

## Green Gas for Grid (g3)

General Electric has established itself as a leader in the market for SF<sub>6</sub>-free high voltage switchgear. In its September 2020 report, the EU Commission deemed that fluoronitrile-based gas mixtures, such as the gas used for insulation in GE's g3, are a viable alternative to current SF<sub>6</sub>-based high voltage equipment in terms of both performance as well as compactness. GE has been winning many HV switchgear projects across the globe, with a particularly strong footing in Europe and Middle-East Africa and this encouraging verdict by the Commission has certainly played a crucial part in more vigorous deployment of g3 solution by GE worldwide. However, GE simultaneously continues to deploy both its g3 as well as SF<sub>6</sub>-based solutions around the world. This is because different regions in the world are moving at a different pace when it comes to adopting SF<sub>6</sub>-free switchgear. While Europe is the biggest market for SF<sub>6</sub>-free solutions at present, Middle East Africa remains the most reluctant to adopt this technology with the main bottleneck being the perception of lesser "reliability" of SF<sub>6</sub>-free solutions as compared to SF<sub>6</sub>-based solutions.

Interestingly, in April 2021, GE and Hitachi Energy signed a non-exclusive, cross-licensing agreement related to the use of fluoronitrile-based gas mixtures in place of SF<sub>6</sub> in high voltage equipment. Fluoronitrile-based gas mixtures have a significantly reduced impact on the environment compared to SF<sub>6</sub>. Under this agreement that was announced just before Earth Day 2021, both companies will share complementary intellectual property related to their respective SF<sub>6</sub>-free solutions. This will help accelerate the use of fluoronitrile-based eco-efficient insulation and switching gas in high voltage equipment as an alternative to SF<sub>6</sub>. This agreement paves the way for a standard SF<sub>6</sub>-free solution for high voltage equipment moving forward. Also, this would assist utilities and industries alike in reducing their greenhouse gas emissions as well as facilitate their ability to plan, operate and maintain their networks as a result of standardized services and the use of the same auxiliary equipment.

Recently, GE Grid Solutions has been awarded EUR 2.5 million through the European Commission's LIFE climate action program to help fund the development of a SF<sub>6</sub>-free 245 kV g<sup>3</sup> live tank circuit-breaker. The co-funding reflects the EU's commitment to accelerate the decarbonization of Europe's electrical grids and help them get ready for the EU's stricter fluorinated (F)-gas regulation, which aims to cut F-gas emissions by two-thirds by 2030. The new GE 245 kV g<sup>3</sup> live tank circuit-breaker is the second g<sup>3</sup> gas project co-funded by the EU. Previously, in 2019, GE received funding of EUR 2.2 million for a g<sup>3</sup> gas-insulated 420 kV, 63 kA circuit-breaker, also as part of the EU LIFE Program. This development can potentially have a ripple effect across Europe in validating that fluoronitrile-based gas mixtures can be applied to all other high voltage levels of European electrical networks.

*Below is a list of recent HV switchgear projects won by GE Grid Solutions in 2020 and 2021:*

Country	Client	Project Description
	EDF Renewables and ESB	A multi-million-dollar project for the design, supply, construction and commissioning of onshore and offshore wind substations for the Neart na Gaoithe (NnG) offshore wind farm.
	Power Grid Corporation of India Limited	Awarded a contract for the construction of 765 kV GIS bays in Rajasthan. The scope of the project includes the end-to-end commissioning of the GIS bays including substation automation and relay panels. The bays will be an extension to an existing GE 765 kV substation, using AIS technology. The project will be executed by GE T&D India Limited.
	Evonik	Evonik signed a contract for 10 F35-145kV g3 GIS bays for its Marl Chemical Park in western Germany.
	Omexom	Omexom ordered eight 145 kV GIS bays using g3 for an industrial customer's waste plant in the UK.
	Iraqi Ministry of Electricity	GE will reinforce Iraq's transmission network, enhancing grid stability and interconnection with the electricity grid of Jordan.
	Ailes Marines	GE Grid Solutions will provide and install the main electrical equipment for the substation on the Saint-Brieuc Bay offshore wind farm in the northwest of France. The company will design and manufacture 72.5 kV and 225 kV GIS at its French plant in Aix-les-Bains.
	Arctic LNG 2 project	GE has been awarded the contract to supply its 110 kV F35 GIS for the Arctic LNG 2 project, a major LNG development located on the Gydan peninsula in Western Siberia, Russia. Delivery of GE's GIS equipment is scheduled between 2020-2021.
	Millennium Challenge Corporation	Under the contract, GE will be responsible for four new substations, including GIS and seven substation extensions in Benin, West Africa. It is the nation's biggest high voltage substation contract.
	RED ELÉCTRICA DE ESPAÑA	Awarded a contract for three containerized gas-insulated mobile substation units at 72.5 kV and seven units with 145/72.5 kV, dual voltage levels, for the Canary and Balearic Islands, including one 72.5 kV SF6-free substation that will support Spain in its decarbonization goals. This marks the first introduction of a g3 substation in Spain and the first time the technology has been integrated into a mobile substation.
	Ministry of Electricity & Water	Awarded a long-term maintenance contract for 54 substations country-wide. The 54 substations of different voltage levels, including 132 and 300 kV, will be maintained by GE's Grid Solutions for a period of five years, ensuring planned maintenance and emergency intervention for smooth operation. The contract is the largest long-term maintenance contract won in Kuwait to date.
	SSEN Transmission	SSEN Transmission awarded a contract to GE Grid Solutions to manufacture, deliver and commission a 420 kV g3 GIS at its new Kintore 400 kV substation in Aberdeenshire on the north-east coast of Scotland.
	ONEE	Awarded a contract to build two substations in the south of Morocco that will evacuate power from the Boujdour wind farm and other renewable energy projects to neighboring communities as well as connect it to the national grid of Morocco.
	Nepal Electricity Authority	Awarded a contract for the construction of three 400 kV Gas-Insulated Substations located in Khimti, Barhabise and Lapsipedi in Nepal. These modern substations will deliver uninterrupted hydro energy to hundreds of thousands of households in the power scarce regions outside Nepal's capital Kathmandu that still do not have access to the national grid.
	Doosan Heavy Industries and Construction Co. Ltd	Won an order to build a turnkey substation that will power the Yanbu-4 independent water producer (IWP) plant. GE Grid Solutions and Al Sharif Group will provide a 380-110 kV GIS substation for the plant, to be operational by 2023.
	Elvia	GE Grid Solutions is awarded a contract by Norwegian utility Elvia to deliver substation in Heggedal, close to Oslo's urban area featuring GE's g3. The project scope covers the design, engineering, delivery, and erection & commissioning of six bays of GE's F-35-41g 145 kV g3 insulated switchgear and associated electrical balance of plant.
	Vattenfall Eldistribution	The project scope covers the design, engineering, delivery, and erection & commissioning of eight bays of GE's F-35-41g 145 kV g3 switchgear.
	ARPA-E	Awarded a total of USD 3.7 million in funding from the U.S. Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E) for two related projects to help accelerate the decarbonization of the U.S. electrical grid. The first award in the amount of USD 2.3 million relates to the development of a SF6-free 245 kV dead tank circuit-breaker. The dead tank circuit-breaker will be developed and manufactured at GE's site in Charleroi, PA, USA. The second award to GE Research Center in the amount USD 1.4 million is part of a USD 2.7 million project led by the University of Connecticut that will focus on the life cycle management of g3 products, mainly gas leakages and byproduct detection, capture and monitoring tools.