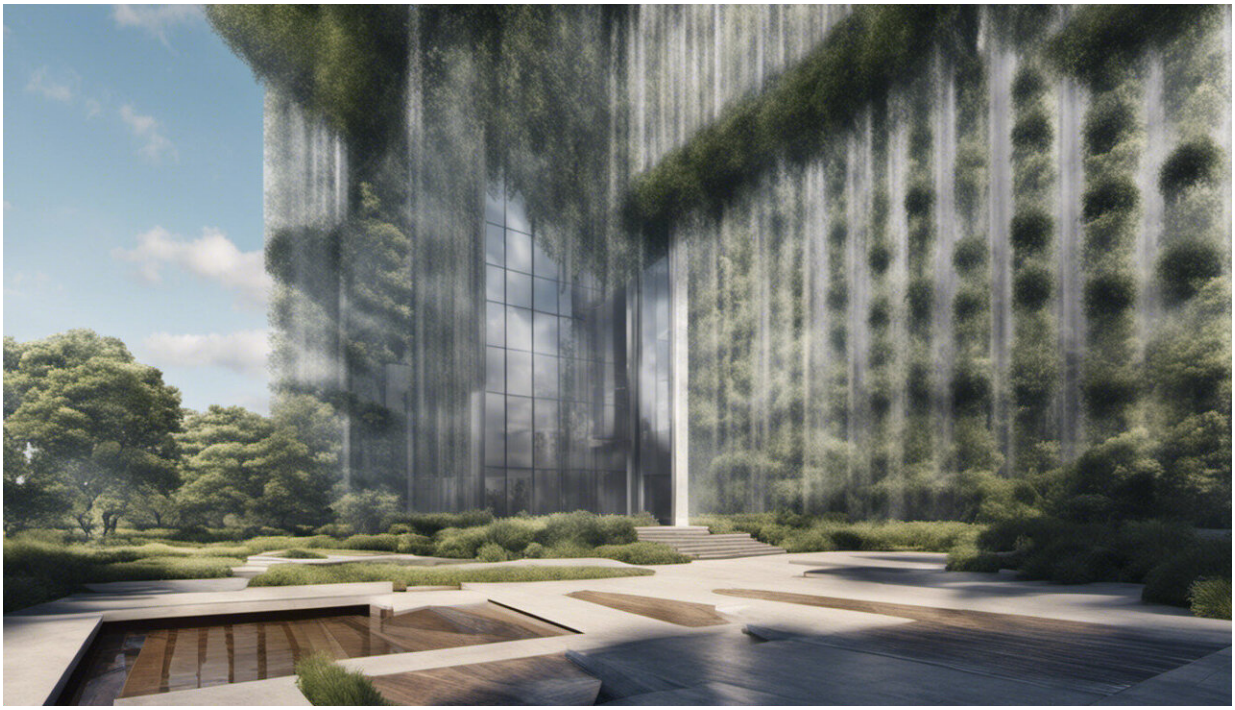
Is the end coming for sulfur hexafluoride, the most powerful greenhouse gas?

October 15 2020, by Marie-Charlotte Guetlein and Carine Sebi



Credit: AI-generated image (disclaimer)

Electrical-transmission towers and the cables are part of the landscape of industrialized countries. Less visible but just as important are switchgear devices that protect electrical equipment. But did you know that many of these devices—widely used in electric-utility transmission and distribution systems as well as commercial and industrial

facilities—integrate the most powerful greenhouse gas, sulfur hexafluoride (SF_6)? Luckily, leakage rates are low and accidents extremely rare.

The sheer amount of SF_6 used in the medium-voltage (MV) and high-voltage (HV) sectors nevertheless raises environmental concerns. This is especially the case as ongoing network extensions and the integration of renewable energy installations are increasing the banked SF_6 volume.

Are there any eco-friendly and efficient alternatives? Will regulations lead to a decrease in the use of SF_6 in the near future?

To answer these questions, we use results from our recent empirical study on the environmental and socio-economic impact of SF_6 and its alternatives. Our study focuses on the MV sector where alternative technologies are more advanced and expected to gain ground faster than in the HV sector.

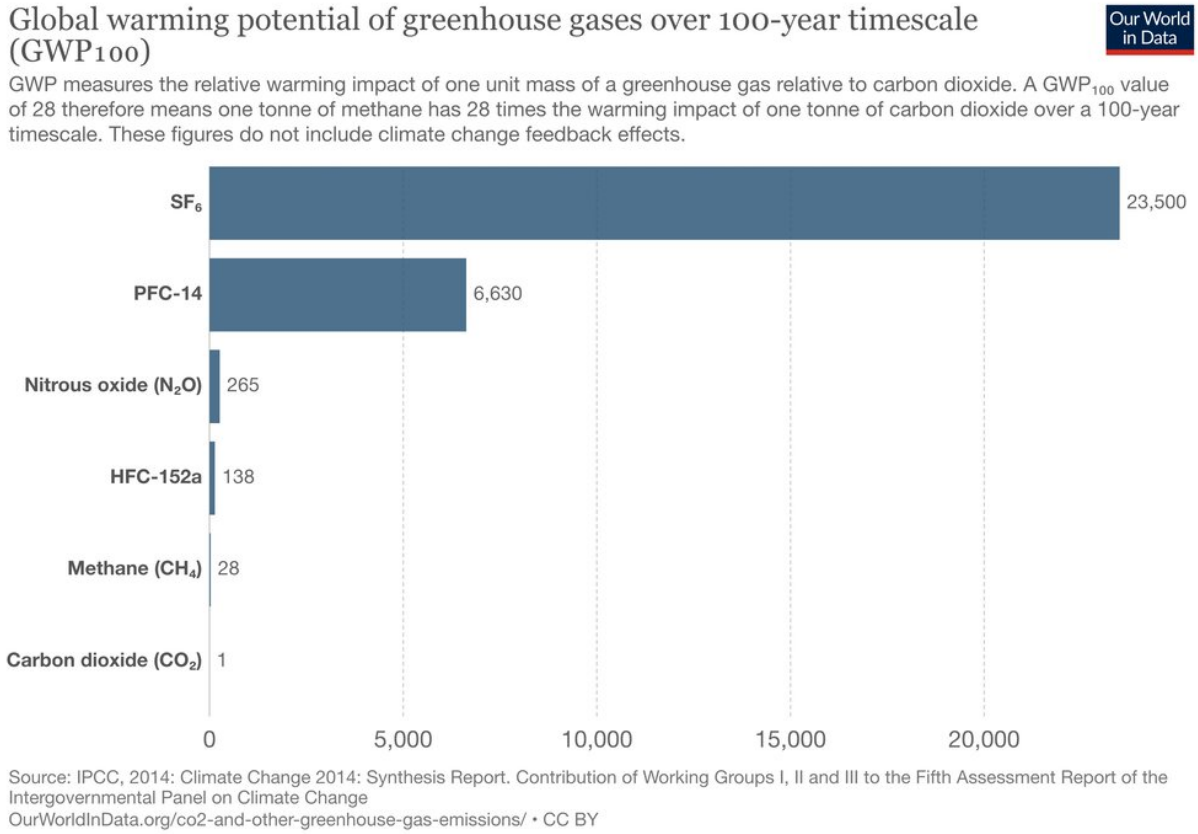
The most powerful greenhouse gas

With a global warming impact that is 23,500 times higher compared to CO_2 and an atmospheric lifetime of 3,200 years, SF_6 is the most harmful known greenhouse gas. Not surprisingly, the Kyoto Protocol lists SF_6 as one of the six greenhouse gases that are restricted for use (together with CO_2, CH_4, N_2O, HFC and PFC).

However, due to its excellent technical properties, SF_6 has been increasingly used as an insulating and switching medium in HV and MV sectors since the 1950s. One of its main advantages is that it allows for more compact installations, in particular compared to air-insulated switchgear. This is an especially important criterion in urban areas where space is limited.

Switchgear is a general term covering switching devices and their combination with associated control, measuring, protective, and regulating equipment. These devices are found throughout the power transmission and distribution system.

Considered cost-effective and high-performing, SF_6 technology plays an important role for the reliability of power transmission and distribution networks in Europe, "which constitutes the backbone of the infrastructure necessary to deliver the energy transition".



Warming power for the different greenhouse gases over a period of 100 years. Credit: GWP100 -- IPCC 2014

The European Commission is keeping an eye on SF_6

Current EU F-gas regulation prohibits the use of SF_6 in many non-electric applications, but not in MV switchgear. Today, about two thirds of the 15 million MV switchgear units installed in Europe (EU28) use SF_6. When the EU F-gas regulation was last revised in 2014, it was considered that no cost-effective and reliable alternatives to SF_6 were available.

In the MV sector, however, this picture is slowly changing thanks to technological progress. The European Commission recently publishing a report reassessing the availability of alternatives to SF_6 in MV switchgear. Based on this report, the Commission might suggest amendments to the current regulation including a phase-out of SF_6 in MV switchgear.

Will industry take up SF_6-free alternatives?

Today, different alternatives to SF_6 in MV switchgear are on the market. Yet users—power utilities, industrial sites, the service and infrastructure sectors—seem reluctant to adopt them.

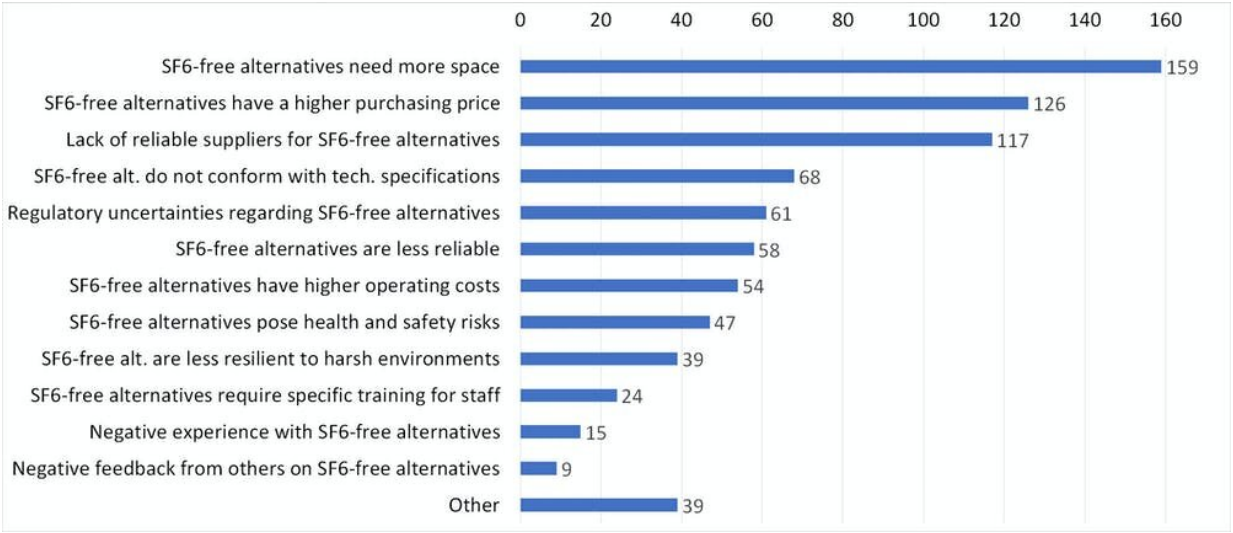
Against this background, we conducted a large-scale survey to better understand MV switchgear customer purchasing criteria, including technical, economic as well as environmental aspects.

Survey respondents were selected to be company representatives with knowledge about switchgear. The survey was completed anonymously by a total of 443 respondents in five European countries during November 2019-January 2020.

Our results reveal that switchgear users generally anticipate a decrease in the use of SF_6 technology. At the same time, they remain uncertain

which technology will most likely replace SF_6. Currently available alternatives are perceived as taking up too much space, being too expensive or not being available from reliable suppliers.

In fact, the anticipated decrease in use of SF_6 appears to be primarily policy driven: A majority of 54% of respondents indicate that policies and regulations are a main driver for their company's decision to adopt SF_6-free alternatives. Asked about policies in general, respondents consider financial incentives (e.g. subsidies) for users of MV switchgear and a complete ban on SF_6 to be the two most useful policies to promote SF_6-free MV switchgear.



Survey results from question 'In your opinion, which factors are most relevant for your company's decision to use an SF6 technology? You can select up to five factors'. Credit: Guetlein/Sebi

Paying for more environmentally friendly switchgear

According to respondents, a higher purchasing price is one of the main barriers for adoption of SF_6-free alternative. At the same time, survey participants were in principle willing to pay more for environmental-friendly switchgear options—on average up to 20% compared to their usual purchasing price. Similarly, eco-friendliness was identified as one of the most important purchase criteria for MV switchgear.

This indicates that customers are willing to move toward SF_6-free—and thus greener—alternatives, though barriers remain.

Accelerating the transition

The fact that customers seem to care about environmental aspects when purchasing MV switchgear suggests that an environmental label for MV switchgear could help accelerate adoption of alternative technologies. Such a label could for instance feature an evaluation of the product's environmental impact or be used to certify F-gas free switchgear.

To be widely adopted, SF_6-free alternatives must not only meet environmental but also technical and economic requirements.

Given these constraints it seems unlikely that market forces will suffice to have the majority of switchgear users switch to alternative technologies in the near future.

A product label could support the transition, but more drastic policy interventions are likely necessary. While production volumes for alternatives remain low and prices high, financial incentives for users could spur adoption.

Ultimately, a phase-out of SF_6 in MV switchgear would push manufacturers and users inevitably toward alternative solutions.

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