Powering the Planet: The Adoption of SF6-Free High Voltage Switchgear for a Sustainable Future

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- In order to mitigate the impact of climate change across the globe, GHG emissions must be curtailed and reach net-zero by 2050.
- Globally, the power sector is a significant contributor to GHG emissions.
- Moving forward, there will be an increase in the adoption of SF_6-free high voltage switchgear with advanced digital features.

In order to mitigate the impact of climate change across the globe, GHG emissions must be curtailed and reach net zero by 2050. To achieve this target, governments across the globe are taking special policy initiatives while the private sector is making investments in clean energy. Last year, in November 2021, countries participated in the UN Climate Change Conference (COP26), held in Glasgow, to discuss and agree upon several initiatives that would act as key enablers of a green future. One significant outcome of the conference was that the signatory countries reaffirmed their pledges towards emissions reductions and the provision of financial support to cap the average rise in global temperature, ideally to 1.5°C.

On a global scale, the power sector is a significant contributor to GHG emissions. As per the estimates of the International Energy Agency, in 2019, electricity and heat producers emitted ~14 billion tons of CO_2 into the atmosphere, which accounted for around 42% of the total global emissions. The challenge, now, for the power sector is to decarbonize itself whilst ensuring grid reliability and stability.

This has resulted in the adoption of renewables and the penetration of decentralized generation into the grid. The changing dynamics of the grid require the secure and reliable operation of power networks, especially at voltage levels greater than 42 kV, which is provided by high voltage switchgear.

Digitalization- a Step Towards a Smarter Electrical Grid

In order to cater to issues regarding the stability and reliability of the grid, the digitalization of the electricity grid is being undertaken in the power sector. It allows for leaps in not just the transparency of power system operations but also increases efficiency and reliability, while reducing costs.

Digital high voltage switchgears have a crucial role to play in the move towards a smart grid. This is because they enable smart ways to control, protect, and monitor the electricity grid. Moreover, digital HV switchgear will reduce space requirements and issues related to manufacturing lead times: OEMs will not have to manufacture new equipment and can customize existing equipment as per requirements, thus, optimizing the overall cost.

As a result, Tier-1 players in the electricity market have radically shifted their focus towards the digitalization of electrical equipment, in order to accommodate changing consumer demand.

Hitachi Energy offers a wide range of high voltage switchgear and breaker solutions up to voltage levels of 1200 kV AC and 1100 kV DC. General Electric does not have a dedicated product offering under digital switchgear; instead, it offers digital substations and digital instrument transformers. Similarly, Siemens Energy has a complete product portfolio of digitally enabled substation equipment referred to as 'Sensformer' and 'Sensgear'.

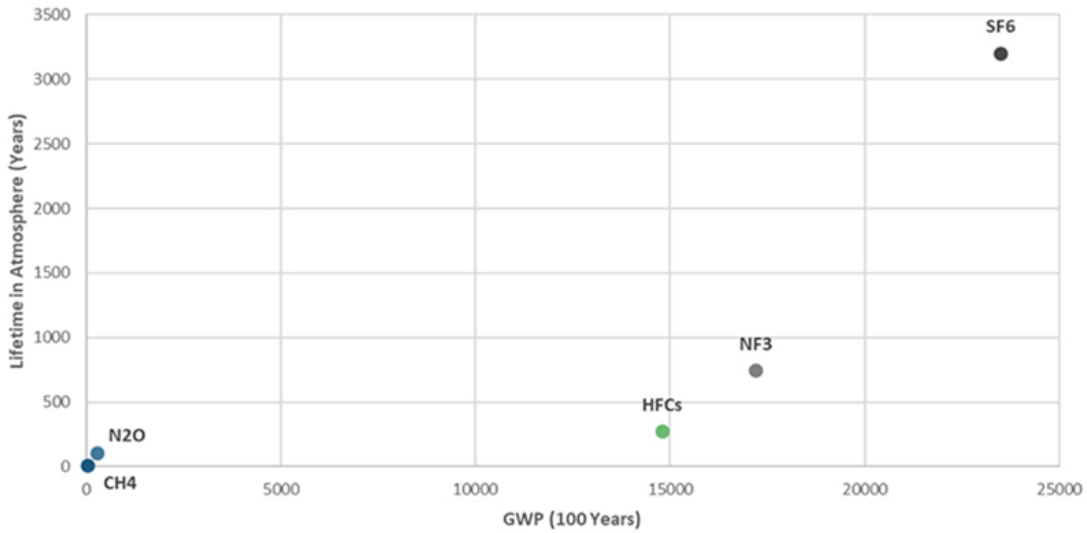

Figure 1: Global warming potential of potent GHG gases.
Source: Power technology Research

Realization of a Green and Sustainable Electrical Grid

SF_6-Free Transmission Switchgear 72.5 - 170 kV (examples)

	Lsis	GE	HITACHI ABB	HITACHI ABB	HYUNDAI	ILJIN	SIEMENS ENERGY	Mitsubishi Electric	Pinggao Group	MEIDEN	TOSHIBA
Design	GIS	GIS/LT	GIS	Live tank	GIS	GIS	GIS/LT	Dead tank	GIS	Dead tank	C-GIS
Insulation	C4-FN mix	C4-FN mix	C5-FK mix -> C4-FN mix	Dry air	C4-FN mix O_2-free	Dry air	Techn.air	Techn.air	CO_2	Dry air	Solid
Switching	C4-FN mix	C4-FN mix	C5-FK mix -> C4-FN mix	O_2/CO_2	C4-FN mix O_2-free	vacuum	Vacuum	Vaccum	Vacuum	Vacuum	Vacuum
Rated voltage (kV)	170	145	170	145	170	170	145	72/84	126	145	72/84
Current (A)	3150	3150	1250	3150	-	4000	3150	1200	2500	3150	1200
Short-circuit current (kA)	50	40	50	40	50	50	40	31.5	40	40	31.5
Fill. Press. (MPa)abs	0.8	0.85	0.83	1.2	0.85	-	0.8	-	0.8	1.0	-

Figure 2: Product range of SF_6 free transmission switchgear 72.5-170 kV.

Source: KEMA Labs

SF_6 gas, which has a global warming potential of approximately 25,200 times that of CO_2, continues to be widely used as an insulating gas in switchgear applications all over the world. The transition from a conventional to smart grid is vital in order to maintain the grid's reliability and stability, given the widespread deployment of renewable, and the role of switchgears in this regard is equally important. Therefore, switchgear manufacturers are pushing technological boundaries to produce SF_6-free switchgear that is not only environment friendly but provides reliable operations, as well.

Advancements in the development of SF_6 alternatives for high voltage GIS

Recently there have been significant developments in the SF_6-free high voltage GIS market; for instance, Siemens Energy and Mitsubishi Electric have signed an MoU to expedite the development of gas solutions that have zero global warming potential and can be used in the power transmission industry. GE recently announced that they are the first to manufacture $SF6_6$-free high voltage (HV) gas insulated substations (GIS) for voltages greater than 54 kV.

On the other hand, Hitachi Energy and GE have reached a non-exclusive, cross licensing agreement which will allow both parties to expand their product range for SF_6 free high voltage equipment.

Looking Ahead

Moving forward, there will be an increase in the adoption of SF_6-free high voltage switchgear with advanced digital features. This will help realize the goal of a smarter and a greener grid, evident from recent developments in the market. General Electric has signed the first three-year contract with SP Energy Networks in the UK for the supply of 145 kV live tank circuit breakers, using GE's g3 gas as an insulating medium. Siemens Energy has recently won the largest order of SF_6-free gas insulated switchgear enabled with digital features, in Finland. Hitachi Energy is partnering with the UK's National Grid to carry out the world's first replacement of SF_6 in the existing high voltage equipment.

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