

National Grid Begins Journey to SF₆-free HV Substations

CASE STUDY





Sellindge - Overall view during site works

The entire electrical transmission industry is buzzing over the technical achievement of energizing the first high voltage gas-insulated line (GIL) using an environmentally friendly alternative to SF₆. This SF₆ alternative insulation medium is called g³: Green Gas for Grid. To date, there has been no alternative to SF₆ technology since its inception in the 1970's, when it was introduced as an insulation medium in High Voltage (HV) switchgear.

Indeed, on April 13 2017, National Grid achieved a huge industry milestone with the energization of the first SF₆-free 420 kV gas-insulated line in their Southeast England network. The new Sellindge substation was deployed in an operationally critical part of the UK's transmission network to help ensure the region would continue to benefit from a safe and reliable supply of electricity. It plays a vital role in the ElecLink project, which will increase the UK's energy security, reliability and capacity by connecting with the French electricity transmission network.

“ We are very pleased to collaborate with National Grid on this project, the first in the world to use a g³ solution. Utilities wanting to take the step to reduce their global warming potential now have an alternative to SF₆.

~Giuseppe Sottero, General Manager
GE Gas-Insulated Substations

Industry Framework: Mitigating Climate Change

In a world of ever increasing power demand, utility companies have a vital role in connecting millions of people safely, reliably and efficiently to the energy they use. This requires continual evaluation of operations, equipment and processes in an effort to respond to the changing environment.

As a matter of course, SF₆ has been a critical technology under review for some time. Sulfur-hexafluoride (SF₆) is used in the HV electrical transmission industry because it is an excellent gaseous dielectric medium.

Unfortunately, it is also the greenhouse gas with the largest global warming potential (GWP)* – 23,500 times more than CO₂.

Thus, much effort has been made across the industry in the last decades to find a viable alternative. Today, with g³ from GE, the industry is well-positioned for the next breakthrough in high voltage equipment.

National Grid at the Forefront of Green Technology Implementation

With strong commitments to their regulator and stakeholders regarding the ongoing reduction of SF₆ gases released into the atmosphere, National Grid has set voluntary targets to reduce greenhouse gas (GHG) emissions across their UK and US businesses by 45% by 2020 (baseline: 1990). This corporate philosophy led National Grid to select g³ technology in 2015 for a new project as part of their Network Reinforcement Program.

The introduction of GE's g³ solution provides an opportunity for National Grid to be at the forefront of new technology development, and obtain an early understanding of the performance of the equipment. In addition to its negligible environmental impact, this new gas checked all the boxes for National Grid's health and safety pre-requisites and stringent performance specifications.

In an interview with Mark Waldron, who spearheaded the project for National Grid, he expressed that: "g³ opens the way for reducing or eliminating SF₆, and that's something that for National Grid is really important."



“ If we can move to a world where we are not using SF₆ at all, this is clearly a better way of managing the problem, rather than using a damaging gas and having to manage it. The g³ project at Sellindge is the start of a road that we can go down to remove SF₆ from equipment newly installed on the network.

~Mark Waldron, Switchgear Technical Leader
National Grid, UK

The Impact of SF₆ is Significant

Replacing 1kg of SF₆ with the corresponding mass of g³ is the carbon equivalent of removing 16 cars running one year off the road.^{***} The potential for global warming reduction is further underscored when you look at the sheer quantity of SF₆ installed worldwide. Specifically, studies indicate 10,000 tons of SF₆ are installed each year, with 80% concentrated in the transmission industry alone.

Replacing 1 kg of SF₆ with g³ = **16 CARS** running one year (10 000 km each)

With the Sellindge GIL installation, the estimated gas emissions savings are significant. More than 7,000 tons of CO₂ equivalent** (CO₂e) will be saved over the service life of the 230 meter-long gas-insulated circuits, which connect the substation to the bushings and overhead lines.

SELLINDGE GIL (comparison)	GIL Gas Quantity	CO ₂ e Gas Qty.	Gas Emissions†	CO ₂ e over 40 years
SF ₆ GWP 23,500	1.54 tons SF ₆	36,237 tons CO ₂ e	0.30 tons SF ₆	7,247 tons CO ₂ e
g ³ GWP 327	0.734 tons g ³	240 tons CO ₂ e	0.15 tons g ³	48 tons CO ₂ e

†Based on 0.5% emissions per year, over 40 years. | CO₂e = carbon equivalent

7,199 tons CO₂e gas emissions avoided over lifetime

Environmental benefit of g³ technology applied on Sellindge project

What's more, the environmental benefit does not compromise the technical performance: g³ applications exhibit the same technical performance, they operate in the same ambient conditions (down to -25°C), and they feature the same dimensional footprint when compared to SF₆ equipment.

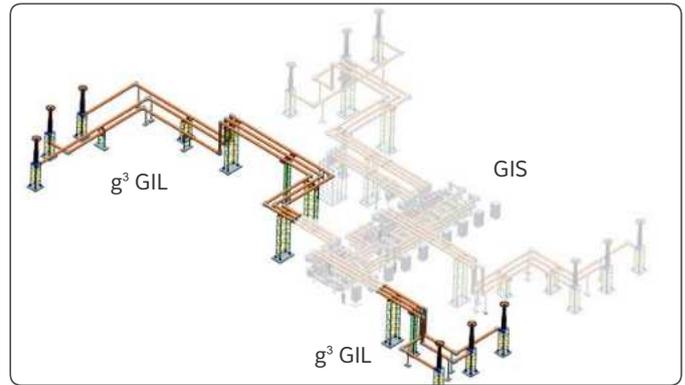


Diagram of the Sellindge 230 meter GIL installation

g³ Now Available to All Utilities

g³ is fully type-tested and commercially available for GIS up to 145 kV, GIL up to 420 kV, and AIS Current Transformers up to 245 kV.



GIL up to 420 kV



GIS up to 145 kV



AIS CT up to 245 kV

Already, six (6) utilities have decided to implement g³ solutions on their networks, and many others are now considering the new GE solution. The environmental argument for g³ is staggering – SF₆ remains in the atmosphere for 3200 years, and its concentration has increased by 20 % in the past 5 years alone.

The time for change has come. Now there is an alternative to SF₆ for HV switchgear. Implementing site applications, and supporting the wider adoption of g³ technology is all about corporate and social responsibility. It's about doing our part to mitigate global warming, and about improving people's lives.

80% of all SF₆ used is in the transmission industry

10 000 tons of SF₆ are installed yearly

3 200 years is the number of years SF₆ remains in the atmosphere

+20% is the SF₆ concentration in the last 5 years



About g³

- g³ ("g cubed" – Green Gas for Grid) is GE 's alternative to SF₆ developed in collaboration with 3M™.
- g³ is a proven and ready-to-go alternative insulating gas mixture for high voltage electrical transmission equipment, which provides the same technical performance as SF₆ with a drastically reduced environmental impact - g³'s impact is a whopping 98% to 99% less than SF₆.
- The g³ gas mixture is blended using 3M™ Novec™ 4710 Insulating Gas with a balanced percentage of Carbon Dioxide to optimise performance.
- The gas mixture offers an efficient combination of low global warming potential (GWP) with high dielectric performance and minimum operating temperatures in accordance with the typical Transmission System Operators' (TSO) needs.

g³ Benefits

Technical

- g³ is fully type-tested and commercially available for GIS up to 145 kV, GIL up to 420 kV, AIS Current transformers up to 245 kV.
- g³ is applicable in the same environmental conditions and at the same ambient temperature ranges as SF₆.
- g³ high-voltage equipment feature the same dimensional footprint as state-of-the-art SF₆ equipment.
- g³ is non toxic and falls in the same safety class as SF₆.

Environmental

- g³ Global Warming Potential represents only 1 to 2 % of that of SF₆.

Financial

- Utilities can qualify for tax reductions or incentives related to greenhouse gas emissions reduction.



Environmental impact of g³ vs SF₆



Utilities can adopt best practices in terms of environmental sustainability



Utilities can qualify for tax reduction or incentives related to greenhouse gas emissions reduction

Notes

* Global Warming Potential is a common unit of measure to allow analysts to compare the global warming impacts of different gases, specifically how much energy the emissions of 1 ton of a gas will absorb (over a given time) relative to the emissions of 1 ton of CO₂ (which has a GWP of 1). The larger the GWP, the more that gas warms the earth as compared to CO₂.

** CO₂e is a measurement of carbon footprint to define the impact of different gases in terms of the equivalent amount of CO₂ that would create the same amount of warming. Source: <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>

*** Calculation based on the following values: SF₆ GWP = 23,500, g³ GWP = 327, Average car emission per km = 0.14 kg CO₂e, Average distance per car per year = 10,000 km [23,173/.14] -->[165,521/10,000] = 16.5

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Imagination at work