

A1 - ROTATING ELECTRICAL MACHINES

PS 1 / GENERATION MIX OF THE FUTURE

- > Effect and risk of an increasing renewable power mix on existing legacy generators, generator auxiliaries, and motors of renewable energy and variable load demand.
- > Improvement in designs and maintenance practices to comply with new and future grid requirements.
- > Evolution and trends in new machines for renewable generation.

PS 2 / ASSET MANAGEMENT OF ELECTRICAL MACHINES

- > Experience with refurbishment, replacement, design improvements, power up-rating, and efficiency improvement of aged generators and motors.
- > Optimised condition monitoring, diagnosis, prognosis, and maintenance practices to improve reliability and extend operational life.
- > Operational and project experience: installations, failure analysis; robotic inspections; recovery options; cost and time reduction initiatives; and effects of torsional electromechanical oscillations for synchronous compensators, wind turbine generators, turbo-generators, hydro-generators, and motors.

PS 3 / LATEST DEVELOPMENTS

- > Designs, specifications, materials, manufacturing, maintenance, performance, and efficiency improvement of electrical machines.
- > Condition monitoring techniques and equipment.

A2 - POWER TRANSFORMERS & REACTORS

PS 1 / TRANSFORMER TECHNOLOGIES TO ENABLE INTEGRATION OF DISTRIBUTED RENEWABLE ENERGY RESOURCES

- > Application, specification, design, and construction.
- > Effect of harmonics, including interharmonics and supharmonics.
- > Effect of extreme operating environments, especially offshore and also subsea.

PS 2 / ADVANCES IN DIELECTRIC DESIGN AND TESTING

- > Specification of dielectric design requirements, especially for new and unusual applications.
- > New and advanced dielectric design concepts and techniques.
- > Challenges in dielectric testing and how to overcome them.

PS 3 / IMPROVING RELIABILITY FOR TRANSFORMERS

- > Long-term reliability studies and surveys for transformers.
- > Improving reliability through specification, design, and construction.
- > Improving reliability through operation, maintenance, refurbishment, and repair.

A3 - TRANSMISSION & DISTRIBUTION EQUIPMENT

PS 1 / FUTURE DEVELOPMENTS OF TRANSMISSION AND DISTRIBUTION EQUIPMENT

- > Medium Voltage DC circuit breakers.
- > Measures to improve reliability.
- > Developments of equipment with reduced environmental impact.
- > SF6 alternatives for switching and isolation.

PS 2 / LIFETIME MANAGEMENT OF TRANSMISSION & DISTRIBUTION EQUIPMENT

- > Diagnosis and prognosis / monitoring of equipment.
- > Influence of environmental and operating conditions.
- > Experience and countermeasures for overstresses and overloads.

PS 3 / IMPACT OF DISTRIBUTED RENEWABLE GENERATION AND STORAGE ON TRANSMISSION AND DISTRIBUTION EQUIPMENT

- > New and emerging technologies for switching devices and other equipment.
- > Incorporation of intelligence into the equipment.
- > Impacts of distributed renewable energy sources and energy storage on equipment requirements.

B1 - INSULATED CABLES

PS 1 / CABLES FOR FUTURE POWER SYSTEMS

- > Innovative cables and systems.
- > Prospective impacts on cable life-cycle from use and implementation of Big Data and Industry 4.0.
- > New functionalities expected from cable systems.

PS 2 / RECENT EXPERIENCES WITH EXISTING CABLE SYSTEMS

- > Design, manufacturing, installation techniques and operation.
- > Advances in testing, including failure location, and relevant experience.
- > Lessons learnt from permitting, consent and implementation.

PS 3 / ENVIRONMENTAL CHALLENGES, ASSET MANAGEMENT, AND RESILIENCE OF CABLE SYSTEMS

- > Environmental challenges in current, planned, and future cable systems.
- > Quality, monitoring, condition assessment, diagnostic testing, upgrading methodologies, and relevant management.
- > Safety considerations, cyber and physical security and Internet of Things, including case studies.

B2 - OVERHEAD LINES

PS 1 / CONDITION BASED MAINTENANCE FOR INCREASED SUSTAINABILITY

- > Monitoring and modelling.
- > Health index, remaining life, and degradation mechanisms.
- > Risk assessment.

PS 2 / ENHANCING OVERHEAD LINE PERFORMANCE

- > Innovative designs and materials; compaction; AC to DC conversion; voltage upgrade; ampacity uprating; losses optimisation; etc.
- > Current carrying capacity.
- > Earthing, lightning performance.

PS 3 / RESOURCES AND DESIGN CONSIDERATIONS

- > Design with respect to construction; maintenance; lifetime and restoration; live line working; ergonomics; skills for installation and maintenance; robotics.
- > Design and refurbishment for a changing environment.

B3 - SUBSTATIONS & ELECTRICAL INSTALLATIONS

PS 1 / DESIGN AND TECHNOLOGY

- > Impact on design and installation of Distributed Renewable Energy Resources, Energy Storage Systems, Electric Vehicle Charging, etc.
- > Mitigating environmental; health and safety; and security impacts.
- > Rapid deployment and cost effective solutions for electrification of developing communities.

PS 2 / OPTIMISED SUBSTATION MANAGEMENT

- > Best use of assets by optimising their life-time.
- > Service continuity for maintenance, refurbishment, and replacement.
- > Evolution of skills and management competency.

PS 3 / INTEGRATION OF INTELLIGENCE

- > Applications of new technologies, e.g. Internet of Things, Virtual Reality, Augmented Reality.
- > Challenges and expectations for digital substations.

B4 - DC SYSTEMS & POWER ELECTRONICS

PS 1 / HVDC SYSTEMS AND THEIR APPLICATIONS

- > Planning and implementation of new HVDC projects including need, justification, design, integration of renewables, environmental assessment, and economic assessment.
- > Application of new technologies including cyber security and advanced controls to address emerging network issues, DC grid, multi-terminal HVDC, hybrid HVDC systems and HVDC circuit breakers.
- > Refurbishment and upgrade of existing HVDC systems, service and operating experience of converter stations including offshore converters, and implications for converter equipment resulting from the conversion of AC circuits to DC circuits.

PS 2 / DC AND POWER ELECTRONICS FOR DISTRIBUTION SYSTEMS

- > DC applications in distribution systems.
- > Power Electronics applied in distribution projects, including economics and reliability.
- > New concepts and designs of equipment.

PS 3 / FACTS

- > Planning and implementation of new FACTS projects including need, justification, for integration of renewables, environmental assessment, and economic assessment.
- > Application of new technologies in FACTS and other Power Electronic equipment, including interfacing generation and storage to the network.
- > Refurbishment and upgrade of existing FACTS and other Power Electronic systems; service and operating experience.

B5 - PROTECTION & AUTOMATION

PS 1 / HUMAN ASPECTS IN PROTECTION, AUTOMATION AND CONTROL SYSTEMS (PACS)

- > Causes, types, stages of occurrence, and consequences of human errors.
- > Impact of PACS complexity and degree of functional integration on human errors.
- > Prevention of human errors including training; work authorisation and peer reviews; procedures; application templates and standardisation; and best practices for working with sub-contractors and third parties.

PS 2 / COMMUNICATIONS NETWORKS IN PROTECTION, AUTOMATION AND CONTROL SYSTEMS (PACS) : EXPERIENCE AND CHALLENGES

- > Management of redundancy in communications networks for applications and Intelligent Electronic Devices.
- > Data Segregation, including use of virtual networks for PACS applications.
- > Architecture of PACS communication network, including management of communication constraints.

C1 - POWER SYSTEM DEVELOPMENT & ECONOMICS

PS 1 / POWER SYSTEM RESILIENCE PLANNING

- > Evaluating, improving, and measuring power system resilience in system planning, economic assessment and asset management, given increasing threats from human and natural hazards, including climate change.

PS 2 / ENERGY SECTOR SYNERGIES FOR DECARBONISING EFFICIENTLY

- > Planning approaches addressing energy sector synergies across power, gas, transport, heating/cooling, and new energy carriers, in order to optimise overall decarbonisation efficiency whilst supporting local development.
- > How do these planning approaches include aspects of energy conversion and storage, technical and economic sector interfaces?

PS 3 / DISTRIBUTED ENERGY RESOURCES IN TRANSMISSION PLANNING

- > Tools, techniques, and data used in transmission system planning and investment decisions to evaluate and enable high levels of renewables, storage, and customer flexibility at all voltage levels.
- > Holistic approaches that combine technical assessments, incentives, and reliability impacts on customers.

C2 - POWER SYSTEM OPERATION & CONTROL

PS 1 / CAPABILITIES REQUIRED FOR FUTURE SYSTEM OPERATION

- > Operator training.
- > Decision support tools including new methodologies.
- > Wide Area Monitoring and Control.

PS 2 / SYSTEM OPERATION INTERFACES: IMPROVING OBSERVABILITY AND CONTROLLABILITY

- > TSO-TSO interface/cooperation/data exchange.
- > TSO-DSO interaction/cooperation/data exchange.

JOINT PS C2 AND C6

PS 3 / SYSTEM OPERATION CHALLENGES WITH INCREASING USE OF DISTRIBUTED ENERGY RESOURCES

- > Enhancing flexibility, reliability, and resilience.
- > Providing grid services through aggregators.
- > Aggregator interaction.

C3 - POWER SYSTEM ENVIRONMENTAL PERFORMANCE

PS 1 / SUSTAINABLE DEVELOPMENT GOALS (SDGs) OF THE UN

- > How do companies integrate the SDGs in their business strategy to contribute to their achievement?
- > What are the main challenges to do so?
- > In what way do companies benefit of integrating SDGs in their business strategies?

PS 2 / ENVIRONMENTAL IMPACT OF ENERGY TRANSITION

- > Effects of raw materials becoming scarce.
- > Which methods are used for measuring these impacts, regarding the whole supply chain.
- > How to deal with the negative impacts of energy transition, e.g. effects of solar farms on biodiversity.

PS 3 / RELATION OF WILDLIFE AND ELECTRICAL INFRASTRUCTURE

- > How to prevent damages or outages for generation, transmission, and distribution equipment from birds, rodents, or other species.
- > Which methods are used and which data are needed to determine mortality.
- > Which methods for mitigation are used.

C4 - POWER SYSTEM TECHNICAL PERFORMANCE

PS 1 / IMPROVING POWER SYSTEM TECHNICAL PERFORMANCE THROUGH THE USE OF ADVANCED METHODS, MODELS AND TOOLS

- > The analysis of widespread dynamic security issues including [intentional] electromagnetic interference, weather, and geomagnetically induced currents.
- > The assessment of frequency stability, system strength, or power quality using Big Data analytics.
- > Development of emerging metrics and tools for quantifying power system reliability, resiliency, and flexibility.

PS 2 / MODELLING OF THE FUTURE GRID BASED ON LESSONS LEARNED FROM SYSTEM EVENTS

- > Experience gained from Smart Grid projects.
- > High penetration levels of inverter-based devices.
- > Deployment of energy storage systems.

PS 3 / METHODS, MODELS, AND TECHNIQUES FOR EVALUATING LIGHTNING, POWER QUALITY, AND INSULATION CO-ORDINATION TO ENHANCE THE PERFORMANCE OF THE EVOLVING GRID

- > UHV AC and/or DC systems.
- > Renewable generation, inverter-oriented power systems, and traction loads.
- > Harmful interactions between power system components.

C5 - ELECTRICITY MARKETS & REGULATION

PS 1 / THE CHANGING NATURE OF MARKETS AND ANCILLARY REQUIREMENTS

- > Market adaptations to handle the value shift between energy and services.
- > Markets and services to address inertia and resilience.
- > Role of markets with respect to aggregation and the provision of network services.
- > Pricing approaches for emerging technologies and impacts of those approaches.

PS 2 / CHANGING ROLE OF REGULATORS AND STANDARDS

- > Role of regulators in the changing markets.
- > Evolving policy, standards, and guidelines to address issues affecting markets.
- > Regulatory policies on transmission and distribution – too little or too much.

PS 3 / MARKET DESIGNS FOR CO-ORDINATION OF GENERATION AND NETWORK INVESTMENTS

- > Markets and regulations to promote co-ordinated investments.
- > Customer-driven market changes – the transition from centralised to distributed planning.
- > Impacts of the changing nature of customers on investments and markets.
- > The impact of peer-to-peer trading on the provision of market services.

C6 - ACTIVE DISTRIBUTION SYSTEMS AND DISTRIBUTED ENERGY RESOURCES

PS 1 / ADVANCED DISTRIBUTION SYSTEM DESIGN INCORPORATING DISTRIBUTED ENERGY RESOURCES

- > Configuring demand response and intelligent loads for customer empowerment.
- > Exploiting local energy storage possibilities and managing uncertainties.
- > Enabling multi-energy systems using intelligent inverters and controls.

PS 2 / ENABLING TECHNOLOGIES AND SOLUTIONS FOR DISTRIBUTION SYSTEMS

- > Management and aggregation platforms for Distributed Energy Resources.
- > Individual microgrid, multiple microgrid, and virtual power plant design and control.
- > Rural electrification and off-grid distribution systems.

JOINT PS C2 AND C6

PS 3 / SYSTEM OPERATION CHALLENGES WITH INCREASING DISTRIBUTED ENERGY RESOURCES

- > Enhancing flexibility, reliability, and resilience.
- > Providing grid services through aggregators.
- > Aggregator interaction.

D1 - MATERIALS AND EMERGING TEST TECHNIQUES

PS 1 / TESTING, MONITORING AND DIAGNOSTICS

- > Experience and insight from monitoring systems.
- > Reliability of test equipment and systems for testing, monitoring, and diagnostics.
- > Data handling, analytics, and advanced condition assessment.

PS 2 / FUNCTIONAL PROPERTIES AND DEGRADATION OF INSULATION MATERIALS

- > New stresses, e.g. power electronics, load cycling, higher temperatures, and compact applications.
- > Materials with lower environmental footprint, during production, operation, and disposal.
- > Characterisation methods for validating functional properties.

PS 3 / INSULATION SYSTEMS OF ADVANCED COMPONENTS

- > Materials under high stresses, e.g. field stress, flux, electric current, and frequency.
- > Experience and requirements for new test procedures and standards.
- > Development of new materials, e.g. 3D printing; lamination; casting; and additive or subtractive manufacturing.

D2 - INFORMATION SYSTEMS & TELECOMMUNICATION

PS 1 / THE IMPACT OF EMERGING INFORMATION AND COMMUNICATION TECHNOLOGIES ON ELECTRIC POWER UTILITIES

- > The potential of Machine Learning and Artificial Intelligence in improving operations.
- > Enhancing asset and lifecycle management using the Internet of Things, Big Data, and Analytics.
- > The role of Blockchain in facilitating efficiency of market operations.

PS 2 / NEW CYBERSECURITY CHALLENGES IN THE CHANGING ELECTRICITY INDUSTRY

- > Cybersecurity challenges in the use of the Internet of Things, Big Data, and Cloud-based platforms.
- > Cybersecurity challenges related to Distributed Energy Resources and interconnection of new flexibility providers.
- > Identification of cybersecurity threats using Big Data analysis and Machine Learning.

PS 3 / INCREASING OPERATIONAL EFFICIENCY USING PACKET SWITCHED COMMUNICATION TECHNOLOGIES

- > Challenges in the migration to packet switched networks.
- > Supporting the changing electricity industry with the use of existing and new communication technologies.
- > Supporting time critical operational services with time distribution and synchronisation.

ACRONYMS

3D	Three dimensions
AC	Alternative Current
DC	Direct Current
DSO	Distribution System Operator
FACTS	Flexible AC transmission systems
HV	High voltage
HVDC	High voltage direct current
PACS	Protection, Automation & Control Systems
SDG	Sustainable Development Goals
SF6	Sulfur hexafluoride
TSO	Transmission System Operator
UN	United Nations