CIGRE Study Committee A2

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG N° A2.68	**Name of Convenor : Peter Werle (DE)**
Strategic Directions #[2]: 1	**Sustainable Development Goal #[3]:** 7, 11
The WG applies to distribution networks: ☒ Yes / ☐ No	
Potential Benefit of WG work #[4] : 3, 5 and 6	
Title of the Group: Failure Survey of Lower Voltage Generator Step Up Transformers installed in Wind farms and Photovoltaic Parks	

Scope, deliverables and proposed time schedule of the Group

Context

As a result of the energy transition several 100.000 generator step up (GSU) transformers have been installed worldwide in the last decade in renewable energy generation plants such as wind farms and photovoltaic parks. These GSUs differ from conventional generator transformers, because they have significantly lower power ratings (typically <10 MVA in contrast to >100 MVA) and significantly lower operating voltages (medium voltage area), so that these transformers are similar to distribution transformers. Moreover, usually these small GSUs are in comparison to conventional GSUs highly stressed by fluctuating loads and in addition by harmonics, because they are often fed by inverter-systems instead of generator sets.

Therefore the design and also the insulating system of these small GSUs differ significantly compared to the conventional ones. In comparison to large GSUs the small units can be designed as dry type transformer insulated by epoxy resin. In case of liquid insulated systems, alternative liquids like natural or synthetic esters in combination with thermally upgraded or even aramid paper are often used, which is unusual for conventional GSUs. Of course the cost-price of the small GSUs is much lower compared to conventional ones, but the importance is similar, because a failure lead to a power interruption and in case of off-shore systems the installation / repair / exchange of a GSU is extremely costly.

In the last decade several failures on such small GSUs have been reported, leading to the assumption that they are less reliable than the conventional large GSUs, for which a failure rate was determined by a CIGRÉ working group (TB 642 presently updated by WG A2.62). A similar study needs to be done in order to better estimate the failure rate, the reliability and failure root causes of these GSUs in wind and photovoltaic parks. Based on such a study, it would be possible to determine failure rates of such small GSUs integrated in different renewable energy systems and therefore also to compare the reliability of different insulating systems in compact GSUs. This will allow to recommend certain design parameters or improved testing for future applications and might trigger additional working groups if specific failure root causes can be identified more often than other ones.

Scope and aim

1. Design a questionnaire for getting data from wind and photovoltaic park operators taking into account different designs as well as insulating and feeding systems of installed GSUs considering the following CIGRÉ contributions:
    a. WG A2.62 Analysis of Transformer Reliability.
    b. A2 TBs 642 (Transformer Reliability Survey), 755 (Transformer Bushing Reliability) and 528 (Guide for Preparation of Specifications for Power Transformers).
    c. An International Survey of Failures in Large Power Transformers in Service, Final Report of the CIGRÉ Working Group 12.05, Électra, 1983, Nr. 88, S. 21-48.
    d. D1 TB 507 (Guidelines for the use of statistics and statistical tools on life data)
    e. Final Report of the 2004 - 2007 International Enquiry on Reliability of High Voltage Equipment (TBs 509 to 514).

2. Identify and convince operators all over the world to share their data from GSU failures and population information in wind and photovoltaic plants anonymously.

3. Analyze the gathered data in order to estimate failure rates for:
    a. applications in wind and photovoltaic parks
    b. various key parameters like power and voltage class
    c. different insulation systems (dry or liquid with different paper types)
    d. different integration environments (e.g. where is the transformer installed, tower or nacelle of a wind turbine, onshore, offshore, climate-zone, how is the transformer fed)
    e. additional design specialities

4. Identify main failure root causes for different GSU technologies.

5. Provide information concerning how to identify failures in an early stage and how they might be avoided or which measures can be taken to improve the condition of the transformer.

6. Provide information concerning best practices of design of GSUs for future applications, or improved testing to demonstrate good performance.

7. Consider how these information can be transferred for transformer applications with similar operating conditions needed in the future, e.g. transformer for e-mobility (or other applications in the area of renewables like battery storage transformers), charging stations (highly fluctuating load), for which million units will be installed in the future. This can lead to avoid specific problems by optimizing the design for such systems based on the WG recommendations in advance, which will have an enormous impact.

8. Recommend to start additional working groups to analyze failure root causes in depth that appear more often in order to better understand the background and to develop more detailed recommendations.

Deliverables:

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

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

Approval by Technical Committee Chairman :

Date : October 3rd 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.

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 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.