CIGRE Study Committee C6 (Active distribution systems and distributed energy resources)

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG C6.44	**Name of Convenor:** Kilian Reiche (Germany)
Strategic Directions #[2]: 1, 2, 3, 4	**SDG #[3]:** 7, 9, 11, 12, 13
The WG applies to distribution networks: Yes	
Potential Benefit of WG work #[4]: 1, 2, 3, 4	
Title of the Group: Nodal Value of Distributed Renewable Energy Generation	

Scope, deliverables and proposed time schedule of the Working Group (WG):

I. Background

Due to falling capital and operating costs, the share of variable renewable energy (VRE), mostly wind and solar PV, in the overall power generation mix has been growing in most countries over the last decade. This trend is expected to accelerate in the near to medium term, as (i) VRE capital cost continues to fall; (ii) global and national decarbonization plans create additional power demand and result in a combination of distributed VRE based and centralized power generation; (iii) improved storage and system operation strategies allow higher VRE shares to be integrated, including in weaker power grids in emerging markets; and (iv) the regulatory framework increasingly allows VRE participation in the electricity markets justifying the business case for new VRE investments and in some cased making it easier to justify than new thermal power plants.

To address the intermittency and distributed nature of VRE power generation, power sector practitioners have focused mainly on technical interconnection issues and impact on the power system. The VRE regulatory framework is also evolving, and in some jurisdictions, moving from uniform feed-in tariffs to auctions and merchant IPPs, thus improving the VRE business case. These trends are reflected in various CIGRE WG mandates.

However, an important issue that merits more attention is the opportunity for joint optimization of generation, transmission and distribution planning that directly arises from the distributed and scalable nature of VRE generation. By estimating and comparing the nodal values of VRE power injection across all nodes of a power grid (that is, the marginal impact on the delivery of power at the power system level achievable through these injections, under an optimized dispatch approach and taking into account line flows and losses), planners can provide to markets locational price signals and/or regulatory guidance. This additional level of techno-economic analysis in turn allows for improved VRE scale-up pathways, by optimizing the VRE investments over time and space simultaneously for (i) reduced grid congestion and distribution, and potentially transmission losses and (ii) impact at each node of specific VRE generation diurnals combined with local load with benefits to the overall power system operation.

Recognizing this potential, several jurisdictions have started adding locational and/or nodal elements to the planning of VRE deployment at the distribution level; and entities such as IEA, IRENA are calling for spatially optimized VRE scale-up. The availability of practical methods to take advantage of the benefits identified above would be useful to sector practitioners.

II. Scope:

The objective of the WG is to document, discuss and analyse in practical terms how the VRE nodal value concept could be applied more broadly and systematically by public and private power sector planners (and investors). This would allow for the joint optimization in distribution and generation expansion of the scaling up of distributed VRE investments, in different countries and energy system contexts. To this end, the following topics and tasks are addressed by the WG:

1. Literature review. Review the literature and practitioner experience on VRE nodal value analysis and uses for technical and economic optimization of scale-up planning. Summarize the experience of DSO and VRE system owners and operators in making use of the nodal value.

2. Assemble practical examples. Assemble examples (i) from countries and jurisdictions that have added nodal or spatial considerations to their technical and/or economic VRE planning or policies; and (ii) from country studies on VRE nodal (net) benefits and their potential for enhancing the business case of VRE investments. (iii) Compare and align the analysis with the established methods currently used for VRE grid integration and optimization in generation and distribution expansion planning, referring to the work of other CIGRE WGs.

3. Analyze practical issues and implications of applying the VRE nodal value concept. (a) Quantify typical economic benefits, directly through reduced distribution losses, and indirectly in terms of providing ancillary services; (b) Discuss the relevance of VRE nodal value analysis in VRE expansion planning and policies, especially in weak power grids; (c) Discuss how nodal value analysis can be integrated into other power sector planning methods and procedures; (d) Investigate how VRE expansion can help with new energy planning challenges such as decarbonization, and electrification of existing and new sectors; (e) Investigate the possibilities of optimizing resource co-incidence at a given node and across all nodes to improve the nodal value. (f) Investigate the required granularity of the VRE scale-up planning to balance gains in system stability and economic, considering the increased control, information, communication and transaction infrastructure required from planners and investors; (g) Determine minimum standards for data, modelling and cost-benefit analysis information needed to obtain for robust results; (h) Determine how system modelling and planning results can be made more useful to practitioners and policy makers; (i) Investigate the frequency of the required VRE planning updates for optimal synergies to be established with other planning cycles.

4. Guidelines and good practices for deployment of a country-wide nodal analysis approach. VRE modelling and planning tools, economic considerations and business case analysis tools, use cases, implementation considerations including regional considerations, environmental impact, and regulatory considerations.

Joint work with other SCs: Liaison experts from SC C1 and C5 will be invited.

III. Deliverables:

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

IV. Time Schedule: Start: July 2021 Final Report: August 2023

Approval by Technical Council Chairman:

Date: July 5th, 2021

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.