CIGRE Study Committee C4

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG [1]N° C4.71	**Name of Convenor: Sachin Goyal** (AUSTRALIA)
Strategic Directions #[2]: 3, 4, 5, 8	**Sustainable Development Goal #[3]:1, 2**
The WG applies to distribution networks: ☒ Yes / ☐ No	
Potential Benefit of WG work #[4] : 2, 3, 4	
Title of the Group: Small Signal Stability Analysis in Inverter Based Resource Dominated Power System	

Scope, deliverables and proposed time schedule of the WG:

Background:

Small-signal stability analysis has been an integral part of secure operation of interconnected power systems. Synchronous generator's controls have been designed to provide positive damping for different modes of oscillations e.g. local, intra and inter area mode of oscillations. With increasing penetration of inverter-based resources (IBR) and a reduction in the number of online synchronous generators, it is important to understand the impact of various forms of stability.

Several working groups have been and currently looking at various forms of stability with focus on large-disturbance power system performance. In a power system dominated by synchronous machines, electromechanical modes of oscillations have been the key point of interest. Modelling, analysis and control methodologies and power system technical requirements in this regard is well understood. However, with high penetration of IBR, pure electrical and control system modes will become important too. Some of these modes and their manifestations differ from known small-signal modes, hence the need for new modelling, analysis and control methodologies and new power system technical requirements.

A reduction in the number of online of synchronous generators and introduction of relatively smaller and more sparse synchronous condensers will also impact the existing power system damping performance. Whilst modelling and simulation methodologies are well-known in this regard, there is still a need to assess system performance for high share of IBR scenarios and determine the need for new control methods to substitute the declining number of power system stabilisers (PSS).

This working group will provide guidance on power system modelling and simulation methodology, and control methods as relate to small-signal oscillations in a power system with high share of IBR.

Scope:

- Definitions and problem statement
- Types of small-signal modes
- Impact of rapidly changing power system and generation mix on existing oscillatory stability modes (electromechanical modes)
- The need for new technical requirements
    - How to differentiate between electromechanical and electrical modes
    - Control system performance requirements

- Power system damping requirements
- Impact of different power system plant on small-signal stability
  - Synchronous machines
    - Generators
    - Condensers
    - Could synchronous machines cause adverse impact on damping of oscillations?
    - Operating generator at its minimum output (Pmin).
  - Grid-following inverters
  - Grid-forming inverters
    - Impact of synthetic inertia
  - Dynamic reactive support plant, e.g. SVCs and STATCOMs
  - HVDC converters
- Impact of Distributed Energy Resources (DER) on small signal stability (inter and intra area mode).
- PSS performance (electromechanical mode) with inverter-based resources
- Control interaction damping with inverter-based resources.
- Emerging modelling tools and techniques
- Small-signal model validation
- Practical case studies

The WG will refer to methodologies developed under WG C4.49 if relevant and will also interact with C4/B4.52 so as not to have any duplication.

Time Schedule (physical meetings):

The working group will start with online meetings, with the first face-to-face meeting to be held in August 2022 during the Paris Session subject to COVID-19 restrictions removed by then.

Deliverables:

☒ Technical Brochure and Executive Summary in Electra
☐ Electra Report
☒ Future Connections
☐ CSE
☒ Tutorial
☒ Webinar

Time Schedule: start: February 2022 **Final Report**: February 2025

Approval by Technical Council Chairman:

Date: January 20th, 2022

Notes: [1] Working Group (WG) or Joint WG (JWG), [2] See attached Table 1, [3]See attached Table 2 and CIGRE reference Paper: Sustainability – at the heart of CIGRE's work. [4] See attached Table 3

Table 1: Strategic directions of the Technical Council

1	The electrical power system of the future reinforcing the End-to-End nature of CIGRE: respond to speed of changes in the industry by preparing and disseminating state-of-the-art technological advances
2	Making the best use of the existing systems
3	Focus on the environment and sustainability (in case the WG shows a direct contribution to at least one SDG)
4	Preparation of material readable for non-technical audience

Table 2: Environmental requirements and sustainable development goals

	CIGRE selected the 7 SDGs that are the most relevant to CIGRE. In case the WG work refers to other SDGs or do not address any specific SDG, it will be quoted 0.
0	Other SDGs or not applied
7	**SDG 7: Affordable and clean energy** Increase share of renewable energy; e.g. expand infrastructure for supplying sustainable energy services; ensure universal access to affordable, reliable, and modern energy services; energy efficiency; facilitate access to clean energy research and technology
9	**SDG 9: Industry, innovation and infrastructure** Facilitate sustainable infrastructure development; facilitate technological and technical support
11	**SDG 11: Sustainable cities and communities** Increase attention on sustainable and resilient buildings utilizing local (raw) materials, power for electric vehicles, strengthening long-line transmission and distribution systems to import necessary power to cities, developing micro-grids to reinforce the sustainable nature of cities; protect and safeguard the world's cultural and natural heritage; reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and waste management
12	**SDG 12: Responsible consumption and production** E.g. Promote public procurement practices that are sustainable; address reducing use of SF6 and promote alternatives, encourage companies to adopt sustainable practices and to integrate sustainability information into their reporting cycle, address inefficient fossil-fuel subsidies that encourage wasteful consumption
13	**SDG 13: Climate action** E.g. Increase share of renewable or other CO_2-free energy; energy efficiency; expand infrastructure for supplying sustainable energy; strengthen resilience and adaptive capacity to climate-related hazards and natural disasters; integrate climate change measures into national policies, strategies and planning; improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning
14	**SDG 14: Life below water** E.g. Effects of offshore windfarms; effects of submarine cables on sea-life
15	**SDG 15: Life on land** E.g. Attention for vegetation management; bird collisions; integration of substations and lines into the landscape

Table 3: Potential benefit of work

1	Commercial, business, social and economic benefits for industry or the community can be identified as a direct result of this work
2	Existing or future high interest in the work from a wide range of stakeholders
3	Work is likely to contribute to new or revised industry standards or with other long term interest for the Electric Power Industry
4	State-of-the-art or innovative solutions or new technical directions
5	Guide or survey related to existing techniques; or an update on past work or previous Technical Brochures
6	Work likely to contribute to improved safety.