CIGRE Study Committee C1

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

JWG C1/C4.46	**Name of Convenor:** Christian Schaefer (AUSTRALIA) **E-mail address**: christian.schaefer@aemo.com.au

Strategic Directions #[2]: 1, 2, 4	**Sustainable Development Goal #[3]:** 7, 9

The WG applies to distribution networks: ☒ Yes / ☐ No

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

Title of the Group: Optimising power system resilience in future grid design

Scope, deliverables and proposed time schedule of the WG:

Background:

Power system resilience has been defined by WG C4.47 as:

> *"… the ability to limit the extent, severity, and duration of system degradation following an extreme event."*

This has been further qualified as:

> *"Power System Resilience is achieved through a set of key actionable measures to be taken before, during and after extreme events, such as:*
>
> - *Anticipation*
> - *Preparation*
> - *Absorption*
> - *Sustainment of critical system operations*
> - *Rapid recovery and*
> - *Adaptation*
>
> *Including the application of lessons learnt."*

As indicated by the actionable measures, power system resilience is an overarching concept that covers the whole spectrum of the power system from design and investment decisions to planning, operations, maintenance and asset management functions. As such, the concept of power system resilience applies to the planning time frame that looks to build resilience into the network, as well as the operational time frame, in which security is managed by optimizing the inherent resilience of the existing power system.

Climate change is notably increasing the severity of catastrophic system events sometimes leading to major interruptions and even blackouts. More frequent floods, cyclones, wildfires, and heat events, as well as human-related hazards, are creating operational challenges for economically designed and built electrical networks based on conventional planning standards. Combined with changes in power system and generation technology, consumer behaviour, and energy policy targets to decarbonize the electrical sector, the resilience of our networks is often stressed.

The complexity of the interconnected and integrated energy system, already today probably the largest and most sensible human-made realisation, shall increase in the next future due to the current energy transition. In managing such energy sector transition and aiming to develop resilient networks, power system planning for the future grid must:

- Enable transmission planning for an energy system rather than an electricity system alone to enable increased and rapid sector coupling where it is needed.
- Consider increasing environmental challenges to system security that can create high impact low probability (HILP) events and whether transmission infrastructure design standards need to change to address these.
- Accurately forecast long-term energy demand and production in a rapidly decarbonizing environment, including likelihood of erratic production patterns that must be managed.
- Anticipate the effect of an ageing thermal generation fleet on power system resilience during the energy sector transition.
- Investigate fast system restoration measures to limit the impact of HILP events.

This working group proposes to focus on establishing the suitability of current system planning and asset management standards to support the energy sector transition to a low emission one, and where possible recommend opportunities for improvements.

This WG will make use of contributions produced by C4.47, mainly related to:

- The Utilisation of suitable metrics for power system resilience and consequently consider the suitability of our current planning standards to meet these.
- Embracing a wide range of network and non-network options to create operational flexibility options, including more active and smarter demand management techniques and customer-sensitive load shedding procedures.

Scope:

The proposed scope will be delivered in three distinct steps: (a) establishing current practices and standards (b) development of a gap analysis and (c) propose opportunities for improving existing planning methods and standards.

Major tasks within the stepped delivery approach for the proposed WG include:

1. Build on work done by prior WGs on power system resilience topics (C2.25, C4.47, C1.17, etc.) and consider their recommendations in the proposed WG scope of works.
2. Adapt and document suitable metrics to define power system resilience for interconnected electrical power networks .
3. Review existing planning methods and standards used for power system infrastructure investments by system operators, and identify notable challenges associated with these in meeting the needs of a decarbonizing energy sector.
4. Consider the resilience of power system equipment in view of changing climatic conditions and identify emerging constraints and limitations.
5. Investigate the most used system restart techniques and consider whether these are viable in a highly decentralized, variable generation, and inverter-based resource power system. A global review of new restart technologies and methods will also be considered.
6. Investigate the concept of flexible grid design, potential barriers presented by market/regulatory frameworks, and investment decision-making / cost-benefit analysis, using a holistic approach that combines network and non-network augmentations, and operational procedures, which can meet the requirements for building a resilient grid.
7. Promote technical papers, technical panel sessions, and workshops for the dissemination of academic research and real-world applications of power system resilience planning for a decarbonizing energy sector.

8. Coordinate activities where appropriate with other CIGRE committees, subcommittees, and working groups about power system resilience.
9. Develop a final report and a Technical Brochure.

The WG would aim to find break-even conditions between preventive, containment and restoration measures and propose guidelines for determining an optimal mix of resilience measures from techniques such as:

- asset redundancy management and grid extension;
- grid users' resources (flexibility, demand response, etc.); and
- mitigation (smart load shedding, fast restoration, etc.).

Joint work with other SCs: Liaison experts from SC C5 will be invited

Deliverables:

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

Time Schedule: start: January 2021 **Final Report**: December 2022

Approval by Technical Council Chairman:

Date: November 28th, 2020

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.