

2024 Paris Session General Programme

Day	Time	Event type	Title	Details
Sunday August 25	15:30 17:30	OPENING CEREMONY	Opening ceremony	<ul style="list-style-type: none"> Welcome address by CIGRE President, Michel AUGONNET Keynote speech by M. Keisuke SADAMORI, Director of Energy Markets and Security in the International Energy Agency (IEA). <p>In his intervention, Director of Energy Markets and Security, Mr Keisuke SADAMORI, will address the critical topic of renewable energy integration and its implications for grid security and energy markets worldwide. Drawing on the latest IEA reports and upcoming research, the speech will provide an update on the current global landscape of the power sector and renewable energy deployment as well as insights into upcoming work on renewables integration and secure electricity.</p> <p>Mr. SADAMORI will offer his insights into the IEA's work on these pressing issues and provide recommendations for policymakers and industry stakeholders, of high relevance to the work that CIGRE members are carrying today.</p> <ul style="list-style-type: none"> TC Chair's presentation of the Session technical content 2024 CIGRE Award ceremony Followed by the opening cocktail.
Monday August 26	8:30 12:00	OPENING PANEL	"A Roadmap to Energy Systems of the Future". Decarbonisation with Flexibility and Resilience	<ul style="list-style-type: none"> Welcome, introduction of the panel and of the keynote speaker Introduction to the panel structure, panelists, chat function; handover to keynote speaker Forum 1: Energy Grid Viewpoints: Speakers: <ul style="list-style-type: none"> ➤ SR Narasimhan (India), GO15 President ➤ Shukai Xu Director General of Technology Innovation China Southern Power Grid CSG ➤ Damian Cortinas, Chairman of the Board of ENTSO-E. Forum 2: Distribution Companies Viewpoints Speakers: <ul style="list-style-type: none"> ➤ Dr. Ambra Sannino, Vice President, Research and Development, Vattenfall AB ➤ Dr. Hiroshi Okamoto, Vice President, TEPCO Power Grid ➤ Dr. Urban Keussen CTO of EWE AG

				<ul style="list-style-type: none"> • Forum 3 Regulatory and Market aspects of DER <p>Speakers:</p> <ul style="list-style-type: none"> ➤ Marzia Zafar; OFGEM, UK Smart Systems and Flexibility Plan ➤ Luciano Martini, Director of Power System dept at RSE, Italian Research Institute on energy Systems, Chair of ISGAN and of Mission Innovation ➤ Gordon van Welie, President & CEO, ISO New England <ul style="list-style-type: none"> • Concluding remarks
Monday August 26	14:30 17:30	Workshop A2/A3/B3/C3/D1	Driving T&D substations and equipment towards ZERO emissions	<p>This workshop is a combined activity from SC A2, A3, B3, C3 and D1. These Committees have come together to provide a comprehensive overview of the possibilities, ongoing activities, and hurdles towards decarbonising substations and associated equipment in all aspects. The focus will be on applying Life Cycle Analysis (LCA) to quantify and compare emissions (through CO₂ equivalent emissions), as well as on the state-of-the-art of SF₆ and other material replacements in station equipment by various alternatives.</p> <p>The audience targeted is specialists working in T&D power system operations who need guidance to make proper decisions in the decarbonisation process and want to learn about ongoing pilots and projects.</p> <p>Stakeholders from utilities and industry will speak. Relevant active CIGRE working group results and “news” related to this topic brought to the 2024 Paris Session will be highlighted. <u>The main part will be an interactive panel session, where your questions regarding LCA and SF₆-replacements</u> will be discussed by a panel consisting of representatives covering the workshop subjects. Your input is highly valued in shaping the discussion.</p> <p>The current key CIGRE WGs are,</p> <ul style="list-style-type: none"> • JWG B3/A3.60 User guide for non-SF₆ gases and gas mixtures in Substations • JWG B3/A2/A3/C3/D1.66 Guidelines for life cycle assessment in substations considering the carbon footprint evaluation • JWG A2/C3.70 Life Cycle Assessment (LCA) of Transformers • WG D1.78 Partial discharge properties of non-SF₆ insulating gases and gas mixtures • WG C3.25 Ecodesign methods for the power system
Monday August 26	14:00 18:00	Workshop C2 & C5	Large disturbances	<p>Managed by Greg Thorpe and Flávio</p> <ul style="list-style-type: none"> • The Large Disturbance Workshop (LDW) originated in the early 1990s with a small group of power system operators meeting on the sidelines of CIGRE Paris Sessions comparing notes about significant operating events they had experienced. The aim was to share knowledge of the events and responses.

				<ul style="list-style-type: none"> ○ Over the following 20 years the meetings grew in size but were still focussed on technical power system operation. ○ For the 2012 Paris Session the LDW became a joint workshop on major disturbances on power system operation (C2 Study Group) and markets & regulation (C5 Study Group) • For the last 6 Paris Sessions each LDW has attracted around 500 participants with approximately 10 events from around the world covering large interconnected power systems to small isolated systems and a range of different market designs. <ul style="list-style-type: none"> ○ For example in 2022, (reduced participation due to Covid) presentations covered events in Europe, Japan, Israel, Australia (west coast), Australia (east coast), New Zealand and India, • Major events often affect both the operation of the power system and market of the region, but not always, and not all power systems are operated as disaggregated markets, for example if a local monopoly electricity utility runs the power system. Power system events presented to LDWs have varied from disruption due to unexpected unstable operating conditions through to wide spread black-out. Market impacts typically involve extreme wholesale prices for energy and ancillary services that are used to maintain safe and secure operation but have also considered disturbances to longer term investment signals. • The focus of the workshops is to understand what went wrong in each case and importantly what was, or could be, done to prevent a recurrence. • In 2022 it was noted that the reason for the events had shifted a little from primarily technical associated with changing generation technology due to decarbonisation to be include issues with coordination with external authorities during natural disasters such wildfire and cyclone conditions. • The presentations selected for the 2024 LDW continue the trend from 2022 and include a mix of disturbances caused by reduced inertia / increasing participation of Inverter based resources and non-technical events including floods, wildfires and cyclones and the consequences of these events over market and energy prices. • In 2024 presentations will be received from Poland, Scandinavia, Singapore, Australia (east coast), Alberta (Canada), The Netherlands, Brazil, Mozambique and India. In addition, there will be a recap of system events over the last 10 years.
Tuesday August 27	EZ8:30 12:30	Workshop C1/C4	Resilience by design	By Emanuele Ciapessoni moderator, C4 co-leader: Mathaios Pantali

				<p>The increasing frequency and severity of extreme weather events, coupled with the growing complexity of power grids, necessitate a paradigm shift towards designing for resilience. This CIGRE workshop explores the concept of "Resilience by Design" for the power system. The workshop will bring together experts from C1 and C4 and from academia to discuss:</p> <ul style="list-style-type: none"> • the definition and key characteristics of a resilient power grid, • strategies for incorporating resilience principles into the design of existing and new grid infrastructure, • new methods and practices that can enhance grid resilience, such as planning for resilience, HVDC architectures, resilient oriented control methods • case studies of successful implementations of resilience-oriented principles. <p>By fostering knowledge sharing and collaboration, the workshop aims to provide participants with the methods and best practices necessary to design and operate power grids that are more resilient to disruptions and can recover quickly from outages.</p>
Tuesday August 27	14:00 16:00	Workshop C5/C6/D2	Consumer-Side Energy Resource Management - Market, Control and Information Systems Perspectives	<p>Moderators: Marcelo Costa de Araujo (D2) and Evert de Haan (C6)</p> <p>Panelists:</p> <ol style="list-style-type: none"> 1. C5: Alex Cruickshank – Australia, chair of SC C5 2. C5: Anant Venkateswaran - USA, convener of JWG C5/C6.29 (Local energy markets) 3. C6: Daniel Eghbal - Australia, Convenor of a WG C6.47 (DSO/Customer interface) 4. D2: Alexey Nebera – Russia, Convenor of JWG D2/C6.47 5. D2: Yannick Jacquemart – France, Director of New Flexibilities for the Electrical system, RTE Electricity Transmission Network. <p>Abstract: This is a joint Workshop with participants from Study Committees C5, C6 and D2, which will examine the Consumer side of the energy grid and markets. Short presentations will be provided from the perspectives of each of the Study Committees and themes and issues developed through moderated questions and discussions.</p>
Wednesday August 28	8:30 12:00	Workshop B4	Interoperable multi-terminal HVDC systems: from dream to reality	<p>Moderator: Jiayang Wu</p> <p>Panel Chair: Cornelis Plet</p> <p><i>P1: Multiterminal-Hubs – a large step towards the energy grid of the future</i></p> <p><i>Speakers:</i> 4 TSOs co-presenting: Dr. Benjamin HÜHNERBEIN (TenneT), Josef HEIMKREITER (50Hertz), Dr. Daniel EICHHOFF (Amprion), Dr. Michael SCHÄFER (TransnetBW)</p>

				<p>In Germany, 70 GW of offshore wind power must be integrated into the power grid by 2045. To achieve this, the four German transmission system operators (TSOs) TenneT, Amprion, 50Hertz, and TransnetBW are building the energy grid of the future. The aim is to create a meshed direct current (DC) grid with innovative multiterminal hubs as nodes. Three hub projects have been initiated in northern Germany for this purpose to become operational in the timeframe from 2030 to 2034. The required DC multiterminal technology will be developed and implemented through an Innovation Partnership between the four TSOs and partners from the industry.</p> <p>P2: Project Aquila - GB HVDC hub and interoperability demonstration. Development progress Speakers: SSEN and National grid co-presenting: Perry HOFBAUER (SSEN), David BARRON (National grid)</p> <ol style="list-style-type: none"> 1. Highlight Concept <ol style="list-style-type: none"> a. Safe-to-fail (Multiple opportunities and states of success) b. Designing a path considering regulatory and political commitments c. Inter-TO Coordination d. Project Work packages 2. Progress to date and learnings from each package <ol style="list-style-type: none"> a. Multi-terminal Control techniques and RTS demonstration b. Hub delivery (Equipment requirements and specifications) c. Procurement & Commercial (warranties & multi-party arrangements) <p>P3: Multi-vendor interoperability from China Speakers : Xueguang WU (SGCC) and Zhiyong YUAN (CSG)</p> <p>1. VSC-HVDC experiences with multi-vendor interoperability from SGCC, particularly based on our Zhoushan MTDC and Zhangbei HVDC grid projects</p> <ul style="list-style-type: none"> • The multi-terminal HVDC projects in SGCC, China • The management of the HVDC project in SGCC • The commissioning test of the HVDC project in SGCC • Development trends for the future HVDC projects in SGCC <p>2. Technical specification considerations and engineering cases for HVDC multi-vendor interoperability</p>
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Wednesday August 28	9:00 12:00	Workshop B2	Corrosion assessment and repair of existing OHL supports, anchors and foundations	<p>Moderator: Pierre VAN DYKE</p> <p>Speakers: João BGF DA SILVA, Rob MEIJERS, George FLOREA, Christian JOHNSON and Denis MONDIÈRE</p> <p>This workshop aims to communicate the essence of two CIGRE Technical Brochures, namely “Assessment of Existing Overhead Line Supports” (TB 230 – already published), and “Detection,</p>

				<p>Prevention and Repair of Sub-Surface Corrosion in Overhead Line Supports, Anchors and Foundations” recently completed and to be published soon.</p> <p>Starting with the TB 230, with the participation of over 60 utilities from around the world, it has become clear that the most critical issue regarding the life of existing OHL supports is corrosion. Different corrosion protection and repair practices and methods were collected and discussed, within the framework of current refurbishment procedures.</p> <p>Many different type of structural foundations have been used throughout the world. The choice of a specific foundation solution, in all case, is made based on several considerations or constraints such as environmental impact, soil type, accessibility, costs, availability of materials and equipment, etc. The most well-known and used type is the concrete foundation (with different types of design), but directly embedded steel solutions such as grillages, piles and anchors are also increasingly used.</p> <p>Although these types of foundation, which result in direct contact of the steel with the soil, have been successfully installed in several regions, there are many cases where the severity of sub-surface corrosion has made such applications unsuitable.</p> <p>The new SC B2 WG B2.65 Technical Brochure aims to address the full complexity associated with this issue.</p> <p>Therefore, based on the TBs mentioned above, this Workshop will focus on:</p> <ol style="list-style-type: none"> 1 - Assessment of existing OHL supports: <ul style="list-style-type: none"> • Inspection philosophies, • Risk management, • Methods for refurbishing and repairing corrosion on existing OHL supports. 2 - Corrosion mechanisms: <ul style="list-style-type: none"> • Different soils and types of corrosion, • Steel foundations in soil (grillage, piles and anchors), • Prevention of corrosion of steel in the ground, • Corrosion above foundation steel at ground level. 3 – Corrosion of steel in concrete foundations: <ul style="list-style-type: none"> • Corrosion in concrete, • Mechanisms of steel corrosion in concrete foundations, • Prevent corrosion of steel in concrete foundations, • Refurbishment of steel corrosion in concrete foundation. 4 - Inspection and detection methods for corrosion: <ul style="list-style-type: none"> • Visual inspection, • Soil samples and soil tests, • Non-destructive tests,
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Wednesday August 28	16:00 18:00	Workshop C1/C5	Role of Green H2 in the Energy Transition and its impacts across the value chain	<p><i>Moderator</i> – Anant VENKATESWARAN, Hitachi Energy and WG C5.36, Tutorial Committee member.</p> <p><i>Presenters:</i></p> <ul style="list-style-type: none"> • Alexandre OUDALOV – WG convenor C1.48 on Green Hydrogen for SC C1. Alex is the Manager Power Systems of the Future at Hitachi Energy. • Ricardo GEDRA – WG convenor for Green H2 certification C5.36. Ricardo is the Market in information manager at CCEE, the Brazilian market operator. <p><i>Abstract:</i> This workshop will showcase the work from Study Committees C1 and C5 on the use and certification of green Hydrogen. Both Study Committees have been working on the various facets of this work. The workshop will feature short presentations from each speaker on the work of their Study Committee and other developments for Green Hydrogen. This will be followed by a moderated panel session and questions from the floor.</p>
Wednesday August 28	14:00 18:00	Workshop C4	Green Book “Power system dynamic modelling and analysis in evolving networks”	<p>Babak BADRZADEH, Zia EMIN, Marta VAL ESCUDERO, Genevieve LIETZ, Julia MATEVOSYAN, David JACOBSON, Nilesh MODI and Deepak RAMASUBRAMANIAN</p> <p>This workshop first provides a summary of all chapters of the Green Book on Power System Dynamics Modelling and Analysis in Evolving Networks and then focuses on detailed presentation of selected topics as follows:</p> <ul style="list-style-type: none"> • Part I introduces the importance of, and the need for, revisiting classical power system stability analysis concepts and textbooks. • Part II discusses different classes and sub-classes of power system stability, with a focus on considerations when performing power system dynamic analysis under high inverter-based resource (IBR) penetration scenarios. Practical experiences of various forms of power system instability are also presented. • Part III provides an in-depth discussion of various dynamic modelling approaches including phasor-domain and electromagnetic transient programs and types of power system dynamic simulation software programs ranging from highly detailed to simplified

				<p>screening. The use of screening methods and the applications of power system dynamic modelling and other tools for operational decision-making are presented in detail.</p> <ul style="list-style-type: none"> • Part IV focuses on different types of models and the necessary level of detail for each to ensure sufficient accuracy whilst respecting practical limitations. Power system components covered include generation technologies such as synchronous machines and IBR, HVDC systems, loads and distributed energy resources (DER) and wide-area network modelling including protection systems. • The focus of Part V is to present dynamic studies typically conducted in power systems with a high penetration of power electronic interfaced devices. Grid interconnection studies for IBRs, HVDC systems, and FACTS controllers, and power system dynamic studies for operational and planning applications are presented. These include assessing and mitigating contemporary electromechanical oscillations and emerging electrical oscillations and control interactions. The impact of protective functions on power system dynamic performance, and studies of industrial power systems and microgrids are also presented. • Part VI focuses on ensuring high-quality, accurate and up-to-date dynamic models for power system plants and the overall system. This spans model acceptance testing during early stages of plant development, to model validation where a mature design has been accomplished, and the plant is already connected and commissioned. • Recognising the need to analyse a higher volume of data with higher accuracy and speed for increasingly complex equipment and power system responses, Part VII discusses contemporary enablers for power system dynamic analysis. It first discusses artificial intelligence (AI) and machine learning-based methods and cloud-based computing and then introduces the use of probabilistic analysis and optimisation techniques and elaborates on the importance of interoperability and standardisation. 				
Friday August 30	8:00 12:30	Workshop C5	Retail market development	<p>Convened by Alexandre VIANA (BR).</p> <p>Overview: This workshop will examine the development and operations of retail markets from the perspectives of existing and developing competition at the customer level. It will consist of six presentations from different markets with questions on the markets and a discussion of themes that emerge.</p> <p>Programme:</p> <table> <tr> <td>1. Introduction (Alexandre VIANA)</td> <td>5 minutes</td> </tr> <tr> <td>2. Presentations by country</td> <td>90 minutes</td> </tr> </table> <ul style="list-style-type: none"> • Retail Competition in Israel, Mr. Igor ARONOVICH 	1. Introduction (Alexandre VIANA)	5 minutes	2. Presentations by country	90 minutes
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				<ul style="list-style-type: none"> • Aggregators to facilitate retail enlargement in Brazil, Mr. Jovanio DOS SANTOS • Retail Competition in Russia, Dr. Marina DOLMATOVA • Retail Competition in France • Retail Competition in Australia, Mr. Lance HOCH, presented by Alex CRUICKSHANK. • Insights from the Norwegian retail market for electricity, Matthias HOFMANN & Aurora OPSTAD <p>3. Questions from the Audience 20 minutes</p> <p>4. Summary and close (Alexandre VIANA) 5 minutes</p>
Monday August 26	8:30 10:20	TUTORIAL A2	Analysis of Transformer Reliability	<p>By Stefan TENBOHLEN et.al.</p> <p>Accurate information about the service experience of high voltage equipment is of significant value to both the electric utilities and to manufacturers of such equipment. It helps the manufacturers improve their products and provides important inputs for the utilities when organizing maintenance and benchmarking their performance. Statistical analysis of the past failure data can display useful features with respect to the future failure behaviour. Equipment reliability data are also required when assessing the overall reliability of an electric power system, including studies of the electric energy supply security. Furthermore, international standards applicable to high voltage equipment are being improved on the basis of service experience and reliability data. This tutorial presents the analysis of transformer failures collected by CIGRE WG A2.62. Based on a transformer population with more than 425,000 unit-years and 1,159 major failures, a failure rate of app. 0.3 % p.a. was determined. Failure location and mode analysis is presented for different voltage classes, along with external effects.</p>
Monday August 26	10:40 12:30	TUTORIAL A3	Application of Generator circuit- breakers in power plants	<p>By Pavel NOVAK, GE and Stanislav KRASNOV, CH</p> <p>A3.46 WG prepares technical brochure dealing with generator circuit-breakers. GCBs are key switching equipment, which increase reliability in operation of power plants. The tutorial will summarize main outcomes of the work. It will discuss typical plant configurations, required operational duties, network sizing calculation and qualification methods of GCBs. It will further gives insights in technologies utilized and life cycle analysis. Final discussion will handle topic of network transition and related requirements on GCB performance. Users, mainly power</p>

				plant operators, are the targeted audience. Generator and GCB manufacturers, as well as other power system experts are welcome to participate and contribute to the tutorial.
Monday August 26	14:00 15:50	TUTORIAL B4	Hybrid LCC/VSC HVDC Systems	By Yuebin ZHOU, Zhibo WANG, Erik BERNE, Paulo Max MACIEL PORTUGAL This tutorial focuses on the hybrid LCC/VSC HVDC system, which combines the LCC and the VSC technologies in one HVDC link. This kind of HVDCs have gained great popularity in recent years. The tutorial has four parts totally. Firstly, the tutorial gives an overview of the WG B4.79, including the background of HVDCs, why the hybrid HVDC is proposed and where it can be applied to, etc. Secondly, it introduces the definition of the hybrid systems, including its configuration, benefits, challenges and some application cases. Thirdly, the tutorial focuses on the hybrid systems with point-to-point configuration and introduces its considerations and typical equipment. Finally, Taking the Wudongde UHVDC project in China Southern Power Grid as an example, the tutorial introduces some typical simulation and experimental results.
Monday August 26	16:10 18:00	TUTORIAL B1	HV DC Cables, TB 852 & 853	The presentations will be by: <ul style="list-style-type: none"> • TB 852: Davide PIETRIBIASI, Roberto GASPARI • TB 853: Alessandro TROLLI, Roman SVOMA • JWG B1/B3/D1.79: Cornelis PLET, Sridhar ALAPATI
Tuesday August 27	8:30 10:20	TUTORIAL A1	(1) "Survey of Partial Discharge Monitoring in Large Rotating Machines" (2) "Challenges in designing salient pole synchronous condensers equipped with negative excitation systems"	(1) This tutorial presents the highlights from the survey carried out by WG A1.63 on discharge monitoring of large motors. The tutorial will be presented by Andre T. Carvalho (Brazil). (2) Due to the challenges resulting from the energy transition, synchronous compensators / condensers are being widely applied in many countries to support grid power quality and operational performance. This tutorial explains their design principles, how operation differs from traditional machines used for power generation, design challenges and will give an example explaining how the application of negative excitation can be used to extend the Mvar capability. The tutorial will be presented by Johnny ROCHA (Brazil).
Tuesday August 27	10:40 12:30	TUTORIAL B3	Guidelines for SF ₆ end-of-life treatment of T&D equipment (>1 kV) in substations	By Maik HYRENBACH et.al. Joint Working group B3/A3.59 used the expertise of an international group of members to prepare a guide for the professional recovery of SF ₆ from electrical equipment at end-of-life. As many users, mainly in MV, only have limited experience in this, the guide supports by explaining all required process steps and guides through the planning of all work steps. The important decision of who is recovering the SF ₆ and where this is done is explained in detail, to find the specific best matching solution for the customer application. Besides the target of

				<p>minimizing emissions, it is also helpful to find the most cost-effective solution. The recycling or destruction of SF₆ is explained, and advice for storage and transportation is given.</p> <p>This tutorial highlights the key points from the guide necessary for efficiently and effectively managing the SF₆ recovery process.</p>
Tuesday August 27	14:00 15:50	TUTORIAL C6	Aggregation of battery energy storage and Distributed Energy Resources.	<p>By Nikos HATZIARGYRIOU and Christine SCHWAEGERL, with contributions by Geza JOOS</p> <p>BESS are key enablers for the implementation of active distribution system functions by providing a range of grid services at the distribution level. This tutorial describes these grid support services, distributed BESS aggregation approaches, BESS operating constraints in terms of battery technology, weight, maintenance, and coordination with other controllers and regulatory and legal frameworks for BESS grid service delivery, regulatory and market considerations.</p>
Tuesday August 27	16:10 18:00	TUTORIAL C2	Wide Area Monitoring Protection and Control Systems – Decision Support for System Operators	<p>Presenters will be:</p> <ul style="list-style-type: none"> • Giorgio GIANNUZZI and Cosimo PISANI from Terna • Tadeja BABNIK from ELPROS • Douglas WILSON from GE • Asja DEVISKADIC and Walter SATTINGER from Swissgrid <p>About current accumulated experience in different world-wide control rooms will be reported. Details about WAMs implementation architecture will be described. Different solutions of event recording and analysis will be shown. Control room SCADA and WAM function comparison will be performed. Dedicated WAMs derived alarms and measurements will be presented. Applications of SIPS and WAMPAC system application will be discussed. The way how model validation with WAM systems could be performed, will be presented. Finally, a few telecommunication architecture details and requirements will be shown.</p>
Wednesday August 28	8:30 10:20	TUTORIAL B5	Protecting a changing power system	<p>By Anita OOMMEN (ZA), Vladimir TERZIJA (GB), Bogdan KASZTENNY (CA) and Alexander TSYLIN (DK)</p> <p>Protection of the power system with high penetration of Renewable Energy Sources</p> <p>1) Introduction,</p> <p>Short introduction of Tutorial by Tutorial Advisory Group advisor</p> <p>2) Impact of inverter based resources (IBRs) on the grid</p>

				<p>The first part of the Tutorial will focus on the shifting landscape of the power system towards renewable energy sources. The grid dynamics affected by increased penetration of IBRs, reliability, stability issues will also be covered.</p> <p>Impact of reduced inertia and fault levels on protection relays, power system inertia and fault level monitoring will be discussed. The distinguishing between grid forming and grid following inverters and their impact to protection systems will be included.</p> <p>Impact on frequency based protection and overall transmission system protection in addition to novel innovative solutions for protection systems is covered in the first part</p> <p>3) Best practices for line and remote backup protection in systems with unconventional sources</p> <p>The next part of the tutorial discuss challenges faced by directional and distance protection elements in systems with a high penetration of unconventional sources. Some practical solutions for various line protection schemes are discussed.</p> <p>Principles of traveling-wave line protection independent of the source-supplied currents will be introduced. The principles of step distance protection elements for remote backup applications optimized for systems with unconventional sources will also be covered.</p> <p>4) Roadmap to the future</p> <p>The last part of the tutorial discusses commonly used protection algorithms that are not optimized for grids with high penetration levels of inverter-based source. It gives an overview of the challenges with the current protection system design and application practice for grids with predominantly inverter-based sources. A roadmap to the future power grids equipped with adequate and reliable protection systems including trends and required developments for source fault response and grid code is introduced. the role of international professional organizations in facilitating the transformation toward power systems of the future is also included.</p>
Wednesday August 28	10:40 12:30	TUTORIAL C1	Energy Sectors Integration and impact on power grids	<p>By Ning ZHANG</p> <p>Energy Sectors Integration (ESI) denotes the system that coordinates the generation, transmission, conversion, and utilization of energy across different energy sectors, pathways, and time scales. Compared with “classical” energy system, ESI on both transmission level and distribution level changes the structure of the power system. The couplings and interactions among multiple energy networks, for example, power, gas, hydrogen, heat/cooling networks,</p>

				<p>as well as electro-mobility, are becoming more and more complex. There are increasing concerns about the coupling of the gas market and the power market in the US and Europe.</p> <p>CIGRE has set up a WG C1.47 titled Energy Sectors Integration and Impact on Power Grids to investigate the impact of energy sector coupling at transmission grid planning. The tutorial comes from the work of WG C1.47. This tutorial aims to address the technical, economic, and regulatory issues for ESI and assess state-of-the-art research in different countries around the world. The tutorial will identify the challenges and benefits of ESI at the transmission grid level. The tutorial will review the methodology and technologies on the modelling, operation, market analysis, and planning towards multi-region level ESI. Finally, the tutorial will summarize lessons learned and introduce the best practices of ESI.</p>
Wednesday August 28	14:00 15:50	TUTORIAL C5	Electric Vehicle integration in markets	<p>By Aditie GARG, Andre NEKRASOV, Anant VENKATESWARAN and Jessica HARRISON</p> <p>Electric vehicles (EVs) are poised to significantly increase electric power consumption across several regions of the world. According to the IEA, the share of EV car sales out of total global sales has more than tripled between 2020 to 2022, growing from 4 to 14%. Though total EV energy consumption in 2022 was less than 0.5 % of all energy used, individual charging infrastructure can range from kW to MWs, having a substantial impact on portions of the grid.</p> <p>In this Tutorial, Working Group C5.34 will summarize their work to explore current approaches to integrating EVs with the grid, including interconnection, operations and market participation.</p> <p>It will summarize current eligible services and pricing approaches, participant roles, and regulatory frameworks for several regions of the world, including India, Europe and North America, and recommend a framework for continued work to successfully integrate EVs.</p>
Wednesday August 28	16:10 18:00	TUTORIAL B2	Risk Management of Overhead Line networks: A model for identification, evaluation and mitigation of operational risks (WG B2.77)	<p>By Asif BHANGOR</p> <p>As the world transitions toward decarbonized, affordable, and sustainable energy systems, the reliance on weather conditions for energy generation and transmission has become increasingly critical. However, this shift also exposes existing power assets to more frequent and extreme events due to the accelerating impact of climate change.</p> <p>Transmission and distribution overhead line (OHL) networks face a variety of operational risks stemming from severe climatic events (such as wind and lightning), fires, vehicle collisions, component failures, and ageing infrastructure. These events impact the safe operation and maintenance of the network, reliability, customer service, public safety, and environmental well-being. Additionally, they can lead to significant financial costs for network operators. As</p>

				<p>the energy landscape shifts towards greater reliance on renewable sources, existing ageing assets pose an additional risk to overall grid stability.</p> <p>Multiple stakeholders are affected, including asset operators, technical and asset managers, asset owners, regulators, legal and finance teams, and the general public. Over the past decade, risk management tools and processes have become increasingly complex, with numerous interdependencies. Analysing these risks is time-consuming and requires substantial geographical, environmental, and network-specific design information. The ultimate goal is to provide concise insights for organizational decision-making.</p> <p>To address these challenges, Working Group B2.77 has developed a generic risk management framework that can be customized to suit the specific needs of power line utilities. This framework considers both simplified and detailed interdependencies, allowing a wide range of stakeholders to assess operational risks for a given network in a relatively short timeframe compared to the complex frameworks available. Key criteria include:</p> <ol style="list-style-type: none"> 1. Network Importance: Evaluating the criticality by considering connected generation, demand and circuit utilisation including value of lost load. 2. Restoration Complexity: Assessing the challenges involved in restoring service after an event to include route accessibility, spares, supply chain and resources to restore the damage 3. Historical Performance: Examining past performance and reliability including condition assessment of the components, design specifications undertaken, historical outage and recorded incidents 4. Route Vulnerability: Identifying vulnerable sections of the network to the extreme events including fire, wind, ice, snow, vandalism, flooding and others. <p>The generic risk management framework includes a straightforward Excel-based application. Stakeholders can populate it without extensive data gathering or complex design calculations. The tool provides insights into proposed mitigations, residual risks, and the benefits of chosen risk reduction strategies.</p> <p>In this tutorial, Working Group B2.77 will share case studies of extreme events from around the globe. These studies underscore the importance of informed decision-making using the suggested framework for all involved stakeholders.</p>
Thursday August 29	8:30 10:20	TUTORIAL D2	5G Application for Power Utilities	<p>By Kunlun GAO, Yi WANG.</p> <p>The tutorial provides an overview of 5G's role as a technology in enabling energy transition through new capabilities not available through previous generations' cellular wireless</p>

				technologies. Use cases for 5G's application in the various points in the end-to-end energy supply chain are also discussed.
Thursday August 29	10:40 12:30	TUTORIAL D1	Functional properties of insulating liquids for transformers: laboratory methodologies and dielectric performance	<p>By Ivanka ATANASOVA-HOEHLIN and Lars LUNDGAARD</p> <p>The tutorial addresses the functional properties of insulating liquids (mineral oils, synthetic and natural esters) in the variety of their applications and is based on the extensive work of D1-70. The tutorial will cover two key areas of the Working Groups activities:</p> <ul style="list-style-type: none"> • Establishing new laboratory methodologies simulating their behaviour in service, e. g. fault-free gassing, oxidation inhibitor depletion. • Linking scientific studies on dielectric performance of insulating liquids to industrial practices and test standards, and reviewing the typical dielectric behaviour of various insulating liquids. <p>This tutorial is based on two Technical Brochures produced by D1.70, namely, TB856 and TB927, published 2021 and 2024 respectively.</p>
Thursday August 29	14:00 15:50	TUTORIAL C4	EMC issues in modern and future power systems	<p>By Patricio MUNHOZ-ROJAS</p> <p>The tutorial will begin with an introduction describing some Electromagnetic Compatibility (EMC) basic concepts, Electromagnetism basic concepts and the relation between Electromagnetism and Circuit Theory, which is the basic theory usually utilized to describe power systems. Next, a description of various common types of electromagnetic disturbances produced by and affecting a power system, will be given.</p> <p>In the second part of the tutorial, some examples of EMC problems of a power system with other systems and the natural ambient, and of problems of Internal EMC of the power system, will be presented.</p> <p>Finally, some conclusions will be drawn about the main EMC issues that are being exacerbated in modern power systems.</p>
Thursday August 29	16:10 18:00	TUTORIAL C3	Sustainable corridor management	<p>By Aleš KREGAR</p> <p>Tutorial will focus on definition of the corridor, regulation of the right-of-way, stakeholder engagement (especially landowners), and vegetation management to ensure the reliable operation of the power lines and the simultaneous multi-purpose use of the corridors. Data collected through survey responses, descriptions of examples of best practices and experiences of working group members will be useful for power grid owners, and other stakeholders involved in activities in power line corridors.</p>

Tuesday August 27	8:45 18:00	GDM B5	Protection and automation	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • Practical experiences and new developments of process bus • Acceptance, commissioning, and field testing for protection, automation and control systems
Tuesday August 27	8:45 18:00	GDM A3	Transmission and distribution equipment	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • Energy transition involving T&D equipment • Lowering the carbon footprint of T&D equipment • Maintaining and management T&D assets
Tuesday August 27	8:45 18:00	GDM D1	Materials and emerging test techniques	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • Testing, monitoring and diagnostics • Materials for electrotechnical purposes and modelling • Materials to enable the energy transition
Tuesday August 27	8:45 18:00	GDM C3	Power system sustainability and environmental performance	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • Public acceptance and stakeholder engagement in power system - generation, transmission & distribution infrastructures • Climate change and impact on power system, a holistic approach • Sustainability starting for the supply chain
Wednesday August 28	8:45 18:00	GDM B3	Substations and electrical installations	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • Challenges & new solutions in T&D substation design and construction for energy transition • Return on operational experiences for substation management
Wednesday August 28	8:45 18:00	GDM C2	Power system operation and control	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • Create operational resilience to extreme/unpredictable events • Changes on system operation and control considering the energy transition
Wednesday August 28	8:45 18:00	GDM C6	Active distribution systems and distributed energy resources	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • Flexibility management in distribution networks • Power electronic based solutions for smart distribution systems • Rural, islanded and industrial electrification standards, practices and technology options
Wednesday August 28	8:45 18:00	GDM A1	Power generation and electromechanical energy conversion	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • Rotating electrical machines and the energy transition • Evolution and development • Keeping the lights on
Thursday August 29	8:45 18:00	GDM B4	DC systems and power electronics	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • DC equipment and systems • FACTS and power electronics • New technologies and concepts of DC and FACTS enabling energy transition

Thursday August 29	8:45 18:00	GDM C1	Power system development and economics	<p>Preferential subjects:</p> <ul style="list-style-type: none"> Steering the energy transition: cooperation, achieving top-down targets through bottom-up investment decisions Flexibility as pivotal criterion for system development Resilience as pivotal criterion for system development
Thursday August 29	8:45 18:00	GDM B1	Insulated cables	<p>Preferential subjects:</p> <ul style="list-style-type: none"> Learning from experiences Future functionalities and applications Towards sustainability
Thursday August 29	8:45 18:00	GDM C5	Electricity markets and regulation	<p>Preferential subjects:</p> <ul style="list-style-type: none"> Characteristics of a resilient market and its regulatory regime Preparing for the future with moving targets Emerging markets and forms of markets
Friday August 30	8:45 18:00	GDM B2	Overhead lines	<p>Preferential subjects:</p> <ul style="list-style-type: none"> Challenges from renewables integration and influences of energy transition on OHL Asset management, strategies, technologies and methods for OHL Impacts from climate change on OHL
Friday August 30	8:45 18:00	GDM C4	Power system technical performance	<p>Preferential subjects:</p> <ul style="list-style-type: none"> Power system dynamic analysis in the energy transition: challenges, opportunities and advances Power quality (PQ) and electromagnetic compatibility (EMC) analysis in the energy transition: challenges, opportunities and advances Insulation co-ordination and lightning interference analysis: challenges, opportunities and advances
Friday August 30	8:45 18:00	GDM A2	Power transformers and reactors	<p>Preferential subjects:</p> <ul style="list-style-type: none"> Design of resilient transformers Advances in transformer analytics Reliability of Transformers for Renewable Energy
Friday August 30	8:45 16:00	GDM D2	Information systems telecommunications and cybersecurity	<p>Preferential subjects:</p> <ul style="list-style-type: none"> IT/OT solutions to improve the efficiency and resilience of electric power systems Cybersecurity in emerging application domains and technologies for securing energy organisations Meeting the challenges of energy transition with reliable, scalable, and efficient telecommunications networks
Monday August 26	08:30 12:30	Poster session A3	Transmission and distribution equipment	<p>Preferential subjects:</p> <ul style="list-style-type: none"> Energy transition involving T&D equipment Lowering the carbon footprint of T&D equipment

				<ul style="list-style-type: none"> • Maintaining and management T&D assets
Monday August 26	08:30 12:30	Poster session C3	Power system sustainability and environmental performance	Preferential subjects: <ul style="list-style-type: none"> • Public acceptance and stakeholder engagement in power system - generation, transmission & distribution infrastructures • Climate change and impact on power system, a holistic approach • Sustainability starting for the supply chain
Monday August 26	14:00 18:00	Poster session B5	Protection and automation	Preferential subjects: <ul style="list-style-type: none"> • Practical experiences and new developments of process bus • Acceptance, commissioning, and field testing for protection, automation and control systems
Monday August 26	14:00 18:00	Poster session D1	Materials and emerging test techniques	Preferential subjects: <ul style="list-style-type: none"> • Testing, monitoring and diagnostics • Materials for electrotechnical purposes and modelling • Materials to enable the energy transition
Tuesday August 27	08:30 12:30	Poster session C6	Active distribution systems and distributed energy resources	Preferential subjects: <ul style="list-style-type: none"> • Flexibility management in distribution networks • Power electronic based solutions for smart distribution systems • Rural, islanded and industrial electrification standards, practices and technology options
Tuesday August 27	08:30 12:30	Poster session B1	Insulated cables	Preferential subjects: <ul style="list-style-type: none"> • Learning from experiences • Future functionalities and applications • Towards sustainability
Tuesday August 27	14:00 18:00	Poster session A1	Power generation and electromechanical energy conversion	Preferential subjects: <ul style="list-style-type: none"> • Rotating electrical machines and the energy transition • Evolution and development • Keeping the lights on
Tuesday August 27	14:00 18:00	Poster session B3	Substations and electrical installations	Preferential subjects: <ul style="list-style-type: none"> • Challenges & new solutions in T&D substation design and construction for energy transition • Return on operational experiences for substation management
Wednesday August 28	08:30 10:30	Poster session C4	Power system technical performance	Preferential subjects: <ul style="list-style-type: none"> • Power system dynamic analysis in the energy transition: challenges, opportunities and advances • Power quality (PQ) and electromagnetic compatibility (EMC) analysis in the energy transition: challenges, opportunities and advances • Insulation co-ordination and lightning interference analysis: challenges, opportunities and advances

Wednesday August 28	10:30 12:30	Poster session C5	Electricity markets and regulation	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • Characteristics of a resilient market and its regulatory regime • Preparing for the future with moving targets • Emerging markets and forms of markets
Wednesday August 28	14:00-16:00	Poster session C1	Power system development and economics	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • Steering the energy transition: cooperation, achieving top-down targets through bottom-up investment decisions • Flexibility as pivotal criterion for system development • Resilience as pivotal criterion for system development
Wednesday August 28	16:00-18:00	Poster session B4	DC systems and power electronics	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • DC equipment and systems • FACTS and power electronics • New technologies and concepts of DC and FACTS enabling energy transition
Thursday August 29	08:30 10:25	Poster session B2	Overhead lines	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • PS1 Challenges from renewables integration and influences of energy transition on OHL • PS3 Impacts from climate change on OHL
	10:35 12:30			<p>Preferential subject:</p> <ul style="list-style-type: none"> • PS2 Asset management, strategies, technologies and methods for OHL • NGN Papers
Thursday August 29	08:30 12:30	Poster session C2	Power system operation and control	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • Create operational resilience to extreme/unpredictable events • Changes on system operation and control considering the energy transition
Thursday August 29	14:00 18:00	Poster session D2	Information systems telecommunications and cybersecurity	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • IT/OT solutions to improve the efficiency and resilience of electric power systems • Cybersecurity in emerging application domains and technologies for securing energy organisations • Meeting the challenges of energy transition with reliable, scalable, and efficient telecommunications networks
Thursday August 29	14:00 18:00	Poster session A2	Power transformers and reactors	<p>Preferential subjects:</p> <ul style="list-style-type: none"> • Design of resilient transformers • Advances in transformer analytics • Reliability of Transformers for Renewable Energy