CIGRE Study Committee B3

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

JWG B3/A2/A3/C3/D1.66 [1]**N°**	**Name of Convenor: Akshaya Prabakar (Netherlands)**
Strategic Directions #[2]: 1, 2, 3	**Sustainable Development Goal #[3]:9, 12, 13**
The WG applies to distribution networks: ☒ Yes / ☐ No	
Potential Benefit of WG work #[4] : 2, 3, 5	
Title of the Group: **Guidelines for Life Cycle Assessment in Substations considering the carbon footprint evaluation**	

Background:

To achieve the energy transition and decarbonization goals called for by specific nation states, substations, must become more environmentally friendly by reducing their carbon footprint throughout their lifecycle. The latest IPCC AR6 report is clear: reducing human contributions to global warming will help to achieve net zero carbon dioxide equivalent (CO_2e) emissions. Substations which have been in service for decades are no longer state of the art with respect to CO_2e emissions. It makes sense to consider whether a modern substation would produce a more favourable carbon footprint for the owner and/or user. It is neither effective or efficient to replace the complete installed base of substations with new substations. A systematic approach is required to select the substations or part of them, having the highest positive impact when considering replacing them, while taking into account the impact of the replacement. Based on life-cycle assessment (LCA) practice, a simplified approach to calculate the carbon footprint of the installed base is the first step, taking into account all substation components. The focus here is on the equipment use phase, since the substation materials and equipment have already been purchased, installed and are in service.

Using the same approach, alternative (new) solutions can initially be compared based on equivalent, modern technology, or even alternative technology. However, alternative technology or/and very different mode of production might require a more comprehensive (greenfield) approach to include the impact of production, i.e., a cradle to grave analysis. Components with significant carbon footprint impact should be the first candidates for retrofit or replacement.

The final calculations and determinations need to include the cost of investment in new material and equipment, impact on the user/owner's financial plan(s) the impact on carbon footprint of brownfield or greenfield solutions, and any impact on equipment depreciation due to reduced lifetime of the original equipment. These studies may include the ability to facilitate the rapid growth of renewable energy sources.

Purpose/Objective/Benefit of this work:

This WG aims to evaluate current substation decarbonisation practices and establish a simplified carbon footprint assessment methodology applicable to the full life cycle of existing substations and, if applicable, including greenfield substation solutions. The method should indicate where and when to act during the life cycle of the equipment. Thus, whether the approach is efficient and effective in LCA decisions for expansions and new substations will be investigated.

The main objectives are:

- To evaluate the reduction in carbon footprints in substations where owners and users need to decarbonise their assets.
- To justify investments and the impact of equipment replacement on substation carbon footprint by comparing existing and renewed or new equipment in substations. To provide comparisons of brownfield and greenfield solutions
- The brochure will determine the most technically effective and cost efficient focus as to where to concentrate on decarbonisation measures.

Scope:

The working group would investigate and report on:

- Recognition of the drivers following a simplified substation LCA analysis focusing on the appropriate LCA phases, if necessary, in the case of an alternative a more comprehensive (greenfield) approach with the full life cycle and correlate them to the corresponding greenhouse gas protocol reporting standards.
- LCA provides an impact category that includes global warming potential (GWP). The use of this value should be evaluated based on how it fits into the framework of the respective GHG Protocols of nation states, system operators and municipalities.
- Identify emission drivers for use stage of individual components and in the case of substitute solutions also for the manufacturing stage.
- Basic calculations involve AIS and GIS installations for indoor and outdoor use.
- The extent to which the simplified decarbonization approach can be extended to other primary components of the substation, for example, gas insulated switchgear.
- The expansion of the method into greenfield solutions and its limitations
- The inclusion of buildings, civil infrastructure, land consumption, and logistics.
- Use-cases would include EHV, HV and MV levels relevant for TSO and DSO operation.
- Only delta calculations of proposed changes that justify investments and show the impact of equipment replacement on substation carbon footprint based on replacement/renewal decisions over relevant lifetime depending on brown or green field analysis are to be considered.
- The LCA-based CO_2e footprint calculations would consider scenarios of different energy mixes.

The Working Group will focus on identifying the issues related to the LCA carbon footprint of substations, particularly what factors improve reliable long-term operation and maintenance, are justified cost effective investments, and having minimal impact on CO2e emissions. The WG will cover all types of existing substations and new substations.

Remarks:

This work may be relevant to many other CIGRE study committees on proper deployment of equipment and materials. Alignment with standardization development in IEC and ISO will be important, for example with TC17 IEC TS 62271-320 on environmental aspects of HV switchgear.

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:

- Recruit members (National Committees) Q1 2024
- Develop final work plan Q2 2024
- Draft TB for Study Committee Review Q4 2025
- Final TB Q2 2026
- Tutorial Q2 2026

Approval by Technical Council Chairman:

Date: January 5th, 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-ofthe-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)

b. WG nominees 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 provide 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.