https://life-sf6-free-gis.eu/

Life SF_6-Free GIS

Co-founded by
the European Union

GE VERNOVA

1. PROJECT DATA

Summary: The LIFE SF_6-FREE GIS program has progressed in two phases: the first delivered a full 245 kV/50 kA SF_6-FREE GIS bay, while the second will enable a full 245 kV/63 kA bay for both onshore and offshore substations. The new B105g bay uses GE Vernova g^3 gas technology instead of SF_6, maintaining the same ratings and footprint as legacy SF_6 equipment while reducing the carbon footprint of the gas by about 99%. The bay also integrates digital low-power instrument transformers (LPITs) and a new merging unit to support smart, data-driven operations.

Coordinating Beneficiary: Grid Solutions SAS

Project Reference: LIFE21-CCM-FR-LIFE-SF_6 FREE-GIS / 101074338
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Project End Date: 31/12/2026
Project Budget: 4.950 M€

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2. ABBREVIATIONS AND CHEMICAL FORMULAE

2.1 ABBREVIATIONS

Acronym	Designation
GIS	Gas-Insulated Substation
AIS	Air-Insulated Substation
GIL	Gas-Insulated Line
TSO	Transmission System Operator
LPIT	Low-Power Instrument Transformer
MU	Merging Unit
GWP	Global Warming Potential
LCA	Life Cycle Assessment
SEA	Socio-Economic Assessment
IEC	International Electro-technical Commission
kA	Kiloamperes
kV	Kilovolts

2.2 GAS

1. SF_6 or sulfur hexafluoride molecule

Insulating and switching gases	Name
SF_6	Sulfur Hexafluoride
g^3	"g" cubed gas mixture containing CO_2, O_2 and C_4F_7N

3. PROJECT IN BRIEF

3.1 INTRODUCTION

Co-funded by the European Union's LIFE Programme, the LIFE SF_6-FREE GIS project will deliver a full 245 kV/63 kA SF_6-free bay for Gas-Insulated Substations (GIS), ready for both onshore and offshore applications. Using GE Vernova's g^3 gas instead of SF_6, the new B105g keeps the same footprint and nameplate ratings as legacy SF_6 equipment while cutting the gas contribution to climate impact by about 99% (GWP basis).

The bay is digital by design, with integrated LPITs and a new merging unit to enable smart, data-driven substation operations. Building on prior SF_6-free achievements at higher voltages in Europe, g^3 provides a scalable pathway to decarbonize 245 kV GIS without sacrificing compactness.

2. Our LIFE21 R&D Expert Team

What is g^3 ?

g^3 is GE Vernova's alternative to SF_6 for high-voltage equipment. It is based on a CO_2-O_2 gas mixture with a small percentage of a fluoronitrile used as an additive. This mixture helps preserve the GIS compactness and performance while lowering its carbon footprint. Building on successful deployment in Europe for up to 420 kV, g^3 enables a scalable transition to SF_6-free substations.

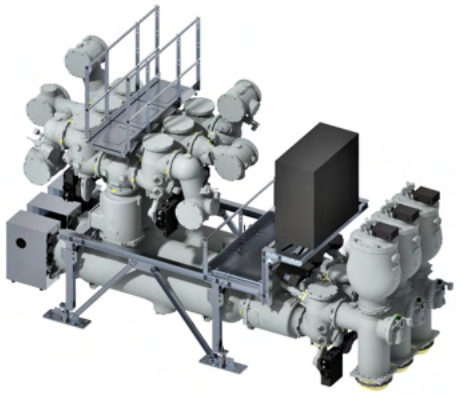
Why It Matters: Since 60 years, SF_6 has enabled compact, reliable GIS in dense urban areas and in space-constrained offshore platforms. Yet SF_6 is a very potent greenhouse gas, with an atmospheric lifetime of about 1,000 years. As Europe expands offshore wind and modernizes its transmission backbone, moving away from SF_6 is essential to meet climate goals while preserving GIS compactness. At the same time, grid digitalization is becoming critical to integrate variable renewables. Replacing conventional instrument transformers with LPITs and fiber-based process interfaces reduces raw material needs and unlocks high-quality measurements for protection, monitoring, and advanced analytics.

3.2 PROJECT OBJECTIVES

We aim to engineer and validate a 245 kV/63 kA SF_6-free GIS bay with g^3, meeting the targeted dielectric, thermal, mechanical and functional performance while preserving the same footprint and interfaces as legacy SF_6 equipment. We will integrate digital measurement and communications at the bay level to enable protection, control and condition-monitoring. Together with European Transmission System Operators (TSOs), we will prepare and execute onshore and offshore pilots to demonstrate compatibility, operability and maintainability under real network conditions. We will quantify benefits through a Life Cycle Assessment (LCA) and a Socio-Economic Assessment (SEA) and track key performance indicators to showcase carbon footprint and operational value. Finally, we will consolidate design rules and practical implementation guidance to enable replication across European grids and beyond.

LIFE SF_6-FREE GIS complements GE Vernova's SF_6-free roadmap for up to 420 kV. Building on the achievements of LifeGRID at 420 kV and alongside the SECO$_2$ND LIFE GIS retrofit initiative for existing bays, it paves the way for a complete SF_6 phase-out in high-voltage GIS while supporting the digital, resilient grid that Europe needs.

4. PROJECT PHASES



3. 3D Representation of a B105g GIS

4.1 PHASE ONE – Prepare and Model

We characterize and model the 245 kV bay for SF_6-free operation with g^3 using multiphysics simulations (dielectric, thermal and electromagnetic) to de-risk design choices before hardware is built.

In parallel, we conduct offshore pre-studies to address compactness constraints, define standardized interfaces and specify corrosion protection and logistics suitable for marine environments.

From the outset, we embed eco-design principles and scope the LCA to minimize the carbon footprint across materials, manufacturing, operation and end of life.

4.2 PHASE TWO — Design, Prototype and Type-Test

We engineer and prototype the B105g 245 kV bay as a fully SF_6-free system with g^3, while preserving the same footprint and interfaces as legacy SF_6 equipment. The redesign covers the core components: disconnectors, earthing switches, maintenance devices and the busduct elements (crosses, elbows, straight sections, and bellows), as well as the connection elements, including bushings, transformer connections and the cable box. Accessories, such as gas monitoring and the low-voltage control cubicle, are finalized to fit the new architecture. Circuit breaker integration draws on the 420 kV work from our LifeGRID project and is adapted to the 245 kV bay. We confirm ratings and margins through standards-based type tests at CERDA and partner laboratories, establishing the evidence base for technical readiness and subsequent pilots with TSOs.

For offshore applications, we improve the bay layout for compact, platform-friendly integration and standardized interfaces, and we specify corrosion protection systems compatible with g^3 operation and marine environments. Tightness, seals and mechanical interfaces are qualified under representative thermal cycles, handling and environmental constraints to support installation, transport and maintenance on offshore platforms. The resulting design maintains the same overall footprint while addressing space, durability and accessibility requirements specific to offshore projects.

The bay is digital by design, with integrated LPITs (RECT for current, CEVT for voltage) and new merging units compliant with IEC 61869-8. Fiber-based process interfaces replace heavy copper harnesses to feed high-quality measurements into protection, control and condition-monitoring systems. Cybersecurity is built-in from the start, including secured boot and hardened communication. Gas monitoring and device supervision are natively integrated, enabling data-driven operations and simplifying deployment in smart, resilient substations.

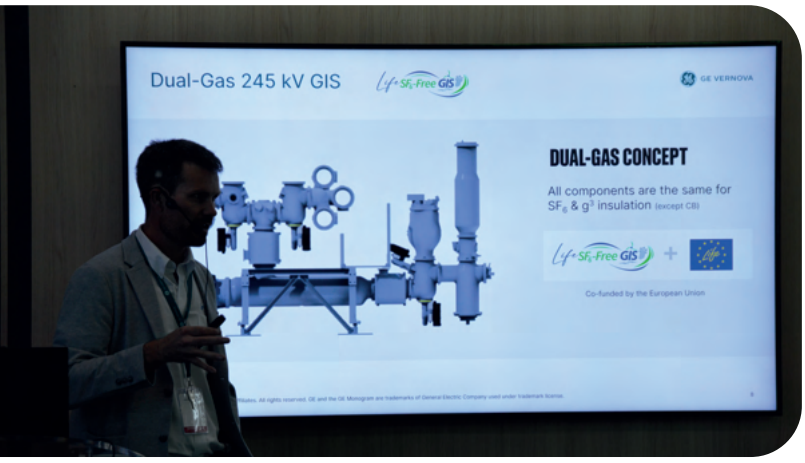
4.3 PHASE THREE: Demonstration and Impact Assessment

We complete technical validation of the 245 kV SF_6-free bay and progress toward Authorization-to-Quote (ATQ) and production release, establishing the evidence needed for market introduction. In parallel, we prepare pilots with European TSOs for both onshore and offshore applications, aligning on-site selection, protection and control interfaces, operational procedures, and outage planning to ensure safe, compatible deployment under real grid conditions.

4. Exhibition of the B105g at our La Prairie Factory

To substantiate benefits, we carry out an LCA in line with international practice, quantifying the environmental gains from removing SF_6 and from enhancing materials and operational energy. A complementary SEA examines worker safety, training for g^3 handling and monitoring, supply-chain readiness and operator acceptance. Throughout, we track key performance indicators covering environmental benefits, technical performance, reliability, and stakeholder adoption, so that decisions remain data-driven and outcomes are measurable and repeatable.

4.4 PHASE FOUR: Communication and Stakeholder Engagement



5. S. Souchal presenting the Dual-Gas Concept in CIGRE Paris

We co-design the solution with TSOs through structured workshops and design reviews, refining interfaces, maintenance practices, gas handling and monitoring to match operational expectations. We share knowledge and contribute to standardization through IEC, CIGRE and industry networks, helping the community adopt SF_6-free practices consistently. Our outreach with the project website, brochures and events distils lessons learned into concise guidance that partners can reuse across their networks, accelerating safe roll-out on onshore substations and offshore platforms alike.

4.5 PHASE FIVE: After-LIFE Replicability

We formalize clear, operator-facing procedures for g^3 gas handling, tightness verification, density monitoring and end-to-end site deployment from factory acceptance through installation, commissioning and handover. These are packaged as method statements, checklists and training modules to support safe, repeatable roll-out at scale, including tooling and competency requirements for field teams.

In parallel, we build a roll-out plan with European TSOs and EPC partners for onshore substations and offshore platforms, aligning spares, logistics, and service readiness, and preparing extension beyond Europe as markets and regulations converge.

6. Installation of a 420 kV GIL in Kintore, Scotland

Finally, we consolidate design rules, performance margins and validation evidence with type-test reports, ATQ/production-release documentation, and pilot feedback into practical implementation guidance. This playbook, combined with the same-footprint bay architecture and standardized interfaces, de-risks replication across voltage levels and configurations while ensuring consistent integration of monitoring, digital communications and cybersecurity in smart, resilient substations.

5. B105g BENEFITS

About 99% lower gas GWP vs. SF_6 at comparable performance

SF_6-free 245 kV/63 kA GIS bay onshore- & offshore-ready

245 kV/63 kA: same footprint & interfaces

Digital ready: LPITs + merging units

This program is aligned with the EU Green deal, REpowerEU, COP21 Paris agreement and the latest F-gas regulations. Contributing to power-sector decarbonization.

To learn more, please visit:
https://life-sf6-free-gis.eu/life-sf6-free-gis

To join our team, please visit:
https://careers.gevernova.com/global/en/search-results

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