cigre NRCC Symposium 2025 Trondheim, Norway

TECHNICAL PROGRAM

The theme for the CIGRE Trondheim Symposium is **CHANGES NEEDED IN THE POWER SYSTEM for the Energy Transition.** The aim is to provide a forum for recent research results, planning and system operations experience related to the changes the power system is undergoing because of the energy transition.

The symposium is organized and supported by eleven CIGRE Study Committees: **SC A3** Transmission and distribution equipment, **SC B1** Insulated cables (**co-lead**), **SC B2** Overhead lines, **SC B3** Substations and electrical installations, **SC B4** DC systems and power electronics, **SC B5** Protection and automation, **SC C2** Power system operation and control, **SC C3** Power system sustainability and environmental performance, **SC C4** Power system technical performance (**co-lead**), **SC C6** Active distribution systems and distributed energy resources, **SC D2** Information systems telecommunications and cybersecurity. A description of each Study Committee can be found at the end of this program.

The theme of the symposium is divided into two topic streams:

PS1: Integration of renewable energy resources to the grid

- Environmentally friendly power grid and its equipment
- New applications and technologies applied to AC and DC onshore and offshore grid
- AC and DC onshore and offshore grid
- AC grid development, protection of the future meshed AC and DC system
- Sector integration including hydrogen, EV, energy hubs, DER
- Services/operation applied to AC and DC onshore and offshore grid
- Monitoring the system applied to AC and DC onshore and offshore grid
- Maintenance and Services applied to AC and DC onshore and offshore grid

PS2: Technologies supporting the power grid for energy transition to carbon neutral energy production

- Requirements for power grid and its equipment
- Inverter based control interacting with existing system and Converter stability issues (resonance stability, converter driven stability)
- Coordination between AC and DC networks
- Grid forming
- Multivendor interoperability
- New modelling tools
- Planning and operation of lower inertia system
- System analysis (technical)
- Black start and resilience aspects including DER integration
- Optimize and increase the capacity of the energy transmission network
- Reliability and security – critical infrastructure

This technical program covers the public sessions available to delegates to the CIGRE Trondheim International Symposium May 12–14, 2025. There are many other meetings taking place of Working Groups and Study Committees. Members of these groups will be issued a detailed schedule.

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Monday 12th May: Tutorials & Workshops

Time	AURORA B+C	COSMOS 1	COSMOS 2	COSMOS 3
08:00	A3/B5 Tutorial: Modern Instrument Transformers for Protection Applications	C2/B4 Tutorial: The Impact of Offshore Wind Power Hybrid AC/DC Connections on System Operations and System Design	C4 Tutorial: Modelling of Inverter Based Resources and Distributed Energy Resources for System Analysis	B2 Tutorial: Forecasting Dynamic Thermal Line Ratings (WG B2.59)
10:00	**Coffee break**			
10:30	B5 Tutorial: Protection and Metering Advancements in the Evolving Power System (WG B5.57 & WG B5.76)	B4 Tutorial: Interoperability in HVDC Systems Based on Partially Open-Source Software	C4/C2 Tutorial: Recent Advancements in Technology and Applications of Synchrophasor Measurements (JWG C4/C2.62)	A3 Workshop: Digitalization of Information for T&D Equipment
12:30	**Lunch**			
13:30	B1 Tutorial: Condition Evaluation and Lifetime Strategy of HV Cable Systems	B4 Workshop: InterOPERA at Crossroads: Advancing Multi-Vendor HVDC Interoperability	B3 Tutorial: Review of Substation Busbar Component Reliability (TB 930 WG B3.49)	C1/B4 Tutorial: JWG C1/B4.49 Offshore Transmission Planning
15:30	**Coffee break**			
16:00	C3 Tutorial: Best Environmental and Socio-Economic Practices for Improving Public Acceptance of High Voltage Substations	B4/C4 Workshop: Modelling and Tools for Resilient Power Systems Design:-a HVDC-WISE Workshop	C6 Workshop: DSO Tools and Practices for Operating Active Distribution Networks	D2 Workshop: Cybersecurity Perspectives on Regulation, Standards, and Technical Developments
19:00	**Welcome reception**			

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Tuesday 13th May: Technical Paper Sessions (i)

Time	AURORA A	AURORA B+C	COSMOS 1	COSMOS 2	COSMOS 3
08:00			**Opening Session & Discussion Panel**		
09:30			**Coffee break**		
10:30	SC A3 session #1: Switchgear technology, reliability and condition assessment	SC B5 session #1: Protection, Automation and Control System engineering and design aspects	SC B4 session #1: DC-Hub, DC-Grid & Multi-Terminal HVDC	Joint SC C2/C4 session: Power System Stability in Inverter Dominated Grids	SC C6 session #1: DER impact on Distribution Systems
12:30			**Lunch**		
13:30	SC A3 session #2: Transformers and Instrument Transformers	SC B5 session #2: Protection implementation experience - schemes, settings & testing	SC B4 session #2: HVDC Planning, Design, Standardization	SC C4 session #1: Instability and Oscillations in Inverter Dominated Power Systems	SC C6 session #2: Microgrid and BESS applications
15:30			**Coffee break**		
16:00	SC C3 session #1: Integrating sustainability criteria into network planning, project design and construction	SC B5 session #3: Impact of Renewable Energy Sources and Inverter Based Resources on Network Protections	SC B4 session #3: Energy Storage, HVDC Auxiliary Equipment and Components	SC C4 session #2: Dynamic Performance of Power Systems in the Energy Transition	SC C6 session #3: DER integration in Active Distribution Networks
20:00			**Symposium Dinner**		

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Wednesday 14th May: Technical Paper Sessions (ii)

Time	AURORA A	AURORA B+C	COSMOS 1	COSMOS 2	COSMOS 3
08:00	SC B2 session #1: Towers and foundations design and maintenance	SC B1 session #1: Insulated Cables -1	SC C2 session #1: System Operational Challenges and Experiences with Integration of Renewables	SC C4 session #3: Power Quality, Transients and EMC Challenges in the Energy Transition	SC D2 session #1: Cybersecurity & Data Protection in Power Grids
10:00	**Coffee break**				
10:30	SC B2 session #2: Conductors and fittings, crossings, vibrations and icing	SC B1 session #2: Insulated Cables -2	SC C2 session #2: Tools and Methods for Congestion Management and Operational Planning	SC C4 session #4: Enhanced Models and Simulation Capabilities for Inverter Dominated Power Systems	SC D2 session #2: Cybersecurity & Data Protection in Power Grids (cont.) / Digital Transformation & Emerging Technologies
12:30	**Lunch**				
13:30	SC B3 session #1: Substations and electrical installations -1	SC B1 session #3: Insulated Cables -3	SC C2 session #3: Inertia Monitoring, DSA and other Tools for Enabling System Operations with Increasing IBR	SC C4 session #5: Enhanced Solution Methods for Analysis of Modern Power Systems	SC D2 session #3: Digital Transformation & Emerging Technologies (cont.) / Advanced Communication & Networking in Power Systems
15:30	**Coffee break**				
16:00	SC B3 session #2: Substations and electrical installations -2	SC C3 session #2: Power infrastructure and biodiversity / Technology to reduce environmental impact	SC C2 session #4: Ancillary Services and Control in Power Electronics Dominated Power Systems	Joint SC B4/C4 session: Grid Forming, analysis methodologies	SC D2 session #4: Advanced Communication & Networking in Power Systems (cont.)
18:00	**Closing**				
	Technical Tour				

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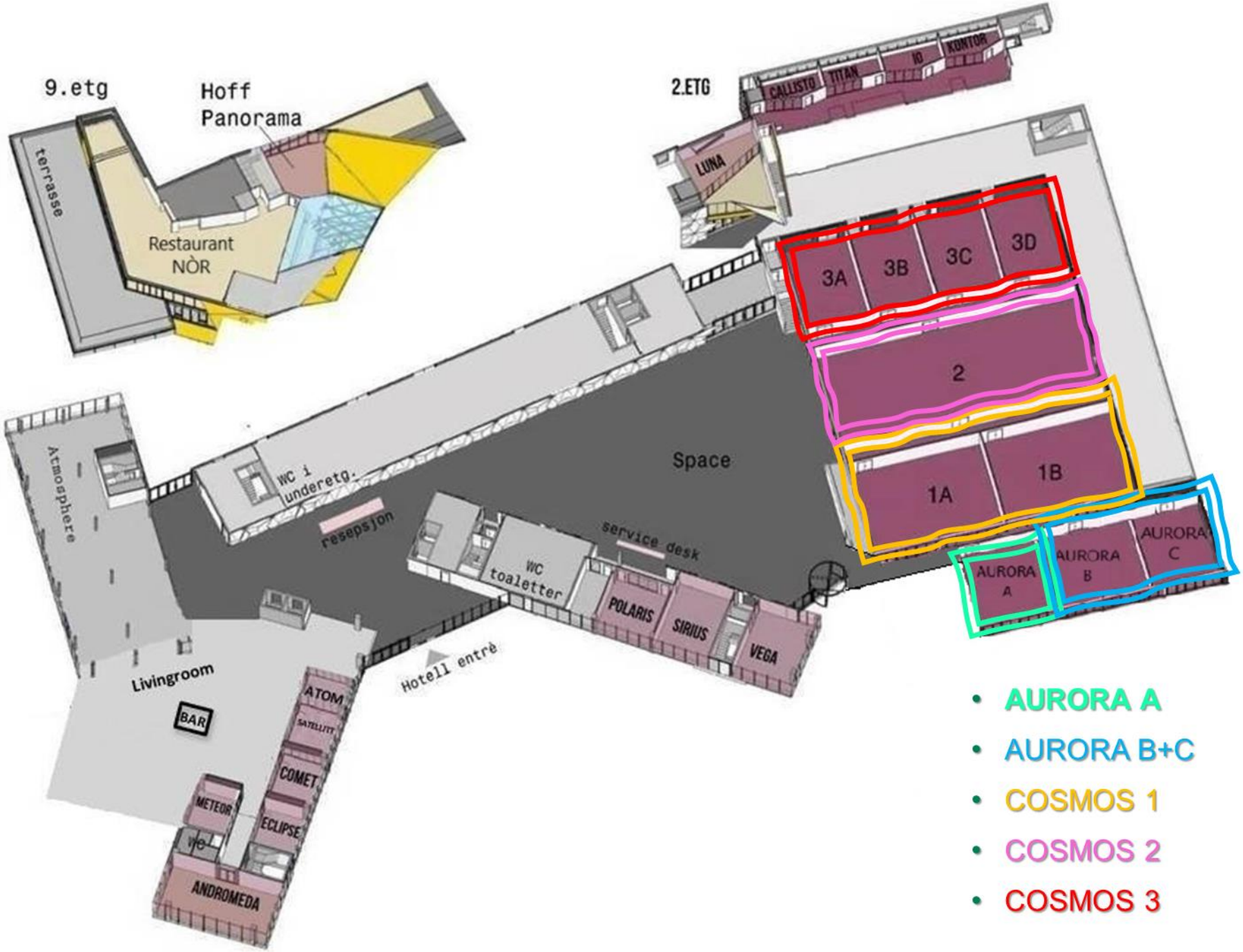

- AURORA A
- AURORA B+C
- COSMOS 1
- COSMOS 2
- COSMOS 3

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Monday 12th May: Tutorials & Workshops

Monday 12th May | **AURORA B+C** | **08:00 – 10:00**

A3/B5 Tutorial: Modern Instrument Transformers for Protection Applications

Speaker: Erik Sperling (OMICRON) , Volker Leitloff (Rte)

Contents:

- Overview of instrument transformer types
- Conventional instrument transformers, design, protection classes and their impact on the IT, Comparison between protection and measurement application
- Low-power instrument transformers, design, protection classes and their impact on the LPIT, Comparison between protection and measurement application
- Comparison between IT and LPIT technologies with a focus on protection application
- Protection functions interfaced with LPIT

Monday 12th May | **COSMOS 1** | **08:00 – 10:00**

C2/B4 Tutorial: The Impact of Offshore Wind Power Hybrid AC/DC Connections on System Operations and System Design

Speaker: Christer Norlander, (Svenska kraftnät), Jan van Putten, (TenneT NL), Mark Jones, (SSEE), Andreas Wasserrab (TenneT DE), Robert Eriksson (Svenska kraftnät), Juergen Krienkamp (DUtrain), Adedotun Agbemuko (Elia-Engineering).

Contents:

- Intro to CIGRE JWG C2/B4.43, ToR, members & organizational, planning & time scheduling
- Market and Regulatory subjects
- TSO roles, System Operator view in general linked to Connecting on land - Supplier side perspectives
- System design - Supplier side perspectives
- Power system subject, like System stabilities, Voltage control
- Operational training and training in general
- Q&A

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Monday 12th May | **COSMOS 2** | **08:00 – 10:00**

C4 Tutorial: Modelling of Inverter Based Resources and Distributed Energy Resources for System Analysis

Speaker: Deepak Ramasubramanian (EPRI)

Summary: The connection of large inverter based resources (IBR) in transmission systems is often located geographically and electrically far away from load centers. This, coupled with the displacement of synchronous machine plants, results in a reduction of the network short circuit strength at the point of connection. Under these conditions, state-of-the-art positive sequence simulation platforms and models can have difficulties maintaining numerical stability and/or providing an accurate representation of IBR plant dynamic behavior. As a result, computationally heavy time domain electromagnetic transient (EMT) simulations may be required to evaluate these systems. However, there are still many studies that can be carried out in a positive sequence environment with high percentage of IBRs. This tutorial will delve into the nuances associated with modeling of these resources, their bandwidth, capabilities, and limitations. Further, the tutorial would also discuss aspects related to model parameterization and its importance in not only providing a reasonable representation of the device, but also in its importance in comparing performance across software platforms.

Monday 12th May | **COSMOS 3** | **08:00 – 10:00**

B2 Tutorial: Forecasting Dynamic Thermal Line Ratings (WG B2.59)

Speaker: George Watt (Consultant)

Summary: Power transmission system operators (TSOs) require a clear knowledge of line ratings in the present and the near future. Managing the power flow on lines is needed to prevent line conductor overheating that causes premature aging of conductor and its accessories and excessive sagging that may exceed minimum electrical clearances to ground and underbuilt infrastructure. This tutorial based on the technical brochure is primarily concerned with forecasting the Dynamic Line Ratings (DLR), i.e., the approaches of predicting overhead line thermal ratings daily, hourly or in several minutes, Given the strong dependence of overhead line ratings on wind convection in the complex environment of the typical line corridor, the forecasting process is quite complex..

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Monday 12th May | **AURORA B+C** | **10:30 – 12:30**

B5 Tutorial: Protection and Metering Advancements in the Evolving Power System (WG B5.57 & WG B5.76)

Speakers: Vladimir Terzija (B5.57 convenor, University of Newcastle), Ross Marcenko (WG B5.76 Convenor, Landis+Gyr), Joao Jesus (GE Vernova), Peter Menke (Siemens Energy), Leif Egil Stene Dahl (Siemens Energy), Geert Borloo (Elia), Sami Najar (RTE).

Summary:

- **New challenges for frequency protection** (WG B5.57)

New challenges and the impact of integration of IBRs to the grid will be presented. Focus will be on the changes to power system inertia. Techniques for frequency measurement will be elaborated. The system response to frequency events will then be analysed for traditional and future power systems in which the presence of IBRs will be high. Fundamentals of traditional underfrequency load shedding will be presented and in the context of new challenges of reduced and volatile system inertia. Experiences and policies in different utilities will be discussed. Approaches for testing frequency-based protective functions will be discussed, concluding with the outlook on frequency protection approaches in future electrical power systems.

- **Architecture, standards and specification for metering system in a digital substation and protection, automation and control (PACS) environment** (WG B5.76)

Modernisation and digitisation of metrology systems in HV applications using process bus. Transition to digital revenue metering involves IEC 61850 series of standards, as well as other related technologies. Focus on exploring digital metering systems based on IEC 61850-9-2, compared with conventional systems from various aspects: measurement, system topologies, component routine and type testing, security. Standardisation, legal requirements and challenges. Summary of literature and research-based, as well as industry-based lessons learnt for technology pathway for the future, recommendations, and possible next steps towards virtualisation of measurements, which is a proposed subject for further research.

Monday 12th May | **COSMOS 1** | **10:30 – 12:30**

B4 Tutorial: Interoperability in HVDC Systems Based on Partially Open-Source Software

Speakers: Staffan Norrga (KTH Royal Institute of Technology), Ilka Jahn (KTH Royal Institute of Technology), Perry Hofbauer (SSEN), Ying Häfner (Hitachi Energy), Pierre Rault (RTE), Rodrigo Alvarez (Siemens Energy).

Summary: The first part of this tutorial reports the findings of WG B4.85: Interoperability in HVDC systems could be supported with open upper-level control and protection (C&P) software, while hardware-near C&P functions stay black-boxed and proprietary. Methodologies like model-based systems engineering and graph theory can assist in defining the boundary between open and closed software. Most likely, partially open C&P software in HVDC is not hindered by legislation, but has to be addressed in contractual agreements. Also, a new responsibility matrix for testing is proposed. The second part of this tutorial consists of a panel discussion with working group members.

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Monday 12th May | **COSMOS 2** | **10:30 – 12:30**

C4/C2 Tutorial: Recent Advancements in Technology and Applications of Synchrophasor Measurements (JWG C4/C2.62)

Speakers: Dr. Athula Rajapakse (University of Manitoba), Dr. Kjetil Uhlen (Norwegian University of Science and Technology), Dr. Krish Narendra (Electric Power Group), Dr. Steven Blair (Synaptec Ltd.)

Summary:

As modern power grids adapt to host increasing amounts of renewable energy, energy storage, and electric vehicle loads, real-time monitoring is essential for maintaining stability, ensuring reliability, and optimizing power system operation. Synchrophasors, through precisely time-stamped, fast-updating measurements, provide a dynamic view of the power system for situational awareness, operation, control, and protection. These capabilities have enabled the development of many advanced applications, including data analytics, operator situational awareness, real-time control, model and control verification, and more. The objective of this tutorial is to share recent technological advancements, existing applications and industry experiences, as well as emerging applications and future directions.

Since their development in the early 1990s, synchrophasor technology and related standards have evolved significantly. This tutorial will introduce the most recent updates to both the technology and the standards. It will then explore how synchrophasor data can enhance situational awareness and enable information sharing among utilities for the early detection of critical operating conditions.

In today's rapidly evolving energy landscape, integrating renewable energy sources and displacing traditional synchronous generators present significant challenges to grid stability. The tutorial will discuss how leveraging synchrophasor measurements for real-time monitoring of system strength and inertia is key to addressing these challenges. Wide-area synchrophasor measurements, combined with advanced machine learning models, can be used to tackle complex tasks, such as predicting instabilities and making emergency control and protection decisions to maintain system integrity. Emerging applications will also be presented.

Finally, the tutorial will explore future directions in synchronized measurement technology, extending beyond synchrophasors.

Contents:

- Introduction to synchrophasor technology and wide-area monitoring
- Improved coordination between transmission system operators through Wide Area Monitoring (WAMS)
- System Inertia Monitoring Using PMU Data
- Real-time prediction and mitigation of short-term voltage instabilities with synchrophasor data using machine learning techniques
- Applications of synchronized waveform measurements

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Monday 12th May | **COSMOS 3** | **10:30 – 12:30**

A3 Workshop: **Digitalization of Information for T&D Equipment**

Speakers: Frank Richter (50Hertz), Alex Apostolov (Omicron), Giovanna Dondossola (RSE)

Summary:

This workshop will explore the critical need for digitalisation in modern electrical grids. Participants will learn about the benefits, requirements, and key differences between digitalisation and digitisation, as well as the importance of cybersecurity. We will also identify areas that require further attention and development.

Join us to gain insights into how digitalisation is revolutionizing the electrical grid, what steps are necessary to achieve a secure and efficient power system, and the areas that need further development to ensure a comprehensive digital transformation.

Monday 12th May | **AURORA B+C** | **13:30 – 15:30**

B1 Tutorial: **Condition Evaluation and Lifetime Strategy of HV Cable Systems**

Speakers: Jacco SMIT (TenneT), Isabella NETT (TenneT), Stelios CHRISTOU (EdF)

Summary:

A suitable remaining life management strategy is crucial for cables assets management. For high voltage underground cable systems, a multitude of different factors from various categories determine their end of life.

The aim of Technical Brochure 912 is to reflect current practices for remaining life management and to assess the usage of the system presented in TB 358.

A new method for condition assessment and lifetime strategy of HV cable systems is proposed.

The approach takes into account condition data of the cable and cable systems as well as their age, past failures and maintenance aspects..

Monday 12th May | **COSMOS 1** | **13:30 – 15:30**

B4 Workshop: **InterOPERA at Crossroads: Advancing Multi-Vendor HVDC Interoperability**

Speakers: Sebastien Silvant (SuperGrid Institute), Ahmed Islam Zama (SuperGrid Institute), Gustavo Figueiredo Gontijo (Orsted), Ben Rennings (Siemens Energy), Benoit de Foucaud (RTE), Christos Dikaiakos (Statnett), Philipp Ruffing (Amprion).

Summary:

Achieving seamless interoperability in multi-vendor HVDC systems is a critical enabler for the future of resilient and efficient power grids. This session will provide insights from the InterOPERA project, detailing its multi-faceted approach to overcoming interoperability challenges. The session begins with a brief introduction to the project's overarching objectives and challenges. It

will explore foundational work from WP2, which establishes the basic functional requirements for multi-vendor HVDC systems.

Building on this, WP3 delves into the InterOPERA Demonstrator, showcasing the journey from conceptual use cases to detailed specifications with practical applications. WP1 feedback highlights the validation of EMT offline/HIL requirements, underscoring the importance of robust simulation tools. Finally, WP4 and WP5 insights will address fostering multi-party cooperation frameworks and preparing multi-vendor tenders, paving the way for actionable steps toward interoperability. The session concludes with a discussion, engaging the audience and encouraging collaboration.

Contents:

- Introduction
- Basic Functional Requirements for Multi-Vendor HVDC Interoperability
- InterOPERA Demonstrator – From Use Cases to Detailed Specifications
- EMT offline model/HIL Requirements Validation in InterOPERA
- Multi-Party Cooperation Framework & Multi-Vendor Tender Preparation
- Q&A and Discussion

Monday 12th May **COSMOS 2** **13:30 – 15:30**

B3 Tutorial: Review of Substation Busbar Component Reliability (TB 930 WG B3.49)

Speakers: Hubert Müller (Lorünser Austria GmbH), Daniel Fetz (PLP Subcon, Austria)

Summary: Substation busbar systems and components have received little attention within CIGRE or the industry in general, while overhead power line fittings have been analysed in several brochures and reports. Cigre working group B3.49 gathered suppliers, utilities, testing lab and other experts in one group and produced technical brochure 930. This tutorial outlines the findings from this brochure, addressing basic topics for newcomers as well as high-level studies for experts. It also includes findings from a survey and an analysis of the importance of connectors for the participants. Some central aspects of this work are reliability, testing and installation.

Monday 12th May **COSMOS 3** **13:30 – 15:30**

C1/B4 Tutorial: JWG C1/B4.49 Offshore Transmission Planning

Speakers: Antonio Iliceto (Terna), Dr. Ervin Spahic (Elia Group), Carolin Guntermann (RWTH), Lara Stregger (Stantec), Dr. Philipp Ruffing (Amprion), Marko Grizelj (Siemens Energy), Perry Hofbauer (SSEN).

Summary: The use of offshore transmission infrastructure has grown significantly over the last decade mainly drive by offshore wind, interconnectors, electrification of oil and gas and islands, and reinforcement of existing grids by offshore transmission systems. The tutorial will address unique challenges like remote offshore connections, submarine cable and platforms applications, harsh sea environment, requiring specific techniques, practices and equipment for installation and maintenance. Furthermore, it often crosses multiple offshore jurisdictions such as national borders, offshore regulatory zones, exclusive economic zones and/or control area

borders, requiring special/innovative regulation and inter-country agreements. Tutorial will try to cover all of these aspects and provide insight and guidelines how offshore transmission grids can be planned, developed, deployed and operated, taking into account the purpose to be fulfilled, the limits of onshore AC grids, limited planning horizons, and technology characteristics.

Contents:

- Introduction/Motivation/General for JWG C1/B4.49
- Offshore transmission projects, existing and planned
- Offshore transmission purposes
- Technologies and equipment for offshore grids
- Offshore grid topologies, functions & performance
- Interface with onshore grids & impact on offshore grid design
- Offshore grid growth models
- Overview of applicable governance & ownership frameworks and their impact on offshore grid design and operation
- Offshore grid planning considerations
- Models for coordination of offshore grid planning

Monday 12th May | **AURORA B+C** | **16:00 – 18:00**

C3 Tutorial: Best Environmental and Socio-Economic Practices for Improving Public Acceptance of High Voltage Substations

Speakers: Joris den Breejen (TenneT TSO), Henk Sanders (TenneT TSO)

Summary:

CIGRE WG C3.15 has made an inventory of the best practices, options, and boundary conditions for the integration of substations in their environment. It describes the results in exploring the best spatial, environmental, and socio-economic practices for improving public acceptance of new and existing substations on land from 2016-2024. This tutorial is a particularly special one for CIGRE, as it diverges from the typical focus on quantitative methodologies and technical solutions. Instead, it serves as an inspiration guide, sparking creativity in the search for innovative ways to enhance public acceptance.

What works, and what does not work, depends on the setting (e.g., country, area, location) and configuration (i.e., voltage levels, installed capacity, size) of the substation. Combinations of various methods, techniques and tools can be used to great effect, and even the use of merely one tool can be effective to increase public acceptance of new substations, potentially decreasing project lead time, and if done right, also project costs, while also strengthening ties between the grid operator and other stakeholders.

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Monday 12th May **COSMOS 1** **16:00 – 18:00**

B4/C4 Workshop: Modelling and Tools for Resilient Power Systems Design:-a HVDC-WISE Workshop

Speakers: Robert Dimitrovski (TenneT), Knut Hornnes (Statnett), Ying Pang (SuperGrid Institute), Ning Yang (Strathclyde University), Sean McGuinness (EPRI Europe).

Summary:

The Horizon Europe funded HVDC-WISE project has been concerned with developing an integrated reliability and resilience framework, that can demonstrate the power of large-scale integrated AC/DC networks to improve system planning and operation to ensure improved resilience to a range of extreme operating conditions. This workshop will highlight some of the resilience issues affecting TSOs today, and will outline some of key modelling and tools developments in the project that will help address these issues.

Monday 12th May **COSMOS 2** **16:00 – 18:00**

C6 Workshop: DSO Tools and Practices for Operating Active Distribution Networks

Speakers: Henning Taxt (SINTEF), Jun Elin Wiik (The Norwegian Smartgrid Centre), Merkebu Zenebe Degefa (University of Stavanger), Raymundo Torres (SINTEF), Gunnar Vist (Heimdall Power), Iver Endresen (Heimdall Power), Sigurd Bjarghov (SINTEF), Almir Augusto Ladeira de Andrade (Kongsberg Digital), Vibeke Ranum (Elvia).

Summary:

Large parts of the required technologies and actors are already in place and are awaiting the scale-up of the market for these products, such as monitoring solution, flexibility market operators and flexibility providers. However, the demand for these products is not growing in a serious way, and will not, before the DSOs have the tools and practices to exploit these opportunities in the grid operation at scale. Several developments are needed:

- Moving on from today's (mainly) manual reactive processes to more proactive automated real-time operation
- Develop the role of operational planning at the DSO level, to prepare for a more automated and optimal real-time operation, including the acquisition of flexibility, optimizing network topology changes
- Combining existing products and services for ADN into a complete value-chain, from sensors and data acquisition to the grid actions, via the decision support systems of the DSO

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Monday 12th May **COSMOS 3** **16:00 – 18:00**

D2 Workshop: **Cybersecurity Perspectives on Regulation, Standards, and Technical Developments**

Speakers: Giovanna Dondossola (RSE), Roberta Terruggia (RSE), Junho Hong (University of Michigan-Dearborn), Chen-Ching Liu (Virginia Tech), Yosi Shneck (YSICONS), Eric Andersen (Denmark).

Moderator: Louise Watts (SA Power Networks)

Summary:

As energy systems become increasingly digital and interconnected, cybersecurity has emerged as a critical area of focus across the sector. This workshop brings together international experts who will share their knowledge and experience in today's regulatory landscape, evolving standards, and technologies that are shaping the way we secure energy infrastructure now and into the future.

Through a series of targeted technical presentations and open discussions, the session explores a wide spectrum of cybersecurity challenges and solutions. Topics range from cybersecurity energy regulations, Artificial Intelligence (AI) driven detection platforms and protocol level vulnerabilities to modern security operations and the emerging impact of quantum computing on cryptographic approaches..

Contents:

- Cybersecurity in energy regulations
- Cyber defence and AI based detection platforms.
- Cybersecurity of the ICCP.
- Beyond the control room: transformative SOC architectures for resilient energy systems.
- Emerging technologies for securing energy communications: post-quantum cryptography and decentralized PKI.

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Tuesday 13th May: Opening Session

08.00 **Opening of Symposium and information on program**

Rannveig Løken, Chair CIGRE Symposium Organizing Committee

08.10 **Welcome by CIGRE President**

Konstantin PAPAILIOU, CIGRE President

08.20 **CIGRE information from Central Office**

Philippe ADAM, CIGRE Secretary General

08.30 **Thank you to all speakers – Now opening panel**

08.30 **Panel discussion: CHANGES NEEDED IN THE POWER SYSTEM for the Energy Transition**

Panel Chair: Marta Val ESCUDERO, Chair CIGRE Study Committee C4

Panel Moderator: Geir Clasen, Chair CIGRE Study Committee B1

Panelists:

- Ane Torvanger Brunvoll, The Norwegian Water Resources and Energy Directorate (NVE)
- Antti-Juhani Nikkilä, D.Sc, FINGRID, Finland
- Bård Lund, CEO Hitachi Energy Norway
- Claus Leth Bak, Aalborg University, CIGRE National Committee Denmark
- Conor MULHOLLAND, NGN Chair
- Diane Watkins, TC chair, IEEE PES,
- Håkon Borgen, Executive Vice President Offshore development, Statnett, Norway

09.30 **End of Panel discussion**

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Tuesday 13th May: Technical Paper Sessions (i)

Tuesday 13th May **AURORA A** **10:30 – 12:30**

SC A3 session #1: Switchgear technology, reliability and condition assessment
Session Chair / Moderator: Nicola Gariboldi (SC A3 Chair, Qualitrol) / Frank Richter (50 Hertz)

ID: 1162
CIGRE fourth reliability survey on equipment
keywords: Life management, Substation equipment, Circuit breakers, GIS, End-of-life decision, Reliability, Maintenance practices, Major failure frequency
Ito, Hiroki (1); Richter, Frank (2); le Roux, Robert (3); Pepper, Wayne (4)
1: Mitsubishi Electric, Japan; 2: 50 Hertz transmission, Germany; 3: ESB, Ireland; 4: Ausgrid, Australia

ID: 1147
Holistic operation and condition assessment enabling efficient usage of equipment
keywords: Condition Assessment, Monitoring, Transformer
Albert, Dennis (1); Wischtukat, Philip (2)
1: OMICRON electronics GmbH, Austria;2: Hubert Göbel GmbH, Germany

ID: 1329
Estimating the Norwegian circuit breaker population towards 2050
keywords: Circuit Breaker, Scenario, SF6, Switchgear
Treider, Thomas;D'Arco, Salvatore
SINTEF Energy Research, Norway

ID: 1235
LCA for AIS /GIS Substations at Axpo Grid and the role of DSO/TSO to become carbon neutral
keywords: LCA für AIS and GIS S/S for 145 kV - the role of the DSO/TSO; CO2 free S/S; CO2 footprint of S/S
Lindner, Christian (1); Schulz, Ingo (1); Spörri, Andy (2); Subal, Luc (2)
1: Axpo Grid AG, Switzerland; 2: Ernst Basel und Partner, Switzerland

ID: 1316
Impact factors on carbon footprint for SF6 free GIS
keywords: LCA, Sustainability, HV, GIS, LCIA, SF6, Clean Air, GHG emissions, GWP, Switchgear
Gronbach, Peter; Böhlert, Rene; Schulz, Richard; Kuschel, Mark; Schwind, Katherine; Wallner, Christian; Meier, Thomas
Siemens Energy, Germany

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ID: 1172

C4FN mixtures solutions for metal-enclosed switchgear to speed up transition to carbon neutral

keywords: C4FN, Dead-tank, GIS, LCA, SF6-free

JOURJON, Jean-Baptiste
GE Vernova Grid Solutions, France

ID: 1287

Investigation of gas mixtures with GWP < 1 in HVCB development and impact on design choices

keywords: Gas, Mixture, GWP < 1, High Voltage, Circuit Breaker, Decarbonization, Simulations, Tools, Design, Development

Pisu, Francesco; Coppo, Carlo; Srinivasan, Satish; Hunziker, Severin
Pfiffner Messwandler AG, Switzerland

ID: 1289

Evaluation of arc clearing performance for a high voltage circuit breaker using a gas mixture with GWP < 1 for isolation and interruption

keywords: High Voltage, Circuit Breaker, Arc, Clearing, Sulphur Hexafluoride, Natural Origin, Mixture.

Coppo, Carlo; Pisu, Francesco; Hunziker, Severin
Pfiffner Messwandler AG, Switzerland

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Tuesday 13th May **AURORA B+C** **10:30 – 12:30**

SC B5 session #1: Protection, Automation and Control System engineering and design aspects

Session Chair / Moderator: Volker Leitloff (SC B5 Chair, Rte) / Cédric Moors (ELIA).

ID: 1118
Risk Management Optimization for Electric Utilities
keywords: Risk, Protection, Portfolio, CAPEX, OPEX
Siqueira, Iony
Tecnix, Brazil

ID: 1292
Reference Implementation of IEC 61850 and 62351-based Generator Curtailment System with Non-Firm connection Agreements
keywords: IEC 61850, generator, control, IEC 62351, cybersecurity, virtualization
Ueda, Noriyuki
Central Research Institute of Electric Power Industry, Japan

ID: 1300
Six-phase line transmission – why do we need it and how do we do it
keywords: IEC 61850, protection, six-phase, transmission line.
Apostolov, Alexander
OMICRON electronics, United States of America

ID: 1305
PACS Substation Network Monitor Acceptance Tests
keywords: Digital Substation, IEC 61850, Substation Network Monitor, PAC, Process bus
Alexandrino, Mateus (1); Lunardi, Mateus Cruz (1); Scheffer, Rafael Bonet (2); Neto, Carlos de Souza Moraes (2); Ferreira, Adriano de Oliveira (2); Oleskowicz, Bruno Alexandre (2)
1: Eletrobras, Brazil; 2: WEG, Brazil

ID: 1398
EVOLUTION TO CENTRALIZED PROTECTION & CONTROL
keywords: Protection automation, IP/MPLS WAN, Digitization of power substations
Verhulst, Dominique (1); Roodenburg, Rob (2); Hemmer, Peter (3)
1: Nokia; 2: Grid to Great; 3: Grid to Great

ID: 1433
Concept of integrating PACS Project Blueprint design and IEC 61850 Top-Down engineering
keywords: Blueprint Design, IEC 61850, PACS, SCL Model, Top-Down Engineering
Lisboa, Guilhermme (1); Alexandrino, Mateus (2)
1: Belden; 2: Eletrobras

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ID: 1175

The Distributed Control Centre Design Utilizing New Smart Grid Decision-Making and Control Agents for the Future Zero-Carbon Massive Electrification

keywords: Control, Monitoring, Safety, Security, Protection, Reliability, Resilience

Ricardo Bessa (1), Clara Gouveia (1), João Peças Lopes (1,2), Everton Alves (1), Gil Sampaio (1), José Villar (1), David Rua (1), Mladen Kezunovic(3)

Organisation(s): 1: INESC TEC, Portugal; 2: FEUP, Portugal; 3: Texas A&M University, USA

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Tuesday 13th May **COSMOS 1** **10:30 – 12:30**

SC B4 session #1: DC-Hub, DC-Grid & Multi-Terminal HVDC

Session Chair: Dr Vajira Pathirana (Pattern Energy, Canada)

ID: 1136
Review of (co-)design methods for HVDC protection systems
keywords: Co-design, Electrical Energy Hubs, HVDC, Multiterminal, Protection
Van Deyck, Merijn; Mohammadi, Abolfazl; Chaffey, Geraint; Van Hertem, Dirk
KU Leuven & Etch-EnergyVille, Belgium

ID: 1138
An Economical DC-Hub System for Large Scale Renewable Energy Integration in CHINA
keywords: DC-Hub system, diode rectifier unit, economical solution, hybrid T-shape DC/DC converter, renewable energy integration
YANG, Jie (1); WANG, Liangyou (1); YUE, Bo (1); WU, Yanan (2); JIA, Na (1); WU, Wen (1)
1: Beijing Huairou Laboratory, China, People's Republic of; 2: China Electric Power Research Institute

ID: 1141
Influence of MMC control philosophies on Multi-Terminal HVDC Design and Expandability
keywords: Multi-terminal HVDC grids, MMC control philosophies, DC Protection design, Virtual Capacitance Control, DC grid expandability
ZAMA, Ahmed (1); VAN DOORN, Joris (2); LU, Liang (3); NEUFELD, Alexander (3); SHINODA, Kosei (1)
1: SuperGrid Institute, France; 2: TenneT TSO B.V, Nederland; 3: Energinet, Denmark

ID: 1143
DC Grid Control and Communication Architecture of MTDC
keywords: Control and Protection, DC Grid Controller, HVDC, MTDC
Jiang Häfner, Ying (1); Sebastian C, Richu (2); Vattigunta, Rakesh Reddy (2); Gozdz-Englund, Simon (1)
1: Hitachi Energy, Sweden; 2: Hitachi Energy Technology Services Pvt Ltd, India

ID: 1297
Expandability of DC Grid Control and Sequencers for Offshore Multi-Terminal HVDC Networks – a North Sea Wind Power Hub pre-FEED study
keywords: DC GRID, HVDC, MULTI-TERMINAL, CONTROL, SEQUENCES, WIND POWER
Love, Geoff (1); Kho, Denis (1); Düllmann, Patrick (2); Klein, Christopher (2); Tackenberg, Vincent (3); Bose, Anurag (4); Randewijk, Peter Jan (4)
1: EPRI, Europe; 2: IAEW at RWTH Aachen University, Germany; 3: TenneT TSO GmbH, Germany; 4: Energinet, Denmark

ID: 1309
Analysis of technical requirements on multi-terminal ready HVDC systems
keywords: HVDC, MTDC, Multi-terminal
Kurth, Benedkt (1); Linden, Kerstin (2); Hytinnen, Mats (2)
1: Hitachi Energy Germany AG, Germany; 2: Hitachi Energy Sweden AB

ID: 1359

Feasibility Assessment of Offshore Energy Hub Topologies

keywords: Offshore Energy Hubs, Offshore Wind Power, HVDC Grids

Figueiredo Gontijo, Gustavo (1); Müller, Daniel (2); Nuhic, Mirza (2); Hjerrild, Jesper (1)
1: Ørsted Wind Power A/S; 2: Technical University of Denmark

ID: 1412

Offshore Wind Power Plants and Energy Hub Integration

keywords: Offshore Energy Hubs, Offshore Wind Power Plants, High Voltage, Direct Current, Grid Codes, Grid Connection

Kamenica, Matin (1); Müller, Daniel (1); Pagnani, Daniela (2); Cutululis, Nicolaos A. (1)
1: DTU, Denmark; 2: Ørsted A/S

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Tuesday 13th May **COSMOS 2** **10:30 – 12:30**

Joint SC C2/C4 session: **Power System Stability in Inverter Dominated Grids**

Session Chair / Moderator: **Vinay Sewdien (Microsoft) / Emil Hillberg (RISE)**

ID: 1388
Optimizing Transmission for Renewable Integration - Indian Perspective
keywords: Decarbonization, Grid Optimization, Grid Stability, Inter-State Transmission System, Independent Energy Storage Systems, Variable Renewable Energy
Fahad, Shekh Mohammad; Pandey, Bhanu Prakash; Kant, Laxmi; Bagadia, Vikas; Pal, Ashok
Power Grid Corporation of India Limited, India

ID: 1320
Grid Stability Challenges with the Integration of Large Quantum of VRE in Close Proximity in the Indian Power System
keywords: Renewable, Resiliency, Stability, Fault ride through, Low voltage ride through, High voltage ride through, Forecasting, System Strength
Jain, Priyam; Prakash, Abhijeet; Dash, Gaurab; Meena, Priyanka; Malviya, Gaurav; Shukla, Rahul; Pandey, Vivek
Grid Controller of India Ltd., India

ID: 1234
Substation reliability when connecting large wind farms
keywords: Busbar Protection, Circuit Breaker Failure, Event Tree, Fault Tree, Offshore, Reliability, Substation, Wind Power
KOHO, Jyrki; HAARLA, Liisa
Fingrid Oyj, Finland

ID: 1173
Coordination and arbitrage related to the insertion of Renewable Energy Sources
keywords: arbitrage, coordination, insertion, organisation, renewable energy sources, requirements, utility
Leitloff, Volker; Sermanson, Vincent; Vernay, Yannick; Perrin, Sylvie
Rte, France

ID: 1267
Dynamic Security Assessment (DSA) application in Vietnamese power system to increase the power transfer limit and operate power system stably with a high share of renewable energy sources
keywords: Dynamic Security Assessment, Renewable, TSA, Transfer Limit, VSA
Nguyen, Duc Ninh; Pham, Quynh; Vo, Minh Long; Nguyen, The Van; Duong, Tuan Anh; Cao Anh Quoc, Hung; Phung, Dang Huy; Le, Van Thong; Tran, Trong Tuan
National power system and market operator company limited, Vietnam

ID: 1456

Transient stability behaviour in the north-south/southeast transmission corridor in Brazil under critical contingency scenarios and online global inertia monitoring

keywords: Global Inertia, Transient Lyapunov Energy Function, Real-Time Decision Making, Transient Stability

Fernandes, Rafael de Oliveira (1); Cardoso, Igor de Siqueira (2); Tavares, Maria Cristina Dias (3); Gomes, Paulo (4)
1: UNICAMP; 2: ONS, Brazil; 3: UNICAMP; 4: PSQ Power Security & Quality

ID: 1227

Transfer Capability Increase with TCSC in the German Transmission System

keywords: Emergency Power Control (EPC), Fixed Series Capacitor (FSC), Power flow control, Sub-synchronous Resonances (SSR), Thyristor Controlled Series Capacitor (TCSC).

WASSERRAB, ANDREAS (1); ENGELBRECHT, TOBIAS (1); HÖHN, SEBASTIAN (1); MÜLLER, JOHANNES (1); VAIDYA, LAKSHMI (2); KUMAR, HEMANT (2); LATORRE, HECTOR (2)
1: TenneT TSO GmbH, Germany; 2: HITACHI ENERGY, Sweden

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Tuesday 13th May **COSMOS 3** **10:30 – 12:30**

SC C6 session #1: DER impact on Distribution Systems
Session Chair : Dr Merkebu Degefa (University of Stavanger)

ID: 1317
Lessons from DER Integration in Australia
keywords: DER, Integration, Australia, Backstop, Hosting, Rooftop PV
Brown, Ray (1); Gannon, Jennifer (2)
1: RBPE, Australia; 2: Energy Queensland Ltd, Australia

ID: 1486
Enabling Large Scale Deployment of LV (Low-Voltage) Connected Solar on the Distribution Network in Ireland
keywords: Distributed energy resources (DER), Low voltage (LV), Solar energy, Network capacity, Empowered Customers, Renewable Energy.
Yasir, Muhammad; Foody, Thomas; Kingston, Paul
Electricity Supply Board (ESB) Networks, Ireland

ID: 1132
Evaluation of voltage fluctuations due to PV output fluctuations in a distribution system with low voltage stability
keywords: Voltage Fluctuations, Voltage stability, DER, PV, Distribution System
Kondo, Fusakazu; Urasaki, Shogo; Takahashi, Naoyuki; Hatta, Hiroyuki
Central Research Institute of Electric Power Industry, Japan

ID: 1167
Current state of dynamic hosting capacity allocation in Australia
keywords: Dynamic, hosting capacity, operating envelope, distributed energy resource, CSIP-AUS
Gannon, Jennifer; Guinman, Alex
Energy Queensland, Australia

ID: 1186
Surge in EV Adoption Among Danish Households: Challenges for the Low-Voltage Distribution Grid
keywords: EV fleet growth, Grid challenges, Low voltage distribution network, Smart charging infrastructure, Static & dynamic simulation
Sinha, Rakesh (1); Zhang, Hanchi (1); Golmohamadi, Hessam (1); Chaudhary, Sanjay (1); Bak-Jensen, Birgitte (1); Donnerup, Morten Veis (2)
1: Aalborg university, Denmark; 2: Neogrid Technologies

ID: 1265
Voltage Droop Control Using Probabilistic and Sensitivity Analysis in AC/DC Hybrid Distribution Network
keywords: AC/DC distribution network, Probabilistic, Sensitivity Analysis, Voltage Droop Control.
Lim, Saehwan; Jeong, Soseul; Yoo, Hyeong-Jun; Kim, Chulwoo; Kim, Gyeong-Hun; Jeon, Jin-Hong
Korea Electrotechonology research institute, Korea, Republic of (South Korea)

ID: 1318

Evaluation on contribution of DERs to distribution networks dealing with the effect of energy transition

keywords: DERs, Congestion mitigation, System analysis

Okura, Hiroyuki (1); Minami, Masahiro (1); Yoshioka, Takumi (1); Anegawa, Takaya (1); Sakamoto, Takuya (1); Yoshizawa, Shinya (2); Yamaguchi, Yohei (2); Uchida, Hideaki (2); Ota, Yutaka (2); Shigematsu, Tomoki (2)

1: Kansai Transmission and Distribution, Inc.; 2: Osaka University

ID: 1338

Optimization of supermarket consumption using cooling machine flexibility

keywords: Demand response, flexibility, optimization, smart supermarket

Kotu, Lasya Priya (1); Iversen, Elisabeth Ottesen (1); Vik, Tiril Berge (1); Rørvik, Ella-Lovise Hammervold (2); Rajasekharan, Jayaprakash (1); Lindberg, Karen Byskov (1)

1: Norwegian University of Science and Technology, Trondheim, Norway; 2: Aneo AS, Trondheim, Norway

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Tuesday 13th May **AURORA A** **13:30 – 15:30**

SC A3 session #2: Transformers and Instrument Transformers
Session Chair / Moderator: Paolo Mazza (RSE) / Nicola Gariboldi (SC A3 Chair, Qualitrol)

ID: 1363
New component designs and technologies to maximize grid resilience and system lifetime
keywords: Bushing, HVDC, Instrument Transformer, Resilience, LPIT, Lifetime
Kaineder, Kurt (1); Prucker, Udo (2); Judendorfer, Thomas (2); Heil, Bernhard (3)
1: Trench Austria, Austria; 2: Trench Germany GmbH; 3: HSP Hochspannungsgeräte GmbH

ID: 1109
Long-term transient signal monitoring at inductive load switching with VCB – objectives and first experiences
keywords: vacuum circuit breaker, CR dividers, switching transients, transient recorder, transient monitoring, LPIT, inductive load switching, shunt reactor
SPERLING, Peter Erik (1); SCHULZE, Roberto (2); TREMPLER, Christian (3)
1: OMICRON, Switzerland; 2: OMICRON, Germany; 3: 50Hertz Transmission GmbH, Germany

ID: 1168
Combined Power Voltage Transformers – a Novel Product Category
keywords: Biodegradable Liquids, Combined Power Voltage Transformer, Rural Electrification, Compact Substation, Carbon Footprint
NENADIĆ, MARIJANA (1); ŽIGER, IGOR (1); CRNKOVIĆ, IVAN (1); JURIŠIĆ, BRUNO (2)
1: Končar Instrument Transformers Inc., Croatia; 2: Končar Electrical Engineering Institute Ltd.

ID: 1242
Quantifying global power transformer demand and supply for grid expansion
keywords: Demand, Forecast, Manufacturing, Power Transformer, Supply Chain
Christoffersen, Edvard; Holmedal, Daniel
Rystad Energy

ID: 1293
Impact of high-powered charging of electric ferries on distribution transformers
keywords: lifetime-estimation, distribution transformers, thermal modelling, electrification
Espedal, Camilla (1); Sadjina, Severin (2); Tveten, Erlend G. (2); Haugen, Stig Julius (3); Myklebust, Rune (3); Eriksen, Pål Egil (4); Eidså, Gerhard (4); Gjørven, André (5); Søholt, Kyrre (6)
1: SINTEF Energi, Norway; 2: SINTEF Nordvest, Norway; 3: Linja, Norway; 4: Elinett, Norway; 5: Mellom, Norway; 6: Møre Trafo, Norway

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Tuesday 13th May **AURORA B+C** **13:30 – 15:30**

SC B5 session #2: Protection implementation experience - schemes, settings & testing
Session Chair / Moderator: Volker Leitloff (SC B5 Chair, Rte) / Cédric Moors (ELIA)

ID: 1127
Successful Testing of commercially-available AI for Protection Relay Setting Calculations
keywords: AI, LLM, Protection relay settings calculations
McGuinness, Sean
EPRI Europe, Ireland

ID: 1177
132 kV power lines - Field tests - High-resistivity ground faults
keywords: Field tests, high ground resistivity, high resistive ground faults, isolated cross-arms, lack of ground wires, power lines, protection, solidly grounding, wooden poles
Goin, Ronny (1); Norberg, Per (2); Sylte, Arnvid (3); Aunemo, Per Morten (1); Kirkvold, Kristoffer (1); Lysheim, Dag Petter (4); Ohnstad, Trond Magne (4); Mangelrød, Ragnar (4)
1: Statkraft Energi AS, Norway; 2: Per Norberg Kraftkonsult AB, Sweden; 3: Tensio AS, Norway; 4: STATNETT SF, Norway

ID: 1248
Mitigating Overreaching in Distance Relays and Addressing Mutual Coupling in Double-Circuit Transmission Lines
keywords: Distance protection, Overreaching, Fault detection, System stability, Transmission Line Protection, mutual coupling
SONI, HARSHKUMAR PRAVINKUMAR; JHA, PANKAJ KUMAR; SHARMA, AKSHAY
POWER GRID CORPORATION OF INDIA, India

ID: 1306
Transforming Differential Relay Communication by Several Strategies for Optimal Fiber Utilization and Reliability: Experiences From Recent Pilot Installations
keywords: Line Differential Protection, Power transmission lines, Multiplexing, Optical fiber, Communication channels
KHURANA, Aman; SHARMA, Akshay; VAISH, Ankit; DUBEY, Anand
Power Grid Corporation of India Ltd., India

ID: 1332
Process bus and LPIT operational experiences from eight Norwegian digital substations
keywords: Substations, pilots, IEC61850, LPIT, time synchronization, modelling tools
Hurzuk, Nargis (1); Pollestad, Karl (2); Istad, Maren Kristine (3); Strømsnes, Svein Morten (4); Andersland, Kjartan (4); Gebs, Christopher (5); Sanchez-Acevedo, Santiago (3); Meyer, Hans Kristian (3)
1: Statnett, Norway; 2: BaneNor, Norway; 3: SINTEF Energy Research, Norway; 4: BKK, Norway; 5: Elvia, Norway

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ID: 1344

Real-Time Field Implementation of Adaptive Single-Phase Auto-Reclosing for EHV Transmission Lines: Lessons Learned

keywords: Overhead transmission lines, Fault detection, Single-phase auto recloser, Power system stability

SURASHE, Sunil; SHARMA, Akshay; DUBEY, Anand; SINGH, Sanjay Kumar
Power Grid Corporation of India Ltd., India

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Tuesday 13th May **COSMOS 1** **13:30 – 15:30**

SC B4 session #2: HVDC Planning, Design, Standardization

Session Chair: Dr. Kamran Sharifabadi (Equinor, Norway)

ID: 1200
Tyrrhenian Link and Adriatic Link – Harmonized Converter Stations for Italian Underwater HVDC Connections
keywords: Converter Station Design, Control and Protection System, System Planning, Environmental Aspects, Commissioning, Expandability
Cortese, Marco (1); Pede, Francesca (1); Deriu, Mattia (1); Hussennether, Volker (2); Lehmann, Markus (2); Priebe, Torsten (2); Sandano, Roberto (2); Krieger, Christian (2)
1: Terna Rete Italia; 2: Siemens Energy Germany

ID: 1221
Operating point dependent DC-FRT requirements in partially-selective MTDC protection - North Sea Wind Power Hub pre-FEED study
keywords: BIPOLAR HVDC, DC PROTECTION, MULTI-TERMINAL, OFFSHORE WIND
Klein, Christopher (1); Düllmann, Patrick (1); Love, Geoff (2); Tackenberg, Vincent (3); Neufeld, Alexander (4); Randewijk, Jan Peter (4); Bose, Anurag (4); Leterme, Willem (1)
1: IAEW at RWTH Aachen University, Germany; 2: EPRI Europe; 3: TenneT TSO GmbH; 4: Energinet

ID: 1225
Trends on Hardware Independent Design and Testing of HVDC Control and Protection Systems
keywords: Control, Hardware-in-the-loop, HVDC, Protection, Software-in-the-loop
Hernandez, Joan; Varshochi, Sadra; Wide, Jonas
Hitachi Energy, Sweden

ID: 1230
DC fault identification in HVDC grids using machine learning algorithms
keywords: High voltage DC grid, DC fault identification, lightning strikes, convolutional neural network (CNN), WaveNet
Zhao, Xiaoyun (1); Wang, Mian (2)
1: University of Erlangen-Nuremberg; 2: Siemens Energy, Germany

ID: 1231
HVDC control system strategy for scalable simultaneously enabled LFSM/FSM-controllers
keywords: Frequency Control, Frequency Sensitive Mode, HVDC, Limited Frequency Sensitive Mode
Pettersson, Martin Per (1,2); Ekestam, Henrik (2); Prescher, Per (3); Bengtsson, Erik (3); Gwoździkowski, Marcin (4)
1: Luleå University of Technology, Sweden; 2: Svenska kraftnät, Sweden; 3: Hitachi Energy, Sweden; 4: Polskie Sieci Elektroenergetyczne, Poland

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ID: 1232

Factory system test program of LFSM/FSM-controllers for an HVDC link

keywords: Factory System Testing, Frequency Control, Frequency Sensitive Mode, HVDC, Limited Frequency Sensitive Mode, Real Time Digital Simulator

Pettersson, Martin Per (1,2); Ekestam, Henrik (2); Prescher, Per (3); Bengtsson, Erik (3); Gwoździkowski, Marcin (4)

1: Luleå University of Technology, Sweden; 2: Svenska kraftnät, Sweden; 3: Hitachi Energy, Sweden; 4: Polskie Sieci Elektroenergetyczne, Poland

ID: 1282

Readiness of USA for 640kV HVDC, considering the most severe single continency

keywords: HVDC, contingency, mesh connections, reliability

Sellick, Rob; Liu, Cory; Reminisetty, Pranay

DNV Energy USA, Inc.

ID: 1426

Planning and Performance Standards for HVDC Systems: Benchmarking of International Practice and Approach for North America

keywords: HVDC, planning, performance, standards, grid code, benchmarking

Del Rosso, Alberto (1); Love, Geoff (1); Sedighizadeh, Mostafa (2)

1: EPRI, USA; 2: Southwest Power Pool, USA

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Tuesday 13th May | **COSMOS 2** | **13:30 – 15:30**

SC C4 session #1: Instability and Oscillations in Inverter Dominated Power Systems

Session Chair / Moderator: Spyros Karamitsos (Scottish Power) / Babak Badrzadeh (Etik Energy)

ID: 1148
Mitigation of Low-Frequency Inter-Area Oscillations Using Grid-Forming Inverters
keywords: Continental Europe synchronous area, Grid-forming inverter, Inter-area oscillation, Renewable energy, Virtual synchronous machine
Zhu, Lin (1); Paz, Benjamin (1); Ramasubramanian, Deepak (1); Farantatos, Evangelos (1); Coletta, Guido (2); Pisani, Cosimo (2); Giannuzzi, Giorgio (2)
1: Electric Power Research Institute; 2: Terna

ID: 1482
Dogger Bank wind farm – HVDC converter control interaction studies
keywords: Control Interaction, EMT, Grid Compliance, HVDC, Offshore Wind, Stability Analysis
Rygg, Atle (1); Sharifabadi, Kamran (1); Villamor, Lila Vazquez (1); Bodal, Sigmund (1); Gjerde, Sverre Skalleberg (1); Kaysers, Christian (1); Shearer, David (2); Elmelid, Charlotte (3); Wijesinghe, Sarath (4)
1: Equinor; 2: Hitachi Energy; 3: Vargronn; 4: SSE Renewables

ID: 1393
Use of Inherent Damping Capability of Thyristor Controlled Series Compensators to Mitigate Wind Sub-Synchronous Controller Interactions in Heavily Series Compensated Networks
keywords: Inherent Damping, Thyristor Controlled Series Compensators, Wind Power Plants, Wind Sub-Synchronous Controller Interactions
Rathnayaka Weerakoon, Dilini Buddhima (1); Karawita, Chandana (1); Suriyaarachchi, Hiranya (1); Annakkage, Udaya (2)
1: TransGrid Solutions, Canada; 2: University of Manitoba, Canada

ID: 1201
Managing Stability in the Future Converter-Dominated Swedish Power System
keywords: converters, stability, impedance, frequency domain
Lennerhag, Oscar; Rogersten, Robert; Hohn, Fabian
Svenska kraftnät, Sweden

ID: 1472
Overview of new transient phenomena arising in power system due to energy transition – EMT analysis of resonance in HVDC-MMC link connected to AC grid
keywords: HVDC-MMC, resonance, non-linearity, overvoltage, EMT simulations
Filipovic-Grcic, Bozidar (1); Xemard, Alain (2); Radecic, Iva (3); Stipetic, Nina (1); Vukovic, Franjo (1); Akiki, Paul (2); Jurisic, Bruno (3)
1: University of Zagreb Faculty of Electrical Engineering and Computing, Croatia; 2: EDF R&D, France; 3: KONČAR – Electrical Engineering Institute, Croatia

ID: 1278

Suitable Classification of Power System Stability Phenomena

keywords: Classification, Power system, Stability

Lindner, Marco (1); Abele, Hans (1); John, Christoph (1); Lehner, Joachim (1); Vennemann, Klaus (2); Hennig, Tobias (2); Dimitrovski, Robert (3); Klötzl, Nico (3); Just, Hendrik (4); Stornowski, Reinhard (4)
1: TransnetBW GmbH, Germany; 2: Amprion GmbH, Germany; 3: TenneT TSO GmbH, Germany; 4: 50Hertz Transmission GmbH, Germany

ID: 1314

Process for Diagnosis of Observed Oscillations in IBR-dominant Systems

keywords: Oscillations, Damping, Forced Oscillations, Natural Oscillations, Inverter Based Resources

Miller, Nicholas
HICKORYLEDGE LLC, United States of America

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Tuesday 13th May **COSMOS 3** **13:30 – 15:30**

SC C6 session #2: Microgrid and BESS applications
Session Chair : Prof. Belgin Turkay (Istanbul Technical University)

ID: 1214
Leveraging Household Flexibility to Optimize Microgrid Efficiency and Resilience
keywords: Resilience, Microgrid, Flexibility, Household
Sjoberg, Niklas (1); Berlin, Arne (2); Bobeck, Kristin (2)
1: Sapio AB, Sweden; 2: Vattenfall Eldistribution AB, Sweden

ID: 1272
A Case Study of Protection of an LV Microgrid
keywords: Microgrid, Low voltage, Protection, BESS
Brown, Ray
RBPE, Australia

ID: 1164
Utilization of Grid Storage Batteries in Rural Microgrid Areas
keywords: Hydroelectric generator, Microgrid, Rural area, Storage battery, PV
Higashi, Yosuke (1); Kawakita, Koji (1); Wada, Hideki (1); Yamada, Shohei (1); Yoshino, Makoto (2); Arikawa, Seiji (2); Hirose, Kazumasa (2)
1: Chubu Electric Power Grid Co., Inc., Japan; 2: AICHI ELECTRIC CO., LTD., Japan

ID: 1181
Cognitive Robust Optimization for Resilient Energy Storage Operation in Ports: A Case Study from Hirtshals
keywords: Resiliency, Flexibility, Robust management, Operation, Prediction
Ghaemi, Sina; Golmohamadi, Hessam; Anvari-Moghaddam, Amjad; Bak-Jensen, Birgitte
Department of Energy (AAU), Aalborg University

ID: 1465
Loss-of-Mains Protection for DER in Australia
keywords: Loss of Mains, Protection, DER, PV Integration
Brown, Ray
RBPE, Australia

ID: 1222
Current protective coordination in off-grid supplied from inverter power sources
keywords: Off-Grid, Inverter, Protection, Relay, Short Circuit, Over Current
Anegawa, Takaya (1,2); Ishigame, Atsushi (1); Takayama, Satoshi (1); Yoshioka, Takumi (2)
1: Osaka Metropolitan University; 2: Kansai Transmission and Distribution, Inc., Japan

ID: 1264

Resilient Microgrids by using Grid Forming Inverters with Rooftop Solar PV and Battery Energy Storage Systems (BESS)

keywords: Battery Energy storage system, Grid Forming inverter, Microgrids, resilient grid, Solar PV

singh, kiran (1); Pankaj, Sharma (2); D K, Javeri (3); Naveen, Srivastava (4)
1: POWERGRID, India; 2: POWERGRID, India; 3: POWERGRID, India; 4: POWERGRID, India

ID: 1436

Simulating Degradation Costs in Li-ion Battery Dispatch: Impacts on Planning and Operational Strategies

keywords: aFFR, BESS arbitrage, Degradation, Li-ion, MILP

Agrela, João Carlos (1,2); Abreu, Tiago (1,2); Silva, Ricardo (1); Soares, Tiago (1,2); Gouveia, Clara (1)
1: INESC TEC - Institute for Systems and Computer Engineering, Technology and Science, Portugal; 2: FEUP - Faculty of Engineering, University of Porto

ID: 1445

Systematic literature review for application of BESS as grid forming: current issues, challenges, and future trends

keywords: BESS, Grid Forming, Distributed Energy Resource, Artificial Intelligence, Predictive Models

Fernandes, Rafael de Oliveira (1); da Silva, Ivan Nunes (2)
1: Equans, France; 2: USP, Brazil

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Tuesday 13th May **AURORA A** **16:00 – 18:00**

SC C3 session #1: Integrating sustainability criteria into network planning, project design and construction

Session Chair / Moderator: TBA

ID: 1115

Network Planning and Decision-Making under Uncertainty

keywords: Energy transition, Knowledge sharing, Network Planning, Sustainable grid development, UN Sustainable Development Goals

Ackeby, Susanne (1); Hamon, Camille (2); Lindqvist, Helena (3); Olofsson, Magnus (4); Hillberg, Emil (1)

1: RISE, Sweden; 2: Sweco; 3: LightSwitch; 4: Swedish Energy Institute (Svenska Energiinstitutet)

ID: 1396

Energy infrastructure sustainable planning using Pathfinder

keywords: Electricity grid, Sustainability, Planning Process, Grid resilience, Routing, Trasmission Lines, Environmental Costs, Environmental Constraints

Maira, Albano (1); Stefano, Grassi (2); Rivabene, Nicoletta (1); Di Tullio, Lorenzo (1)

1: Terna S.p.A., Italy; 2: Gylitics A.G. Switzerland

ID: 1429

Planning the future power grid for the energy transition: routing through multicriterial Geographical Information Systems (GIS) modelling

keywords: Energy transition, Power lines, Routing, GIS, Environmental Impact Assessment

Lopes, João (1); Varela, João (1); Parada, Francisco (1); Matos, Nuno (2); Salvador, Isabel (2)

1: REN, Portugal; 2: Matos, Fonseca & Associados

ID: 1226

Principles of Sustainable Development in Multi-Criteria Selection of Tower Types for the Development of a 400 kV Transmission System Network

keywords: Sustainable development principles, Multi-criteria optimization, 400 kV Overhead lines, Towers

Curovic, Nada (1); Milanov, Ivan (2); Perisic, Dana (2)

1: EMS, Serbia; 2: Elektroistok projektni biro

ID: 1244

THE MANAGEMENT OF ELECTRICALS LINES CORRIDORS IN SENEGAL : H–P O EXAMPLE

keywords: Corridors, occupations, electricals lines, cohabitation, urban growth

NDIAYE, CHEIKHOU OUMAR

SENELEC, Senegal

ID: 1212

LCA and ECI as a tool for sustainable procurement

keywords: Environmental Cost Indicator, Corporate Social Responsibility, Sustainable Procurement, Life Cycle Assessment

Swinkels, Garnt; Hendriks, Ronald
TenneT TSO, Netherlands, The

ID: 1440

Towards a Sustainable and Resilient Power Grid: Implementing Circular Economy Principles and Practices

keywords: Corporate Social Responsibility, Resilience, Circular Economy, Ecodesign, Sustainable Procurement, Life Cycle Assessment, Transparency, Reliable Data, Traceability, Raw Material Digital Passport, Regulation

MANTILLA, Marcela; PRIEUR, Pascale; LAFRAGETTE, Amelie
RTE, France

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Tuesday 13th May **AURORA B+C** **16:00 – 18:00**

SC B5 session #3: Impact of Renewable Energy Sources and Inverter Based Resources on Network Protections

Session Chair / Moderator: Volker Leitloff (SC B5 Chair, Rte) / Nirmal Nair (University of Auckland)

ID: 1146
Transitioning to differential protection for offshore wind collector cables using passive sensing
keywords: Offshore wind, cables, differential protection, passive sensing
Blair, Steven (1); Chandran, Aneesh (1); Kasztenny, Bogdan (2); Tsylin, Alexander (3)
1: Synaptec, United Kingdom; 2: SEL, Canada; 3: Ørsted, Denmark

ID: 1171
Addressing Transmission Congestion in India's Renewable Energy Rich Grid using System Integrity Protection Schemes (SIPS)
keywords: Grid Stability, RE Integration, Surge Impedance Loading (SIL), System Integrity Protection Schemes (SIPS), Transmission Congestion
JHA, Pankaj Kumar; SINGH, Brijendra; DAS, Jiten; SAHU, Kuleshwar
Power Grid Corporation of India Ltd., India

ID: 1180
Impact of Inverter-Based Resources on Power System Protection and Coordination in India's Renewable Energy-Rich Grid
keywords: Directional Earth Fault, Distance Protection, Grid Disturbances, Inverter-Based Resources (IBR), Protection Coordination, RE Integration
Jha, Pankaj Kumar; Singh, Brijendra; DAS, Jiten
Power Grid Corporation of India Limited, India

ID: 1245
Relay Protection for Offshore Export Cables, Challenges and Solutions
keywords: Offshore Wind Farm, Submarine Cable, Differential Protection, Distance Protection, Directional Protection
Tsylin, Alexander (1); Graumann Moser, Asmus (1); Gajić, Zoran (2)
1: Ørsted, Denmark; 2: Hitachi Energy, Sweden

ID: 1298
Improving the Transmission Line Protection for Systems with High Penetration of IBRs
keywords: IBR, protection, transmission line.
Apostolov, Alexander
OMICRON electronics, United States of America

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Tuesday 13th May **COSMOS 1** **16:00 – 18:00**

SC B4 session #3: Energy Storage, HVDC Auxiliary Equipment and Components

Session Chair: Dr Taosha Jiang (Beijing Huairou Laboratory, China)

ID: 1135
Arm equivalent circuit based and average arm model of a DC MMC branch including distributed energy storage submodules to integrate energy storage in HVDC system
keywords: High voltage direct current, Multilevel converter, Energy storage, Energy storage submodules, Dc-dc converter, Modelling, Electromagnetic-transients program, Power losses
Ouoba, Sidlawendé (1); Errigo, Florian (1); Farias de Barros, Heitor (1); Zama, Ahmed Islam (1); Sau Bassol, Joan (1); Morel, Florent (1); Rault, Pierre (2); Benchaïb, Abdelkrim (1); Bourgeat, Xavier (2)
1: SuperGrid Institute, France; 2: RTE, France

ID: 1154
On operation of renewable source and battery energy storage system integrated to the VSC-based HVDC technology
keywords: Voltage Source Converter (VSC), Coordinated control, Grid forming control (GFM), Grid following control (GFL), High Voltage DC (HVDC) Transmission, Solar PV, Battery Energy Storage (BESS) System
K, VINOTHKUMAR (1); REDDY, AVINASH (1); HAFNER, YING JIANG (2); PONGIGLIONE, PAOLA (3)
1: HITACHI ENERGY TECHNOLOGIES PRIVATE LIMITED, CHENNAI, India; 2: HITACHI ENERGY SWEDEN AB, LUDVIKA, SWEDEN; 3: HITACHI ENERGY, ITALY SPA

ID: 1199
Real-Time Verification of Digital Twin VSC Models for Loss Analysis by Calorimetric Measurement
keywords: Calorimetry, Digital Twin, Efficiency, Electrical Modelling, HVDC, Measurement, MMC, Real-Time, Thermal Modelling
Bernet, Daniel; Lange, Julian; Schmitt, Daniel; Wang, Yeqi
Siemens Energy Global GmbH & Co. KG, Germany

ID: 1304
HVDC circuit breaker reliability and availability model
keywords: HVDC, Multi-terminal, Circuit Breaker, Reliability, Availability
Wu, Jiayang (1); van Nieuwstadt, Saskia (2); Plet, Cornelis Arie (3); Vaessen, Peter (2)
1: DNV, Netherlands; 2: Technical University Delft; 3: DNV, Canada

ID: 1331
Basic Considerations - HVDC Circuit Breaker Reactor
keywords: reactor, HVDC, VSC, DC breaker, DC grid
Pointner, Klaus (1); Westerweller, Thomas (2); Monni, Taneli (1); Dopplmair, Peter (1)
1: Trench Austria GmbH, Austria; 2: Siemens Energy Global GmbH, Germany

ID: 1368

Mutual Short-Circuit Coupling of Air-Core Dry-Type Reactors in HVDC schemes

keywords: HVDC, Dry-type, Series Reactors, Short-Circuit, Station, Layout, Mutual, Coupling, Equipment design

Gaun, Alexander; Fröhlich, Bernhard; Katzensteiner, Johannes; Wirth, Stefan
Coil Innovation Gmbh, Austria

ID: 1373

Assessment of vulnerabilities in the transition to SF6-free coupled onshore and offshore power grids

keywords: Circuit breaker, Converter, HVDC, Hybrid AC-DC grids, Reliability, Resilience, Vulnerability

Sperstad, Iver Bakken; Vistnes, Matias; Treider, Thomas
SINTEF Energy Research, Norway

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Tuesday 13th May | **COSMOS 2** | **16:00 – 18:00**

SC C4 session #2: Dynamic Performance of Power Systems in the Energy Transition

Session Chair / Moderator: Yannick Vernay (RTE) / Oscar Lennerhard (Svenska kraftnät)

ID: 1411
Impact of Voltage Difference between IBRs and Point of Interconnection on Design and Performance of Renewable Plants
keywords: Renewable, Collector system, Voltage drop, Low voltage ride through, High voltage ride through
Kishan, Raj; Jain, Priyam; Dash, Gaurab; Singh, Gaurav; Saha, Arpan; Shukla, Rahul; Pandey, Vivek
Grid Controller of India limited, India

ID: 1163
Investigation of Inertia Services on Grid Stability with Low-Inertia Systems in Victoria
keywords: Victorian Network, AEMO, Low Inertia, Inertia Services, Grid Forming Inverters, Grid Following Inverters, Synchronous Generators, Synchronous Condensers, EMT Modelling, System Planning, System Strength
Srimannarayanan, Shriramaprasad; Caspersz, Nathan
AEMO, Australia

ID: 1256
Stability Analysis of Grids with a High Share of IBRs – Evaluation of Parametric Interdependencies
keywords: Electromagnetic Transients, Grid-Forming, Grid Planning, IBR, System Stability
Wenig, Simon (1); Barth, Daniel (1); Haeusler, Kristof (1); Goertz, Max (1); Just, Hendrik (2); Kuechler, Sebastian (2); Schoell, Christian (3); Lindner, Marco (3); Stenzel, Daniel (4); Vennemann, Klaus (5); Knechtges, Martin (5)
1: Mosaic Grid Solutions GmbH, Germany; 2: 50HertzTransmission GmbH, Germany; 3: TransnetBW GmbH, Germany; 4: TennetTSO GmbH, Germany; 5: Amprion GmbH, Germany

ID: 1349
Comparison Between Synchronous Condensers and Grid Forming BESS in Providing System Strength Support to IBRs in Weak and Strong Power Systems Using EMT Simulation
keywords: Grid Forming Battery, IBR, Synchronous Condenser, System Strength
Aghanoori, Navid (1); Peiris, Jahan (1); Steinfeld, Jesse (1); Yong Kwen Chong, Jeffrey (1); Wang, Yunbo (2); Weaver, Chris (1); Liang, Xinyu (2); Ranmanna Dewayalage, Imanka (1); Zhao, Jinping (1); Arayamparambil Vinaya Mohanan, Vishnu (1)
1: Transgrid, Australia; 2: Manitoba Hydro International

ID: 1471
Optimal Power Supply Strategy for a Near Shore Archipelago in NEOM
keywords: Interconnection, Island, Grid, Reliability, Transmission
Bhattarai, Roshan
NEOM Energy & Water (ENOWA), Saudi Arabia

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Tuesday 13th May **COSMOS 3** **16:00 – 18:00**

SC C6 session #3: DER integration in Active Distribution Networks
Session Chair : David Lundback (Vattenfall)

ID: 1169
Modeling Market Participation of Energy Storages in a Renewable Power System Through Loop Block Orders
keywords: Block Orders, Storages, Market, Offering
Wirtz, Peter; Moehrke, Fabian; Moser, Albert
Institute for High Voltage Equipment and Grids, Digitalization and Energy Economics, RWTH Aachen University, Germany

ID: 1149
Development of Distribution System and Market Operations in South Africa
keywords: South Africa, distribution system operator (DSO), distribution markets, decarbonisation
Pandarum, Aradhna
The Impact Catalyst, South Africa

ID: 1204
Value of demand-side flexibility by reducing grid loss costs
keywords: CINELDI Reference Grid, Flexibility, Grid Loss, Power Flow Analysis
Grøtan, Åshild; Stevik, Tor Kristian; Nygård, Heidi S.
Norwegian University of Life Sciences (NMBU)

ID: 1207
Sector integration including hydrogen, EV, energy hubs, DER
keywords: Sector Integration, Carbon-Neutral, Electric Vehicles (EVs), Energy Hubs, Distributed Energy Resources (DERs)
DHAKA, BHUPINDER; KALA, AMANDEEP
Power Grid Corporation of India Limited

ID: 1266
Enabling adoption of offshore wind coupled with Green Hydrogen innovation
keywords: Efficiency, Green Hydrogen, Green Ammonia, Offshore wind, Offshore hydrogen
singh, kiran (1); Pankaj, Sharma (2); D K, Javeri (3); Naveen, Srivastava (4)
1: POWERGRID, India; 2: POWERGRID, India; 3: POWERGRID, India; 4: POWERGRID, India

ID: 1364
Leveraging AI techniques to deploy ACOPF as a routine operational practice in the distribution network: A state-of-the-art analysis
keywords: Artificial Intelligence, Distribution Network, Optimal Power Flow
Zubair, Ahmad Opeyemi; Degefa, Merkebu Zenebe
University of Stavanger, Norway

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ID: 1353

Smart Energy Meters: a tool for near Real-Time Monitoring of Voltage Stability in Low Voltage Grid with Distributed Energy Resources

keywords: Distributed Energy Resources, Load Flow, LV Grid, Net Metering, Renewable Integration, Simulation, Smart Energy Meter, Voltage Stability

Agarwal, Vineeta; Soni, Ramkishor; Gupta, Ashish; Chakraborty, Ankur
Power Grid Corporation of India Limited, India

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Wednesday 14th May: Technical Paper Sessions (ii)

Wednesday 14th May **AURORA A** **08:00 – 10:00**

SC B2 session #1: Towers and foundations design and maintenance

Session Chair / Moderator: João B.F.G. da Silva (Paranaíba Transmissora de Energia SA, Brazil) / Boris Adum (Statnett, Norway).

ID: 1176
60 Days of Excellence: Balancing Speed, Sustainability, and Success in the Neemuch-Mandsaur Transmission Line Project".
keywords: Exceptional project Management, Effective Teamwork, Environmental Conservation Innovative problem solving, Safety Considerations.
RAI, Kumar Pankaj, Abhishek, GUPTA Rajesh Kumar
POWERGRID corporation of India limited, India

ID: 1189
Adaption of Electric Tower Ascender Equipment for Transmission Line Construction Work
keywords: Ascender, Construction, Maintenance, Restoration, Safety-work, Work-efficiency
HOTTA, Shinji (1); ONODERA, Toshiyuki (1); FUJIMOTO, Yoichi (2)
1: Tohoku Electric Power Network co., inc., Japan; 2: Toasu inc. Japan

ID: 1271
Study on Seismic Control Retrofit of Power Transmission Tower by Pantograph Damper
keywords: Earthquake Response Analysis, Equivalent Damping Rate, Pantograph Damper, Transmission Tower, Vibration Control Retrofit
YAMAZAKI, Motoyuki; TANAKA, Keigo; OSONO, Tomoaki; KAWAMURA, Tomoaki; SHIRAISHI, Tomonori
TEPCO POWER GRID Inc., Japan

ID: 1356
Evaluation of Stresses in Critical Members of Transmission Line Towers During Prototype Testing Using Wired and Wireless Strain Gauges
keywords: Realtime Monitoring, Strain Gauges, Strain measurement, Structural integrity, Wireless Sensors
ROURIYA, Indra Singh; KUMAR, Satish; SINHA, Nitesh Kumar; SINGH, Raj Kumar; KUMAR, Abhay; BURRA, Vamsi Rama Mohan
Power Grid Corporation of India Ltd, India

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ID: 1357
Parallel Giants: The Twin Steel Poles in Heart of National Capital Region
keywords: Compact Corridor, Crossing, Monopole, Right of Way, Twin-pole, Urbanisation
GAJBHE, Shrikant Govind; SINHA, Nitesh Kumar; SINGH, Manoj Kumar; KUMAR, Abhay; BURRA, Vamsi Rama Mohan
Power Grid Corporation of India Ltd, India

ID: 1358
From Weakness to Strength - Innovating Soil Strength and Corrosion Solutions for Renewable Energy Infrastructure in Creek Salt Pan Area.
keywords: Stone column, plate load test, creek area, soil strengthening, liquefaction
RENU, Bimlesh Kumar; DWIVEDI, Pankaj Kumar; SINHA, Nitesh Kumar; SINGH, Raj Kumar; KUMAR, Abhay; BURRA, Vamsi Rama Mohan
POWER GRID CORPORATION OF INDIA LTD, India

ID: 1381
Navigating the Energy Transition: A Comparative Study of Aging Power Grids in India and the USA
keywords: Infrastructure, Investment, Modernization, Policy, Regulation
JOSEPH, Vipin Jacob; KHAJKUMAR, L K
Power Grid Corporation of India Limited, India

ID: 1386
Use of Monopole & Ultra Narrow base Towers in High RoW area
keywords: Circuit Switching, Caisson Foundation, High Temperature Low Sag Conductor, HTLS, Monopole, Narrow Corridor, RoW, Road Median, Ultra Narrow Base Tower
MAHAJAN, Amit; KALRA, Chandan; KUMAR, Satendra; SURI, Rajesh
Sterlite Power, India

ID: 1395
Advance Design Solution for Transmission Tower Foundations on Steep Slopes
keywords: Steep slopes, Mountainous terrain, Foundation design, STAAD Pro software, Frame structure
DWIVEDI, Pankaj Kumar; PUNDIR, Karanvir Singh; KUMAR, Abhay; BURRA, Vamsi Rama Mohan
POWERGRID Corporation of India Ltd., India

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Wednesday 14th May **AURORA B+C** **08:00 – 10:00**

SC B1 session #1: Insulated Cables -1
Session Chair / Moderator: TBA

ID: 1174
High voltage wet design power cables with aluminum conductor
keywords: high voltage; power cables; XLPE; wet design; aluminum conductor
Hølto, Jorunn (1); Ese, Marit Helen G. (1); Ve, Torbjørn Andersen (1); Hvidsten, Sverre (1); Olsen, Elise (2); Skagemo, Jørgen (2); Haglo, Audun (2); Bengtsson, Magnus (2)
1: SINTEF Energi AS, Norway; 2: Nexans Norway AS

ID: 1187
Compression and bending test on a three-core HV submarine cable with SZ lay-up
keywords: Bending, Compression, Factory joint, High voltage, Inter-Array cable, Mechanical test, Open helix, Submarine cable, Twisting
CASLINI, Francesco (1); MUELLER-SCHUETZE, Sven (1); FAREMO, Hallvard (2); KLÆBO, Frank (2); MIDTTVEIT, Steinar (3); COLLA, Luigi (1); TROLLI, Alessandro (1)
1: Prysmian, Italy; 2: SINTEF, Norway; 3: Equinor, Norway

ID: 1195
Lifetime Estimation based on HVDC Breakdown Strength of Thin Films Peeled from Fresh and PQ-Tested 525 kV DC-XLPE Cables
keywords: Extruded cable insulation, Peelings, HVDC, Lifetime, Electric breakdown
Gerhard, Silas Merlin (1); Mauseth, Frank (1); Hestad, Øystein (1); Doedens, Espen (2); Jarvid, Markus (2)
1: Norwegian University of Science and Technology (NTNU); 2: Nexans Norway AS

ID: 1202
Advanced Pre-Terminated Dynamic Submarine Cables for Floating Offshore Wind Energy
keywords: Fibre Optic Cable Connector, Floating Offshore Wind, Maintenance, Power Core Connector, Pre-Terminated Submarine Cable
Mueller-Schuetze, Sven (1);Bouvier, Nicolas (2); Mangoni, Marzia (3); Betti, Deborah (3); Miyoshi, Maryelen (3); Pistonesi, Alessandro (3)
1: Prysmian, Germany; 2: Prysmian, France; 3: Prysmian, Italy

ID: 1215
Predicting cables temperatures with probabilistic modelling
keywords: Cable, Offshore, Rating, Submarine, Probabilistic, Temperature, Wind
CWIKOWSKI, Oliver (1); OŁDZIEJEWSKI, Rafał (2); PIATEK, Remi (3); THØISEN, Mads (3); GARCIA, Franciso (3)
1: Ørsted, London, (United Kingdom); 2: Ørsted Polska OF Services, (Poland); 3: Ørsted, Copenhagen, (Denmark)

ID: 1249

Vortex Induced Vibrations (VIV) of an Export Submarine Power Cable: A Holistic Approach

keywords: Free Span, Modal Analysis, Subsea Power Cable, Vortex Induced Vibrations, VIV

Delizisis, Panagiotis; Georgopoulos, George; Kopanidis, Anastasios; Pytharouliou, Angelina; Prousanidou, Katerina; Alexandridis, Petros
Asso.subsea, Greece

ID: 1421

Evaluation of PD commissioning tests for Dutch (E)HV land cable systems

keywords: Discharge, Measurement, Test, Onsite, Commissioning

Zuijderduin, Roy (1); van Oosterom, Jozua (1); Hermans, Theo (2); Janssen Klomp, Henning (3); Corjanus, Robin (3)
1: TenneT TSO B.V.; 2: Prysmian; 3: Qirion B.V.

ID: 1435

Impact of MVDC cables on the energy transition

keywords: Cable, MVDC, testing, transfer capacity

Schichler, Uwe (1); Ratheiser, Patrik (1); Lapthorn, Andrew (2); Stewart, Brian (3)
1: Graz University of Technology, Austria; 2: University of Canterbury, New Zealand; 3: University of Strathclyde, Great Britain

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Wednesday 14th May **COSMOS 1** **08:00 – 10:00**

SC C2 session #1: System Operational Challenges and Experiences with Integration of Renewables

Session Chair / Moderator: Renuka Chatterjee (SC C2 Chair, US) / Greg Hesse (AU).

ID: 1101
21 GW offshore wind power in Norwegian waters by 2040. System effects of demand elasticity and grid topology.
keywords: offshore wind, demand-response, transmission grid, North Sea
Steiro, Hanna (1); Korpås, Magnus (1); Andresen, Christian Andre (2)
1: NTNU, Norway; 2: SINTEF ENERGI AS, Norway

ID: 1205
Virtual multi-camera sky images for regional solar irradiation forecasts
keywords: Multi-camera systems, Photovoltaic systems, Regional prediction, Renewable energy forecasting, Solar irradiance forecasting
Jakoplić, Alen (1); Franković, Dubravko (2); Plavšić, Tomislav (1); Dobraš, Branka (1)
1: Faculty of Engineering, University of Rijeka, Rijeka, Croatia; 2: Croatian Transmission System Operator (HOPS) Zagreb, Croatia

ID: 1113
Experience from the Nordic Market for Balancing Capacity
keywords: Balancing Capacity, Bidding Formats, Exchange, Pricing, Social Welfare
Stenkløv, Inge (1); Doorman, Gerard (2); Möhr, Jan (1); Bräuner, Line Kamp (3); Hausken, Magnus (4)
1: Statnett SF, Norway; 2: Norwegian University of Science and Technology; 3: Energinet Elsystemansvar A/S; 4: Optimeering AS

ID: 1184
Analysis of Economic Incentives and Historical Frequency Deviations in the Nordic Power System
keywords: Economic Incentives, Grid Stability, Frequency Control, Electricity Market, Statistical Analysis.
Rajeh, Haya; Max, Lena; Agneholm, Evert
University West, Sweden

ID: 1350
Multi-year Evolution of the Energy Balance to Optimize the Integration and Operation of Renewable Energy Sources
keywords: Energy System Analysis, Power System Operation, Power System Simulation, Renewable Energy Integration, Renewable Energy Sources
Cuccia, Paolo; Tisti, Pietro; Epifani, Mariella; Papate, Angela; Mosca, Carmelo
Terna Rete Italia, Italy

ID: 1313

Solutions for calculating and monitoring minimum operational configuration of thermal power sources on planning software and real-time SCADA/EMS systems in the context of high renewable penetration

keywords: Mininal Thermal Power plants, real-time SCADA/EMS System, Monitoring

Vu, Xuan Khu; Do, Huy Hoang; Pham, Quynh; Phung, Dang Huy; Lai, Viet An; Le, Van Thong; Nguyen, The Van; Tran, My Hung; Vo, Viet Thang; Nguyen, Ngoc Han
National power system and market operator company limited, Vietnam

ID: 1371

Transmission Expansion in Energy System Optimization Models - a Comparative Study

keywords: Alternating Current, Direct Current, Energy System, Electricity Grid, Expansion, Infrastructure, Investments, Linear, Mixed-Integer, Optimization, Power Flow, Planning, Transmission

Fischer, Lina; Ziwes, Lutz; Houben, Raphael; Moser, Albert
Institute of High Voltage Equipment and Grids, Digitalization and Energy Economics, RWTH Aachen University, Aachen, Germany

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Wednesday 14th May **COSMOS 2** **08:00 – 10:00**

SC C4 session #3: Power Quality, Transients and EMC Challenges in the Energy Transition

Session Chair / Moderator: Peet Schutte (DNV) / Andreia Leiria (EDP Labelec)

ID: 1213
System strength impact on harmonic voltage management in transmission systems in relation to IBR (Inverter Based Resources) connections
keywords: system strength, harmonic compliance assessments, harmonic impedance polygons, Inverter Based Resources
Jayatunga, Dr. Upuli (1); Herath, Dr. Chandana (1,2); Peiris, Mr. Kasun (1); Geddey, Dr. Don (1); Peiris, Dr. Jahan (1)
1: TransGrid, Sydney, NSW 2000, Australia; 2: Energy Corporation of NSW, Sydney, NSW 2000, Australia

ID: 1409
Application of the IEC harmonic allocation framework in an interconnected transmission system: Experiences and Lessons learned
keywords: Harmonics, Limits, Transmission, Meshed, Allocation
Singh, Gaurav Kumar (1); Emin, Zia (1); Meyer, Jan (2)
1: Electric Power Research Institute, United States of America; 2: TUD Dresden University of Technology

ID: 1220
Impact of extreme geomagnetical storm in the Finnish Transmission Grid
keywords: Geomagnetically Induced Current, GIC, Geomagnetic, Disturbance, Power System
Volanen, Ville Esa Akseli
Fingrid Oyj, Finland

ID: 1151
Evaluation of induced voltages occurring during the repair of a high-voltage cable system - A comparison between measurement and simulation
keywords: Cable systems, modelling and simulation, Induced voltages, insulated cables, electromagnetic coupling
Abuaisha, Tareq Saber; Soppe, Bastian; Krokowski, Jan-Nicas; Engel-Kalt, Sebastian; Thomas, Leon; Freye, Claudius; Zhang, Roland Dongping
TenneT TSO GmbH, Germany

ID: 1330
A Statistical Analysis for the Switching Overvoltages in 420kV Siphon Underground Cable Systems: A Study Case in the Norwegian EHV Grid
keywords: Siphon, Insulation Coordination, Sheath Bonding System, Lightning, Switching
MATALLANA, Jerome (1); VELITSIKAKIS, Kostas (2)
1: Statnett, Norway; 2: TenneT, The Netherlands

ID: 1424

Failure Investigation Analysis for Switching Overvoltage Stresses in a Cross-Bonding Joint of a 380kV Siphon Underground Cable System in the Netherlands

keywords: Siphon, Failure Investigation, Sheath Bonding System, Switching Overvoltages, Sheath Voltage Limiter (SVL)

Velitsikakis, Konstantinos; Kumar, Anurag; Faragalla, Marina; Zuijderduin, Roy
TenneT TSO, Netherlands, The

ID: 1337

EMT Studies for 132kV Offshore Wind Farms with HVDC Connection

keywords: Offshore, Overvoltage, Switching, Transient recovery voltage, Wind energy

de Foucaud, Benoît; Michel, Julien; Vu, Thanh
RTE, France

ID: 1152

First Operational Experience With Vacuum Circuit Breakers in Austria - Measurements and Tests on the 110 kV Voltage Level

keywords: Operational experiences, European green deal, F-gas regulation, Switching, Vacuum circuit breaker, CR divider

Hackl, Philipp (1); Schwalt, Lukas (2); Schürhuber, Robert (1); Belavic, Fredi (2); Schöffer, Werner (3); Klambauer, Reinhard (4)
1: Graz University of Technology, Institute of Electrical Power Systems; 2: Austrian Power Grid AG, Austria; 3: Artemes GmbH; 4: Graz University of Technology, Institute of Electrical Measurement and Sensor Systems

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Wednesday 14th May **COSMOS 3** **08:30 – 10:00**

SC D2 session #1: Cybersecurity & Data Protection in Power Grids
Session Chair / Moderator : Victor Tan (SC D2 Chair, VTan Consulting) / Peter Ceferin (SC D2 Review Coordinator and Slovenia Member, Smart Com)

ID: 1102
Cybersecurity in renewable evacuation interconnections
keywords: Renewables, Interconnection, Cybersecurity, Intrusion Detection System
Feijoo-Martinez, Juan Ramon; Castro-Fernandez, Mario
REDEIA, Spain

ID: 1123
Security of Wide-Area Monitoring, Protection, and Control Systems: Evaluation of Stealthy Data Integrity Attacks
keywords: power system, wide-area monitoring, protection, control, cybersecurity, attack, false data injection
Mishchenko, Denys (1); Oleinikova, Irina (1); Erdodi, Laszlo (2)
1: Norwegian University of Science and Technology. Department of Electric Energy; 2: Norwegian University of Science and Technology. Department of Information Security and Communication Technology

ID: 1161
DCDIAS: Decentralized cross-domain identity authentication scheme for numerous power terminal equipment
keywords: decentralization, power business, cross-domain authentication, decentralized identifier
Yao, Shuang; Zhu, Chaoyang; Zhu, Yayun; Hu, Baiji; Zhang, Dahua; Cao, Jingyi; Lin, Ziqing
China Electric Power Research Institute Co., Ltd., China, People's Republic of

ID: 1190
Encrypted Traffic Identification in Power IoT based on One-Dimensional CNN with Batch Normalization
keywords: Encrypted Traffic, Power IoT, CNN, Batch Normalization
Li, Menglin; Zhu, Chaoyang; Zhang, Dahua; Xu, Qiang; Zhu, Yayun; Hu, Lizhi; Hu, Baiji; Yao, Shuang
China Electric Power Research Institute Co., Ltd., China, People's Republic of

ID: 1322
Information Security Laboratory at Power Grid Corporation of India Limited
keywords: Power System Automation, Operational Technology, Cybersecurity, Testbed, Situational Awareness
Sarkar, Sajal; Kumar, Santosh; Tiwari, Yogendra
Power Grid Corporation of India Limited, India

ID: 1326

Asset Inventory Management for Information Security Preparedness

keywords: Asset Inventory, Asset Management, Software/Hardware, Information Security, Information Security Risk

Sarkar, Sajal; ., Ankit

Power Grid Corporation of India Limited, India

ID: 1342

Dataset Manipulation for Cross-Substation Transfer Learning: A Promising Path to Enhanced Cybersecurity

keywords: Cybersecuity, IEC 61850, IEC 62351, Machine learning, Intrusion detection system

Natvig, Filip (1); Ericsson, Göran N. (1); Nordström, Lars (2)

1: Uppsala University, Sweden; 2: KTH - Royal institute of technology

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Wednesday 14th May **AURORA A** **10:30 – 12:30**

SC B2 session #2: Conductors and fittings, crossings, vibrations and icing

Session Chair / Moderator: Kjell Halsan (Statnett, Norway) / Wolfgang Troppauer (Mosdorfer, Austria).

ID: 1233
Wind-induced conductor motion on a long fjord crossing – Preliminary results from a novel measurement approach
keywords: Aeolian Vibration, Damping, Conductor Motion, Crossing, Fjord, Monitoring, Wind, Enhancing Lifespan
ADUM, Boris (1); ROCHA, Pedro H. C. (2); MATENE, Elhacene (2); PARADIS, Jean-Philippe (2)
1: Statnett SF, Norway; 2: PLP CANADA, Canada

ID: 1277
Development of multi-function conductor
keywords: Conductor, Snow, Wind pressure, Development
MATSUDA, Yuta (1); SHIRAISHI, Tomonori (1); TAKADA, Noriyuki (1); SUGA, Nobuaki (2); TAKASHI, Tadahiro (2); ENAKA, Taisei (2)
1: TEPCO Power Grid, Inc., Japan; 2: Sumitomo Electric Industries,Ltd., Japan

ID: 1290
Conductor Optimization for +/-350kV HVDC Transmission system for evacuation of 13 GW of RE power from renewable energy parks in Ladakh, India
keywords: Altitude correction factor, Conductor bundle selection, Extreme altitude, Galloping, HVDC Link
SINGH, Ashish Kumar; JHA, Nikhil; KANT, Chandra; SINGH, Manoj Kumar; KUMAR, Abhay; BURRA, Vamsi Rama Mohan
POWER GRID CORPORATION OF INDIA LIMITED, India

ID: 1362
Visibility as a Key Parameter for Accurate In-Cloud Icing Modelling based on Weather Station Data
keywords: In-cloud icing, overhead power lines, ice loads, visibility, liquid water content, energy transition, grid resilience, simulation models
ULLOA JIMENEZ, Erick; STEEVENS, Stefan; UNTERFINGER, Jeremy
Amprion GmbH, Germany

ID: 1378
Tackling Overhead Transmission Line Grounding System Challenges through Introduction of Mechanisms for Enhanced Grounding Management and Maintenance Processes
keywords: overhead transmission line, grounding system, asset management, process reengineering, corrosion, maintenance
BEČAN, Miha; TOMAŽIČ, Roman; ANTONČIČ, Mitja; OSOLIN, Jošt; KERIN, Uroš
ELES, d.o.o., Slovenia

ID: 1397

Innovative Monitoring Systems for High Voltage Power Lines: Laser Sag Meter, and Electric Line Ice Sag Accretion monitor

keywords: Conductor Rotation monitoring, High Voltage Overhead Line, Ice Accretion Monitoring, Image Analysis, Online Monitoring

GOLINELLI, Elena; BARTALESI, Daniele
R.S.E. S.p.A., Italy

ID: 1454

Optimizing Overhead Line Maintenance: Splice and Connector Strategies

keywords: Connector, Overhead lines, Maintenance, Strategy, Splice

HASSANIPOUR, Meysam; CANUEL, Sylvain
Hydro-Quebec, Canada

ID: 1485

Influence of Broken Wire on Multistrand Core

keywords: Composite, Multistrand, Overhead Lines (OHL), Polymeric Matrix Composites (PMC), Residual Strength, Structural Integrity, Tensile Strength, Transverse Compression, Trapezoidal

HASSINEN, Antti (1); MORA, Luca (2); PERONI, Davide (2); MIMO, Debora (2); KLOSTER, Heini (1)
1: Exel Composites, Finland; 2: De Angeli Prodotti, Italy

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Wednesday 14th May **AURORA B+C** **10:30 – 12:30**

SC B1 session #2: Insulated Cables -2
Session Chair / Moderator: TBA

ID: 1217
Active Monitoring of cable temperature to facilitate overplanting
keywords: Overplanting, temperature monitoring, export cables, operational experience
de Vries, Frank; van Oosterom, Jozua
TenneT TSO, Netherlands, The

ID: 1182
Survey of test methods and measurement performance to assess arc hazards in cable components
keywords: Arcing, Fault, Cable, Accessory, Insulation, Hazard, Design, Test, Measurement, High Current, Experiments
Cuppen, André N. (1,2); Levine, Jody P. (3); Nair, Nirmal-Kumar C. (1)
1: University of Auckland, New Zealand; 2: Powerco, New Zealand; 3: Hydro One, Canada

ID: 1185
Next Generation Integrated Platform for the management of HV assets
keywords: HV Cables, Monitoring, risk avoidance, RTTR
Gaspari, Roberto (1); Andre, Aymeric (2)
1: Nexans Norway AS, Norway; 2: Nexans France SA, France

ID: 1196
Behaviour of Underground Cable Systems under Large Disturbances
keywords: Climate Change, Global Warming, Large Disturbances, Mitigation Methods, Underground Cable Systems.
Orton, Harry
OCEI, Canada

ID: 1198
"Heritage Meets Innovation: Varanasi's Power Transformation"
keywords: Cultural preservation, Improved Power quality, Underground cabling, Urban renewal, Wireless city
Rai, Pankaj kumar
POWERGRID corporation of India limited, India

ID: 1284
Dynamic Profile Selection for Mitigating Dielectric Stresses in Bipolar HVDC MIND Cables
keywords: Cable, direct current, dynamic, submarine, optimization
Reinikainen, Emma; Rantanen, Jussi; Nepola, Kimmo
Fingrid Oyj, Finland

cigre NRCC Symposium 2025 Trondheim, Norway

ID: 1370

DAS for ultra-long submarine interconnectors and cables

keywords: DAS, Fault, Location, Monitoring, Long-range

Brenne, Jan Kristoffer; Rønnekleiv, Erlend
Alcatel Submarine Networks Norway

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Wednesday 14th May **COSMOS 1** **10:30 – 12:30**

SC C2 session #2: Tools and Methods for Congestion Management and Operational Planning

Session Chair / Moderator: Adrian Kelly (IE) / Giorgio Giannuzzi (IT).

ID: 1105
Evaluation of DLR for each span of transmission lines using wind condition estimation results - Consideration on the necessity of comprehensive wind condition assessment in DLR -
keywords: Dynamic Line Rating (DLR), wind condition analysis
Shimoo, Takahiro; Saito, Keita; Ueda, Takashi; Ohnari, Takaaki; Kase, Takahiro
Toshiba Energy System & Solutions, Japan

ID: 1117
Leveraging Thermal Reserves of HVDC Underground Cables in Curative System Operation – A Scenario-based Approach
keywords: Cable, Curative, Congestion Management, HVDC, Scenarios, Thermal Reserves
Gatermann, Carsten Thomas; Schlegel, Steffen; Westermann, Dirk
Technische Universität Ilmenau, Germany

ID: 1191
Evaluation of TATL Potentials Based on Line Loading and Reaction Time
keywords: Curative, Dynamic Line Rating, Higher Utilization, Overhead Line, Permanent Admissible Transmission Loading, Reaction Time, Temporary Admissible Transmission Loading, Threshold Value
Sennewald, Tom (1); Wasserab, Andreas (1); Thiele, Mark (1); Schneider, Thomas (2); Beißel, Volker (2); Puffer, Ralf (3)
1: TenneT TSO, Germany; 2: Amprion, Germany; 3: RWTH Aachen University, Germany

ID: 1302
DYNLAST – Dynamic line rating
keywords: Dynamic Line Rating, Laser Scanning, Overhead Lines, Utility Grid, Weather API
Smidsrød, Dan
Glitre Nett AS, Norway

ID: 1263
A Comprehensive Solution Framework for Multi-node Optimal Power Generation Planning of Vietnam Power System to resolve Regional Grid Congestion Problem
keywords: Grid congestion, Hydrothermal, Multi-node Simulation, Generation Planning, Optimization, Optimal Power Flow, Unit Commitment
Nguyen, Quoc Trung; Pham, Quynh; Nguyen, Minh Quang; Hoang, Anh Tuan; Nguyen, The Van; Nguyen, Sy Quan; Duong, Tuan Anh; Nguyen, Anh Tu; Nguyen, Duc Thanh
National power system and market operator company limited, Vietnam

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ID: 1283
The Various Constraint Relief Strategies of South Korea's Massive Generation Surplus Areas
keywords: Constraint Relief, Generation Constraints, Renewable Energy, Special Protection Schemes (SPS), Static Synchronous Compensators (STATCOM), Thyristor Controlled Series Capacitors (TCSC)
Joo, Won; Song, Tae-Yong; Choi, Hong-Seok
Korea Power Exchange (KPX)

ID: 1110
Robustness indicators for the Nordic power system
keywords: Robustness, Resilience, Transfer Corridors, Utilisation, Availability
Hillberg, Emil; Lindquist, Tommie; Bengtsson, Gustaf; Weihs, Erik
RISE Research Institutes of Sweden, Sweden

ID: 1170
Outage planning in a converter dominated grid – A Finnish case study and lessons learned
keywords: Converter Stability, Curtailment, Outage Planning, Power System Operation
Nikkilä, Antti-Juhani; Mäkihannu, Tuomo; Salonen, Otso; Klaver, Samuel; Hytti, Valtteri; Peltoketo, Suvi; Korhonen, Riku
Fingrid Oyj, Finland

ID: 1351
Demand Simulator of energy transition variables for the Spanish electric power system
keywords: Energy Transition, Self-Consumption, Electric Vehicle, Green Hydrogen, Heat Pump
del Río Molina, María Cruz; Rodríguez Aparicio, Ana
Red Eléctrica, Spain

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Wednesday 14th May **COSMOS 2** **10:30 – 12:30**

SC C4 session #4: Enhanced Models and Simulation Capabilities for Inverter Dominated Power Systems

Session Chair / Moderator: Babak Badrzadeh (Etik Energy) / Gilles Chaspierre (Elia Grid Int)

ID: 1423
Enhancing Power System Simulation Interoperability: Application of Functional Mock-up Interface for Model Exchange
keywords: Co-simulation, Model exchange, Functional Mock-up Interface, Modelica, Intellectual Property
Yang, Ning (1); Egea Alvarez, Agusti (1); Morel, Florent (2); Ouoba, Sidlawende (2); Xu, Lie (1)
1: University of Strathclyde, United Kingdom; 2: SuperGrid Institute SAS

ID: 1183
Challenges faced by TSO to specify, test and integrate EMT models of IBRs to support grid stability
keywords: EMT simulation, IBR integration, Grid code requirements
DENNETIERE, SEBASTIEN; VERNAY, YANNICK; THIBERT, MICKAEL; MORRETTON, FABIEN; MBEROU, ELIAS
RTE, France

ID: 1382
Large-scale Electromagnetic Transient Simulation of the French grid: Challenges and Solutions
keywords: Electromagnetic Transients, simulation, large-scale networks, Common Information Model, Model exchange; Data portability, sparse matrix solver, parallelization.
Bruned, Boris; Martin, César; Petit, Ambroise
RTE, France

ID: 1137
Overhead line modeling for wide area EMT grid simulations
keywords: Electromagnetic Transients, Grid, Modelling, Overhead Line, Section
Barth, Daniel (1); Goertz, Max (1); Wenig, Simon (1); Pinter, Peter (1); Lindner, Marco (2); Oldehinkel, Niklas Phil (2)
1: Mosaic Grid Solutions GmbH, Germany; 2: TransnetBW GmbH, Germany

ID: 1310
Centralized Network Model in a Colombian DSO Company for Enhanced Planning and Operation
keywords: DSO, Network Model, DER, planning, operation, Protection analysis, Hybrid Architecture, ETL, transmission, distribution, GIS
Londono, Vanesa; Morales, Rafael; Sanchez, Jonh Alexander; Silva, Jessica
Celsia, Colombia

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ID: 1255

A Study on the Impact of EV Chargers on Transient Stability and Root-mean-square Model

keywords: EV chargers, Laboratory test, Power system, RMS model, Transient stability

Masuda, Muneki; Satoh, Hayato
Central Research Institute of Electric Power Industry, Japan

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Wednesday 14th May **COSMOS 3** **10:15 – 12:30**

SC D2 session #2: Cybersecurity & Data Protection in Power Grids (cont.) / Digital Transformation & Emerging Technologies

Session Chair / Moderator : Victor Tan (SC D2 Chair, VTan Consulting) / Peter Ceferin (SC D2 Review Coordinator and Slovenia Member, Smart Com) / Marit Owren Valmot (SC D2 Norway Member, Statnett)

Cybersecurity & Data Protection in Power Grids (continued)

ID: 1383

Quantum-resistant grid communications with enhanced MACsec

keywords: MACsec, quantum resistant, Cryptographically Relevant Quantum Computer, Asymmetric encryption, Symmetric Encryption

Chan, Hansen; Chan, Hansen

Nokia, Canada

ID: 1391

An Advanced Cyber-Physical System Security Testbed for Substation Automation

keywords: Cyber-Physical, Security, System, Substation, Automation, Testbed

Herath, Akila (1); Liu, Chen-Ching (1); Hong, Junho (2); Girdhar, Mansi (2)

1: Virginia Polytechnic Institute and State University; 2: University of Michigan Dearborn

ID: 1415

Demystifying IT-OT Convergence: Strengthening Critical Infrastructure Security Through DMZ Implementation and Cross-Domain

keywords: Demilitarized Zones, IT-OT convergence, IT-OT collaboration

MANYAPETSA, Kgomotso; BIYELA, Thuthukani

Eskom/NTCSA, South Africa

ID: 1438

Implementation of the Security Information and Event Management (SIEM) System in ANDE's OT Network

keywords: Cybersecurity, SIEM, OT Network, Vulnerability mitigation, SCADA

Loreiro Quevedo, Ricardo Matias; Ruiz Diaz, Chrystian; Mujica, Hugo

Administración Nacional de Electricidad, Paraguay

Digital Transformation & Emerging Technologies

ID: 1251

Advancement of Demand and Supply Forecasting Technology in Renewable Energy

keywords: Energy Aggregation, Digital Transformation, AI, Timeseries Recognition

Saeki, Kazuya; Sakuraba, Kotaro; Miyagi, Tomoya

Tohoku Electric Power co.,inc., Japan

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ID: 1258

Utilizing Generative AI and RAG for Knowledge Transfer in the Electric Power Industry

keywords: Retrieval-Augmented Generation, Large Language Model, Generative AI, On-premises Data Integration, Graph-based Knowledge Structure

NAMBA, Eijiro

Electric Power Development Co., Ltd., Japan

ID: 1288

Digital technology for analysing the correctness of relay protection and automation operation in real time

keywords: CIM, Fault event analysis, Integration, Misoperation detection, Relay protection and automation

Malakhov, Evgeniy (1); YASKO, Dmitrii (1); GERDT, Diana (1); FEDOROV, Oleg (2)

1: «System Operator of the United Power System», Joint-stock Company, Russian Federation; 2: «RTSoft - Smart Grid», OOO, Russian Federation

ID: 1294

PG IMPACT: Accelerating Renewable Energy Integration into India's Transmission System Through Unified Control and Big Data Integration

keywords: PG IMPACT, Renewable Energy (RE), Unified Control, Big Data Integration, Project Management Real-time Data Analysis, Capital Expenditure (CAPEX), Just-in-Time Supply Management AI Algorithms, Project Health Index

GUPTA, PRIYANKA; Sathyanarayana, S V S; Chaudhary, Shivraj

POWERGRID CORPORATION OF INDIA LTD, India

ID: 1319

Transformative potential of digitization, particularly in grid operation and control by use of Digital Twins

keywords: Digital Twin, Digitalization, Data Management, Regulation, Asset Administration Shell

Palaniappan, Rajkumar (4); Aumann, Erhard (1); Eyrich, Wolfgang (2); Fischer, Bastian (3); Häger, Ulf (4); Hoppe-Oehl, Heinrich (5); Schuy, Mathias (2)

1: Siemens AG, Germany; 2: Entegra GmbH, Germany; 3: Maschinenfabrik Reinhausen GmbH, Germany; 4: TU Dortmund University, Germany; 5: University of Wuppertal, Germany

ID: 1401

General approaches to the development of advanced power system modelling tools

keywords: Common information model, Modelling tools, Power system modelling

Beliaev, Nikolai; Bogomolov, Roman

SO UPS OF RUSSIA, Russian Federation

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Wednesday 14th May **AURORA A** **13:30 – 15:30**

SC B3 session #1: Substations and electrical installations -1

Session Chair : Mark McVey (SC B3 Chair, Dominion Energy).

ID: 1106
Application of BS EN 1991-1-4 for Specification of Substation Equipment on Severe Wind Speed Locations
keywords: Severe wind, climate change, extreme weather, substation equipment, BS EN 1991-1-4, terminal load
Beretta, Felipe; Yates, David; Gokulachandran, Mohan; Koehler, Fabian
SSEN Transmission, United Kingdom

ID: 1145
Substation Auxiliary Power Systems - A New Approach to Supply Selection
keywords: LV AC, Auxiliary Power, Station Services, PVT, SSVT, Low Voltage, Substation Design, Energy Hubs
Johnson, Perry Willis; Beretta, Felipe
SSEN Transmission, United Kingdom

ID: 1156
Fiber Optic-based Acoustic Emission Sensing Technology to Online Detect, Monitor, and Localize Partial Discharge in 400kV Cable Terminations
keywords: Cable termination, Extra high voltage (EHV), Fiber optic acoustic emission (FOAE) sensing technology, Field test, Online monitoring, OptiFender, Partial discharge (PD)
Zadeh, Aydin R (1); Hashemi-Dezaki, Hamed (1); Steffansen, Simon Dalsgård (2); Canada, Francisco Javier (1); Niemann-Larsen, Joachim (2); Lebedev, Nikita (1)
1: Optics11 B.V., The Netherland; 2: Energinet, Denmark

ID: 1229
Installation, testing and commissioning of Optical Fiber Network within GI conduit/pipe to mitigate rodent induced vulnerabilities
keywords: Cable Trench, Fault diagnosis, HVDC, Maintenance, Mitigation Measures, Optical Fiber
KUMAR, ALOK (1); SUBRAMANI, Madhan Kumar (2); RAJAN, ANAND (3)
1: Powergrid Corporation of India Limited; 2: BHEL; 3: Powergrid Corporation of India Limited

ID: 1328
ENHANCING RELIABILITY AND SECURITY OF STRUCTURES USING VIBRO STONE COLUMN NETWORK TO MITIGATE LIQUEFACTION
keywords: Bearing, Column, Foundation, Ground, Improvement, Khavda, Liquefaction, Stone
KHANDELWAL, MONA; Prasad, Satyendra Kumar; Sharma, Sanjay; Kumar, Abhay; Burra, Vamsi Rama Mohan
POWER GRID CORPORATION OF INDIA LTD, India

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ID: 1354

ONLINE NOISELESS ACOUSTIC DISCHARGE DETECTION IN INSULATION OF HV EQUIPMENT

keywords: Partial Discharges, Noiseless acoustic camera, Switchyard

Soni, Umesh Nirnajanbhai; Patel, Shaileshkumar Babubhai
Electrical Research and Development Association, India

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Wednesday 14th May **AURORA B+C** **13:30 – 15:30**

SC B1 session #3: Insulated Cables -3
Session Chair / Moderator: TBA

ID: 1377
Seabed interference monitoring on power cables using DAS
keywords: DAS, Cable, Trawler, Anchor, Protection
Morten, Jan Petter (1); De Rijcke, Simon (2); Brenne, Jan Kristoffer (1); Quaghebeur, Ward (2); Reynaert, Bjorn (3); De Baere, Bram (3)
1: Alcatel Submarine Networks Norway; 2: Marlinks; 3: Norther

ID: 1387
Thermomechanical Modelling of Cables in Flexible Installations
keywords: Buckling, Flexible Installation, Thermomechanical Thrust, Underground Cable
Liangou, Theodora; Tzortzopoulos, Georgios; Koumlis, Stylianos; Chatzipetros, Dimitrios
Hellenic Cables, Greece

ID: 1404
Installation of underground cables through peatland and challenging terrain to support decarbonisation of a remote Scottish Island
keywords: Peat, Settlement, Surveys, Tromino, Rock, Cable Installation, Peat Slide, High Voltage Cables
Keane, Tom; Anild, Sara; Scott, James; Burke, Oisín
BakerHicks, United Kingdom

ID: 1437
Transient Effects of DC Fault Current Interruption on HVDC Cable Performance in Multiterminal Network
keywords: DC Circuit Breaker, Electromagnetic Transients, HVDC Cables, Multi-terminal HVDC Grid
Karmokar, Tanumay Rabindranath (1,2); Popov, Marjan (2)
1: TenneT TSO GmbH, Germany; 2: Delft University of Technology, The Netherlands

ID: 1451
Monitoring the shape of a subsea dynamic cable from the floater continuously in time and space
keywords: sea trials, dynamic, cable, shape, monitoring
Maison, Antoine (1); Roulet, Mélanie (1); Ryden, Vilhelm (2); Clément, Pierre (3); Di Battista, Andrew (4); Hebden, Guy (5); Chassagne, Dominique (6); Piot, Xavier (7)
1: France Energies Marines, France; 2: NKT, Sweden; 3: Febus Optics, France; 4: Viper Innovations, UK; 5: Sonardyne, UK; 6: Cadden, France; 7: Eolink, France

ID: 1469

Novel Anomaly Detection Machine Learning Based Model for Real-Time Monitoring of Transmission Cables Using DTS

keywords: transmission cables, data-driven monitoring, distributed temperature sensing, machine learning, anomaly detection, real-time monitoring, statistical validation, dynamic rating, overload prediction

Holbøll, Joachim
Denmark Technical University, Denmark

ID: 1474

Experimental validation of wave propagation characteristics in EHV cables

keywords: Travelling waves, propagation velocity, high frequency attenuation, fast transients, EMTP, cable systems

COLLA, Luigi
Prysmian

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Wednesday 14th May **COSMOS 1** **13:30 – 15:30**

SC C2 session #3: Inertia Monitoring, DSA and other Tools for Enabling System Operations with Increasing IBR

Session Chair / Moderator: Vivek Pandey (IN) / Juan Peiro (ES)

ID: 1315
Automatic Assessment of Voltage Regulation in Power Plants Using a Web-Based Tool Integrated with SCADA/EMS Systems
keywords: SCADA, SCADAweb, operarion post-check.
Lai, Viet An (1); Nguyen, Duc Ninh (1); Pham, Quynh (1); Vo, Minh Long (1); Phung, Dang Huy (1); Le, Van Thong (1); Do, Huy Hoang (1); Vo, Van Luom (2); Hoan Nguyen, Kim Huy (2)
1: National power system and market operator company limited, Vietnam; 2: National System and Market Operation Company – Southern Branch

ID: 1193
Inertia in the Dutch Power Grid: Trends and Implications
keywords: Inertia, power system stability, system operation, grid planning, frequency stability
Boricic, Aleksandar; Frohn, Sam; Liu, Shiyi; Bos, Jorrit
TenneT TSO B.V., Netherlands, The

ID: 1206
Inertia Estimation with Increasing Inverter-based Generation on the Grid
keywords: Frequency Stability, Grid Inertia, Inertia Estimation, Renewable Energy, System Strength
Farmer, Warren James; Minnaar, Ulrich; Jooste, Frans; Kgosiemang, Thabiso
Eskom Holdings SOC Ltd, South Africa

ID: 1210
A global grid frequency measurement technique for operational planning studies
keywords: Constraints, Control, Frequency, Renewables, ROCOF
Paoli, Joshua Peter; Wembridge, Christopher James
TasNetworks, Australia

ID: 1218
Real-time calculation and visualization of corrective actions for N-1 secured Nordic system operation
keywords: N-1 analysis, Real-time, Security-constrained OPF, System Protection Schemes
Stanković, Stefan (1); Haugdal, Hallvar (2); Ackeby, Susanne (1)
1: RISE Research Institutes of Sweden, Sweden; 2: Sintef, Norway

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ID: 1311

Development and Operation of a novel tool for real-time monitoring & intraday forecasting of reactive power demand & reserve in Vietnam power system

keywords: Reactive power demand & reserve, monitoring & forecast, voltage control, integration of IT-OT

Nguyen, Duc Ninh (1); Phung, Dang Huy (1); Dinh, Xuan Duc (2); Vo, Minh Long (1); Lai, Viet An (1); Nguyen, Son Tung (1); Le, Van Thong (1); Do, Huy Hoang (1); Vo, Viet Thang (1); Dinh, Nhat Minh (1)
1: National power system and market operator company limited, Vietnam; 2: Electricity of Vietnam

ID: 1158

Modelling of distributed generation in the EMS/SCADA system

keywords: Distributed Generation, EMS/SCADA, Forecasts, Grid Control, Grid Model, Modelling, Operational Planning, PV, RES, Schedules

Slezsák, István; Nagy Dr., Melinda; Belső, Bence
MAVIR Ltd., Hungary

ID: 1312

Strengthening SCADA and EMS Systems for a Sustainable Energy Transition: Experience in Vietnam

keywords: SCADA quality assessment, state estimator tuning, EMS, automation

Nguyen, Duc Ninh (1); Phung, Dang Huy (1); Dinh, Xuan Duc (2); Lai, Viet An (1); Le, Van Thong (1); Nguyen Thi, Thanh Binh (1); Pham, Trung Thanh (1); Nguyen, Ba Hoai (1); Hoang, Anh Tuan (1)
1: National power system and market operator company limited, Vietnam; 2: Electrical Power Trading Company

ID: 1299

Manage Grid Uncertainties using Cloud Technologies

keywords: Energy Transition, Power Grid, Uncertainty Management, Cloud Computing, Data Architecture, Data Analytics

Wang, Congcong; Sattler, Evan; Zhao, Long; Steider, Stephanie
MISO, United States of America

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Wednesday 14th May **COSMOS 2** **13:30 – 15:30**

SC C4 session #5: **Enhanced Solution Methods for Analysis of Modern Power Systems**

Session Chair / Moderator: **Claus Leth Bak (Aalborg University) / Geoff Love (EPRI)**

ID: 1188
Improved Eigenvalue Sensitivity Method for Designing Power System Damping Controllers
keywords: Controller Design, Eigenvalue Sensitivity, Oscillation Damping, Small-Signal Stability
Cedenilla Bote, Alejandra (1); Rouco, Luis (3); Sigrist, Lukas (3); Guironnet, Adrien (2); Torresan, Gilles (2); Carpentier, Philippe (2)
1: CRESYM, Belgium; 2: RTE, France; 3: IIT Universidad Pontificia Comillas, Spain

ID: 1134
A Case Study on Torsional Resonance Stability Amidst Series Capacitor Upgrades in the Swedish Power System
keywords: Impedance Scan, Interaction, Resonance, Speed Perturbation, Sub-synchronous, Torsional
Behrouzian, Ehsan; Rogersten, Robert; Lennerhag, Oscar; Råström, Stefan
Svenska Kraftnät, Sweden

ID: 1407
Indicator-based identification of critical grid situations for voltage stability analyses in future transmission grids
keywords: Complexity reduction, Discriminant Analysis, Grid Situation Selection, Stability Indicators, Voltage Stability
Tepe, Sophia; Fester, Christian; Moser, Albert
Institute of High Voltage Equipment and Grids, Digitalization and Energy Economics (IAEW), RWTH Aachen University, Germany

ID: 1422
Investigation of Non-Linear and Linear Optimal Reactive Powerflow Models for Voltage Control in Future Transmission Grids
keywords: Voltage Control, Grid Operation, Non-Linear Optimization, Linear Optimization, Optimal Reactive Powerflow, Reactive Power, Transmission Grid
Fester, Christian; Engel, David Alexander; Preuschoff, Felix; Moser, Albert
IAEW, RWTH Aachen University, Germany

ID: 1253
A short-circuit calculation method considering current-limiting strategies of inverter-based resources
keywords: Inverter Based Resource (IBR), Power Flow Calculation, Short Circuit Current
Jeong, Soseul; Lim, Saehwan; Yoo, Hyeongjun
Korea Electrotechnology Research Institute, Korea, Republic of (South Korea)

ID: 1390

Substation equipment design considerations due to short-circuit impact of HVDC converter and other IBR with grid forming control

keywords: Power system planning, isolated operation, HVDC systems, short circuit calculation, electromagnetic transients calculation

Patynowski, Daniel; Hibberts-Caswell, Richard; Oprea, Liliana; Popescu, Victor
Fichtner Gmbh&Co KG, Germany

ID: 1416

Determination of Sub-Transient Short-Circuit Current Equivalents of IBRs

keywords: Short-circuit current, IBR, sub-transient, Wavelet transform, Space vector

Bisseling, Alexander (1); Lindner, Marco (2); Mehta, Shashank (2); Oldehinkel, Niklas Phil (2); Schöll, Christian (2); Suriyah, Michael (1); Leibfried, Thomas (1)
1: Karlsruhe Institute of Technology (KIT), Germany; 2: TransnetBW GmbH, Germany

ID: 1335

How reliable are offshore transmission when RE generation power is not 100% of its capacity? - A case study for hybrid offshore wind and PV in the North Sea

keywords: Availability, Cable reliability, Hybrid offshore, Offshore Solar PV, Failure Rate

HERNANDEZ-MATHEUS, Alejandro; Prusty, Pratikshya; Perez, Ainhoa Maria Blasco; Fuglsang, Nicklas; Gonzalez, Ana; FARAJIFARD, Amir
Ramboll

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Wednesday 14th May **COSMOS 3** **13:30 – 15:30**

SC D2 session #3: Digital Transformation & Emerging Technologies (cont.) / Advanced Communication & Networking in Power Systems

Session Chair / Moderator : Victor Tan (SC D2 Chair, VTan Consulting / Marit Owren Valmot (SC D2 Norway Member, Statnett) / Vitor Meneguim (SC D2 France Member, GE Vernova)

Digital Transformation & Emerging Technologies (continued)

ID: 1408

Digital Twins for DSOs and Consumers Coordination and Interoperability: Problem statement and Challenges

keywords: Digital Twins, Energy Consumers, Flexibility Markets, DERs, CIM Standards, Grid Integration

Nepsha, Fedor (1,2); Nebera, Alexey (1); Shubin, Nikolay (1); Voronin, Vyacheslav (2)

1: RTSoft Smart Grid, Russian Federation; 2: T.F. Gorbachev Kuzbass State Technical University

ID: 1441

Hyperconvergence in OT Networks: Implementation in ANDE's SCADA Systems and Feasibility of Operating with Virtualized Protection and Control IEDs in Substations

keywords: CPC, IED, IEC61850, OT, PAC, SCADA, SDS, SDN, Hyperconvergence, HCI, Virtualization

Ruiz Diaz, Chrystian (1); Loreiro, Matias (1); Davalos, Enrique (2); Gonzalez, Fernando (1); Rojas, Diego (1); Fernandez, Ubaldo (1); Adorno, Cesar (1); Paiva, Enrique (1); Salas, Percy (1)

1: Administracion Nacional de Electricidad - ANDE, Paraguay; 2: Facultad Politécnica - UNA, Paraguay

Advanced Communication & Networking in Power Systems

ID: 1458

Monitoring the performance of 2.4GHZ ISM band wireless communication technologies for power grid IoT applications

keywords: Bluetooth, Industrial IoT, Industry 4.0, Renewables, Wi-Fi, Wireless Communication

Gore, Rahul

Hitachi Energy Research, Sweden

ID: 1111

Leveraging MQTT and cloud technology for effective continuous online condition monitoring of transformers

keywords: Cybersecurity, Cloud, Condition monitoring, Data collection, Data visualization, Information systems, IoT, Monitoring, Network infrastructure, Offshore, Telecommunications

Mellin, Toni (1); Van der Broeck, Stephan (2); Mitjonen, Jarno (1); Funk, Rolf (2)

1: Vaisala Oyj, Finland; 2: RheinNetz GmbH, Germany

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ID: 1116

On the utilization of wireless transport in mission-critical packet-based operational networks for power utility

keywords: Packet, WAN, MPLS-TP, wireless, microwave, teleprotection, distance protection, differential protection, synchronization, Quality-of-service, QoS, adaptive modulation.

Lucente, Eugenio (1); Colosimo, Alessio (1); Baechli, Ramon (1); Bergling, Johannes (2); Monti, Paolo (2)

1: Hitachi Energy, Switzerland; 2: Ericsson

ID: 1131

Teleprotection for DER over cellular networks

keywords: DER, teleprotection, LTE, 5G, slicing

Costa, Jorge

UTE, Uruguay

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Wednesday 14th May **AURORA A** **16:00 – 18:00**

SC B3 session #2: Substations and electrical installations -2
Session Chair : Mark McVey (SC B3 Chair, Dominion Energy).

ID: 1197
Conceptual Design of A Tension-leg Platform (TLP) Floating Offshore Substation Solution
keywords: Floater design, Floating offshore substation (FOSS), Global performance, Tension-leg platform (TLP), USA west coast
Song, Hongbiao (1); TANG, Zhaoxiang (2); Bjork, Thomas (3)
1: GE Grid Solutions, United States of America; 2: Technip Energies, United States of America; 3: GE Grid Solutions, United Kindom

ID: 1211
Assessment of Structural Robustness for modern Gas-Insulated Switchgear in Offshore Substations.
keywords: Gas Insulated Switchgear, Offshore Wind, Finite Element Method, Fatigue, Vibrations
Ramos Cordero, Edgar Armando; Nehring, Thilo
Siemens Energy Global GmbH & Co. KG, Germany

ID: 1240
Design considerations of floating offshore substations for renewables
keywords: FEM analysis, Floating, Offshore, Renewables, Substation
Laneryd, Tor (1);
Andrew-Morlet, Genaro (2); Johansson, Joakim (1); Hosain, Lokman (1); Scian, Ilario (3); Keller, Markus (4); Huang, Hui (5)
1: Hitachi Energy, Sweden; 2: Hitachi Energy, Germany; 3: Hitachi Energy, Italy; 4: Hitachi Energy, Switzerland; 5: Hitachi Energy, Canada

ID: 1243
Design and Qualification of Floating Offshore Wind Substations: Insights and Challenges
keywords: design and qualification, floating offshore wind substation, HVAC, HVDC, high voltage equipment
Huang, Hui (1); Weimer, Leonard (1); Stavenes Hallan, Andreas (2); Etemaddar, Mahmoud (2); Sandeberg, Peter (1); Rahmqvist, Elin (1); Wahlers, Henning (1); Örtenmark, Patrik (1); Backström, Daniel (1)
1: Hitachi Energy; 2: Aibel AS

ID: 1336
Advancing the Economic Viability of Floating Offshore Wind through Subsea Substations
keywords: Cost, Floating offshore wind, Subsea, Substation, Transmission
Normann, Truls (1); Martinsen, Øistein (2); Müller, Leif Arne (3)
1: Aker Solutions, Norway; 2: ABB, Norway; 3: Aker Solutions, Norway

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ID: 1380

Enhancing Reliability of Floating HVDC Substations through Monitoring and Inspections

keywords: Reliability, Floating substation, HVDC, Monitoring, Inspection

Dupriez-Robin, Florian; Roux, François; Marine, Leduc; Jérémy, Bioud
France Énergies Marines, France

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Wednesday 14th May **AURORA B+C** **16:00 – 18:00**

SC C3 session #2: Power infrastructure and biodiversity / Technology to reduce environmental impact

Session Chair / Moderator: TBA

ID: 1121
Mechanisms and mitigation of bird-related power outages of power grids: a case study involving herons at a substation
keywords: Bird damage, Control method, Environmental management, Human-wildlife conflict, Mobile robot
SHIRAI, Masaki (1); NAKANISHI, Yoshito (2); SUGIMOTO, Toshifumi (2); TSUDA, Sonoko (2); HAREYAMA, Takayuki (3); HITOTSUMATSU, Yosuke (4); ISHINO, Ryuichi (1); KOBAYASHI, Soh (1); NAKAYA, Ko (1)
1: Central Research Institute of Electric Power Industry, Japan; 2: Chubu Electric Power Co., Inc., Japan; 3: Tohoku Electric Power Network Co., Inc., Japan; 4: J-POWER Transmission Network Co.,Ltd., Japan

ID: 1150
Eco-crossings, the effect of rock size and material on sprinkle layer on biodiversity in subsea power cable crossings
keywords: Subsea power cables; reef development; cable crossings; artificial reefs; benthic community; fish community
Hermans, Annemiek (1,3); Joost, Bergsma (2); Driessen, Floor (2); van Dongen, Udo (2); de Haan, Eva (2); Jaarsma, Saskia (1); Swinkels, Garnt (1); van Veldhuisen, Marcel (1)
1: T.S.O. TenneT, Netherlands, The; 2: Waardenburg Ecology; 3: Wageningen University

ID: 1323
Avian interaction with powerlines
keywords: Increase in predation, powerline designs, important conservation habitat
Hayward, Brett
Essential Energy., Australia

ID: 1376
Good environmental practices: conservation and recovery of maritime habitats
keywords: Renewable energy integration; conservation and recovery of maritime habitats; Eco-friendly concrete; Posidonia restoration.
San Millán, Rodrigo
Red Eléctrica, Spain

ID: 1473
Avian collision mitigation, global best practices and technology review
keywords: Bird flight diverter, avian collision, bird strike, overhead line collision, collision outage
McGowan, Brian
Scientias Ireland Limited, Ireland

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ID: 1241

Green Substation- 100% Green Captive Power using GH2

keywords: Anode, cathode, chemical, electricity, electrodes, electrolyser, Fuel cell, Green Substation, GH2, Hydrogen, recharging, renewable

SINGH, Akhilesh Kumar; MITTAL, Himanshu; JAIN, Samrat
POWER GRID CORPORATION OF INDIA LIMITED, India

ID: 1285

Ageing of Environmentally Friendly Insulation Gases by Partial Discharges

keywords: Decomposition, Dielectric Performance, Environmentally Friendly Insulation Gas, Partial Discharge, Switchgear

Subhana, Arik (1); Støa-Aanensen, Nina Sasaki (2); Meyer, Hans Kristian Hygen (2); Kragset, Jonas (1); Mauseth, Frank (1)
1: Norwegian University of Science and Technology, Norway; 2: SINTEF Energy Research, Norway

ID: 1352

420 kV Retrofill: from Gas-Insulated Lines to Gas-Insulated Switchgear another Step Towards the Decarbonisation of High-Voltage Switchgear Installed Base

keywords: Carbon Neutrality, Global Warming, Climate Change, SF6 free Solution, Reduction of CO2 equivalent

Jorge, Teresa (1); Christen, Dennis (2); von Arx, Freddy (3); Pachlatko, Samuel (4); Agostini, Francesco (5)
1: Hitachi Energy Ltd., Switzerland; 2: Hitachi Energy Ltd., Switzerland; 3: Hitachi Energy Ltd., Switzerland; 4: Hitachi Energy Ltd., Switzerland; 5: Hitachi Energy Ltd., Switzerland

ID: 1372

Natural & Synthetic Ester Fluid Filled Power Transformers and Reactors-A Pathway to achieve Carbon Neutrality in Electricity Transmission Sector

keywords: Decarbonization, Net Zero, Carbon neutrality, Carbon intensive, Natural Ester, Synthetic Ester, Power Transformer, Reactor, capacity enhancement

Chakraborty, Dibyendu Dey; Das, Richik Manas
POWERGRID, India

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Wednesday 14th May **COSMOS 1** **16:00 – 18:00**

SC C2 session #4: Ancillary Services and Control in Power Electronics Dominated Power Systems
Session Chair / Moderator: Jan van Putten (NL) / Emil Hillberg (SE)

ID: 1120
Optimal and Coordinated Voltage Control: Case Study on a 132kV Norwegian Grid Subsystem
keywords: Centralized Optimizer, Dynamic Simulation, Optimal Power Flow, Power Losses, Reactive Power Management, Secondary Voltage Regulation, Voltage Stability
de Brito, Hugo Rodrigues; Baltensperger, Daniel Simon; Uhlen, Kjetil Obstfelder
Norwegian University of Science and Technology (NTNU), Norway

ID: 1280
A New Vision for HVDC Control
keywords: HVDC, Control, Network, Coordination, Stations, Converter, Management, Interoperability, Multi-vendor
COCCO, Marco (1); GIANNUZZI, Giorgio (1); GNUDI, Roberto (1); MELONI, Roberto (1); MASONES, Giuseppe (1); CURTONI, Aldo (2); SALVETTI, Massimo (2)
1: Terna SpA, Italy; 2: CESI SpA, Italy

ID: 1419
Unlocking DSO services through Centralised and Distributed Control
keywords: Blackstart, Control, DER, DSO Services, Microgrids, Stability, Zonal Control
Norris, Sean (1); Wilson, Douglas (1); Kanabar, Mital (2); MacDonald, David (3); Bagleybter, Oleg (1)
1: GE Vernova, United Kingdom; 2: GE Vernova, Canada; 3: GE Vernova, Spain

ID: 1461
Methodology for valuing the flexibility attribute performed by BESS in the Brazilian Electric System
keywords: Battery, Storage, BESS, Flexibility, Transmission
Cunha, Ana Carolina; Dall'Orto, Celso; Aredes, Maynara; Pinho, Renan
PSR, Brazil

ID: 1439
Nordic perspective on System Integrity Protection Schemes in relation to capacity allocation
keywords: Automation, Capacity Allocation, Flow-Based, Protection Schemes, SIPS
Malmer, Gabriel (1); Rolander, Arvid (2); Hillberg, Emil (3); Samuelsson, Olof (1); Ackeby, Susanne (3); Nordström, Lars (2)
1: Lund University; 2: KTH Royal Institute of Technology; 3: RISE Research Institutes of Sweden

ID: 1457

Prediction of Positive/Negative Error Sign of A Day-ahead Forecast of Aggregated PV Power Output

keywords: Battery energy storage systems, day-ahead forecast, flexibility, photovoltaic power generation

Kato, Takeyoshi; Nakamura, Miyu
Nagoya University, Japan

ID: 1360

A new Data-Driven application for Secondary Voltage Regulation on Transmission Network based on Model Predictive Control for offset-free tracking

keywords: Data-Driven Modelling, Model Predictive Control, Reactive Power Management, Secondary Voltage Control

Acerbi, Federica (1); Piccagli, Davide Stefano (1); Pozzi, Fabio (1); Sciarpa, Luca (1); Giannuzzi, Giorgio Maria (2); Pisani, Cosimo (2); Bruno, Gianluca (2)
1: CESI S.p.A., Italy; 2: Terna S.p.A., Italy

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Wednesday 14th May **COSMOS 2** **16:00 – 18:00**

Joint SC B4/C4 session: Grid Forming, analysis methodologies

Session Chair / Moderator: Julia Matevosyan (ESIG) / Marta Val Escudero (SC C4 Chair EirGrid)

ID: 1384
The role of the Grid Forming technology in the decarbonisation of the italian electricity grid
keywords: Dynamic stability, Grid forming, IBR, Inertia, Inverter Control, System strength
Baffa Scirocco, Temistocle (1); Belmonte, Luca (1); Carlini, Enrico Maria (1); Malgarotti, Stefano (2); Mussi, Corrado (2); Pisaneschi, Francesco (1); Pretolani, Francesco (2); Urbanelli, Andrea (1); Zanghì, Antonio (1)
1: Terna s.p.a, Italy; 2: Cesi s.p.a.,Italy

ID: 1428
Assessment of Grid Forming capabilities of HVDC links with analytical envelopes - Application to HVDC link with grid forming on both sides
keywords: HVDC, Grid forming, Specification
RAULT, Pierre (1); Costan, Valentin (1); Lemaire, Robin (2); Lennerhag, Oscar (3); Rogersten, Robert (3); VOR DEM BERGE, Markus (2)
1: RTE, France; 2: RTE International, France; 3: SVK, Sweden

ID: 1341
Compliance process for grid forming control: Best practice and way forward
keywords: Grid forming control, HVDC, STATCOM, BESS, power system stability
Höhn, Sebastian; Deiml, Georg; Rauscher, Florian
TenneT TSO GmbH, Germany

ID: 1443
Performance Verification of the First Grid Forming STATCOM in the US for South Fork Offshore Wind Farm
keywords: SFW01, PSEG-LI, Point of Interconnection, Performance Requirements, Grid Forming, STATCOM, Weak Grid Connection, Voltage Control, Fault Ride-Through, Stability, Controller Gain, Control Tuning, Power Quality
Heissel, Claus G (1); Owens, Andrew J (2); Lindstrøm, Emil (2); Sahukari, Sridhar (1); Idehen, Osazee Edo (1); Sedaghat, Behzad (1)
1: Ørsted; 2: Hitachi Energy

ID: 1453
Comparison of Two Grid-Forming Controls with Inversed Droop Controls in MTDC systems
keywords: MTDC, Grid-Forming, Droop, Stability
Pang, Ying; Egea, Agusti; Perez, Filipe; Gonzalez, Juan-Carlos; Shinoda, Kosei; Benchaib, Abdelkrim
SuperGrid Institute, France

ID: 1432

Voltage Control Stability of Grid Forming Wind Turbines During Faults

keywords: Off-shore wind power plants, HVDC link, Grid Forming Control, Fault-ride-through.

Martinez-Turegano, Jaime; Navarro-Martinez, Gala; Blasco-Gimenez, Ramon
Universitat Politecnica de Valencia, Spain

ID: 1114

Small signal analysis of grid-forming control properties

keywords: Control design, Grid forming (GFM) converters, HVDC, Instantaneous reserve, Small signal analysis, Small signal modelling, Stability analysis

Schön, André; Strong, Błażej; Dadjo Tavakoli, Saman
Siemens Energy Global GmbH & Co. KG, Germany

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Wednesday 14th May **COSMOS 3** **16:00 – 18:00**

SC D2 session #4: Advanced Communication & Networking in Power Systems (cont.)
Session Chair / Moderator : Victor Tan (SC D2 Chair, VTan Consulting / Vitor Meneguim (SC D2 France Member, GE Vernova)

Advanced Communication & Networking in Power Systems (continued)

ID: 1155
Verification of wide-area wireless communication technology using Wi-Fi HaLow
keywords: IEEE802.11ah, LPWA, Private LoRa, Smart Maintenance, Wi-Fi HaLow
SUZUKI, Eisuke (1); SUZUKI, Yoshikazu (1); KAMATA, Kyoya (2); KANEKO, Hirokazu (3); SHISHIDO, Naoya (3); KUROSAWA, Kazuki (4)
1: Tohoku Electric Power Co., Inc.; 2: Tohoku Electric Power Network Co., Inc.; 3: Tsuken Electric Ind Co., Ltd.; 4: Tsuken Engineering Service Co., Ltd.

ID: 1209
Construction and operation of a multivendor IP network for integrated legacy analog signals
keywords: Internet protocol (IP), network, multi-protocol label switching-transport profile (MPLS-TP), multi-protocol label switching-traffic engineering (MPLS-TE), software-defined networking (SDN)
Nitta, Jumpei; Takahashi, Yuma
Tohoku Electric Power Network Co., Inc., Japan

ID: 1250
High resilience of power communication using Non-Terrestrial Networks (NTNs), including Low Earth Orbit (LEO) satellites and High Altitude Platform Stations (HAPS)
keywords: NTN, Non-Terrestrial Network, HAPS, Satellite, Low Earth Orbit
Hiramatsu, Yuta
Kyushu Electric Power Transmission and Distribution Co., Inc., Japan

ID: 1259
Sustainable Grid Growth through Migration to an MPLS-TP Packet-based Network
keywords: MPLS-TP, 1.5M, J1, Line differential protection, Renewables, Windfarm, Solar plant, Telephone, Telecontrol, IEC61850
Yokoyama, Tomohiro (1); Terachi, Wataru (1); Haegdorens, Davy (2)
1: HokkaidoElectricPowerNetwork, Inc./Japan; 2: Belden/Belgium

ID: 1346
DC System Upgrades for Optical Transport Network Deployment
keywords: Battery, Charger, DC, Dense Wavelength Division Multiplexing, DWDM, IP/MPLS, Lithium-Ion, Optical Transport Network, OTN, Recharge, Recharge Time, Telecommunications
Bebwele, Phumudzo; Setlhapelo, Kgomotso; Mahlangu, Thabang; Hina, Mfundiso
NTCSA, South Africa

ID: 1379

Telecoms Modelling Tools in Carbon Neutral Power Generation

keywords: Modelling, Smart Grid, South Africa, Telecommunications, Tools, Utility

Ngwenya, Sicelokuhle Oscar; Setlhapelo, Kgomotso; Shezi, Bongani
NTCSA, South Africa

ID: 1464

Unified Network Management System (UNMS)-an amalgamation of multivendor communication systems into a single centralized monitoring system.

keywords: Multivendor, Unified Network Management System (UNMS), Communication System, Network Discovery, Topology, Circuit Discovery

Sarkar, Sangita; Mishra, Nutan; Agarwal, Atul Kumar; Singh, Jasbir
POWERGRID Corporation of India Limited, India

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Wednesday 14th of May: Technical Tour

SINTEF and **NTNU** invites to a tour in their labs:

- Hydropower lab
- Experiments on new gases and liquids
- Testing of cables
- Power electronic stresses on electric insulation
- Smartgrid labs

Time: 06.00 – 08.00 PM (*)

Busses from to venue will be arranged.

Advance booking is required.

(*) *This tour is nearly fully booked. A second tour from 04.00 – 06.00 PM will be scheduled if there is sufficient demand.*

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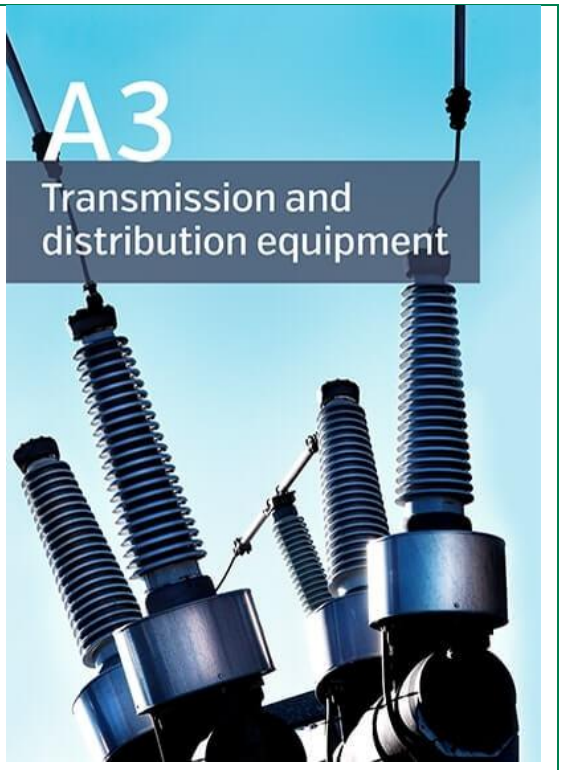
Description of CIGRE Study Committees participating in the Trondheim 2025 symposium

Study Committee A3 Transmission and distribution equipment

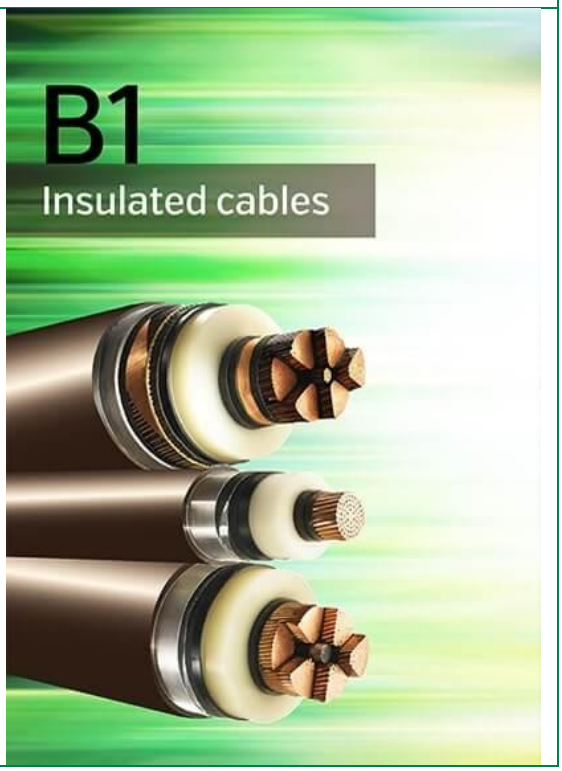
SC A3 addresses topics throughout the asset management life-cycle phases; from conception, through research, development, design, production, deployment, operation, and end-of life. At all stages, technical, safety, economic, environmental and social aspects are addressed as well as interactions with, 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.



Study Committee B1 – Insulated cables

Within its technical field of activity, Study Committee B1 addresses topics throughout the asset management life-cycle phases; from conception, through research, development, design, production, deployment, operation, and end-of life related to:

- AC and DC insulated power cable systems for power transmission, distribution and generation connections on land and in submarine applications.
- Power cable systems associated with microgrids and the integration of distributed resources.



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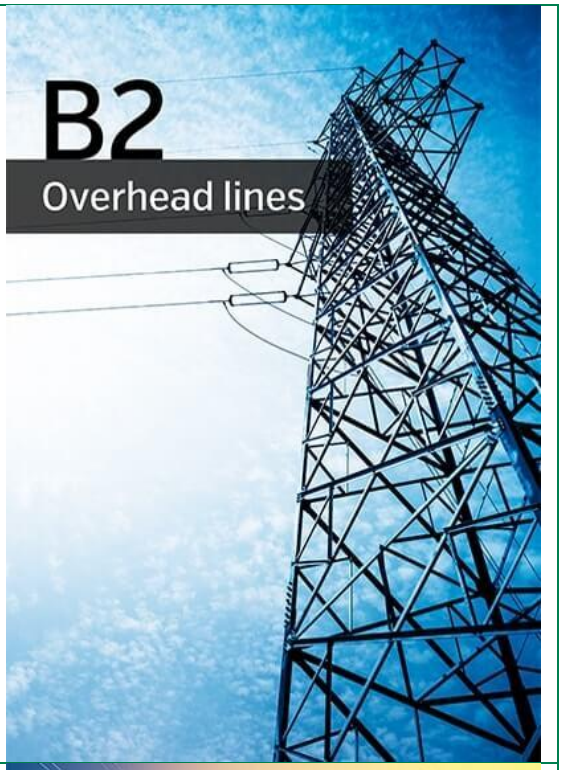
Study Committee B2 – Overhead lines

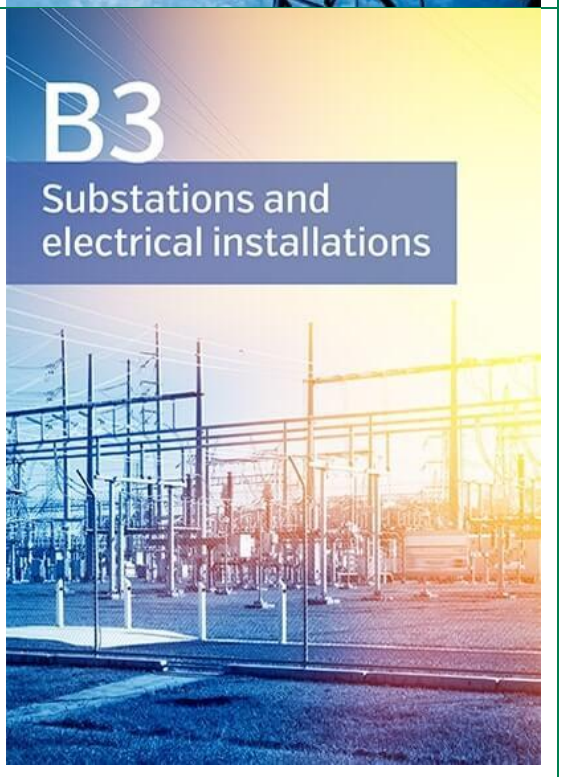
Study Committee B2 covers all aspects of overhead line design (AC and DC), including construction, maintenance, modification of existing lines and environmental considerations. Specific areas of interest are:

- Electrical Performance.
- Towers, Insulators and Foundations.
- Conductors and Fittings.
- Asset management .



Study Committee B3 – Substations and electrical installations

Study Committee B3 deals with issues in all phases of the substation lifetime; 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 environment. All aspects of performance, specification, testing and the application of testing techniques are within the scope, with particular emphasis on the impact of changing interactions and requirements due to the evolution of the power system. Life cycle assessment techniques, risk management techniques, education and training are also important aspects.



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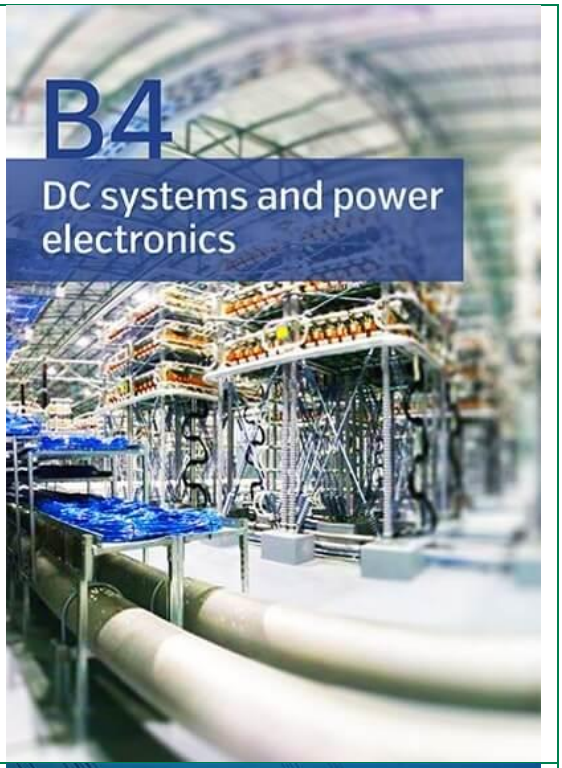
Study Committee B4 – DC systems and power electronics

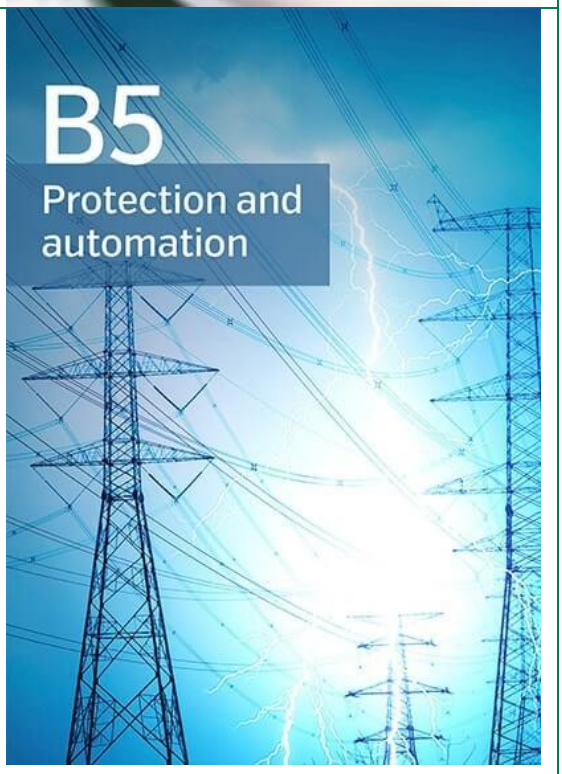
SC B4 covers the full spectrum of DC systems and PE devices including technology, specification, design, implementation, operation, maintenance, refurbishment of DC systems and FACTS devices.

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.



Study Committee B5 – Protection and automation

Within its technical field of activity, Study Committee B5 addresses topics throughout the protection, control, monitoring, metering, and fault locating devices and systems management life-cycle phases; from conception, through research, development, design, engineering, configuration, production, deployment, operation, and end-of life. Within this framework specific areas of attention include: (i) Theory, principles and concepts, functionality, technological development, design, performance and application of materials, efficiency, (ii) Application guidance, planning, installation, service conditions, (iii) Reliability, availability, dependability, maintainability and maintenance, service, condition monitoring, diagnostics, restoration, repair, loading, upgrading, uprating, (iv) Refurbishment, re-use/re-deployment, deterioration, dismantling, disposal.



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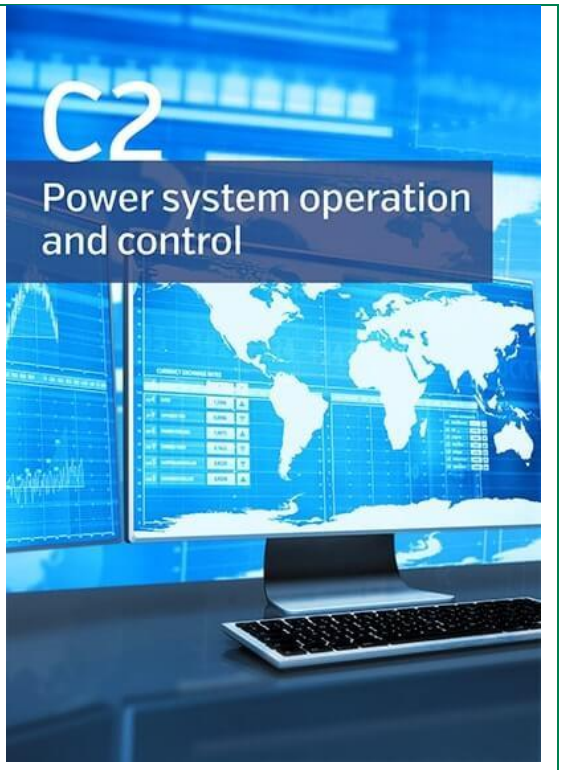
Study Committee C2 – Power system operation and control

The scope of the SC C2 covers the technical, human resource and institutional aspects and conditions for a secure and economic system operation of power systems in a way that is in compliance with requirements for network security, against system disintegration, equipment damages and human injuries, and security of electricity supply. Key areas of interest include (i) Developments and changes in the business of System Operators to meet the evolving environment, (ii) WAMS, WAMPS and WAMPACS and their integration within the control centre environment (iii) Development and use of power system analysis and security assessment functionalities within operational planning and real-time supervision, supporting system operators.

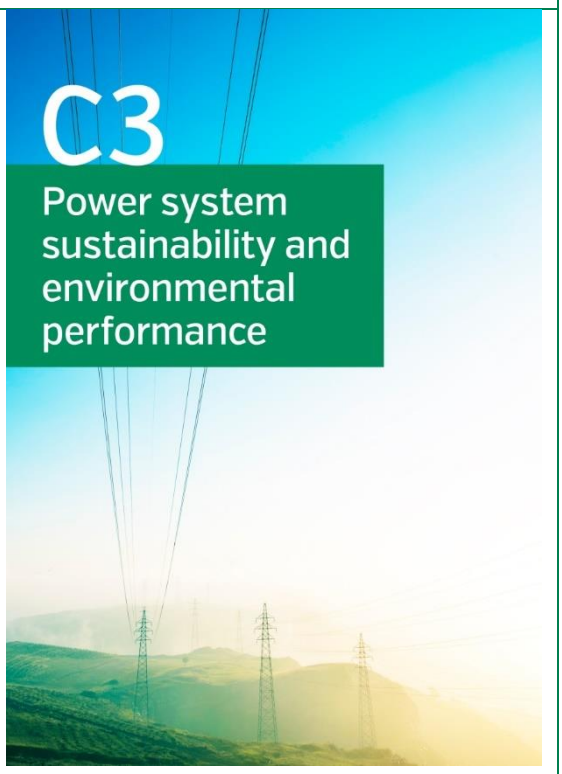


Study Committee C3 – Power system sustainability and environmental performance.

The scope of Study Group C3 covers the 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 role of the power system in relation to the UN Sustainable Development Goals (SDGs) is also a field of work for SC3.



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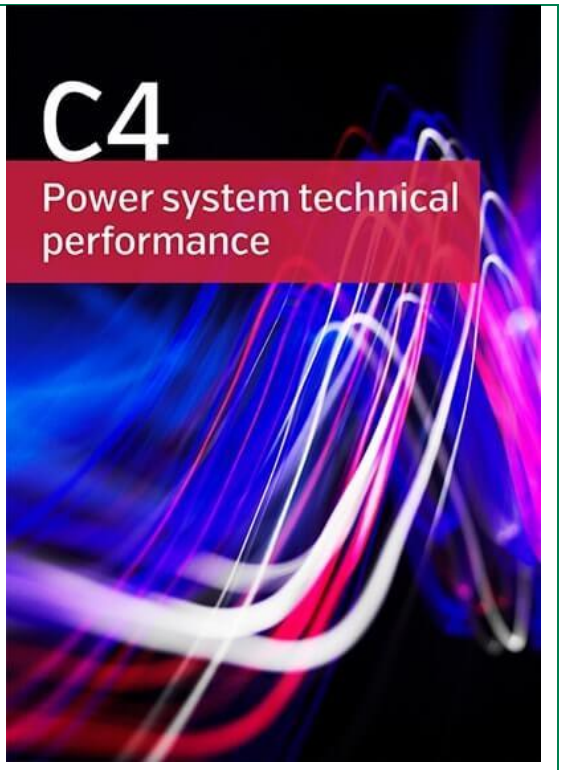
Study Committee C4 – Power system technical performance

Study Committee C4 is responsible for advanced methods and tools for analysis related to end-to-end power systems, with particular reference to dynamic and transient conditions and to the interaction between the power system and its apparatus/sub-systems (including external causes of stress, other installations and non-standardised waveforms). The scope of SC C4 covers power system technical performance phenomena that range from nanoseconds to many hours. Areas of attention include:

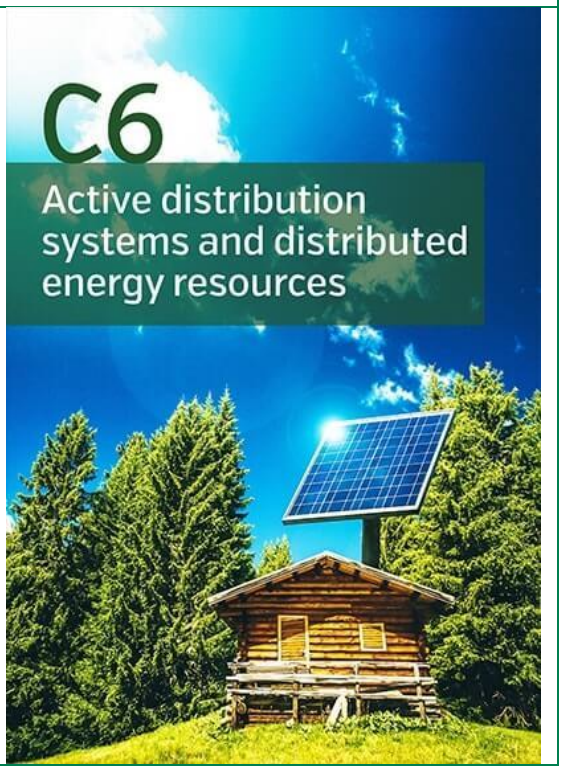
- Power System Dynamics:
- Power Quality
- Electromagnetic Compatibility and Interference (EMC/EMI)
- Lightning
- Insulation Co-ordination



Study Committee C6 – Active distribution systems and distributed energy resources

The mission of Study Committee C6 is the aassessment of the technical impacts resulting from a 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.

Key areas of interest include integration of DER, storage technologies, electric vehicles, multi-energy systems, smart cities, rural electrification, microgrids, virtual power plants, customer integration and empowerment, demand response, advanced metering systems and MV/LV DC systems.



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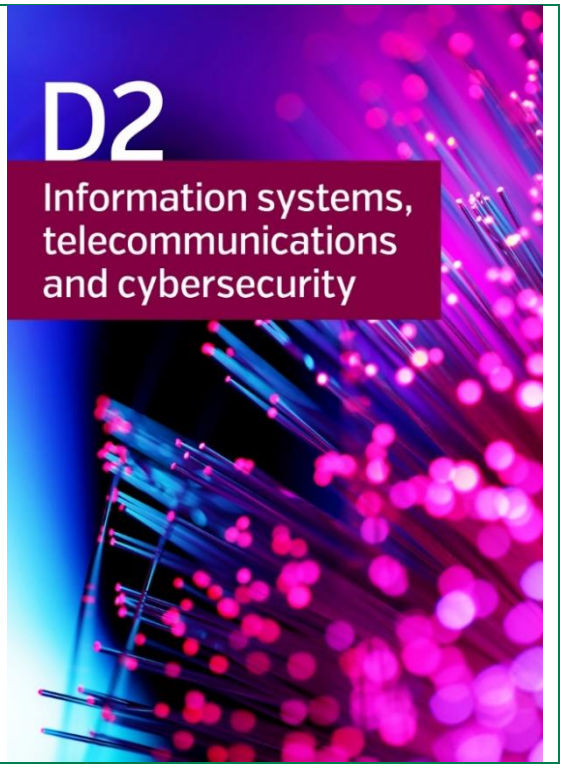
Study Committee D2 – Information systems telecommunications and cybersecurity

Study Committee D2 provides guidance, shares knowledge, and develops best practices and publications in areas of information systems, telecommunications, and cybersecurity throughout the entire electricity supply chain. Main areas of interest include ICT equipment, architectures, security and governance including consideration of fundamental principles, design, specification, testing engineering, commissioning, performance, operation and maintenance aspects. ICT applied to digital networks, communication solutions, interoperability and data exchange, IT systems in Asset Management.



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