

Written contribution to 4th Consultation forum

4/26/2020

## **T&D Europe comment on Öko-Recherche and RE-xpertise Briefing Paper on SF6 and alternatives in electrical switchgear and related equipment.**

T&D Europe, the European Association of the Electricity Transmission and Distribution Equipment and Services Industry welcomes the briefing paper presented as an important and truthful step towards further preparation of the European Commission's report according Article 21 (4) to the F-gas Regulation.

The paper highlights and rewards the intense work of T&D Europe members and associate members on research, development and installation of alternative technologies to SF6 for all electrical equipment above 1 kV. It gives some answers for the first and second objectives to the project given by the Support Letter ARES(2019)5560136-04/09/2019.

- Produce an overview of relevant existing alternatives and of ongoing R&D activities for new switchgears and related electrical equipment in the European Union;
- Assess the EU market potential of existing alternatives in accordance with the four criteria of cost-effectiveness, technical feasibility, energy efficiency and reliability.

T&D Europe has noticed and regrets that the paper did not fully answer the third and fourth objectives:

- Propose a methodology for assessing SF6 emissions and estimating the reduction potential from switchgears and related electrical equipment based on a life cycle approach;
- Produce recommendations towards further developing EU policies in these areas.

For Europe's T&D industry, the last point is critical and T&D Europe will support a clear regulatory framework at EU level that will enable a reliable long-term planning basis for the use of SF6 and alternative technologies to SF6 for all stakeholders, as stated in our T&D Europe Position Paper copied in annex 1.

European T&D equipment manufacturers represent a world leading industry that exports outside EU, ensuring employment in the EU. Any regulatory framework shall avoid jeopardizing the leading export position of this industry sector.

On a closer analysis, the briefing paper contains a number of details that require rectification or clarification, and this is described in the annex 2.

Cost effectiveness, including additional product costs (initial and long-term), of alternative solutions depend on many parameters and cannot be quantified as a lump sum as mentioned in the document. Cost effectiveness and additional product costs require a separate analysis by range of voltage and type of application considering the associated requirements<sup>1</sup>.

The conclusion, *“It is foreseen that SF6 free switchgear can become technically feasible and associated with reasonable extra investments for nearly all segments of MV applications within 2 to 4 years”* is not fully clear. It should be taken into account that additional time is needed to complete all the development, pilots, end-user homologation and industrialisation process. Its duration depends on specific market circumstances. For specific MV applications (e.g. RMU above 24 kV, overhead lines and niche equipment), T&D Europe manufacturers estimate a period of 5 to 10 years from now to complete this process.

For new SF6-free high voltage applications above 145 kV, around 5 years of development shall be considered, followed by a piloting, end user homologation and industrialization process of another estimated 5 years.

As stated before, these above time frames can only be possible if a clear regulatory framework at EU level will be established.

Generally, where alternative to SF6 products are available (with operational experiences) and offering an overall benefit for climate protection while maintaining at least the same level of safety and protection of human health, they should be widely used as soon as possible.

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<sup>1</sup> Within T&D Europe association manufacturers are not exchanging information about cost. Please refer to the individual manufacturers.

## **ANNEX 1 : T&D Europe position paper on SF<sub>6</sub> and SF<sub>6</sub> alternative technologies. (dated 10th February 2020)<sup>2</sup>**

*F-Gas Regulation, SF<sub>6</sub> Technology and Alternatives for Transmission and Distribution (T&D) Electrical Switchgear*

The products and systems of the T&D industry are an enabler for a green power by connecting, transmitting and distributing CO<sub>2</sub> neutral, renewable energy sources to the power network.

T&D Europe supports the European Union's climate and energy objectives, including controlling and reducing emissions from fluorinated greenhouse gases (F-gases) through the implementation of the F-gas Regulation<sup>3</sup> and the directive on mobile air conditioning (MAC Directive)<sup>4</sup>.

### T&D EUROPE POSITION

T&D Europe fully supports the EC target of climat-neutral Europe by 2050 and the European ambition to cut the EU's F-gas emissions by two-thirds by 2030 compared with the 2014 baseline. T&D Europe continues to contribute to this target by further reducing SF<sub>6</sub> gas emissions in a fair and cost-effective way over the lifecycle, while ensuring the continued reliable functioning of Europe's public electrical networks.

T&D Europe supports a clear regulatory framework at European level enabling a reliable long term planning basis for all stakeholders.

An appropriate regulatory framework to achieve this shall consider the following levers:

- Favouring SF<sub>6</sub> free solutions for new installations whenever it offers an overall benefit for climate protection while maintaining at least the same level of safety and protection of human health;
- Continue reducing emissions during operation on installed base by prioritizing the replacement of equipment with high leakage rates;
- Further improving SF<sub>6</sub> processes and handling;
- Ensuring proper end of life management.

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<sup>2</sup> [T&D Europe position paper on SF<sub>6</sub> and SF<sub>6</sub> alternative technologies.](https://www.tdeurope.eu/component/attachments/attachments.html?id=1421)

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<sup>3</sup> [Regulation \(EU\) No 517/2014 of the European Parliament and of the Council on fluorinated greenhouse gases and repealing Regulation \(EC\) No 842/2006](#)

<sup>4</sup> [Directive 2006/40/EC of the European Parliament and of the Council of 17 May 2006 relating to emissions from air conditioning systems in motor vehicles and amending Council Directive 70/156/EEC](#)

## BACKGROUND

Thanks to the provisions in the current F-gas Regulation 517/2014, which applies since 1<sup>st</sup> January 2015 - strengthening previous existing measures and introducing a number of far-reaching changes - by 2030 it expects to cut the EU's F-gas emissions by two-thirds compared with 2014 levels. This represents a fair and cost-efficient contribution by the F-gas sector to the EU's objective of striving towards climate neutrality by 2050, thus cutting its overall greenhouse gas emissions by 80-95% of 1990 levels by 2050.

One of the F-gases regulated is sulphur hexafluoride (SF<sub>6</sub>), which in Europe is mainly applied as an insulating and switching gas in high- and medium-voltage equipment. The SF<sub>6</sub> technology has been developed and permanently advanced and enhanced over decades and has been technically matured to highest operational reliability and highest personnel safety. Such SF<sub>6</sub> technology is important for the reliability of power transmission and distribution networks in Europe, which constitutes the backbone of the infrastructure necessary to deliver the energy transition.

The SF<sub>6</sub> emissions from the 2.G <sup>5</sup> sector contributed with a very modest 0.158% to all GHG emissions from EU-28 plus Iceland in 2016. The situation can be further improved by implementing the best existing practice of countries where Voluntary Agreements for SF<sub>6</sub> emission reduction are in force (e.g. Germany, Spain, Switzerland) along all European countries

Nevertheless, the Members and Associates of T&D Europe intensely work on further reduction of SF<sub>6</sub>-emissions for all applications of electrical power transmission and distribution. These efforts include research, development and installation of alternative technologies for all electrical equipment above 1kV. In recent years, this has also led to the emerging of SF<sub>6</sub>-free alternatives.

Against this background, the Members and Associates of T&D Europe would like to highlight the importance of the following points:

- The Life Cycle Assessment (LCA) method according to ISO 14040/44 is the state-of-the-art tool to evaluate the impact of products and systems on the environment, e.g. by the global warming impact when assessing alternatives. However it is important to

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<sup>5</sup> Based on the classification given by EU CRF (Common Reporting Format): 2.G: Other product manufacture and use where SF<sub>6</sub> emissions from electrical equipment among other products are reported. Ref. table 4.49 EEA report 2018 Annual European Union greenhouse gas inventory 1990-2016 and inventory report 2018. F-gases: HFCs, PFCs, N<sub>2</sub>O, CH<sub>4</sub>, CO<sub>2</sub>, NF<sub>3</sub> and SF<sub>6</sub> are reported separately under 2.G

note, that the overall carbon footprint strongly depends on the boundary conditions, related to electrical equipment those are e.g. electricity mix or load conditions, used in the LCA evaluation.

- Any alternative will need to achieve industry required characteristics especially concerning required electrical, physical, environmental, health and safety criteria. The new alternatives must meet the conditions laid out in the F-gas Regulation i.e. be cost-effective, technically feasible, energy efficient and reliable. The total environmental footprint of any alternatives need to be evaluated considering the entire lifecycle.
- T&D Europe also notes that appropriate measures for emission reduction and raise further potential for reduction are to some extent quite different for high voltage switchgear and medium-voltage distribution switchgear.

## Annex 2 detailed comments from T&D & Nat. Associations



Switchgear briefing paper-with line numbers

For easier identification line numbers have been added to the original text of OKO-Recherche briefing paper

Nat. Association	Line number (e.g. 17)	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment	Comments	Proposed change
NL (Fedet)				General	While Fedet supports the overall conclusions of the Oko Research report, Fedet agrees with the comments made by T&D Europe in this paper	
NL (Fedet)				General	Fedet is also keen to learn more about the policy recommendations following from the report	
ES (AFBEL)				General	The report is too optimistic for the current state of the art, at least in Spain.	
FR (GIMELEC)				General	Gimelec Supports the comments from T&D Europe	
DE (ZVEI)				General	<p>The use of air-insulated switchgear (AIS) for all applications with no or only limited impact on the footprint is not correct, since the space requirement is a major hurdle. In many applications, SF<sub>6</sub> gas-insulated switchgear is selected, beside its high reliability and extensive freedom from maintenance. Especially in the higher voltage range of medium and high voltage, the space requirement may increase slightly in the future when alternative solutions to SF<sub>6</sub> gas-insulated technology are used. Additional space requirements, especially for secondary switchgear (RMU), can lead to restrictions in application :</p> <p>see: <a href="https://www.zvei.org/en/press-media/publikationen/scenario-for-reducing-sf6-operating-emissions-from-electrical-equipment-through-the-use-of-alternative-insulating-gases/">https://www.zvei.org/en/press-media/publikationen/scenario-for-reducing-sf6-operating-emissions-from-electrical-equipment-through-the-use-of-alternative-insulating-gases/</a></p>	

Nat. Association	Line number (e.g. 17)	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment	Comments	Proposed change
DE (ZVEI)				General	The additional costs of alternative solutions depend on many parameters and cannot be quantified as a lump sum as mentioned in the document.	
T&D Europe				General	There is no mention of Generator Circuit breakers in the briefing paper	This category of switchgear is specific and need a special attention as per in T&D Europe Technical Report <sup>6</sup>
T&D Europe				General	There is no mention of AIS for High voltage applications in the briefing paper	This category of switchgear is listed in T&D Europe Technical Report and there are alternative too.
T&D Europe	11	1			As per as T&D Technical report (§3) <sup>6</sup> SF6 is neither toxic nor flammable and does not have any carcinogenic, mutagenic or repro-toxic (CMR) characteristics. Safety requirements of alternative gases and their possible by-products at end-of-life should also be mentioned.	SF6 is the most potent greenhouse gas known and its use in switchgear can produce toxic by-products depending on arc fault energy (voltage, current, time) and the type of SF6-filled equipment. Example, in a RMU the amount of SF6 by-products at end-of-life use to be negligible. You can also refer to Report CIGRÉ ELECTRA No. 136, June 1991 ("Handling of SF6 and its decomposition products in GIS", table 2 "Rough characterisation of the major decomposition products resulting from different sources") Other possible reference is the FAQ on SF6 of T&D Europe. <a href="https://www.tdeurope.eu/component/attachments/attachments.html?id=747">https://www.tdeurope.eu/component/attachments/attachments.html?id=747</a>
T&D Europe	32	2.2			"Regulated" is not the right wording for kind of network, use "public" instead	public or industrial network operators
T&D Europe	32	2.2			"Such devices are integrated directly into the networks of the final users." : this is only valid for industrial network	Please add "in case of industrial network, such devices are integrated directly into the networks of the final users."
T&D Europe	34 to 36	2.2			Overhead-line equipment, and generally outdoor equipment can also be part of secondary power distribution networks. MV switching substations are also part of the secondary power distribution networks.	From T&D Europe Technical Report you can extract the following description "In most cases secondary power distribution equipment refers to switchgear found in MV/LV substations (S/S) or in MV switching substations (S/S) with mainly load switching functions and rated for load current up to 630A and short-circuit current up to 25kA. It can also be found outdoor on overhead lines (OHL) pole-mounted with load-break switch or circuit-breaker (reclosers) and rated for load current up to 630A and short-circuit current up to 20kA."

<sup>6</sup> Technical report on alternative to SF6 gas in medium voltage & high voltage electrical equipment <https://www.tdeurope.eu/component/attachments/attachments.html?id=1435>

Nat. Association	Line number (e.g. 17)	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment	Comments	Proposed change
T&D Europe	56-57	2.2			What is the <b>New</b> secondary distribution , an explanation can also help to understand why AIS does not play any role of importance?	See comment
T&D Europe	64	2.2			The T&D Europe technical Report <sup>6</sup> is saying that footprint is similar and not equal	Please use similar instead of equal
T&D Europe	64 to 67	2.2			“Market share... higher” please Explain the reason why the market share is low, (partial) and why some customers adopted the technology and some not and which level of voltage (where it is used)	See comment
T&D Europe	68	2.2			“ambient pressure” this is not only the case for SIS, it is better to use “defined pressure”. “an hermetically sealed tank” is by concept almost never at ambient pressure but at a defined pressure.	See comment
DE (ZVEI)	89	2.3	Table 2		Table 2, which shows examples of alternatives, contains a number of details that require correction or clarification	See below other table 2 comments
T&D Europe	89	2.3			Table 2: is presenting new alternatives	Please add “new” in the title before alternative

T&D Europe	89	2.3	Table 2		The first 3 columns of table 2 are confusing . T&D Europe is proposing a new structure that can fit with the Status/comment presented	Rated voltage	Type of application	<i>Solution for insulation</i> <i>Solution for load breaking / circuit breaking</i>	
						up to 12kV	Secondary distribution	<i>air-like gases + solid</i> vacuum circuit-breaker load-break switch	
								<i>air-like gases (gas using natural substances)</i> vacuum circuit-breaker load-break switch (VI based / design not published)	
								<i>F-Gas alternative (gas using synthetic fluor compounds)</i> vacuum circuit-breaker load-break switch	
					up to 24kV			Secondary distribution	<i>air-like gases + solid</i> vacuum circuit-breaker load-break switch
									<i>air-like gases (gas using natural substances)</i> vacuum circuit-breaker load-break switch (VI based)
									<i>F-Gas alternative (gas using synthetic fluor compounds)</i> vacuum circuit-breaker load-break switch
					up to 36kV	Secondary distribution	<i>any gas alternative</i> vacuum circuit-breaker load-break switch (design not published)		
					up to 12kV	Primary distribution	<i>air-like gases (gas using natural substances)</i> vacuum circuit-breaker		
					up to 24kV		<i>air-like gases (gas using natural substances)</i> vacuum circuit-breaker		

Nat. Association	Line number (e.g. 17)	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment	Comments	Proposed change												
						<table border="1"> <tr> <td></td> <td><i>F-Gas alternative (gas using synthetic fluor compounds)</i></td> </tr> <tr> <td></td> <td><a href="#">vacuum circuit-breaker</a></td> </tr> <tr> <td></td> <td><i>air-like gases (gas using natural substances)</i></td> </tr> <tr> <td></td> <td><a href="#">vacuum circuit-breaker</a></td> </tr> <tr> <td></td> <td><i>F-Gas alternative (gas using synthetic fluor compounds)</i></td> </tr> <tr> <td></td> <td><a href="#">vacuum circuit-breaker</a></td> </tr> </table>		<i>F-Gas alternative (gas using synthetic fluor compounds)</i>		<a href="#">vacuum circuit-breaker</a>		<i>air-like gases (gas using natural substances)</i>		<a href="#">vacuum circuit-breaker</a>		<i>F-Gas alternative (gas using synthetic fluor compounds)</i>		<a href="#">vacuum circuit-breaker</a>
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	<a href="#">vacuum circuit-breaker</a>																	
						up to 36kV												
T&D Europe	92	2.3			Suggestion to add before the following text: “SF6-free alternatives such as those presented in Table 2 could be used with different constraints depending on the chosen solution, such as minimum operating temperature, size, purchasing cost, operating costs, regulation, operating complexity and user’s preference for standardized solutions.”	See comment												
T&D Europe	97	2.3			explanation about additional investments cost will be appreciated : is it investment for user or manufacturer ?	See comment												
T&D Europe	101	2.3			The term “operational efficiency” is not clear . It would be useful for the reader to know what exactly is covered	See comment												
T&D Europe	106	2.3			Maintenance is a question of confidence by the end user. This is not only just because of sealed for life technology	You can delete thus and make 2 sentences to avoid confusion												
T&D Europe	110	2.3	Footnote 8		The footnote 8 is not related to the sentence.	See comment and clarify												
T&D Europe	110	2.3	Footnote 8		The origins of facts and figures in the footnote are not referenced. The estimated CO2 eq emissions and the possible worst case scenario described at end-of-life are not in line.	please document these figures or delete the note												
T&D Europe	124 to 126	2.3			“The needed period .... market readiness.” : the full process takes around 5+ years . however, some new SF6 alternatives have already passed part of the process. then their commercial availability can be reached earlier.	See comment												

Nat. Association	Line number (e.g. 17)	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment	Comments	Proposed change
T&D Europe	135	2.4			The additional costs of any other alternative solutions depend on many parameters and cannot be quantified as a lump sum as mentioned in the document.	
T&D Europe	139	2.4			“Implementation of different technology approaches” -> Not clear what is meant,	improvement should be in the way to mention, in the next two years more DSO's & TSO's will implement these alternatives technologies.
T&D Europe	141	2.4			“by several manufacturers”	“by several manufacturers and users for several years already”
T&D Europe	144	2.4			technical point of view it is feasible to use SF6 free solution for some uses	“From technical and from operational experiences point of view”
T&D Europe	144	2.4			feasible to use SF6 free solution for some uses	“main market requirements are covered (e.g. 40 kA, 3150 A, temp. range, switching duties” -> see T&D Europe Technical Report
T&D Europe	149	2.4			for various components	“for most advanced switching components up to 5 years”
T&D Europe	149	2.4			Information regarding homologation, pilot phase are missing	Modify the text to include cited phases which implies a period of 5-10 years
T&D Europe	149	2.4			seems to be realistic to have user acceptance for the main market requirements for high voltage applications (>145 kV)	See comment
T&D Europe	156	2.5			Gas insulated lines using a gas blend with synthetic substances have been demonstrated for voltages up to 420 kV	including bushings
T&D Europe	157	2.5			bushings available for voltages up to 145 kV	up 145 kV and for 420 kV
T&D Europe	158	2.5			Higher voltages still require fundamental research higher voltage > 420 kV?, what is fundamental research?	See comment
T&D Europe	160	2.5			Instrument transformer -> Information missing for alternative solution	(Low Power Instrument transformer, Oil-Insulated AIS Instrument transformer)
T&D Europe	162	2.5			Instrument transformer: of technology options -> do you mean variants, e.g. combination transformer for voltage and current	

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T&D Europe	163	2.5			Diversification of technology approaches -> what is diversification, please explain	
T&D Europe	165	2.5			As for MV -> This paragraph should be moved to chapter of MV applications	See comment
T&D Europe	169	3	title		The chapter seems to focus only on medium voltage . end users for MV and HV are physically different (TSO or DSO), and their concern about SF6 may be different too since there are more impact of SF6 emission in HV than in MV because of maintenance and leakage of equipment	If so it would be nice to specify the kind of end user in the title
T&D Europe	202	3	Table		There is on title of the table	Add table 3
T&D Europe	202	3	Table		Line “complete retrofit” column “remark” : What do you mean by near future ? for T&D Europe Industry market perspective the retrofit of SF6 products by SF6 alternative product into the same substation may represent a huge market (reducing the environmental impact by reusing current building)	If it is an end user perspective, it would be better to write <i>“from end user perspective, the total volume now and in the near future (please be more specific) of replacement of old AIS and GIS in existing building structures is limited.”</i>
T&D Europe	207	4			“certainly when there are special constraints such as space,” : space in secondary /primary is not the only argument (usage, insensitivity to environment, purchase or operational cost)	Part of the sentence containing space to be removed
T&D Europe	214	4			please be specific (quite short) ?	See comment
ES (AFBEL)	216/217/ 218	4			The availability of industrialized alternative solutions we do not see it in a period of 2 to 4 years, as said in the report, also taking into account that in Spain the commercialization is very dependent on homologation processes of utilities.	
FR (GIMELEC)	216/217/ 218 and 223/224/ 225	4			The time period required for alternatives to be technically feasible for some specific applications will be sensibly longer than the delay mentioned in the report (2 to 4 years for MV applications and up to 5 years for HV application > 145 kV )	See comment

Nat. Association	Line number (e.g. 17)	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment	Comments	Proposed change
DE (ZVEI)	216/217/218 and 223/224/225	4			We assume a period of 5-10 years to be realistic for medium-voltage applications in order to implement a more extensive portfolio in line with the market	
T&D Europe	217	4			What is reasonable ? is it product cost , investment for manufacturer ?	See comment
T&D Europe	218	4			2 to 4 years : What does this period mean ? R&D, all process, homologation ?	See comment and the main T&D Europe comments (1 <sup>st</sup> page)
T&D Europe	219	4			“an initial cost increase of up to 20%,” What is an initial cost ? be consistent with that was written before Do you mean it can go to zero after large scale implementation ?	See comment
T&D Europe	220	4			Sentence “On the other hand, .... SF6 equipment.” How do you arrive to this conclusion ? It is not mentioned before	It would be nice to have an explanation
T&D Europe	223/224/225	4			As per as main T&D Europe comment : add « Remark : a pilot step will be needed for this new application , another 5 years will be needed”	See comment
ES (AFBEL)	223/224/225	4			Of course, the alternatives to higher voltages, for example 36 kV whose market is significant in our country, are not at the same level of progress and should be set beyond that time, say between 5 to 10 years.	

## ABOUT T&D EUROPE

T&D Europe is the European Association of the Electricity Transmission & Distribution Equipment and Services Industry, which members are the European National Associations representing the interests of the electricity transmission and distribution equipment manufacturing and derived solutions. The companies represented by T&D Europe account for a production worth over € 25 billion EUR, and employ over 200,000 people in Europe. Further information on T&D Europe can be found here: <http://www.tdeurope.org>

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