National Emissions of Fluorinated Gases in Jersey

A scoping report to the Department of the Environment

19th December 2016

Aether

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1 Introduction

This scoping report documents a series of analyses undertaken to support the Department of the Environment in assessing whether a policy position or policy guidance is needed regarding the use and disposal of fluorinated gases (F-gases). Currently there is no national plan to phase out on-island use of F-gases and Jersey is not covered by the EU F-Gas Regulation, however, it is a signatory of the Montreal Protocol through the UK.

F-gases are man-made substances used for a variety of activities that take advantage of their unique chemical properties. They are used as an effective alternative to ozone-depleting substances (ODS) phased out under the Montreal Protocol. F-gases have very high global warming potentials (GWPs) making them far more harmful than other greenhouse gases (GHGs). Whilst they currently contribute to approximately 10% of total GHG emissions in Jersey, the increasing trend in emissions means that these could be highly significant sources of GHG emissions in the future[1].

Aether has compiled Jersey's national greenhouse gas (GHG) emissions inventory for over five years. The inventory includes all activities resulting in emissions of F-gases. The current methodological approach for these activities uses proxy datasets (e.g. population) from Jersey and the UK, to derive a scaling factor, which is applied to the UK emission estimates of F-gases to estimate relative emissions from Jersey.

The proxy datasets used to derive scaling factors are chosen to reflect the linkages between activity associated with the sector and the likely driver of change in this activity, e.g. if the sector is linked to residential properties, then the number of households will influence the emissions arising from this sector, and hence can act as a driver.

Because the Jersey inventory is a scaled version of the UK inventory, the assumption is that the more detailed methodologies, datasets and expert judgment used to compile the UK inventory are applicable to Jersey. It is also assumed that this methodology provides a more accurate reflection of Jersey's emissions than would be the case using a simple methodology and international default assumptions and emission factors.

Through this scoping report, the Department of the Environment would like to gain further insight into the current inventory methodologies to understand whether these current assumptions are applicable for all F-gas sources. This report will also provide information on ways that these methodologies could be improved in future inventories, and an understanding of the process required to estimate projected emissions. This report is split into four sections:

1. The first section discusses the outcomes of sector analyses investigating the dominant cause of the **trends seen in Jersey's F-gas emissions**.
2. The second section investigates the additional **data required to improve methodologies** applied in the F-gas inventory.
3. The third section provides guidance on how **F-gas emissions could be projected** in order to evaluate the needs and effects of policies in future years.
4. The fourth section summarises the **conclusions and recommendations** of this scoping report.

[1] http://www.aether-uk.com/Resources/Jersey-Infographic

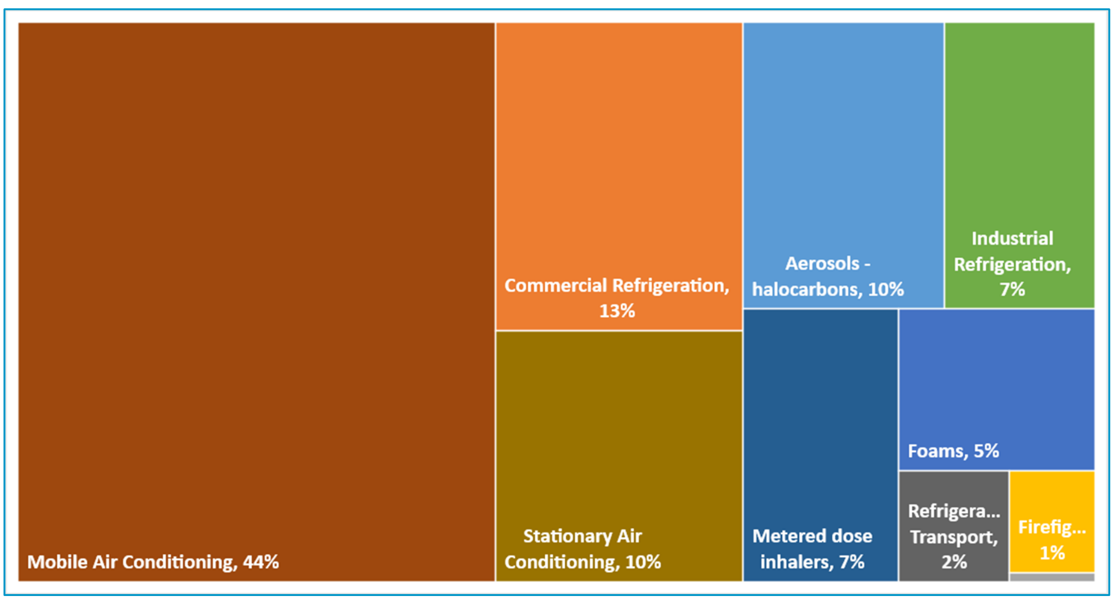
2 Sector analysis

The following section of this scoping report provides an overview of the drivers behind the trend of each F-gas category. This information will help the Department of the Environment to determine whether the current assumptions regarding the correlation between the UK and Jersey's situations are appropriate.

The latest published F-gas inventory for Jersey[2] was used for this analysis. This contains emission estimates for the period 1990 to 2014 split across 12 categories and 11 species of F-gases grouped as HFCS, PFCs and SF_6.

The current distribution of emissions for F-gases in 2014 by category is displayed in Figure 1 below. Nearly 50% of F-gas emissions in Jersey originate from mobile air conditioning. Despite the fact these data are scaled, and primarily reflects the distribution of emissions occurring in the UK, this distribution is an important consideration to help prioritise any efforts in methodological improvements.

Figure 1 - Tree map displaying the proportion of emissions 2014 F-gas emissions according to sector



In order to supply any recommendations regarding methodological improvements, there is a need to first establish the underlying cause behind the trends displayed in the Jersey F-gas inventory. Due to the current methodology, the trends displayed in the F-gas inventory can be linked to two mechanisms:

1. Differences caused by variation in the proxy datasets used to derive the driver;
2. Variation in UK emissions.

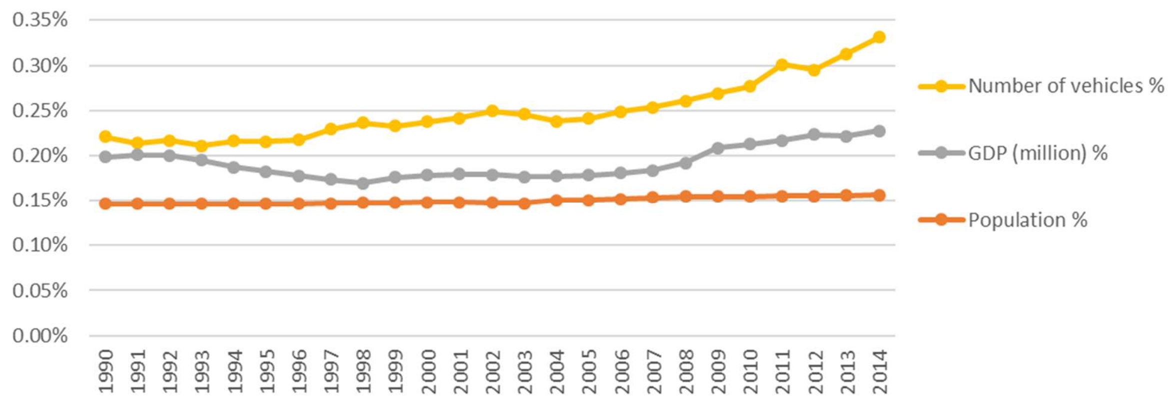
The graph below provides the driver values (percentage applied to the UK inventory) to calculate the Jersey inventory estimates. The graph clearly shows that the population driver will have very little effect on the trend of estimates because the percentage value remains very stable across the time

[2] http://www.aether-uk.com/Resources/Jersey-Infographic

series. In contrast, there will be an impact on the Jersey trend when applying the driver: “number of vehicles”. This indicates that the growth rate of vehicles in Jersey is greater than that in the UK.

The graph also shows that there is also a noticeable difference between the magnitude of the resulting emissions from each driver. When applying the population driver, emission estimates will be between 0.15% and 0.16% of the UK emission estimates, whereas the vehicle number driver will result in emission estimates between 0.21% and 0.33% of UK emission estimates. This means that switching between these two drivers could halve (or double) the emission estimates.

Figure 2 – Time series of drivers (Jersey proxy data divided by UK proxy data) as a percentage (1990-2014)



In order to further assess the influence of each of these mechanisms, the emission estimates for both the UK and Jersey for each of the 12 sectors, split according to pollutant, in addition to the proxy datasets via which the relevant driver was derived, were plotted across the available time series.

Each of these datasets were normalised so that the trend in these datasets could be directly compared on the same axes. This enabled a degree of visual analysis to be undertaken to determine the most significant cause of the trend in each category. The results of this analysis are available in the accompanying spreadsheet: “Jersey_driver_analysis”.

For the vast majority of sectors, the main cause of the Jersey emission trend is the trend in the UK emission estimates. The source where this is not the case is “mobile air conditioning”. This is the only source that uses “number of vehicles” as a driver, which (as shown by Figure 2 above) is the only driver that does not have a generally flat time series. This source accounted for 44% of emissions in 2014 making it the most significant source in Jersey’s F-gases inventory.

With this outcome in mind, the following questions were considered:

- Are the trends that we see in the UK applicable to Jersey (e.g. can we assume that what influences the UK trend would also have a similar impact on Jersey’s trend)?
- Are emissions per driver unit sufficiently similar in the UK as they are in Jersey (e.g. emissions from domestic air conditioning per person)?

In consultation with the Department of the Environment, it was concluded that the UK trends are applicable to Jersey, and that the emissions per driver unit are sufficiently similar to the UK. As such, the current methodology is sufficient. However, a review of the proxy data used by category was performed to identify categories where these assumptions could be improved. The outcomes are provided in Table 1 in the section: “Conclusions and recommendations”.

3 Methodological assessment

The current methodological approach for sources of F-gases uses proxy datasets (e.g. population) from Jersey and the UK, to derive a scaling factor, which is applied to the UK emission estimates of F-gases to estimate relative emissions from Jersey. The proxy datasets used to derive scaling factors are chosen to reflect the linkages between activity associated with the sector and the likely driver of change in this activity.

Annex 1 provides a list of the scaling factors currently used in the inventory, which have been reviewed by the Department of the Environment to ensure that the current scaling factors applied to the UK inventory categories are appropriate. As a result, some will be updated for the inventory published in 2018 covering the years 1990 to 2016. These are highlighted in the conclusions and recommendations.

This current approach is a simplistic methodology, which is not specifically defined in the 2006 IPCC Guidelines[3]. Within these guidelines the methodologies used to estimate F-gas emissions can be split into three methodological tiers:

- Tier 1 is typically less data intensive and hence requires less detailed or further disaggregated data;
- Tier 2 requires more disaggregated data and hence is considered a more sophisticated approach;
- Tier 3 requires the use of actual monitoring and measurements of emissions from sources, which is rarely utilised due to the disparate nature of these sources.

The following sections provide information on Tier 1 and Tier 2, so that the Department of the Environment can assess the resources required to move from the current methodology to a Tier 1 or Tier 2 approach consistent with the 2006 IPCC Guidelines. Each section will list the data and information required to create a methodology that is not dependent on scaling the UK inventory. **Annex 2** provides a single list of these data requirements for all sectors**.**

It is important to note that moving away from the current approach is not necessarily the most appropriate course of action: there will be cases where the detailed data and expert judgement applied to the UK inventory will create more accurate estimates than those calculated using international default emission factors.

3.1 Life cycle of F-gas sources

F-gases are man-made substances manufactured for and used in a wide range of products. These include air conditioning units, asthma inhalers and insulation materials. In many of these products, F-gases are present within the unit throughout its life-time. When estimating emissions, three phases must be considered:

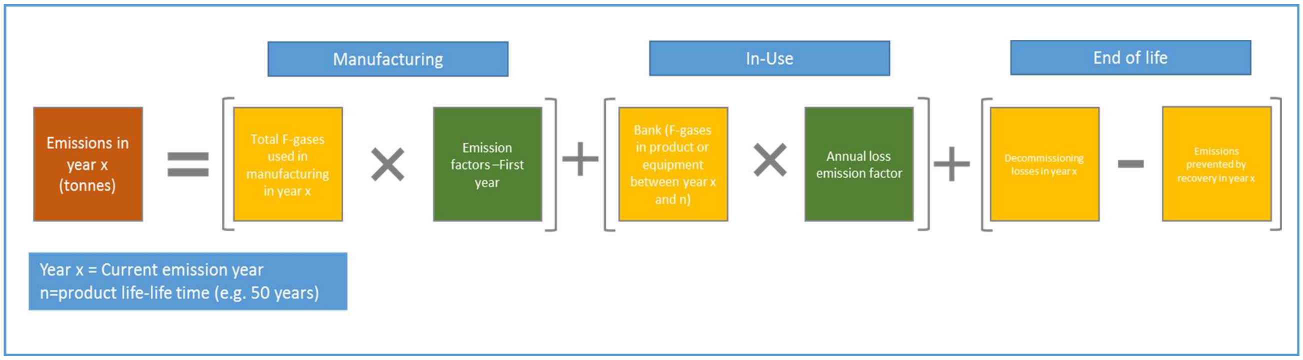
1. Manufacturing – emissions released during the manufacture of products,
2. In-Use – emissions released whilst the unit is in use, e.g. through leakage,
3. End of life – emissions released during the disposal of products.

The diagram below depicts these phases. Emissions are only considered if they take place within Jersey; emissions related to units manufactured or disposed of in other countries are not included in

[3] 2006 IPCC Guidelines for National Greenhouse Gas Inventories provides guidance on the compilation of national emission estimates of GHGs: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol3.html

Jersey's F-gas inventory. There is a wide range of F-gas blends available (see **Annex 3**) all of which are defined as a specific blend of specific F-gas species.

Figure 3 - Diagram depicting the emissions of F-gases over a product's life cycle.



3.2 Mass balance approach

The key concept behind estimating emissions of F-gases is understanding the quantity of blends that are arriving and leaving the country. From this overarching information, default emission factors and assumptions can be applied to estimate annual releases of F-gases. These data need to be disaggregated by type of blend (see **Annex 2**) and preferably be available for all years during which the blend was used within the country.

This overarching mass balance approach to F-gases provides a helpful way to understand the magnitude of use and release of F-gases by building a picture of the national bank of blends. This is a simplistic picture of calculating emissions, and could be a very helpful first step to assessing the accuracy of the current emission estimates within Jersey: the current methodology does not take into account any country-specific data regarding the import or export of F-gases to and from Jersey.

The table below provides information on the data required to evaluate the overarching mass balance.

Overarching Mass Balance	Significance
Annual sales of all blends, imported and exported	100%
Sales of new equipment manufactured, imported and exported	
Year of introduction for each blend	
Information on destruction and recovery activities	

To provide a more detailed estimate for F-gases, information regarding the appliances that use the F-gases is required. This is because different appliances will emit F-gases at have different speeds and times within their life cycle. The following sections provide information by appliance.

Annex 4 provides a suggested data collection template that could be used to collect data regarding the production, import and export of F-gases for each category.

3.3 Refrigeration and air conditioning

F-gases are used in refrigeration and air conditioning as a coolant. Current F-gas Jersey emissions for stationary refrigeration and air conditioning are estimated for six categories using the following drivers:

- Industrial refrigeration e.g. chillers – GDP
- Domestic refrigeration e.g. fridges – number of households
- Commercial refrigeration e.g. vending machines – GDP
- Stationary air conditioning e.g. a building air conditioning system – population
- Transport refrigeration e.g. refrigerated chilled vehicles
- Mobile air conditioning e.g. air conditioning unit within passenger cars

The UK methodology is consistent with a Tier 2 approach. Refrigeration and air conditioning is anticipated to be a significant source of F-gases in most countries, including the UK. Hence in most cases, due to this status, a Tier 2 approach is required. The table below summarises the required data for Tier 2, as well as the overall significance of current 2014 emission estimates, relative to all F-gases.

Tier 2	Significance (% of F-gas emissions, 2014)
Annual sales of all blends, imported and exported used for each sub-application	74%
Sales of new equipment manufactured, imported and exported for each sub-application	
Year of introduction for each sub-application.	
Disposal and recovery practices for each sub-application	

3.4 Aerosols

F-gases are used as propellants in a variety of aerosols. In the 2006 IPCC Guidelines, two methodologies exist; tier 1 and tier 2, which differ as to whether they account for the application or sub-application level. The tier 2 method estimates emissions over the following sub-applications:

1. Metered dose inhalers (e.g. asthma inhalers)
2. Personal care products (e.g. deodorant)
3. Household products (e.g. air fresheners)
4. Industrial products (e.g. lubricants)
5. Other (e.g. klaxons)

Emissions from aerosols are estimated using a driver derived from Jersey's and the UK's population. The UK methodology is consistent with a Tier 2 approach. The table below summarises the required data for each tier, as well as the overall significance of current 2014 emission estimates, relative to all F-gases.

Tier 1	Tier 2	Significance (% of F-gas emissions, 2014)
Amount of each F-gas species sold within aerosol products (including imports)	Amount of aerosol products sold (including imports) by sub-application	17%

3.5 Closed-cell foams

Foams are an important cellular engineering material. Closed-cell foams contain pores that are completely surrounded by the medium and can contain F-gases, which are being used as replacements for CFCs and HCFCs, and particularly in insulation. In the 2006 IPCC Guidelines, two methodologies exist; tier 1 and tier 2, which differ as to whether they account for the application or sub-application level. The tier 2 method attempts to estimate emissions over the following sub-applications:

- Polyurethane panels

- Polyurethane appliance foam
- Polyurethane injected foam
- Polyurethane blocks
- Polyurethane laminate
- Polyurethane spray foam
- Extruded polystyrene
- Phenolic block
- Phenolic laminate

Emissions from closed-cell foams are estimated via a driver derived from Jersey's and the UK's gross domestic product (GDP). The UK methodology is consistent with a Tier 2 approach. The table below summarises the required data for each tier, as well as the overall significance of current 2014 emission estimates, relative to all F-gases.

Tier 1	Tier 2	Significance (% of F-gas emissions, 2014)
Amount of each F-gas species used annually in the manufacturing of closed cell foams	Amount of each F-gas species used annually in the manufacturing of closed cell foams, by sub-application	7.2%
Annual import and export of closed cell foams	Annual import and export of closed cell foams, by sub-application	
Information on disposal and recovery practices	Information on disposal and recovery practices, by sub-application	

3.6 Open-cell foams

Open-cell foams differ from closed-cell foams because the pores are not self-contained and, therefore, cannot contain the gas. As such, emissions are most likely to occur in the manufacturing stage, so there is no need to consider the emissions from these foams throughout the various stages of its life cycle. In the 2006 IPCC Guidelines, two methodologies exist; tier 1 and tier 2, which differ as to whether they account for the application or sub-application level. The tier 2 method attempts to estimate emissions over the following sub-applications:

- PU Flexible Foam
- PU Flexible Moulded Foam
- PU Integral Skin Foam
- PU One Component Foam

Emissions from open-cell foams are estimated via a driver derived from Jersey's and the UK's gross domestic product (GDP). The UK methodology is consistent with a Tier 2 approach. The table below summarises the required data for each tier, as well as the overall significance of current 2014 emission estimates, relative to all F-gas species.

It should be noted that in 2014 no emissions from open-cell foams were estimated, however historical emissions over the time series do exist. The table below summarises the data requirements.

Tier 1	Tier 2	Significance (% of F-gas emissions, 2014)
Amount of each F-gas species used annually in the manufacturing of open cell foams	Amount of each F-gas species used annually in the manufacturing of open cell foams, by sub-application	0%

3.7 Firefighting

F-gases are used as a fire suppressant in fire protection systems. As such, they are stored inside the system with a low likelihood of release. Emission estimates for Jersey are scaled from UK emission estimates using GDP as a driver. The 2006 IPCC Guidelines lists a range of sub-applications, however a tier 2 methodology doesn't exist in regards to this sector, as the sub-applications are determined as too similar to warrant this terminology. Similar dynamics between this sector and refrigeration and air conditioning exist, as both rely heavily on the incorporation and development of banks within the equipment used.

The table below details data requirements for this sector.

Tier 1	Significance (% of F-gas emissions, 2014)
Amount of each F-gas species added to firefighting equipment annually	1.5%
Information regarding recovery and end of life practices	
Estimated equipment life time	

3.8 Electrical equipment

SF_6 is used for electrical insulation and current interruption in equipment used in the distribution and transmission of electricity. It is currently assumed that emissions from this activity do not occur in Jersey. This assumption should be reviewed by the Department of the Environment to understand whether SF6 is used in national distribution network for electricity. If it is, this assumption will be revised in the next inventory (1990-2016). These estimates will either be calculated using an appropriate driver and scaling the UK inventory, or derived using country-specific data on the use of F-gases for this activity.

3.9 Minor emission sources

There are also some categories that are considered not to occur in Jersey whilst they do occur in the UK. These categories are listed below and it is recommended that the Department of the Environment reviews the accuracy of these assumptions (see **Annex 1**):

- Production of fluorinated gases
- Semi-conductor manufacture
- Primary aluminium production
- Magnesium production
- Electronics production
- Manufacture of refrigeration and air conditioning units (i.e. all units are imported)
- Disposal of refrigeration and air conditioning units (i.e. all units are exported at end of life)

The following emission source is considered to be very minor in the Jersey context. Emissions from **sporting goods** mainly refer to the use SF_6 within sport footwear. In the UK, it is noted that the production of this footwear only occurred between 1990 and 2003, and was progressively phased out of production by national policy. The nature of SF_6 results in the gas unable to diffuse out of the product until it is destroyed at the end of life. Hence all emissions occur at the end of life, according to the amount initially added to each product.

Activity data required therefore needs to document the amount of sport footwear containing SF_6 destroyed in a certain year. In respect to the UK, activity data on production is supplied directly from the manufacturer. Jersey could investigate whether sport footwear containing SF_6 is imported, and hence whether emissions from this sector applies.

4 Methodology for F-gas projections

Projections of F-gases can support the assessment of potential policy gaps and needs in future years, and can also be used to evaluate the potential effectiveness of a policy on a specific pollutant or activity. Formally, there is no specific methodology for greenhouse gas projections and hence F-gases, however draft guidance on projections is publically available from the European Commission[4]. Other projection guidelines for air quality pollutants can be obtained through the EMEP EEA guidebook, however both are based upon similar principles[5]. This section provides information on a simple approach consistent with these guidelines.

Before any projection methodology can be applied, it is recommended each sector is prioritised in order of significance, both in level (i.e. contribution to total) and trend (i.e. contribution to total change across a time series). This helps to identify areas key to the inventory, or in this case, important sectors in the context of F-gas emissions.

This can be done with respect to current F-gas emissions for Jersey, which will reflect key sectors in respect to the UK, or, if country-specific emission estimates are derived relative to the methodological analysis above, key sectors specific to Jersey. In regards to the former option, key sectors include mobile air conditioning, stationary air conditioning, and commercial refrigeration. This can then be used to prioritise efforts on projections.

Projections, similarly to methodologies, can be segregated into 3 categories, differing in complexity. To avoid confusion with Tiers, these are referred to as 'Grades'. Both Grades 2 and 3 utilise data or models developed at the European level, and hence could be considered overly resource intensive for Jersey's requirements. Grade 1 uses proxies for parameters to stimulate future development of emissions, and represents the simplest projection methodology.

A proxy is defined as a measurable unit that can be used to construct a non-directly measureable unit (e.g. population size is generally considered a good proxy to derive the energy use of consumers). A good proxy should have a close correlation with the variable (this correlation isn't confined to linear or positive correlations only). A generic formula for these Grade 1 emission projections is displayed below. This formula is made up of two key components.

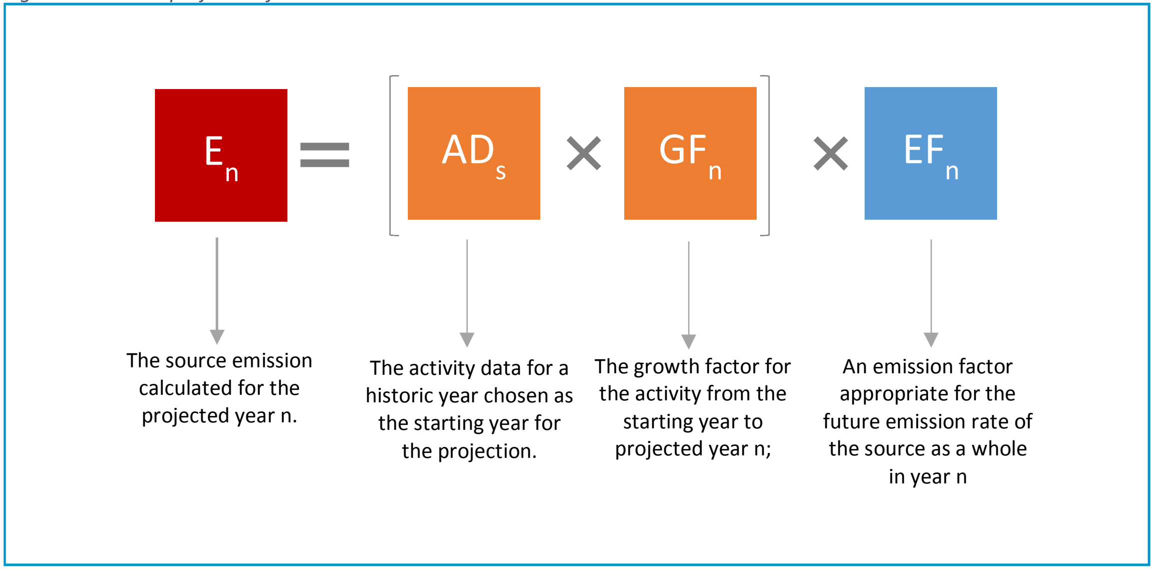
[4] Draft GHG projection guidelines, Part A: General Guidance, https://ec.europa.eu/clima/sites/clima/files/strategies/progress/monitoring/docs/ghg_projection_guidelines_a_en.pdf

[5] EMEP EEA Guidebook, chapter 8 – projections, http://www.eea.europa.eu//publications/emep-eea-guidebook-2016

Firstly, an activity growth factor (GF_n) which is used to predict the activity data in future years. Usually a growth factor is applied to the latest year of available data (e.g. the latest year in the inventory), however in this case this latest year will be dependent on whether any country specific emissions are calculated.

The second component is the future year emission factor (EF_n) and is defined as the future emission rate for the source of emissions taken as a whole. If no change in the emission factors is anticipated, it is recommended the factor stays constant, and hence any change from the starting year of the projections in solely due to the growth factor. The future emission factor is often adjusted to take into account the influence of a certain policy or the introduction of different technologies.

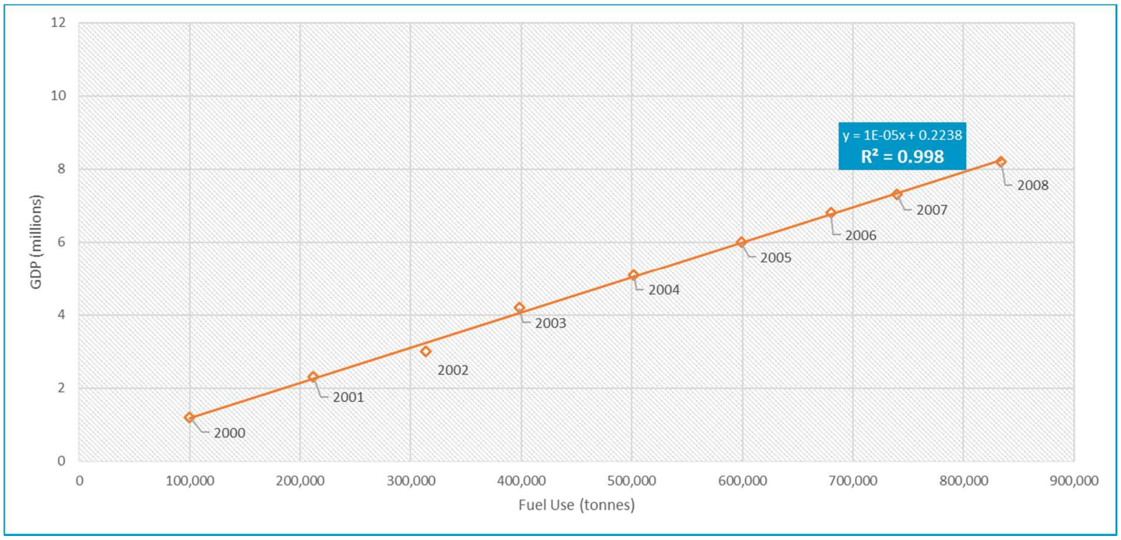
Figure 4 - Generic projection formula



The Growth factor (GF_n) will need to be derived from the proxy dataset employed, and usually consists of deriving the ratio between the historical starting year and the year for which a projection is required (e.g. if the proxy dataset considered was GDP, dividing the GDP of the latest available year by the predicted GDP for a future year will provide a growth factor of GDP over the projection time period).

It is also best practice to develop some form of statistical justification, in order to evaluate the applicability of using this methodology. Common practice is to employ regression analysis to investigate the relationship between the proxy and the activity data over a historical time series. If a satisfactory degree of correlation is determined, the proxy can be used to predict future activity data via a growth factor. A hypothetical example is given below, which compares a proxy of GDP and the consumption of a hypothetical fuel over the time period 2000 to 2008. A good correlation occurs with a regression close to a value of 1, the highest degree of correlation. Hence, GDP appears to act as a good indicator of fuel use.

Figure 5 - Regression analysis of a projection proxy across a historical time series.



Using these approaches, F-gas projections can be derived simply and effectively in order to support policy discussion and development. Aether has extensive experience in calculating air emission projections, developing country-specific projection tools, and providing training regarding projection methodologies. If such projections are concluded to be a priority activity for the Department of the Environment, we would be able to support these activities.

5 Conclusions and recommendations

This scoping note provided evidence and analysis regarding the methodologies applied to estimate F-gas emissions for Jersey. The conclusions and recommendations of this report are as follows:

1. The **underlying methodology applied to estimate Jersey's F-gas emissions is appropriate** and does not need to be improved considering the current significance of these categories;

2. The **proxy data used for these calculations are, generally, appropriate** though there are some modifications that require implementation or further investigation for Jersey's 2018 GHG inventory submission (see Table 1 below for details);

3. **Communicating the underlying trends for the Jersey F-gas estimates should be improved** in Jersey's online infographic by ensuring that the tooltip visible for these categories provides an explanation for the causes of the increasing emissions trends;

4. **Simple projections can be calculated for the F-gas estimates** if this becomes a priority for the Department of the Environment in the future.

The recommendations highlighted in Table 1 below have been added to the improvements plan for Jersey's inventory, which is managed by Aether. The recommendation related to Jersey's infographic should be considered by the relevant body that updates this output if the Department of the Environment decides to undertake an update.

Table 1: Findings from the assessment of the proxy data used for each F-gas category.

<table>
<tr><th>Species</th><th>IPCC Sector</th><th>Source Name</th><th>Current proxy data</th><th>Proposed proxy data</th></tr>
<tr><td>HFC-125</td><td>2F1</td><td>Industrial Refrigeration - Lifetime</td><td>GDP</td><td>GVA by sector</td></tr>
<tr><td colspan="5">Conclusion: Initial analysis indicates that the industry breakdown for UK[6] and Jersey[7] GVA is considerably different and will require further analysis in order to use the data. The UK F-gas emission estimates are not based on GVA sector, so the UK inventory categories would need to be matched to the GVA categories – this will be a one-to-many and many-to-one relationship.</td></tr>
<tr><td colspan="5">Recommendation: Review this methodology update during the compilation of Jersey's 2018 GHG inventory submission</td></tr>
<tr><td>C3F8</td><td>2F1</td><td>Commercial Refrigeration - Manufacture</td><td>GDP</td><td>Zero</td></tr>
<tr><td colspan="5">Conclusion: The Department of the Environment has confirmed that no manufacture activities take place in Jersey[8]. However, it is important to understand whether emissions from first-fill of commercial units is included in this sector. This is applicable to all manufacture categories. Note that it will not be possible to disaggregate emissions from manufacture and first-fill in the UK inventory.</td></tr>
<tr><td colspan="5">Recommendation: Update the proxy data for Jersey's 2018 GHG inventory submission making it consistent with other RAC categories.</td></tr>
<tr><td>C3F8</td><td>2F1</td><td>Commercial Refrigeration - Disposal</td><td>GDP</td><td>Zero</td></tr>
<tr><td colspan="5">Conclusion: The Department of the Environment confirmed that no disposal activities take place in Jersey. All other disposal categories are set to zero, as expected.</td></tr>
<tr><td colspan="5">Recommendation: Update the proxy data for Jersey's 2018 GHG inventory submission making it consistent with other RAC categories.</td></tr>
<tr><td>HFC-134a</td><td>2F4</td><td>Metered dose inhalers</td><td>Population</td><td>Population</td></tr>
<tr><td colspan="5">Conclusion: The Department of the Environment provided evidence of the prevalence of asthma in Jersey and England[9]. This indicated that the prevalence of asthma is 18% less in Jersey than in England. It did not provide information for the UK. The UK inventory estimates are based on prescription data rather than prevalence data, which is more accurate.</td></tr>
<tr><td colspan="5">Recommendation: Review this methodology during the compilation of Jersey's 2018 GHG inventory submission and consider whether the implementation of an 18% reduction in emissions would be appropriate.</td></tr>
<tr><td>SF6_C_equiv</td><td>2F9</td><td>Electrical insulation</td><td>Zero</td><td>GDP</td></tr>
<tr><td colspan="5">Conclusion: This activity does occur in Jersey[10] and therefore emissions should be included in the inventory.</td></tr>
<tr><td colspan="5">Recommendation: Update the proxy data for Jersey's 2018 GHG inventory submission.</td></tr>
</table>

[6] https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/regionalgrossvalueaddedincomeapproach
[7] https://www.gov.je/government/jerseyinfigures/businesseconomy/pages/nationalaccounts.aspx#anchor-1
[8] Personal communication 15/12/2016: progress meeting by telephone of Jersey F-gases project between Fiona Glover and Emma Salisbury
[9] https://www.gov.je/SiteCollectionDocuments/Government%20and%20administration/R%20HealthProfile2016%2020161123%20HI.pdf
[10] Jersey returns for inventory compilation, Department of the Environment, 2016

Annex 1: List of categories and scaling factors

Table 2: Summary of all F-gas categories in the UK inventory and how they are scaled for the Jersey inventory. Note that some of these categories use "zero" as a proxy data thus assuming that this activity that occurs in the UK does not occur in Jersey.

Species	IPCC Sector	Source Name	Proxy data
HFC-125	2E1	Halocarbons production	Zero
HFC-134a	2E1	Halocarbons production	Zero
HFC-143a	2E1	Halocarbons production	Zero
HFC-152a	2E1	Halocarbons production	Zero
HFC-227ea	2E1	Halocarbons production	Zero
HFC-23	2E1	Halocarbons production	Zero
HFC-32	2E1	Halocarbons production	Zero
C2F6	2E2	Halocarbons production	Zero
C3F8	2E2	Halocarbons production	Zero
CF4	2E2	Halocarbons production	Zero
PFC_C_equiv	2E2	Halocarbons production	Zero
C2F6	2C3	Primary aluminium production	Zero
CF4	2C3	Primary aluminium production	Zero
HFC-134a	2C4	Magnesium production	Zero
SF6_C_equiv	2C4	Magnesium production	Zero
HFC-134a	2F1	Domestic Refrigeration - Manufacture	Zero
HFC-134a	2F1	Domestic Refrigeration - Lifetime	Population
HFC-134a	2F1	Domestic Refrigeration - Disposal	Zero
HFC-125	2F1	Commercial Refrigeration - Manufacture	Zero
HFC-134	2F1	Commercial Refrigeration - Manufacture	Zero
HFC-134a	2F1	Commercial Refrigeration - Manufacture	Zero
HFC-143a	2F1	Commercial Refrigeration - Manufacture	Zero
HFC-32	2F1	Commercial Refrigeration - Manufacture	Zero
HFC-125	2F1	Commercial Refrigeration - Lifetime	GDP
HFC-134	2F1	Commercial Refrigeration - Lifetime	GDP
HFC-134a	2F1	Commercial Refrigeration - Lifetime	GDP
HFC-143a	2F1	Commercial Refrigeration - Lifetime	GDP
HFC-32	2F1	Commercial Refrigeration - Lifetime	GDP
HFC-125	2F1	Commercial Refrigeration - Disposal	Zero
HFC-134	2F1	Commercial Refrigeration - Disposal	Zero
HFC-134a	2F1	Commercial Refrigeration - Disposal	Zero
HFC-143a	2F1	Commercial Refrigeration - Disposal	Zero
HFC-32	2F1	Commercial Refrigeration - Disposal	Zero

HFC-125	2F1	Refrigerated Transport - Manufacture	Zero
HFC-134a	2F1	Refrigerated Transport - Manufacture	Zero
HFC-143a	2F1	Refrigerated Transport - Manufacture	Zero
HFC-32	2F1	Refrigerated Transport - Manufacture	Zero
HFC-125	2F1	Refrigerated Transport - Lifetime	GDP
HFC-134a	2F1	Refrigerated Transport - Lifetime	GDP
HFC-143a	2F1	Refrigerated Transport - Lifetime	GDP
HFC-32	2F1	Refrigerated Transport - Lifetime	GDP
HFC-125	2F1	Refrigerated Transport - Disposal	Zero
HFC-134a	2F1	Refrigerated Transport - Disposal	Zero
HFC-143a	2F1	Refrigerated Transport - Disposal	Zero
HFC-32	2F1	Refrigerated Transport - Disposal	Zero
HFC-125	2F1	Industrial Refrigeration - Manufacture	Zero
HFC-134a	2F1	Industrial Refrigeration - Manufacture	Zero
HFC-143a	2F1	Industrial Refrigeration - Manufacture	Zero
HFC-32	2F1	Industrial Refrigeration - Manufacture	Zero
HFC-125	2F1	Industrial Refrigeration - Lifetime	GDP
HFC-134a	2F1	Industrial Refrigeration - Lifetime	GDP
HFC-143a	2F1	Industrial Refrigeration - Lifetime	GDP
HFC-32	2F1	Industrial Refrigeration - Lifetime	GDP
HFC-125	2F1	Industrial Refrigeration - Disposal	Zero
HFC-134a	2F1	Industrial Refrigeration - Disposal	Zero
HFC-143a	2F1	Industrial Refrigeration - Disposal	Zero
HFC-32	2F1	Industrial Refrigeration - Disposal	Zero
HFC-125	2F1	Stationary Air Conditioning - Manufacture	Zero
HFC-134a	2F1	Stationary Air Conditioning - Manufacture	Zero
HFC-143a	2F1	Stationary Air Conditioning - Manufacture	Zero
HFC-32	2F1	Stationary Air Conditioning - Manufacture	Zero
HFC-125	2F1	Stationary Air Conditioning - Lifetime	Population
HFC-134a	2F1	Stationary Air Conditioning - Lifetime	Population
HFC-143a	2F1	Stationary Air Conditioning - Lifetime	Population
HFC-32	2F1	Stationary Air Conditioning - Lifetime	Population
HFC-125	2F1	Stationary Air Conditioning - Disposal	Zero
HFC-134a	2F1	Stationary Air Conditioning - Disposal	Zero
HFC-143a	2F1	Stationary Air Conditioning - Disposal	Zero
HFC-32	2F1	Stationary Air Conditioning - Disposal	Zero
HFC-125	2F1	Mobile Air Conditioning - Manufacture	Zero
HFC-134a	2F1	Mobile Air Conditioning - Manufacture	Zero
HFC-32	2F1	Mobile Air Conditioning - Manufacture	Zero

HFC-125	2F1	Mobile Air Conditioning - Lifetime	Vehicles
HFC-134a	2F1	Mobile Air Conditioning - Lifetime	Vehicles
HFC-32	2F1	Mobile Air Conditioning - Lifetime	Vehicles
HFC-125	2F1	Mobile Air Conditioning - Disposal	Zero
HFC-134a	2F1	Mobile Air Conditioning - Disposal	Zero
HFC-32	2F1	Mobile Air Conditioning - Disposal	Zero
C3F8	2F1	Commercial Refrigeration - Manufacture	GDP
C3F8	2F1	Commercial Refrigeration - Lifetime	GDP
C3F8	2F1	Commercial Refrigeration - Disposal	GDP
HFC-134a	2F2	Foams	GDP
HFC-152a	2F2	Foams	GDP
HFC-227ea	2F2	Foams	GDP
HFC-227ea	2F3	Firefighting	GDP
HFC-23	2F3	Firefighting	GDP
C4F10	2F3	Firefighting	GDP
HFC-134a	2F4	Metered dose inhalers	Population
HFC-227ea	2F4	Metered dose inhalers	Population
HFC-134a	2F4	Aerosols - halocarbons	Population
HFC-152a	2F4	Aerosols - halocarbons	Population
HFC-43-10mee	2F5	Precision cleaning	Zero
PFC_C_equiv	2F5	Other PFC use	GDP
HFC-134a	2F9	One Component Foams	GDP
HFC-152a	2F9	One Component Foams	GDP
C2F6	2F9	Sporting goods	Population
C3F8	2F9	Sporting goods	Population
C2F6	2F9	Electronics manufacture	Zero
C3F8	2F9	Electronics manufacture	Zero
C4F8	2F9	Electronics manufacture	Zero
CF4	2F9	Electronics manufacture	Zero
SF6_C_equiv	2F9	Sporting goods	Population
SF6_C_equiv	2F9	Electrical insulation	Zero
SF6_C_equiv	2F9	Electronics manufacture	Zero

Annex 2: List of data collection requirements

Table 3: Summary list of data collection requirements for an overarching mass balance approach.

Overarching Mass Balance	Significance
Annual sales of all blends, imported and exported	100%
Sales of new equipment manufactured, imported and exported	
Year of introduction for each blend	
Information on destruction and recovery activities	

Table 4: Summary list of data collection requirements for Tier 2 and Tier 2 methodologies by sector.

Sector	Data requirements for Tier 1	Sub-application	Data requirements for Tier 2	Significance
Refrigeration and air conditioning	N/A	Mobile air conditioning	• Annual sales of all blends used in this sub-application • Sales of new equipment (including those imported or exported) • Year of introduction for each blend. • Disposal and recovery practices for this sub-application	44%
		Stationary air conditioning	• Annual sales of all blends used in this sub-application • Sales of new equipment (including those imported or exported) • Year of introduction for each blend. • Disposal and recovery practices for this sub-application	10%
		Commerical refrigeration	• Annual sales of all blends used in this sub-application • Sales of new equipment (including those imported or exported) • Year of introduction for each blend. • Disposal and recovery practices for this sub-application	13%
		Domestic refrigeration	• Annual sales of all blends used in this sub-application • Sales of new equipment (including those imported or exported) • Year of introduction for each blend. • Disposal and recovery practices for this sub-application	0%
		Industrial refrigeration	• Annual sales of all blends used in this sub-application • Sales of new equipment (including those imported or exported) • Year of introduction for each blend. • Disposal and recovery practices for this sub-application	7%
			• Annual sales of all blends used in this sub-application	

			• Sales of new equipment (including those imported or exported)	
			• Year of introduction for each blend.	
			• Disposal and recovery practices for this sub-application	
Aerosols	• Amount of each F-gas species sold within aerosol products (including imports)	Metered dose inhalers (MDIs)	• Amount of aerosol products sold (including imports) by sub-application	7%
		Other aerosols	• Amount of aerosol products sold (including imports) by sub-application	10%
Closed cell foams	• Amount of each F-gas species used annually in the manufacturing of closed cell foams	*See report for 9 sub-applications*	• Amount of each F-gas species used annually in the manufacturing of closed cell foams, by sub-application	7%
	• Annual import and export of closed cell foams		• Annual import and export of closed cell foams, by sub-application	
	• Information on disposal and recovery practices		• Information on disposal and recovery practices, by sub-application	
Open cell Foams	• Amount of each F-gas species used annually in the manufacturing of open cell foams		• Amount of each F-gas species used annually in the manufacturing of open cell foams, by sub-application	0%
Firefighting	• Amount of each F-gas species either exported, imported, produced or destroyed.	N/A		2%
	• Information regarding recovery/end of life practices			
	• Estimated equipment life time			

Annex 3: List of fluorinated gas blends

Table 5: List of F-gas blends and their constituent F-gas species (2006 IPCC Guidelines)

TABLE 7.8
BLENDS (MANY CONTAINING HFCs AND/OR PFCs)

Blend	Constituents	Composition (%)
R-400	CFC-12/CFC-114	Should be specified[1]
R-401A	HCFC-22/HFC-152a/HCFC-124	(53.0/13.0/34.0)
R-401B	HCFC-22/HFC-152a/HCFC-124	(61.0/11.0/28.0)
R-401C	HCFC-22/HFC-152a/HCFC-124	(33.0/15.0/52.0)
R-402A	HFC-125/HC-290/HCFC-22	(60.0/2.0/38.0)
R-402B	HFC-125/HC-290/HCFC-22	(38.0/2.0/60.0)
R-403A	HC-290/HCFC-22/PFC-218	(5.0/75.0/20.0)
R-403B	HC-290/HCFC-22/PFC-218	(5.0/56.0/39.0)
R-404A	HFC-125/HFC-143a/HFC-134a	(44.0/52.0/4.0)
R-405A	HCFC-22/ HFC-152a/ HCFC-142b/PFC-318	(45.0/7.0/5.5/42.5)
R-406A	HCFC-22/HC-600a/HCFC-142b	(55.0/14.0/41.0)
R-407A	HFC-32/HFC-125/HFC-134a	(20.0/40.0/40.0)
R-407B	HFC-32/HFC-125/HFC-134a	(10.0/70.0/20.0)
R-407C	HFC-32/HFC-125/HFC-134a	(23.0/25.0/52.0)
R-407D	HFC-32/HFC-125/HFC-134a	(15.0/15.0/70.0)
R-407E	HFC-32/HFC-125/HFC-134a	(25.0/15.0/60.0)
R-408A	HFC-125/HFC-143a/HCFC-22	(7.0/46.0/47.0)
R-409A	HCFC-22/HCFC-124/HCFC-142b	(60.0/25.0/15.0)
R-409B	HCFC-22/HCFC-124/HCFC-142b	(65.0/25.0/10.0)
R-410A	HFC-32/HFC-125	(50.0/50.0)
R-410B	HFC-32/HFC-125	(45.0/55.0)
R-411A	HC-1270/HCFC-22/HFC-152a	(1.5/87.5/11.0)
R-411B	HC-1270/HCFC-22/HFC-152a	(3.0/94.0/3.0)
R-411C	HC-1270/HCFC-22/HFC-152a	(3.0/95.5/1.5)
R-412A	HCFC-22/PFC-218/HCFC-142b	(70.0/5.0/25.0)
R-413A	PFC-218/HFC-134a/HC-600a	(9.0/88.0/3.0)
R-414A	HCFC-22/HCFC-124/HC-600a/HCFC-142b	(51.0/28.5/4.0/16.5)
R-414B	HCFC-22/HCFC-124/HC-600a/HCFC-142b	(50.0/39.0/1.5/9.5)
R-415A	HCFC-22/HFC-152a	(82.0/18.0)
R-415B	HCFC-22/HFC-152a	(25.0/75.0)
R-416A	HFC-134a/HCFC-124/HC-600	(59.0/39.5/1.5)
R-417A	HFC-125/HFC-134a/HC-600	(46.6/50.0/3.4)
R-418A	HC-290/HCFC-22/HFC-152a	(1.5/96.0/2.5)
R-419A	HFC-125/HFC-134a/HE-E170	(77.0/19.0/4.0)
R-420A	HFC-134a/HCFC-142b	(88.0/12.0)
R-421A	HFC-125/HFC-134a	(58.0/42.0)
R-421B	HFC-125/HFC-134a	(85.0/15.0)
R-422A	HFC-125/HFC-134a/HC-600a	(85.1/11.5/3.4)
R-422B	HFC-125/HFC-134a/HC-600a	(55.0/42.0/3.0)
R-422C	HFC-125/HFC-134a/HC-600a	(82.0/15.0/3.0)
R-500	CFC-12/HFC-152a	(73.8/26.2)
R-501	HCFC-22/CFC-12	(75.0/25.0)
R-502	HCFC-22/CFC-115	(48.8/51.2)
R-503	HFC-23/CFC-13	(40.1/59.9)
R-504	HFC-32/CFC-115	(48.2/51.8)
R-505	CFC-12/HCFC-31	(78.0/22.0)
R-506	CFC-31/CFC-114	(55.1/44.9)
R-507A	HFC-125/HFC-143a	(50.0/50.0)
R-508A	HFC-23/PFC-116	(39.0/61.0)

Annex 4: Template for data collection

Table 6: Sample data collection table providing information on the production, import and export for each applicable blend

Application: stationary air conditioning															
Year	**R-407C (tonnes)**			**XXX (tonnes)**			**XXX (tonnes)**			**XXX (tonnes)**			**XXX (tonnes)**		
	Production	**Import**	**Export**	**Production**	**Import**	**Export**	**Production**	**Import**	**Export**	**Production**	**Import**	**Export**	**Production**	**Import**	**Export**
1996															
1997															
1998															
1999															
2000															
2001															
2002															
2003															
2004															
2005															
2006															
2007															
2008															
2009															
2010															
2011															
2012															
2013															
2014															
2015															

Bulk import and export of blends will provide enough information to estimate F-gas emissions. However, understanding the end user of these blends will significantly improve estimates. As such, creating a table as shown above for the following categories would be desirable:

- Industrial refrigeration
- Domestic refrigeration
- Commercial refrigeration
- Stationary air conditioning
- Transport refrigeration
- Mobile air conditioning
- Aerosols
- Closed-cell foams
- Open-cell foams
- Firefighting
- Sporting goods

Aether