (R) WG B5.63 (R) WG B5.81 (Convener)
Abraham Varghese	Vendor	WG B5.58 (R)
Thomas Charton	Tx Utility	WG B5.69(R)
Colin Scoble	Dx Utility	WG B5.65 (R)
Dave York	Vendor	WG B5.70 (C)
Dave Hewings	Other (Network Rail)	WG B5.65 (C)
Chee-Pinp Teoh	Vendor	WG B5.77
Rasoul Azizipanah	Tx Utility	JWG B5/C4.61 (C)
Raju Paidi	University	JWG B5/C4.61 (C)
Chen, Linwei	Tx Utility	WG B5.68
Stockton, Mark	Tx Utility	WG B5.68 (C) WG B5.71 (R)
Hengxu Ha	Vendor	WG B5.70 (C)
Shimeh Jahangiri	Vendor	WG B5.71 (C)
Dr Jianing Li	Consultant	WG B5.72 (C)
Dr. Daniel Gheorghe	Consultant	WG B5.72 (C)
Joao Pestana	Vendor	WG B5.73 (R)
Saurabh Makwana	Vendor	WG B5.73 (C)

Country Member	Type <ul style="list-style-type: none"> ○ Tx Utility ○ Dx Utility ○ Gx Utility ○ Vendor ○ Consultant ○ University ○ Other 	WG Member (WG-___(R)/(C) (R) - regular (C) – corresponding
Yasemin Baygar	Vendor	WG B5.73 (C)
Mohseen Moheemmed	Tx Utility	WG B5.74 (R)
Robert Leone	Vendor	WG B5.74 (C)
Piotr Sawko	Vendor	WG B5.75 (C)
Ian Nicoll	Other	WG B5.76 (R)
Jesus Joao	Vendor	WG B5.76 (C)
Daniel Dantas	Utility	WG B5.77 (C)
Conor Shore	Vendor	WG B5.77 (C)
Simanand Gandhi-Jeyaraj	Other	WG B5.77 (C)
Haiyu Li	University	WG B5.78 (R)
Ricardo Bouchet	Vendor	WG B5.78 (C)
Jesus Valdivieso	NGN	WG B5.78 (C)
Venkatesh Chakrapa	Vendor	WG B5.79 (R)
Ryan Young	Gx	WG B5.79 (C)
Adam Dysko	University	WG B5.79 (C)
Ryan Murphy	Vendor	WG B5.81 (R)
PP Angela	TSO	WG B5.81 (C)
Philip Carss	Other	WG B5.81 (C)
Jesudoss Savarimuthu	Gx	WG B5.81(C)
Beatrice Chong	TSO	WG B5.82 (C)
David Meadows	Vendor	WG B5.82 (C)
Himanshu Bhatia	Vendor	WG B5.83 (R)
Fainan Hassan	Other	WG B5.83 (C)
Deepa Shaji Kumar	University	WG B5.83 (C)
Campbell Booth	University	WG B5.83 (C)
Calum Jardine	TSO	WG B5.83 (C)
Tony Yip	Vendor	WG B5.83 (C)
Ali Adbulla	Vendor	WG B5.84 (C)

Country Member	Type	WG Member
	<ul style="list-style-type: none"> ○ Tx Utility ○ Dx Utility ○ Gx Utility ○ Vendor ○ Consultant ○ University ○ Other 	(WG-___(R)/(C) (R) - regular (C) – corresponding
Thomas Charton	TSO	WG B5.84 (R)
Daniel Otto	Vendor	WG B5.84 (C)
Ryan Sims	University	WG B5.85 (C)
Liang Wuxing	Consultants	WG B5.85 (C)
Li Ding	Vendor	WG B5.85 (C)
Roshini Shaik	NGN	WG B5.85 (C)
Venkatesh Chakrapani –	Vendor	WG B5/C4.79 (R)
Ryan Young	Gx	WG B5/C4.79 (C)
Adam Dysko	University	WG B5/C4.79 (C)
Sean Norris	Vendor	WG C2/B5.46 (C) WG B5.85 (C)

12.11 Notable Industry Activities, Highlighting Positive Issues And Difficulties

Recognition that technology is a key enabler to meet the net zero targets.

Lack of Engineering skills to meet increasing demand.

Operation of distance protection with the increase is REN

Impact of Cyber Security on PAC's particularly as standards are still evolving.

Digital Substation (process bus) starting to gain momentum as business as usual in Transmission. Driven by demand targets. Also includes, digital twin, virtualised protection, Zonal control, and edge technology – enabled by improved communications.

IEC61850 development to improve flexibility and standardisation – need to meet net zero targets. Impact of 2.1, vendor agnostic tools, top-down engineering, integration of legacy devices etc.

Increased move to standard designs and focus on asset / obsolescence management. Supply chain challenges.

System level schemes such as Dynamic System rating, PMU's etc to meet congestion challenges without large infrastructure investment or upgrades – aided by improved communications networks – reach and reduced latency.

12.12 UK Members of the B5 Technical Panel

Chairman: John Wright
Secretary: Ryan Murphy

- Academia by Haiyu Li / Xiao-Ping Zhang
- Transmissions by Mark Stockton / Thomas Charton / Craig McTaggart
- Distributions by Sean Stack / Colin Scoble
- Manufacturers (OEMs) by Robbie Smith / Dave York
- Consultancies/Contractors by Peter Watson
- Others/Rail by Dave Hewings
- NGN : Zhenkun Yang
- Women's Network : Bojana Djukic / Anis Yaakob
- Testing – Ali Abdulla - Omicron

13RM Report on SC C1 System Development and Economics

14.1 Study Committee Scope

SC Chair: Antonio Iliceto
SC Secretary: Peter Roddy

The scope of Study Committee C1 is to study economics and system analysis methods for the development of power systems: methods and tools for steady state and dynamic analysis, planning issues and methods in various contexts, asset management strategies, in order to support electricity system planners worldwide to anticipate and successfully manage system changes to address the arising needs, opportunities and uncertainties while respecting multiple constraints.

14.2 UK C1 Technical Panel

In the last few months, a Technical Panel for UK C1 activities has been established. The purpose of the panel is to achieve the core values of Cigre through actively building a community of UK C1 members, facilitating knowledge sharing, fostering and mentoring the next generation engineers, and promoting Cigre in the wider technical community.

The Technical Panel is made up of eight members from industry and academia. The Chair of the Technical Panel is Bless Kuri, (Regular Member) and Mark Kent (NGN) is the Secretary. The Panel met once, and has a further meeting planned in November 2024 to developed details of activities in 2025.

Draft Terms of Reference (ToR) were developed and submitted to the UK Technical Chair for approval.

14.3 Draft Preferential Subjects

Preferential subjects for Paris Session 2026 were proposed in the following areas:

PS1: Holistic planning of an Integrated Energy System for the Energy Transition

- Sustainable scenarios encompassing Gases, Heat, Mobility, IT (Data Centres) as loads and as flexibility sources
- Planning methodologies and modelling targeting Net Zero while ensuring adequacy of resources and increased resilience
- Prioritisation of Asset Management Plan and allocation of capital, including role of private investments in Transmission Networks

PS2: Strategic investment decisions in the context of the Energy Transition

- Optimal portfolio mix of transmission, generation, storage and non-wire solutions for ensuring adequacy, resilience and flexibility, and relevant governance framework
- Investment Economics and Risk Analysis in the New Energy Landscape
- Sustainable Asset Management Practices, especially for aging infrastructures

PS3: Planning the Cyber-Physical System

- Impact of digitalisation on Power System planning: role of AI, digital twins, big data
- Integration of Physical, Cyber and Electrical security with Asset Management techniques
- Case studies of successful applications of modelling and digital tools in power system planning

14.4 New Working Groups

Several new working groups have been established this year with candidates provided from the UK including C1.50, C1.51, C1.52, C1.53 and C1.54. Joint working groups have also been established with B2 and C5.

There are a number of new working groups also in the early planning stages including C1.55 which is currently undergoing ToR review. In Paris, some key topics for future potential establishment of working groups included the roles of flexibility, resilience, system strength and hydrogen in system planning and economic activities. UK members shall be sought for these topics in due course.

14.5 Technical Panel Meetings, Seminars & Tutorials

- Paris General Session August 2024
 - Workshop – Resilience by Design – Joint C1/C4
 - Workshop – Role of Green H2 in the Energy Transition – Joint C1/C5
 - Tutorial – Energy Sections Integration & Impact on Power Grids
- Supported the University of Birmingham Decarbonisation Summer School (BDSS) in June 2024
- Support on Cairns Symposium and Paris 2024 session paper review
- Montreal Symposium in September 2025 - C1 involvement
- UK C1/NGN Webinar planned for Jan 2025 – **“How far does the power need to go? GB transmission network development to accommodate renewables”**
- C1 Liaison Meeting is planned to be held in person Q1 2025 & Q3 2025
- UK C1 Factory/Site Visit planned to be held Q2 2025

14.6 Last Study Committee Meeting (Highlights)

Study Committee (Aug 24) – Face to face during Paris session

- Updates from active working groups and recently closed working groups
- Update on C1 session and webinars/tutorials
- Green Book on Asset Management has been published – short summary provided
- Discussed and agreed new Working Groups

- Discussed and proposed preferential subjects for 2026
- Excellent attendance online and virtually

14.7 Current Working Groups and UK Members

Number	Title	Status	UK Member
C1.23	Transmission investment decision points and trees	Draft sent for publication	Daniel Clarke (National Grid) Peter Roddy (NESO)
C1.33	Interface & Allocation Issues in multi-party and/or cross-jurisdiction power infrastructures projects	First draft complete but stalled	Peter Roddy (NESO)
C1.37	Optimal transmission and distribution investment decisions under growing uncertainty	TBC	Geev Mokryani (University of Bradford)
C1/6.42	Planning tools and methods for systems facing high levels of distributed energy resources	TBC	Charlotte Higgins (Arup) Xiaolong Hu (National Grid)
C1.44	Global Interconnected and sustainable electricity system - Effects of storage, demand response and trading rules	Published TB938	Xiao-Ping Zhang (UoB)
C1.45	Harmonised metrics and consistent methodology for benefits assessment in Cost-Benefit Analysis (CBA) of electric interconnection projects	TBC	Spyros Skarvelis-Kazakos
C1/4.46	Optimising power system resilience in future grid design	TBC	Mathaios Panteli (University of Cyprus) Calum Mackenzie
C1.47	Energy Sectors Integration and impact on power grids	TBC	Graeme Hawker (University of Strathclyde) Polly Osborne (Burns McDonnell) Spyros Skarvelis-Kazakos
C1.48	Role of green hydrogen in energy transition: opportunities and challenges from technical and economic perspectives	TBC	TBC
C6/C1.33	Multi-energy system interactions in distribution grid	TBC	Eduardo Martinez-Cesena (University of Manchester)
C1.50	Global Sustainable Energy System Coupling electricity and Hydrogen	Activities ongoing	Raul Montano (Hitachi Energy)
B2/C1.86	Approach for Asset Management of Overhead Transmission Lines (new)	TBC	UK member TBC
C5/C1.35	Integration of hydrogen in electricity markets and sector regulation	TBC	UK member TBC
C1/B4.49	Offshore Transmission Planning	Draft of TB ongoing. Good industry representation.	Marko Grizelj (Siemens Energy) Perry Hofbrauer (SSE)

C1.51	Potential Roles of Energy Storage in Electric Power Systems	Final draft of TB to be reviewed	Mark Kent (SPEN) Kelly Loukatou (NESO) Keith Bell (UoS) Colin Ray
C1.52	Virtual Power Plants - Role and deployment in large power systems operation and planning	Agreed contents and lead author for each chapter	Sivapriya Mothilal Bhagavathy
C1/C5.53	Forecasting of demand combined with DER penetration driven by consumer behaviour	Initialisation of WG	TBC
C1.54	Assessment of system reserves and flexibility needs in the power systems of the future	Initialisation of WG	TBC

14.8 UK Members of the Technical Panel

Bless Kuri (SSE) – Regular Member
 Mark Kent (SPEN) – Secretary (NGN)
 Sami Abdelrahman (NGET)
 Charlotte Higgins (Arup)
 Calum Mackenzie (NESO)
 Sivapriya Mothilal Bhagavathy (PNDC)
 Keith Bell (UoS)
 Kelly Loukatou (NESO)

We are seeking additional members who may be interested, in particular in the OEM/manufacture space.

14RM Report on SC C2 System Operation and Control

14.1 Study Committee Scope

SC Chair: **Renuka Chatterjee**
 SC Secretary: **Vinay Sewdien**
 UK Regular Member – **Ronan Jamieson**

The scope of C2 covers the technical, human resource and institutional aspects and conditions for the secure and economic operation of power systems under security requirements against system disintegration, equipment damages and human injuries and security of electricity supply.

14.2 Strategic Advisory Groups

TD 1: Real-time System Operation and Control
 TD 2: System Operational Planning and Performance Analysis
 TD 3: Control Centre Infrastructure and Human Resources for System Operation

14.3 Preferential Subjects

The Paris 24 Session had the following preferential subjects on

PS1: Create operational resilience to extreme/unpredictable events

- Natural phenomena forecasting applied to operation planning studies & real time decision support.
- Threats and hazards from other systems that affect supply/demand of electricity.
- Lessons learned & best practices to deal with high impact/low probability events on system operation.

PS2: Changes on system operation and control considering the energy transition

- Disturbances and system restoration in power systems with a high share of inverter-based resources.
- Flexibility and ancillary services for high RES share environments.
- Power system operation strategies & operation planning studies considering a high share of RES.

14.4 New Working Groups

Number	Title	UK Member
WG	JWG C2/B5.46 - System Integrity Protection Schemes and the (N-1) criteria	TBC

New potential WGs:

- System Operational Resilience Indexes
- Digitalization

New potential JWGs:

- System Operation & Cybersecurity (JWG w/ D2?)
- Influence of Changing Climate Policies on System Operation (JWG w/ C3?)
- Changes in Control Centers due to technology changes and new functionalities available in Distribution Management Systems

New JWGs:

- C2/C5.06 - The Impact of Market Interventions by System Operators during emergency situations
- C2/B4.43 The Impact of offshore wind power hybrid AC/DC connections on system operations and system design

14.5 Technical Panel Meetings, Seminars & Tutorials

- Tutorial - C2/C5.06 - The Impact of Electricity Market Interventions by System Operators during Emergency Situations - TBD (webinar)
- Tutorial - C2.42 - The impact of the growing use of AI/ML for power system operations from an operational perspective - November 19th 2024 - RTE headquarters - Paris - France / Teams (hybrid)

14.6 Technical Brochures

Published Technical Brochures

- TB 925 - Operator Training in Electricity Grids at Different Control Levels and for Different Participants/Actors in the New Environment (WG C2.39)
- TB 936 - Enhanced Information and Data Exchange to Enable Future TSO-DSO Coordination and Interoperability (JWG D2/C2.48)

Expected to be published soon

TB - The Impact of Electricity Market Interventions by System Operators during Emergency Situations (JWG C2/C5.06)

TB - The Impact of the Growing Use of Machine Learning/Artificial Intelligence in the Operation and Control of Power Networks from an Operational Perspective (WG C2.42)

14.7 Last Study Committee Meeting (Highlights)

Paris Session 2024 - A summary of the sessions

During the general discussions for PS1 there were concerns regarding emerging challenges for human performance at the control center and the application of new technologies for decision support. Members opined that reliability of automated decision making and human performance is critical for reliable operations. Collaboration for improving operator training, need for improving modelling tools were stressed upon. Reinforce the offline support to real-time control centre operations

There was one presentation (C2-11877) from NGN under PS1 presented the possibilities of harnessing the vehicle to grid technologies for enhancing speed of post-event power restoration. It proposed co-optimization of multiple distributed resources such as electric vehicles, electric buses, photo voltaic storage bus stations and mobile energy storage systems to enhance flexibility of regional power scheduling, improve speed of post-event power restoration.

The main theme of discussion for PS2 were based on understanding how flexibility and ancillary services are suitably available and utilised (and how should they be incentivised to connect - e.g. via a regulated or market environment). The reduction in system parameter like inertia due to a high share of RES impact other parameters like system voltage and frequency, therefore these RES need to provide services to assist in managing the overall system security and reliability. Also better planning strategies should ensure smoother system operations. These strategies based on the different contributions submitted argue that all power systems require better power system study techniques, computational approaches and understanding and modelling of the interactions of the Inverter based resources.

The NGN paper (C2-11872) shared experiences with the new challenges and solutions faced by power system operations as a consequence of the current trends in the energy transition and the resulting high share of Renewable Energy Sources (RES) and Inverter-Based Resources (IBRs). It also highlights the need for appropriate monitoring tools to provide fast and reliable situational awareness for operators to monitor and assess the real-time state of the power grid.

The conclusions of the Group Discussion Meeting of SC C2 during the CIGRE Session have once more revealed the challenges and the increasing complexity that power system operation is facing and will continue to face in the future. There are major areas where developments are happening:

- Resource adequacy planning with growing uncertainties
- Solar PV forecasting in snow bound areas
- Demand side flexibility
- Geomagnetic induced current simulations
- System Protection Schemes
- System resiliency
- Deployment of artificial intelligence in power system
- Deployment of Wide Area Monitoring Systems
- Enhanced usage of wide area monitoring systems to assist in identifying system disturbances and solutions as early as possible
- Improved power system studies to better simulate potential issues early in the planning process thereby enabling early identification of solutions
- Improved understanding and shared learning on how to optimise frequency control using wind, solar in combination with battery storage
- The growing use of advanced computation techniques (machine learning, genetic algorithms) to speed up the process of finding an optimise solution

In conclusion, system operations and control will keep on developing innovative solutions and concepts to operate the power system today and in the future as the energy transition increases.

The Paris Session also included

- Workshop : C2&C5 Large Disturbances in Systems and Markets Workshop.
- Tutorial : Wide Area Monitoring Protection and Control Systems – Decision Support for System Operators – WG C2.14

UPCOMING EVENTS

- Trondheim Symposium (May, 2025)
- Montreal Symposium (September/October, 2027)

14.8 Current Working Groups and UK Members

Number	Title	UK Member
WG C2.4	Estimation, evaluation and provision of power system inertia in networks with a high share of renewable generation – convener Yaran Li	
WG C2.42	The Impact of the growing use of machine learning/Artificial Intelligence in the operation and control of Power Networks from an Operational perspective	Ewa Krywkowska
WG C2.44	Operational strategies to manage power system minimum operating conditions	Ramana Budha

14.9 UK Members of the Technical Panel

RM – Ronan Jamieson (Baringa)

15RM Report on SC C3 System Environmental Performance

15.1 Study Committee Scope

SC Chair: Mercedes Vazquez

SC Secretary: Angel Salinas

The mission of SC C3 is to facilitate and promote the principles of **sustainable development** in the field of power system performance through the global exchange of information and knowledge, generating added value by identifying best practices and developing recommendations in line with global best practices.

The scope of SC C3 covers interactions between the natural and social environments and the end-to-end electricity system. It involves addressing environmental and social impacts such as land use, biodiversity; greenhouse gases; air, soil, and water pollution; natural resource consumption; waste generation; electromagnetic fields; noise or landscape. It also considers the prominent role and relevance of different stakeholder groups, with a special focus on local communities.

The main areas of attention for the C3 SC are: All kinds switching devices, including AC and HVDC;

- Environmental & social impacts of power system development and operation with a life cycle approach
- Sustainability: role of the power system
- Stakeholders' engagement and public acceptance

15.2 Strategic Advisory Groups

AG 3.01 Electric and magnetic fields and human health – Convenor: Michel Plante

15.3 Current Working Groups and Joint Working Groups

SC C3 presently consists of the following WGs detailed below by topic and their current status.

Working Group number	Title	Activity	UK member
AG 3.01	EMF and human health	Active	Hayley Tripp
WG 3.09A	Corridor management	Active	
WG C.12	Methodologies for Greenhouse gas inventory and reporting for T&D utilities (Renewed TOR, not approved yet): Managing GHG emissions of T&D activities. Accounting, reducing & reporting progress.	To be relaunched (TOR to be reviewed and need of convenor)	
WG C3.15	Best environmental and socioeconomic practices for improving public acceptance of high voltage substations	Disbanded. A TB and tutorial is being prepared by Joris den Breejen (NL)	
WG C3.16	Interactions between electrical infrastructure and wildlife	Finished work	
WG C3.17	Interaction between wildlife and emerging renewable energy sources and submarine cables	To be relaunched (TOR to be	

		reviewed and need of convenor)	
WG C3.20	Sustainable Development Goals in the Power Sector	Active. Convenors: Lou Cecere (USA) /Katia Garcia (BR) /Manon Schenkels (NL)	
WG C3.22	Vegetation management in substations	Active: Vincent Du Four (BE)	
WG C3.23	Eco-design methods for TSOs/DSOs under environmental transition	Relaunched (C3.25)	
JWG B1/C3 85	Environmental impact of decommissioning of underground and submarine cables	Active: Kieron Leeburn (ZA)	
JWG A2/C3.70	Life Cycle Assessment (LCA) of Transformers	Myles Margot (DE) New WG	

15.4 New and Disbanded Working Groups

New WGs:

- WG C3.23: Eco design methods for the power system -
- JWG C3/B2.24: Methods of reducing electrocution of birds from power lines

WGs Disbanded:

- WG C3.13 Impact of environmental liability on transmission and distribution activities - disbanded with no publication
- WG C3.18 Eco-friendly approaches in transmission and distribution disbanded with no publication
- WG C3.21 Including stakeholders in the investment planning process (Renewed TOR of former JWGC1/C3.31)- disbanded with no publication

15.5 Technical Brochures and Publications

The following table details the most recent publications, and pending publications related to SC C3.

Ref	WG	Title
CSE 032	AG 3.01	Smart Meters and human health
Submitted to CSE	AG 3.01	HVDC Transmission lines and health
Submitted to Scandinavian Journal of work environment and health	AG 3.01	Risk of interference of high 50/60 Hz electric and magnetic fields with the normal functioning of active cardiac implants: from the recent 20 years of research to return to work facilitation for utility workers
TB 876	WG C3.16	Interactions between Electrical Infrastructure and Wildlife

15.6 Preferential Subjects

The Preferential Subjects during the Paris 2024 session were:

- Public acceptance and stakeholder engagement in power system - generation, transmission and distribution infrastructures
- Climate change and impact on power system, a holistic approach
- Sustainability starting for the supply chain.

In all 36 reports were accepted and presented during the Symposium.

15.7 Technical Meetings, Seminars & Tutorials

The 2024 Annual SC C4 Meeting was held in person at the Paris sessions on Wednesday, August 28, during the CIGRE 2024

The meeting agenda covered, among others, the following:

- The SAG meetings
- Study Committee Chair's Report
- An update of AG 3.01 activities.
- Updates of WG from Convenors
- SC discussions on:
 1. Existing WG: cancellation or relaunching of “non- active” WG.
 2. New working groups
 - Participation in Cigre activities
 - 1. Paris session 2026: Preferential Subjects
 - 2. Next SC3 meeting: Trondheim-Norway 2025
 - Discussion of preferential subjects and reviewer
 - 3. Other Symposiums in 2025: Canada, Israel.

The next meeting of the C3 SC will be at the Trondheim symposium in May 2025.

15.8 Last Study Committee Meeting (Highlights)

Study Committee C3 met during the Paris 2024 Symposium on the 28th August 2024. It was chaired by Mercedes Vazquez who welcomed all attendees.

The meeting agenda was reviewed and approved along with the minutes of the last meeting in 2023. Mercedes discussed changes to the C3 Regular Members and introductions for all new members were made. A discussion proceeded about the number of disbanded WG, and that the scope of these WGs is large and a narrower approach for proposals may be more successful. A reminder was given about the need for WGs to use the correct online tools to draft Technical Brochures. Working Groups were also reminded that it must produce Technical Brochures as part of its work.

An update of current WGs were made by convenors of each group, including focus of work to date, members, and progress.

Next Mercedes opened the floor to invitations about preferential subjects for the upcoming Trondheim Symposium in Norway, with topics chosen by member's vote. The preferential subjects agreed were:

- PS1: Biodiversity conservation and enhancement: Positive enhancements;
- PS2: Building a more sustainable power system for the future;
- PS3: Disclosing sustainability.

The Trondheim meeting will be the location of the next SC Technical committee meeting and members were encouraged to attend in person. Proposals for new working groups were presented. There was a call for new work proposals and an encouragement of SC members to use their networks to promote the process. Finally, an encouragement to submit synopsis for the Trondheim meeting.

16RM Report on SC C4 System Technical Performance

16.1 Study Committee Scope

SC C4 Chair: Marta Val Escudero (IE)

SC C4 Secretary: Dr Genevieve Lietz (DE)

The main mission of Study Committee (SC) C4 is to facilitate and promote the progress of power systems engineering and the international exchange of information and knowledge in the field of system technical performance and to add value to this information and knowledge by means of gathering state-of-the-art practices from around the world and developing recommendations.

The scope of SC C4 is the development and review of methods and tools for analysis related to power systems, with reference to dynamic and transient conditions and the interaction between the power system and its apparatus/subsystems, as well as between the power system and external causes of stress and other installations. Specific issues related to the design and manufacturing of components and apparatus are not in the scopes of SC C4, nor are those specifically related to planning, operation, and control, apart from those cases in which a component, apparatus, or subsystem behaviour depends on, or significantly interacts with the performance of the nearby power system. Thus, the scope of SC C4 is quite broad and covers all aspects of the technical performance of large power systems across the entire range of phenomena and time frames, the continuum of which is shown in [Figure 17.1](#).

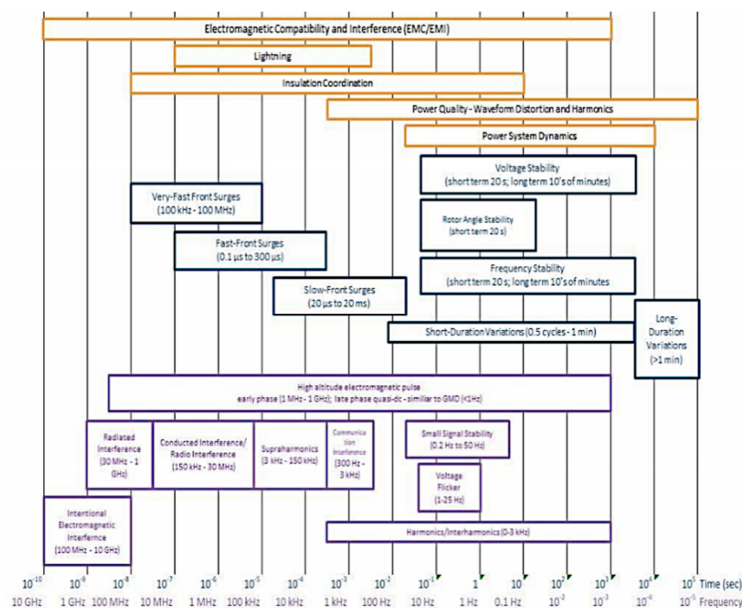


Figure 17.1: Time Frame with the Range of Phenomena Investigated by SC C4.

To better define the scope of SC C4, the following broad topics of interest are covered:

- Power Systems Stability & Dynamics – Performance, Models and Numerical Analysis (PMNA)
- Power Quality (PQ)
- Electromagnetic Compatibility and Interference (EMC/EMI)
- Insulation Coordination (IC)
- Lightning (L), Switching

The common theme among these broad topics is the investigation and development of new tools, models, analysis methods and techniques for the assessment of such phenomena. The list provided above also relates to the emerging smart grid, microgrid and distributed and renewable energy resource technologies (such as wind and solar), with emphasis concerning power quality and advanced tools for the analysis of electromagnetic and electromechanical transients and dynamic performance.

Due to its wide remit, SC C4 alone cannot investigate all technical performance issues without being in close cooperation with other CIGRE SCs that deal with equipment, system planning and operations, distribution networks, materials and testing, and environmental aspects of the power system.

16.2 Structure and Strategic Advisory Groups

The membership of SC C4 presently encompasses 35 countries. At the 2024 SC C4 meeting on Tuesday, August 27th, Palais des Congrès, Paris, France, [the composition of the SC C4](#) was confirmed as follows:

- Chair: Marta Val Escudero (MVE)
- Secretary: Dr Genevieve Lietz
- 27 Regular Members, 3 Additional Regular Members
- 1 NGN Regular Member, 1 WiE Regular Member and 9 Observer Members

Figure 17.2 shows the organisational structure of the CIGRE SC C4. It comprises 3 Advisory Groups (AGs), as follows:

- Strategic Directions AG C4.1 (SAG) – AG1 includes liaisons with IEC and IEEE;
- Customers AG C4.2 (CAG) – Convenor: Position Open
- Tutorials & Conferences AG C4.3 (TAG) – Convenor: Papiya Dattaray (PD)

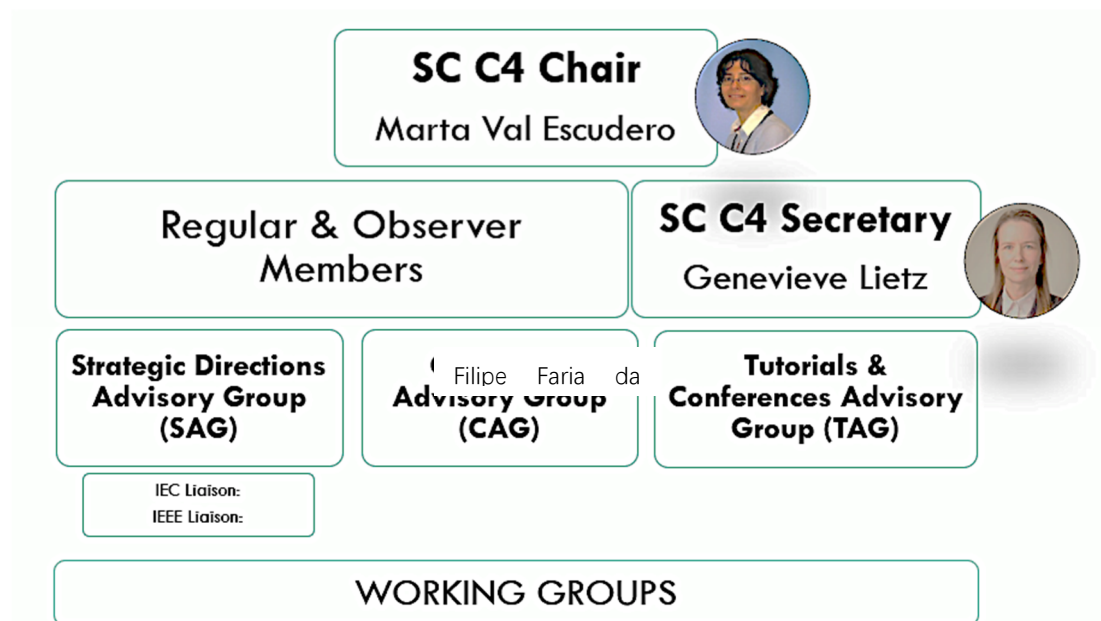


Figure 17.2: Organisational Structure of SC C4.

Awards

Individuals associated with SC C4 works were recognised with a CIGRE Award:

- Babak Badrzadeh: TC Award
- Angélica Rocha: WiE Award
- Jinliang He: Fellow Award
- Distinguished Member Award:
 - Australia: Sarath PERERA, Andrew HALLEY, Don GEDDEY
 - Canada: William CHISHOLM
 - Croatia: Božidar FILIPOVIĆ GRČIĆ

- Denmark: Filipe FARIA DA SILVA
- France: Manuel MARTINEZ DURO
- Russia: Stanislav UTTS

16.3 CIGRE SESSION 2024 – Preferential Subjects

The **Preferential Subjects (PS) for the CIGRE 2026 Paris Session** were scoped in the 2024 Annual SC C4 Meeting and are expected to be finalised:

PS1: Power System Dynamics Aspects of Decarbonization of Power Systems and the Road to Net-Zero

- Emerging methodologies for plant and system-wide modelling, model validation, advanced data analyses, screening methods and metrics, study processes and performance monitoring.
- Power system impact of new technologies including storage, large scale inverter-based generators, loads (e.g. electrolyzers), network elements and control methods (e.g. grid forming), including relevant specifications.
- Phenomena impacting power systems security and dynamic performance - e.g. wide-area, local interactions and forced oscillations.
- Demystifying system strength

PS2: Power Quality and Electromagnetic Compatibility Aspects of Decarbonization of Power Systems and the Road to Net-Zero

- Modeling and simulation for assessment of EMC and Power Quality phenomena and mitigation strategies in meshed transmission systems.
- Experiences with Power Quality issues in IBR dominated systems, utilization of advanced data analytics to analyze measurements and trends. Approaches for allocation of power quality limits and compliance of new connections to power systems.
- Experiences with EMI for large converter connected generators and loads and interference between the power system (AC or DC) and pipelines and telecom systems.

PS3: Insulation Co-Ordination and Lightning Research: Paving the Way to Net-Zero in Decarbonized Power Systems

- Future of insulation co-ordination for AC, DC and hybrid systems addressing non-standard waveforms and enhancing the resilience of power system equipment against transient disturbances.
- Improvement of lightning detection systems, with a focus on the integration of lightning warnings and weather data into grid control rooms related to power system reliability.
- Lightning protection designs and accepted risk of damage in particular to inverter-based resources, such as large photovoltaic and wind power plants, and assessment of the impact of thunderstorms and extreme weather events.

16.4 Current Working Groups and UK Members

SC C4 presently consists of some **41 active (J)WGs** performing highly technical work aligned with its strategic fields. These WGs are composed of over 600+ individual technical experts from 60+ countries around the world, some serving in more than one WG. The number of active WGs by topic is as follows:

Number	Title (RAG Status)	UK Member
<u>WG C4.36</u>	Winter Lightning – Parameters & Engineering Consequences for Wind Turbines	

<u>JWG C4.40/CIRED</u>	Revisions to IEC Technical Reports 61000-3-6, 61000-3-7, 61000-3-13, and 61000-3-14	Emin, Zia Foster, Sarah Koo, Leong Thomas, Dave Djokic, Sasa Vujatovic, Davor
<u>JWG C4.42/CIRED</u>	Continuous assessment of low-order harmonic emissions from customer installations	Djokic, Sasa Moore, Fabian
<u>WG C4.43</u>	Lightning problems and lightning risk management for nuclear power plants	Siew, Wah-Hoon Knott, Robert
<u>WG C4.44</u>	EMC for Large Photovoltaic Systems	Siew, Wah-Hoon
<u>JWG C1/C4.46</u>	Optimizing power system resilience in future grid design	Panteli, Mathaios
<u>WG C4.47</u>	Power System Resilience (PSR WG)	Rapier, Aisling Panteli, Mathaios Skarvelis-Kazakos, Spyros Strbac, Goran Zhou, Yutian
<u>WG C4.50</u>	Evaluation of Transient Performance of Grounding Systems in Substations and Impact on Primary & Secondary System	Negi, Himanshu
<u>WG C4.51</u>	Connection of Railway Traction System to Power Network	Vujatovic, Davor-Convenor Emin, Zia Ghassemi, Forooz
<u>JWG A1/C4.52</u>	Wind generators and frequency-active power control of power systems	Vujatovic Davor, Jamil Shakin
<u>WG C4.54</u>	Protection of high voltage power network control electronics from the High-altitude Electromagnetic Pulse (HEMP)	Hoad, Richard
<u>WG C4.55</u>	EMC related very-fast transients in gas-insulated substations - EMI, measured characteristics, modelling and simulations	James, Jonathan Haddad, Manu
<u>WG C4.57</u>	Guidelines for the Estimation of Distribution OHL Lightning Performance and Application to Lightning Protection Design Scope	Haddad, Manu
<u>JWG C4/C2.58/IEEE</u>	Evaluation of Voltage Stability Assessment Methodologies in Transmission Systems	Awadallah, Selma
<u>WG C4.59</u>	RT Lightning Protection of the Electricity Supply Systems of the Future	
<u>WG C4.60</u>	Generic EMT-Type Modelling of Inverter-Based Resources for Long Term Planning Studies	Li, Rui Vozikis, Dimitrios Nieto Calvo, Alejandro Larkins, Andrew Vaheeshan, Jeganathan Abiri Jahromi, Amir
<u>WG C4.61</u>	Lightning transient sensing, monitoring and application in electric power systems	Siew, Wah-Hoon
<u>JWG B5/C4.61</u>	Impact of Low Inertia Network on Protection and Control	Zhang, Ray - Convenor
<u>JWG: C4/C2.62/IEEE</u>	Review of Advancements in Synchrophasor Measurement Applications	Blair, Steven Clark, Stuart Simmons, Clarke Li, Yun Cowan, Ian L Shams, Negar
<u>WG C4.63</u>	Harmonic power quality standards and compliance verification – a comparative assessment and practical guide	Emin, Zia Shore, Nigel – Convenor Koo, Kah-Leong

		Pampana, Ramesh Blair, Steven Ghassemi, Forooz
<u>WG C4.64</u>	Application of Real-Time Digital Simulation in Power Systems	Ponnalagan. Bharath Wijesinghe, Sarath
<u>WG C4.65</u>	Specification, Validation and Application of Harmonic Models of Inverter Based Resources	Pampana, Ramesh Monteiro, Jose
<u>WG C4.66</u>	New concept for analysis of multiphase back-flashover phenomena of overhead transmission lines due to lightning	Nurashikin, Jamil
<u>WG C4.67</u>	Lightning Protection of Hybrid Overhead Lines	
<u>WG C4.68</u>	Electromagnetic Compatibility (EMC) issues in modern and future power systems	Ragusa, Antonella Frosinou, Asimina
<u>WG C4.69</u>	Quantifying the lightning response of tower-footing electrodes of overhead transmission lines: methods of measurement	Fabian Koehler
<u>JWG B1/C4.69</u>	Recommendations for the insulation coordination on AC cable systems	
<u>WG C4.70</u>	Application of space-based lightning detection in power systems	Fabian Koehler
<u>WG C4.71</u>	Small signal stability analysis in IBR dominated power system	Tatiana Assis Can Li
<u>JWG C4/B4.72</u>	Lightning and Switching Induced Electromagnetic Compatibility (EMC) issues in DC power systems and new emerging power electronics-based DC equipment	Oheidhin, Gearoid
<u>JWG B4/B1/C4.73</u>	Surge and extended overvoltage testing of HVDC Cable Systems	
<u>JWG B2/C4.76</u>	Lightning & Grounding Considerations for Overhead Line Rebuilding and Refurbishing Projects, AC and DC	
<u>WG C4.73</u>	Insulation Coordination of HVDC Overhead Lines	
<u>WG C4.74</u>	Accurate Line and Cable Models for Steady-State and Transient Studies	Alexander Yanushkevich, Ross Falconer
<u>JWGC4/A3/B2/B4.75</u>	Guide to Procedures for the Creation of Pollution Maps Required for Outdoor Insulation Coordination	
<u>WG C4.76</u>	Protection in Switching Inductive Devices with Vacuum Circuit Breaker	Garret Dakin
<u>WG C4.77</u>	Best practices for individual and collective conformity assessment	Jayaraman Ramachandran Colin Foote
<u>JWG B5/C4.79</u>	Protection Roadmap for Low Inertia and Low Fault Current Networks	
<u>JWG B4/C4.93</u>	Development of Grid Forming Converters for Secure and Reliable Operation of Future Electricity System	Dechao Kong – Convenor Peng, Jinsheng
<u>JWG B4/C4.97</u>	Benchmarking of simulation Models for control interaction in meshed AC networks with multiple converters	
<u>JWG B4/C4.103</u>	AC Network Equivalents for HVDC and FACTS Project Studies	

The number of the above-mentioned 44 active (J)WGs by topic is as follows:

- Power Systems Performance Models and Numerical Analysis (PMNA): 15 (J)WGs
- Power quality (PQ): 5 (J)WGs
- EMC/EMI: 5 (J)WGs
- Insulation Coordination (IC): 6 (J)WGs
- Lightning (L): 10 (J)WGs

16.5 New Working Groups

Following the 2023 Annual SC C4 2 **new WGs** were formed in SC C4 as listed below, while there is further work in progress to propose new WGs:

- **WG C4.77:** “Best practices for individual and collective conformity assessment”. Convener Babak Badrzadeh (Australia)
- **JWG B4/C4.103:** “AC Network Equivalents for HVDC and FACTS Project Studies”. Convener iranya Suriyaarachchi (Canada)

New working group TOR proposals:

- Development of network equivalents for assessment of large IBR projects and use of EMT for large scale stability analysis in planning and operations timeframes. ToR under development by Nilesh Modi (Australia)
- Interference effects between DC transmission lines and nearby pipelines/ telecom lines. JWG with B2 and B4. ToR under development by Alain Xemard (France).
- Insulation Co-ordination of AC/DC hybrid transmission lines: gap analysis in international standards. Task Force led by Hideki Motoyama (Japan)
- System Strength: concept, metrics and approaches for management from planning to real-time operations. ToR under development by Andrew Halley (Australia).
- WG B4. “Guide for Electromagnetic Transient Studies of VSC-HVDC connected offshore wind farms”. Convenor Pierre ULT (rance). C4 liaison member.

Invitations for nominating new WG members will be circulated in due course once the Terms of References for any new WGs are finalised and accepted.

16.6 Technical Brochures

The following **Technical Brochures (TBs) have been published** since September 2023 as a result of work done by SC C4 WGs and JWGs:

- **TB 909:** “Guidelines for Subsynchronous Oscillation Studies in Power Electronics Dominated Power Systems”, JWG C4/B4.52, 2023 – UK C4 Members: Lapova Elisabetta, Pashaei Afshin.
- **TB 913:** “Evaluation of Temporary Overvoltages in Power Systems due to Low Order Harmonic Resonances”, WG C4.46, 2023 – UK C4 Members: Mills David, Munji Kiran, Peng Jinsheng.
- **TB 921:** “Applying Low-Residual-Voltage Surge Arresters to Suppress Overvoltages in UHV AC Systems”, JWG C4/A3.53, 2023. Convenor: J. L. He – UK C4 Members: Haddad Manu.
- **TB 922:** “Review of Large City & Metropolitan Area power system development trends taking into account new generation, grid and information technologies”, JWG C1/C4.36, 2024. Convenor: S. Utts. Co-Convenor: V. S. de Jesus.
- **TB 928:** “Multi-frequency stability of converter-based modern power systems.”, WG C4.49, 2024. Convenor: Ł. Kocewiak – UK C4 Members: Mills David, Ding Xiaoling, Shore Nigel, Emin, Zia.

The following **TBs are expected to be finalised** and submitted for publication in 2024/2025:

Ready for Publication:

- JWG C4/C2.58/IEEE: Evaluation of Voltage Stability Assessment Methodologies in Transmission Systems
- WG C4.61: Lightning transient sensing, monitoring and application in electric power systems

Already reviewed by SC C4. Waiting for final TB Revision:

- JWG C4.42/CIRED: Continuous assessment of low-order harmonic emissions from customer installations
- WG C4.59: Real-time Lightning Protection of the Electricity Supply Systems of the Future
- JWG B4/B1/C4.73: Surge and extended overvoltage testing of HVDC Cable Systems

Draft TBs currently under review by SC C4:

- JWG B1/C4.69 Recommendations for the insulation coordination on AC cable systems

Draft TBs expected in Q4 2024, to be reviewed by SC C4:

- WG C4.36 Winter Lightning - Parameters and Engineering Consequences for Wind Turbines
- WG C4.43 Lightning problems and lightning risk management for nuclear power plants
- WG C4.44 EMC for Large Photovoltaic Systems
- WG C4.47 Power System Resilience
- WG C4.57 Guidelines for the Estimation of Overhead Distribution Line Lightning Performance and its Application to Lightning Protection Design
- WG C4.60 Generic EMT-Type Modelling of IBR for Long Term Planning Studies
- JWG B5/C4.61 Impact of Low Inertia Network on Protection and Control
- JWG C4/C2.62/IEEE Review of Phasor Measurement Unit Applications
- JWG A1/C4.66 “Guide on the Assessment, Specification and Design of Synchronous Condensers for Power Systems with Predominance of Low or Zero Inertia Generators”
- JWG B2/C4.76 Lightning & Grounding Considerations for Overhead Line Rebuilding and Refurbishing Projects, AC and DC

SC C4 in CIGRE Science & Engineering Journal (CSE) since October 2023:

- **Best Of Papers CIGRE Cairns 2023 Symposium** (December 2023 edition): “Wind Power Integration in Weak Grids”, J. Sivasankaran, M. Campos and R.Kabiri.
- **Best Of Papers CIGRE Sendai 2023 Colloquium** (February 2023 edition): “Development of Evaluation Process for Demand-Side Resilience against Power Outage”, N. Sakai, T. Tobo, R. Takahashi, Y. Iino, K. Yabe, Y. Hayashi.

SC C4 Newsletter issued in July 2024. Chief Editor: Udaya Annakkage (CA)

SC C4 Green Book published on “**Power system dynamic modelling and analysis in evolving networks**”, 2024. Co-edited by Dr Babak Badrzadeh and Dr Zia Emin. Chapters within the book were led by various SC C4 experts.

Reference guide for practicing engineers around the world to understand, model, and analyse more confidently various forms of system stability in a rapidly changing power system with increasing uptake of inverter-based resources.

- Provide information about all aspects of contemporary PS dynamic modelling and analysis
- Provide information about all aspects of contemporary power system dynamic modelling and analysis in a rapidly changing power system with increasing uptake of IBR.
- Provide a comparison of changes occurring between conventional power systems with the dominance of synchronous generators and an evolving power system with high share of grid-connected and distributed inverter-based resources in terms of dynamic phenomena experienced, analysis methods and simulation tools required, and enablers to achieve this.
- Describe different types of PS studies and associated analysis tools as the system evolves.
- Present modelling requirements for different PS components, both existing and emerging technologies, such that power system can be planned and operated securely and reliably.

- Present practical examples obtained from real power systems worldwide as a step-by-step study guide such that they can be applied by practicing engineers in their day-to-day tasks.
- Demonstrate the importance of PS model acceptance testing and validation by practical examples describing applications of various methods.

16.7 Last Study Committee Meeting (Highlights)

The 2024 Annual SC C4 Meeting was held on Tuesday, August 27, during the **CIGRE Session 2024 in Paris, France**. Participants included SC C4 Regular Members, AG Members and WG Conveners. The meeting agenda covered, the following:

MEETING AGENDA

1	Welcome and introductions	09:00 – 09:15
2	CIGRE Antitrust guidelines	09:15 – 09:20
3	Approval of Agenda (additions/changes)	09:20 – 09:25
4	Review of SC C4 membership & structure	09:25 – 09:45
5	Study Committee Chair's report	09:45 – 10:10
6	Paris 2024 session	10:10 – 10:20
	Morning Coffee break	10:20 – 10:40
7	CIGRE Paris 2026 Session: Preferential Subjects	10:40 – 11:45
8	Advisory Group 2 – Customers	11:45 – 11:50
9	Advisory Group 3 – Tutorials & Conferences <ul style="list-style-type: none"> Review of recent supported events Recent Tutorials and Workshops Recent Webinars 2025 Symposia 	11:50 – 12:15
10	New WG management tool	12:15 – 12:30
	Lunch break	12:30 – 14:00
11	WG presentations: <ul style="list-style-type: none"> C4.36 -- Masaru Ishii C4.43 -- Akiyoshi Tatematsu C4.44 -- Ener Salinas C4.47 -- Mathaios Panteli 	14:00 – 15:00
12	Publications: Technical Brochures, CSE papers, Green Book	15:00 – 15:20
	Afternoon Coffee break	15:20 – 15:40
13	Advisory Group 1 – Strategic Directions: <ul style="list-style-type: none"> SAG Membership Review of SC C4 Strategic Plan Review of Status of Current Active WGs/JWGs New WG suggestions Institutional liaison reports 	15:40 – 16:40
14	Next SC C4 Meetings	16:40 – 16:50
15	Any Other Business	16:50 – 17:00
16	Final remarks and close of the meeting	17:00

16.8 Technical Panel Meetings, Seminars & Tutorials

Past Events: Since August 2023, SC C4 has supported the following events:

CIGRE 2023 Symposium: Cairns (Australia): “Renewables and challenges of integration and the impact of renewable generation on the Grid”, September 2023. It comprised of:

- **9 paper sessions with 46 selected Papers and 45 Presentations.**

- **The SC C4 Workshop** entitled: WG C4.56, WG C4.71 and JWG A1/C4.52 – “Modelling and analysis of new and emerging forms of system stability”.

CIGRE 2023 International Colloquium: Sendai (Japan): “Recent Overhead Transmission Line Technology and Environmental Measures”, International Colloquium SC B2/C/C4, October 2023. It included **9 submitted Papers** and the following **2 Tutorials**:

- **Tutorial 1** entitled: WG C4.59 – “Real-time Lightning Protection of the Electricity Supply Systems of the Future”.
- **Tutorial 2** entitled: JWG C4/A3.53 – “Advanced metal-oxide varistors for surge arresters with better protection properties”
- **Tutorial-3** entitles: JWG B2/C4.76 – “Lightning & grounding considerations for overhead line rebuilding and refurbishing projects, AC and DC”

CIGRE 2023 International Colloquium ICLPS-CIPDA: Suzhou (China): “International Colloquium on Lightning and Power Systems (ICLPS)”, October 2023.

- **Tutorial-1** entitled: WG C4.59 – “Real-time Lightning Protection of the Electricity Supply Systems of the Future”
- **Tutorial-2** entitled: JWG_C4/A3.53 – “Advanced metal-oxide varistors for surge arresters with better protection properties”

CIGRE Brazil Workshop 2024: “Experiences and Challenges in Integrating Wind and Photo-Voltaic into the Operation of the Electric Grid”. Co-Organised by three Brazilian Sub-committees C4, C2 & C6.

CIGRE 2024 Paris Session: As part of the CIGRE 2024 Paris Session that was held from Sunday 25 to Friday 30 August 2024, SC C4 had a Group Discussion Meeting on Friday August 30, 2024, a Paper Session, as well as Workshop and Tutorial events described below:

- **The SC C4 Group Discussion and Paper Session:** SC C4 selected **81 papers** aligning with the **3 Preferential Subjects (PS)** for the 2024 CIGRE Session. 2 out of the 81 selected papers were submitted as part of NGN Member showcase competition.
- **Joint C4/C1 Workshop** entitled: “Resilience by design”, August 27, 2024
- **The SC C4 Workshop** entitled: Workshop: C4 Green Book – “Power system dynamic modelling and analysis in evolving networks”, August 28, 2024.
- **The SC C4 Tutorial** entitled: WG C4.68– “EMC issues in modern and future power systems “, August 29, 2024.
- **SC C4 Group Discussion Meeting**, August 30, 2024.

CIGRE ACADEMY Webinars:

- **WG C4.46** – “Evaluation of Temporary Overvoltages in Power Systems due to Low Order Harmonic Resonances” Filipe Miguel Faria da Silva, Konstantinos Velitsikakis, Oscar Lennerhag, Chris Liberty Skovgaard, Julien Michel
- **JWG C4/B4.52** – “Guidelines for Sub-synchronous Oscillation Studies in Power Electronics Dominated Power Systems”, Chandana Karawita, Udaya Annakkage, Olli-Pekka Janhunen and Anuradha Dissanayaka
- **WG C4.49** – “Multi-frequency Oscillations in Power Electronic Based Energy Systems”, Łukasz Kocewiak, Christoph Buchhagen, Xiongfei Wang, Mats Larsson, Ramón Manuel Blasco, Giménez and Yin Sun

Future Events: Below are the upcoming events supported by the CIGRE SC C4, in terms of planned Meetings, Seminars, and Tutorials:

CIGRE 2025 Symposium Trondheim (Norway) – “Changes needed in the power system for the energy transition”, 12-15 May 2025.

Preferential Subjects:

- **PS1:** Integration of renewable energy resources to the grid
- **PS2:** Technologies supporting the power grid for energy transition to carbon neutral energy production

CIGRE 2025 Symposium Montreal (Canada), – “Grid Enhancement, Strategic Planning, Technological Innovation and Climatic Adaptation for Resilient Future Energy Systems”, 29 September - 2 October 2025:

Preferential Subjects:

- **PS1:** System Enhancement, Markets and Regulation
- **PS2:** Application of Technologies, Information Technology (IT) and Artificial Intelligence (AI)
- **PS3:** Climate Change and Extreme Weather Events
- **EHV & UHV AC and DC**

CIGRE 2026 Paris Session, France, 23-28 August 2026

Preferential Subjects:

- **PS1:** Power System Dynamics Aspects of Decarbonization of Power Systems and the Road to Net-Zero
- **PS2:** Power Quality and Electromagnetic Compatibility Aspects of Decarbonization of Power Systems and the Road to Net-Zero
- **PS3:** Insulation Co-Ordination and Lightning Research: Paving the Way to Net-Zero in Decarbonized Power Systems

16.9 UK SC C4 Technical Panel Members and Meeting

The 2024-2025 CIGRE UK Study Committee C4 Technical Panel Liaison Meeting will be held in conjunction with the CIGRE UK SC C4 Technical Event on January 21st, 2025 (TBC, Glasgow ScottishPower HQ Building) and will be chaired by SC C4 UK Regular Member, Spyros Karamitsos. It will aim to provide a high-level overview of the ongoing activities in CIGRE related to C4 and bring together experts from industry and academia to present certain issues on the grid integration of renewables and discuss developments towards modelling methods and study tools for the analysis of the transforming power system.

The 2024-2025 CIGRE UK Event's Agenda will also include updates on the Technical Brochures published in the last year, along with a status update on the active SC C4 Working Groups where the UK has an interest as well as latest work items approved by the C4 Study Committee during the Paris 2024 session and possible work items that could be proposed in the future.

Three UK SC C4 Papers were presented at the CIGRE PARIS 2022 POSTER SESSION, all at PS3:

- **11096:** “Automatic Detection of Subsynchronous Oscillations”, D. CHAKRAVORTY, A.C. NEAGU, J.L. CREMER
- **11099:** “Framework for Identification of Subsynchronous Oscillations Risks”, D. CHAKRAVORTY, J. TRIVINO, S. ABDELRAHMAN.

- **11448:** “Oscillation Modes Identification Via Singular Value Decomposition and Principal Component Analysis”, C. FERRANDON, A. ALVAREZ, J. CERVANTES, Z. EMIN.



Photograph of CIGRE UK SC C4 RM together with SC C4 C4 UK Paper Authors-Presenters
at the CIGRE PARIS SESSION 2024
(Spyros Karamitsos, Alex Boyd, Kah Leong Koo, Diptargha Chakravorty)

The UK SC C4 technical panel to be confirmed for 2024-2025. The goal will be to organise a CIGRE UK SC C4 Technical Panel and hold a successful CIGRE UK SC C4 Liaison Meeting and Technical Event including a (J)WG Update Session and invite Keynote and Guest Speakers from industry, utilities, and academia to maintain member engagement.

17 RM Report on SC C5 Electricity Markets and Regulation

17.1 Study Committee Scope

SC C5 Chair: Yannick Phulpin (France)

SC C5 Secretary: Anthony Giacomoni (Canada)

The scope of Study Committee C5 focuses on the analysis of the impacts on the planning and operation of electric power systems of different market approaches and solutions. This includes new structures, institutions, actors and stakeholders as well as the role of competition and regulation in improving end-to-end efficiency of the electric power system.

17.2 C5 2024 Paris Session

From the 25th August to the 30th August 2024, the Cigre Paris session was convened in Paris. The C5 General Discussion Meeting was on Thursday the 29th August 2024.

There were three preferential topics for the 2024 Cigre Session, a total of 57 papers were selected. The three preference topics were the following:

- PS1 - Characteristics of a resilient market and its regulatory regime
 - Responds to dynamic changes in the market environment and able to withstand external shocks
 - What markets and regulations have proven resilient so far and are still efficient and successful.
 - Governance and institutional arrangements that assist resilient: who makes the decisions and takes risks.
- PS2 – Preparing for the future with moving targets
 - Innovative approaches to markets and regulation to achieve climate and energy policy targets
 - The design and structure of electricity markets to support capital intensive climate neutral investments.
 - Market and regulatory arrangements for supply, demand and storage that function across transmission, distribution and behind the meter resources.
- PS3 – Emerging Markets and forms of markets
 - Markets and regulations addressing the attributes of electricity that customers are seeking from industry.
 - Market based approaches to integrate community and distributed resources
 - New market approaches to overcome the barriers and limitations on current market designs.

17.3 Current working groups and UK members

There are currently six working groups in the SC C5 and the SC has decided to establish two additional working groups. There is limited UK members' participation in the current working groups.

Number	Title	UK Member
JWG C5.C6-29	New Electricity Markets, local energy communities	
WG C5-31	Wholesale and Retail electricity cost impacts of flexible demand response	
WG C5-34	Summary of Current Uses of Electric Vehicle Charge/Discharge Flexibility in wholesale energy markets and reliable grid operations	

WG C5-35	Integration of hydrogen in electricity markets and sector regulation	
WG C5-36	Certification of electricity used to produce hydrogen	
WG C5-37	Regulatory framework on modernization and extension of useful life of transmission and distribution assets	
TBD	Regulatory frameworks and market integration for assets under non-firm grid connection	Sarah Soliman (invited)
TBD	Support schemes for the energy transition: design and cost allocation	TBD

17.4 Technical Brochures

Reference	Working Group	Title
941	JWG C2/C5.06	The impact of Electricity Market Interventions by System Operators during Emergency Situations
897	WG C5.32	Carbon Pricing in Wholesale Electricity Markets

17.5 Last C5 Study Committee Meeting (highlights)

SC C5 welcomed new members and thanked those who have contributed over the last few years. The meeting discussed the overall strategic plan, the SC achievements and activities. There was also an update from each of the working groups on their activities, plans and whether they intend on publishing a technical brochure. The SC also discussed and agreed the preferential subjects for the upcoming 2025 Montreal (Canada) Symposium, which will be held from September 29th through to October 2nd 2025.

The next SC meeting is expected to be held at the same time as the Montreal Symposium. The SC discussed an idea for two new working groups, which are as follows:

- New WG1 - Regulatory frameworks and market integration for assets under non-firm grid connection. The UK RM (Sarah Soliman) has been invited to join this working group.
- New WG2 - Support schemes for the energy transition: design and cost allocation.

17.6 Awards

SC C5 congratulated Greg Thorpe (Australia) on his award for his dedicated and contributions to the activities of SC C5.

18 RM Report on SC C6 Active Distribution Systems and Distributed Energy Resources

18.1 Study Committee Scope

SC Chair: Kurt Dedekind (SA)

SC Secretary: Evert de Haan

Communications Officer: Harry Evans

NGN Representative: Stefanie Cray (unconfirmed)

WiE Representative : Belgin Turkey

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.

Areas of attention include:

- Enabling technologies: active network management, micro-grids, virtual power plants, distribution management systems (ADMS, DERMS), DER monitoring and control, aggregation systems, platforms, block-chain applications.
- Innovative solutions: smart inverters and power electronic interfaces and interconnection device applications, MV/LV DC supply systems, distribution system modernization
- Storage technologies: electrochemical electric battery energy storage systems, flywheels, flow batteries, and new storage technologies, hydropower, hydrogen, multi-energy solutions (with thermal storage), power2X applications (power to heat, power to gas ...), electric vehicles.
- 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 and solutions.

18.2 Strategic Advisory Groups (AG C6.01)

AG C6.02 Quality Check of Brochures' (Conv. Ray Brown, AU)

AG C6.03 Tutorials (Conv. Samuel Jupe, GB)

AG C6.04 Women in Energy (Conv. Belgin Turkey)

AG C6.05 Next Generation Network

AG C6.06 Communication (Harry Evans)

AG C6.07 'Rural Electrification' (Conv. Britta Buchholz, DE, Kurt Dedekind)

18.3 Preferential Subjects (CIGRE 2026 draft)

Preferential Subject 1 Enabling flexibility with increased Multi-Energy integration in Distribution Networks

- Impact of and grid services provision by energy storage systems and energy conversion units (e.g. hydrogen) in distribution systems

- The role of energy communities, aggregators and virtual power plants to enhance the flexibility of distribution networks
- Risk appetite in times of network congestion and the balance between flexibility procurement and stretching operational limits

Preferential Subject 2 The interface between the DSO and customers in distribution networks

- The impact of evolving planning objectives and criteria, with increased electrification and new electric loads, coupled with the changes in end-use technology behaviours.
- Electric Vehicle integration and impact in Distribution Systems
- The role of the DSO to improve power quality and network resilience of distribution networks.

Preferential Subject 3 The adoption of appropriate rural electrification standards, practices and technology options.

- Microgrid and multi-microgrid installations (including industry networks)
- Off-grid and island DER applications including appropriate resilience measures
- Applications highlighting the connection of the last mile of rural electrification projects

18.4 New Working Groups

Potential gaps for new WGs:

- MV/LV DC systems
- Protection requirement for DER integration
- Storage
- Sector coupling

Specific suggested topics

- Distribution Planning for End-use Electrification; Active System Management in the Context of Flexibility Services
- Tools for DSOs to enable more "risk based" MV/LV grid operation
- Technical losses especially due to DER penetration
- Flexibility availability during short-term planning (1-5 years): how to make sure there is sufficient flexibility to operate at expected reliability levels?
- How to effectively contract flexibility with professional and behind-the-meter consumers?
- System optimization during TSO congestion and impact on DSO grids
- Integration of hydrogen into DER-systems: opportunities, risks and possible impact on system operation

Some wider group ideas:

- Active Distribution System Simulation
- Hydrogen as a form of storage
- The role of energy communities, aggregators and virtual power plants in distribution systems
- Hydrogen production in distribution systems
- DER models (further the work of C6.36)
- Smart grids in distribution systems
- Dynamic Simulation Technologies and Benchmark Systems for Distribution Systems with DERs (further the work of C6.36)

18.5 Technical Panel Meetings, Seminars & Tutorials

The following tutorials were presented by SC C6 recently:

- **CIGRE Symposium Cairns, September 2023:** Webinar on Distributed Energy Resource Benchmark Models for Quasi-Static Time-Series Power Flow Simulations (WG C6.36) delivered by Jason Taylor, Jouni Peppanenand Kurt Dedekind

- **CIGRE Session, Paris, 2024:** Tutorial on Aggregation of Battery Energy Storage and Distributed Energy Resources (WG C6.43) delivered by Nikos Hatziaargyriou, Christine Schwaegerl and Geza Joos

Workshop on Consumer-Side Energy Resource Management -Market, Control and Information

18.6 Technical Brochures

Recently completed Technical Brochures:

- JWG C6/D2.32: TB 782 –Utilization of data from smart meter system, 2019
- WG C6.31: TB 793 –Medium Voltage Direct Current (MVDC) grid feasibility study, 2020
- WG C6.28: TB 826 –Hybrid systems for Offgrid-Supply, 2021
- WG C6.38: TB 835 –Rural electrification, 2021
- WG C6/C1.33: TB 863 –Multi-Energy interactions in Distribution Grids, 2022
- JWG C6/B4.37: TB 875 –Medium Voltage DC Systems, 2022
- WG C6.36: TB 906 –Distributed Energy Resource Models for quasi-static time-series power flow simulations, 2023
- JWG C1/C6.37/CIRED: TB 923 –Optimal investment decisions for transmission and distribution networks under increasing energy scenario uncertainty, 2024
- JWG D2/C6.47: TB 929 –Advanced Consumer side energy resource management systems, 2024
- WG C6.43: TB 932 –Aggregation of BESS and DER, 2024

18.7 Last Study Committee Meeting (Highlights)

The last SC C6 meeting took place hybrid (in-person and online) on 29th August 2024 in Paris CIGRE 2024. Minutes from the meeting has been published.

The meeting covered the following topics:

1. Welcome and introduction
2. Report of the Chair
3. Summary of recent SC C6 events
4. Final reports of terminated WGs
5. Report of Advisory Groups
6. Status of ongoing SC C6 WGs
7. Status of WGs led by other SCs
8. Study committee membership
9. Awards
10. SC C6 Green Book
11. SC C6 Strategy
12. New and Planned WGs
13. 2026 Paris General Session
14. Next SC meetings, future events and activities
15. Organisational matters and other business

18.8 Current Working Groups and UK Members

Number	Title	UK Member
JWG C6/C2.34	Flexibility provision from distributed energy resources	
C6.35	Distributed energy resources aggregation platforms for the provision of flexibility services	
C6.39	Distribution Customer Empowerment	
C6.40	Electric Vehicles as Distributed Energy Resource (DER) systems	
C6.42	Electric Transportation Energy Supply Systems	
C6.44	Nodal Value of Distributed Renewable Energy Generation	

C6.45	The Impact of DER on the Resilience of Distribution Networks	
C6.46	Energy Efficiency in Distribution systems	
C6.47	DSO-customer interfaces for efficient system operation	
JWG C1/C6.42	Planning tools and methods for systems facing high levels of distributed energy resources	
JWG C5/C6.29	New Electricity Markets, Local Energy Communities	
JWG C5.31	Wholesale and Retail Cost Impact of Flexible Demand Response	

18.9 UK Members of the Technical Panel

Name	Company	Role
Jun Liang	Cardiff University	RM C6 UK
Neha Moturi	NGET	C6 Secretary
Samuel Jupe	Nortech Management Ltd	TP Secretary / Manufacturer Representative
Julio Perez Olvera	SSEN	NGN / DSO Representative
Harry Evans	GHD	NGN / Industry Representative
Tania Wallis	University of Strathclyde	Women's Network / Academia Representative
James Yu	SP Energy Networks	DNO / DSO Representative
Greg Shirley	NGED	DNO Representative
Matthew Williams	Ionate	Consultancy Representative
Gordon Watson	TNEI	Consultancy Representative

19 RM Report on SC D1 Materials and Emerging Test Techniques

19.1 Study Committee Scope

SC Chair: Simon Sutton (UK)

SC Secretary: Gordon Wilson (UK)

UK RM: Thomas Andritsch

The scope of SC D1 is concerned with the monitoring and evaluation of:

- new and existing materials for electrotechnology,
- diagnostic techniques and related knowledge rules,
- emerging test techniques which may be expected to have a significant impact on power systems in the medium to long term.
- support of other study committees in their analysis of recently introduced and developing materials, emerging test techniques and diagnosis techniques

19.2 Strategic Advisory Groups

AG D1.01 Liquids and Liquid Impregnated Insulation Systems (Qiang Liu (UK))

AG D1.02 High Voltage and Current Testing and Diagnostic (Uwe Riechert (CH))

AG D1.03 Solid Materials (Jerome Castellon (FR))

AG D1.04 Gases (Karsten Juhre (DE))

Tutorial AG (Ivanka Atanasova-Hoehlein (DE))

Strategic and Customer AG (Simon Sutton (UK))

19.3 Preferential Subjects

The Preferential Subjects for 2024 Paris Session were:

PS 1 Testing, Monitoring and Diagnostics

- Testing and condition monitoring for reliability in conventional high voltage systems and power electronics applications.
- Assessment of diagnostics for equipment in remote or inaccessible locations.
- PD measurement under DC, rectifier, and impulse stress.

PS 2 Materials for electrotechnical purposes and modelling

- Ageing of materials under electrical, mechanical or thermal stresses and ageing markers.
- Modelling materials and field simulations for AC and DC applications.
- Assessment of compatibility of aged and new materials resulting from refurbishment or life extending activities.

PS 3 Materials to enable the energy transition

- Alternative electrotechnical materials or manufacturing processes which reduce environmental footprint.
- Materials and systems for energy storage; batteries, charging devices, capacitors etc.
- Materials to enable a hydrogen economy.

19.4 New Working Groups Approved

Number	Title	UK Member
D1.82	Additive Manufacturing/3D Printing in Service of the Electrical Power Industry	Thomas Andritsch
A2/D1.74	Online moisture monitoring of transformers for ageing assessment	TBC
B3/A2/A3/C3/D1.66	Guidelines for Life Cycle Assessment in Substations considering the carbon footprint evaluation	TBC

19.5 Technical Panel Meetings, Seminars & Tutorials

Three UK liaison meetings were/are held in the 2024:

- 09/01/24 – Joint A2/D1 meeting.
- 17/09/24 – Joint B1/D1 meeting.
- 27/11/24-28/11/24 – Joint A2/D1 meeting.

Both already held events were attended by 40+ people (hybrid in case of B1/D1).

19.6 Technical Brochures

In the past 12 months the following technical brochures have been published:

- TB927 New Laboratory Methodologies for Investigating of Insulating Liquids - Further Developments in Key Functional Properties
- TB933 Requirements and application of UHF PD monitoring systems for gas insulated systems

19.7 Last Study Committee Meeting

- Held at the 2024 Paris Session, France.
- New D1 website live:
<https://www.cigre.org/article/d1---materials-and-emerging-test-techniques>
- Two new working groups approved
- Next meeting will be held in Seoul, South Korea in November 2025.

19.8 Current Working Groups and UK Members

Number	Title	UK Member
D1.50	Atmospheric and altitude correction factors of air gaps and clean insulators	
D1.62	Surface degradation of polymeric insulating materials for outdoor applications	Sean Lewington
D1.63	Partial discharge detection under DC stress	Malcolm Seltzer-Grant Ian Cotton
D1.66	Requirements for partial discharge monitoring systems for gas insulated systems	Graeme Coapes (NGN) Fraser Cook Carl Johnstone
D1.68	Natural and synthetic esters - Evaluation of the performance under fire and the impact on environment	Russell Martin
D1.69	Guidelines for test techniques of High Temperature Superconducting (HTS) systems	Bartek A. Glowacki
D1.70	Functional properties of modern insulating liquids for transformers*	Qiang Liu Attila Gyore

Number	Title	UK Member
		Zhongdong Wang
D1.73	Nanostructured dielectrics: Multi-functionality at the service of the electric power industry	Raed Ayoob Thomas Andritsch
D1.74	Partial discharge measurement on insulation systems stressed from HV power electronics	
D1.76	Tests for verification of quality and ageing performance of cellulose insulation for power transformers	Attila Gyore Richard Heywood Qiang Liu Mike Munro Shanika Matharage Gordon Wilson
D1.78	Partial discharge properties of non-SF6 insulating gases and gas mixtures	Fraser Cook Graeme Coapes (NGN)
D1.81	Methods and common data file format for Time-Domain Reflectometry	Andrew Barclay
D1.82	Additive Manufacturing/3D Printing in Service of the Electrical Power Industry	Thomas Andritsch
B1/B3/D1.79	Recommendations for dielectric testing of HVDC gas insulated system cable sealing ends	
B1/D1.75	Interaction between cable and accessory materials in HVAC and HVDC applications	Thomas Andritsch
D1/B1.75	Strategies and tools for corrosion prevention for cable systems	
D1/A2.77	Liquid Tests for Electrical Equipment	Gordon Wilson Russel Martin Attila Gyore Dave Walker Qiang Liu
A2/D1.66	Breathing systems of liquid filled transformers and reactors	
B3/D1.63	Guideline for assessing the toxicity of used SF6 gas onsite and in the lab of T&D equipment above 1 kV in substations	
A2/D1.67	Guideline for online dissolved gas analysis monitoring	
D1/A2.79	Improved understanding of dynamic behaviour of winding insulating materials in liquid insulated power transformers	
D1/A2.80	Functional properties of non-metallic solid materials for liquid filled transformers and reactors and their compatibility with insulating liquids	
A2/D1.72	Retrofill of Mineral Oil in Transformers – Motivations, Considerations and Guidance	Gordon Wilson

19.9 UK Members of the Technical Panel

There is currently no UK Technical Panel for D1. The plan for 2025 is to identify a suitable secretary for the RM and build a UK technical panel.

20 RM Report on SC D2 Information Systems & Telecommunication

20.1 Study Committee Scope

SC Chair: Mr Victor Tan (AU)
SC Secretary: Mr Marcelo DE ARAUJO (BR)

SC D2 aims to facilitate and promote the progress of engineering on information and telecommunications systems for electric power systems, as well as the international exchange of information and knowledge in those fields. To add value to this information and knowledge by means of summarizing state-of-the-art practices and developing recommendations and to make managers, decision-makers and regulators (between other stakeholders) in the EPI sector aware of its work.

The activities cover the specification, design, engineering, performance, operation, maintenance, economic and management aspects of the Information and the Telecommunication systems :

- ICT applied to digital networks from UHV to distribution (smart meter, IoT, big data, EMS, etc...).
- Communication solutions for information exchange in the smart delivery of electrical energy
- Interoperability and data exchange (file format, frequency, etc.) between network operators, market players, off-grid premises
- Cyber security issues from field equipment to corporate IT (Governance constraints, system design, implementation, testing, operation and maintenance...)
- Technologies and architecture to ensure business continuity and disaster recovery
- IT systems to support the decision-making process in Asset Management

20.2 Strategic Advisory Groups

- AG D2.01: Core business information systems and services – Marcelo Aroujo (Brazil)
This advisory group is ITS user oriented. It monitors the needs and the stakes of the users in their core business which is linked with ITS like Telecontrol, asset management, customer relationship etc.
- AG D2.02: Cybersecurity techniques and technologies – Giovanna Dondossola (Italy)
This Advisory Group fosters the adoption of specialized cybersecurity measures to protect Operational Systems
- AG D2.03: Telecommunication networks, services and technology – Zwelandle Mbebe (South Africa)
This Advisory group focuses on pure telecommunication issues like transmission media, protocols, network architecture, service provision, etc.

20.3 Preferential Subjects for 2026 Paris Session

PS 1: IT/OT solutions to improve the efficiency and resilience of electric power systems:

- IoT architectures and applications in physical asset management
- Applications and Platforms of Artificial Intelligence, Big data and Analytics in operation and maintenance
- Technical challenges in the development of digital twins in operation and maintenance of power systems and DERs
- Business Continuity Architectures in the Cloud

PS 2: Cybersecurity in emerging application domains and technologies for securing energy organisations:

- Cybersecurity for DER and microgrid control infrastructures

- Cybersecurity for Energy Communities' digitalization
- Cybersecurity for Electric Vehicle charging and discharging control
- Cybersecurity in cloud-based applications of EPU

PS 3: Meeting the challenges of energy transition with reliable, scalable, and efficient telecommunications networks:

- Building scalable and resilient networks with management, automation and orchestration solutions and methods.
- Integration of current and new wireless technologies in meeting the requirements of power utility applications.
- Techniques and methods in building resilient networks to support critical utility applications

20.4 New Working Groups

Restarted in 2024:

Number	Title	UK Member/Status
D2.44	Usage of public or private wireless communication infrastructures for monitoring and maintenance of grid assets and facilities	Restarted
D2.49	Augmented reality to support EPU operation and maintenance	Restarted
D2.51	Implementation of Security Operations Centers (SOC) in Electric Power Industry as Part of Situational Awareness System	Restarted

Proposals and ideas:

- Cybersecurity of Energy Operators Supply Chain – ToR drafted
- An assessment of EPU digital certificate management schemes – ToR drafted

Approved in 2024:

Number	Title	UK Member/Status
D2.59	Intelligent Computing for Power Industry	Approved
D2.61	High Voltage Power Line Carrier Communications Current State and Future Application	Approved

20.5 Technical Panel Meetings, Seminars & Tutorials

- One day conference: “Data Science and Next Generation Communications in Electricity Networks, 30/06/2023, London.
- CIGRE Paris Session 2024, 25/08 – 19/08/2024.
- Webinar: Equipping utilities to better understand weather related outages in a changing climate, 24/04/2024

Future events planned for 2024/25:

- Webinar: To be confirmed
- D2 one day conference – spring 2025, details tbc

- CIGRE Symposium organised by Nordic Regional Council of CIGRE (NRCC) - Changes needed in the power system for the Energy Transition 12/05 – 15/05/2025, Trondheim, Norway.

20.6 Technical Brochures and Publications

During the last year the following key documents from Study Committee D2 were published:

- TB 936: Enhanced Information and Data Exchange to Enable Future TSO-DSO Coordination and Interoperability; Convenor: Gareth Taylor (GB)
- TB 929 : Advanced Consumer Side Energy Resource Management Systems; Convenor: Aleksey Nebera (RU)

Previous publications:

- TB 892: Data Management
- TB 884: Time in Communications networks, Protection and Control applications
- TB 866: Enabling Software Defined Networking for electric power utilities
- TB 840: Cyber Security for Contingency Operations
- TB 796: Cyber security – future threats
- TB 746 Design, Deployment and Maintenance of Optical Cables associated to Overhead HV Transmission Lines.

20.7 Last Study Committee Meeting Highlights

During the last SC meeting as part of the CIGRE Paris Session 2024 an overview of key topics was discussed:

- SC D2 Strategic Plan updated in January 2024:
 - Increase collaboration with other SCs and External Parties with increased openness
 - Improve CIGRE events:
 - Consistent paper review process
 - Explore use of collaboration enhancing tools (Slido, etc.)
 - Encourage diversity in collaboration (WiE, NGN), and new SC members' participation
 - Development and management of knowledge:
 - WGs – AGs monitoring and assistance
 - Encourage formation of new WGs
 - Publication quality via review process and pool of SC D2 reviewers
 - Full Strategic Plan accessible online
- April 2024: Cybersecurity Maturity, Victor Tan
- September 2023: Common Information Model (CIM), Roman Bogomolov, Nikolay Belyaev

In 2024/25 the SC D2 aims to focus on the following objectives:

- New WGs in the pipeline (undergoing Technical Council approval):
 - Consumer-side Digital Twin Models, proposed by Fedor Nepha (RU)
 - High Voltage Power Line Carrier Communications Current State and Future Application, proposed by Anton Merkulov (KZ)
 - Intelligent Computing for Power Industry, proposed by Kunlun Gao (CN)
- Upcoming Webinar recording:
 - Time in Communication Networks, Protection and Control Applications, presented by Antti Viro (FI)
- 2025 Trondheim Symposium
- 2026 Paris session

20.8 Current Working Groups and UK Members

UK membership is currently reviewed – current records indicate the following:

WG	WG Title	WG Convenor
		GB representative
WG D2.58	Monitoring, Maintenance and Control of Packet Networks & Services – From Situational Awareness to Network Control	Bongani Shezi (South Africa)
		Carlos Diago (GE Vernova) James Milsom (NGET)
WG D2.57	CIM (Common Information Model) Methodology	Roman Bogomolov (RU)
		Siva Kaviya, Trichy Siva Raman (NG ESO) / Gareth Taylor (Brunel)
WG D2.56	Interdependence and Security of Cyber-Physical Power System	QINGLAI GUO (CN)
		Wentao Zhu (GB)
WG D2.55	Application of 5G Technology to Smart Grids	KUNLUN GAO (CN)
		Lin Jiang (GB)
WG D2.54	Regulatory approaches to enhance EPU's cybersecurity frameworks	Tbc.
		Mohammed Zumla (GB)
WG D2.53	Technology and Applications of Internet of Things in Power Systems	ZHENGYUN SUN
		Ester Hwang (GB)
WG D2.52	Artificial Intelligence Application and Technology in Power Industry	KUNLUN GAO (CN)
		Fraser Cook / Giulio Riccardi (GB)
WG D2.51	Implementation of Security Operations Centers (SOC) in Electric Power Industry as Part of Situational Awareness System	V. KARANTAEV (RU)
		Shimeh Jahangiri / Gareth Taylor (GB)
WG D2.49	Augmented reality / Virtual reality to support Operation and Maintenance In Electric Power Utilities	S. H. KHALAJ (IR)
		Douglas Gray / Richard Moore (GB)
JWG B2/D2.72	Condition monitoring and remote sensing of overhead lines	Y. Chen (CN) / A.KULKARNI (GB)
JWG D2/C2.48	Enhanced information and data exchange to enable future transmission and distribution interoperability	G. TAYLOR (GB)
		Rui Zhang (GB)
JWG D2/C6.47	Advanced consumer side energy resource management systems	A.A NEBERA (RU)
		James King / Spyros Skarvelis-Kazakos (GB)
JWG B5/D2.67	Time in Communication Networks, Protection and Control Applications – Time Sources and Distribution Methods	Qiaoyin YANG (CN)
WG D2.45	Impact of governance regulations and constraints EPU sensitive data distribution and location of data storage	H. KLIMA (AT)
WG D2.44	Usage of public or private wireless communication infrastructures for monitoring and maintenance of grid assets and facilities	P. MULVEY (IE)
JWG A2/D2.65	Transformer Digital Twin – concept and future perspectives	P. Picher (CA)
JWG B3/D2.62	Life-long Supervision and Management of Substations by use of Sensors, Mobile Devices, Information and Communication Technologies	N. Fantana (DE)

20.9 UK Members of the Technical Panel

UK D2 Technical Panel Chair: Jianing Li



UK D2 Technical Panel: Thomas Charton
D2/B5 liaison officer: Gareth Taylor