CIGRE Study Committee C4

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG[1] SC C4.77	**Name of Convenor:** Babak BADRZADEH (AUSTRALIA) **E-mail address**: babak.badrzadeh@ieee.org **Name of Secretary:** Julia MATEVOSYAN (USA) **E-mail address**: julia@esig.energy
Strategic Directions #[2]: 1,2	**Sustainable Development Goal #[3]: 7,9, 13**

This Working Group addresses these Energy Transition topics:

- [x] **Storage**
- [ ] **Hydrogen**
- [x] **Digitalization**
- [ ] **Sustainability and Climate Change**
- [x] **Grids and Flexibility**
- [x] **Solar PV and Wind**
- [x] **Consumers, Prosumers and Electrical Vehicles**
- [ ] **Sector Integration**
- [ ] **None of them**

Potential Benefit of WG work #[4] : 1,2,3,4,5,6

Title of the Group: Best practices for individual and collective conformity assessment of inverter-based resources during their lifetime

Scope, deliverables and proposed time schedule of the WG:

Background:

Power systems around the world are experiencing a rapid uptake of inverter-based resources (IBR) coincident with a reduction in the number of online synchronous generators. Concurrently, several countries are also experiencing a rapid uptake of large inverter-based loads (IBL). Inverter-based and synchronous devices exhibit different dynamic performance characteristics with different levels of complexity and controllability. Lack of understanding these differences from the wider power system perspective has sometimes resulted in system instabilities manifesting themselves in real-time power system operation before they are observed and mitigated during the studies phase.

Timely assessment and understanding of these differences will provide developers, original equipment manufacturers, consultants, network owners and system operators more certainty and allow managing any undue risks that may arise during the lifetime of the installation.

Fundamental to gaining this understanding is the process of conformity assessment with applicable interconnection requirements prior to connection of a new resource. Despite some differences, conformity assessment processes for synchronous machines are reasonably well-established worldwide. However, the same cannot be said for IBRs, particularly in areas with a high concentration of multiple IBRs. Furthermore, significant differences can be observed in practices adopted worldwide, ranging from scant modelling and studies to highly extensive studies with detailed full-scale models. Practices with very little modelling and studies carry the risk of system instability, equipment damage, or resource curtailment if an instability is identified after the resource is commissioned as seen e.g., in multiple large disturbance events in North America. On the other hand, approaches with highly detailed

assessment of each individual IBR have often resulted in significant delay to the project timeline especially when an instability is identified which requires remediation. Collective performance assessment of multiple IBRs concurrently serves as an important step to gain both the efficiency and confidence in the solution developed but is currently missing in most practices worldwide. A further concern with most existing practices is that while the resource is expected to operate for 20-30 years, little consideration is given to analysing and understanding plant performance during its lifetime, noting that significant changes could occur in the power system and generation mix after plant commissioning.

Concurrently, some power systems around the world are experiencing a rapid uptake of large industrial IBLs. The interconnection process for these resources is in its infancy, but there are lessons that can be learned and applied from the IBR interconnection process.

Purpose/Objective/Benefit of this work:

This work aims to develop and report on best practices for the conformity assessment process for IBR, with key consideration given to striking a balance between the level of accuracy required, time, cost, complexities of the project, and confidentiality of the data and models for various stakeholders.

Note that IBR is defined as devices either operating as a generator only, or with the ability to operate both as a generator and as a load, e.g. BESS or pumped hydro. The treatment of devices operating as a load only will be investigated in a future working group led by the same team, to be initiated 9-12 month after the start of this proposed WG.

Scope:

The working group would investigate and report on:

1. The role of electromagnetic transient (EMT) and phasor-domain transient (PDT) simulation for the conformity assessment process, including the judicious, simultaneous use of both approaches, i.e., co-simulation.
2. The role of single-machine infinite bus (SMIB), multi-machine infinite bus (MMIB) and wide-area network (WAN) network modelling for conformity assessment.
3. The role of vendor-specific and generic models.
4. Potential impact of plant type, e.g., offshore wind vs onshore wind vs solar, grid-forming vs grid-following inverters, or connection point voltage, i.e., direct transmission connection vs distribution connection.
5. The role of screening methods, including the need for developing new methods.
6. Challenges for extensive use of EMT modelling and possible countermeasures.
7. Approaches for confidential model and data sharing between multiple parties.
8. Individual vs collective performance assessment.
9. How to account for the impact of future power system and generation changes at the beginning of the connection process.
10. Identification of IBRs of interest for collective conformity assessment.
11. Solution development for non-conformance mitigation including control system tuning, and the use of synchronous condensers and grid-forming inverters.
12. Individual vs collective control system tuning of IBRs during the interconnection process and the lifetime of IBRs.
13. Survey of international practices on ensuring confidence in the plant and power system models during the connection process and the lifetime of the installation.

Remarks:

Noting the large scope of work, it is proposed split the scope between IBR and IBL and create two different WGs. The first WG will start from Q2 2024 focusing on IBRs and will deliver the scope described above. The second WG will be created 9-12 months thereafter focusing on IBLs and other contemporary topics not possible to start immediately due to reliance on other ongoing industry activities which will only be complete in a year or so. A separate ToR will be created accordingly.

Noting potential overlap with current activities within IEEE, a liaison member will be invited to participate in this WG.

Deliverables:

☒ Annual Progress and Activity Report to Study Committee
☒ Technical Brochure and Executive Summary in Electra
☒ Electra Report
☒ Future Connections
☒ CIGRE Science & Engineering (CSE) Journal
☒ Tutorial
☒ Webinar

Time Schedule:

First WG

• Recruit members (National Committees, WiE, NGN)	Qtr 2 2024
• Develop final work plan	Qtr 3 2024
• Draft TB for Study Committee Review	Qtr 2 2027
• Final TB	Qtr 4 2027
• Tutorial	Qtr 3 2028
• Webinar	Qtr 1 2028

Second WG

• Recruit members (National Committees, WiE, NGN)	Qtr 2 2025
• Develop final work plan	Qtr 3 2025
• Draft TB for Study Committee Review	Qtr 2 2028
• Final TB	Qtr 4 2028
• Tutorial	Qtr 3 2029
• Webinar	Qtr 1 2029

Approval by Technical Council Chair:

Date: May 7th, 2024

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

WG Membership: refer Comments at end of document

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.

Comments:

1) CIGRE Official Study Committee Rules: WG Membership

https://www.cigre.org/GB/about/official-documents

a. Only one member per country: by exception of SC Chair, WiE and NGN nominees.

b. WG nominees by NCs must first be supported by their National Committee (or local SC Member) as an appropriate representative of their country.

c. Acceptance of the nomination is granted by the SC Chair and advised to the WG Convener.

2) Collaboration Space

https://www.cigre.org/article/GB/collaborative-tools-2

CIGRE will provision the WG with a dedicated Knowledge Management System Space.

The WG will use the KMS for drafting collaboration, capture and retention of discussion and meeting records.

Official country WG Members will be sent registration instructions by the Convener.

Official country WG Members may request the WG Convener to allow additional access for an extra national subject matter specialist to aid in the work at the national level, including NGN members.