Statistics Norway
Statistisk sentralbyrå

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Documents

# Emissions from consumption of HFCs, PFCs and $SF_6$ in Norway

Statistics Norway/Department of Economic Statistics/Environmental Statistics

# Contents

# Executive summary

Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride ($SF_6$) are very potent greenhouse gases. They are stable molecules that can remain in the atmosphere up to 50 000 years ($SF_6$), allowing incoming solar shortwave radiation to reach the Earth's surface while absorbing outgoing longwave radiation.

In 2005, HFCs, PFCs and $SF_6$ accounted for about 3 per cent of the Norwegian greenhouse gas emissions: 2 per cent came from metal production and 1 per cent from use for other purposes. While the emissions from the metal industry were largely reduced in Norway during the 1990s due to improved technology and production routines, emissions from other sources showed an opposite trend. Consequently, several measures have recently been introduced in order to limit the growth in emissions from these other sources, which constitute the IPCC source category 2F: Consumption of Halocarbons and $SF_6$. The report presents new methodology accounting for the effect of these measures

**HFCs and PFCs**

HFCs are widely used in Norway as refrigerants in cooling and freezing equipment for food, in equipment for heating and cooling of buildings and transportation, in fire extinguishers and as blowing agents in the production of foam. PFCs are also used as refrigerants, but at a very small scale. In addition, PFCs are created during production of aluminium, but this emission source was not considered in this study.

The use of HFCs was very limited before 1990, but has since increased rapidly as they are used as substitutes for CFCs and HCFCs, chemicals being phased out under the Montreal protocol. The imports reached a peak of about 1.5 million tonnes $CO_2$-equivalents in 2002, the year before a tax of 183[1] NOK (approx. 22 Euro) per tonne $CO_2$-equivalent was introduced on imported chemicals. Parts of the chemicals imported prior to the tax were used the subsequent years.

The introduction of tax seems to have decelerated the yearly growth rate of imports by inducing a change in technology towards equipment using less chemical per unit, and by augmenting the use of alternative refrigerants like ammonia and $CO_2$. These changes are mainly occurring in medium sized equipment, such as air conditioning and refrigeration/freezing installations in supermarkets, hotels, restaurants, etc.. The price increase of chemicals has made changing technology good economy.

The blue bars in Figure ES 1 show the imports of HFCs and PFCs to Norway from 1990 to 2005. Yellow bars show the estimated additional amount of imported chemicals if no import tax had been introduced in 2003 (business as usual).

By importing equipment containing HFCs and PFCs, and by importing these chemicals in bulk for use in such equipment, we are increasing the stock of these chemicals in Norway year by year. A bank of substances is being built up. The size of this bank is currently estimated to be more than 6.5 million tonnes of $CO_2$-equivalents, or of about 4 500 metric tonnes of chemicals. Almost 3 000 metric tonnes of this is HFC-134a. The rest of the bank is mainly HFC-152a[2], HFC-125 and HFC-143a. About 70 per cent of the chemicals are stored in equipment related to refrigeration and air conditioning. Figure ES 2 gives an overview of the composition of the bank (species of chemicals and emission sources).

[1] The tax is adjusted yearly and is currently about 194 NOK per tonne $CO_2$-equivalent.

[2] HFC-152a is mainly used in production of foam. The bank size of HFC-152a might be overestimated as new knowledge indicates rapid diffusion of the chemical out of the foam.

**Figure ES 1 Actual imports and imports "business as usual" of HFCs and PFCs. 1990-2005. Million tonnes $CO_2$-equivalents**

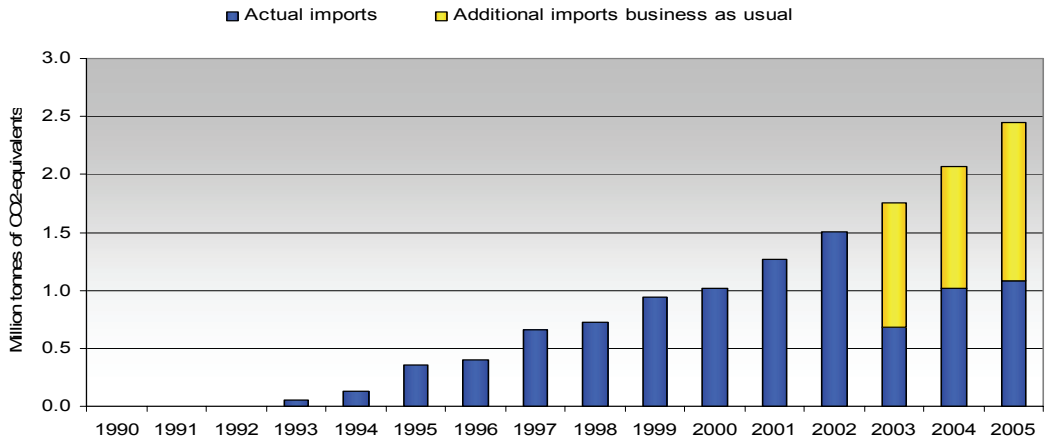



**Figure ES 2 Composition of bank 2005. Species of chemicals and applications. Percentages of 4 500 tonnes**

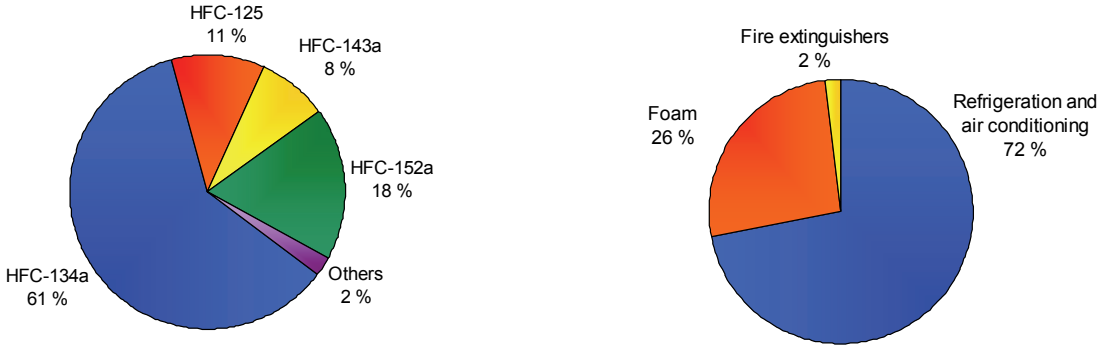
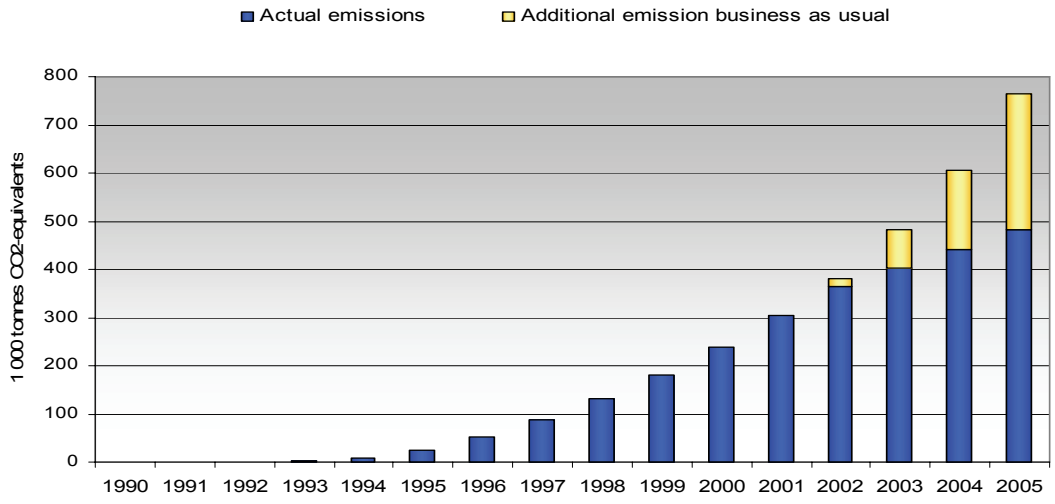



**Figure ES 3 Actual emissions (Tier 2) and emissions "business as usual" of HFCs and PFCs[1]. 1990-2005. 1 000 tonnes CO2-equivalents**




[1] Not including emissions from metal production

All of the 6.5 million tonnes of $CO_2$-equivalents currently stored in equipment will eventually end up in the atmosphere unless they are collected and destructed. Collection and destruction of HFCs and PFCs from used equipment started around the year 2000, and in 2004 a refund of 183[3] NOK (approx. 22 Euro) per tonne $CO_2$-equivalent was introduced in order to further encourage this practice. A total of 33 000 tonnes $CO_2$-equivalents has been removed from the bank and burnt in the period 2000-2005. In 2006, an additional 20 000 tonnes $CO_2$-equivalents were destructed.

Roughly 10 per cent of the HFCs and PFCs in use in Norway are released every year. In 2005 almost 0.5 million tonnes of $CO_2$-equivalents were released into the atmosphere, amounting to almost 1 per cent of the total emission of greenhouse gases in Norway. Figure ES 3 shows the annual emissions of HFCs and PFCs from 1990 to 2005 in blue bars. The yellow bars show the estimated additional amount of chemicals that would have been emitted if no import tax had been introduced in 2003, assuming the development of the bank would follow the same trend as before 2002. The peak in imports of chemicals in 2002 is not reflected in the emission estimates because the build up of stock is corrected for in the calculations, in order to mirror the actual use of chemicals each year. The tax seems to have resulted in a flattened growth rate of the emissions.

An important part of the study described in this report, was the exploration and evaluation of data from the Norwegian Directorate of Custom and Exice (TAD). They administer the tax on imports of HFCs and PFCs. This study concluded that information from TAD can be used to update data on imports of HFCs and PFCs in refrigeration and air conditioning equipment, but that further work is needed before the data on bulk imports can be applied in the model for estimating emissions.

**$SF_6$**

In Norway, $SF_6$ was until 2006 mainly used in metal production, which is not covered by this report. $SF_6$ was added as a covering gas, unlike the PFCs that are unwanted by-products from metal production. The major use of $SF_6$ covered here is in high voltage switchgear and circuit breakers (GIS). Other products include several other types of electrical equipment, sound-insulated windows and shoes. $SF_6$ is also used as a tracer gas in semiconductor manufacturing, eye surgery, and other areas.

A large base of $SF_6$-insulated electrical equipment was installed during the 1980s. New capacity is still installed, but at a lower rate. The bank is currently around 320 tonnes. Emissions increased in proportion to the installed base until around 2000. However, not all emissions are from the installed base. Production of electrical equipment is also a major source. In addition, emissions from use as a tracer gas were significant from 1997 to 2001, due to a major research project.

Leakage rates from the bank are lower for $SF_6$ than for the HFCs. Up until around 2000, about 1 per cent was emitted yearly from the larger, closed pressure systems. Smaller, sealed pressure systems have lower leakage rates.

A voluntary agreement was signed between the Ministry of Environment and the most important users and producers of $SF_6$-insulated electrical equipment in March 2002. According to this agreement emissions from this sector should be reduced by 13 per cent in 2005 and 30 per cent in 2010, using 2000 as base year. The increased focus on emissions has led to less leakage during both production and use. Emissions from electrical equipment were almost halved from 2000 to 2005.

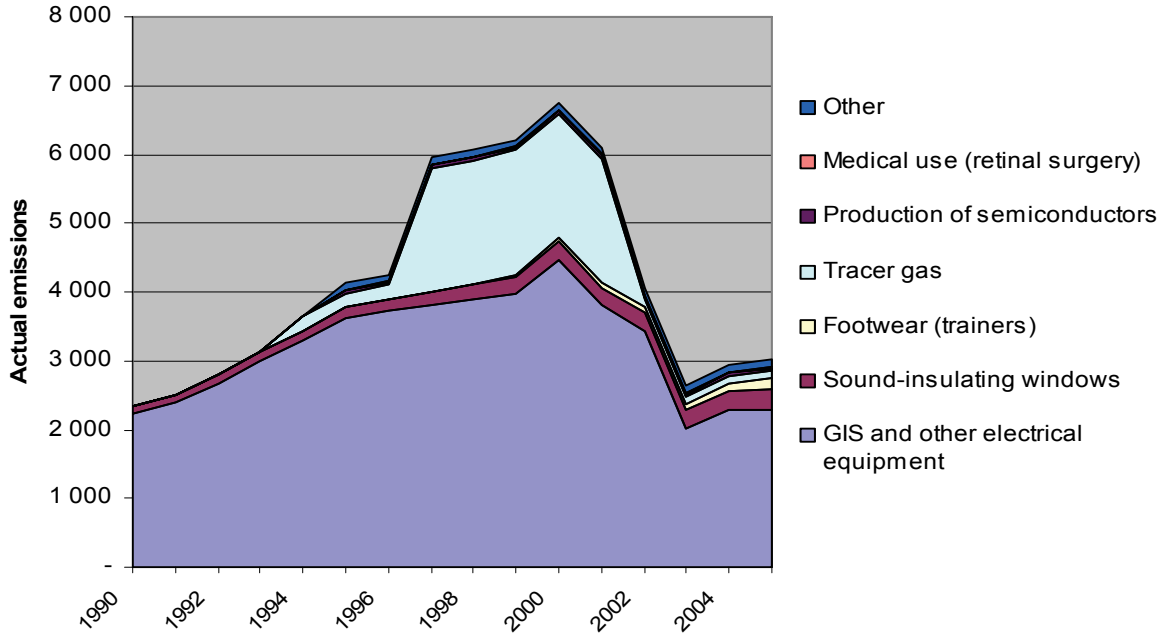
Figure 4 shows the annual emissions of $SF_6$ by source from 1990 to 2005.

**Acknowledgements**

The work related to $SF_6$ was performed by Ketil Flugsrud in Statistics Norway.

[3] The refund is adjusted yearly and is currently about 194 NOK per tonne $CO_2$-equivalent.

**Figure ES 4 Actual emissions[2] of $SF_6$. 1990-2005. Kg**




[2] Not including emissions from metal production

# 1 Introduction

Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride ($SF_6$) are synthetic chemicals with properties that make them suitable for many industrial processes and use in various kinds of equipment: They are chemically and thermally stable molecules with low flammability, they are not very corrosive, explosive, or poisonous. In Norway they are widely used in metal production, electrical equipment, sound-insulated windows, as refrigerants in cooling and freezing equipment for food and beverages, in equipment for temperature regulation in buildings and transportation, in fire extinguishers, and as blowing agent in production of foam.

Unfortunately, the chemical properties that make HFCs, PFCs and $SF_6$ extremely useful also make them very potent greenhouse gases. They are stable molecules that can maintain in the atmosphere up to 50 000 years ($SF_6$), allowing incoming solar shortwave radiation to reach the Earth's surface, while absorbing outgoing longwave radiation. The climatic impact of one tonne of $SF_6$ is almost 24 000 times higher than one tonne of $CO_2$. Table 1 lists the most common chemicals and their Global Warming Potential (GWP) values.

Roughly two thirds of the Norwegian emissions of HFCs, PFCs and $SF_6$ come from metal production. $SF_6$ is used as a covering gas in production of magnesium, and PFCs are by-products created during production of aluminium. These sources are not covered by this report and only briefly described below.

## 1.1. Background

HFCs, PFCs and $SF_6$ accounted for about 3 per cent of Norway's greenhouse gas emissions in 2005, measured in $CO_2$-equivalents: 2 per cent came from metal production and 1 per cent from other emission sources. While emissions of PFCs and $SF_6$ from the metal industry were largely reduced in Norway during the 1990s due to improved technology and production routines, emissions from other sources showed an opposite trend. The imports of HFCs and PFCs for use as refrigerant, in fire extinguishers and for foam blowing, started around 1990 and increased every year until it reached a peak of more than 1.5 million tonnes $CO_2$-equivalents in 2002. $SF_6$ has been increasingly used as insulation in high-voltage switchgear. The main build-up of $SF_6$-containing equipment was in the 1980s, due to major hydropower construction.

In order to decelerate the growth of the Norwegian emissions from product use, several measures have been taken by the authorities during the last few years:

- ✓ A voluntary agreement was signed between the Ministry of Environment and the most important users and producers of $SF_6$-insulated electrical equipment in March 2002. According to this agreement emissions from this sector should be reduced by 13 per cent in 2005 and 30 per cent in 2010, using 2000 as base year.

- ✓ Tax on import and production of HFC and PFC was introduced in January 2003. The tax was 183 NOK per tonnes of $CO_2$-equivalents in 2003, and is currently about 194 NOK.

- ✓ A refund for the destruction of used chemical was introduced in July 2004. The refund was 183 NOK per tonnes of $CO_2$-equivalents in 2004, and is currently about 194 NOK.

This report describes the results from a study carried out with financial support from The Norwegian Pollution Control Authoritiy (SFT). The main objectives of this study were to explore new data

sources, update and document the methodology for estimating Norwegian emissions of HFCs, PFCs[4] and $SF_6$, recalculate emissions for the years 1990 to2005 and explore the effects of the measures taken by the authorities.

**Table 1 The GWP values (100 years) of SF6 and common HFCs and PFCs**

| Chemical | | GWP |
|---|---|---|
| $SF_6$ | Sulphur hexafluoride | 23 900 |
| HFC-23 | $CHF_3$ | 11 700 |
| HFC-32 | $CH_2F_2$ | 650 |
| HFC-125 | $C_2HF_5$ | 2 800 |
| HFC-134 | $C_2H_2F_4$ | 1 000 |
| HFC-134a | $CH_2FCF_3$ | 1 300 |
| HFC-143 | $C_2H_3F_3$ | 300 |
| HFC-143a | $C_2H_3F_3$ | 3 800 |
| HFC-152a | $C_2H_4F_2$ | 140 |
| HFC-227ea | $C_3HF_7$ | 2 900 |
| PFC-218 (Perfluoropropane) | $C_3F_8$ | 7 000 |

## 1.2. Structure of this report

This report is divided in four main parts. This chapter, introducing the project and report, is followed by a chapter giving a description of the updated methodologies used for estimating emissions of HFC, PFC and $SF_6$. Chapter 2 also presents the results from the calculations and the effects of the measures taken by the authorities to reduce the emissions. Chapter 3 accounts for the work performed in order to update the activity data for calculating the HFC and PFC emissions. The last part of the report consists of references and appendices with tables and additional information.

## 1.3. Abbreviations

AFS Tollvesenets avgiftsfastsettelsessystem: A system for managing tax used by the Norwegian Directorate of Customs and Excise

HS8 National classification system for goods: An eight digit code according to the Harmonized System developed by World Customs Organization

GIS Gas insulated switchgear (containing $SF_6$)

GWP The global warming potential is the ratio of the time-integrated radiative forcing from a pulse emission of 1 kg of a substance, relative to that of 1 kg of carbon dioxide, over a fixed horizon period (100 years)

SAD Single administration document for declaration of imported and exported goods

SFT Statens forurensningstilsyn: The Norwegian Pollution Control Authority

SSB Statistisk sentralbyrå: Statistics Norway

TAD Toll- og avgiftsdirektoratet: The Norwegian Directorate of Customs and Excise

TVINN Tollvesenets informasjonssystem med næringslivet: The electronic declaration system used by the Norwegian Directorate of Customs and Excise

[4] Not including the emissions of PFCs from production of aluminium.

# 2 Methodology and results

This chapter gives a description of the methodology used for estimating emissions of HFC, PFC and $SF_6$, and the results from the calculations.

## 2.1 HFC and PFC: Methodology for estimating emissions

The Norwegian emissions of HFCs and PFCs are calculated yearly by Statistics Norway. The species currently included in the calculations are HFC-23, HFC-32, HFC-125, HFC-134, HFC-134a, HFC-143, HFC-143a, HFC-152a, HFC-227ea and PFC-218. Both potential and actual emissions are estimated.

The potential emissions are equal to the net influx of chemicals to Norway each year: imports minus exports and destruction. This way of calculating emissions is referred to as a Tier 1 methodology in the Revised 1996 IPCC Guidelines. There is no production of these substances in Norway.

The Tier 2 methodology, or actual emissions, takes into account the time lag in emissions from long-lived sources, such as refrigerators and air-conditioning equipment. A household refrigerator imported to Norway will normally contain around 140 grams of HFCs. Part of this will slowly leak out from seams and ruptures during the lifetime of the refrigerator. Studies indicate that about 1 per cent of the refrigerant will leak out every year. This leakage rate, or emission factor, varies considerably depending on type of equipment.

By importing equipment containing HFCs and PFCs, we are increasing the amounts of such chemicals in Norway year by year. A bank of these substances is built up. This means that even if the imports of chemicals are stopped, emissions will continue until the bank is empty.

In the Tier 2 methodology, data on imports and exports of the substances are combined with emission factors, in order to acquire emission estimates for each chemical and source category. Calculations are done in the following order (Haukås et al. 1999):

1. A bank of HFCs and PFCs is established based on activities the previous years
2. Imported amounts of HFCs and PFCs by type of product are added to the bank
3. Emissions of each individual HFC and PFC are calculated according to bank sizes and corresponding emission factors for different kinds of equipment
4. Imported amounts of HFCs and PFCs in bulk are divided between
    a. recharging of existing systems according to emissions calculated in point 3 above
    b. charging of new systems manufactured in Norway, of which a small percentage is emitted during production/installation
5. A number of systems are taken out of service having reached their technical lifetime

Emissions from manufacturing, stock and disposal are calculated for each category, both in $CO_2$-equivalents and in metric tonnes for each chemical. Further details and model assumptions are described in Haukås et al. 1999.

The main categories are the following (i.e. source categories with individual emission factors and activity data in the Norwegian model):

- Household refrigerators and freezers
- Commercial and industrial applications (excl. refrigerated transport), imports
- Refrigerated transport, imports
- Air conditioning (stationary) aggregates and heat pumps, imports

- Water/liquid refrigerating aggregates, water-based heat pumps, imports
- Stationary equipment produced in Norway
- Mobile air conditioning
- Foam - polyurethane (PUR) without diffusion barrier
- Foam - polyurethane (PUR) with diffusion barrier
- Foam - extruded polystyrene (XPS)
- Fire extinguishers
- Solvents
- Areosol propellants

### 2.1.1 Activity data

There is no production of HFC or PFC in Norway. Hence all emissions of these chemicals are originating from imported chemicals. The methodology requires that annual imported amounts of each chemical are obtained by source category. The way this is done is described below.

*Chemicals imported in bulk*

a. Whole time series (1990-2005): Imported amounts of chemicals in bulk are collected by SFT and reported to SSB every year. SFT collects this information by sending out paper forms to all known bulk importers. Importers report amounts of chemicals used by main source categories (refrigeration and air conditioning, foam, fire extinguishing, solvents or aerosols).

b. Time series 1995-1997: Amounts of chemicals imported in bulk destined for goods manufactured in Norway for the years 1995 to 1997 were collected in a survey (Haukås et al. 1999).

c. Time series 1990-1994 and 1998-2005: The information from the survey (b) was used to estimate amounts of chemicals used in goods manufactured in Norway for the years previous to and after the survey, assuming there was no manufacturing in 1990.

*Chemicals imported in products*

d. Time series 1995-1997: Information on imported amounts of chemicals in products for the years 1995 to 1997 was collected in a survey (Haukås et al. 1999).

e. Time series 1990-1994 and 1998-2005: The information from the survey was used to estimate imports the years previous to and after the survey, assuming there were no imports in 1990. For the source category refrigeration, data on imports from customs statistics were used to update the estimated amounts for 1998-2005.

Export data is obtained in the same manner as import data: Exports of chemicals in bulk are collected by SFT and reported to SSB, and export data on chemicals in products have been obtained by projecting the figures collected in the survey in 1999.

The part of the model accounting for recycling and destruction of chemicals has not yet been in use. Because only small amounts are currently being destructed, this does not have a significant impact on the estimated emissions.

### 2.1.2. Emission factors and lifetime of products

Table 2 shows the emission factors and lifetime of products used in the calculations (Haukås et al. 1999 and Revised 1996 IPCC Guidelines).

**Table 2 Emission factors and lifetime of products**

| Application category | Annual emission during lifetime (per cent of initial charge) 1990-2004 | Lifetime of products (years) |
|---|---|---|
| Refrigeration and air conditioning | | |
| Household refrigerators and freezers | 1 | 15 |
| Commercial and industrial applications, imported | 3.5 | 15 |
| Refrigerated transport, imported | 20 | 15 |
| Air conditioning aggregates and heat pumps, imported | 4 | 15 |
| Water/liquid refrigerating aggregates, water-based heat pumps, imported | 5 | 15 |
| Stationary equipment produced in Norway | 10 | 15 |
| Mobile air conditioners | 10 | 12 |
| Foam | | |
| Polyurethane with diffusion barrier | 1 | 40 |
| Polyurethane without diffusion barrier | 5 | 20 |
| Extruded polystyrene | 3 | 30 |
| Fire extinguishers | 5 | 15 |
| Solvents | 50 | 2 |
| Aerosol propellants | 50 | 2 |

## 2.2. HFCs and PFCs results: Development of bank and emissions

The model for estimating the Norwegian emissions starts in the year 1990, with small amounts of HFC-152a imported in bulk for use as refrigerant. The imports of chemicals both as bulk and in equipment increased every year until reaching a peak in 2002. During the peak year of 2002, more than 400 metric tonnes of chemicals were imported in bulk, and about the same amount was imported stored in equipment. The imports of chemicals in bulk in 2002 were higher than normal because of the introduction of a tax in January 2003. The tax was 183 NOK per tonne $CO_2$-equivalent.

### 2.2.1. Bank and emissions

Currently, there is around 4 500 metric tonnes of chemicals (more than 6.5 million tonnes $CO_2$-equivalents) stored in various kinds of equipment in Norway (Table 3). Almost 3 000 metric tonnes of this is HFC-134a. The rest of the bank is mainly HFC-152a[5], HFC-125 and HFC-143a. Figure 1 shows the composition of the bank, both by species of chemical and by equipment. Appendix 1 contains tables with the amount of species of chemicals stored in each category, for the years 1990, 1995, 2000 and 2005.

About 70 per cent of the chemicals in the bank are stored in equipment related to refrigeration and air conditioning. In a study from 2003 (Haukås 2003) a bank size of about 2 350 metric tonnes is estimated for refrigeration and air conditioning. This agrees with the bank size calculated by the model used in this study, which was 2 123 metric tonnes in 2003. Haukås estimated that about 1 450 metric tonnes of this were HFCs with low GWP values (< 2 000), and 900 metric tonnes were HFCs with high GWP values (> 2 000). The figures from this study are 1 329 metric tonnes of low GWP HFCs, and 794 metric tonnes of high GWP HFCs.

Unless the chemicals are collected and destructed (burnt) or removed in some way, all of the 6.5 million tonnes of $CO_2$-equivalents stored in the bank will eventually end up in the atmosphere.

[5] HFC-152a is mainly used in production of foam. The bank size of HFC-152a might be overestimated as new knowledge indicates rapid diffusion of the chemical out of the foam.

Roughly 10 per cent of the bank is being released every year, and in 2005 almost 0.5 million tonnes $CO_2$-equivalents were released into the atmosphere (Table 4). This was about 1 per cent of the total emission of greenhouse gases in Norway. Appendix 2 contains tables with annual sector specific emissions, per chemical and totals. The differences in pattern between bank and emissions are due to the emission factors.

**Table 3 Bank of HFCs and PFCs. Total and main categories. 1 000 tonnes CO2-equivalents**

| | 1990 | 1995 | 2000 | 2005 |
|---|---|---|---|---|
| **Total** | **< 1** | **498** | **3 380** | **6 767** |
| Refrigeration and air conditioning | < 1 | 451 | 2 812 | 4 876 |
| Foam | - | 47 | 482 | 1 756 |
| Fire extinguishers | - | < 1 | 86 | 135 |

**Figure 1 Composition of bank 2005. Species of chemicals and application areas. Total bank size 4 662 tonnes**

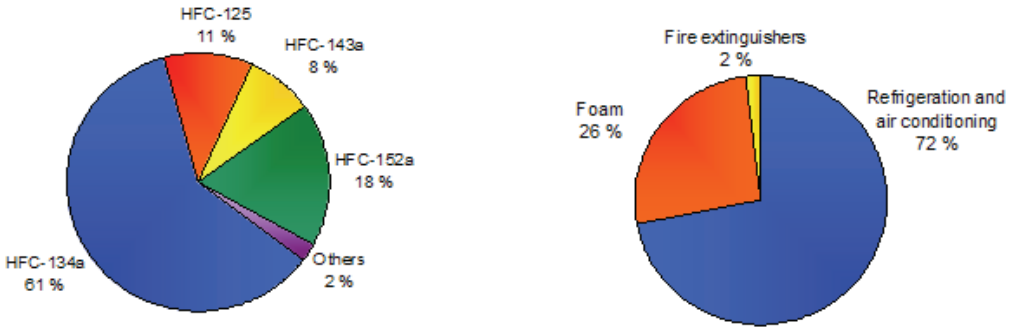



**Table 4 Emissions of HFCs and PFCs. Total and main categories. 1 000 tonnes $CO_2$-equivalents**

| | 1990 | 1995 | 2000 | 2005 |
|---|---|---|---|---|
| **Total** | **< 1** | **26** | **238** | **484** |
| Refrigeration and air conditioning | < 1 | 26 | 225 | 441 |
| Foam | - | < 1 | 9 | 36 |
| Fire extinguishers | - | - | 4 | 7 |

### 2.2.2. Effects of tax introduction and future emissions

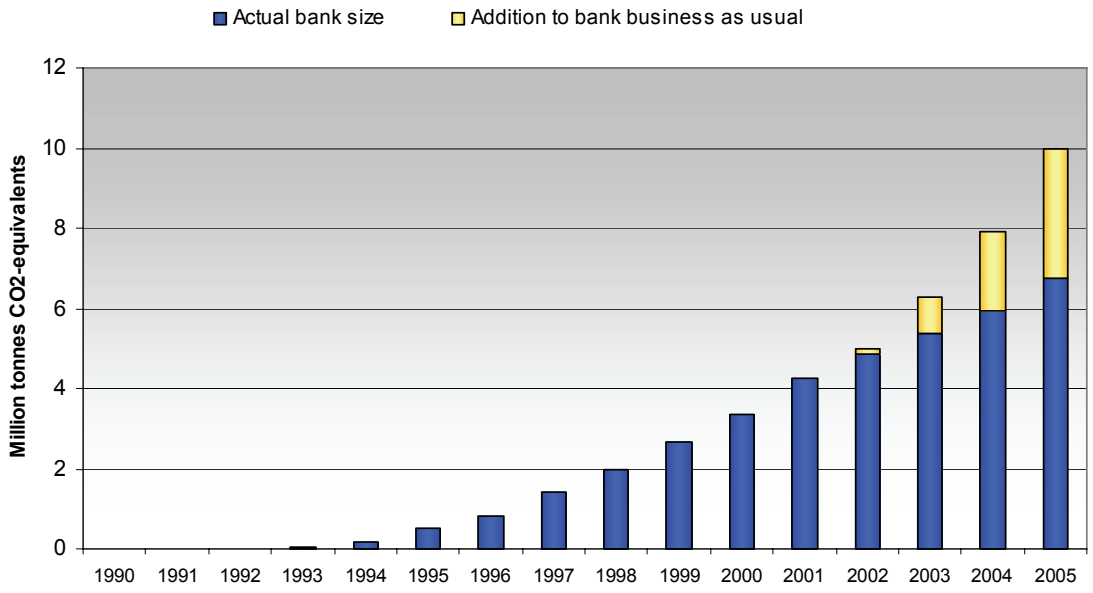
As described in the first chapter of this report, two measures have been taken by the authorities the last few years:

- ✓ Tax on import and production[6] of HFC and PFC was introduced in January 2003. The tax was 183 NOK per tonnes of $CO_2$-equivalents in 2003, and is currently about 194 NOK.
- ✓ A refund for the destruction of used chemical was introduced in July 2004[7]. The refund was 183 NOK per tonnes of $CO_2$-equivalents in 2003, and is currently about 194 NOK.

The bank of HFCs and PFCs was increasing annually with about 26 per cent in the years 2000 and 2001. This means that the amount of chemicals stored in equipment in Norway increased with almost 700 000 $CO_2$-equvialents from 1999 to 2000, and with almost 900 000 tonnes $CO_2$-equivalents from 2000 to 2001. The reason for this was the continuing annual increase in imported amounts of chemicals.

After the introduction of taxes on imports of HFCs and PFCs in 2003, the growth rate was halved. The average growth over the years 2002[8] to 2005 was around 12 per cent. Assuming the growth rate stayed at 26 per cent after 2001, the bank of chemicals would have reached almost 10 million $CO_2$-equivalents by 2005. This is about 3.5 million tonnes $CO_2$-equivalents more then the current bank size.

**Figure 2 Actual bank size and the additional amounts of chemicals given "business as usual". Million tonnes $CO_2$-equivalents**




The growing bank of chemicals in Norway from 1990-2005 is shown in blue bars in Figure 2. The yellow bars illustrate the effect of tax introduction by representing the additional amount of chemicals

[6] There is no production of HFCs and PFCs in Norway.

[7] Small amounts of chemicals were collected and destructed even before 2004.

[8] The figures on imports of chemicals in bulk used in the model are averages of the four years 2002-2005.

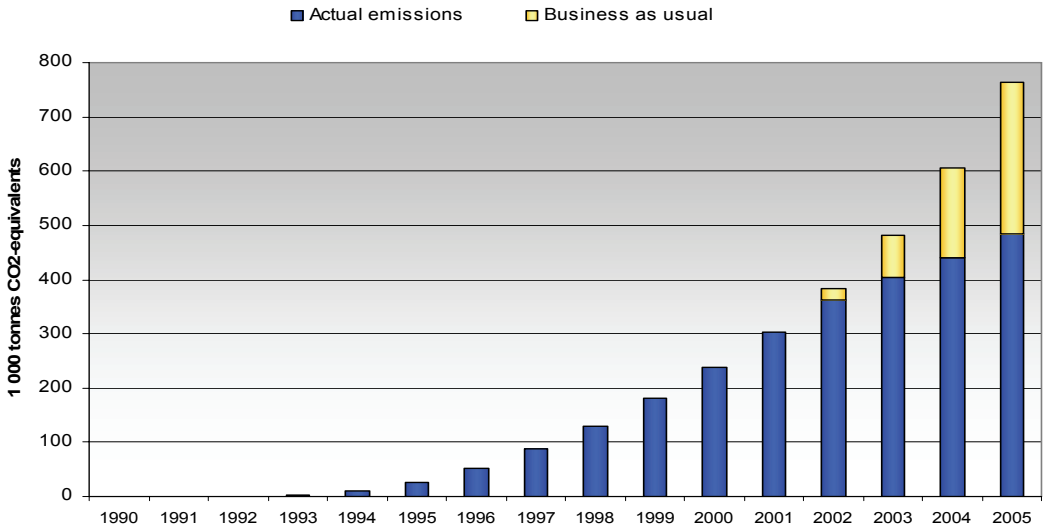
in the bank given a continued growth rate of 26 per cent if no tax was introduced. The figures are given in appendix 3.

According to experts, the taxes have induced both a change of technology towards equipment using less refrigerant per unit, and a change toward using alternative refrigerants like ammonia and $CO_2$. The taxes made changing technology to systems using less HFC good economy. In equipment used for air conditioning and refrigeration, there has been a shift from direct cooling systems, to indirect cooling systems. The indirect cooling does not use HFCs in the whole system, as the direct does, but only in a small central cooling unit. The temperature transfer in the rest of the system is achieved using for instance glycol. This has substantially lowered the amount of HFC needed in the systems (Haukås pers. comm. 2006). These changes in technology are reflected in the figures of imports of chemicals in bulk.

The effect of refund is not shown in the figures because the amount of collected chemical is still small, compared to the size of the bank. About 33 000 tonnes $CO_2$-equvalents have been removed from the bank and destructed (burnt) the last few years. In 2006, an additional 20 000 tonnes $CO_2$-equvalents were removed. This is small share of the total bank size, but it is a substantial share (roughly 70 per cent) of what was available for destruction (Haukås 2003).

Figure 3 shows the annual actual emissions from 1990-2005 (Tier 2) in blue bars. 483 000 tonnes of $CO_2$-equvalents were released from the Norwegian bank in 2005. The yellow bars show the additional amount of chemicals that would have been emitted, assuming the bank would develop as described above and an annual emission percentage of 7.12 for the years 2002 to 2005 (average of 2000 and 20001). The figures are given in appendix 3.

**Figure 3 Actual emissions and emissions given "business as usual" of HFCs and PFCs. 1990-2005. 1 000 tonnes $CO_2$-equivalents**




Information given by the industry does not indicate a reduction in future emissions. It is expected that small emission sources, like the use of HFCs in domestic refrigeration and of HFC-152a in foam, will disappear. This does however, not have a large impact on the total emission. A continued growth in the use of refrigerants in mobile air conditioning and heat pumps is expected. These are individually small sources, but the high number of units makes them important sources of future emissions.

The amount of HFCs and PFCs collected and destructed in the year 2010 is estimated by SRG to be about 26 metric tonnes. The amount available for destruction is however expected to increase to more than 200 metric tonnes (from refrigeration and air conditioning) in 2015 (Haukås 2003).

## 2.3. $SF_6$: Methodology for estimating emissions

The Norwegian emissions of $SF_6$ are calculated yearly by Statistics Norway. The methodology for $SF_6$ from product use (IPCC source category 2F) is described in this chapter. Metal production was the largest source of $SF_6$ emissions in Norway until the plants were closed in 2006. These emissions are included in IPCC source 2.C (metal production) and are not included in this study.

### 2.3.1. Electrical equipment

Today's method for electrical equipment is largely in accordance with the Tier 3a methodology in the IPPC Good Practice Guidance (IPCC 2000). As a part of the agreement between the major $SF_6$ users and the government, the users have reported annually to the government since 2003. The user group includes almost all major hydropower companies and major electricity distribution companies. Their reports cover installed capacity and changes in capacity, as well as emissions and other changes in the $SF_6$ stock. Emissions are estimated as the amount of $SF_6$ used for recharging. The emissions will include both continuous leakage, handling losses and accidents.

The reports from the user group cover most of the *high voltage switchgear and circuit breakers* (GIS; equipment for 72.5 kV and above[9]). These are medium to big, closed pressure systems. The installed capacity in the user group companies was 202 tonnes $SF_6$ in 2005. In addition, non-members have a few installations with an estimated capacity of 2 tonnes.

The installed capacity before 2003 is slightly revised since the previous methodology (SFT 1999). In this earlier analysis, the bank was estimated to be 100 tonnes $SF_6$ in 1985 and 206 tonnes in 1998, with estimates of further growth. However, the new reporting indicates that the 1998 value was too high. Thus, the time series for the bank from the study by SFT (1999) was scaled down, so that the 1985 value was maintained while the 2002 estimate was equal to the reported value (including non-members).

New systems may have emission rates in the order of 0.5 per cent or lower, and the reported emissions since 2003 have been 0.3-0.4 per cent. However, we assume an emission rate of 1 per cent for the years until 2003 and for installations that are not covered by reports from the user group.

*Medium voltage switchgear* (36 kV and below) is mainly used in distribution companies. These installations are relatively small, sealed pressure systems. The installed capacity was estimated to be 60 tonnes in 2000 (SINTEF 2000). The $SF_6$ user group estimates that around half of this capacity is with their members and the rest with non-members. The reports from the user group do not exclude the possibility that some of these systems are included in their data. However, we have conservatively assumed that all these systems are in addition to the bank and emissions reported from the user group.

As for the larger GIS systems, we have adjusted the time series for the bank from SFT (1999) slightly downward, in order to arrive at the 2000 value from SINTEF (2000). For the years after 2000, it is assumed that equipment with 4.5 tonnes $SF_6$ were installed yearly.

The sealed pressure systems have lower emission rates than the larger GIS systems. A revised emission factor of 0.1 per cent has been used throughout the period (Ecofys 2005). In previous analyses, a 0.2 percent leakage rate was assumed for the systems.

[9] GIS (Gas insulated switchgear) as defined here includes both switchgear for >145 kV and circuit breakers for >72.5 kV, as defined in SFT(1999).

Emissions from production of electrical equipment are now reported. The Norwegian producer has, as part of the voluntary agreement with the Ministry of the Environment, made detailed emission estimates back to 1985. These emissions constitute a significant part of national emissions of $SF_6$. In recent years emissions rates have been considerably reduced due to new investments and better routines. The company now performs detailed emission calculations based on accounting of the $SF_6$ use throughout the whole production chain.

A small amount of $SF_6$ is used in measurement transformers. Installed capacity was estimated to be 1 tonne in 2005, based on the method in SFT (1999).

The lifetime for medium voltage switchgear and transformators is assumed to be 30 years. No equipment is yet assumed to be retired. Decommissioning of larger GIS systems is covered by reports from the user group.

### 2.3.2. Other use of $SF_6$

$SF_6$ is used for a variety of other purposes. Emissions from these sources are estimated with the tier 2 methodology of SFT (1999). Activity data were collected from direct consultations with importers and exporters of bulk chemicals and products containing $SF_6$, and from companies that use $SF_6$ in various processes. Leakage rates and product lifetimes used in the calculations are shown in tables 5 and 6.Table 1

**Table 5 Yearly rate of leakage of SF6 from different processes**

| Process emission source | Leakage rate (per cent of input of $SF_6$) |
|---|---|
| Secondary magnesium foundries | 100 |
| Tracer gas in the offshore sector | 0 |
| Tracer gas in scientific experiments | 100 |
| Production of semiconductors | 50 |
| Medical use (retinal surgery) | 100 |
| Production of sound-insulating windows | 2 |
| Other minor sources | 100 |

Source: SFT (1999).

**Table 6 Product lifetimes and leakage rates from products containing SF6**

| Product emission source | Yearly rate of leakage (per cent) | Product lifetime (years) |
|---|---|---|
| Gas-insulated switchgear (GIS) | 1 | 30 |
| Sealed medium voltage switchgear | 0.1 | 30 |
| Electrical transformers for measurements | 1 | 30 |
| Sound-insulating windows | 1 | 30 |
| Footwear (trainers) | 25 | 9 |
| Other minor sources | .. | .. |

Source: SFT (1999).

No use of $SF_6$ from fire extinguishers or car tyres have been reported from Norway.

### 2.3.3. Potential emissions

Potential emissions (tier 1) are calculated for all sources, based on the data used in the more advanced tiers. For $SF_6$ use in processes where no gas is retained in the product, potential emissions equal consumption. For $SF_6$ use in products with a lifetime, potential emissions equal the sum of charge in

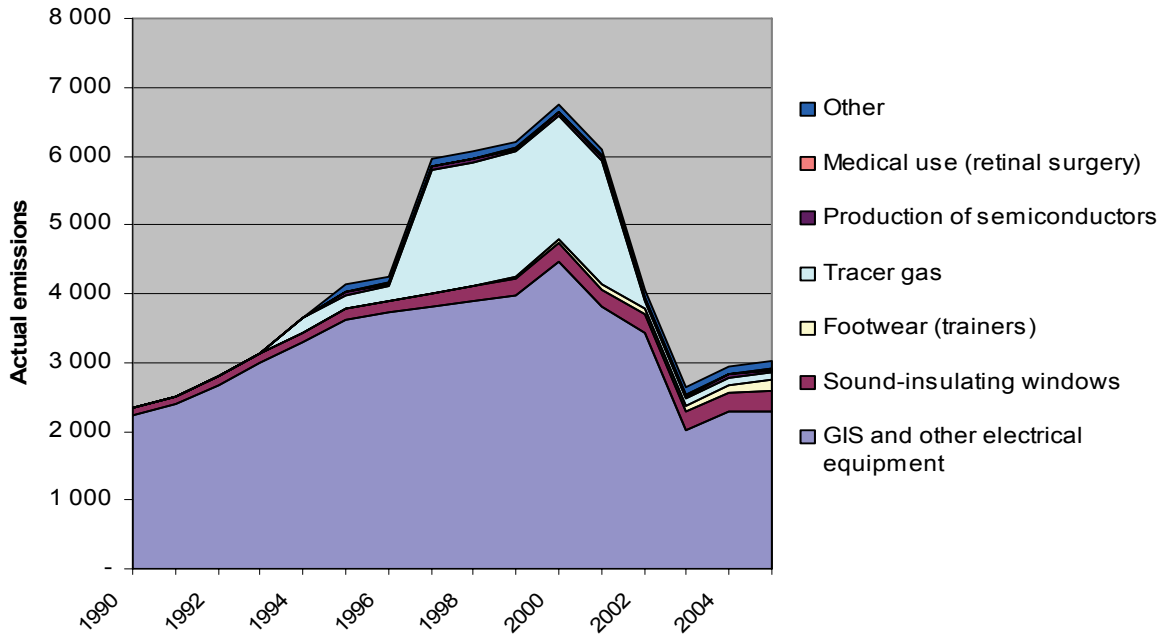
new products and recharging of leakage from existing products. There is currently no calibration with respect to total $SF_6$ import.

## 2.4. $SF_6$ results: Development of bank and emissions

The actual emissions of $SF_6$ have varied considerably since 1990 (Figure 4). A steady increase in emissions from electrical equipment until 2000 was followed by a sharp drop. The subsequent shift in the emission trend may be due to a methodological change, as the new reporting practice was introduced in 2003. According to the industry, there was a significant improvement in the handling of $SF_6$ in this last period.

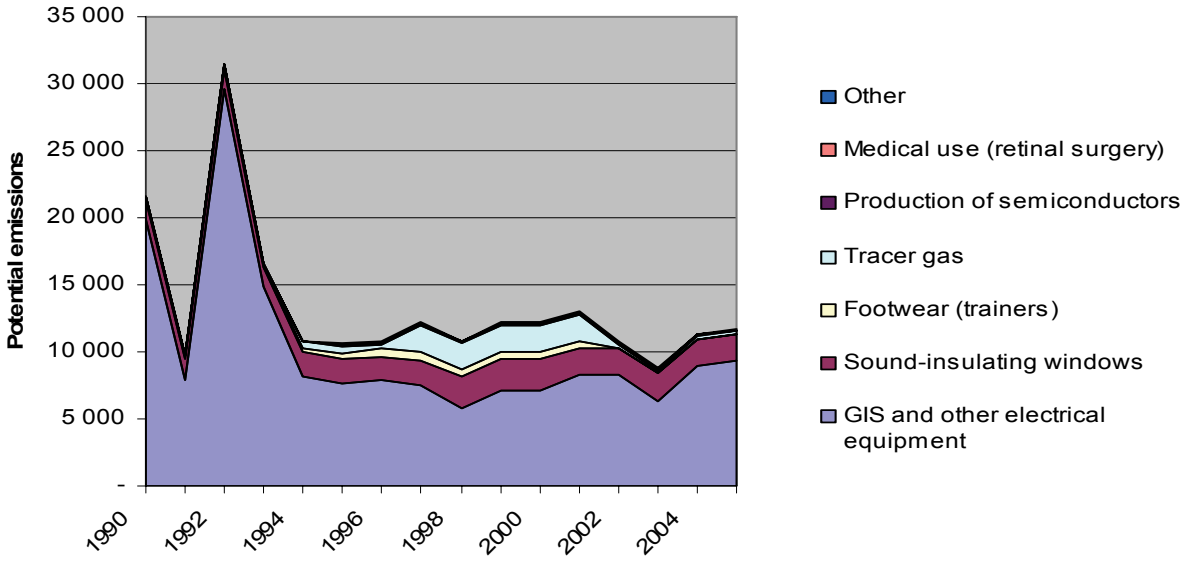
The large emissions from tracer gas in 1997-2001 are due to a major research project. The other sources give only small contributions to the total emission of $SF_6$.

**Figure 4 Actual emissions of SF6. 1990-2005. Kg**



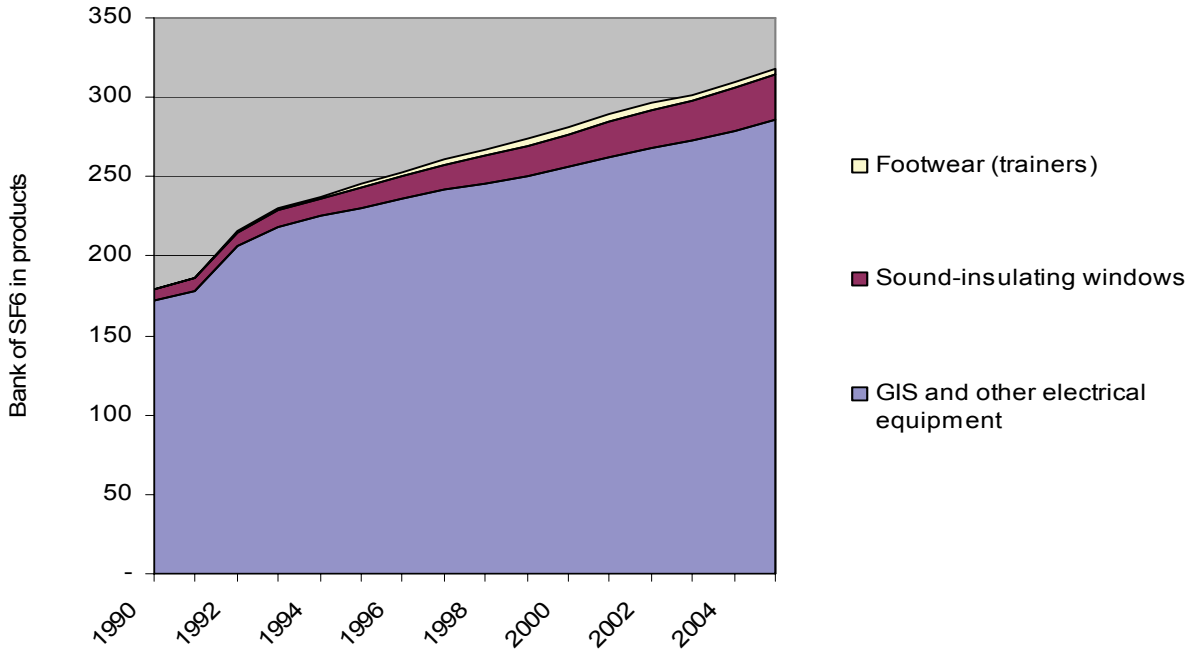

The potential emissions show a very different trend (Figure 5). As for the actual emissions, electrical equipment is the major source. However, the largest emissions appeared in the beginning of the period included in the analysis, due to large activity in hydropower and electricity grid construction.

**Figure 5 Potential emissions of SF6. 1990-2005. Kg**




The bank of $SF_6$ in existing products shows the same trend as indicated by the potential emissions (Figure 6). The bank increased rapidly until the early 1990s. Then the installation of new capacity in electrical equipment dropped to under half of the previous level. The growth has remained at this lower level.

**Figure 6 Bank of SF6 in products. 1990-2005. Tonnes**




Tables with all values are given in appendix 4.

# 3. Background information on methodology for HFC and PFC

This section describes the work performed in order to update the activity data for recalculating the HFC and PFC emissions.

## 3.1. Custom statistics: New data source on imports

The administration of the tax introduced in January 2003 on imports of HFCs and PFCs, is carried out by TAD (the Norwegian Directorate of Customs and Excise). Detailed information is registered in their declaration systems, and in the following the possibilities of using this new source in obtaining activity data is explored.

Exports of HFCs and PFCs are not subjected to tax. Therefore export information is not available from Customs Statistics.

### 3.1.1. Description of customs statistics

All imported goods (with a few exceptions) are to be declared through the Norwegian Custom Authority's electronic system TVINN. This is done by the importer or by the authorities after receiving a declaration on paper. The declaration document is called a SAD-document. It contains information about the origin of the goods, what they are, their weight, value etc. (Table 7).

Goods are classified according to the Harmonized System (HS), developed by the World Customs Organization in 1983. This is an eight digit code (hereinafter referred to as HS8), where the first six digits are international, and the two last digits are national. The HS8 is revised every year.

From the year 2003 and onwards, all imported goods containing HFCs and PFCs are submitted to pay taxes, and this is being registered and administered in two different systems: AFS or TVINN.

Some importers have a special permit that allows them to pay the taxes monthly through the customs "AFS" –register. In these cases there will be no information in the regular TVINN system about the type and amount of chemical imported. The declaration will however be marked with "U0" and "FK" in the SAD-document field for "additional information":

- "U0" are the two first digits in the importers permission number and indicates that they are paying taxes through the AFS-system.
- "FK" links the type of tax paid to imports of HFCs or PFCs.

The AFS-system contains information about companies and imported amounts of a chemical, but only as monthly aggregated figures. There is no information in this register on whether the chemical is imported in bulk or in a product, nor in what kind of product.

If the importer does not have this special permit, taxes will be registered and administered in the normal TVINN-system. In this case, SAD-document field number 47 will contain information on amount and kind of chemical imported, which can be linked to the kind of imported good that contains the chemical.

### 3.1.2. What activity data can be obtained from customs data?

The organization of the two systems used to register taxes by Norwegian Customs implies that it is not possible to obtain detailed information about all imports of HFCs and PFCs to Norway. Total imports by species of chemical can be obtained for some applications, but to segregate the imports and get the required information about the following is not a straight forward process:

1. Whether a chemical is imported in bulk or in a product.
2. How a chemical imported in bulk is used
3. What kind of imported equipment contain the chemicals

When taxes are registered and paid through the TVINN system, it is possible to segregate the chemicals imported in bulk from chemicals imported in products (1) by simply looking at the HS8 classification of the imported good. All chemicals imported in bulk should be classified with an HS8 chapter 29 (organic chemicals). In order to identify what the chemical is used for (2) it is necessary to combine the information about what company is importing the chemicals, which is found in the TVINN system, with information about the company's main activities. The number of companies importing chemicals in bulk to Norway is limited and they are more or less engaged in specific activities, so it should be possible to get sufficiently segregated information to make this a satisfactory approach. Through the TVINN system it is also possible to obtain information about what kind of imported equipment that contains a chemical (3), in the cases where chemicals are not imported in bulk. The equipment is however classified by the HS8 classification system, which is not directly comparable to the categories used in the Norwegian emission model. Chapter 0 gives a description of the differences and thereby uncertainties in linking these classification systems when obtaining figures on import of chemicals by kind of equipment.

**Table 7 Information in the two registers AFS and TVINN, used for administration of the HFC/PFC taxes**

| Register name | AFS | TVINN |
|---|---|---|
| **Identification key in SAD** | U0 and FK | FK |
| **Information available** | • Importer (company)<br>• Species of chemical<br>• Amounts of chemical, monthly aggregated figures | • Importer (company)<br>• Species of chemical<br>• Amount of chemical<br>• Imported in bulk or product<br>• Kind of product |
| **Lacks information about** | • Imported in bulk or product<br>• Bulk use/kind of product | • Bulk use |

When taxes are registered and paid through the AFS system, less information is available than when this is done through the TVINN system. The AFS system contains information about imported amounts of chemicals and about the company that have imported the chemicals, but no information about source category. In order to link the chemicals to a specific kind of bulk use or equipment, it is necessary to obtain information about the importers activities and by this assume something about how a chemical is imported by each company. As described above, the number of companies importing chemicals in bulk to Norway is limited and they are more or less engaged in specific activities, so it should be possible to get sufficiently segregated information in order to make this a satisfactory approach.

In summary, only aggregated figures for each species of chemical is directly obtainable from customs statistics, but they can indirectly be allocated to some source categories. Imports of chemicals in bulk, their use, and imports of chemicals in the source category refrigeration and air conditioning, as well as fire protection, is possible to obtain. Chemicals in foams, solvents and aerosols need to be collected by other means.

### 3.1.3. Allocation of goods (HS8) to corresponding source categories

Main source categories in the Norwegian model and their corresponding classification in customs statistics (HS8) are discussed in the following. Table 8 gives an overview of the main source categories and HS8 (including bulk).

**Chemicals in bulk**

HFCs and PFCs imported as chemicals in bulk are expected to be classified in HS8 chapter 29 (organic chemicals) or 3824 (mixtures of chemicals). Main areas of application of these chemicals should also be possible to identify through company information (i.e. refrigerants and air conditioning, fire protection, foam, aerosols or solvents). This was discussed in chapter 0.

**Table 8 Source categories in the Norwegian model and the corresponding categories in customs statistics (HS8)**

| Model source code | Model source name | Customs statistics classification HS | Suitable as input data |
|---|---|---|---|
| | Bulk | 29 , 3824 | Good |
| 1.1.1 | Domestic refrigeration | 84181-84184 | Good |
| 1.2.1.1-1.2.1.9 | Commercial and industrial refrigeration | 84185-84189, 8419, 8476, 8509 | Good |
| 1.2.1.10 | Refrigerated transport | see text | Not sufficient |
| 1.2.1.2 | Stationary air conditioning and heat pumps | 8415 (except 84152) | Good |
| 1.2.1.3 | Water/liquid chillers | 8414, see text | Good |
| 1.3.1 | Mobile air conditioning | 84152, 8427-84.36, 84.79, 86-87, 89 | Good |
| 2.1 | Foams | 44, 94, 7, see text | Not sufficient |
| 3.1 | Fire protection | 38130001, 84241002 | Good |
| 4.1 | Solvents | 38140000 | Not sufficient |
| 5.1 | Aerosols | variety of products | Not sufficient |
| | Other | variety of products | |

**Domestic refrigeration**

Chemicals imported in refrigerators and freezers for domestic use, are most likely to be classified in HS8 chapters 84181-84184 which includes refrigerators and freezers not exceeding 900 l capacity and combined refrigerator-freezers.

**Commercial and industrial refrigeration**

This source category is divided in two different sub-sources in the IPCC guidelines. One includes only commercial refrigeration, the other only industrial refrigeration.

Chemicals imported in products for commercial and industrial refrigeration (except for transport refrigeration) are classified under a number of different HS8. In this analysis the following were included in this source category:

- ✓ 84185-84189 (other refrigerating or freezing chests, cabinets, display counters, show-cases and similar refrigerating or freezing furniture, other refrigerating or freezing equipment; heat pumps and parts)
- ✓ 8419 (machinery, plant or laboratory equipment, whether or not electrically heated (excluding furnaces, ovens and other equipment of heading 85.14), for the treatment of materials by a process involving a change of temperature such as heating, cooking, roasting, distilling, rectifying, sterilizing, pasteurizing, steaming, drying, evaporating, vaporizing, condensing or cooling, other than machinery or plant of a kind used for domestic purposes; instantaneous or storage water heaters, non-electric)
- ✓ 8476 (automatic goods-vending machines (for example, postage stamp, cigarette, food or beverage machines))
- ✓ 8509 (electro-mechanical domestic appliances, with self-contained electric motor)

The above mentioned categories will probably also include transport refrigeration, and this is solved as described below.

**Transport refrigeration**
Transport refrigeration includes equipment used in refrigerated trucks, containers, reefers and wagons. This will probably be classified under the same categories as the source category above (commercial and industrial refrigeration), and maybe under chapters 86-87 or 89, which will be used if the whole truck, wagon or reefer is imported. In this analysis the chapters 86-87 and 89 are included in the sub-application "mobile air conditioning". This source category has lower emission factors, so if large amounts of chemicals that should have been included in transport refrigeration, is instead included in the mobile air conditioning, then emission estimates will be too low. In order to at least get the part used for transport refrigeration separated from commercial and industrial (which in many cases also has lower emission factors), the ratio between these two sub-applications obtained in the survey of 1999 (Haukås et al 1999) is used. In this survey, half of the amount of chemicals was used in each source category.

**Stationary air conditioning and heat pumps**
Air conditioning is classified under 8415 (air conditioning machines, comprising a motor-driven fan and elements for changing the temperature and humidity, including those machines in which the humidity cannot be separately regulated), except 84152 which is mobile air conditioning.

**Water/liquid chillers**
In this analysis products imported under 8414 have been allocated to the source category of water/liquid chillers. Water chillers are specified under 84148001.

**Mobile air conditioning**
This sub source category should include air conditioning in cars, vans, trucks, busses, tractors, trains etc, and all chapters including these kinds of "machines" have been included in this source category in this analysis:

- ✓ 84152 air conditioning machines of a kind used for persons, in motor vehicles
- ✓ 8427-8436 fork-lift trucks, bulldozers, angle dozers, graders, levelers, scrapers, mechanical shovels, excavators, shovel loaders, tamping machines and road rollers, agricultural, horticultural or forestry machinery, harvesting or threshing machinery, etc.
- ✓ 8479 machines and mechanical appliances having individual functions, not specified or included elsewhere in this chapter
- ✓ 86-87 railway and other vehicles
- ✓ 89 ships and boats

This means that transport refrigeration might erroneously be included in this sub source category.

**Foams**
HFCs can be used as blowing agents in foams used in a variety of different products. Foams are used for construction, as insulation in refrigerators, for packaging and cushioning, in car seats, mattresses, toys etc. When the foams are used in other products (e.g. insulation in refrigerators) or as packaging, it is not possible to achieve information about this through the customs statistics.

In this analysis, products containing HFCs and PFCs and classified as 44 (wood and articles of wood), 94 (furniture) or 7 (different materials) are allocated to the source category foams.

**Fire protection**
HFCs and PFCs can be used in both portable and fixed flooding fire protection equipment, but mainly the fixed ones use HFCs. Fire protection containing these chemicals should be classified under 38130001 (preparations and charges for fire- extinguishers; charged fire-extinguishing grenades) and 84241002 (fire extinguishers, whether or not charged: Containing hydrofluorocarbons (HFC) or

perfluorocarbons (PFC)). Probably most of the HFCs and PFCs used in fire protection is imported as chemicals in bulk.

**Solvents**
This source category is supposedly very limited in Norway. It should be classified under 38140000 (organic composite solvents and thinners, not elsewhere specified or included; prepared paint or varnish removers), but might also be classified in other groups (e.g. cleaning products) as it is also used for precision and electronics cleaning. Only 38140000 is included in solvents in this analysis.

**Aerosols**
HFCs can be used in a variety of different products in this application area, like pharmaceutical products (e.g. metered dose inhalators used by asthmatics), personal-care products (e.g. deodorants and shaving foams), household products (e.g. air fresheners and cleaning products), industrial products (e.g. lubricants and cleaning sprays) and other products like tyre inflators and klaxons. This means that this application area covers many classification groups. In this analysis aerosols have not been assigned to any classification group. The extent of use of HFCs in these products has to be looked further into.

**Other and wrong classification**
Products with other classifications are put into this category. They might be products that should have been included in the above classifications, and should be studied and corrected if necessary.

### 3.1.4. Retrieving data from customs statistics – data processing

This section describes how data from custom statistics can be retrieved in order to obtain as much of the required input data for the Norwegian model, as possible. Data for 2003 and 2004 was retrieved in the suggested manner, and the results are presented in chapter 0.

Data from customs statistics has to be worked through in order to fit into the established model for estimation of emissions to air of HFCs and PFCs. The process of obtaining the data is not a straightforward process because the two sources of information (TVINN and AFS) have to be combined with other sources of information in order to get the data needed. Figure 7 shows how data can be processed in order to obtain information on amounts of HFCs and PFCs imported in bulk and products.

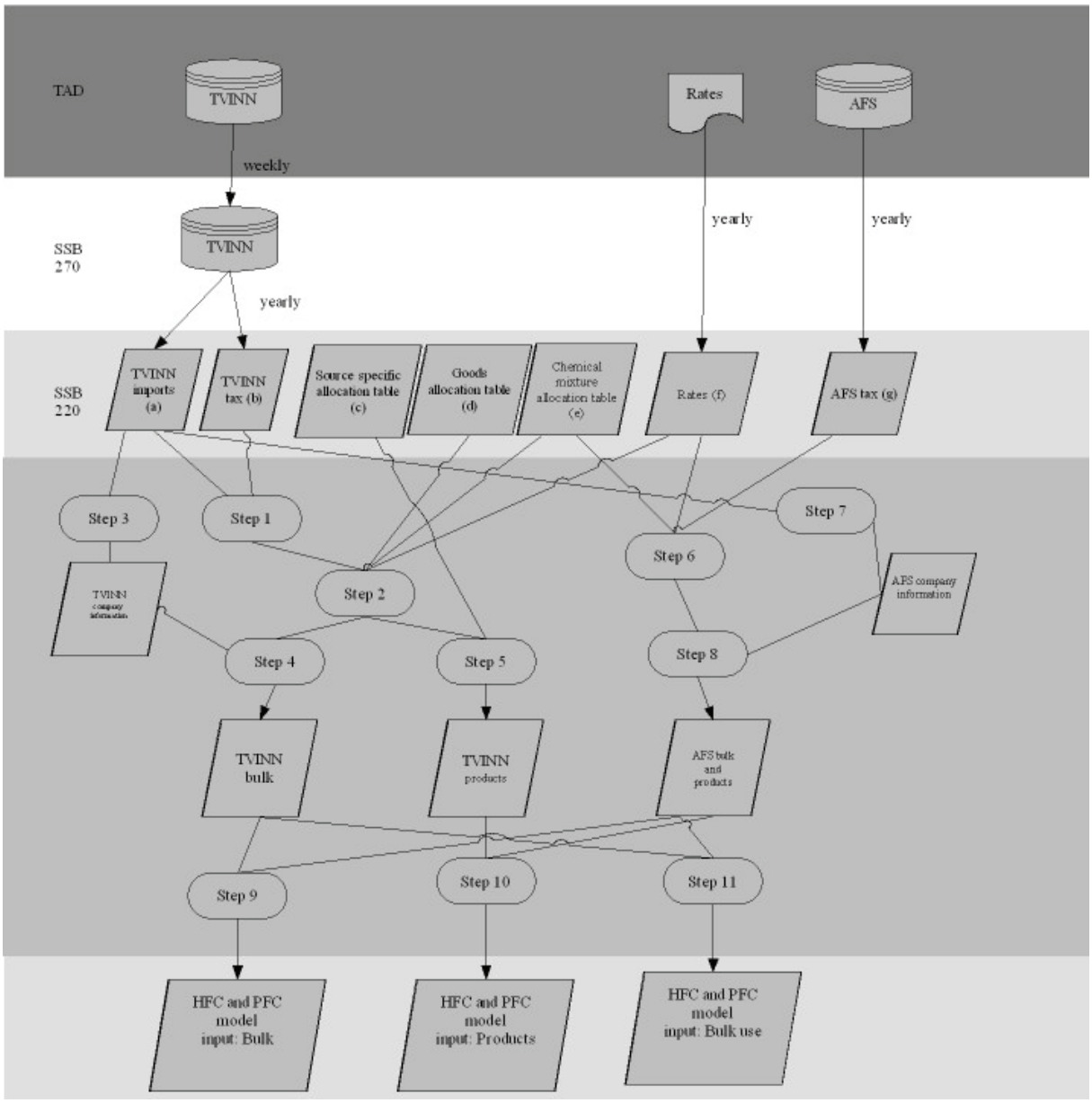
The starting point is seven datasets. These can be combined through a series of steps as described below, in order to obtain adequate input data for the emission model. The seven datasets are as follows:

a. TVINN imports. Dataset containing information on all imports registered by the TVINN system.
b. TVINN tax. Dataset containing tax information on all imports where tax is paid through the TVINN system because of the HFC/PFC regulation.
c. Source specific allocation table. Provides information for allocating chemicals to sub-groups, where this information is not available through customs statistics.
d. Goods allocation table. Provides information for allocating the chemicals imported in products (HS8) to the corresponding source category.
e. Chemical mixture allocation table. Provides information about a mixture, i.e. percentages of each chemical in a mixture.
f. Rates. Dataset containing information on what tax rates are charged a particular year for a particular species of chemical.
g. AFS tax. Dataset containing tax information on all imports where tax is paid through the AFS system because of the HFC/PFC regulation.

In step 1 information from the (a) TVINN import dataset is combined with (b) TVINN tax data. This provides a table containing information on all imports related to HFCs and PFCs where taxes are paid through the TVINN-system. The table contains company names, goods classified by HS8, rate and

amount of gas. Unfortunately information (that is the "sequence"- a three digit number referring to a chemical or a mixture) about kind of chemical is not currently transferred from TAD to SSB, because this information has not been used by SSB up till now. Receiving this information would simplify the data processing and reduce errors in the datasets.

**Figure 7 Flow chart illustrating the process of obtaining data from the new data source**




Step 2 combines information from the three datasets d-f with the table obtained in step 1. TVINN import and tax data are first combined with information on what rate (f) corresponds to what chemical. In this step, control of data and correction of errors need to be done. Each of the imported goods is then given an application or a sub-application name in accordance with the goods allocation table (d). Table 8 shows how the goods were allocated. It is not possible to retrieve information for all application areas from customs data. This is further discussed in chapter 0. Controls and correction of errors in this allocation stage is important. Thirdly, mixtures are taken care of. The chemicals mixture table (e) contains information with percentages of the different HFCs and PFCs in each mix.

Step 3 provides a table containing information about importing companies from the TVINN system. This is used in a manual way, combined with additional information, to help identify what activity the bulk is used for.

Step 4 provides a table containing all bulk import registered by the TVINN system. This is combined with company information in order to obtain imports of chemicals by main source categories.

Step 5 provides a table containing all imports of chemicals in products registered through the TVINN system. Since the HS8 does not provide sufficiently detailed information to distribute the products to all sub-application levels, a table of allocation (c) is used. The information in this table is currently based on information on distribution from the survey performed in 1999 (for the years 1995 to 1997). As an example, the table of goods does not separate the sub-application commercial and industrial refrigerants from refrigerants used in transports (as in boats, trucks etc.). This is achieved using the total from these data, and allocate them in the two subgroups assuming that the ratio between the two groups have been constant since 1997.

Data from the AFS system is retrieved in step 6. It is combined with the dataset containing rates (f) in order to identify chemicals and the chemicals mixture allocation table (e) allowing calculation of amounts of pure chemicals.

Step 7 retrieves company information in a similar way to step 4, and also requires manual manipulation in order to provide information about how the chemical registered through the AFS system was imported, i.e. if it is imported as chemicals in bulk and what it will be used for, or in products and what kind of application.

In step 8, the company information in step 7 is combined with the amounts of chemicals retrieved through step 6, in order to provide a table containing all chemicals registered through the AFS system, by source category.

The steps 9-11 combines the information obtained in steps 3, 5 and 8 and provides the final tables needed as model input: Imported amounts of chemicals in bulk (totals), imported amounts of chemicals in products (sub-applications) and the use of imported bulk.

### 3.1.5. Comparing import data from TAD with SFT data and projections

Chemicals imported in bulk

When comparing the data obtained from TAD on imports of chemicals in bulk, with data collected by the Norwegian Pollution Control Authority (SFT), there is a clear pattern of higher amounts in the latter (see Table 9 and Figure 8), with one exception: HFC-152a.

Chemicals imported in products

Import figures for chemicals in products for the years 2003 and 2004 have been obtained by projecting the figures for 1995-1997, collected in the survey in 1999. It is assumed that the tax does not have a large impact on the imports of products, because the price of the chemicals is much lower than the product as a whole. It is important to keep in mind that this might not be correct, and that the introduction of taxes in 2003 might have lowered the imports of products containing HFCs and PFCs.

In Table 10 the imports of chemicals in products, as used in the model for the years 1993 to 2003, is compared with figures obtained from customs data for 2003 and 2004. It is important to recall that the customs data probably underestimates the imports because they might not include HFCs and PFCs in products like foams.

**Table 9 Imports of chemicals in bulk. 2003-2004. Tonnes**

| | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-152a | HFC-227ea |
|---|---|---|---|---|---|---|
| TAD 2003 | 38.0 | 20.3 | 10.3 | 4.7 | 55.6 | - |
| SFT 2003 | 49.0 | 27.0 | 19.6 | 5.0 | - | 2.2 |
| TAD 2004 | 62.2 | 21.9 | 15.0 | 3.9 | 67.7 | - |
| SFT 2004 | 83.3 | 51.8 | 35.6 | 8.2 | 1.3 | 8.2 |

**Figure 8 Difference between data sources (customs data minus data collected by the Norwegian Pollution Control Authorities) on bulk imports in 2003 and 2004**

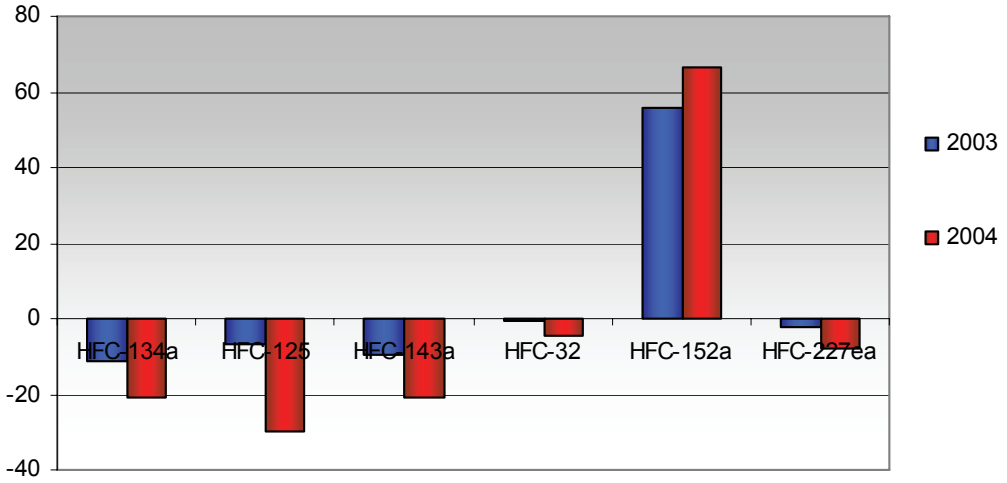



**Table 10 Imports of chemicals in products. 1993-2004. Tonnes**

| | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-152a |
|---|---|---|---|---|---|
| 1993 | 12.4 | - | - | - | - |
| 1994 | 22.3 | 0.4 | 0.4 | - | - |
| 1995 | 81.2 | 0.5 | 0.5 | - | - |
| 1996 | 84.8 | 1.5 | 1.3 | 0.2 | - |
| 1997 | 151.4 | 3.1 | 2.7 | 0.4 | 33.8 |
| 1998 | 163.8 | 3.2 | 2.8 | 0.4 | 38.9 |
| 1999 | 177.7 | 3.4 | 2.9 | 0.4 | 44.8 |
| 2000 | 193.4 | 3.5 | 3.0 | 0.4 | 51.7 |
| 2001 | 240.8 | 4.2 | 3.6 | 0.5 | 67.5 |
| 2002 | 300.6 | 5.0 | 4.3 | 0.6 | 88.3 |
| *TAD 2003* | *116.7* | *10.4* | *2.9* | *7.4* | *0.0* |
| 2003 | 376.0 | 5.9 | 5.1 | 0.8 | 115.4 |
| *TAD 2004* | *176.4* | *20.2* | *3.7* | *16.8* | *0.0* |

The figures described in the following are found in appendix 5.

**HFC-134a**
For HFC-134a, the imports in 2003 are only about one third of the projected imports used in the model. This is due to missing registration of imports in foams. Customs data is not likely to register imports of chemicals in foams, so it is to be expected that customs data are lower than projections. In customs data, the imports of HFC-134a in refrigerants and air conditioning are completely dominated by mobile air conditioning. In the model projections, more is imported in domestic refrigerators.

**HFC-125**
In the customs data for 2003, imported amounts of HFC-125 in products are twice the amount estimated from the survey in 1999. This is mainly due to higher imports of stationary air conditioning and heat pumps.

**HFC-143a**
The imports of HFC-143a seem to have been overestimated by the projections.

**HFC-32**
HFC-32 seems to be used to a greater extent than what was expected from the projections, like HFC-125 mainly because of imports of stationary air conditioning and heat pumps.

**HFC-152a**
HFC-152a is only found in imports of foam in the projections, a source that is difficult to cover using the customs statistics. In the customs data only a few kilograms are used in the application area of refrigeration and air conditioning.

### 3.1.6. Conclusions and suggestions

From the results presented in previous chapters, it was concluded that activity data on imports should be updated for use in the calculation of emissions 1990-2005, based on the new knowledge obtained from analyzing customs data. The following was done:

A. No new chemicals were included in the calculations. Customs data showed that only small amounts of HFCs and PFCs not currently included in the calculations are in use in Norway.

B. Imported amounts of chemicals in bulk
- For all chemicals except HFC-152a, data collected by SFT were used for the years 1990 to 2001
- For HFC-152a, customs data was used for the years 2003 and 2004, and it is assumed that the import has been more or less constant the years 2001-2003 and 2005. The years 1998 to 2000 are given a growth rate of 10 tonnes a year, assuming that the collected data from the survey in 1999 for the years 1995 to 1997 are correct.
- One of the model assumptions is that all imported chemicals are used that same year. In 2002 imports were higher than normal because of the introduction of an import tax in 2003, and subsequently lower than normal in 2003-2005. According to the industry, part of the chemicals imported in 2002 has been used the following years, and imports are supposed to normalize in 2005. For this reason, the import figures used in the model for 2002-2005 are not the actual reported figures, but the average of these four years.

C. Allocation of chemicals imported in bulk
- Dataset "production": Because the emission model requires production data to be equal or higher than export data, production was set to be equal to exports. As opposed to the old model, as much of the imported chemical in bulk as possible was distributed to production through the input data set "fordele", which is described below.
- Dataset "fordele": This data sheet contains information obtained from SFT on what the chemicals imported in bulk is used for.

D. Import of chemicals in products

- For the years 1990 to 1997, old figures where used for all applications
- For the years 1998 to 2005, projections (old figures for the period 1990-1997) where used for the application areas foams, fire protection, solvents and aerosols.
- For the application area refrigeration and air conditioning, figures from customs statistics were used for 2003 and 2004, and imports were set to increase or decrease gradually between the levels in 1995-1997 and 2003-2004. Imports in 2005 were set to be equal to 2004.

In order to be able to use the information from customs statistics on a regular basis in updating activity data on imports of HFCs and PFCs, the following activities are suggested:

- It is suggested that TAD and SFT look into the differences and try to map why their figures differ significantly.

- Routines for data transfer should be established between TAD and SSB: It is probable that a formalization of the use of data for emission calculation is necessary and some routines for data transfer must be established. Information on "sequence" would make chemical identification easier and it is suggested that the division of foreign trade statistics also get this information in their weekly data transfers.

## 3.2. Update of data on exports and destruction

Removal of HFCs and PFCs occur either by export or collection and burning of the chemicals in old equipment. Very small amounts of chemicals are exported or destructed in Norway.

### 3.2.1. Exports

Export data for the calculation of Norwegian emissions of HFC and PFC are obtained in the same manner as import data: Exports of chemicals in bulk are collected by SFT and reported to SSB, and export data on chemicals in products have been obtained by projecting the figures collected in the survey (1995-1997).

Exports of HFCs and PFCs are not subject to tax, and detailed information is therefore not available from Customs Statistics for updating the projections. According to the projections, around 35 tonnes of HFC and PFC were exported in 2003. Of this, 9.7 tonnes was HFC-134a in foams (almost 1400 tonnes $CO_2$ equivalents). This was set to zero after contacting the foam industry, as this chemical no longer is used in this source category.

### 3.2.2. Recycling and destruction

Almost 8 tonnes of HFC were collected and destructed in 2005. This is about 0.1 per cent of the total amount of these chemicals stored in various kinds of equipment in Norway. All recovered HFC and PFC is burnt, and according to the industry, the emissions from the destruction process are insignificant.

After the introduction of collection refund in July 2004, information on destructed amounts of chemicals is available. SRG[10] reports destructed amounts by chemical each year to SFT. SRG do not extract the chemicals from the equipment themselves, and possess no information about what type of equipment the chemicals have been extracted from. This information was not obtained even when contacting main extracting companies. Lack of available source specific information resulted in no updating of destructed amounts of chemicals in the Tier 2 calculations. Destructed amounts of chemicals can however be included in the calculation of potential emissions (Tier 1).

[10] Stiftelsen ReturGass (SRG) is a Norwegian receiving system for used coolant substances. The institute was established in 1990.

The input needed for including recycling and destruction in the current model is:

- Percentages of the equipment (by source category) being recovered for recycling or destruction
- Percentages of recovered amount of chemical (by source category) being destructed

Information from SRG suggests that around 26 tonnes of HFC and PFC will be collected and burnt in 2010. This is about 3 per cent of the annual import, assuming annual imports do not increase over the next 5 years (stabilizes at 900 tonnes).

## 3.3. Update of emission factors

The emission factors and lifetime of products used in the Norwegian model are based on work by Haukås et al. (1999), Haukås (2003) and Revised 1996 IPCC Guidelines.

A gradual improvement of emission factors is suspected to have occurred over many years. A broader survey among entrepreneurs and users is probably necessary in order to quantify this change. The extent of the change is however expected not to affect the estimated emissions substantially.

**Table 1 Emission factors for HFCs and PFCs from products and lifetime of products**

| Application category | Lifetime of products (years) | Emissions during lifetime (per cent of initial charge) 1990-2004 |
|---|---|---|
| **Refrigeration and air conditioning** | | |
| Household refrigerators and freezers | 15 | 1[1] |
| Commercial and industrial applications, imported | 15 | 3.5 |
| Refrigerated transport, imported | 15 | 20[2] |
| Air conditioning aggregates and heat pumps, imported | 15 | 4 |
| Water/liquid refrigerating aggregates, water-based heat pumps, imported | 15 | 5 |
| Stationary equipment produced in Norway | 15 | 10 |
| Mobile air conditioners | 12 | 10 |
| **Foam** | | |
| Polyurethane with diffusion barrier | 40 | 1 |
| Polyurethane without diffusion barrier | 20 | 5 |
| Extruded polystyrene | 30 | 3 |
| **Fire extinguishers** | 15 | 5 |
| **Solvents** | 2 | 50 |
| **Aerosol propellants** | 2 | 50 |

[1] Emission factor changed from 1.5.
[2] Emission factor changed from 15.

Two emission factors were updated according to Haukås (2003) and Revised 1996 IPCC Guidelines before the calculation of emissions 1990-2005:

- The emission factor for household refrigerators and freezers was lowered from 1.5 to 1. This sub category consists of small refrigerators and freezers for food storage, with a storing capacity ranging from 20-850 litres. They are factory made sealed units with low leakage rates. According to Haukås (2003) the annual leakage rate is about 1 per cent

- The emission factor for refrigerated transport was changed from 15 to 20. The conditions in Norway (poor roads and high share of sea transport) are assumed to give emissions in the high end of guidelines for refrigerated transport. The emission factors used was quite low and was changed to 20 according to Revised 1996 IPCC Guidelines

## 3.4. Differences in updated and old time series

Input data for the emission calculations were updated for the whole time series in calculations performed in 2006. In this section the main differences between "updated" and "old" input data are discussed: The main differences in model input are pointed out, and the major changes in resulting emissions are described.

### 3.4.1. Calculation of emissions 2003

Because imports of chemicals were extremely low after the introduction of taxes, the calculations performed in 2005 (2003 emissions) were different from the normal model run. Emissions were set to be equal to the imports of chemicals in bulk that year. This resulted in much lower emission figures in 2003 than the figures produced by the recalculations.

### 3.4.2. Updated vs. old model input

In summary, the updated input data and calculations differ from the old in the following way:

- ✓ A lower use of "ad-hoc imports"[11] during model run. This was achieved by using SFT figures on what the chemicals imported in bulk is used for, instead of using projections.
- ✓ No exports of HFC-134a in foams. This means that 9.7 tonnes less HFC-134a was exported in 2003 (almost 1 400 tonnes $CO_2$ equivalents).
- ✓ Imports of chemicals in bulk for the years 2002 to 2005 are not reported figures, but averaged over the four years.
- ✓ Almost 8 000 tonnes $CO_2$-equivalents *more* were imported in bulk and almost 80 000 tonnes *less* imported chemicals in products (see further details below) in 2004-2005.
- ✓ A shift from imports of chemicals imported in products with low emission factors (household refrigerating), to products with higher emission factors (mobile air conditioning).

In more detail, the activity data on imports were changed in the following manner:

1. Higher imports of HFC-152a in bulk. In 2003 the import of HFC-152a was almost 56 tonnes according to customs data, while imports based on old data were zero. This means almost 8 000 tonnes $CO_2$ equivalents more HFC-152a was imported in bulk.

2. Imports of chemicals in bulk for the years 2002 to 2005 were set to be the average of the four years.

3. Imports of chemicals in the product group refrigerants and air conditioning were adjusted according to customs data for the period 1998-2004, which means a total reduction in growth rates. The import of chemicals in products in 2003 was almost 80 000 tonnes $CO_2$-equivalents lower according to customs data, than what was expected from the projections.
    a. Imports of HFC-134a in products were given a lower growth rate, which means that 62 tonnes (-35 per cent) less was imported in 2003 according to the new activity data as opposed to old data. In addition there was a shift in product groups:
        i. A reduction in imports of HFC-134a in household refrigerants, commercial and industrial refrigeration, refrigerated transports and water/liquid chillers.
        ii. An increase in imports of HFC-134a in mobile air conditioning and stationary air conditioning and heat pumps.
    b. Imports of HFC-125 in products were given a higher growth rate, which means that almost 3 tonnes (+ 45 per cent) more were imported in 2003 according to the new activity data as opposed to old data. In addition there was a shift in product groups:
        i. A reduction in commercial and industrial refrigeration, and transport refrigeration and water/liquid chillers.

[11] By "ad-hoc imports" is meant the amount of chemicals that had to be added to the registered imports, in order to run the model (the model required higher imports than what was reported from SFT).

ii. An increase in imports in domestic refrigeration and mobile air conditioning.

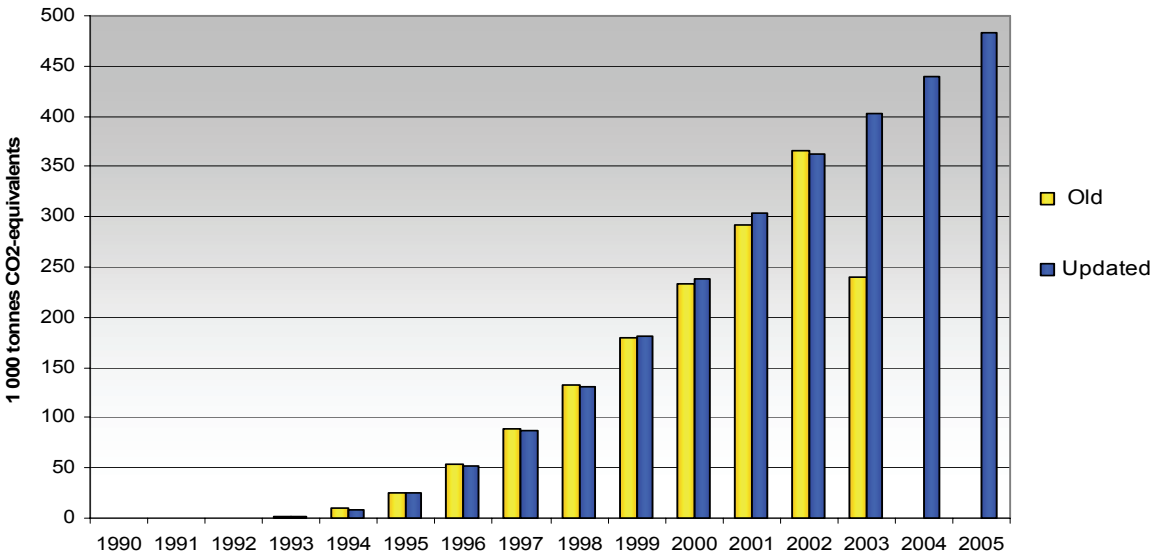
c. Imports of HFC-143a in products was given a lower growth rate, which means that 3 tonnes (-60 per cent) less was imported in 2003 according to the new activity data as opposed to old data. In addition there was a shift in product groups:
   i. A reduction in imports of HFC-143a in commercial and industrial refrigeration, and transport refrigeration and water/liquid chillers.
   ii. An increase in imports in domestic refrigeration and mobile air conditioning.

d. Imports of HFC-32 in products was given a higher growth rate, which means that almost 6 tonnes (ten times higher) more was imported in 2003 according to the new activity data as opposed to old data. In addition there was a shift in product groups:
   i. A reduction in imports of HFC-32 in water/liquid chillers.
   ii. An increase in imports in most of all stationary air conditioning and heat pumps, but also commercial and industrial refrigeration, and refrigerated transport.

### 3.4.3. Differences in emissions

When comparing emissions calculated with the updated input data with emissions calculated when applying old input data, the main difference is found in the year 2003 (Figure 9). This is because of the effect of tax introduction, which led to imports higher than normal in 2002 and lower imports than normal in 2003. Part of the chemicals imported in 2002 have been used in subsequent years, and this was not corrected for in the old calculations. In the updated time series this effect is corrected for.

**Figure 9 Emissions as calculated with old and updated input data. Emissions for 2004 and 2005 were only calculated with updated input data. 1 000 tonnes CO2 equvalents**




Emissions are largely equal for the period 1990-2002. In 1999-2001 the updated input data result in slightly higher emissions. These higher emissions seem to be a result of the shift from use of HFC-134a in products with low emission factors (household refrigerators) to products with higher emissions, i.e. air conditioning and heat pumps.

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**Appendix 1**

# Estimated bank of HFC and PFC in Norway

The tables contain estimated amounts of chemicals in the source categories refrigeration and air conditioning, foam and fire exstinguishers for the years 1990, 1995, 2000 and 2005.

**Tonnes of chemicals in source category refrigeration and air conditioning. 1990, 1995, 2000 and 2005**

| | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1990 | - | - | - | - | - | 2.9 | - | - | - | - |
| 1995 | 174.4 | 39.8 | 28.5 | 0.1 | <0.1 | 11.8 | - | - | - | 0.3 |
| 2000 | 824.6 | 294.9 | 234.8 | 12.4 | 0.6 | 18.0 | 0.1 | - | - | 0.6 |
| 2005 | 1522.6 | 491.0 | 378.0 | 58.3 | 1.2 | 26.0 | 4.9 | 9.1 | 9.0 | 0.6 |

**Tonnes of chemicals in foam. 1990, 1995, 2000 and 2005**

| | HFC-134a | HFC-152a |
|---|---|---|
| 1990 | - | - |
| 1995 | 35.9 | - |
| 2000 | 348.9 | 206.5 |
| 2005 | 1261.3 | 827.8 |

**Tonnes of chemicals in fire extinguishers. 1990, 1995, 2000 and 2005**

| | HFC-134a | HFC-125 | HFC-227ea |
|---|---|---|---|
| 1990 | - | - | - |
| 1995 | 0.2 | - | - |
| 2000 | 43.9 | 6.9 | 3.3 |
| 2005 | 45.2 | 12.1 | 14.7 |

**Appendix 2**

# Emissions (Tier 2) 1990-2005

The following tables show annual sector specific emissions, per chemical (tonnes) and totals in $CO_2$-equivalents (1 000 tonnes).

| 1990 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.1** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Refrigeration** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.1** | **0.0** | **0.0** | **0.0** | **0.0** |
| Domestic refrigeration | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| Mobile air conditioning | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| 1991 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **0.1** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.4** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Refrigeration** | **0.1** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.4** | **0.0** | **0.0** | **0.0** | **0.0** |
| Domestic refrigeration | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| Mobile air conditioning | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| 1992 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **0.3** | **0.2** | **0.0** | **0.0** | **0.0** | **0.0** | **0.7** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Refrigeration** | **0.3** | **0.2** | **0.0** | **0.0** | **0.0** | **0.0** | **0.7** | **0.0** | **0.0** | **0.0** | **0.0** |
| Domestic refrigeration | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 0.3 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| Mobile air conditioning | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| 1993 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **2.4** | **1.8** | **0.0** | **0.0** | **0.0** | **0.0** | **0.8** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Refrigeration** | **2.4** | **1.7** | **0.0** | **0.0** | **0.0** | **0.0** | **0.8** | **0.0** | **0.0** | **0.0** | **0.0** |
| Domestic refrigeration | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 2.0 | 1.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| Mobile air conditioning | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **0.1** | **0.1** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| 1994 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **9.2** | **5.4** | **0.5** | **0.2** | **0.0** | **0.0** | **0.8** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Refrigeration** | **9.2** | **5.4** | **0.5** | **0.2** | **0.0** | **0.0** | **0.8** | **0.0** | **0.0** | **0.0** | **0.0** |
| Domestic refrigeration | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 7.6 | 4.3 | 0.5 | 0.2 | 0.0 | 0.0 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| Mobile air conditioning | 1.0 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| 1995 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **25.9** | **10.2** | **2.4** | **1.5** | **0.0** | **0.0** | **1.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Refrigeration** | **25.7** | **10.0** | **2.4** | **1.5** | **0.0** | **0.0** | **1.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| Domestic refrigeration | 0.3 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 0.9 | 0.5 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 22.0 | 7.4 | 2.3 | 1.5 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Mobile air conditioning | 2.1 | 1.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **0.2** | **0.1** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| 1996 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **52.5** | **16.7** | **5.5** | **3.9** | **0.0** | **0.0** | **1.5** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Refrigeration** | **50.9** | **15.6** | **5.5** | **3.9** | **0.0** | **0.0** | **1.2** | **0.0** | **0.0** | **0.0** | **0.0** |
| Domestic refrigeration | 0.5 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 2.5 | 1.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 42.9 | 10.1 | 5.3 | 3.7 | 0.0 | 0.0 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| Mobile air conditioning | 4.4 | 3.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **1.4** | **1.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.3** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **0.3** | **0.1** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| 1997 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **86.9** | **24.6** | **9.7** | **6.9** | **0.1** | **0.0** | **2.4** | **0.1** | **0.0** | **0.0** | **0.1** |
| **Refrigeration** | **83.2** | **22.4** | **9.6** | **6.9** | **0.1** | **0.0** | **1.3** | **0.0** | **0.0** | **0.0** | **0.1** |
| Domestic refrigeration | 0.7 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 5.2 | 2.5 | 0.3 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 67.8 | 12.0 | 9.3 | 6.6 | 0.1 | 0.0 | 1.3 | 0.0 | 0.0 | 0.0 | 0.1 |
| Mobile air conditioning | 8.6 | 6.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **2.5** | **1.8** | **0.0** | **0.0** | **0.0** | **0.0** | **1.2** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **1.1** | **0.4** | **0.1** | **0.0** | **0.0** | **0.0** | **0.0** | **0.1** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.1** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| 1998 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **130.2** | **35.7** | **14.8** | **10.5** | **0.3** | **0.1** | **5.6** | **0.1** | **0.0** | **0.0** | **0.1** |
| **Refrigeration** | **123.7** | **31.9** | **14.6** | **10.5** | **0.3** | **0.1** | **1.3** | **0.0** | **0.0** | **0.0** | **0.1** |
| Domestic refrigeration | 0.9 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 9.2 | 4.1 | 0.6 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 98.4 | 15.5 | 14.0 | 9.9 | 0.3 | 0.1 | 1.3 | 0.0 | 0.0 | 0.0 | 0.1 |
| Mobile air conditioning | 14.2 | 10.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **4.1** | **2.7** | **0.0** | **0.0** | **0.0** | **0.0** | **4.3** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **2.1** | **1.0** | **0.2** | **0.0** | **0.0** | **0.0** | **0.0** | **0.1** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.1** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.2** | **0.1** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| 1999 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **180.9** | **50.2** | **20.0** | **14.9** | **0.6** | **0.1** | **8.7** | **0.2** | **0.0** | **0.0** | **0.1** |
| **Refrigeration** | **170.8** | **44.1** | **19.7** | **14.9** | **0.6** | **0.1** | **1.5** | **0.0** | **0.0** | **0.0** | **0.1** |
| Domestic refrigeration | 1.1 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 13.5 | 5.8 | 0.9 | 0.9 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 134.0 | 20.5 | 18.8 | 14.0 | 0.6 | 0.1 | 1.5 | 0.0 | 0.0 | 0.0 | 0.1 |
| Mobile air conditioning | 21.2 | 16.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **6.5** | **4.3** | **0.0** | **0.0** | **0.0** | **0.0** | **7.2** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **3.4** | **1.7** | **0.3** | **0.0** | **0.0** | **0.0** | **0.0** | **0.2** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.1** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.1** | **0.1** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| 2000 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **238.7** | **64.4** | **26.2** | **20.5** | **1.0** | **0.1** | **12.4** | **0.2** | **0.0** | **0.0** | **0.1** |
| **Refrigeration** | **225.3** | **56.3** | **25.8** | **20.5** | **1.0** | **0.1** | **1.7** | **0.0** | **0.0** | **0.0** | **0.1** |
| Domestic refrigeration | 1.2 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 18.0 | 7.5 | 1.3 | 1.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 175.5 | 24.5 | 24.5 | 19.2 | 1.0 | 0.1 | 1.7 | 0.0 | 0.0 | 0.0 | 0.1 |
| Mobile air conditioning | 29.7 | 22.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **9.3** | **6.0** | **0.0** | **0.0** | **0.0** | **0.0** | **10.7** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **4.2** | **2.1** | **0.3** | **0.0** | **0.0** | **0.0** | **0.0** | **0.2** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| 2001 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **304.1** | **78.8** | **33.4** | **27.1** | **1.5** | **0.1** | **16.4** | **0.3** | **0.0** | **0.0** | **0.1** |
| **Refrigeration** | **286.9** | **68.6** | **33.0** | **27.1** | **1.5** | **0.1** | **1.9** | **0.0** | **0.0** | **0.0** | **0.1** |
| Domestic refrigeration | 1.3 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 22.8 | 9.3 | 1.7 | 1.6 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 222.5 | 27.4 | 31.3 | 25.5 | 1.4 | 0.1 | 1.9 | 0.0 | 0.0 | 0.0 | 0.1 |
| Mobile air conditioning | 39.5 | 30.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **12.5** | **8.1** | **0.0** | **0.0** | **0.0** | **0.0** | **14.5** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **4.7** | **2.2** | **0.4** | **0.0** | **0.0** | **0.0** | **0.0** | **0.3** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| 2002 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **363.1** | **95.2** | **39.2** | **32.3** | **2.3** | **0.1** | **19.3** | **0.5** | **0.0** | **0.0** | **0.1** |
| **Refrigeration** | **341.5** | **82.2** | **38.8** | **32.3** | **2.3** | **0.1** | **2.1** | **0.1** | **0.0** | **0.0** | **0.1** |
| Domestic refrigeration | 1.4 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 28.4 | 11.5 | 2.1 | 2.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 260.3 | 30.4 | 36.6 | 30.3 | 2.1 | 0.1 | 2.1 | 0.1 | 0.0 | 0.0 | 0.1 |
| Mobile air conditioning | 50.6 | 38.5 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **16.4** | **10.8** | **0.0** | **0.0** | **0.0** | **0.0** | **17.2** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **5.2** | **2.2** | **0.4** | **0.0** | **0.0** | **0.0** | **0.0** | **0.4** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| 2003 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **403.2** | **111.8** | **42.4** | **34.3** | **3.0** | **0.1** | **22.8** | **0.8** | **0.0** | **0.0** | **0.1** |
| **Refrigeration** | **376.0** | **95.3** | **41.9** | **34.3** | **3.0** | **0.1** | **2.4** | **0.2** | **0.0** | **0.0** | **0.1** |
| Domestic refrigeration | 1.4 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 33.9 | 13.5 | 2.6 | 2.4 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 277.5 | 32.7 | 39.2 | 31.8 | 2.8 | 0.1 | 2.4 | 0.2 | 0.0 | 0.0 | 0.1 |
| Mobile air conditioning | 62.4 | 47.4 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **21.4** | **14.3** | **0.0** | **0.0** | **0.0** | **0.0** | **20.5** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **5.8** | **2.2** | **0.5** | **0.0** | **0.0** | **0.0** | **0.0** | **0.5** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| 2004 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **440.1** | **127.6** | **45.3** | **35.9** | **3.8** | **0.1** | **27.0** | **1.0** | **0.4** | **0.0** | **0.1** |
| **Refrigeration** | **406.0** | **106.5** | **44.8** | **35.9** | **3.8** | **0.1** | **2.6** | **0.3** | **0.4** | **0.0** | **0.1** |
| Domestic refrigeration | 1.4 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 36.7 | 13.8 | 3.1 | 2.6 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 292.3 | 34.2 | 41.5 | 33.2 | 3.3 | 0.1 | 2.6 | 0.3 | 0.4 | 0.0 | 0.1 |
| Mobile air conditioning | 74.5 | 56.5 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **27.9** | **18.8** | **0.0** | **0.0** | **0.0** | **0.0** | **24.4** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **6.2** | **2.3** | **0.5** | **0.0** | **0.0** | **0.0** | **0.0** | **0.6** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

| 2005 | GWP | HFC-134a | HFC-125 | HFC-143a | HFC-32 | HFC-23 | HFC-152a | HFC-227ea | HFC-134 | HFC-143 | PFC-218 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **482.9** | **148.8** | **47.8** | **37.3** | **4.5** | **0.1** | **34.5** | **1.1** | **0.9** | **0.4** | **0.1** |
| **Refrigeration** | **440.6** | **122.2** | **47.2** | **37.3** | **4.5** | **0.1** | **5.4** | **0.4** | **0.9** | **0.4** | **0.1** |
| Domestic refrigeration | 1.5 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Imported stationary equipment | 39.4 | 14.4 | 3.4 | 2.8 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stationary equipment produced in Norway | 305.3 | 35.0 | 43.6 | 34.4 | 3.8 | 0.1 | 5.4 | 0.4 | 0.9 | 0.4 | 0.1 |
| Mobile air conditioning | 93.0 | 70.6 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Foam** | **35.7** | **24.3** | **0.0** | **0.0** | **0.0** | **0.0** | **29.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Fire extinguishers** | **6.6** | **2.3** | **0.6** | **0.0** | **0.0** | **0.0** | **0.0** | **0.7** | **0.0** | **0.0** | **0.0** |
| **Solvents** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Aerosols** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |

**Appendix 3**

# Bank size and emissions - actual and business as usual

**Bank size, business as usual and destucted amounts. 1 000 tonnes $CO_2$-equvalents**

| Year | Actual bank size | Bank size business as usual | Destructed amounts of chemicals |
|---|---|---|---|
| 1990 | 0.4 | 0.4 | - |
| 1991 | 2.0 | 2.0 | - |
| 1992 | 5.0 | 5.0 | - |
| 1993 | 56.5 | 56.5 | - |
| 1994 | 172.3 | 172.3 | - |
| 1995 | 497.4 | 497.4 | - |
| 1996 | 836.0 | 836.0 | - |
| 1997 | 1 398.2 | 1 398.2 | - |
| 1998 | 1 959.0 | 1 959.0 | - |
| 1999 | 2 670.9 | 2 670.9 | - |
| 2000 | 3 368.5 | 3 368.5 | 0.5 |
| 2001 | 4 258.2 | 4 258.2 | 1.0 |
| 2002 | 4 847.5 | 4 983.3 | 1.9 |
| 2003 | 5 375.2 | 6 279.0 | 3.8 |
| 2004 | 5 946.5 | 7 911.5 | 7.6 |
| 2005 | 6 766.9 | 9 968.5 | 18.6 |

**Actual emissions and emissions business as usual. 1 000 tonnes of $CO_2$-equvalents**

| Year | Actual emissions | Emissions business as usual |
|---|---|---|
| 1990 | - | - |
| 1991 | 0.1 | 0.1 |
| 1992 | 0.3 | 0.3 |
| 1993 | 2.4 | 2.4 |
| 1994 | 9.2 | 9.2 |
| 1995 | 25.9 | 25.9 |
| 1996 | 52.5 | 52.5 |
| 1997 | 86.9 | 86.9 |
| 1998 | 130.2 | 130.2 |
| 1999 | 180.9 | 180.9 |
| 2000 | 238.7 | 238.7 |
| 2001 | 304.1 | 304.1 |
| 2002 | 363.1 | 382.0 |
| 2003 | 403.2 | 481.3 |
| 2004 | 440.1 | 606.5 |
| 2005 | 482.9 | 764.2 |

# Emissions and bank of $SF_6$

**Actual emissions of $SF_6$. 1990-2005. kg**

| | Total | Electrical equipment | Sound-insulating windows | Footwear (trainers) | Tracer gas | Production of semiconductors | Medical use (retinal surgery) | Other |
|---|---|---|---|---|---|---|---|---|
| 1990 | **2 341** | 2 243 | 98 | - | - | - | - | - |
| 1991 | **2 494** | 2 385 | 109 | - | - | - | - | - |
| 1992 | **2 794** | 2 674 | 120 | - | - | - | - | - |
| 1993 | **3 117** | 2 986 | 131 | - | - | - | - | - |
| 1994 | **3 636** | 3 286 | 149 | - | 200 | - | - | - |
| 1995 | **4 131** | 3 613 | 162 | - | 200 | 45 | 10 | 100 |
| 1996 | **4 251** | 3 721 | 175 | - | 200 | 45 | 10 | 100 |
| 1997 | **5 962** | 3 820 | 187 | - | 1 800 | 45 | 10 | 100 |
| 1998 | **6 057** | 3 885 | 218 | - | 1 800 | 45 | 10 | 100 |
| 1999 | **6 217** | 3 978 | 236 | 44 | 1 800 | 50 | 10 | 100 |
| 2000 | **6 747** | 4 469 | 254 | 64 | 1 800 | 50 | 10 | 100 |
| 2001 | **6 105** | 3 801 | 260 | 83 | 1 800 | 50 | 10 | 100 |
| 2002 | **4 041** | 3 428 | 274 | 79 | 100 | 50 | 10 | 100 |
| 2003 | **2 627** | 2 019 | 269 | 79 | 100 | 50 | 10 | 100 |
| 2004 | **2 935** | 2 286 | 282 | 106 | 100 | 50 | 10 | 100 |
| 2005 | **3 007** | 2 298 | 296 | 154 | 100 | 50 | 10 | 100 |

**Potential emissions of $SF_6$. 1990-2005. kg**

| | Total | Electrical equipment | Sound-insulating windows | Footwear (trainers) | Tracer gas | Production of semiconductors | Medical use (retinal surgery) | Other |
|---|---|---|---|---|---|---|---|---|
| 1990 | **21 553** | 19 878 | 1 500 | 175 | - | - | - | - |
| 1991 | **9 695** | 7 940 | 1 500 | 255 | - | - | - | - |
| 1992 | **31 399** | 29 566 | 1 500 | 333 | - | - | - | - |
| 1993 | **16 623** | 14 809 | 1 500 | 314 | - | - | - | - |
| 1994 | **10 737** | 8 171 | 1 800 | 316 | 450 | - | - | - |
| 1995 | **10 631** | 7 608 | 1 800 | 423 | 600 | 90 | 10 | 100 |
| 1996 | **10 736** | 7 871 | 1 800 | 615 | 250 | 90 | 10 | 100 |
| 1997 | **12 233** | 7 483 | 1 800 | 750 | 2 000 | 90 | 10 | 100 |
| 1998 | **10 844** | 5 785 | 2 400 | 459 | 2 000 | 90 | 10 | 100 |
| 1999 | **12 221** | 7 111 | 2 400 | 500 | 2 000 | 100 | 10 | 100 |
| 2000 | **12 238** | 7 128 | 2 400 | 500 | 2 000 | 100 | 10 | 100 |
| 2001 | **13 009** | 8 299 | 2 000 | 500 | 2 000 | 100 | 10 | 100 |
| 2002 | **10 726** | 8 316 | 2 000 | - | 200 | 100 | 10 | 100 |
| 2003 | **8 790** | 6 380 | 2 000 | - | 200 | 100 | 10 | 100 |
| 2004 | **11 368** | 8 958 | 2 000 | - | 200 | 100 | 10 | 100 |
| 2005 | **11 743** | 9 333 | 2 000 | - | 200 | 100 | 10 | 100 |

**Bank of installed $SF_6$ in products 1990-2005. Tonnes**

| | **Total** | Electrical equipment | Sound-insulating windows | Footwear (trainers) |
|---|---|---|---|---|
| 1990 | **179** | 172 | 7 | 0 |
| 1991 | **187** | 178 | 8 | 0 |
| 1992 | **216** | 206 | 9 | 1 |
| 1993 | **230** | 219 | 10 | 1 |
| 1994 | **238** | 225 | 11 | 1 |
| 1995 | **245** | 231 | 13 | 2 |
| 1996 | **253** | 237 | 14 | 2 |
| 1997 | **260** | 242 | 15 | 3 |
| 1998 | **267** | 246 | 17 | 4 |
| 1999 | **274** | 251 | 19 | 4 |
| 2000 | **281** | 256 | 21 | 4 |
| 2001 | **289** | 262 | 22 | 5 |
| 2002 | **296** | 268 | 23 | 4 |
| 2003 | **302** | 273 | 25 | 4 |
| 2004 | **309** | 279 | 26 | 4 |
| 2005 | **317** | 287 | 28 | 3 |

**Appendix 5**

# Projected figures and customs data

Projected figures and customs data on imports of chemicals in refrigeration and air conditioning in 2003 are compared in the following tables. Figures are given in tonnes.

| HFC-134a | Projections 2003 | Customs 2003 |
|---|---|---|
| Total refrigeration and air conditioning | 176.78 | 115.22 |
| Domestic refrigeration | 33.86 | 0.84 |
| Commercial and industrial refrigeration | 10.03 | 2.96 |
| Refrigerated transport | 0.72 | 0.20 |
| Stationary air conditioning and heat pumps | 0.14 | 3.90 |
| Water/liquid chillers | 50.05 | - |
| Mobile air conditioning | 81.98 | 107.31 |

| HFC-125 | Projections 2003 | Customs 2003 |
|---|---|---|
| Total refrigeration and air conditioning | 5.90 | 8.56 |
| Domestic refrigeration | - | 0.04 |
| Commercial and industrial refrigeration | 1.40 | 0.95 |
| Refrigerated transport | 2.20 | 1.39 |
| Stationary air conditioning and heat pumps | 0.10 | 5.70 |
| Water/liquid chillers | 2.20 | - |
| Mobile air conditioning | - | 0.47 |

| HFC-143a | Projections 2003 | Customs 2003 |
|---|---|---|
| Total refrigeration and air conditioning | 5.00 | 1.79 |
| Domestic refrigeration | - | 0.05 |
| Commercial and industrial refrigeration | 1.40 | 0.47 |
| Refrigerated transport | 2.20 | 0.74 |
| Stationary air conditioning and heat pumps | - | <0.01 |
| Water/liquid chillers | 1.40 | - |
| Mobile air conditioning | - | 0.53 |

| HFC-32 | Projections 2003 | Customs 2003 |
|---|---|---|
| Total refrigeration and air conditioning | 0.80 | 6.58 |
| Domestic refrigeration | - | <0.01 |
| Commercial and industrial refrigeration | - | 0.76 |
| Refrigerated transport | - | 0.71 |
| Stationary air conditioning and heat pumps | 0.10 | 5.10 |
| Water/liquid chillers | 0.70 | <0.01 |
| Mobile air conditioning | - | <0.01 |