

Key Take Away's C3

CIGRE Paris Session 2026



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For power system expertise

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Today

1. What is C3?
2. Papers
3. Working Groups (WGs)
4. Tutorial WG C3.25
5. Preferential subjects 2028
6. What's next?

What is C3?

- Power System Sustainability and Environmental Performance
- Mission: facilitate and promote sustainable development of power grid
 - Environmental and social impact (life cycle approach)
 - Sustainability and climate change
 - Stakeholder engagement, communication and public acceptance
- Focus on interaction between human and natural environment



Papers

- 69 in total, 5 from the Netherlands
- 24 for PS1
- 33 for PS2
- 12 for PS3

PREFERENTIAL SUBJECTS



C3

Power system
sustainability
& environmental
performance

PS1: Biodiversity conservation & enhancement. Towards positive contribution

- › Mitigating the impact from power system infrastructure: new renewable generation facilities, transmission and distribution. Preventive and corrective measures: nature inclusive design, commissioning, asset management and end of life.
- › Offsetting measures & ecosystems restoration. Net Zero impact and positive impact. How to measure?
- › New standards regarding biodiversity, i.e. IPBES; TCNFD.

PS2: Building a more sustainable power system for the future

- › Identification, quantification and assessment of impacts. Tools and methodologies. LCA approach, considering climate change and beyond.
- › Eco-design to reduce impacts.
- › Innovative solutions to enhance circularity.

PS3: Disclosing sustainability

- › Reporting standards & regulation. Indicators.
- › Stakeholder reporting requirements. Impact of disclosure on social perception and acceptance.
- › Value chain information, strategies and methodologies to obtain complete and reliable information.

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Power system sustainability and
environmental performance
10301 2026

KINGMA, E. M., BITTNER, D., HERMANS, A., VAN VELOHUISEN, M., SCHILT, B., SWINKELS, G., JAARSMA, S., NULAND, R. & BOS, O. G.

Offshore wind farms in the southern North Sea are rapidly expanding and introduce large amounts of hard substrate into a predominantly soft-sediment environment. These structures may therefore function as **artificial reefs**, increasing habitat heterogeneity and enhancing local biodiversity for hard substrate dwelling organisms.

However, the ecological role of complex offshore infrastructure, such as **Offshore High-Voltage Station (OHVS)** jackets, remains poorly understood. This study investigated the ecological implications of an OHVS jacket with its associated microhabitats and simultaneously deployed artificial reef elements in the Hollandse Kust Noord offshore wind farm (The Netherlands) for guiding future **Nature-Inclusive Design (NID)** strategies.

Species assemblages were assessed across seven distinct microhabitats associated with an OHVS jacket in the Hollandse Kust Noord offshore wind farm:

- Jacket structure (coated steel)
- Cathodic sacrificial anodes
- Gabions (rock-filled cable protection)
- Scour protection (granite substrate)
- Export cable
- Artificial reef elements (blocks & reef balls)
- Surrounding sandy seabed (reference habitat)

These habitats differ in substrate type, surface complexity, and ecological function.

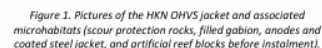


Figure 2. ROV video screenshots at the microhabitats. (A) Coated steel jacket, (B) Anode (C) Artificial reef element, (D) Gabion, (E) Export cable, (F) Scour protection, and (G) Sandy seabed.

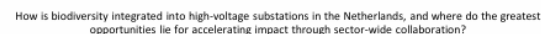
- **ROV video survey (4K):** visual identification of macrofauna and fish around the microhabitats and artificial reef elements
- **SACFOR scale:** abundance estimation of benthic organisms based on videos obtained
- **eDNA sampling:** 1 L seawater samples filtered (0.45 µm)
- **Genetic analysis:** COI (invertebrates) + MiFish (fish) primers

Species presence was compared across microhabitats based on video data analysis and eDNA results.

Species richness was highest on artificial reef elements, gabbions, and scour protection, and lowest on the export cable and surrounding sandy seabed. Complex hard-bottom structures supported a diverse assemblage dominated by blue mussel (*Mytilus edulis*) (for the jacksnets and anodes), anemones, hydroids, amphipods, crabs (*Portunus*, *Decapoda*), and the common starfish (*Asterias rubens*) (Figure 2). Fish communities showed habitat associations, with whiting post occurring on reef structures, horse mackerel around the jacket, and common dragonet on the seabed. eDNA analyses complemented ROV observations by detecting additional invertebrate and fish taxa not observed in the video footage.

PS1 Public acceptance and stakeholder engagement in power systems - generation, transmission & distribution infrastructures - 10300 2026.

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Pierre Oskam - Stedin - pierre.oskam@stedin.net



Biodiversity is becoming central in policy and infrastructure [1][9]. Grid operators are already working on it extensively.

However:

- ‡ approaches differ across organisations
- ‡ knowledge is not shared
- ‡ there is no clear sector overview

Result: high effort, but limited collective learning and impact

- ✦ desk research, literature research
- ✦ survey (n = 16)
- ✦ 4 case studies
- ✦ interviews
- ✦ validation at CIGRÉ NL Seminar

Comparison along 5 dimensions:

- ✦ Ambition
- ✦ Governance
- ✦ Design
- ✦ Implementation
- ✦ Monitoring

- † Fragmentation limits comparison, learning and scaling
- † Monitoring differences are the main barrier to sector alignment

The Dutch grid sector shows a strong shared ambition. All operators are moving towards nature-inclusive infrastructure and Net Gain. In practice, however, approaches differ. Biodiversity is integrated in different ways, at different moments, and with different methods. As a result, progress is real but remains fragmented. Valuable knowledge is created, but not easily compared or reused, and learning largely stays within organisations.

The challenge is not doing more, but connecting what already exists

The key opportunity is to move towards a shared system approach, where methods are aligned, data is comparable and learning is collective.

In essence: from many good individual projects one coherent, nature-inclusive grid network

† Scope: high-voltage substations in the Netherlands (10kV – 380kV).

- † Operators included TSO TenneT and DSO Alliander, Stedin, and Enexis.

Power System Sustainability and Environmental Performance

10318 2026

Allander, The Netherlands



Figure 2 – The biannual framework designed to help embed asset-focused climate adaptation into the DSO's policy framework.

- Climate change poses a risk to the physical assets in the electricity grid due to a higher probability of extreme weather events.
- Difficulty to address climate change related risks from an asset management point of view:
 - Many climate change related weather events.
 - Broad range of expected frequency and magnitude per weather event due to different scenarios.
 - Many different asset designs which will be differently affected by the weather events
- The aim of this work is to embed climate adaptation into the DSO's asset policy framework using a pragmatic and adaptive approach.

A qualitative and quantitative approach was chosen:

- All electricity grid assets were categorized into four groups.
- Qualitative screening on what kind of climate change effects pose a 'substantial' risk to what group of assets; prior (qualitative) risk analyses interviews with experts:
 - Increasing temperature, Flooding, Vegetation growth, Increasing humidity, Soil subsidence, Wildfires and the Drying of soil*
- Creating a compiled document with all pre-existing mitigation measures to these risks, an short-term goals in climate adaptation.
- Linking the framework to the existing quantitative 'risk analysis and policy'-cycle.

- An iterative framework to support the creation of quantitative risk analyses and associated mitigation measures for climate change related risks.
- Exposure maps are the first step towards prioritizing what weather events to focus on.
- Many mitigation measures are already in place for climate change related risks.

- Climate adaptation in grid management requires a risk-based and adaptive approach.
- Quantitatively addressing the gaps in knowledge regarding regional exposure levels and vulnerability of different asset types is essential for developing a climate-resilient grid.
- However, for climate adaptation both the helicopter view and the detail-oriented view are important.
- By incorporating qualitative steps to gather all expected risks and decide on what specific topic to focus the quantitative risks analyses on first, a steady development of climate adaptation is ensured within the DSO.

Papers from NL



Study Committee C3

Power System Sustainability &
Environmental Performance

Paper 10302 — PS2

A Life-Cycle-Based Environmental Passport for High-Voltage Substations

R. Faaij (Hanab Energy Solutions); J. Boyce, R. Dijkster (Witteveen+Bos); G. Korevaar (Rotterdam UAS); J. den Breijer (TenneT TSO); F. Middel (Prysmian)
The Netherlands

Motivation

- Net-zero by 2050 requires rapid grid expansion; over 670 new HV/MV substations in the Netherlands alone, each with significant embodied carbon, critical raw materials and SF₆ impacts.
- TSOs lack a standardised way to summarise and compare environmental impact in the design phase. This study explores an environmental passport to fill that gap.

Approach

- Practical case-study approach following the ISO 14040 LCA framework: goal & scope, inventory, impact assessment, interpretation.
- Impacts aligned with LCA method EN 15804+A2 (core + additional categories), the EC-A2 single score, and a Material Circularity Indicator (MCI).
- Results aggregated to a single-page passport for easy reading and comparison of design alternatives.

Scope of the case study

In scope

- Disciplines: civil & building (incl. terrain), primary, secondary
- A1-A3 production - A4-A5 transport & installation
- B (part): energy use, SF₆ leakage, 30-yr replacement, terrain
- C end-of-life - 50-year station lifespan

Out of scope

- Overhead lines, underground cables, telecom, EMC
- Central service building & small components
- Grid & component losses during operation
- Stage D credits — already captured in MCI

Case Study: Halsteren 150 kV

- 150 kV air-insulated High Voltage substation (TenneT TSO), a common Dutch station type, assessed during the design phase.
- Data from BIM models, supplier raw material passports (50% of primary components), withecoinvent / NMD datasets and expert judgement filling gaps.

Key findings case study

- Who you need:** building the passport is inherently multidisciplinary: designers, asset specialists, procurement and sustainability experts work together, stimulating cross-disciplinary dialogue and surfacing trade-offs that isolated analyses miss.
- What the data looks like:** supplier RMPs covered only ~50% of primary components; data was not centrally stored, material types were not linked to quantities in the 3D export, and installation data was missing. Gaps filled with ecoinvent/NMD datasets and expert judgement.
- What you can do with it:** the passport makes hotspots visible early (civil groundworks alone drove ~20% of GWP) and lets teams compare design alternatives, read as indicative and scope-dependent, not definitive.



Study Committee C3

Power System Sustainability and Environmental Performance

11084_2026

Role of SDGs in Shaping Sustainability in the Electric Power Sector

Katia Cristina GARCIA, Tal KATZ, Joris den BREEJEN, Marcela MANTILLA

Motivation

- The paper examines how the electric power sector (EPS) is evolving in its alignment with the United Nations Sustainable Development Goals (SDGs), with a particular focus on SDGs 7, 9, and 13, identified as key performance indicators for electric power generation.



- By building on earlier CIGRE work and incorporating recent regulatory, financial, and policy developments, this paper provides an updated and forward-looking perspective on SDG integration in the electric power sector.



PS1 – Biodiversity

- The focus is moving from limiting impacts to creating positive outcomes for biodiversity.
- Delivering biodiversity gains requires collaboration, good governance, and a whole-lifecycle approach.
- Portugal paper combines biodiversity, stakeholder engagement, economy value, culture heritage and wildfire protection for overhead lines

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C3 Power System Sustainability and Environmental Performance
PS1 - Biodiversity conservation & enhancement. Towards positive contribution

Reconversion of Powerline Rights-of-Way: Biodiversity, Resilience and Local Value in the Face of Climate Change and Wildfires

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SUMMARY

The Portuguese transmission system operator, REN – Rede Elétrica Nacional (REN), manages more than 33,500 hectares of Rights-of-Way (ROW), 66% of which in forest areas, including ecologically sensitive and fire-prone regions of the country. For decades, these corridors were managed almost exclusively as technical buffer zones, subjected to periodic vegetation clearing intended to maintain safety distances between conductors and vegetation. However, the intensification of climate change, the increasing recurrence of large-scale wildfires and the degradation of rural landscapes have revealed the limitations of reactive management strategies. In response, REN initiated, in 2010, a long-term Integrated Vegetation Management (IVM) strategy, that transformed the ROW from passively managed infrastructure protection zones, into actively managed, multifunctional corridors capable of providing social, economic and environmental values, while strengthening the robustness of the electricity system.

This strategy includes the ecological reconversion of vegetation within the ROW, replacing fast-growing exotic and invasive species, with native, slow-growing species compatible with electrical infrastructure, promoting grid resilience, operational efficiency and biodiversity. Between 2010 and 2025, REN reconverted 4,836 hectares, with the planting of over 1,6 M trees, including 283 hectares reforested in 2025. The programme also relies heavily on collaborative governance, with more than 25,000 landowners engaged over fifteen years, ensuring social legitimacy, operational continuity and shared benefits. One of the most emblematic outcomes of this approach is the restoration of the historic Ermelo Orange, a citrus variety introduced in the thirteenth century and nearly lost due to rural depopulation.

PS2 – Life Cycle Assessment

- Life Cycle Assessment is a well-established key tool for understanding and reducing sustainability impacts.
- Early-stage design choices, circular solutions, and new technologies can significantly improve environmental performance.
- Building a sustainable power system also means improving resilience to climate change through long-term planning and adaptation.
- Discussion CO₂eq (GHG) focus, or all impact categories? → Various WGs on the topic, very dynamic!

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C3 Power system sustainability & environmental performance
PS2 Building a more sustainable power system for the future

Life Cycle Impact Assessment and Weighting in Switching Station: Insights from a Case Study

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SUMMARY

In the power industry, continuous commitments have been undertaken to reduce environmental impacts throughout the entire life cycle. Initiatives for transmission and distribution (T&D) equipment have focused on mitigating global warming by reducing conversion losses and developing SF₆ alternatives, serving greenhouse gas (GHG) emissions the primary indicator in environmental assessments.

As evaluation has expanded to entire systems, the necessity of selecting diverse environmental impact categories in accordance with assessment objectives has become increasingly evident. Eco-design, aiming to minimize life cycle environmental impacts, requires informed decisions on design and operational strategies. These decisions demand integration of multiple indicators expressed in different units, typically achieved through Life Cycle Impact Assessment (LCIA), which comprise characterization, damage assessment, and weighting processes, ultimately yielding a single aggregated score. However, applications within T&D remain limited, and methodological challenges are yet to be systematically addressed.

This study aims to investigate approaches for building an integrated environmental impact assessment framework to support eco-design for T&D. The analysis targets 145 kV switching stations —Air-Insulated Switchgear (AIS) and Gas-Insulated Switchgear (GIS) with different in configuration and installation areas. Using the LIME3 (Lifecycle Impact Assessment Method based on Endpoint Modelling 3) methodology for integrated assessment, environmental impacts were quantified across the entire life cycle, including raw material extraction, manufacturing, operation (conversion losses and sulfur hexafluoride (SF₆) leakage), end-of-life (EoL), and land development. The assessment encompassed GHG emissions and four areas of protection. The assessment also considered electricity emission factors and the impacts of land use for seven countries.

As results indicate, AIS exhibited greater power losses during operation, whereas GIS emissions were primarily due to SF₆ leakage; overall, GIS showed a tendency toward lower

PS3 – Disclosing Sustainability

- Clear reporting and communication are increasingly more important for gaining and maintaining public trust and support.
- Companies are improving how sustainability information is measured, reported, and integrated into decision-making.
- Stakeholders expect earlier and more meaningful involvement in projects and their environmental impacts.
- Great inter-sectional collaboration!

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C3 - Power System Sustainability and Environmental Performance

PS3 – Disclosing sustainability

Unlocking Resilience: Detailed Equipment Data for Future-proof Transmission Grids

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SUMMARY

The paper presents an initiative involving several European Transmission System Operators (TSOs) aimed at establishing a common data basis to enable an objective comparison of the sustainability performance of products and equipment for transmission grids across multiple vendors. Rooted in “The Greener Choice” manifesto, the initiative leverages TSOs’ procurement activities to encourage greener manufacturing, services and logistics, supporting Europe’s climate goals of reducing greenhouse gas emissions by 55% by 2030 and achieving climate neutrality by 2050. It aligns with key EU regulations, including Corporate Sustainability Reporting Directive (CSRD), Net-Zero Industry Act (NZIA), Ecodesign for Sustainable Products Regulation (ESPR) and EU Taxonomy, and complements initiatives such as ENTSO-E’s RDI Roadmap.

Active C3 Working Groups

- AG C3.01 – EMF and human health (permanent advisory group)
- C3.22 – Vegetation management in substations
- C3.25 – Eco-design methods for the power system (tutorial, next slides)
- B1/C85 – Environmental impact of decommissioning of underground and submarine cables (finalization)
- A2/C3.70 – Life Cycle Assessment (LCA) of transformers
- B3/A2/A3/C3/D1.66 – Guidelines for life cycle assessment in substations considering carbon footprint evaluation (convenor)
- C3/B2.24 – Methods of reducing electrocution of birds from DSO power lines
- C3/B2.95 – Impact of extreme weather events under climate change on high voltage overhead line design standards

New WGs

- [TOR JWG B3 C3 75](#) Guidelines for End of Life Treatment of Substations
- [TOR-JWG A2 C3.79](#) Power Transformers and Reactors Sound Levels On Site



Tutorial WG C3.25 Eco-design methods for the power system

- Presented by Michael Gatzsche (Hitachi) and Marcella Mantilla (RTE), moderated by me

Motivation for WG C3-25

- The planet is moving towards and exceeding its environmental limits at an accelerating pace
- The power system is a major tool for humanity to lower environmental footprint by:
 - Connecting renewable energy sources
 - Enabling electrification of heating, transportation, ...
- The infrastructure of the power system has environmental impact: overhead lines, cables, SF₆ in switchgear, losses in power transformers...
- **Ecodesign** is an approach to designing **products and services** that gives special consideration to the environmental impacts of a product over its entire lifecycle
- How to apply ecodesign to the power **system**?
- Are users already applying it? What is their experience?
- Can ecodesign on the system level guide ecodesign on the subsystem / equipment level?

CIGRE decided to create WG C3-25 to answer these questions! ToR
TB finalization within 2026



Tutorial WG C3.25 Eco-design methods for the power system



Structure of the Tutorial & How Survey Insights Shape the Technical Brochure



We clarify **definitions and methodologies**. This gives us a framework for an aligned vocabulary for the entire tutorial and TB. Key definitions are ecodesign and power system; life cycle assessment (LCA) is the core methodology

We give a structured summary on **standardization, regulation, directives, and guidelines** related to ecodesign. While Europe is a hub for ecodesign activities, we have a global view covering all continents

We investigate which **existing activities** integrate ecodesign in the power system, both on an equipment and a system level; based on real world examples

We give guidance on **prioritization** on three levels:

- Environmental impact categories (e.g. climate change, resource use)
- Life cycle stage (e.g. use phase, manufacturing phase)
- Elements of the power system (e.g. transformer, substations)

Data sharing is key for ecodesign, we give a framework and highlight challenges in implementation

Finally, we develop **practical guidelines for implementation of ecodesign** on a system level: Current gaps, perspectives (user, OEM), and guidance on systemic ecodesign requirements

External survey to captured the state of the art and challenges in the T&D industry → your opportunity to contribute!

Tutorial WG C3.25 Eco-design methods for the power system



Outcome of the Working Group C3.25



- ✓ **Shared framework for ecodesign in power systems**

Clear definitions, scope, and methodology. LCA is the core decision-support tool, and it can be applied to products, sub-systems and systems

- ✓ **Global overview of standards, regulations, and guidelines**

Where more and more aspects are covered and regulations is continuously getting stricter. The EU is farthest along on this path; however, it is a global trend

- ✓ **Assessment of current industry practice**

Current activities are focused on impact assessment (LCA of products, sometimes sub-system to system-level). Concrete ecodesign practices are emerging in the power sector to reduce environmental footprint. Going further from evaluation to effective actions to reduce environmental impacts is needed.

- ✓ **Prioritization approach for impactful action**

Guidance on identifying environmental hotspots across life-cycle stages, impact categories, and equipment/system levels. Generally, use phase and manufacturing have the greatest environmental impacts. Current ecodesign activities mainly target climate change impact, although a broader range of environmental impact categories should increasingly be considered (e.g., resource use, land use, etc.)

- ✓ **Practical implementation guidance**

Recommendations on data sharing, governance, product- and system-level levers, and future CIGRE work needed to scale ecodesign

CIGRE brochure is at final draft stage. We plan to finish in 2026, publication in 2027.

Tutorial WG C3.25 Eco-design methods for the power system



Main Messages: Ecodesign for the Power System



- **Ecodesign** means taking responsibility and reducing environmental impacts of a **product or system** over its **whole lifecycle** – and beyond: **circularity**.
- Life Cycle Assessment **LCA** is the core tool to assess, decide, **take action** and measure progress.
- To **take** decisions, it is essential to **prioritize** impact categories and elements of the power system. Main drivers are clear today.
- Due to the complexity of the power system and the variety of its practitioners (TSO, DSO, OEM, ...) is essential to **share data across organizations**.
- **Standardization** facilitates data sharing, comparability and making adequate simplifications.
- **Ecodesign on the system level** can have benefits beyond optimization on product level.

Proposal WG: regenerative design for power sector



- Move beyond sustainability to include broad society welfare (*Dutch: brede welvaart*)
- Increase public acceptance, speed up projects
- ToR currently being drafted

DRAFT for discussion

CIGRE Study Committee C3 PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG¹ SC C3.[number to be assigned]

Name of Convenor: Gabriela M. Ramos (PT) [to be confirmed with SC C3 Chair; co-convenor from a TSO/DSO should be proposed]

Sustainable Development Goal: 15 (Life on land); also addresses 9 (Industry, Innovation and Infrastructure) and 11 (Sustainable cities and communities)

This Working Group addresses these topics:

☐ Storage ☐ Hydrogen ☐ Digitalization ☒ Sustainability and Climate Change ☐ Grids and Flexibility ☐ Solar PV and Wind ☒ Community integration ☒ Net-positive biodiversity

Title of the Group: Key Performance Indicators for the design of Regenerative Grid Infrastructure Projects

Scope, deliverables and proposed time schedule of the WG:

Background:

The scale of grid expansion required by the energy transition implies an unprecedented footprint of substations, overhead lines and cable systems on land use, materials, ecosystems and local communities. Current environmental practice in the power sector is predominantly oriented towards impact minimisation and mitigation, supported by established instruments such as life cycle assessment (LCA), environmental product declarations (EPD), environmental impact assessment and offsetting schemes.

The regenerative development paradigm goes one step further: it asks whether infrastructure projects can be designed to make a net-positive contribution to the ecological and social systems in which they are embedded, restoring ecosystem condition, building community capacity and improving the health of the wider system over the asset life cycle. While regenerative design has gained traction in the built environment, there is at present no shared conceptual basis, and no agreed set of key performance indicators (KPIs), that would allow transmission and distribution utilities to specify, tender, design, monitor and report regenerative outcomes for grid infrastructure projects in a consistent and auditable way.

This proposal is complementary to, and explicitly not overlapping with, JWG B3/A2/A3/C3/D1.66 (Guidelines for life cycle assessment in substations considering the carbon footprint evaluation): that work addresses the quantification of impacts, primarily carbon; the present proposal addresses the definition and measurement of intended net-positive ecological and social outcomes and of the quality of the design process itself, which existing LCA-based instruments do not capture.

Purpose / Objective / Benefit of this work:

The aim of the Technical Brochure developed by the Working Group is to provide utilities, regulators, designers and suppliers with (1) a clear and rigorous terminology distinguishing sustainable from regenerative development in the context of power systems, (2) a structured KPI framework for regenerative design of grid infrastructure, and (3) practical guidance and case studies for applying the framework across the project life cycle, from early planning and permitting to operation and end-of-life.

Scope:

The TB shall in particular discuss the following points:

- State-of-the-art survey of regenerative design theory and practice and of its application to infrastructure, including clarification of terminology (sustainable vs regenerative development, net-positive, nature-positive).

- Review of existing assessment schemes and indicator sets relevant to grid projects (LCA/EPD, biodiversity net gain, infrastructure sustainability rating schemes, SDG mapping) and identification of the gaps they leave for regenerative outcomes.
- A KPI framework for regenerative design of grid infrastructure structured around four complementary categories:
 - Target indicators: the net-positive ecological and social ambitions set for a project;
 - Condition indicators: the measured state of the ecological and social systems affected;
 - Pressure indicators: the drivers of impact exerted by the project;
 - Process indicators: the quality of the design and stakeholder process itself, auditing how outcomes are produced rather than only what is produced.
- Guidance on embedding the KPIs in the project life cycle: strategic planning, permitting, procurement and tendering, design, construction, operation and end-of-life.
- Methods for multi-stakeholder engagement and co-design in defining project-specific regenerative targets.
- Case studies contributed by member utilities (substations, overhead lines, cable projects) illustrating application of the framework.
- Recommendations for standardisation, procurement language and regulatory dialogue.

Out of scope:

- LCA methodology and carbon footprint quantification guidelines (covered by JWG B3/A2/A3/C3/D1.66).
- Jurisdiction-specific offsetting and permitting regulation, beyond illustrative examples.

Remarks:

- Possible connection with JWG B3/A2/A3/C3/D1.66; consideration to be given to constituting this group as a JWG with SC B3 (substations) and/or SC C1 (planning).
- Participation of WIE and NGN members is encouraged; academic members to be balanced with TSO/DSO and supplier representation.

Deliverables:

- ☒ Annual Progress and Activity Report to Study Committee
- ☒ Technical Brochure and Executive Summary in Electra
- ☒ CIGRE Science & Engineering (CSE) Journal
- ☒ Workshops
- ☒ Webinar
- ☐ others...?

Preferential subjects Paris Session 2028 (draft)

PS1. Assessing and managing environmental impacts of Power Systems

- How can negative and positive environmental impacts be effectively assessed? Metrics, data relevance, and indicators beyond carbon emissions.
- Projects and solutions for enhancing biodiversity associated with power system development and operation.
- Eco-design approaches to minimise environmental impacts & foster circularity across the asset life cycle: raw materials, manufacturing, operation, refurbishment, end of life.

PS2. Nature-related Impacts on the power system. Enhancing resilience.

- Forecasting the future: developing scenarios, projections, and risk assessment.
- Understanding and assessing nature impact of power systems.
- Adaptation measures to enhance the resilience of power system assets and operations & emergency response during natural disasters to reduce environmental impact of power facilities.

PS3. People and Power Systems

- Creating social value & improving social acceptance to speed up energy transition: effective engagement strategies and technical & societal solutions



What's next?

- Bangkok 2027
- Papers for Bangkok
- Papers for Paris 2028
- Working Groups

KEY DATES

Call for papers	June 2026
Opening of the synopses submission portal	Sept. 7, 2026
Deadline for synopses uploading	Jan. 11, 2027
Opening of registrations	Spring 2027
Selection of synopses by SCs and information to authors	Feb. 14, 2027
Deadline for Full Papers uploading	July 25, 2027
Feedback to author of full papers	Sept. 12, 2027
Final papers	Sept. 26, 2027
Final papers on ConfTool	Oct. 10, 2027
Power Point presentation	Oct. 24, 2027
Bangkok symposium	Nov. 8-12, 2027

Member SC D1

Simon Sutton

PS3 GRID INFRASTRUCTURE FOR FUTURE ENERGY TRANSITION AND DECARBONIZATION

B2, B4, D1	Advanced transmission technologies, materials and testing methodologies, including HVDC, multi-terminal DC, power semiconductor device and composite-core conductors
B2, B3, C1, C2, C3, C4, D1	Grid resilience and adaptation to extreme climate events (wildfires, storms, floods, lightning, geomagnetic storms, etc.) including methods of analysis, design innovations, new materials, and restoration strategies
C1, C4	Electric Vehicles (EV) fast charging and smart charging, reverse power flows, and their implications for grid capacity planning. Impact of other large inverter-based loads (IBLs), such as Data Centres (DC), on planning and dynamic performance of power systems
B3, C3, D1	Sustainable grid projects, including eco-design, sustainable materials, certificates of origin, and low-carbon solutions
B3	Substation modernization and integration of advanced equipment for sustainable transmission and distribution development
B2, B3, B4, C1, C2, C3, C4, D1, D2	Asset management strategies under high renewable penetration, including inspection, predictive maintenance, refurbishment planning, climate stress and aging infrastructure – balancing reliability, cost, and sustainability
B2	Dynamic line rating (DLR), online measurement, and advanced overhead line innovations to support high renewable penetration

Shaping the Future of Grids - Resilience, Intelligence, and Innovation for the Energy Transition

CIGRE, the world's leading non-profit association for the power sector, representing a global community of more than 20,000 experts across the utility, transmission, and distribution industries, welcomes you to the CIGRE 2027 International Symposium in Bangkok, Thailand.

This prestigious Symposium features high-level expert sharing sessions, where senior professionals exchange the latest industry knowledge, breakthrough research, and forward-looking insights shaping the future of power systems.

Unlike a traditional tradeshow, the CIGRE Symposium offers a content-driven, deeply technical, and highly selective programme. Attendees participate in rigorously reviewed technical paper presentations, hands-on tutorials, interactive workshops, and inspiring keynote sessions delivered by renowned leaders from around the world.

Building on the momentum of the CIGRE International Symposium 2025, which welcomed over 2,300 senior participants, and the legacy of the flagship CIGRE Paris Sessions, the CIGRE International Symposium 2027 in Bangkok will deliver an unparalleled platform for collaboration, knowledge exchange, and innovation for the global power and energy community.

PREFERENTIAL SUBJECTS

PS1 RENEWABLE ENERGY INTEGRATION, STORAGE, AND CROSS-BORDER INTERCONNECTIONS

B3, B4, C4, C5	Grid-forming Battery Energy Storage Systems (BESS), hybrid storage solutions and other grid-enhancing technologies to improve power system strength, stability and resilience
C2, C4, C5, D2	Grid operational codes, TSO-DSO coordination, big-data based forecasting for congestion management and situational awareness. Enhanced techniques for TSO-DSO co-simulation and data exchange
C4, C5	Enhanced analysis methods and solutions to address emerging instability phenomena, system strength, flexibility and resilience challenges in future power systems
C1, C5	Planning and economics of Renewable Energy (RE) integration, including energy policy, interconnections, and cross-border power exchange
D1	Advanced materials for energy storage and enhanced operational flexibility (e.g. improved thermal, electrical, or mechanical capabilities)
C1, C4, C5	Integration of hydrogen and ammonia in power system planning, enabling cross-sector decarbonization, and their dynamic interaction with the power system

PS2 DIGITALIZATION AND SMART MONITORING FOR THE ENHANCEMENT OF POWER SYSTEMS

B2, B4, C2, C4, D1, D2	Application of Artificial Intelligence and Machine Learning (AI/ML) and advanced data analytics for transmission and distribution online monitoring, predictive maintenance, fault detection, power quality and power system stability
B2, B3, B4, D1, D2	Innovative asset management and diagnostics, including Building Information Modeling (BIM), drone inspection, and Internet of Things (IoT) sensors, to extend the life cycle of transmission and distribution equipment
B4, D2	Cybersecurity and communication technologies for secure and reliable operation of transmission and distribution grids
B3, D2	Smart substations and advanced electrical installations for digitalized grid operation

PS3 GRID INFRASTRUCTURE FOR FUTURE ENERGY TRANSITION AND DECARBONIZATION

B2, B4, D1	Advanced transmission technologies, materials and testing methodologies, including HVDC, multi-terminal DC, power semiconductor device and composite-core conductors
B2, B3, C1, C2, C3, C4, D1	Grid resilience and adaptation to extreme climate events (wildfires, storms, floods, lightning, geomagnetic storms, etc.) including methods of analysis, design innovations, new materials, and restoration strategies
C1, C4	Electric Vehicles (EV) fast charging and smart charging, reverse power flows, and their implications for grid capacity planning. Impact of other large inverter-based loads (IBLs), such as Data Centres (DC), on planning and dynamic performance of power systems
B3, C3, D1	Sustainable grid projects, including eco-design, sustainable materials, certificates of origin, and low-carbon solutions
B3	Substation modernization and integration of advanced equipment for sustainable transmission and distribution development
B2, B3, B4, C1, C2, C3, C4, D1, D2	Asset management strategies under high renewable penetration, including inspection, predictive maintenance, refurbishment planning, climate stress and aging infrastructure – balancing reliability, cost, and sustainability
B2	Dynamic line rating (DLR), online measurement, and advanced overhead line innovations to support high renewable penetration

PARTICIPATING CIGRE STUDY COMMITTEES (SC)

SC B2 Overhead Lines (co-lead)	SC C3 Power System Sustainability & Environmental Performance
SC B3 Substations & Electrical Installations	SC C4 Power System Technical Performance
SC B4 DC Systems & Power Electronics	SC C5 Electricity Markets & Regulation
SC C1 Power System Development & Economics	SC D1 Materials & Emerging Test Techniques
SC C2 Power System Operation & Control	SC D2 Information Systems Telecommunications & Cybersecurity (co-lead)

Thank you for your attention!

