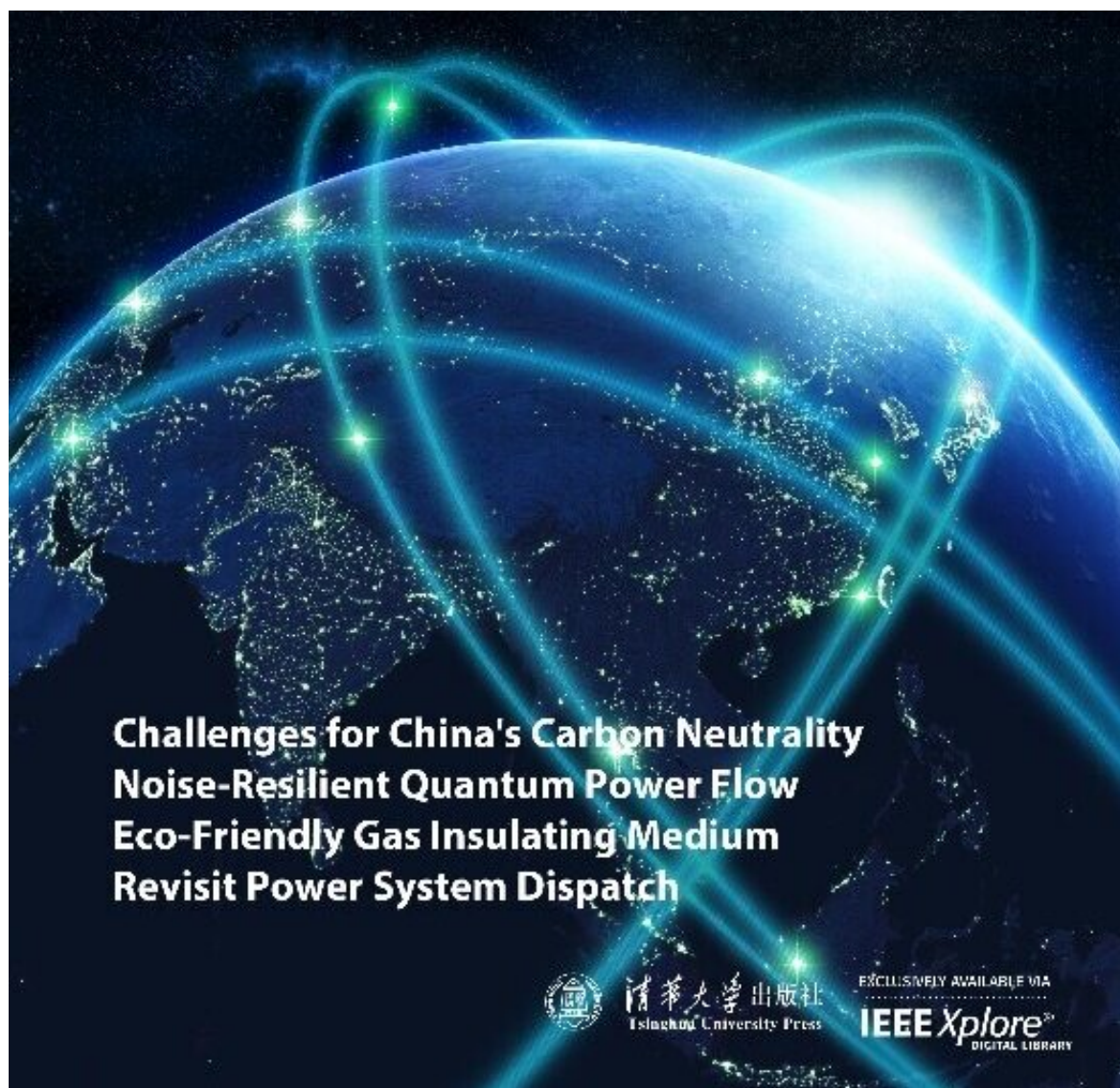


Advances in eco-friendly gas insulating medium for next-generation SF6-free equipment

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The green light dots on the cover image stand in for SF6-free substations, and

the light bands represent electrical energy. The eco-friendly insulating gas based power transmission and distribution equipment light up cities and brings dawn to "net zero emission" worldwide. Credit: *iEnergy*, Tsinghua University Press

Gas-insulated equipment (GIE) that utilizes the most potent greenhouse gas sulfur hexafluoride (SF_6) as insulation and arc-quenching medium has been widely used in the power industry. Seeking eco-friendly insulating gas with advanced performance for next-generation SF_6 -free GIE is significant for the "net-zero" goal and sustainable development.

A research team led by Xiaoxing Zhang of Hubei University of Technology in China and scientists from Wuhan University, Southeast University, North China Electric Power University, Université de Toulouse, Xi'an University of Technology, Schneider Electric and South China University of Technology recently summarized the advances in eco-friendly gas insulating medium for next-generation SF_6 -free equipment. The review report was published in the journal *iEnergy* as the cover article on March 31, 2023.

An overview of the SF_6 -based GIE, the emission and reduction policies of SF_6 were introduced firstly to clarify the necessity of seeking eco-friendly insulating gas.

" SF_6 is one of the most potent greenhouse gases with a global warming potential of 25200 and an atmospheric lifetime of 3200 years. The power industry accounts for 80% of the SF_6 consumption, which value reaches over 7000 tons in China. Various countries have established regulations on the use, recovery and treatment of SF_6 , promoting the development of eco-friendly insulating gas" said Prof. Zhang.

Basic requirements for eco-friendly gas including environmental

features, insulation & arc-quenching performance, stability, material compatibility, biosafety were proposed and the main categories containing traditional gas (CO_2 , N_2 , air), Perfluorocarbons and Trifluoroiodomethane, Fluorinated-nitrile ($\text{C}_4\text{F}_7\text{N}$), Fluorinated-ketones ($\text{C}_5\text{F}_{10}\text{O}$, $\text{C}_6\text{F}_{12}\text{O}$), Hydrofluoro-Olefins (HFO-1234ze(E), HFO-1336mzz(E)) were introduced. The molecular design method of eco-friendly gas was also provided.

Recent progress of various eco-friendly insulating gas in terms of dielectric insulation (in terms of AC/DC breakdown, LI breakdown, partial discharge, surface flashover), arc-quenching (in terms of particle compositions, [thermodynamic properties](#), transport coefficients, radiation coefficients, post-arc dielectric breakdown properties), stability and decomposition (in terms of thermal, discharge stability, decomposition mechanism), materials compatibility (in terms of metal, [epoxy resin](#), elastomer, Adsorbent), biosafety (in terms of LC50, target organ toxicity, by-products toxicity) were highlighted.

The latest application of eco-friendly insulating gas in medium-voltage (MV), high-voltage (HV) scenarios as well as relevant maintenance-related technologies were also summarized.

"The $\text{C}_4\text{F}_7\text{N}/\text{CO}_2$, $\text{C}_5\text{F}_{10}\text{O}/\text{air}$ based gas insulated switchgear, gas insulated transmission line, ring main units, etc. have been developed by GE, ABB since 2016. The other fluorinated-free technology roadmap using technical air combined with vacuum interruption also have been focused," said Prof. Zhang.

Although substantial efforts have been made in the field, several significant challenges remain that call for more solutions to achieve the next-generation SF_6 -free GIE in the future. The improvement of stability, interruption capacity, material compatibility is highly desired. The SF_6 control and recycling, insulation coordination, scientific

management of PFAS, etc. will hopefully steer the development of eco-friendly insulating gas and GIE.

More information: Yi Li et al, Eco-friendly gas insulating medium for next-generation SF6-free equipment, *iEnergy* (2023). [DOI: 10.23919/IEN.2023.0001](https://doi.org/10.23919/IEN.2023.0001)

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