## Technical Programme

See the list of Accepted Paper based on synopses AND Full Papers final review.

Authors have been duly notified about acceptance or non-acceptance.

The selection process is now over.

<table>
<thead>
<tr>
<th>A1 - POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS1 - ROTATING ELECTRICAL MACHINES AND THE ENERGY TRANSITION</td>
<td>3</td>
</tr>
<tr>
<td>PS2 - EVOLUTION AND DEVELOPMENT</td>
<td>4</td>
</tr>
<tr>
<td>PS3 - KEEPING THE LIGHTS ON</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A2 - POWER TRANSFORMERS AND REACTORS</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS1 - DESIGN OF RESILIENT TRANSFORMERS</td>
<td>7</td>
</tr>
<tr>
<td>PS2 - ADVANCES IN TRANSFORMER ANALYTICS</td>
<td>12</td>
</tr>
<tr>
<td>PS3 - RELIABILITY OF TRANSFORMERS FOR RENEWABLE ENERGY</td>
<td>18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS1 - Energy Transition Involving T&amp;D Equipment</td>
<td>20</td>
</tr>
<tr>
<td>PS2 - Lowering the Carbon Footprint of T&amp;D Equipment</td>
<td>22</td>
</tr>
<tr>
<td>PS3 - Maintaining and Management T&amp;D Assets</td>
<td>26</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B1 - INSULATED CABLES</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS1 - LEARNING FROM EXPERIENCES</td>
<td>30</td>
</tr>
<tr>
<td>PS2 - FUTURE FUNCTIONALITIES AND APPLICATIONS</td>
<td>38</td>
</tr>
<tr>
<td>PS3 - TOWARDS SUSTAINABILITY</td>
<td>40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B2 - OVERHEAD LINES</th>
<th>42</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS1 - CHALLENGES FROM RENEWABLES INTEGRATION AND INFLUENCES OF ENERGY TRANSITION ON OHL</td>
<td>42</td>
</tr>
<tr>
<td>PS2 - ASSET MANAGEMENT, STRATEGIES, TECHNOLOGIES AND METHODS FOR OHL</td>
<td>46</td>
</tr>
<tr>
<td>PS3 - IMPACTS FROM CLIMATE CHANGE ON OHL</td>
<td>52</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B3 - SUBSTATIONS AND ELECTRICAL INSTALLATIONS</th>
<th>55</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS1 - CHALLENGES AND NEW SOLUTIONS IN T&amp;D SUBSTATION DESIGN AND CONSTRUCTION FOR ENERGY TRANSITION</td>
<td>55</td>
</tr>
<tr>
<td>PS2 - RETURN ON OPERATIONAL EXPERIENCES FOR SUBSTATION MANAGEMENT</td>
<td>57</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B4 - DC SYSTEMS AND POWER ELECTRONICS</th>
<th>63</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS1 - DC EQUIPMENT AND SYSTEMS</td>
<td>63</td>
</tr>
</tbody>
</table>
PS2 - FACTS AND POWER ELECTRONICS ................................................................. 70
PS3 - NEW TECHNOLOGIES AND CONCEPTS OF DC AND FACTS ENABLING ENERGY TRANSITION ....................................................................................... 72
B5 - PROTECTION AND AUTOMATION .................................................................. 77
PS1 - PRACTICAL EXPERIENCES AND NEW DEVELOPMENTS OF PROCESS BUS ... 77
PS2 - ACCEPTANCE, COMMISSIONING, AND FIELD TESTING FOR PROTECTION, AUTOMATION AND CONTROL SYSTEMS ................................................................. 83
C1 - POWER SYSTEM DEVELOPMENT AND ECONOMICS ................................... 91
PS1 - STEERING THE ENERGY TRANSITION: COOPERATION, ACHIEVING TOP-DOWN TARGETS THROUGH BOTTOM-UP INVESTMENT DECISIONS ........................................... 91
PS2 - FLEXIBILITY AS PIVOTAL CRITERION FOR SYSTEM DEVELOPMENT .......... 95
PS3 - RESILIENCE AS PIVOTAL CRITERION FOR SYSTEM DEVELOPMENT ............ 99
C2 - POWER SYSTEM OPERATION AND CONTROL .................................................. 100
PS1 - CREATE OPERATIONAL RESILIENCE TO EXTREME/UNPREDICTABLE EVENTS 100
PS2 - CHANGES ON SYSTEM OPERATION AND CONTROL CONSIDERING THE ENERGY TRANSITION ...................................................................................... 104
C3 - POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE ... 108
PS1 - PUBLIC ACCEPTANCE AND STAKEHOLDER ENGAGEMENT IN POWER SYSTEM GENERATION, TRANSMISSION & DISTRIBUTION INFRASTRUCTURES .......... 108
PS2 - CLIMATE CHANGE AND IMPACT ON POWER SYSTEM, A HOLISTIC APPROACH 110
PS3 - SUSTAINABILITY STARTING FOR THE SUPPLY CHAIN .................................... 113
C4 - POWER SYSTEM TECHNICAL PERFORMANCE ............................................... 114
PS1 - POWER SYSTEM DYNAMIC ANALYSIS IN THE ENERGY TRANSITION: CHALLENGES, OPPORTUNITIES AND ADVANCES ................................................................. 114
PS2 - POWER QUALITY (PQ) AND ELECTROMAGNETIC COMPATIBILITY (EMC) ANALYSIS IN THE ENERGY TRANSITION: CHALLENGES, OPPORTUNITIES AND ADVANCES ................................................................. 120
PS3 - INSULATION CO-ORDINATION AND LIGHTNING INTERFERENCE ANALYSIS: CHALLENGES, OPPORTUNITIES AND ADVANCES ......................................................... 123
C5 - ELECTRICITY MARKETS AND REGULATION .................................................... 126
PS1 - CHARACTERISTICS OF A RESILIENT MARKET AND ITS REGULATORY REGIME 126
PS2 - PREPARING FOR THE FUTURE WITH MOVING TARGETS ................................. 127
PS3 - EMERGING MARKETS AND FORMS OF MARKETS ........................................ 131
C6 - ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES .. 133
PS1 - FLEXIBILITY MANAGEMENT IN DISTRIBUTION NETWORKS .................... 133
PS2 - POWER ELECTRONIC BASED SOLUTIONS FOR SMART DISTRIBUTION SYSTEMS ................................................................. 140
PS3 - RURAL, ISLANDED AND INDUSTRIAL ELECTRIFICATION STANDARDS, PRACTICES AND TECHNOLOGY OPTIONS ......................................................................................... 142
D1 - MATERIALS AND EMERGING TEST TECHNIQUES ........................................... 144
PS1 - TESTING, MONITORING AND DIAGNOSTICS .............................................. 144
PS2 - MATERIALS FOR ELECTROTECHNICAL TECHNICAL PURPOSES AND MODELLING 149
PS3 - MATERIALS TO ENABLE THE ENERGY TRANSITION ...................................... 152
<table>
<thead>
<tr>
<th>ID: 10306</th>
<th>A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> A1 PS1 - Rotating Electrical Machines and the Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Keywords:</strong> Nuclear turbogenerators, Grid, PV production, Power capability, technical features</td>
<td></td>
</tr>
<tr>
<td><strong>The benefits of nuclear turbogenerators for grids of the future</strong></td>
<td></td>
</tr>
<tr>
<td>Herve BIELLMANN¹, Florent CHARVET¹, Jacques MARCHAND¹, Martin TOULEMONDE¹, Stephane BRAEM², Vincent DUBS², Baptiste GUIDOUX², Vincent FERNAGUT², Thierry VINAS²</td>
<td></td>
</tr>
<tr>
<td>¹General Electric, France; ²EDF, France</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10692</th>
<th>A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> A1 PS1 - Rotating Electrical Machines and the Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Keywords:</strong> International Standard; Hydro-Generators; Motor-Generators; IEC 60034-33; Pumped storage</td>
<td></td>
</tr>
<tr>
<td><strong>Insights to the new IEC 60034-33 – The Standard for Hydro-Generators and Motor-Generators for Pumped Storage</strong></td>
<td></td>
</tr>
<tr>
<td>Thomas HILDINGER</td>
<td></td>
</tr>
<tr>
<td>Brazilian NC of CIGRE, Brazil; Voith Hydro</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10904</th>
<th>A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> A1 PS1 - Rotating Electrical Machines and the Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Moneypoint Synchronous Condenser and Flywheel - A Zero Carbon Solution to Increasing Renewables and Improving Resilience on the Irish Electricity Grid</strong></td>
<td></td>
</tr>
<tr>
<td>Katie WALL, Ruairí COSTELLO</td>
<td></td>
</tr>
<tr>
<td>Electricity Supply Board (Ireland)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11031</th>
<th>A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> A1 PS1 - Rotating Electrical Machines and the Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Practical Experience with the Thermal Evaluation and Classification of Type II Machine Insulation Systems according to IEC 60034-18-31</strong></td>
<td></td>
</tr>
<tr>
<td>Hans BÄRNKLAU², Lena M. ELSPASS¹, Stephan SCHLEGEL¹, Kai NEIKES², Jens PROSKE²</td>
<td></td>
</tr>
<tr>
<td>¹Technische Universität Dresden, Germany; ²VEM Sachsenwerk GmbH, Germany</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11065</th>
<th>A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> A1 PS1 - Rotating Electrical Machines and the Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Incorporating Fibre Optic Arc Flash Detection into a Conventional Generator Protection Scheme</strong></td>
<td></td>
</tr>
<tr>
<td>James DASH, Len GUNN</td>
<td></td>
</tr>
<tr>
<td>Origin Energy, Australia</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11102</th>
<th>A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> A1 PS1 - Rotating Electrical Machines and the Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Synchronous Condenser to Ensure Stable, Reliable And Quality Power in Renewable Energy Rich Regions – India Perspective</strong></td>
<td></td>
</tr>
<tr>
<td>D.K. CHATURVEDI</td>
<td></td>
</tr>
<tr>
<td>NTPC</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11271</th>
<th>A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> A1 PS1 - Rotating Electrical Machines and the Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Challenges in Core Flux test of Large Hydro Generators with natural frequency near to Power Frequency</strong></td>
<td></td>
</tr>
<tr>
<td>Vipin GUPTA, Ashwatthama TIWARY*, Randhir KUMAR*, Sanjeeb BAG</td>
<td></td>
</tr>
<tr>
<td>NHPC Limited, India</td>
<td></td>
</tr>
</tbody>
</table>
**A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers**

**Topics:** A1 PS1 - Rotating Electrical Machines and the Energy Transition

**Design individualization of an air-cooled synchronous condenser with directly water-cooled stator winding due to varying market requirements for grid stabilization services**

Monja EVENKAMP, Hendrik STEINS, Uwe EICKELBECK, Moritz ACKERMANN  
Siemens Energy Global GmbH & Co. KG, Germany

**Measurement and Practical Applications of Magnetic Flux Sensors by Radial and Tangential Axis in Synchronous Generator-Motors**

Oleg AGAMALOV  
Tashlyk Pump-Storage Power Plant (TPSPP)

---

**PS2 - EVOLUTION AND DEVELOPMENT**

**Rotating diode rectifier, machine, diode failure, frequency, digital signal processor**

Marc FLORES, Luc TEMPLIER, Léo PERDRIEL  
EDF Hydro DTG, France

---

**Damping local and inter-area oscillations with synchronous compensators: a fundamental study**

Luis ROUCO, Jorge SUÁREZ, Fidel FERNÁNDEZ-BERNAL, Lukas SIGRIST  
ETS ICAI-IT Universidad Pontificia Comillas, Spain

---

**On the Design of Salient Pole Synchronous Machine to Operate Strictly as Synchronous Condensers**

Jorge Johnny ROCHA ECHEVERRIA, Mauro UEMORI  
Brazilian NC of CIGRE, Brazil; Trassínio Consultoria Ltda.

---

**Retrofit to 2 x 303MW Doubly-Fed Asynchronous Machine (DFAM) System at Oku-Tataragi Pumped Hydro Power Plant of Kansai Electric Power Co.**

Akira BANDO¹, Toshinari FUJII², Shinji ONO², Osamu NAGURA³, Masayuki OKADA³, Tomohiro YANO³  
¹HM Hydro Corp., Japan; ²Kansai Electric Power Co., Japan; ³Hitachi, Ltd., Japan

---

**Development and design of an air-cooled 944.5 MVA hydro-generator**

Thomas HILDINGER, Gunar KLAUS, Babette SCHWARZ, Georges MORONIS, Stefan ALLGEYER  
Voith Hydro, Germany
Qualification of a HV-Insulation System according IEC 60034-18-42 for a Hydro-generator Operating with Inverter Technology

Thomas HILDINGER¹, Christian STAUBACH²
¹Voith Hydro, Germany; ²Hochschule Hannover, Germany

Design Aspects of Synchronous Condensers
Gerfried MAIER, Serdar KADAM
Andritz Hydro

Development of Engine Mounted Generators for Eco-Friendly Onboard Power Generation in Marine Applications
Sándor Rajmund HORVÁTH
HD Hyundai Electric Hungary Ltd.

Fatigue breaking mechanism study at the coils connections of a stator winding and at the magnetic core fasteners
Aymen AMMAR¹, Thibaud FANGET², Romain SEIGNEURET²
¹JEUMONT ELECTRIC, France; ²EDF (DTG CNEPE), France

Use of Non-Destructive Tests (NDT) for synchronous condensers flywheel inspection
Gianluigi GEMELLI¹, Alessandro DEL GRACCO¹, Mauro GAMBASSI¹, Roberto SPEZIE¹, Andrea VALANT¹, Enrico VELLucci¹, Giuseppe NARDONI², Pietro NARDONI², Marco FEROLDI²
¹TERNA; ²I&T Nardoni Institute, Italy

Detection of Generator Earth-brush Fault Types from Shaft Voltage and Currents Measurements to monitor the performance of Earthing Brushes
Oupa MAILULA
Eskom Research, Testing & Development

Deep learning applied to bearing anomaly detection using advanced signal processing techniques
Marcos NISHIOKA, Gustavo G. de SOUZA, Tiago MATSUIO, Emerson LIMA DO NASCIMENTO, Vitor POHLENZ
Brazilian NC of CIGRE, Brazil; AQTECH
<table>
<thead>
<tr>
<th>ID: 10701</th>
<th>A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A1 PS3 - Keeping the Lights on</td>
<td></td>
</tr>
<tr>
<td>Keywords: Corona Effect; Corona Discharges; Corona glove; Partial Discharges; Relief Interface</td>
<td></td>
</tr>
<tr>
<td><strong>Reconfiguration of the Corona Prevention System and Application to a Practical Case</strong></td>
<td></td>
</tr>
<tr>
<td>Paulo VILHENA¹, Renan DUARTE¹, Fernando BRASIL¹, Jorge Johnny ROCHA ECHEVERRIA², Mauro UEMORI²</td>
<td></td>
</tr>
<tr>
<td>¹Brazilian NC of CIGRE, Brazil; Eletrobras Eletronorte; ²Brazilian NC of CIGRE, Brazil; Trassinio Consultoria</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10702</th>
<th>A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A1 PS3 - Keeping the Lights on</td>
<td></td>
</tr>
<tr>
<td>Keywords: Synchronous Compensator, Short Circuit, Stator, Maintenance</td>
<td></td>
</tr>
<tr>
<td><strong>The painful (and expensive) experience of having to remedy an avoidable stator failure</strong></td>
<td></td>
</tr>
<tr>
<td>Rafael FERREIRA, André GARGHETTI</td>
<td></td>
</tr>
<tr>
<td>Brazilian NC of CIGRE, Brazil; CGT Eletrosul</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10865</th>
<th>A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A1 PS3 - Keeping the Lights on</td>
<td></td>
</tr>
<tr>
<td>Keywords: Synchronous generator, Non-contact sensor, Condition monitoring and diagnosis, Partial discharge</td>
<td></td>
</tr>
<tr>
<td><strong>Application of Non-contact On-line Partial Discharge Monitoring System to Hydro Generator</strong></td>
<td></td>
</tr>
<tr>
<td>Tomoaki TAKAHASHI, Makoto TAKANEZAWA, Takashi HARAKAWA, Akira FUJIMOTO, Hirotaka TSUBAKIHARA, Hideyuki NAKAMURA</td>
<td></td>
</tr>
<tr>
<td>Toshiba Energy Systems &amp; Solutions Corporation, Japan</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11047</th>
<th>A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A1 PS3 - Keeping the Lights on</td>
<td></td>
</tr>
<tr>
<td>Keywords: EL CID, low flux core test, electromagnetic core test, high flux core test, high frequency, hot spot, interlaminar insulation, core fault, stator core</td>
<td></td>
</tr>
<tr>
<td><strong>Low Flux Core Testing of Rotating Electrical Machines at Elevated Excitation Frequencies</strong></td>
<td></td>
</tr>
<tr>
<td>Nick STRANGES¹, Mladen SASIC¹, David R BERTENSHAW²</td>
<td></td>
</tr>
<tr>
<td>¹QUALITROL® LLC - Iris Power, Canada; ²ENELEC LTD, United Kingdom</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 111047</th>
<th>A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A1 PS3 - Keeping the Lights on</td>
<td></td>
</tr>
<tr>
<td>Keywords: diagnostics, hydrogenator, stator to rotor eccentricity, vibration and air-gap measurements</td>
<td></td>
</tr>
<tr>
<td><strong>Mechanical Diagnostic Campaign of a 415 MW Vertical Francis Hydro-Unit</strong></td>
<td></td>
</tr>
<tr>
<td>Ozren ORESKOVIC¹, Ozren HUZNJAK¹, Damijan CERINSKI², Andrija KOSTELAC³, Lucas Eduardo GUNE⁴</td>
<td></td>
</tr>
<tr>
<td>¹Veski Ltd Croatia; ²4-cube Croatia; ³Visum Energy Croatia; ⁴Hidroeléctrica de Cahora Bassa Mozambique</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11172</th>
<th>A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A1 PS3 - Keeping the Lights on</td>
<td></td>
</tr>
<tr>
<td><strong>Evaluation and Assessment of Operational Data for Condition Based Service Interventions on Synchronous Machines</strong></td>
<td></td>
</tr>
<tr>
<td>Sven MUSIELAK, Hendrik STEINS, Jan HOFFMANN, Moritz ACKERMANN</td>
<td></td>
</tr>
<tr>
<td>Siemens Energy Global, Germany</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 111813</th>
<th>A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A1 PS3 - Keeping the Lights on</td>
<td></td>
</tr>
<tr>
<td>Keywords: Burn-out test, Generator stator, Ground fault generator, Locate phase-to-ground fault</td>
<td></td>
</tr>
<tr>
<td><strong>Locate Generator Stator Phase-to-ground Fault Point by Burn-out Test</strong></td>
<td></td>
</tr>
<tr>
<td>Aticha WONGKHAMLA, Passapong PORNPHACHARAPUN, Yodsanon WITITTHUMAKUN, Apichart PALATORNPARIRUK</td>
<td></td>
</tr>
<tr>
<td>Electricity Generating Authority of Thailand (EGAT), Thailand</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 111853</th>
<th>A1 POWER GENERATION AND ELECTROMECHANICAL ENERGY CONVERSION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A1 PS3 - Keeping the Lights on</td>
<td></td>
</tr>
<tr>
<td>Keywords: Wind Turbine Maintenance; Automated Diagnostics; Pitch Imbalance; Vibration Analysis</td>
<td></td>
</tr>
<tr>
<td><strong>Case Study: How Pitch Imbalance May Affect Vibration and Performance in a Wind Turbine</strong></td>
<td></td>
</tr>
<tr>
<td>Marcos H. N. NISHIOKA, Emerson L. do NASCIMENTO, Vitor POHLENZ, Tiago K. MATSUO</td>
<td></td>
</tr>
<tr>
<td>AQTech Brazil</td>
<td></td>
</tr>
</tbody>
</table>
Impact of Front of Wave Impulse Testing on Dielectric Design of Transformer

Dharam VIR, Pradeep RAMASWAMY, Tim ROCQUE, Ajith VARGHESE
Prolec-GE Waukesha, United States of America

Comparison of Structural Strength of UHV AC Transformers with Different Outgoing Modes under Arc Fault in Oil

Yikun ZHAO1, Ke WANG1, Jinxhong LI2, Shuqi ZHANG1, Jiaxi Li1
1China Electric Power Research Institute,China; 2State Grid Corporation of China,China

Research on the Static Stress Distribution of Winding Transposition Structure under External Short-circuit Fault

Yi ZHAO1, Tao WEN1, Weijiang CHEN2, Guangjin ZHANG3, Ke WANG4, Jinxhong LI2
1Hefei university of technology,China; 2the State Grid Corporation of China,China; 3Xi'an Jiaotong University,China; 4China Electrical Power Research Institute,China

Transformer Winding Deformation Monitoring Technology Based on Distributed Fiber Optic

Peng LI, Zhengyu XU, ZuoXian WANG, Shuqi ZHANG, Huanchao CHENG
CEPRI,China

Research on Analysis for Fire and Explosion Prevention Capability of Large Transformers and its Improvement Measures

Jun DENG, Zhicheng XIE, Zhicheng PAN, Haibin ZHOU
China Southern Power Grid, Co., Ltd., China

Insulating liquid requirements for power transformers

Christophe PERRIER, Marielle MARUGAN, Sébastien LOUISE, Juliette SULPICE
GE Grid Solutions, France

Stresses on Power Transformers in Floating Offshore Applications

Triomphant NGNEGUEU1, Max GILLET1, Vivekkumar CHAUBEY2, Rupesh DARIPA2, Oguzkan SENTURK3, Tobias STIRL4, Jian ZHANG5, Hongbiao SONG6
1Grid Solutions, GE Vernova, France; 2Grid Solutions, GE Vernova, India; 3Grid Solutions, GE Vernova, Turkey; 4Grid Solutions, GE Vernova, Germany; 5Grid Solutions, GE Vernova, China; 6Grid Solutions, GE Vernova, USA
**Natural Ester in Arc-Furnace Transformers for Steel Production**

Fabio SCATIGGIO, Rainer FROTSCHER, Cristian CHITTARO, Fabrizio FERRARI, Giorgio CAMPIL, Daniele GIRO, Luca LOMBINI

1 A&A Fratelli Parodi, IT; 2 Maschinefabrik Reinhausen GmbH; 3 BS Acciaierie Bertoli Safau; 4 Tamini Trasformatori S.r.l.; 5 A&A Fratelli Parodi SpA

**Thermal and Electrical Designs of Transformers by Considering Different Insulating Liquids**

Qiang LIU, Sicheng ZHAO, Haichuan YU, Zhongdong WANG, Mark WILKINSON, Massimo NEGRO, Christoph KRAUSE, Andree HILKER, Ed Van SCHAIK, Muhammad DAGHRAH, Attila GYORE

1 The University of Manchester UK; 2 SGB-SMIT Group Netherlands; 3 Weidmann Electrical Technology AG Switzerland; 4 Shell Global Solutions Germany; 5 Shell Downstream Services International BV Metherland; 6 M&I Material Ltd UK

**Challenges regarding Factory acceptance Test of large offshore Shunt Reactors**

Daniel WIKBERG

Hitachi Energy Sweden AB, Sweden

**GIC Field Test on 500 kV Single-Phase Transformers**

Bart SIMONS, Luc DORPMANNS, Roland BRANDIS, Adedasola A. ADEMOLA, Andy SCHUETZINGER, Robert ORNDORFF, Marlu DEVERICK, Francisco VELEZ-CEDENO, Katelynn VANCE, Micah J. TILL, Mike LAMB, Matthew GARDNER, Emanuel BERNABEU

1 Royal SMIT Transformers B.V.; 2 Dominion Energy; 3 PJM

**Dynamic model analysis of shell power transformers under short circuit vibration and the influence in the tank design**

Miguel AGUIRRE, Daniel GARCÍA-VALLEJO, Jesús VÁZQUEZ, Carlos NAVARRO, Jaime DOMÍNGUEZ-ABASCAL

1 Hitachi Energy, Spain; 2 University of Seville, Spain

**Design of transformers suitable for different insulating liquids**

Andres AGUADO, Izaskun ARICETA, Diego LUMBRERAS, Miguel MARTINEZ

i-DE Redes Eléctricas Inteligentes, Spain

**Transformer Sustainable Refurbishment for Ultra Long-Life**

Ed TENYENHUIS, Lars Andreas ERIKSSON, Goizeder PAJARO

1 Hitachi Energy, Canada; 2 Hitachi Energy, Norway; 3 Hitachi Energy, Spain
Resilient Transformers – holistic Approach considering Aspects in Operation, Maintenance and Design
Radoslaw SZEWCZYK1, Jean-Claude DUART2, Anastasia O’MALLEY3, Robert MAYER4, Ewald SCHWEIGER5
1DuPont, Poland; 2DuPont, Switzerland; 3Consolidated Edison Co. of NY, USA; 4Siemens Energy, Austria; 5Siemens Energy, Germany

Optimized design methodology of a resilient power transformer
Mphumuzi KHOZA
ACTOM HIGH VOLTAGE EQUIPMENT

Multidisciplinary approach to achieving resilient transformers – an end user perspective
Sidwell MTETWA
Eskom Holdings SOC Limited

Swiss Experience in IEC Short Circuit Testing of Distribution Transformers
Marcel STOECKLI1, Bruno BOSNJAK*2, Rolf FLURI3, Davide BOTTA2
1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2Rauscher & Stoecklin AG, Switzerland; 3R&S Group, Switzerland

Design evaluations with advanced insulation systems for resilient transformers
Marcel STOECKLI1, Jean-Claude DUART*2, Radoslaw SZEWCZYK3, Peter HATOS4, Marco MILONE4, Frank KUEBLER5
1ELECTROSUISSE / CIGRE Switzerland NC Secretary; 2DuPont, Switzerland; 3DuPont, Poland; 4SBG-SMIT Group GmbH, Germany; 5Krempel, Germany

GIC Test with Mock-up Transformer for Verification of Temperature Rise Calculation
Heesung YOON, Myung Gong SOHN, Tae Sung PARK, Cheul Hyeok CHANG, Woo Heng HEO
Hyosung Heavy Industries, Korea, Republic of (South Korea)

Power Transformer Protection against Geomagnetic Induced Currents: Thyristor Neutral Earthing
Aleksandr KHRENNIKOV1, Alexey KUVSHINOV2, Vera VAKHNINA2
1S&T Centre of Rosseti FGC UES, Russian Federation; 2Togliatti State University, Russian Federation

Identification of Switching Operations Leading to Harmful Fast Transient Overvoltages in Power Transformers Windings
Vasily LARIN1, Anton ZHUYKOV2, Daniil MATVEEV3, Mikhail FROLOV3, Andrey SELIKHANOVICH4, Alexander SMIRNOV5
1VEI – branch of RFNC-VNIITF, Russian Federation; 2FACTS Plus, LLC, Russian Federation; 3National Research University «MPEI», Russian Federation; 4BO-Energo, LLC, Russian Federation; 5SMTT High-Voltage Solutions, LLC, Russian Federation
Specifications for a Calculation Procedure to Achieve an Adequate Arc-Resistant Design for Power Transformers and Reactors

Jean-Bernard DASTOUS
Hydro-Québec, Canada

On-site GIC withstand experiment on a 1000 MVA 3-limb autotransformer and a 300 MVA 5-limb transformer Part 1: Design, Modelling, Instrumentation, DAQ and Testing

Roald KLEIVI1, Dietrich BONMANN2, Claes CARRANDER3, Geir Morten BJØRKVIK4, Dejan SUSA5
1Statnett; 2Hitachi Energy Germany; 3Hitachi Energy Sweden

Flexible Transformers for Resilient and Adaptable Power Systems

Enrique BETANCOURT-ROMIREZ1, Juan Gonzalo CASTELLANOS-GONZALEZ2, Omar MENDEZ-ZAMORA3, Ibrahima NDIAYE4
1Prollec-GE International, Mexico; 2GE Research, USA

On-site GIC withstand experiment on a 1000 MVA autotransformer and a 300 MVA 5-limb transformer Part 2: Measurements and Evaluation

Dietrich BONMANN1, Roald KLEIVI2, Claes CARRANDER3
1Hitachi Energy Germany AG, Germany; 2Statnett Norway; 3Hitachi Energy Germany AG, SVEDEEN

Summary of In-Service Assessment of Synthetic Ester Filled Transformers

Muhammad DAGHRAH1, Rafat AL JARRAH2, Ayham BAKHEER3
1M&I Materials Ltd UK; 2Princess Sumaya University for Technology Jordan; 3Jordan Electric Power Company Ltd Jordan

Design of rupture-proof transformers equipped with on-load tap-changer in the event of internal arc failures

Moritz BENGLER1, Michael STEMLINGER1, Marc FOATA1, Sebastian REHKOPF1, Ewald TASCHLER5, Martin STOESSL2, Monther SAR12
1Maschinenfabrik Reinhausen GmbH; 2Siemens Energy Austria GmbH

Seismic strengthening of large-capacity transformers and methods of diagnosis in the event of a huge earthquake

Atsushi ETO, Keisuke YOKOHATA, Yuki ISHIKAWA
TEPCO Power Grid, Inc., Japan

Short Circuit Tested Power Transformer FAT Healthiness check

Minal KATARIA*, D K Marghade MARGHADE, Sunil Kumar LAL
NTPC, India
### Indian Experience of Reactive Power Compensation at 220kV Grid using Variable Shunt Reactor (VSR) for Voltage Stability

Ayyaj MANER*, Manali SARVANKAR*, Raitu HASSAN, Vini VAZHAPPULLY, Sonu KAREKAR, Mahesh AMBARDEKAR
Adani Electricity, India

### EDF specifications for hydro power transformers

OLivier VACHERON¹, Mohamed RYADI², Dominique SOUIRE¹, Jean SANCHEZ³
¹EDF CIH, France; ²EDF LAB, France; ³EDF DTG, France

### Calculation of Internal Transformer Overvoltages for Non-Standard Impulse Waveforms

Zvonimir JURKOVIC¹, Bruno JURISIC¹, Mladen MARKOVIC², Tomislav ZUPAN¹
¹Končar – Electrical Engineering Institute Ltd, Zagreb, Croatia; ²Končar – Distribution and Special Transformers Inc. Zagreb, Croatia

### Calculation and visualization of forces on leads during short circuit of a large offshore power transformer with axially split dual MV windings

Igor TELALOVIĆ
Končar Power Transformers Ltd. – A Joint Venture of Siemens Energy and Končar Croatia

### DC Injection Testing on In-Service Power Transformers for Replicating GIC

Soren SUBRITZKY¹, Andrew LAPTHORN¹, Stewart HARDIE¹, Michael DALZELL²
¹University of Canterbury, New Zealand; ²Transpower New Zealand

### Modelling of Dual-Core Phase Shifting Transformer in ATP-EMTP environment

Gabriele TRESSO, Luca BUONO, Pierluigi VACANTE, Lorenzo PAPI, Gaia LEONE, Franco DI BONA, Daniele DIFINO, Francesco PALONE
Terna S.p.A. Italy

### Impact of Cellulose Degradation on Space Charge Dynamics and Conductivity of Synthetic Ester Liquid-Impregnated Kraft Paper Insulation

Abdelrahman ALSHEHAWY
University of Exeter, United Kingdom
| ID: 10126 | A2 POWER TRANSFORMERS AND REACTORS - Full Papers |
|-----------------------------------------------|
| **Topics:** A2 PS2 - Advances in Transformer Analytics |
| **Keywords:** Powers transformers, maintenance, critical outage, technical policies, strategy |
| **RTE’s Large Power Transformers: new fleet management strategy** |
| Abasse TIMERA1, Rudy BLANC1, Benoît IZAC2, Philippe CLAUDE3 |
| 1RTE France Substation Expertise Dpt., France; 2RTE France Asset Management Dpt., France; 3RTE France R&D Dpt., France |

| ID: 10158 | A2 POWER TRANSFORMERS AND REACTORS - Full Papers |
|-----------------------------------------------|
| **Topics:** A2 PS2 - Advances in Transformer Analytics |
| **Keywords:** Powers transformers, maintenance, critical outage, technical policies, strategy |
| **Vibration Characteristics and Typical Mechanical Failure Analysis of Converter Transformer** |
| Zhicheng PAN, Jun DENG, Zhicheng XIE, Haibin ZHOU |
| China Southern Power Grid, Co., Ltd., China |

| ID: 10317 | A2 POWER TRANSFORMERS AND REACTORS - Full Papers |
|-----------------------------------------------|
| **Topics:** A2 PS2 - Advances in Transformer Analytics |
| **Keywords:** Degree of Polymerization, Dielectric Frequency Response, Insulation Transformers, Mineral Oil, Moisture |
| **Analysis of Non-accelerated Thermal Aging of Model Windings Immersed in Mineral Oil and Natural Ester** |
| Diego ROBALINO1, Matias MEIRA2, Raul ALVAREZ3, Fabio SCATIGGIO4 |
| 1MEGGER, United States of America; 2INTELYMEC (UNCPBA), Argentina; 3ITREE-FI-UNLP, Argentina; 4A&A Fratelli Parodi SpA, Italy |

| ID: 10318 | A2 POWER TRANSFORMERS AND REACTORS - Full Papers |
|-----------------------------------------------|
| **Topics:** A2 PS2 - Advances in Transformer Analytics |
| **Keywords:** Transformer Aging, Life Assessment, Digital Twin, Numerical Simulation |
| **Power Transformer Digital Twin: Incorporating Thermodynamic and Water Diffusion Discrete Elements Model for Enhanced Aging Calculation** |
| Alan SBRAVATI, Luiz V. CHEIM, Mauricio SOTO |
| Hitachi Energy, United States of America |

| ID: 10403 | A2 POWER TRANSFORMERS AND REACTORS - Full Papers |
|-----------------------------------------------|
| **Topics:** A2 PS2 - Advances in Transformer Analytics |
| **Keywords:** Dissolved Gas Analysis, Data Analytics, Power Transformer, Asset Management, Trend Detection, Rate of Change, Anomaly Detection. |
| **Data Analytics for Transformer Dissolved Gas Analysis to Aid Asset Management** |
| Zhongdong WANG1, Thathsara HERATH1, Qiang LIU1, Gordon WILSON2, Ruth HOOTON2, David WALKER3, Timothy RAYMOND4, Luke van der ZEL5 |
| 1The University of Manchester UK; 2National Grid Electricity Transmission UK; 3SP Energy Network UK; 4Electric Power Research Institute USA |

| ID: 10404 | A2 POWER TRANSFORMERS AND REACTORS - Full Papers |
|-----------------------------------------------|
| **Topics:** A2 PS2 - Advances in Transformer Analytics |
| **Keywords:** Statistical Model – Data Mining – Polychlorinated Biphenyls – Asset Management – Pole Mounted Transformers |
| **Data Mining for Targeted PCBs Management of Pole Mounted Transformers** |
| ShengJi TEE, David NEILSON, Matthew JONES, Malcolm BEBBINGTON |
| SP Energy Networks UK |

<p>| ID: 10410 | A2 POWER TRANSFORMERS AND REACTORS - Full Papers |
|-----------------------------------------------|
| <strong>Topics:</strong> A2 PS2 - Advances in Transformer Analytics |
| <strong>Keywords:</strong> Power Transformer, CFD, Windings, Natural Ester |
| <strong>Analysis of Simplifications and Accuracy of a Thermal-hydraulic Model of Core-type Power Transformer Winding</strong> |
| Sandra COUTO, João SILVA, Beatriz OLIVEIRA, Catarina SOUSA, Ricardo CASTRO LOPES |
| Power Transformers R&amp;D, Efacec Energia S.A., Portugal |</p>
<table>
<thead>
<tr>
<th>ID: 10411</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
<tr>
<td>Keywords: Hot-Spot Temperature, Hot-Spot Location, HST, Natural Ester</td>
<td></td>
</tr>
<tr>
<td><strong>Evaluation of the Hot-Spots’ Location during Dynamic Loading of a Natural Ester Cooled Power Transformer</strong></td>
<td></td>
</tr>
<tr>
<td>Beatriz OLIVEIRA, Catarina CORTE-REAL, João SILVA, Sandra COUTO, Ricardo CASTRO LOPES</td>
<td></td>
</tr>
<tr>
<td>EFACEC Energia, S.A., Portugal</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10488</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
<tr>
<td><strong>Artificial Intelligence in Transformer Manufacturing</strong></td>
<td></td>
</tr>
<tr>
<td>Robin AXELSSON</td>
<td></td>
</tr>
<tr>
<td>Hitachi Energy Sweden AB, Sweden</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10612</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
<tr>
<td>Keywords: online bushing monitoring, network unbalance, measuring uncertainty of isolation coefficients, cyber security</td>
<td></td>
</tr>
<tr>
<td><strong>Application of Online Bushing Monitoring With Low Measurement Uncertainty</strong></td>
<td></td>
</tr>
<tr>
<td>Marek ANDRZEJEWSKI¹, Wiesław GIL¹, Maciej LECHMAN², Wiktor MASŁOWSKI³, Piotr RYTKA²</td>
<td></td>
</tr>
<tr>
<td>¹MIKRONIKA, Poland; ²PSE S.A., Poland</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10661</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
<tr>
<td><strong>The evolution of power transformer appraisal methodology towards an effective and efficient risk assessment for the South African power utility</strong></td>
<td></td>
</tr>
<tr>
<td>Sidwell MTETWA</td>
<td></td>
</tr>
<tr>
<td>Eskom Holdings SOC Limited</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10663</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
<tr>
<td><strong>The usefulness of capacitive moisture sensors in online gas analysers</strong></td>
<td></td>
</tr>
<tr>
<td>Carl WOLMARANS</td>
<td></td>
</tr>
<tr>
<td>GE Vernova M&amp;D</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10691</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
<tr>
<td><strong>Non-uniform winding Temperature Distribution in directed cooling Mode</strong></td>
<td></td>
</tr>
<tr>
<td>Tor LANERYD</td>
<td></td>
</tr>
<tr>
<td>Hitachi Energy Sweden AB, Sweden</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10706</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
<tr>
<td>Keywords: Power Transformer, Renewables, Thermo-Chemical Evaluation, Aging, Dynamic rating</td>
<td></td>
</tr>
<tr>
<td><strong>Dynamic Loading of Transformers in Renewable Energy Generation: A Comparison of Traditional Methods and a Novel Thermo-Chemical Evaluation of Transformers Ageing</strong></td>
<td></td>
</tr>
<tr>
<td>Wilerson CALIL, Alan SBRAVATI, Luiz V. CHEIM</td>
<td></td>
</tr>
<tr>
<td>Brazilian NC of CIGRE, Brazil; HITACHI ENERGY</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10841</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
<tr>
<td>Keywords: Transformers, Thermal hydraulic network model, Dynamic thermal modelling</td>
<td></td>
</tr>
<tr>
<td><strong>Advancements in Dynamic Thermal Modelling of Power Transformers: Integrating Detailed Thermal Hydraulic Network Models</strong></td>
<td></td>
</tr>
<tr>
<td>Patrick PICHER², Federico TORRIANO¹, Zoran RADAKOVIC², Marko NOVKOVIC²</td>
<td></td>
</tr>
<tr>
<td>¹Hydro-Québec, Canada; ²University of Belgrade, Serbia</td>
<td></td>
</tr>
</tbody>
</table>
Thermal Modeling of Power Transformer and Shunt Reactor Using Physics-Informed Neural Networks

Jhelum CHAKRAVORTY1, Michele LUVISOTTO2, Nicolo RIPAMONTI1, Tor LANERYD2, Annamalai LAKSHMANAN3
1Hitachi Energy Research, Canada; 2Hitachi Energy Research, Sweden; 3Hitachi Energy Research, Switzerland

Detecting degraded bushings with DFR – A case study

Lars Andreas ERIKSSON1, Evgenii ERMAKOV2, Lars JONSSON2, Erik NICOLAISEN3
1Hitachi Energy Norway; 2Hitachi Energy Sweden; 3Statnett

Monitoring Clamping Pressure in 40 MVA Power Transformer: A Study of Short and Long-Term Trends

Inge MADSHAVEN1, Henrik ENOKSEN1, Stefan JAUFER2, Christoph KRAUSE2, Borut PRASNIKAR3, Asgeir MJELVE4, Alexander REITBAUER5, Mohamed RYADI6
1SINTEF Energy Norway; 2Weidmann Switzerland; 3Kolektor Etra Slovenia; 4Eliva Norway; 5Siemens Energy Austria; 6EDF France

Improvement and Validation of IEC dynamic Transformer thermal Model

Tim GRADNIK1, Xiang ZHANG2, Irina LUPANDINA3, Remi DESQUIENS4, Alvare PORTILLO5, Patrick PICHÉ7
1Elektroinstitut Milan Vidmar (EIMV)Slovenian engineering and scientific research organisation; 2Manchester Metropolitan University; 3Technische Universität Wien; 4EDF France; 5Independent researcher; 6Independent researcher; 7Hydro-Québec

The Good and Bad about Online Transformer DGA Monitoring

Varun GOYAL
Hydro One, Canada

Digital Transformation of Power-Transformer Solid-Insulation Drying Process

Gerardo TAMEZ-TORRES, Enrique BETANCOURT-RAMIREZ
Prolec-Ge International, Mexico

Modeling and Simulation to Analyze the Propagation of the Partial Discharge UHF Signals and Localization of Their Source in the Power Transformer

Djordje DUKANAC
Joint Stock Company "Elektromreza Srbije", Belgrade, Serbia

Steady State and Dynamic Thermal Performance of Liquid-Filled Distribution Transformers
ID: 11034
A2 POWER TRANSFORMERS AND REACTORS - Full Papers
Topics: A2 PS2 - Advances in Transformer Analytics

Results of Long-Term Monitoring for the Proof of Stability in the Switching Process of On-Load Tap-Changers based on Vibroacoustic Measurements

Karsten VIERECK1, Anatoli SAVELIEV1, Julia MASSMANN1, Johannes VEIT2
1Maschinenfabrik Reinhausen GmbH, Germany; 2Amprion GmbH, Germany

ID: 11056
A2 POWER TRANSFORMERS AND REACTORS - Full Papers
Topics: A2 PS2 - Advances in Transformer Analytics

Study on Estimation System of Partial Discharge Position in Oil/Gas Transformer

Byoung-Woon MIN, Danbi LEE, Jeong-Bok LEE, Kwang-Don BAE
HD Hyundai Electric, Korea, Republic of (South Korea)

ID: 11064
A2 POWER TRANSFORMERS AND REACTORS - Full Papers
Topics: A2 PS2 - Advances in Transformer Analytics

Australian and New Zealand transformer reliability analytics within the context of the international failure surveys

Daniel MARTIN1, Stefan TENBOHLEN2, Zeenat HANIF2, Chris BECKETT3
1Essential Energy, Australia; 2University of Stuttgart, Germany; 3United Energy, Australia

ID: 11151
A2 POWER TRANSFORMERS AND REACTORS - Full Papers
Topics: A2 PS2 - Advances in Transformer Analytics

Advancing Electrical Fault Diagnosis in Power Transformers with AI

David ALVAREZ1, Oswaldo ARENAS1, Jhonatan ANAYA1, Isabella ARANGO2
1ISA Intercolombia; 2Universidad Nacional

ID: 11174
A2 POWER TRANSFORMERS AND REACTORS - Full Papers
Topics: A2 PS2 - Advances in Transformer Analytics

Transformer Electromagnetic Modelling based on DC Hysteresis Measurements

Dennis ALBERT12, Alexander FRÖHLICH1, Sergey ZIRKA1, Johannes RAITH2
1Graz University of Technology; 2OMICRON electronics; 3Siemens Energy; 4Dnipro National University Ukraine

ID: 11187
A2 POWER TRANSFORMERS AND REACTORS - Full Papers
Topics: A2 PS2 - Advances in Transformer Analytics

A Reliable Future in Power Transformers and Reactors Through Proactive Bushing Management

Elkin CANTOR
ISA Intercolombia

ID: 11235
A2 POWER TRANSFORMERS AND REACTORS - Full Papers
Topics: A2 PS2 - Advances in Transformer Analytics

Detailed Study of Aging Shunt Reactors to Determine Suitable Maintenance and Replacement Strategies

Takashi YAMAMOTO, Ryo SAEKI, Atsushi ETO, Shunsuke TAMURA, Harukazu AKIYAMA, Yasuhiko HANAMAKI
TEPCO Power Grid, Inc., Japan
<table>
<thead>
<tr>
<th>ID: 11240</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
<tr>
<td><strong>Keywords:</strong> Transformer Diagnostics, Continuous Monitoring, Active Parts Deformation, Load Condition, Acceleration Sensor, Magnetic Sensor</td>
<td></td>
</tr>
</tbody>
</table>

**Power Transformer Diagnostics using Magnetic and Acceleration Sensors**

Kohei YAMAGUCHI, Mizuki OGI, Satoshi ICHIMURA, Yusuke TAKENAKA, Kota DOI  
Hitachi Ltd., Japan

<table>
<thead>
<tr>
<th>ID: 11243</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
<tr>
<td><strong>Keywords:</strong> Dissolved-gas-analysis, Fault-detection, Machine-learning, Oil-immersed-transformer</td>
<td></td>
</tr>
</tbody>
</table>

**Incipient fault detection method for oil-immersed transformer using time series data of dissolved gas analysis**

Shunichi HATTORI, Kosuke MIKUNI, Hiroshi MURATA, Taisei HOMMA, Satoru MIYAZAKI, Yoshinobu MIZUTANI  
Central Research Institute of Electric Power Industry, Japan

<table>
<thead>
<tr>
<th>ID: 11245</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
<tr>
<td><strong>Keywords:</strong> Aging, Diagnosis, Degree of polymerization, Power transformer, Thermally upgraded paper</td>
<td></td>
</tr>
</tbody>
</table>

**Diagnostic method for thermal deterioration of insulating paper used in power transformers based on winding temperature calculation**

Satoru MIYAZAKI, Yoshinobu MIZUTANI  
Central Research Institute of Electric Power Industry, Japan

<table>
<thead>
<tr>
<th>ID: 11274</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
</tbody>
</table>

**Determination of Short-Circuit Reactance of Transformers from Sweep Frequency Response Analysis Measurements**

Sreeram V*, Rajkumar M, Rajaramamohanarao CHENNU, T GURUDEV, S Sudhakara REDDY  
Central Power Research Institute, India

<table>
<thead>
<tr>
<th>ID: 11278</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
</tbody>
</table>

**Development of AI-ML based Reliability Centred Maintenance Framework for Power Transformers and Reactors in Powergrid**

Deo Nath JHA*, Amandeep SINGH, Devaprasad PAUL, Joseph George JOSE, P R S YADAV, Kuleshwar SAHU, Pradeep KUMAR  
Powergrid, India

<table>
<thead>
<tr>
<th>ID: 11290</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
</tbody>
</table>

**A novel approach in Development of Furan and Methanol-Based Accelerated Ageing Model for Power Transformers and Shunt Reactors**

Deo Nath JHA*, Rohit Kumar JAIN, P R S YADAV, Pradeep KUMAR  
POWERGRID, India

<table>
<thead>
<tr>
<th>ID: 11292</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
</tbody>
</table>

**AI-Driven Intelligent Objective Analysis of SFRA Signatures for EHV Transformers and Reactors**

Deo Nath JHA*, Maganti SIDDHARDHA, Akash TRIVEDI, Aakash KHANDELWAL, Keshav GUPTA  
POWERGRID, India

<table>
<thead>
<tr>
<th>ID: 11274</th>
<th>A2 POWER TRANSFORMERS AND REACTORS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> A2 PS2 - Advances in Transformer Analytics</td>
<td></td>
</tr>
</tbody>
</table>

**Practical Implementation of Two-Dimensional Transformer Fleet Management Approach based on an example of a German Utility.**

Alexei BABIZKI¹, Philipp BIRGMEIER¹, Martin GUTH¹, Rolf FUNK¹, Martin KNAPP²  
¹Maschinenfabrik Reinhausen GmbH, Germany; ²Rheinische NETZgesellschaft mbH, Germany
A2 POWER TRANSFORMERS AND REACTORS - Full Papers

**11432**

*Shared digital twins as approach for the data-sovereign collaboration between TSO and 3rd Party in the condition assessment of a transformer fleet*

Bastian FISCHER¹, Christian HOFMEISTER¹, Jochen JUNG², Michael GRATZA²

¹Maschinenfabrik Reinhausen GmbH, Germany; ²TenneT TSO GmbH, Germany

**11467**

*Advancing Transformer Condition Assessment through Fuzzy Logic*

Abdulla ALABBASI¹, Mohamed KHALIL²

¹Bahrain Center for Strategic International and Energy Studies, Bahrain; ²Doble Power Test, UK

**11518**

*Characteristic Evaluation and Performance Analysis for Cast Resin Transformer of Large Capacity*

Hongwoo JIN, Youngbae CHOI, Byungjun HWANG, Woonghee LEE, Jonggun LEE

HD Hyundai electric, Korea, Republic of (South Korea)

**11579**

*Requirement for reliable transformer diagnostics using Frequency Response Analysis (FRA)*

Evgenii ERMAKOV

Hitachi Energy Sweden AB, Sweden

**11585**

*Advances in Transformer Data Management and Analytics in Malaysian Grid Utility (TNB)’s Perspective*

Gobi Kannan SUPRAMANIAM, So’adiah NANYAN, Roslina YASSIN

Tenaga Nasional Berhad, Malaysia

**11647**

*Predicting oil quality to support asset management decisions using Markov chains*

Niklas SCHMIDT¹, Markus ZDRALLEK¹, Alexei BABIZKI², Karlheinz LINDL²

¹University of Wuppertal, Germany; ²Maschinenfabrik Reinhausen GmbH, Germany

**11675**

*Simulations and Measurements of Lightning Overvoltages Transferred Through Power Transformers*

Bruno JURISIĆ¹, Bozidar FILIPOVIC-GRCIĆ², Tihomir JAKOVIĆ¹, Tomislav ZUPAN¹

¹Končar – Electrical Engineering Institute Ltd. Zagreb Croatia; ²University of Zagreb Faculty of Electrical Engineering and Computing, Zagreb Croatia

**11726**

*A new method for health index calculation using power transformers as an example*

Mahmoud MOH'D, Henning SCHNITTKER, Peter WERLE

University of Hannover, Germany


**ID: 11742**
A2 POWER TRANSFORMERS AND REACTORS - Full Papers
Topics: A2 PS2 - Advances in Transformer Analytics

*Dielectric Condition Assessment Index of Power Transformer a Case Study at UIT-JBM Population*
Fermi TRAFIANTO, Indra KURNIAWAN, Didik Fauzi DAKHLAN, Ika SUDARMAJA
PT. PLN (PERSERO), Indonesia

**ID: 11792**
A2 POWER TRANSFORMERS AND REACTORS - Full Papers
Topics: A2 PS2 - Advances in Transformer Analytics

*Enhancing Power Transformer Transmission Reliability Evaluating and Strategizing Online Monitoring Implementation for Power Transformer in PLN*
Harry GUMILANG, Rahmat BETA, Andhy Dharma SETYAWAN, Tejo WIHARDIYONO
PT. PLN (Persero), Indonesia

**ID: 11842**
A2 POWER TRANSFORMERS AND REACTORS - Full Papers
Topics: A2 PS2 - Advances in Transformer Analytics

*Analysis of AC Transformer Reliability*
Stefan TENBOHLEN1, Dan MARTIN1
1Essential Energy; 2University of Stuttgart

**ID: 11865**
A2 POWER TRANSFORMERS AND REACTORS - Full Papers
Topics: A2 PS2 - Advances in Transformer Analytics

*Estimating the Dynamic Rating of Distribution Transformers using Digital Twins*
Saravanan BALAMURUGAN
Minaatral Power Systems Private Limited, India

---

**PS3 - RELIABILITY OF TRANSFORMERS FOR RENEWABLE ENERGY**

**ID: 10117**
A2 POWER TRANSFORMERS AND REACTORS - Full Papers
Topics: A2 PS3 - Reliability of Transformers for Renewable Energy

*1 How Charging Electric Vehicles Affects the Lifespan of Power Transformers : A Study from Aswan City*
Mohamed ORABI1, Al-Attar ALI1, Omar ABDEL RAHIM2, Mostafa ALI ELDAWY3
1Faculty of Engineering, Aswan University; 2Egypt-Japan University of Science and Technology; 3Upper Egypt Electricity Distribution Company

**ID: 10413**
A2 POWER TRANSFORMERS AND REACTORS - Full Papers
Topics: A2 PS3 - Reliability of Transformers for Renewable Energy

*Transforming the Future: The Innovative Design of Distribution Transformers*
Andrea SOTO1, Luis Filipe AZEVEDO2, Valter PIMENTA2, Ricardo CASTRO LOPES1, Fernando XAVIER1, Ricardo RIBEIRO1, Pedro Miguel SILVA1, Simão ALMEIDA1, Luis Almeno FERNANDES1
1Power Transformers R&D, Efacec Energia S.A., Portugal; 2Smart Power R&D, Efacec Energia, S.A., Portugal; 3Service R&D, Efacec Energia, S.A., Portugal

**ID: 10498**
A2 POWER TRANSFORMERS AND REACTORS - Full Papers
Topics: A2 PS3 - Reliability of Transformers for Renewable Energy

*Comparative analysis of Life Cycle Assessment methodology for a power transformer manufacturer’s transition to Circular Economy*
Filipa FARIA1, Beatriz TEIXEIRA2, Viviana PINTO1, Luis Almeno FERNANDES2, Ricardo RIBEIRO2
1INEGI, Portugal; 2Efacec Power Solutions, SGPS, S.A., Portugal
Experimental analysis of transient overvoltage protections in distribution transformers
Victor Manuel GARCÍA-CHOCANO, Antonio NOGUÉS
Hitachi Energy, Spain

Wind Farm Transformers. Relevance of FAT Tests for Safe and Reliable Operation
Raúl ALVAREZ1, Leonardo CATALANO1, Hernán MAYORA2, Pablo MORCELLE1, Tomas SCHMIDT1
1IITREE-FI-UNLP; 2FI-UNLP

The sustainability benefits of liquid cooled dry-type transformers in renewable energy and vent-closed applications
Luiz OLIVEIRA, Müge ÖZERTEN, Ghazi KABLOUTI, Antonio NOGUÉS
Brazilian NC of CIGRE, Brazil; HITACHI

Effects of Rooftop Photovoltaics on the Load Profile and Ageing of Distribution Transformers
Xin ZHONG1, Chandima EKANAYAKE1, Hui MA1, Tapan SAHA1, David FINK2, Greg CALDWELL2
1The University of Queensland; 2Energy Queensland Limited

Development of multi-windings power transformer in frequency regulation system
Jaeyong PARK, Hyeon Gu JEONG, Seo Hyun LEE, Min Gyu KIM, Jae Seop RYU, Chae Yoon BAE, Jang Cheol SEO
LS ELECTRIC, Republic of Korea

Investigation of the transformer winding shield design parameters on electrical performance
Serenay CURUKOVA KALE1, Oluş SONMEZ1, Yunus Berat DEMIROL2, Bora ALBOYACI3
1Sönmez Transformatör Türkiye; 2Genetek Güç&Enerji Türkiye; 3Kocaeli University Türkiye

Important Aspects of HV Dry Type Shunt Reactors in Comparison with Oil Immersed Shunt Reactors
Peter DOPPLMAIR1, Naveen BHARDWAJ1, Simon EL-KHOURY2
1Trench Group; 2RTE

Smart Solar Transformer
D K MARGHADE1, Minal KATARIA, A K GUPTA
NTPC LIMITED, India

Design, Reliability and Operational Consideration of Wind Turbine Generator Transformer
Koushik DAS1, Subir KARMAKAR
NTPC Limited, India
A2 POWER TRANSFORMERS AND REACTORS - Full Papers
Topics: A2 PS3 - Reliability of Transformers for Renewable Energy

Integration of Photovoltaic considering Dynamic Transformer Rating in the Distribution Grid Planning Process
Moritz FRANZ1, Martin BRAUN2, Jan WIEMER3, Denis MENDE1
1University of Kassel, Germany; 2Fraunhofer Institut für Energiewirtschaft und Energiesystemtechnik IEE & Universität Kassel, Germany

Enhancing Variable Shunt Reactors with a Power Electronic Fast-Switching Module
Ilya BURLAKIN1, Sebastian REHKOPF2, Elisabeth SCHEINER1, Gert MEHLMANN1, Matthias LUTHER1, Martin WOLFRAM2, Christian HURM2
1Friedrich-Alexander-University Erlangen-Nueremberg, Germany; 2Maschinenfabrik Reinhausen GmbH, Germany

A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT
PS1 - ENERGY TRANSITION INVOLVING T&D EQUIPMENT

Development of High Voltage Intelligent Fast Circuit Breaker
Zhijing LI1, Yu TIAN1, Jianwei WEI2, Bo LIU1, Sheng YIN3, Yang TIAN1, Jinghua JIANG1, Zhihua MA1, Qingchao SUN2, Kejia XIE1, Liyan ZHANG1, Enyuan DONG1
1China Electric Power Research Institute, China; 2Pinggao Group Co., Ltd., China; 3Shandong Taikai high voltage switchgear CO., LTD., China; 4Dalian University of Technology, China

Enhancing the Supporting Insulation Reliability in HVDC Gas Insulated Power Transmission Equipment based on Novel Ceramic Dielectrics
Bo QI1, Xiao YANG1, Mingcheng HUA1, Yi ZHANG1, Licheng LU2, Faqiang YAN3, Hao TANG4, Chengrong LI1
1North China Electric Power University, China; 2State Grid Smart Grid Research Institute Co. Ltd., China; 3Sinoma Jiangxi Electric Porcelain Electrical Co., Ltd., China; 4China Electric Power Research Institute, China

Key Technology Research, Prototype Development, and Engineering Application of Self-trigger/Self-discharge Gap for Fast Control of UHV DC/AC Controllable Arresters
Zhijing LI1, Ran ZHANG1, Xiaoang LI1, Xiaodong XU1, Huangguo ZHOU1, Jinyang LIN1, Ningbo ZHANG2, Wen WANG1
1China Electric Power Research Institute, China; 2Xi’an Jiaotong University, China

Research And Prospect Of High-speed Switch Fault Current Limiter
Rui CAO, Pei YUAN, Yishi YUE1, Yun LIU
State Grid Hunan Electric Power Company Limited Research Institute, China

Solidly Insulated Buses and Pluggable Connectors and Bushings for the Substations Modernization
Boris GUREVICH1, Can TAKAN2, Christian SPAETH2
1Exelon/ComEd, United States of America; 2Moser-Glaser Ltd., Switzerland; 3PFISTERER Kontaktysysteme GmbH, Germany
Frequency Response Modelling of Instrument Transformers: Validation of Simulation Results with Industrially Viable Tests
Urko ZATIKA LARRINAGA, Alvaro ZARANDONA ARRUE
Arteche Group, Spain

Development of an HVDC circuit-breaker and study of the requirements -Residual current interruption in multi-terminal HVDC system-
Takashi INAGAKI1, Motohiro SATO1, Frederick PAGE1, Simon NEE2, Tomas MODEER2, Staffan NORRGA2
1Mitsubishi Electric Corporation, Japan; 2Scibreak AB, Sweden

Selection Criteria of NGR Value Based on Measurements and Simulation of Actual Fault Events
Dr Subir SEN, B.B MUKHERJEE, Pradeep Tanaji PATIL*, Ashish SONI
Power Grid, India

Optimization of controlled Switching for Transmission Lines
Urmil PARIKH
Hitachi Energy Sweden AB, Sweden

An Approach for Economic Evaluation of Superconducting Fault Current Limiters in City Grids with Relay Protection Considerations
Mikhail MOYZYKH, Daria KOLOMENTSEVA, Kirill BABURIN, Eldar MAGOMMEDOV
SJSC SuperOx, Russian Federation

A Soft-switched Hybrid DC Circuit Breaker for the Protection of Fusion Power Plant Electrical Systems
Hanwen ZHANG1, Ferro ALBERTO2, Thomas FRANKE3, Mattia DANI4, Cristina TERLIZZI5, Yanbo WANG1, Zhe CHEN1
1Aalborg University; 2Consorzio RFX; 3Max-Planck-Institute for Plasma Physics; 4University of Rome Tor Vergata
<table>
<thead>
<tr>
<th>ID: 10127</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT</strong> - Full Papers</td>
</tr>
<tr>
<td><strong>Topics:</strong> A3 PS2 - Lowering the Carbon Footprint of T&amp;D Equipment</td>
</tr>
<tr>
<td><strong>Keywords:</strong> Gas Insulated switchgear, Metal enclosed, SF6-free, Circuit-breaker, GIS Bay</td>
</tr>
</tbody>
</table>

**SF6-free metal enclosed switchgear at 245kV and above**

Cyril GREGOIRE, Antoine PERRET, Jean-Baptiste JOURJON, Samuel SOUCHAL
GE Vernova, France

<table>
<thead>
<tr>
<th>ID: 10165</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT</strong> - Full Papers</td>
</tr>
<tr>
<td><strong>Topics:</strong> A3 PS2 - Lowering the Carbon Footprint of T&amp;D Equipment</td>
</tr>
<tr>
<td><strong>Keywords:</strong> SF6-free metal enclosed switchgear at 245kV and above</td>
</tr>
</tbody>
</table>

**Diagnostic Study of Two-dimensional Distribution Spectroscopy of Vacuum Circuit Breaker Arc**

Yilong LI1, Zhao YUAN1, Lixue CHEN1, Shan LIU1, Liming LIU1, Penglong YA1, Chuanqi WU2, Yuan PAN1

1 Huazhong University of Science and Technology, China; 2 State Grid Hubei Electric Power Research Institute Measurement

<table>
<thead>
<tr>
<th>ID: 10321</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT</strong> - Full Papers</td>
</tr>
<tr>
<td><strong>Topics:</strong> A3 PS2 - Lowering the Carbon Footprint of T&amp;D Equipment</td>
</tr>
<tr>
<td><strong>Keywords:</strong> Safety, Eco-Friendly and Durability Delivered by Advanced Dry Type Insulation Technologies</td>
</tr>
</tbody>
</table>

**Component Gas Losses Over Simulated Lifetime in a CO2/C4-FN Gas Blend**

Jeff MOORE, Rahul JAIN
S&C Electric Company, United States of America

<table>
<thead>
<tr>
<th>ID: 10323</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT</strong> - Full Papers</td>
</tr>
<tr>
<td><strong>Topics:</strong> A3 PS2 - Lowering the Carbon Footprint of T&amp;D Equipment</td>
</tr>
<tr>
<td><strong>Keywords:</strong> H4 Substation Products, HV Dry Type Insulation Technologies, Non-conventional Instrument Transformers</td>
</tr>
</tbody>
</table>

**New Approach to Life Cycle Assessment for Digital Solutions & Components**

Marco RIVA
ELDS Technology Centre – ABB spa Italy

<table>
<thead>
<tr>
<th>ID: 10352</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT</strong> - Full Papers</td>
</tr>
<tr>
<td><strong>Topics:</strong> A3 PS2 - Lowering the Carbon Footprint of T&amp;D Equipment</td>
</tr>
<tr>
<td><strong>Keywords:</strong> C4-FN, Expected Lifetime, Gas Components, Aging, Thermal Cycling</td>
</tr>
</tbody>
</table>

**Partial Discharge Measurement in SF6-Alternative Electrical Insulation Systems**

Alistair REID1, Rahmat ULLAH1, Fatima ELENEZI1, Manu HADDAD1, Peter TADDEI2, Mini NAMBIAR2, Matthew BARNETT2

1 Cardiff University UK; 2 SSEN Transmission UK
**How working with customers on specifications leads to a reduced carbon footprint impact**

Ixone URRUELA, Asier ZORROZUA, Sonia GONZALEZ, Eneko MADARIAGA
Arteche Group, Spain

**Advancing Circuit Breaker Maintenance and Repair through Metal Additive Manufacturing Technology**

Alexandre PINHEL¹, Rodrigo MAIA¹, Gabriel Ângelo VIEIRA¹, Anselmo THIESEN²
¹Brazilian NC of CIGRE, Brazil; Eletrobras Furnas; ²Brazilian NC of CIGRE, Brazil; SENAI-SC

**An Advanced Intelligent Online Monitoring System for Current Transformers**

George LIRA¹, Ana MAROTTI², Edson COSTA³, Antonio LEITE NETO¹, João MELO¹, André COSTA², João Paulo DE SOUZA², Fabiana FERNANDES³, Allan David SILVA¹, João Paulo SOUZA²
¹Brazilian NC of CIGRE, Brazil; Federal University of Campina Grande; ²Brazilian NC of CIGRE, Brazil; Eletrobras Furnas; ³Brazilian NC of CIGRE, Brazil; Concert Technologies S.A

**SF6-alternative 145 kV metal enclosed circuit breaker**

Marcel STOECKLI¹, Patrick STOLLER², Mahesh DHOTRE², Brooke SPREEN², Jakub KORBEL²
¹ELECTROSUISSE / CIGRE Switzerland NC Secretary; ²Hitachi Energy Switzerland Ltd, Switzerland

**RDDS and RRDS characterization for 420 kV 63 kA SF6-free High Voltage Circuit Breaker**

Marcel STOECKLI¹, Reto KARRER², Valeria TEPPATI², Mahesh DHOTHRE², Sami KOTILAINEN², Peter FREI²
¹ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; ²Hitachi Energy, Switzerland

**Development and type testing of a 420 kV 63 kA 50 Hz and 60 Hz SF6-free High Voltage Circuit Breaker**

Marcel STOECKLI¹, Valeria TEPPATI², Reto KARRER², Mahesh DHOTRE², Peter FREI², Patrick STOLLER², Markus BUJOTZEK²
¹ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; ²Hitachi Energy, Switzerland

**72.5 kV C4-FN/O2/CO2 GIS and CB performance and comparison with its SF6-equivalent**

Marcel STOECKLI¹, Maxime PERRET², Robert LUESCHER³, Clement COCHI², Bernhard SPICHER², Alexis COMBAZ³
¹ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; ²GE Vernova, Switzerland; ³GE Vernova, France
**Evaluation of Environmental Impact of SF6-based SP-3 and SF6-free GREENTRICtm 145 kV High Voltage Gas Insulated Switchgear through Life Cycle Assessment**

Marcel STOECKLI¹, Kedar PANDYA*², Manuel GOTTI², Nicole SONG³, Javier MANTILLA², Hyounjin JOO³

¹ELECTROSUISSE / CIGRE Switzerland NC Secretary; ²HD Hyundai Electric Switzerland Ltd, Switzerland; ³HD Hyundai Electric Ltd, South Korea

**Experience in the development of a Fluoronitriles-based 145 kV / 40 kA / 50-60Hz HVCB with an extremely low CO2 footprint**

Marcel STOECKLI¹, Manuel GOTTI*², Kilsoo HAN³, Jeong Cheol KIM³, Sihyeong KIM³, Xiangyang YE², Javier MANTILLA², Kedar PANDYA²

¹ELECTROSUISSE / CIGRE Switzerland NC Secretary; ²HD Hyundai Electric Switzerland Ltd, Switzerland; ³HD Hyundai Electric Ltd, South Korea

**High Voltage type testing of a 420 kV SF6-free High Voltage Circuit Breaker for Gas Insulated Switchgear and Dead Tank Breaker Applications**

Marcel STOECKLI¹, Peter FREI*², Reto KARRER², Wilhelm THUNBERG², Valeria TEPPATI², Brian CHRISTOPHER³, Marc CUPPETT³, Carl R. KURINKO³

¹ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; ²Hitachi Energy, Switzerland; ³Hitachi Energy, United States

**Future Needs and Common Approach of the Implementation of SF6 Free Equipment in the Grid of Six European TSOs**

Frank RICHTER¹, Lisa SCHAEFER¹, Aurelien TAUREAUD, Jonas BAUMANN⁵, Thomas WIJNOVEN⁶, Maria Isabel MARTIN DIAZ-TOLEDO⁷, Patrick SCHOERNBOECK⁷, Pierre MEYER²

¹50Hertz Transmission GmbH, Germany; ²RTE, France; ³Swissgrid AG, Switzerland; ⁴Elia Transmission, Belgium; ⁵REDEIA, Spain; ⁶APG, Austria

**SF6 Free 170kV 50kA GIS verification test considering substation energization**

Sooik LEE, Dongwook MOON, Kwangjoong LEE, Seungwan SON

Hyosung Heavy Industries Corporation, Republic of (South Korea)

**F-gas-free, zero-emission clean air switchgear for 420 kV**

Paul Gregor NIKOLIC, S. WILKE, A. GRIEGER

Siemens Energy, Germany

**Hot Gas Temperature Measurement in High Voltage Circuit Breakers Using Micro-gaps in SF6-free circuit breakers**

Man-Jun HA, Jung-Ho PARK, Dong-Hoon JEONG

Hyosung Corporation
<table>
<thead>
<tr>
<th>ID: 11261</th>
<th>A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A3 PS2 - Lowering the Carbon Footprint of T&amp;D Equipment</td>
<td></td>
</tr>
<tr>
<td>Keywords: Life cycle assessment, Global warming, Switchgears, SF6 gas, Alternative technologies, Standardization</td>
<td></td>
</tr>
</tbody>
</table>

**A Common LCA Format for High-Voltage Switchgears**

Toshiyuki UCHII¹, Satoshi TAKAHASHI², Haruhiko KOYAMA³

¹Toshiba Energy Systems & Solutions Corporation, Japan; ²JEMA (The Japan Electrical Manufacturers' Association), Japan

<table>
<thead>
<tr>
<th>ID: 11263</th>
<th>A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A3 PS2 - Lowering the Carbon Footprint of T&amp;D Equipment</td>
<td></td>
</tr>
<tr>
<td>Keywords: Gas - insulated - switchgear (GIS), Global - warming, SF6 - emission, SF6 - alternative - gas, Synthetic - air, Natural - origin - gas, O - ring, Grease, Silver - platting</td>
<td></td>
</tr>
</tbody>
</table>

**Lifetime Aspects and Experiences through Commercial Operations of 72 kV SF6-free Gas-Insulated Switchgear using Natural Origin Gas**

Tomoya ONISHI¹, Toru KOIKE¹, Akihisa MUKAIDA¹, Hideaki SHIRAI¹, Shigeyuki TSUKAO², Syuichi TAMURA²

¹Toshiba Energy Systems & Solutions Corporation, Japan; ²TEPCO Power Grid, Inc., Japan

<table>
<thead>
<tr>
<th>ID: 11265</th>
<th>A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A3 PS2 - Lowering the Carbon Footprint of T&amp;D Equipment</td>
<td></td>
</tr>
<tr>
<td>Keywords: Synthetic air, Gas-Insulated Switchgear (GIS), Vacuum Circuit-Breaker (VCB), Vacuum Interrupter (VI)</td>
<td></td>
</tr>
</tbody>
</table>

**Application of SF6 alternative switchgears – circuit-breakers and GIS using vacuum interrupter in synthetic air-insulated systems**

Naoya AIHARA¹, Ryosuke ITOTANI², Koki SADAHIRO², Shinichiro NAKAUCHI¹, Kenji SASAMORI¹

¹Mitsubishi Electric Corporation, Japan; ²Kansai Transmission and Distribution, Inc., Japan

<table>
<thead>
<tr>
<th>ID: 11266</th>
<th>A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A3 PS2 - Lowering the Carbon Footprint of T&amp;D Equipment</td>
<td></td>
</tr>
<tr>
<td>Keywords: Carbon neutral, Compactness, SF6-free, Solid-insulated switchgear(SIS), Solid insulation</td>
<td></td>
</tr>
</tbody>
</table>

**Long operational experiences of medium-voltage solid-insulated switchgears**

Satoru MAENO¹, Yuk ISHIKAWA², Ryosuke ITOTANI³, Yoshimitsu NIWA⁴, Hiroyuki SHIRAI⁵

¹Mitsubishi Electric Corporation, Japan; ²TEPCO Power Grid, Inc., Japan; ³Kansai Transmission and Distribution, Inc., Japan; ⁴Toshiba Infrastructure Systems & Solutions Corporation, Japan; ⁵Hitachi Industrial Equipment Systems Co., Ltd., Japan

<table>
<thead>
<tr>
<th>ID: 11336</th>
<th>A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A3 PS2 - Lowering the Carbon Footprint of T&amp;D Equipment</td>
<td></td>
</tr>
</tbody>
</table>

**SF6 alternatives in GIS/AIS Switchgear and challenges faced in its execution and project management**

Ravi Sushant CHAUDHARY*, Anshul SHARMA, R. P. S. RANA, M. THIRUMALA

POWERGRID, India

<table>
<thead>
<tr>
<th>ID: 11337</th>
<th>A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A3 PS2 - Lowering the Carbon Footprint of T&amp;D Equipment</td>
<td></td>
</tr>
</tbody>
</table>

**Subject - Life cycle management and life extension of AIS/GIS Switchgear, FACTS equipment by application of RCM**


POWERGRID, India

<table>
<thead>
<tr>
<th>ID: 11369</th>
<th>A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A3 PS2 - Lowering the Carbon Footprint of T&amp;D Equipment</td>
<td></td>
</tr>
</tbody>
</table>

**Utilization of smart measurement technologies to improve medium voltage switchgear sustainability**

Roman PERNICA, Karol MAJER, Pavel VANO

ABB Czech Republic

<table>
<thead>
<tr>
<th>ID: 11638</th>
<th>A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: A3 PS2 - Lowering the Carbon Footprint of T&amp;D Equipment</td>
<td></td>
</tr>
</tbody>
</table>

**Digital model and supply chain of a MV GIS, to manage a low carbon energy system**

Thomas DUERR, Achim KALTER, Florian WOLFRUM, Patrick SCHNEIDER

Siemens AG & Siemens Ag France, Germany
### Implementation of Various Biodegradable Insulation Liquids in Instrument Transformers Rated at 420 kV

Kresimir KOPRIVEC¹, Igor ZIGER¹, Darko IVANOVIC¹, Tomislav ZUPAN²

¹Končar – Instrument Transformers Zagreb, Croatia; ²Končar – Electrical Engineering Institute Zagreb, Croatia

<table>
<thead>
<tr>
<th>ID: 11757</th>
</tr>
</thead>
</table>

### Design Aspects for the use of Alternative Gases in GIS Voltage Transformers

Marcel STOECKLI¹, Mostafa REFAEY²*, Martin BOSS³

¹ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; ²alumni Pfiffner Instrument Transformers, Switzerland; ³Pfiffner Instrument Transformers, Switzerland

<table>
<thead>
<tr>
<th>ID: 11858</th>
</tr>
</thead>
</table>

### Molecular Dynamics Simulation of Cathode Spots Formation and Contact Erosion in Vacuum Circuit Breakers

Haonan YANG

University of Manchester, UK

<table>
<thead>
<tr>
<th>ID: 10132</th>
</tr>
</thead>
</table>

### Status of the utilisation of Low Power Instrument Transformers in electrical networks

Laurent ROUX

RTE, France

<table>
<thead>
<tr>
<th>ID: 10195</th>
</tr>
</thead>
</table>

### Research on Magnetic-controlled Vacuum Arc Technology and Circuit Breaker Development

Jianying ZHONG, Xiaoming ZHAO, Hang ZHANG, Wenkui LIU, Yaopeng LU, Linying CHENG

Pinggao Group Co., LTD, China

<table>
<thead>
<tr>
<th>ID: 10257</th>
</tr>
</thead>
</table>

### Health Index computation in Switchgear Monitoring Systems: providing Asset Performance Management crucial data straight from the primary equipment

Nicolas GADACZ, Jean-Luc RAYON, Eros STELLA, Samuel FIFI, Raphaël LEBRETON

GE Vernova, France

<table>
<thead>
<tr>
<th>ID: 10258</th>
</tr>
</thead>
</table>

### Return on Experience of Smart Live Tank Circuit Breaker with SF6-Alternative

Nicolas GADACZ¹, Henrik Roland HANSEN²

¹GE Vernova, France; ²Energinet, Denmark

---

**PS3 - MAINTAINING AND MANAGEMENT T&D ASSETS**

---
Enhancing Fault Detection and Classification in Power Transmission Systems Using Two-stage Detection System
Hassan MAHMOUD\(^1\), Haitham H MAHMOUD\(^2\)

\(^1\)Egyptian Electricity Holding Company; \(^2\)Birmingham City University

Condition Monitoring Analyses: from Straightforward to Surprising
Tony MCGRAIL\(^1\), Philip BOREHAM\(^1\), Jamie BEARDSALL\(^2\), Mark ROWBOTTOM\(^3\), Carl JOHNSTONE\(^4\), Rachael SUH\(^5\)

\(^1\)Doble Engineering, United States of America; \(^2\)Drax Power, United Kingdom; \(^3\)Asset Management, United Kingdom; \(^4\)Energy Harbor, United States of America

Utilizing Asset Performance to Guide Asset Replacement and Maintenance Optimization Decisions at TVA
Jeffrey H. NELSON\(^1\), Jay JAYARAMAN\(^2\), Siri VARADAN\(^3\)

\(^1\)Tennessee Valley Authority, United States of America; \(^2\)Hitachi Energy, United States of America; \(^3\)Quanta Technology, United States of America

Towards online condition assessment of oil-paper insulated current transformers: experiences from laboratory experiments
Daniël WOLDENDORP, Sjoerd NAUTA, Reinder PETERSE

Alliander N.V.

Smart Sensor with Embedded AI Model for Automatic Detection of PD Defects in Distribution Networks
Javier ORTEGO\(^1\), Elvis JORGE\(^1\), J. David BIELVA\(^2\), Antonio GONZALEZ\(^2\)

\(^1\)Ampacimon, Spain; \(^2\)EDP Redes Spain, Spain

Monitoring 245 kV instrument transformers using AI for condition assessment and operation optimization
Amaia RECALDE\(^1\), Jone JUIZ\(^1\), Iñigo HUERTA\(^1\), Jesús SAEZ\(^1\), Mikel FERNANDEZ\(^2\), Jose Antonio EGUREN\(^3\)

\(^1\)Arteche Group, Spain; \(^2\)Tecnalia, Spain; \(^3\)i-DE (Iberdrola), Spain

A Wireless Self-Powered and Edge Computing Sensor for Power Quality and Grid Analysis
Antonio-Miguel MUÑOZ-GÓMEZ\(^1\), Alfonso MARECA-MIRALLES\(^1\), Javier BALLESTÍN-FUERTES\(^1\), José-Francisco SANZ-OSORIO\(^2\)

\(^1\)Circe, Spain; \(^2\)University of Zaragoza, Spain

Test voltage level analysis for frequency response measurements on instrument voltage transformers
Mathieu NADEAU\(^1\), Erik SPERLING\(^2\), Roberto SCHULZE\(^3\)

\(^1\)Hydro-Québec, Canada; \(^2\)OMICRON Energy, Switzerland; \(^3\)OMICRON Energy, Germany
### ID: 10711
**A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT - Full Papers**

**Topics:** A3 PS3 - Maintaining and Management T&D Assets  
**Keywords:** IEC 61850, Optical Current Transformer, Low-Power Instrument Transformer, Substation Instrumentation, Faraday Effect, Process Bus Integration, Comparative Analysis, Laboratory Testing, TECO, Substation Technology

**Assessment of Critical Aspects Related to Optical Current Transformer Measurements**

Carlos DUTRA, Luan TOMINAGA, Vitor WOYAKEWICZ, Tiago MATSUO  
1Brazilian NC of CIGRE, Brazil; PowerOpticks; 2Brazilian NC of CIGRE, Brazil; AQTech

---

### ID: 10726
**A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT - Full Papers**

**Topics:** A3 PS3 - Maintaining and Management T&D Assets  
**Keywords:** Electric Stray Field, CR Divider, Voltage Divider, Accuracy, Frequency Response Behaviour, Power Quality

**Investigation of the impact of external stray fields on voltage divider accuracy for 36 kV and 123 kV system voltage levels**

Marcel STOECKLI, Erik SPERLING, Roberto SCHULZE, Thomas HEID  
1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2OMICRON energy, Switzerland; 3OMICRON energy, Germany; 4CONDIS SA, Switzerland

---

### ID: 10727
**A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT - Full Papers**

**Topics:** A3 PS3 - Maintaining and Management T&D Assets  
**Keywords:** power quality monitoring, transient monitoring, CR-divider, RC-divider, low-power voltage transformer

**High bandwidth low-power voltage transformers for power quality measurement and fast transient monitoring in MV and HV substations - technological overview and experience from field installations**

Marcel STOECKLI, Thomas HEID, Werner SCHOEFFER, Dominique ROLLE  
1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2CONDIS SA, Switzerland; 3Artemes GmbH, Austria; 4HEIA Fribourg University of Applied Sciences, Switzerland

---

### ID: 11015
**A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT - Full Papers**

**Topics:** A3 PS3 - Maintaining and Management T&D Assets  
**Keywords:** Asset Performance Management System (APMS), Condition Based Maintenance Strategy, Assets Health Indici (AHI), Risk Indices, AHI methodology, APMS roadmap, Online Monitoring Systems, Real-time DataHub, IT solution architecture, Data management

**Asset Performance Management System Design for a Modern TSO**

Ales HVALA, Andrej F. GUBINA, Despoina MAKRIDOU, Anastasios PATSIOTIS  
1Blueprint Energy Solutions, Austria; 2IRI UL, Slovenia; 3TSO Greece

---

### ID: 11079
**A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT - Full Papers**

**Topics:** A3 PS3 - Maintaining and Management T&D Assets

**Service experience with the POW control switching on power transformers**

David PITA, Haren MUTUKUMARANA  
1Powerlink QLD Australia; 2The University of Queensland, Australia

---

### ID: 11110
**A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT - Full Papers**

**Topics:** A3 PS3 - Maintaining and Management T&D Assets

**Digitization Techniques for Smart Asset Management in the Energy Sector**

Dario Alberto MEYER, Gino Leonel FURLANO, Fabián Edgardo LÓPEZ, Gabriel Franriq BONILLA

DISTROCUYO SA

---

### ID: 11148
**A3 TRANSMISSION AND DISTRIBUTION EQUIPMENT - Full Papers**

**Topics:** A3 PS3 - Maintaining and Management T&D Assets

**Multi-Country and Multi-Company Concatenating Failure Catalogue**

Diego VARGAS, Euro ALMEIDA, Irwin LOPEZ, Nc CIGRE  
1ENLAZA; 2ARGO; 3CONECTA; 4NC CIGRE
Risk Management Through the Implementation of Digital Twins for the Analysis of Safe Ground Clearance and Solution of Non-Compliance in High-Voltage Transmission Lines
Yasert PEREZ, Alexander BEDOYA
ISA Intercolombia

Current Transformer Hysteresis Modelling for Condition Assessment under standard and non-standard Operation
Dennis ALBERT1, Nicolai SCHWARTZE1, Lukas DOMENIG2
1OMICRON electronics; 2Graz University of Technology

Reliability-Centered Maintenance for Optimized IoT-based Maintenance and Life Extension of Aging Substation Equipment
Toshiaki KONO, Ryoichi SHINOHARA, Hiroaki HASHIMOTO, Li LU
Hitachi Ltd., Japan

Robotic isolation of MV breakers and condition monitoring using AI and AR
Ravi SAHU, Amit PATEL, Ashish MHATRE, Kapil UMAK
Tata Power Co. Ltd, India

A Study on the Location Estimation of the Partial Discharge Signal using Current Transformer Sensors with Ultra-high Frequency Bandwidth in C-GIS
Sang Hyuk IM, Seung Hun OK, Jung Soo LEE, Doo Ki LEE
HD Hyundai-Electric, Korea, Republic of (South Korea)

IoT based Solution – Smart LT Distribution System Smart MCCB (Protection, Remote Control, and Auto-Reclosing)
Gagandeep KAUR*, Brajanath DEY, Amit BANSAL
TATA Power DDL, India

Fiber Optic Current Transformers (FOCT) - High Voltage Design Considerations and Challenges
Mritunjay KUMAR*, Aditya N YADAV, S Nagesh KUMAR, M Mohana RAO, Shyamala VENKATARAMAN
BHEL R&D, India

Online Partial Discharge Monitoring System for Gas Insulated Substation - Utility Experience
Rashmi* CHAUDHARY, B. P. SONI, Dr. A. J. CHAVDA
Gujarat Energy Transmission Corporation Ltd, India
**Research on UHF Sensor Signal Attenuation Simulation Method for Improvement of GIS Partial Discharge Diagnosis**

Danbi LEE, Byoung-woon MIN
HD Hyundai Electric, Korea, Republic of (South Korea)

**Failure Investigation of Series Capacitors on Transmission Lines and Novel Technique to Mitigate the Damage During Fire on the Platform.**

Randhir SINGH*, M.S. HADA, Pankaj Kumar JHA
POWERGRID, India

**In-service circuit breaker condition assessment**

Phil MOORE1, Keith WILLIAMS2, Mark WALDRON2
1 Elimpus Ltd UK; 2 National Grid UK

**Benefits of Smart Generator Circuit Breaker Solutions from a Manufacturer-Utility Collaboration Perspective**

Vitsanu PHONPHAI1, Nicolas GADACZ2, Charcrist KUHAKARN1, Panupan THAKONG1
1 Electricity Generating Authority of Thailand (EGAT), Thailand; 2 GE VERNova, France

**Applying a Deep-Learning Method to Diagnose the Capacitor Voltage Transformers with Excessive Measurement Errors**

Hamid Reza MANSOURI1, Mohammad Majid JALALI1, Hojjat DEZFULI2
1 Nirou Trans Co.; 2 Monenco Iran Consultant Engineering Co., Iran, Islamic Republic of

**Real-time pollution monitoring and diagnostics of Air Insulated Switchgear oriented to predictive maintenance**

Rodolfo SARACENI1, Alberto PIGINI2, Marco NOSILATI1, Eros STELLA1
1 GE Vernova Italy; 2 Independent Consultant Italy

**220kV three-core submarine cable armouring loss test**

Yuantao ZHAO1, Kanghong LIU1, Mingyue LIU2, Guojun YU2, Fan YANG2, Feng XIA2, Fei LI1, Lisheng ZHONG1
1 Xi’an Jiaotong University, China; 2 Ningbo Orient Wires & Cables Co., Ltd., China
**ID: 10169**

B1 INSULATED CABLES - Full Papers

**A Location Method of Local Defects in Power Cables Based on Reflection Coefficient Spectrum**

Kai ZHOU, Yao FU

Sichuan University, China

---

**ID: 10170**

B1 INSULATED CABLES - Full Papers

**Design, manufacturing, and installation of world’s first 500kV three-core XLPE insulated AC submarine cable**

Muhammad AWAIS, Yuantao ZHAO, Yongming ZHANG, Guojun YU, Feng XIA, Jianjun YANG, Ziwei ZHAO

Ningbo Orient Wires & Cables Co., Ltd., China

---

**ID: 10303**

B1 INSULATED CABLES - Full Papers

**Keywords:** HVDC cable, bending stiffness, FEM, testing, mechanical

**Comparison of bending stiffness modelling and measurements on HVDC cables**

Raquel MARCHENA¹, Annalisa VERRILLO², Nicolas BOUVIER¹

¹Prysmian Group, France; ²Prysmian Group, Italy

---

**ID: 10354**

B1 INSULATED CABLES - Full Papers

**Analysis of the screen currents on the HV and EHV cable systems through on-line measurement: study of the main issues and case-studies investigation**

Luca GUIZZO

TERNA, Italy

---

**ID: 10355**

B1 INSULATED CABLES - Full Papers

**Design and testing of the dynamic export cable of Gruissan offshore floating wind farm**

Luigi COLLA

Prysmian Group, Italy

---

**ID: 10356**

B1 INSULATED CABLES - Full Papers

**New 132 kV intertie between Elba Island and Italian Mainland designed for security of supply, safety and environmental conservation**

Lucia DE MERICH

PRYSMIAN GROUP, Italy

---

**ID: 10357**

B1 INSULATED CABLES - Full Papers

**Tyrrenian Link - Sea Trials for ultra-high-depth cable system**

Federico CORDO’

PRYSMIAN GROUP, Italy

---

**ID: 10416**

B1 INSULATED CABLES - Full Papers

**On-spot PD Measurements on Singapore 22 kV XLPE Circuits: Experiences and Challenges**

Kai Xian LAI, Chun Sern YIONG, Javan Chun Fong LEE, Hongyan CAO, Vincent Kum Kong WONG, Ranjan THIRUCHELVAM

SP Group Singapore
A proportional approach of subsea UneXploded Ordnance (UXO)
Marijn HELSLOOT¹, Wino SNIP², Ira HELSLOOT², Anja DREWS¹
¹TenneT; ²Crisislab; ³Radboud Universiteit

Using continuous in situ measurements to probe the diverse thermal dynamics of MVAC & HVAC power cables
Pjotr MUIS, Colin VAN WIJK, Ramon CREYGHTON, Anna VAN VELSEN, Joan RESSING, Sjoerd NAUTA
Alliander N.V.

Development of an Electromechanical Test Technique to Grow Electrical Trees in Dynamic Power Cables
Christopher EMERSIC¹, Frances HU¹, Lujía CHEN¹, Simon ROWLAND¹, Aidan EBRAHIM²
¹The University of Manchester UK; ²ORE Catapult UK

Analysis of Ground Penetrating Radar (GPR) technologies used in areas with high density of underground utilities for insulated cable projects
Pedro LLOVERA-SEGÖVIA¹, Luis ARIAS FERNÁNDEZ², Pablo RODRÍGUEZ HERRERIAS², Gregorio DENCHE CASTEJÓN², Guillem GIL PRIETO¹, Marcos DOMÍNGUEZ-LAGUNILLA¹
¹Instituto Tecnológico de la Energía (ITE), Spain; ²Red Eléctrica, Spain; ³Universitat Politècnica de València, Spain

Fault location on the Spain Morocco HV Submarine Cable – Improving Fault Distance Measuring Accuracy
Ricardo GOMEZ RIVERA¹, Manfred BAWART², Daniel BLANCO SACEDO¹, Jose Luis FERRERES NOS², Ricardo REINOSO DELGADO¹, Gonzalo DONOSO CONEJO¹, Elena NOGUEROLES LAGUIA³
¹Red Eléctrica, Spain; ²BAUR GmbH, Austria; ³MARTIN BAUR S.A, Spain

New measurement technique and use cases in the inspection of partial discharges of circuits with insulated cable in the Spanish TSO
Ricardo GÓMEZ, Ricardo REINOSO, Gonzalo DONOSO, Elena NOGUEROLES
Red Eléctrica, Spain

Construction methods civil works power link Tenerife-La Gomera
Alberto MARTÍN VILLALTA, Álvaro FRANCÉS PÉREZ, Virginia MORENO FERNÁNDEZ
Red Eléctrica, Spain

Construction challenges in terms of permitting, consents, and safety issues in highly touristic places in Spain
Alexandra GAVILANES, Berta DÍAZ DE FIGUEROA, Carlos GARCÍA
Red Eléctrica, Spain
Distributed temperature sensing: detection and mitigation of observed hot spots due to soil dehydration

Daniel VREE, Vincent GEVERS, Wouter VAN DOELAND, Richard KONING

Energy Solutions

Environmental and Technical Lessons learnt during the cable repair of a legacy cable in a watercourse

Shamaine THULASAIE

Eskom Distribution

Results of PQ Test and Various Type Tests for AC 400kV Submarine Cable System

Hunjun LEE

LS Cable&System, Korea, Republic of (South Korea)

Bend Stiffness Test For Cable Considering Tension During Installation Or Operation

Chulmin KIM1, Jaebok LEE1, Kwangsu CHAE1, Yuho RHO2, Chunsik SHIM2

1LS Cable & System Ltd; 2Mokpo National University

Failure Statistics of High Voltage Underground Cables in Urban Areas – Experience of the Southeastern Brazilian Large City Centers

Carla DAMASCENO1, Adrielson MENEZES2, Paulo DEUS3, Daniel Lucas SILVA4

1Brazilian NC of CIGRE, Brazil; Consultor; 2Light SESA; 3Enel SP; 4ISA-CTEEP

Challenges and solutions to implement an underground transmission line in the biggest city of Brazil

Jody FUJHARA1, Rogerio LAVANDOSCKI1, Gabriela RODRIGUES1, Julio LOPES2

1Brazilian NC of CIGRE, Brazil; ISA CTEEP; 2INOVATEC

Learnings from a third party accident in a 220 kV underground transmission line in Colombia

Julio LOPES1, Antonio PEDRAZA2

1Brazilian NC of CIGRE, Brazil; INOVATEC; 2ISA
ID: 10763
B1 INSULATED CABLES - Full Papers
Topics: B1 PS1 - Learning from Experiences
Keywords: High voltage, Underground Lines, Cable insulated, Two Cables per Phase

The Construction of High Voltage Underground Lines Using Two Cables Per Phase in Large Cities - Their Motivations, and Installation and Maintenance Complexities
Paulo DEUS, Eduardo LEANDRO, Artur CONFORTI
Brazilian NC of CIGRE, Brazil; ENEL

ID: 10787
B1 INSULATED CABLES - Full Papers
Topics: B1 PS1 - Learning from Experiences
Keywords: cable line, insulation, partial discharges, insulation aging, reliability, residual life, overvoltage, insulating materials

Limitation of Switching Overvoltage as a Way to Provide the Reliability of Power Cable Lines
Jan KOROSTELEV1, Rasim BABAEV2, Anton KORZHOV2, Mikhail DZIUBA2, Valery SAFONOV2
1EnergyV+2T JSC / South Ural State University, Russian Federation; 2South Ural State University, Russian Federation

ID: 10879
B1 INSULATED CABLES - Full Papers
Topics: B1 PS1 - Learning from Experiences
Keywords: EPDM PMJ, HVDC PMJ, PMJ

Development of EPDM Insulation Material for 500kV-class HVDC PMJ
Yeonwoo JO, Jaecheol JUNG, Dongseok HONG, Hyunjoo KIM
TAIHAN Cable&Solution, Korea, Republic of (South Korea)

ID: 10892
B1 INSULATED CABLES - Full Papers
Topics: B1 PS1 - Learning from Experiences
Keywords: Thermal assessment, Semi-conductive PE Sheath, HVDC, Fault Simulation

Thermal assessment of the transition joint between insulating and semiconductive inner PE sheath
Abbas LOTFI, Martin HOVDE, Allen TUNHEIM
Nexans Norway AS

ID: 10950
B1 INSULATED CABLES - Full Papers
Topics: B1 PS1 - Learning from Experiences
Keywords: Siphon underground XLPE cable system - cross-bonding - earthcontinuity conductor - insulation coordination

420 kV underground cable system in environment with high electrical resistivity of soil. Use of an earth continuity conductor in combination with cross bonding and consequences on insulation coordination
Jerome MATALLANA1, Kostas VELITSIKAKIS2, Thinus DU PLESSIS2
1Statnett, Norway; 2TENNET The Netherlands

ID: 11085
B1 INSULATED CABLES - Full Papers
Topics: B1 PS1 - Learning from Experiences

Dynamic Analysis on HVDC Land Cable and Prefabricated Joint under Salt-mine Blasts
Yang ZHOU1, Christian ANDERSSON1, Markus SALTZER2, Daniel PESTANA2, Martin SPLETTSTÖSSER2, Herbert LOBÜSCHER2, Marc JEROENSE3, Giampaolo MARTUFI1
1NKT Sweden; 2NKT Germany; 3TransnetBW Germany; 4MJ MarCable Consulting Sweden

ID: 11167
B1 INSULATED CABLES - Full Papers
Topics: B1 PS1 - Learning from Experiences

Development of an extended commissioning program for temporary 220 kV cable connections
Alexander PIRKER1, Anita MACHL2
1Verfahren Umwelt Management GmbH; 2Austrian Power Grid AG

ID: 11173
B1 INSULATED CABLES - Full Papers
Topics: B1 PS1 - Learning from Experiences

The role of quality assurance in a high voltage cable market shaped by the energy transition from a grid operators’ perspective
Florian AINHIRN, Andreas BOLZER
Wiener Netze
**ID: 11176**

**B1 INSULATED CABLES - Full Papers**  
**Topics:** B1 PS1 - Learning from Experiences  

**Derivation and Application of a Sustainability Assessment System for the Installation of High and Extra-High Voltage Cables in the City of Vienna**  

Florian AINHIRN¹, Michael KLEIN¹, Alicia OGRYSEK², Lea ORTH²  
¹Wiener Netze; ²Technical University Vienna

---

**ID: 11181**

**B1 INSULATED CABLES - Full Papers**  
**Topics:** B1 PS1 - Learning from Experiences  

**New approaches in performing commissioning tests in HVAC on long land and inter array cable projects using Resonant Test Systems**  

Peter MOHAUPT¹, Marco BRAMBILLA², Emilio DEL RIO RUIBAL²  
¹Mohaupt HV; ²Prysmian Powerlink

---

**ID: 11188**

**B1 INSULATED CABLES - Full Papers**  
**Topics:** B1 PS1 - Learning from Experiences  

**Experiences and Perspectives in the Application of the BIM Methodology to the Design and Construction Phases of Underground Transmission Lines for the "El Río" 220 kV Project**  

Hernan RESTREPO, Antonio PEDRAZA, Luis SARMIENTO  
ISA Intercolombia

---

**ID: 11193**

**B1 INSULATED CABLES - Full Papers**  
**Topics:** B1 PS1 - Learning from Experiences  

**Keywords:** Cable Condition Monitoring, HV Cable, Cable Termination, Cable Joint, Passive Sensing, Distributed Electrical Sensing, Sheath Current, IEC 61850-9-2, Sampled Values  

**Installing passive sensing for condition monitoring of a 400 kV cable**  

Steven BLAIR, Neil GORDON, Iain MCKEEMAN, Philip ORR, Marcus PERRY  
Synaptec UK

---

**ID: 11258**

**B1 INSULATED CABLES - Full Papers**  
**Topics:** B1 PS1 - Learning from Experiences  

**Insulated Cables Statistics 2012 to 2021**  

Russell WHEATLAND¹, Soren MIKKELSEN², Francis WAITE³, Kim ove ASKLUND⁴, Peter van der WIELEN⁵, Andrew WOOLES⁶  
¹Ausnet Services, Australia; ²Energinet, Denmark; ³Balfour Beatty, United Kingdom; ⁴Hafslund Nett, Norway; ⁵DNV, Netherlands; ⁶TE Connectivity, New Zealand

---

**ID: 11275**

**B1 INSULATED CABLES - Full Papers**  
**Topics:** B1 PS1 - Learning from Experiences  

**Keywords:** Natural Degradation, Pre-breakdown, Discharge Detection, Water Tree, Wet Design, XLPE, Asset Management  

**Assessment and asset management of aged 66 kV – 77 kV wet design XLPE cable**  

Shoji MASHIO¹, Kimihiro IWASAKI¹, Takeshi KAYA², Toshihiro TAKAHASHI³  
¹Sumitomo Electric Industries, Ltd., Japan; ²TEPCO Power Grid, Incorporated, Japan; ³Kansai Transmission and Distribution, Inc., Japan; ³Central Research Institute of Electric Power Industry, Japan

---

**ID: 11279**

**B1 INSULATED CABLES - Full Papers**  
**Topics:** B1 PS1 - Learning from Experiences  

**Keywords:** Optimization, Rationalization, Replacement, Y-branch joint  

**Challenges and Initiatives for replacement of aged SCFF or HPFF cables to XLPE cables**  

Hiroki YOKOTA¹, Masahiro NARITA¹, Kimihiro IWASAKI¹, Hidenori SATOU², Takeshi KAYA³, Tatshiko SAKAMOTO³  
¹Furukawa Electric Co., Ltd., Japan; ²TEPCO Power Grid, Incorporated, Japan; ³Kansai Transmission and Distribution, Inc., Japan
**ID: 11307**
B1 INSULATED CABLES - Full Papers
*Topics:* B1 PS1 - Learning from Experiences
*Keywords:* Ampacity, Cable, Harmonic, Tripens

**Current rating in the presence of Harmonics**
Andreas CHRYSOCHOS, Konstantina BITSI, Iordanis CHALEPLIDIS, Dimitrios CHATZIPETROS, Varvara RIZOU, Vasileios KANAS
Hellenic Cables, Greece

**ID: 11308**
B1 INSULATED CABLES - Full Papers
*Topics:* B1 PS1 - Learning from Experiences
*Keywords:* Cable System, Direct Cross Bonding, Insulation Coordination, Lightning, Overvoltage

**Evaluation of Cable Bonding Scheme under Lightning Overvoltages in HVAC Modern Siphon Systems**
Christos TRAIANOS1, Iordanis CHALEPLIDIS2, Andreas CHRYSOCHOS2, Dimitrios CHATZIPETROS2
1Electrical Engineer, Greece; 2Hellenic Cables, Greece

**ID: 11311**
B1 INSULATED CABLES - Full Papers
*Topics:* B1 PS1 - Learning from Experiences
*Keywords:* FEM, Modeling, Rigid Joint, Submarine Cable.

**Modeling of the Thermoelectric Performance of Offshore Power Cable Joints**
Konstantina BITSI, Dimitrios CHATZIPETROS, Andreas CHRYSOCHOS, Vasileios KANAS
Hellenic Cables, Greece

**ID: 11354**
B1 INSULATED CABLES - Full Papers
*Topics:* B1 PS1 - Learning from Experiences
*Keywords:* Electric field, finite element method, heat-shrink cable terminal, structural defect

**Electric field analyzes in heat-shrink cable terminals depending on the assembly and defects parameters with FEM**
Yunus Berat DEMİROL1, Eif Sakallioglu1, Bora Alboyacı2, Mehmet Aytâç CINAR2
1Genetek Güç&Enerji, Türkiye; 2Kocaeli University, Türkiye

**ID: 11356**
B1 INSULATED CABLES - Full Papers
*Topics:* B1 PS1 - Learning from Experiences

**A Machine Learning-Induced Cable Health Indexing Model for Utilities**
Akshat KULKARNI*, Sanjeev KUMAR, Pratik BAJARIA, Yash KULKARNI
OrxaGrid Pvt Ltd, India

**ID: 11368**
B1 INSULATED CABLES - Full Papers
*Topics:* B1 PS1 - Learning from Experiences

**Improvisation in Laying & Installation of HV/EHV Power cables in extreme challenging conditions**
Puneet CHAWLA, Jai KUMAR, Dileep K. SHUKLA, Vivek KAPIL, Aruna GULATI
BHEL, India

**ID: 11468**
B1 INSULATED CABLES - Full Papers
*Topics:* B1 PS1 - Learning from Experiences
*Keywords:* Single Sheath Bonding-Induced Voltage-Sheath Circulating Current-Earth Continuity Conductor-Ground potential Rise

**Single Sheath Bonding Method To Eliminate Earth Continuity Cable**
Mohamed KHAN
Electricité De France, UAE

**ID: 11568**
B1 INSULATED CABLES - Full Papers
*Topics:* B1 PS1 - Learning from Experiences

**Challenge of TDR Fingerprint on Viking Link**
Henrik Roland HANSEN1, Manfred BAWART2, Marco BRAMBILLA3, Emilio DEL RIO RUIBAL4
1Energinet; 2BAUR GmbH; 3Prysmian Powerlink
Calculation of Magnetic Fields around Stranded 3 core cables
Thomas KVARTS, Anna Candela GAROLERA
Ørsted Wind Power a/s

Data-Driven Laying Condition Assessment of High Voltage Cables using Distribute Temperature Sensing - DTS
Soumya THAKUR1, Joachim HOLBØLL1, Joachim NIEMANN-LARSEN2
1Technical University of Denmark (DTU); 2Energinet

Requirements for onsite test systems for the after-installation test of HVDC cable systems
Marcel STOECKLI1, Michael GAMLIN*2, Carl-Hendrik STUCKENHOLZ2, Tobias MUELLER2, Manuel ECKERT2
1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2Haefely AG, Switzerland

Complete power cable monitoring for floating marine energy technologies
Pierre CLEMENT1, Gaetan CALBRIS1, Caroline LOURIE2, John EMEC2
1FEBUS Optics, France; 2EMEC Ltd, UK

Approach, experiences and lessons learned from failures investigations on power cable systems
Peter VAN DER WIELEN1, Anurag KUMAR2, Jacco SMIT2
1DNV & TU Eindhoven; 2TenneT TSO

Solutions to prevent theft of earth continuity conductor in galleries and tunnels
Alicia JANDIN, Matthieu CABAU, Mathieu GROULT
RTE, France

Root Cause Analysis in Onshore Wind Farm MV Cable: A Study Based on IEEE 1511.1 Guide
Phelipe SILVA
BAUR do Brasil

Comparative Study on Detection Methods for Buffer Layer Defects in High-voltage XLPE Cable with Corrugated Aluminum Sheath
Yanpeng HAO1, Yanting CHENG1, Wanxing TIAN1, Qishun LI1, Haotian TAN1, Peng ZHAO2, Baojun HUI2, Licheng LI1
1School of Electric Power Engineering, South China University of Technology; 2Jiaxing Power Supply Company of State Grid Zhejiang Electric Power Co., Ltd.; 3Electric Power Research Institute, China Southern Power Grid
**PS2 - Future Functionalities and Applications**

**ID: 10134**
B1 INSULATED CABLES - Full Papers

*Topics: B1 PS2 - Future Functionalities and Applications*

*Keywords: MVDC cables system, electrical field stabilization, proposition, qualification procedure, electrothermal stresses*

**Proposition of qualification procedure for MVDC cables**
Amjad MOUHAIDALI¹, Raphaël GUFFOND², Ludovic BOYER¹, Lina RUIZ²
¹SuperGrid Institute, France; ²Nexans, France

**ID: 10172**
B1 INSULATED CABLES - Full Papers

*Topics: B1 PS2 - Future Functionalities and Applications*

*Keywords: Routing, Superconductor, Transmission, Underground*

**Development and Experiment of Two-section Three-phase Coaxial 10 kV/1 kA HTS Cable with Three-phase Balance Design**
Panpan CHEN, Jiahui ZHU, Qifan YANG, Yanfang YANG, Hongjie ZHANG
China Electric Power Research Institute, China

**ID: 10328**
B1 INSULATED CABLES - Full Papers

*Topics: B1 PS2 - Future Functionalities and Applications*

*Keywords: High-Temperature Superconducting Cable Systems as a Solution to Underground Transmission Line Routing in Congested Project Areas*

**High-Temperature Superconducting Cable Systems as a Solution to Underground Transmission Line Routing in Congested Project Areas**
Collin EDWARDS, Darin LAWTON
Burns & McDonnell, United States of America

**ID: 10331**
B1 INSULATED CABLES - Full Papers

*Topics: B1 PS2 - Future Functionalities and Applications*

*Keywords: Underground Transmission, Submarine, Finite Element Modeling (FEM), Cable Ampacity*

**Developing an FEM Model of the TB880 3-Core Cable Case Study**
Brian RUTHERFORD
Burns & McDonnell, United States of America

**ID: 10405**
B1 INSULATED CABLES - Full Papers

*Topics: B1 PS2 - Future Functionalities and Applications*

*Keywords: Temperature, Crosslinked-polyethylene (XLPE), Qualification Testing*

**Thermal limit of XLPE insulation: Is 90 still the magic number?**
James PILGRIM¹, Thomas ANDRITSCH², Paul LEWIN², George CALLENDER²
¹Ørsted Wind Power UK; ²University of Southampton UK

**ID: 10520**
B1 INSULATED CABLES - Full Papers

*Topics: B1 PS2 - Future Functionalities and Applications*

*Keywords: HVDC, GIS, cable connection assemblies, dielectric testing, type test*

**Recommendations for dielectric testing of HVDC gas insulated cable connection assemblies**
C.A. PLET¹, M. KOSSE², S. ALAPATH³, N. LALLOUET⁴, F. JACQUIER⁴, U. RIECHERT⁵, T. KARMOKAR⁶, F. MICHON⁷, H. HE⁸, H. HE⁹, C. BEVERWIJK⁵, D. BOA¹⁰, M. YAGI¹¹, L. HOEFER¹², J. STRIDE¹³, K. ZHOU¹⁴, Marco ALBERTINI¹⁵, Diego CiSILINO¹⁶, Guoyan SUN¹⁷
¹DNV; ²Siemens Energy; ³Vattenfall; ⁴Nexans; ⁵SGI; ⁶Hitachi; ⁷TenneT; ⁸Prysmian; ⁹KEMA; ¹⁰SSEN Transmission; ¹¹Furukawa; ¹²Pfisterer; ¹³UL; ¹⁴Tech4Speed; ¹⁵Brugg Cables
Testing Experience on Temporary High Voltage Cable Connection Solutions
Panos TSAKONAS1, Corné VAN EEDEN1, Riccardo BODEGA1, Roy ZUIJDERDUIN1, Jacco SMIT2
1 Prysmian Group; 2 TenneT

Analysis of Parameters Affecting Current Rating of Cables Installed in J-tube for Offshore Wind Farms
Ruhi RUHI1, Tapabrata MUKHERJEE1, Camilo APRAEZ2, George J. ANDERS2
1 Eaton Energy Automation Solutions, Canada; 2 Lodz University of Technology, Poland

Feasibility Assessment of Solutions for the Introduction of High-Temperature Superconducting AC Cable Lines in Megacities
Andrey KASHCHEEV, Mikhail DUBININ, Victor SYTNIKOV, Elena FILIPEVA, Dmitriy SOROKIN
1 ROSSETI R&D Center, Russian Federation

Motion Characterization of dynamic Cables with distributed acoustic Sensing obtained from Field Measurements
Simon DE RIJCKE1, Carlos ARBOLEDA1, Koen DE BAUW2, Antoine VERGAERDE3, Andrés MCKAY3
1 MARLINKS, Belgium; 2 ENGIE Laborelec, Belgium; 3 OCEAN WINDS, Spain

Evaluation of Thermal Network Modelling and Finite Element Analysis for Ampacity Rating Calculation of Wind Farm Export Cable
Camilla ESPEDAL, Henrik STRAND, Espen EBERG, Henrik STRAND, Espen EBERG, Svein Magne HELLESØ, Nina Marie THOMSEN
1 SINTEF Energiforskning

Cable Dimensioning based on Wind Predictions in an Offshore Meshed Network
Tom EGAN1, Vasileios L. KANAS2, Andreas I. CHRYSOCHOS2, Nikolaos Ion BATISTATOS2, Maryam ZADFALLAH1, Henry ABRAMS1, Casey FONTANA1
1 Invenergy, United States of America; 2 Hellenic Cables, Greece

Qualification of Submarine AC Cables for 1500 m Water Depth
Lisa JOHANSSON
NKT AB, Sweden

Development and Validation of a Third-Party Intrusion Detection Software Based on DAS Measurement Data
Florian AINHAR1, Andreas BOLZER1, Werner LIENHART2, Lisa STRASSER2
1 Wiener Netze; 2 Graz University of Technology
Dynamic cable rating with partial drying of the soil

Robert SPICE¹, Martin HIRD¹, Justin DIX²
¹ITP Energised UK; ²University of Southampton UK

Superconducting Power Cable For 500 MVA at 110 kV in Munich - First Insights in the Test Run

Robert BACH¹, Robert PRINZ², Werner PRUSSEIT³, Dag WILLÉN⁴, Patrick MANSHEIM¹, Alexander ALEXSEEV⁵, Wescley Tiago BATISTA DE SOUSA⁶
¹South Westphalia University of Applied Sciences, Germany; ²NKT Cables Group, Denmark; ³SWM Infrastruktur GmbH & Co. KG, Germany; ⁴THEVA Dünnschichttechnik GmbH, Germany; ⁵Linde Kryotechnik AG, Germany; ⁶Karlsruher Institut für Technik, Germany

Concept and development of a digital twin of a 110-kV-cable line

Robert BACH¹, Rouven BERKEMEIER², Judith SCHRAMM³, Carsten WOLFF⁴
¹South Westphalia University of Applied Sciences, Soest, Germany; ²Fachhochschule Südwestfalen, Abt. Soest, Germany; ³Rheinische NETZGesellschaft mbH, Germany; ⁴NKT GmbH & Co. KG, Germany

High Reliability Zero Failures in Underground and Underwater Transmission Systems

Pablo REALPOZO¹, Victor SIERRA-MADRIGAL², Jose Luis GARCIA-URRESTI²
¹CFE, Mexico; ²CIGRE México, Mexico

New HVDC Insulation System Electrical Evaluation on Small Scale Samples and Model Cables

Marc BAILLEUL¹, Ramona HUUVA², Johan ANDERSSON², Anette JOHANSSON²
¹BOREALIS N.V., Belgium; ²BOREALIS AB, Sweden

Harnessing solar-wind complementarity to unlock the full potential of submarine high voltage cables: a case study for the Belgian North Sea

Oscar DELBEKE, Johan DRIESEN
KU Leuven

PS3 - TOWARDS SUSTAINABILITY

Sustainable Circular Solutions for Cables with XLPE Insulation System

Paul BRIGANDI¹, Maria MOUBARAK², Edit BERCZI³, Saurav SENGUPTA¹, Alison SHAPIRO⁴
¹Dow, United States of America; ²Dow Deutschland, Germany; ³Dow Europe GmbH, Switzerland; ⁴University of Delaware, United States of America
Positive Impact of Novel XLPE on both Performance and Sustainability

Timothy PERSON¹, Roshan AARONS², Edit BERCZI³, Saurav SENGUPTA¹
¹Dow, United States of America; ²Dow, Germany; ³Dow, Switzerland

Design for sustainability (D4S)

Alberto BAREGGI
PRYSMAN GROUP, Italy

Development of GIS Cable Termination with improved Compactness and Compatibility towards SF6 alternative Gases

Lei CHEN
NKT AB, Sweden

On-site testing and 1-year operational experience for 145 kV, 2500 A pressurized air insulated cables

Marcel STOECKLI¹, Walter HOLAUSS⁴, Zejko TANASIC⁵, Raphael LUETHI², Jasmin SMAJIC³
¹ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; ²Hivoduct AG, Switzerland; ³ETH Zurich Institute of Electromagnetic Fields, Switzerland

Towards innovative solutions to connect HVDC cables with less potential environmental impact

Espen DOEDNES¹, Nils-Bertil FRISK¹, Abdellatif Ait AMAR²
¹Nexans Norway AS Norway; ²Nexans S.A. France

Enhanced HV Cable Connection Alarm System: Introducing i-LinkBox™

Sadettin ERDENİZ, Yusuf HIZAL
EM Elektrik-EMELEC Türkiye

Development of replacing method from HPFF cable to XLPE cable system sustaining old steel pipe

Yusuke MURAKAMI¹, Fumihiko TAKI¹, Kimihiro IWASAKI¹, Takuto KOBAYASHI², Makoto SUIZU³, Ryu MATSUO⁴
¹TEPCO Power Grid, Incorporated, Japan; ²TEPCO Holdings, Incorporated, Japan; ³Sumitomo Electric Industries, Ltd., Japan; ⁴STEC, Japan

Design process for the assessment of currents distribution and ampacity on high loaded 36 kV links with multiple cables per phase

Enrico DI VITO, Paolo FALESSI, Lorenzo GARZELLI, Luca GUIZZO
Terna SpA
Application of Phase-to-phase Spacers in Prevention and Control of Ice-Shedding on Compact Transmission Lines

**Zenghao HUANG**, **Hao LI**, **Lingmeng FAN**, **Linjie ZHAO**, **Qi YANG**, **Hao PAN**

1China Southern Power Grid Research Institute Co., Ltd, China; 2Electric Power Science Research Institute of Yunnan Power Grid Co., Ltd, China

---

**ID: 10313**

**HVDC overhead line insulators: basics and performance**

**Jean-Marie GEORGE**, **Damien LEPLEY**

Sediver, France

---

**ID: 10359**

**Double circuits overhead lines DC + AC: focus on EMF of the pilot project 500kV DC + 132kV AC**

**Andrea PIGNATA**

TERNA, Italy

---

**ID: 10360**

**The new 500 kV HVDC Italian Overhead Lines**

**Gabriele TRESSO**

TERNA, Italy

---

**ID: 10522**

**Considerations for temporary earthing in compact and heavy loaded OHL**

**Ebbo DE MEULEMEESTER**, **Ranjan BHUYAN**, **Dhruvi SHUKLA**, **Pragati KIDAMBI**, **Chris ENGELBRECHT**

1DNV; 2TenneT TSO; 3DNV / Technical University of Delft

---

**ID: 10574**

**Design Challenges and Recommendations in Uprating the Existing 380 kV Overhead Lines, The Netherlands**

**Tom BÖRGER**, **E. PLATENKAMP**, **Jeff BROWN**, **Renata GHENO**

1DNV; 2TenneT TSO

---

**ID: 10620**

**Nodes-based connection system for the cost-effective assembly of tubular lattice towers**

**José Ramón LÓPEZ-BLANCO**, **Pablo RODRÍGUEZ-HERRERÍAS**, **Norberto IBÁN-LORENZANA**, **Antolin LORENZANA-IBÁN**, **Álvaro MAGDALENO-GONZALEZ**, **Carlos GARCÍA-BARRIOS**

1Anisopter Insightful Research, Spain; 2Red Eléctrica, Spain; 3CARTIF, Spain; 4Universidad de Valladolid, Spain
<table>
<thead>
<tr>
<th>ID: 10766</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B2 PS1 - Challenges from Renewables Integration and Influences of Energy Transition on OHL</td>
<td></td>
</tr>
<tr>
<td>Keywords: Energy transition, regional interconnections, transmission line optimization, compacting, bundle expansion, Surge Impedance Level (SIL)</td>
<td></td>
</tr>
<tr>
<td><strong>500 kV Paranaíba OHL - A HSIL line with high transmission capacity: Design, construction and performance report</strong></td>
<td></td>
</tr>
<tr>
<td>Luiza Lemos Nogueira MARTINS, João Batista Guimarães Ferreira DA SILVA, Ricardo ANDRADE, Ronaldo COELHO</td>
<td></td>
</tr>
<tr>
<td>Brazilian NC of CIGRE, Brazil; Paranaíba</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10790</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B2 PS1 - Challenges from Renewables Integration and Influences of Energy Transition on OHL</td>
<td></td>
</tr>
<tr>
<td>Keywords: remote monitoring, power transmission capacity of OHLs, wire state</td>
<td></td>
</tr>
<tr>
<td><strong>Real-time Continuous Remote Wire Condition Monitoring System for Evaluation of Overhead Line Capacity</strong></td>
<td></td>
</tr>
<tr>
<td>Mikhail PANARIN, Viktor TOKAREV</td>
<td></td>
</tr>
<tr>
<td>ServiceEnergy Ltd, Russian Federation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10900</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B2 PS1 - Challenges from Renewables Integration and Influences of Energy Transition on OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Maximizing power transfer and RES integration using Dynamic Line Rating (DLR) - Ireland TSO experience</strong></td>
<td></td>
</tr>
<tr>
<td>Kingsuk SAHA¹, Derek CARROLL¹, Andrew MCGRATH¹, Aidan GEOGHEGAN¹, Dag DREJER², Vegmund LOSNEDAL³, Aran STOKES¹</td>
<td></td>
</tr>
<tr>
<td>¹EirGrid; ²ESB Networks; ³Heimdall Power</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10912</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B2 PS1 - Challenges from Renewables Integration and Influences of Energy Transition on OHL</td>
<td></td>
</tr>
<tr>
<td>Rohit TRIVEDI, Chittesh CHANDRAN</td>
<td></td>
</tr>
<tr>
<td>EirGrid</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10928</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B2 PS1 - Challenges from Renewables Integration and Influences of Energy Transition on OHL</td>
<td></td>
</tr>
<tr>
<td>Keywords: Braced line posts, Compact lines, Composite insulators, Insulated cross-arm</td>
<td></td>
</tr>
<tr>
<td><strong>Evolution, State of the Art and Future Development Trends in Composite Insulated Cross-arm Technology</strong></td>
<td></td>
</tr>
<tr>
<td>Usama AHMED¹, Eric MOAL³, Xinlong WANG², Yanlin LI², Jie YU², Liu CHAO²</td>
<td></td>
</tr>
<tr>
<td>¹SHEMAR, Canada; ²SHEMAR, China; ³SHEMAR, France</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10954</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B2 PS1 - Challenges from Renewables Integration and Influences of Energy Transition on OHL</td>
<td></td>
</tr>
<tr>
<td>Keywords: Dynamic line rating - Increased capacity of existing OHL – LiDAR - Sensor application - Weather data</td>
<td></td>
</tr>
<tr>
<td><strong>Predicting Capacity Gains from Dynamic Line Rating prior to Sensor Deployment</strong></td>
<td></td>
</tr>
<tr>
<td>Tobias AASPRONG, Gunnhild SVANDAL PRESTHUS</td>
<td></td>
</tr>
<tr>
<td>Statnett Norway</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10957</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B2 PS1 - Challenges from Renewables Integration and Influences of Energy Transition on OHL</td>
<td></td>
</tr>
<tr>
<td>Keywords: Ampacity, Conductor, High temperature low sag, Transmission, Test</td>
<td></td>
</tr>
<tr>
<td><strong>High temperature low sag conductors in high ice load regions</strong></td>
<td></td>
</tr>
<tr>
<td>Vivendhra NAIDOO¹, Bjarni Helgi THORSTEINSSON², Kjell Age HALSAN²</td>
<td></td>
</tr>
<tr>
<td>¹EFLA Consulting Engineers Norway; ²Statnett Norway</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10977</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B2 PS1 - Challenges from Renewables Integration and Influences of Energy Transition on OHL</td>
<td></td>
</tr>
<tr>
<td>Keywords: Overhead line, Ampacity, DLR, Realtime, Forecast, Conductor temperature, Wind speed</td>
<td></td>
</tr>
<tr>
<td><strong>Efficacy of introducing a DLR system for the operation of an overhead line connected with high power photovoltaic facilities</strong></td>
<td></td>
</tr>
<tr>
<td>Tomoki KITASHIMA¹, Yves BRUSTEN², Daisuke SAITO¹, Brian BERRY², Jonathan MCGINNIS², Laurent GERLACHE²</td>
<td></td>
</tr>
<tr>
<td>¹Furukawa Electric Power Systems, Co. Ltd., Japan; ²Ampacimon S.A., Belgium</td>
<td></td>
</tr>
</tbody>
</table>
Audible Noise and Radio Interference Constraints for Hybrid Conversion of Existing EHV AC Overhead Lines: Mexican and Italian Case Studies
Francesco PALONE1, Carlos TEJADA-MARTINEZ2
1Terna S.p.A., Rome, Italy; 2Instituto Politécnico Nacional (IPN), México

Noise-reducing conductors for reconductoring projects
Jeremy UNTERFINGER, Stefan STEEVENS, Saskia MÖLLENBECK, Benjamin SCHRÖDER, Steffen RIEBLING
Amprion GmbH, Germany

Voltage Uprating of 275 kV Overhead Transmission Lines to 400 kV with Retrofit Insulated Cross-arms (RICA)
James DEAS1, Usama AHMED2, Xinlong WANG3, Yanlin LI4, Tango Teh PT5, Alfredo FERNANDEZ6, Bahare HASSANPOUR7
1National Grid UK; 2SHEMAR Canada; 3SHEMAR China; 4SHEMAR UK; 5SHEMAR Spain; 6Wood plc UK

Improved Model for Overhead Line Audible Noise Prediction
Oliver PISCHLER1, Uwe SCHICHLER2, Isobel GREEN2, Azeez AJIBOLA2
1TU Graz; 2SSEN Transmission

Sustainable Transmission Innovation with Poles, Cables, and Insulators -TRIPI-Study Case in Urabá, Colombia
Jhjoiner OSORIO, Diego TAUTA
EPM

Optimization Algorithm for Transmission Line Routing with Multicriteria Constraints
Anderson VELANDIA1, Cristian MENDOZA1, Fernando DINIZ2, Judy VALVERDE1, Wallace HONORATO2
1Enlaza Grupo Energía Bogotá; 2Argo

Wind speed measurement at the conductor for exact ampacity calculation for overhead power lines
Wolfgang FRÖB1, Carsten BROCKMANN2, Andreas HORETH1, Alexandra KRAEMER3
1LTB Leitungsbau GmbH, Germany; 2Fraunhofer-Institut für Zuverlässigkeit und Mikrointegration IZM, Germany; 3BKW ES, Germany

First HV DC links in KSA OHL networks, conductor design, DC loss studies, manufacturing and testing
Mohamad EL CHMOURI
RIYADH CABLES GROUP, KSA
**Turning Cold Deserts of India into Solar Energy Powerhouse by Developing a Transmission system Through Snow Cladded Mountains**
Karanvir Singh PUNDIR, Nitesh KUMAR, Dr. Subir SEN, Rajesh GUPTA, Abhay CHOUDHARY
Power Grid Corporation of India Limited, India

**Innovative Solution & Construction Technique For Cable Termination Arrangement for Transmission Line Towers**
Rahul PURI*, Nitesh Kumar SINHA, Rajesh GUPTA, Dr. Subir SEN, Abhay CHOUDHARY
Power Grid Corporation of India Limited, India

**Rock bolting raft foundation of a Long span Narrow based terminal tower for Lower Subansiri Hydropower project – POWERGRID Experience**
Pradeep PALANISAMY*, Neeraj Singh GAUTAM, Nitesh Kumar SINHA, Rajesh Gupta GUPTA, Dr Subir SEN, Abhay CHOUDHARY
Power Grid Corporation of India Limited, India

**DESIGN CONSIDERATIONS & ROUTE SELECTION FOR WORLD's HIGHEST ALTITUDE +/-350 kV MULTIPOLE HVDC TRANSMISSION LINE**
Ashish SINGH, Nikhil JHA, Chandra KANT, Anil SHARMA, Rajesh KUMAR
POWERGRID CORPORATION OF INDIA LIMITED, India

**A Study on the New Adjustment Device to Adjusting a Sagging of Wires for Overhead Lines**
Heejeong YU, Kyunghun LEE, KiHyun CHO, Jongchae KIM
KEPCO, Korea, Republic of (South Korea)

**Passive asset activation through a measuring system based on fiber optics in context of asset management, strategies, technologies and methods for OHL**
Franziska GEBHARDT¹, Roman SIMKIN¹, Uwe ZIEBOLD¹, Dirk KUNZE¹, Dennes MENTZ²
¹50 Hertz Transmission GmbH, Germany; ²WG SYSTEMS e.K., Germany

**Development of Design Rules for the Use of New High-Strength Steels for Lattice Towers**
Jan MAESSCHALCK¹, Sofia ANTONODIMITRAKI², Marios-Zois BEZAS², Jean-François DEMONCEAU², Muhammad Omer ANWAAR²
¹ELIA ENGINEERING, Belgium; ²UNIVERSITY OF LIEGE, Belgium; ³ARCELOR-MITTL, Luxembourg

**Key challenges of Design & Construction in Creek Area of 765 kV D/C Hexa Conductor Based Lakadia Vadodara Transmission Project**
Chandan KALRA*, Harish KUMAR*, Prem KUMAR, Rajesh SURI
Sterlite Power Transmission Limited, India
**Dynamic modeling and analysis of a DLR System towards increasing overhead transmission Lines ampacity**

Jemma MAKRYGIORGOU, Christos – Spyridon KARAVAS, Ioannis MORAITIS, Efthimia CHASSIOTI, Jun RONG

Department of Research Technology & Development, Independent Power Transmission Operator (IPTO) S.A., Athens, Greece

**Emission-free Electric Drum Winch eST 140**

Michael ERSPAMER², Gisela GRUBER¹, Ulrich OTTERMANN³

¹Zeck GmbH, Germany; ²Omexom Hochspannung GmbH Zeck GmbH, Germany; ³TenneT TSO GmbH

**Optimal routing of corridors and paths of OHL for grid connectivity and substation siting with improved stakeholder engagement**

Marcel STOECKLI¹, Stefano GRASSI²

¹ELECTROSUISSE, Switzerland – CIGRE NC Secretariat; ²GILYTICS AG, Switzerland

**Advanced Overhead Power Lines Electric Field and Stationary AC Corona Analysis Utilizing Artificial Intelligence**

Adnan MUJEZINOVIC, Ajdin ALIHODŽIĆ, Emir TURAJLIĆ, Maja MUFTIĆ DEDOVIĆ, Zijad BAJRAMOVIĆ

University of Sarajevo - Faculty of Electrical Engineering, Bosnia and Herzegovina

**Navigating Uncertainties in Dynamic Line Rating Estimation**

Brian LEIST, Kristine ENGEL, Josef SPALENKA, Clay WATERS, Rachael GRUDT, Nathan PINNEY, Jon MARMILLO

LineVision Inc.

**PS2 - ASSET MANAGEMENT, STRATEGIES, TECHNOLOGIES AND METHODS FOR OHL**

**Damage in overhead lines – A tool for lifespan prediction**

Julien SAID¹, Emmanuel CIEREN², John REFORD², Maxime GUEGUIN³, Rémi CAPILLON³, Matthieu ANCELLIN²

¹RTE, France; ²Eurobios, France

**A Forest Fire Target Detection Method Based on YOLOv8**

Yuanjun ZUO, Zhihong HUANG, Yunlong SUN, Jian XIAO, Sheng WU

State Grid Hunan Electric Power Company Lmitted Research Institute, China
**ID: 10176**

**B2 OVERHEAD LINES - Full Papers**

**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL

**Analysis of lightning strike distribution of typical 500 kV transmission lines based on lightning data and distributed transient traveling wave**

Shanqiang GU, Yingpu XIE, Jian LI, Min WU, Mengfei LEI, Xiaqin ZHANG

State Grid Electric Power Research Institute, China

---

**ID: 10178**

**B2 OVERHEAD LINES - Full Papers**

**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL

**Experimental Study on the Characteristics of Grounding Devices for Towers of Overhead Transmission Line**

Bo ZHANG¹, Sen WANG², Shanqiang GU³, Zhizhong LI¹, Yingpu XIE³

¹Tsinghua University, China; ²Shaanxi Electric Power Research Institute, China; ³State Grid Electric Power Research Institute, China

---

**ID: 10179**

**B2 OVERHEAD LINES - Full Papers**

**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL

**Lightning Risk Assessment Method for Transmission Channel Based on EGM and Numerical Solution**

Shanqiang GU, Mengfei LEI, Jian LI, Min WU, Hua REN, Yingpu XIE

Wuhan NARI Limited Company, State Grid Electric Power Research Institute, China

---

**ID: 10314**

**B2 OVERHEAD LINES - Full Papers**

**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL

**Keywords:** overhead line cable, asset management, non-destructive testing, ACSR

**Test bench and database for ACSR cable non-destructive testing**

Pascale PRIEUR¹, Stéphane HEURTAULT¹, Louise EYMARDAUPHIN¹, Julien SAID¹, Jean-Philippe SAUT², Kieu-Diem HO²

¹RTE, France; ²EUROBIOS, France

---

**ID: 10336**

**B2 OVERHEAD LINES - Full Papers**

**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL

**Keywords:** Artificial Intelligence, Asset Management, Object Detection, Transmission Line Inspection

**AI-Enabled Transmission Line Inspections**

Zefan TANG, Jing YANG, Junhui ZHAO, Elizabeth HALL, Asim FAZLAGIC

Eversource Energy, United States of America

---

**ID: 10490**

**B2 OVERHEAD LINES - Full Papers**

**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL

**Risk-based after-service Inspections and Testing of overhead Line Composite and Porcelain Insulators for residual Life Assessment**

Igor GUTMAN¹, Johan LUNDENGÅRD¹, Matthew HEATH², Charles KURNIAWAN²

¹Independent Insulation Group Sweden AB; ²Transgrid Australia

---

**ID: 10500**

**B2 OVERHEAD LINES - Full Papers**

**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL

**Keywords:** Resilience, Decision Support, Wildfires, Natural Risks, Infrastructure, Protection, Simulation

**Decision Support Center with Multi-sensory Data for Infrastructure Protection**

João GASPAR¹, Luis Mário RIBEIRO¹, José MOREIRA¹, Carlos VIEGAS², Pedro MARQUES¹, David ALMEIDA²

¹REN - Redes Energéticas Nacionais, SGPSS, S.A.; ²Univ Coimbra, ADAl, Department of Mechanical Engineering

---

**ID: 10501**

**B2 OVERHEAD LINES - Full Papers**

**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL

**Keywords:** Polymeric insulators, Condition assessment

**Defect Analysis of Polymeric High Voltage Insulators: Condition Assessment and Inspection Techniques**

André COELHO¹, Gonçalo PINTADO², Pedro NUNES³, Rui MARTINS¹

¹EDP Labelec, Portugal; ²REN, Portugal
On the assessment of electromagnetic interference of overhead lines and underground cables on gas pipelines
Andrea LEIRIA, João TARQUÍNIO, António ESTEVES
EDP Labelec, Portugal

Use of insulating towers in high voltage transmission lines: effect of grounding elimination on lightning performance
Iván HIGUERO-TORRES, Carlos GARCÍA-BARRIOS, Alexandra BURGOS-MELGUIZO, Paulino APARICIO-CILLÁN, Pedro LLOVERA-SEGOVIA
1Instituto Tecnológico de la Energía, Spain; 2Red Eléctrica, Spain; 3Universitat Politècnica de València, Spain

Integrated system for work at height safety management
Pablo RODRÍGUEZ, Carlos RODRÍGUEZ, Guillermo GONZÁLEZ, Javier VALDÉS, Abel SANCHO, Jesús MARTÍN, Alejandro SICILIA
1Red Eléctrica, Spain; 2Elewit, Spain; 3Redeia, Spain; 4AOS, Spain; 5Amplia, Spain

Experience with Satellite Imagery for Maintenance of OHL Lines
Emanuel DE BOE, Górg Philip MAXIMILIAN, William VAN DEN BROECK, Irid BUFI
1ELIA, Belgium; 250 hertz, Germany

Influence of Acid Attack on the Hydrophobicity of HTV Silicone Rubber on Composite Insulators
Marcel STOECKLI, Jaka STRUMBELJ, Yannick INDERBITZIN, Urs GASSER, Christine BAER
1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2Pfisterer Switzerland AG, Switzerland; 3Wacker Chemie AG, Germany

Combined Effects of Audible Noise Mitigation Measures for OHLs by Surface Treatments and Enlargement of Conductor Diameter
Marcel STOECKLI, Hannah KIRCHNER, Christian FRANCK, Benjamin SCHROEDER
1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2ETH Zurich, Switzerland; 3Amprion GmbH, Germany

Monitoring Overhead Lines through images from nanosatellites
Carlos NASCIMENTO, Thiago MUNIZ, Demetrio AGUIAR, Valter SILVA, Guilherme BRANGIONI, Lucas SOUZA
1Brazilian NC of CIGRE, Brazil; Cemig GT; 2Cemig D
<table>
<thead>
<tr>
<th>ID: 10778</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Keywords:</strong> Corrosion, Atmospheric pollution, Transmission lines, Galvanized carbon steel, Atmospheric corrosion, Artificial Salt Spray, Electrochemical tests</td>
<td></td>
</tr>
<tr>
<td><strong>Atmospheric weathering and corrosion, in a tropical country such as Brazil, in the maintenance costs of metallic materials in power transmission lines</strong></td>
<td></td>
</tr>
<tr>
<td>Fernando DINIZ1, Euro PINTO DE ALMEIDA2, Thiago Luiz FERREIRA1, Alberto RODRIGUES DE SOUSA1, Camila PACHER3, Julia Stefany ALBRECHT1, Mariana BRAGANÇA1, Kleber PORTELLA1, Juliano DE ANDRADE1, Bruno KOWALCZUK1, Mauricio MAZUR3</td>
<td></td>
</tr>
<tr>
<td>1Brazilian NC of CIGRE, Brazil; 2ARGO; 3Consultor; LACTEC</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10921</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Keywords:</strong> Full-scale test, Slim type tower, Tower in Tower, Wind tunnel experiments</td>
<td></td>
</tr>
<tr>
<td><strong>Hyperspectral Imaging for the Corrosion Detection on Metallic Lattice Towers</strong></td>
<td></td>
</tr>
<tr>
<td>Frédéric MANGIALETO1, Irid BUFI2, Mohring WENCKE2, Eveline VRANKEN1, Roeland VANDEBRIEL3, Michiel VLAMINCK3, Zakaria BNOULKACEM3, Mina ZAHIRI3, Hiep LUONG3</td>
<td></td>
</tr>
<tr>
<td>1ELIA, Belgium; 250Hz, Germany; 3Imec, Belgium</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10973</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Keywords:</strong> Full-scale test, Slim type tower, Tower in Tower, Wind tunnel experiments</td>
<td></td>
</tr>
<tr>
<td><strong>Development of the design and construction method for newly constructing a slim tower inside an existing 275 kV tower</strong></td>
<td></td>
</tr>
<tr>
<td>Hayato SANO, Motoyuki YAMAZAKI, Yoshiyuki SAITO, Tomoaki OSONO, Keito MURAKAMI, Tomonori SHIRAISHI</td>
<td></td>
</tr>
<tr>
<td>TEPCO Power Grid, Japan</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10979</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Keywords:</strong> CFRP, maintenance technology, reliability, existing tower, flat bar</td>
<td></td>
</tr>
<tr>
<td><strong>Development of steel tower reinforcement method using flat bar and steel tower repair method using carbon fiber</strong></td>
<td></td>
</tr>
<tr>
<td>Hiromitsu IJICHI, Keito MURAKAMI, Keigo TANAKA, Tomoaki OSONO, Motoyuki YAMAZAKI, Tomonori SHIRAISHI</td>
<td></td>
</tr>
<tr>
<td>TEPCO Power Grid, Inc., Japan</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10980</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Keywords:</strong> Anomaly detection, Automated inspection, Drones, Machine learning</td>
<td></td>
</tr>
<tr>
<td><strong>Development of automated inspection technology for overhead transmission lines using drones</strong></td>
<td></td>
</tr>
<tr>
<td>Fumihiko KONDO1, Yuki MARUME1, Takaya MASUDA2, Masahiro OGAWA3, Kentaro FUKAMI3, Erika TANAKA2</td>
<td></td>
</tr>
<tr>
<td>1Chubu Electric Power Grid Co., Inc., Japan; 2SENSYN ROBOTICS, Inc., Japan</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10981</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Keywords:</strong> Audible noise, Inspection robot, Partial discharge</td>
<td></td>
</tr>
<tr>
<td><strong>Field Experience and Maintenance Assessment of RTV Coated Cap and Pin Insulators in Japan</strong></td>
<td></td>
</tr>
<tr>
<td>Ryo YUZAWA1, Asuka TOKURIKI1, Motohiro MAEDA2, Toshiyuki NAKACHI2</td>
<td></td>
</tr>
<tr>
<td>1Chubu Electric Power Grid Co., Inc., Japan; 2NGK Insulators, Ltd., Japan</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10986</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Keywords:</strong> Composite insulator, Spacer, Polymer, Electrical breakdown, Aging</td>
<td></td>
</tr>
<tr>
<td><strong>Mechanism Clarification of Insulating Performance Decreasing by Aging of Polymer Insulators for Overhead Transmission Lines</strong></td>
<td></td>
</tr>
<tr>
<td>Teruhisa TATSUOKA1, Toshihiro TSUBOI1, Hiromitsu IJICHI2, Tatsuya ISHIKAWA2, Sakae TANIGUCHI2, Tomonori SHIRAISHI2</td>
<td></td>
</tr>
<tr>
<td>1Tokyo Electric Power Company Holdings, Inc., Japan; 2TEPCO Power Grid, Inc., Japan</td>
<td></td>
</tr>
</tbody>
</table>
### ID: 11007
**B2 OVERHEAD LINES - Full Papers**  
**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL  
**Keywords:** asset health index, mechanical stresses, temperature influence, tower, vibration  

**Asset Health Index for Towers and Conductors in the Framework of EU Project FARCROSS**  
Viktor LOVRENCIC\(^1\), Nenad GUBELJAK\(^2\), Bálint NÉMETH\(^3\), Matej KOVAČ\(^4\), Levente RACZ\(^5\), Ana LOVRENCIC\(^6\)  
\(^1\)C&G Ljubljana, Slovenia; \(^2\)Faculty of Mechanical Engineering, Maribor, Slovenia; \(^3\)BME Budapest, Hungary; \(^4\)GRIDPULSE Ljubljana, Slovenia; \(^5\)BME Budapest, Hungary; \(^6\)C&G Ljubljana, Slovenia

### ID: 11082
**B2 OVERHEAD LINES - Full Papers**  
**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL  

**Case study for refurbishment of 33kV line with surge arresters on the earth wire**  
Anne WILLIAMS  
Aurecon, Australia

### ID: 11108
**B2 OVERHEAD LINES - Full Papers**  
**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL  

**Impact of Bushfire on Conductor Performance - Prioritising Rectification Works**  
Matthew HEATH\(^1\), Charles KURNIAWAN\(^1\), Brendan SHANAHAN\(^1\), Tim MACPHerson\(^2\), Denis DOWLING\(^2\)  
\(^1\)Transgrid, Australia; \(^2\)Raedyne Systems, Australia

### ID: 11160
**B2 OVERHEAD LINES - Full Papers**  
**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL  

**Wind induced acoustic emissions on glass insulators**  
Carina LINTNER\(^1\), Oskar OBERZAUCHER\(^1\), Michael LEONHARDSBERGER\(^1\), Fabien VIRLOGEUX\(^2\)  
\(^1\)Austrian Power Grid AG; \(^2\)Sediver S.A.S.

### ID: 11194
**B2 OVERHEAD LINES - Full Papers**  
**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL  

**Incorporation of New Technologies (drones) in the Maintenance and Monitoring of the Condition of High-Voltage Transmission Lines in ISA-INTERCOLOMBIA**  
Natalia RESTREPO, Carlos PUELLO, Juan PEÑA  
ISA Intercolombia

### ID: 11230
**B2 OVERHEAD LINES - Full Papers**  
**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL  
**Keywords:** Drones, innovative methods, asset reliability, technological advances  

**The use of drones for preventive maintenance of high voltage transmission lines: business case and field experiences**  
Samuel A. ASTO\(^1\), Daiana A. DA SILVA\(^2\), Alejandra M. LUNA\(^3\)  
\(^1\)ISA REP; \(^2\)Military Engineering Institute, Brazil

### ID: 11314
**B2 OVERHEAD LINES - Full Papers**  
**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL  
**Keywords:** Risk Management – Storm - Resilience - High Voltage – Overhead Line – Protection Zone – Dynamic Model – Network Performance - Optimisation  

**Towards a Digital Twin for Management of OHL Risk**  
Allidh MEEK\(^1\), Matthew JONES\(^1\), Alexandra CAMPBELL\(^1\), Iain DIVERS\(^1\), Taco ENGELAR\(^2\), Mark LEEMAN\(^2\)  
\(^1\)SP Energy Networks UK; \(^2\)Nera UK

### ID: 11353
**B2 OVERHEAD LINES - Full Papers**  
**Topics:** B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL  
**Keywords:** DLR, overhead line, sensor, neural network, distributed monitoring  

**Power System Management based on Distributed Line Monitoring**  
Levente RÁCZ, Dávid SZABÓ, Gábor GŐCSEI, Bálint NÉMETH  
Budapest University of Technology and Economics
<table>
<thead>
<tr>
<th>ID: 11357</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Keywords:</strong> Live-line maintenance, accident analysis, work safety, overhead line, personal protective equipment</td>
<td></td>
</tr>
<tr>
<td><strong>Analysis of Live Work Accidents in Transmission Lines and Recommendations to Improve Working Safety</strong></td>
<td></td>
</tr>
<tr>
<td>Dávid SZABÓ¹, Dániel BALOGH¹, Bálint NÉMETH¹, Eduardo RAMIREZ-BETTONI²</td>
<td></td>
</tr>
<tr>
<td>¹Budapest University of Technology and Economics; ²Xcel Energy</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11471</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Assessment of Operating Life of Silicone Rubber HV Insulator Coatings in Harsh Desert Environment</strong></td>
<td></td>
</tr>
<tr>
<td>Raouf ZNAIDI¹, Ahmad ALTHAGAFI²</td>
<td></td>
</tr>
<tr>
<td>¹GCC Interconnection Authority, KSA; ²GCC Interconnection Authority, KSA</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11504</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Use Of Convolutional Neural Network For Defect Identification From Tower Images And Unsupervised Machine Learning Algorithms For Transmission Line Vulnerability Estimation</strong></td>
<td></td>
</tr>
<tr>
<td>POWERGRID CORPORATION OF INDIA LIMITED, India</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11508</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Comprehensive Rectification Methodology for Submerged Pile Foundation of Overhead Transmission Line Towers</strong></td>
<td></td>
</tr>
<tr>
<td>Pankaj Kumar DWIVEDI, Nitesh Kumar SINHA, Rajesh GUPTA, Dr. Subir SEN, Abhay CHOUDHARY</td>
<td></td>
</tr>
<tr>
<td>Power Grid Corporation of India Limited, India</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11515</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Transforming Transmission Line Surveys: An Innovative AI-Based Optimization Approach</strong></td>
<td></td>
</tr>
<tr>
<td>Neeraj Singh GAUTAM*, Priti NAHAR, Rajesh GUPTA, Dr. Subir SEN, Abhay Chaudhary CHAUDHARY</td>
<td></td>
</tr>
<tr>
<td>Power Grid Corporation of India Limited, India</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11524</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Residual Life Estimation of Overhead Transmission Lines based on Asset Health Indexing</strong></td>
<td></td>
</tr>
<tr>
<td>Devaprasad PAUL*, Joseph George JOSE, Deo Nath JHA, Kuleshwar SAHU</td>
<td></td>
</tr>
<tr>
<td>POWERGRID, India</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11630</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Implementation of AHI for risk-based asset management approach on overhead lines and the strategic value towards transmission grid</strong></td>
<td></td>
</tr>
<tr>
<td>Franziska GEBHARDT, Roman SIMKIN, Andre DECKWERTH, Dirk KUNZE</td>
<td></td>
</tr>
<tr>
<td>50 Hertz Transmission GmbH, Germany</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11672</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> B2 PS2 - Asset Management, Strategies, Technologies and Methods for OHL</td>
<td></td>
</tr>
<tr>
<td><strong>Use of Gantries as Medium-Term Support to Ensure Continuity of Service for OHL After Severe Structural Damage in an Impact Incident</strong></td>
<td></td>
</tr>
<tr>
<td>Jan MAESSCHALCK¹, Kris NUYTS²</td>
<td></td>
</tr>
<tr>
<td>¹ELIA ENGINEERING, Belgium; ²SARENS, Belgium</td>
<td></td>
</tr>
</tbody>
</table>
The Innovative Project “ALTITUDE” - Automatic aerial Network inspection using Drones and Machine Learning

Georgios CHATZARGYROS1, Vasiliki KOTOULA1, Evangelia RIGATI1, Dimitrios STIMONIARIS2, Dimitrios TSIAMITROS2, Apostolos PAPAKONSTANTINOU3, Argyrios MOUSTAKAS3, Dimitrios SIMOS3, Georgios LOUKOS4, Sotirios CHRISTOPOULOS5, Georgios DOUKAKIS6, Konstantinos MARIOLIS7, Konstantinos KAOUSIAS7
1Renel I.K.E, Greece; 2INNORA, Greece; 3SciDrones, Greece; 4Hellenic Electricity Distribution Network Operator (HEDNO), Greece

Probabilistic Assessment of the Residual Life of Overhead Conductors Under Aeolian Vibrations

Shaoqi YANG1, Luc CHOUINARD1, Sébastien LANGLOIS2, Pierre VAN DYKE3, Josée PARADIS3
1McGill University; 2Université de Sherbrooke; 3Institut de recherche d’Hydro-Québec

Dielectric testing for integrity assessment of overhead composite core conductors

Léo RICHARD
Epsilon Composite Cable

Investigation of audible noise emissions from corona discharges of single water droplets on different surfaces under AC stress

Yang LU, Christian FRANCK
ETH Zurich

PS3 - IMPACTS FROM CLIMATE CHANGE ON OHL

Analysis of ice shedding induced faults of multiple voltage levels overhead lines and its mitigation strategies

Kunpeng JI, Bin LIU, Jialun YANG
China Electric Power Research Institute, China

Design and experimental analysis of arrester for ± 800kV UHVDC OHL

Wei CAO1,2, Shiqiang GU1,2, Jian LI1,2, Shuai WAN1,2, Jian WANG3
1Wuhan NARI Limited Company, China; 2State Grid Electric Power Research Institute, China; 3State Grid Corporation of China, China

Development of Galloping Distribution Maps for Overhead Transmission Lines with Specific Return Period in China

Jialun YANG, Bin LIU, Bin ZHAO, Yi LIU, Zhiyuan LU
China Electric Power Research Institute, China
<table>
<thead>
<tr>
<th>ID: 10186</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
<th>Potential Wildfire-induced Tripping Section Assessment of Transmission Line Based on Tree Identification and Flame Combustion</th>
</tr>
</thead>
</table>
|           | Topics: B2 PS3 - Impacts from Climate Change on OHL | Linneng FAN1, You ZHOU1, Enze ZHOU1, Lei WANG1.4  
1 Electric Power Research Institute, China; 2 Southern Power Grid Co., Ltd., China; 3 Changsha University of Science and Technology, China; 4 Guangdong Power Grid Co., Ltd., China |

<table>
<thead>
<tr>
<th>ID: 10307</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
<th>Hurricane IRMA feedback in the French West Indies</th>
</tr>
</thead>
</table>
|           | Topics: B2 PS3 - Impacts from Climate Change on OHL | Pierrick PRIGENT, Jean MARTINON  
EDF, France |

<table>
<thead>
<tr>
<th>ID: 10327</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
<th>Testing the Effectiveness of Covered Conductors for Wildfire Mitigation</th>
</tr>
</thead>
</table>
|           | Topics: B2 PS3 - Impacts from Climate Change on OHL | Matt BOWERS1, Alex HUDGINS1, Hunly CHY2, Arianne LUY2, Ben GEORGIN1  
1 Exponent, Inc., United States of America; 2 SCE Company, United States of America |

<table>
<thead>
<tr>
<th>ID: 10608</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
<th>A Novel Probe for Non-Contact, In-Situ Assessment of Solar Absorptivity: The Special Case of ACSR Conductors</th>
</tr>
</thead>
</table>
|           | Topics: B2 PS3 - Impacts from Climate Change on OHL | Jonathan BELLEMARE, Ghislain LAMBERT, Sébastien LEPROHON, Marion NOURRY, Vincent Q. GUAY, Pierre-Luc RICHARD, Nicolas POULIOT  
Hydro-Québec, Canada |

<table>
<thead>
<tr>
<th>ID: 10884</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
<th>Multiphysics OHL modeling</th>
</tr>
</thead>
</table>
|           | Topics: B2 PS3 - Impacts from Climate Change on OHL | Aleksandar TERZIĆ, Nebojša PETROVIĆ  
Elektromreža Srbije JSC, Serbia |

<table>
<thead>
<tr>
<th>ID: 10982</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
<th>Packed Snow Accretion on Overhead Transmission Line Insulators - Field Monitoring and Snow Conductivity Measurement using Atmospheric Corrosion Monitor -</th>
</tr>
</thead>
</table>
|           | Topics: B2 PS3 - Impacts from Climate Change on OHL | Manabu SAKATA1, Yusaku SATO1, Hiroki MIZOE2, Masayoshi MASUDA2, Ryota ICHIKAWA3  
1 Nippon Katan Ltd., Japan; 2 Tohoku Electric Power Co., Inc., Japan; 3 Tohoku Electric Power Network Co., Inc., Japan |

<table>
<thead>
<tr>
<th>ID: 10983</th>
<th>B2 OVERHEAD LINES - Full Papers</th>
<th>Design and verification of countermeasure against snow accumulation on transmission towers</th>
</tr>
</thead>
</table>
|           | Topics: B2 PS3 - Impacts from Climate Change on OHL | Kento FUJII1, Katsuyuki ENDO1, Akihiro WATANABE1, Koichi MINAGAWA2, Isamu HIROTA2  
1 Tohoku Electric Power Network Co., Inc., Japan; 2 TOMOE Corporation, Japan |
GIS database for overhead lines resilience to extreme ice events
Anne WILLIAMS¹, Matthew HEATH², Charles KURNIAWAN²
¹Aurecon, Australia; ²Transgrid, Australia

Data analysis and technical description of the ice monitoring system at Austrian Power Grid
Oskar OBERZAUCHER¹, Carina LINTNER¹, Conner GARCIA¹, Tommy MYRVÍK²
¹Austrian Power Grid AG; ²Heimdall Power

Investigation of the future development of temperature and low wind velocity in climate change for the Austrian power grid
Kerstin WEINDL¹, Klemens REICH¹, Hans RESSL², Theresa SCHELLANDER-GORGAS², Max NUTZ²
¹Austrian Power Grid; ²Geosphere Austria

Satellite Images as a Tool for Risk Management in Transmission Lines: Results of a Pilot with Emphasis on Landslides
Alexander BEDOYA, Mallory SUAREZ
ISA Intercolombia

Influence of transient impedance due to atmospheric discharges in the design of grounding of transmission towers
Hugo Eduardo BARREDA SÁNCHEZ
Redinter - Redeia

Measures to mitigate effect of cyclone on the transmission line structures
Karanvir Singh PUNDIR*, Nitesh Kumar SINHA, Rajesh GUPTA, Dr. Subir SEN, Abhay Choudhary CHOUDHARY
Power Grid Corporation of India Limited, India

Climate change and its associated materials requirements
Franziska GEBHARDT¹, Wencke MOHRING¹, Jan KNACKMUß¹, Dirk KUNZE¹, Milad MEHDIANPOUR², Jan MAESSCHALCK³
¹50 Hertz Transmission GmbH, Germany; ²IPU Ingenieurgesellschaft Berlin mbH, Germany; ³Elia Engineering, Belgium
<table>
<thead>
<tr>
<th>ID: 10322</th>
<th>B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B3 PS1 - Challenges and New Solutions in T&amp;D Substation Design and Construction for Energy Transition</td>
<td></td>
</tr>
<tr>
<td>Keywords: Distribution of Electricity, Environmentally Conscious Design, Electrical Enclosure, Technology, Substation</td>
<td></td>
</tr>
<tr>
<td><strong>Next Generation Distribution Center in a Box (DCIAB)</strong></td>
<td></td>
</tr>
<tr>
<td>Kushal SINGH, Jose MITRA, Sean FITZGERALD</td>
<td></td>
</tr>
<tr>
<td>Exelon/ComEd, United States of America</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10337</th>
<th>B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B3 PS1 - Challenges and New Solutions in T&amp;D Substation Design and Construction for Energy Transition</td>
<td></td>
</tr>
<tr>
<td>Keywords: Small Modular Reactor, Electrolyzer, Hydrogen, Nuclear, Substation</td>
<td></td>
</tr>
<tr>
<td><strong>Small Modular Reactor and Hydrogen Production: “Impacts on Substation Design”</strong></td>
<td></td>
</tr>
<tr>
<td>George W. BECKER</td>
<td></td>
</tr>
<tr>
<td>POWER Engineers, Inc., United States of America</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10338</th>
<th>B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B3 PS1 - Challenges and New Solutions in T&amp;D Substation Design and Construction for Energy Transition</td>
<td></td>
</tr>
<tr>
<td>Keywords: USA West Coast, Offshore Substation (OSS), Floating Offshore Substation (FOSS), Finite Element Analysis (FEA), Wave Basin Model Test</td>
<td></td>
</tr>
<tr>
<td><strong>Conceptual Design of Semi-submersible Floating Offshore HVAC Substation Solution</strong></td>
<td></td>
</tr>
<tr>
<td>Hongbiao SONG1, Zhaoxiang TANG3, Yang OUYANG2, Robert LUESCHER2, Tobias STIRL1, Hana ASSEFA2</td>
<td></td>
</tr>
<tr>
<td>1GE Vernova Grid Solutions, United States of America; 2GE Vernova Grid Solutions, Norway; 3GE Vernova Grid Solutions, Switzerland; 4GE Vernova Grid Solutions, Germany; 5Genesis Technip Energies, United States of America</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10362</th>
<th>B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B3 PS1 - Challenges and New Solutions in T&amp;D Substation Design and Construction for Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>The 36 kV voltage level – a new standard solution for grid integration of renewable energy sources</strong></td>
<td></td>
</tr>
<tr>
<td>Andrea VALANT</td>
<td></td>
</tr>
<tr>
<td>Terna, Italy</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10737</th>
<th>B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B3 PS1 - Challenges and New Solutions in T&amp;D Substation Design and Construction for Energy Transition</td>
<td></td>
</tr>
<tr>
<td>Keywords: Floating Offshore Substation, FOSS, GIS, Simulation, Vibrations, Experimental Correlation</td>
<td></td>
</tr>
<tr>
<td><strong>GIS for offshore and floating applications</strong></td>
<td></td>
</tr>
<tr>
<td>Marcel STOECKLI1, Yang OUYANG2, Lukas TREIER2, Bernhard SPICHIGER2, Robert LUESCHER2, Hongbiao SONG1</td>
<td></td>
</tr>
<tr>
<td>1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2GE Vernova, Switzerland; 3GE Vernova, USA</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10738</th>
<th>B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B3 PS1 - Challenges and New Solutions in T&amp;D Substation Design and Construction for Energy Transition</td>
<td></td>
</tr>
<tr>
<td>Keywords: High voltage switchgear, SF6 alternatives, disconnector, earthing switch, C4-FN, LCA</td>
<td></td>
</tr>
<tr>
<td><strong>420 kV SF6-free High Voltage Gas Insulated Switchgear Design, Type Tests and Product Footprint</strong></td>
<td></td>
</tr>
<tr>
<td>Marcel STOECKLI1, Vincent TILLIETTE4, Navid MAHDIZADEH2, Ueli STRAUMANN2, Patrick STOLLER2, Denis TEHLAR2, Kalpesh CHAUHAN3</td>
<td></td>
</tr>
<tr>
<td>1ELECTROSUISSE / CIGRE Switzerland NC Secretary; 2Hitachi Energy Ltd, Switzerland; 3Hitachi Energy Ltd, India</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10781</th>
<th>B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B3 PS1 - Challenges and New Solutions in T&amp;D Substation Design and Construction for Energy Transition</td>
<td></td>
</tr>
<tr>
<td>Keywords: Energy Transition, BESS, Grid Code Compliance, Grid Impact</td>
<td></td>
</tr>
<tr>
<td><strong>First Step toward Carbon Neutrality using BESS Project in South Africa</strong></td>
<td></td>
</tr>
<tr>
<td>Jung Bae KIM, Minsoo LEE</td>
<td></td>
</tr>
<tr>
<td>Hyosung Heavy Industries</td>
<td></td>
</tr>
</tbody>
</table>
The role of increased standardisation in the delivery of substation infrastructure to enable a low carbon future in Ireland
Hugh CUNNINGHAM, Ivan CODD, Enda HARRINGTON, Brendan LINEHAN, Bernard O’SULLIVAN, Colm TWOMEY
Electricity Supply Board (Ireland)

Experience with HVDC GIS application during commissioning and early operation phase
Maria KOSSE, Christoph KLEIN, Maximilian TUCZEK, Frank Rene RICHTER, Thomas GÖTZ
1Siemens Energy Global GmbH & CO. KG, Germany; 2TenneT TSO GmbH, Germany; 350Hertz Transmission GmbH, Germany

New test and commissioning tools and concepts for Low Power Instrument Transformers
Franz GATZE, Peter MENKE, Patrick MORITZ, Federico CANAS, Max BUROW, Joerg BLUMSCHEIN, Antoni Furlani ROSA, Lucas VARELA, Thomas NEUMEIER
1Siemens Energy, Germany; 2Siemens AG, Germany; 3SecuControl, Brazil

Offshore floating HVAC and HVDC substations – Experiences in design of selected primary equipment
Douglas RAMSAY, Mark GEARY, Thomas HAMMER, Thorsten STEINHOFF, Matthias STEUER, Stephan VOSS, Joerg HAIFERMAAS, Yana SHATEROVA
1Corio Generation UK; 2Siemens Energy Germany

Optimization of overall HV cable length in hybrid transmission technologies used for evacuation of power from offshore wind parks/Solar parks by implementation of compact transition station.
BB MUKHERJEE, Sasikiran KANDALAM, PNV Murali PRAKASH
Power Grid Corp. of India Ltd., India

EV Changing Infrastructure Design Challenges And Solutions – Case Study
Nilesh KANE, Ravindra BHANAGE, Ajay POTDAR
TATA POWER, India

Challenges And Precautions During Design And Engineering Of Gas Insulated Switchgear (GIS) Substation Of Hydro Projects
Gorav VIG, Sudhir KUMAR, Dileep SHUKLA, Vivek KAPIL, Aruna GULATI
BHEL, India

Novel Solution for Converting Existing 400kV I-Type One & a Half Breaker Scheme to D-Type for Evacuating Double Circuit Lines in Same Direction Using 3D Modelling
Nishant SINGH, Vinay Anand ANAND, Sanjeev SHRIVASTAVA, Aruna GULATI
BHEL, India
<table>
<thead>
<tr>
<th>ID: 11605</th>
<th>B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B3 PS1 - Challenges and New Solutions in T&amp;D Substation Design and Construction for Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Optimization Approach for the Layout design of 400/220kV Gas insulated Switchgear (GIS) Substations</strong></td>
<td></td>
</tr>
<tr>
<td>Akhilesh KUMAR*, Aruna GULATI, Vivek KAPIL, Dileep K SHUKLA, Puneet CHAWLA</td>
<td></td>
</tr>
<tr>
<td>BHEL, India</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11646</th>
<th>B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B3 PS1 - Challenges and New Solutions in T&amp;D Substation Design and Construction for Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Development of DC 320kV, 525kV GIS Cable terminations</strong></td>
<td></td>
</tr>
<tr>
<td>Eui-hwan JUNG, Jin-ho NAM, Sung-yun KIM, Si-ho SON, Jung-nyun KIM</td>
<td></td>
</tr>
<tr>
<td>LS Cable&amp;system, Republic of (South Korea)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11816</th>
<th>B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B3 PS1 - Challenges and New Solutions in T&amp;D Substation Design and Construction for Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Design and Considerations for Station Service Voltage Transformer (SSVT) to Provide Low-Voltage Supply in EGAT’s Substation</strong></td>
<td></td>
</tr>
<tr>
<td>Koranee PHONGKHUMPHAI, Nabhat CHAIYAPHAN, Thanyathep NANTACHAI, Korrikot WONGNIYOM, Pornpimon SAWADDEEMONGKON</td>
<td></td>
</tr>
<tr>
<td>Electricity Generating Authority of Thailand (EGAT), Thailand</td>
<td></td>
</tr>
</tbody>
</table>

---

**PS2 - RETURN ON OPERATIONAL EXPERIENCES FOR SUBSTATION MANAGEMENT**

<table>
<thead>
<tr>
<th>ID: 10139</th>
<th>B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B3 PS2 - Return on Operational Experiences for Substation Management</td>
<td></td>
</tr>
<tr>
<td><strong>In situ monitoring of the precision shift of capacitive voltage transformers</strong></td>
<td></td>
</tr>
<tr>
<td>Bernard PAYA1, Alain JEANMAIRE1, Benoit BRUCHON2</td>
<td></td>
</tr>
<tr>
<td>1EDF R&amp;D, France; 2EDF CIST-INGEUM, France</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10141</th>
<th>B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B3 PS2 - Return on Operational Experiences for Substation Management</td>
<td></td>
</tr>
<tr>
<td><strong>Solutions for temporarily increasing the Reliable Installation Capacity</strong></td>
<td></td>
</tr>
<tr>
<td>François GEGOT1, Lars EBBERS2, Robert VOSSE3</td>
<td></td>
</tr>
<tr>
<td>1Wika, France; 2Qirion, Netherlands; 3Alliander, Netherlands</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10309</th>
<th>B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B3 PS2 - Return on Operational Experiences for Substation Management</td>
<td></td>
</tr>
<tr>
<td><strong>Integration, Operation and Maintenance of AIS Circuit Breakers using SF6 alternatives - experience with the 3 HV main technologies</strong></td>
<td></td>
</tr>
<tr>
<td>Emmanuel LOPES1, Minh NGUYEN2, Benoit BRUCHON1, Fabrice MARETTE1</td>
<td></td>
</tr>
<tr>
<td>1EDF, France; 2RTE, France</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10339</th>
<th>B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B3 PS2 - Return on Operational Experiences for Substation Management</td>
<td></td>
</tr>
<tr>
<td><strong>Seismic Resilience of Interconnected Substation Equipment: Lessons Learned from a Comprehensive Test and Modelling Program</strong></td>
<td></td>
</tr>
<tr>
<td>Leon KEMPNER. JR.1, M.V. SIVASELVAN2</td>
<td></td>
</tr>
<tr>
<td>1Bonneville Power Administration, United States of America; 2University at Buffalo, United States of America</td>
<td></td>
</tr>
</tbody>
</table>
Condition & Risk Assessment: Plans and Reality

Tony McGRAIL1, Philip BOREHAM1, Jamie BEARDSALL4, Mark ROWBOTTOM4, Reena DHIR2, Carl JOHNSTONE3
1Doble Engineering, United States of America; 2Manitoba Hydro, Canada; 3Asset Management, United Kingdom; 4Drax Power, United Kingdom

System Approach to Evaluation and Deployment of Substation Robotics

Poorvi PATEL1, Dean GORDON2, Sergio SAGARELP, Dexter LEWIS1, Sunny BELLARY1
1Electric Power Research Institute (EPRI), United States of America; 2Con Edison, United States of America; 3Black & Veatch, United States of America

Evaluating and Comparing Substation Threat Mitigation Tactics: Substation Improvements for a More Resilient Power Grid

Paul SOMBOONYANON1, Connor BOWEN2
1AEC Lionstech, United States of America; 2Burns & McDonnell, United States of America

Overcoming Challenges and Progressing Electrical Substations toward Digital Transformation

Paul SOMBOONYANON1, Brian PALMER2
1AEC Lionstech, United States of America; 2Burns & McDonnell, United Kingdom

Monitoring System of Earth Loop Impedance to Verify Step and Touch Voltages

José R. VIDAL2, Abderrahim KHAMLICHI2,1, Antonio GONZALEZ3, José L. NAVARRO4, Pascual SIMÓN2, Fernando GARNACHO1
1Universidad Politécnica de Madrid, Spain; 2FFII-LCOE, Spain; 3EDP REDES ESPAÑA, Spain; 4UFD-GRUPO NATURGY, Spain

European Experience of Developing from Asset Reliability Information to Risk Method for Optimal Investment on Substation Assets

Jos SLANGEN1, Qikai ZHUANG2, Branislav PILAT3, Despoina MAKRIDOU4, Ilic VLADIMIR5, Jan CERNOHORSKY6, Phillipe CLAUDE7, Mehdi OTHMANI7, Uros KERIN8
1TenneT TSO B.V.; 2TenneT TSO GmbH; 3SEPS; 4IPTO; 5EMS; 6CEPS; 7Rte; 8ELES

A system risk approach for management and optimization of critical spare parts

Marcel STOECKLI1, Enrico CONTE2, Sourav ADHYA3, Saktivel DURAIPAN4
1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2Hitachi Energy, Switzerland; 3Hitachi Energy, Poland; 4Hitachi Energy, India
New Standards and Solutions for Service Continuity of HV GIS

Marcel STOECKLI1, Jens HETTLER2, Mark KUSCHEL3, Samuel PACHLATKO4
1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2Swissgrid AG, Switzerland; 3Siemens Energy AG, Germany; 4Hitachi Energy AG, Switzerland

Retrofit for 420 kV Gas-Insulated Lines: Technical Concept and Return of Experience

Marcel STOECKLI1, Samuel PACHLATKO2, Michael GATZSCHE2, Freddy VON ARX1, Manuel NAEF2, Francesco AGOSTINI1, Mark WALDRON2
1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2Hitachi Energy, Switzerland; 3National Grid Electricity Transmission, United Kingdom

Implementation of the new IEC and CIGRE requirements on service continuity to high voltage gas insulated switchgears

Marcel STOECKLI1, Samuel PACHLATKO2, Denis TEHLAR2, Josef HANSON3, Jennifer-RuiQiong PAN4, Benoit GODEAU2, Thomas WIJNHOVEN5, Nicolas DEMARTHE2
1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2Hitachi Energy, Switzerland; 3Hitachi Energy, Germany; 4Hitachi Energy, China; 5Elia, Belgium

Case Studies - GEOBIM Substation and Power Generation Reality Capture for Digital Twin purposes

Ana MAROTTI1, Gerson LIMA2, Daniel FERNANDES3, Rodrigo AGUIAR4, Lucas HOLANDA5, Juliano Calazans MARQUES6, Sergio SILVEIRA7
1Brazilian NC of CIGRE, Brazil; Eletrobras FURNAS; 2Computer Graphics Works; 3Eletrobras ELETRONORTE; 4Energia BIM; 5Eletrobras CHESF; 6Eletrobras CGT ELETROSUL; 7Imagem

Digital twins applied for intelligent analysis and real-time monitoring of circuit breakers in electrical power substations

Ana MAROTTI1, Giovanni BERNARDES2, Sergio SILVEIRA2, Clayton DUARTE PESSOA3, Gerson F. M. LIMA4, ClodualdSOUSA2, Fabiano VILLANI1
1Brazilian NC of CIGRE, Brazil; Eletrobras FURNAS; 2UNIFEI; 3Imagem Geosistemas; 4Computer Graphics Works

New Competencies and diagnostic Methods needed for the Application of Composite Insulators in Substations

Peter SIDENVALL
Independent Insulation Group Sweden AB, Sweden

The Impact of Digital Transformation on the Asset Management System

Dmitry VODENNIKOVA1, Yulia ZHLIKINA1, Svetlana ZAKIROVA2
1PJSC ROSSETI, Russian Federation; 2S&T Centre of Rosseti FGC UES, Russian Federation
Experiences with commissioning of a 132 kV GIS SF6-free digital substation

Karl POLLESTAD¹, Jean-Luc RAYON², Christopher GEBS³, Hans Kristian MEYER³, Asgeir MJELVE⁴, Alban LUCIOL², Jean-François MIRONNEAU², Assan SARR²

¹Bane NOR Norway; ²GE Renewable Energy France; ³SINTEF Energy Research Norway; ⁴Elvia Norway

Commissioning and operational experience with the first switchgear of its kind to integrate digital and greenhouse gas-free components for power transmission

Marcel ENGEL², Peter MENKE¹, Mark KUSCHEL¹, Fred OECHSLE², Julian SPRINGER², Grzegorz POLICHT², Tim FRITSCH², Jakob SIEMAYR⁴

¹Siemens Energy, Germany; ²Netze BW GmbH, Germany; ³Siemens AG, Germany; ⁴OMICRON electronics GmbH

Management experience of condition-monitoring system and development of new IoT devices

Yuki YATABE, Shinya AICH, Takayuki KANAMORI, Tetsuya IKEDA, Yusuke TAKENAKA

Chubu Electric Power Grid Co., Inc., Japan

Management of SF6 gas leakage and repair technology in gas insulated equipment

Keisuke NAKAMURA, Keisuke MURAKITA, Shigeyuki TSUKAO, Wataru ISHIKAWA, Harukazu AKIYAMA, Syuichi TAMURA

TEPCO Power Grid, Inc., Japan

Study on Advanced Maintenance Strategies and Asset Management for Substation Equipment in Japan

Kiyohiro TSUBOI¹, Shinya AICHI¹, Satoshi ICHIHARA¹, Kosho KAMATANI¹, Ryosuke ITOTANI¹, Koki SADAHIRO²

¹Chubu Electric Power Grid Co., Inc., Japan; ²TEPCO Power Grid, Inc., Japan; ³Kansai Transmission & Distribution, Inc., Japan

Sustainable improvement on substation resilience and reliability by using eco-friendly equipment and remote maintenance systems

Ryosuke ITOTANI¹, Koki SADAHIRO¹, Masashi TOKAI², Hiroyuki HAMA³, Kazuki SUGINO³, Manabu TAKEDA³

¹Kansai Transmission and Distribution, Inc., Japan; ²Mitsubishi Electric Corporation, Japan; ³DAIHEN Corporation, Japan
**Verification of Substation Condition Monitoring by Linking IEDs with Existing Substation Equipment**

Hiroko ISAJI, Yousuke OGURA, Masanobu YOSHIDA  
Chubu Electric Power Co., Inc., Japan

**Retrofit GIS Service Solution for extended Lifetime Maintenance**

Philip BENGTSSSON  
Hitachi Energy Sweden AB, Sweden

**Operational experience with dynamic current rating of busbar systems in 220-kV substations**

Ralf PUFFER¹, Richard WEISSNAR², Klemens REICH², Anita MACHL²  
¹RWTH Aachen University; ²Austrian Power Grid AG

**SF6 Insulated Substations: Challenges and Lessons Learned for Improving ISA Group Operational Reliability and Sustainability.**

Marcelo MEZA, Johan SÁNCHEZ  
ISA Interconexión Eléctrica

**Sustainable Urban Electrical Substations: an Integral View for a Sustainable Transformation of the Energy Sector**

Andrés LONDOÑO, Diego TAUTA, Juan SIERRA  
EPM

**Methodology for the Condition Analysis of High Voltage Capacitor Banks (Proposal and application case)**

Gerardo GUERRA¹, Fabian ROJAS¹, Edgar TORRES¹, Carlos VARGAS², José MORATAYA²  
¹Enlaza Grupo Energía Bogotá; ²Conecta

**Return of experience on gas handling with C4-FN mixtures for high-voltage equipment**

Matthew BARNETT¹, Ewan SCOTT¹, Manuel NAEF², Michael GATZSCHE², Maxime PERRET¹, Fabrice MORAND³, Peter PILZECKER³, Martin GOPPEL⁴, Chrystelle BASSET⁵, Roland KURTE⁶, Neil GWINNUIT⁷  
¹SSEN Transmission UK; ²Hitachi Energy Switzerland; ³GE Vernova Switzerland; ⁴GE Vernova France; ⁵DILO Germany; ⁶Air Liquide France; ⁷WIKA Germany; ⁸EMT United Kingdom

**Sensitivity Study and Operational PD Monitoring Experiences of SF6-free GIS**

Constantinos ONOUFRIOU¹, Lujia CHEN¹, Malcolm SELTZER-GRANT²  
¹The University of Manchester UK; ²Monitora, Manchester UK
Autonomous Inspection Robots for use in HVDC Converter Halls
Georg FRÜBING1, David INGRAM2, Jörg HAFERMAAS3, Mark VAES4
150Hertz Transmission GmbH, Germany; 2Elia System Operator S.A., Belgium; 3Ross Robotics Ltd, United Kingdom, Great Britain; 4Siemens Energy Global GmbH & Co. KG, Germany

Compact photoacoustic sensor system for the continuous monitoring of SO2 and SF6 percentage in gas-insulated switchgears
Roland KURTE1, Christian WEBER2, Daniel STAIGER1, Johannes KAPP2, Michael MANN3, Carlo LEIDECKER3, Daniel FUCHS1
1WIKA Alexander Wiegand SE & Co. KG, Germany; 2Fraunhofer IPM, Germany; 3TH Aschaffenburg, Germany

Continuous Improvement of Arc Flash Assessment for Work Place Safety
Md Abid KHAN, Rashid ALMISFER
Saudi Aramco, KSA

Development of Asset Risk Mapping to Support Asset Management Decision Making in an Integrated Electricity Utility
Andreas Putro PURNOMOADI, Heri Setyo PURNOMO, Indera ARIFIANTO, Erny ANUGRAHANY, Ova KURNIAWAN, Anita PHARMATRISANTI, Herru NUGRAHA
PT. PLN (PERSERO), Indonesia

Challenges And Lessons Learnt Through Failure Experience And Initiatives To Strengthen Resilience Of The Gas Insulated Switchgear
Mayank RANA*, Pankaj Kumar JHA, M.S. HADA, Sandeep YADAV
POWER GRID CORPORATION OF INDIA LIMITED, India

Controlled Switching Of Coupled Power Transformers Based On Residual Flux Estimation Including State Of Art Digital Monitoring Technique – Field Experiences
Snigdha TALE*, Chintan PATEL, Umanahesh P, Mehulbhai SONAGRA
Hitachi Energy India Limited, India

Design Philosophy of Extension bays for EHV Gas Insulated Switchgear
M. Mohana RAO*, Neelam TIWARI, Sonali Abhinav ROY, Mritunjay KUMAR, Arun KUMAR, Krishna PRASAD, HR PATEL, SanJai Kumar RAI, K Venkateswar REDDY, B. Jagadeesh Chandra PRASAD
BHEL , India

Anoop Kumar SINGH, M A Naveen NAVEEN, Anirban Bhattacharyya BHATTACHARYYA
POWERGRID, India
### B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers

| ID: 11560 | Service Continuity Criteria for Gas Insulated Switchgear (GIS) - Utility Experience in Green Field and Brown Field GIS Substations  
Rashmi CHAUDHARY *, B P SONI  
Gujarat Energy Transmission Corporation Ltd, India |
| --- | --- |
| ID: 11725 | Gas Insulated Substation (GIS) Overhaul Prioritizing Index Calculation a Case Study East Java and Bali Population  
Wisnu F PRADITAMA, Nur Fajar FARDIANSYAH, Muftakhul EFENDI, Fermi TRAFIANTO  
PT. PLN (Persero), Indonesia |
| ID: 11800 | Digital Technology Breakthrough Experience in Increasing Grid Operational Efficiency and Productivity  
Abdul Halim BAHARUDIN, Sugumar SHUNMUGAM, Zainizam MOHAMED  
Tenaga Nasional Berhad, Malaysia |
| ID: 11801 | Spearheading Asean Utility Role in Sustaining Green Environment by Intensifying Effort to Reduce SF6 Leakage in GIS Equipment – User Experience Sharing  
Abdul Halim BAHARUDIN1, Suthep SINGHARERG2  
1Tenaga Nasional Berhad, Malaysia; 2Electricity Generation of Thailand |
| ID: 11824 | Amesbury #5 Substation Emergency Power Transformer Relocation  
Carli GAVIN  
National Grid, United States of America |
| ID: 11893 | Substation Design Improvement Considering Actual Accident Due to Direct Multiple Lightnings  
Keisuke MURAKITA  
TEPCO Power Grid, Inc. |

### B4 - DC SYSTEMS AND POWER ELECTRONICS

#### PS1 - DC EQUIPMENT AND SYSTEMS

| ID: 10142 | Technical-economic analysis of different HVDC transmission topologies for large offshore wind power connection  
Tanh VU-CONG, Marco SCHUDEL, William BELE, Guillaume MEYER  
RTE, France |
EMT simulation of an MTDC system integrating Modular Multilevel DC/DC converter with DC voltage control
Ghazala SHAFAQI1,2, Frédéric COLAS1,3, François GRUSON1,3, Xavier GUILLAUD1,3
1L2EP, France; 2Arts et Metiers, France; 3Centrale Lille Institute, France

Study and mitigation of DC harmonics on Corsica’s SACOI HVDC-LCC station causing long unavailability, a case study.
Yannick VERNAY1, Jordann BRIONNE2, Julien MICHEL1
1RTE, France; 2EDF, France

A contribution to HVDC protection interoperability through components sizing
Myriam RATAJCZYK1,2,3,4, Bertrand RAISON2,3,4,5, Alberto BERTINATO1, Pascal TORWELLE1
1SuperGrid Institute, France; 2University Grenoble Alpes, France; 3CNRS, France; 4Grenoble INP, France; 5G2Elab, France

Advancement in HVDC Technology: Exploring Controllable Current Source Converters Utilizing Reverse Blocking IGCTs
Guangfu TANG1, Xiaoguang WEI1, Longlong CHEN2, Taosha JIANG1, Anyou DONG1
1Beijing Huairou Laboratory, China; 2State Grid Smart Grid Research Institute Co., Ltd., China

Development and Engineering Application of Controllable-Line-Commutated Converter
Zhiyuan HE1, Chong GAO1, Kunpeng ZHA2, Jun YANG1, Guangfu TANG2, Dongshan HE1
1State Grid Smart Grid Research Institute, China; 2C-EPRI Electric Power Engineering Co., Ltd., China; 3Beijing Huairou Laboratory, China

Key Techniques and Engineering Applications of ± 500kV High Voltage and Large Capacity DC grid Based on Voltage Source Converter with 100% New Energy connected
Jin ZHANG1, Ming LI2, Jie LIU1, Zheng ZHAO2, Tan LI2, Qichen CHEN2
1State Grid Corporation of China, China; 2State grid economic and technological research Institute Co., Ltd., China

Key Technology of Baihetan-Jiangsu ±800kV Hybrid Cascaded UHVDC Transmission Project
Jing ZHOU, Jiapei ZHOU, Dong LIU
State Grid Smart Grid Research Institute Co., Ltd, Beijing, China

Research and application of new technology and equipment for Baihetan-Jiangsu ±800 kV UHVDC project
Kunpeng ZHA, Fan ZHANG, Yuefeng YANG, Fuyue WEN, Xiaolin ZHANG, Ting ZHAN
C-EPRI Electric Power Engineering Co., Ltd., China
The world's first series-connected multi-terminal LCC UHVDC transmission -- System studies for the Jinshang-Hubei ±800 kV project
Ying XU1, Ying PU1, Zijian GAO1, Ling WANG1, Yajun LU1, Weiran CAO2, Andersson MATS2, Ying YE2, Xun WANG2
1State Grid Economic and Technological Research Institute Co.,Ltd. (SPERI), China; 2Hitachi Energy, China

A Staged Approach for Upgrade of the Square Butte HVDC System
Christian WINTER1, Peter SCHOMMER1, Joanne HU2, Bruno BISEWSKI2
1Minnesota Power, United States of America; 2RBJ Engineering, Canada

Innovative Design of a Reduced Scale Prototype for the New Multiterminal Italian HVDC Network with SiC-based HVDC Hybrid Circuit Breaker
Pierluigi VACANTE
TERNA, Italy

Software-In-the-Loop Real-Time Simulation of a HVDC Terminal
Carl BARKER1, Emmanuel AMANKWAH1, Omar JASIM1, Samek ELIMBAN2, Stella ZHANG2, Hui DING2, Yuan CHEN2, Paul FORSYTH2
1GE Vernova UK; 2RTDS Technologies Inc., Canada

Application of Harmonic Loci-Based Control Design in Frequency and Time Domain for a Consistent Design of VSC HVDC Harmonic Active Solutions
Omar JASIM, Jose A R MONTEIRO, Nagasesha REDDY
GE Vernova UK

Successful Test Method for primary Faults on a VSC-HVDC overhead Line
Martin PETTERSSON
Svenska kraftnät, Sweden

Verification of Performance for VSC-HVDC with a DC primary Fault Test
Martin PETTERSSON
Svenska kraftnät, Sweden

Modular offshore HVDC transmission planning principles
Cornelis PLET1, Maksym SEMENYUK1, Hans CLELINE1, Michel DUBBELBOER2
1DNV; 2TenneT
±525 kV 2 GW Bipole VSC-HVDC Offshore Transmission (TenneT Projects) - Key Design Aspects
Ashish BANGAR¹, Amit KUMAR², Francisco CHACON³, Nadew Adisu BELDA¹, Yogesh GUPTA², Olivier RUITON²
¹TenneT; ²GE Vernova

LCC UHVDC System Improvements, with a novel Converter Transformer Configuration
Mats ANDERSSON
Hitachi Energy Sweden AB, Sweden

Two Approaches to HVDC IT System Replacement
Colin MADSEN¹, Michael PARADIS¹, Tong SHU¹, Lee HARROP², Lydia SMITH²
¹ATCO Electric, Canada; ²Transpower, New Zealand

Labrador Island Link Overload Design Considerations
James NUGENT, Tyler THOMPSON
Newfoundland and Labrador Hydro, Canada

Hydro-Québec’s Chateauguay Back-to-Back HVDC Converter Replacement Project: Integration of New Operating Modes for System Resiliency Improvement and Water Management Effectiveness using VSC Technology
Amr ABDELLAOUI, Vito DE LUCA, Marie-Jacinthe HEMSAS
Hydro-Québec, Canada

Survey of the Reliability of HVDC Systems Throughout the World During 2021-2022
P.V.I. TAIAROL
Advisory Group AG-04, Study Committee B4, Canada

Development and Application of HVDC Analysis System for Improving Operational Reliability
Woojin CHO¹, Insoo PARK¹, Seonho LEE², Olivier CLEMENCON¹
¹KAPES, Korea, Republic of (South Korea); ²KEPCO, Korea, Republic of (South Korea)
The experience of the Power Oscillation Damping Study based on the hybrid simulation method for the Bukdangjin 2nd project in South Korea

Hyunjae YOO1, Kumar MANOJ2, Panyoung SUNG1, Hyunkeun KU3, Olivier CLEMENCON1
1KAPES, Korea, Republic of (South Korea); 2GE Grid Solution, UK; 3KEPCO, Korea, Republic of (South Korea)

A HVDC 800 kV link, enlarging regional interconnection, to increase the utilization of variable renewable generation

Dourival CARVALHO, Rodrigo CABRAL, Tiago RIZZOTTO, Fabiano SCHMIDT, Thais TEIXEIRA
Brazilian NC of CIGRE, Brazil; EPE

Crustal Conductance - an Index for the Estimate of the Minimum Electrode Size and Electrode - Converter Substation Distance

Paulo Edmundo da Fonseca FREIRE
Brazilian NC of CIGRE, Brazil; PAIOL Engenharia

Analysis of Power Oscillation Damping Performance in Grid-forming VSC HVDC System

Jae-hyuk KIM1, Hyung-seung KIM1, Hyun-jun KIM1, Jun-chol LEE1, Hong-ju JUNG1
1Hyosung, Korea, Republic of (South Korea); 2Hyosung Heavy Industries, Korea, Republic of (South Korea)

Generic EMT study circuit and TOV for the design of a DC link.

El-Mehdi KARMANI, Julien POUGET, Pierre RAULT, Marco SCHUDEL
RTE, France

The Greenlink Interconnector - A new 504 MW HVDC Interconnector

Jonathan RUDDY1, Katrin RASCHKE1, Ernest NKUSI2, Vincent FOO3, Katherine HAROLD4
1Greenlink; 2Siemens Energy; 3Sumitomo Electric Industries; 4WSP

Measures to secure long lifetime of an LCC based HVDC link with a potentially aged cable

Magne MEISINGSET1, Jon Ivar JUVIK2, Kees KOREMAN3, Thinus DU PLESSIS4
1Statnett SF Norway; 2Statnett SF Norway; 3Tennet The Netherlands; 4Tennet The Netherlands

Refurbishment of the control and protection system devices and thyristor valve modules in the 300 MW Shin-Shinano No.2 Frequency Converter

Masanori TAKECHI1, Masahito KANEKO1, Shigenori KAKUNO1, Taihei SATO2, Takahiko KIKUI3
1TEPCO Power Grid, Inc., Japan; 2Toshiba Energy Systems & Solutions Corporation, Japan; 3Hitachi,Ltd, Japan
Refurbishment and System Test of High Voltage Converter Unit 3 (HVCU3) at Vyborg Back-to-Back HVDC Link
Natalya LOZINOVA1, Sergey KATANTSEV2, Olga SUSLOVA1, Evgeniy ZMAZNOV1
1JSC «NIPT», Russian Federation; 2PJSC ROSSETI, Russian Federation

A classification framework for HVDC-based transmission grid architectures
Sarah ANHAUS1, Patrick DÜLLMANN1, Lars OSTERKAMP1, Robert DIMITROVSKI2, Paul MCNAMARA3, Juan-Carlos GONZALEZ4
1RWTH Aachen University, Germany; 2TenneT TSO GmbH, Germany; 3EPRI Europe, Ireland; 4Super Grid Institute, France

Switching Voltage Capability of Air-Core Dry-Type VSC Converter Reactors
Klaus POINTNER, Wolfgang BIERBAUMER, Taneli MONNI
Trench Austria GmbH

Advanced Maintenance Recommendation for HVDC and FACTS Air-core Drytype Reactors
Bernhard FRÖHLICH, Alexander GAUN, Christian GRUBERBAUER
Coil Innovation GmbH

Overvoltages experienced by Metallic Return Cables in Bipolar HVDC Configuration
Max GOERTZ1, Simon WENIG1, Daniel BARTH1, Simon BECKLER2
1Mosaic Grid Solutions GmbH, Germany; 2TransnetBW, Germany

Sunrise Wind: USA’s first HVDC connected offshore wind farm
Lorenzo ZENI1, Gustavo F. GONTIJO1, Peter MCGARLEY2, Lennart SCHUETZE2, Alejandro B. SALAS2, Stefan HANSEN3, Ahmed SOLIMAN4
1Ørsted; 2Siemens Energy; 3Siemens Gamesa Renewable Energy

DC/DC Conversation and Distributed Grid based Solution of HVDC Tapping
Qi ZHANG1, Filipe Faria SILVA1, Roni IRNAWAN1, Rian FATAH2
1Aalborg University; 2Gadjah Mada University

HVDC Valve Hall Fire Incident: A Case Study at GCCIA Al Fadhili HVDC
Abdullah ALGHAMDI1, Jayakumar MUTHUSAMY2, Ranjith PANIGRAHI2
1GCCIA, KSA; 2GCCIA, KSA; 3GCCIA, KSA
ID: 11645
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS1 - DC Equipment and Systems
Dynamic Performance of Dual HVDC Terminals (±800 KV LCC and ±320 KV VSC) at the same busbar- Operational Experience
Narendra KUMAR*, Puneet TYAGI, S. BHATTACHARYA, V. DIWAKAR, P. RAVI
POWERGRID, India

ID: 11655
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS1 - DC Equipment and Systems
Challenges, Design Considerations & Field Studies for Relocation of Earth Electrode Station- User’s Perspective
Narendra KUMAR*, Aditya B. CHANDRAN1, Dr. Puneet TYAGI1, S. BHATTACHARYA1, Dr. Subir SEN1, Rohidas MASKE1, Sandeep KALANTRI1, Abhay CHOUDHARY1
1POWERGRID, India; 2MSETCL, India

ID: 11657
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS1 - DC Equipment and Systems
Operational Experience on the Black-Start Exercise of VSC Based HVDC Systems in Southern Regional Grid of India
Arthi Sahaya Rones V*, Nikhitha C J, T Muthu KUMAR, T SRINIVAS, S P KUMAR
Grid-India, India

ID: 11688
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS1 - DC Equipment and Systems
Addressing Operational Contingencies Faced in Parallel Operation of ±800 kV 6000 MW Champa Kurukshetra HVDC Link.
Anoop KUMAR*, Keshav GUPTA, Gopesh Kumar JHAJHARIA, Vishnu Parkash SRIVASTAVA
POWERGRID, India

ID: 11689
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS1 - DC Equipment and Systems
Evolving of protection strategies for DMR Faults in the ±800 kV 6000 MW Champa Kurukshetra HVDC Link.
Anoop KUMAR*, Gopesh Kumar JHAJHARIA, Vishnu Parkash SRIVASTAVA
POWERGRID, India

ID: 11751
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS1 - DC Equipment and Systems
Keywords: Derisk, HVDC, Stability analysis, MIIF
A Novel Methodology to Derisk HVDC and Offshore Wind Connections to A Network
Xiao-Ping ZHANG1, Shuailong DAI1, Chengyi WU1, David LI1, Dechao KONG2, Xiaoyao ZHOU2
1University of Birmingham UK; 2NG ESO

ID: 11894
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS1 - DC Equipment and Systems
Keywords: HVDC circuit breakers, VSC, type tests, fully assembled, multi-terminal grids.
Test procedures for ± 500 kV HVDC circuit breakers: how to assess their performances based on current world laboratory facilities
Sino PATTI1, Massimo MARZINOTTO1, Giuseppe PELLICCIONE1, Roy NIJMAN2, Shankar SUBRAMANY2, Roberta ALUNNI3
1Terna S.p.A; 2KEMA Labs; 3CESI S.p.A

ID: 11895
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS1 - DC Equipment and Systems
Keywords: Grid-forming, Virtual Synchronous Machine, MMC, STATCOM, VSC.
Optimal Control Selection for Grid-Forming MMC-Based Assets: An analysis of interplay between GFM and internal MMC controls
Eros AVDIAJ, Jef BEERTEN
KU Leuven ESAT/ELECTA & EnergyVille
# B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers

## PS1 - DC Equipment and Systems

### Integrated Design Scheme of VSC-HVDC System for 10GW Large-Scale New Energy Ultra-long-distance Transmission

**Qingming XIN, Junjie FENG, Zhiyong YUAN, Xiaobin ZHAO, Chuang FU, Ting HOU, Biyue HUANG, Yuebin ZHOU, Changyue ZOU**  
State Key Laboratory of HVDC, Electric Power Research Institute of China Southern Power Grid, Guangzhou 510663, China

### 220kV Direct-connected Static Synchronous Series Compensation and the First Demonstration Application in China

**Yuhong WANG, Kunpeng ZHA, Xiong ZHAN, Gang ZHAO, Yuefeng YANG, Lanfang LI**  
C-EPRI Electric Power Engineering Co., Ltd, China

### Design of Hybrid Active AC filter Scheme in MinYue back-to-back DC Project

**Weimin MA\(^1\), Yiming YANG\(^1\), Fangjie WU\(^1\), Ling WANG\(^1\), Yiming JI\(^1\), Yiran CHANG\(^2\), Xiujuan ZHANG\(^3\)**  
\(^1\)State Grid Economic & Technological Research Institute, China; \(^2\)RONGXIN HUIKO Electric Co., LTD, China; \(^3\)Sieyuan Qingneng Electric & Electronics Co. Ltd, China

### Key Technologies and Engineering Application of Distributed Power Flow Controller

**Yizhe LIN, Lei PAN, Qiang ZOU, Yunlong DONG**  
NR Electric CO., LTD, China

### Stability enhancement of weak Grids with high penetration of Renewables with grid-Forming STATCOM/Enhanced-STATCOM

**Rasool HEYDARI**  
Hitachi Energy Sweden AB, Sweden

### Health Monitoring Approaches for high Voltage Capacitors in Power Converters

**Riddhi GHOSH**  
Hitachi Energy Sweden AB, Sweden

### Application of Large STATCOMs for Dynamic Reactive Power Support in California 500kV Series Compensated Transmission System

**Joanne HU\(^1\), Eric STAUFFER\(^2\), Stefan SCHILLING\(^3\), Bruno BISEWSKI\(^1\), John RANDOLPH\(^2\), Felix NABEIN\(^3\)**  
\(^1\)RBJ Engineering, Canada; \(^2\)LS Power, USA; \(^3\)Siemens Energy, Germany
Transformer-coupled Static Synchronous Series Compensators for transmission and distribution operators, based on industrial-class converters
Markel ZUBIAGA, Javier CHIVITE, Pedro IZURZA, David SANTOS, Javier CAÑAS
1Ingeteam Research Institute, Spain; 2Ingeteam P. Technology, Spain

Experimental validation of the General Power Theory using Power Hardware-in-the-Loop - Opportunities for New Converter Controls
Pitamber JANKEE, Trevor GAUNT, Zhiwang FENG, Graeme BURT
1University of Cape Town South Africa; 2University of Strathclyde United Kingdom

The Analysis of the SSR between TCSC and Synchronous Generator using RTDS and TCSC Replica
Hyunkeun KU, Seungchan OH, Yonghan KROWN, Injoo JUNG, Moonsung BAE, Gumin KROWN, Hyukil KROWN, Jeonghoon SHIN
Korea Electric Power Corporation, Korea, Republic of (South Korea)

Hunting Issues in the Brazilian Interconnected Power System – A Case Study of Multiple SVCs
Antonio Ricardo TENORIO, Saulo SILVA FILHO, Rodrigo PRAXEDES, Felipe SOBRINHO
1Brazilian NC of CIGRE, Brazil; ONS; 2ARGO; 3Hitachi Energy; 4Jordão Energia

The Vectorized Approach: An Efficient Method to Model VSC Converters and its Verification Against Tests
Joan HERNANDEZ, P. SAMUELSSON, Y. JIANG HÄFNER
Hitachi Energy Sweden AB

Improved dynamic Voltage Control based on Network Sensitivity Characteristics
Francisco Javier CIFUENTES GARCIA, Özgür Can SAKINCI, Jef BEERTEN
EnergyVille/KU Leuven, Belgium

Subsynchronous Resonance Analysis for an M-SSSC FACTS Installation in the Atlantico Region of the Colombian Transmission System
Juan BOTERO, Carlos BORDA, Mohammad HAMMAD
1Smart Wires Inc; 2Siemens Energy

Operation of Static Series Synchronous Compensators integrated into the Colombian Power System: Challenges, Experiences and Lessons Learned
Jaime PINZÓN, Camilo MORENO
XM
ID: 11476
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS2 - FACTS and Power Electronics
Reflection on applicable standards and learnings from actual failures of power inverters
Muhannad ALSUHAILY1, Robert HEUCKELBACH2, Ashutosh SHARMA3, Sukant BHATTACHARYA4
1DNV, UAE; 2DNV, The Netherlands; 3DNV, UAE; 4DNV, UAE

ID: 11603
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS2 - FACTS and Power Electronics
Control Strategies For Parallel Operation Of Statcoms – Securing For Bulk Renewable Energy Transmission
Prashant SALI, Karikalan M, Jaiganesh RAMKUMAR
Siemens Ltd, India

PS3 - NEW TECHNOLOGIES AND CONCEPTS OF DC AND FACTS ENABLING ENERGY TRANSITION

ID: 10160
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS3 - New Technologies and Concepts of DC and FACTS enabling Energy Transition
Application of Multi-ports Energy Router to Coordinated Control of Renewable Energy, Network, Load and Storage at County-level Power Grid
Chong ZHANG1, Zhiyuan HE1, Xiaotong JI1, Huafeng WANG1, Xueguang WU1, Junda QIN1
1State Grid Smart Grid Research Institute Co., Ltd., China; 2State Grid Hubei Electric Power Co., Ltd., China

ID: 10201
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS3 - New Technologies and Concepts of DC and FACTS enabling Energy Transition
Analysis of Oscillation Mechanism of Renewable Energy Generation Integrated into MMC-HVDC Under Islanded and Grid-connected Modes
Yuntao XIAO, Guanghui LI, Weisheng WANG, Guoqing HE, Ni ZHEN
China Electric Power Research Institute, China

ID: 10203
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS3 - New Technologies and Concepts of DC and FACTS enabling Energy Transition
Grid-Forming Control for VSC-HVDC System with Large-scale New Energy Integration
Xiuda MA, Yu LU, Jie TIAN, Changjiang ZHAN, Nannan WANG, Qiang ZOU, Gang LI
NR Electric Co., Ltd., China

ID: 10311
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS3 - New Technologies and Concepts of DC and FACTS enabling Energy Transition
Linear PV power plant based on MVDC collection network
Piotr DWORAKOWSKI1, Silvain MARACHE1, Eric LAMARD2, Caroline RAMONDOU2
1SuperGrid Institute, France; 2CNR, France

ID: 10348
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS3 - New Technologies and Concepts of DC and FACTS enabling Energy Transition
Modeling, Analysis, and Control of an Islanded Grid-Connected RES-Hydrogen DC Microgrid with Floating Solar Integration
Libin VARGHESE, Peng ZHANG
Stony Brook University, United States of America

ID: 10364
B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers
Topics: B4 PS3 - New Technologies and Concepts of DC and FACTS enabling Energy Transition
The innovative Damping Resistor System adopted in the Italian Transmission Grid
Gianluigi GEMELLI
TERNA, Italy
A new STATCOM topology equipped with short-time energy storage and Grid Forming control for HV network voltage and frequency regulation

Gianluca POSTIGLIONE
Nidec-ASI Italy

Dynamic demand control applied to synchronous grid forming controlled HVDC

Carl BARKER¹, Si DANG¹, Omar JASIM¹, Syed Aaqib HASSAN², Girish G³, Kerry EVANS⁴, Taoufik QORIA⁵
¹GE Vernova UK; ²GE Vernova India; ³GE Vernova USA; ⁴GE Vernova Germany

On the Role of Energy Storage in the Future HVDC Systems

Frans DIJKHUIZEN
Hitachi Energy Sweden AB, Sweden

Analysis of Converter Interactions in HVDC systems

Pragati KIDAMBI MURALI, Jiayang WU, Theo BOSMA, Yontao YANG, Cornelis PLET
DNV

Application of Synchronous Grid Forming Back-to-Back HVDC System for System Frequency Support

Arash FAZEL DARBANDI¹, Phaedra TAIAROL¹, Sharmen ANDREW², Ani CHOPRA²
¹Stantec, Canada; ²Berkshire Hathaway Energy Canada, Canada

Performance of Generic grid forming RMS models under standardized test contingencies

Benjamin PAZ¹, Hazem KARBOUJ², Shivraman MUDALIYAR², Deepak RAMASUBRAMANIAN², Xiaoyao ZHOU²
¹EPRI Europe, Spain; ²National Grid ESO, UK; ³EPRI, USA
Battery storage with power oscillation damper for improved stability performance
Manfred MANCHEN
NamPower

DC Circuit Breaker feasibility study - protection system design
Domagoj HART1, Amjad MOUHAIDALI1, Alberto BERTINATO1, Colin FOOTE2, Suresh RANGASAMY2, Benjamin MARSHALL2
1Supergrid Institute, France; 2SSEN, UK

Grid-Forming Variable-Speed Full Converter Pumped-Storage Hydropower
Marcel STOECKLI1, Alexandre CHRISTE2, Mats LARSSON2, Christoph HAEDERLI2, Michail VASILADIOTIS2, Tobias THURNHERR2
1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2Hitachi Energy Switzerland Ltd, Switzerland

Grid Connection of Offshore Wind with Grid Forming Turbines
Marcel STOECKLI1, Mats LARSSON3, Jiuping PAN1, Alberto BOLZONI2, Ying-Jiang HAFNER4, Per HOLMBERG4, Pankaj ROY4
1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2Hitachi Energy, Switzerland; 3Hitachi Energy, United States; 4Hitachi Energy, Sweden

Expandability of offshore HVDC grids during (in) development planning considering protection system design
Merijn VAN DEYCK1, Geraint CHAFFEY1, Mudar ABEDRABBO2, Hakan ERGUN1, Dirk VAN HERTEM1, Ervin SPAHIC3, Dennis DE DECKER2
1KU Leuven and EnergyVille, Belgium; 2WindGrid, Elia Group, Belgium

Functional Modelling for HVDC grids – State-of-the-art and future Outlook
Geraint CHAFFEY1, Ilkka JAHN2, Melanie HOFFMANN2, Rodrigo ALVAREZ VALENZUELA4, Eduardo PRIETO ARAUJO6, Staffan NORRGA1
1KU Leuven and EnergyVille, Belgium; 2RWTH Aachen, Germany; 3TUBS, Germany; 4Siemens Energy, Germany; 5UPC, Spain; 6KTH, Sweden

DC System power quality and stability assessment and management: method, simulation, and on-site validation
Xavier YANG1, Xingyan NIU1, Xiaolin LI1, Yifeng WANG2, Wei LI2, Pengfei LI3
1EDF R&D, France; 2Tianjin University, China; 3Hebei University, China
<table>
<thead>
<tr>
<th>ID: 11043</th>
<th>B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B4 PS3 - New Technologies and Concepts of DC and FACTS enabling Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Application of VSC-HVDC Dynamic Capacity: Technical, commercial, and legal opportunities and challenges</strong></td>
<td></td>
</tr>
<tr>
<td>Kevin SCHOENLEBER¹, Rickard EKSTROM², Peter LUNDBERG⁴, Niils ENGLUND², Jens REIFSCHEIDER², Andreas WASSERRAB³, Mark THIELE⁵, Robert FELLER⁶</td>
<td></td>
</tr>
<tr>
<td>¹Hitachi Energy Research, Germany; ²Hitachi Energy, Sweden; ³TenneT TSO, Germany</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11059</th>
<th>B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B4 PS3 - New Technologies and Concepts of DC and FACTS enabling Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>DC Switching Stations with High-speed DC Breakers: Enabling Multi-vendor DC Grids</strong></td>
<td></td>
</tr>
<tr>
<td>Frederick PAGE¹, Yu ARAI¹, Takashi INAGAKI¹, Tomas MODEER², Staffan NORRGA², Simon NEE²</td>
<td></td>
</tr>
<tr>
<td>¹Mitsubishi Electric Corporation, Japan; ²Scibreak AB, Sweden</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11116</th>
<th>B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B4 PS3 - New Technologies and Concepts of DC and FACTS enabling Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Assessment of Operational Challenges of HVDC Multi-Purpose Interconnectors with Low Short Circuit Levels</strong></td>
<td></td>
</tr>
<tr>
<td>Asif KHAN¹, Wasim AHMAD¹, Nikhil SHARMA¹, Ben GOMERSALL¹, Benjamin MARSHALL¹, Richard POOLE²</td>
<td></td>
</tr>
<tr>
<td>¹The National HVDC Centre, SSEN UK; ²National Grid Ventures UK</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11121</th>
<th>B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B4 PS3 - New Technologies and Concepts of DC and FACTS enabling Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Grid Forming Solution for Offshore Wind Park with HVDC Connection</strong></td>
<td></td>
</tr>
<tr>
<td>Mian WANG¹, Blazej STRONG¹, André SCHÖN¹, Mohammad SUWAN¹, Roberto ROSSO¹, Nicholas CHEROUVIM¹, Tobias NEUMANN², Philipp RUFFING³, Eduard Wiebe WIEBE³, Tobias BARTH³, Thyge KNÜPPEL³</td>
<td></td>
</tr>
<tr>
<td>¹Siemens Energy, Germany; ²Amprion GmbH, Germany; ³Siemens AG</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11214</th>
<th>B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B4 PS3 - New Technologies and Concepts of DC and FACTS enabling Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Modular Static Synchronous Series Compensator (M-SSSC): EMT Modeling for Real Time and Offline Applications</strong></td>
<td></td>
</tr>
<tr>
<td>Camilo ORDONEZ</td>
<td></td>
</tr>
<tr>
<td>Smart Wires Inc</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11272</th>
<th>B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B4 PS3 - New Technologies and Concepts of DC and FACTS enabling Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>A study on the mitigation effect of hybrid STATCOM system on low inertia and voltage regulation issue</strong></td>
<td></td>
</tr>
<tr>
<td>JooYong JUNG²,³, WooSeok SEO¹, NamKyu Kim¹, Young-Jin KWON¹</td>
<td></td>
</tr>
<tr>
<td>¹Hyosung Corporation, Republic of Korea; ²Yonsei University, Republic of Korea</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11455</th>
<th>B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B4 PS3 - New Technologies and Concepts of DC and FACTS enabling Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Insulation Coordination Criteria of VSC-HVDC Overhead Power Lines in Colombia Considering Climatic and Environmental Conditions</strong></td>
<td></td>
</tr>
<tr>
<td>Hernan RESTREPO¹, Cristian C. ACOSTA², Alejandro PALACIO³, Eros ESCOBAR³, Antonio PEDRAZA³, Jorge GONZALEZ³, Ernesto PÉREZ²</td>
<td></td>
</tr>
<tr>
<td>¹ISA Interconexión Eléctrica; ²Universidad Nacional; ³Universidad pontificia Bolivariana</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11590</th>
<th>B4 DC SYSTEMS AND POWER ELECTRONICS - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: B4 PS3 - New Technologies and Concepts of DC and FACTS enabling Energy Transition</td>
<td></td>
</tr>
<tr>
<td><strong>Dynamic Analysis of a Synchronverter with Virtual Inertia for Wind Power System Integration</strong></td>
<td></td>
</tr>
<tr>
<td>Kah Yung YAP, Osaze Edo IDEHEN, Jakob Boss SKARHØJ</td>
<td></td>
</tr>
<tr>
<td>Orsted A/S Denmark</td>
<td></td>
</tr>
</tbody>
</table>
**Energy Dissipation Strategies for Offshore MT-HVDC systems**

Alban DUVIVIER1, Nicolaos CUTULULIS1, Oscar SABORÍO-ROMANO1, Peter Jan RANDEWIJK2, Li YANG3

1DTU; 2Energinet; 3KU Leuven

**DC Voltage Control Strategy for NEOM Multi-terminal HVDC Grid**

Peng LI, Md HABIBURRAHMAN, Grain ADAM

ENOWA, NEOM, KSA

**Stability Analysis and Mitigation of Power Oscillations Between Parallel MMC-HVDC Connections Operating in Grid-Forming Mode in Offshore Energy Hubs**

Benjamin VILMANN1, Daniel MÜLLER1, Gustavo Figueiredo GONTIJO2, Hjörtur JOHANNSSON1

1Technical University of Denmark; 2Ørsted Wind Power

**Phased Approach to MTDC: Proposed integration of DC Circuit Breakers in a DC Switching Station facilitating a partially selective protection scheme**

David DEVOY, Ian COWAN, Perry HOFBAUER

SSEN Transmission
ID: 10100
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus
Keywords: Centralised protection, IEC 61850, Process bus, Testing, Virtualisation, Functional tests, System tests

**Functional Testing of virtualized and centralized Protection Systems**

Janne STARCK¹, Juana DOMINGUEZ², Rob COGGAN³, Jani VALTARI¹
¹ABB Oy; ²OMICRON Electronics; ³Energy Queensland

ID: 10106
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus
Keywords: Centralised protection, IEC 61850, Virtualisation, Wide-area protection

**Demonstration of enhanced and virtualised Protection of the Distribution Network**

Anna KULMALA¹, Ontrei RAIPALA¹, Petri HOVILA¹, Boris-Emanuel YAZADZHIYAN², Colin SCOBLE³, Ibrahim ABDULHADI²
¹ABB Oy; ²UK Power Networks; ³PNDC

ID: 10204
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus

**Integration and Application of merging unit and intelligent terminal in smart substation based on IEC 61850**

Chen FAN¹, Zhiqiang YAO¹, Naichao CHANG², Yu LIU², Zhihuai SHU², Zhongqing LI¹, Renhui DOU¹, Jiangwen MENG¹
¹China Electric Power Research Institute, China; ²State Grid Corporation of China, China

ID: 10261
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus
Keywords: Process Interface Unit, Requirements, interface, interoperability framework, configuration chain

**Process Interface Unit requirements related to industrial deployment**

Volker LEITLOFF, Jean-Etienne LEMAIRE, Yann LELOUP, Frédéric FOUSSERET, Maud MERLEY, Alexandre AZEVEDO
RTE, France

ID: 10265
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus
Keywords: Digital Substation, Hydraulic Power Plant, Intelligent Electronic Device (IED), Merging Unit (MU), Nuclear Power Plants

**IEC 61850 digital substations technologies applied to power plants**

Valentin BOUVIGNIES, Damien JOUAN, Edouard THEZELAIS
EDF, France

ID: 10304
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus
Keywords: Digital Substation, Intelligent Electronic Device (IED), Merging Unit (MU), Process Bus, Protection Automation and Control Systems (PACS)

**Digital substation with process bus: grid operator and PACS manufacturer feedback 2 years after the commissioning**

Gérard CHAROT¹, Valentin BOUVIGNIES², Julien TISSERAND³, Samir EL HADI¹, Apolline MAZAS¹, Sylvain AUPETIT²
¹Siemens, France; ²EDF, France; ³EDM, France
| ID: 10349 | B5 PROTECTION AND AUTOMATION - Full Papers | **Object Modeling of Process-near Interface Intelligent Electronic Devices in Digital Substations**  
Alexander APOSTOLOV  
OMICRON electronics, United States of America |
| --- | --- | --- |
| ID: 10367 | B5 PROTECTION AND AUTOMATION - Full Papers | **Interoperability of protection devices among a multi-vendor IEC 61850 process bus system**  
Emiliano CASALE  
TERNA, Italy |
| ID: 10420 | B5 PROTECTION AND AUTOMATION - Full Papers | **Unified Grid Control Platform Requirements of Process Bus**  
Herb FALK¹, Paul MYRDA¹, Glenn WILSON², Sean MCGUINNESS¹, Eric UDREN⁴  
¹Electric Power Research Institute (EPRI), United States of America; ²Southern Company, United States of America; ³Outside the Box Consulting, United States of America; ⁴Quanta Technology, United States of America |
| ID: 10421 | B5 PROTECTION AND AUTOMATION - Full Papers | **Quiet Revolution: How Low-Power Instrument Transformers and Digital Secondary Systems are Changing What is Possible**  
Veselin SKENDZIC¹, Peter MENKE², Normann FISCHER¹  
¹Schweitzer Engineering Laboratories, Inc., United States of America; ²Siemens Energy, Germany |
| ID: 10427 | B5 PROTECTION AND AUTOMATION - Full Papers | **Protection and Control of Active Distribution Systems**  
Sakis MELIPOULOS¹, George COKKINIDES¹, Glenn WILSON², Kenneth WILHELM³, Rebecca RYE⁴  
¹Georgia Tech, United States of America; ²Southern Company, United States of America; ³Avista Utilities, United States of America; ⁴Dominion Energy, United States of America |
| ID: 10503 | B5 PROTECTION AND AUTOMATION - Full Papers | **Assessment of Time-Critical IEC 61850 Process Bus Communications in a Virtualized Protection and Control System**  
Ana Cristina ALEIXO, Fernando GOMES, Carlos ARANTES, José VENTURA, João PERES, Rui JORGE  
EFACEC, Portugal |
| ID: 10504 | B5 PROTECTION AND AUTOMATION - Full Papers | **DSAS Rollout Experience - Picking the Ripe Fruits**  
João PERES, Sara COSTA, Rui JORGE, Diogo CORREIA  
EFACEC, Portugal |
**Distance Protection Performance Evaluation with Process Bus by using Modular Merging Units**

Marieke HEERZE¹, Nicolas BRANCHE²

¹Grid to great; ²RTE

**Impact on Busbar Protection by mixed analogue Input Chains in digital Substations**

Janping WANG

Hitachi Energy Sweden AB, Sweden

**System Architectures for Virtualisation and Hardware Consolidation**

David MACDONALD¹, Mital KANABAR², Camilo DE ARRIBA¹, Thomas CHARTON³, Ibukunolu OLADUNJOYE³

¹GE Grid Automation, Spain; ²GE Grid Automation, Canada; ³National Grid, UK

**Implementation of an IEC 61850 MMS interface for Centralized Protection and Control (CPC) virtualized platforms**

Carlos ALBERO CASTILLÓN¹, Miguel Ángel OLIVÁN MONGE¹, Yasmina GALVE PASTOR¹, Carlos RODRÍGUEZ DEL CASTILLO²

¹CIRCE Research Centre, Spain; ²Elewit, Spain

**Practical experiences with process bus technology for substation retrofit**

Marcel STOECKLI¹, Stefan MEIER², Rajesh K. YADAV³, Yuji KIMURA³

¹ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; ²Hitachi Energy, Switzerland; ³Hitachi Energy, Japan

**Practical experiences with process bus based transformer protection system**

Marcel STOECKLI¹, Stefan MEIER², Ruben MARTINI³, Markus HELWIG²

¹ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; ²Hitachi Energy, Switzerland; ³OFIMA, Switzerland

**SV-stream Processing in the Event of Synchronization Loss by Publishers**

Mikhail BEZDENEZHNYKH, Nikolai DONI, Ivan KOSHHELKOV, Nataliya DONI

EKRA Research and Production Enterprise Ltd., Russian Federation
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus</td>
<td>Aleksandr KULIKOV¹, Anton LOSKUTOV¹, Vladimir ZININ², Anton PETROV³</td>
</tr>
<tr>
<td></td>
<td>Keywords: transmission line differential protection, IEC 61850-9-2(SV), process bus, cybersecurity, relay protection prototype</td>
<td>¹NNSTU n.a. R. E. Alekseev, Russian Federation; ²LLC NPP &quot;ALIMP&quot;, Russian Federation; ³JSC &quot;NIPOM&quot;, Russian Federation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10809</th>
<th>B5 PROTECTION AND AUTOMATION - Full Papers</th>
<th>Development and Pilot Operation of the Intelligent PAC System Using the Concept of Virtual IEDs and Migration of Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus</td>
<td>Andrey LEBEDEV¹, Alexander VOLOSHIN¹, Andrey ZHUKOV², Vitaly AKULICHEV²</td>
</tr>
<tr>
<td></td>
<td>Keywords: protection and automation, digital substation, process bus, virtual IEDs, migration of functions, pilot operation</td>
<td>¹National Research University «MPEI», Russian Federation; ²JSC SO UPS, Russian Federation; ³Rosseti Center, Russian Federation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10813</th>
<th>B5 PROTECTION AND AUTOMATION - Full Papers</th>
<th>Developments and Practical Experiences of Merging Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus</td>
<td>Dmitry ULYANOV¹, Andrey MARTYNOV¹, Alexey MOKEEV², Sergei PISKUNOV²</td>
</tr>
<tr>
<td></td>
<td>Keywords: Digital Substation, IEC 61850, Process Bus, Sample Value, Station Bus</td>
<td>¹Energoservice, Russian Federation; ²NARFU, Russian Federation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10844</th>
<th>B5 PROTECTION AND AUTOMATION - Full Papers</th>
<th>Experience and Challenges in the Practical Implementation of Four Digital Substations in Brazil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus</td>
<td>Denys LELLYS¹, Pablo HUMERES², Júlio Cesar LIMA³</td>
</tr>
<tr>
<td></td>
<td>Keywords: Digital Substation, IEC 61850, Process Bus, Sample Value, Station Bus</td>
<td>¹Brazilian NC of CIGRE, Brazil; GE Vernova; ²Eletrobras CGT ELETROSUL; ³PUC Minas University</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10846</th>
<th>B5 PROTECTION AND AUTOMATION - Full Papers</th>
<th>Digital Substation: Lessons Learned by CPFL in Process Bus Application</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus</td>
<td>Wagner HOKAMA¹, Julia Beatriz CONCEICAO¹, Douglas FERREIRA¹, Daniel BERNARDON¹</td>
</tr>
<tr>
<td></td>
<td>Keywords: Process Bus, Merging Unit, GOOSE, Sample Values</td>
<td>¹Brazilian NC of CIGRE, Brazil; CPFL Energia; ²Automalógica; ³UFSM University</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10969</th>
<th>B5 PROTECTION AND AUTOMATION - Full Papers</th>
<th>LPIT operational experiences and challenges in a Norwegian digital substation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus</td>
<td>Karl POLLESTAD¹, Thomas JUDENDORFER², Christopher GEBS³</td>
</tr>
<tr>
<td></td>
<td>Keywords: LPIT, Optical Current Transformer (OCT), Digital Substation, Process Bus, IEC 61850</td>
<td>¹Bane NOR Norway; ²Trench Germany; ³Elvia Norway</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11003</th>
<th>B5 PROTECTION AND AUTOMATION - Full Papers</th>
<th>Advantages and Challenges in Implementing the IEC 61869-9 Standard versus IEC 61850-9-2-LE in the Digitization of the Right Bank Substation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus</td>
<td>Gustavo MERELES¹, João JORGE², Jose CHIARADIA¹, Marcos MENDES¹</td>
</tr>
<tr>
<td></td>
<td>Keywords: IEC 61850-9-2LE, IEC 61869-9, Process Bus, Sampled Values</td>
<td>¹Itaiup Binacional; ²Omicron Brazil</td>
</tr>
<tr>
<td>ID: 11094</td>
<td>B5 PROTECTION AND AUTOMATION - Full Papers</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Topics</strong>: B5 PS1 - Practical Experiences and new Developments of Process Bus</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Keywords</strong>: Virtualisation – Wide Area Protection – IEC 61850 – Digital Substation – 5G – Validation</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Experience from integration, functional and performance testing of virtualised wide area protection</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ibrahim ABDULHADI¹, Boris Emanuel YAZADZHIYAN², Colin SCOBLE³, Ontrei RAIPALA³, Anna KULMALA³</td>
<td></td>
<td></td>
</tr>
<tr>
<td>¹PNDC UK; ²UK Power Networks UK; ³ABB Oy Finland</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11112</th>
<th>B5 PROTECTION AND AUTOMATION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Using process bus over substation boundaries with multi-vendor line differential protection</strong></td>
<td></td>
</tr>
<tr>
<td>Philipp STACHEL¹, Yann GOSTELI², Adolf FREI³, Stefan FLEMMING¹</td>
<td></td>
</tr>
<tr>
<td>¹Siemens AG, Germany; ²CKW AG, Switzerland; ³Hitachi Energy Ltd, Switzerland</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11142</th>
<th>B5 PROTECTION AND AUTOMATION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experiences from a substation pilot project implementing process bus based partly centralized protection and control</strong></td>
<td></td>
</tr>
<tr>
<td>Thomas LIEBACH¹, Bendic RITT²</td>
<td></td>
</tr>
<tr>
<td>¹Siemens AG, Germany; ²Stromnetz Hamburg, Germany</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11146</th>
<th>B5 PROTECTION AND AUTOMATION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The Full Digital Substation Success in Vietnam</strong></td>
<td></td>
</tr>
<tr>
<td>Chee-Pinp TEOH¹, Van Ha NGO², Than Tuan BUI³, Hung HOANG⁴, Dang-Thoang VO⁴, Chin-Fei CHOW⁵, Simon RICHARDS¹</td>
<td></td>
</tr>
<tr>
<td>¹GE VERNOVA UK; ²AIT Corporation Vietnam; ³EGRID Vietnam; ⁴GE VERNOVA Vietnam; ⁵GE VERNOVA Singapore</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11220</th>
<th>B5 PROTECTION AND AUTOMATION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assessment of Distributed and Centralized Protection: Comparison of Response Times for Protective Dynamic System on Process Bus</strong></td>
<td></td>
</tr>
<tr>
<td>Johan CASTRO¹, Germán RUEDA¹, Rodolfo GARCÍA², César HERNÁNDEZ¹, Germán ZAPATA¹, Oscar TOBAR¹</td>
<td></td>
</tr>
<tr>
<td>¹Universidad Nacional; ²Enel Colombia</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11231</th>
<th>B5 PROTECTION AND AUTOMATION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Merging Unit Performance Evaluation and Issues for Multi-Vendor Configuration in Process Bus</strong></td>
<td></td>
</tr>
<tr>
<td>Hiroki DOI¹, Noriyuki UEDA¹, Akihiro TANAKA¹, Kenji KONDOU², Makoto MIZUNO², Yusaku SANO²</td>
<td></td>
</tr>
<tr>
<td>¹Central Research Institute of Electric Power Industry, Japan; ²TEPCO Power Grid, Incorporated, Japan</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11387</th>
<th>B5 PROTECTION AND AUTOMATION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Case Study: IEC 61850 Process Bus-Based Protection System Applications For One and Half Breaker Bus System in NEPCO 400 Kv stations</strong></td>
<td></td>
</tr>
<tr>
<td>Hussien ALMOMANI, Mohammad DAWOOD</td>
<td></td>
</tr>
<tr>
<td>National Electric Power Company, Jordan, Hashemite Kingdom of</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11439</th>
<th>B5 PROTECTION AND AUTOMATION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transition from device management to application management for Protection &amp; Control through virtualization and centralization</strong></td>
<td></td>
</tr>
<tr>
<td>Matthias REIS, Marcus STOLLFUSS, Saurabh TALWAR</td>
<td></td>
</tr>
<tr>
<td>Siemens AG, Germany</td>
<td></td>
</tr>
</tbody>
</table>
ID: 11445
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus

How a well-designed, optimized time synchronization concept can increase the reliability and availability of a digital switchgear's protection system
Stefan FLEMMING¹, Andrej GOERBING¹, Joerg WEILBIER¹, Igor KOGAN¹, Ji CHEN², Lu WANG²
¹Siemens AG, Germany; ²Siemens Power Automation Ltd. China

ID: 11457
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus

Interoperability Challenges in Multi-Vendor Digital Substations: PTP Time Synchronization and Profile Compatibility
César HERNÁNDEZ¹, Johan CASTRO¹, Oscar TOBAR¹, German RUEDA¹, Germán ZAPATA¹, Rodolfo GARCÍÁ²
¹Universidad Nacional; ²Enel Colombia

ID: 11660
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus

Utility Experience of FEED for IEC 61850 Process Bus based Protection and Automation system for 765/400/220KV Greenfield Substation
Subir Sen SEN, Rajil SRIVASTAVA, Abhay KUMAR, S.J. LAHIRI, Mr ANURAG, M.S. HADA, C.P AWASTHI, Sitesh BADERIA*
Powergrid Corporation of India Limited, India

ID: 11666
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus

Commissioning & Operational Experiences of Brownfield & Greenfield Process Bus Substations in POWERGRID
Jeetesh KUMAR*, Gopinath S S, Joydip GHOSH, B. B. SINGH, M.K. JHA
POWERGRID, India

ID: 11669
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus

A comprehensive approach towards implementing the Process Bus based Substation Automation system in Substations and its benefits.
Vikram GANDOTRA*, Laurent TOOGNAZZI, Hamza EHTISHAM, Nimish RASTOGI
Siemens Ltd, India

ID: 11778
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus

Reliable Time Synchronization for IEC 61850 Substations by Distributed Time Sources and Visibility
Raymond SHIEH, King WU, Sever SUDAKOV
Moxa Taïwan

ID: 11788
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS1 - Practical Experiences and new Developments of Process Bus

Experience and Challenge in Deploying the IEC 61850 Driven Digital Substation within Indonesia Utility Context
Eko PRASETYO, Fermi TRAFIANTO, Amiruddin AMIRUDDIN, Andhy D SETYAWAN
PT. PLN (Persero), Indonesia
Field testing, Experiences and Results with Line Differential and Teleprotection Applications in TDM/MPLS-TP Hybrid Networks
Sebastian SJÖGREN, Teemu VIINIKAINEN, Mikko HOLMGREN
Fingrid Oyj

Coordinating Zone Settings of Distance Protection with Reactive Power Capabilities and Voltage Support of Inverter-based Resources
Mikko HOLMGREN, Minna LUOJUS, Lasse LINNAMAA
Fingrid Oyj

Performance of Distance Relays in the Finnish Power System under High Penetration of Converter-Connected Generation
Valtteri HYTTI, Pauli PARTINEN
Fingrid Oyj

Experiences, Secondary Injection testing and Grid Studies on Distance Protection and Current and Voltage Harmonics during Power System Faults
Mikko HOLMGREN, Juho TUOMINEN, Paavo OJAVALLI
Fingrid Oyj

Testing approach for Rte’s R#SPACE Protection Automation and Control System
Maud MERLEY*, Jean-Etienne LEMAIRE, Yann LELOUP, Alexandre AZEVEDO, Xavier MICHAUT, Volker LEITLOFF
RTE, France

LPITs in High Voltage Switchgear and Field-testing of Relay Protection with LPIT Inputs
Dhanabal MANI1, Niclas WETTERSTRAND2, Peter MENKE3, Thomas NEUMEIER4, Franz GATZEN4
1Megger Dallas, United States of America; 2Megger Group, Sweden; 3Siemens Energy, Germany; 4Siemens AG, Germany
ID: 10422
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems
Keywords: IEC 61850, Acceptance, Commissioning and Maintenance Testing, Efficiency

Improving the Efficiency of Acceptance, Commissioning, and Maintenance Testing of IEC 61850 Based Digital Substations
Alexander APOSTOLOV
OMICRON electronics, United States of America

ID: 10423
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems
Keywords: IEC 61850, Acceptance, Commissioning and Maintenance Testing, Efficiency

Experience in the UCA International Users Group Interoperability Tests
Keith GRAY1, Sina KARIMI2, Chris DYER1
1POWER Engineers, Inc., United States of America; 2POWER Engineers Canada, Inc., Canada

ID: 10424
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems
Keywords: Hardware-in-the-loop, Inverter-based Resource, Modelling, Relay Misoperation, Relay Testing

Use of Detailed Real-Time System Models to Evaluate Relay Performance Impacted by High Penetration of Inverter-Based Resources
Yi HU1, Henry CHAO1, Zheyuan CHENG1, Juergen HOLBACH1, Thai Thanh NGUYEN2, Edward L. SEITER3, Michael RAZANOUSKY4, Damir NOVOSEL1
1Quanta Technology, United States of America; 2New York Power Authority, United States of America; 3National Grid, United States of America; 4New York State Energy Research and Development Authority, United States of America

ID: 10425
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems
Keywords: Synchrophasor, Testing, Protection, Control, Monitoring, Standards

Life-cycle Testing of Synchrophasor Systems
Mladen KEZUNOVIC
Texas A&M University, United States of America

ID: 10428
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems
Keywords: Testing, Commissioning, 3-D Printer, IEC61850, GOOSE

Evolution of Testing Practices: A Utility’s Experience
Steven WALKER, Matt DUBOIS, Pat SCANNELL. JR., Bill HORN
Commonwealth Edison, United States of America

ID: 10429
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems
Keywords: Fault Location, Islanding, and Service Restoration; Protection; FLISR; Distribution Automation

Design and Testing of Distributed Fault Location, Isolation and Service Restoration Scheme for Open-loop Electric Distribution Systems using IEC61850 GOOSE
Palberz KHALEDI1, Yujie YIN1, Amin ZAMANI2, Farid KATIRAEI2, John WILTSHIRE3, Roy LUO4, Ben ROSENFELD5, Shawn DEANGELO6, Drazena BROCIL07, Selver CORHODZIC8, Alan DUONG9
1Quanta Technology, United States of America; 2Quanta Technology, Canada; 3Meta Platforms, Ireland; 4Meta Platforms, United States of America

ID: 10505
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems
Keywords: Distribution Grid, Real-Time Digital Simulation, Digital Substation, MV Advanced Applications, Protection and Control Centralization, Virtualization, IEC 61850

Testing of Centralized Protection, Control and Advanced Automation for MV networks with DER
Claira COUVE1, Everton ALVE5, André MELM1, Jorge PEREIRA1, António CARRAPATOSO1, Nuno FONSECA1, José ANDRADE1, Tiago HEKKERT1, Ana Cristina ALEIXO2, Carlos ARANTES2
1INESC TEC, Portugal; 2EFACEC, Portugal
| ID: 10629 | B5 PROTECTION AND AUTOMATION - Full Papers | 
| Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems | 
| **Implementation of the line differential protection in the 30 kV distribution network of i-DE** | 
| Iñaki OJANGUREN¹, Ziorta LLONA², Oscar HERNANDEZ¹, Isabel LOUREIRO¹, Juan Mari GARCIA² | 
| ¹i-DE, Spain; ²Ingeteam, Spain | 

| ID: 10630 | B5 PROTECTION AND AUTOMATION - Full Papers | 
| Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems | 
| **Development and Implementation of a WAMPAC Algorithm for Detecting Real-Time Voltage Instability Phenomena in Electric Power Systems** | 
| Aníbal Antonio PRADA HURTADO¹, Eduardo MARTINEZ CARRASCO¹, Jose SALDANA¹, Carlos ALBERO CASTILLÓN¹, Konstantinos F. KROMMYDAS², Christos-Spyridon G. KARAVAS³, Konstantinos A. PLAKAS³, Efthimia CHASSIOTI³, Ioannis MORAITIS² | 
| ¹CIRCE Technological Centre, Spain; ²Indep. Power Transmission Operator, Greece | 

| ID: 10631 | B5 PROTECTION AND AUTOMATION - Full Papers | 
| Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems | 
| **Challenges and perspectives for a new era of protection, automation and control systems through IEC 61850** | 
| Victor LLAMAS SANJUAN | 
| CIRCE Centro Tecnológico, Spain | 

| ID: 10713 | B5 PROTECTION AND AUTOMATION - Full Papers | 
| Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems | 
| **IEC61850 Engineering of a Digital Substation: Common User Vision on Top-down Engineering** | 
| Thomas STERCKX¹, Florian SOYEZ¹, Maud MERLEY² | 
| ¹ELIA, Belgium; ²RTE, France | 

| ID: 10747 | B5 PROTECTION AND AUTOMATION - Full Papers | 
| Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems | 
| **PMU-based fault distance calculation in long radial feeders using an enhanced reactance-based approach** | 
| Marcel STOECKLI¹, Mayank NAGENDRAN², Lorenzo ZANNI², Paolo ROMANO², Farnoosh RAHMATIAN², Ali ALVI², Sihikhar PANDEY² | 
| ¹ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; ²Zaphiro Technologies, Switzerland; ³NuGrid Power Corporation, United States; ⁴Exeloncorp, United States; ⁵ComEd, United States | 

| ID: 10797 | B5 PROTECTION AND AUTOMATION - Full Papers | 
| Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems | 
| **Experience of the Field Testing of Power Units Control Systems** | 
| Andrei GERASIMOV, Ruslan IZMAILOV, Evgeniy SATSUUK, Andrei SMIRNOV, Dmitriy KABANOVA, Oleg GURIKOV | 
| JSC STC UPS, Russian Federation | 

| ID: 10798 | B5 PROTECTION AND AUTOMATION - Full Papers | 
| Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems | 
| **A New Technological Approach for Commissioning and Operation of Relay Protection and Automation Systems** | 
| Alexey ANOSHIN, Aleksandr GOLOVIN, Natalya MARARAKINA | 
| Tekvel, Russian Federation | 

| ID: 10803 | B5 PROTECTION AND AUTOMATION - Full Papers | 
| Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems | 
| **Experience of the Field Testing of Power Units Control Systems** | 
| Andrei GERASIMOV, Ruslan IZMAILOV, Evgeniy SATSUUK, Andrei SMIRNOV, Dmitriy KABANOVA, Oleg GURIKOV | 
| JSC STC UPS, Russian Federation |
Experimental Verification of Fault Location Technology in Power Distribution Networks with Complex Topology
Andrey KUCHERIAVENKOV, Pavel GOROZHANKIN, Ekaterina KARTASHEVA
ANTRAKS Research&Development& Manufacturing Co, Russian Federation

Development and Commissioning of PACS for Operating Modes of the Power System Based on PMU Data
Andrey ZHUKOV1, Evgeniy SATSUK1, Dmitrii DUBININ1, Maksim POROZKOV2, Jury IVANOV2, Anna DMITRIEVA2
1JSC SO UPS, Russian Federation; 2Prosoft systems, Russian Federation

Methods for Configuring, Testing and Inspecting Automatic Excitation Regulators for Synchronous Generators during Commissioning
Andrey ZHUKOV1, Evgeniy SATSUK1, Tatiana KLIMOVA2, Andrei GERASIMOV1
1JSC SO UPS, Russian Federation; 2National Research University «MPEI», Russian Federation

Automating commissioning tests, accepting remote maintenance, and guaranteeing inventory integrity using a Device Management System
Adriano PIRES, David MACDONALD, Mital KANABAR, Shobhit MEHTA
Brazilian NC of CIGRE, Brazil; GE Grid Automation

Time Synchronization Interoperability and Testing Challenges for Process Bus
Guilherme LISBOA, Guilherme NORMANTON
Brazilian NC of CIGRE, Brazil; Belden

Practical approaches for improving reliability and availability of digital multivendor substations
José Eduardo DA ROCHA ALVES JUNIOR, Tiago MORAES, Marco Antonio MACCIOLA RODRIGUES
Brazilian NC of CIGRE, Brazil; Eletrobras ELETROSUL
A Practical Approach to The Requirements and Strategies for Monitoring the IEC 61850 Process Bus in a Multivendor Test Platform
Pablo HUMERES FLORES¹, Mateus ALEXANDRINO¹, Júlio Cesar MARQUES DE LIMA¹, Denise BORGES DE OLIVEIRA², Jorge DAMASCENO², Denys LELLYS³, José Eduardo DA ROCHA ALVES JUNIOR⁴, João JORGE⁴, Paulo Sergio PEREIRA JUNIOR⁵
¹Brazilian NC of CIGRE, Brazil; CGT ELETROSUL; ²PUC Minas University; ³ONS; ⁴Siemens; ⁵GE Vernova; ⁶Eletrobras CEPEL; ⁷Omicron Energy; ⁸Conprove

How to Test Virtual Protection, Automation and Control Systems (vPACS)
Pablo Sergio PEREIRA JUNIOR, Rodolfo Cabral BERNARDINO, Gustavo Silva SALGE, Cristiano Moreira MARTINS, Paulo Sergio PEREIRA, Gustavo Espeinha LOURENÇO
Brazilian NC of CIGRE, Brazil; CONPROVE

FAT and SAT Procedures from the Perspective of the Brazilian TSO
Rafael de Oliveira FERNANDES¹, Ricardo DUTRA²
¹Brazilian NC of CIGRE, Brazil; UNICAMP University; ²State Grid

Lab Environment for fully digital Substation Solution Validation - technical Solution and testing Solution
Yiming WU
Vattenfall Distribution Sweden AB, Sweden

A consistency validation Tool for IEC 61850 Substation System Integration Configuration
Yiming WU
Vattenfall Eldistribution Sweden AB, Sweden

A Study on the Development of Interoperability Test Automation System for Digital Substation
Yu-Yeong PARK, Nam-Ho LEE, Chang-Seob LEE, Woo-Joong KIM, Nam-Dae KIM, Seok-Kon KIM, Byung-Tae JANG
KEPCO Research Institute

Certification and On-site Calibration of Metering System Based on LPIT
Peter MENKE¹, Vladan LAPČEVIĆ², Michael FREIBURG³, Vladimir RAJOVIĆ⁴, Mikhail VASSILYEV²
¹Siemens Energy, Germany; ²Meter&Control, Serbia; ³TH Köln – University of applied sciences, Germany; ⁴University of Belgrade, School of Electrical Engineering, Serbia
Joint-Development and Demonstration of an Adaptive Protection System at a German DSO – Practical Experiences and Lessons Learned
Jasper LAMMERING¹, Jessica STEPHAN², Jan Peter KEMPER¹, Stefan DALHUES¹, Tobias LORZ², Wesley DRECHSEL¹, Andreas KUBIS³, Tobias PLETZER¹, Gerrit ERICHSEN³
¹PSI Software AG, Germany; ²FAU Nürnberg, Germany; ³Schleswig-Holstein Netz AG, Germany; ⁴In

Acceptance and Commissioning of a Wide-Area Broken Conductor Detection System for Distribution Networks
Michael STANBURY
Ausgrid, Australia

Testing of Travelling Wave Fault Locators
Jörg BLUMSCHEIN¹, Bruno Alencar ARRAES¹, Tiago Fernandes BARBOSA²
¹Siemens AG, Germany; ²Eletrouso, Brazil

Collaborative Engineering and Testing of Smart Grid Automation Applications
Christof BRANDAUER¹, Filip PRÖSTL ANDRÉN², Catalin GAVRILUTA³, Thomas STRASSER³, Armin VEICHTLBAUER³, Gerald STEINMAURER³, Jürgen RESCH³, Sebastian SCHÖNDORFER⁴
¹Salzburg Research; ²AIT Austrian Institute of Technology; ³FH Oberösterreich; ⁴COPA-DATA

A modern retrofit solution for induction disc overcurrent relays
Graeme LLOYD¹, Richard DUFFY¹, John WRIGHT¹, Majid HASHEEM², Peng SHEN³, Dickson LAU⁴, K M TSANG⁴, Carol FISHER⁵
¹GE Grid Solutions UK; ²GE Grid Solutions India; ³GE Grid Solutions Hong Kong; ⁴CLP Hong Kong; ⁵GE Grid Solutions USA

Efficiency Improvement in Testing: Maximizing Resources and Reducing Time with Digital Twins
Jhonatan ANAYA, Santiago YEPES
ISA Intercolombia

Performance of Distance and Directional Overcurrent protections in a HVDC connected Offshore Windfarm
Chris SMITH¹, Jose JARAMILLO², Mauricio CORREA², Camilo GARCIA², Andres GARCIA²
¹RWE UK; ²IEB Colombia; ³GE Verno France

User-centric tools for engineering, commissioning and operation of protection and automation devices
Cedric HARISPURU, Francois SIMON
Siemens AG, Germany
ID: 11418
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems

Protection instrument transformers characterization and modelling for travelling wave applications
Federico CANAS¹, Johannes BLESER¹, Cezary DZIENIS², Thomas JUDENDORFER², Joerg BLUMSCHEIN¹
¹Siemens AG, Germany; ²Trench Germany GmbH, Germany; ³University of Applied Sciences Zittau / Görlitz, Germany

ID: 11423
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems
Keywords: Digital substation, Engineering process, IEC 61850, SCL (System Configuration Language), OCL (Object Constraint Language), XML, XSD (XML Schema Definition)

Introduction to IEC 61850-6-3 OCL: Machine-processable rules for validation of IEC 61850 XML-based files
Aurélie DEHOUCK¹, Sina KARIMI², Christophe DYER¹, Keith GRAY³
¹EDF R&D, France; ²POWER Engineers, Inc., Canada; ³POWER Engineers, Inc., USA

ID: 11451
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems

Performance of the Overcurrent Function in the Event of Loss of Information in the Process Bus Using a Merging Unit Developed in ATP-EMTP
Ernesto PEREZ, Oscar TOBAR, Johan CASTRO, César HERNÁNDEZ
Universidad Nacional

ID: 11456
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems

EMT Based Protection Coordination Study Considering M-SSSC FACTS Technology in the Atlántico Region of the Colombian Transmission System
Alejandro DUQUE¹, Dilan CARO¹, David URBÆZ², German GUTIERREZ², Jhon CALDERON³, Carlos BORDA¹
¹Smart Wires Inc; ²ISA Intercolombia; ³ISA Interconexión Eléctrica

ID: 11458
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems

Enhancing Protection Schemes for Inverter-Based Renewable Generation in Transmission Networks
Oswaldo ARENAS⁴, Sebastián MANRIQUE⁵
⁴ISA Intercolombia; ⁵FEDERAL UNIVERSITY OF TECHNOLOGY - PARANÁ

ID: 11493
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems
Keywords: Blackout, Black Start, Grid Protection Relay, Grid Restoration

Performance Test of Grid Protection Relay for Black Start
Tomoya ISHII¹, Atsushi OKAHISA¹, Iori NAKAYAMA¹, Mai ARAKI²
¹Kansai Transmission & Distribution Co, Inc., Japan; ²Enegate Co., Ltd., Japan

ID: 11497
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems
Keywords: IEC 61850, MMS, Japanese Connect And Manage, N-1 Inter-trip Scheme

IEC 61850 Compliant N-1 Inter Trip Scheme Suitable for Japanese Connect and Manage
Ryutichi KAWAZOE¹, Shotaro SAKAI¹, Kazuhiro KOJIMA¹, Hironori IMAEDA¹, Yutaka ANDO²
¹Chubu Electric Power Grid Co., Inc., Japan; ²C-tech Corp., Japan
ID: 11599
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems

Protection verification for HVDC connected wind farms
Adnan COKIC1, Alexander TSYLIN1, Michael PARADIS2, Deepak H. NAIR1
1Ørsted Wind Power A/S; 2ATCO

ID: 11676
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems

Plug & Play of Protection, Automation & Communication system with Portable SCADA for EHV Substations
Vivekanandan S*, Tushar KULKARNI, Ganesh Jagtap JAGTAP, Dayanand Konduskar KONDUSKAR, Vishal KULKARNI, Akhilesh Chandrakar CHANDRAKAR
TATA Power Company, India

ID: 11745
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems
Keywords: Protection coordination, protection relay, transmission network, wide area assessment

A wide Area protection coordination assessment for the Albanian transmission System
Aristotelis TSIMTSIOS1, Vassilis PAPASPILIOTOPoulos1, Vassilis KLEFTAKIS1, Mohammad DJAMALI2, Ralf KYNAST3, Elgi HAXHIRAJ4
1PROTASIS SA, Greece; 2Fichtner Gmbh & Co. KG, Germany; 3KfW Development Bank, Germany; 4OST sh.a., Albania

ID: 11756
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems

Real-Time Simulations to Validate the Impact of m-sssc Devices on Protection Coordination in Power Systems
Sebastian HINCAPIE1, Jhon CALDERON2, Carlos BORDA1, Alejandro DUQUE1, Pablo MACEDO1, Juan GALLEGO3
1Smart Wires Inc; 2ISA Interconexión Eléctrica; 3Transelca

ID: 11807
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems
Keywords: Digital transformation, Smart test solutions, Power grid, Maintenance, Commissioning, Artificial Intelligence, Data analysis

Digital Transformation of the Power Grid and Smart Testing Solution for Commissioning and Maintenance
Anas ABDULKHADER
GCC CIGRE, Qatar

ID: 11821
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems
Keywords: Commissioning, Digital substation, FAT, Protection Systems, SAT

Experience in Protection System Commissioning for Digital Substation Pilot Project in Thailand
Wanlert TANAYUWANNA, Banthoeng KONGKAEO, Sunphead CHAIJUNPHA
Electricity Generating Authority of Thailand (EGAT), Thailand

ID: 11901
B5 PROTECTION AND AUTOMATION - Full Papers
Topics: B5 PS2 - Acceptance, Commissioning, and Field Testing for Protection, Automation and Control Systems
Keywords: FAT, SAT, Routine Field Test, Field Experience, Substation Automation System

Current Practices of Acceptance, Commissioning and Field Testing for Protection, Automation & Control System in a Transmission Utility, its Efficacy and Benefits
Nikunj KANJARIYA, Sanjay JADAV, Jayesh GANDHI
Gujarat Energy Transmission Corporation Limited
C1 - POWER SYSTEM DEVELOPMENT AND ECONOMICS
PS1 - STEERING THE ENERGY TRANSITION: COOPERATION, ACHIEVING TOP-DOWN TARGETS THROUGH BOTTOM-UP INVESTMENT DECISIONS

ID: 10266
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers
Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions
Keywords: electrolysis capacities, production of hydrogen, Power-to-Gas, electricity system

The challenges of developing electrolysis for the French electricity system over different time horizons
Marc LE DU*, Mathilde FRANÇON, Marie-Alix DUPRE LA TOUR, Cédric LEONARD
RTE, France

ID: 10267
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers
Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions
Keywords: flow-based, studies, exchange capacity, models, long-term

Modelling flow-based exchange capacities in medium to long-term studies
Nicolas LHUILLIER*, Jean-Yves BOURMAUD, Marjorie COSSON, Marion LI, Emily LITTLE, Paul PLESSIEZ, Harry UNG
RTE, France

ID: 10370
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers
Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions

An optimization tool for the planning of transmission grid investments and development
Elia D'ANDREA
TERNA, Italy

ID: 10371
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers
Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions

Off-shore network development to foster the energy transition
Michela MIGLIORI
TERNA, Italy

ID: 10430
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers
Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions
Keywords: Capacity Planning, Electrification, Climate Change, Adaptation, DER

From Resilient and Ready to Used and Useful: Managing Temporal and Locational Uncertainty in Electrification, DER Adoption, and Climate Adaptation
Kevin HAPP1, Shaun MORAN1, Vincent WESTFALLEN1, Ryan BURG2
1Commonwealth Edison, United States of America; 2National Renewable Energy Laboratory (NREL), United States of America

ID: 10432
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers
Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions
Keywords: Continental System Modelling, Global Grid Development, HVDC, Long-term Studies, Optimization

From Regional to Continental Scale System Development: a New Methodological Approach to Studies of an Intercontinental Global Grid
Charlie SMITH1, Angelo L'ABBATE2, Enzo SAUMA2, Ali MOEINI4, Antonio ILICETO3, Robert GAUGL5, Karthik S. BHAT4, Xiao-Ping ZHANG2, Jay CASPARY9, David POZO10
1ESIG, United States of America; 2RSE SpA, Italy; 3PUC, Chile; 4Hydro-Quebec, Canada; 5Terna SpA, Italy; 6TU Graz, Austria; 7UAST Wien, Austria; 8University of Birmingham, United Kingdom; 9Consultant, United States of America; 10EC JRC, The Netherlands

ID: 10434
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers
Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions
Keywords: Energy Transition, Decarbonization, Electrification, Climate Adaptation, Grid Planning

Accelerating the Energy Transition: Case Studies and Lessons Learned in the USA
 Jun WEN1, Maigha FNU2, Sherry LI2, Sarah CARKNER4, Logan ROLLES6, Katherine INGE5, Shuying ZHEN1, Beth LAROSE2, HyeKyung KIM3
**ID: 10516**

**C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers**

**Topics:** C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions

**Keywords:** RES integration, grid reinforcement, system integration, power-to-gas, power-to-heat, gas-to-power, social economic optimization

**Optimal power system planning through P2G and P2H system integration and flexibility**

Arjen JONGEPIER, Arjan VAN VOORDEN, Tjebbe VROON, Sangitha HARMSEN, Paul BIERLING

Stedin

---

**ID: 10636**

**C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers**

**Topics:** C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions

**Rethinking CGMES**

Santiago PENATE-VERA, Miguel ESCRIBANO-RÓDENAS

Redeia, Spain

---

**ID: 10670**

**C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers**

**Topics:** C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions

**A Novel Framework for Assessing Reform and Transition of The Electricity Supply Sector in Developing Countries**

Trevor GAUNT, Brent HAMPTON

University of Cape Town South Africa

---

**ID: 10818**

**C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers**

**Topics:** C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions

**Metropolitan Area and Regional Power System Planning Approach and Correlation with Energy Sector Integration in Energy Transition Period Based on JWG C1/C4.36 Experience**

Stanislav UTTS1, Valsdon Simoes DE JESUS2, Megan LUND3, Denis PILENIEKS1

1JSC SO UPS, Russian Federation; 2Eletrobras, Brazil; 3IESO, Canada

---

**ID: 10819**

**C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers**

**Topics:** C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions

**Changing the Planning Process of Power System of Russia Development to Improve the Accuracy, Efficiency and Openness of Planning at the Time of Energy Transition**

Fedor OPADCHIY, Denis PILENIEKS, Stanislav UTTS

JSC SO UPS, Russian Federation

---

**ID: 10918**

**C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers**

**Topics:** C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions

**Competitive Process for Transmission Margin Contracting by Wind and Solar Generators in Brazil’s Transmission Network**

Laércio GUEDES1, Thiago PRADO2, Sumara TICOM1, Fernando MACHADO1, Ivair FREIRIA1, Lucas SANTOS E SILVA2, Alexandre DANTAS1, Roseane NUNES1, Maria Paula SALVADOR1, Andreia Maia MONTEIRO1

1Brazilian NC of CIGRE, Brazil; ONS; 2Ministério das Minas e Energia - MME; EPE; 3Consultant

---

**ID: 10919**

**C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers**

**Topics:** C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions

**Challenges and opportunities of massively connecting distributed energy resources in developing countries (Brazil- Cemig Distribuição)**

Michele dos Reis PEREIRA, José P. R. FERNANDES, Weber R. R. FILHO, Iago S. A. DA SILVA

Brazilian NC of CIGRE, Brazil; Cemig Distribuição
ID: 10925
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers
Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions
Keywords: Energy Transition, Power System Reliability, Synchronous Machines, Inverter-based Resources and Brazilian National Interconnected System

Energy Transition – Risks Related to Underestimation of Security Issues
Xisto VIEIRA FILHO¹, João Carlos DE OLIVEIRA MELLO², Paulo GOMES²
¹Brazilian NC of CIGRE, Brazil; ABBRAGET; ²Thyoms Energia; ³PSQ

ID: 10935
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers
Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions
Keywords: decarbonisation, just transition, renewable energy, coal phase-out

Optimization of Power Utility Portfolio Decarbonisation Pathway - EPBiH Case Study
Elma REDZIC, Anes KAZAGIC, Mustafa MUSIC
Elektroprivreda BiH, Sarajevo, Bosnia and Herzegovina

ID: 10962
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers
Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions
Keywords: Carbon Neutrality, Cost–Benefit Analysis, HDVC, Renewable Energy, System Planning, Transmission Development

Hikaru GOTO, Kodai ONODA, Kenichi HARADA, Akiji MATSUDA
OCCTO, Japan

ID: 10963
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers
Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions
Keywords: Electrification, Energy supply chain, Energy transition, Hydrogen, PtoG

Energy Supply Chain from Hydrogen Production to End Use by PtoG for Carbon Neutrality 2050
Koichiro YAMAKI, Sachiko NUKAGA
Tokyo Electric Power Company Holdings, Japan

ID: 11046
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers
Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions
Keywords: Demand, Forecast, Planning, Long-Term

The Relevance and Importance of the Demand and Consumption Forecast in the Long-Term Planning of Electrical System
Miguel AGUILAR-LUNA, Guillermo GARCIA-TOBON, Ramon ARENAS, Mayra CORTES, Romina CIPRIAN, Fatima ORTIZ, Nancy GARCIA
CENACE, Mexico

ID: 11165
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers
Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions

Analysis of the current configuration of the capacity calculation regions – towards possible alternatives
Benoit BLETTERIE, Lukas MITMANNSGRUBER, Wilhelm SCHWEIGHOFER, Milan VUKASOVIC, Carla WOLF
Austrian Power Grid

ID: 11246
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers
Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions

Governments’ approaches to drive private investment in renewable energy infrastructure in Australia
Jasmin BORSOVSZKY, Andrew KINGSMILL
Energy Corporation of NSW, Australia
| ID: 11346 | C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers | Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions | Keywords: Congestion, Flexibility, Grid development, Modelling | The impact of sub-transmission levels' modelling on congestions' visualization for European transmission grid calculations – a CIGRE benchmark models study | Louise PETIT1, Martin HENNEBEL2, Hugo NAHEL1 | 1 EDF, France; 2 Centrale-Supelec, France |
| ID: 11498 | C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers | Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions | Keywords: Energy Transition, System Strength, System Planning, Decarbonization | Energy Transition and System Strength in the Chilean National Electric System | Juan ARANEDA, Rodrigo ESPINOZA, Victor VELAR, Roger MELLADO | Coordinador Eléctrico Nacional, Chile |
| ID: 11565 | C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers | Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions | Future-proof Grid Code for Energy Transition | Nishal SURESHCHANDRA, Rofidah MOHAMED, Amirul Ruzainy AZLAN | Tenaga Nasional Berhad, Malaysia |
| ID: 11581 | C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers | Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions | Revamping Policy Framework to Facilitate Renewable Energy Integration with the Transmission Network - Indian Perspective | Amandeep KALA*, Laxmi KANT, V S BHAL, Ashok PAL, P C GARG | Central Transmission Utility of India Ltd, India |
| ID: 11591 | C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers | Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions | Exploring the Interplay between Market-Based Economic Dispatch and Transmission System Planning in the Context of Renewable Energy Integration | Prashant PRASHANT, Nitu SHUKLA*, Abhinav VERMA, B. Anantha SARMA, Abhay CHOUDHARY | POWERGRID, India |
| ID: 11729 | C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers | Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions | Multi-stage optimisation towards transformation pathways for municipal energy systems | Paul Maximilian RÖHRIG, Nils KÖRBER, Andreas ULBIG | RWTH Aachen University, Germany |
| ID: 11805 | C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers | Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions | An 100% renewable power system through innovative HVDC technology-based power system architecture | Ying HAFNER1, Nand SINGH2, Grain ADAM2 | 1 Hitachi Energy, KSA; 2 ENOWA, KSA |
| ID: 11819 | C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers | Topics: C1 PS1 - Steering the Energy Transition: Cooperation, achieving Top-Down Targets through Bottom-Up Investment Decisions | Keywords: Policy-maker, Renewable Energy (RE), Tariff structure, Utilities Green Tariff (UGT), Renewable Energy Certificate (REC) | Calculation Model of Utilities Green Tariff: A sustainable strategy toward renewable energy adoption for regulated market in Thailand | Noppadol CHUANCHAIYAKUL | Electricity Generating Authority of Thailand (EGAT), Thailand |
Trends for ensuring the safety of the Romanian Power System
Alisa FLEANCU1, Ana – Maria APOSTOIU2
1CNTEE Transelectrica SA; 2UNSTPB - National University of Science and Technology

PS2 - FLEXIBILITY AS PIVOTAL CRITERION FOR SYSTEM DEVELOPMENT

Maximum Efficiency Point Tracking Control for the Water Electrolysis System Based on Power Hardware in the Loop
Hao LI1, Zhiyao ZHONG1, Kewei HU1, Danji HUANG1, Jiakun FANG1, Alexandre OUDALOV2, Xiaobo YANG3
1Huazhong University of Science and Technology, China; 2Hitachi Energy, Switzerland; 3Hitachi Energy Research, China

Deep Learning-Based Wind Power Low Output Process Forecast Using CGAN and Convolutional Residual Network
Zhao WANG, Zhiyuans MA, Bo WANG, Chun LIU
China Electric Power Research Institute, Beijing, China

Analysis and prediction of load demand response characteristics based on demand-side data mining
Feixiang GONG1, Songsong CHEN1, Bowen ZHENG1, Linjuan ZHANG2, Pengcheng DU3, Liye ZHAO1, Ping ZHANG2, Dan LU2, Chenyu XIA1
1China Electric Power Research Institute, China; 2State Grid Henan Economic Research Institute, China; 3Guangxi University, China

A Date-driven Planning Method for Regional Hybrid Energy Storage Systems with Decoupled Operation and Planning Stages
Yanda HUO1,2, Zhen WU1, Wei DUAN1, Jianfeng DAI1, Jintao JIANG3
1China Electric Power Planning & Engineering Institute, China; 2Tianjin University, China; 3State Grid Changchun Power Supply Company, China

Scenarios for changes in the needs and means of flexibility
Marc LE DU, Thomas HEGGARTY, Cédric LEONARD
RTE, France

How storage is implemented in the network of the major global operators of GO15
Marco TURCHIANO
TERNA, Italy
Impact on the power system of the electrification of transport, both light and heavy-duty vehicles
Sara SALAMONE¹, Andrea CAZZANIGA¹, Silvia CELASCHI¹, Filippo COLZI¹, Antonio ILCETO², Giuseppe MAURI¹, Francesca SOLDAN¹
¹RSE, Italy; ²Terna, Italy

A New Class of Flexibility Products: DER-Provided Reserve Services
Tanguy HUBERT
Electric Power Research Institute (EPRI), United States of America

Flexible Capacity Expansion Planning for a Decarbonized Market
Jinxian ZHU¹, Steven ZHOU¹, Hongyan LI¹, Alexandre OUDALOV², Sebastian PORRAS APARICIO²
¹Hitachi Energy, United States of America; ²Hitachi Energy, Switzerland

Characterisation of Flexibility Resources in Integrated Electrical and Thermal Systems: A Novel Short-term Flexibility Quantification Method
Carlos E UGALDE-LOO, Ivan DE LA CRUZ, Muditha ABHEYSEKERA, Yue ZHOU
Cardiff University UK

Unlocking the Potential of Distributed Energy Storage Systems for Island Power Systems
Nikolay SHUBIN¹, Fedor NEPSHA¹, Vladimir TARASOV², Evgeniy SATSUK³
¹RTSoft Smart Grid, LLC, Russian Federation; ²INTER RAO Engineering, LLC, Russian Federation; ³JSC SO UPS, Russian Federation

Planning Tool Integration of Demand Flexibility: Focus on Electric Vehicles
Irene DANTI LOPEZ¹, Alison O’CONNELL², Phillip DE MELLO², Nils JOHNSON³, Sujit TRIPATHY³, Shaun TUYURI³
¹EPRI, Spain; ²EPRI, Ireland; ³EPRI, USA

A planning tool for minimizing overloads through active demand and generation response
Fernando POSTIGO¹, Andrés RAMIRO¹, Belén DÍAZ-GUERRA¹, Santiago PEÑATE²
¹Red Eléctrica, Spain; ²Elewit, Spain

Reducing balancing power requirements through the complementarity of RES based technologies in hybrid power system concepts
Ajla MERZIC¹, Nedzad HASANSPAHIC², Muamer BAHTO², Mustafa MUSIC²
¹BH K CIGRE, Bosnia and Herzegovina; ²Elektroprivreda BiH, Sarajevo, Bosnia and Herzegovina
**ID: 10970**
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers

Topics: C1 PS2 - Flexibility as Pivotal Criterion for System Development

Keywords: Coincidence factor, Electric vehicles, Residential flexibility, Smart charging

**Flexibility from electric vehicles - residential charging coincidence factors in Norway**

Aurora OPSTAD¹, Kristian SEVDARI², Heidi S. NYGÅRD³, Bjørn Harald BAKKEN¹, Gerard DOORMAN¹

¹Statnett Norway; ²Technical University of Denmark - DTU / Statnett Denmark; ³Norwegian University of Life Sciences Norway

**ID: 10971**
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers

Topics: C1 PS2 - Flexibility as Pivotal Criterion for System Development

Keywords: Final customer – Hourly demand - Demand side response - Dynamic electricity price contract - Real time pricing

**A comparative analysis of implicit demand side response among Norwegian electricity consumers during the 2022/23 energy crisis**

Matthias HOFMANN¹, Hanne SÆLE²

¹Statnett/NTNU; ²Statnett, Norway

**ID: 11103**
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers

Topics: C1 PS2 - Flexibility as Pivotal Criterion for System Development

Keywords: Clustering, long-term planning, load flow convergence, machine learning, scenario-based analysis, unsupervised learning

**Machine Learning Method to Improve Stability Requirements Calculation for the Planning Process**

Yueqi WU, Diptargha CHAKRAVORTY, Nicolas MELCHOR

TNEI Services Ltd. UK

**ID: 11388**
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers

Topics: C1 PS2 - Flexibility as Pivotal Criterion for System Development


**Battery Energy Storage System Techno-Economic Performance to Meet the Grid Flexibility: Case Study of Jordan’s Power Sector**

Murad ALOMARI, Mustafa Walid ALZAHLAN

National Electric Power Company, Jordan, Hashemite Kingdom of

**ID: 11389**
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers

Topics: C1 PS2 - Flexibility as Pivotal Criterion for System Development


**Enhancing Grid Stability and Renewable Integration: Examining the Potential of Pumped Hydro Storage as a Key Player in Jordan’s Power Sector**

Murad ALOMARI, Mustafa Walid ALZAHLAN

National Electric Power Company, Jordan, Hashemite Kingdom of

**ID: 11392**
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers

Topics: C1 PS2 - Flexibility as Pivotal Criterion for System Development

**Experimental Studies on Jordan’s power grid stability with integrated electricity storage systems**

Abdallah ALHAYAJNEH, Yousef ABABNEH, Mohammad MASAED

Samra Electric Power Company

**ID: 11447**
C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers

Topics: C1 PS2 - Flexibility as Pivotal Criterion for System Development

**Use instead of ‘curtail’ in Germany – Power to Heat technology as flexibility for TSOs to optimize RES feed-in and manage congestion**

Wilhelm KIEWITT¹, Matthias GERDES¹, Nidal MEYER¹, Jan SIECK², Christoph COSLER²

¹50Hertz Transmission GmbH, Germany; ²Hamburger Energiewerke GmbH, Germany

David URBANEZ, Laura SALAZAR, Natalia GALLEGÓ, Alejandro DUQUE, Santiago GOMEZ, Pablo VIANA, Mario PATIÑO
Smart Wires Inc

**Long-Term Power Expansion Considering Hydrogen Production**

Enzo SAUMA
Pontificia Universidad Católica de Chile, Chile

**100% RES Power System Supported by Flexibility Resources**

Nagaraju POGAKU, Nand SINGH, Alexandre OUDALOV, Sebastian PORRAS APARICIO

1. ENOWA, KSA; 2, 3. ENOWA, KSA; 4. Hitachi Energy, Switzerland; 5. Hitachi Energy, Switzerland

**Operational analysis of Purulia Pumped Storage Plant (PPSP) and Maximizing the benefits using Mixed Integer Linear Programming (MILP) Model from Flexible Operation**

Saibal GHOSH, Manash Protim NATH, Alok Pratap SINGH, Pinki DEBNATH, Akash Kumar MODI, Saugato MONDAL, Saurav SAHAY, Shyamal KONAR, Rajib SUTRADHAR
Grid Controller of India Limited, India

**Flexibility potential: A building cluster study case**

Carolina ESCUDERO, Lisa CALEARO
Ramboll Danmark A/S


Sina GAHEMI, Amjad ANYARI-MOGHADDAM
Department of Energy (AAU Energy), Aalborg University

**Application of BESS in Power Systems with Challenges of Security, Stability and Flexibility**

Archil KOKHTASHVILI, Giorgi AMUZASHVILI, Giorgi ERIKASHVILI, Irakli GORDIASHVILI, Gvantsa BARDADZE
Georgian State Electrosystem

**What are the economic conditions for the feasibility of a low-carbon electricity mix? Profitability and investment considerations for long-term flexibility solutions**

Sebastien PEZZA, Sandrine SELOSSE, Edi ASSOUMOU, Caroline BONO, Fabien BRICAULT

1. EDF, France; 2. Mines Paris PSL, France
| ID: 11832 |
| C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers |
| Topics: C1 PS2 - Flexibility as Pivotal Criterion for System Development |
| **30 Years of Reform of the Colombian Electricity Sector: a Macroeconomic Perspective to the Challenges Facing of Energy Transition.** |
| Diana PEREZ XM |

| ID: 10198 |
| C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers |
| Topics: C1 PS3 - Resilience as Pivotal Criterion for System Development |
| **Application of Flexible Low Frequency Transmission Technology in Zhejiang Province** |
| Peng QIU, Yi LU, Xiaoming HUANG, Fangyu GAN |
| State Grid Zhejiang Electric Power Research Institute, Hangzhou, China |

| ID: 10211 |
| C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers |
| Topics: C1 PS3 - Resilience as Pivotal Criterion for System Development |
| **The Power Adequacy and Flexibility Assessment in the Process of Energy Transition in the China’s Power Sector** |
| Kun YANG, Xiaomeng LEI, Guangbin XU, Kun LIU, Dan XU |
| China Electricity Council, China |

| ID: 10281 |
| C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers |
| Topics: C1 PS3 - Resilience as Pivotal Criterion for System Development |
| **Keywords:** IBR power, scenarios, RMS simulation, frequency, rotor angle stability |
| **System impacts of IBR power reduction after a short-circuit** |
| Julien CALLEC, Gilles TORRESAN, Thibault PREVOST, Adrien GUIRONNET |
| RTE, France |

| ID: 10373 |
| C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers |
| Topics: C1 PS3 - Resilience as Pivotal Criterion for System Development |
| **Application of a multi-hazard risk-based Resilience assessment methodology to real cases in the Italian Transmission System** |
| Emanuele CIAPESSONI |
| RSE, Italy |

| ID: 10433 |
| C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers |
| Topics: C1 PS3 - Resilience as Pivotal Criterion for System Development |
| **Keywords:** Power System Planning and Operation, Renewable Resources, Grid Transformation, Decarbonization, Distributed Resources |
| **Creating a Sustainable National Electric Infrastructure While Maintaining Reliability and Resiliency of the Grid** |
| Vijay VITTAL¹, Anjan BOSE², Damir NOVOSEL³, Mark LAUBY⁴, Chanan SINGH⁵, Gordon van WELIE⁶ |
| ¹Arizona State University, United States of America; ²Washington State University, United States of America; ³Quanta Technology, United States of America; ⁴North American Electric Reliability Corporation (NERC), United States of America; ⁵Texas A&M University, United States of America; ⁶ISO New England, United States of America |

| ID: 10614 |
| C1 POWER SYSTEM DEVELOPMENT AND ECONOMICS - Full Papers |
| Topics: C1 PS3 - Resilience as Pivotal Criterion for System Development |
| **Keywords:** Resilience, substation, power system development, flexibility of power supply, availability of infrastructure |
| **Evaluation of Substation Configuration as an Element of Resilience Management in System Development** |
| Maksymilian PRZYGRODZKI¹, Sławomir KAŁUŻA¹, Agnieszka DZIENDZIEL¹,², Paweł KUBEK¹,², Piotr RZEPKA¹,² |
| ¹PSE Innowacje, Poland; ²Silesian University of Technology, Poland |
Governance and its importance for the success of an electric power company from the point of view of resilience
Josias MATOS DE ARAUJO¹, Antonio SIMÕES PIRES², Marcelo COSTA DE ARAUJO³
¹Brazilian NC of CIGRE, Brazil; ²Eng Smart Lead; ³Consultant; ⁴Eletronorte

Reliability and Resilience needs for future hybrid AC/DC Grid
Asif KHAN¹, Colin FOOTE¹, Benjamin MARSHALL¹, Paul MCNAMARA², Lampros PAPANGELIS³
¹The National HVDC Centre UK; ²EPRI International Ireland; ³Engie Impact Belgium

Assessment of the Resilience of the Colombian Electricity Sector
Jaime ZAPATA¹, Juan MOLINA², Luisa BUITRAGO²
¹XM; ²Colombia Inteligente

Proposed Methodology for Incorporating Resilience Criteria into Transmission Planning based on Risk Mapping
Lilian HERNANDEZ¹, Francisco BECERRA¹, Roger MELLADO²
¹Comisión Nacional de Energía, Chile; ²STM, Chile; ³Coordinador Eléctrico Nacional, Chile

Improving Distribution Network Climate Resilience Using Statistical Models For Conventional And Technology Agnostic Solutions
Kiran SINGH, Pankaj KUMAR, Rakesh KUMAR, Naveen SRIVASTAVA
POWERGRID, India

Less connection for more security – Novel transmission and power grid design in NEOM grid with 100% renewable
Grain ADAM¹, Nand SINGH², Ying JIANG HAFNER², Mauro MONGE³
¹ENOWA, KSA; ²ENOWA, KSA; ³Hitachi Energy, SWEDEN; ⁴Hitachi Energy, SWEDEN

C2 - POWER SYSTEM OPERATION AND CONTROL
PS1 - CREATE OPERATIONAL RESILIENCE TO EXTREME/UNPREDICTABLE EVENTS

Emergency Dispatch and Electricity Sales Strategies for Distribution Networks Considering Diverse User Demands and Resilience Enhancement
Mingqian XU, Gengfeng LI, Siyuan SUN, Minghao LI, Wenqiu ZOU
Xi’an Jiaotong University, China
Verification of a 3-Dimensional Geoelectric Field Model for Geomagnetic Disturbance and Geomagnetically Induced Current Studies

Christopher BALCH1, Matthew CAHER1, Gary KOBET1, Ian GRANT1, Anna KELBERT3
Tennessee Valley Authority, United States of America; 1CIRES/NOAA, United States of America; 3United States Geological Survey, United States of America

Weather and Operational Uncertainty in Electricity Market Operations: Stochastic Nodal Adequacy Pricing Approach

F. Selin YANIKARA2, Alex RUDKEVICH2, Russ PHILBRICK3, Richard TABORS3
Newton Energy Group, United States of America; 2Polaris System Optimization, United States of America; 3Tabors Caramanis Rudkevich, United States of America

Increasing the resilience of electric transmission grid to extreme events

Pedro MARQUES1, Luís Mário RIBEIRO2, João GASPAR1, Miguel ALMEIDA2, David ALMEIDA2
REN - Redes Energéticas Nacionais, SGPS, S.A; 2Univ Coimbra, ADAI, Department of Mechanical Engineering

Mitigating the Risk of Damaging Overvoltages Caused by Back Feeding an Isolated 230 kV Cable System

Bruce CHEN, Baike SHEN, Anil PRADHAN, Edward BURT
BC Hydro, Canada

Determination of Reference Incidents as a Key Tool for Reliable Power System Operation

Vladimir DIYACHKOV, Igor OKSHIN
JSC SO UPS, Russian Federation

Advancing Forecast Technique for Photovoltaic Power Generation in Kansai Area under Snow Conditions

Shiho NAKATA1, Takayuki YOSHIDA1, Shota MIYAKE1, Masaaki SAWASAKI1, Nozom TAKADA2, Naoki INABA2
Kansai Transmission & Distribution, Inc., Japan; 1Meteorological Engineering Center, Inc., Japan

Tight supply-demand due to unseasonably hot weather and the establishment of countermeasures to deal with the situation

Toshiro KATAOKA, Koji ENYA
TEPCO Power Grid, Inc., Japan
<table>
<thead>
<tr>
<th>ID: 10929</th>
<th>C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C2 PS1 - Create Operational Resilience to Extreme/Unpredictable Events</td>
<td></td>
</tr>
<tr>
<td>Keywords: Alarm Management, SCADA, Data Engineering, Machine Learning, Operation</td>
<td></td>
</tr>
</tbody>
</table>

**Comprehensible Alarm Text Clustering for Reconfiguration and Real-Time Support**

Jhelum CHAKRAVORTY1, David MARINO1, Antony HILLIARD1, Faeza HAFIZ2, Susanne SCHMITT3, Georgios MITRENTSIS3, Giancarlo DALLE AVE1, Zhaohan SUN1

1Hitachi Energy Research, Canada; 2Hitachi Energy Research, USA; 3Hitachi Energy Research, Germany

<table>
<thead>
<tr>
<th>ID: 10932</th>
<th>C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C2 PS1 - Create Operational Resilience to Extreme/Unpredictable Events</td>
<td></td>
</tr>
<tr>
<td>Keywords: Resilience, HILF events, operational resilience, new generation mix, climate change</td>
<td></td>
</tr>
</tbody>
</table>

**Power System Resilience: Some Lessons Learned & Best Practices Already Identified, and Other Proposed Measures to Improve the BIPS Operational Resilience**

Paulo GOMES1, Nelson MARTINS2

1Brazilian NC of CIGRE, Brazil, PSQ; 2Brazilian National Engineering Academy

<table>
<thead>
<tr>
<th>ID: 10933</th>
<th>C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C2 PS1 - Create Operational Resilience to Extreme/Unpredictable Events</td>
<td></td>
</tr>
<tr>
<td>Keywords: HVDC - Electrode sharing - Operating procedure - Installation sharing</td>
<td></td>
</tr>
</tbody>
</table>

**Electrode sharing in the Madeira’s HVDC and Xingu’s HVDC systems – Synergy for an integrated operation**

Guilherme AMBON1, Ana Bárbara FERNANDES NEVES1, Edineol PADOVANI1, Hanni GONÇALVES1, Hannah Maria CALDEIRA ANGELKORTE1, Paulo Eduardo MARTINS QUINTÃO1, Karina STOCKLER HERSZTERG1, Sergio Luiz SARDINHA1, Fernando CATTAN JUSAN1, Rafael ZYMLER1, Andre Luiz BARBOSA CORREA1, Paulo Victor SANTOS2, Mário ALBUQUERQUE1, Edson CARVALHO1, Victor TEIXEIRA3

1Brazilian NC of CIGRE, Brazil; ONS; 2Eletrobras ELETRONORTE; 3IE MADEIRA; 4BMTE; 5XRTE State Grid

<table>
<thead>
<tr>
<th>ID: 10937</th>
<th>C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C2 PS1 - Create Operational Resilience to Extreme/Unpredictable Events</td>
<td></td>
</tr>
<tr>
<td>Keywords: Commutation Failure, HVDC, Artificial Neural Networks, Synchrophasor Measurement, Predictive Index</td>
<td></td>
</tr>
</tbody>
</table>

**Commutation Failure Prediction in the HVDC Multi-Infeed Scenario in Brazil Using Neural Network Technique Application**

Rafael DE OLIVEIRA FERNANDES, Maria Cristina DIAS TAVARES

Brazilian NC of CIGRE, Brazil; Unicamp University

<table>
<thead>
<tr>
<th>ID: 11051</th>
<th>C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C2 PS1 - Create Operational Resilience to Extreme/Unpredictable Events</td>
<td></td>
</tr>
<tr>
<td>Keywords: Distribution Three-phase Linear State Estimator, Phasor Measurement Units (PMUs), Microgrid, Situational Awareness and Control, Distributed Energy Resources (DERs)</td>
<td></td>
</tr>
</tbody>
</table>

**Pioneering Development and Deployment of Distribution Linear State Estimator: One Utility’s Journey**

Ali ALVI1, Thomas ALFORD1, Marianna VAIMAN2, Farnoosh RAHMATIAN2

1ComEd, United States of America; 2V&R Energy, United States of America; 3NuGrid Power Corp., Canada

<table>
<thead>
<tr>
<th>ID: 11252</th>
<th>C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C2 PS1 - Create Operational Resilience to Extreme/Unpredictable Events</td>
<td></td>
</tr>
</tbody>
</table>

**Impacts of High Renewable Integration on Interconnector Transient Stability – Case Study of Australian Grid**

Germane ATHANASIUS, Rodney REUBEN

APD Engineering, Australia

<table>
<thead>
<tr>
<th>ID: 11397</th>
<th>C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C2 PS1 - Create Operational Resilience to Extreme/Unpredictable Events</td>
<td></td>
</tr>
<tr>
<td>Keywords: 2021 Jordan blackout, power system resilience, black start units (BSUs), non-black start units (NBSUs), power plant response, preparedness and response strategies, Samra Power Plant, artificial intelligence (AI) techniques, restoration sequences, power gr</td>
<td></td>
</tr>
</tbody>
</table>

**Enhancing Power system Resilience: A Case Study of Samra Power Plant Preparedness and Power Restoration during Blackout 2021 in Jordan**

Yousef MASHAGBEH, Sara ZYOUD

Samra Electric Power Company, Jordan, Hashemite Kingdom of
<table>
<thead>
<tr>
<th>ID: 11398</th>
<th>C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C2 PS1 - Create Operational Resilience to Extreme/Unpredictable Events</td>
<td></td>
</tr>
<tr>
<td><strong>Keywords:</strong> power distribution networks, operational resilience, control center, Irbid district electricity company, renewable energy projects</td>
<td></td>
</tr>
<tr>
<td><strong>Operational Resilience for Irbid District Electricity Company (IDECO)</strong></td>
<td></td>
</tr>
<tr>
<td>Zayed ALHAMMOURI, Haneen BAIDAS</td>
<td></td>
</tr>
<tr>
<td>IDECO</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11441</th>
<th>C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C2 PS1 - Create Operational Resilience to Extreme/Unpredictable Events</td>
<td></td>
</tr>
<tr>
<td><strong>Keywords:</strong> Current Zero-Missing, Compensated Cable Circuits, Operational Philosophy, Protection Design</td>
<td></td>
</tr>
<tr>
<td><strong>Holistic Approach to Solving the Current Zero Missing Phenomenon in Cable Compensated Networks</strong></td>
<td></td>
</tr>
<tr>
<td>Fabian KOEHLER, Keith HARMER, Mark STOCKTON</td>
<td></td>
</tr>
<tr>
<td>SSEN Transmission UK</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11483</th>
<th>C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C2 PS1 - Create Operational Resilience to Extreme/Unpredictable Events</td>
<td></td>
</tr>
<tr>
<td><strong>Development of a Platform for Energy and Power Demand Forecasting Using Advanced Prediction Models, Considering Variables of the Electrical System Operation</strong></td>
<td></td>
</tr>
<tr>
<td>Leonardo SANDOVAL, Maria ASPRILLA, Luis SANTANDER, Maria HERNANDEZ</td>
<td></td>
</tr>
<tr>
<td>1Celsia; 2Guane Enterprises</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11564</th>
<th>C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C2 PS1 - Create Operational Resilience to Extreme/Unpredictable Events</td>
<td></td>
</tr>
<tr>
<td><strong>Operation Strategy &amp; Impact Assessment of Extreme Severe Cyclonic Storm 'Biparjoy' on Indian Power System</strong></td>
<td></td>
</tr>
<tr>
<td>Akhil GUPTA, Tushar R MOHAPATRA, Aman GAUTAM, Rohit ANAND, M ANANTHAKRISHNAN, B M SHAH</td>
<td></td>
</tr>
<tr>
<td>1Grid Controller of India Limited, India; 2Gujarat Energy Transmission Corporation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11636</th>
<th>C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C2 PS1 - Create Operational Resilience to Extreme/Unpredictable Events</td>
<td></td>
</tr>
<tr>
<td><strong>Analytical review of major disturbances in the electric power system and their impact on the overall power system stability and reliability</strong></td>
<td></td>
</tr>
<tr>
<td>Ahmed TAHA, Zain ALABDEEN</td>
<td></td>
</tr>
<tr>
<td>Emirates Water &amp; Electricity Company, UAE</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11685</th>
<th>C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C2 PS1 - Create Operational Resilience to Extreme/Unpredictable Events</td>
<td></td>
</tr>
<tr>
<td><strong>Real-Time Estimation of Interarea Oscillation Mode Using Sliding Window Prony’s Method</strong></td>
<td></td>
</tr>
<tr>
<td>Manuel Leonardo SOSA RIOS, Oscar Miguel SANTACRUZ SILVERO, Luis Fernando COSTA ALBERTO, Glauco NERY TARANTO</td>
<td></td>
</tr>
<tr>
<td>1Itaipu Binacional; 2University of São Paulo; 3Federal University of Rio de Janeiro</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11697</th>
<th>C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C2 PS1 - Create Operational Resilience to Extreme/Unpredictable Events</td>
<td></td>
</tr>
<tr>
<td><strong>Operational Planning for High-Demand Periods in the Indian Power System: Leveraging Operational Experience and Policy Interventions</strong></td>
<td></td>
</tr>
<tr>
<td>Talluri SUDHEER, Anuj KUMAR, Rohit ANAND, Ashok KUMAR, S. C. SAXENA</td>
<td></td>
</tr>
<tr>
<td>Grid Controller of India Ltd., India, India</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11797</th>
<th>C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C2 PS1 - Create Operational Resilience to Extreme/Unpredictable Events</td>
<td></td>
</tr>
<tr>
<td><strong>Methodology of calculating Balancing Reserves in Georgian Power System</strong></td>
<td></td>
</tr>
<tr>
<td>David TKESELASHVILI, Irakli VAKHTANGADZE, Irakli GORDIASHVILI, Ivane MCHEDLISHVILI, Archil KOKHTASHVILI</td>
<td></td>
</tr>
<tr>
<td>Georgian State Electrosystem</td>
<td></td>
</tr>
</tbody>
</table>
PS2 - CHANGES ON SYSTEM OPERATION AND CONTROL CONSIDERING THE ENERGY TRANSITION

ID: 10219
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition
Approximate optimal control of wind-HESS system for online frequency regulation based on fuzzy logic control
Zao TANG1, Jia LIU1, Pingliang ZENG1, Youbo LIU2, Peng LI3
1Hangzhou Dianzi University, China; 2Sichuan University, China; 3North China Electric Power University, China

ID: 10276
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition
Switching Strategy for Minimizing Energy Losses in Ring Distribution Network during Repairing Time
Abd-El Fattah S. HAMMAD1, Hossam A. ABD EL GHANY2, Ahmed M. AZMY2
1Behira Electricity Distribution Company; 2Faculty of Engineering, Tanta University

ID: 10282
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition
Impact of an enhanced secondary controller on the voltage regulation performance in the French Transmission System
Julien CALLEC, Adrien GUIRONNET, Carmen CARDOZO, Philippe JUSTON
RTE, France

ID: 10379
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition
An Innovative Indicator for Instability Risk Assessment
Giorgio GIANNUZZI
TERNA, Italy

ID: 10446
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition
Key Findings and Recommendations Regarding Systemic Performance and Modeling Issues for Bulk Power System Inverter-Based Resources
Alex SHATTUCK1, Ryan QUINT2, Aung THANT1, Rich BAUER2
1North American Electric Reliability Corporation (NERC), United States of America; 2Elevate Energy Consulting, United States of America

ID: 10448
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition
Mitigating Continental Europe North-South Oscillations Using An Adaptive Wide-area Damping Controller: Field Implementation and Testing
Lin ZHU1, Evangelos FARANTATOS1, Xinlian JIA2, Wenheng YU2, Yi ZHAO2, Yilu LIU2,4, Salvatore TESSITORE3, Pietro PAU3, Guido COLETTA3, Cosimo PISANI5, Giorgio GIANNUZZI5
ID: 10508
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition
Keywords: Reactive Power Compensation, DSO-TSO Coordination, Distributed Energy Resources (DER) Integration, Reactive Power Monitoring System

Coordinated Reactive Power Compensation: A Collaborative DSO-TSO Approach
Miguel LOURO¹, Rita LOPES MOURÃO¹, Gonçalo SANTOS¹, José VIEIRA COUTO², Filipe RIBEIRO²
¹E-Redes, Portugal; ²REN, Portugal

ID: 10528
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition
Keywords: Congestion Management, Topological Remedial Actions, Decision Support, Multi-Objective Optimization, Artificial Intelligence, DC load flow, Human-Machine Interface

GridOptions Tool: Real-World Day-Ahead Congestion Management using Topological Remedial Actions
Jan VIEBAHN¹, Sjoerd KOP¹, Joost VAN DIJK¹, Hariadi BUDAYA¹, Marja STREEFLAND¹, Davide BARBIERI¹, Paul CHAMPION², Mario JOTHY², Vincent RENAULT², Simon TINDEMANS²
¹TenneT TSO; ²Artelys; ³TU Delft

ID: 10553
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition
Keywords: Energy Transition, Low Frequency Demand Disconnection, Low-Inertia, RoCoF, System Defence

Improving Frequency Defence Schemes for Critical System Conditions in the Continental European Power System
Padraig BUCKLEY¹, Aleksandar BORIČIĆ², Martijn JANSSEN⁴, Timothy PLEVIER⁴, Jorrit BOS³, Danny KLAAR³, Marjam POPOV¹
¹Delft University of Technology, Faculty of EEMCS; ²Delft University of Technology, Faculty of EEMCS & TenneT TSO; ³TenneT TSO; ⁴Alliander N.V.

ID: 10593
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition

Protection Schemes for Renewable Energy Sources Integration in Romanian Power Grid
Roxana A ISTRATE¹, Costel CONSTANTIN¹, Lucian TOMA²
¹CNTEE Transelectrica SA; ²University Politehnica of Bucharest

ID: 10596
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition

Optimal allocation of Distributed Energy Sources and Capacitor Banks in Distribution Network using Genetic Algorithm
Nikolina MRAKOVIC¹, Zoran MILJANIC²
¹Montenegrin Transmission System; ²Faculty of Electrical Engineering

ID: 10640
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition

Voltage control sandbox in the Spanish Power System
Juan Julián PEIRÓ, Pablo MARTÍNEZ-FRESNEDA, Hugo GONZÁLEZ, Nicolás SANTOS, Agustín DÍAZ, Marta CABALLERO, Carlos RAMOS
Red Eléctrica, Spain

ID: 10675
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition
Keywords: Power system inertia, VRE, PFR, RoCoF

Effects of increasing variable renewable energy (VRE) integration on the power system inertia - South African power system
Fiona OLOO
The Council for Scientific and Industrial Research
ID: 10686
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition

Standards-based interoperable Testbed for Development and Assessment of stability monitoring Applications in the Nordic interconnected Grid

Emil HILLBERG
RISE, Sweden

ID: 10688
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition

Challenges of Frequency and Transient Stability arising from the Increased Renewable Energy

Ju-Yong KIM, Tae-Gyun KIM, Hoon-Chul SHIN, Tae-Yong SONG, Jun-Young JOO
Korea Power Exchange, Korea, Republic of (South Korea)

ID: 10748
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition
Keywords: Outage Planning, Outage Planning Coordination, Net Transfer Capacity, Mixed Integer Linear Programming, Contingency Analysis, DC Power Flow, Operational Planning, Asset Management

Outage Planning Automation and Optimization at Swiss Electricity Transmission Grid with High Shares of Hydropower Generation

Marcel STOECKLI1, Davood RAOOFSHEIBANI2, Evangelos VRETROS2, Felipe ALVAREZ2, Beat LOETSCHER2, Jose ANICETO2, Adrian SCHULZE2, Oliver HAUBENSAK2, Matthias BUCHER2
1 ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2 Swissgrid Ltd, Switzerland

ID: 10875
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition
Keywords: Power System Stability, Cooperative Control, Multi Purpose, BESS, RES

Development of multi-purpose cooperative control method of BESS for a power system with a high share of RES

Ryo YAMAGUCHI1, Shigeyuki SUGIMOTO1, Suresh Chand VERMA1, Kotaro HATTORI2
1 Chubu Electric Power Co., Inc., Japan; 2 Chubu Electric Power Grid Co., Inc., Japan

ID: 10876
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition
Keywords: Distribution Network, Electricity Demand, Hydrogen, Modelling, Open Data, Renewable Energy, Time Series Data

Development of Future Energy Service Demand Model for Integrated Assessment of High Penetration Renewable Power Generations

Takeyoshi KATO, Chiyori URABE
Nagoya University, Japan

ID: 10927
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition
Keywords: Wind Generation, Synthetic Inertia, Load-Generation Control, Underfrequency, Overfrequency, Power System Dynamics, Fast Frequency Response

Operation Performance of the Brazilian Electric System with the Contribution of Frequency Controls from the Wind Farms

Flávia FERREIRA1, Dilton VASCONCELOS1, Leonardo SANTOS1, Darlanny DINIZ1, Arlindo LINS2
1 Brazilian NC of CIGRE, Brazil; ONS; 2 Consultant

ID: 10972
C2 POWER SYSTEM OPERATION AND CONTROL - Full Papers
Topics: C2 PS2 - Changes on System Operation and Control Considering the Energy Transition
Keywords: IT platform architecture, Data exchange, Situational awareness, Voltage stability, Phasor Measurement Units

Wide Area Monitoring and Protection - Application Developments and IT infrastructure

Kjetil O. UHLEN1, Kjell P. MYREN2, Hallvar HAUGDAL3, Daniel BALTENSPERGER3, Ole FINSETH2, Aldrich ZENO1, Valeria Monteiro DE SOUZA3
1 NTNU Norway; 2 Statnett Norway; 3 SINTEF Energy Norway
Adaptive Parameterization of Grid-Supporting Inverters: An Investigation into Complex Coupling Effects for Islanded Operation
Carina LEHMAL, Ziqian ZHANG, Herwig RENNER, Robert SCHÜRHubER
Graz University of Technology

Power sharing and secondary frequency control for Greek island systems supplied by RES+storage hybrid stations and thermal generating plants
Apostolos PAPAKONSTANTINOU, Georgios PSARROS, Stavros PAPATHANASSIOU
National Technical University of Athens (NTUA), Greece

Advanced functionalities for managing Wind Parks in non-interconnected Islands
Stefanos KOKKINELIS, Despoina KOUKOLA, Charalampos PAPPAS, Eleni LAMPRINIDI, Argyro MAGKANIOTI, Konstantinos KAOUSIAS, Andreas REPPAS, Theodora PATSAKA
HEDNO S.A., Greece

Impact of the balancing strategy in future meshed HVDC offshore systems
Felix RUDOLPH1, Simon KRAHL2
1FGH GmbH, Germany; 2FGH e.V., Germany

Operation And Control Challenges With Large Penetration Of Renewable Energy Resources In The Indian Grid
Pankaj Kumar JHA*, M. S. HADA, Jiten DAS
POWERGRID, India

Solar Forecasting for Medium Voltage Distributed Energy Resource across a region
Chun Yin FOON, Azizul HilmI ZULKIFLI, Dg Fatimah AHMAD
Tenaga Nasional Berhad, Malaysia

A Concept for Frequency Control and Power Balancing in NEOM Grid of the Future
Lie XU1, Ramon GIMENEZ2, Md HABIBURRAHMAN3, Nagaraju POGAKU3, Peng Li3, Nand SINGH3, Grain ADAM3
1University of Strathclyde,UK; 2University Polytechnic of Valencia,SPAIN; 3ENOWA, NEOM, KSA

Itaipu's experience using Monte Carlo Simulation based tool for short-term operation planning
Ricci OVIEDO, Reinaldo GONZALEZ, Rafael ANDRADE
Itaipu Binacional
Enhanced Intra-hour Solar PV Power Generation Forecast with Satellite Imagery
Jarudate VORASEE, Surat ASVAPOOSITKUL, Somphop ASADAMONGKOL, Somruedee TIPMABUTR
Electricity Generating Authority of Thailand (EGAT), Thailand

An approach to evaluate Under-frequency Load Shedding System of Power System with high share of distributed source
Viet Anh VO HAI*, Anh Tuan NGUYEN, Quynh PHAM, Minh Long VU, Thanh Hai TRAN, The Van NGUYEN, Minh Ha HOANG, Cong Man LE
EVNCRDLDC Vietnam

AEP’s Operation Strategy for High Share of RES: Linear State Estimator and Oscillation Monitoring
Horacio SILVA1, S. WHALEN1, B. ABU-JARADEH1, J. KOUTSOURAIS2, Y. LU2, P. P. NIEVES2
1Electric Power Group (EPG); 2American Electric Power Service Corporation (AEP)

C3 - POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE
PS1 - PUBLIC ACCEPTANCE AND STAKEHOLDER ENGAGEMENT IN POWER SYSTEM GENERATION, TRANSMISSION & DISTRIBUTION INFRASTRUCTURES

Harmonizing Nature's Symphony: biodiversity as a powerful tool for public acceptance
Paul HARTMAN1, Claire DEURVORST2, Henk SANDERS2
1Antea Group; 2TenneT

A geodesign-based framework that implements BIM methodology with GIS tools and involve stakeholders in transmission infrastructures projects
Francisco Javier MORENO MARIMBALDO
Red Eléctrica, Spain

Public acceptance of Facilities in Power Transmission Network in Montenegro
Ljiljana VUČINIĆ, Gordana PEROVIĆ
Crnogorski elektroprenosni sistem

Multidisciplinary approach to managing wildlife risk in a DSO
Rudi KRUGER
Eakom
ID: 10894
C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers
Topics: C3 PS1 - Public Acceptance and Stakeholder Engagement in Power System Generation, Transmission & Distribution Infrastructures

Levels of Electromagnetic Field in the Vicinity of Transmission Overhead Power Lines with Special Conductors
Maja GRBIC1, Nada CUROVIC2, Ivan MILANOV2, Aleksandar PAVLOVIC3
1Nikola Tesla Institute of Electrical Engineering, Republic of Serbia; 2Elektromeza Srbije JSC, Republic of Serbia; 3Elektroistok – Projektni biro, Republic of Serbia

ID: 10938
C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers
Topics: C3 PS1 - Public Acceptance and Stakeholder Engagement in Power System Generation, Transmission & Distribution Infrastructures

Periodic stakeholder perception mapping combining social impact and relationship assessments: A strategy to assess and enhance levels of social legitimacy for enterprises
Delfim ROCHA
Brazilian NC of CIGRE, Brazil; Ferreira Rocha Assessoria e Servicos Socioambientais

ID: 10942
C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers
Topics: C3 PS1 - Public Acceptance and Stakeholder Engagement in Power System Generation, Transmission & Distribution Infrastructures

Stakeholder Engagement in the Hydropower Decommissioning Process: a Groundbreaking Study in Latin America
Raquel LOURES1, Marcelo MICHERIF2, Mariana COELHO2, Eduardo VAN DEN BERG3, Paulo POMPEU4, Adriano LEMOS1, Yuri CALDEIRA1, Rafael SOUZA1, Rafael A. FIORINE1
1Brazilian NC of CIGRE, Brazil; 2SC Empreendimentos; 3UFLA University - Federal University of Lavras

ID: 10943
C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers
Topics: C3 PS1 - Public Acceptance and Stakeholder Engagement in Power System Generation, Transmission & Distribution Infrastructures

Indicator Systems to Measure Efficacy and Effectiveness of Socio-Environmental Programmes of Hydroelectric Power Plants
Ricardo CAVALCANTI FURTADO, Maria F. G. FURTADO, Marcelo FURTADO, Elena FLORISSI
Brazilian NC of CIGRE, Brazil; Diversa Sustainability

ID: 11001
C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers
Topics: C3 PS1 - Public Acceptance and Stakeholder Engagement in Power System Generation, Transmission & Distribution Infrastructures

Dialogue as an Important Link for Increasing the Level of Projects Feasibility
Katarina Ana LESTAN1, Ana CERK2, Uška KUGOVNIK2, Erik MARČENKO2, Masa DJURC2, Maja IVANOVS2, Damjan KOVAC1, Andrej SUSTERSIC2, Rudi VONCINA2
1Elektroinštitut Milan Vidmar (EIMV); 2Elektroinštitut Milan Vidmar (EIMV)

ID: 11069
C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers
Topics: C3 PS1 - Public Acceptance and Stakeholder Engagement in Power System Generation, Transmission & Distribution Infrastructures

Investigation on Current Trend of Land Use of Installation Site for Photovoltaic Power Generation Systems
Takeyoshi KATO, Chiyori URABE
Nagoya University, Japan

ID: 11406
C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers
Topics: C3 PS1 - Public Acceptance and Stakeholder Engagement in Power System Generation, Transmission & Distribution Infrastructures

Assessing the Sustainability of Future Regional Energy Systems: Integrating Stakeholder Perspectives
Witold POGANIEZ1, Johannes GAISER2, Ines JENDRITZKI2, Peter NOGLIK1
1Hitachi Energy Germany AG, Germany; 2Karlsruhe Institute of Technology, Germany
<table>
<thead>
<tr>
<th>ID: 11535</th>
<th>Design &amp; Development of India’s 1st Indigenous Pivoted Type Insulated Cross Arm for 400kV Transmission Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C3 PS1 - Public Acceptance and Stakeholder Engagement in Power System Generation, Transmission &amp; Distribution Infrastructures</td>
<td></td>
</tr>
<tr>
<td>Authors: Ashish Kr SINGH*, Mahendra CHAURASIA, Chandra KANT, Neeraj Singh GAUTAM, Rajesh GUPTA, Dr Subir SEN, Abhay CHOUDHARY</td>
<td></td>
</tr>
<tr>
<td>Affiliation: POWERGRID Corporation Of India Limited, India</td>
<td></td>
</tr>
</tbody>
</table>

**PS2 - CLIMATE CHANGE AND IMPACT ON POWER SYSTEM, A HOLISTIC APPROACH**

<table>
<thead>
<tr>
<th>ID: 10120</th>
<th>Installation of Near to Zero Liquid Discharge (NZLD) Units at New Capital Combined Cycle Power Plant (NCCCPP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keywords: Near to Zero Liquid Discharge (NZLD) - Egyptian Electricity Holding Company (EEHC) – Water rationalization - Dissolved Air Flotation process - Filtration system</td>
<td></td>
</tr>
<tr>
<td>Authors: Marwa Mansour HUSSEIN1, Maher Aziz BEDROUS2, Ismail Yehia Ali ELSAWI3</td>
<td></td>
</tr>
<tr>
<td>Affiliation: 1Egyptian Electricity Holding Company EEHC; 2Senior Counsellor for Energy &amp; Environment</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10237</th>
<th>Climate Change Impacts on Low Power Output of Photovoltaic in China</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors: Zongpeng SONG, Bo WANG, Xiaolin LIU, Zheng WANG</td>
<td></td>
</tr>
<tr>
<td>Affiliation: China Electric Power Research Institute, China</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10381</th>
<th>Future projections of extreme conditions affecting the Italian Energy System with a multi-hazard approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors: Paola FAGGIAN</td>
<td></td>
</tr>
<tr>
<td>Affiliation: RSE, Italy</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10450</th>
<th>From Risk to Resilience: Quantifying the Financial Impact of Proactive Physical Infrastructure Improvements in Substations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors: Charlie {Chun} LI1, Brian P. HERRMANN1, Matthew D. UBER2</td>
<td></td>
</tr>
<tr>
<td>Affiliation: 1Burns &amp; McDonnell, United States of America; 2J-Power USA, United States of America</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10750</th>
<th>Impact of Climate and Weather Variability on Energy System Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors: Marcel STOECKLI1, Sebastian PORRAS APARICIO1, Alexandre OUDALOV2, Georgios MAVROMATIDIS3</td>
<td></td>
</tr>
<tr>
<td>Affiliation: 1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2Hitachi Energy, Switzerland; 3ETH Zurich, Switzerland</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10974</th>
<th>Highlighting forgotten emissions: Calculate and mitigate carbon loss from infrastructure construction on peatland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors: Ellen TORSJÆTER1, Magni O. Kyrkjebi2, Marte Fandrem3</td>
<td></td>
</tr>
<tr>
<td>Affiliation: 1Statnett SF Norway; 2NINA Norway; 3NTNU Norway</td>
<td></td>
</tr>
</tbody>
</table>
Impacts on T&D products by climate change and visa verse

Martin A. STOESSL1, Ewald SCHWEIGER2, Eduardo GOMEZ HENNIG3
1Siemens Energy Austria; 2Siemens Energy Germany; 3Siemens Energy Canada

Methodology for the Use of Live Line Works as an Effective Solution During Environmental Phenomena and Regulatory Changes in Developing Countries

William SANTANA, Juan VARELA
ISA Intercolombia

Risk Management of Fluvio-Torrential Events on Electric Transmission Infrastructure in the Face of Climate Change: Lessons Learned from the Mocoa Disaster

Judy VALVERDE, Hernán CORTÉS
Enlaza Grupo Energía Bogotá

Climate Change Adaptation in Distribution Network Planning: A Resilient Approach for Sustainable Power Systems

Priyanshu PRALIYA*, Ankur SANGWAN, Sovik SHARMA, Akash KUMAR
Tata Power Delhi Distribution Limited, India

Faults and damages in the distribution network due to impact of climate change

Krešimir UGARKOVIC, Ivan ANDRIĆ, Hrvoje JELIĆ, Dinko HRKEC
HEP ODS d.o.o., Croatia

Development of Trinity Renewable Energy for the Future of East Nusa Tenggara Electricity

Halomoan PARNINGOTAN, Tommy NOVIANTO, Ansats Pram Andreas SIMAMORA, Cristine C BUBRE
PT.PLN (Persero), Indonesia

The impact of climate change on the Dutch transmission grid: Leading risks and adaptation strategies

Joris DEN BREEJEN1, Astrid SCHELLINGS-KOEKOEK2
1TenneT TSO; 2Movares

Impacts on T&D products by climate change and visa verse

Martin A. STOESSL1, Ewald SCHWEIGER2, Eduardo GOMEZ HENNIG3
1Siemens Energy Austria; 2Siemens Energy Germany; 3Siemens Energy Canada
Methodology for the Use of Live Line Works as an Effective Solution During Environmental Phenomena and Regulatory Changes in Developing Countries
William SANTANA, Juan VARELA
ISA Intercolombia

Risk Management of Fluvio-Torrential Events on Electric Transmission Infrastructure in the Face of Climate Change: Lessons Learned from the Mocoa Disaster
Judy VALVERDE, Hernán CORTÉS
Enlaza Grupo Energía Bogotá

Climate Change Adaptation in Distribution Network Planning: A Resilient Approach for Sustainable Power Systems
Priyanshu PRALIYA*, Ankur SANGWAN, Sovik SHARMA, Akash KUMAR
Tata Power Delhi Distribution Limited, India

Achieving electrical resilience in the face of climate change in Kuwait
Nayef ALHADAD¹, Jana ALI²
¹Kuwait Authority for Partnership Projects, KUWAIT; ²Kuwait Authority for Partnership Projects, KUWAIT

Faults and damages in the distribution network due to impact of climate change
Krešimir UGARKOVIC, Ivan ANDRIĆ, Hrvoje JELIĆ, Dinko HRKEC
HEP ODS d.o.o., Croatia

Development of Trinity Renewable Energy for the Future of East Nusa Tenggara Electricity
Halomoan PARNINGOTAN, Tommy NOVIANTO, Ansats Pram Andreas SIMAMORA, Cristine C BUBRE
PT.PLN (Persero), Indonesia

The impact of climate change on the Dutch transmission grid: Leading risks and adaptation strategies
Joris DEN BREEJEN¹, Astrid SCHELLINGS-KOEKOEK²
¹TenneT TSO; ²Movares
<table>
<thead>
<tr>
<th>ID: 10286</th>
<th>C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C3 PS3 - Sustainability Starting for the Supply Chain</td>
<td></td>
</tr>
<tr>
<td>Keywords: Ecodesign, Green Procurement, Grids supply chain, LCA, Sustainability</td>
<td></td>
</tr>
<tr>
<td><strong>Ecodesign aspects to enhance circularity and boost sustainable</strong></td>
<td></td>
</tr>
<tr>
<td>Marcela MANTILLA, Pascale PRIEUR, Samuel NGUEFEU</td>
<td></td>
</tr>
<tr>
<td>RTE, France</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10287</th>
<th>C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C3 PS3 - Sustainability Starting for the Supply Chain</td>
<td></td>
</tr>
<tr>
<td>Keywords: Product Circularity, High-Voltage equipment, Circularity Strategies, Critical Raw Materials, Life Cycle</td>
<td></td>
</tr>
<tr>
<td><strong>Circularity for High-Voltage Equipment</strong></td>
<td></td>
</tr>
<tr>
<td>Christophe PERRIER, Thomas BERTELOOT, Eliott PEREZ, Clémence DUMOULIN</td>
<td></td>
</tr>
<tr>
<td>GE Grid Solutions, France</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10451</th>
<th>C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C3 PS3 - Sustainability Starting for the Supply Chain</td>
<td></td>
</tr>
<tr>
<td>Keywords: Construction, Embodied Carbon, Power Infrastructure, Sustainability</td>
<td></td>
</tr>
<tr>
<td><strong>A Framework for Sustainability-centric Decision Making in the Selection of Construction Materials for Power System Projects</strong></td>
<td></td>
</tr>
<tr>
<td>Alexander D. PAGNOTTA, Lyndsey COVERT</td>
<td></td>
</tr>
<tr>
<td>Burns &amp; McDonnell, United States of America</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 1085</th>
<th>C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C3 PS3 - Sustainability Starting for the Supply Chain</td>
<td></td>
</tr>
<tr>
<td>Keywords: Audible Noise, Corona Effect, HV Overhead Transmission Line</td>
<td></td>
</tr>
<tr>
<td><strong>Audible noise reduction of high-voltage overhead lines by applying an eco-design approach while considering impact on the environment</strong></td>
<td></td>
</tr>
<tr>
<td>Nebojša PETROVIĆ1, Iva SALOM2, Nada CUROVIĆ1, Vladimir ĆELEBIĆ2, Valerijan AKSIĆ1, Dejan TADOROVIĆ1, Milenko KABOVIĆ3</td>
<td></td>
</tr>
<tr>
<td>1Elektromreža Srbije JSC, Serbia; 2Institute Mihajlo Pupin, University of Belgrade, Serbia; 3Dirigent acoustics LLC, Serbia</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10944</th>
<th>C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C3 PS3 - Sustainability Starting for the Supply Chain</td>
<td></td>
</tr>
<tr>
<td>Keywords: Carbon footprint; water footprint, life cycle assessment; sustainability</td>
<td></td>
</tr>
<tr>
<td><strong>A step forward on sustainability in the electricity sector: putting LCA on the table</strong></td>
<td></td>
</tr>
<tr>
<td>Denise MATOS, Katia GARCIA, Alexandre MOLLICA, Igor RAUPP, Juliano ABREU, João Gabriel LASSIO</td>
<td></td>
</tr>
<tr>
<td>Brazilian NC of CIGRE, Brazil; Eletrobras CEPEL</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11067</th>
<th>C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C3 PS3 - Sustainability Starting for the Supply Chain</td>
<td></td>
</tr>
<tr>
<td>Keywords: Electric vehicle (EV), EV Charger, Modelling, Renewable Energy, Road Traffic Census, LCA</td>
<td></td>
</tr>
<tr>
<td><strong>Development of EV Charging Demand Estimation Model based on Road Traffic Census Data for Impact Assessment of High Penetration EV</strong></td>
<td></td>
</tr>
<tr>
<td>Takeyoshi KATO, Chiyori URABE</td>
<td></td>
</tr>
<tr>
<td>Nagoya University, Japan</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11078</th>
<th>C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C3 PS3 - Sustainability Starting for the Supply Chain</td>
<td></td>
</tr>
<tr>
<td>Keywords: CO2 Emissions, Life Cycle Assessment, Lithium-ion Battery, Stationary Battery Energy Storage System, Carbon Intensity of Electricity, Degradation, Repurposing, Lifespan</td>
<td></td>
</tr>
<tr>
<td><strong>Identifying key factors to mitigate life cycle carbon emissions of stationary battery energy storage systems</strong></td>
<td></td>
</tr>
<tr>
<td>Reiko TAKAHASHI1, Koji NEGISHI1, Takenori KOBAYASHI1, Hideki NODA2, Mami MIZUTANI2</td>
<td></td>
</tr>
<tr>
<td>1Toshiba Energy Systems &amp; Solutions Corporation, Japan; 2Toshiba Infrastructure Systems &amp; Solutions Corporation, Japan</td>
<td></td>
</tr>
</tbody>
</table>
ID: 11303
C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers
Topics: C3 PS3 - Sustainability Starting for the Supply Chain
Tackling Scope 3 GHG Emissions of Grid Investments: Creation of Accounting Platform and CO2 Models for Tracking Emissions of Purchased Goods and Works
Vincent DU FOUR, Philipp VON NORMANN
Elia Group, Belgium

ID: 11395
C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers
Topics: C3 PS3 - Sustainability Starting for the Supply Chain
CO2-reduced steel in transformers & challenges with impact evaluation
Matthias SCHICK¹, Marcel HILGERS³, Georg PUKEL³, Christina LOSIFIDOU², Julian SUER¹, Katherine SCHWIND²
¹Thyssenkrupp Electrical Steel, Germany; ²Siemens Energy, Germany; ³Siemens Energy, Austria

ID: 11694
C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers
Topics: C3 PS3 - Sustainability Starting for the Supply Chain
Transforming Sustainable Procurement in the Power Transmission Sector: Evolving Qualification Requirements and Evaluation Criteria
M Siddhardha SIDDHARDHA, Karan SINGH, Priti NAHAR*, Amit BHARGAVA, B Anantha SARMA, G RAVISANKAR
POWERGRID, India

ID: 11789
C3 POWER SYSTEM SUSTAINABILITY AND ENVIRONMENTAL PERFORMANCE - Full Papers
Topics: C3 PS3 - Sustainability Starting for the Supply Chain
Keywords: Renewable Energy, Energy Transition, Digitalization, PPA
RENOVA: Traceability System for the Trading of Renewable Energies in the Chilean Electric Market based on Blockchain Technology
Juan AVALOS, Barbara ACEVEDO, Juan Carlos OLMEDO
Coordinador Electro Eléctrico Nacional, Chile

C4 - POWER SYSTEM TECHNICAL PERFORMANCE

PS1 - POWER SYSTEM DYNAMIC ANALYSIS IN THE ENERGY TRANSITION: CHALLENGES, OPPORTUNITIES AND ADVANCES

ID: 10102
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances
Keywords: Nordic Power System, Power Electronic Interfaced Devices, PEID, Inverter Based Resources, IBR, Converter Stability
Antti HARJULA¹, Herman HÖRNEQUIST², Robert ROGERSTEN², Christian FLYTKJÆR³, Olli-Pekka JANHUNEN¹, Jun Bum KWON³, Eli Maria STENSETH⁴, Knut Styve HORNNES⁴
¹Fingrid Oyj; ²Svenska Kraftnät; ³Energinet; ⁴Statnett

ID: 10289
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances
Keywords: Grid connexion requirements, IBR, RMS model validation
An Open-Source Tool for the Validation of Power Park Modules Generic Models
Carmen CARDozo¹, J. L. MARIN², M. DE MIGUEL², G. OMS², Adrien GUIRONNET¹
¹RTE R&D, France; ²Grupo AIA, Spain

ID: 10291
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances
Keywords: Co-simulation, EMT-type simulation, FMI, HVDC transmission, Interactions
Parallel simulation of a wide-area EMT model with high penetration of power electronic converters using co-simulation: a real case study
Boris BRUNED, Mehdi OUAFI, Ambroise PETIT, Valentin COSTAN, Yannick VERNAY
RTE, France
**Study of New Types of Dynamic Interactions in Power Systems with Mixed Conventional and Renewable Generation**

Pamela ZOGHBY1,2,3, Bogdan MARINESCU2,3, Antoine ROSSE1, Grégoire PRIME1
1EDF R&D, France; 2Ecole Centrale Nantes, France; 3LS2N, France

**Dynamic assessment of Power System Strength in systems with a large share of generation from renewable sources**

Luca BELMONTE
TERNA, Italy

**System stability in dynamic analysis of large power systems enhanced with HVDC reinforcement: HVDC Foggia-Forlì**

Andrea URBANELLI
TERNA, Italy

**Regulating Resistors: an Advanced Control Strategy to Achieve Overall System Stability in the Italian Transmission Grid**

Cosimo PISANI
TERNA, Italy

**Location and Sizing of Grid Forming Devices in Transmission Power Networks**

Deepak RAMASUBRAMANIAN
Electric Power Research Institute (EPRI), United States of America

**Unlocking Capability in Transmission Connected Inverters for Improved Reliability of Transmission Power Networks**

Deepak RAMASUBRAMANIAN1, Sushrut THAKAR1, Julia MATEVOSYAN2
1Electric Power Research Institute (EPRI), United States of America; 2Energy Systems Integration Group (ESIG), United States of America

**Collector System Equivalencing with Frequency-Dependent Representation for Electromagnetic Transient Models**

Swetha SRINIVASAN, Monica PADALA, David ROOP, Kaitlyn BABIAZ, Adam SPARACINO
Mitsubishi Electric Power Products, Inc., United States of America


Aung THANT1, Hongtao MA1, Andrew ISAACS2, Lukas UNRUH2, Ryan QUINT3, Deepak RAMASUBRAMANIAN2, Julia MATEVOSYAN4, Andy HOKE5
North American Electric Reliability Corporation (NERC), United States of America; 2Electranix, Canada; 3Electric Power Research Institute (EPRI), United States of America; 4Energy Systems Integration Group (ESIG), United States of America; 5National Renewable Energy Laboratory (NREL), United States of America; 6Elevate Energy Consulting, United States of America

ID: 10461
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances
Keywords: Inertia Trend, Rate of Change of Frequency, Field Measurement, Generation Mix
Inertia Trend Analysis in the U.S. Eastern Interconnection with Field Measurement Data
Chengwen ZHANG1, Mark BALDWIN2, Hongyu LI1, Zhihao JIANG3, Saurav DULAL1, Yilu LIU1,3
1University of Tennessee, United States of America; 2Dominion Energy, United States of America; 3Oak Ridge National Laboratory, United States of America

ID: 10463
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances
Keywords: 1% Frequency Droop, Primary Frequency Response, Frequency Containment, Inverter-based Resources, Battery Energy Storage Systems (BESS)
Evaluation of Primary Frequency Response from Inverter-based Resources with 1% Droop Setting
Shruti RAO1, Jason MACDOWELL1, Sheila MANZ1, Sebastian ACHILLES1, Nicholas MILLER2, Weifeng Li1, Pengwei DU1, Luis HINOJOSA2, Shun Hsien (Fred) HUANG3
1Consulting Services at GE Vernova, United States of America; 2Hickory Ledge Consulting LLC, United States of America; 3Electric Reliability Council of Texas (ERCOT), United States of America

ID: 10495
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances
Simultaneous Voltage and Power Oscillation Damping Control: Towards robust and scalable Grid Requirements and control Solutions
Joakim BJÖRK
Svenska kraftnät, Sweden

ID: 10800
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances
Impact on Frequency Stability of the Feedback in the active Power Control for synchronous Generation
Lena MAX
Protrol AB, Sweden

ID: 10837
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances
Impact of active Distribution Networks on Power System Stability – a Case Study
Frédéric SABOT1, Pierre HENNEAUX1, Ifigeneia S. LAMPRIANIDOU2, Panagiotis N. PAPADOPOULOS2, Keith BELL2
1BEAMS, Université libre de Bruxelles, Belgium; 2Dept. of Electronic and Electrical Engineering, University of Strathclyde, United Kingdom

ID: 10907
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances
Impact of Converter-based Demand on Frequency Quality in the Ireland and Northern Ireland Power Systems
Taulant KERCI, Connor DUGGAN, Usman FAROOQ, Simon TWEED, Marta VAL ESCUDERO
EirGrid

ID: 10910
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances
Mohammad JAFARIAN1, Marta VAL ESCUDERO1, Niall RUTHERFORD1, Eoin KENNEDY1, Diarmuid GILLESPIE1, Mary HENNESSY1, Narsi VEMPATI1, Roger TREINE2, Fernando MAGNAGO2, Joseph BRIGHT2, Mauro PRAIS2, Roozbeh EMAMI2, Madhusudhana SADAGOPAN2, Wesley VANCE2
1EirGrid; 2Resource Innovations
<table>
<thead>
<tr>
<th>ID: 10911</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Enhancing the Evaluation of Rate of Change of Frequency During Fault Contingencies Simulated in Phasor-Domain Tools</td>
<td></td>
</tr>
<tr>
<td>Mostafa BAKHTVAR¹, Dusko NEDIC², Mohammad JAFARIAN³, Ismail IBRAHIM², Emma FAGAN², Marta VAL ESCUDERO², Eoin KENNEDY²</td>
<td></td>
</tr>
<tr>
<td>¹SSE Thermal; ²EirGrid</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11030</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Energy Storage to enhance Transmission Capacity - a Case Study on the Swedish Transmission Grid</td>
<td></td>
</tr>
<tr>
<td>Arvid BJÖREMARK</td>
<td></td>
</tr>
<tr>
<td>DNV Sweden AB, Sweden</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11060</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Keywords: Power System, Frequency Stability, Frequency Containment Reserve, Demand-Side Device, Lighting Device</td>
<td></td>
</tr>
<tr>
<td>Experimental Evaluation of Lighting Device’s Potential for Securing Frequency Control Reserve Using Demand-Side Devices</td>
<td></td>
</tr>
<tr>
<td>Hayato SATOH, Ayako YASUOKA, Muneki MASUDA</td>
<td></td>
</tr>
<tr>
<td>Central Research Institute of Electric Power Industry, Japan</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11096</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Keywords: Automated framework, control interaction, machine learning, python framework, stability analysis, subsynchronous oscillations</td>
<td></td>
</tr>
<tr>
<td>Automatic Detection of Subsynchronous Oscillations</td>
<td></td>
</tr>
<tr>
<td>Diptargha CHAKRAVORTY¹, Alexandru Christian NEAGU², Jochen I CREMER²</td>
<td></td>
</tr>
<tr>
<td>¹TNEI Services Ltd UK; ²Delft University of Technology Netherlands</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11099</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Keywords: Automated framework, control interaction, eigenvalue, frequency domain analysis, grey box method modal analysis, machine learning, small signal analysis, subsynchronous oscillation</td>
<td></td>
</tr>
<tr>
<td>Framework for Identification of Subsynchronous Oscillation Risks</td>
<td></td>
</tr>
<tr>
<td>Diptargha CHAKRAVORTY¹, Jaime TRIVINO¹, Sami ABDELRAHMAN²</td>
<td></td>
</tr>
<tr>
<td>¹TNEI Services Ltd UK; ²National Grid ESO UK</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11119</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Identifying potential sub-synchronous oscillations using impedance scan approach</td>
<td></td>
</tr>
<tr>
<td>Shahil SHAH¹, Jingwei LU², Nilesh MODI¹</td>
<td></td>
</tr>
<tr>
<td>¹National Renewable Energy Laboratory, USA; ²Australian Energy Market Operator, Australia</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11122</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Large scale grid forming BESS replaces synchronous generation enabling high renewable penetration &amp; low system load in Australia’s major northern grid</td>
<td></td>
</tr>
<tr>
<td>Brendan TRUONG¹, Stanislav CHEREVATSKIY², Stephen SPROUL², Vimeshan PILLAY¹, Heath LANG³</td>
<td></td>
</tr>
<tr>
<td>¹Power and Water, Australia; ²Hitachi Energy, Australia; ³Owners Engineer - Territory Generation, Australia</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11163</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>On the Use of the Congestion Forecast Processes for Early Warning of Possibly Tensed Situations</td>
<td></td>
</tr>
<tr>
<td>Benoit BLETTERIE², Martin LENZ², Mike Alexander LAGLER¹, Herwig RENNER²</td>
<td></td>
</tr>
<tr>
<td>¹Austrian Power Grid; ²Graz University of Technology</td>
<td></td>
</tr>
</tbody>
</table>
Impact of Grid-Forming Solutions on North-Western Victorian Network in Australia

Logan PETERS, Yiju MA
Australian Energy Market Operator, Australia

PMU Applications for Voltage Stability monitoring and Oscillation analysis
Costas VOURNAS1, Panos MANDOLUIDIS1, Orestis DARMIS1, Spiros CHOUNTASIS2, Stavros TSAKIRIS2, George KORRES1
1ECE NTUA, Greece; 2IPTO, Greece

A Novel Methodology for Grid Impact Studies of Photovoltaic Systems
Saddam ALTAMIM, Sawsan ABDELAH, Ahmad ALSAYIS
IDECO

Oscillation Modes Identification Via Singular Value Decomposition and Principal Component Analysis
Carlos FERRANDON1, Abraham ALVAREZ2, Jonathan CERVANTES3, Zia EMIN3
1PSC UK; 2Energinet Denmark; 3EPRI UK

Load Model Evolution for the Colombian Power System
Neby CASTRILLÓN1, Juan GONZÁLEZ1, Estefanía GALLEGO1, Natalia BARROS1, Sebastián LOAIZA2, Juan MESA2, Juan GALINDO2, Juan HOYOS3
1XM; 2University Pascual Bravo; 3Universidad Nacional

EMT Modeling and Analysis of the Chile's Power Grid with High Penetration of Inverter-Based Renewable Energy Sources
Victor VELAR, Rodrigo ESPINOZA, Eugenio QUINTANA, Simon VELOSO
Coordinador Eléctrico Nacional, Chile

Real Time System Strength Monitoring in the Chilean National Electric System
Jorge VARGAS, Rodrigo ESPINOZA, Victor VELAR, Gretchen ZBINDEN
Coordinador Eléctrico Nacional, Chile

STATCOM Modelling Assessment and Performance Analysis in Rajasthan Renewable Complex of India
Ebin Cherian MATHEW⁴, Priyam JAIN, Gaurav DASH, Aman GAUTAM, Rahul SHUKLA, Manas Ranjan CHAND, Vivek PANDEY, Surajit BANERJEE, S.C. SAXENA
Grid Controller of India Limited, India
ID: 11521
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances

Strategies for Mitigation of Oscillations in IBR Penetrated Network in India
Ebin Cherian MATHEW *, Aman GAUTAM
Grid Controller of India Limited, India

ID: 11639
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances

Enabling System-Level EMT Studies of Danish Power Systems
Yicheng LIAO1, Liang LU1, Jun Bum KWON1, Nan QIN1, Dharshana MUTHUMUNI2, Yousef PIPELZADEH2, Karl DIRKS2
1Energinet; 2Power Systems Technology Centre

ID: 11731
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances

SSSC Model Validation Experience for the Colombian Power System
Neby CASTRILLÓN, Jaime PINZÓN, Juan GONZÁLEZ, María ZAPATA, Camilo MORENO

ID: 11732
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances

Comprehensive Analysis of Colombian Power System Oscillations
Juan GONZÁLEZ, Neby CASTRILLÓN, Victor MEZA

ID: 11748
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances
Keywords: Data Center, Generator Pool, Pulse Load, Model Validation, Dynamic Security

Evaluation of the robust operation of a diesel Generator Pool in new proposed Data Center electrical topology considering specific Generator manufacturer
Georgios KARVELIS1, Christos AGATHOKLEOUS1, Vassilis BAKOLAS1, Drazena BROCILO2, John WILTSHIRE2, Salver CORHODZIC2
1PROTASIS SA, Greece; 2META, USA

ID: 11762
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances

Enhancing Dynamic Performance Validation of Transient Stability Models using Argentina’s Phasor Measurement Units
Nicolás DE SAN JUAN, Félix GALLEGO, Trinidad UBICI
CAMMESA

ID: 11871
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS1 - Power System Dynamic Analysis in the Energy Transition: Challenges, Opportunities and Advances
Keywords: Type IV Wind Turbine Generator, Model Validation, EMT Modelling, Offshore Wind, Machine Learning

EMT-Based Machine Learning Model for Fault Ride-Through Assessment in Type IV Offshore Wind Turbine Generators
Gabriel Miguel Gomes GUERREIRO1, Ranjan SHARMA1, Frank MARTIN1, Guangya YANG2
1SGRE; 2Technical University of Denmark (DTU)
ID: 10293
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances
Keywords: EMT simulation, harmonic studies, sensitivity analysis, wind parks

Sensitivity Analysis Methods for Onshore Harmonic Studies
Benoît DE FOUCAUD, Xavier-Marie VIEL
RTE, France

ID: 10452
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances
Keywords: Load Composition Modelling, Frequency-Dependent Impedance, Distribution Network, Modelling Process, Motor Load

Influence of Composition-Dependent Load Modelling on System-Wide Harmonic Impedance Characteristics
Peter BONINO, Samantha DEENEY, David ROOP
Mitsubishi Electric Power Products, Inc., United States of America

ID: 10455
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances
Keywords: Geomagnetic Disturbance, Geoelectric Field Grid Map, Nearest Neighbor Search, Geomagnetically-Induced Current, Transmission Line Branch Induced Voltage

Real Time Geomagnetic Disturbance Analysis of Bulk Power System Grid using Geoelectric Field Grid Maps
Krishnat PATIL¹, Christopher BALCH²
¹Siemens Power Technologies International, United States of America; ²CIRES & NOAA Space Weather Prediction Center, United States of America

ID: 10462
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances
Keywords: Inverter Based Resources, Power Quality, Harmonic Model, Harmonic Summation, Harmonic Aggregation

Estimation of Harmonic Exponent Summation Factors for Type 3 DFIG Wind Turbines
Amir KAZEMI, Jagdeep KAUR
GE Consulting Services, United States of America

ID: 10464
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances
Keywords: Emission, Supraharmonics, Summation, Aggregation

Harmonic and Supraharmonic emission and Aggregation Characteristics of some end use loads sold in the US
Gaurav SINGH, Jason JOHNS
Electric Power Research Institute (EPRI), United States of America

ID: 10509
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances
Keywords: Power quality, voltage unbalance, negative phase sequence, overhead lines

Voltage unbalance in overhead lines with EHV and HV circuits combined in the same tower
Jeroen VAN WAES¹, Frederik GROEMAN², Tam MAI³, Kees KOREMAN²
¹TenneT TSO / Eindhoven University; ²DNV; ³TenneT TSO
<table>
<thead>
<tr>
<th>ID: 10595</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Advancing Power Quality Measurements in the Swedish Transmission Grid</td>
<td></td>
</tr>
<tr>
<td>Oscar LENNERHAG</td>
<td></td>
</tr>
<tr>
<td>Independent Insulation Group Sweden AB, Sweden</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10598</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Keywords: Power Quality, Voltage Dips, Energy Transition</td>
<td></td>
</tr>
<tr>
<td>Post-Energy Transition Voltage Dips Assessment: A Dutch Transmission Network Case Study</td>
<td></td>
</tr>
<tr>
<td>Roozbeh TORKZADEH¹, Jeroen VAN WAES², Sjef COBBEN¹</td>
<td></td>
</tr>
<tr>
<td>¹Eindhoven University of Technology; ²TenneT TSO BV and Eindhoven University of Technology</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10678</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Keywords: Geomagnetically induced currents, Power quality, Reactive power Q-loss, Voltage stability</td>
<td></td>
</tr>
<tr>
<td>Towards A Novel Approach To Voltage Magnitude, Harmonics, And Voltage Stability In The Presence Of GICs</td>
<td></td>
</tr>
<tr>
<td>Trevor GAUNT¹, Pitambar JANKEE¹, Hilary CHISEPO², Michel MALENGRET³</td>
<td></td>
</tr>
<tr>
<td>¹University of Cape Town; ²ESP Consulting; ³MLT Drives, South Africa</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10794</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>A Methodology to Define Radiated High Frequency Emission of In-Situ Measurements in Harsh Environments</td>
<td></td>
</tr>
<tr>
<td>Emil ERIKSSON</td>
<td></td>
</tr>
<tr>
<td>Hitachi Energy Sweden AB, Sweden</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10898</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Voltage Harmonics Trends based on Field Measurements on the Irish Transmission Network</td>
<td></td>
</tr>
<tr>
<td>Daphne SCHWANZ¹, Aisling CARROLL², Chandrasekaran SUBRAMANIAN¹, Oisin GOULDING¹, Alan ROGERS¹</td>
<td></td>
</tr>
<tr>
<td>¹EirGrid; ²University College Dublin</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10947</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Keywords: Power quality – Harmonic - Harmonic Emission - Background Harmonic - Harmonic Responsibility - Superposition Method - Wind Farm - Wind Turbine - Harmonic Study</td>
<td></td>
</tr>
<tr>
<td>Reduction of the Influence of the Background Harmonic Voltage on the Assessment of Harmonic Current at WT Terminals by the Application of the Superposition Method</td>
<td></td>
</tr>
<tr>
<td>Miguel P. DE CARLI, Leonardo O. GRANDER</td>
<td></td>
</tr>
<tr>
<td>Brazilian NC of CIGRE, Brazil; Eletrobras CGT ELETROSUL</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11070</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Keywords: power system, electromagnetic compatibility, investigation method, power plants and substations, monitoring system</td>
<td></td>
</tr>
<tr>
<td>Electromagnetic Compatibility in Auxiliary DC Power Supply System</td>
<td></td>
</tr>
<tr>
<td>Ruslan BORISOV¹, Andrey GOLDUN², Maxim SMIRNOV²</td>
<td></td>
</tr>
<tr>
<td>¹National Research University «MPEI», Russian Federation; ²RPC ELNAP Ltd., Russian Federation</td>
<td></td>
</tr>
<tr>
<td>ID: 11238</td>
<td>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Harmonic Assessment in Renewable Energy Zones</td>
<td></td>
</tr>
<tr>
<td>Yilun SUN, Jiacheng LI, Nalin PAHALAWATTA, Salim ANWARI, Sarath PERERA</td>
<td></td>
</tr>
<tr>
<td>HATCH, Australia</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11440</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Keywords: HVDC, GIS, VFTO, EMC, IEC Standards</td>
<td></td>
</tr>
<tr>
<td>EMC Issues within HVDC System under GIS Environment</td>
<td></td>
</tr>
<tr>
<td>Keesang SONG¹, Insoo PARK¹, Gearoid OHEIDHIN², Olivier CLEMENCON³, Chanhyuk YIM³</td>
<td></td>
</tr>
<tr>
<td>¹KAPES, Republic of Korea; ²GE Grid Solutions, United Kingdom; ³KEPCO, Republic of Korea</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11649</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Exploratory Analyses of Power System Harmonic Measurements Using Principal Component Analysis</td>
<td></td>
</tr>
<tr>
<td>Bjørn S. BUHK¹, Vladislav AKHMATOV¹, Chris L. SKOVGAARD¹, Filipe F. DA SILVA¹, Claus LETH BAK²</td>
<td></td>
</tr>
<tr>
<td>¹Energinet; ²Aalborg University</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11651</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Flexible network model to study the impact of future changes in transmission systems on harmonic levels and impedance</td>
<td></td>
</tr>
<tr>
<td>Ana M BLANC¹, Max DOMAGK¹, Jan MEYER¹, Marco LINDNER²</td>
<td></td>
</tr>
<tr>
<td>¹Dresden University of Technology, Germany; ²TransnetBW GmbH, Germany</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11760</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Multi-Platform Analysis for Harmonic Emission Assessment of M-SSSC FACTS Devices in the Santa Marta Substation (Colombia)</td>
<td></td>
</tr>
<tr>
<td>Juan BOTERO¹, Carlos BORDA¹, Jhon CALDERON²</td>
<td></td>
</tr>
<tr>
<td>¹Smart Wires Inc; ²ISA Interconexión Eléctrica</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11876</th>
<th>C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C4 PS2 - Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis in the Energy Transition: Challenges, Opportunities and Advances</td>
<td></td>
</tr>
<tr>
<td>Keywords: Power Quality, Background Harmonics, Amplification Factor, Planning Level, Data Analysis</td>
<td></td>
</tr>
<tr>
<td>Background harmonics: Quantifying network assumptions and impacts</td>
<td></td>
</tr>
<tr>
<td>YILin {Inez} ZHENG</td>
<td></td>
</tr>
<tr>
<td>Goldwind</td>
<td></td>
</tr>
</tbody>
</table>
ID: 10278
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS3 - Insulation Co-Ordination and Lightning Interference Analysis: Challenges, Opportunities and Advances
Keywords: ATP; Grounding Grid, Lightning stroke, Soil Resistivity, Transmission Line Approach (TL), Frequency content, Uniform Soil
Effect of frequency content on the effective area of grounding grid at uniform soil resistivity
Adel Z. EL DEIN1, Sara YASSIN OMAR2
1 Aswan University, Thebes Technological University; 2 Upper Egypt Electricity Distribution Company

ID: 10294
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS3 - Insulation Co-Ordination and Lightning Interference Analysis: Challenges, Opportunities and Advances
Keywords: Overvoltage withstand, transformers, TOV, insulation coordination
Transformer withstand capability to temporary overvoltages: a general determination method from standard input data
Manuel MARTINEZ-DURO
EDF, France

ID: 10326
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS3 - Insulation Co-Ordination and Lightning Interference Analysis: Challenges, Opportunities and Advances
Keywords: Incipient Fault Detection, Online Condition Assessment, Condition Based Maintenance, Waveform Analytics
Utilizing Substation-based Monitoring to Improve Condition Assessment of Distribution Networks
Jeffrey WISCHKAEMPER, B. Don RUSSELL, Carl BENNER, Karthick MANIVANNAN
Texas A&M University, United States of America

ID: 10382
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS3 - Insulation Co-Ordination and Lightning Interference Analysis: Challenges, Opportunities and Advances
Long Tail Withstand Voltage Test (TOV) on the HVDC Cable and Accessories of the Italy-France Interconnection: a comparison between laboratory and infield results
Grazia BERARDI
PRYSMIAN GROUP, Italy

ID: 10385
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS3 - Insulation Co-Ordination and Lightning Interference Analysis: Challenges, Opportunities and Advances
Contamination Map and Design Optimization for Increased Transmission Reliability and Resilience: The Italian Experience
Massimo MARZINOTTO1, Alessandra BALZARINI2, Piero BERARDI1, Michele DE NIGRIS3, Paolo OMODEO GIANOLO2, Alberto PIGNI3, Giovanni PIROVANO2, Guido PIROVANO2, Pierluigi PORTOGHESE1, Roberto SPEZIE1, Anna Maria TOPPETTI2
1 Terna, Italy; 2 RSE – Italy; 3 Consultant - Italy

ID: 10531
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS3 - Insulation Co-Ordination and Lightning Interference Analysis: Challenges, Opportunities and Advances
Keywords: Protection, System Interaction, Transients, Transformer Modeling
Enhancing Power Transformer Reliability: High-Frequency Modeling, Transient Interactions, and Overvoltage Protection Scheme
F. NASIRPOUR1, B. BEHDANI1, A. HEIDARY1, M. GHAFFARIAN NIASAR1, F. GHASSEMI1, K. VELITSIKAKIS2, M. VAN RIET4, M. WILKINSON5, M. VAN DER MEIJDEN1, S. NAUTA6, I. TANNEMAAT7, J. VEENS7, M. POPOV8
1 Delft University of Technology, Faculty of EEMCS; 2 National Grid Electricity Transmission plc; 3 TenneT TSO B.V.; 4 Alliander N.V.; 5 Royal SMIT Transformers B.V.
ID: 10550
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS3 - Insulation Co-Ordination and Lightning Interference Analysis: Challenges, Opportunities and Advances
Keywords: non-standard waveform, re-ignition, temporary overvoltage, TOV, harmonic resonances, vacuum circuit breaker

Service Experience in the Dutch Transmission Grid with Non-standard Overvoltage Waveforms & their Impact on the Component Insulation
K. VELITSIKAKIS, I. TANNEMAAT
TenneT TSO B.V.

ID: 10575
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS3 - Insulation Co-Ordination and Lightning Interference Analysis: Challenges, Opportunities and Advances
Keywords: Earthing impedance, high frequency, lightning strike, measurement, simulation

A methodology of measuring, modelling and simulating of high frequency earthing impedance
Aman LAMBA, Jiayang WU, Ebbo DE MEULEMEESTER, Onno NOBEL, Leo LAGENDIJK
DNV

ID: 10751
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS3 - Insulation Co-Ordination and Lightning Interference Analysis: Challenges, Opportunities and Advances
Keywords: Harmonic, EHV Cable, Inrush Current, Overvoltage

Overvoltages with high harmonics when connecting step-up transformers in a pumped-storage power plant: A case study
Marcel STOECKLI1, Florian BRANTSCHEN1, Romain BIRBAUM1, Cecile JOST2, Yves PANNATIER3, Georg KOEPPL4
1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2Alpiq SA, Switzerland; 3Swissgrid AG, Switzerland; 4HYDRO Exploitation SA, Switzerland; 5self employed, Switzerland

ID: 10881
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS3 - Insulation Co-Ordination and Lightning Interference Analysis: Challenges, Opportunities and Advances

Simplified Methods and Models for Calculation of Switching Overvoltages on Transmission Lines including Effects of corona Discharges
Jan LUNDQUIST
Independent Insulation Group Sweden AB, Sweden

ID: 10949
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS3 - Insulation Co-Ordination and Lightning Interference Analysis: Challenges, Opportunities and Advances
Keywords: Gas insulated substations - Clean Air insulation – Sulfur Hexafluoride insulation – Very Fast Transient Overvoltage – Conducting Pipe Modelling - Transformer Modeling

Very Fast Transient Overvoltage Analysis in Clean Air and SF6 Gas Insulated Substation Modules Using the Extended Transmission Line Theory
Edgar RIBEIRO1, Angélica ROCHA1, Alberto DE CONTI2
1Brazilian NC of CIGRE, Brazil; NSA Consultoria e Informática LTDA; 2ATG Engenharia LTDA; 3Universidade Federal de Minas Gerais

ID: 10953
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS3 - Insulation Co-Ordination and Lightning Interference Analysis: Challenges, Opportunities and Advances
Keywords: Climate change, Lightning, Transmission Line

Climate Characterization and Historical Changes in Density and Intensity of Lightning around the 500 kV Bacabeira-Parnaíba Transmission Line
Rafael SILVA ALÍPIO1, Ana Clara MARQUES1, Pedro REGOTO1, Luciano RITTER1, Euro PINTO DE ALMEIDA1, William MEJIA2, Fernando DINIZ1, Thiago Luiz FERREIRA1, Fabian ROJAS3, Oscar GONZALEZ4
1Brazilian NC of CIGRE, Brazil; Cefet-MG University; 2Argo Energia; 3Climatempo; 4Consultant; 5Enlaza GEB

ID: 10955
C4 POWER SYSTEM TECHNICAL PERFORMANCE - Full Papers
Topics: C4 PS3 - Insulation Co-Ordination and Lightning Interference Analysis: Challenges, Opportunities and Advances
Keywords: Transient Overvoltage, Isolated Ground Systems, Mitigation, Voltage Scaling, Intermittent Earth-Fault

Voltage Scaling Phenomenon in Isolated Ground Systems – Approach and Proposal for Mitigation Analysis of a Real Case in Brazil
Rafael DE OLIVEIRA FERNANDES1, Caio ELEUTÉRIO2
1Brazilian NC of CIGRE, Brazil; UNICAMP University; 2ARGO Energia
Recent progress in three-dimensional FDTD-based electromagnetic transient analysis of electric power facilities
Akiyoshi TATEMATSU1, Yoshihiro BABA2, Toshiaki UEDA3, Toshihiro TSUBOI4, Soichi MORIGUCHI5
1Central Res. Inst. of Electric Power Industry, Japan; 2Doshisha University, Japan; 3Daido University, Japan; 4Tokyo Electric Power Company, Japan; 5Chubu Electric Power Grid Co, Inc., Japan

Effect of cable sheaths on grounding performance of wind power plants in high frequency region
Melih GÜNERI1, Bora ALBOYACI2
1Kratis Engineering Türkiye; 2Kocaeli University Türkiye

William Gonzalez FLORES RUIZ1, Jaimis S. LEON COLOQUI2, Jose PISSOLATO FILHO2
1National University of Engineering, Peru; 2State University of Campinas, Brazil

Transient switching mitigation in 115kV offshore platforms sensitive loads by introducing controlled switching device in three-phase gang-operated breakers
Nabil FARES1, Thaiban RAJAB1, Vincent BALVET2, Abdulaziz HANNANI1
1Saudi Aramco, KSA; 2Vizimax, Canada

Modelling of Flashover on Insulator Strings of Overhead Lines Due to Lightning Overvoltages
Bozidar FILIPOVIC-GRCIC1, Nina STIPETIC1, Franjo VUKOVIC1, Dalibor FILIPOVIC-GRCIC2
1University of Zagreb Faculty of Electrical Engineering and Computing, Zagreb, Croatia; 2Končar – Electrical Engineering Institute Ltd., Croatia
C5 - ELECTRICITY MARKETS AND REGULATION
PS1 - CHARACTERISTICS OF A RESILIENT MARKET AND ITS REGULATORY REGIME

ID: 10506
C5 ELECTRICITY MARKETS AND REGULATION - Full Papers
Topics: C5 PS1 - Characteristics of a Resilient Market and its Regulatory Regime
Keywords: Electricity Market, External Shock, Governance, Resilience, Technology Integration, Innovation

Future Electricity Market Design to Ensure Resilient and Efficient Operations
Jan VAN PUTTEN1, Greg THORPE2, John GING3, Vivek PANDEY4, Amjad ANVARI-MOGHADDAM5, Danny KLAAR5, Gourav MUKHERJEE6, Juan BOGAS7
1 TenneT TSO B.V.; 2 Oakley Greenwood; 3 Eirgrid; 4 Posoco; 5 OMIE; 6 Aalborg university

ID: 11236
C5 ELECTRICITY MARKETS AND REGULATION - Full Papers
Topics: C5 PS1 - Characteristics of a Resilient Market and its Regulatory Regime

Analysis of the Temporary Price Cap as a Guardrail Measure in the Singapore Wholesale Electricity Market
Zhenhui LI, Vincent WISE, Mary FU
Energy Market Company, Singapore

ID: 11253
C5 ELECTRICITY MARKETS AND REGULATION - Full Papers
Topics: C5 PS1 - Characteristics of a Resilient Market and its Regulatory Regime
Keywords: Fuel Cooperation scheme, Co-optimization Market, Renewable Energy Sources

Challenges and future prospects for Japanese wholesale electricity market and balancing market
Hiroki SAKAI1, Kenichi SUGAHARA2, Yuki KATAOKA1, Akihiro MAEKAWA3, Ken FURUSAWA4
1 Chubu electric Power Grid Co., Inc., Japan; 2 Chubu electric Power Co., Inc., Japan; 3 Kansai Transmission and Distribution, Inc., Japan; 4 Central Research Institute of Electric Power Industry, Japan

ID: 11371
C5 ELECTRICITY MARKETS AND REGULATION - Full Papers
Topics: C5 PS1 - Characteristics of a Resilient Market and its Regulatory Regime

Benchmarking Indian Load Despatch Centres for Excellence and Good Governance: The Experience of LDC Excellence Award in India
S K SOONEE1, V K AGRAWAL2, Prof. Anjan BOSE3, S R NARASIMHAN4, S S BARPANDA4, R K PORWAL5, S C SAXENA6, M K AGRAWAL7, Vivek PANDEY8, S K VERMA9, Bindiya JAIN4, G M Sharat CHANDRA4, Sourav SAHAY10
1 Ex-CEO, Grid-India, India; 2 South Asia Regional Energy Partnership, India; 3 Washington State University, USA; 4 Grid Controller of India Limited, India

ID: 11373
C5 ELECTRICITY MARKETS AND REGULATION - Full Papers
Topics: C5 PS1 - Characteristics of a Resilient Market and its Regulatory Regime

Accounting and Settlement of Secondary Reserve Ancillary Services in Indian Power System
Harish Dora MONGAM*, Phanisankar CHILUKURI
Grid-India, India
Can Demand Side Management in the Sectors of Industry and Services Increase Market Resilience?

Stephan KIGLE¹, Nadja HELMER², Quirin STROBEL¹, Peter WIRTZ³, Christiane GOLLING⁴
¹FfE Munich & TUM, Germany; ²FfE Munich, Germany; ³RWTH Aachen University, Germany; ⁴50Hertz Transmission GmbH, Germany

Moral Hazard Assessment of Loss Reduction Plans in Colombia

Carolina GOMEZ, Hector GOMEZ
XM

Comparing the Co-Optimized and Market-Based Allocation of Cross-Zonal Capacity for the Exchange of Balancing Capacity

Claire LAMBRIEX, Marlon THIES
RWTH Aachen University

Conjectural-Variations Equilibria in Electricity-Carbon Coupling Markets: An All-Scenario-Feasible MIP Formulation

Yanzhe REN¹, Yue ZHOU², Gengfeng LI¹, Zhaohong BIE¹
¹Xi’an Jiaotong University, China; ²Cardiff University

Study on the effects of the flow-based approach in the Italian bidding zones capacity calculation

Luca LUZI¹, Mario LIMONE¹, Alessio MARCHESIN¹, Federico DEL PEDRO², Ulderico BAGALINI², Stefano QUAIA³, Federico QUAGLIA¹
¹TERNA, Italy; ²CESI GROUP; ³University of Trieste, Italy

Structuring the Coordination Across Transmission and Distribution to Support Value Stacking Scenarios Combining Multiple DER-Provided Grid Services

Tanguy HUBERT
Electric Power Research Institute (EPRI), United States of America

Dynamic Procurement of Reserves in New York Electricity Markets

Pradip KUMAR¹, Matt MUSTO¹, Nate GILBRAITH¹, Rana MUKERJI¹, Michael DESOCIO²
¹New York Independent System Operator (NYISO), United States of America; ²Luminary Energy, United States of America
Optimizing Combined-Cycle Generators in PJM's Wholesale Electricity Markets Using a Hybrid Multiple Configuration Resource Model for Enhanced Flexibility

Anthony GIACOMONI, Danial NAZEMI

PJM Interconnection, United States of America

Finding Flexibility in Large Flexible Loads: Making Demand Equivalent to Generation in Wholesale Markets

Debra LEW1, Richard O'NEILL2, Erik ELA3, Mark AHLSTROM4

1Energy Systems Integration Group (ESIG), United States of America; 2Consultant, United States of America; 3Electric Power Research Institute (EPRI), United States of America; 4NextEra Energy Resources, United States of America

Novel Settlement Mechanism for Encouraging Flexibility in the Balancing Markets

Mazaher HAJI BASHI, Brendan O'SULLIVAN

EirGrid

The Idea of Fed-Balancing Energy Market, a Smart Use of Balancing Capacity Auction Results

Mazaher HAJI BASHI, Niamh DELANEY

EirGrid

Transforming the power system for future generations - the role of dynamic capacity markets and de-rating factors

Aodhagan DOWNEY

EirGrid

Analysis on the integration of new technology in the Brazilian electricity market – Offshore wind case

Solange DAVID1, Vinicius DAVID2

1Brazilian NC of CIGRE, Brazil; Consultant; 2Thymos Energia

Connection products in electricity networks

Eivind GRAMME1, Selina KERSCHER2

1Lede Norway; 2University of oviedo Spain

Implementation of Virtual Power Purchase Agreements to Support Carbon Neutral Investments in the Russian Electricity Market

Vladislav BEREZOVSKY1, Anna PAVLYCHEVA2, Sergey GAFAROV3, Andrey SVIRIDOV4, Victor BALYBERDIN4

1Carbon Zero LLC, Russian Federation; 2University of Chicago, USA; 3Association «NP Market Council», Russian Federation; 4SKM Market Predictor AS, Norway
Impact of Carbon Pricing on Wholesale Electricity Prices and Energy Transition Scenarios in Russia

Vladislav BEREZOVSKY¹, Nikita IVANOV², Tatiana REMIZOVA³, Ljubov CHERNEY⁴, Dmitry KOSHELEV⁵

Connection agreements subject to limitations for renewable generation and storage facilities in Greece

Apostolos PAPAKONSTANTINOU, Evangelos CHATZISTYLIANOS, Georgios PSARROS, Stavros PAPATHANASSIOU
National Technical University of Athens (NTUA), Greece

Connection agreements subject to limitations for renewable generation and storage facilities in Greece

Apostolos PAPAKONSTANTINOU, Evangelos CHATZISTYLIANOS, Georgios PSARROS, Stavros PAPATHANASSIOU
National Technical University of Athens (NTUA), Greece

Mechanisms for Trading the Electrical Value of the Demand Side to Promote the Usage of Distributed Energy Resources

Takeshi YAMASHITA¹, Hideki KIBATA¹, Tokunari ANAI¹, Hiroshi OKAMOTO²
¹Tokyo Electric Power Company Holdings. Inc., Japan; ²TEPCO Power Grid. Inc., Japan

Electricity Market in India- Present and Future

C. Rethi NAIR*, DVS PHANEENDRA, N AHMAD, S MUKHERJEE, T. SRINIVAS, S P KUMAR
Grid Controller of India Ltd, India

Introduction of the Operational Core Day-Ahead Flow-Based Capacity Calculation and Market Coupling through Active Constraints and Price Spread

Ferenc NAGY, Melinda NAGY, Luca TÓTH, Ágnes TAKÁCSNÉ ESZE, Ákos ARNOLD
MAVIR Ltd.

Key Initiatives, Regulatory Framework & Challenges to attain the ambitious target of 500 GW non-fossil fuel energy by 2030 in India

Priyanshi AGGARWAL*, Prashant GARG, Sheikh SHADRUDDIN, Rajiv PORWAL
Grid-India, India

State Tariff Design using Regulatory Sandbox Approach for Enhancing Renewable Energy Demand

Reji Kumar PILLAI*, Reena SURI, Anand Kumar SINGH
ISGF, India
130

**Initiatives to develop dedicated market segments for Green Energy in India**
Sonali MANGAL*, S. C. SAXEMA, Subhendu MUKHERJEE, Manisha SUBHLAXMI, Datta GADEKAR, Rohit HISARIYA
Grid-India, India

**Market Design And Regulatory Enablers For The Evolving Indian Electricity Market**
Dr. Rajib K MISHRA*, Rajesh CHERAYIL
PTC India Limited, India

**Coal phase out in Chile: lessons from an ongoing process**
Javier BUSTOS-SALVAGNO
CIISGER - Universidad del Desarrollo, Chile

**Advance Procurement of Reserves in Indian Electricity Market –Policy and Regulatory Intervention and Implementation Experience**
Neeraj KUMAR, Rohit HISARIYA, Anupam KUMAR, Amish Kumar SINHA, S C SAXENA
National Load Despatch Centre, Grid Controller of India Ltd., India

**Implementation of Market Based Tertiary Reserve Ancillary Services in the Indian Power System**
Phanisankar CHILUKURI*, Saif REHMAN, Subhendu MUKHERJEE
Grid-India, India

**Benchmarking Of Grid Connection Permit Process For RES Installations In Energy Community Contracting Parties – Key Findings And Recommendations**
Minea SKOK, Hrvoje DOROTIC, Tomislav BARICEVIC
Energy Institute Hrvoje Pozar, Croatia

Juan VILLARREAL, Juan CUARTAS, José MONTOYA, Juan GAVIRIA, Natalia BASTIDAS
XM

**Probabilistic Analysis of Market Exposure in the Event of the El Niño Phenomenon**
Juan CUARTAS, Juan VILLARREAL, Cristian OSPINA
XM
**PS3 - EMERGING MARKETS AND FORMS OF MARKETS**

**ID: 10470**
C5 ELECTRICITY MARKETS AND REGULATION - Full Papers
Topics: C5 PS3 - Emerging Markets and Forms of Markets
Keywords: Bidding, Energy Market, Optimization, Battery Energy Storage Systems, Price Uncertainties

**Automated Market Bidding for Battery Energy Storage Systems**
Faeeza HAFIZ1, Iiro HARJUNKOSKI2, Mohamed EISSA3, Elisabetta VALLARINO3, Silvia PICERNO3
1Hitachi Energy Research, United States of America; 2Hitachi Energy Research, Germany; 3Hitachi Energy, Italy

**ID: 10471**
C5 ELECTRICITY MARKETS AND REGULATION - Full Papers
Topics: C5 PS3 - Emerging Markets and Forms of Markets
Keywords: Distributed Energy Resources (DERs), Wholesale Electricity Markets, Grid Services, Metering Telemetry, Measurement & Verification (M&V)

**New Market Rules to Meter Behind-the-Meter DERs Participating in Wholesale Electricity Markets: Overcoming Technical Limitations and Economic Barriers**
Tanguy HUBERT
Electric Power Research Institute (EPRI), United States of America

**ID: 10566**
C5 ELECTRICITY MARKETS AND REGULATION - Full Papers
Topics: C5 PS3 - Emerging Markets and Forms of Markets
Keywords: Energy Trading, Energy Price Forecasting, Ancillary Service Price Forecast, Probabilistic Forecast, Quantile Forecast

**Evaluating the Quality of Probabilistic Forecast for Energy and Ancillary Service Trading**
Xiaoming FENG1, Nandinee HAQ2
1Hitachi Energy, United States of America; 2Hitachi Energy, Canada
| ID: 10834 |
| C5 ELECTRICITY MARKETS AND REGULATION - Full Papers |
| Topics: C5 PS3 - Emerging Markets and Forms of Markets |
| Keywords: peak load hours, demand response, forecasting, machine learning |
| **Enhancing Power Consumption Efficiency: a Comprehensive Analysis of Demand Response and Tariff-Based Mechanisms** |
| Vyacheslav VORONIN¹, Fedor NEPSHA², Mikhail KRASILNIKOV², Kirill PEREVALOV² |
| ¹T.F. Gorbachev Kuzbass State Technical University, Russian Federation; ²RTSoft Smart Grid, LLC, Russian Federation |

| ID: 10839 |
| C5 ELECTRICITY MARKETS AND REGULATION - Full Papers |
| Topics: C5 PS3 - Emerging Markets and Forms of Markets |
| Keywords: socially vulnerable customers, total cost of delivering electricity solar power plants, prosumer facility, public supplier, financing model |
| **Financing model for the construction of solar power plants on prosumer facilities provided by Public Supplier** |
| Senad AGANOVIC¹, Elvisa BECIROVIC², Dzemal HADZIOMANOVIC², Edina AGANOVIC³ |
| ¹FERK, Mostar, Bosnia and Herzegovina; ²Elektroprivreda BiH, Sarajevo, Bosnia and Herzegovina; ³Elektroprivreda HZ HB, Mostar, Bosnia and Herzegovina |

| ID: 10959 |
| C5 ELECTRICITY MARKETS AND REGULATION - Full Papers |
| Topics: C5 PS3 - Emerging Markets and Forms of Markets |
| Keywords: Hydrogen – Certification – Renewable Energy – Decarbonization |
| **Certification of the electricity used to produce hydrogen** |
| Ricardo GEDRA¹, Vanessa GRUNWALD¹, Anant VENKATESWARAN² |
| ¹Brazilian NC of CIGRE, Brazil; CCEE; ²Hitachi Energy |

| ID: 11071 |
| C5 ELECTRICITY MARKETS AND REGULATION - Full Papers |
| Topics: C5 PS3 - Emerging Markets and Forms of Markets |
| **Facilitating Efficiency of LMP-based Electricity Markets Through Distributed Demand Response** |
| Marina DOLMATOVA¹, Alexey SELEZNEV² |
| ¹Association NP Market Council, Russian Federation; ²SKM Market Predictor AS, Norway |

| ID: 11348 |
| C5 ELECTRICITY MARKETS AND REGULATION - Full Papers |
| Topics: C5 PS3 - Emerging Markets and Forms of Markets |
| **Enabling Behind the Meter DER Participation to Provide Bulk and Distribution Grid Services** |
| Aditie GARG*, Ahmed SAAD² |
| ¹Progressive Grid Solutions Pvt Ltd, India; ²Electric Power Research Institute (EPRI), USA |

| ID: 11588 |
| C5 ELECTRICITY MARKETS AND REGULATION - Full Papers |
| Topics: C5 PS3 - Emerging Markets and Forms of Markets |
| **Energy Scheduling & Imbalance Settlement between GCC Interconnection System and an External System** |
| Mohamed ALHAMAD¹, Ehsan SHARIEF² |
| ¹GCC Interconnection Authority, KSA; ²GCC Interconnection Authority, KSA |

| ID: 11722 |
| C5 ELECTRICITY MARKETS AND REGULATION - Full Papers |
| Topics: C5 PS3 - Emerging Markets and Forms of Markets |
| Keywords: Intraday auctions, Cross-zonal capacity, Market Coupling, Croatian electricity market |
| **The Implementation of Intraday Auctions And Its Impact on The Electricity Market From Local And Regional Perspective** |
| Martina VAJDIĆ, Ana RAGUŽ, Luka ŠEŠO, Marko KELAVA |
| Croatian Power Exchange Ltd. Croatia |

<p>| ID: 11768 |
| C5 ELECTRICITY MARKETS AND REGULATION - Full Papers |
| Topics: C5 PS3 - Emerging Markets and Forms of Markets |
| <strong>Experiences of DER Integration in the Colombian Energy Market</strong> |
| Andres RUIZ, Lina ACEVEDO |
| XM |</p>
<table>
<thead>
<tr>
<th>ID: 11769</th>
<th>C5 ELECTRICITY MARKETS AND REGULATION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C5 PS3 - Emerging Markets and Forms of Markets</td>
<td></td>
</tr>
<tr>
<td><strong>Use of Blockchain Technology for the Issuance and administration of Bank Guarantees in the Colombian Energy Market</strong></td>
<td></td>
</tr>
<tr>
<td>Julián CARDONA, Juan GOMEZ, Juan URIBE, Martha GIL</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11798</th>
<th>C5 ELECTRICITY MARKETS AND REGULATION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C5 PS3 - Emerging Markets and Forms of Markets</td>
<td></td>
</tr>
<tr>
<td><strong>Designing balancing Products for the Georgian Power Grid under the liberalized Market Model</strong></td>
<td></td>
</tr>
<tr>
<td>Mikheil ODISHARIA, Levan AITSURADZE</td>
<td></td>
</tr>
<tr>
<td>Georgian State Electrosystem</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11799</th>
<th>C5 ELECTRICITY MARKETS AND REGULATION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C5 PS3 - Emerging Markets and Forms of Markets</td>
<td></td>
</tr>
<tr>
<td><strong>Modernization of Metering System in the Georgian Electricity Market</strong></td>
<td></td>
</tr>
<tr>
<td>Giorgi KHORBALADZE, Zviad GACHECHILADZE, Gocha KOKHREIDZE, Irakli CHOMAKHIDZE</td>
<td></td>
</tr>
<tr>
<td>Georgian State Electrosystem</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11822</th>
<th>C5 ELECTRICITY MARKETS AND REGULATION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C5 PS3 - Emerging Markets and Forms of Markets</td>
<td></td>
</tr>
<tr>
<td><strong>ASEAN Cross-Border Electricity Trading Lessons From the LTM-PIP and LTMS-PIP: The Proposed GMS Regional Renewable Energy Market</strong></td>
<td></td>
</tr>
<tr>
<td>Suppapit WONGPATTANASIRI, Thamolwan KUNASIRIN, Worrapong WONGLIMAMORNLENT</td>
<td></td>
</tr>
<tr>
<td>Electricity Generating Authority of Thailand (EGAT), Thailand</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11833</th>
<th>C5 ELECTRICITY MARKETS AND REGULATION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C5 PS3 - Emerging Markets and Forms of Markets</td>
<td></td>
</tr>
<tr>
<td><strong>Challenges and Opportunities for Ancillary Services on the Energy Transition in Colombia</strong></td>
<td></td>
</tr>
<tr>
<td>Diana PEREZ</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11862</th>
<th>C5 ELECTRICITY MARKETS AND REGULATION - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C5 PS3 - Emerging Markets and Forms of Markets</td>
<td></td>
</tr>
<tr>
<td><strong>Metering Aggregation: An Approach to Enhance Market Design – A Case Study</strong></td>
<td></td>
</tr>
<tr>
<td>Jovanio Silva dos SANTOS</td>
<td></td>
</tr>
<tr>
<td>Thymos Energia</td>
<td></td>
</tr>
</tbody>
</table>

### C6 - ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES

#### PS1 - FLEXIBILITY MANAGEMENT IN DISTRIBUTION NETWORKS

<table>
<thead>
<tr>
<th>ID: 10244</th>
<th>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C6 PS1 - Flexibility Management in Distribution Networks</td>
<td></td>
</tr>
<tr>
<td><strong>Application of a 50MW/100MWh energy storage system with grid-forming converters</strong></td>
<td></td>
</tr>
<tr>
<td>Dajun MA, Xing ZHANG, Nannan WANG, Yu LU, Xu LI, Yong DING</td>
<td></td>
</tr>
<tr>
<td>NR Electric Co. Ltd., China</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10247</th>
<th>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topics:</strong> C6 PS1 - Flexibility Management in Distribution Networks</td>
<td></td>
</tr>
<tr>
<td><strong>Quantitative Analysis of Supply and Demand Flexibility Region at pre-disaster Stage of Active Distribution Systems</strong></td>
<td></td>
</tr>
<tr>
<td>Wenhu TANG, Yueqing SHEN, Tong QIAN, Xuehua XIE - South China University of Technology, China</td>
<td></td>
</tr>
</tbody>
</table>
Integrating Renewable Energy and Battery Stationary Storage for Electric Ferry Recharge: A Green Port study on Italian Lake Maggiore
Giuseppe MAURI
RSE, Italy

Flexibility local market models for enhanced distribution planning
Fabrizio PILO
università di Cagliari, Italy

Quantifying maximum limits for reactive power flexibility provision in energy communities: a case study of a real distribution power network
Tohid HARIGHI
università di Bologna, Italy

Electric Vehicle integration on the LV grid for ancillary services provision: an experimental case study leveraging 2nd generation smart meters in Italy
Piersilvio MARCOLIN
RSE, Italy

Local Network Management and Distributed Generation Curtailment Avoidance through Domestic Demand Response
Kailash SINGH1, Russell BRYANS1, Gerard BOYD1, Malcolm BEBBINGTON1, Guy SHAPLAND1, Wendy MANTLE1, ShengJi TEE1, Kieron STOPFORTH2
1SP Energy Networks UK; 2Octopus Energy UK

Revisiting the Terminology Used in Distribution Planning to Describe System Conditions Triggering DER-Provided Flexibility Services
Tanguy HUBERT
Electric Power Research Institute (EPRI), United States of America

Understanding Risk Factors and Risk Management Practices Related to DER-Provided Flexibility Services in the Planning and Operational Timeframes
Tanguy HUBERT
Electric Power Research Institute (EPRI), United States of America
The Evolving Distribution Operations Architecture for a Future Integrated Grid
Jessica LAU, Yashar KENARANGUI, Beth CHACON
Xcel Energy, United States of America

Quantification of Distribution Grid Value of Distributed Energy Resources
Imran RAHMAN1, Shikhar PANDEY1, Farnaz FARZAN2, Ralph MASIELLO2, Michael LEE1, Kathleen KREMER1, Jessica MILEY1, Matthew LUDWIG1
1Commonwealth Edison, United States of America; 2Quanta Technology, United States of America

Distribution Planning for Reliability and Resilience
Jouni PEPPANEN, Nick HEINE, Prajwal GAUTAM, Matthew RYLANDER, Sarmad HANIF
Electric Power Research Institute (EPRI), United States of America

Evaluating Demand Flexibility as a Distribution Planning Alternative
Jouni PEPPANEN1, Angela CHUANG1, Alison O'CONNELL2
1Electric Power Research Institute (EPRI), United States of America; 2Electric Power Research Institute (EPRI), Ireland

John Paul SKEATH1, Ryan QUINT5, Joseph ETO2, Parag MITRA3, Lakshmi SUNDARESH3, Shruti RAO4
1North American Electric Reliability Corporation (NERC), United States of America; 2Lawrence Berkeley National Laboratory (LBNL), United States of America; 3Electric Power Research Institute (EPRI), United States of America; 4GE Vernova Consulting Services, United States of America; 5Elevate Energy Consulting, United States of America

Ensuring ADMS Functionality and Flexibility with Hardware-in-the-Loop Verification
Josh SNODGRASS1, Christopher HUFF2, Aleksandar PARMAKOVIC3
1POWER Engineers, Inc., United States of America; 2Pacific Gas and Electric, United States of America; 3Schneider Electric, Serbia

Business Cases for Energy Storage Project at Distribution Level Participating in European Electricity Markets with Examples of Real Projects
Takashi USAMI1, Hamideh BITARAF2, Ernesto SORESSI3
1Hitachi, United States of America; 2Hitachi Energy, United States of America; 3Hitachi Energy, Italy
Coordinated voltage control between Medium and Low Voltage distribution grids with market-based flexibility

Clara GOUVEIA1, Gil Sampaio1, Fábio Retorta1, Ricardo Bessa1, José Villar1, Miguel Louro2, Christian Merckx3, Feres Benothman3

1INESC TEC, Portugal; 2E-Redes, Portugal; 3ENGIE Impact, Belgium

Portable Energy Storage Systems as an Alternative to Reinforcement in Distribution Networks

Carlos E Ugalde-LoO, Isaac Yamamoto, Pranaynil Saikia

Cardiff University UK

Evaluating the Impact of New Technology Deployment on Future Congestion of LV Distribution Grids

Na Li1, Anton Ishchenko2, Simon Tindemans1, Kenneth Bruninx1

1Delft University of Technology; 2Phase to Phase BV

Implementing congestion management in Dutch distribution grids

Chris Ripken, Evert De Haan, Atze Peters, Bart Pluijms

Liander

Methodology and benefits of integrating a BESS system in the operation of an isolated power systems – Design Approach and Dynamic Simulation

Laura Casado1, Pedro Ribeiro2, Renato Verissimo2, José Damasio2, José Mori1, Miquel Escoto1, Fernando Henriques3

1Siemens, Spain; 2Siemens, Portugal; 3EDA, Portugal

Self-heating vs. district heating: A case beyond power-to-heat

Rudi Nel

Renewed Projects

Optimal Operation of Distributed Energy Resource Integrated Energy Router to Enhance Local Flexibility

Dongjun Han, Seungwoo Nam, Dongjun Won

Inha University, Korea, Republic of (South Korea)

Development of an Electric Vehicle Charging Control System for Substation Load Management

Vychaeslav Voronin1, Fedor Nepsha2

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

Methodology and benefits of integrating a BESS system in the operation of an isolated power systems – Design Approach and Dynamic Simulation

Laura Casado1, Pedro Ribeiro2, Renato Verissimo2, José Damasio2, José Mori1, Miquel Escoto1, Fernando Henriques3

1Siemens, Spain; 2Siemens, Portugal; 3EDA, Portugal

Self-heating vs. district heating: A case beyond power-to-heat

Rudi Nel

Renewed Projects

Optimal Operation of Distributed Energy Resource Integrated Energy Router to Enhance Local Flexibility

Dongjun Han, Seungwoo Nam, Dongjun Won

Inha University, Korea, Republic of (South Korea)

Development of an Electric Vehicle Charging Control System for Substation Load Management

Vychaeslav Voronin1, Fedor Nepsha2

1T.F. Gorbachev Kuzbass State Technical University, Russian Federation; 2RTSoft Smart Grid, LLC, Russian Federation
**Rethinking Distribution Network Operational Planning with Flexibility Resources**

Merkebu Z. DEGEFA¹, Gunnar VIST², Mathias F. ELIASSEN¹, Ashild VATNE¹, Rubi RANA¹, Line BERGEFJORD¹, Iver BAKKEN SPERSTAD¹, Sigurd H. JAKOBSEN¹, Raymundo E. TORRES-OLGUIN¹

¹SINTEF Energi As Norway; ²Heimdall Power Norway; ³Kongsberg Digital Norway; 4Ashild.Vatne@elvia.no; ⁵BKK Norway

**ID: 10985**

C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers

Topics: C6 PS1 - Flexibility Management in Distribution Networks

Keywords: Flexibility – Resources – Digitalisation – Distribution – Planning

**Flexibility for increased electrification and utilisation of the distribution grid**

Gerd KJØLLE¹, Oddbjørn GJERDE¹, Merkebu Z. DEGEFA¹, Stig SIMONSEN¹, Mariona ZHURI², Katrine UTVIK²

¹SINTEF Energy Research Norway; ²Lede Norway; ³Elvia Norway

**ID: 10987**

C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers

Topics: C6 PS1 - Flexibility Management in Distribution Networks

Keywords: Battery energy storage systems, Electric vehicles, Fast charging stations, GAP analysis

**Evaluation of battery energy storage systems (BESS) in the Norwegian power grid to cope with increased vehicle electrification**

Heidi S. NYGÅRD¹, Ruth OLERUD¹, Petter LUNDE²

¹Norwegian University of Life Sciences (NMBU) Norway; ²Tronrud Engineering Norway

**ID: 10997**

C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers

Topics: C6 PS1 - Flexibility Management in Distribution Networks

Keywords: electricity fast-charging infrastructure, direct current recharging stations, DC stations, decarbonising transport, e-mobility, electric vehicles, electricity grid connexion, Alternative Fuel supply infrastructure, TEN-T road network

**A Methodology for Determining optimal DC Charging-station Locations and Operation for Electric-vehicles based on typical technical and commercial Requirements in Europe**

Ursula KRISPER
Elektro Ljubljana, d.d.

**ID: 11000**

C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers

Topics: C6 PS1 - Flexibility Management in Distribution Networks

Keywords: Load forecasting, machine learning, microgrids

**Optimal Design of a Microgrid Considering Load Forecasting**

Ersa AYDIN, Belgin TURKAY, Cenk ANDIC
Istanbul Technical University Türkiye

**ID: 11131**

C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers

Topics: C6 PS1 - Flexibility Management in Distribution Networks

Keywords: Wide Area Control, Synchronophase, System Restoration, Zonal co-ordinated control, Grid Services, Distribution restoration, Virtual Power Plant

**Trialling Distribution-based Electricity System Restoration and Other Services**

Douglas WILSON¹, Marta LATERZA¹, Marcos SANTOS¹, Richard DAVEY¹, Ian MACPHERSON², Mark MORRISON², James YU²

¹GE Vernova UK; ²SP Energy Networks UK

**ID: 11135**

C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers

Topics: C6 PS1 - Flexibility Management in Distribution Networks

**Two-stage stochastic programming for optimal BESS & DER Total Cost of Ownership and sizing considering grid services in data centre applications**

Marco GIUNTOLI¹, Dario CICIO², Fabrizio LANDINI³

¹Hitachi Energy Research, Germany; ²Hitachi Energy, Switzerland; ³Hitachi Energy, Italy

**ID: 11157**

C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers

Topics: C6 PS1 - Flexibility Management in Distribution Networks

Keywords: Active Network Management; Digital Substations; Distributed Energy Resources; Distributed Energy Resource Management Systems; Flexible Connections; Flexibility Services; Wide Area Monitoring, Protection and Control
| ID: 11239 | **Local Active Network Management (LANM) and the role of Smart Substations in Minimising Curtailment of Flexible DER Connections**  
Peter WALL1, Douglas WILSON1, Lihong HAO1, Andreas GLATZ2, Yusen FEI1, Ivan MARTIN1, Richard DAVEY1, Boris YAZADZHIYAN2, James MILLS2, Mayamiko HARA2, Tam SOKARI-BRIGGS2, Tim MANANDHAR2  
1GE Vernova UK; 2UK Power Networks UK |
| --- | --- |
| ID: 11293 | **DER integration and optimisation to enable Australia’s first fully electric public road transport system**  
Stephen SPROUL1, John GLASSMIRE2, Francesco BACCINO3, Pablo ALMALECK2  
1Hitachi Energy, Australia; 2Hitachi Energy, USA; 3Hitachi Energy, Italy |
| ID: 11324 | **Eliminating overload in distribution systems by utilizing DER**  
Yoshifumi IKEMOTO1, Masahiro MINAMI1, Noriaki KANO1, Shinya YOSHIZAWA1, Yohei YAMAGUCHI1, Yutaka OTA2  
1Kansai Transmission and Distribution, Inc., Japan; 2Osaka University, Japan |
| ID: 11342 | **Distributed Energy Management System (DERMS) for Solar and Storage to Demonstrate Grid Flexibility and Reliability**  
Aditie GARG*, Summer FABUS, Stuart MCMAHON, Robert MACDONALD, Frazor WATSON  
Progressive Grid Solutions Pvt Ltd, India |
| ID: 11360 | **Low voltage measurement system to support distribution system state estimation**  
István TÁCZI1, Kristóf Péter JUHÁSZ2, István VOKONY2, Bálint HARTMANN2  
1E.ON DSO; 2Budapest University of Technology and Economics |
| ID: 11409 | **Kopernikus projects - Field applications and OT-IT-integration to enable the full potential of future power systems**  
Peter NOGLIK1, Marco GIUNTOLI1, Katarina KNEZOVIC1, Antony HILLIARD1, Maximilian DAUER2, Maximilian ROSE3, Michael GRATZA4, Andreas SCHLERETH4, Robert SCHMIDT4, Stephan RUPP4, Sebastian BRUSKE4, Alexander MAGES4  
1Hitachi Energy AG, Germany; 2Siemens AG, Germany; 3TenneT TSO GmbH, Germany; 4Fraunhofer IPA, Germany; 5Hitachi Energy Research RWTH Aachen, Germany; 6RWTH Aachen, Germany; 7Maschinenfabrik Reinhausen GmbH, Germany; 8Schleswig-Holstein Netz AG, Germany; 9Hitachi Energy Research, Switzerland; 10Hitachi Energy Research, Canada |
| ID: 11413 | **A New Wide Area Protection Scheme for Active Distribution Network**  
Khaled AL-MAITAH1, Abdullah AL-ODIENAT2  
1EDCO; 2Mutah University |
| ID: 11415 | **Data analytics, planning of distribution networks, PV hosting capacity, smart meters**  
CIGRE 138
<table>
<thead>
<tr>
<th>ID: 11417</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</td>
</tr>
<tr>
<td>Topics: C6 PS1 - Flexibility Management in Distribution Networks</td>
</tr>
<tr>
<td><strong>Smart Meters: A Key to Sustainable Energy With Applied Study Cases in Palestine</strong></td>
</tr>
<tr>
<td>Dana BANNOURA</td>
</tr>
<tr>
<td>IDECO</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11443</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</td>
</tr>
<tr>
<td>Topics: C6 PS1 - Flexibility Management in Distribution Networks</td>
</tr>
<tr>
<td><strong>Efficient Identification of Customer Types in Energy Consumption Data: Leveraging Dimensionality Reduction and K-Means Clustering Method</strong></td>
</tr>
<tr>
<td>Leonie RIEDL¹, Martin BRAUN¹, Philip HEHLERT¹</td>
</tr>
<tr>
<td>¹Fraunhofer Institut für Energiewirtschaft und Energiesystemtechnik IEE &amp; Universität Kassel, Germany; ²Georg-August-Universität Göttingen, Germany</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11452</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</td>
</tr>
<tr>
<td>Topics: C6 PS1 - Flexibility Management in Distribution Networks</td>
</tr>
<tr>
<td><strong>Evaluating Distribution Transformer Utilisation for Flexibility and Enhanced Observability using Multiple Sources of Data</strong></td>
</tr>
<tr>
<td>Jelena PONOCKO, Rebecca THRELFALL, Josephine O’BRIEN, Shengji TEE, Russell BRYANS, Malcolm BEBBINGTON</td>
</tr>
<tr>
<td>SP Energy Networks UK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11563</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</td>
</tr>
<tr>
<td>Topics: C6 PS1 - Flexibility Management in Distribution Networks</td>
</tr>
<tr>
<td><strong>Energy Storage System Design Considering Multiple Revenue Streams for Large Scale Solar in Malaysia</strong></td>
</tr>
<tr>
<td>Junainah SARDI¹, Wan Syakirah WAN ABDULLAH², Hazriq Hakimi YAACOB², Ahmad Amirul Hamid MOHD HAMID²</td>
</tr>
<tr>
<td>¹Universiti Teknikal Malaysia Melaka; ²Tenaga Nasional Berhad</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11563</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</td>
</tr>
<tr>
<td>Topics: C6 PS1 - Flexibility Management in Distribution Networks</td>
</tr>
<tr>
<td><strong>Investigating the Capabilities of Weight-Based Gravity Storage for Delivering Ancillary Services</strong></td>
</tr>
<tr>
<td>Alexander SIEMSEN¹, Rasmus VIG JENSEN¹, Lisa CALEARO¹, Jill MACPHERSON²</td>
</tr>
<tr>
<td>¹Ramboll Danmark A/S; ²Gravitricity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11702</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</td>
</tr>
<tr>
<td>Topics: C6 PS1 - Flexibility Management in Distribution Networks</td>
</tr>
<tr>
<td><strong>The challenge of smooth cooperation of hydroelectric Turbines with thermal Units to provide FCR and aFRR in a Non-Interconnected Island</strong></td>
</tr>
<tr>
<td>Anastasis TSOUMANIS¹, Stefanos KOKKINELIS², Konstantinos NATSIS¹, Stavros PAPATHANASSIOU², Despoina KOUKOULA², Charalampos PAPPAS², Eleni LAMPRINIDIS², Theodora PATSAKA²</td>
</tr>
<tr>
<td>¹PPC Renewables S.M.S.A., Greece; ²Hellenic Electricity Distribution Network Operator S.A., Greece; ³National Technical University of Athens, Greece</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11859</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</td>
</tr>
<tr>
<td>Topics: C6 PS1 - Flexibility Management in Distribution Networks</td>
</tr>
<tr>
<td><strong>Impact of hybrid generation and storage system, including virtual inertia, on the grid connection for planning studies</strong></td>
</tr>
</tbody>
</table>
140

PS2 - POWER ELECTRONIC BASED SOLUTIONS FOR SMART DISTRIBUTION SYSTEMS

Classification of Highly Resonant Wireless Charging Techniques for Light EVs and Similar Low Applications

Eman GOMAA¹, Ahmed SHAWKY², Mohammed SAAD², Mohammed ORABI²

¹Upper Egypt Electricity Distribution Company; ²Aswan University

A Hybrid Networking Scheme With Grid-forming and Grid-following Converters for Resilient Active Distribution System

Zhuhu HUA, Lei SHANG, Xuzhu DONG

Wuhan University, China

Black Start Operation of Grid-Forming Converters Based on Generalized Three-phase Droop Control Under Unbalanced Conditions

Zexian ZENG¹, Prajwal BHAGWAT², Maryam SAEDIFARD¹, Dominic GROSS²

¹Georgia Institute of Technology, United States of America; ²University of Wisconsin-Madison, United States of America

How to detect and mitigate electricity theft in a South African distribution network in spite of the inadequacy of the network to be a fully smart system

Ndoro NETSHIPALE

Eskom Holdings SOC Ltd, South Africa

How does the inadequate network to be a fully smart system affect the detection and mitigation of electricity theft?
Soft Open Point at Bermeo substation to improve distribution system reliability and hosting capacity

Markel ZUBIAGA1, David SANTOS2, Eneko OLEA3, Javier CHIVITE1, Javier CAÑAS3, Raul PEÑA3

1Ingeteam Research Institute, Spain; 2Ingeteam P. Technology, Spain; 3Iberdrola, Spain

ID: 10753
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Low-Voltage Direct Current (LVDC), Microgrids, DC Systems, DC Fault Protection, Solid-State Circuit Breaker (SSCB), Semiconductor Circuit Breaker (SCB), Power Electronics, Integrated Gate-Commutated Thyristor (IGCT)

Semiconductor circuit-breaker based on RB-IGCT to protect LVDC microgrids

Marcel STOECKLI1, Antonello ANTONIAZZI2, Thomas MASPER2, Thorsten STRASSEL2, Umanaheswara VEMULAPATI3, Christian WINTER4, Tobias KELLER4

1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2ABB, Italy; 3ABB, Switzerland; 4Hitachi Energy, Switzerland

ID: 10822
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Synthesis of Adaptive Control System of Converter-Interfaced Generation Based on a Virtual Synchronous Generator

Alisher ASKAROV1, Aleksey SUVOROV1, Pavel ILYUSHIN2
1National Research Tomsk Polytechnic University, Russian Federation; 2Energy Research Institute of the Russian Academy of Sciences, Russian Federation

ID: 11295
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Electric Vehicle, Dynamic Pricing, Distribution System, Voltage Variation

Evaluation of the Effect of Dynamic Pricing on EV Charging to Voltage Variation in Distribution Lines

Toko MANNARI, Hiroyuki HATTA, Masahito TAKAHASHI
Central Research Institute of Electric Power Industry (CRIEPI), Japan

ID: 11297
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Power Distribution System, IBR, Virtual Inertia Function

Development of GFM Inverters for Increased Penetration of Variable Renewable Energy

Yusuke NISHIDA, Teru MIYAZAKI
Tokyo Electric Power Company Holdings, Inc., Japan

ID: 11414
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Active distribution networks, Conventional inverters, CYMDIST, Distribution systems, IDECO, Renewable Energy Resources, Smart inverters, Voltage Regulation, Volt-VAR Control

Volt-Var Technique Utilization for Voltage Control in Distribution Networks with Smart Inverters – A Case Study of Jordan

Walaa THIABAT, Mu’men BODOOR, Mahdi ALSHATNAWI, Abdalrheem JAWARNEH, Mohammad NASER
IDECO

ID: 11479
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Fault limiting converter model, DC microgrid protection, fault current limiter, short circuit characteristics

Average Models and Characteristics of Current-Controlled Converters for Fault Analysis in DC Microgrids

Jin-Su Kim1, Ji-Song HONG1, Young-Bin CHO1, Seok-Chan LEE1, Sang-Yun YUN2
1LS ELECTRIC Co., Ltd., Korea, Republic of (South Korea); 2Chonnam University, Korea, Republic of (South Korea)

ID: 11804
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Solar photovoltaic-based microgrid, Distribution systems, Voltage rise suppression, PV curtailment, Financial loss

ID: 10753
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Low-Voltage Direct Current (LVDC), Microgrids, DC Systems, DC Fault Protection, Solid-State Circuit Breaker (SSCB), Semiconductor Circuit Breaker (SCB), Power Electronics, Integrated Gate-Commutated Thyristor (IGCT)

Semiconductor circuit-breaker based on RB-IGCT to protect LVDC microgrids

Marcel STOECKLI1, Antonello ANTONIAZZI2, Thomas MASPER2, Thorsten STRASSEL2, Umanaheswara VEMULAPATI3, Christian WINTER4, Tobias KELLER4

1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2ABB, Italy; 3ABB, Switzerland; 4Hitachi Energy, Switzerland

ID: 10822
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Synthesis of Adaptive Control System of Converter-Interfaced Generation Based on a Virtual Synchronous Generator

Alisher ASKAROV1, Aleksey SUVOROV1, Pavel ILYUSHIN2
1National Research Tomsk Polytechnic University, Russian Federation; 2Energy Research Institute of the Russian Academy of Sciences, Russian Federation

ID: 11295
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Electric Vehicle, Dynamic Pricing, Distribution System, Voltage Variation

Evaluation of the Effect of Dynamic Pricing on EV Charging to Voltage Variation in Distribution Lines

Toko MANNARI, Hiroyuki HATTA, Masahito TAKAHASHI
Central Research Institute of Electric Power Industry (CRIEPI), Japan

ID: 11297
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Power Distribution System, IBR, Virtual Inertia Function

Development of GFM Inverters for Increased Penetration of Variable Renewable Energy

Yusuke NISHIDA, Teru MIYAZAKI
Tokyo Electric Power Company Holdings, Inc., Japan

ID: 11414
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Active distribution networks, Conventional inverters, CYMDIST, Distribution systems, IDECO, Renewable Energy Resources, Smart inverters, Voltage Regulation, Volt-VAR Control

Volt-Var Technique Utilization for Voltage Control in Distribution Networks with Smart Inverters – A Case Study of Jordan

Walaa THIABAT, Mu’men BODOOR, Mahdi ALSHATNAWI, Abdalrheem JAWARNEH, Mohammad NASER
IDECO

ID: 11479
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Fault limiting converter model, DC microgrid protection, fault current limiter, short circuit characteristics

Average Models and Characteristics of Current-Controlled Converters for Fault Analysis in DC Microgrids

Jin-Su Kim1, Ji-Song HONG1, Young-Bin CHO1, Seok-Chan LEE1, Sang-Yun YUN2
1LS ELECTRIC Co., Ltd., Korea, Republic of (South Korea); 2Chonnam University, Korea, Republic of (South Korea)

ID: 11804
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Solar photovoltaic-based microgrid, Distribution systems, Voltage rise suppression, PV curtailment, Financial loss

ID: 10753
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Low-Voltage Direct Current (LVDC), Microgrids, DC Systems, DC Fault Protection, Solid-State Circuit Breaker (SSCB), Semiconductor Circuit Breaker (SCB), Power Electronics, Integrated Gate-Commutated Thyristor (IGCT)

Semiconductor circuit-breaker based on RB-IGCT to protect LVDC microgrids

Marcel STOECKLI1, Antonello ANTONIAZZI2, Thomas MASPER2, Thorsten STRASSEL2, Umanaheswara VEMULAPATI3, Christian WINTER4, Tobias KELLER4

1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2ABB, Italy; 3ABB, Switzerland; 4Hitachi Energy, Switzerland

ID: 10822
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Synthesis of Adaptive Control System of Converter-Interfaced Generation Based on a Virtual Synchronous Generator

Alisher ASKAROV1, Aleksey SUVOROV1, Pavel ILYUSHIN2
1National Research Tomsk Polytechnic University, Russian Federation; 2Energy Research Institute of the Russian Academy of Sciences, Russian Federation

ID: 11295
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Electric Vehicle, Dynamic Pricing, Distribution System, Voltage Variation

Evaluation of the Effect of Dynamic Pricing on EV Charging to Voltage Variation in Distribution Lines

Toko MANNARI, Hiroyuki HATTA, Masahito TAKAHASHI
Central Research Institute of Electric Power Industry (CRIEPI), Japan

ID: 11297
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Power Distribution System, IBR, Virtual Inertia Function

Development of GFM Inverters for Increased Penetration of Variable Renewable Energy

Yusuke NISHIDA, Teru MIYAZAKI
Tokyo Electric Power Company Holdings, Inc., Japan

ID: 11414
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Active distribution networks, Conventional inverters, CYMDIST, Distribution systems, IDECO, Renewable Energy Resources, Smart inverters, Voltage Regulation, Volt-VAR Control

Volt-Var Technique Utilization for Voltage Control in Distribution Networks with Smart Inverters – A Case Study of Jordan

Walaa THIABAT, Mu’men BODOOR, Mahdi ALSHATNAWI, Abdalrheem JAWARNEH, Mohammad NASER
IDECO

ID: 11479
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Fault limiting converter model, DC microgrid protection, fault current limiter, short circuit characteristics

Average Models and Characteristics of Current-Controlled Converters for Fault Analysis in DC Microgrids

Jin-Su Kim1, Ji-Song HONG1, Young-Bin CHO1, Seok-Chan LEE1, Sang-Yun YUN2
1LS ELECTRIC Co., Ltd., Korea, Republic of (South Korea); 2Chonnam University, Korea, Republic of (South Korea)

ID: 11804
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems
Keywords: Solar photovoltaic-based microgrid, Distribution systems, Voltage rise suppression, PV curtailment, Financial loss
<table>
<thead>
<tr>
<th>ID: 11866</th>
<th>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C6 PS2 - Power Electronic based Solutions for Smart Distribution Systems</td>
<td></td>
</tr>
<tr>
<td>Keywords: smart transformer; real-time simulation; power quality; control system</td>
<td></td>
</tr>
<tr>
<td>Voltage Rise Suppression Strategies for Utility-Scale Solar Photovoltaic-based Microgrids</td>
<td></td>
</tr>
<tr>
<td>Krit KONGURAI</td>
<td></td>
</tr>
<tr>
<td>Electricity Generating Authority of Thailand (EGAT), Thailand</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10482</th>
<th>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C6 PS3 - Rural, Islanded and Industrial Electrification Standards, Practices and Technology Options</td>
<td></td>
</tr>
<tr>
<td>Keywords: Microgrid, Effective Grounding, Distributed Energy Resources (DERs), Photovoltaic (PV), Resiliency Enhancement</td>
<td></td>
</tr>
<tr>
<td>Smart Transformer Real-time Simulation Model with External Control Script Implementation and Performance Analysis</td>
<td></td>
</tr>
<tr>
<td>Ville OLLIKAINEN</td>
<td></td>
</tr>
<tr>
<td>VTT Technical Research Centre of Finland</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10682</th>
<th>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C6 PS3 - Rural, Islanded and Industrial Electrification Standards, Practices and Technology Options</td>
<td></td>
</tr>
<tr>
<td>Energy Management System to Improve Resilience in Islanded Interconnected Microgrids</td>
<td></td>
</tr>
<tr>
<td>Fundiswa MTHETHWA</td>
<td></td>
</tr>
<tr>
<td>Eskom</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10683</th>
<th>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C6 PS3 - Rural, Islanded and Industrial Electrification Standards, Practices and Technology Options</td>
<td></td>
</tr>
<tr>
<td>The Design of an Islanded Microgrid in the Kalahari Desert of South Africa: Noenieput Settlement Off-grid Electrification</td>
<td></td>
</tr>
<tr>
<td>Soni M</td>
<td></td>
</tr>
<tr>
<td>Eskom SOC Ltd</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10861</th>
<th>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C6 PS3 - Rural, Islanded and Industrial Electrification Standards, Practices and Technology Options</td>
<td></td>
</tr>
<tr>
<td>Protection scheme for single pole to ground faults in multi-terminal MMC-MVDC grid utilizing sequential tripping</td>
<td></td>
</tr>
<tr>
<td>Gvan Chun CHO1,2, Seul-Ki KIM1, Gyeong-Hun KIM1, Jihui HWANG1</td>
<td></td>
</tr>
<tr>
<td>1Korea Electrotechnology Research Institute, Korea, Republic of (South Korea); 2National Research University 'Moscow Power Engineering Institute', Russia</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10966</th>
<th>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics: C6 PS3 - Rural, Islanded and Industrial Electrification Standards, Practices and Technology Options</td>
<td></td>
</tr>
<tr>
<td>Detection of Open Conductor Fault using Multiple Measurement Factors of RTUs in Active Distribution Networks with DERs</td>
<td></td>
</tr>
<tr>
<td>JiSong HONG</td>
<td></td>
</tr>
<tr>
<td>LS ELECTRIC, Korea, Republic of (South Korea)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11299</th>
<th>C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers</th>
</tr>
</thead>
</table>
Challenge to establish decarbonized, resilient, and semi-independent microgrid in islands
Hideo ISHII1, Naoto HIGA2, Tomohiro SHIOHAMA3, Satoru NAKAMURA2, Kiyomasa KOHATSU1
1Waseda University, Japan; 2NEXTEMS, Japan; 3Okinawa Electric Power Company, Japan

Validation of Off-grid System in Real Cases
Keisuke UEKAWA, Yoshikazu IIDA, Keiichi FUJIMOTO, Yoshihiko KAKUMOTO, Noriaki KANO, Yuki KAWACHI
Kansai Transmission and Distribution, Inc., Japan

Best Investment Planning of Microgrid Networks: Jordan Case Study
Suad S. ALMATTAR
National Electric Power Company, Jordan, Hashemite Kingdom of

Case study promoting a state of art solution for growing residential load in Palestine using community microgrid
Ibrahim KIRIAKOS
JDECO

A model for future load profiles considering extreme weather conditions
Michael DAHMS, Torsten SOWA
AMPERIAS GMBH, Germany

Optimal Service Restoration Using Distributed Generations After Blackout in Distribution Networks
Saehwan LIM1,2, Jin-Oh LEE1, Hyeong-Jun YOO1, Gyeong-Hun KIM1
1Korea Electrotechnology Research Institute, Korea, Republic of (South Korea); 2Yonsei University

Achieving successful community engagement in the evolving power system landscape: A case for micro- and mini-grids
Tshwanelo RAKAIBE
Cigre Southern Africa, South Africa

A Combined Prepaid and Post-Paid Scheme for Non-Connected Zones and Migration from a Conventional Energy-Based Tariff to an Availability Solution in Terms of Time
Luis BERRÍO, Jimena RAIGOZA, Catalina GARCÉS, Ángela BURITICÁ, Juan FRANCO, Rafael LUNA
EPM
ID: 11774
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS3 - Rural, Islanded and Industrial Electrification Standards, Practices and Technology Options

Validation of the Engineering for a Protection System in a Microgrid at the Universidad del Valle Campus in Colombia
Andres DÍAZ, Edison FRANCO, Eduardo GOMEZ
Universidad del Valle

ID: 11775
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS3 - Rural, Islanded and Industrial Electrification Standards, Practices and Technology Options

Impacts and Challenges of the Integration of Connected to the Grid-Microgrids: Colombian Case
Luisa ESCOBAR, Eduardo GÓMEZ
Universidad del Valle

ID: 11867
C6 ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES - Full Papers
Topics: C6 PS3 - Rural, Islanded and Industrial Electrification Standards, Practices and Technology Options
Keywords: Off-grid power system, electrical energy storage system, autonomous hybrid power plant, solar power plant, gas piston generator, diesel generator, automatic control system, frequency control, abruptly variable load, power quality

An automatic frequency control system for off-grid power systems with energy storages
Gleb NESTERENKO1, Vyacheslav ZYRYANOV2
1SO UPS, JSC «Branch Regional Dispatching Office, Energy System of Novosibirsk Region, Altai Territory and the Altai Republic, Russia; 2Novosibirsk State Technical University, Russia

D1 - MATERIALS AND EMERGING TEST TECHNIQUES
PS1 - TESTING, MONITORING AND DIAGNOSTICS

ID: 10166
D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

A High Performance Differential Acoustic Emission Sensor for Partial Discharge Detection
Yongling LU1, Zhen WANG1, Chengtao LUO2, Yang SONG2
1State Grid Jiangsu Electric Power Company Ltd. Research Institute,China; 2Shanghai Jiao Tong University,China

ID: 10249
D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

Differential Pressure Method for Measuring Gas Leakage of Dynamic Sealing Units in GIS
Zhiqiang TAO1, Liang SONG2, Lu LIU1, Manuel NAEF1, Luopeng LIU2, Yang WANG1
1Hitachi Energy Research; 2Hitachi Energy High Voltage Technology Center

ID: 10295
D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers
Topics: D1 PS1 - Testing, Monitoring and Diagnostics
Keywords: UHF monitoring, narrow band system, Power Transformers, noisy environment, SF6-alternatives

Use of narrow band UHF monitoring system for Power Transformer and GIS including SF6-free solution in laboratory and site environments
Raphael LEBRETON, Sebastien LOUISE
GE Vernova, France

ID: 10395
D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

Testing, Measuring and Diagnostic Partial Discharge: use case examples in MV applications
Marco RIVA, Massimo SCARPPELLINI, Marco TESTA, Stefano MELZI, Andrea CRESPI
ELDS Technology Centre – ABB spa Italy
**ID: 10396**
**D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers**
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

*Use of state observer and load cell sensors for monitoring overhead line ice sleeve overload and conductor temperature*

Lorenzo PAPI
TERNA, Italy

**ID: 10415**
**D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers**
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

*Compensating Losses in On-line HFCT Partial Discharge Measurements under High Load Current Conditions*

Kai Xian LAI, Javan Chun Fong LEE, Bing Hong LECK, Hongyan CAO, Ranjan THIRUCHELVAM, Vincent Kum Kong WONG
SP Group Singapore

**ID: 10483**
**D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers**
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

*Keywords: Dielectric Frequency Response (DFR), Gas Chromatography, High Molecular Weight Acids, Low Molecular Weight Acids, Water*

*Determination of Low and High Molecular Weight Carboxylic Acids by Chromatography and Possible Implications for Dielectric Frequency Response Measurements*

Lance R. LEWAND, Ronald HERNANDEZ, Zach HOLLAND
Doble Engineering Company, United States of America

**ID: 10484**
**D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers**
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

*Keywords: Bushings, Dielectric Frequency Response, DFR Baseline, Diagnostic Test, Early Detection*

*Application of Performing DFR on Bushings: Utility Perspective*

Poorvi PATEL1, Peter ZHAO2, Varun GOYAL2, Timothy RAYMOND3
1Electric Power Research Institute (EPRI), United States of America; 2Hydro One, Canada

**ID: 10496**
**D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers**
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

*Challenges on atmospheric Corrections for external Insulation Design and Testing - Revisited*

Liliana AREVALO
Hitachi Energy Sweden, Sweden

**ID: 10497**
**D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers**
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

*Diagnostic of On-Load Tap-Changer based on vibroacoustic Measurements*

Joachim SCHIESSLING
Hitachi Energy Sweden AB, Sweden

**ID: 10513**
**D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers**
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

*Keywords: Power Transformers, Dissolved Gas Analysis, Stray Gassing*

*Stray Gassing of Insulating oils - Transformer condition assessment tool*

Anabela PEIXOTO, Cláudia FARINHA, João VALENTIM, Rui MARTINS
EDP Labelec, Portugal

**ID: 10556**
**D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers**
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

*Keywords: Condition Assessment, Data Analytics, Early Failure, Forecasting, Weibull Distribution, Prognostics, Parameter Estimation, Weighted Linear Regression, Linear Regression, Reliability*

*Condition Assessment after Early Failures in Power Equipment despite successfully passed Factory Acceptance and Commissioning Tests*

Robert ROSS1, Aart-Jan DE GRAAF2, Peter YPMA2, Maria ROSS2
1TU Delft; 2IWO
Pseudo passive sensing of partial discharges of electrical assets in multiple and remote locations

Daniel BLANCO1, Fco. Javier DE PAZ2, Rafael FUERTES2, Ricardo GÓMEZ1, Ricardo REINOSO1, Gonzalo DONOSO1, Elena NOGUEROLES1

1Red Eléctrica, Spain; 2DXIoT Systems, Spain

Cyclic Corrosion Testing of HV Disconnectors Under Continuous Current

Hélène GAUTHIER, Catherine LE POSTEC

Hydro-Québec, Canada

Lifetime analysis and extended impulse and superimposed impulse voltage tests on a GIS voltage divider for HVDC applications

Marcel STOECKLI1, Uwe RIECHERT2, Erik SPERLING3, Andreas DOWBYSCH4

1ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; 2Hitachi Energy, Switzerland; 3Omicron electronics, Switzerland; 4Technische Universität Dresden, Germany

Dissolved Gas On-line Monitor Based on Tunable Diode Laser Absorption Spectroscopy and Enhanced by Vacuum Extraction

Dmitriy VODENNIKOV1, Alexander GUK1, Artem KLIMCHUK2, Mikhail BALANOV2, Leonid POSPEEV2

1PJSC ROSSETI, Russian Federation; 2Individual expert, Russian Federation

Monitoring of Seasonal Changes in the Concentrations of Chemical Markers Dissolved in Power Transformer Oil

Leonid DARIAN1, Sergey ASOSKOV2, Vladimir POLISHCHUK2, Roman OBRAZTSOV1, Alexey MAKSIMCHENKO1

1JSC «Technical Inspection UES», Russian Federation; 2LLC Gazprom Energo, Russian Federation; 3Joint Institute for High Temperatures of the RAS, Russian Federation

Mobile Diagnostic X-ray System for Inspection of High-voltage Equipment in Operation

Leonid DARIAN1, Roman OBRAZTSOV1, Oleg OZEROV2, Pavel GOLUBEV3, Pavel GONCHAROV3

1JSC «Technical Inspection UES», Russian Federation; 2Dukhov Research Institute of Automatics, Russian Federation; 3PJSC «Rosseti South», Russian Federation

Generation of Gases Related to Partial Discharges in High Voltage Equipment: a theoretical-practical approach

Adriana DE CASTRO PASSOS MARTINS1, Sheila SOUTHGATE DE OLIVEIRA2, Alain François SANSON LEVY3, Arthur DE CASTRO RIBEIRO2, Alexandre R. MARTINS2

1Brazilian NC of CIGRE, Brazil; CEMIG; 2Consultant; 3Consultant; 4Eletrobras CEPEL; 5Consultant
ID: 11032
D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

Alternative methods for the simultaneous determination of diagnostic parameters
Ivanka HOEHLEIN, Carolin SCHUETT, Zhe SHAN
Siemens Energy, Germany

ID: 11053
D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers
Topics: D1 PS1 - Testing, Monitoring and Diagnostics
Keywords: Space-charge, XLPE-cables, Pulsed-electro-acoustic-method, Load-cycles

Novel Space Charge Measurement System for Full-size XLPE cables under Actual Operating Voltage and Temperature Conditions
Shosuke MORITA¹, Norikazu FUSE¹, Takayuki MATSUBARA², Yoshinao MURATA², Yoshinobu MURAKAMI³, Naohiro HOZUMI³
¹Central Research Institute of Electric Power Industry, Japan; ²Sumitomo Electric Industries Ltd., Japan; ³Toyohashi University of Technology, Japan

ID: 11055
D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers
Topics: D1 PS1 - Testing, Monitoring and Diagnostics
Keywords: Current, Integration, Charge, Q(t) method, Dielectric Properties, Diagnosis

Direct Current Integrated Charge Method as a Useful Tool for Dielectric Measurements
Yoitsu SEKIGUCHI¹, Takashi KURIHARA², Hiroaki MIYAKE³, Tatsuo TAKADA³
¹Sumitomo Electric Industries, Japan; ²CRIEPI, Japan; ³Tokyo City University, Japan

ID: 11095
D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

AI-based DGA Interpretation Method for On-Load Tap-Changers
Rainer FROTSCHER¹, Eva KELEMEN², Alexander ALBER¹, Jim RIPPON²
¹Maschinenfabrik Reinhausen GmbH, Germany; ²ALTALINK, L. P., Canada

ID: 11115
D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

Development and verification of an online method for determining the oil condition of on-load tap-changers and transformers
Andreas KURZ¹, Roland GÖTZ¹, Julia MASSMANN², Johannes VEIT²
¹Maschinenfabrik Reinhausen, Germany; ²Amprion GmbH, Germany

ID: 11139
D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

Optical PD Measurements on GIS and Power Transformers
Claus NEUMANN¹, Maximilian VOGL²
¹Technical University of Darmstadt, Germany; ²Vogl electronic, Germany

ID: 11319
D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers
Topics: D1 PS1 - Testing, Monitoring and Diagnostics

Effects of Glass Transition Temperature (Tg) of Composite Core Rod on Performance of Polymer Insulators
Nitin SHINGNE*, Uday PUNTAMBEEKAR, Satish CHETWANI
Electrical Research and Development Association (ERDA), India

ID: 11326
D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers
Topics: D1 PS1 - Testing, Monitoring and Diagnostics
Keywords: transformer health, DGA, sampling, extraction, measurement

Imperative Technicalities for Managing Reliable Dissolved Gas Analysis and Adequate Diagnosis of Contemporary Oil-Filled Power Transformers
Marius GRISARU
Transformer oil tests independent consultant and educationalist at Transformer Academy, Israel
Partial discharge behaviour in GIS with C4-FN mixtures: Comparison of conventional and UHF measurement techniques
Johanna LINKE1, Uwe RIECHERT2, Stephan SCHLEGEL1, Willy JAROSZCZINSKY1
1Technische Universität Dresden, Germany; 2Hitachi Energy, Switzerland

Evaluation of the Dielectric Strength of Silicone Elastomers at DC Stress
Stefan KUEHNEL1, Stefan KORNHUBER1, Jens SEIFERT3, Jens LAMBRECHT2, Christiane BAER2
1Hochschule Zittau/Görlitz, Germany; 2Wacker Chemie AG, Germany; 3Maschinenfabrik Reinhausen, Germany

Tests experiences of Temporary Over-Voltage for HVDC cable system
Dae-Jin PARK, Tae-Ho LEE, Sang-Taek PARK, Jin-Ho NAM, Sung-Yun KIM, Jung-Nyun KIM
LS Cable & System

Model To Estimate Solid Insulation Ageing in Power Transformers via Alcohol Based Chemical Indicators
Abhay CHAUDHARY, Dr Subir SEN, B.B MUKHERJEE, V K BHASKAR, Abhishek ABHISHEK, N K BHASKAR, Dr Satish KUMAR, Dr Arun Prakash UPADHYAY*
Power Grid Corporation of India Ltd, India

New Approach in Condition Monitoring of Power Transformers Oil Pumps
Sebastián LAURIA, Franco LEIVA, Agustín AVALOS, Andrés LANTOS
Laboratorio Dr. Lantos

High Insulation Power Factor in Power Transformer!!! Deep Diagnostic Approaches for Root Cause Analysis
Pongpon SINGKHAWAT, Anchalee TONG-IN
Electricity Generating Authority of Thailand (EGAT), Thailand

How Can Image Processing Empower Decision-Making in Corrosive Sulfur Analysis of Transformer Oil?
Wutthipan PARIYOTHAI, Sirapa THONGDEE
Electricity Generating Authority of Thailand (EGAT), Thailand

Lightning Properties of selected insulating Liquids based on the Acceleration Voltage Parameter
Filip STUCHAŁA, Paweł RÓZGA
Lodz University of Technology, Institute of Electrical Power Engineering, Poland
Several equations of state for SF6: how to avoid errors?
Nathalie BARNEL, Alain JEANMAIRE
EDF R&D, France

Characterization of the liquefaction properties of fluoronitrile mixtures by a thermodynamic experimental approach
Caterina TOIGO1, Antoine PEREZ2, Frank JACQUIER1, Alain GIRODET1, Michael INVERSIN2, Didier LASSERRE2
1SuperGrid Institute, France; 2RTE, France

Effect of temperature on the development and partial discharge characteristics of electrical trees under combined AC/DC voltage in epoxy resin
Yingman SUN1, Xuandong LIU1, Gaoyi SHANG1, Hao SUN1, Hao TANG2, Xining LI2
1Xi’an Jiaotong University, China; 2China electric power research institute, China

Modelling and decoupling of the dielectric response of silicone rubber composites used for outer insulation
Qian WANG, Ying ZHOU, Chao WU, Xidong LIANG
Tsinghua University, China

Research progress in environmentally friendly epoxy resins
Qiang FU1, Lei PENG1, Li ZHANG1, Chengxi FU2, Musong LIN1, Zhi Li1
1Guangdong Key Laboratory of Electric Power Equipment Reliability, Electric Power Research Institute of Guangdong Power Grid Co., Ltd., China; 2School of Energy and Environment, City University of Hong Kong, China

Study on Epoxy Resin Insulation Characteristics of Valve-Side Bushing in Converter Transformer Under Composite Voltage and Thermal Field
Hao SUN1, Xuandong LIU1, Wanbao SHI1, Yingman SUN1, Hao TANG2, Xining LI2
1Xi’an Jiaotong University, China; 2China electric power research institute, China

Study on water ingress characteristics of HTV silicone rubber
Ying ZHOU1, Xidong LIANG1, Zhou ZUO1, Chao WU1, Qian WANG1, Shuming LIU1, Shuqi LIU1, Yanfeng GAO2
1Tsinghua University, China; 2State Grid Jibe Electric Power Co. Ltd. Research Institute, China

Ageing behaviour of RIP material under several DC voltages and temperature
Matthieu DALSTEIN1, Laura DE FINA2, Thanh VU-CONG1, Franck JACQUIER1, Armando PASTORE2
1SuperGrid Institute, France; 2GE RPV, Italy
<table>
<thead>
<tr>
<th>ID: 10298</th>
<th>D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers</th>
<th>Topics: D1 PS2 - Materials for Electrotechnical Technical Purposes and Modelling</th>
<th>Keywords: mineral oil, ester oil, biodegradable hydrocarbons, thermal ageing, ageing markers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative liquids for transformers: thermal ageing comparison and ageing markers correlation</td>
<td>Anthony JEANNETON¹, Christophe PERRIER¹, Abderrahmane BEROUAL²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>¹GE Grid Solutions, France; ²Ecole Centrale de Lyon, France</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10299</th>
<th>D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers</th>
<th>Topics: D1 PS2 - Materials for Electrotechnical Technical Purposes and Modelling</th>
<th>Keywords: Dielectric properties, liquid nitrogen, resistive superconductive, pre-conditioning, DC applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dielectric properties of liquid nitrogen for the design of Resistive Superconductive Fault Current Limiters</td>
<td>Diego BRASILIANO, Christophe CREUSOT, Nicolas DEVEAUX, Alain GIRODET, Laurent MATHRAY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SuperGrid Institute, France</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10487</th>
<th>D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers</th>
<th>Topics: D1 PS2 - Materials for Electrotechnical Technical Purposes and Modelling</th>
<th>Keywords: Interfacial Dielectric Strength, Breakdown Strength, Cable Joint, Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluating the Interfacial Compatibility of Dielectric Materials for Cable Joints</td>
<td>Paul MWASAME¹, Xiaoshuang WEI¹, Timothy PERSON¹, Saurav SENGUPTA¹, Michael CHERRY¹, Wenbo XU¹, Joel CERVA¹, Yuanqiao RAO¹, Junsu GU¹, Robert DRAKE²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>¹Dow Chemical, United States of America; ²Dow Chemical, United Kingdom</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10824</th>
<th>D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers</th>
<th>Topics: D1 PS2 - Materials for Electrotechnical Technical Purposes and Modelling</th>
<th>Keywords: accelerated testing, thermal aging, ethylene vinyl acetate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigation of Aging of the Polymer Cable Composition Based on Ethylene Vinyl Acetate</td>
<td>Darya BOLOTINA¹, Alexander KONONENKO¹, Alexey POMERANTSEV², Alexander TSIKANIN¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>¹RISI JSC, Russian Federation; ²RISI JSC, FRCCP RAS, Russian Federation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10826</th>
<th>D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers</th>
<th>Topics: D1 PS2 - Materials for Electrotechnical Technical Purposes and Modelling</th>
<th>Keywords: cellulose, insulation, degree of polymerization, supramolecular structure, grinding</th>
</tr>
</thead>
<tbody>
<tr>
<td>The influence of Preparation Method of Cellulose Insulation Samples on Determining the Degree of Polymerization</td>
<td>Leonid DARIAN¹, Victor GAVRILYUK², Darya VERAKSO¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>¹JSC «Technical Inspection UES», Russian Federation; ²MIREA — Russian Technological University, Russian Federation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10855</th>
<th>D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers</th>
<th>Topics: D1 PS2 - Materials for Electrotechnical Technical Purposes and Modelling</th>
<th>Keywords: Contamination, Finite element method, Insulating paper, Partial discharges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of Finite Element Model for Simulation of Partial Discharge Detection Circuit in Contaminated Paper-Oil Insulation Systems</td>
<td>Carlos Kleber DA COSTA ARRUDA¹, Adriana DE CASTRO PASSOS MARTINS², Alain François SANSON LEVY², Orsino BORGES DE OLIVEIRA FILHO¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>¹Brazilian NC of CIGRE, Brazil; Eletrobras CEPEL; ²CEMIG; ³Consultant</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10856</th>
<th>D1 MATERIALS AND EMERGING TEST TECHNIQUES - Full Papers</th>
<th>Topics: D1 PS2 - Materials for Electrotechnical Technical Purposes and Modelling</th>
<th>Keywords: Natural Ester - Paper degradation - IEEE Std C57.100 - Arrhenius curve - Thermal Class - Thermal Index - Sealed Tube - IEC 60076-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal class of thermally upgraded paper in natural ester and in mineral insulating oils according to IEEE C57.100-2011</td>
<td>Helena Maria WILHELM¹, Paulo FERNANDES¹, Richard MAREK²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>¹Brazilian NC of CIGRE, Brazil; Vegoor; ²Consultant</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Thermal stresses of hybrid paper (aramid/cellulose) in natural ester and in mineral insulating oils
Helena Maria WILHELM¹, Paulo FERNANDES¹, Richard MAREK², Marco MARIN³, Germano F. MORAES³, Nelson VELOSO³, Tiago MARCHESAN³, Vitor BENDER⁴
¹Brazilian NC of CIGRE, Brazil; ²Consultant; ³COPEL; ⁴UFSM University

Silver Corrosion Testing and Mitigation
Jelena LUKIĆ¹, Jelena JANKOVIĆ¹, Draginja MIHAJLOVIĆ¹, Sandra GLIŠIĆ², Aleksandar ORLOVIĆ²
¹Electrical Engineering Institute Nikola Tesla, Serbia; ²Faculty of Technology and Metallurgy of the University of Belgrade, Serbia

Assessing dissolved Gas Analysis on inhibited and uninhibited Mineral Oils and natural Esters under simulated Thermal Fault
Pär WEDIN
Nynas AB, Sweden

Enhancing Electrical Insulation Performance of Insulating Spacers using Functionally Graded Materials in Natural-Origin Gas GIS
Kenji OKAMOTO¹, Naoki HAYAKAWA², Katsumi KATO³, Naoki OSAWA⁴, Masahiro KOZAKO⁵, Hitoshi OKUBO⁶
¹Fuji Electric Co., Ltd., Japan; ²Nagoya University, Japan; ³N. I. T., Niihama College, Japan; ⁴Kanazawa Institute of Technology, Japan; ⁵Kyushu Institute of Technology, Japan; ⁶Aichi Institute of Technology, Japan

Comparison of PRPD Pattern of Electrical and UHF PD Measurements at Cable Terminations
Rouven BERKEMEIER¹, Robert BACH¹, Niklas PECK¹, Stefan TENBOHLEN²
¹South Westphalia University of Applied Sciences Soest, Germany; ²Universität Stuttgart, Germany

Development of Superhydrophobic Coating for Outdoor Polymeric Insulators
M-Ramez HALLOUM, Subba REDDY B*
Indian Institute of Science, India

Degassing Simulator for XLPE Cables
Taeuk KIM, Jonghae KIM, Youngjae CHOI, Youngseng KIM
LS Cable & System, Korea, Republic of (South Korea)

On the development of multiscale conductivity models for extruded HVDC Cable Insulation
Mikael UNGE - NKT AB, Sweden
SF6 Gas Disposal Using Microwave Plasma Technology
Sethuraman MUTHUKARUPPAN¹, Avinash Ashwin Raj RAJA GOPAL², Nur Syazwani ABDUL BAHARI²
¹Tenaga Nasional Berhad Malaysia; ²TNB Research Sdn. Bhd. Malaysia

PS3 - MATERIALS TO ENABLE THE ENERGY TRANSITION

Chemistry of C4-FN gas mixtures and application in high-voltage equipment
Marcel STOECKLI¹, Lise DONZEL*², Saskia BUFFONI², Pawel KRAWCZYK², Michael GATZSCHE²
¹ELECTROSUISSE, Switzerland - CIGRE NC Secretariat; ²Hitachi Energy, Switzerland

Environmentally friendly and highly efficient novel corrosion protection coatings for electrical equipment under harsh environmental conditions
Ivanka HOEHLEIN², Jürgen BÜTTNER¹, Valentin KOPP¹, Christian SCHRAMM¹
¹Chemische Industrie Erlangen, Germany; ²Siemens Energy, Germany

Recent development of nanomaterials for batteries and dielectric capacitors for energy storage in Japan
Yasunori TANAKA¹, Makoto KAMBARA¹, Minoru OSADA³, Shigemitsu OKABE², Akiko KUMADA²
¹Kanazawa University, Japan; ²Osaka University, Japan; ³Nagoya University, Japan; ⁴The University of Tokyo, Japan

Data-driven Exploration for SF6 alternative Gas with Quantum Mechanics-assisted Machine Learning
Masahiro SATO, Hajime SHIMAKAWA, Akiko KUMADA
The University of Tokyo, Japan

New C4-FN and C4-FN mixture gas models as a common reference for users and equipment manufacturers
Christian IHMELS¹, Max CLAESSENS², Michael GATZSCHE³, Maxime PERRET³, Thomas BERTELOOT⁴, Christophe COQUELET⁵
¹LTP GmbH, Germany; ²Hitachi Energy, Switzerland; ³GE Vernova, Switzerland; ⁴GE Vernova, France; ⁵IMT Mines Albi, France

Experimental evaluation of the dielectric properties of insulating paper impregnated in mineral and vegetable oil as function of moisture
Ismael ANTOLIN, Pedro J. QUINTANILLA, Cristina MENDEZ, Cristian OLMO, Pablo GOMEZ
Departamento de Ingeniería Eléctrica y Energética, Universidad de Cantabria Santander, Spain
ID: 10270
D2 INFORMATION SYSTEMS, TELECOMUNICATIONS AND CYBERSECURITY - Full Papers
Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems
Exploration and Practice of Cloud Orchestration in New Power System Distribution Scenarios
Fuyou SUN1, Xiaolong REN2, Yunzhan LI1, Shoubin ZAI1, Wenbo XIA1, Lianchang SONG1
1Huawei Technologies Co., Ltd., China; 2State Grid Corporation of China, China

ID: 10273
D2 INFORMATION SYSTEMS, TELECOMUNICATIONS AND CYBERSECURITY - Full Papers
Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems
Keywords: DoA estimation, Substation asset management, Switched beam antenna array, WSN
Design of smart planar antenna array with optimal directivity in eight directions detecting ISM band wireless sensors for IT/OT solutions and substation asset condition monitoring & deep learning applications
Reham Elsamnty EL SAMNTY1, Sabah Mashaly MASHALY1, Ahdab El Morshedh MORCHEDY2
1Egyptian Electricity Transmission Company (EETC) Egypt; 2Egyptian National Committee of Cigre

ID: 10300
D2 INFORMATION SYSTEMS, TELECOMUNICATIONS AND CYBERSECURITY - Full Papers
Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems
Keywords: Open-source, standardization, grid-related data models, IEC CIM semantic standards, IOT
A possible win-win cohabitation of open-source and standardization
Laurent GUISE1, Gilles NATIVEL2, Benoit JEANSON3, Philippe TAILHADES4, Boris DOLLEY2, Eric LAMBERT5, Camille BLOCH6
1Emergysemantic.com, France; 2ENEDIS, France; 3RTE, France; 4GIMELEC, France; 5EDF, France; 6Schneider Electric. France

ID: 10344
D2 INFORMATION SYSTEMS, TELECOMUNICATIONS AND CYBERSECURITY - Full Papers
Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems
Keywords: energy data, electric power system, AI solutions, common semantic data model, IEC standards
OMEGA-X: Energy Data Space for improving efficiency of electric power systems leveraging semantic interoperability and AI
Eric LAMBERT1, Erik MAQUEDA2, Javier VALIÑO3, Olivier GENEST4, Valentina JANEV5, Bruno TRAVERSON1, Maxime LEFRANÇOIS6, Lina NACHABE6, Amélie GYRARD4, Antonio KUNG4
1EDF R&D, France; 2Tecnalia, Spain; 3ATOS, Spain; 4Trialog, France; 5Pupin Institute, Serbia; 6Mines St Etienne, France

ID: 10397
D2 INFORMATION SYSTEMS, TELECOMUNICATIONS AND CYBERSECURITY - Full Papers
Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems
The journey of digitalization: how Smart Digital Substations can drive the Industrial Internet of Things revolution
Alessandro PEDRETTI
Hitachi Energy, Italy

ID: 10398
D2 INFORMATION SYSTEMS, TELECOMUNICATIONS AND CYBERSECURITY - Full Papers
Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems
Digital twin for asset management of electric power systems based on IEC CIM and BIM integration
Enea BIONDA
RSE, Italy

ID: 10399
D2 INFORMATION SYSTEMS, TELECOMUNICATIONS AND CYBERSECURITY - Full Papers
Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems
Market driven architecture for remote monitoring of HV assets
Sebastiano SCAR PACI
HITACHY ENERGY, Italy
Orchestrated ICT architecture for grid monitoring of distribution power grid
Roberta TERRUGGIA
RSE, Italy

Development of Common Distribution Power System Model (CDPSM) based profiles and the proposed validation process
Harish KRISHNAPPA, Stephan LUPP, Bas KRUIMER, Lino PRKA
DNV

Integrating Artificial Intelligence Models and Synthetic Image Data for Enhanced Asset Inspection and Defect Identification
Po-Chen CHEN¹, Reddy MANDATI¹, Vladyslav ANDERSON¹, Ankush AGARWAL¹, David BARNARD², Michael FINN², Jesse CROMER², Tatjana ĐOKIĆ, Andrew MCCAULEY¹, Clay TUTAJ¹, Neha DAVE¹, Bobby BESHARATI¹, Jamie BARNETT², Timothy KRALL¹
¹Exelon Corporation, United States of America; ²BGE, An Exelon Company, United States of America

A.I. Searchable Synchrophasor Database for Power System Protection
Alberto RAMÍREZ ORQUÍN, Vanessa RAMÍREZ
Resilient Grids LLC, United States of America

AI and Cloud-based Digital Transformation of Utility Asset Management and Inspections
Junhui ZHAO, Jing YANG, Umair ZIA, Asim FAZLAGIC
Eversource Energy, United States of America

Digitalization of distribution assets by use of DSO-API-REST
Markel SANZ HERAS¹, David SANTACRUZ PELAEZ¹, Fernando IBÁÑEZ ALAMEDA², Jonathan GONZÁLEZ RÍOS³
¹I-DE, Spain; ²Tecnalia, Spain; ³Merytronic, Spain

Development and HILS Test of an AI Model for Optimal Operation of ESS in Renewable Energy Integrated EV Charging Station
Yundong SEO¹, Seungho HWANG¹, Gilsung BYEON², Dongjun WON³
¹SK Telecom Co., Ltd.; ²Korea Electrotechnology Research Institute, Korea, Republic of (South Korea); ³Inha University, Korea, Republic of (South Korea)
| ID: 10830 |
| D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers |
| Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems |
| Keywords: common information model (CIM), data verification, grid model verification, network model management |

**Data Verification in Power System Modelling**  
Nikolay BELYAEV, Roman BOGOMOLOV  
JSC SO UPS, Russian Federation

| ID: 10831 |
| D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers |
| Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems |
| Keywords: big data, machine learning, RES, forecasting |

**Improving the Accuracy of RES Generation Forecast to Ensure Their Reliable Operation in the Power System**  
Irina BOBRITSKAYA, Aleksandr KRYMOV, Alexey ARKHFIPOV  
JCS SO UPS, Russian Federation

| ID: 10832 |
| D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers |
| Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems |
| Keywords: big data, machine learning, RES, forecasting |

**Big Data Processing and Representation in the Low-frequency Oscillations Analysis**  
Andrey RODIONOV1, Kirill BUTIN2, Aleksandr POPOV3, Dmitry DUBININ3, Olga ZHURAVLEVA3  
1Energoservice, Russian Federation; 2NARFU, Russian Federation; 3JSC SO UPS, Russian Federation

| ID: 10833 |
| D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers |
| Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems |
| Keywords: AI, ADMS, Big Data, decision support system, distribution networks, neural networks, state estimation, power flow forecasting |

**Symbiosis of Artificial Intelligences in Automated Systems of Supervisory Control of the Electrical Grid of a Distribution Grid Company**  
Sergey RYKOVANOV, Mikhail KHOZYAINOV  
SYSTEL LLC, Russian Federation

| ID: 10858 |
| D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers |
| Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems |
| Keywords: Technology; Virtual reality; Power Transmission, Distribution and Generation |

**Virtual Reality and gamification as tools for training operation teams, maintenance of substations and energy transmission lines**  
Leandro Henrique DA SILVA1, Juliano CORTES DE SOUZA2, Josias MATOS DE ARAUJO3  
1Brazilian NC of CIGRE, Brazil; Virtual Engenharia; 2Comando Engenharia; 3Eng Smart Lead

| ID: 10859 |
| D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers |
| Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems |
| Keywords: Utility Communications, Substation IED Management, Telecom Management |

**Advanced Management and Control of Grid Substation’s IEDs and Communication Devices in the Electric Power Utility**  
Marcelo ZAPELLA, Ramesh POTLAPULA, Adriano PIRES, Mehrdad MESBAH  
Brazilian NC of CIGRE, Brazil; GE Grid Solutions

| ID: 10860 |
| D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers |
| Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems |
| Keywords: WAMPAC, 5G, IEC 61850, Power System |

Mayara Helena SANTOS1, Nicolas FULLI1, Fabio BRUNS2, Ana Carolina PEDREIRA CAPELLA1, Joyce MEIRELLES2, Yona LOPES2  
1Brazilian NC of CIGRE, Brazil; UFF Fluminense Federal University; YSMART ECT; 2UFF Fluminense Federal University; 3TIM Brasil
## Leveraging Machine Learning for Multi-Step Failure Forecasting in RTU Analog Modules and Estimating Key Performance Indicators to Support Management Decision-Making

Daniel FELIP, Eduardo CORONEL  
Itaipu Binacional

## Probabilistic framework for resilience enhancement of distribution grids

Ashwin SHIRSAT2, Jishnudeep KAR2, Kevin SCHOENLEBER1, Katarina KNEZOVIC2, Dmitry SHCHETININ2, Lena SEMBACH2, Elise FAHY2, Hennie NEL4  
1Hitachi Energy Research, Germany; 2Hitachi Energy Research, USA; 3Hitachi Energy Research Switzerland; 4Hitachi Energy South Africa

## Optical Fiber Monitoring and Management System (ONMS)

Ariel CAMPOS  
TRANSENER

## Digital Edge Platform applied on Power Systems as a Key to Energy Transition

Fabián Edgardo LÓPEZ, Edgardo Exequiel NOGARA, Gabriel Franriq BONILLA, Edgardo Rubén FONOLL  
DISTROCUYO SA

## Data collection considerations for AI and machine learning in wind power equipment

Tsuyoshi SUGIYAMA  
Electric Power Development Co., Ltd., Japan

## Augmented Operator Advisor based on Augmented Reality

Ashish MHATRE, Ramakant MADANE, Prithviraj KHAN  
TATA Power Company, India

## Upgradation of SCADA/EMS System at National Level – A Case Study

Mohneesh RASTOGI, Harish Kumar RATHOUR, Debasis DE, S C SAXENA  
GRID-INDIA, India

## Convergence of Information Technology and Operational Technology Systems – Business Operational Requirements in a Secure Manner

Amba Prasad TIWARI, Royal SUTNGA, Abrar AHMAD, Paominlal DOUNGEL, Sakal DEEP*  
Grid Controller of India Limited, India
**ID: 11277**

**D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers**

*Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems*

**Keywords:** Unified Asset Management Platform, Data Integration, Big Data Analytics, OT integration

**UDAAN - Creation of a Unified Asset Management Platform via IT/OT Integration for Big Data Management in POWERGRID**

Kuleshwar SAHU*, Deo Nath JHA, Devaprasad PAUL, Shumali MEENA

POWERGRID, India

**ID: 11280**

**D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers**

*Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems*

**Innovative Approaches for Improving Efficiency and Resilience in Electric Power Systems: A Focus on IT/OT Architectures and Solutions**

Dr Sunita CHOHAN*, A K SINGH, Nitin SINGH, G RAVITEJA

POWERGRID, India

**ID: 11288**

**D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers**

*Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems*

**Monitoring of remote S/S through Robotics, Augmented Reality and Artificial Intelligence**

Ashish MHATRE*, Ravi Sahu SAHU, Ramakant MADANE

TATA Power Company, India

**ID: 11294**

**D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers**

*Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems*

**Grafana for Grid data Monitoring and Visualization at Western Regional Load Despatch Centre (WRLDC), GRID-INDIA**

Pulla Naga SUDHIR*, Mahesh M MEHANDALE, Veluri BALAJI, Sunil K PATIL

Grid Controller Of India Limited, India

**ID: 11298**

**D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers**

*Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems*

**Energy Optimization in Blockchain Enabled Smart Distribution Grid**

Shyam AGARWAL, Amit JAIN*

Central Power Research Institute, India

**ID: 11304**

**D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers**

*Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems*

**Keywords:** Energy, Residential Load Consumption, Electricity Forecasting, Long Short-Term Memory, Multilayer Perceptron

**State-of-the-Art Algorithms for short-term residential Load forecasting for Smart Grids**

Vasileios LAITSOS1, Georgios VONTZOS2, Georgios LOUKOS1, Paschalis PARASCHOUDIS1, Sotiris CHRISTOPOULOS1, Konstantinos KAOUSSIAS1, Katerina DRIVAKOU1, Despoina MAKRYGIORGOU1, Dimitrios BARGIOTAS2

1Hellenic Electricity Distribution Network Operator, Greece; 2Univ. of Thessaly - Dept. of Elec. and Comp. Eng., Greece; 3UBITECH ENERGY, Belgium; 4Independent Power Transmission Operator, Greece

**ID: 11658**

**D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers**

*Topics: D2 PS1 - IT/OT Solutions to improve the Efficiency and Resilience of Electric Power Systems*

**Enhancing Power Grid Failure Data by Leveraging AI-driven Text Classification: A Danish Case Study**

Konrad SUNDGAARD

Green Power Denmark
Analyses of Lightning Induced Faults Recorded by Diverse Monitoring Systems in the Transmission Network Based on a New Concept of Data Lake Design

Bozidar FILIPOVIC-GRCIC1, Bojan FRANC1, Bruno JURISIC2, Tihomir JAKOVIC2, Tomislav ZUPAN2, Antonija IVISIC3, Ivan STURLIC4, Alan ZUPAN4

1University of Zagreb Faculty of Electrical Engineering and Computing, Zagreb, Croatia; 2Končar – Electrical Engineering Institute Ltd., Croatia; 3Business Analytics and BI, Comping d.o.o., Croatia; 4Croatian Transmission System Operator Plc., Croatia

IT/OT Convergence and Standard Architectures for DERs Considering Companion Specifications, Interoperability, IoT Technologies and Cloud Solutions

Luis BERRIO, Daniel URQUINA, Rafael LUNA, Fabio GIRALDO, Melqui CAMACHO, Omar ALZATE, Marcela GIRALDO

EPM

Driving and Empowering Digital Transformation: Successful Implementation of IIoT Pilots for Advanced Monitoring

Mauricio HERNANDEZ, German CARDENAS

ISA Intercolombia

Artificial Neural Network-Based Peak Demand Forecasting and Biogas Power Plant Control for Peak Demand Reduction in Factory

Praditthon PATCHARAUBONGASEAM, Supatchaya LEELUDEJ

Electricity Generating Authority of Thailand (EGAT), Thailand

PS2 - CYBERSECURITY IN EMERGING APPLICATION DOMAINS AND TECHNOLOGIES FOR SECURING ENERGY ORGANISATIONS

Cybersecurity In the Loop for multi energy infrastructures

Giovanna DONDOSOLA

RSE, Italy

The Elektrilevi's Advanced Remote Engineering Platform (AREP)

Indrek KÜNNAPUU1, Hando LUUS2, Rene VOOG1, Ameen HAMDON3

1Elektrilevi OU, Estonia; 2Enefit, Estonia; 3SUBNET Solutions Inc., Canada

Performing Risk Assessments of EV Charging Systems

Djenana CAMPARA1, Nikolai MANSOUROV2, Adnan BOSOVIC1, Svetlana MISUT1, Adnan AHMETHODZIC2, Meludin VELEDAR1

1BH K CIGRE, Bosnia and Herzegovina; 2KDM Analytics, Canada; 3Elektroprivreda BiH, Bosna i Hercegovina
Lessons Learned from Infrastructure Attacks on Substations A Lens on North and South America.
Pablo Narvaez, Elkin Cantor
1 UMS Group; 2 ISA Intercolumbia

A Strategy for Cyber Risk Mitigation in Smart Grids Through Traffic Management
Oscar Tobar, German Rueda, Johan Castro, Octavio Diaz, German Zapata, Rodolfo Garcia
1 Universidad Nacional; 2 Enel Colombia

Cybersecurity for Communication Systems for Digital Electrical Substations Leveraging Emerging Network Technologies
German Rueda, Oscar Tobar, John Branch, Juan Botero, Sergio Gutierrez, Germán Zapata
1 Universidad Nacional; 2 Universidad de Antioquia

Implementing a Protection Management System in AWS Cloud: Strict Cyber Security Standards & Rules and experience of system in Production
Santitos Garcia Zamora, Pavel IPenza, Ameen HAMDON
1 ENEL Distribution Peru; 2 Nakama S.A.C Peru; 3 SUBNET SOLUTIONS INC

N.M. Sheth*, B.J. Patel, D.P. Singh
Gujarat Energy Transmission Co. Ltd, India

Cyber Security Assessment of Digital Substation using Petri Nets
Sajal Sarkar*, Yogendra Tiwari, Anand Shankar
Power Grid Corporation of India Ltd, India

Hardened (Air-gapped) IT-OT Interconnection – A Case study on Proof of Concept in Context of Power System Operation
K MuraliKrishna, Harish Rathour, Ankur Gulati, Anwaya Bilas Sengupta
GRID-India, India

Evaluation of the Maturity of Cybersecurity in the Colombian Power System
Jaime Zapata, Juan Molina, Luisa Buitrago
1 XM; 2 Colombia Inteligente
### PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks

**ID: 10101**
*D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers*
*Topics: D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks*
*Keywords: 5G, 5G Standalone, Protection, Fault, Fault Indication, Edge Computing*
*Exploring the Reliability of Commercial 5G Standalone Networks for Virtual Fault Passage Indication*
*Petra RAUSSELL, Heli KOKKONIEMI-TARKKANEN, Jorma KILPI, Anna KULMALA, Petri HOVILA*
1 VTT Technical Research Centre of Finland; 2 ABB Oy

**ID: 10109**
*D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers*
*Topics: D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks*
*Keywords: 5G, Edge computing, Fault, Line differential, Protection*
*Applicability of 5G Communication to Line Differential Protection for Distribution Networks*
*Petri HOVILA, Petri SYVÄLUOMA, Anna KULMALA, Rajasekaran DEVADASS, Petteri VAARA*
ABB Oy

**ID: 10110**
*D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers*
*Topics: D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks*
*Keywords: MPLS-TP, teleprotection, PTP, inter substation communications*
*Migration from TDM Networks to MPLS-TP, Field Experiences*
*Kimmo KARKULEHTO, Antti VIRO*
1 Fingrid Oyj; 2 DNWP

**ID: 10376**
*D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers*
*Topics: D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks*
*Keywords: MPLS-TP, SDH, Line Differential Protection, Teleprotection*
*Optical Systems Performance for Line Protection Schemes*
*Jozthdwing RAMIREZ, Jose BORDA*
1 GE Grid Automation Venezuela; 2 Nakama Soluciones Peru

**ID: 10571**
*D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers*
*Topics: D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks*
*Keywords: Utility Infrastructure, Network Telecommunication, Radio Frequency, Smart Metering, Smart City*
*The Next Generation of Joint-Use Utility Infrastructure*
*Mahavish MAHMOOD, Marianne GUIEB, Gregory R. BELL*
Commonwealth Edison, United States of America
<table>
<thead>
<tr>
<th>ID: 10572</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers</strong></td>
</tr>
<tr>
<td><strong>Topics:</strong> D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks</td>
</tr>
<tr>
<td><strong>Keywords:</strong> Passive Optical Network (PON); Gigabyte Passive Optical Network (GPON); Expedited, Deterministic, Redundant, PON (EDRP); Optical Line Terminal (OLT); Optical Network Terminal (ONT)</td>
</tr>
<tr>
<td><strong>Redundant Passive Optical Network (PON) Transport for Grid Intelligence</strong></td>
</tr>
<tr>
<td>Juan ORNELAS¹, Michael MORGAN¹, Arien MAJETTE¹, James CONWAY²</td>
</tr>
<tr>
<td>¹Exelon, United States of America; ²ComEd, United States of America</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10573</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers</strong></td>
</tr>
<tr>
<td><strong>Topics:</strong> D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks</td>
</tr>
<tr>
<td><strong>Keywords:</strong> Evolved Packet Core (EPC), Private Long-Term Evolution (PLTE), Radio Access Network (RAN), User Equipment (UE)</td>
</tr>
<tr>
<td><strong>PLTE Testing of Utility Use Cases in Support of Grid Modernization</strong></td>
</tr>
<tr>
<td>Jayson SHIAU¹, Arien MAJETTE¹, Nwabueze PHIL-EBOSIE¹, Michael MORGAN³</td>
</tr>
<tr>
<td>¹Commonwealth Edison (ComEd), United States of America; ³Exelon, United States of America</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10648</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers</strong></td>
</tr>
<tr>
<td><strong>Topics:</strong> D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks</td>
</tr>
<tr>
<td><strong>Migration from MPLS-TP &amp; SDH Hybrid Networks to OTN Optical Transport Networks</strong></td>
</tr>
<tr>
<td>Ariel CAMPOS</td>
</tr>
<tr>
<td>TRANSENER</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10652</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers</strong></td>
</tr>
<tr>
<td><strong>Topics:</strong> D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks</td>
</tr>
<tr>
<td><strong>Mapping Multiprotocol Services into a MPLS Critical Infrastructure Network</strong></td>
</tr>
<tr>
<td>Juan Ramón FEIJOO MARTÍNEZ, José María DELGADO ÁLVAREZ, Bruno PERALTA VICENTE</td>
</tr>
<tr>
<td>Red Electrica, Spain</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10758</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers</strong></td>
</tr>
<tr>
<td><strong>Topics:</strong> D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks</td>
</tr>
<tr>
<td><strong>Quantum Key Distribution for MPLS-TP Traffic Encryption</strong></td>
</tr>
<tr>
<td>Marcel STOECKLI¹, Ramon BAECHLI¹, Rouven FLOETER², Vivek PALANGADAN², Axel FOERY³</td>
</tr>
<tr>
<td>¹ELECTROSUISSE, Switzerland; ²Hitachi Energy, Switzerland; ³ID Quantique, Switzerland</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 10992</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers</strong></td>
</tr>
<tr>
<td><strong>Topics:</strong> D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks</td>
</tr>
<tr>
<td><strong>Electric Power Industry of Serbia IP MPLS network application for communications of technical information systems</strong></td>
</tr>
<tr>
<td>Danilo LALOVIC¹, Vesna VUKICCEVIČ¹, Ivan VUKADINOVIĆ¹, Vigor STANIŠIĆ¹, Zlatko MITROVIĆ¹, Miodrag JEVTIĆ², Dalibor MITIĆ²</td>
</tr>
<tr>
<td>¹EPS JSC, Serbia; ²SAGA, Serbia</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11209</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers</strong></td>
</tr>
<tr>
<td><strong>Topics:</strong> D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks</td>
</tr>
<tr>
<td><strong>Implementation of “Software-Defined Networking” as an Alternative for Efficient Traffic Management in Digital Substations</strong></td>
</tr>
<tr>
<td>Octavio DIAZ¹, Germán RUEDA¹, Johan CASTRO¹, Oscar TOBAR¹, Germán ZAPATA¹, Rodolfo GARCIA²</td>
</tr>
<tr>
<td>¹Universidad Nacional; ²Enel Colombia</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: 11222</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers</strong></td>
</tr>
<tr>
<td><strong>Topics:</strong> D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks</td>
</tr>
<tr>
<td><strong>IP Network Availability Improvement Initiatives</strong></td>
</tr>
<tr>
<td>Sho TAMURA, Yuichi SHINOHARA</td>
</tr>
<tr>
<td>TEPCO Power Grid, Inc., Japan</td>
</tr>
<tr>
<td>ID: 11227</td>
</tr>
<tr>
<td>---</td>
</tr>
</tbody>
</table>
| **Topics:** D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks  
**Keywords:** Internet protocol, Network, Microwave, MPLS TE, Resilient  
**Techniques and methods in building resilient networks that support critical applications for Electricity Power Utilities** |

Ryutichi MURAKAMI¹, Makoto KUBO¹, Hiroyuki NAKAGAWA²  
¹Tohoku Electric Power Network Co., Inc., Japan; ²Nakagawa Juniper Networks, Inc., Japan

<table>
<thead>
<tr>
<th>ID: 11229</th>
<th>D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers</th>
</tr>
</thead>
</table>
| **Topics:** D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks  
**Keywords:** MPLS-TP, Packet-switched network, Resiliency, TDM, Wireless microwave network  
**Requirements for resilient packet-switched network using MPLS-TP and wireless microwave technology** |

Toshiki KINOSHITA¹, Davy HAEDEGORENS²  
¹Chugoku Electric Power Transmission & Distribution Co., Inc., Japan; ²OTN Systems, Belgium

<table>
<thead>
<tr>
<th>ID: 11233</th>
<th>D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers</th>
</tr>
</thead>
</table>
| **Topics:** D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks  
**Keywords:** IEC 61850, Process Bus, Availability, Parallel Redundancy Protocol, High-availability Seamless Redundancy  
**A Fast and Accurate Calculation Method of Availability for Protection Relays Applying the IEC 61850 Process Bus** |

Akihiro TANAKA, Eiji OHBA  
Central Research Institute of Electric Power Industry, Japan

<table>
<thead>
<tr>
<th>ID: 11260</th>
<th>D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers</th>
</tr>
</thead>
</table>
| **Topics:** D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks  
**Keywords:** Internet Protocol Security, Optical Fiber Ground Wire, Time Division Multiplexing  
**Implementing Telecommunications Network For Remote Operation Of Substations From National Transmission Asset Management Centre (NTAMC) By POWERGRID – A Novel Experience** |

Manoj KUMAR, Anoop Kumar SINGH, Vimlesh KUMAR  
POWERGRID, India

<table>
<thead>
<tr>
<th>ID: 11264</th>
<th>D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers</th>
</tr>
</thead>
</table>
| **Topics:** D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks  
**Implementation of HVDC-Emergency Power Control at HVDC Raigarh by Integrating Two Different Geographical Locations Through IEC 61850 Platform Over SDH Network** |

TVS Praveen KUMAR, N.B ADARI, Sunil KUMAR, Yogesh MISAL  
POWERGRID, India

<table>
<thead>
<tr>
<th>ID: 11283</th>
<th>D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers</th>
</tr>
</thead>
</table>
| **Topics:** D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks  
**Overview of State-of-the-Art Unified Network Management System for Managing Multivendor and Multi-Technology Power System Communication Network and attaining more Reliable, Scalable & Efficient Communication Network** |

Dr. Sunita CHOHAN*, Shyama KUMARI, Gaurav AWAL, Sangita Sarkar SARKAR, Nutan Mishra MISHRA, VS Bhal BHALL  
POWERGRID, India

<table>
<thead>
<tr>
<th>ID: 11492</th>
<th>D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers</th>
</tr>
</thead>
</table>
| **Topics:** D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks  
**Development of Wireless Communication Environments for the Smart Industrial Safety in Power Plants** |

Kazuari KUWAHARA, Ryota HIGASHI, Tetsuya KOTOKA, Kazuaki NARIAI, Koushiro NAKAGAWA  
Kyushu Electric Power Co., Inc., Japan

<table>
<thead>
<tr>
<th>ID: 11773</th>
<th>D2 INFORMATION SYSTEMS, TELECOMMUNICATIONS AND CYBERSECURITY - Full Papers</th>
</tr>
</thead>
</table>
| **Topics:** D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks  
**Strengthen cybersecurity and device management of cellular communication systems** |

Sever SUDAKOV, Yin CHANG  
Moxa Inc. Taiwan
ID: 11781
D2 INFORMATION SYSTEMS, TELECOMUNICATIONS AND CYBERSECURITY - Full Papers
Topics: D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks
Keywords: ANDE, BGP, Fast ReRoute, OSPF, PDC, PMU, Pseudowire, MPLS-TP, SDN, SDH, WAMPAC.

**MPLS-TP as a communication protocol for Critical Infrastructure transport networks: Challenges in the implementation of the protocol in WAMPAC systems of ANDE - Paraguay**

Chrystian RUIZ DIAZ¹, Enrique DAVALOS², Cecilia VEGA¹
¹ANDE; ²Facultad Politécnica – UNA

ID: 11850
D2 INFORMATION SYSTEMS, TELECOMUNICATIONS AND CYBERSECURITY - Full Papers
Topics: D2 PS3 - Meeting the Challenges of Energy Transition with Reliable, Scalable, and Efficient Telecommunications Networks
Keywords: failure detection, network management, network monitoring, Operational Technology, OT, SCADA

**Implementation and Impact of Network Management and Monitoring Systems on ANDE's Operational Technology (OT) Network**

Ricardo LOREIRO, Chrystian RUIZ DIAZ
ANDE

ACKNOWLEDGMENTS

CIGRE would like to particularly thank Study Committee Chairs and Secretaries for their valuable contribution in reviewing and assessing 2024 Synopses and Session Papers.

STUDY COMMITTEES

<table>
<thead>
<tr>
<th>Name</th>
<th>Chair</th>
<th>Secretary</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Kevin MAYOR</td>
<td>Peter WIEHE</td>
</tr>
<tr>
<td>A2</td>
<td>Pascal MUELLER</td>
<td>Marc FOATA</td>
</tr>
<tr>
<td>A3</td>
<td>Nenad UZELAC</td>
<td>Frank RICHTER</td>
</tr>
<tr>
<td>B1</td>
<td>Geir CLASEN</td>
<td>Matthieu CABAU</td>
</tr>
<tr>
<td>B2</td>
<td>Pierre Van DYKE</td>
<td>Vivek T. CHARI</td>
</tr>
<tr>
<td>B3</td>
<td>Koji KAWAKITA</td>
<td>Samuel NGUEFEU</td>
</tr>
<tr>
<td>B4</td>
<td>Joanne HU</td>
<td>Rebecca OSTASH</td>
</tr>
<tr>
<td>B5</td>
<td>Rannveig Løken</td>
<td>Richard ADAMS</td>
</tr>
<tr>
<td>C1</td>
<td>Antonio ILICETO</td>
<td>Peter RODDY</td>
</tr>
<tr>
<td>C2</td>
<td>Jayme DARRIBA</td>
<td>Flavio Rodrigues de MIRANDA ALVES</td>
</tr>
<tr>
<td>C3</td>
<td>Mercedes VAZQUEZ</td>
<td>Angel SALINAS</td>
</tr>
<tr>
<td>C4</td>
<td>Marta VAL ESCUDERO</td>
<td>Genevieve LIETZ</td>
</tr>
<tr>
<td>C5</td>
<td>Alex CRUICKSHANK</td>
<td>Yannick PHULPIN</td>
</tr>
<tr>
<td>C6</td>
<td>Kurt DEDEKIND</td>
<td>Evert De HAAN</td>
</tr>
<tr>
<td>---------</td>
<td>---------------</td>
<td>---------------</td>
</tr>
<tr>
<td>D1</td>
<td>Simon SUTTON</td>
<td>WILSON Gordon</td>
</tr>
<tr>
<td>D2</td>
<td>Victor TAN</td>
<td>Joël NOUARD</td>
</tr>
</tbody>
</table>
CIGRE would like to thank also the Experts for their valuable contribution in reviewing and assessing 2024 Synopses and Session Papers.

EXPERTS
(Alphabetical order)

Ahmad Taufiq ABDULLAH THANI
Henry ABRAMS
Michel Guy ACACIA
Praveen Kumar AGARWAL
Adedotun AGBEMUKO
Abdulrahman AHLI
Florian AINHIRN
Aqeel Mohamed ALAWADY
Mohamed ALHAMAD
Abeer M ALMAIMOUNI
Nasser ALSHAHRANI
Raul ALVAREZ
Anish ANAND
Bruno ANDRE
Thomas ANDRITSCH
Sara ANILD
Arfan ANJUM
Juan Carlos ARANEDA
Carlos Kleber da Costa ARRUDA
Theerasak ARUNTHANAKIJ
Kim Ove ASKLUND
Ivanka ATANASOVA-HOEHELIN
Omar Salah Elsayed ATWA
Alphons Dirk Jan BAAS
Babak BADRZADEH
Behrooz BAHRAKI
Claus Leth BAK
Xabier BALZA
Mladen (Svetozar) BANJANIN
Andrew Leslie BARCLAY
Carl David BARKER
Graeme BARNEWALL
Earle C. (Rusty) BASCOM III
Jonas BAUMANN
George BECKER
Jan BEDNARIK
Jean-Luc BEDWANI
Glenn J BEHRMANN
Jean BÉLANGER
Regine BELHOMME
Jabulani BEMBE
Vladislav BEREZOVSKY
Rachel Kristin BERRYMAN
Josu BESTEIRO
Wojciech BETLEJ
Andreas Alan BEUTEL
Asif BHANGOR
Kankar BHATTACHARYA
Bruno John BISEWSKI
Peter BISHOP
Thuthukani BIYELA
Jeff BLADEN
Juan BOGAS
Roman BOGOMOLOV
Christian F. BONILLA
Dietrich BONMANN
Pieter BOOYSEN
Alberto BORGHETTI
Anjan BOSE
François BOULET
Karim BOUSOLTANE
Dalton O C BRASIL
Fernando BRASIL
Jana BREEDT
Ella BRODTKORB
Jitro BROEKAERT
Ray BROWN
Timothy BROWNE
Jan BRÜGGMANN
Christoph BUCHHAGEN
Emmanuel BUE
Joel BULOW
Alexandra BURGOS MELGUIZO
Griffin BURK
Joshua Glen BURROUGHS
Jeff BUTLER
A.J. (Tony) CARREIRA
Antonio Carlos CARVALHO
Emiliano CASALE
Jerome CASTELLON
Leonardo CATALANO
Gary CATLIN
Peter CEFERIN
Jan ČERNOHORSKÝ
Geraint CHAFFEY
SCA1 CHAIR
Markos CHAMPAKIS
Chakradhar Reddy CHANDUPATLA
Nadine CHAPALAIN
Enrique Ramon CHAPARRO VIVEROS
Fabien CHARLES
Dhananjay Kumar CHATURVEDI
Lujia CHEN
Man CHEN
Po-Chen CHEN
Sudhakar CHERUKUPALLI
Sorawit CHIARAPISITPHONG
William A. CHISHOLM
Sunetra CHOWDHURY
Claus Fridtjof CHRISTENSEN
Per CHRISTENSEN
Christos CHRISTODOULO
Andreas CHRYSOCHOS
Simona CIANCIO
Emanuele CIAPESSONI
Nuran CIHANGIR MARTIN
Colin CLARK
Graeme COAPES
Ivan CODD
Neta COHEN
Claudia Georgiana COJOCARU
Adnan COKIC
Haoxi CONG
Sergio CORTIO MONTES
Thierry COSTE
Stefanie CRAY
Alessandr CRIPPA
Hugh CUNNINGHAM
Andre Nico CUPPEN
Matthieu DALSTEIN
Jean-Bernard DASTOUS
Papiya DATTARAY
Jason DAVID
Michalis KARYSTIANOS
Bogdan KAZSTENNY
Shoshi KATALAI
Shigehiro KAYUKAWA
Ross KELLY
Leon KEMPNER JR
Uros KERIN
Bahram KHODABAKHCHIAN
Andrew John KIENITZ
Iljia Gliso KLASNIC
Michael KLEIN
Herwig KLIMA
Piet KNOL
Kazuhiro KOJIMA
Ming KONG
Banthoeng KONGKAEO
Eduard Philip KONIG
Stefan KORNHUBER
Jens KORTENBREDE
Masayuki KOSAKADA
Johannes KOSKI
Terry KRIEG
Martin KRIEGEL
Uršula KRISPER
Lara KRUK
Kulbhushan KUL
Raghavendra KULKARNI
Abhay KUMAR
Santosh KUMAR A
Dirk KUNZE
Yuko KURANE
Roland KURTE
Mark KUSCHEL
Jun Bum KWON
Marta LACORTE
Vasileios LAKIOTIS
Danilo LALOVIC
Tor LANERYD
Sebastien LANGLOIS
Andrew Craig LAPTTHON
Bruce Richard LARGE
Elizabeth LAROSE
Anette LARSEN
Mats LARSSON
Andres LASO
Andre LATHOUWERS
Robert LE ROUX
Minsoo LEE
Pieter LEEMANS
Diana LEGUIZAMON-CABRA
BO LEI
Andreia LEIRIA
Volker LEITLOFF
Senja LEIVO
Jody P. LEVINE
Alexander LEVINZON
Alain Francois Sanson LEVY
Gen LI
Shuji LI
Yaran LI
Yi LI
Mengjun LIAO
Yicheng LIAO
Bingxiang LIN
Christian LINDNER
Tommie Mikael LINDQUIST
Chen-Ching LIU
Chongru LIU
Qiang LIU
Pedro LLOVERA-SEGOVIA
Julio LOPES
Amadou LOUH
Viktor LOVRENČIČ
Herbert LUGSCHITZ
Jelena Mile LUKIC
Torsten LUND
Jan LUNDQUIST
Tara-lee MACARTHUR
Anita MACHL
Elizabeth Ann MACKENZIE
Rory Keir MACNEILL
Gert MADONSELA
Jan MAESSCHALCK
Thomas MAGG
Jernej MACJEN
Sami MÄKI
Bart MAMPAEY
Nitin Narayanan MANGALATH
Thomas MANTHE
Javier D. MANTILLA
Myles Caleb MARGOT
Benjamin MARSHALL
Daniel MARTIN
John Patrick MARTIN
Manuel MARTINEZ
Shoji MASHIO
Nicolae MATEI
Julia MATEVOSYAN
Frank MAUSET
Peter Frederick MAYER
Nkululeko Ntuthuko MAZIBUKO
Paolo MAZZA
Zwelandile MBEBE
Gerard Philippe MBOUYAP
John MCCORMACK
Sean MCGUINNESS
Mark MCVEY
Juan Manuel MEDINA
João Carlos MELLO
Ahmet MEREV
Arezki MERKHOUF
Maud MERLEY
Jan MEYER
Søren Damsgaard MIKKESEN
Federico MILANO
Tadao MINAGAWA
Pierre M MIREBEAU
Birger MO
Eric MOAL
Nilesh MODI
Gian MOFFA
Jainulabdeen MOHAMED ZAVAHIR
Mandava MOHANA RAO
Peter MOHAUP
Christina Matankiso MOHLOKOANA
Gabriela MOLINAR
Matthieu MONTFROND
Cedric MOORS
Christophe MOREAU
Florent MOREL
Albert MOSER
Patricio Enrique MUNHOZ-ROJAS
Rodrigo MUNIZ
Sharon MUSHABE
Ladislav MUSIL
Mukesh NAGPAL
Osamu NAGURA
Nirmal NAIR
Hideyuki NAKAMURA
Jinho NAM
Kiran NATKAR
Sjoerd NAUTA
Tomas NAZARCIC
Masoud NEGARPOUR