## Dutch C4 Key Takeaways from Session 2022 Feedback

Peet Schutte Midden Nederland Hallen, Barneveld, Nederland 10 November 2022



## Agenda

- Introduction
- C4 update
- Key takeaways Session 2022
- Session 2022 C4 Concluding remarks





## Introduction

**Dutch C4 representative** 



### **Dutch C4 Representative**

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South African born, relocated to Netherlands in 2020

Background in power system technical performance (studies and design) and insulation coordination

Currently working for DNV, Team lead and senior consultant

**Resides in Ede, Netherlands** 





# C4 Update



### **C4 Study Committee**

#### Mission – System Technical Performance

- To facilitate and promote the progress of engineering
- International exchange of information and knowledge
- Add value to this information and knowledge
- Synthesizing state-of-the-art practices
- Developing recommendations.



#### Scope

- SC C4 -methods and tools for analysis related to power systems.
- Dynamic / transient conditions and to the interaction between the power system and its apparatus/sub-systems,
- between the power system and external causes of stress and between the power system and other installations.

Specific issues related to the design and manufacturing of components and apparatus **are not** in the scopes of SC C4, as well as those specifically related to planning, operation and control, apart from those cases in which a component, apparatus, or subsystem behavior depends on, or significantly interacts with, the performance of the nearby power system.



### **C4 Study Committee**

#### C4 Update

- New Chair
- New formal Dutch representation C4

The SC C4 consists of forty-six (46) members from forty-three

(43) countries: Chairman, Secretary, twenty-four (24) Regular Members, two (2) additional Regular Members and eighteen (18) Observer Members.

- Working groups
  - At present, forty-two (42) WGs/JWGs are active.

The number of active WGs by topic is as follows:

- Power quality: 6 WGs
- EMC/EMI: 5 WGs
- Insulation coordination: 5 WGs
- Lightning: 10 WGs
- Power Systems Performance Models and Numerical Analysis: 16 WGs





# **Session 2022**

Key Takeaways



## **Session Highlights**

#### **Papers**

- SC C4 selected 59 papers aligning with the three Preferential Subjects (PS) for the 2022 CIGRE Session.
- Two papers were submitted as part of Next Generation Network Young Member showcase competition.
- PS 1: Challenges and advances in power quality (PQ) and electromagnetic compatibility (EMC) 19 Papers
- PS 2: Challenges and advances in insulation coordination and lightning research 11 Papers
- PS 3: Challenges and advances in power system dynamics. 29 Papers



## **Session Highlights - Papers PS1**

- PS 1: Challenges and advances in power quality (PQ) and electromagnetic compatibility (EMC)
- 19 Papers

- PS1 Theme 1 Modelling, measurement and assessment of PQ phenomena including emerging areas such as supra-harmonics, harmonic instability, geo-magnetically induced currents and other similar phenomena
  - PQ management in rapidly evolving power system with inverter-based resources remains challenging and broad topic of interest for Tx and Dx
- **PS1 Theme 2** Integration and application of advanced signal processing, artificial intelligence techniques and big data analytics for event diagnostics and system planning purposes such as hosting capacity or emission limit calculation
  - Resulting from the geographically wide-spread integration of medium and small-scale solar photovoltaic generation systems, several power quality problems and violation of other operational constraints are being witnessed
  - network owners / operators require tools to determine the hosting capacity levels of such generation where studies can be undertaken on a feeder basis or on a wide network basis.
- **PS1 Theme 3** Impacts on equipment compatibility and immunity, and emerging mitigation approaches.
  - challenges continue to arise with regard to new power quality mitigation approaches and relevant modelling and analysis techniques to be used for EMC mitigation /standards and guidelines
  - Papers 10526, 10816, 10926 cover power quality mitigation approaches and compatibility and immunity of equipment in AC and DC power systems.



## **Session Highlights - Papers PS2**

- PS 2: Challenges and advances in insulation coordination and lightning research
- 11 Papers

- **PS2 Theme 1** Insulation coordination practices for end-to-end power networks, including the effects of long lines, long cables and frequency dependent models
  - The rapid developments in the power networks can, under certain circumstances, impose challenges to the application of the common insulation coordination practices.
  - Typical example is the tendency towards the introduction of long underground and submarine cable connections to the grids, which impacts the performance of the system with respect to transient overvoltages.
- **PS2 Theme 2** Development of insulation coordination in AC systems interfaced with power electronics-based systems and devices, and the need for standardization
  - Insulation coordination is regarded as a challenging task in power networks, where the share of power electronics-based systems and devices is increasing.
  - The challenges are in the interest of both transmission and distribution system operators as well as in that of the rest of the stakeholders.
  - ✓ This sub-category, cover aspects relevant to the transient phenomena that occur in power electronic based systems and new approaches for the insulation coordination of HVDC systems, as presented in the papers 10215, 10823, 11155.
- PS2 Theme 3 Lightning evaluation of transmission and distribution systems covering new asset designs and extreme meteorological events
  - increasing frequency of extreme meteorological events. This sub-category deals with the utilization of available data (measurements, monitoring systems, etc.) when evaluating the impact of lightning events on the performance of overhead lines and substation equipment



## **Session Highlights - Papers PS3**

- PS 3: Challenges and advances in power system dynamics.
- 29 Papers

- PS3 Theme 1 Modelling, analysis and validation of individual components and wide-area system interactions including system level protection schemes considering changing system dynamics
  - Emerging modelling tools such as offline and real-time electromagnetic transient (EMT) simulation, the use of cloud computing to expedite off-line EMT simulation time, application of mathematical techniques such as machine learning to aid decision making when performing dynamic studies, and the impact of simplifying assumptions on the accuracy of dynamic simulation results.
  - Screening methods such as short circuit ratio (SCR) calculations
  - More detailed models, used to provide more accurate answers as the power system and generation mix, and the resultant dynamics change. However, even most detailed models will need to be validated against the actual plant performance to ensure sufficient accuracy, and they cannot be assumed accurate by default.
  - System level protection and need for more system wide protection studies
- PS3 Theme 2 Impact of emerging technologies such as hydrogen and other storage devices, grid forming inverters and demand side management
  - ✓ Grid forming inverters not well understood in large integration to replace synchronous generators. Focus on this topic and paper submissions received.
- **PS2 Theme 3** Analysis of security and resilience of power systems having high share of grid-connected or distributed inverter-based resources including feasibility of providing system support such as black start, islanding, system strength and inertia
  - ✓ System inertia, frequency and voltage control IBR replacing Synchronous gen's and impact on dynamics such as inertia and frequency response
  - Power system planning and flexibility considerations -Power system planning has been historically relying on market modelling, and load flow and fault level analyses. With changing system dynamics, it is becoming more and more important to account for power system dynamic performance under future high IBR penetration scenarios



# **Session 2022**

Key Takeaways



### Session 2022 C4 Concluding remarks

- There remains a significant focus on the challenges of system wide technical performance related to the PS1-3 of 2022. For 2024 the focus deepens especially for PS3.
- Rapid expansion of the transmission and distribution system require innovate methods and tools for design, evaluation and benchmarking of models that directly relates to power system resilience and performance.
- The main focus point of attention is the challenges and advances in power system dynamics. Most working groups active in this area and most papers received.

World grid-connected electricity generation by power station type



Historical data source: IEA WEB (2022), GlobalData (2022)

