ABB is the first to offer MV GIS with a climate-friendly alternative to \( \text{SF}_6 \)

Gas-insulated switchgear (GIS) technology with sulfur hexafluoride (\( \text{SF}_6 \)) gas provides the most compact dimensions, highest reliability and maximum safety. However, \( \text{SF}_6 \) is a potent greenhouse gas. ABB is the first company to offer MV GIS with a climate-friendly insulation gas based on a new molecule.

Lighting residential and commercial areas, and powering energy-intensive industries, sports stadiums and metro lines, the medium-voltage grid sits between the high-voltage (HV) long-distance transport grid and low-voltage household consumer grids.

Switchgear forms the central nodes in the electricity grid where all connections come together. It is designed to switch currents on and off under all expected conditions. Under normal conditions, it gives the operators flexibility and control over their networks and under failure conditions it automatically breaks high fault currents and protects the rest of the grid – thus saving people from serious injury.

GIS offers not only a smaller footprint but also higher reliability.

SF\(_6\) under discussion

ABB built the world’s first GIS in 1967 and pioneered the technology, which is now state-of-the-art for demanding applications. The outstanding electrical performance of \( \text{SF}_6 \) has made the technology a global success story – in MV as in HV. However, despite all its advantages, \( \text{SF}_6 \) has a downside: It is a potent greenhouse gas if released into the atmosphere.
The impact of greenhouse gases is expressed by their global warming potential (GWP). GWP is a calculated value that takes two main factors into consideration:

- Radiative forcing capacity: How well does a gas absorb warmth (in the form of infrared rays) instead of letting it reradiate to outer space?
- Decay time: How long does the gas exist in the atmosphere before it decomposes?

Despite all its advantages, SF₆ has a downside: It is a potent greenhouse gas if released into the atmosphere.

The GWP of carbon dioxide (CO₂) is defined as a reference value of 1; SF₆ has a GWP of 22,800.

Since the 1990s, in the light of growing awareness of climate change, the search for climate-friendly alternatives to SF₆ has received growing attention. Until now, results have always been disappointing as promising candidate gases turned out to be unstable or toxic.
A further downside to SF₆ is that because of its high global warming potential and the lack of a suitable alternative for electrical applications, SF₆ users in many countries are now bound by regulatory and inventory procedures, which increase administrative overheads.

**AirPlus – A low-GWP alternative to SF₆**
Fifty years after pioneering the world’s first GIS, ABB is again making GIS history. Together with partner 3M, ABB has or identified a promising alternative to SF₆: ABB’s AirPlus insulation gas.

partner 3M, ABB has developed a promising alternative to SF₆: ABB’s AirPlus Insulation gas. While coming close to the technical performance of SF₆, the new gas – with a GWP of around 0.5 – has virtually no impact on global warming.

Compared to SF₆ with a GWP of 22,800, the GWP of the new gas represents a reduction of more than 99.99 percent. After an average of 16 days exposed to solar radiation in the atmosphere, AirPlus’s new molecule decomposes – compared to over 3,000 years for SF₆. Of course, these figures only apply if the gas were to be released to the environment, which is why ABB has a closed gas life cycle in its GIS products that avoids emissions wherever possible, irrespective of whether AirPlus or SF₆ is used. Unlike SF₆, AirPlus is not a pure gas but a gas mixture. More than 80 percent by volume is made up of dry air and the remaining part is NOVEC 5110 dielectric fluid, a C₅ fluoroketone (C₅ FK or C₅F₁₀O) molecule provided by 3M. This molecule combines remarkable dielectric performance with a very low carbon footprint.
With regard to gas handling, AirPlus does not require any more safety measures than SF₆. It is classified as practically nontoxic with a permissible exposure limit comparable to SF₆. And AirPlus comes with additional safety benefits for underground applications like tunnels or mining: While large amounts of SF₆ take time to mix with air—leading to oxygen deficiency—the AirPlus mixture is already more than 80 percent air and quickly dilutes even further.

After an average of 16 days exposed to solar radiation in the atmosphere, AirPlus’s new molecule decomposes—compared to over 3,000 years for SF₆.

Apart from the environmental and safety aspects, users of AirPlus will benefit from streamlined processes and reduced operational costs. The use of SF₆ is regulated in many countries, which involves inventory keeping and regulatory procedures, and even SF₆ taxes in a few cases. These regulations do not apply to AirPlus, nor is regulation expected in the future.

Pilot project with Netze BW
Netze BW is one of the biggest distribution system operators (DSOs) in Germany, operating their network in the southwestern part of the country. As part of the EnBW group, they are among Germany’s top four power utility companies.

In a 10 million EUR project, Netze BW is modernizing the 110 kV/20 kV Trochtelfingen substation. The old 20 kV MV switchgear was replaced by ABB’s ZX2 GIS in a double busbar configuration—saving 40 percent of space compared to air-insulated switchgear (AIS) technology →3–5. This allowed Netze BW to install additional feeders and to remain flexible, as renewable power sources like wind or solar are growing in popularity in this region.

“When ABB mentioned their ongoing developments in SF₆ alternatives, we were interested from the very beginning,” said Chief Technology Officer Martin Konermann from Netze BW, “as AirPlus fulfills two of our mission goals at the same time: being innovative and preserving the environment.”

Netze BW and ABB agreed to change a part of the lineup from SF₆ to AirPlus, demonstrating that panels of both technologies can be mixed even within the same switchgear lineup. This is the first AirPlus GIS to the installed in Germany and the second worldwide.
While the inner parts have been adapted for the use of AirPlus, the exterior remains unchanged so that users can rely on the known compact dimensions and proven ZX2 design.

As primary switchgear is a long-term investment with lifetimes of over 40 years, ABB can optionally offer ZX2 Ready-for-AirPlus – ideal for the user who may want to switch to AirPlus later. ZX2 Ready-for-AirPlus comes factory-filled with SF₆ but with all necessary preparations to use AirPlus whenever the user wishes to switch.
SafeRing AirPlus

SafeRing AirPlus is ABB’s secondary distribution ring main unit (RMU) featuring the new AirPlus insulation gas. It has the same compact dimensions as the well-known SafeRing/SafePlus products with SF₆ insulation and initially covers IEC ratings up to 24 kV with 16 kA short-circuit and 630 A nominal current. The most important load-break switch and circuit breaker units will be available in different configurations in block design, covering the most typical applications.

As AirPlus requires a broader redesign of the existing RMU, both circuit breakers as well as load-break switches are based on vacuum technology. In this way, switching is done with reliable vacuum interrupter technology, and the AirPlus gas is used exclusively as an insulation medium.

AirPlus technology for everyone

ABB is convinced that AirPlus helps to reduce the global warming impact of the power grid and wants as many users as possible to benefit from this innovative technology. This is why ABB decided to disclose its patents, inviting other manufacturers to join the AirPlus journey.

At the Hannover Fair in April 2016, ABB announced the launch of two products that use the climate-friendly alternative insulation gas AirPlus.

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05 ABB’s ZX2 GIS is much more compact than its predecessors.

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