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SC B3 – Substations and electrical installations
PS 1 – Increased impact of clean energy transition on Substation Design
Q 4 – To what degree are the new environmental directives impacting on the industry's ability to respond and deliver the substation infrastructure necessary to facilitate Net Zero?

Application of HVDC GIS with Clean Air along the entire energy transmission

To contribute to the most sustainable solution also in the field of energy transmission, SF_6, the state-of-the-art insulating gas and the gas with the highest known global warming potential (GWP), should be replaced by an alternative with suitable dielectric properties and minimal GWP. To politically support this, several countries will ban SF_6 in new GIS as soon as alternatives with lower GWP are available. The European parliament suggests in the current draft of the new F-gas proposal a stepwise ban of SF_6. For instance, GIS in the voltage level >145 kV with a GWP >10 will not be allowed to be installed after January 1st, 2031, if suitable alternatives with a GWP <10 are available. In exceptional cases, i.e. if no suitable alternatives are available, GIS with a GWP in the range of 10 to 2000 are permitted. Exclusively if no GIS are available on the market in this GWP range either, GIS with a GWP >2000 are permissible.

Therefore, new environmental directives and the aim of NetZero give clear guidance for manufacturers and grid operators to focus on

- further SF_6 emission reduction
- no more SF_6 in new installations in the future
- development and application of new SF_6-free equipment.

From our point of view, the most sustainable solution is the application of Clean Air (synthetic air, 80% N_2 / 20% O_2). It fulfils all product relevant criteria for a suitable insulating gas: a GWP of 0, enabling climate-neutral GIS in the future, no hazard for humans due to non-toxic gases, and simple and safe gas handling. Further, it is safe in terms of compliance with all future greenhouse gas restrictions and concerning multi-vendor long-term availability.

The increasing electrical energy demand requires the integration of renewable energy by use of multi-terminal HVDC interconnectors. Within the context of current and planned HVDC links, the application of HVDC system voltage levels of up to ±525 kV is intended. The associated technical challenges require the development and qualification of advanced HVDC systems as well as the combination of different HVDC technology solutions, such as cable systems and gas-insulated systems (HVDC GIS), especially in terms of space-saving installations.

Clean Air is a potential insulating gas for HVDC GIS also. A first feasibility study [1] has shown that the voltage level of U_{rdc} = ±352 kV with Clean Air as insulation gas is possible, based on the components of the already available and type-tested design of the SF_6-based ±550 kV HVDC GIS. Further work on feasibility and product development of F-gas free HVDC GIS up to ±550 kV DC is ongoing to serve projects on- and offshore with small-footprint solutions.

[1] K. Juhre, M. Kosse, C. Klein, R. Plath, "Feasibility Tests of a 320 kV Gas-insulated DC Switchgear with Clean Air", Cigre Session 2022, Paper B3-11079, 2022