SMED 2014

Swedish Environmental Emissions Data

Fluorinated greenhouse gases – is there a risk of underestimation of reported Swedish emissions from disposal of products and equipment?

Memorandum

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2014-09-15

Contract No: 2250-14-004

Commissioned by the Swedish Environmental Protection Agency

Published at: www.smed.se
Publisher: Swedish Meteorological and Hydrological Institute
Address: SE-601 76 Norrköping, Sweden
Start year: 2006
ISSN: 1653-8102

SMED is short for Swedish Environmental Emissions Data, which is a collaboration between IVL Swedish Environmental Research Institute, SCB Statistics Sweden, SLU Swedish University of Agricultural Sciences, and SMHI Swedish Meteorological and Hydrological Institute. The work co-operation within SMED commenced during 2001 with the long-term aim of acquiring and developing expertise within emission statistics. Through a long-term contract for the Swedish Environmental Protection Agency extending until 2014, SMED is heavily involved in all work related to Sweden's international reporting obligations on emissions to air and water, waste and hazardous substances. A central objective of the SMED collaboration is to develop and operate national emission databases and offer related services to clients such as national, regional and local governmental authorities, air and water quality management districts, as well as industry. For more information visit SMED's website www.smed.se.

Introduction

Sweden submits annual greenhouse gas emission inventories to the EU Monitoring mechanism, the UNFCCC and the Kyoto Protocol. A number of fluorinated greenhouse gases (F-gases) are included in this reporting process. F-gases are used primarily as refrigerants in various types of refrigeration equipment, such as stationary freezers and air conditioning systems in vehicles, but are also used as a propellant in technical and medical aerosols, in the production of XPS foam, in fire extinguishers, in electrical equipment, etc.

During the work with submission 2014 of the Swedish report of greenhouse gas emissions to the UNFCCC there were indications that there was a risk for underestimation of emissions of F-gases from disposal of products/equipment.

At the UNFCCC In-Country Review of submission 2013 it was also prompted that the methods for estimating F-gas emissions from disposal of products/equpiment need clarification in the Swedish National Inventory Report (NIR).

Aim

The aim of the project is to investigate whether there is a need for modifications in the F-gas emission calculations to avoid underestimation of the emissions as well as to improve the description in the NIR concerning the methods used for F-gas emission estimations from disposal of products/equipment.

Issues

The following issues were dealt with within the project:

- Emissions from disposal of products/equipment:
    - Which “end-of-life” factors are presented in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories? Are these factors representative for Swedish conditions?
    - Are F-gases emitted or recycled/destructed at disposal of the products/equipment?
    - For some CRF codes, estimates of emissions from disposal are already included in the Swedish F-gas model. Is it time to include estimates of emissions from disposal of additional products/equipment (eg. fire protection, electrical equipment, sound-proof windows)?
    - Improve the description in the NIR concerning the methods used for F-gas emission estimations from disposal of products/equipment.

Emissions from disposal of products/equipment

Sweden is currently reporting F-gas emissions from disposal of Refrigeration and Air Conditioning Equipment (2.F.1), Foam Blowing Agents (2.F.2), Aerosols (2.F.4) and Sport Shoes (2.G.2). As can be seen in Table 1 emissions from disposal are also expected for Fire Protection (2.F.3), Electrical Equipment (2.G.1) and for Double-glazed sound-proof windows (2.G.2). In submission 2014 no emissions from disposal were reported for these three source categories. As a result of this project, emissions from disposal are to be reported for Fire Protection (2.F.3) and Electrical Equipment (2.G.1) in submission 2015, due to new information from the respective industries.

Table 1. End-of-life factors in the 2006 IPCC Guidelines, the corresponding Swedish factors as well as the first year in which the emissions from disposal should be included in the Swedish inventory.

CRF	Application	Fluorinated substances	2006 IPCC Guidelines	Swedish factors	First year reporting of emissions from disposal
2.F.1	Household fridges and freezers	HFCs	12 ≤ y ≤ 20	20	2011
	Heat pumps	HFCs	10 ≤ y ≤ 20	20 - 15	2010
	Other refrigeration and air conditioning equipment	HFCs PFCs	10 ≤ y ≤ 15 7 ≤ y ≤ 15 15 ≤ y ≤ 30	15	2005
	Refrigerated transport	HFCs	6 ≤ y ≤ 9	10	2003
	Mobile air conditioning, lorries	HFCs	6 ≤ y ≤ 16	6	1999
	Mobile air conditioning, cars	HFCs	6 ≤ y ≤ 16	11	2005
	Mobile air conditioning, buses	HFCs	6 ≤ y ≤ 16	12	2002
2.F.2	Extruded Polystyrene (XPS)	HFCs	50	12	2008
2.F.3	Fire Protection*	HFCs	15 ≤ y ≤ 20	10	2007
2.F.4	Metered dose inhalers	HFCs	1	1	1997
	Technical aerosols	HFCs	1	1	1991
2.G.1	Electrical Equipment*	SF6	35	35	2010
2.G.2	Double-glazed sound-proof windows	SF6	25	30	2020
	Sport shoes	HFCs PFCs	3	8	1998

*indicating to be included in submission 2015

As can be seen in Table 1, the Swedish “end-of-life” factors are in line with the corresponding factors given in the 2006 IPCC Guidelines for all applications except for Extruded Polystyrene (XPS) (2.F.2) and Fire Protection (2.F.3). The Swedish "end-of-life" factors are determined with the help of industry experts and can be considered to reflect Swedish conditions. Thus, inspite of the fact that the Swedish “end-of-life” factors for 2.F.2 and 2.F.3 differ from the corresponding factors given in the 2006 IPCC Guideline, there is no need for revision of the Swedish factors.

Table 2 presents the factors used in the Swedish inventory for estimating emissions at disposal for various F-gas applications.

Table 2. Percentage emitted F-gases at time of disposal in the Swedish inventory.

CRF	Application	Fluorinated substances	% Emitted at disposal
2.F.1	Household fridges and freezers	HFCs	5
	Heat pumps	HFCs	5
	Other refrigeration and air conditioning equipment	HFCs PFCs	5
	Refrigerated transport	HFCs	15
	Mobile air conditioning, lorries	HFCs	15
	Mobile air conditioning, cars	HFCs	15
	Mobile air conditioning, buses	HFCs	15
2.F.2	Extruded Polystyrene (XPS)	HFCs	100 - 62
2.F.3	Fire Protection	HFCs	5
2.F.4	Metered dose inhalers	HFCs	100
	Technical aerosols	HFCs	100
2.G.1	Electrical Equipment	SF6	2
2.G.2	Double-glazed sound-proof windows	SF6	100
	Sport shoes	HFCs PFCs	100

2.F.3, Fire Protection

HFC's in fire protection equipment have been used in Sweden since 1997. In submissions prior to submission 2015 an "end-of-life" factor of 30 years was used. After contact with the industry[i, ii], it has become evident that this "end-of-life" factor is too high. The information from the industry revealed that there are regulated controls of the cylinders in fire protection systems in Sweden. The cylinders have to be controlled by an accredited personel every 10th year. Because of this new information, the "end-of-life" factor should be changed from 30 to 10 years. This means that F-gas emissions from disposal of F-gases in Fire Protection (2.F.3) are to be included in submission 2015 beginning with emission year 2007.

This addition of emissions from disposal of fire protection equipment results in an increase of annual emissions in the range of 1 to 9 Gg CO_2-eq.

2.G.1, Electrical Equipment

The use of SF_6 for insulation purposes in operating power systems started to occur in Sweden in the middle of the 1970s[iii]. The end-of-life factor of 35 years indicates that SF_6 containing equipment are now beginning to be replaced. Therefore the Swedish reporting of SF_6 from Electical Equipment (2.G.1) has to be updated to include also emissions from disposal.

Swedenergy[iii] has estimated the SF_6 content in the operating Swedish power system from 1975 until 1990. Based on this information, estimates of SF_6 emissions from diposal can be made.
Procedures for the handling of SF_6 during installation, commissioning, normal and abnormal operations, disposal at the end-of-life of high-voltage switch gear and control gear are regulated by the International Electrotechnical Commission standard "IEC 62271-4". At disposal the gas is evacuated and most of it is reprocessed and used again; only a minor part is destructed and less than 2% of the gas is emitted[iv, v].
Based on the estimates and emission factors described above, the emissions from disposal can be calculated. Given a lifetime of 35 years and the first installations being in place in 1975, emissions from disposal first occurred in 2010.

By adding emissions from disposal from 2010 and onwards, the yearly emissions in 2.G.1 are increased in the range 4-9 Gg CO_2-eq.

2.G.2, Other, Double-glazed sound-proof windows and Sport Shoes

In Sweden SF_6 started to be used for double-glazed sound proof windows in the beginning of the 1990s[vi]. As the Swedish end-of-life factor is 30 years, no SF_6 emissions from disposal of sound-proof windows are relevant until 2020. With no country-specific information on recovered amounts of SF_6, it is good practice to use the default recovery factor of zero[vii], i.e. all remaining SF_6 in the windows are emitted at disposal.

Clarification on F-gas emission estimations from disposal

Information collected within this study will be used to improve the description concerning the methods used for F-gas emission estimations from disposal of products/equipment in

NIR. E.g. tables such as Table 1 and Table 2 will be included in the NIR of submission 2015.

[i] Stefan Lindström, Exting, pers. com. 2014-05-21, 2014-05-22.
[ii] Mikael Hansson, Kidde, pers. Com. 2014-05-21
[iii] Matz Tapper, Swedenergy, pers com. 2014-05-07, 2014-05-08, 2014-05-16
[iv] Jan-Martin Rhiemeier, Sina Wartmann, Marcello Pagnotta, Natalia Makowska, Xingyu Li. 2010. Update on global SF6 emissions trends from electrical equipment – Edition 1.1. Ecofys Emission Scenario Initiative on Sulphur Hexafluoride for Electric Industry (ESI-SF6). Project No.: PCESDE073349.
[v] Winfried Schwarz, Friedrich Plöger, Johannes Stein. 2006. The new German monitoring system for SF6 in electrical equipment for power transmission and distribution. ZVEI – Zentralverband Electrotechnik und Elektronikindustrie.
[vi] Patrik Johansson, Inwido Produktion AB, pers. com. 2014-04-12
[vii] 2006 IPCC Guidelines for National Greenhouse Gas Inventories (p. 8.31)