



Transition times necessary for alternative gas- insulated electrical equipment

Manufacturers and users recommend appropriate transition times

VDE FNN strongly supports the goals of the European Commission to strengthen all climate protection efforts and to achieve climate neutrality for Europe by 2050.

Experts from users and manufacturers are working also in VDE FNN on issues surrounding the technical applications and practical use of SF₆-free alternatives, with the aim of achieving transparency and acceptance in the introduction of these new technologies. Manufacturers and users in VDE FNN have jointly developed a recommendation for transition times that should be taken into account in the revision of the EU F-Gas Regulation so that alternative technologies can be safely introduced for gas-insulated electrical equipment.

With a revised EU F-Gas Regulation that supports the use of alternative technologies, the gradual transition in energy technology for new operating equipment can then be achieved within 5 to 9 years per application, based on the Regulation coming into force on 01.01.2023, without creating risks for the safe operation of the electric grids and the energy transition.

These transition times were evaluated in a differentiated manner for the various use cases. By closely merging the implementation steps at manufacturers and users, existing synergies can be used and the times kept as short as possible.

For example, the transition to SF₆-free switchgears in the primary distribution level up to 24 kV is possible by the end of 2027, when a new EU F-Gas Regulation would apply from the beginning of 2023.

Other voltage levels and technologies will then follow step by step.

About the Forum Netztechnik/Netzbetrieb in the VDE (VDE FNN)

The Forum Netztechnik/Netzbetrieb im VDE (VDE FNN) develops the technical requirements for the operation of electricity grids in a forward-looking manner. The aim is to ensure secure system operation at all times in the face of increasing consumption of electricity from renewable energies.

The EU F-Gas Regulation should also clarify that it only applies to equipment placed on the market and newly installed in the EU.

Notes on the report of the EU Commission

VDE FNN therefore welcomes the report "*Assessing the availability of alternatives to fluorinated greenhouse gases in switchgear and related equipment, including medium-voltage secondary switchgear*" published by the European Commission on 30 September 2020 as a guide in the current debate on the necessary further development of the EU F-Gas Regulation.

The EU report compactly summarises the state of availability and existing operational experience of alternative products and provides an overview of the technological progress to date in the development of alternatives to SF₆ in the various application areas of electrical equipment in the energy supply.

The authors of the EU report recognise that alternative products are available and successfully in operation for some specific applications and conclude that policy interventions are likely to be needed to trigger a transition where the SF₆-free alternatives are more costly than switchgear containing SF₆.

In addition, the EU report provides orientation for the future legal framework, which should bring the urgently needed planning security for users and manufacturers.

Shared responsibility of manufacturers and users

The manufacturers and users acknowledge their responsibility and will push ahead with further pilot projects, especially in voltage levels for which products in alternative gas-insulated technologies have yet to be developed.

Further considerable efforts are required from the manufacturers to develop alternative, gas-insulated product portfolios and to transfer these to series production. Users must have sufficient opportunity to test these new technologies for use in their critical infrastructure for reliability and availability in real grid operation (various grid and operating conditions, environmental influences, maintainability, etc.). A regulation must not threaten this process to ensure reliable network operation.

The continued operation of SF₆ operating equipment in use and its repair and extensions must remain possible in order to fulfil the supply task and maintain reliable network operation. Users expect a revised EU F-Gas Regulation to take a clear position that SF₆ operating equipment with closed or sealed pressure systems may be kept in service until the end of its service life or until a significant increase in leakage rates.

Recommendations for transitional times

In the following, the transition time refers to the start from the date of application of a revised EU F-Gas Regulation until the entry into force of measures significantly restricting the use of new SF₆-insulated equipment.

The transition time should include the steps required at manufacturers as well as at users (see Annex) for the development and introduction of new gas-insulated technologies.

VDE FNN assumes that a revised EU F-Gas Regulation will come into force from January 2023. The times given in the EU report are not specified in more detail and appear to be significantly too optimistic as transitional times in certain areas of application.

For the transition times, VDE FNN makes a technology/market-oriented subdivision, which is also based on the report of the EU Commission.

Transition times for centre voltage		
From the entry into force of the F-Gas Regulation (presumably from 01.01.2023)		
	12 / 24 kV	36 kV
Primary Switchgear Usually indoor applications	Rated current ≤ 2000 A 5 years	9 years
	Rated current > 2000 A 7 years	
Secondary Switchgear Usually outdoor applications	7 years	
Special applications e.g. generator circuit breaker, railway applications	In the revision of the F-Gas Regulation, no restrictive measures should be provided for this segment, as there is only a small share of the market volume in these niche applications and the total amount of SF ₆ used in this segment is also low.	

The systems for the primary and secondary distribution level 12/24 kV are estimated to cover about 80 % of the "mass market" in medium voltage, the 36 kV applications another 20 %.

The special applications have only a small share of the market volume, but are indispensable for specific infrastructures, e.g. generator switches or single/two-pole switches for railway traction applications. In addition, these are usually associated with very high demands on the performance and/or their reliability. The total use of SF₆ in this segment is very low.

Transition times high/maximum voltage			
From the entry into force of the F-Gas Regulation (presumably from 01.01.2023)			
	$52 < U_m \leq 72.5 \text{ kV}$	$72.5 < U_m \leq 145 \text{ kV}$	$145 \text{ kV} < U_m \leq 420 \text{ kV}$
Standard applications	5 years	6 years	9 years
Special and limit value applications e.g. railway applications	In the revision of the F-Gas Regulation, no restrictive measures should be provided for this segment. Limit applications should be considered again in a later, renewed review of the F-Gas Regulation.		
Extension and repair of existing installations	SF ₆ will also be needed beyond 2050 for the maintenance, repair and expansion of existing installations ¹		

Standard applications (switchgear (GIS), circuit-breakers (AIS), transformers (AIS), ...) are estimated to cover about 80 % of the high-voltage market, with a further 20 % being special and limit value applications or extensions or repairs.

The special and limit value applications are indispensable, e.g. for network nodes, inner city areas, offshore. In addition, these are usually associated with very high performance requirements, special requirements for temperature ranges, maximum size/weight (limited e.g. by buildings) and/or their reliability.

Requirements for transitional times

A mandatory prerequisite for the application of transition times is multiple suppliers incl. service providers for each application area. In addition, sufficient and stable product supply capacities from several manufacturers must always be available on the market in order not to delay the grid expansion and integration of renewable energies or to jeopardise supply reliability. Otherwise, recourse to conventional technology must remain possible for bridging purposes.

In order to avoid delays in grid expansion, it must be ensured that projects that have already been commissioned or are in the process of being implemented can still be carried out using the technology envisaged.

For the maintenance, repair and expansion of existing installations and equipment, the use of SF₆ technology and also the availability of SF₆ gas is necessary beyond 2050.

The VDE FNN recommends the European Commission not to consider restrictive measures for medium and high/very high voltage equipment before the end of the mentioned transition times.

¹ Scenario for reducing SF₆ operating emissions from electrical equipment through the use of alternative insulating gases, ZVEI July 2020
<https://www.zvei.org/en/press-media/publications/scenario-for-reducing-sf6-operating-emissions-from-electrical-equipment-through-the-use-of-alternative-insulating-gases>

Annex - Explanatory notes on the transitional time and its components

The transition time is intended to include the steps required at the manufacturers as well as at the users to develop and introduce alternative gas-insulated technologies.

Necessary steps to be taken by the manufacturers:

1. Technology / pre-development / feasibility
2. Product development incl. development tests
3. Type tests / product release
4. Initial/pilot applications / industrialisation / production ramp-up
5. If applicable, portfolio completion (incl. related type tests)

The various manufacturers and the respective technologies have individual implementation statuses.

Necessary steps to be taken by the users:

1. Adaptation of technical specifications, operating and interference suppression processes
2. Prequalification
 - Prerequisite: Manufacturer provides all necessary documentation, e.g. safety data sheet.
 - Prequalification of the manufacturer (plant/production facility)
 - Prequalification of the product incl. arc fault qualification if applicable
 - Service concepts, risk assessment, training offers
 - Life cycle consideration (storage, transport, commissioning and disposal)
3. Qualification and technical release, realisation projects
 - Initial delivery of a commercial system incl. accessories and use under operating conditions (limited number of units, complexity, trial batch).
 - Completed commissioning phases (e.g. partial discharge and high voltage tests etc.)
 - Gaining operational experience
4. Tendering and awarding of framework contracts as well as multi-year realisation projects/bundle projects (optional)

Transitional times			
From the entry into force of the F-Gas Regulation (presumably from. 01.01.2023)			
Medium voltage	Times Manufacturer	Times user	Transitional times (synergy potential taken into account)
Primary Switchgear 12 / 24 kV ≤ 2000 A	2 years	Total 4 years Synergy potential: 1 year *)	5 years
Primary Switchgear 12 / 24 kV > 2000 A	4 years		7 years
Primary Switchgear 36 kV	6 years		9 years
Secondary Switchgear 12 / 24 kV	4 years		7 years
Secondary Switchgear 36 kV	6 years		9 years
Medium-voltage special applications	In the revision of the F-Gas Regulation, no restrictive measures should be provided for this segment, as these niche applications only account for a small share of the market volume and the total quantity of SF ₆ used in this segment is also low.		
High/maximum voltage	Times Manufacturer	Times user	Transitional times (synergy potential taken into account, if applicable)
Standard applications 52 < U _m ≤ 72.5 kV	Available from various manufacturers, international operating experience available	5 years	5 years
Standard applications 72.5 < U _m ≤ 145 kV		6 years	6 years
Standard applications 145 kV < U _m ≤ 420 kV	3 years Especially devices with circuit breaker function require longer development times	8 years Synergy potential: 2 years *)	9 years
Special and limit value applications High/maximum voltage	Limit value requirements require additional development times of about 2 years	Open	Limit applications should be considered again in a later, renewed review of the F-Gas Regulation.
SF ₆ will also be needed beyond 2050 for the maintenance, repair and expansion of existing equipment ²			
*) The synergy potential takes into account that certain steps 1 to 5 by manufacturers and steps 1 to 4 by users can be processed in parallel.			

² Scenario for reducing SF₆ operating emissions from electrical equipment through the use of alternative insulating gases, ZVEI July 2020
<https://www.zvei.org/en/press-media/publications/scenario-for-reducing-sf6-operating-emissions-from-electrical-equipment-through-the-use-of-alternative-insulating-gases>

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