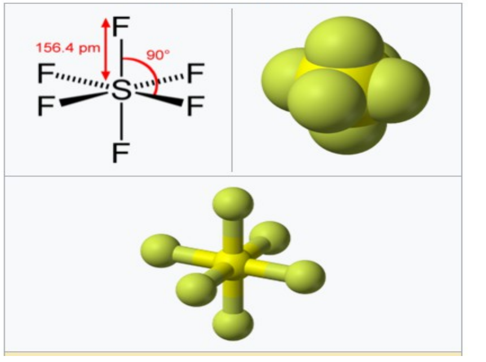
Sulfur hexafluoride



SF_6

Is it an essential medicine?

Presentation to HCWH May 2021

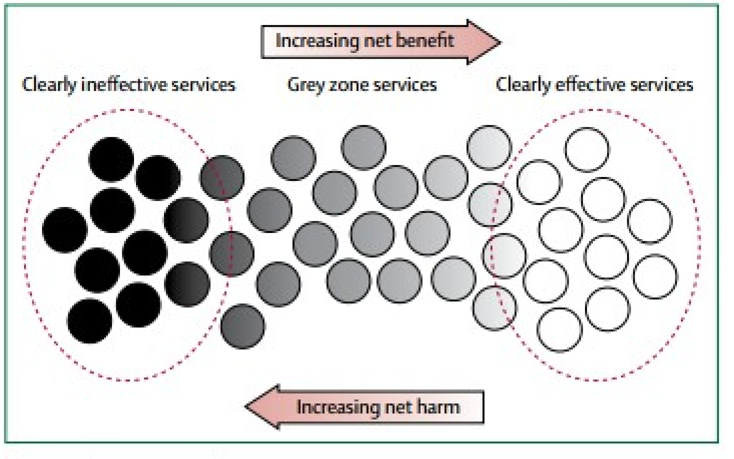


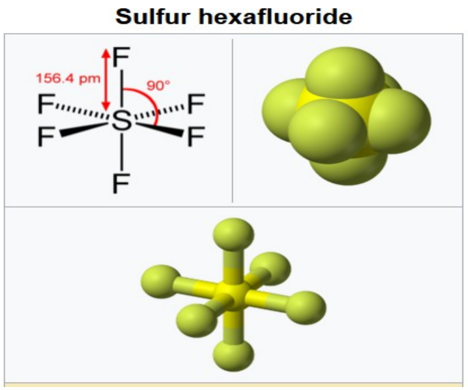
Figure 1: Grey zone services

www.thelancet.com **Vol 390 July 8, 2017**

SF_6

What is it
What is it used for
Origin of SF6
Repurposing
GHG emissions
Use in medicine
Licensing
Q & A
Next steps

SF_6



Sulphur hexafluoride is used as an electrical insulator

SF6 has a global warming potential of 23,500

Sulphur hexafluoride has an atmospheric lifetime of 800–3,200 years

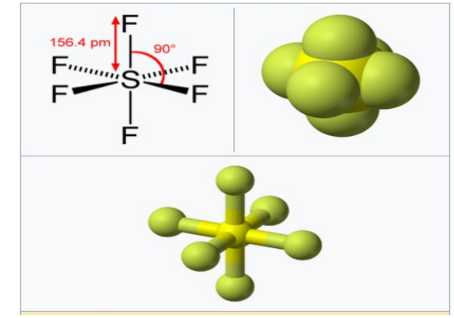
It is inorganic, colourless, odourless, non-flammable, and non-toxic

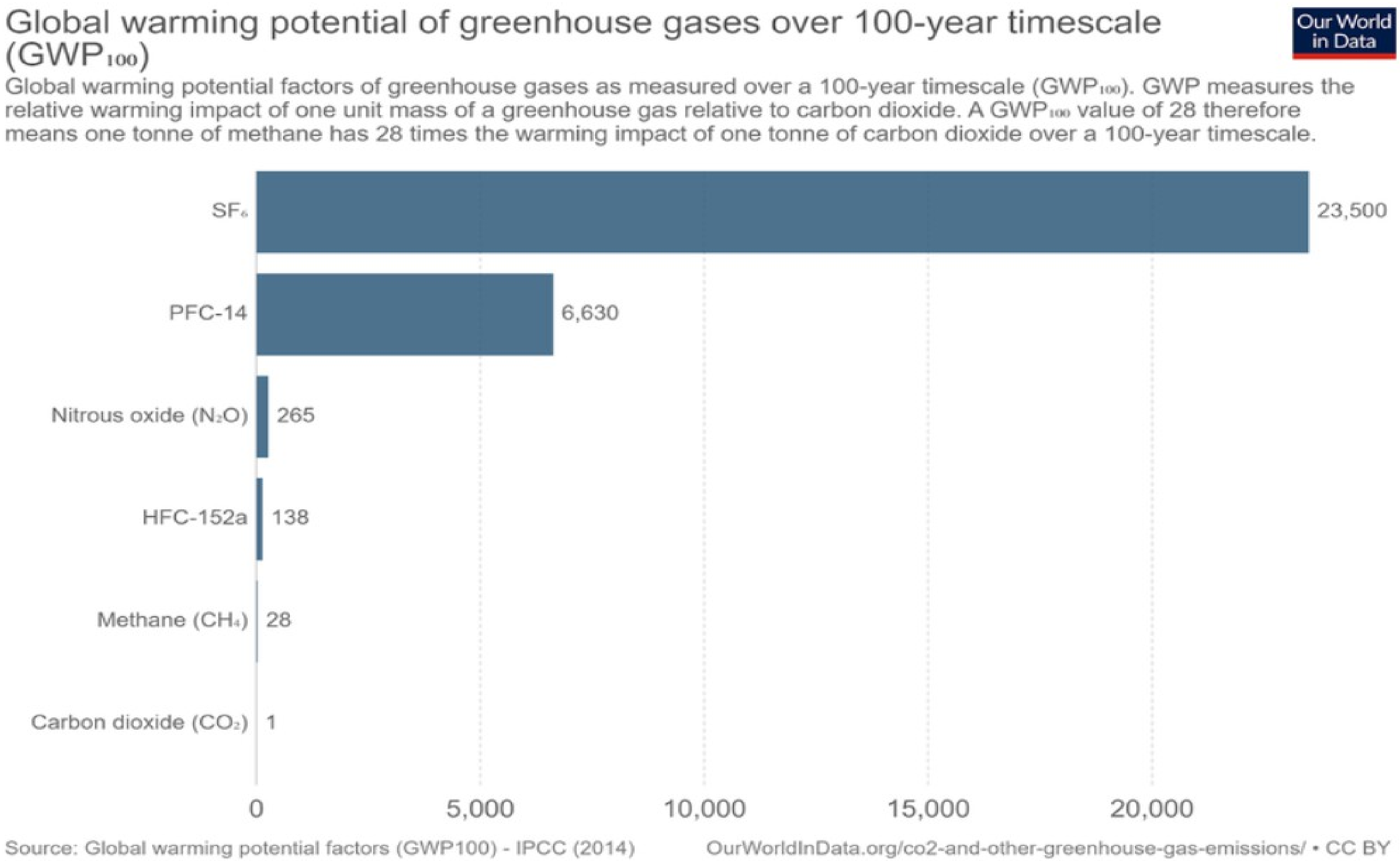
SF6 has an octahedral geometry, consisting of six fluorine atoms attached to a central sulphur atom

SF6 is poorly soluble in water but soluble in organic solvents

Used in magnesium, aluminium, and electronics manufacturing

Sulfur hexafluoride

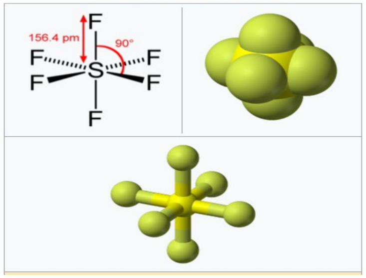




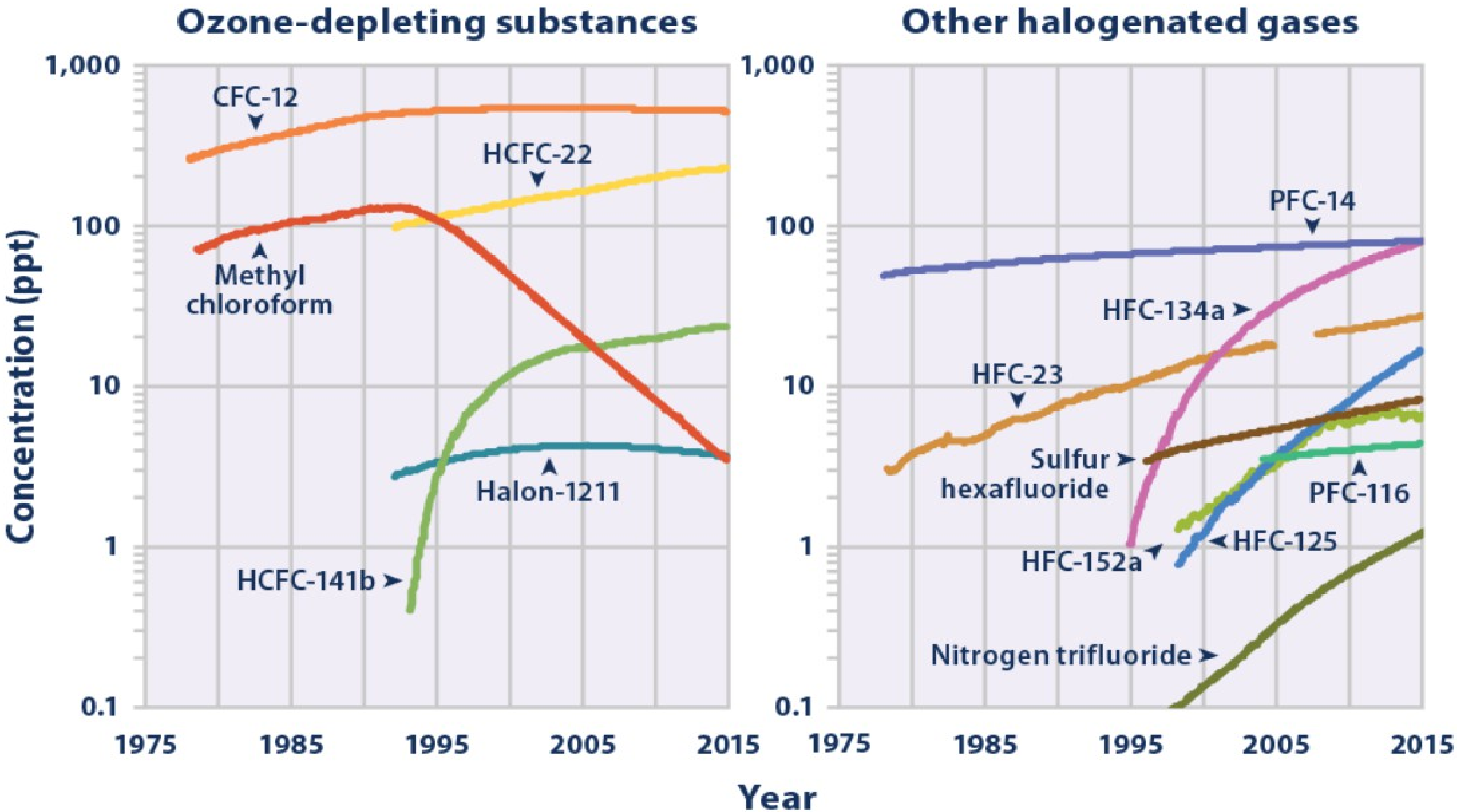
Global warming potential of various greenhouse gases

Image: Our World in Data

Sulfur hexafluoride



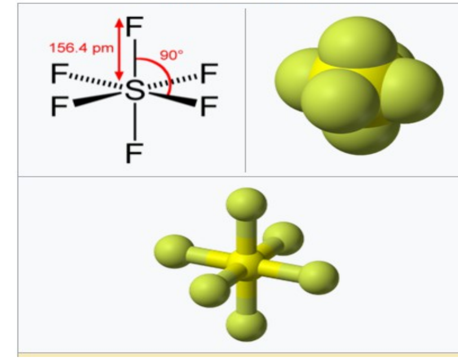
Atmospheric concentration of a select group of halogenated gas from years 1978 to 2015

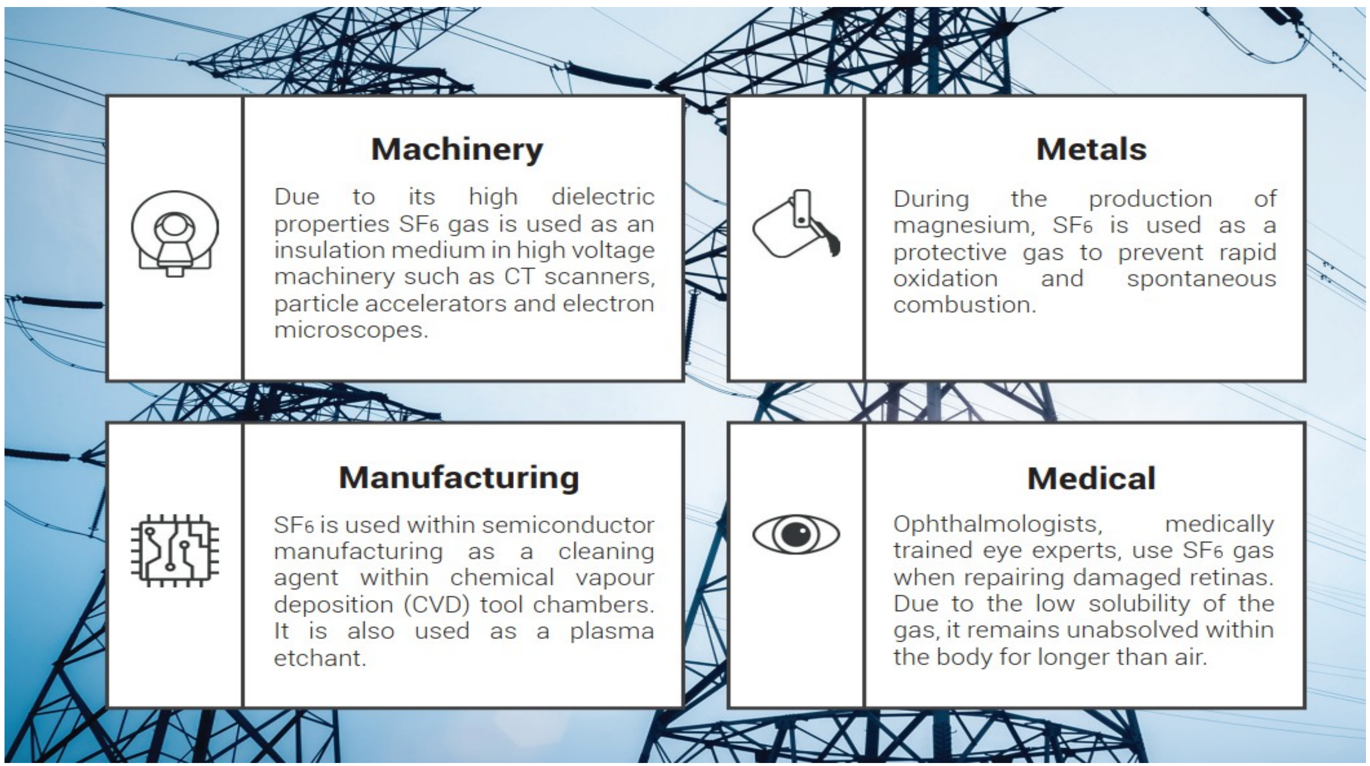


Source Wikipedia

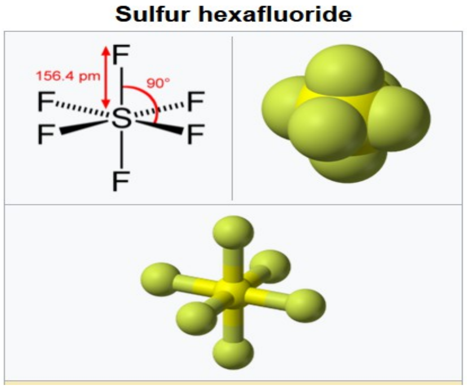
SF_6

Sulfur hexafluoride



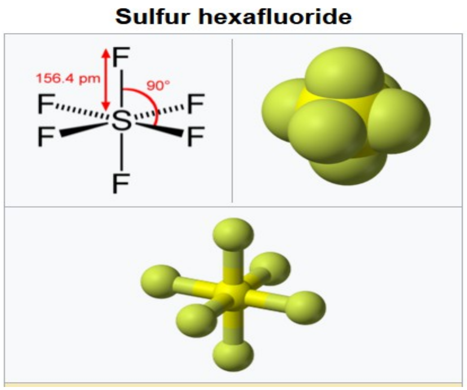


SF_6



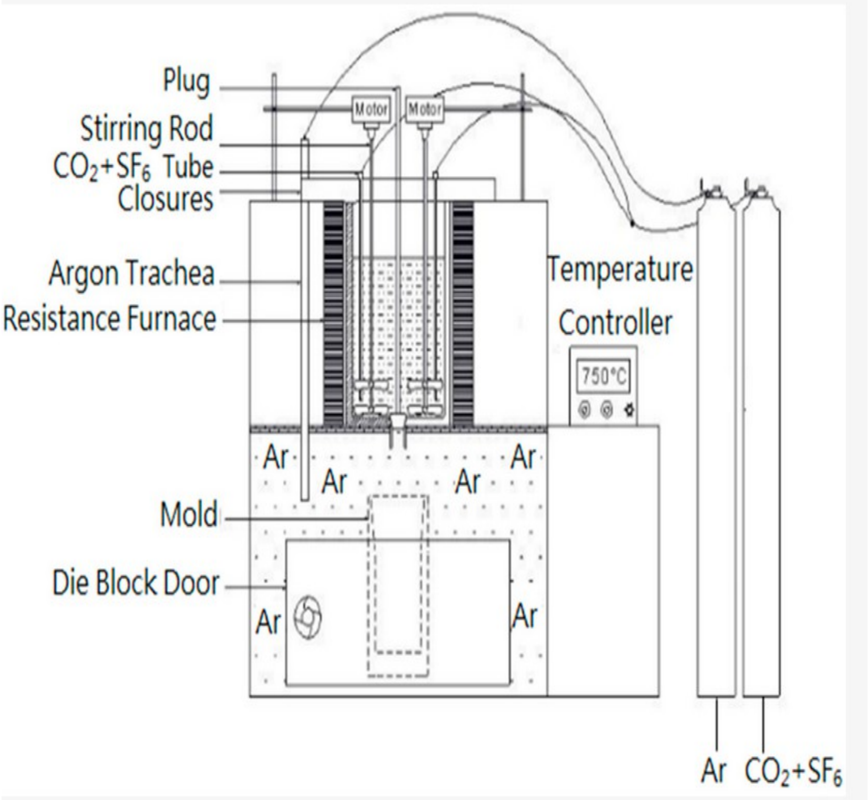
Machinery

SF_6



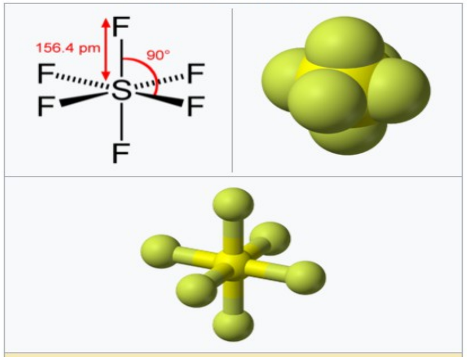
Metals

Figure 1. Schematic of the stir-casting melting furnace.



SF_6

Sulfur hexafluoride



Manufacturing

SF_6 as a process gas in the semiconductor industry

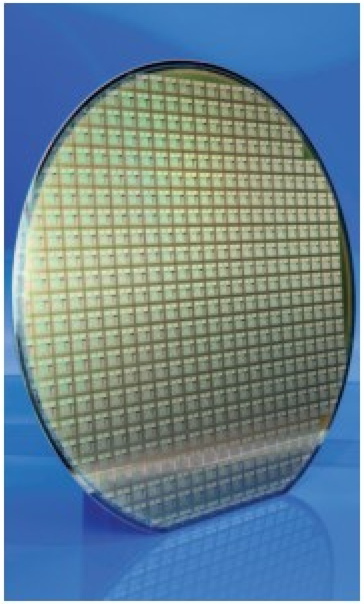
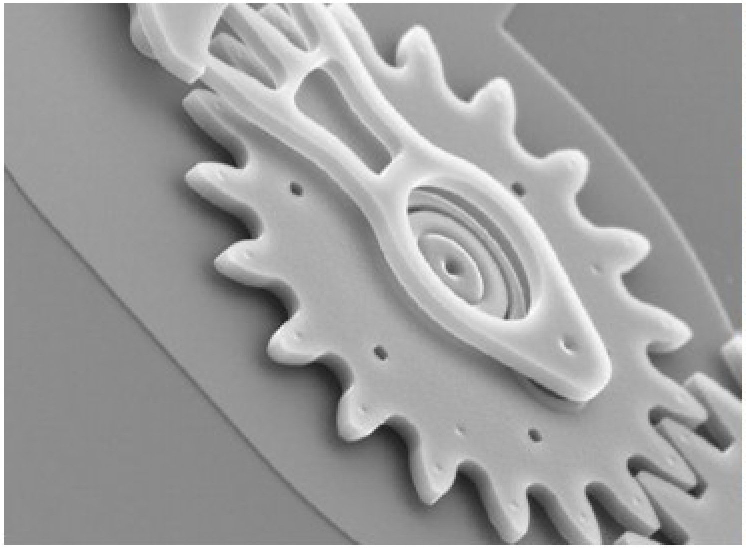


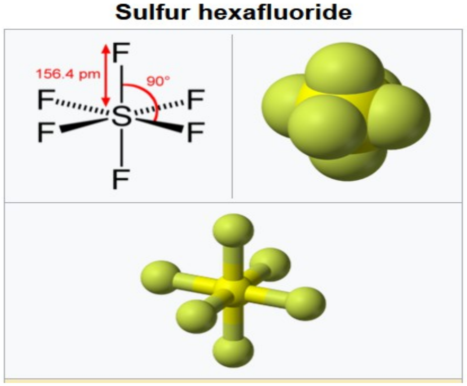
Fig. 21 *Silicon wafer*

Micro-Electro-Mechanical-Systems



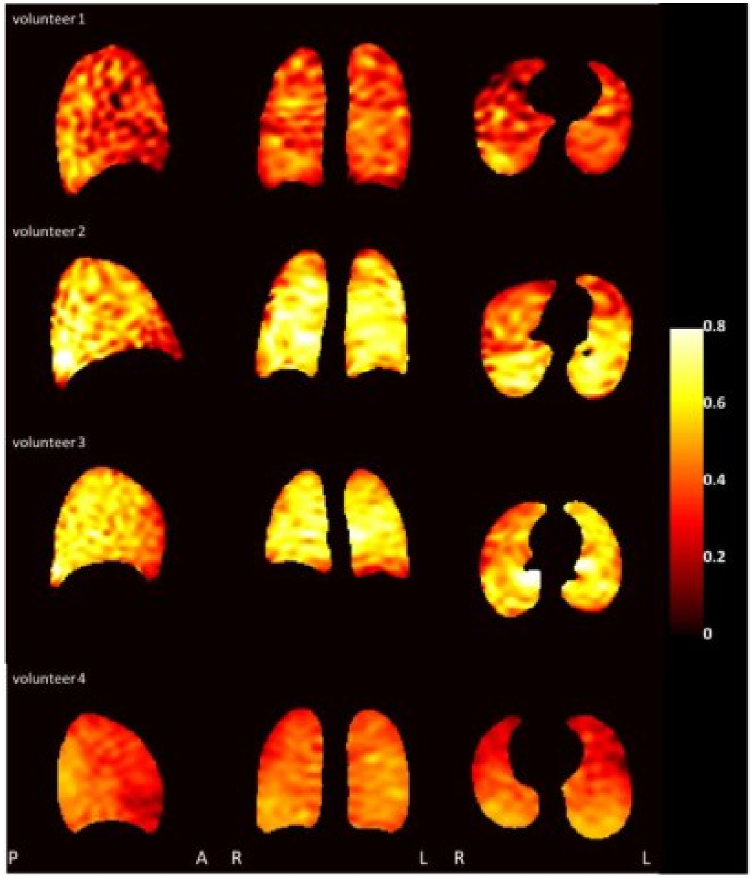
Courtesy of Sandia National Laboratories, SUMMiT(TM) Technologies, www.mems.sandia.gov

SF_6

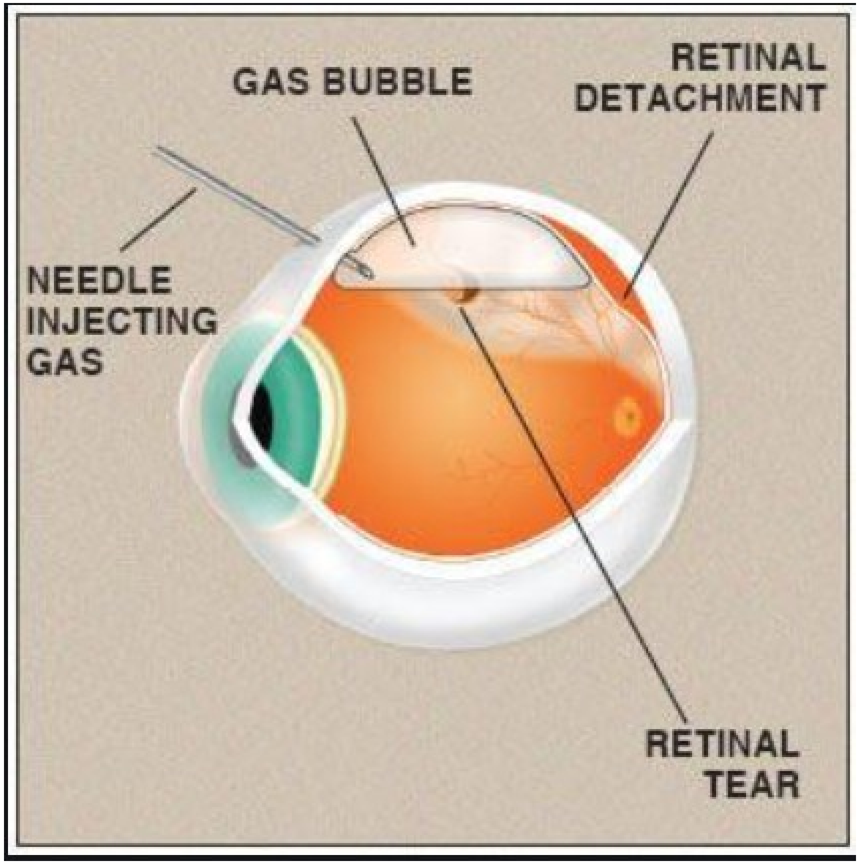


Sulfur hexafluoride
156.4 pm
90°

Medical



volunteer 1
volunteer 2
volunteer 3
volunteer 4
0.8
0.6
0.4
0.2
0
P
A
R
L
R
L



GAS BUBBLE
RETINAL DETACHMENT
NEEDLE INJECTING GAS
RETINAL TEAR

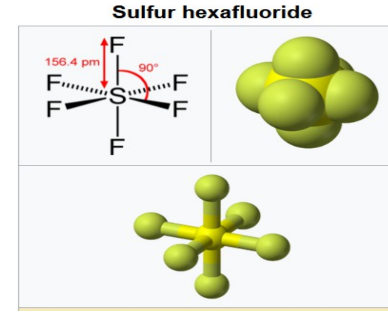
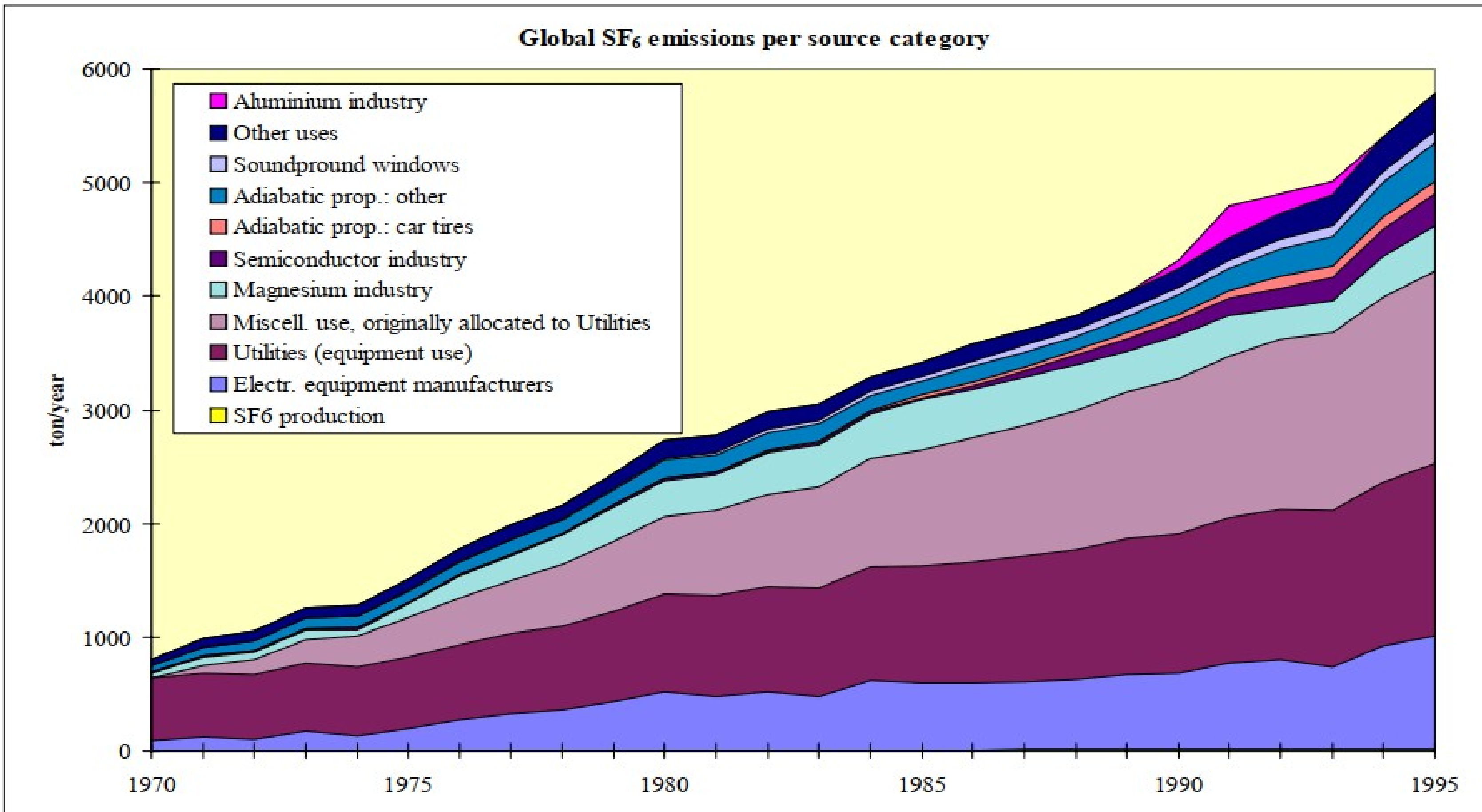


Figure 4 Global historical SF_6 emissions by end-use categories



Global Emission Sources of Greenhouse Gas Emissions from Industrial Processes: SF6 1998

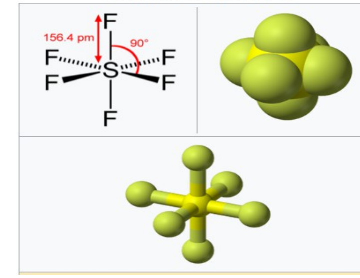
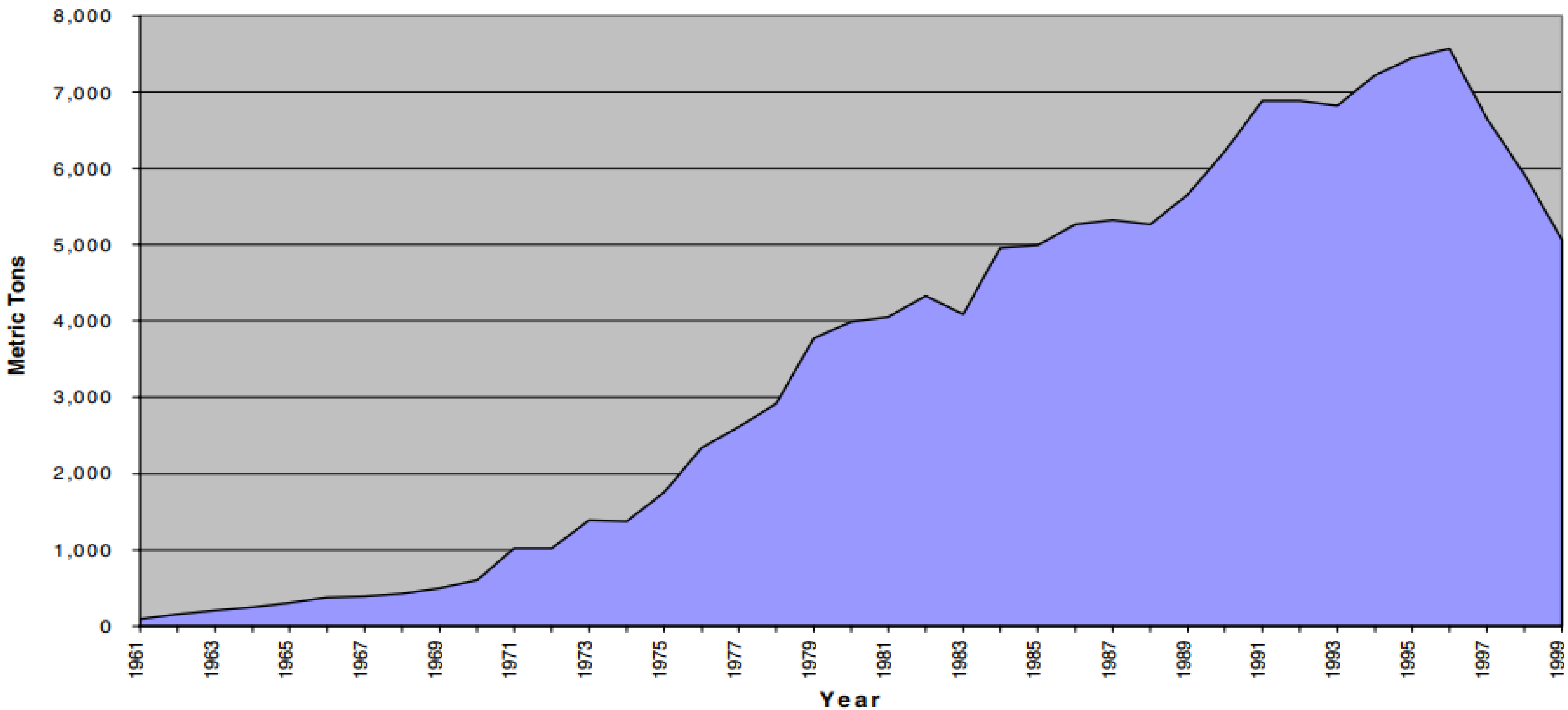


Figure 1. Total Annual Sales of SF_6
(1961-1999)



Focusing on just the past 20 years, there has been mixed growth in the various market sectors, although original equipment manufacturers remains the largest market application (Figures 2 and 3). The electronics sector has increased steadily but represents a very small portion of the overall market. Most other sectors have declined in recent years.

Production and Distribution of SF_6 by End-Use Application by Rand Group 2000

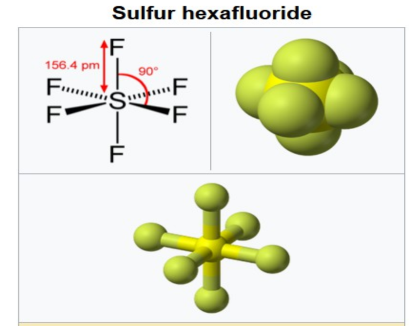
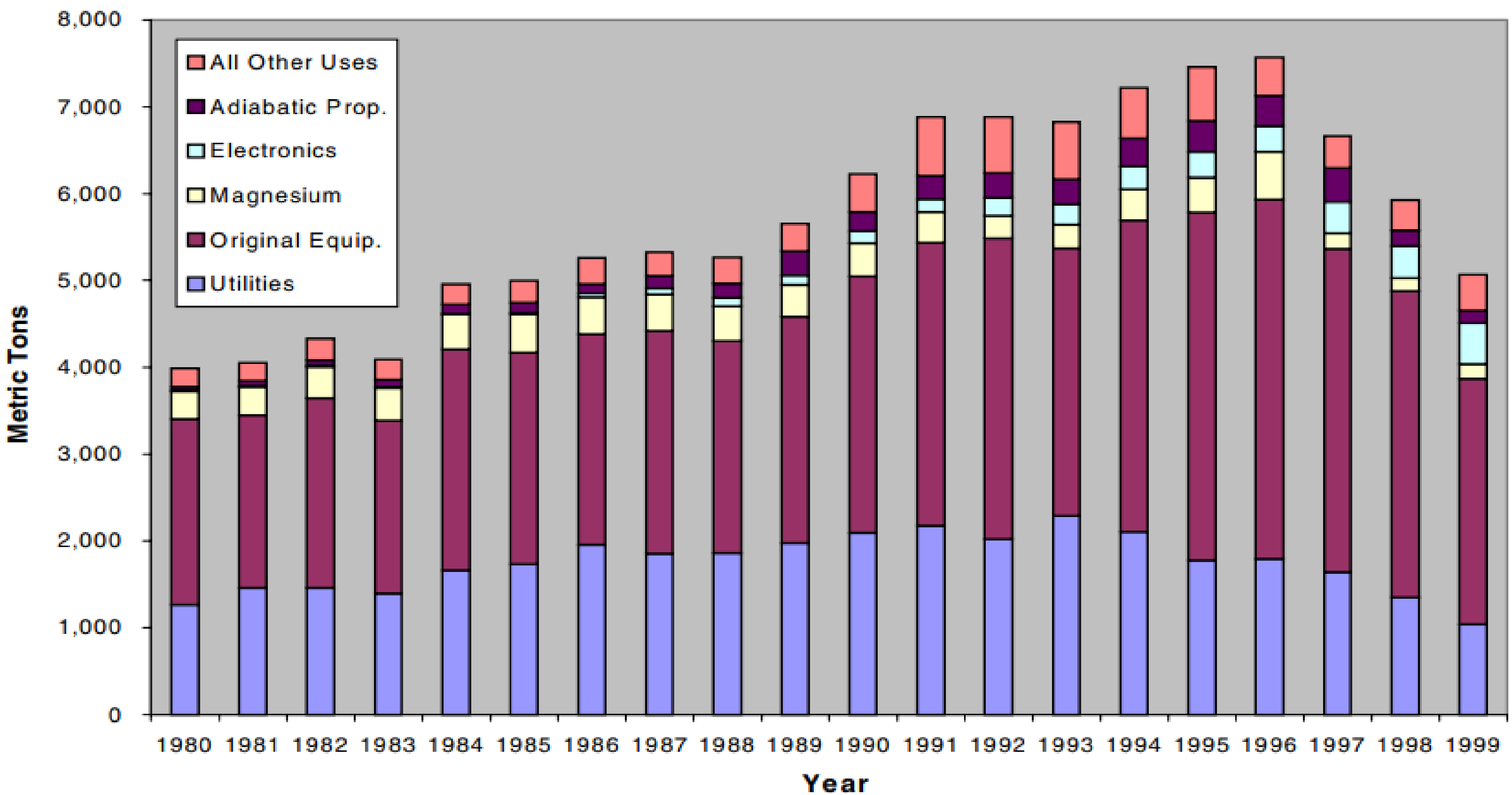
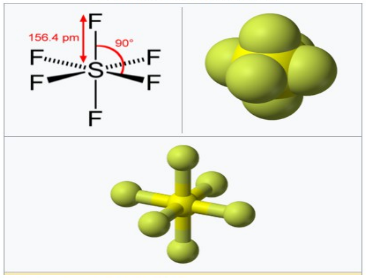


Figure 2. Sales of SF_6 by End-Use Category
(1980-1999)



Production and Distribution of SF_6 by End-Use Application by Rand Group 2000

Sulfur hexafluoride



CARB Amending SF6 Regulation: Stricter Requirements for California Electrical Equipment

By Latham & Watkins LLP on March 4, 2019
Posted in Air Quality and Climate Change, California

California proposes phasing out the use of SF6 in GIE and further reducing allowable GHG emissions from such equipment.

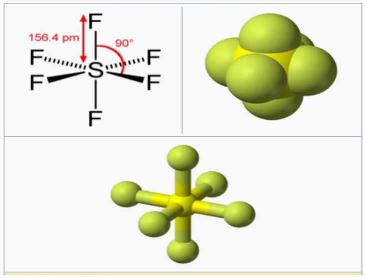
By Aron Potash and Kimberly D. Farbota

California Air Resources Board (CARB) staff recently published a discussion draft (Draft Amendments) of potential changes to the current Regulation for Reducing Sulfur Hexafluoride Emissions from Gas Insulated Switchgear (SF6 Regulation).

Key proposed changes to the SF6 Regulation include:

- Phasing out sulfur hexafluoride (SF6) gas-insulated equipment (GIE)
- Further reducing allowable emissions from GIE
- Expanding the regulation to encompass greenhouse gases (GHG) other than SF6

Sulfur hexafluoride



As a result, the Energy Industry has been actively seeking an alternative solution to ideally eliminate it from power network assets. Research has examined a multitude of different mediums; however it has been difficult to identify a suitable alternative which satisfies all the requirements. There are a number of candidates which have been successful in recent laboratory trials and these are currently being assessed in field tests.

From literature, there are a number of attractive alternatives to SF_6 including AirPlus (developed by 3M and ABB), g^3 (developed by 3M and GE), HFO1234zee and solid epoxy.

The identified possible interrupting alternatives to SF_6 are g^3 and vacuum interruption.

Pending engagement with manufacturers, it is anticipated that these mediums will be retro-fit into existing switchgear and tested to support possible integration into business as usual, on the basis of positive outcomes from laboratory tests.

Sulfur hexafluoride

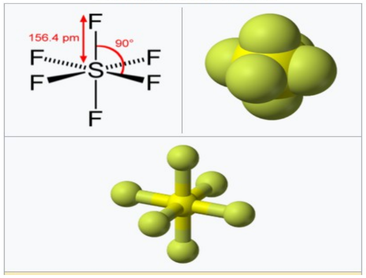


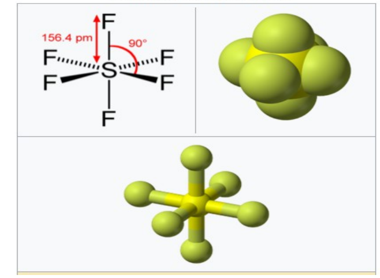
Table 2.1 Key drivers of greenhouse gas emissions excluding land-use and global shares

Type of gas	Share gas in GHG	Main source drivers/ Other source drivers	Share in gas total	Year of statistics
CO_2	**72%**	**Coal combustion**	39%	2018
		Oil combustion	31%	2018
		Natural gas combustion	18%	2018
		Cement clinker production	4%	2017
		Subtotal drivers of CO_2	**92%**	
CH_4	**19%**	**Cattle**	21%	2017
		Rice production	10%	2018
		Natural gas production (including distribution)	14%	2018
		Oil production (including associated gas venting)	9%	2018
		Coal mining	10%	2018
		Landfill: municipal solid waste generation ~ food consumption	10%	2013
		Waste water	11%	
		Subtotal drivers of CH_4	**85%**	
N_2O	**6%**	**Cattle** (droppings on pasture, range and paddock) *	23%	2017
		Synthetic fertilisers (N content) *	13%	2017
		Animal manure applied to soils *	5%	2017
		Crops (share of N-fixing crops, crop residues and histosols)	11%	2017
		Fossil fuel combustion	11%	2018
		Manure management (confined)	4%	2017
		Indirect: atmospheric deposition & leaching and run-off (NH_3)*	9%	2017
		Indirect: atmospheric deposition (NO_x from fuel combustion)	7%	2018
		Subtotal drivers of N_2O, incl. other, related drivers (*)	**83%**	
F-gases	**3%**	HFC use (emissions in CO_2 eq)	61%	NA/2017 **
		HFC-23 from HCFC-22 production (emissions in CO_2 eq)	22%	NA/2017 **
		SF_6 use (emissions in CO_2 eq)	14%	NA/2017 **
		PFC use and by-product (emissions in CO_2 eq)	3%	NA/2017 **
		Subtotal drivers of F-gases	**100%**	

* Activity data compiled by FAO cf. IPCC source category definitions.
** Statistics for Annex I countries only, reporting annually to UNFCCC (CRF files): up to year t-1.
Sources: EDGAR v5.0 for CO_2, CH_4 and N_2O (1970–2015); EDGARv4.2 FT2010 for F-gases (1970–2010); FT2018 for all.

The Hague, 2020
PBL publication number: 4068

Sulfur hexafluoride



GHG emissions per capita

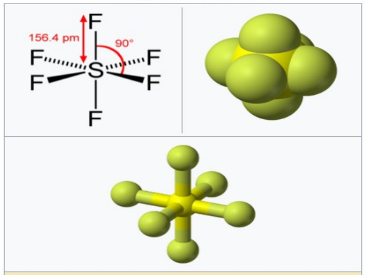
Table B.5 Greenhouse gas emissions per capita, per country and group, 1990–2018[24] (unit: tonnes of CO_2 eq per person)

Total greenhouse gas emissions per capita, per country/group, 1990-2018 (unit: kg CO_2 eq per person)																														
Country/group	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Country/group
China	3.3	3.4	3.4	3.6	3.7	4.0	4.0	3.9	4.0	3.9	4.1	4.2	4.4	4.9	5.6	6.2	6.7	7.2	7.3	7.7	8.2	8.9	9.0	9.3	9.4	9.3	9.3	9.3	9.4	China *1
United States	24.2	23.8	23.9	24.2	24.3	24.2	24.6	24.9	24.7	24.5	25.0	24.4	23.9	24.0	24.2	24.0	23.6	23.7	22.9	21.4	22.1	21.6	20.9	21.0	21.3	20.6	20.2	20.0	20.5	United States *1
European Union	12.1	11.9	11.4	11.2	11.1	11.1	11.4	11.2	11.0	10.8	10.8	10.8	10.7	10.9	10.9	10.7	10.7	10.6	10.3	9.6	9.9	9.5	9.4	9.2	8.8	8.9	8.8	8.9	8.7	European Union *1
France	9.6	9.9	9.7	9.3	9.1	9.2	9.4	9.2	9.4	9.2	9.1	9.1	9.0	8.9	8.9	8.8	8.6	8.5	8.3	8.0	8.2	7.6	7.6	7.6	7.0	7.1	7.0	7.1	7.0	France *1
Germany	15.7	15.3	14.4	14.1	13.9	13.8	14.1	13.6	13.2	12.7	12.7	12.8	12.6	12.6	12.5	12.2	12.4	12.1	12.2	11.3	12.1	11.7	11.8	12.0	11.4	11.5	11.4	11.3	10.8	Germany *1
Italy	9.1	9.0	8.9	8.8	8.7	9.1	9.1	9.2	9.5	9.6	9.7	9.6	9.7	10.0	10.0	10.0	9.8	9.6	9.3	8.4	8.6	8.3	8.0	7.4	7.0	7.2	7.1	7.1	6.9	Italy *
Netherlands	14.7	14.9	14.7	14.8	14.7	15.0	15.7	15.3	15.0	14.5	14.3	14.2	13.9	14.0	14.0	13.8	13.6	13.6	13.2	12.8	13.4	12.6	12.6	12.4	11.9	12.3	12.3	11.9	11.7	Netherlands
Poland	13.5	13.3	12.8	12.7	12.4	12.4	12.8	12.5	11.5	11.3	10.8	10.6	10.4	10.7	10.7	10.8	11.1	11.1	10.9	10.5	11.0	11.0	10.8	10.7	10.4	10.5	10.8	11.0	11.2	Poland
Spain	7.6	7.8	8.0	7.6	7.9	8.2	8.0	8.5	8.7	9.2	9.6	9.4	9.8	9.8	10.1	10.2	9.9	10.1	9.2	8.3	7.9	7.9	7.8	7.2	7.3	7.6	7.4	7.7	7.6	Spain
United Kingdom	14.1	14.4	14.0	13.7	13.6	13.4	13.8	13.4	13.2	12.7	12.6	12.7	12.3	12.4	12.2	12.0	12.0	11.7	11.2	10.0	10.2	9.5	9.7	9.4	8.8	8.5	8.1	7.9	7.7	United Kingdom *1
India	1.6	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.7	1.8	1.8	1.7	1.7	1.8	1.8	1.9	1.9	2.0	2.1	2.2	2.2	2.3	2.4	2.4	2.5	2.6	2.6	2.6	2.7	India *1
Russian Federation	20.3	20.0	18.4	16.9	15.1	14.7	14.3	13.5	13.4	13.8	14.1	14.3	14.3	14.7	15.0	14.9	15.5	15.6	15.6	14.6	15.5	16.1	16.3	16.0	15.9	15.9	15.8	16.1	16.9	Russian Federation *1
Japan	10.4	10.4	10.5	10.4	10.8	11.1	11.1	11.0	10.6	10.8	10.9	10.7	11.0	11.0	11.0	11.0	10.9	11.3	10.6	10.1	10.6	11.0	11.4	11.6	11.4	11.1	11.0	11.1	11.0	Japan *1
Other OECD G20	9.5	9.5	9.6	9.8	10.0	10.1	10.4	10.7	10.5	10.7	11.2	11.0	11.0	10.9	11.1	11.0	11.3	11.5	11.2	11.0	11.2	11.7	11.7	11.3	11.4	11.4	11.4	11.7	11.7	Other OECD G20
Australia	30.7	30.5	30.2	30.0	29.8	30.3	30.2	30.7	32.2	34.1	35.3	35.6	35.5	32.1	34.5	32.9	34.2	33.6	31.9	32.0	30.7	34.9	34.1	29.8	30.2	29.8	28.7	29.8	29.0	Australia *1
Canada	22.3	21.9	22.2	22.2	22.8	22.8	23.4	23.7	23.3	23.5	24.1	23.3	23.3	23.8	23.4	23.6	23.1	24.0	22.9	21.6	21.9	22.1	22.0	22.5	22.8	22.4	22.1	22.3	22.3	Canada *1
Mexico	5.5	5.6	5.5	5.7	5.9	5.8	5.9	6.2	6.4	6.1	6.3	6.3	6.3	6.5	6.5	6.6	6.8	6.8	6.8	6.7	6.7	6.7	6.7	6.6	6.4	6.4	6.4	6.4	6.3	Mexico *1
South Korea	7.5	8.0	8.4	9.0	9.5	10.2	10.8	11.2	9.7	10.5	11.7	11.8	11.6	11.5	11.9	11.8	11.9	12.1	12.2	12.3	13.2	13.7	13.7	13.5	13.4	13.7	13.8	14.2	14.6	South Korea *1
Turkey	4.1	4.1	4.2	4.2	4.1	4.3	4.6	4.7	4.8	4.7	5.0	4.6	4.7	4.8	4.8	4.9	5.4	5.7	5.7	5.7	5.8	6.1	6.5	6.4	6.8	7.0	7.5	7.9	8.0	Turkey *1
Other G20 countries	4.9	4.9	4.9	4.9	5.0	5.1	5.2	5.2	5.2	5.2	5.2	5.2	5.3	5.5	5.6	5.7	5.8	5.9	6.0	5.9	6.1	6.1	6.3	6.3	6.5	6.5	6.4	6.4	6.4	Other G20 countries
Argentina	8.9	8.6	8.6	8.6	9.0	8.5	8.9	8.6	8.4	8.5	8.5	8.3	8.1	8.7	9.0	9.0	9.3	9.4	9.6	8.9	8.9	8.9	9.0	8.9	9.1	9.0	9.0	9.0	8.9	Argentina *1
Brazil	4.5	4.5	4.6	4.7	4.8	4.9	4.9	5.0	5.0	5.0	5.0	5.1	5.2	5.3	5.5	5.5	5.4	5.5	5.6	5.4	5.8	5.9	6.0	6.1	6.2	6.1	5.9	6.0	6.0	Brazil *1
Indonesia	2.4	2.4	2.5	2.6	2.6	2.6	2.7	2.8	2.7	2.7	2.7	2.7	2.8	2.9	2.9	2.9	3.0	3.1	3.0	3.1	3.2	3.2	3.4	3.4	3.5	3.5	3.5	3.6	3.7	Indonesia *1
Saudi Arabia	15.0	14.7	14.7	14.4	15.9	15.3	15.7	15.6	15.9	15.6	16.0	16.1	16.4	16.9	17.2	17.7	18.1	18.4	19.3	19.5	20.6	20.9	21.6	21.4	22.0	22.4	21.9	21.6	21.0	Saudi Arabia *1
South Africa	10.8	10.3	9.9	9.8	9.7	9.9	10.1	10.4	10.3	9.8	9.8	9.9	10.1	10.5	11.1	11.2	11.1	11.4	11.9	11.1	11.1	10.6	10.8	10.8	10.9	10.6	10.5	10.2	10.1	South Africa *1
Total Group of Twenty (G20)	6.9	6.8	6.7	6.7	6.7	6.8	6.8	6.8	6.7	6.7	6.8	6.8	6.8	7.0	7.3	7.4	7.6	7.8	7.7	7.6	8.0	8.2	8.2	8.2	8.3	8.2	8.1	8.2	8.3	G20 *3

Trends in global CO_2 and total greenhouse gas emissions: 2019 Report

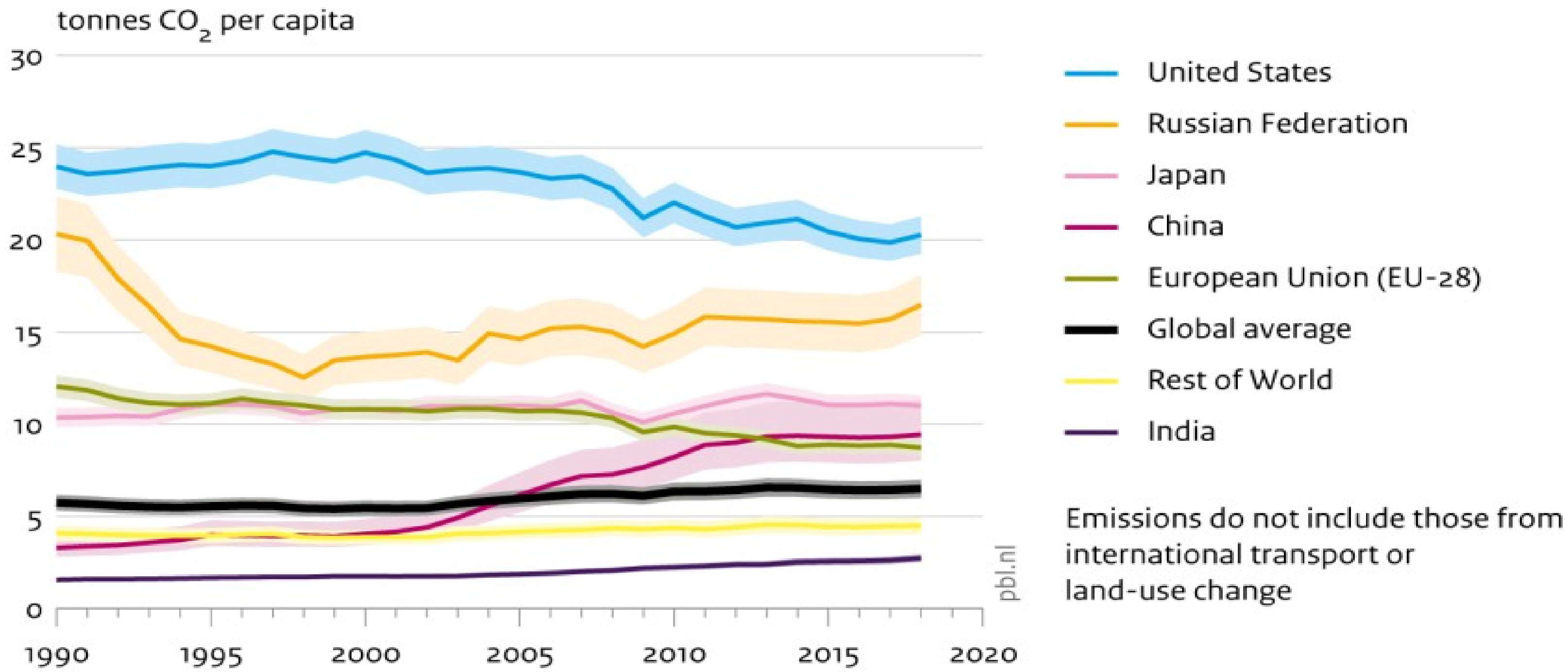
The Hague, 2020
PBL publication number: 4068

Sulfur hexafluoride



GHG emissions per capita

Figure 3.2
Greenhouse gas emissions, per capita, per country and region

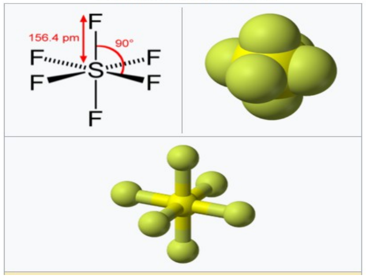


Source: UNPD; EDGAR v5.0 (EC-JRC/PBL, 2019) FT2018; incl. savannah fires FAO; F-gas: EDGAR v4.2 FT2018

Trends in global CO_2 and total greenhouse gas emissions: 2019 Report

The Hague, 2020
PBL publication number: 4068

HCWH 2019 Report



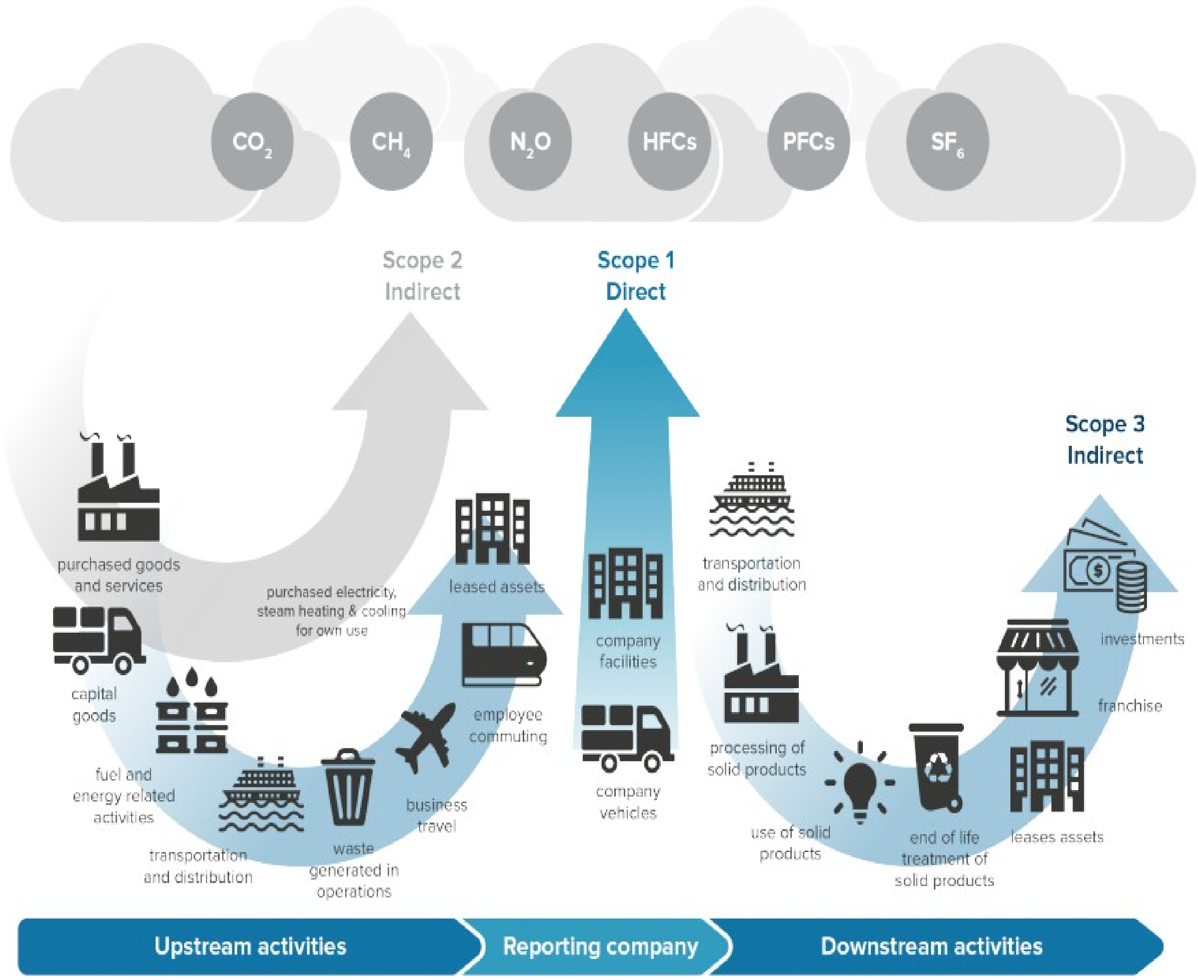


Figure 3: Greenhouse Gas Protocol Scopes 1, 2, and 3. (Source: Greenhouse Gas Protocol)

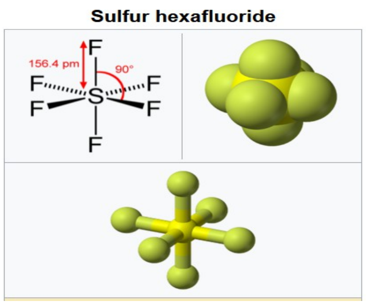
Presentation and reporting of results

The reporting of climate change impacts requires careful presentation so that the language used, and the systems and scopes applied are familiar to the intended audience and users of the information. The study reporting is framed by three general perspectives including the:

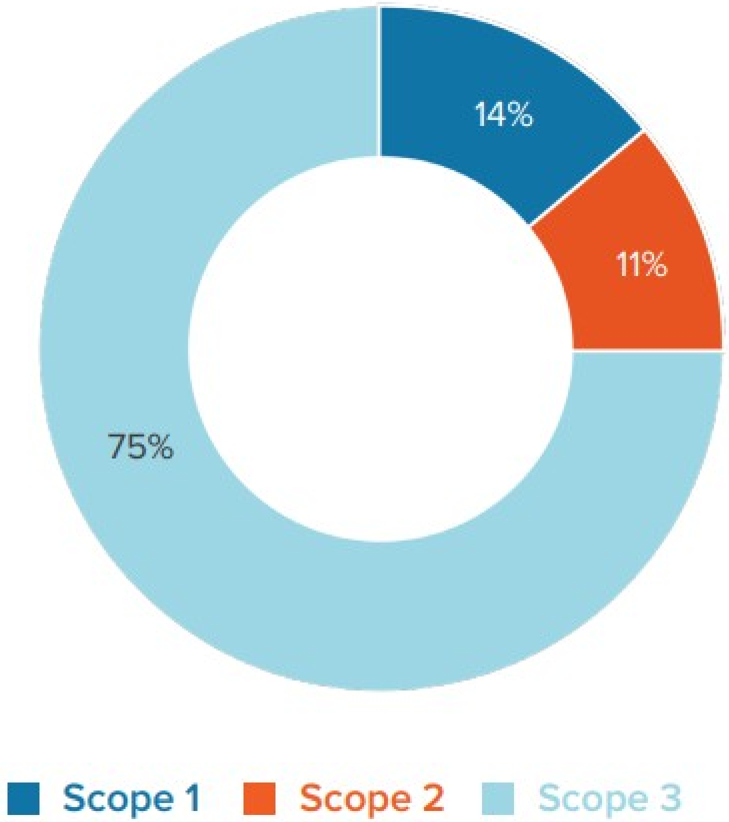
- World Input Output Database (WIOD) structure and economy sectors
- Structure of the WHO System of Health Accounts (SHA)
- Greenhouse Gas Protocol (GHGP) Scope 1, 2, and 3 categories

The GHGP scope categories are a widely applied and common framework (also in the health sector), for the allocation and reporting of GHG emissions of organizational and supply chain settings (Figure 3).

HCWH 2019 Report



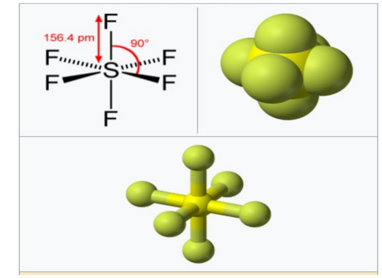
European Union



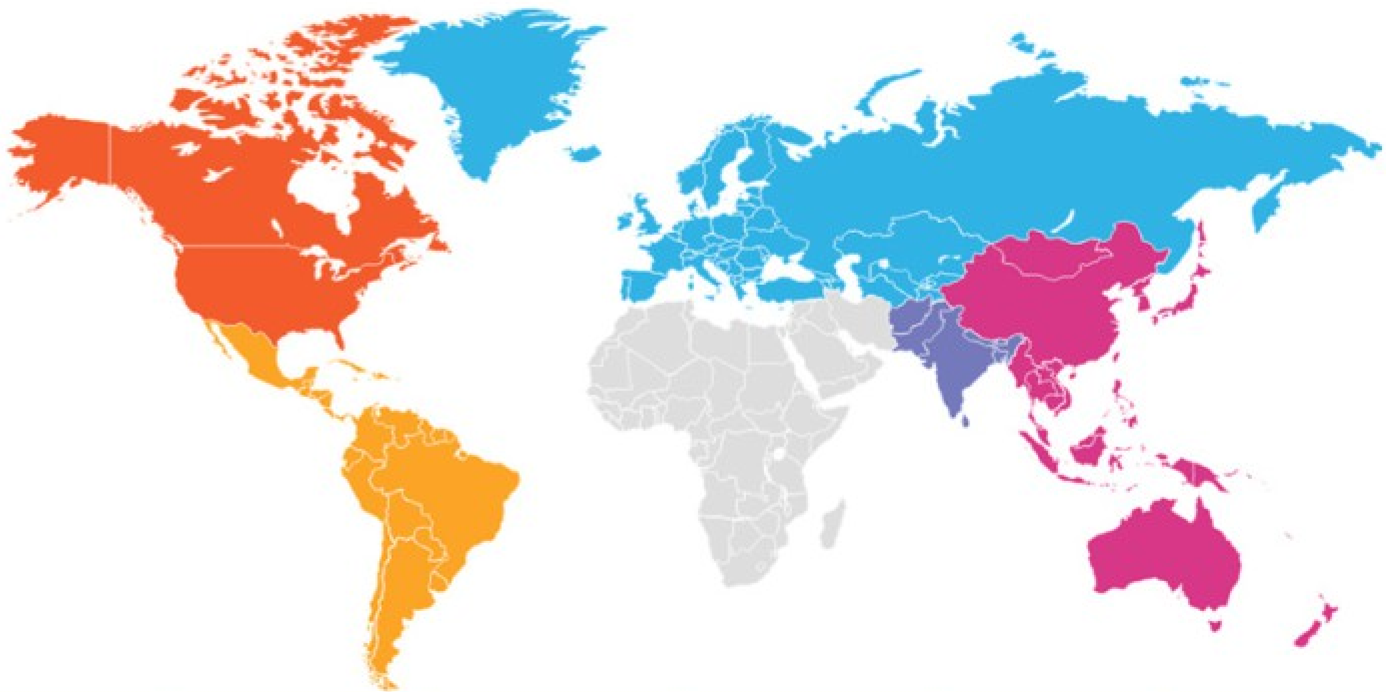
European Union health care	Value	Unit
Climate footprint	249	$MtCO_2e$
Emissions per capita	0.49	tCO_2e/ capita
Emissions as % of national footprint	4.7	%
Expenditure per capita	3668	USD
Expenditure as percentage of GDP	10.0	%
Health sector footprint equivalence to coal power plant emissions[32]	64	coal-fired power plants in one year

HCWH 2019 Report

Sulfur hexafluoride



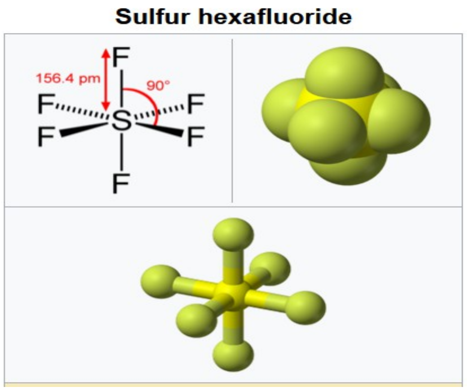
GHG emissions by region



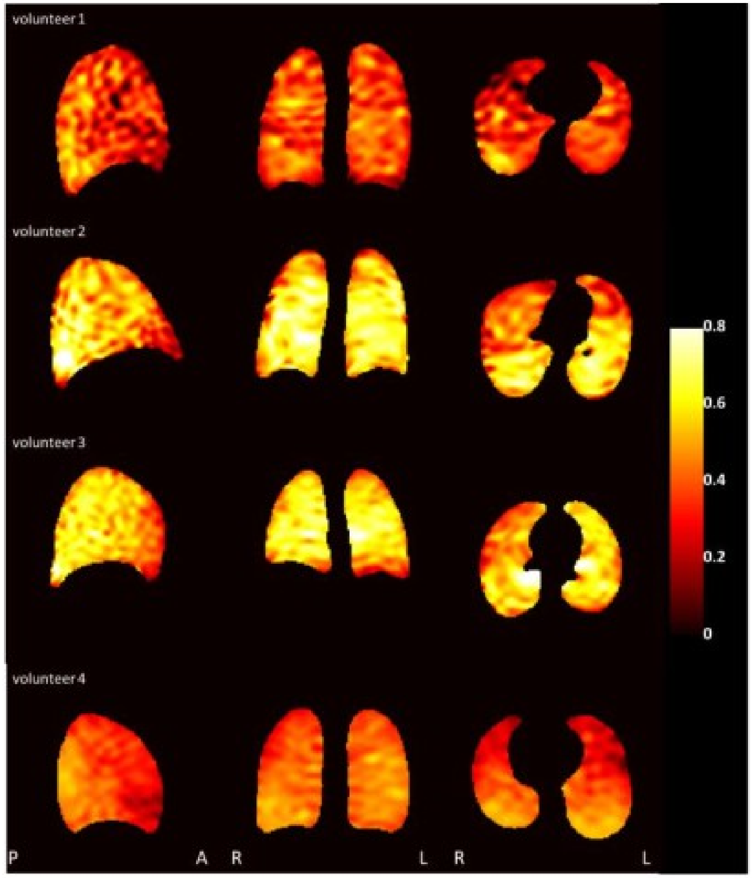
North America	Latin America & Caribbean	East Asia Pacific	South Asia	Europe & Central Asia	
1.65	0.20	0.26	0.03	0.43	tCO_2e/capita
0.58	0.13	0.60	0.05	0.39	$GtCO_2e$ total
29	6	30	2	19	% global

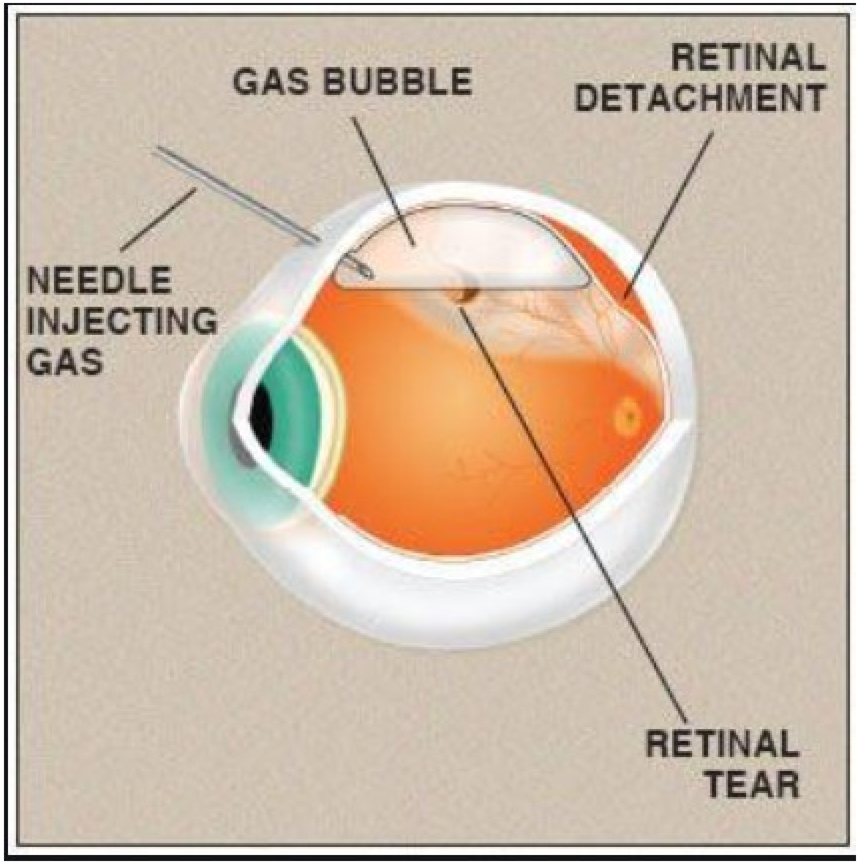
Figure 9: Estimated health care emissions for World Bank regions other than Sub-Saharan Africa and Middle East and North Africa

SF_6

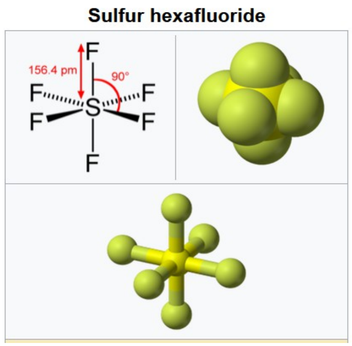

Sulfur hexafluoride
156.4 pm
90°
F
S

Medical


volunteer 1
volunteer 2
volunteer 3
volunteer 4
0.8
0.6
0.4
0.2
0
P
A
R
L
R
L


GAS BUBBLE
RETINAL DETACHMENT
NEEDLE INJECTING GAS
RETINAL TEAR

Contrast Media - SF_6

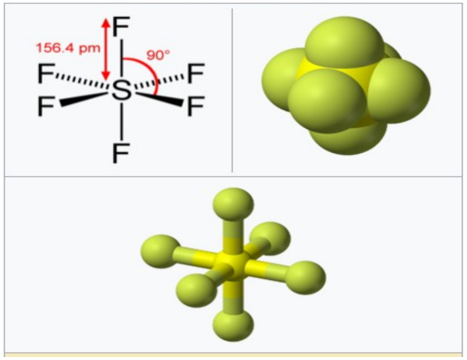


Sulfur hexafluoride lipid type A microspheres is an ultrasound contrast agent (Lumason/SonoVue)

SF6 content 8microlitre/mL (45microgram)
45ug equivalent to 1.125g CO2

Retinal Surgery

Sulfur hexafluoride



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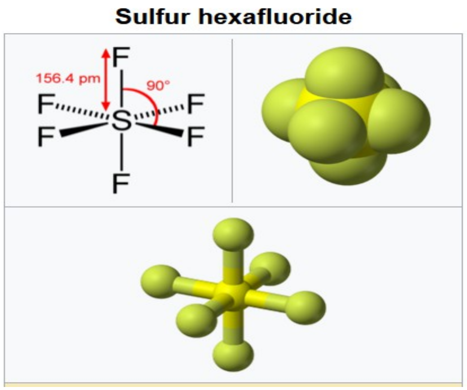
Sulfur Hexafluoride (SF6) versus Perfluoropropane (C3F8) in the Intraoperative Management of Macular Holes: A Systematic Review and Meta-Analysis.

Source: PubMed

Publisher: Journal of ophthalmology

Publication date: 12 March 2019

GWP



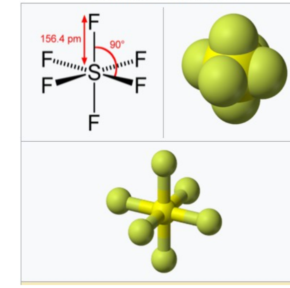
C_3F_8 GWP 100 year = 7,000

SF_6 GWP 100 year = 23,900

Silicone oil GWP 100 year = 0

Vitrectomy USA - 225,000/year

Sulfur hexafluoride



Study Description Go to ▼

Brief Summary:

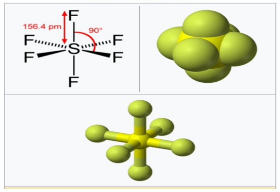
Since the introduction of vitrectomy in 1971, this procedure has become the third most frequently performed ophthalmic surgery. Approximately 225,000 vitrectomies are performed annually in the United States and indications continue to expand. Known long-term complications of vitrectomy are relatively few and include retinal detachment and cataract formation. Although much has been written in the literature concerning acute rises in intraocular pressure (IOP) in the immediate postoperative period, there is surprisingly little information on long term IOP outcomes after vitrectomy. A recent report by Chang given at the LXII (62) Edward Jackson Memorial Lecture hypothesized a causal relationship between vitrectomy and open-angle glaucoma (OAG) via oxidative stress exacerbated by removal of the crystalline lens. A second report by Luk and colleagues reported similar conclusions in a modified cohort. Both studies, were retrospective in nature and did not perform baseline evaluations to exclude pre-existing glaucoma. Furthermore neither study accounted for natural history. Finally, our analysis has not reproduced similar results.

The primary purpose of this study is to analyze the full spectrum of optic nerve and macular changes between vitrectomized study eyes and their non-vitrectomized fellow eyes to control for natural history. Baseline evaluations will include examination by fellowship trained retina and glaucoma specialists, fundus photography, autofluorescence, optical coherence tomography (macula and optic nerve) and automated visual field testing. At 3 month then annually for 5 years after vitrectomy surgery, the cohort will undergo similar evaluation.

https://clinicaltrials.gov/ct2/show/study/NCT01162356

EasyGas SF6

Sulfur hexafluoride



https://www.fluoron.de/products/long-term-tamponades/easygas-sf6/?lang=en

FLUORON®

Products About us Literature Contact

EasyGas® SF6

The first ready-to-use air gas mixture

EasyGas® SF6

Syringe G-80950, 40 ml, sterile

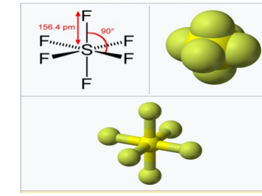
- Quick and easy application through sterile, pre-filled system
- Safe usage because of precise, non-expanding mixture ratio in each syringe
- Nomix-up of gases due to colour coding

Use

EasyGas® EasyGas SF6 is used as a long-term tamponade after operative treatment of severe retinal detachment, particularly for:

- Retinal detachments with giant tears
- Retinal detachments without proliferation
- Retinal detachments in cases of proliferative diabetic retinopathy (PDR))
- Traumatic retinal detachments

Sulfur hexafluoride



Medical Device – Class IIa

https://www.fluoron.de/products/long-term-tamponades/easygas-sf6/?lang=en

bsi.

By Royal Charter

EC Certificate - Full Quality Assurance System

Supplementary Information to CE 575554

Issued To: **Fluoron GmbH**
Magirus-Deutz-Str. 10
89077 Ulm
Germany

Number	Device Name	Intended purpose per IFU
Class IIb		
MD 0105	silicone oil based long-term tamponades	implantable, postoperative eye tamponade
MD 0105	silicone oil/alkane mix as long-term tamponades	implantable, postoperative eye tamponade
MD 0105	perfluorinated gases as long-term tamponade	implantable, postoperative eye tamponade
MD 0105	semi-fluorinated alkane as long-term tamponades	implantable, postoperative eye tamponade
Class IIa		
MD 0105	perfluorinated alkanes as intraoperative tamponade	--
MD 0105	semi-fluorinated alkane as wash-out	--
MD 0105	aqueous solution for staining	--

First Issued: **2016-06-27** Date: **2019-03-05** Expiry Date: **2021-04-10**

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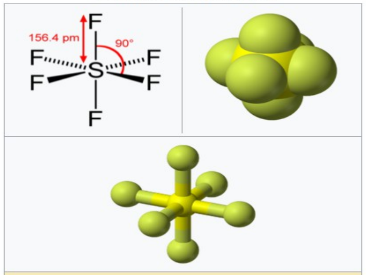
Sulfur hexafluoride



Multiple Breath Washout Devices

Table 1: Currently available multiple breath washout devices.

	Eco Medics infants	**Eco Medics preschool and older**	**ndd EasyOne Pro LAB***	**Innovision Innocor**
Method	SF_6	N_2	N_2	SF_6
Flow/volume measurement	Ultrasonic flowmeter;	Ultrasonic flowmeter	Ultrasonic flowmeter	Pneumotachometer
Tracer gas measurement	indirect via molar mass mainstream	Indirect via O_2 and CO_2 measurement	Indirect via molar mass, O_2 and CO_2 measurement	Direct via photoacoustic spectroscopy, gas reservoir bag
Gas concentration	4% SF_6	100% O_2	100% O_2	SF_6 mixture: 0.1% or 0.2% SF_6 (27.6% O_2, 0.35% N_2O)
Validation studies	Lung model Schmidt [29], Gustafsson [30]	Lung model and *in vivo* Singer [31]	-	*In vivo* Horsley [10] Lung model and *in vivo* Gonem [32]
Methodological studies	Anagnostopoulou [33], Latzin [34]	Jensen [35], Summermatter [36]	-	Horsley [37], Downing [38], Grønbæk [39], Gonem [25], Gonem [32], Nielsen [40], Shawcross [41]
Application in healthy	Fuchs [42], Anagnostopoulou [33], Gray [43] Gray [44]			Downing [38]
Studies in cystic fibrosis	Belessis [45], Simpson [46], Hall [47]	Stanojevic [48], Stahl [49], Amin [50], Ramsey [51]		Davies [52]
Cystic fibrosis and controls		Singer [53], Poncin [54]	Poncin [54]	Downing [38]
Other disease groups	Hulskamp [55], Latzin [56]	Yammine [57], Boon [58], Nyilas [59], Madsen [60], Jarenback [61]	Fuchs [62]	Macleod [63]

CO_2 = carbon dioxide; O_2 = oxygen; N_2 = nitrogen; N_2O = nitrogen dioxide; SF_6 = sulphur hexafluoride This table is meant to provide a current overview of available setups and does not necessarily represent the full body of existing literature. Please refer to the respective manufacturer for an update on current studies and recent developments. Manufacture of AMIS 2000 (Innovision) has been discontinued (http://www.innovision.dk/Products/AMIS_2000.aspx, accessed on 1 March 2017). * Before 2012, ndd EasyOne Pro was in use for multiple-breath washout measurement using 4% SF_6 (MM sidestream) (Fuchs [64], Fuchs [65], Ellemunter [66], Fuchs [62]).

Review article: Biomedical intelligence | Published 16 August 2017 | doi:10.4414/smw.2017.14483
Cite this as: Swiss Med Wkly. 2017;147:w14483

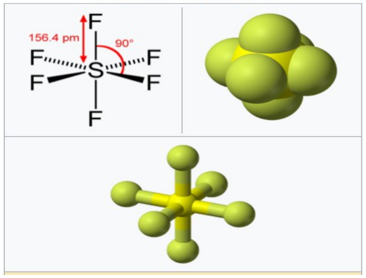
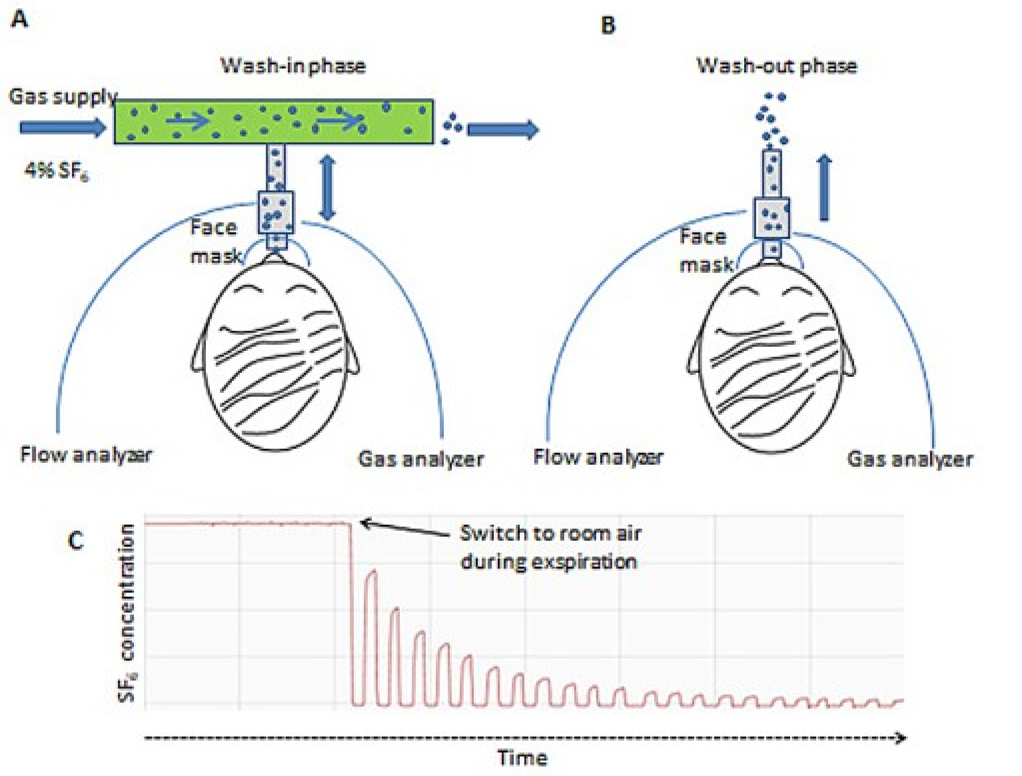


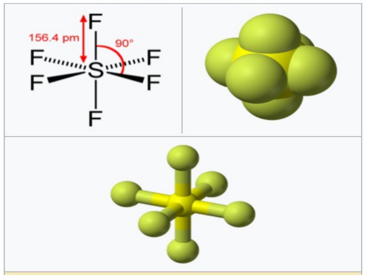
Figure 1: Schematic illustration of a sulphur hexafluoride (SF_6) multiple breath inert gas washout test. Equipment displayed includes a facemask, flowmeter, gas analyser and the inert extrinsic gas used. The wash-in phase of 4% SF_6 is given in panel A, the washout phase in panel B. The red tracing in panel C shows the decay in the SF_6 concentration during the washout-phase.



Review article: Biomedical intelligence | Published 16 August 2017 | doi:10.4414/smw.2017.14483
Cite this as: Swiss Med Wkly. 2017;147:w14483

Thorax March 2021

Sulfur hexafluoride



PDF

Respiratory research

Original research

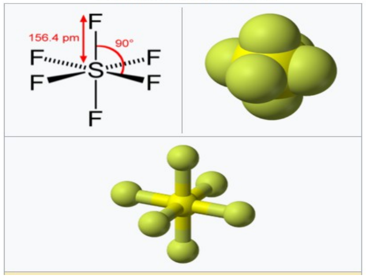
Multiple breath washout (MBW) testing using sulfur hexafluoride: reference values and influence of anthropometric parameters

Abstract

Background Multiple breath washout (MBW) using sulfur hexafluoride (SF_6) has the potential to reveal ventilation heterogeneity which is frequent in patients with obstructive lung disease and associated small airway dysfunction. However, reference data are scarce for this technique and mostly restricted to younger cohorts. We therefore set out to evaluate the influence of anthropometric parameters on SF_6-MBW reference values in pulmonary healthy adults.

Nature 2020

Sulfur hexafluoride



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natureresearch

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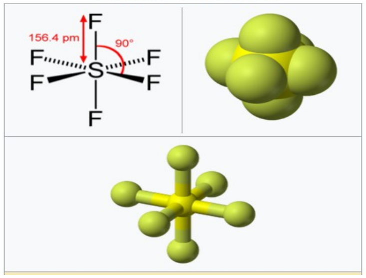
Feasibility and clinical applications of multiple breath wash-out (MBW) testing using sulphur hexafluoride in adults with bronchial asthma

Frederik Trinkmann[1,2*], Steffi A. Lenz[1], Julia Schäfer[1], Joshua Gawlitza[3], Michele Schroeter[1], Tobias Gradinger[2], Ibrahim Akin[1,4], Martin Borggrefe[1,4], Thomas Ganslandt[2] & Joachim Saur[1]

SCIENTIFIC REPORTS | (2020) 10:1527 | https://doi.org/10.1038/s41598-020-58538-x

Sulfur hexafluoride



PLOS 2011

OPEN ACCESS Freely available online

PLoS one

Tidal Volume Single Breath Washout of Two Tracer Gases - A Practical and Promising Lung Function Test

Florian Singer[1], Georgette Stern[1], Cindy Thamrin[1], Oliver Fuchs[1], Thomas Riedel[2], Per Gustafsson[3], Urs Frey[4], Philipp Latzin[1]*

1 Division of Respiratory Medicine, Department of Paediatrics, University Children's Hospital of Bern, Bern, Switzerland, **2** Paediatric and Neonatal Intensive Care Unit, Department of Paediatrics, University Children's Hospital of Bern, Bern, Switzerland, **3** Department of Paediatrics, Central Hospital, Skövde, Sweden, **4** Department of Paediatrics, University Children's Hospital Basel, Basel, Switzerland

Abstract

Background: Small airway disease frequently occurs in chronic lung diseases and may cause ventilation inhomogeneity (VI), which can be assessed by washout tests of inert tracer gas. Using two tracer gases with unequal molar mass (MM) and diffusivity increases specificity for VI in different lung zones. Currently washout tests are underutilised due to the time and effort required for measurements. The aim of this study was to develop and validate a simple technique for a new tidal single breath washout test (SBW) of sulfur hexafluoride (SF_6) and helium (He) using an ultrasonic flowmeter (USFM).

Methods: The tracer gas mixture contained 5% SF_6 and 26.3% He, had similar total MM as air, and was applied for a single tidal breath in 13 healthy adults. The USFM measured MM, which was then plotted against expired volume. USFM and mass spectrometer signals were compared in six subjects performing three SBW. Repeatability and reproducibility of SBW, i.e., area under the MM curve (AUC), were determined in seven subjects performing three SBW 24 hours apart.

Results: USFM reliably measured MM during all SBW tests (n = 60). MM from USFM reflected SF_6 and He washout patterns measured by mass spectrometer. USFM signals were highly associated with mass spectrometer signals, e.g., for MM, linear regression r-squared was 0.98. Intra-subject coefficient of variation of AUC was 6.8%, and coefficient of repeatability was 11.8%.

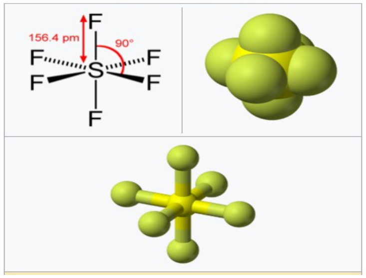
Conclusion: The USFM accurately measured relative changes in SF_6 and He washout. SBW tests were repeatable and reproducible in healthy adults. We have developed a fast, reliable, and straightforward USFM based SBW method, which provides valid information on SF_6 and He washout patterns during tidal breathing.

Citation: Singer F, Stern G, Thamrin C, Fuchs O, Riedel T, et al. (2011) Tidal Volume Single Breath Washout of Two Tracer Gases - A Practical and Promising Lung Function Test. PLoS ONE 6(3): e17588. doi:10.1371/journal.pone.0017588

Editor: Dominik Hartl, Ludwig-Maximilians-Universität München, Germany

Received December 11, 2010; **Accepted** January 27, 2011; **Published** March 10, 2011

Sulfur hexafluoride



Early Work - 1987

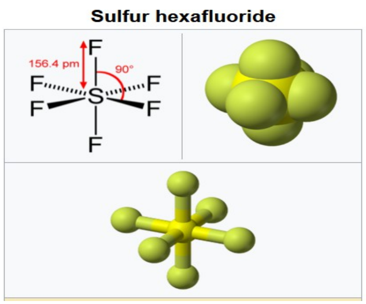
LABORATORY REPORTS

Anesthesiology
67:543–550, 1987

Measurement of Lung Volume by Sulfur Hexafluoride Washout during Spontaneous and Controlled Ventilation: Further Development of a Method

A. Larsson, M.D., D. Linnarsson, M.D.,† C. Jonmarker, M.D.,* B. Jonson, M.D.,‡
H. Larsson, M.S.,§ O. Werner, M.D.¶*

We conclude that the present system retains the advantages of its predecessor, but has a wider scope. It can be used both during spontaneous breathing and during artificial ventilation in awake and anesthetized patients.



Benefit of SF6 in MBW

Improved resolution

Q&A