

CIGRE Key Take Away's

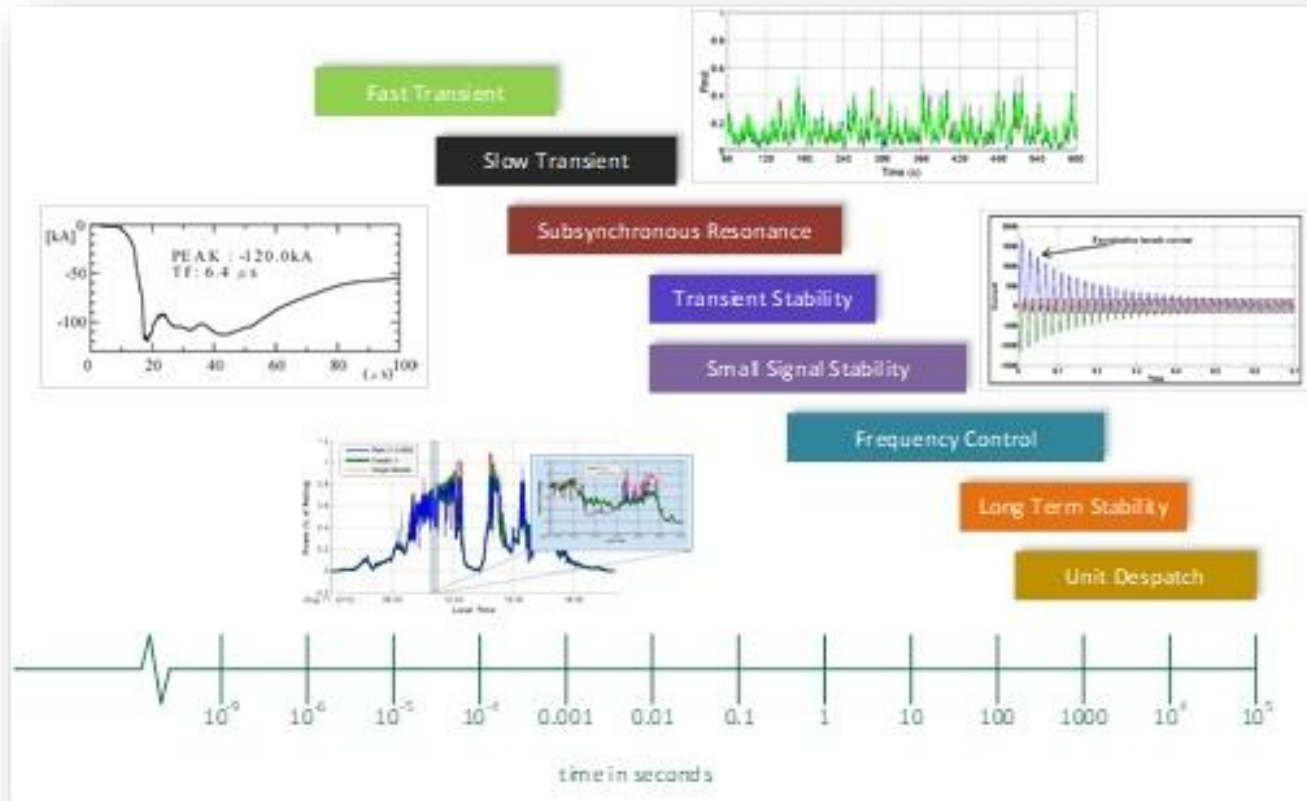
Study Committee C4 – Kostas Velitsikakis



29 September 2026

SC C4 at a glance

- SC C4 covers power system technical performance phenomena that range from nanoseconds to many hours.



Power system dynamics

Power quality

EMC & EMI

Lightning

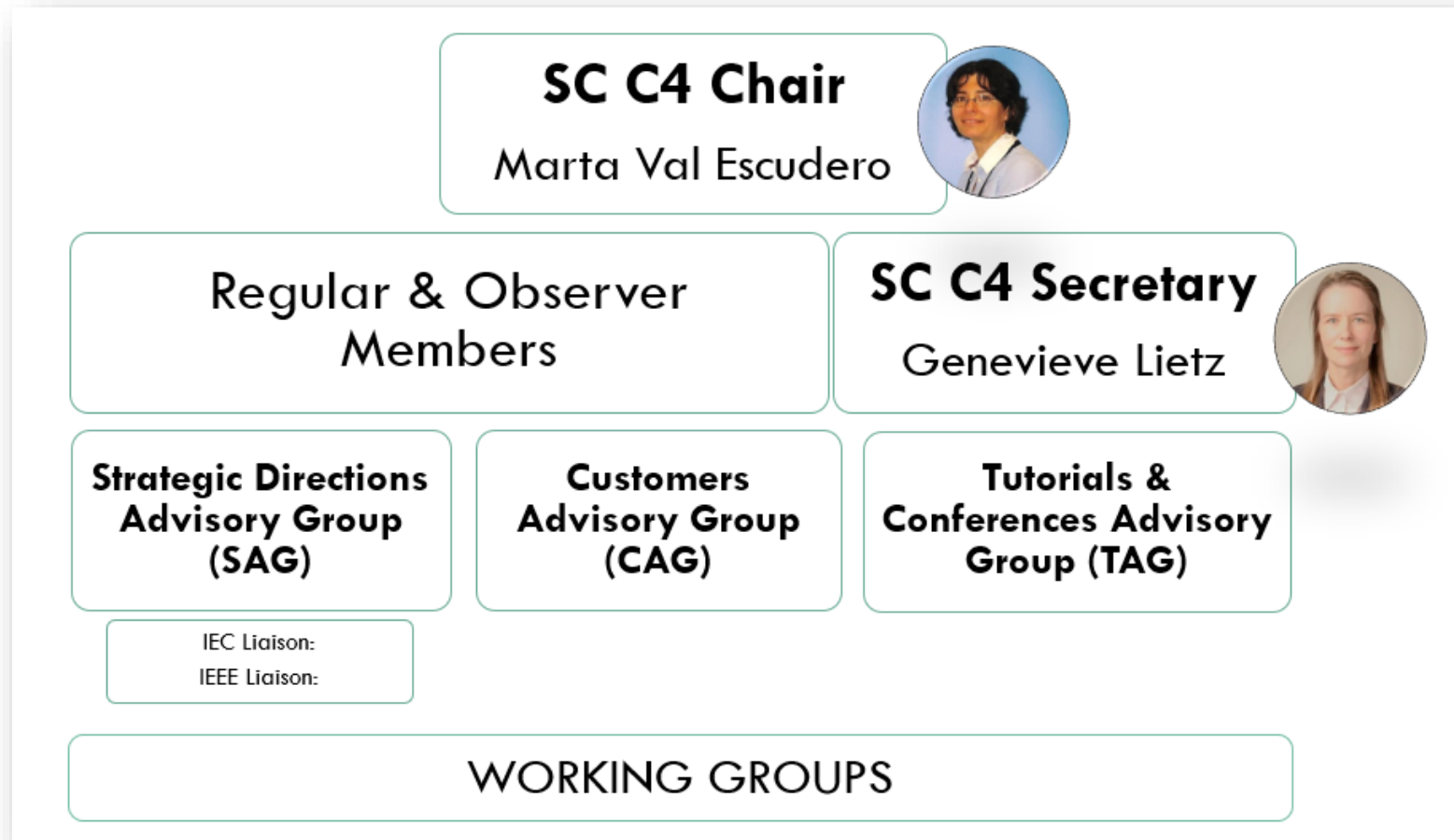
Insulation co-ordination

SC C4 at a glance

- Important scope “behind the curtains”:
 - Investigation and development of new tools and models.
 - Development of methods and techniques for the assessment and analysis of relevant issues.

Identification of power system needs, scarcities, design requirements and new power system phenomena caused or accelerated by the energy transition.

SC C4 at a glance



SC C4 in the Paris Session 2026

- Preferential subjects (PS)

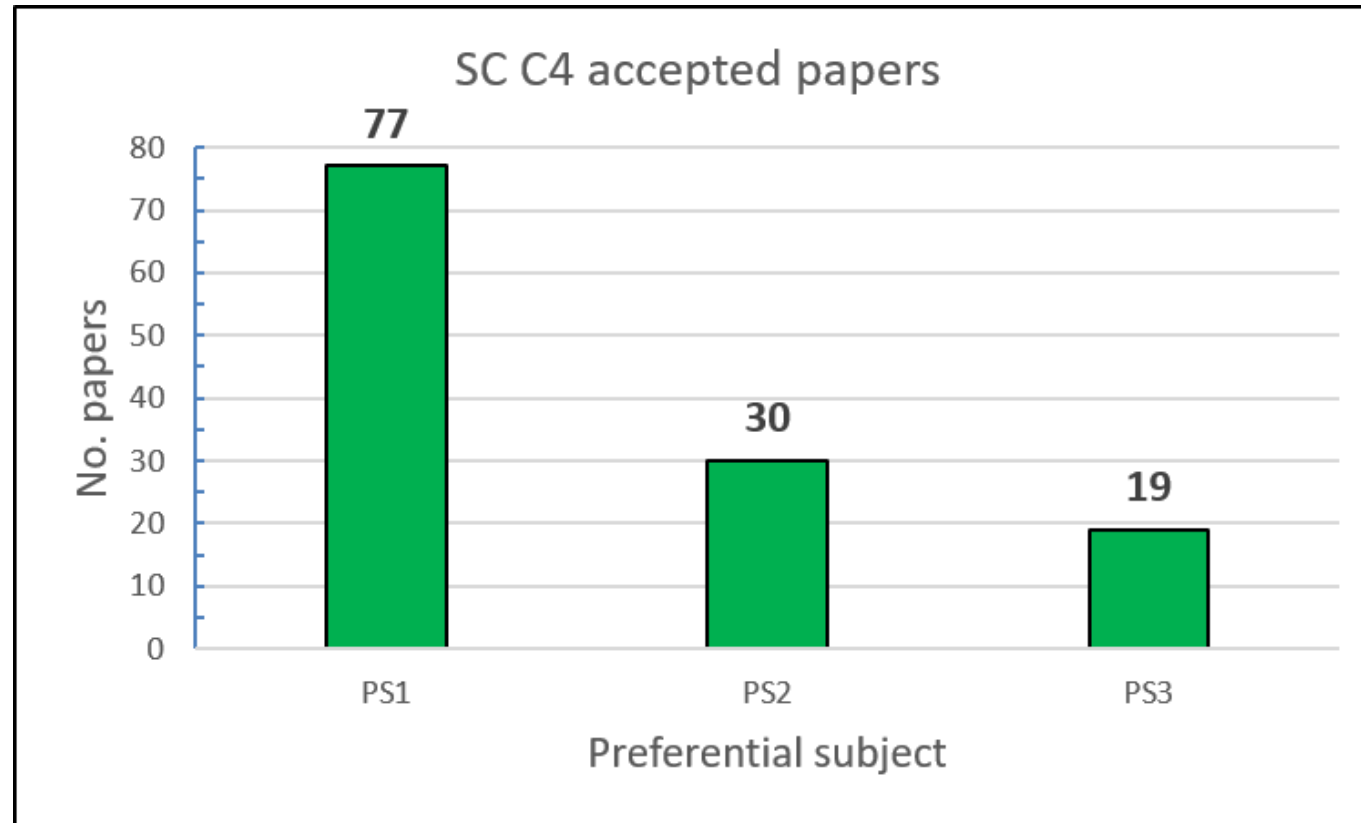
PS1: *Power system stability aspects of decarbonisation of power systems and the road to net-zero*

PS2: *Power quality (PQ) and EMC/EMI aspects of decarbonisation of power systems and the road to net-zero*

PS3: *Insulation co-ordination and lightning research: paving the way to net-zero in decarbonised power systems*

SC C4 in the Paris Session 2026

- Preferential subjects (PS) – Total of 126 accepted papers



SC C4 in the Paris Session 2026

Sunday 23rd August	SC C4 AG meeting
Monday 24th August 2026	Joint B4/C4 workshop on Grid Forming
Tuesday 25th August 2026	SC C4 Group Discussion Meeting
	Joint C4/C1/C2 workshop on Large Inverter Based Loads
	Joint C2 (PS3) / C4 Poster session
Wednesday 26th August 2026	SC C4 Poster session
	C4 Tutorial “Modelling and Simulation of Electromagnetic Transients in Lines, Cables, and Gas-Insulated Substations”
	C4 workshop on “Generic EMT-Type Modelling of Inverter-Based Resources for Long-Term Planning Studies
Thursday 27th August 2026	C4 workshop on “Wide Area EMT Simulations for Stability Analysis in Modern Power Systems”
	Joint C2 (PS3) / C4 GDM
Friday 28th August 2026	SC C4 AG meeting

SC C4 in the Paris Session 2026

Sunday 23rd August	SC C4 AG meeting
Monday 24th August 2026	Joint B4/C4 workshop on Grid Forming
Tuesday 25th August 2026	SC C4 Group Discussion Meeting
	Joint C4/C1/C2 workshop on Large Inverter Based Loads
	Joint C2 (PS3) / C4 Poster session
Wednesday 26th August 2026	SC C4 Poster session
	C4 Tutorial “Modelling and Simulation of Electromagnetic Transients in Lines, Cables, and Gas-Insulated Substations”
	C4 workshop on “Generic EMT-Type Modelling of Inverter-Based Resources for Long-Term Planning Studies
Thursday 27th August 2026	C4 workshop on “ Wide Area EMT Simulations for Stability Analysis in Modern Power Systems”
	Joint C2 (PS3) / C4 GDM
Friday 28th August 2026	SC C4 AG meeting

PS1 – Key take aways

PS1: Power system stability aspects of decarbonisation of power systems and the road to net-zero

- Emerging tools and methods for plant and system-wide stability analysis, model validation, advanced data analytics, screening and performance monitoring.
- Power system stability impact of new technologies including storage, large scale inverter-based generators, inverter-based loads, network elements and control methods (e.g. grid forming). Development of appropriate specifications.
- Dynamic phenomena impacting power systems stability - e.g. wide-area, local interactions and forced oscillations.
- Demystifying system strength: definition, metrics, impact on power systems, experiences, challenges and solutions

PS1 – Key take aways

Theme 1: System strength, stability and oscillatory interactions in converter-dominated power systems (32 papers)

- Growing importance of advanced monitoring
 - Frequency-domain analysis
 - High-resolution measurements
 - Data-driven techniques for identifying and mitigating stability risks
- Impact of emerging technologies: data centers, electrolyzers, grid-forming resources, etc.

PS1 – Key take aways

Theme 2: Modelling and advanced simulation methods (28 papers)

- Traditional analysis approaches are challenged by the scale and dynamic complexity of modern networks.
- Advancements in a broad suite of tools, from high-fidelity electromagnetic transient (EMT) models to digital twins.
 - Interoperability
 - Practical usability of dynamic models
 - Effective collaboration between system operators, developers and equipment manufacturers

PS1 – Key take aways

Theme 3: Grid forming and grid enhancing technologies for stability and resilience (17 papers)

- GFM converters, BESS, STATCOMs, synchronous condensers, advanced converter controls can provide many of the stability services traditionally supplied by synchronous machines.
 - System strength
 - Enhance oscillation damping
 - Frequency & voltage recovery support following disturbances
 - System restoration

PS2 – Key take aways

PS2: Power quality (PQ) and EMC/EMI aspects of decarbonisation of power systems and the road to net-zero

PS2 – Key take aways

Theme 1: Modelling and simulation for assessment of PQ and EMC phenomena and mitigation strategies in meshed transmission systems (12 papers)

- Cable-rich transmission networks.
- Modelling uncertainties due to uncertain harmonic sources & necessity for measurement-validated models.
 - Harmonic propagation
 - Resonances & amplification risks
 - System-wide visibility of impedance & resonance conditions

PS2 – Key take aways

Theme 2: Experiences with PQ issues in IBR-dominated systems and advanced data analytics, including allocation and compliance (12 papers)

- Impact of IBR on harmonics.
 - Grid-code compliance (offshore wind farms).
 - PQ allocation.
-
- Large-scale monitoring
 - Advanced data analytics for long-term PQ trends

PS2 – Key take aways

Theme 3: Experiences with EMI for large inverter-based generators and loads and interference between the power system (AC or DC) and pipelines and telecom systems (6 papers)

- Safety, corrosion and coexistence challenges in shared corridors.
- Geomagnetically induced currents & their impact on harmonic distortion.

PS2 – Key take aways

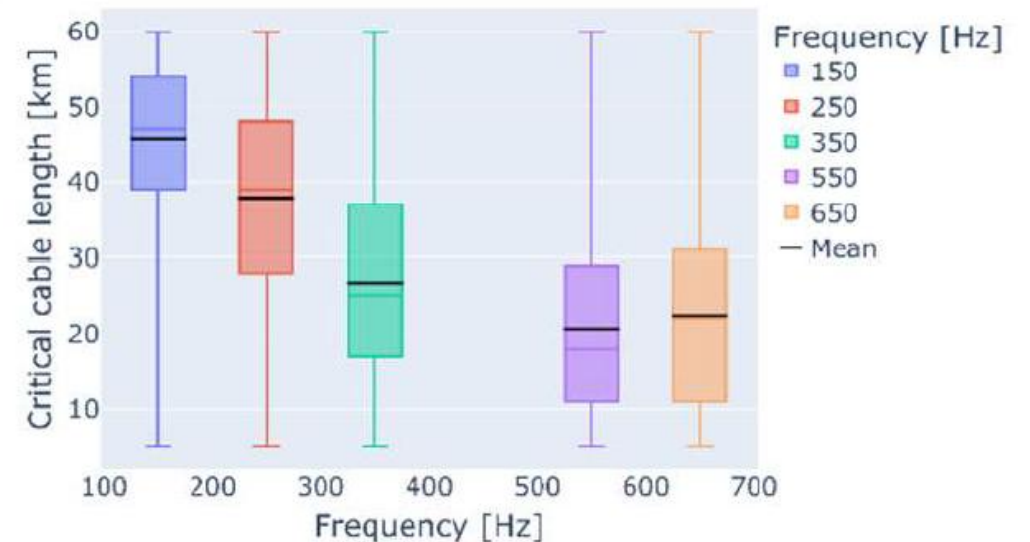
Paper 10908

New approach for assessing the risk of harmonic amplification on the French network.

Xavier-Marie VIEL, Fabien MORRETTON, Sara FILALI, Maxime PAUMIER, Yannick VERNAY

RTE

- Requirement on full-scale grid model
- Radially connected underground cables.
- Challenge the “traditional” assessment.



PS2 – Key take aways

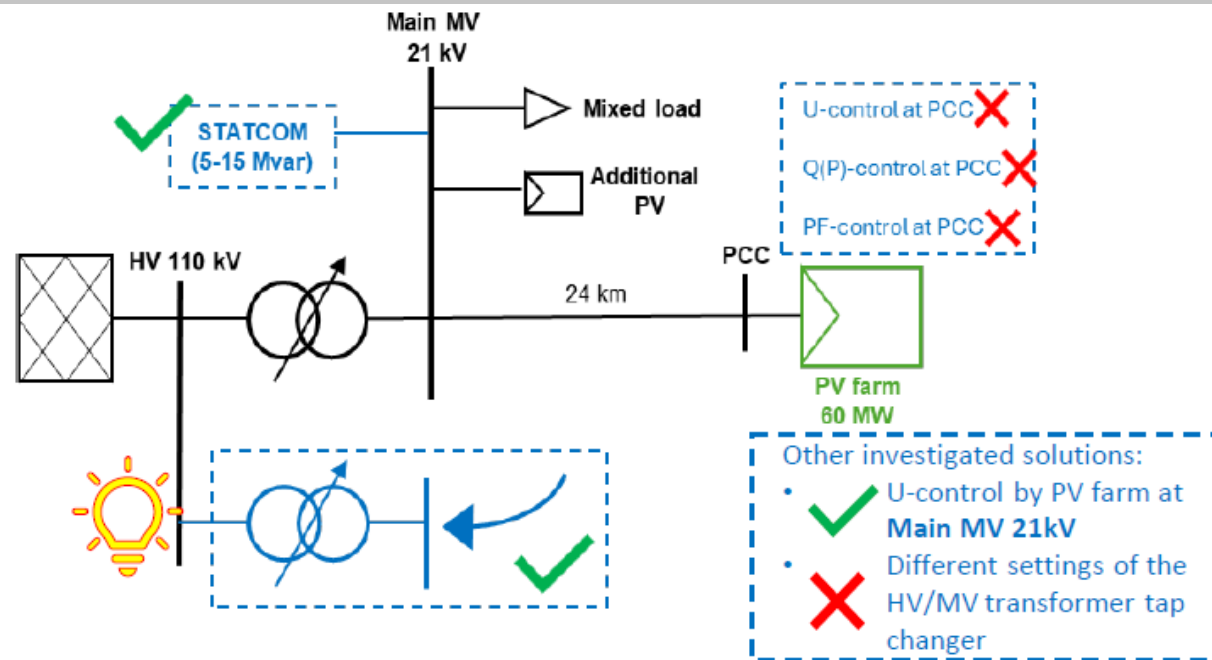
Paper ID: 10303

Large, moderately rapid voltage fluctuations due to a PV farm: a limit on how much PV fits into the medium-voltage grid

Frederik Groeman¹, Maarten Berende², Alwin Jonker², Emilija Lazdanaitė¹ and Wim Kuijpers¹

¹DNV Energy Systems

²Enexis Netbeheer B.V.



PS3 – Key take aways

PS3: Insulation co-ordination and lightning research: paving the way to net-zero in decarbonised power systems

PS3 – Key take aways

Theme 1: Future of insulation co-ordination for AC, DC and hybrid systems

- Continuous transient voltage measurements.
- HVDC insulation co-ordination.
- Contamination mapping.

PS3 – Key take aways

Theme 2: Improvement of lightning detection systems with a focus to enhance power system reliability

- Impact of lightning detection systems on performance assessment methodologies.
- Hourly lightning risk assessment for overhead transmission lines.

PS3 – Key take aways

Theme 3: Lightning protection strategies for transmission lines and hybrid systems, including the impact of thunderstorms and extreme weather events

- Real-time monitoring of lightning currents on transmission towers.
- Statistical methodology for grounding design of transmission and wind turbine towers.
- Work safety on overhead transmission lines and temporary protection grounding.

PS3 – Key take aways

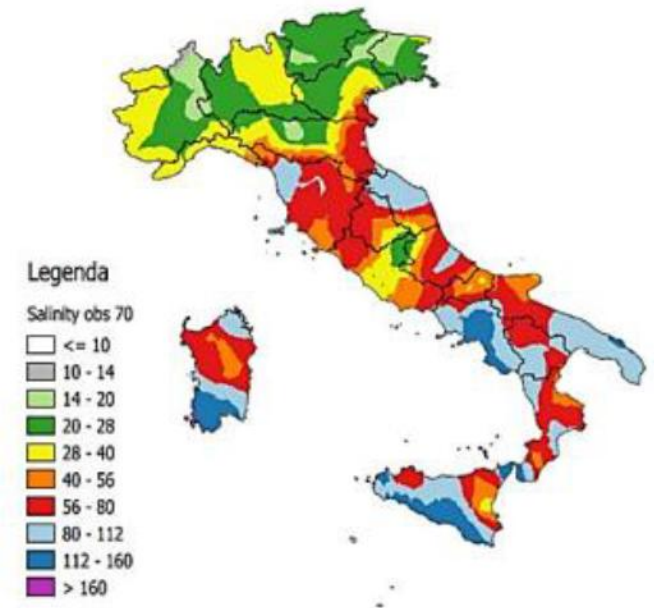
11249_2026

Insulator contamination maps toward outdoor insulation coordination

Massimo Marzinotto¹, Alberto Pigni²

¹Terna Rete Italia SpA, ²Senior Consultant HV AC-DC engineering

- On-going WG.
- Optimization of pollution class ranges for both AC and DC applications.
- Support revision of IEC standards.



PS3 – Key take aways

10305

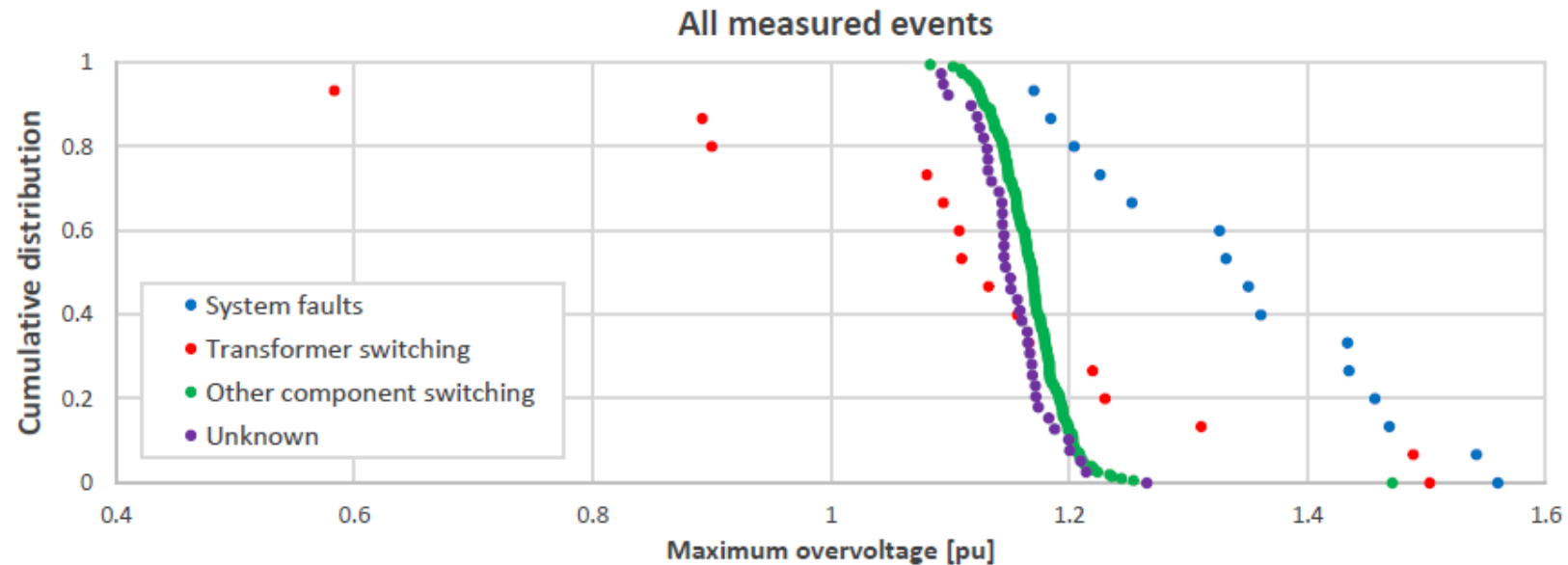
Results of continuous transient voltage measurement in the Dutch 110kV grid

I. Tannemaat
TenneT TSO B.V.

K. Velitsikakis
TenneT TSO B.V.

S. Nauta
Alliander

J. McBride
JMX High Voltage



CIGRE International Symposium 2027

- Bangkok, Thailand
- 8-12 November 2027



Thank you for your attention!

Kostas.velitsikakis@tennet.eu



cigre

For power system expertise