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# Fluorinated greenhouse gases 2017

## Data reported by companies on the production, import, export and destruction of fluorinated greenhouse gases in the European Union, 2007-2016

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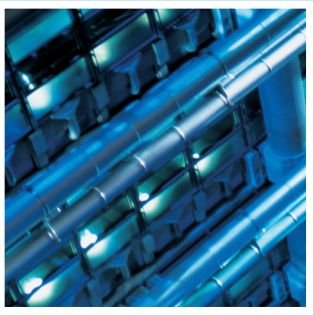

European Environment Agency

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# Contents

# Acknowledgements

This report was prepared for the European Environment Agency (EEA) by its European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM). The authors of this public report were Benjamin Greiner, Wolfram Jörß and Graham Anderson (ETC/ACM partner Öko-Institut).

The EEA report coordinator was Peder Gabrielsen and the ETC/ACM task manager was Wolfram Jörß. François Dejean (EEA) and the European Commission Directorate-General for Climate Action are thanked for their support in finalising the report.

# Executive summary

The 2017 edition of the European Environment Agency (EEA) report on fluorinated greenhouse gases (F-gases) confirms the good progress achieved in 2016 by the European Union (EU) in phasing down the use of hydrofluorocarbons (HFCs), a set of fluorinated gases with a high global warming potential (GWP) that is significantly contributing to climate change.

The report evaluates and presents the data reported by companies in 2017 about their activities involving F-gases in 2016, assessing both the progress made under the ongoing EU-wide HFC phase-down and the outlook towards the global HFC phase-down, which is due to begin in 2019 under the Kigali Amendment to the Montreal Protocol. The report also details the amount of F-gases supplied to different industrial applications.

The report uses two different metrics: F-gas amounts expressed in physical tonnes reflect the use patterns of F-gases in European industries, while their GWP (in tonnes of carbon dioxide ($CO_2$) equivalents (t $CO_2$e)) are relevant for climate change policy.

***Context***

The EU Regulation on F-gases, No 517/2014, implements an EU-wide phase-down for HFCs, which started in 2015, with the aim of cutting emissions by two thirds by 2030 in the EU compared with 2014. It mandates companies to report their annual production, imports, exports and other activities involving HFCs, as well as other F-gases, and includes all the F-gases covered by the Kyoto Protocol: HFCs, perfluorocarbons (PFCs), sulphur hexafluoride ($SF_6$) and nitrogen trifluoride ($NF_3$), as well as others such as unsaturated HFCs and HCFCs (hydrochlorofluorocarbons).

Many ozone-depleting substances (ODS) also contain fluorine and have very high GWPs. Those ODS are regulated separately under Regulation (EC) No 1005/2009.

The use of F-gases, most prominently in refrigeration and air conditioning, has been increasing, in particular as a replacement for ODS globally phased out under the Montreal Protocol. F-gases, mostly HFCs (more than 90 %), accounted for approximately 3 % of overall greenhouse gas emissions expressed in t $CO_2$e in the EU in 2015 (EEA, 2017a). 2015 was the first year of declining EU F-gases emissions (4 %) in 15 years.

***Phase-down of HFCs under the EU F-Gas Regulation***

The HFC phase-down under the F-Gas Regulation is being implemented by the introduction of annual quantitative limits (quotas) to the placing on the EU market of HFCs by producers and importers. In 2016, EU-wide placing on the market (POM) of HFCs was 4 % below the 2016 overall market limit. In comparison, in 2015, companies remained 8 % under the overall limit (Figure ES.1). The few cases of quota exceedance were balanced by companies that did not fully use their quota. A number of equipment importers were able to build up a reserve of quota authorisations for the period beginning 2017, when imports of refrigeration, air conditioning and heat pump (RACHP) equipment containing HFCs became subject to the phase-down. The size of this reserve is approximately twice the amount of actual annual equipment imports or 22 % of the maximum available HFC amount for 2017.

***EU contribution to the global phase-down of HFCs under the Kigali Amendment to the Montreal Protocol***

The global HFC phase-down under the Montreal Protocol Kigali Amendment introduces limits to the consumption of HFCs, starting in 2019. In 2016, HFC consumption in the EU was the lowest since reporting started in 2007 and was already 14 % below the first limit for the EU under the Montreal Protocol Kigali Amendment (Figure ES.2).

***Supply of F-gases in the EU***

In 2016, the supply of total F-gases, reflecting the actual use of F-gases by EU industries, increased by 2 % in mass but decreased by 2 % in $CO_2$e. This indicates a

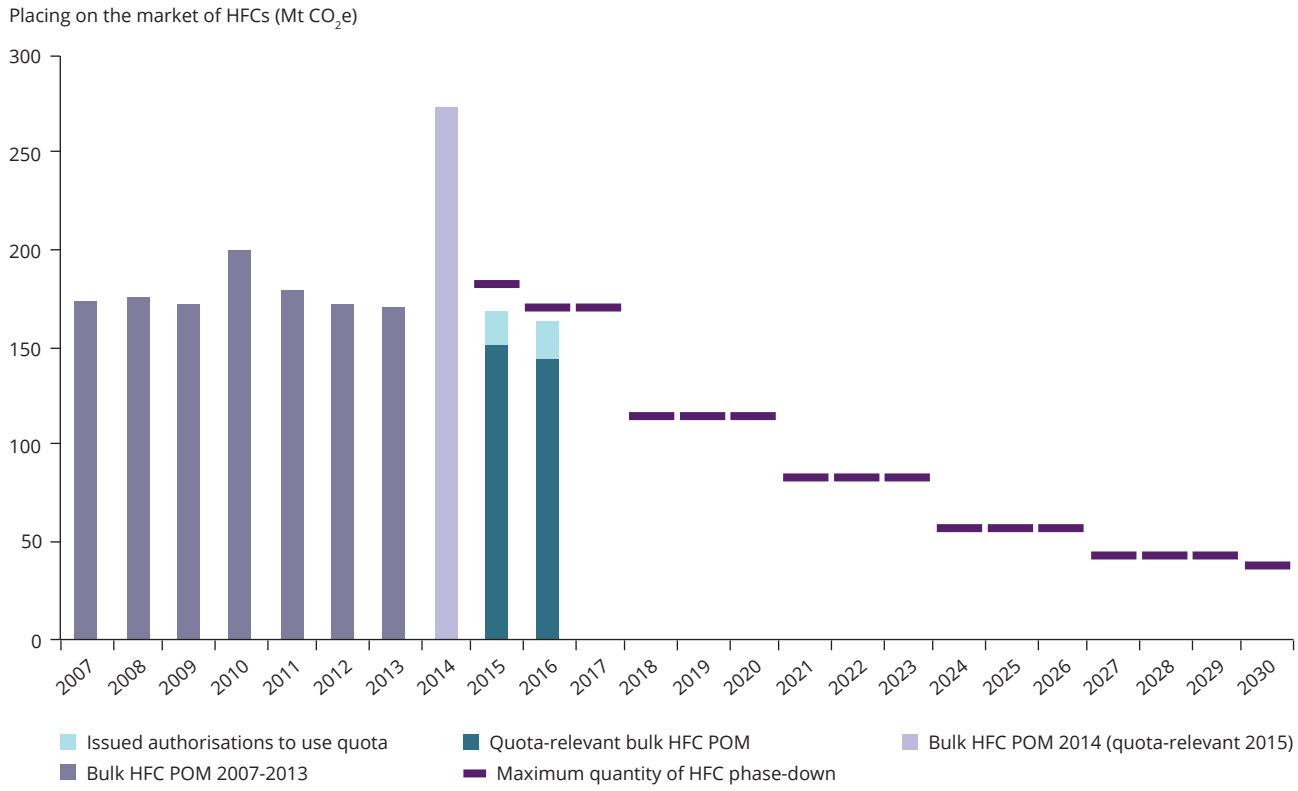
move towards gases with lower GWPs. Refrigeration and air conditioning continue to be key applications. Large increases can be observed for unsaturated HFCs and HCFCs with very low GWPs, replacing HFCs with significantly higher GWPs. In contrast, HFC supply decreased by 2 %. Looking at the gases with the highest GWPs, increased $NF_3$ supply is outweighed by decreasing $SF_6$ supply.

### *Detailed physical flows of F-gases*

The key findings presented above are based on the following trends in physical F-gases flows in 2016, reported by companies in 2017 (see Figures ES.3 and ES.4):

- Production of virgin F-gases in the EU indicates a trend towards more climate-friendly gases: quantities measured in $CO_2e$ have continued to decline since 2012 (2 % below 2015), while production reported in tonnes has been increasing since 2014 (2 % above 2015).
- Reclamation of used F-gases meeting the specifications of virgin gases has doubled since 2015. Under the HFC phase-down, 2016 HFC reclamation has risen to a level equivalent to 5 % ($CO_2$ e) of HFC production.
- Imports of F-gases into the EU in 2016 increased by 5 % compared with 2015 or by 2 % if measured in $CO_2e$. This increase is primarily due to an 80 % rise

**Figure ES.1 Progress of the EU HFC phase-down**




**Notes:** POM, placing on the market.

Values from 2007 to 2013 are based on the reporting obligations of the old F-Gas Regulation (EC) No 842/2006 and are therefore not fully comparable to data from 2014 onwards (based on obligations of the new F-Gas Regulation No 517/2014). Similarly, the maximum quantities of the EU HFC phase-down will be recalculated for 2018 and are therefore for indicative purposes only.

The quantity of bulk HFCs placed on the market in 2014 was used to determine 2015 quotas.

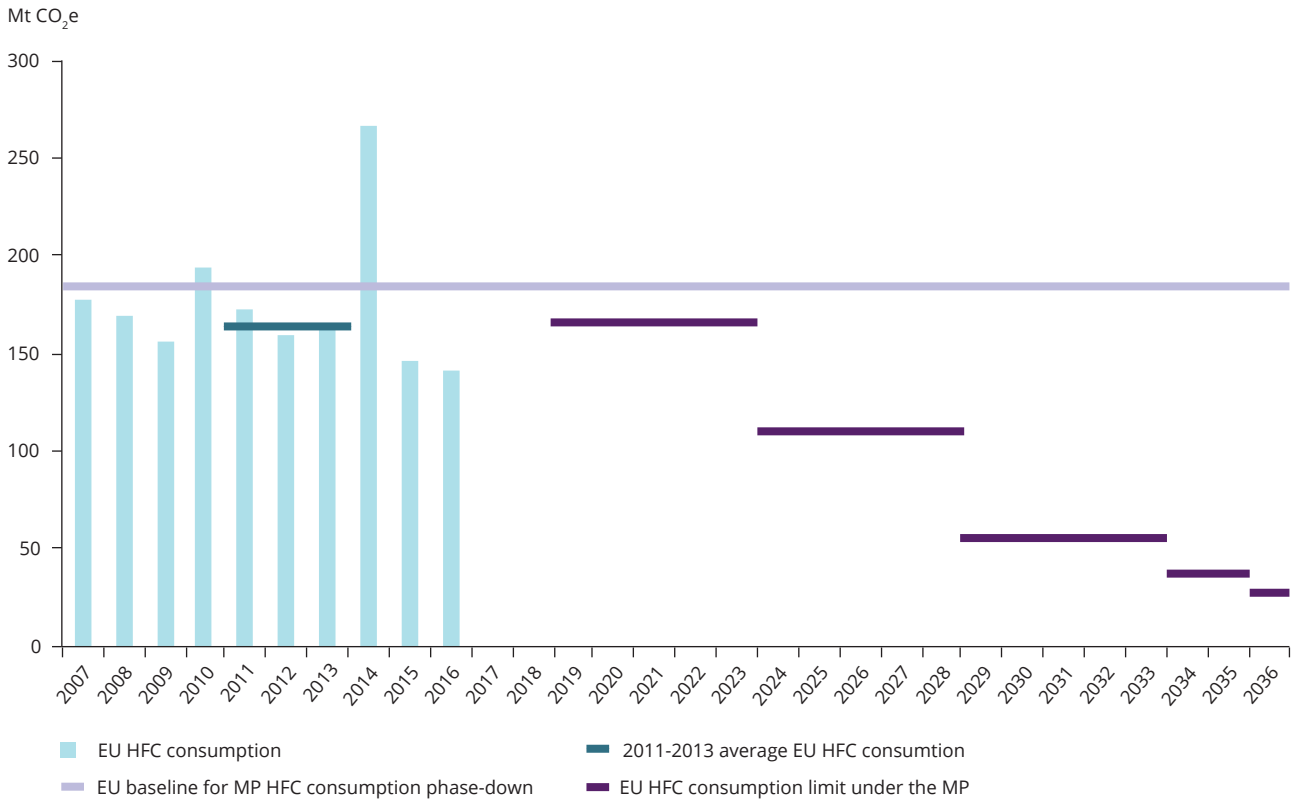
**Sources:** EC, 2011 and 2017a; EEA, 2016 and 2017b.

in low-GWP unsaturated HFCs and a 60 % rise in high-GWP $NF_3$, both in bulk imports, which account for almost 90 % of total 2016 imports. Under the HFC phase-down, bulk HFC imports decreased by 4 % (in $CO_2e$). However, a 45 % increase in HFC equipment imports was observed. This was, to a large extent, caused by more complete reporting from equipment importers; twice as many companies reported on their imports in 2016 than in 2015.

- Bulk exports of F-gases from the EU in 2016 have risen by 6 % (tonnes) or 2 % ($CO_2e$) compared with 2015, mainly due to increased HFC exports, while $SF_6$ exports decreased. Both in bulk exports and in production, $SF_6$ accounts for approximately 50 % if measured in $CO_2e$ throughout the whole time series analysed since 2007. Exports of F-gases contained in products and equipment are not subject to obligatory reporting.

- Destruction and feedstock use of F-gases is reported mainly for HFCs and has declined by 43 % (mass) or 30 % ($CO_2e$) compared with 2016. The negative contribution to HFC consumption calculated in $CO_2e$ thus declined from 9 % in 2015 to 6 % in 2016.

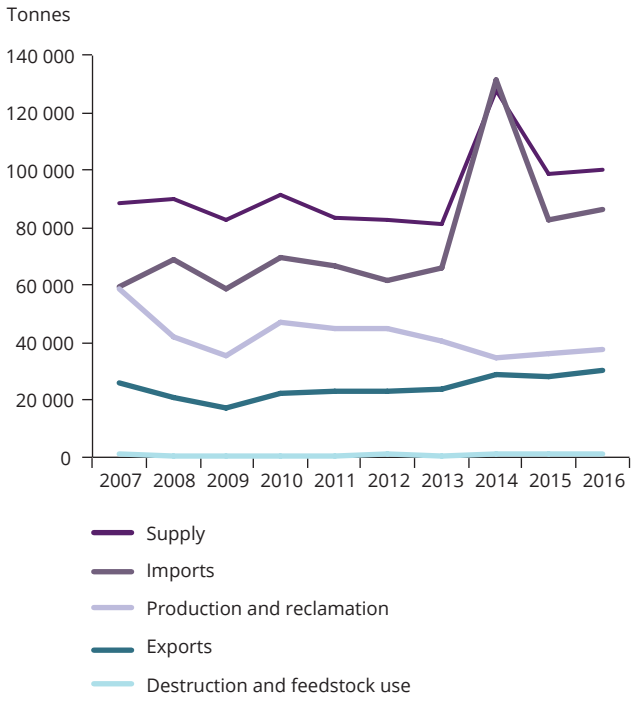
**Figure ES.2 Approaching the Montreal Protocol HFC phase-down**




**Notes:** MP, Montreal Protocol.
The baseline consists of 2011-2013 average HFC consumption plus 15 % of the 1989 HCFC baseline.
HFCs covered under the Montreal Protocol include all HFCs covered under EU F-Gas Regulation No 517/2014, except HFC-161.

**Sources:** EC, 2011 and 2017b; EEA, 2016 and 2017b.

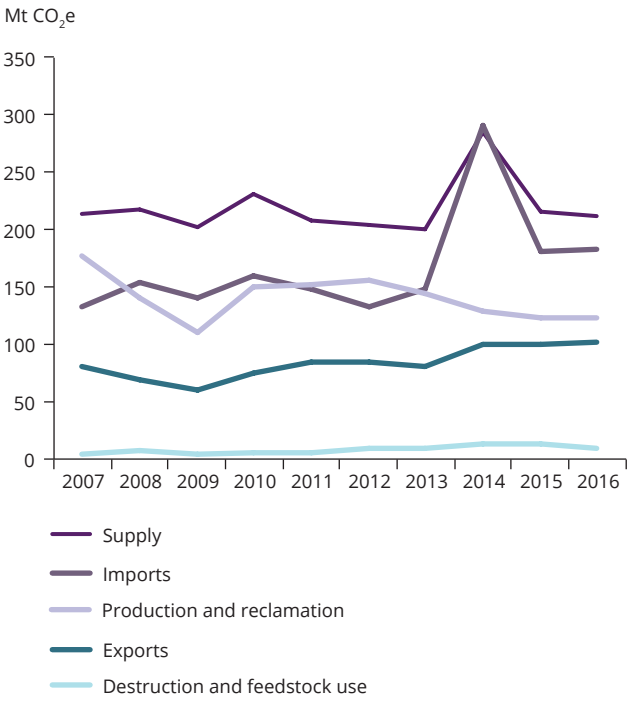
**Figure ES.3** **Supply, production, import, export and destruction of fluorinated gases in the EU (tonnes)**




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, hydrofluoroethers (HFEs) and alcohols, and 'other' perfluorinated compounds) and HFCs, PFCs and $SF_6$ in products and equipment were not subject to reporting for the period 2007-2013. Data presented for import and supply between 2007 and 2013 are thus limited to bulk import and bulk supply. Export is limited to bulk export for the whole time series.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

**Figure ES.4** **Supply, production, import, export and destruction of fluorinated gases in the EU ($CO_2e$)**




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and 'other' perfluorinated compounds) and HFCs, PFCs and $SF_6$ in products and equipment were not subject to reporting for the period 2007-2013. Data presented for import and supply between 2007 and 2013 are thus limited to bulk import and bulk supply. Export is limited to bulk export for the whole time series.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

# 1 Introduction

## 1.1 Background

*International policy framework*

The United Nations Framework Convention on Climate Change (UNFCCC) addresses several groups of fluorinated greenhouse gases (F-gases). The majority of these F-gases have very high global warming potentials (GWPs) in comparison with other greenhouse gases. Among them are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride ($SF_6$) and nitrogen trifluoride ($NF_3$). They are also covered by the Kyoto Protocol and included in the European Union's commitment under the Paris Agreement.

Certain F-gases have come into use since the 1990s for the replacement of ozone-depleting substances (ODS) that were phased out under the Montreal Protocol and Regulation (EC) No 1005/2009 ([1]). Their use in many different applications has been increasing and has considerable potential for further growth. F-gases accounted for approximately 3 % of overall greenhouse gas emissions expressed in carbon dioxide ($CO_2$) equivalents ($CO_2e$) in the 28 Member States of the European Union (EU) in 2015 (EEA, 2017a). Emissions, of which more than 90 % are HFCs, have declined for the first time in 15 years in 2015 (– 4 %).

The EU has committed, under the UNFCCC, to reduce emissions of greenhouse gases by 20 % by 2020 compared with 1990 levels. F-gases are included in this target. Under the Paris Agreement, the EU is committed to a 40 % reduction in domestic emissions by 2030, compared with 1990.

The strong policy mechanisms adopted under the EU F-Gas Regulation of 2014, which implements an EU-wide phase-down of HFCs, as well as measures taken by other industrialised countries, gave momentum to the global development of HFC regulation. This culminated in October 2016 in Kigali, when the Montreal Protocol was amended to regulate HFCs. Both developed and developing countries have taken on mandatory commitments on reducing production and consumption of HFCs in the next three decades ([2]).

*EU fluorinated gases legal framework*

*Old F-Gas Regulation*

Regulation (EC) No 842/2006, the old F-Gas Regulation, employed two tracks of action from 2007:

- Improving the leak-tightness of equipment containing F-gases. Measures comprised labelling of equipment containing F-gases, training and certification of personnel and companies handling these gases, containment of F-gases within equipment, and proper recovery of F-gases from equipment that is no longer used.
- Avoiding the use of F-gases in some applications in which more environmentally superior alternatives are already cost-effective. Measures included restrictions on the use and marketing of F-gases in these cases.

*New F-Gas Regulation (2014)*

In 2015, the new F-Gas Regulation (No 517/2014) ([3]) was implemented, which aims to reduce F-gas emissions by two thirds of the 2010 level by 2030. The relevant measures from the 2006 regulation remain in force. This regulation includes a phase-down timeline for HFCs with GWP. Sales of HFCs on the EU market are progressively capped, reaching 21 % of baseline levels

([1]) Regulation (EC) No 1005/2009 of the European Parliament and of the Council of 16 September 2009 on substances that deplete the ozone layer (EU, 2009).
([2]) The Kigali Amendment regulates production and consumption, while reducing emissions of HFCs remains within the remit of the UNFCCC and the Paris Agreement.
([3]) Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006 (EU, 2014b).

by 2030. In addition, F-gases with very high GWPs are banned entirely.

Under the regulation, companies are obliged to report on produced, imported and exported quantities of F-gases and mixtures as before. The new regulation extends the reporting obligation to:

- use of F-gases as a feedstock for chemical reaction processes;
- destruction of F-gases;
- import of products or equipment containing F-gases.

Furthermore, under the new regulation, the list of reportable fluorinated gases was extended beyond HFCs, PFCs and $SF_6$ (as listed in Annex I of the new F-Gas Regulation) to include:

- unsaturated hydro(chloro)fluorocarbons;
- fluorinated ethers and alcohols;
- other perfluorinated compounds.

Commission Implementing Regulation (EU) No 1191/2014 ([4]) establishes the format in which the reports are to be submitted.

## 1.2 Report structure

The report consists of six chapters:

1. The introductory Chapter 1 outlines legal arrangements and their implementation.
2. Chapter 2 details the reporting arrangements and the technical facilities used.
3. Chapter 3 presents an overview of the data on production, imports, exports and destruction of fluorinated greenhouse gases as reported by companies.
4. Chapter 4 presents key indicators for the EU, based on reported data about the supply of F-gases to the EU market and their intended applications.
5. Chapter 5 discusses progress under the EU HFC phase-down.
6. Chapter 6 presents an outlook towards the global HFC phase-down under the Montreal Protocol.

## 1.3 Institutional arrangements

Companies that need to report are obliged to register with the European Commission's F-gas portal ([5]), which also hosts the HFC registry provided for under Article 17 of the 2014 F-Gas Regulation.

Since 2012, the European Commission has given the responsibility for collecting, archiving and evaluating the data reported by companies to the European Environment Agency (EEA). The reporting process is executed through the EEA's online platform, the Business Data Repository (BDR), while technical support for the F-gas reporting process is provided by the EEA's European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM) ([6]).

## 1.4 Scope

The report is based on submissions for the year 2016 as received by 30 May 2017 (including some late reports and corrections received after the legal deadline on 31 March 2017). Data for 2015 were changed slightly after corrections were submitted, especially for equipment imports.

Data for 2007-2013 are covered by the old 2006 F-Gas Regulation, while data for 2014 and onwards are covered by the new 2014 Regulation. Due to the different reporting frameworks, data from the two periods are not always directly comparable.

## 1.5 Confidentiality

The new F-Gas Regulation requires that the confidentiality of the information submitted by companies is protected (Article 19(8)). The EEA is therefore taking appropriate measures to protect confidentiality and prevent publication of commercially sensitive information. These measures include public reporting of F-gases data only at higher levels of

([4]) Commission Implementing Regulation (EU) No 1191/2014 of 30 October 2014 determining the format and means for submitting the report referred to in Article 19 of Regulation (EU) No 517/2014 of the European Parliament and of the Council on fluorinated greenhouse gases (EU, 2014a).
([5]) https://webgate.ec.europa.eu/ods2/. This is the general login page of the European Commission. To request access, please click on the 'About EU login' link at the foot of the page.
([6]) http://acm.eionet.europa.eu/

aggregation, to protect data that are the result of reports from fewer than three corporate groups, and additional steps to prevent deduction of sensitive information. It is for confidentiality reasons that some of the statements about fluorinated gas activity in this report are of a general nature and do not refer to figures or percentages. A detailed account of the confidentiality measures applied to the data published in this report is included in Annex 5.

# 2 Reporting arrangements

## 2.1 Reporting format and quality control

The format for the reporting by companies in accordance with Article 19 of the new F-Gas Regulation is laid down in Commission Implementing Regulation (EU) No 1191/2014. A further specification of data to be reported is given in Annex 2. An overview of the reporting format applied for 2007-2013 under the old F-Gas Regulation is given in Annex 3.

Company registration for reporting and the reporting process are two separate procedures. Registration for reporting is centralised in the European Commission's F-gas portal at https://webgate.ec.europa.eu/ods2/. This provides 'one-stop-shop' access for both the HFC Registry (for quota purposes) and for reporting under Article 19.

From their account in the F-gas portal, companies have a direct link to the BDR at https://bdr.eionet.europa.eu. This reporting platform ensures that the reporting process maintains traceability and transparency for all stakeholders.

*Support for reporting companies*

Reporters received support regarding the reporting procedure and technical questions from the EEA and the ETC/ACM reporting support team and various guidance documents made available at https://bdr.eionet.europa.eu/help/fgases:

- How to register? The F-gas portal registration manual ([7]);
- How to use the BDR reporting platform? The BDR user manual ([8]);
- What (numbers) should be reported? Frequently asked questions (FAQ) document ([9]).

*Companies that are not obliged to support*

The companies that considered that they were not covered by Article 19 of the new F-Gas Regulation in the past year were invited to communicate this through the web questionnaire in the BDR ('nil report') or per email in the event of technical difficulties.

*Data quality control*

Data quality checking procedures included an automatic quality control implemented in the online questionnaire, which can also be invoked by the reporters manually. It is followed by manual quality control applied after submission of the reports. If problems were identified, reporters were contacted and invited to submit a revised report where necessary. All submissions were done via the BDR and never via informal communications or manual modifications in order to ensure the transparency of the reporting process. This process was repeated until submissions passed all quality checks.

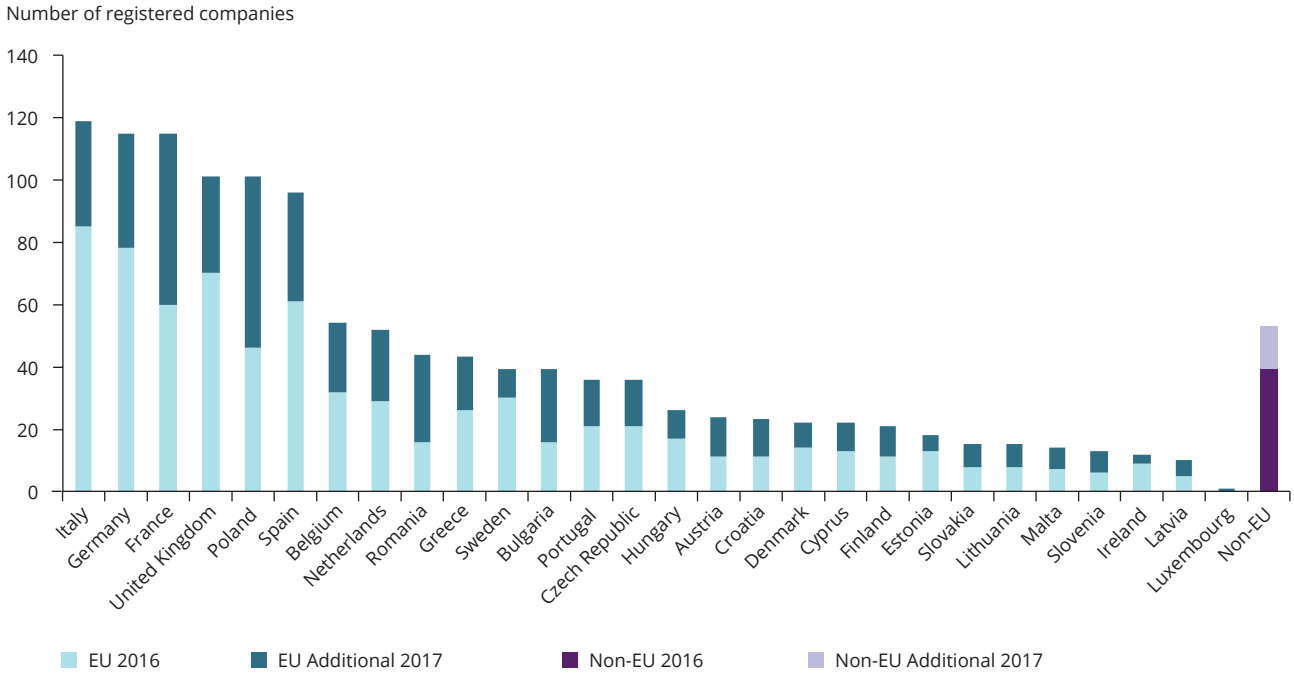
## 2.2 Companies reporting in 2017

By 30 May 2017, 1 279 companies had reported on their F-gas activity during 2016, 514 more than in the previous year. A further 803 companies reported no reportable activity during 2016 (nil report). As shown in Figure 2.1, companies are distributed across all EU Member States but concentrated in Italy, Germany, France, the United Kingdom, Poland and Spain. Of the 52 non-EU companies, most are Chinese companies that export gases or equipment to European subsidiaries and partners.

The majority of companies reported on HFC-charged equipment imports or bulk imports of HFCs (Figure 2.2). There was a larger increase in the

([7]) https://ec.europa.eu/clima/sites/clima/files/f-gas/docs/guidance_document_en.pdf.pdf
([8]) https://bdr.eionet.europa.eu/help/bdr_user_manual.pdf
([9]) https://ec.europa.eu/clima/sites/clima/files/f-gas/docs/faq_reporting_en.pdf

**Figure 2.1 Reporting companies and new registrations in 2017 by Member State**

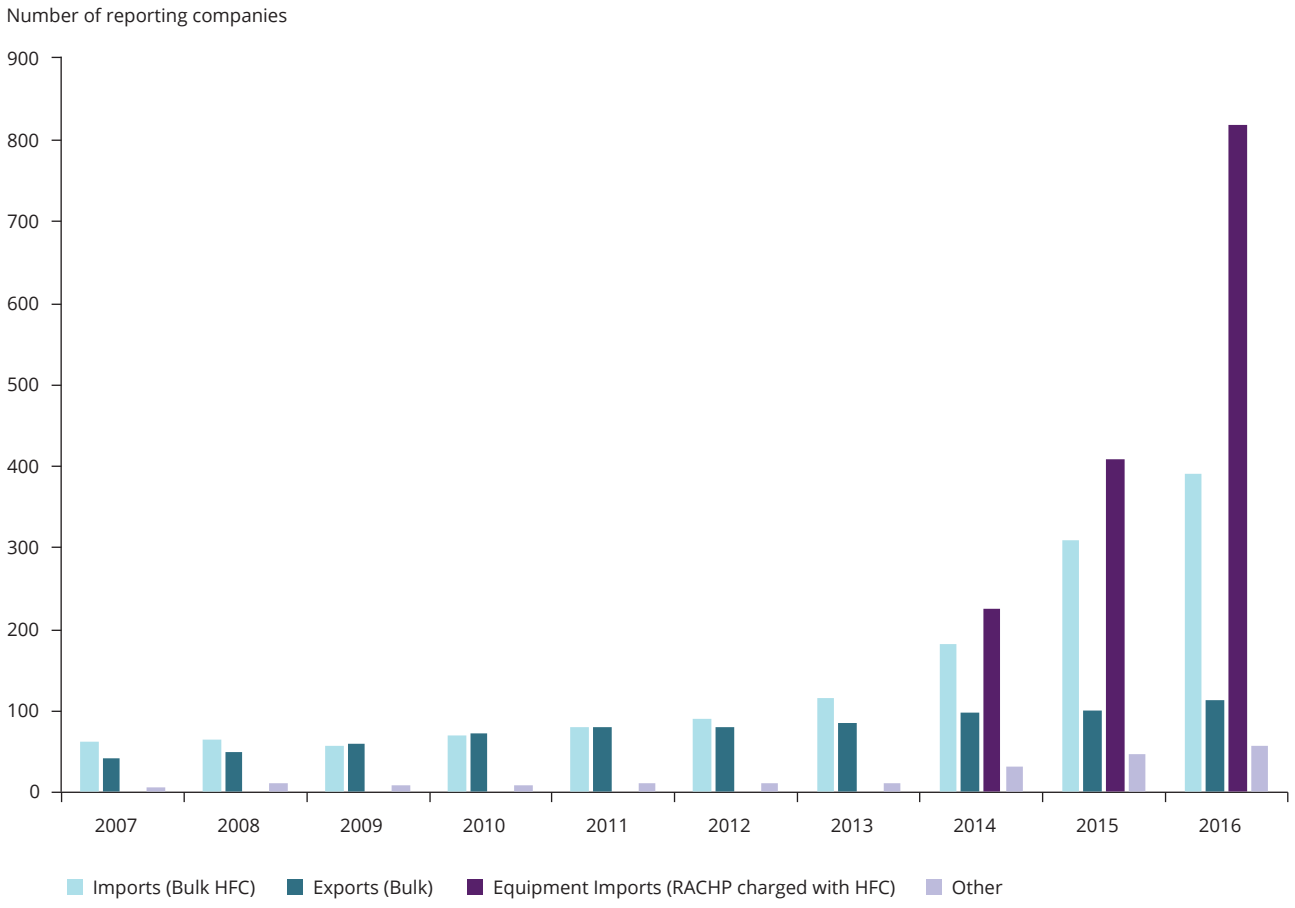



**Note:** Nil reports not included.
Non-EU countries: China, Gibraltar, Hong Kong, Japan, Malaysia, Monaco, Norway, Serbia, Switzerland and the United States.

**Source:** EEA, 2017b.

reporting of equipment imports, probably largely because equipment imports have been included in the regulation only since 2014. Producers of F-gases in the EU are few, but they are usually larger companies with significant impacts (see Table A5.23, page 69).

**Figure 2.2 Activities in companies, 2007–2016**



# 3 F-gas activity in the European Union

This chapter presents data reported by companies on:

- production and reclamation (Section 3.1);
- imports, both bulk and in products/equipment, and exports (Section 3.2);
- destruction and feedstock use (Section 3.3).

These data are the basis for the calculation of the EU F-gases supply (Chapter 4), the assessment of progress under the EU HFC phase-down (Chapter 5) and for the calculation of the EU HFC consumption (Chapter 6).

Table A4.1 in Annex 4 explains the differences in the definitions of EU 'supply', as used in this report, compared with the compliance metrics of the HFC phase-down schemes, i.e. 'placing on the market' (POM), for the EU-wide HFC phase-down under the EU F-Gas Regulation, and 'consumption', for the global HFC phase-down under the Montreal Protocol.

All numbers are presented both as tonnes of fluorinated gases and as tonnes of $CO_2$e. The statistics in physical tonnes reflect the usage patterns of fluorinated gases in European industries, while usage of fluorinated gases expressed as $CO_2$e reflects the potential relevance for climate change policy and the HFC phase-down.

## 3.1 Production and reclamation

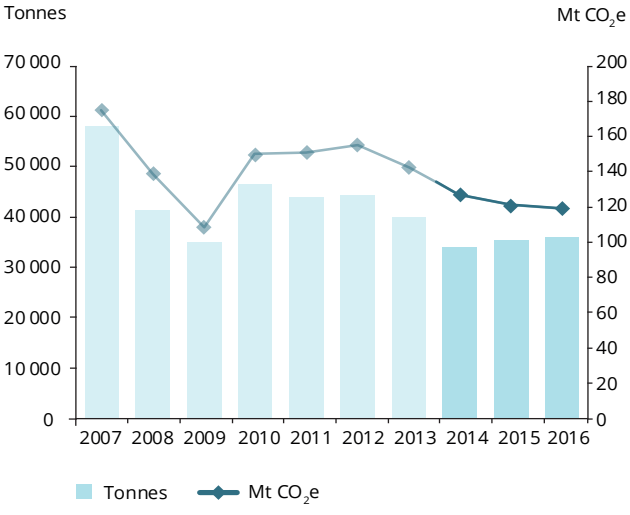
'Production' refers to the production of virgin F-gases. The F-Gas Regulation defines 'reclamation' as 'the reprocessing of a recovered fluorinated greenhouse gas in order to match the equivalent performance of a virgin substance, taking into account its intended use'. Note that reclaimed HFCs do not count as 'placed on the market' and are not subject to the limits of the HFC phase-down.

***Production***

Production of fluorinated gases in Europe showed a declining trend from 2007 to 2014 (Figure 3.1), not taking into account the dip in production induced by the financial crisis in 2008 and 2009. After 2014, there was a slight increase in production (blue bars; up 2 % in 2016) together with a continued decrease in the GWP of the produced gas (dark blue line; down 2 % in 2016). This indicates a shift to F-gases with lower GWPs.

Production of F-gases is dominated by HFCs, which account for more than 90 % of the total, with HFC-134a accounting for the largest part. While only small amounts of $SF_6$ are produced, it contributes about 50 % to the total GWP of production. Detailed numbers are found in Table A5.1 and Table A5.2, page 55).

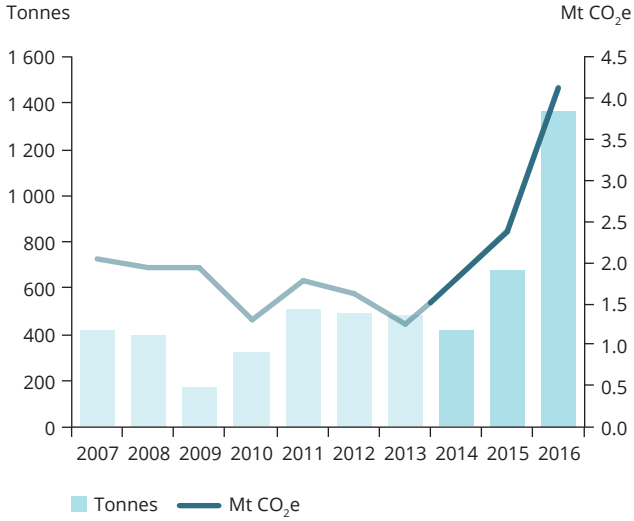
**Figure 3.1 EU production of fluorinated gases**




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

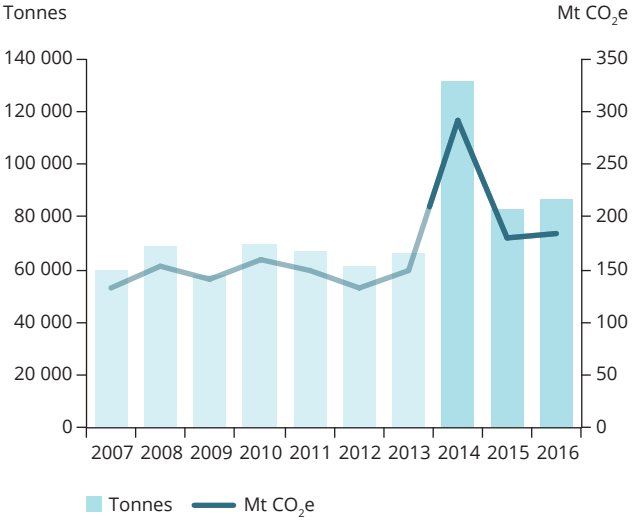
**Figure 3.2 EU reclamation of fluorinated gases**




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

**Figure 3.3 EU imports of fluorinated gases**




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) and gases contained in products and equipment were not subject to reporting before 2014.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

***Reclamation of fluorinated gases***

Reclamation of fluorinated gases in the EU has fluctuated, but there has been a steady increase since 2014 (Figure 3.2). In 2016 alone, the reclaimed amount doubled compared with 2015, an increase mostly caused by the reclamation of HFCs. Because most other reclaimed gases have high GWPs, such as $SF_6$, the total GWP of reclaimed gases increased by only 75 %. Reclaimed HFCs now make up almost 5 % of the produced amount ($CO_2$e). Details can be found in Table A5.3 and Table A5.4.

## 3.2 Imports and exports

***Imports***

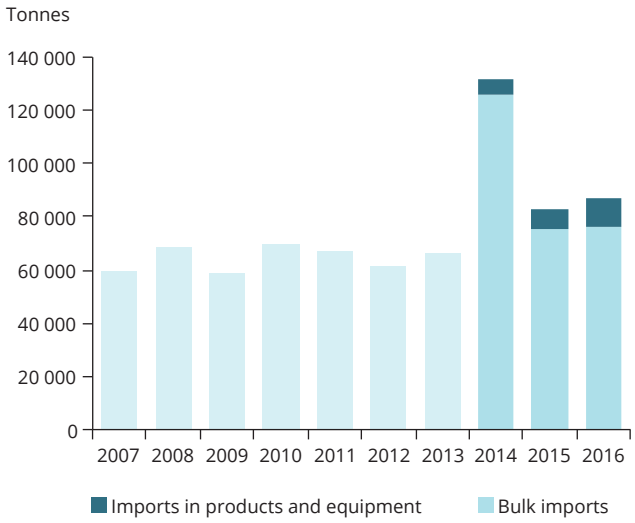
Imports of F-gases into the EU, including both bulk imports and imports contained in products and equipment, increased by 5 % compared with 2015. GWP increased by only 2 %, indicating a shift to gases with lower GWPs (Figure 3.3). In particular, the increase in GWP is mostly due to a strong growth of $NF_3$ imports (see Tables A5.5 and Table A5.6, page 57).

Note that, for the years 2014 to 2016, this figure includes both bulk and equipment imports, which were not reported before 2014. The figures before 2014 include only bulk imports. In 2016, equipment imports made up 12 % of the total imported amount (Figure 3.4). Note that this increase is also due to more and more companies reporting their equipment imports and not only the physical changes in their trade flows.

Bulk imports of F-gases into the EU have so far not shown a clear trend. In 2014, imports were extraordinarily high: this was the last year before the quota system came into force, creating an incentive for stockpiling. After 2014, there appears to be a growing trend, and (excluding 2014) total imports in 2016 were the highest since reporting started in 2007.

Imports of F-gases are also dominated by HFCs, which account for about 90 % of the total. HFC imports in 2016 increased by 1 % compared with 2015, but the lower GWP of the imported gases completely offsets this increase when looking at the $CO_2$e. Most of the growth in imports is caused by Annex II gases: about three quarters of the overall increase in metric tonnes is due to unsaturated HFCs, which represent 7 % of total F-gases imports in 2016, and $NF_3$, which caused nearly all the increase in the imports' GWP.

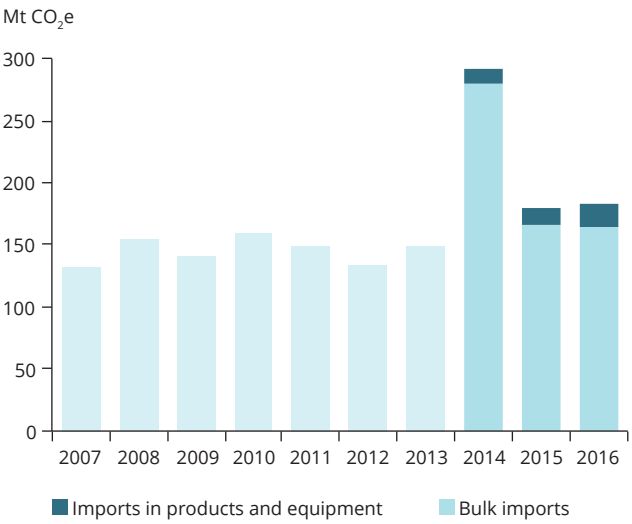
**Figure 3.4 EU imports by type (tonnes)**




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

**Figure 3.5 EU imports by type ($CO_2e$)**




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

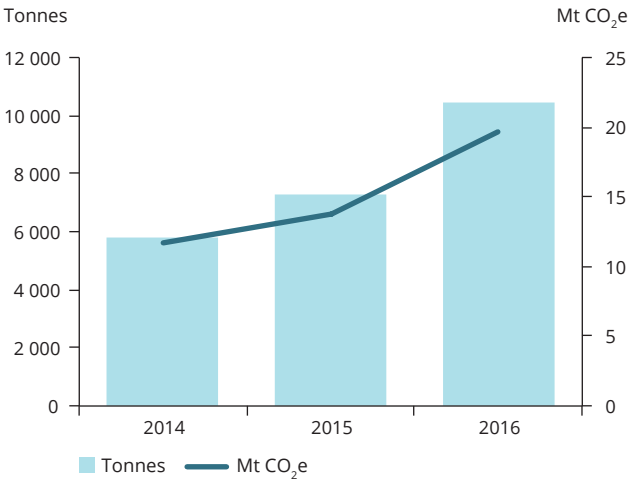
**Sources:** EC, 2011; EEA, 2016 and 2017b.

### *Imports contained in products and equipment*

Imports of F-gases contained in products and equipment ([10]) have been subject to reporting since 2014, and they have risen significantly since then (Figure 3.6). The increase was especially high in 2016, at nearly 50 %. However, a large part of this increase can be attributed to more complete reporting and not to actual increases in imports. Based on data from companies that reported before 2016, the actual increase in imported F-gases contained in products and equipment is probably closer to 25 %, i.e. only half of the total increase, while the other half is contributed by first-time reporters.

In summary, the 45 % increase (measured in $CO_2e$) in reported equipment imports outweighs a 4 % decrease in bulk HFC imports. Details can be found in Table A5.9 and Table A5.10, page 59.

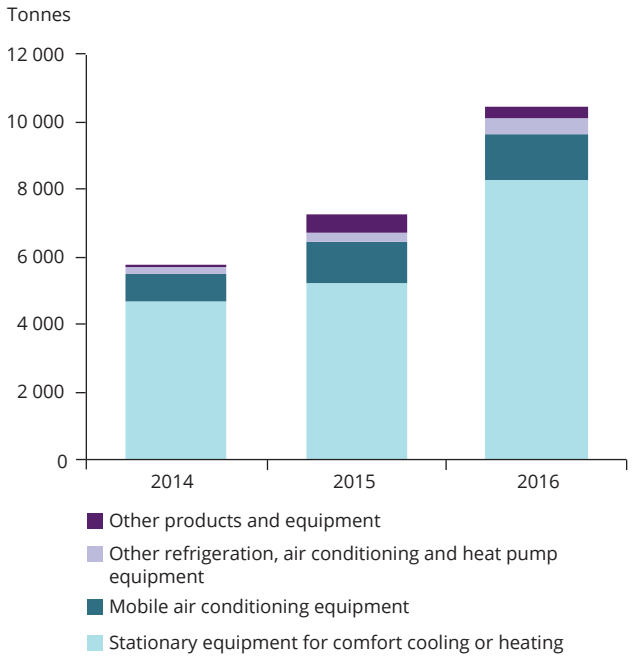
**Figure 3.6 EU imports of fluorinated gases within products and equipment**




**Sources:** EEA, 2016 and 2017b.

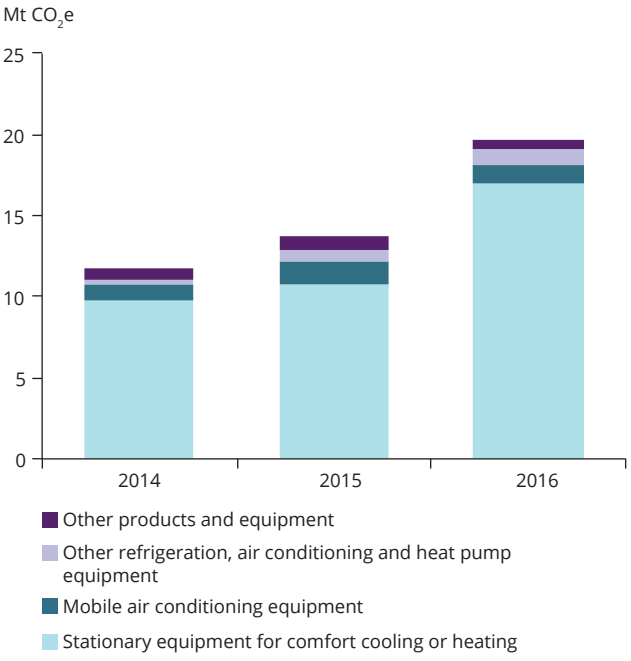
([10]) Data reported by importers of products or equipment under the F-Gas Regulation (EU) No 517/2014 are defined as including quantities imported and placed on the market. Products and equipment that are imported but not placed on the market (e.g. for re-export) are not to be reported. Considering this limitation, the import of gases within products and equipment presented here have been approximated using the reported data.

**Figure 3.7** **Categories of EU supply in products and equipment of fluorinated gases (tonnes)**




**Sources:** EEA, 2016 and 2017b.

**Figure 3.8** **Categories of EU supply in products and equipment of fluorinated gases ($CO_2e$)**




**Sources:** EEA, 2016 and 2017b.

The most important category in equipment imports (Figure 3.7 and Figure 3.8) with the strongest growth is 'stationary equipment for comfort cooling or heating' (mostly air conditioning). Reported imports in that category have risen by about 60 % compared with 2015, constituting 79 % of total equipment imports. However, this type of equipment makes up 86 % ($CO_2e$) of the total GWP of the F-gases imported in products and equipment. This is because the units are mostly operated with R-410A, which has a GWP of more than 2 000, higher than most other F-gases commonly used in products and equipment, such as HFC-134a and unsaturated HFC-1234yf.

In contrast, F-gases in mobile air conditioning (mostly in passenger cars and light duty vehicles) have risen by 11 % in tonnes, but decreased by 22 % in $CO_2e$, which reflects the increasing proportion of unsaturated HFC-1234yf, with its low GWP, replacing HFC-134a.

Tabular overview of tonnes and $CO_2e$ of fluorinated gases imported into the EU since 2007 are given in Annex 5 in Table A5.5 and Table A5.6 for total imports, in Table A5.7 and Table A5.8 for bulk imports and in Table A5.9 and Table A5.10 for imports in products and equipment (page 59.). Equipment imports by equipment category are given in Table A5.11 and Table A5.12 (page 60).

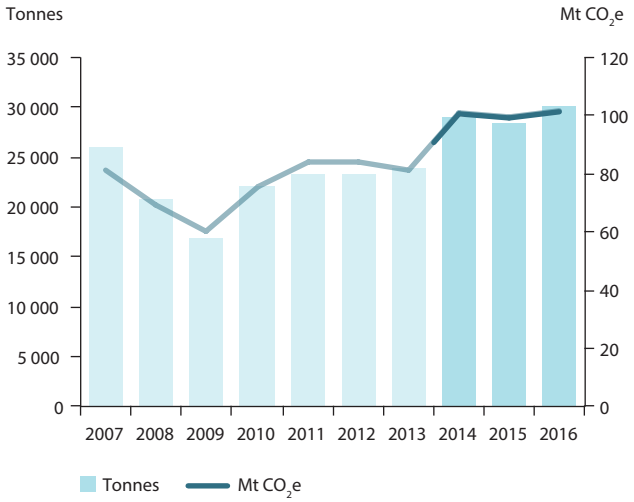
### *Exports*

Bulk exports ([11]) of fluorinated gases from the EU in 2016 rose by 6 % (tonnes) or 2 % ($CO_2e$) compared with 2015 (Figure 3.9). The general trend shows that exports have been rising since 2009, surpassing the previous high of 2007 in 2014. Details can be found in Table A5.13 and Table A5.14, page 61. 2016 exports were the highest since reporting started in 2007.

The composition of exports mirrors that of production. Exports are dominated by HFCs (about 90 % of the total). Other gases make up a small proportion of exports but contribute almost 50 % to their total GWP (mostly due to $SF_6$) (Figure 3.10 and Figure 3.11, page 19). In 2016, there was a decrease in $SF_6$ exports, which was more than offset by a 6 % increase in HFC exports. The GWP of these HFCs was comparatively high (total GWP increased by 16 %), indicating that high-GWP HFCs produced in the EU are being exported in increasing amounts.

([11]) The F-Gas Regulations do not stipulate data collection on exports of products and equipment.

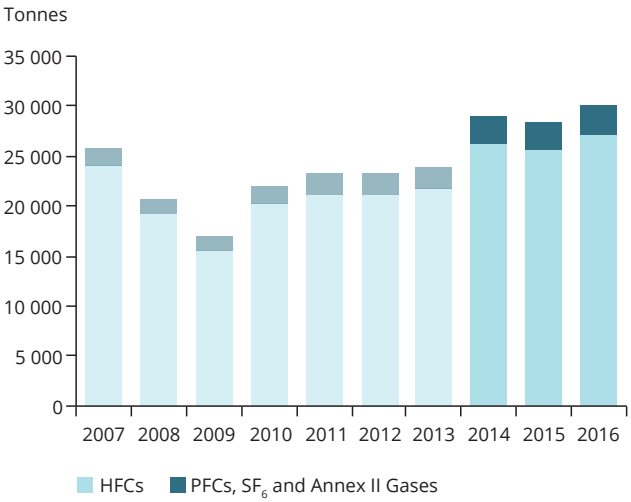
**Figure 3.9 EU bulk exports of fluorinated gases**




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

**Figure 3.10 EU bulk export by groups of fluorinated gases (tonnes)**




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

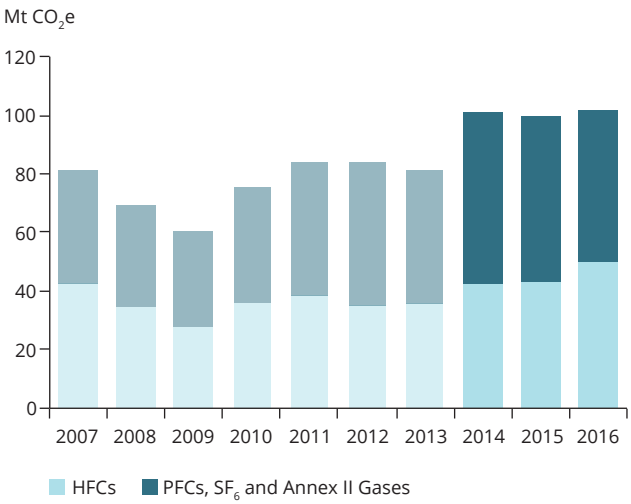
## 3.3 Destruction and feedstock use of fluorinated gases

This section presents the amounts of F-gases reported as destroyed or used for feedstock. Use for feedstock means that the F-gas undergoes a chemical transformation that converts it to a different substance, which will result in insignificant emissions. Note that some industrial processes that use F-gases, for example etching or cleaning chemical vapour deposition chambers in the electronics industry, do result in considerable destruction rates, but they do not qualify as destruction or feedstock use.

### *Destruction*

Destruction of fluorinated gases in the EU consistently and strongly increased from 2008 to 2015, with the exception of very low reported levels for 2013 ([12]). However, the destruction reported for 2016 was about 50 % below that of 2015 (40 % in $CO_2e$) (Figure 3.12).

**Figure 3.11 EU bulk export by groups of fluorinated gases ($CO_2e$)**

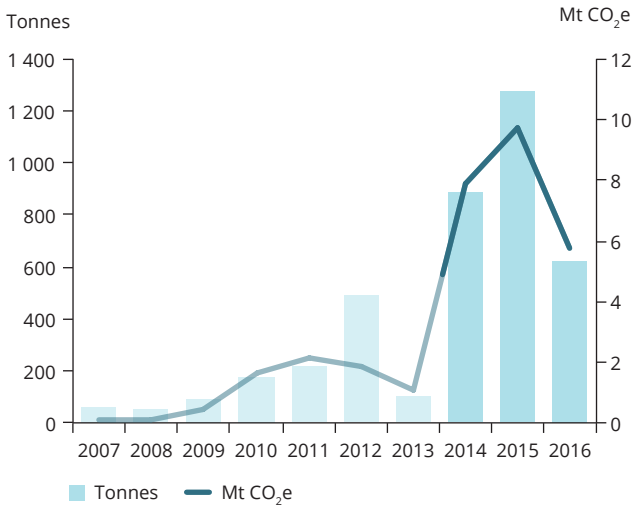



**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

([12]) A thorough analysis of the confidential data indicates that this is likely to be due to incomplete reporting, which manifested itself most strikingly in 2013.

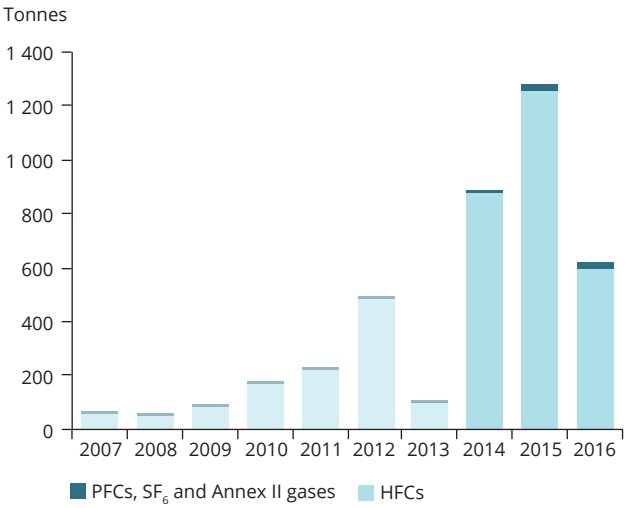
**Figure 3.12 EU destruction of fluorinated gases**




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

**Figure 3.13 EU destruction by groups of fluorinated gases (tonnes)**



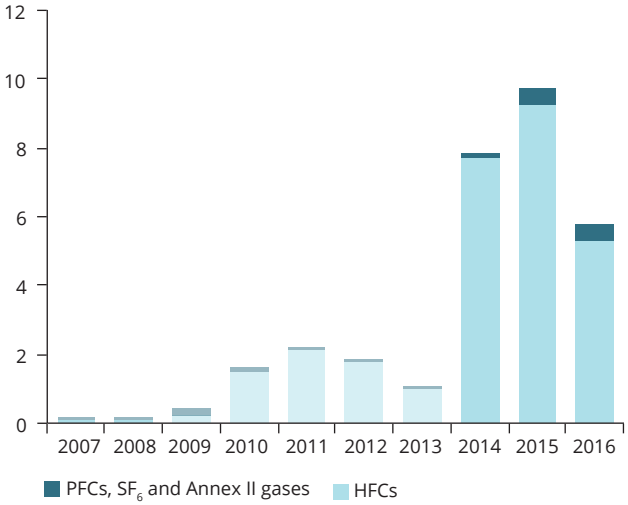

**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

Destruction is focused on HFCs (96 % of total amount), of which about half is HFC-23. HFC-23 occurs as a by-product in certain production processes of fluorinated gases, and its destruction or reclamation is obligatory under the F-Gas Regulation (Figure 3.13 and Figure 3.14). Note that, despite making up only 45 % of the total proportion of destroyed F-gases, HFC-23 alone constitutes more than 80 % of total destroyed GWP in $CO_2$e.

HFC destruction plays a role in determining consumption because HFCs that are destroyed are subtracted from the amounts of HFCs that are produced and imported in that calculation (see Chapter 6, page 30). In comparison with final consumption, the amount of destroyed HFCs was 6 % in 2015 and 4 % in 2016 (measured in $CO_2$e).

**Figure 3.14 EU destruction by groups of fluorinated gases ($CO_2$e)**




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

### *Feedstock use*

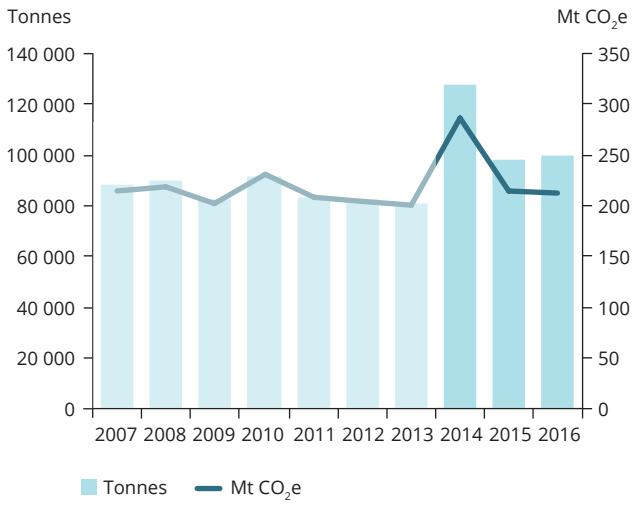
Since 2007, EU feedstock use has been fluctuating, but it shows a declining trend. The reported amounts for 2015 and 2016 are similar and the lowest since reporting started. Feedstock use consists almost exclusively of HFCs, most of which is HFC-23, and small amounts of unsaturated HCFCs. As for destruction, HFCs that are used as feedstock do not count towards consumption (see Chapter 6, page 30). The amount of HFCs used as feedstock, in comparison to HFC consumption, was about 2 % in 2016 ($CO_2$e).

# 4 Supply of fluorinated gases to the EU

EU supply is a metric used by the EEA that provides information on the actual use of fluorinated gases by EU industries. It is calculated primarily from reported production, imports and exports ([13]). Details can be found in Table A5.15 to Table A5.18, page 66.

The supply of fluorinated gases to the EU declined slightly from 2010 to 2013. There was an exceptionally high amount in 2014 (driven by an incentive to stockpile before the quota system entered into force: see discussion on bulk imports in Section 3.2). Total supply in 2016 was slightly (2 %) higher than in 2015, but with a lower total GWP (2 % decrease) than in 2015 (Figure 4.1).

**Figure 4.1 EU supply of fluorinated gases**




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) and gases contained in products and equipment were not subject to reporting before 2014.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

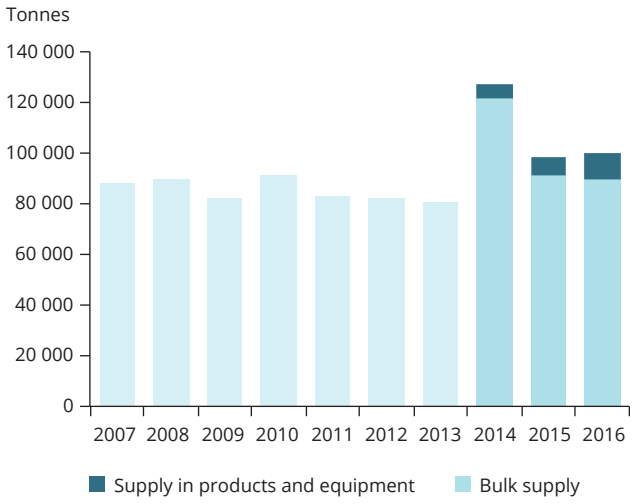
Not taking 2014 into account, reported levels of supply in 2015 and 2016 were markedly higher than in 2007-2013: this is partly due to imports of F-gases in equipment, which were not part of the reporting system before 2014. Only bulk supply is included in those years. The proportion of equipment imports in the total supply has been increasing since 2014 and was 10 % (tonnes) or 9 % ($CO_2$e) in 2016 (Figure 4.2 and Figure 4.3). As discussed in Section 3.2 on imports, however, that rise is probably due, to a large extent, to more complete reporting by equipment importers. Taking this into account, the level of bulk supply in 2015 and 2016 corresponds to the levels observed in 2010 and earlier years.

The supply of F-gases is dominated by HFCs, which accounted for 92 % (in tonnes) or 85 % (in $CO_2$e) of the total in 2016 (Figure 4.4 and Figure 4.5). The proportion of gases with low GWP increased compared with 2015 (amounts of unsaturated HFCs and HCFCs, in particular HFC-1234yf, have doubled). $SF_6$, a gas with a very high GWP, decreased, but this is almost entirely offset by an increase in $NF_3$ supply. Therefore, the total GWP of bulk supply decreased by 2 % in $CO_2$e, even though the total amount was higher than in 2015.

While previous graphs focused on analyses split either by gas or by supply type, Figure 4.6 and Figure 4.7 combine these perspectives and show the order of magnitude of HFCs, PFCs and $SF_6$ in products and equipment and Annex II F-gases that were not subject to reporting before 2014.

([13]) For methodological details on the calculation of EU supply, please refer to Annex 4, in particular Table A4.1 (page 51), which explains the difference between the metrics of 'EU supply', 'placing on the market', and 'consumption', which are relevant for different aspects of the legal framework.

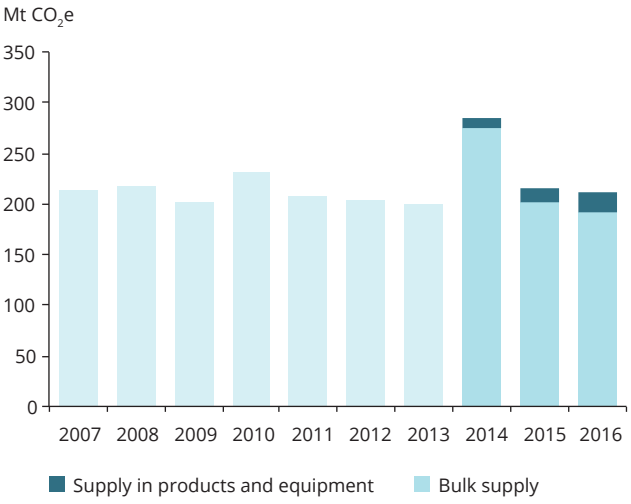
## Figure 4.2 EU supply of fluorinated gases by types (tonnes)




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) and gases contained in products and equipment were not subject to reporting before 2014.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

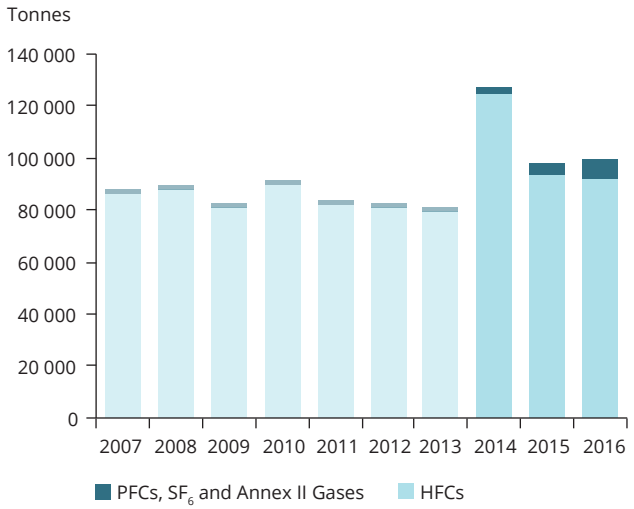
## Figure 4.3 EU supply of fluorinated gases by types ($CO_2e$)




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) and gases contained in products and equipment were not subject to reporting before 2014.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

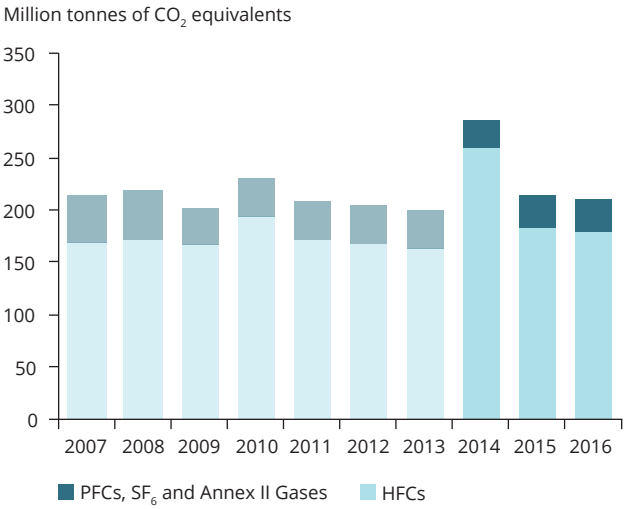
## Figure 4.4 EU supply by groups of fluorinated gases (tonnes)




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) and gases contained in products and equipment were not subject to reporting before 2014.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

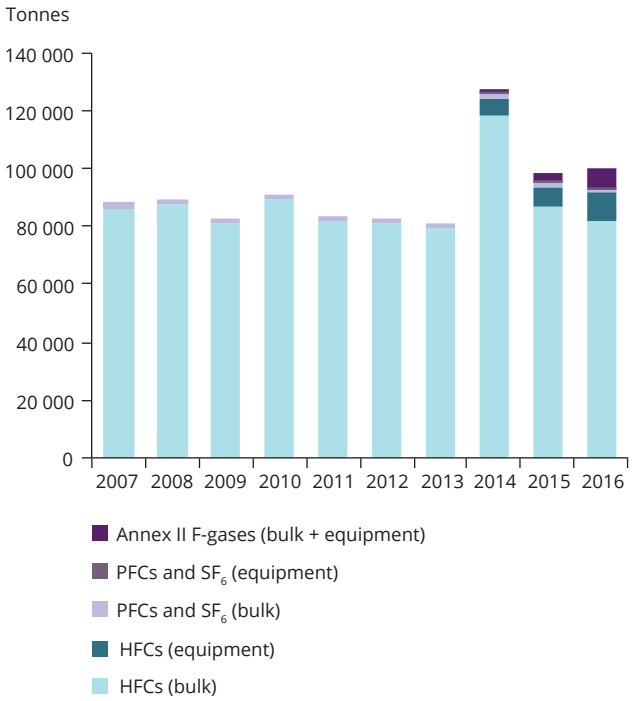
## Figure 4.5 EU supply by groups of fluorinated gases ($CO_2e$)




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) and gases contained in products and equipment were not subject to reporting before 2014.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

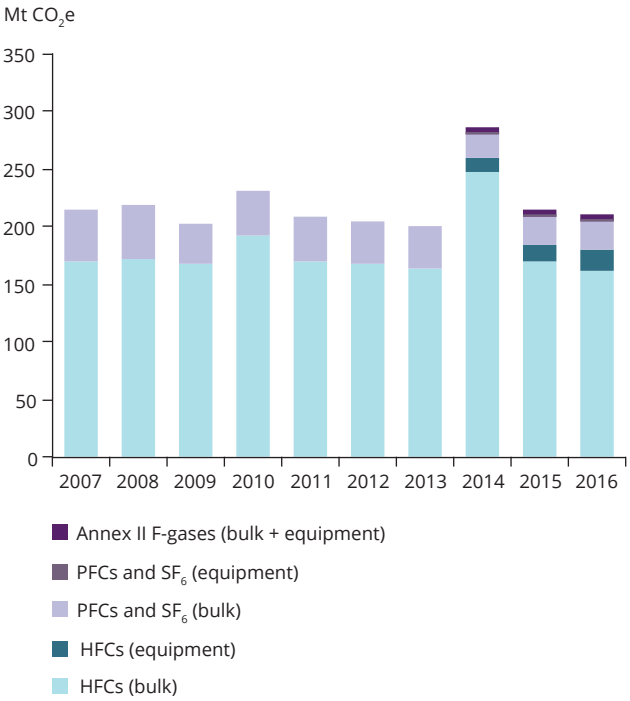
**Figure 4.6** **EU supply by supply types and groups of fluorinated gases (tonnes)**




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) and gases contained in products and equipment were not subject to reporting before 2014.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

**Figure 4.7** **EU supply by supply types and groups of fluorinated gases ($CO_2e$)**



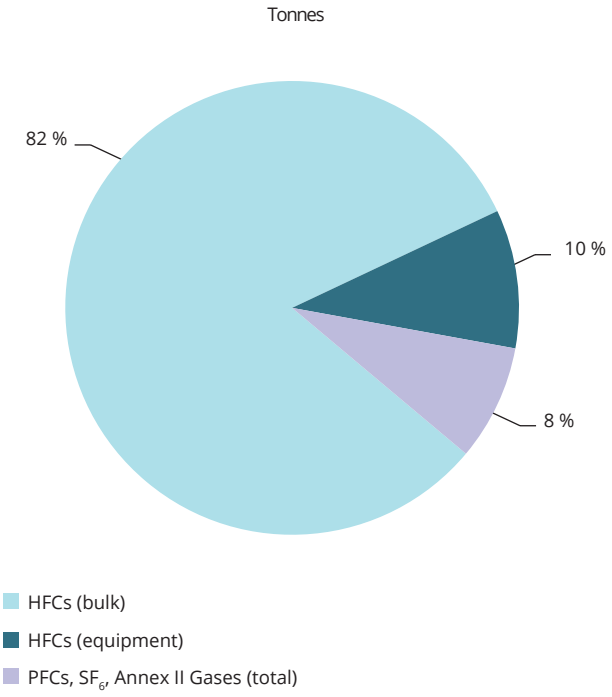

**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) and gases contained in products and equipment were not subject to reporting before 2014.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

The figures above show that, of all the F-gases that are subject to reporting, only HFCs are imported in products and equipment in significant amounts (dark blue part of the columns). However, HFCs in bulk imports constitute the lion's share (light blue). Figure 4.8 (See page 24) shows the make-up of supply in 2016 in more detail: the largest proportion is HFCs delivered in bulk (82 % of total EU supply of F-gases) and about 10 % is HFCs delivered in products and equipment. PFCs, $SF_6$ and other gases are supplied almost exclusively in bulk.

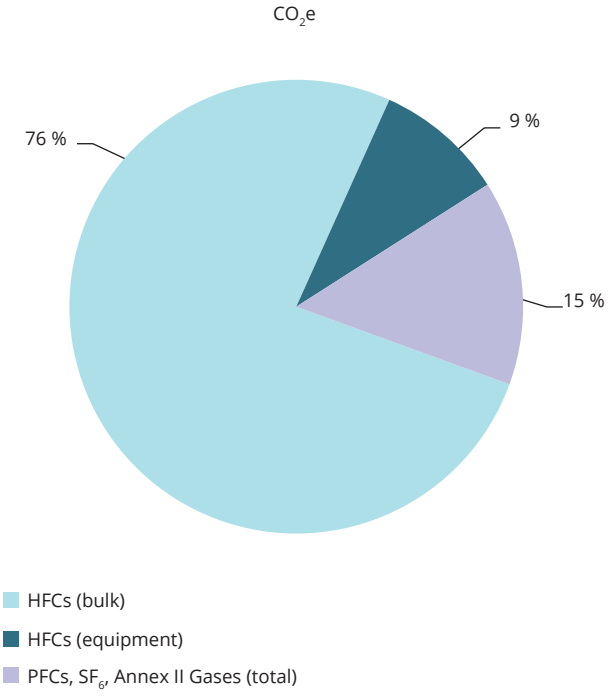
The picture looks slightly different when looking at the total GWP of the EU supply (Figure 4.9). The proportion of non-HFCs is much higher, at 15 % of the total GWP, which is mainly due to the very high GWP of $SF_6$.

**Figure 4.8** **2016 EU supply by supply types and groups of fluorinated gases (% tonnes)**




**Source:** EEA, 2017b.

**Figure 4.9** **2016 EU total supply by supply types and groups of fluorinated gases (% $CO_2e$)**




**Source:** EEA, 2017b.

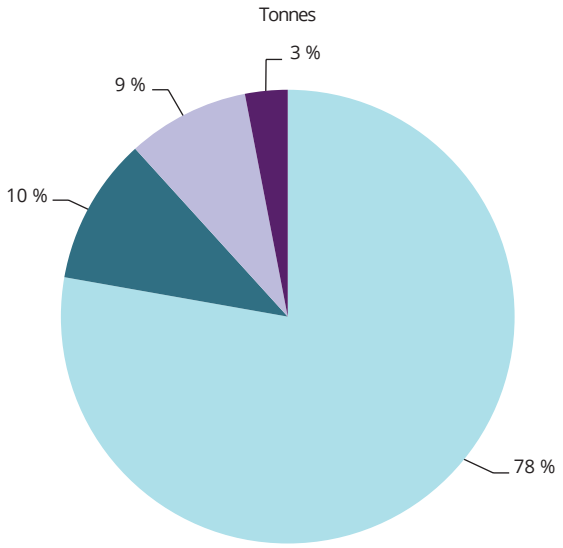
Overviews of tonnes and $CO_2e$ of fluorinated gases supplied in bulk to the EU since 2007 are given in Annex 5 in Table A5.15 and Table A5.16 for total supply (page 62-64) and in Table A5.17 and Table A5.18 for bulk supply. For supply in imports and equipment, please refer to Table A5.9 and Table A5.10 (page 59).

***Intended applications of EU supply***

Figure 4.10 and Figure 4.11 show the proportions of intended applications calculated for the 2016 supply of F-gases, while Figure 4.12 and Figure 4.13 (page 26) show the trends over time since 2007. For details of the calculation methods, please refer to Annex 4; data can be found in tables A5.19 and A5.20, page 67. When interpreting trends, the limitations of the consistency of the results between 2013 and 2014 because of new reporting requirements on equipment imports and Annex II gases should be kept in mind.

Refrigeration, air conditioning and heating are by far the most relevant applications of supplies of F-gases to the EU, representing more than three quarters of the 2016 supply. The supplied quantity of refrigerants increased by 3 % compared with 2015, while its total

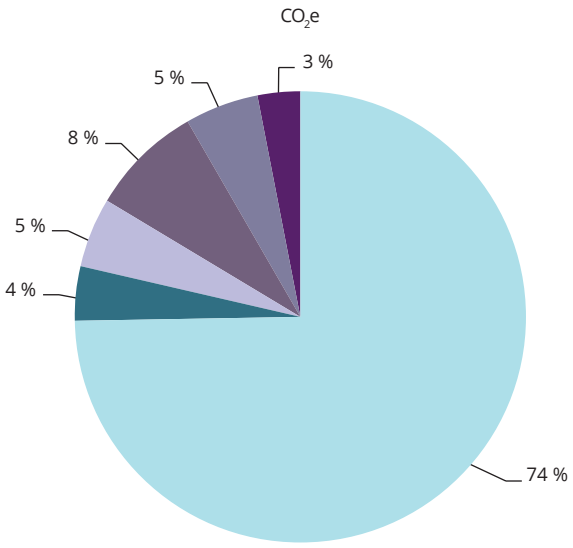
**Figure 4.10** 2016 EU supply by intended applications (% tonnes)




- Refrigeration, air-conditioning and heating and other heat transfer fluids
- Foams, including pre-blended polyols
- Aerosols
- Other or unknown applications

**Source:** EEA, 2017b.

**Figure 4.11** 2016 EU supply by intended applications (% $CO_2e$)




- Refrigeration, air-conditioning and heating and other heat transfer fluids
- Foams, including pre-blended polyols
- Aerosols
- Electrical equipment
- Semiconductor, photovoltaics and other electronics manufacture
- Other or unknown applications

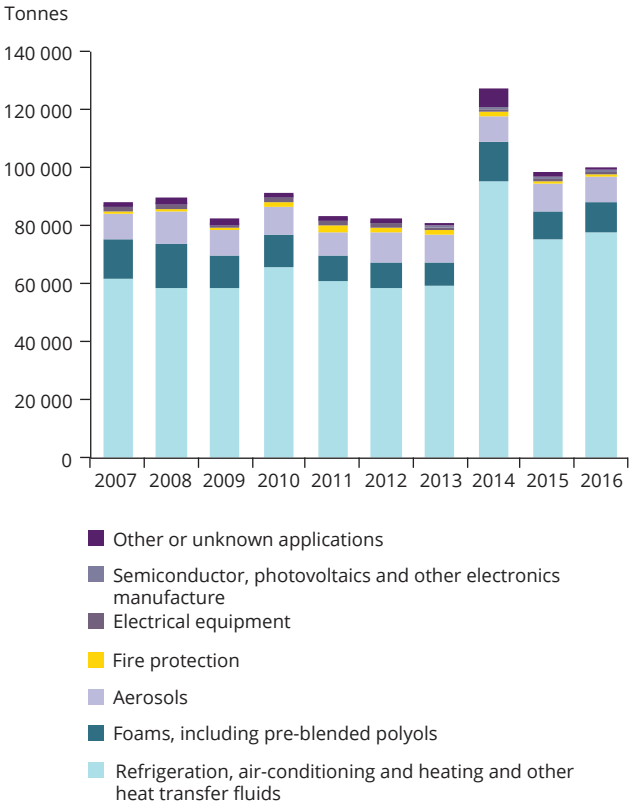
**Source:** EEA, 2017b.

GWP measured in $CO_2e$ decreased slightly, mostly because of the larger proportion of HFC-1234yf. This confirms the trend of using refrigerants with lower GWPs, as described in the previous EEA report (EEA, 2016).

F-gases used for foam blowing account for 10 % of the 2016 supply, when measured in tonnes. The gases used here, mostly HFCs, have comparatively low GWPs; therefore, foams account for only 4 % of total GWP. In absolute numbers, the supply for foam blowing increased by 10 % compared with 2015, an increase of mostly unsaturated HFCs and HCFCs. Nevertheless, the total GWP of F-gases used for foam blowing has increased by 27 % compared with 2015, mainly because of an increase in the use of HFC-227ea, which has a relatively high GWP, rather than HFC-134a.

The use of F-gases, mainly HFC-134a, for aerosols and foams dropped by about 10 % compared with the previous year. These uses now each account for 9 % of the total use, but, because they use gases with comparatively low GWP, only 5 % of the total $CO_2e$. The use of F-gases for fire protection has declined to approximately 25 % of the 2011 amount. It now stands at about 1 % of total supply, in both tonnes and $CO_2e$.

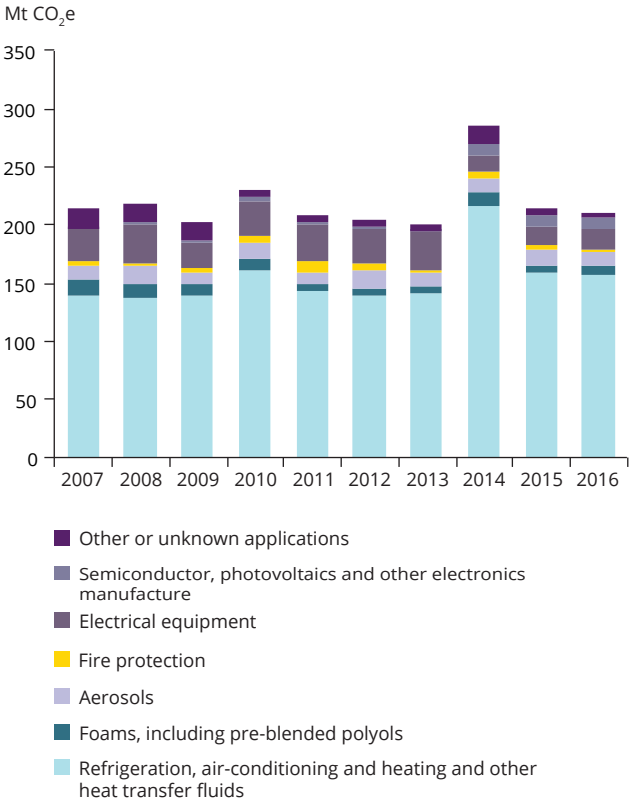
**Figure 4.12 Intended applications of EU total supply of fluorinated gases (tonnes)**




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) and gases contained in products and equipment were not subject to reporting before 2014.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

**Figure 4.13 Intended applications of EU total supply of fluorinated gases ($CO_2e$)**




**Note:** Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) and gases contained in products and equipment were not subject to reporting before 2014.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

Some smaller applications use F-gases with very high GWPs, which means they will represent a large proportion of total GWP, even though the amounts of F-gases used are small. These are primarily $SF_6$, PFCs and $NF_3$ used in electrical equipment (8 % of total GWP in 2016) and in semiconductor, photovoltaics and other electronics manufacture (5 %). $SF_6$ quantities reported for electrical equipment decreased by 7 % compared with 2015, while F-gases supplied for semiconductor, photovoltaics and other electronics manufacturing, primarily $NF_3$, increased by 5 %, with a higher average GWP (7 % increase if measured in $CO_2e$). Note that the time series in Figure 4.13 shows a substantial increase in semiconductor, photovoltaics and electronics manufacturing use between 2013 and 2014: this in mainly because companies were not obliged to report use of $NF_3$ before 2014.

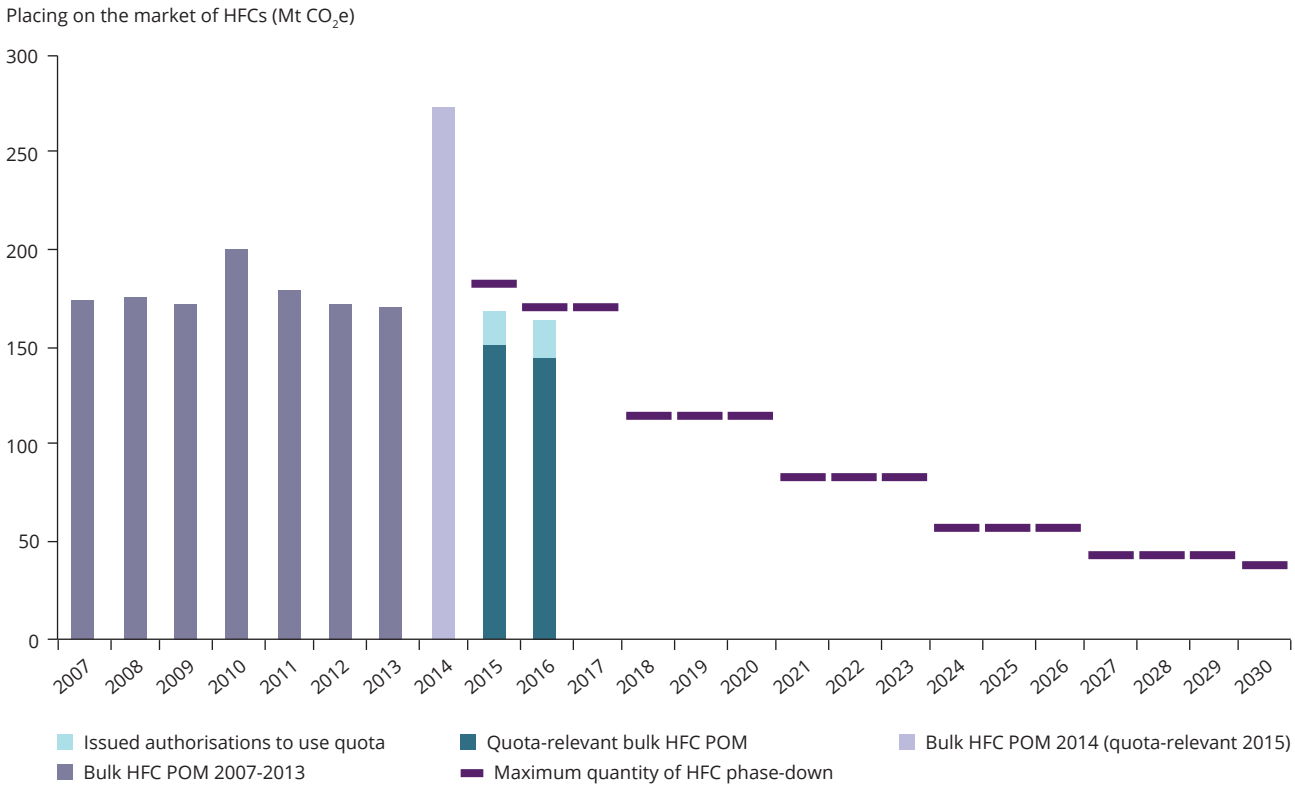
Tabular overviews of intended applications of EU F-gas supply are given in tables A5.19 and A5.20 (page 67). For categories of supply in products and equipment, please refer to Table A5.11 and Table A5.12 (page 60).

# 5 Progress of the EU HFC phase-down

Starting in 2015, the amount of HFCs that can be placed on the EU market annually is capped to a limited HFC quota, which is being progressively reduced ('EU HFC phase-down'). Companies that deal in HFCs annually receive quotas that are transferrable under certain conditions, although, unlike emissions allowances under the EU ETS, they are not freely tradable ([14]). In order to legally place HFC bulk gases on the EU market, companies must hold a sufficient quota. Companies exceeding their quota face a penalty of twice the exceedance amount, applied to the subsequent quota allocation by the European Commission. Additional consequences for non-compliant companies are subject to Member States' legislation.

Quotas are expressed in $CO_2e$, rather than physical tonnes of gases, to create an incentive to use gases with lower GWPs. The initial total allocation in 2015

**Figure 5.1 Progress of the EU HFC phase-down**




**Notes:** POM, placing on the market.

Values from 2007 to 2013 are based on the reporting obligations of the old F-Gas Regulation (EC) No 842/2006 and are therefore not fully comparable with data from 2014 onwards (based on the obligations of the new F-Gas Regulation (EU) No 517/2014). Similarly, the maximum quantities of the EU HFC phase-down will be recalculated for 2018 and are for indicative purposes only.

**Sources:** EC, 2011 and 2017a; EEA, 2016 and 2017b.

([14]) Quota allocations are set out in Article 16 and Annexes V and VI of the F-Gas Regulation (EU) No 517/2014. Transfers and authorisations are regulated in Article 18. Penalties are covered in Article 25.

was 183.1 Mt $CO_2$e (EC, 2017a). In 2016 and 2017, the first stage of reduction applied and only 170.3 Mt $CO_2$e was allocated (93 % of the 2015 allocation ([15]).

From 2017 onwards, HFCs contained in refrigeration, air conditioning and heat pump (RACHP) equipment are also covered by the quota mechanism. In order to import such equipment, importers must acquire authorisations to use quota from quota-holding companies. Notably, it is the sale of authorisations by the quota holder and not the actual import of RACHP equipment by the authorised party that counts as POM ([16]). Therefore, equipment imports can physically occur in a later year, while the sale of authorisations must be covered by quota for the year of the sale. Contrary to authorisations, quota is time-stamped for a specific year and unused quota cannot be carried over to the following year. Issued authorisations are already accounted for in the following figures on bulk POM.

The EU is on track for the HFC phase-down (Figure 5.1). Total quota-relevant POM was well below the maximum quantity since the phase-down started in 2015. For 2015, an over-achievement of 8 % can be observed. For 2016 ([17]), the margin was somewhat closer at 4 %.

The EU-level assessment presented in Figure 5.1 is based on company-level data concerning amounts of bulk HFCs placed on the market and the quotas held by these companies ([18]). In 2015 and 2016, the sum of unused quotas was much larger than the quota exceedances observed for some companies (Figure 5.2).

For 2015, the total of the unused 2015 quota amounted to 15.8 Mt $CO_2$e (9 % of the 2015 maximum quantity), while the total shortfall by all companies that exceeded their quota was 0.6 Mt $CO_2$e (EC, 2017a), which is equivalent to 0.3 % of the 2015 maximum quantity. This resulted in an EU-wide over-achievement margin of 15.2 Mt $CO_2$e. A 2016 study (Jörß et al., 2016) showed that a large part of the quota that was unused in 2015 was held by new entrant companies, i.e. companies that did not place bulk HFCs on the market in the baseline period, 2009-2012, of the EU HFC phase-down.

A similar situation was observed for 2016: total unused 2016 quota was 7.6 t $CO_2$e (4.5 % of the 2016 maximum quantity), while the sum of exceedances by companies was 1.3 Mt $CO_2$e (0.7 % of the 2016 maximum quantity). This resulted in a surplus of 6.4 Mt $CO_2$e for 2016. These data have not yet undergone in-depth scrutiny by the European Commission and final numbers may change.

Quota-relevant POM as shown in Figure 5.1 does not include amounts of HFCs placed on the market under the exemptions of Article 15(2) of the F-Gas Regulation. In total, about 12 % of HFCs reported fall under the Article 15(2) exemptions (a) to (e) (see Table A5.21, page 68). This proportion has been rising since reporting on these exemptions started in 2014. Exemptions under Article 15(2)(f) for pharmaceutical metered dose inhalers (MDIs) will not be in force before 2018.

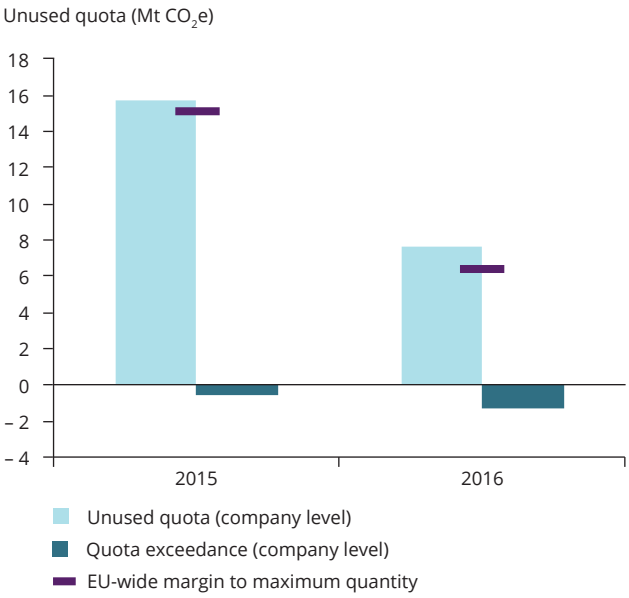
As mentioned above, HFCs contained in imported RACHP equipment will be included in the EU HFC phase-down starting in 2017. Equipment importers will then need to hold authorisations to use quota issued by HFC producers or bulk importers that were allocated quota by the European Commission. Figure 5.3 compares the levels of HFCs in imported RACHP equipment with authorisations issued up to and including 2016.

The figure shows that, in both 2015 and 2016, the amount of HFCs covered by the authorisations issued was even greater than actual HFC imports in RACHP equipment, even though equipment imports will fall under the quota system only from 2017 onwards. Equipment importers appear to have started building a reserve that is about twice the amount of actual 2016 HFC imports in RACHP equipment. This reserve accumulated by the end of 2016 to 22 % of the 2017 maximum quota allocation and can be used to cover equipment imports in 2017 and future years under the EU HFC phase-down because acquired authorisations are not earmarked for a particular year.

At the same time, this accumulated reserve of authorisations reduces the overall strain on quota issued for the following years, as RACHP equipment imports in those years will, at least partially, not need to be covered by quota issued for those years. This may be particularly relevant for 2018, when the quantity of issued quota will be significantly reduced in the next phase-down step.

([15]) See the phase-down schedule in Annex V of the F-Gas Regulation (EU) No 517/2014.
([16]) The monitoring of the EU HFC phase-down relies on the metric 'placing on the market' (POM). For calculation details, please refer to Annex 4 (page 49). Compliance-relevant POM is the physical POM of bulk HFCs, where not covered by one of the exemptions of Article 15 of the F-Gas Regulation, in addition to authorisations issued by quota holders.
([17]) Data for 2016 are preliminary and subject to scrutiny by the European Commission.
([18]) Data at company level are confidential and cannot be disclosed further.

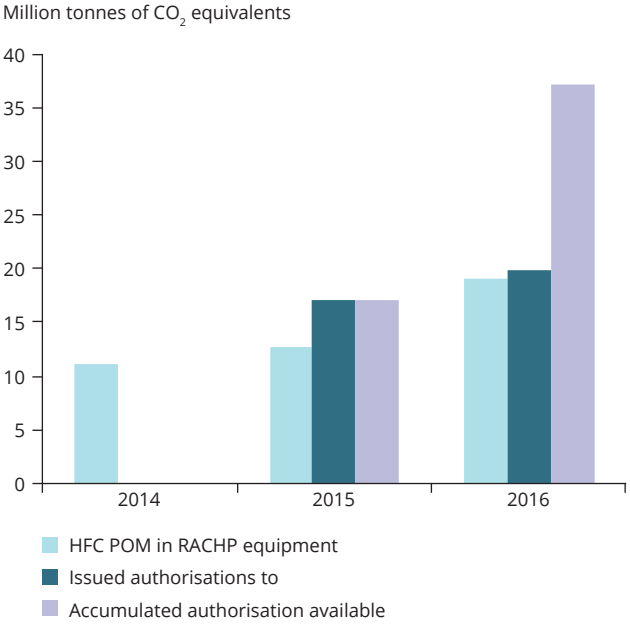
**Figure 5.2** **Balance between placing on the market of HFCs and related quotas at EU level**




**Note:** The data for 2016 have not yet undergone scrutiny by the European Commission.

**Sources:** EC, 2017a; EEA, 2016 and 2017b.

**Figure 5.3** **Authorisations for HFCs in RACHP equipment imports**




**Notes:** POM, placing on the market.

RACHP, refrigeration, air conditioning and heat pumps.

HFCs placed on the market in RACHP equipment until 2016 are not subject to the EU HFC phase-down.

**Sources:** EEA, 2016 and 2017b.

# 6 Approaching the international HFC phase-down under the Montreal Protocol

In October 2016, in Kigali, Rwanda, the Montreal Protocol was amended to regulate HFCs (the Kigali Amendment). Both developed and developing countries have taken on mandatory commitments on reducing production and consumption of HFCs in the next three decades. Under the amended protocol, for the EU and other developed countries, HFC consumption is limited to 90 % of the baseline starting in 2019, with further reduction steps until a 15 % level is reached from 2036 onwards (Figure 6.1). Measuring progress of this phase-down relies on the metric of 'consumption', which is similar, but not identical, to the metrics of 'supply' (Chapter 4) and 'placing on the market' (POM) used for the EU HFC phase-down (Chapter 5) ([19]).

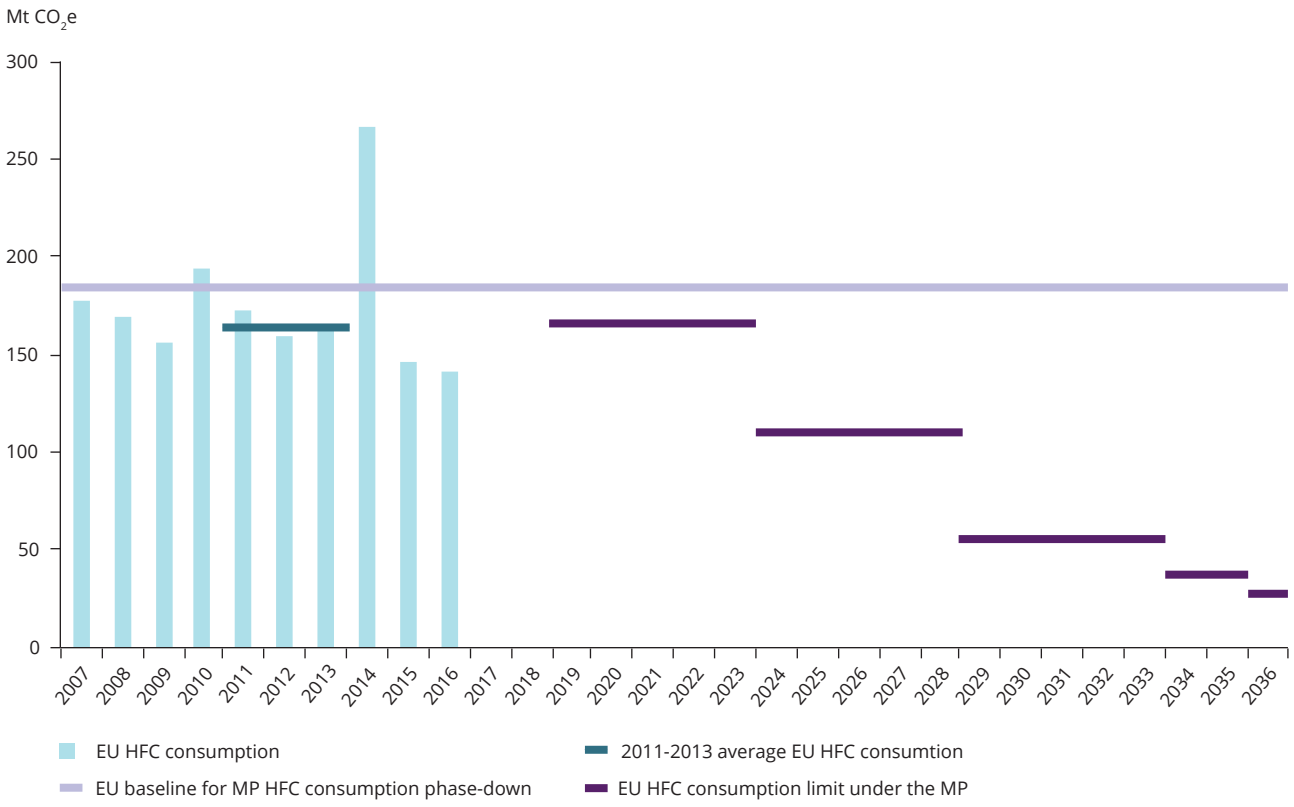
The baseline for the Montreal Protocol HFC phase-down is defined as the average HFC consumption during 2011-2013, plus 15 % of the HCFC baseline in 1989, all expressed in $CO_2$e. As set out in the Montreal Protocol, the HCFC baseline also includes 2.8 % of the 1989 chlorofluorocarbon (CFC) consumption. The 2011-2013 average EU HFC consumption, according to reporting under the F-Gas Regulation, was 165.1 Mt $CO_2$e (EEA, 2016, Figure 6.1). The HCFC/CFC part of the EU baseline was calculated as 19.0 Mt $CO_2$e (EC, 2017b). In total, the EU baseline under the Montreal Protocol HFC phase-down is estimated ([20]) as 184.1 Mt $CO_2$e.

In Figure 6.1, EU consumption of HFCs covered under the Montreal Protocol since 2007 is presented and contrasted with the Montreal Protocol phase-down steps applying to the EU starting in 2019. With the exception of 2014 (where consumption was probably inflated as a result of the upcoming phase-down, see Section 3.2, page 16), HFC consumption is experiencing a downward trend. 2016 has seen the lowest HFC consumption since reporting started (4 % less than 2015). 2016 HFC consumption is already 14 % below the allowed amount for 2019, when the Montreal Protocol phase-down begins.

A tabular overview of HFC consumption is given in Table A5.22 in Annex 5 (page 68).

([19]) For details on how the metrics are calculated, please refer to Annex 4 (page 49).
([20]) The quantification of the EU baseline is preliminary, subject to confirmation by the United Nations Environment Programme Ozone Secretariat.

**Figure 6.1 Approaching the Montreal Protocol HFC phase-down**




**Notes:** MP, Montreal Protocol.

HFCs covered under the Montreal Protocol include all HFCs covered under EU F-Gas Regulation No 517/2014, except HFC-161 (see Annex 1).

**Sources:** EC, 2011 and 2017b; EEA, 2016 and 2017b.

# Terminology

***Fluorinated gases (F-gases)***

F-gases covered by this report can be grouped into:

- gases contained in Annex I of the new F-Gas Regulation, as listed in Annex 1 of this report;
- gases contained in Annex II of the new F-Gas Regulation, as listed in Annex 2 of this report.

Jointly, those gases are referred to in this report as 'fluorinated gases' or 'F-gases'.

The list of reportable fluorinated gases under the old F-Gas Regulation was restricted to HFCs, PFCs and $SF_6$, as identified in Annex 1 on page 40.

## Annex I F-gases

F-gases under Annex I of the new F-Gas Regulation include HFCs, PFCs and $SF_6$. The majority of these gases have high GWPs.

The gases of Annex I of the new F-Gas Regulation are given in Annex 1 to this report.

***Hydrofluorocarbons (HFCs)***

HFCs are relatively short aliphatic organic compounds that contain fluorine, carbon and hydrogen. They are most commonly used as refrigerants. Nineteen HFCs and their GWPs are listed in Annex 1. All HFCs in Annex 1, except HFC-152 and HFC-161, were previously covered by the old F-Gas Regulation (EC) No 842/2006.

***Perfluorocarbons (PFCs)***

PFCs are relatively short aliphatic organic compounds that contain fluorine and carbon only. They are most commonly used in semiconductor manufacture. Seven PFCs and their GWPs are listed in Annex 1. All PFCs in Annex 1 were previously covered by the old F-Gas Regulation.

***Sulphur hexafluoride ($SF_6$)***

$SF_6$ is an inorganic compound; because it is an excellent electrical insulator, its main use is in the electrical industry. $SF_6$ is a potent greenhouse gas; its GWP is listed in Annex 1. $SF_6$ was also covered by the old F-Gas Regulation.

## Annex II F-gases

'Other fluorinated greenhouse gases' are listed in Annex II of Regulation No 517/2014 and include:

- unsaturated hydro(chloro)fluorocarbons (Section 1 of Annex II);
- fluorinated ethers and alcohols (Section 2 of Annex II);
- other perfluorinated compounds, including $NF_3$ (Section 3 of Annex II).

All these gases and their GWPs are listed in Annex 1 of this report. The Annex II F-gases were not covered by the reporting obligations under the old F-Gas Regulation (EC) No 842/2006.

***Bulk gases and gases contained in equipment***

Gases contained in gas containers, including bottles and isotanks, are referred to as bulk gases, irrespective of the absolute amounts of gases handled. Bulk gases are to be differentiated from gases contained in products or equipment, as different reporting obligations apply.

*Mixtures*

Mixtures of fluorinated gases are often used in industrial applications. In their reports under Article 19 of the F-Gas Regulation (EU) No 517/2014, companies report on their transactions (import, export, etc.) of such mixtures, while specifying their composition. For the purpose of the present aggregation report, the amounts of mixtures are recalculated as the proportions of their constituent fluorinated gases as listed in Annex 1, unless indicated otherwise.

*Annex IV gases*

Annex IV of the new F-Gas Regulation lists some non-fluorinated greenhouse gases that have GWPs that also need to be considered when determining the GWP of a mixture. These gases and their GWPs are also listed in Annex 1 of this report. For all other substances included in a mixture, a default value of 0 is used for the calculation the GWP.

*Nil report*

A nil report is a notification by a company that it considers itself not obliged to report under the F-Gas Regulation.

*Global warming potentials (GWPs)*

GWPs are used to make different gases comparable in terms of their potential impact on climate change. The multiplication of a quantity of a gas by its GWP results in that quantity expressed as $CO_2e$.

The GWPs used under the new F-Gas Regulation are in line with those published in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) (IPCC, 2007). The old F-Gas Regulation (EC) No 842/2006 used the earlier set of GWPs published by the IPCC in its Third Assessment Report (TAR) (IPCC, 2001). Accordingly, previous EEA technical reports on fluorinated gases up to 2014 used TAR GWPs.

Quantities of F-gases are reported in physical tonnes. Conversion of the figures into $CO_2e$ based on gas-specific GWPs facilitates a focus on the potential warming effect caused by these gases after release to the atmosphere. Both metrics are used in this report when analysing the data.

The GWPs of gases used for the present report are listed in Annex 1. GWPs of mixtures are calculated according to Annex IV of the new F-Gas regulation (EU, 2014b).

# Abbreviations

| | |
|---|---|
| BDR | Business Data Repository of the EEA |
| CFC | Chlorofluorocarbon |
| $CO_2$ | Carbon dioxide |
| $CO_2e$ | $CO_2$ equivalent |
| EC | European Commission |
| DG CLIMA | Directorate-General for Climate Action of the European Commission |
| EEA | European Environment Agency |
| ETC/ACM | European Topic Centre on Air Pollution and Climate Change Mitigation |
| EU | European Union |
| EU-28 | Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom |
| AR4 | Fourth Assessment Report of the IPCC |
| F-gases | Fluorinated gases |
| GWP | Global warming potential |
| HCFC | Hydrochlorofluorocarbon |
| HFC | Hydrofluorocarbon |
| HFE | Hydrofluoroether |
| IPCC | Intergovernmental Panel on Climate Change |
| kg | Kilogrammes |
| kt | Kilotonnes |
| MP | Montreal Protocol |
| Mt | Megatonnes |
| $NF_3$ | Nitrogen trifluoride |
| ODS | Ozone-depleting substances |

| | |
|---|---|
| PFCs | Perfluorocarbons |
| PFPMIE | Perfluoropolymethylisopropylether |
| POM | Placing on the market |
| QA/QC | Quality assurance/quality control |
| R-134a | Refrigerant classification of HFC-134a |
| R-404A | Refrigerant mixture of HFCs (52 % HFC-143a, 44 % HFC-125, 4 % HFC-134a) |
| R-407C | Refrigerant mixture of HFCs (52 % HFC-134a, 25 % HFC-125, 23 % HFC-32) |
| R-410A | Refrigerant mixture of HFCs (50 % HFC-125, 50 % HFC-32) |
| R-507A | Refrigerant mixture of HFCs (50 % HFC-143a, 50 % HFC-125) |
| RACHP | Refrigeration, air conditioning and heat pump |
| $SF_6$ | Sulphur hexafluoride |
| t | Tonne |
| TAR | Third Assessment Report of the IPCC |
| UNEP | United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |

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EU, 2006, Regulation (EC) No 842/2006 of the European Parliament and of the Council of 17 May 2006 on certain fluorinated greenhouse gases (OJ L 161, 14.6.2006, p. 1-11).

EU, 2007a, Treaty of Lisbon amending the Treaty on European Union and the Treaty establishing the European Community, signed at Lisbon, 13 December 2007 (OJ C 306, 17.12.2007, p. 1-271).

EU, 2007b, Commission Regulation (EC) No 1493/2007 of 17 December 2007, establishing, pursuant to Regulation (EC) No 842/2006 of the European Parliament and of the Council, the format for the report to be submitted by producers, importers and exporters of certain fluorinated greenhouse gases (OJ L 332, 18.12.2007, p. 7-24).

EU, 2009, Regulation (EC) No 1005/2009 of the European Parliament and of the Council of 16 September 2009 on substances that deplete the ozone layer (OJ L 286, 31.10.2009, p. 1-30).

EU, 2014a, Commission Implementing Regulation (EU) No 1191/2014 of 30 October 2014 determining the format and means for submitting the report referred to in Article 19 of Regulation (EU) No 517/2014 of the European Parliament and of the Council on fluorinated greenhouse gases (OJ L 318, 5.11.2014, p. 5-20).

EU, 2014b, Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006 (OJ L 150, 20.5.2014, p. 195–230).

IPCC, 2001, *Third assessment report — Climate change*, Intergovernmental Panel on Climate Change (https://www.ipcc.ch/ipccreports/tar/), last accessed 14 Nov 2017.

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Montreal Protocol on Substances That Deplete the Ozone Layer, international treaty, adopted in Montreal on 16 September 1987.

# Annexes

# Annex 1 Gases covered by Regulation (EU) No 517/2014

**Table A1.1 Annex I of Regulation (EU) No 517/2014**

| Gas | GWP (AR4) | Gas group | Reference | Coverage in 'the old F-Gas Regulation' No 842/2006 |
|---|---|---|---|---|
| HFC-23 | 14 800 | HFCs | Annex I Section 1 | Covered |
| HFC-32 | 675 | HFCs | Annex I Section 1 | Covered |
| HFC-41 | 92 | HFCs | Annex I Section 1 | Covered |
| HFC-125 | 3 500 | HFCs | Annex I Section 1 | Covered |
| HFC-134 | 1 100 | HFCs | Annex I Section 1 | Covered |
| HFC-134a | 1 430 | HFCs | Annex I Section 1 | Covered |
| HFC-143 | 353 | HFCs | Annex I Section 1 | Covered |
| HFC-143a | 4 470 | HFCs | Annex I Section 1 | Covered |
| HFC-152 | 53 | HFCs | Annex I Section 1 | Not covered |
| HFC-152a | 124 | HFCs | Annex I Section 1 | Covered |
| HFC-161 | 12 | HFCs | Annex I Section 1 | Not covered |
| HFC-227ea | 3 220 | HFCs | Annex I Section 1 | Covered |
| HFC-236cb | 1 340 | HFCs | Annex I Section 1 | Covered |
| HFC-236ea | 1 370 | HFCs | Annex I Section 1 | Covered |
| HFC-236fa | 9 810 | HFCs | Annex I Section 1 | Covered |
| HFC-245ca | 693 | HFCs | Annex I Section 1 | Covered |
| HFC-245fa | 1 030 | HFCs | Annex I Section 1 | Covered |
| HFC-365mfc | 794 | HFCs | Annex I Section 1 | Covered |
| HFC-43-10mee | 1 640 | HFCs | Annex I Section 1 | Covered |
| PFC-14 (CF4) | 7 390 | PFCs | Annex I Section 2 | Covered |
| PFC-116 (C2F6) | 12 200 | PFCs | Annex I Section 2 | Covered |
| PFC-218 (C3F8) | 8 830 | PFCs | Annex I Section 2 | Covered |
| PFC-3-1-10 (C4F10) | 8 860 | PFCs | Annex I Section 2 | Covered |
| PFC-4-1-12 (C5F12) | 9 160 | PFCs | Annex I Section 2 | Covered |
| PFC-5-1-14 (C6F14) | 9 300 | PFCs | Annex I Section 2 | Covered |
| PFC-c-318 (c-C4F8) | 10 300 | PFCs | Annex I Section 2 | Covered |
| $SF_6$ | 22 800 | $SF_6$ | Annex I Section 3 | Covered |

**Sources:** EU, 2006; EU, 2014b.

**Table A1.2 Annex II of Regulation (EU) No 517/2014 (not covered by old Regulation (EC) No 842/2006)**

| Gas | GWP (AR4) | Gas group | Reference |
|---|---|---|---|
| HFC-1234yf | 4 | Unsaturated HFCs/HCFCs | Annex II Section 1 |
| HFC-1234ze | 7 | Unsaturated HFCs/HCFCs | Annex II Section 1 |
| HFC-1336mzz | 9 | Unsaturated HFCs/HCFCs | Annex II Section 1 |
| HCFC-1233zd | 5 | Unsaturated HFCs/HCFCs | Annex II Section 1 |
| HCFC-1233xf | 1 | Unsaturated HFCs/HCFCs | Annex II Section 1 |
| HFE-125 | 14 900 | HFEs and alcohols | Annex II Section 2 |
| HFE-134 | 6 320 | HFEs and alcohols | Annex II Section 2 |
| HFE-143a | 756 | HFEs and alcohols | Annex II Section 2 |
| HCFE-235da2 (isofluorane) | 350 | HFEs and alcohols | Annex II Section 2 |
| HFE-245cb2 | 708 | HFEs and alcohols | Annex II Section 2 |
| HFE-245fa2 | 659 | HFEs and alcohols | Annex II Section 2 |
| HFE-254cb2 | 359 | HFEs and alcohols | Annex II Section 2 |
| HFE-347 mcc3 (HFE-7000) | 575 | HFEs and alcohols | Annex II Section 2 |
| HFE-347pcf2 | 580 | HFEs and alcohols | Annex II Section 2 |
| HFE-356pcc3 | 110 | HFEs and alcohols | Annex II Section 2 |
| HFE-449sl (HFE-7100) | 297 | HFEs and alcohols | Annex II Section 2 |
| HFE-569sf2 (HFE-7200) | 59 | HFEs and alcohols | Annex II Section 2 |
| HFE-43-10pccc124 | 1 870 | HFEs and alcohols | Annex II Section 2 |
| HFE-236ca12 (HG-10) | 2 800 | HFEs and alcohols | Annex II Section 2 |
| HFE-338pcc13 (HG-01) | 1 500 | HFEs and alcohols | Annex II Section 2 |
| HFE-347mmy1 | 343 | HFEs and alcohols | Annex II Section 2 |
| 2,2,3,3,3-pentafluoropropanol | 42 | HFEs and alcohols | Annex II Section 2 |
| bis(trifluoromethyl)-methanol | 195 | HFEs and alcohols | Annex II Section 2 |
| HFE-227ea | 1 540 | HFEs and alcohols | Annex II Section 2 |
| HFE-236ea2 (desfluoran) | 989 | HFEs and alcohols | Annex II Section 2 |
| HFE-236fa | 487 | HFEs and alcohols | Annex II Section 2 |
| HFE-245fa1 | 286 | HFEs and alcohols | Annex II Section 2 |
| HFE 263fb2 | 11 | HFEs and alcohols | Annex II Section 2 |
| HFE-329mcc2 | 919 | HFEs and alcohols | Annex II Section 2 |
| HFE-338mcf2 | 552 | HFEs and alcohols | Annex II Section 2 |
| HFE-338mmz1 | 380 | HFEs and alcohols | Annex II Section 2 |
| HFE-347mcf2 | 374 | HFEs and alcohols | Annex II Section 2 |
| HFE-356mec3 | 101 | HFEs and alcohols | Annex II Section 2 |
| HFE-356mm1 | 27 | HFEs and alcohols | Annex II Section 2 |
| HFE-356pcf2 | 265 | HFEs and alcohols | Annex II Section 2 |
| HFE-356pcf3 | 502 | HFEs and alcohols | Annex II Section 2 |
| HFE 365mcf3 | 11 | HFEs and alcohols | Annex II Section 2 |
| HFE-374pc2 | 557 | HFEs and alcohols | Annex II Section 2 |
| - $(CF_2)_4CH(OH)$ - | 73 | HFEs and alcohols | Annex II Section 2 |
| $NF_3$ (nitrogen trifluoride) | 17 200 | Other perfluorinated compounds | Annex II, Section 3 |
| c-$C_3F_6$ (perfluorocyclopropane) | 17 340 | Other perfluorinated compounds | Annex II, Section 3 |
| PFPMIE | 10 300 | Other perfluorinated compounds | Annex II, Section 3 |
| $SF_5CF_3$ | 17 700 | Other perfluorinated compounds | Annex II, Section 3 |

**Note:** Annex II gases were not covered under the old F-Gas Regulation 842/2006.

**Source:** EU, 2014b.

***Non-fluorinated gases in Annex IV of Regulation (EU) No 517/2014 (not covered by the old Regulation (EC) No 842/2006)***

According to Annex IV of the new F-Gas Regulation (EU) No 517/2014, the GWP of mixtures containing gases outside the scope of Annexes I and II of Regulation (EU) No 517/2014 are to be calculated using the GWPs given here for the non-fluorinated gases. For other constituents of mixtures that are not listed here (e.g. ODS), a GWP value of zero shall be used.

**Table A1.3**

| Substance | Formula | GWP (AR4) |
|---|---|---|
| R-170 (Ethane) | $CH_3CH_3$ | 6 |
| R-290 (Propane) | $CH_3CH_2CH_3$ | 3 |
| R-600 (Butane) | $CH_3CH_2CH_2CH_3$ | 4 |
| R-600A (Isobutane) | $CH(CH_3)_2CH_3$ | 3 |
| R-601 (Pentane) | $CH_3CH_2CH_2CH_2CH_3$ | 5 |
| R-601A (Isopentane) | $(CH_3)_2CHCH_2CH_3$ | 5 |
| $C_5H_{10}$ (Cyclopentane) | $C_5H_{10}$ | 5 |
| R-610 (Ethoxyethane, diethyl ether) | $CH_3CH_2OCH_2CH_3$ | 4 |
| R-611 (Methyl formate) | $HCOOCH_3$ | 25 |
| R-702 (Hydrogen) | $H_2$ | 6 |
| R-717 (Ammonia) | $NH_3$ | 0 |
| R-744 (Carbon dioxide) | $CO_2$ | 1 |
| R-1150 (Ethylene) | $C_2H_4$ | 4 |
| R-1270 (Propylene) | $C_3H_6$ | 2 |
| E-170 (Dimethyl ether) | $CH_3OCH_3$ | 1 |
| $CH_3Cl$ (Methyl chloride) | $CH_3Cl$ | 13 |
| $CHCl_3$ (Chloroform) | $CHCl_3$ | 31 |
| Methylene chloride | $CH_2Cl_2$ | 9 |
| $CH_4$ (Methane) | $CH_4$ | 25 |
| $N_2O$ (nitrous oxide) | $N_2O$ | 298 |

**Source:** EU, 2014b.

# Annex 2 F-gas reporting form

The reporting format for submitting the F-gas reports under Article 19 of Regulation (EU) No 517/2014 is laid out in Commission Implementing Regulation (EU) No 1191/2014. It was implemented as an online questionnaire on the BDR reporting platform at https://bdr.eionet.europa.eu/. Reporting is mandatory for every company that engages in the activities listed in Article 19 of Regulation (EU) No 517/2014.

***Cover sheet***

On the cover sheet, companies provide their current data and the activities during the reporting year, which may be one or more of the following:

- producer of HFCs or other fluorinated gases;
- importer of HFCs or other fluorinated gases;
- exporter of bulk gases;
- EU feedstock user;
- EU destruction company;
- importer of products or equipment containing F-gases of Annexes I or II;
- undertaking having given an authorisation to use its HFC quota to another undertaking.

In addition, companies select F-gases that will be reported and specify the mixtures used by them.

If none of these sections apply, companies may state that they are not obliged to report, skipping the quantitative part of the reporting process (nil report).

Large companies with subsidiaries in several EU countries are required to report separately for each country. To protect their data, companies may voluntarily list affiliated companies on the cover sheet. Numbers for such groups of affiliates are treated in aggregate when the confidentiality of figures is determined, thus increasing the likelihood that a figure remains confidential under the rules detailed in Annex 5.

***Section 1 (producers only)***

Section 1 contains data about production of F-gases and mixtures:

- total quantity of production (1A);
- destroyed by-products, mandatory specification of destruction company (1B, 1C);
- sum of destroyed production (1D);
- net production (1E, which equals 1A minus 1D);
- production of mixtures (1F to 1H);
- **voluntary:** sales and purchases on the EU market (1I to 1K).

From the data specified by the reporters, the total production available for sale (1E), relevant for calculating supply, is determined by subtracting destroyed side-products (1B, 1C) from total production (1A).

***Section 2 (importers only)***

- total imports of bulk gases (2A);
- imports that were destined for re-export contained in products or equipment and never released for free circulation in the EU (2B).

***Section 3 (exporters only)***

Section 3 contains data about bulk exports only. Exporters of products containing F-gases must not report here.

- total exports (3A);
- thereof: amounts from own production or purchased amounts (3B);
- thereof: determined amount of exports purchased in the Union (3C);
- breakdown of destination of exports (recycling, reclamation, destruction) (3D to 3F).

***Section 4 (producers and importers)***

Section 4 contains data on stocks of F-gases and their sources.

- stocks on 1 January (4A) and breakdown by source and previous status of free circulation (4B to 4E);
- stocks on 31 December (4F) and breakdown by source and previous status of free circulation (4G to 4J);
- reclaimed and recycled amounts (4K, 4L).

From the data provided on production, imports, exports and stocks, the total amount physically placed on the market by the reporter (4M) is determined using the formula:

*4M=Net production (1E) + Total imports (2A) – Imports for reexport (2B)*
*– Export of own production (3B)*
*+ 1st Jan stocks previously not placed on the market (4C)*
*– 31st Dec stocks previously not placed on the market (4D)*

***Section 5 (producers and importers of HFCs)***

Section 5 contains data about quantities of HFCs imported for uses exempted under the F-Gas Regulation, Article 15(2). For all these transactions, trade partners must be specified and uses broken down by company:

- destruction (5A);
- feedstock applications (5B);
- supply to other undertakings for re-export in bulk (5C exempted);
- military equipment (5D);
- semiconductor manufacturing (5E);
- production of medical dose inhalers (5F).

From the values, the total amounts of HFCs supplied to exempted uses and the resulting quota requirement are determined (5G to 5H). Reporters may voluntarily state their supply to other undertakings for production of equipment that is destined for re-export (5C voluntary); however, this figure does not feed into the total amount for exempted uses.

***Section 6 (producers and importers)***

Section 6 contains a breakdown of the intended applications of the total amounts supplied to the EU market by the reporting company. In this section, companies must account for the full amount as determined by the formula:

*6X=Net production (1E) + Total imports (2A) – Imports for reexport (2B)*
*– Export of own production (3B)*
*+ 1st Jan stocks of own production (4B)*
*– 31st Dec stocks of own production (4G) – Own reclamation (4K)*

Note that this formula differs from the POM determination in Section 4 in the method of correction for stocks. The full list of applications is:

- export (in bulk, not in equipment or smaller packages);
- destruction;
- military equipment;
- refrigeration, air-conditioning and heating;
- other heat transfer fluids;
- foams;

- production of pre-blended polyols, e.g. for polyurethane foam;
- fire protection;
- aerosols — medical dose inhalers;
- aerosols — other uses;
- solvents;
- feedstock;
- semiconductor manufacture;
- photovoltaics manufacture;
- other electronics manufacture;
- electrical equipment;
- particle accelerators;
- magnesium die casting operations;
- anaesthetics;
- other or unknown application;
- leakage during storage, transport or transfer.

***Section 7 (feedstock users)***

Contains the amount of gas used as feedstock by the undertaking itself (7A). The reporting obligation on feedstock use is limited to Annex I gases (see Annex 1). Feedstock use of Annex II gases is not subject to reporting.

***Section 8 (destruction companies)***

Section 8 contains data on destruction during the reporting year using different methods (8A to 8C), summed as total destruction in 8D, as well as stocks intended for destruction (8E, 8F).

***Section 9 (producers and importers)***

Starting in 2015, companies reported for the first time on authorisations they have issued to third parties to use their HFC quota, specifying each recipient in Section 9A.

***Section 10 (producers and importers that received quota through the new entrants reserve)***

In Section 10, companies specify physical supplies of F-gases accompanying authorisations, as reported in Section 9A. Reporters specify each recipient and are required to supplement proof of delivery (receipts, etc.) for each one. This reporting section applies only to companies that received HFC quota fully based on a declaration according to Article 16(2) of the new F-Gas Regulation and was used in 2016 for the first time.

***Section 11 (importers of equipment containing F-gases)***

Section 11 contains a detailed breakdown of the types of equipment imported by the reporting company. It differentiates between:

- equipment for refrigeration, air conditioning, and heat pumps (RACHP containing HFCs in lines 11A to 11F; summed in 11G;
- other types of equipment (11H to 11P).

The total content is found in line 11Q.

For each type of equipment, users must specify:

- total quantity of equipment expressed in a suitable unit;
- total amount of F-gases contained in this equipment.

From these numbers, specific charges per piece of equipment are determined. Where equipment does not fall into pre-defined categories, users must report them in the respective 'Other' sections and provide a description of the equipment (11A3, 11D, 11E4, 11F9, 11H4, 11P) and/or the intended use of the equipment (11A9, 11A12, 11B3, 11B5, 11B7, 11B9, 11D). The full list of categories is contained in Table A2.1.

***Sections 12 and 13 will be applied for the first time in reporting on 2017 in 2018.***

**Table A2.1 Equipment categories for reporting**

| Code | Description |
|---|---|
| 11A | Stationary equipment for comfort cooling or heating |
| 11B | Stationary equipment for refrigeration |
| 11C | Heat pump tumble dryers |
| 11D | Stationary heating/air conditioning including heat pumps as well as refrigeration (HACR) equipment for any other purposes |
| 11E | Mobile refrigeration equipment |
| 11F | Mobile air conditioning equipment |
| 11G | Total refrigeration, air conditioning or heat pump equipment |
| 11H | Foam products |
| 11I | Fire protection equipment (including systems incorporated in vehicles) |
| 11J | Medical or pharmaceutical aerosols |
| 11K | Non-medical aerosols |
| 11L | Medical equipment (without aerosols) |
| 11M | Switch gear for transmission and distribution of electricity |
| 11N | Other electrical transmission and distribution equipment |
| 11O | Particle accelerators |
| 11P | Other products and equipment containing gases listed in Annex I or Annex II of Regulation (EU) No 517/2014 |
| 11Q | Total of products and equipment containing fluorinated gases listed in Annex I or Annex II of Regulation (EU) No 517/2014 |

**Source:** EU, 2014a.

# Annex 3 Information contained in the reporting forms under Regulation (EC) No 842/2006

The reporting format for submitting the F-gas reports under the old F-Gas Regulation (EC) No 842/2006 was described in Regulation (EC) No 1493/2007 (EU, 2007b). The reported information is contained in the following sets of forms:

- Part 3 of the Reporting Form for Producers, Importers and Exporters of Fluorinated Greenhouse Gases (company information) ([21]).
  This is to be completed by all companies and includes a statement of whether the company that reports as a producer of F-gases within the EU, is an importer of F-gases into the EU and/or is an exporter of F-gases out of the EU. For production and import activities, the gas groups HFCs, PFCs and $SF_6$ need to be differentiated. Based on the choice of F-gas activities, a tailored set of data reporting sheets is offered to the user of the form.

- Co-producer forms — specific for HFCs, PFCs and $SF_6$.
  These are to be completed by producers only.
  In these forms, purchases from and sales to other producers in the EU are to be reported by substance.

- Producer and importer forms — specific for HFCs, PFCs and $SF_6$.
  These are to be completed by producers and importers. In these forms companies report by substance on:

  - production (A);
  - import (B);
  - export (C);
  - other amounts collected for reclamation or destruction from within the EU ([22]) (D);
  - purchases from (E) and sales to (F) EU co-producers (item for producers only, sums of the figures in the respective co-producer forms);
  - amounts purchased from other EU sources (G) (item for producers only);
  - stocks at 1 January (H) and 31 December (I) (for non-producers, covering previously imported quantities only; for producers, full stocks);
  - amount reclaimed by the reporting company (J);
  - amount destroyed by the reporting company (on-site) (K);
  - amount destroyed on behalf of the reporting company (off-site within the EU) (L);
  - amount used as a feedstock by the reporting company (M).

Of these amounts, a calculated total for the 'net amount available for sale in the EU' is determined according to the formula (A + B – C + D + E – F + G + H – I – K – L – M).

Furthermore, reporting companies need to give their best estimates of the intended applications of the amounts 'placed on the EU market for the first time'. The total amount placed on the EU market does not include any quantities previously held by EU importers and/or distributors. Therefore, for non-producing importers, the sum of the figures reported for intended applications should equal the calculated total mentioned above. For producers, the sum of the figures reported for the intended

([21]) Part 3 of the Reporting Form for Producers, Importers and Exporters of Fluorinated Greenhouse Gases (Annex to Commission Regulation (EC) No 1493/2007) was labelled 'company information' within the spreadsheet implementation of the reporting form used up to 2012. The term 'company information' was also used in the implementation of the online questionnaire in the BDR.

([22]) In Regulation (EC) No 842/2006 and Commission Regulation (EC) No 1493/2007, the terms 'European Community', 'Community' and 'EC' are used. In this report, the terminology 'European Union', 'Union' or 'EU' respectively is used, as the European Community has been replaced by the European Union in accordance with the Treaty of Lisbon (EU, 2007a).

applications should equal the calculated total minus any quantities sold on the EU market that were previously purchased from EU importers/distributors in the present reporting year or in previous years.

- Importer form 3: HFC preparations/HFC blend importer form ([23]).
  This form is to be completed by HFC importers. The sheet is structured as in the 'producer and importer forms'. However, the producer-specific lines (A, E, F and G above) are missing. Instead of single substances, companies report on HFC preparations.
- Exporter form.
  This form is to be completed by exporters with amounts exported from the EU per substance/preparation. In addition, the amounts exported for recycling, reclamation or destruction are also to be reported. All substances and preparations (HFCs, PFCs and $SF_6$) are covered in the 'Exporter Form'.

The form sheets concerning HFCs and PFCs, as well as the exporter form, offer the possibility to add substances or preparations in addition to those that are pre-defined. If a reporting company uses this option, the composition of an added preparation has to be stated. These functionalities were also implemented in the BDR online questionnaire.

([23]) In part 4 of the Reporting Form for Producers, Importers and Exporters of Fluorinated Greenhouse Gases (Annex to Commission Regulation (EC) No 1493/2007) this form is called 'Importer Form 3: HFC preparations', while it is labelled 'HFC Blends Importer Form' in the spreadsheet implementation of the reporting form. In this report, the names as set in Commission Regulation (EC) No 1493/2007) are used. The term 'blend' is commonly used by industry for 'preparations' as defined in Commission Regulation (EC) No 1493/2007.

# Annex 4 Calculation methods

This Annex provides documentation for:

- calculation of EU supply (page 49);
- calculation of HFC amounts placed on the market (POM) under the EU HFC phase-down (page 50) and
- calculation of HFC consumption under the international HFC phase-down under the Montreal Protocol (page 50).

The codes (1A), (2A), etc. used in the following paragraphs refer to the codes of reportable transactions in the reporting form; see Annex 2.

Where calculation details for 2007-2013 are discussed, these refer to the reporting items as presented in Annex 3.

## Calculation of EU supply

***Total supply (TS)***

'EU total supply' is a parameter that provides information on the actual use of fluorinated gases by EU industries. Notably, TS also includes gases that are contained in exported products and equipment. In the logic of the supply metrics used in this report, such gases count towards the gas demand of EU industries. 'EU total supply' is the sum of 'EU bulk supply' and 'EU supply in products/equipment'. It is comparable to the net supply metric used in earlier EEA reports on F-gases.

***Bulk supply (BS)***

The 'bulk supply' metric is focused on emission-relevant supplies of bulk gases to EU industries and therefore does not cover EU supplies intended for feedstock or destruction. Starting in 2014, BS has been defined as:

> Bulk supply (BS) = (net) production (1E = 1A to 1D) + full imports (2A) – full exports (3A) + 1 January stocks from own import/production (4B) – 31 December stocks from own import/production (4G) + reclamation (4K) – POM intended for destruction (6B) – feedstock use (7A).

For the years 2007-2013, bulk supply (BS) is calculated as follows:

> BS = Production + Imports – Exports + Stocks 1 January – Stocks 31 December + Reclamation – own feedstock use – intended application: feedstock.

***EU supply in products/equipment***

The 'EU supply in products/equipment' (SPE) metric covers the amount of fluorinated gases that are imported into the EU within products or equipment and placed on the market. Exports of F-gases within products and equipment are not reported under the new F-Gas Regulation (No 517/2014) or subtracted for the SPE metric. Thus, the SPE metric covers only imports and it is not intended to cover the net flows of F-gases within products or equipment across EU borders.

SPE is calculated as the sum of all gases reported in Section 11 of the reporting questionnaire. No data on SPE were collected before 2014.

***Intended applications of bulk or total supply***

In Section 6 of the reporting questionnaire, companies report on the intended applications of bulk gases supplied to the EU market (6X). This metric differs from bulk supply in the way it accounts for re-exports, amounts intended for destruction and feedstock. It is calculated as follows:

> 6X = (net) production (1E = 1A–1D) + full imports (2A) – re-exports within products of own bulk imports (2B) – bulk re-exports of own imports (3B) + 1 January stocks from own import/production (4B) – 31 December stocks from own import/production (4G) + reclamation (4K).

To estimate the intended applications of EU bulk or total supply, a four-step process is used:

1. Per gas, determine the proportion of each reported application in a subset of categories without export (6A), destruction (6B), leakage (6U) and accountancy adjustments (6V).

2. Assume leakage and accountancy adjustments in bulk or total supply to be equal to the amounts reported in Section 6 and subtract those from total bulk or total supply.

3. Apply the proportions determined in step 1 to the remainder of bulk or total supply.

4. Assign any remainder to the category 'Other or unknown applications' (6T).

## Calculation of HFC amounts placed on the market (POM) under the EU HFC phase-down

**The quota of relevant POM starting in 2015 is calculated as:**

Bulk HFCs physically placed on the market (4M), converted into $CO_2e$
minus
Exemptions under Article 15(2) (5A + (5B) + 5C_ exempted + 5D + 5E), converted into $CO_2e$
(5F is included in the exemptions from 2017)
plus
Issued authorisations (9A).

**Bulk HFC POM 2007-2013 is calculated per year and per company based on data reported under the old F-Gas Regulation (see Annex 3) as:**

HFC production, converted into $CO_2e$
plus
HFC imports, converted into $CO_2e$
minus
HFC exports, converted into $CO_2e$
plus
1 January HFC stocks, converted into $CO_2e$
minus
31 December HFC stocks, converted into $CO_2e$
minus
HFCs used for feedstock, converted into $CO_2e$
minus
HFC supplies intended for feedstock use, converted into $CO_2e$.

Where the amount thus calculated is negative for a given company in a given year, the POM is set to zero before calculating the EU total as the sum of all companies.

## Calculation of HFC consumption under the international HFC phase-down under the Montreal Protocol

The HFCs considered under the Montreal Protocol are all HFCs as listed in Annex I, Section 1 of the new F-Gas Regulation No 517/2014 (see Annex 1, page 40), except HFC-161.

**HFC consumption starting in 2014 is calculated as follows:**

HFC production (1A), converted into $CO_2e$
plus
HFC imports (2A), converted into $CO_2e$
minus
HFC exports (3A), converted into $CO_2e$
minus
HFC feedstock use (7A), converted into $CO_2e$
minus
Total HFC destruction (8D), converted into $CO_2e$.

**HFC consumption until 2013 is calculated from data reported under the old F-Gas Regulation (see Annex 3) as follows:**

HFC production, converted into $CO_2e$
plus
HFC imports, converted into $CO_2e$
minus
HFC exports, converted into $CO_2e$
minus
Reporting companies' own HFC destruction, converted into $CO_2e$
minus
HFC amounts supplied by reporting companies to third parties for destruction, converted into $CO_2e$
minus
HFCs used for feedstock, converted into $CO_2e$
minus
HFC supplies intended for feedstock use, converted into $CO_2e$

*Comparison of supply, POM and consumption metrics*

**Table A4.1 Scope of supply, POM, and consumption metrics**

| Transactions covered | | | Supply | Placing on the market (POM), relevant for compliance with the EU HFC phase-down | Consumption, relevant for compliance with the MP HFC phase-down |
|---|---|---|---|---|---|
| | | **Covered gases** | **Applicable to total F-gases and single gases/gas groups (e.g. HFCs)** | **HFCs of Annex I of EU F-Gas Regulation 517/2014, including HFC shares and non-HFC shares of HFC-containing mixtures** | **HFCs of Annex I of EU F-Gas Regulation 517/2014 except HFC-161, including HFC shares of HFC-containing mixtures** |
| | | **Units used** | **Both physical tonnes and t $CO_2$e** | **t $CO_2$e** | **t $CO_2$e** |
| | | **Type of contribution** | | | |
| Production | | Plus | Yes | Yes | Yes |
| Reclamation | | Plus | Yes | No | No |
| Recycling | | Plus | No | No | No |
| Bulk imports | | Plus | Yes | Yes | Yes |
| Imports in products and equipment | Refrigeration, air conditioning and heat pump (RACHP) equipment | Plus | Yes | 2015-2016: no<br>starting 2017, only amounts not covered by quota authorisations | No |
| | Other products and equipment | Plus | Yes | No | No |
| Bulk exports | | Minus | Yes | Exports from own production and exports from own imports are subtracted.<br>Other bulk exports subtracted if directly supplied by the importer/ producer to the exporter (exemption Art. 15(2)c) | Yes |
| Exports in products and equipment | | Minus | No | Considered in case the contained gases had never been placed on the market after bulk import (re-export) | No |
| Destruction | | Minus | Only destruction of EU production, destroyed before placing on the market and imports for destruction.<br>Destruction of used gases recovered within the EU is not subtracted | Only destruction of EU production, destroyed before placing on the market, and imports for destruction (exemption Art. 15(2)a).<br>Destruction of used gases recovered within the EU is not subtracted | Yes |
| Feedstock use | | Minus | Yes | Yes<br>(exemption Art. 15(2)b) | Yes |
| Supplies to military uses | | Minus | No | Yes<br>(exemption Art. 15(2)d) | No |
| Supplies to semiconductor industry | | Minus | No | Yes<br>(exemption Art. 15(2)e) | No |

**Table A4.1 Scope of supply, POM, and consumption metrics (cont.)**

| | | Supply | Placing on the market (POM), relevant for compliance with the EU HFC phase-down | Consumption, relevant for compliance with the MP HFC phase-down |
|---|---|---|---|---|
| | **Covered gases** | **Applicable to total F-gases and single gases/gas groups (e.g. HFCs)** | **HFCs of Annex I of EU F-Gas Regulation 517/2014, including HFC shares and non-HFC shares of HFC-containing mixtures** | **HFCs of Annex I of EU F-Gas Regulation 517/2014 except HFC-161, including HFC shares of HFC-containing mixtures** |
| | **Units used** | **Both physical tonnes and t $CO_2$e** | **t $CO_2$e** | **t $CO_2$e** |
| **Transactions covered** | **Type of contribution** | | | |
| Supplies to pharmaceutical MDIs | Minus | No | Not considered 2015-2017, considered 2018 onwards (exemption Art. 15(2)f) | No |
| 1 January stocks | Plus | Full stocks from own production or own import considered, stocks from EU purchases not considered | Only those stocks from own production or own import considered that have not yet been placed on the market, stocks from EU purchases and stocks from own imports/own production already placed on the market not considered | No |
| 31 December stocks | Minus | | | |
| HFC quota authorisations issued by producers/importers | Plus | No | Yes | No |

# Annex 5 Data tables

*Measures to protect confidential data*

The EEA takes appropriate steps to protect the confidentiality of commercially sensitive information in accordance with Article 19(8) of the new F-Gas Regulation. Throughout the report, three rules are applied to all numbers and figures to determine whether a data item must remain confidential.

**Three-company group rule:** This rule stipulates that any value that is published must be the sum of at least three different companies. In addition, companies are invited to specify affiliates in their report. These groups of affiliates, if mutually confirmed, count as one company for the purpose of this evaluation.

**5 % significance rule:** The contributions of small companies to any value may be insignificant, and larger companies' confidentiality may be compromised in spite of the first rule. Therefore, a value remains confidential if fewer than three companies make up more than 95 % of the total, discounting the smallest contributors that make up 5 % of the sum.

**Preventing deduction:** Deduction might be possible where a confidential value is part of a sum of substances or transactions. For example, a confidential value for $SF_6$ may be deduced if there are figures published for PFCs as well as a total for $SF_6$ and PFCs. In the case of metrics such as 'Supply', a confidential value, e.g. for 'Production', may be deduced if values for both 'Import' and 'Export' are known and the remainder of small transactions that make up 'Supply' is very small. Therefore, two steps are taken:

- In cases where a sum across substances or transactions is published, and there is only one contributing value to that sum that is confidential according to the above rules, a second part of the sum is made confidential to make sure that the lone confidential value cannot be deduced from the sum and remaining parts.

- In the case of supply metrics, a second of the major contributors (Production, Import, and Export) is made confidential if one of them is confidential according to the above rules and the remainder of small transactions makes up less than 5 % of the total.

## List of data tables in Annex 5

**Table A5.1 EU production of fluorinated gases (tonnes)**

| Gas | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tonnes | | | | | | | | | |
| HFCs | 55 235 | 38 519 | 33 106 | 43 792 | 41 040 | 40 854 | 36 717 | 31 050 | 32 339 | 33 380 |
| PFCs | C | C | C | C | C | C | C | C | C | C |
| $SF_6$ | C | C | C | C | C | C | C | C | C | C |
| Unsaturated HFCs and HCFCs | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | 1 | 2 |
| HFEs and alcohols | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | - | - |
| $NF_3$ and other perfluorinated compounds | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | - | - |
| **Total fluorinated gases** | **58 098** | **41 359** | **35 123** | **46 440** | **44 030** | **44 220** | **39 909** | **34 049** | **35 377** | **36 159** |
| *Average GWP* | *3 012* | *3 361* | *3 088* | *3 226* | *3 432* | *3 508* | *3 573* | *3 723* | *3 419* | *3 293* |

**Table A5.2 EU production of fluorinated gases ($CO_2e$)**

| Gas | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Million tonnes of $CO_2$ equivalents | | | | | | | | | |
| HFCs | 112,2 | 75,6 | 63,3 | 91,1 | 85 | 81,4 | 73,1 | 61,1 | 54,6 | 58,6 |
| PFCs | C | C | C | C | C | C | C | C | C | C |
| $SF_6$ | C | C | C | C | C | C | C | C | C | C |
| Unsaturated HFCs and HCFCs | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | 0 | 0 |
| HFEs and alcohols | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | - | - |
| $NF_3$ and other perfluorinated compounds | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | - | - |
| **Total fluorinated gases** | **175** | **139** | **108,4** | **149,8** | **151,1** | **155,1** | **142,6** | **126,8** | **121** | **119,1** |
| *Average GWP* | *3 012* | *3 361* | *3 088* | *3 226* | *3 432* | *3 508* | *3 573* | *3 723* | *3 419* | *3 293* |

**Notes:** C, confidential; -, no data reported; n.a., not applicable: Annex II gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

## Table A5.3 EU reclamation of fluorinated gases (tonnes)

| Gas | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tonnes | | | | | | | | | |
| HFCs | C | C | 100 | C | C | 460 | C | 377 | 647 | 1 314 |
| PFCs | - | - | - | - | - | C | - | C | C | C |
| $SF_6$ | C | C | 77 | C | C | C | C | C | C | C |
| Unsaturated HFCs and HCFCs | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | C | C |
| HFEs and alcohols | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | - | - |
| $NF_3$ and other perfluorinated compounds | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | - | - |
| **Total fluorinated gases** | **417** | **398** | **177** | **326** | **508** | **487** | **484** | **416** | **679** | **1 364** |
| *Average GWP* | *4 919* | *4 860* | *10 963* | *3 961* | *3 498* | *3 321* | *2 555* | *4 250* | *3 527* | *3 033* |

## Table A5.4 EU reclamation of fluorinated gases ($CO_2e$)

| Gas | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Million tonnes of $CO_2$ equivalents | | | | | | | | | |
| HFCs | C | C | 0,2 | C | C | 1 | C | 0,9 | 1,7 | 3,1 |
| PFCs | - | - | - | - | - | C | - | C | C | C |
| $SF_6$ | C | C | 1,8 | C | C | C | C | C | C | C |
| Unsaturated HFCs and HCFCs | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | 0 | 0 |
| HFEs and alcohols | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | - | - |
| $NF_3$ and other perfluorinated compounds | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | - | - |
| **Total fluorinated gases** | **2,1** | **1,9** | **1,9** | **1,3** | **1,8** | **1,6** | **1,2** | **1,8** | **2,4** | **4,1** |
| *Average GWP* | *4 919* | *4 860* | *10 963* | *3 961* | *3 498* | *3 321* | *2 555* | *4 250* | *3 527* | *3 033* |

**Notes:** C, confidential; -, no data reported; n.a., not applicable: Annex II gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

**Table A5.5 Total EU imports of fluorinated gases (tonnes)**

| Gas | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tonnes | | | | | | | | | |
| HFCs | 58 667 | 68 094 | 57 612 | 68 794 | 65 940 | 60 778 | 65 301 | 128 452 | 78 085 | 78 831 |
| PFCs | 253 | 306 | 129 | 230 | 238 | 310 | 155 | 350 | 409 | 363 |
| $SF_6$ | 747 | 691 | 671 | 539 | 587 | 374 | 483 | 430 | 392 | 420 |
| Unsaturated HFCs and HCFCs | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFEs and alcohols | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| $NF_3$ and other perfluorinated compounds | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 333 | 305 | 492 |
| **Total fluorinated gases** | **59 666** | **69 091** | **58 411** | **69 564** | **66 765** | **61 462** | **65 939** | **131 794** | **82 977** | **86 703** |
| *Average GWP* | *2 218* | *2 230* | *2 412* | *2 285* | *2 231* | *2 171* | *2 259* | *2 209* | *2 172* | *2 116* |

**Table A5.6 Total EU imports of fluorinated gases ($CO_2$e)**

| Gas | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Million tonnes of $CO_2$ equivalents | | | | | | | | | |
| HFCs | 112,7 | 135,1 | 124,2 | 144,2 | 133,1 | 121,7 | 136,4 | 272,1 | 162 | 161,8 |
| PFCs | 2,6 | 3,2 | 1,4 | 2,5 | 2,5 | 3,2 | 1,6 | 3,4 | 3,9 | 3,6 |
| $SF_6$ | 17 | 15,8 | 15,3 | 12,3 | 13,4 | 8,5 | 11 | 9,8 | 8,9 | 9,6 |
| Unsaturated HFCs and HCFCs | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFEs and alcohols | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| $NF_3$ and other perfluorinated compounds | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 5,7 | 5,2 | 8,5 |
| **Total fluorinated gases** | **132,4** | **154,1** | **140,9** | **158,9** | **148,9** | **133,4** | **149** | **291,1** | **180,2** | **183,5** |
| *Average GWP* | *2 218* | *2 230* | *2 412* | *2 285* | *2 231* | *2 171* | *2 259* | *2 209* | *2 172* | *2 116* |

**Notes:** C, confidential; -, no data reported; n.a., not applicable: Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) and HFCs, PFCs and $SF_6$ in products and equipment were not subject to reporting for the years 2007-2013. The data shown for 2007-2013 are thus limited to bulk imports.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

**Table A5.7 EU bulk imports of fluorinated gases (tonnes)**

| Gas | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tonnes | | | | | | | | | |
| HFCs | 58 667 | 68 094 | 57 612 | 68 794 | 65 940 | 60 778 | 65 301 | 122 781 | 71 098 | 68 947 |
| PFCs | 253 | 306 | 129 | 230 | 238 | 310 | 155 | 343 | 388 | 355 |
| $SF_6$ | 747 | 691 | 671 | 539 | 587 | 374 | 483 | 412 | 386 | 417 |
| Unsaturated HFCs and HCFCs | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFEs and alcohols | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| $NF_3$ and other perfluorinated compounds | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | 305 | 492 |
| **Total fluorinated gases** | **59 666** | **69 091** | **58 411** | **69 564** | **66 765** | **61 462** | **65 939** | **125 986** | **75 720** | **76 224** |
| *Average GWP* | *2 218* | *2 230* | *2 412* | *2 285* | *2 231* | *2 171* | *2 259* | *2 218* | *2 198* | *2 149* |

**Table A5.8 EU bulk imports of fluorinated gases ($CO_2e$)**

| Gas | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Million tonnes of $CO_2$ equivalents | | | | | | | | | |
| HFCs | 112,7 | 135,1 | 124,2 | 144,2 | 133,1 | 121,7 | 136,4 | 260,9 | 148,5 | 142,2 |
| PFCs | 2,6 | 3,2 | 1,4 | 2,5 | 2,5 | 3,2 | 1,6 | 3,3 | 3,8 | 3,5 |
| $SF_6$ | 17 | 15,8 | 15,3 | 12,3 | 13,4 | 8,5 | 11 | 9,4 | 8,8 | 9,5 |
| Unsaturated HFCs and HCFCs | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFEs and alcohols | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| $NF_3$ and other perfluorinated compounds | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | 5,2 | 8,5 |
| **Total fluorinated gases** | **132,4** | **154,1** | **140,9** | **158,9** | **148,9** | **133,4** | **149** | **279,4** | **166,3** | **163,8** |
| *Average GWP* | *2 218* | *2 230* | *2 412* | *2 285* | *2 231* | *2 171* | *2 259* | *2 218* | *2 198* | *2 149* |

**Notes:** C, confidential; -, no data reported; n.a., not applicable: Annex II gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

**Table A5.9 EU imports of fluorinated gases within products and equipment (tonnes)**

| Gas | 2014 | 2015 | 2016 |
|---|---|---|---|
| | | Tonnes | |
| HFCs | 5 671 | 6 987 | 9 884 |
| PFCs | C | C | C |
| $SF_6$ | C | 6 | 2 |
| Unsaturated HFCs and HCFCs | 112 | 230 | 583 |
| HFEs and alcohols | - | C | C |
| $NF_3$ and other perfluorinated compounds | - | - | - |
| **Total fluorinated gases** | **5 808** | **7 257** | **10 479** |
| *Average GWP* | *2 015* | *1 900* | *1 873* |

**Notes:** C, confidential; -, no data reported.

**Sources:** EEA, 2016 and 2017b.

**Table A5.10 EU imports of fluorinated gases within products and equipment ($CO_2e$)**

| Gas | 2014 | 2015 | 2016 |
|---|---|---|---|
| | | Million tonnes of $CO_2$ equivalents | |
| HFCs | 11,2 | 13,5 | 19,5 |
| PFCs | C | C | C |
| $SF_6$ | C | 0,1 | 0,1 |
| Unsaturated HFCs and HCFCs | 0 | 0 | 0 |
| HFEs and alcohols | - | C | C |
| $NF_3$ and other perfluorinated compounds | - | - | - |
| **Total fluorinated gases** | **11,7** | **13,8** | **19,6** |
| *Average GWP* | *2 015* | *1 900* | *1 873* |

**Notes:** C, confidential; -, no data reported.

**Sources:** EEA, 2016 and 2017b.

**Table A5.11 Categories of imports of fluorinated gases in products and equipment (tonnes)**

| Categories of products and equipment | 2014 | 2015 | 2016 |
|---|---|---|---|
| | Tonnes | | |
| Stationary equipment for comfort cooling or heating | 4 698 | 5 224 | 8 282 |
| Stationary equipment for refrigeration | 32 | 76 | 95 |
| Heat pump tumble dryers | C | 144 | 189 |
| Other stationary refrigeration, air conditioning or heat pump equipment | 86 | 95 | 225 |
| Mobile refrigeration equipment | C | C | 20 |
| Mobile air conditioning equipment | 798 | 1 205 | 1 337 |
| Foam products | C | C | C |
| Fire protection equipment | - | 10 | C |
| Medical or pharmaceutical aerosols | 69 | 131 | 143 |
| Non-medical aerosols | C | C | C |
| Other medical equipment (without aerosols) | - | - | - |
| Electrical switchgear | C | 5 | 2 |
| Other electrical equipment | C | C | C |
| Particle accelerators | - | - | - |
| Other products and equipment | C | C | - |
| **Total supply in products and equipment** | **5 808** | **7 257** | **10 479** |

**Table A5.12 Categories of imports of fluorinated gases in products and equipment ($CO_2e$)**

| Categories of products and equipment | 2014 | 2015 | 2016 |
|---|---|---|---|
| | Million tonnes of $CO_2$ equivalents | | |
| Stationary equipment for comfort cooling or heating | 9,8 | 10,8 | 17 |
| Stationary equipment for refrigeration | 0,1 | 0,3 | 0,2 |
| Heat pump tumble dryers | C | 0,2 | 0,3 |
| Other stationary refrigeration, air conditioning or heat pump equipment | 0,1 | 0,2 | 0,4 |
| Mobile refrigeration equipment | C | C | 0 |
| Mobile air conditioning equipment | 1 | 1,4 | 1,1 |
| Foam products | C | C | C |
| Fire protection equipment | - | 0 | C |
| Medical or pharmaceutical aerosols | 0,1 | 0,2 | 0,2 |
| Non-medical aerosols | C | C | C |
| Other medical equipment (without aerosols) | - | - | - |
| Electrical switchgear | C | 0,1 | 0 |
| Other electrical equipment | C | C | C |
| Particle accelerators | - | - | - |
| Other products and equipment | C | C | - |
| **Total supply in products and equipment** | **11,7** | **13,8** | **19,6** |

**Notes:** C, confidential; -, no data reported.

**Sources:** EEA, 2016 and 2017b.

## Table A5.13 EU bulk exports of fluorinated gases (tonnes)

| Gas | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tonnes | | | | | | | | | |
| HFCs | 24 162 | 19 187 | 15 564 | 20 292 | 21 162 | 21 044 | 21 699 | 26 239 | 25 577 | 27 069 |
| PFCs | C | C | C | C | C | C | C | 91 | 95 | 132 |
| $SF_6$ | C | C | C | C | C | C | C | C | 2426 | C |
| Unsaturated HFCs and HCFCs | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFEs and alcohols | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| $NF_3$ and other perfluorinated compounds | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| **Total fluorinated gases** | **25 915** | **20 742** | **17 012** | **22 070** | **23 214** | **23 320** | **23 822** | **29 065** | **28 417** | **30 065** |
| *Average GWP* | *3 140* | *3 342* | *3 538* | *3 414* | *3 635* | *3 604* | *3 405* | *3 469* | *3 506* | *3 376* |

**Notes:** C, confidential; -, no data reported; n.a., not applicable: Annex II gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

## Table A5.14 EU bulk exports of fluorinated gases ($CO_2e$)

| Gas | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Million tonnes of $CO_2$ equivalents | | | | | | | | | |
| HFCs | 42,5 | 34,6 | 27,5 | 36 | 38,8 | 35,5 | 36 | 42,4 | 43,2 | 50,3 |
| PFCs | 0,8 | 0,5 | 0,2 | 0,7 | C | 2,4 | 2,4 | 0,8 | 0,9 | 1,3 |
| $SF_6$ | C | C | C | C | C | C | C | C | 55,3 | C |
| Unsaturated HFCs and HCFCs | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFEs and alcohols | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| $NF_3$ and other perfluorinated compounds | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| **Total fluorinated gases** | **81,4** | **69,3** | **60,2** | **75,4** | **84,4** | **84** | **81,1** | **100,8** | **99,6** | **101,5** |
| *Average GWP* | *3 140* | *3 342* | *3 538* | *3 414* | *3 635* | *3 604* | *3 405* | *3 469* | *3 506* | *3 376* |

**Notes:** C, Confidential; -, no data reported; n.a., not applicable: Annex II gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

**Table A5.15 Total EU supply of fluorinated gases (tonnes)**

| Gas | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Tonnes | | | | | |
| HFC-23 | C | C | C | 299 | 306 | 137 | C | 94 | 78 | 63 |
| HFC-32 | 3 987 | 5 086 | 4 406 | 5 378 | 4 914 | 5 009 | 5 334 | 11 060 | 9 510 | 11 005 |
| HFC-41 | C | - | C | C | C | C | C | 1 | 2 | 1 |
| HFC-125 | 12 429 | 12 556 | 13 942 | 18 218 | 15 321 | 15 580 | 15 147 | 25 476 | 18 208 | 18 685 |
| HFC-134 | C | C | - | C | - | - | - | - | C | C |
| HFC-134a | 49 102 | 46 196 | 41 310 | 43 588 | 40 095 | 40 007 | 39 337 | 60 771 | 47 370 | 44 093 |
| HFC-143 | C | - | - | - | - | - | - | - | - | - |
| HFC-143a | 9 066 | 9 883 | 9 590 | 10 552 | 8 845 | 9 005 | 8 853 | 13 512 | 7 260 | 7 205 |
| HFC-152a | 3 816 | 6 162 | 5 182 | 4 468 | 4 676 | 4 175 | 3 657 | 6 227 | 3 914 | 3 417 |
| HFC-227ea | C | C | C | C | C | C | C | 2 695 | 1 977 | 1 802 |
| HFC-236fa | C | C | C | C | 43 | 30 | C | 52 | 40 | 42 |
| HFC-245ca | - | - | - | - | - | - | - | - | - | C |
| HFC-245fa | C | C | C | C | C | C | C | C | C | C |
| HFC-365mfc | C | C | C | C | C | C | C | C | C | C |
| HFC-43-10mee | C | C | 50 | C | C | C | C | C | C | 60 |
| PFC-14 | C | C | 42 | 59 | 56 | C | C | 147 | 168 | 152 |
| PFC-116 | 93 | 178 | 113 | C | C | C | C | 157 | 164 | 129 |
| PFC-218 | C | 59 | C | 24 | 23 | 40 | 38 | 41 | 59 | 37 |
| PFC-c-318 | C | 6 | 4 | 6 | 10 | C | C | 14 | 27 | 26 |
| PFC-3-1-10 | C | C | - | C | C | C | C | C | C | C |
| PFC-4-1-12 | - | - | - | - | - | - | - | C | C | C |
| PFC-5-1-14 | C | C | C | C | C | C | C | C | C | 117 |
| $SF_6$ | C | C | C | C | C | C | C | C | C | C |
| HCFC-1233xf | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | - | C |
| HCFC-1233zd | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFC-1234yf | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 826 | 1 928 | 5 145 |
| HFC-1234ze | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFC-1336mzz | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFE-245fa1 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | - | C |
| HFE-347mcc3 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFE-449sl | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFE-569sf2 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| 2,2,3,3,3-pentafluoropropanol | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | - | C |
| Bis(trifluoromethyl)-methanol | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | - | C |
| $NF_3$ | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | 339 | 381 |
| PFPMIE | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | - | - |

**Table A5.15 Total EU supply of fluorinated gases (tonnes) (cont.)**

| Gas group | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tonnes | | | | | | | | | |
| HFCs | 86 148 | 87 454 | 80 771 | 89 564 | 81 673 | 80 892 | 79 293 | 124 408 | 93 788 | 91 799 |
| PFCs | C | C | C | C | C | C | C | C | C | C |
| $SF_6$ | C | C | C | C | C | C | C | C | C | C |
| Unsaturated HFCs and HCFCs | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 1 306 | 2 544 | 6 236 |
| HFEs and alcohols | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| $NF_3$ and other perfluorinated compounds | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 321 | 339 | 381 |
| **Total fluorinated gases** | **88 257** | **89 712** | **82 447** | **91 389** | **83 464** | **82 625** | **80 967** | **127 547** | **98 485** | **100 051** |
| *Average GWP* | *2 425* | *2 435* | *2 451* | *2 528* | *2 490* | *2 471* | *2 475* | *2 241* | *2 187* | *2 113* |

**Notes:** C, confidential; -, no data reported; n.a., not applicable: Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) and HFCs, PFCs and $SF_6$ in products and equipment were not subject to reporting for the years 2007-2013. The data shown for 2007-2013 are thus limited to bulk supply.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

**Table A5.16 Total EU supply of fluorinated gases ($CO_2e$)**

| Gas | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Million tonnes of $CO_2$ equivalents | | | | | | | | | |
| HFC-23 | C | C | C | 4,4 | 4,5 | 2 | C | 1,4 | 1,2 | 0,9 |
| HFC-32 | 2,7 | 3,4 | 3 | 3,6 | 3,3 | 3,4 | 3,6 | 7,5 | 6,4 | 7,4 |
| HFC-41 | C | - | C | C | C | C | C | 0 | 0 | 0 |
| HFC-125 | 43,5 | 43,9 | 48,8 | 63,8 | 53,6 | 54,5 | 53 | 89,2 | 63,7 | 65,4 |
| HFC-134 | C | C | - | C | - | - | - | - | C | C |
| HFC-134a | 70,2 | 66,1 | 59,1 | 62,3 | 57,3 | 57,2 | 56,3 | 86,9 | 67,7 | 63,1 |
| HFC-143 | C | - | - | - | - | - | - | - | - | - |
| HFC-143a | 40,5 | 44,2 | 42,9 | 47,2 | 39,5 | 40,3 | 39,6 | 60,4 | 32,5 | 32,2 |
| HFC-152a | 0,5 | 0,8 | 0,6 | 0,6 | 0,6 | 0,5 | 0,5 | 0,8 | 0,5 | 0,4 |
| HFC-227ea | C | C | C | C | C | C | C | 8,7 | 6,4 | 5,8 |
| HFC-236fa | C | C | C | C | 0,4 | 0,3 | C | 0,5 | 0,4 | 0,4 |
| HFC-245ca | - | - | - | - | - | - | - | - | - | C |
| HFC-245fa | C | C | C | C | C | C | C | C | C | C |
| HFC-365mfc | C | C | C | C | C | C | C | C | C | C |
| HFC-43-10mee | C | C | 0,1 | C | C | C | C | C | C | 0,1 |
| PFC-14 | C | C | 0,3 | 0,4 | 0,4 | C | C | 1,1 | 1,2 | 1,1 |
| PFC-116 | 1,1 | 2,2 | 1,4 | C | C | C | C | 1,9 | 2 | 1,6 |
| PFC-218 | C | 0,5 | C | 0,2 | 0,2 | 0,4 | 0,3 | 0,4 | 0,5 | 0,3 |
| PFC-c-318 | C | 0,1 | 0 | 0,1 | 0,1 | C | C | 0,1 | 0,3 | 0,3 |
| PFC-3-1-10 | C | C | - | C | C | C | C | C | C | C |
| PFC-4-1-12 | - | - | - | - | - | - | - | C | C | C |
| PFC-5-1-14 | C | C | C | C | C | C | C | C | C | 1,1 |
| $SF_6$ | C | C | C | C | C | C | C | C | C | C |
| HCFC-1233xf | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | - | C |
| HCFC-1233zd | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFC-1234yf | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 0 | 0 | 0 |
| HFC-1234ze | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFC-1336mzz | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFE-245fa1 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | - | C |
| HFE-347mcc3 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFE-449sl | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFE-569sf2 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| 2,2,3,3,3-pentafluoropropanol | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | - | C |
| Bis(trifluoromethyl)-methanol | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | - | C |
| $NF_3$ | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | 5,8 | 6,6 |
| PFPMIE | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | - | - |

**Table A5.16 Total EU supply of fluorinated gases ($CO_2e$) (cont.)**

| Gas group | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Million tonnes of $CO_2$ equivalents | | | | | | | | | |
| HFCs | 169,7 | 172 | 166,9 | 193,2 | 170,7 | 167,7 | 164 | 259,2 | 183,5 | 180,6 |
| PFCs | C | C | C | C | C | C | C | 4,6 | 5 | 4,4 |
| $SF_6$ | C | C | C | C | C | C | C | C | C | C |
| Unsaturated HFCs and HCFCs | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 0 | 0 | 0 |
| HFEs and alcohols | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| $NF_3$ and other perfluorinated compounds | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 5,5 | 5,8 | 6,6 |
| **Total fluorinated gases** | **214** | **218,5** | **202,1** | **231** | **207,9** | **204,2** | **200,4** | **285,8** | **215,4** | **211,4** |
| *Average GWP* | *2 425* | *2 435* | *2 451* | *2 528* | *2 490* | *2 471* | *2 475* | *2 241* | *2 187* | *2 113* |

**Notes:** C, confidential; -, no data reported; n.a., not applicable: Annex II F-gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) and HFCs, PFCs and $SF_6$ in products and equipment were not subject to reporting for the years 2007-2013. The data shown for 2007-2013 are thus limited to bulk supply.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

## Table A5.17 EU bulk supply of fluorinated gases (tonnes)

| Gas | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tonnes | | | | | | | | | |
| HFCs | 86 148 | 87 454 | 80 771 | 89 564 | 81 673 | 80 892 | 79 293 | 118 737 | 86 801 | 81 915 |
| PFCs | C | C | C | C | C | C | C | 472 | 503 | 457 |
| $SF_6$ | C | C | C | C | C | C | C | C | C | C |
| Unsaturated HFCs and HCFCs | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFEs and alcohols | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| $NF_3$ and other perfluorinated compounds | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 321 | 339 | 381 |
| **Total fluorinated gases** | **88 257** | **89 712** | **82 447** | **91 389** | **83 464** | **82 625** | **80 967** | **121 739** | **91 227** | **89 572** |
| *Average GWP* | *2 425* | *2 435* | *2 451* | *2 528* | *2 490* | *2 471* | *2 475* | *2 251* | *2 210* | *2 141* |

**Notes:** N.a., not applicable: Annex II gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

## Table A5.18 EU bulk supply of fluorinated gases ($CO_2e$)

| Gas | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Million tonnes of $CO_2$ equivalents | | | | | | | | | |
| HFCs | 170 | 172 | 167 | 193 | 171 | 168 | 164 | 248 | 170 | 161 |
| PFCs | C | C | C | C | C | C | C | 5 | 5 | 4 |
| $SF_6$ | C | C | C | C | C | C | C | C | C | C |
| Unsaturated HFCs and HCFCs | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| HFEs and alcohols | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| $NF_3$ and other perfluorinated compounds | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 6 | 6 | 7 |
| **Total fluorinated gases** | **214** | **218** | **202** | **231** | **208** | **204** | **200** | **274** | **202** | **192** |
| *Average GWP* | *2 425* | *2 435* | *2 451* | *2 528* | *2 490* | *2 471* | *2 475* | *2 251* | *2 210* | *2 141* |

**Notes:** C, confidential; n.a., not applicable: Annex II gases (unsaturated HFCs and HCFCs, HFEs and alcohols, and $NF_3$ and other perfluorinated compounds) were not subject to reporting for the years 2007-2013.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

**Table A5.19 Intended applications of EU total supply of fluorinated gases (tonnes)**

| Intended applications of total supply | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tonnes | | | | | | | | | |
| Refrigeration, air-conditioning and heating and other heat transfer fluids | 61 510 | 58 862 | 58 479 | 65 852 | 60 913 | 58 506 | 59 069 | 95 688 | 75 675 | 77 822 |
| Foams, including pre-blended polyols | 13 971 | 15 284 | 11 697 | 11 358 | 9 232 | 8 524 | 8 202 | 12 967 | 9 572 | 10 483 |
| Aerosols | 8 997 | 11 131 | 8 402 | 9 474 | 7 790 | 10 931 | 9 689 | 8 954 | 9 422 | 8 714 |
| Fire protection | 650 | 492 | 531 | 1 677 | 2 505 | 1 450 | 1 385 | 1 858 | 818 | 599 |
| Electrical equipment | 1 197 | 1 422 | 969 | 1 290 | 1 344 | 1 362 | 1 419 | 622 | 753 | 703 |
| Semiconductor, photovoltaics and other electronics manufacture | 127 | 301 | 184 | 265 | 243 | 169 | 71 | 1.057 | 715 | 751 |
| Other or unknown applications | 1 807 | 2 219 | 2 184 | 1 473 | 1 436 | 1 683 | 1 132 | 6 402 | 1 486 | 979 |
| **Total supply** | **88 257** | **89 712** | **82 447** | **91 389** | **83 464** | **82 625** | **80 967** | **127.547** | **98 440** | **100.051** |

**Notes:** Feedstock use does not appear in this table as it is excluded from the scope of EU total supply.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

**Table A5.20 Intended applications of EU total supply of fluorinated gases ($CO_2e$)**

| Gas | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Million tonnes of $CO_2$ equivalents | | | | | | | | | |
| Refrigeration, air-conditioning and heating and other heat transfer fluids | 139 | 137 | 139,1 | 161,4 | 143,5 | 140,1 | 140,7 | 216,5 | 158,8 | 156,8 |
| Foams, including pre-blended polyols | 13,3 | 12,9 | 9,8 | 10,4 | 6,5 | 6,1 | 5,9 | 11,7 | 7,2 | 9,1 |
| Aerosols | 12,2 | 14,5 | 11,1 | 12,5 | 9,8 | 14,1 | 12,7 | 11,7 | 13,1 | 11,6 |
| Fire protection | 4 | 3 | 3,2 | 7,5 | 9,7 | 5,8 | 2,6 | 6,6 | 3 | 2,2 |
| Electrical equipment | 27,3 | 32,4 | 22,1 | 29,4 | 30,7 | 31 | 32,4 | 14,2 | 17,2 | 16 |
| Semiconductor, photovoltaics and other electronics manufacture | 1,5 | 3,2 | 2,1 | 3,1 | 2,8 | 2,1 | 1 | 9,4 | 9,9 | 10,5 |
| Other or unknown applications | 16,6 | 15,4 | 14,7 | 6,7 | 4,9 | 4,9 | 5,3 | 15,8 | 6,1 | 5 |
| **Total supply** | **214** | **218,5** | **202,1** | **231** | **207,9** | **204,2** | **200,4** | **285,8** | **215,3** | **211,4** |

**Notes:** Feedstock use does not appear in this table as it is excluded from the scope of EU total supply.

**Sources:** EC, 2011; EEA, 2016 and 2017b.

## Table A5.21 HFCs placed on the market and quota compliance

| | POM category | | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Million tonnes of $CO_2$ equivalents | | | | | | | | | |
| (1) | Bulk HFC POM 2007-2013 | | 173.5 | 174.9 | 172.4 | 200.6 | 179.0 | 172.0 | 169.6 | n.a. | n.a. | n.a. |
| (2) | Bulk HFC POM 2014 onwards | | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 279.4 | 158.4 | 158.1 |
| (3) | *Thereof for exempted uses Art.15(2)a-e:* | | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 7.0 | 7.6 | 14.1 |
| (4) | *Exemption Art. 15(2)f: Pharmaceutical MDIs* | | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | C | C | C |
| (5) | Bulk HFC POM (quota relevant) | *= (2) – (3)* | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 150.8 | 144.0 |
| (6) | POM of HFCs in equipment | *= (7) + (8)* | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 11.2 | 13.5 | 19.5 |
| | *thereof:* | | | | | | | | | | | |
| (7) | *HFC POM in RACHP equipment* | | *n.a.* | *n.a.* | *n.a.* | *n.a.* | *n.a.* | *n.a.* | *n.a.* | *11.1* | *12.8* | *19.0* |
| (8) | *HFC POM in other equipment* | | *n.a.* | *n.a.* | *n.a.* | *n.a.* | *n.a.* | *n.a.* | *n.a.* | *0.1* | *0.7* | *0.5* |
| (9) | Total physical HFC POM 2014 onwards (bulk + equipment) | *= (2) + (6)* | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 290.6 | 171.9 | 177.6 |
| (10) | Quota authorisations issued | | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 17.2 | 19.9 |
| (11) | Quota-relevant POM 2015 onwards | *= (5) + (10)* | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 167.9 | 163.9 |
| (12) | Maximum quantity of HFC phase-down | | | | | | | | | | | |
| | (= total allocated quota) | *n.a.* | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 183.1 | 170.3 | |
| | **Quota balance** | | | | | | | | | | | |
| (13) | Unused quota (company level) | | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | **15.8** | 7.6 |
| (14) | Quota shortfall (company level) | | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 0.6 | 1.3 |
| (15) | EU-wide margin to maximum quantity | *= (12) - (11)* | | | | | | | | | | |
| | | *= (13) - (14)* | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 15.2 | 6.4 |

**Notes:** C, confidential; -, no data reported; n.a., not applicable; POM: Placing on the market; RACHP: refrigeration, air conditioning, and heat pumps

**Sources:** EC, 2011 and 2017a; EEA, 2016 and 2017b.

## Table A5.22 Consumption of HFCs covered under the Montreal Protocol

| POM category | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Million tonnes of $CO_2$ equivalents | | | | | | | | | |
| EU consumption of HFCs covered under the Montreal Protocol | 178,0 | 169,7 | 156,0 | 193,7 | 172,9 | 159,0 | 163,5 | 267,0 | 147,1 | 141,7 |

**Sources:** EC, 2011; EEA, 2016 and 2017b.

**Table A5.23 Activities reported 2007-2016**

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Reports Received** | **78** | **87** | **91** | **108** | **122** | **129** | **154** | **469** | **778** | **1279** |
| of which mention: | | | | | | | | | | |
| Production (from 2014: HFC) | 6 | 11 | 8 | 8 | 9 | 9 | 9 | 7 | 6 | 6 |
| Bulk Import (from 2014: HFC) | 60 | 64 | 56 | 70 | 78 | 88 | 114 | 181 | 308 | 389 |
| Non-HFC Production ([b]) | *no differentiation before 2014* | | | | | | | 5 | 5 | 5 |
| Non-HFC Import | | | | | | | | 33 | 32 | 36 |
| Bulk Export | 42 | 48 | 58 | 72 | 78 | 78 | 83 | 97 | 100 | 111 |
| HFC RACHP ([a]) equipment import | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 224 | 409 | 819 |
| Other Eq. Import | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 56 | 102 | 162 |
| Feedstock Use | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 5 | 4 | 4 |
| Destruction | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 10 | 15 | 14 |
| Supply of Authorisations | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | - | 21 | 45 |

**Note:** N.a., not applicable: the reporting obligations for feedstock users, destruction companies and equipment importers applied to companies reporting on 2014 for the first time. A small number of companies (7 %) report on more than one activity.
([a]) RACHP equipment: refrigeration, air conditioning, and heat pumps.
([b]) Before 2014, the numbers for Production and Bulk Import include all importers and producers of fluorinated gases, whether they trade in HFCs or non-HFCs.

**Source:** EEA, 2017b.

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