Guide to the Greenhouse Gas Inventories of Jersey and Guernsey

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List of acronyms

AIS – Automatic Identification System
CAA – Civil Aviation Authority
CH_4 - Methane
CO_2 - Carbon dioxide
DUKES – Digest of UK energy statistics
ERF – Energy recovery facility
EMEP/EEA – European Monitoring and Evaluation Programme/European Environment Agency
FAO – Food and Agriculture Organisation of the United Nations
FAOSTAT – Food and Agriculture Organisation Corporate Statistical Database
F-gases – Fluorinated gases
GDP – Gross domestic product
GHG – Greenhouse gas
GVA – Gross value added
GWP – Global Warming Potential
HFCs - Hydrofluorocarbons
IPCC – Intergovernmental Panel on Climate Change
LTO – Landing/take off
LULUCF – Land use, land use change and forestry
MSW – Municipal solid waste
N_2O - Nitrous oxide
PFCs - Perfluorocarbons
SF_6 - Sulphur hexafluoride
SOC – Soil organic carbon
tCO_2eq – Tonnes of carbon dioxide equivalent
UK – United Kingdom
UNFCCC – United Nations Framework Convention of Climate Change

Introduction

Both Jersey and Guernsey have acknowledged that climate change is an issue that requires immediate action and resources. Associated with this are plans for both islands to reduce their greenhouse gas emissions and ultimately be carbon neutral. In order to put in place a plan for net zero carbon emissions, it is important for all stakeholders to understand current and historical greenhouse gas emissions. This will provide a good foundation on which to make decisions on policies and measures that will impact future emissions. In recognising that climate change is an urgent issue, there are also opportunities to explore issues further, investigate new concepts and work in collaborative and innovative ways to come up with possible solutions.

A key component of this planning is to understand the key sources of emissions in Jersey and Guernsey, the trends in these key sources and their potential for future emissions reductions. As part of the UK National Atmospheric Emissions Inventory Programme, a greenhouse gas emissions inventory's for Jersey and Guernsey are produced annually. These inventories provide estimates for historical emissions of greenhouse gases from 1990 until the most recent submission year minus 2 (i.e. the 2019 inventory covers the period 1990 to 2017). This is in line with international reporting standards. The 2-year lag is to allow for time required for official statistics to become available and the amount of time to compile the necessary data and check and finalise emissions reported. The data are provided annually in accordance with international regulations.

This document provides a guide to the greenhouse gas inventories including an overview of the inventory methodology; how it is compiled, coverage and information on specific sources. Further detailed information on the inventory data, planned actions to reduce emissions and potential future reduction targets in Jersey can be found here.[1]

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

1 Introduction to greenhouse gas inventories

1.1 What is a greenhouse gas inventory?

A greenhouse gas (GHG) inventory is a dataset which presents estimates of emissions of various greenhouse gases from a wide range of activities in a country or other geographical area. Greenhouse gas inventories are reported to the United Nations Framework Convention on Climate Change (UNFCCC) by countries and are used for policymaking, monitoring progress in carbon reductions and for modelling in the scientific community.

1.2 What sectors are included and excluded?

In line with international reporting guidelines, produced by the Intergovernmental Panel on Climate Change, greenhouse gas emissions are reported by National Communications sectors:

- Agriculture
- Business
- Energy supply
- Land use change
- Residential
- Transport
- Waste management

Figure 1 provides an overview of what is included and excluded from the greenhouse gas inventories of Jersey and Guernsey. Emissions from international aviation and shipping are reported as memo items. This means that the activity is occurring outside of the country jurisdiction and, whilst an estimate of emissions is calculated, it is not included in the total emissions value (more information on aviation and shipping is provided in Chapter 4).

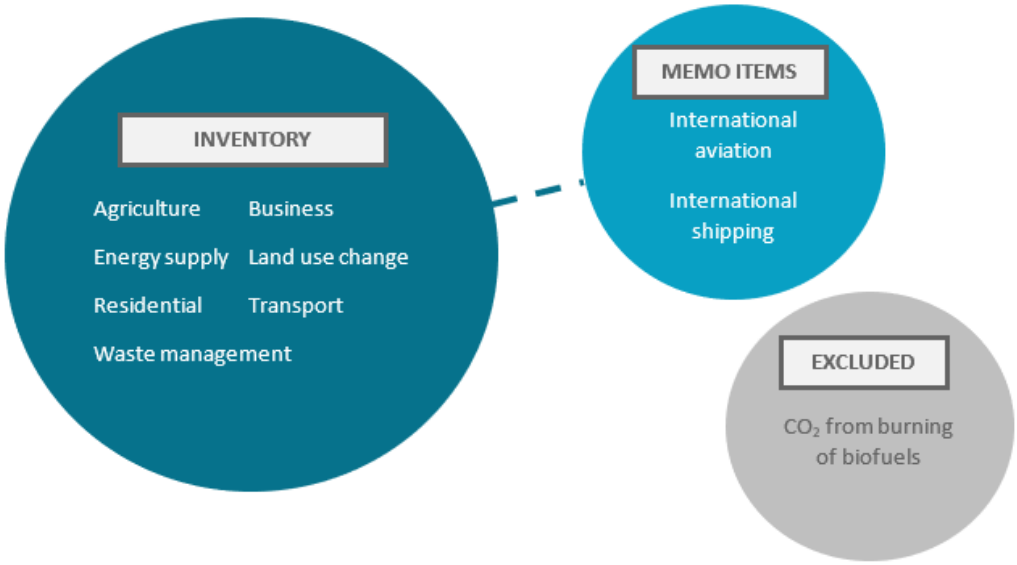

Figure 1 - Overview of sectors included and excluded from the greenhouse gas

1.3 What is included within each inventory sector?

Figure 2 provides an overview of the key activities that are included in each inventory sector. Further information and data on sector and sub-sector trends and methodologies can be found in Chapters 3 and 4 (Jersey) and Chapters 6 and 7 (Guernsey). A description of each sub-sector can be found in Annex 1.

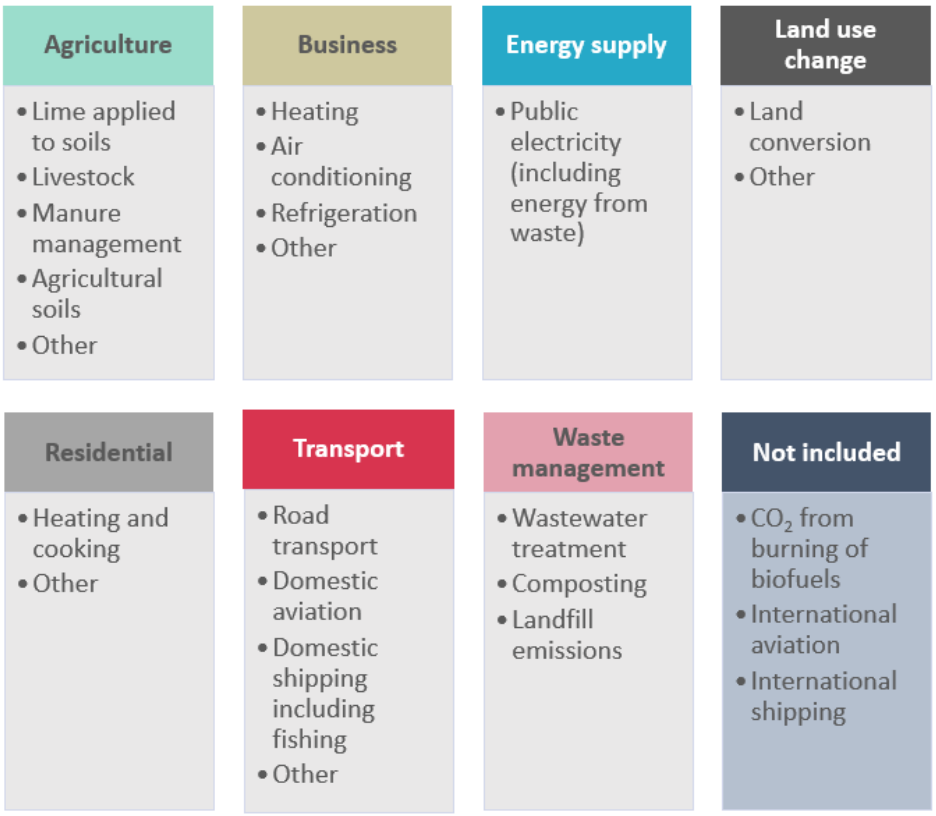

Figure 2 - Overview of activities covered in each sector. Not all sub-sectors are applicable to both islands, for example landfill emissions only occur in Guernsey as there are no landfills in Jersey.

All percentages provided in the following section are percentages of the respective island total greenhouse gas emissions.

Agriculture – This includes emissions from livestock, crop production and fertiliser application. In 2017 this sector contributed 4% in Jersey and 3% in Guernsey.

Business – This includes emissions from fuel use in the commercial and industrial sector as well as some specific industrial processes relating to the use of aerosols in air conditioning and refrigeration. In 2017, this sector contributed 22% in Jersey and 16% in Guernsey.

Energy supply – This sector includes emissions from fuel combustion for the generation of energy, predominantly the production of public electricity. For Jersey, this includes emissions from the Energy Recovery Facility where energy is generated from burning solid, non-biogenic waste and for both islands it includes on-island energy generation. In 2017, this sector contributed 6% in Jersey and 9% in Guernsey.

Land use change – This sector consists of emissions or removals from the conversion of land from one use to another, for example the conversion of forest land to crop land. In

2017, this sector contributed -2% in and 1% in Guernsey. The negative value for Jersey means that overall this sector was a sink for emissions rather than a source.

Residential – This sector includes emissions from combustion of fuels in homes, for heating and cooking, as well as some smaller sources such as metered dose inhalers and other aerosols used in a domestic setting. In 2017 this sector contributed 15% in Jersey and 13% in Guernsey.

Transport – This sector includes emissions from road transport, domestic aviation and domestic shipping. The largest source in this sector is passenger cars. This sector is the largest emissions source in both Jersey and Guernsey in 2017, contributing 51% and 32% respectively.

Waste management – This sector includes emissions from the treatment of domestic wastewater for both islands and composting and landfill emissions for Guernsey. In 2017, this sector contributed 3% in Jersey but 27% in Guernsey.

Not included - CO_2 emissions from the burning of biofuels are not included in the Jersey inventory, in accordance with IPCC Guidelines, and are therefore not included in national total emission estimates. Biogenic emissions are excluded in GHG inventories as bio carbon is renewable and naturally circulates in the environment.

Emissions from international aviation and shipping in Jersey and Guernsey are not included in the GHG inventory total but are included added as a 'Memo Item' for the UK inventory. These memo items provide the two islands with an opportunity to report emissions from international transport, but not including these emissions in the national totals.

More information on the emission trends for each sector can be found in Chapters 3 (Jersey) and 6 (Guernsey).

1.4 Which greenhouse gases are reported in the inventory?

The inventories of Jersey and Guernsey cover the six main greenhouse gases (GHG) required for reporting under the Kyoto Protocol. These six GHGs directly contribute to climate change:

- Methane (CH_4)
- Carbon dioxide (CO_2)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF_6)

HFCs, PFCs and SF_6 are commonly referred to as 'F-gases'.

Global Warming Potentials

Greenhouse gases absorb energy and slow the rate at which the energy can escape into space, causing global temperatures to increase. Different greenhouse gases absorb

energy at different rates and therefore have different 'global warming potentials' (GWP). GWPs allow you to compare the impacts of each gas on global warming.

Carbon dioxide always has a global warming potential of 1 because it is used as the reference gas. The global warming potential of other gases is therefore a measure of how much energy will be absorbed by 1 tonne of the gas, relative to the amount of energy absorbed by 1 tonne of CO_2 over a given period of time (usually 100 years). **Table 1** shows the GWPs for key greenhouse gases.

Example: The global warming potential of methane is 25. Therefore, 1 metric tonne of methane (CH_4) emitted is equivalent to 25 metric tonnes of carbon dioxide (CO_2).

In the GHG inventory, each of the six GHGs is presented in carbon dioxide equivalent (CO_2eq) units, as this helps to increase consistency in reporting and allows the emissions to be added together to calculate a total. These are calculated by multiplying the emissions of a gas by the corresponding global warming potential. This metric of measurements allows for emissions from various GHGs to be compared.

***Table 1** - Global Warming Potentials (GWPs) for 100-year time horizon from IPCC Fourth Assessment Report (AR4) **

Greenhouse gas (GHG)	Global Warming Potential (tonnes of CO_2 equivalent per tonne of gas)
Carbon dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous oxide (N_20)	298
Hydrofluorocarbons (HFCs)	Between 124 and 14,800
Perfluorinated compounds (PFCs)	Between 7,390 and 12,200
Sulphur hexafluoride (SF_6)	22,800

* AR4 values are used in line with international reporting requirements

1.5 How frequently are emissions reported?

The most recent inventory includes estimates of emissions from all sources and sectors for the years 1990 to 2017. The inventory always reports data for the timeframe of 1990 to the year that is 2 years before the year of reporting i.e. 2017 in 2019. This delay is the result of the time required for official statistics to be available and the amount of time to compile the necessary data and check and finalise the emissions reported. The data are provided annually in accordance with international regulations.

Every year the whole time series is updated and revised (from 1990) to capture any improvements in methodologies and ensure internal consistency. This is important as emissions from one source in 2010 may differ between the 2016 and 2017 inventory for example, as methodologies may have changed. The latest inventory year is therefore the most up to date and is the inventory which should be used.

Example: In the domestic aviation sector of the Jersey inventory, the numbers reported across the time series in the 1990-2016 inventory are between 5 and 7% different from those reported in the 1990-2017 inventory. This is because there was a methodology improvement implemented in the most recent submission which adjusted aircraft taxiing times to be more specific to Jersey.

1.6 How are greenhouse gases emissions estimated?

The basic equation for estimating most emissions is:

Activity - This is a measure of the activity which is taking place, such as number of cows or tonnes of fuel combusted. This data typically comes from national statistical datasets.

Emission Factor - This is the emissions per unit of activity, which usually comes from the scientific literature. It is typically derived from measurement.

Example: Emissions of N_2O from diesel fuelled power stations in 2017 in Guernsey

In this example the emission factor comes from scientific literature and reference documentation, most notably the 2019 EMEP/EEA Air Pollutant Guidebook[2] and the IPCC National Greenhouse Gas Inventory Guidelines[3]. The activity data is derived from the national datasets. By multiplying both values together, an amount of emissions for N_2O from diesel fuelled power stations for the relevant year is calculated. It is important to note that this is basic equation for calculating emissions, and that in reality it is rarely this simple. In this example, the type of fuel used, maintenance of the power station, age and more will impact the emissions estimate.

1.7 What is the difference between 'by source' and 'end user' emission inventories?

There are two methods for reporting GHG emissions, by-source and end user. The difference in the two lies in where the emissions related to fuel production are reported.

By Source – In a by-source inventory, emissions are allocated to the source sector in which they occur and emit emissions directly. The emissions related to fuel production are allocated to where the fuel is produced and processed.

Example: The energy supply emissions in the Jersey inventory remain continually small as emissions from electricity production and fuel processing are reported by source. As Jersey predominantly imports its electricity from France, the resultant greenhouse gas emissions from the energy supply sector are therefore counted in France's national inventory. However, the on-island generation of energy i.e. from Energy from Waste facilities is counted within Jersey's inventory.

[2] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019
[3] https://www.ipcc-nggip.iges.or.jp/public/2006gl/

End User – This method reallocates some emissions to the final user of fuels. This means that emissions from the production and processing of fuels, including the production of electricity, are reallocated to users of these fuels to reflect total emissions for each type of fuel consumed.

The officially reported greenhouse gas inventory for Jersey and Guernsey is a 'by source' inventory, rather than an 'end user' one, in line with international reporting. This means emissions reported are attributed to the sector that emits them directly, from the production and processing of fuels (including the production of electricity). An 'end user' inventory by comparison allocates these emissions to the consumers of these fuels, to reflect the total emissions relating to that fuel use.

Example: If Jersey or Guernsey's inventory was reported on an end-user basis, this would include emissions associated with the production of imported electricity used in the island. This would increase emissions related to energy consumption.

1.8 Are there other methods for carbon accounting?

The UK government has historically published GHG emissions using 3 different accounting methods:

- **Emissions from the GHG inventory** – a by-source inventory of emissions occurring in the country for reporting under the United Framework Convention on Climate Change (UNFCCC) and for tracking progress against national and international emission reduction targets.
- **Emissions measured by the UK Environmental Accounts** – estimates emissions resulting from the various sectors of the UK economy. The figures represent emissions resulting from activities of UK residents and industries whether in the UK or abroad. This excludes emissions produced within the UK by oversees residents and businesses.
- **Embedded emissions** – measures emissions on a "consumption" basis and takes into account emissions that are embedded in goods and services imported and exported by the UK.

Jersey and Guernsey only produce emissions using the first method of accounting, the GHG inventory. Scope definitions and embodied carbon are therefore not considered as they are not included within the framework of UNFCCC inventories.

When looking at other forms of carbon accounting beyond the inventory, emissions are sometimes divided into three categories, or scopes, in order to distinguish between direct and indirect emission sources:

- **Scope 1:** These are emissions directly produced by the activity taking place in a geographic location such as the burning of fuels in the industrial and road transport sectors, and the rearing of livestock in the agricultural sector.
- **Scope 2:** These are indirect emissions from the generation of purchased and consumed electricity.
- **Scope 3**: These are indirect emissions associated with the consumption and production of materials and products and services where emissions result in other geographical areas. This is more complex and includes embodied carbon in the supply chain up and downstream in the economy.

This approach can help to improve completeness of reporting for certain requirements (such as organisation level carbon reporting) but is not consistent with the methods used for national inventories and so is not relevant to the Jersey and Guernsey GHG inventories.

More information on carbon accounting including scopes can be found in the 'GHG Protocol for Cities'[4] (this relates to city level emissions).

Embodied emissions are not included as such in the Channel Island inventories, because the structure of the inventory is not defined in this way. However, some production emissions are included at source such as for food products in the agriculture sector. Embodied carbon can be defined as the full carbon footprint of a certain product or material. Different emissions are produced throughout the supply chain of the material including emissions from fuel combustion at the factory where a product is created, or emissions from transport as the goods are imported.

The following chapters provide more information on the inventories of Jersey and Guernsey looking at trends, sources and methodologies in more detail.

[4] https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities

2 Jersey's greenhouse gas inventory – overview

2.1 Total GHG emissions from different sources

Figure 3 provides an overview of Jersey's Inventory categorised by sector.

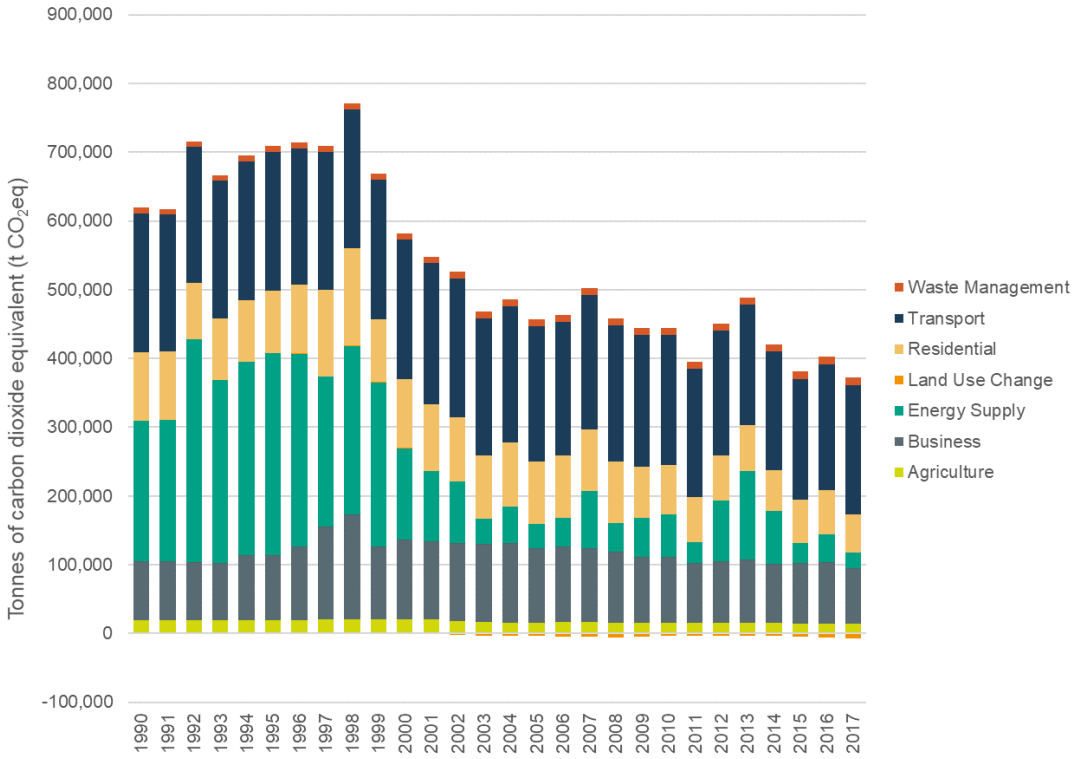

Figure 3 - Jersey's Inventory categorised by sector

Between 1990 and 2017, emissions in Jersey have decreased by 41%. As **Figure 3** shows, this reduction is largely driven by a decrease in emissions from energy supply. This reduction has been noticeable since the installation of the 90MW Normandie 2 supply cable in 2000. This cable supplies electricity to Jersey from France. Emissions associated with electricity supplied via the cable are accounted for in France's inventory. Emissions from transport are the largest source in the 2017 inventory and have remained largely constant across the timeseries, decreasing by 7% between 1990 and 2017.

Table 2 outlines the percentage contribution from each sector to the total GHG emissions by year. Overall, the waste management, agriculture, business and transport sectors saw increasing contributions between 1990 and 2017 while the residential and energy supply sectors saw decreasing contributions. In 1990, the largest contributions to total emissions came from energy supply and transport (both 33%) whilst in 2017 the largest contribution came from transport alone (51%). Between 1990 and 2017 the largest decrease in contribution to total emissions was 27%, seen in the energy supply sector. Conversely, the largest growth in contribution to total emissions was seen in the transport sector (increase of 19% from 1990 to 2017).

Table 2 Percentage contribution of each sector to Jersey's total GHG emissions

	Waste Management	Agriculture	Business	Transport	Residential	Energy Supply	Land Use, Land Use Change and Forestry
1990	1%	3%	14%	33%	16%	33%	0%
1995	1%	3%	13%	28%	13%	41%	0%
2000	2%	4%	20%	35%	17%	23%	0%
2007	2%	3%	21%	39%	18%	17%	-1%
2008	2%	3%	23%	44%	20%	9%	-1%
2009	2%	3%	22%	44%	17%	13%	-1%
2010	2%	4%	22%	43%	16%	14%	-1%
2011	3%	4%	22%	48%	17%	8%	-1%
2012	2%	3%	20%	40%	15%	20%	-1%
2013	2%	3%	19%	36%	14%	26%	-1%
2014	3%	4%	20%	41%	14%	18%	-1%
2015	3%	4%	23%	47%	17%	8%	-1%
2016	3%	4%	22%	46%	16%	10%	-2%
2017	3%	4%	22%	51%	15%	6%	-2%

2.2 Total GHG emissions from different gases

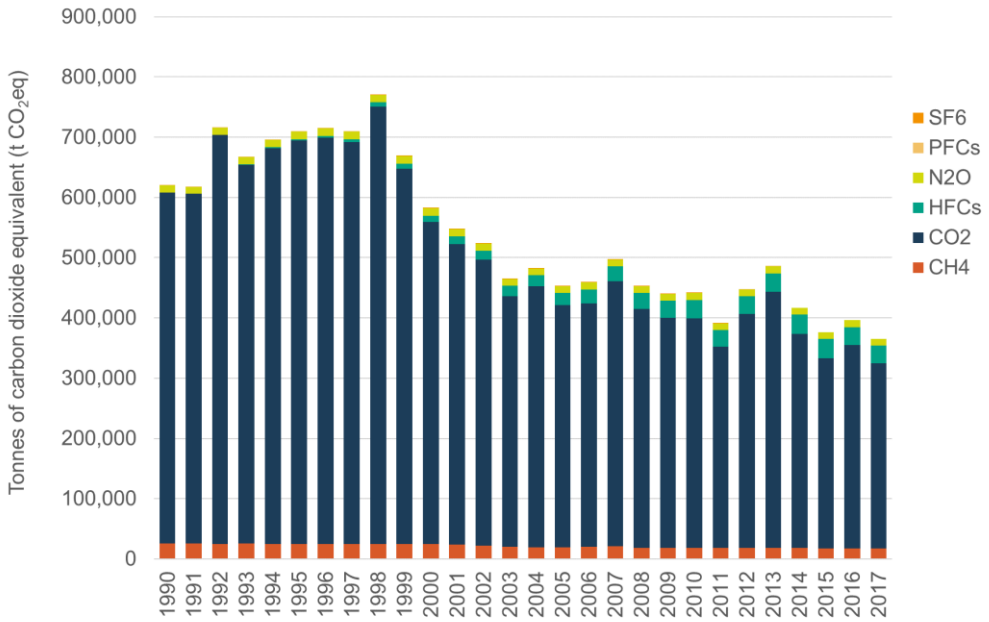

Figure 4 - Jersey's greenhouse gas inventory by gas

Figure 4 provides an overview of Jersey's inventory categorised by gas

CH_4 – 70% of methane emissions in Jersey's 2017 inventory came from the agricultural sector, through activity such as livestock and use of fertilisers. Waste management is also a methane source, with emissions from domestic wastewater treatment.

Jersey has seen an overall reduction in methane emissions between 1990 and 2017, largely driven by the reduction in the number of cattle between 2000 and 2005. There was a peak in the number of cattle in 2006 and 2007 resulting in a peak of methane emissions.

CO_2 – 60% of carbon dioxide emissions in Jersey's 2017 inventory came from the transport sector, with passenger cars being the biggest source. The residential and business sectors additionally continue to be significant sources of carbon dioxide. Carbon dioxide emissions in Jersey have seen a decrease since 1990 due to a reduction in the number of flights to the island, increased energy and fuel efficiency of buildings and vehicles, and decreased activity in the glasshouse sector of the agriculture industry.

Emissions reduced significantly between 1998 and 2005 when the first subsea cable was installed, causing a reduction in electricity generation. The spike in emissions in 2013 was when the cable failed, meaning Jersey saw an increase in electricity generation on the island. Carbon dioxide emissions continued to reduce from 2014, once the subsea cable had been restored.

N_2O – The biggest source of nitrous oxide in Jersey's 2017 inventory was from waste management, specifically wastewater treatment. The waste management sector accounted for 62% of N_2O emissions. The agricultural sector was an additional source, with 19% of total N_2O emissions emitted due to activity such as fertiliser application on soils.

Nitrous oxide emissions have remained relatively stable across the time series. There was a decrease in emissions between 2000 and 2003 due to a reduction in the number of cattle.

Fluorinated gases (F-gases) – The three F-gases are largely produced by the business and residential sectors. HFCs are mainly used as refrigerants and in foams, aerosols and fire extinguishers. PFCs are used in the electronics sector, whilst SF_6 is used in magnesium casting. These gases were introduced to replace ozone depleting substances, meaning F-gas emissions have increased since 1990.

3 Jersey's greenhouse gas inventory - by sector

3.1 Agriculture

3.1.1 Sector and sub-sector trends

Emissions from the agriculture sector accounted for 4% of total greenhouse gas (GHG) emissions in the 2017 inventory. The largest agriculture emissions source in 2017 is enteric fermentation from dairy cattle (**Figure 5**). Enteric fermentation is part of the digestive process in ruminant animals which produces methane emissions. Emissions therefore come from the raising of animals for meat and milk.

Emissions from the agriculture sector for Jersey are separated into 4 different subsectors: 3F field burning, 3G liming, 3H urea application and 3J livestock. The subsector 3J livestock, includes enteric fermentation and manure management, and is by far the largest emission source in the agriculture sector.

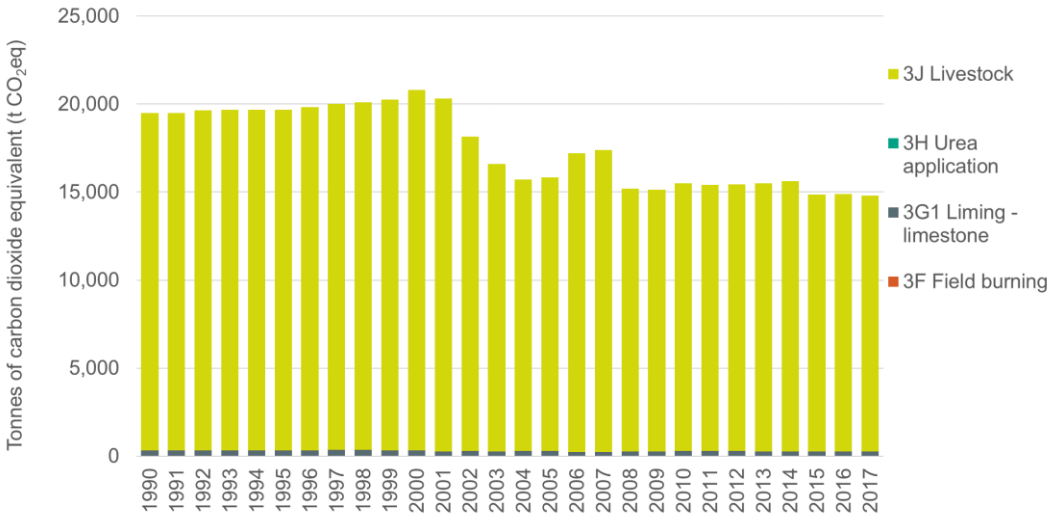

Figure 5 - Agriculture sector emissions by sub-sector 1990-2017

Emissions from the agriculture sector reduced by 24% from 1990-2017 and saw a reduction of 0.5% between 2016 and 2017. Urea application increased 36% across the time series, but this was offset by a larger decrease in emissions from other agricultural sources. Field Burning (3F) ceased in 1993 in England and Wales and is considered negligible in Northern Ireland and Scotland. It is assumed that Jersey followed the same time trend as England, and hence emissions from field burning cease in 1993 (**Table 3**).

Across the timeseries, agricultural emissions have steadily decreased, largely due to declining numbers of dairy cattle. There was, however, a peak in the number of cows in 2006 and 2007 resulting in a peak in emissions.

Table 3 Agriculture sector emissions by sub-sector with percentage changes

Tonnes of carbon dioxide equivalent (tCO_2eq)	1990	2016	2017	% change 1990-2017	% change 2016-2017
3F Field burning	0.35			-100%	-
3G1 Liming - limestone	322	263	263	-18%	0%
3H Urea application	0.32	0.44	0.44	36%	0%
3J Livestock	19,159	14,619	14,550	-24%	0%
Grand Total	**19,481**	**14,883**	**14,814**	**-24%**	**-0.5%**

3.1.2 Gases

Emissions in the agriculture sector are dominated by emissions of methane (CH_4), which accounts for 83% of agriculture sector emissions in 2017. Of the remaining 2017 emissions, 15% came from nitrous oxide (N_2O) emissions and 2% from carbon dioxide (CO_2) (**Figure 6**). Emissions from methane primarily come from enteric fermentation and manure management from livestock. Mineralisation/immobilisation of agricultural soils, and application of fertilisers lead to emissions of N_2O. CO_2 emissions are caused by the application of urea to agricultural soils and liming.

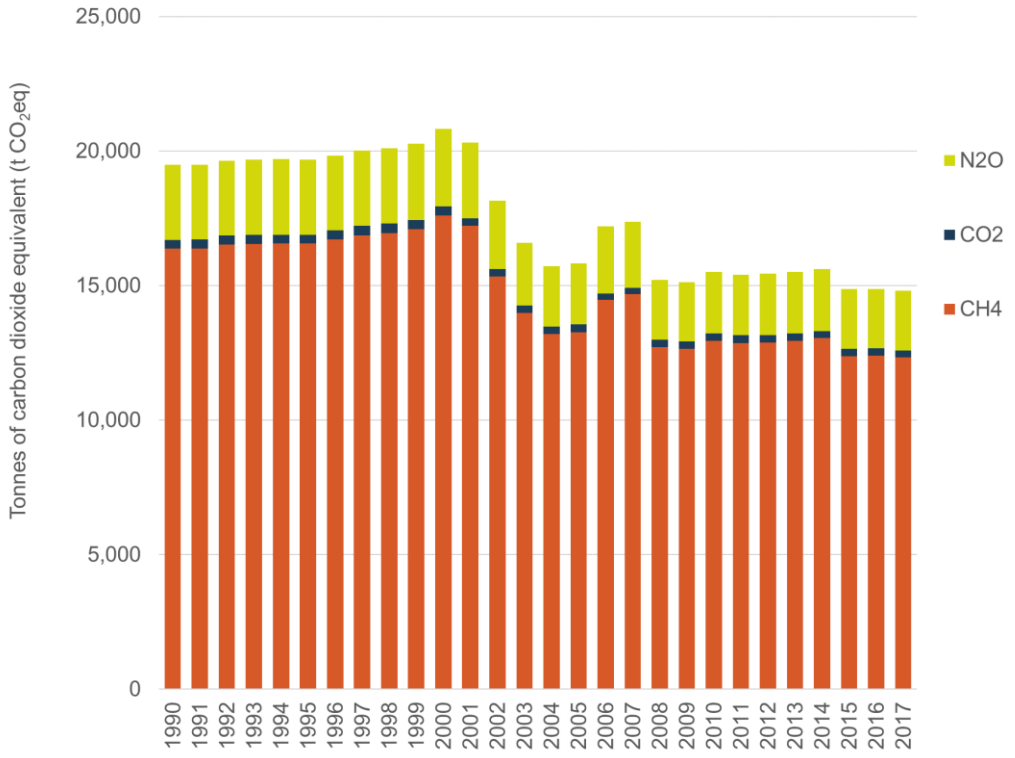

Figure 6 Agriculture sector emissions by greenhouse gas 1990-2017

3.1.3 Methodologies

Activity data

Activity data for the agriculture sector is provided by the Jersey Government, in the 'Agricultural Statistics' document. The most recent addition was published in 2017 by the Department of Growth, Housing and Environment. The statistics provided include number of livestock, grassland and cereal areas, and crop and vegetable exports. Animal numbers are included in the inventory in the following categories: dairy cattle, non-dairy cattle, sheep, pigs, poultry, goats and horses.

Emission factors

"Implied emission factors" for the UK are generated by dividing total emissions from a source by total activity data such as livestock data and land area. In order to calculate the emission factor for enteric fermentation from pigs for example, the total UK emissions of methane from pig enteric fermentation is divided by total livestock numbers of pigs in the UK. This gives an emission factor that represents a weighted average of several different sources. These implied emission factors are applied to Jersey. Therefore, in this example, the implied emission factor for methane from pig enteric fermentation (based on UK data) is applied to Jersey pig livestock numbers. Similarly, in order to calculate the implied emission factor for synthetic fertilisers applied to grasslands, the UK total emissions of N_2O from synthetic fertilisers would be divided by total grassland areas in the UK. This implied emission factor would then be multiplied by Jersey specific activity data (grassland areas which are provided by the Centre for Ecology and Hydrology), in order to give the emissions from that source.

UK implied emission factors (which consider agricultural practices and climatic conditions on a UK level) are applied to the livestock data and, for agricultural soils, to cropland and grassland land areas. However, Jersey specific nuances are not captured (for example, body weight of Jersey specific cattle breeds and specific feed types). A reflection of these specific Jersey distinctions in the data would require improvements in the methodology and increased complexity in the inventory.

Assumptions

Implied emission factors represent weighted averages based on values from the UK which it is assumed can be applied to Jersey because the activities in Jersey are similar to those in the UK. The use of implied emission factors is a common approach used in calculating emission estimates where local data cannot be sourced.

Recent improvements to the inventory

Between the 1990-2016 and the 1990-2017 inventories, there were updates made to all livestock numbers provided by Jersey for 2016 leading to recalculations in N_2O and CH_4 emissions for this year. Non-dairy cattle numbers were updated for the years 2014-2016, which further led to recalculations in N_2O emission from indirect manure leaching. Indirect manure leaching is when nitrogen compounds are lost from manure stores in water leaching away which is then converted to N_2O elsewhere. There were recalculations in emissions from field burning across 1990-1993 for greenhouse gases N_2O and CH_4. This is due to an update in the total UK cropland areas which in turn changed the implied emission factors, resulting in a recalculation of emissions.

3.2 Business

3.2.1 Sector and sub-sector trends

Emissions from the business sector accounted for 22% of total greenhouse gas (GHG) emissions in the 2017 inventory. The largest business emissions source in 2017 is Other Manufacturing Industries and Construction (**Figure 7**).

Emissions from the business sector for Jersey are separated into 12 different subsectors, including air conditioning, refrigeration, stationary combustion in commercial and institutional settings and other manufacturing industries.

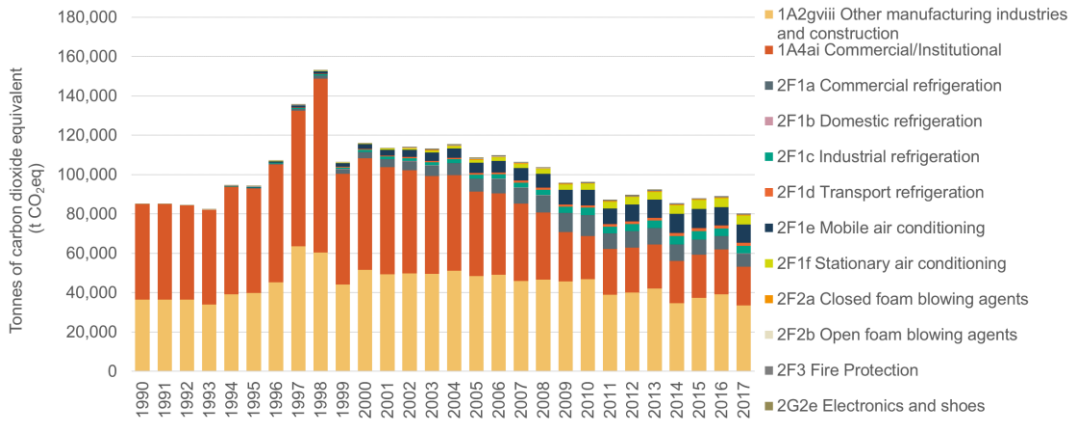

Figure 7 Business sector emissions by sub-sector 1990-2017

Emissions from the business sector reduced by 6% from 1990-2017 and saw a reduction of 10% between 2016 and 2017. Between 1990 and 2017 there were no significant increases in emissions from any subsector. There is limited data from all of the subsectors at the start of the timeseries however, with no emissions reported from refrigeration, air conditioning, blowing agents and fire protection. There was a decrease in emissions of 59% from commercial and institutional sources, across the whole time series (**Table 4**).

Gas oil imports peaked in the late 1990s and this is related to an increase in the area of protected crops that were grown under glass. These crops, especially tomatoes, required heating which is reflected in the increased gas oil imports. Since the late 1990s this activity has substantially reduced and in 2006 and 2007 there was a government supported exit strategy for the high value protected crop sector.

Table 4 - Business sector emissions by sub-sector with percentage changes

Tonnes of carbon dioxide equivalent (tCO_2eq)	1990	2016	2017	% change 1990-2017	% change 2016-2017
1A2gviii Other manufacturing industries and construction	36,556	39,286	33,468	-8.4%	-14.8%
1A4ai Commercial/Institutional	48,450	22,774	19,769	-59.2%	-13.2%
2F1a Commercial refrigeration		6,626	6,626	-	0.0%
2F1b Domestic refrigeration		14.4	14.4	-	0.0%
2F1c Industrial refrigeration		4,045	4,045	-	0.0%
2F1d Transport refrigeration		1,483	1,483	-	0.0%
2F1e Mobile air conditioning		9,306	9,306	-	0.0%
2F1f Stationary air conditioning		4,430	4,430	-	0.0%
2F2a Closed foam blowing agents		482	482	-	0.0%
2F2b Open foam blowing agents				-	-
2F3 Fire Protection		687	687	-	0.0%
2G2e Electronics and shoes	44.2			-100.0%	-
Grand Total	**85,049**	**89,133**	**80,310**	**-6%**	**-10%**

3.2.2 Gases

Emissions in the business sector are dominated by emissions of carbon dioxide (CO_2), which account for 66% of business sector emissions in 2017. 34% of the remaining 2017 emissions come mostly from fluorinated gases, especially HFCs (**Figure 8**). Between 1990 and 2017, CO_2 emissions fell by 37% from 84,602 tonnes of carbon dioxide equivalent (tCO_2eq) to 53,006 tCO_2eq but peaked in 1998 at 148,098 tCO_2eq.

HFC emissions are associated with refrigeration and air conditioning. Whilst these emissions have grown since 1990, emissions have remained relatively constant since 2012 (between 26,500 and 29,300 tCO_2eq) (**Figure 8**).

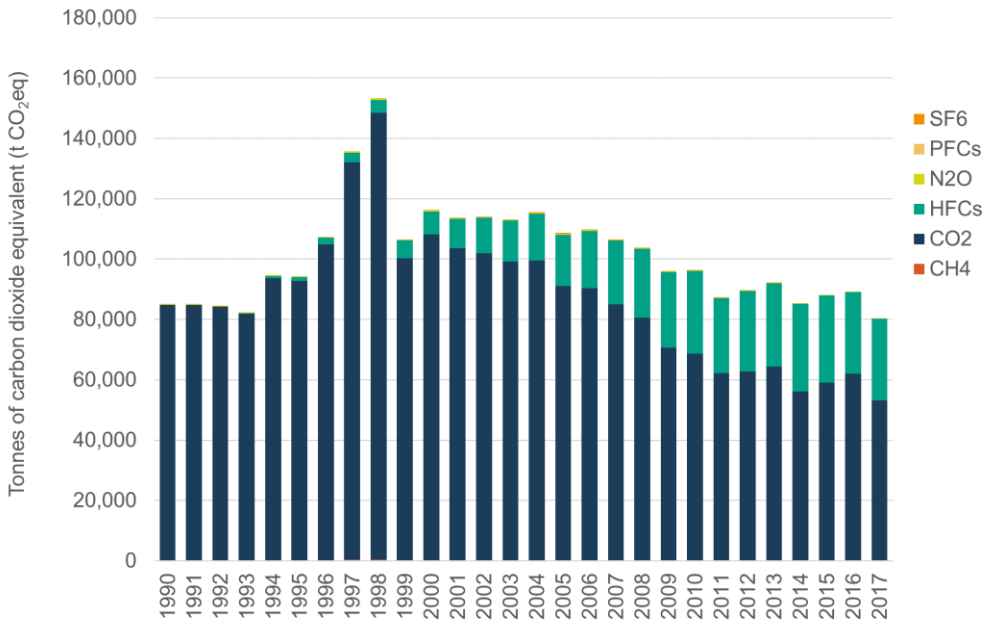

Figure 8 Business sector emissions by greenhouse gas 1990-2017

3.2.3 Methodologies

Activity data

Data to calculate emissions in the business sector comes from the 'Jersey Energy Trends' report which is published annually. Emissions arising from solvents are based on UK emissions and scaled by Jersey specific indicators such as population, GDP and number of houses. Population estimates are sourced from States of Jersey publications, most recently 'Jersey Resident Population 2017 Estimate' report. GDP estimates are taken from 'Measuring Jersey's Economy GVA and GDP'. House numbers are extrapolated from the 2011 census figure, by dividing the Jersey total population by the 'number of persons per household' statistic.

Emission factors

Emission factors for carbon are UK specific, applied to the Jersey inventory. For other gases, default emission factors found in the 2019 EMEP/EEA Guidebook[5] are used. The Guidebook is an international document that supports the reporting of national emissions inventories by setting out methodologies, describing the data that is needed and providing default emission factors.

Assumptions

To split fuel use data between residential and commercial, a 50/50 split is used, therefore assuming that half of the fuel used is being used in commercial settings. This assumption has been made as actual data on fuel split is not currently available. Emissions arising from solvent use (e.g. substances used to make products such as paint) are based on UK emissions and are scaled by proxy data such as GDP, population and number of households thereby assuming that activities are similar to those in the UK. Similarly, for carbon dioxide emissions, UK emissions factors are used therefore assuming that activities in Jersey are similar to those in the UK.

Recent improvements to the inventory

Between the 1990-2016 inventory and the most recent 1990-2017 inventory, there were recalculations to the fuel use data due to revisions to the Jersey energy balance, replacing previously extrapolated values with actual data. There were also very minor changes made to the GDP data, again replacing 2016 extrapolated values with actual data.

[5] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019

3.3 Energy supply

3.3.1 Sector and sub-sector trends

Emissions from the energy supply sector accounted for 6% of total greenhouse gas (GHG) emissions in the 2017 inventory. All emissions in this sector are attributed to the generation of public electricity (**Figure 9**).

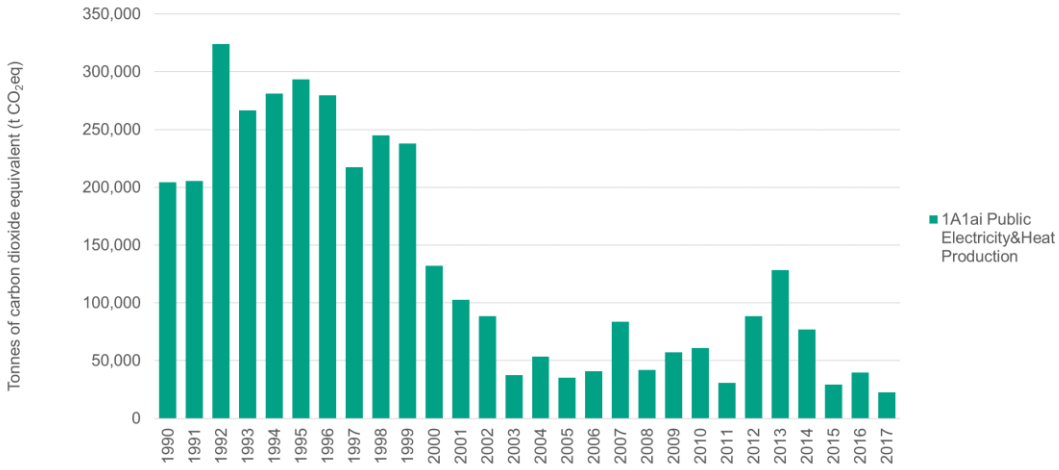

Figure 9 Energy supply sector emissions by sub-sector 1990-2017

Emissions from the energy supply sector reduced by 89% from 1990-2017 and saw a reduction of 43% between 2016 and 2017 (**Table 5**). Emissions from the energy supply sector reduced significantly when the 900MW Normandie 2 supply cable was installed in 2000 reducing the need for the diesel engine power plant. In 2012, the failure of this cable meant electricity had to be generated on-island using gas turbines and diesel engines leading to a spike in emissions until the cable was restored in 2014.

Table 5 Energy supply sector emissions by sub-sector with percentage changes

Tonnes of carbon dioxide equivalent (tCO_2eq)	1990	2016	2017	% change 1990-2017	% change 2016-2017
1A1ai Public electricity and heat production	204,320	39,748	22,656	-89%	-43%
Grand Total	**204,320**	**39,748**	**22,656**	**-89%**	**-43%**

3.3.2 Gases

Emissions in the energy supply sector are dominated by emissions of carbon dioxide (CO_2), which accounts for 97% of emissions in 2017. Between 1990 and 2017, CO_2 emissions fell by 89% from 203,171 tCO_2eq to 22,088 tCO_2eq but peaked in 1992 at 322,251 tCO_2eq (**Figure 10**).

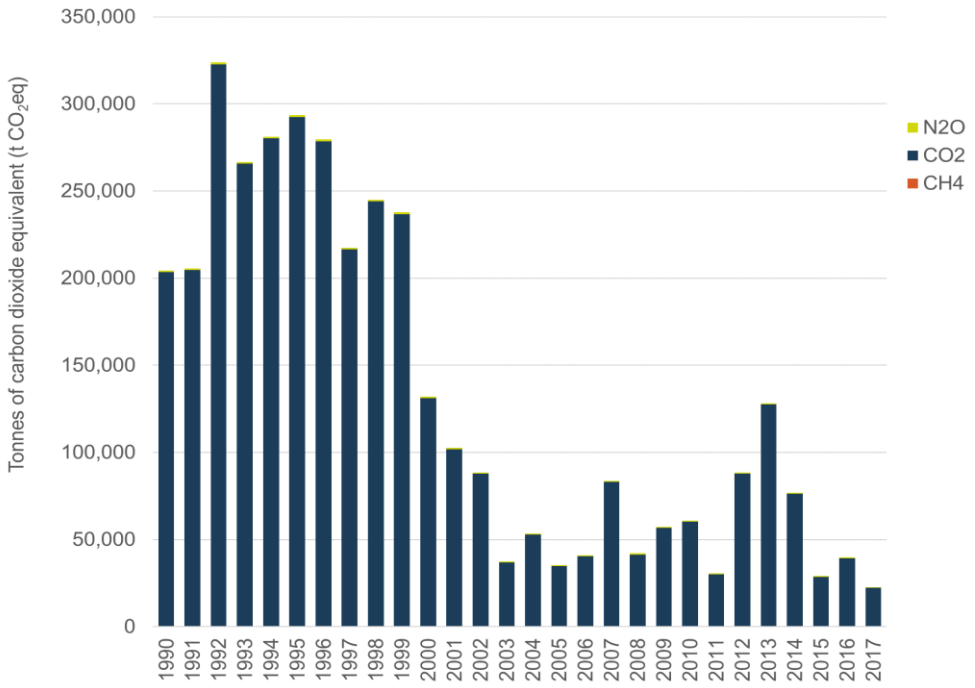

Figure 10 Energy supply sector emissions by greenhouse gas 1990-2017

3.3.3 Methodologies

Activity data

The Jersey government publishes the 'Jersey Energy Trends' annually which provides the statistics for the energy supply and transport sector. The amount of heavy fuel used on the island is influenced by the consistency of energy supply from France. For example, when the subsea cable failed in 2012, electricity had to be generated using the on-island backup generators, increasing emissions from energy supply. These emissions are accounted for in the Jersey inventory. For electricity that is imported from France, emissions are accounted for in the French inventory and not in the Jersey inventory.

Emission factors

Emissions factors for CO_2 from power stations are taken from the UK inventory and are UK specific factors. Non-CO_2 emission factors and the emissions factor for incineration of municipal solid waste are IPCC defaults. IPCC defaults are emissions factors that are found in the IPCC guidelines – international literature providing methods and information on emissions inventories.

Assumptions

The energy balance statistics received from the Jersey government provide all the data required for estimating emissions from energy supply, so there are no significant assumptions that have been made.

Recent improvements to the inventory

There have been no significant recalculations to the energy supply sector for the 1990-2017 inventory.

3.4 Land use change

The land use, land use change and forestry (LULUCF) sector includes emissions from the conversion of land to other land types and forestry and harvested wood products.

3.4.1 Sector and sub-sector trends

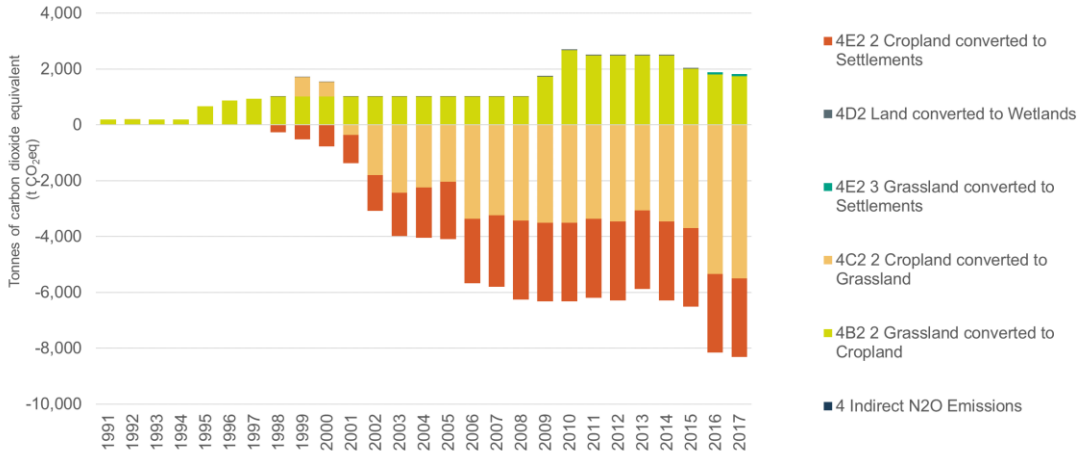

Figure 11 Land Use Change sector emissions by sub-sector 1991-2017

Jersey has a net sink (a negative emission) in the land use change sector, mostly attributed to cropland converted to grassland (**Figure 11**). This means that more carbon dioxide (CO_2) is removed from the atmosphere than the amount of greenhouse gases that are released. When this arises, the emissions source is instead referred to as a sink, and emissions can be expressed as a negative value. Cropland converted to grassland is the largest emission sink in 2017, with 5,502 tonnes of carbon being stored in the land and not emitted into the atmosphere (**Table 6**). As there is very limited data available for land cover types and a simple methodology is applied to calculate emissions, some sources do not have any associated emissions.

Cropland, Settlement, Wetland and Grassland are the only land types in Jersey considered to have significant associated emissions. Converting cropland to grassland results in a large net sink whilst converting grassland to cropland results in 1,739 tonnes of carbon being released.

Table 6 Land Use, Land Use Change and Forestry (LULUCF) sector emissions by sub-sector with absolute changes

Tonnes of carbon dioxide equivalent (tCO_2eq)					
	1991	2016	2017	Absolute change 1990-2017	Absolute change 2016-2017
4 Indirect N_2O Emissions	0.033	0.333	0.321	0.288	-0.01
4B2 2 Grassland converted to Cropland	187	1,807	1,739	1,552	-68
4C2 2 Cropland converted to Grassland		-5,339	-5,502	-	-163
4E2 3 Grassland converted to Settlements		78.9	78.9	-	0
4D2 Land converted to Wetlands				-	-
4E2 2 Cropland converted to Settlements		-2,819	-2,819	-	0
Grand Total	**187**	**-6,272**	**-6,504**	**- 3758**	**-232**

3.4.2 Gases

Emissions in the LULUCF sector are dominated by CO_2 and the sector is an overall net sink. LULUCF in 2017 removed 6,646 tonnes of CO_2. Between 2016 and 2017, the amount of CO_2 emission saved increased from 6,420 to 6,646 tonnes, an increase of 3.5%.

N_2O emissions from the LULUCF sector are emitted from grassland converted to cropland and grassland converted to settlements and through indirect emissions. Emissions of N_2O increased by 870% across the time series, from 14.7 to 143 tCO_2eq. N_2O emissions reduced by 3.6% from 2016 and 2017 (**Figure 12**). This is led by an increase in emissions from 'Indirect N_2O'. This nitrous oxide gas is released when nitrogen is removed from agricultural soils and animal waste, via processes like leaching, harvest and runoff.

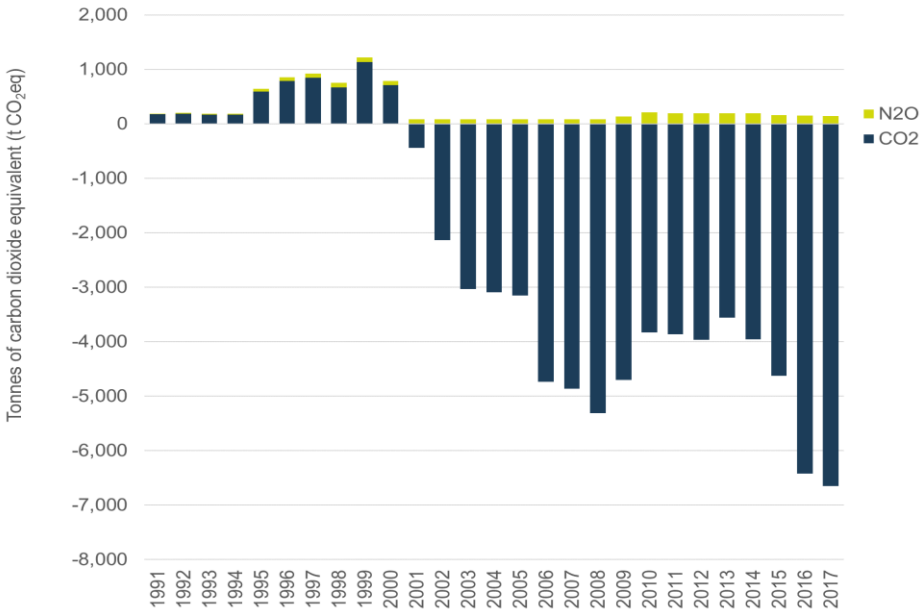

Figure 11 Land Use Change sector emissions by greenhouse gas 1991-2017

3.4.3 Methodologies

Activity data

Land cover surveys and agricultural land statistics have been used to compile annual land use change matrices for Jersey. These are then converted into a format consistent with international guidance (from the UNFCCC). Activity data for this sector, specifically land use areas, are supplied from various publications from the States of Jersey. Forestry land area statistics for the years 1990-2010 are provided by the 'FAO (2010) Global Forest Resources Assessment: Jersey'. Statistics on Forestland, Cropland, Grassland and Settlement land areas for 2006, 2008-2011 are provided in the documents 'Jersey in Figures 2008-2011'. As no new survey's have been conducted, data for the most recent years has been extrapolated from the last available data.

Emission factors

Emission factors for estimating LULUCF emissions from Jersey are default factors found in the IPCC Guidebook. Emission factors for calculating harvested wood products and forest land fluxes come from a Carbon-Flow model.

Assumptions

The activity data for Jersey does not cover the entire time series, with most data covering until 2011. Activity data for the latter years are therefore extrapolated from the latest available year, which assumes a certain trend in the activity data has occurred. Other specific assumptions include the use of a carbon flow model to calculate forest land fluxes; only perennial crops included in the 'Crop remaining crop' subsector; and default values for Soil Organic Carbon (SOC) in different land areas.

Recent improvements to the inventory

Between the 1990-2016 inventory and the most recent 1990-2017 inventory there have been a few recalculations in this sector. Biomass carbon stock densities have been adjusted to use updated UK values. In Jersey a 5-year rolling average has been applied to the reported cropland area to remove the impact of crop-grass rotation and the resulting insufficient grassland area. Small inconsistencies in the reporting of conversion of land to Settlement have also been resolved.

3.5 Residential

The residential sector includes emissions from residential stationary combustion, metered dose inhalers and other aerosols.

3.5.1 Sector and sub-sector trends

Emissions from the residential sector accounted for 15% of total GHG emissions in the 2017 inventory. The majority of emissions are from residential stationary combustion, the burning of fuels in homes, mainly for heating and cooking (**Figure 13**).

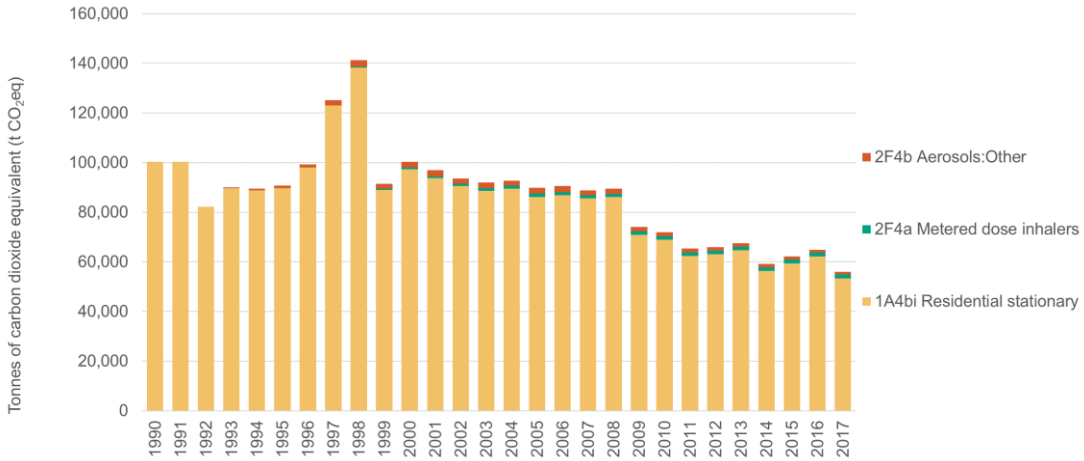

Figure 12 Residential sector emissions by sub-sector 1990-2017

Between 1990 and 2017, residential sector emissions have decreased by 44% from 100,347 to 56,041 tonnes of carbon dioxide equivalent (tCO_2eq). As mentioned above, this is driven by emissions from combustion of fuels in houses. There is an increase in emissions from 1996 to 1998 which is being driven by a peak in kerosene and gas oil use. Emissions were increasing between 2014 and 2016 but have since decreased by 14% from 2016 to 2017 (**Table 7**).

Table 7 Residential sector emissions by sub-sector with percentage changes

Tonnes of carbon dioxide equivalent (tCO_2eq)					
	1990	2016	2017	% change 1990-2017	% change 2016-2017
1A4bi Residential stationary	100,347	62,155	53,318	-47%	-14%
2F4a Metered dose inhalers		1,549	1,549	-	0%
2F4b Aerosols: Other		1,173	1,173	-	0%
Grand Total	**100,347**	**64,878**	**56,041**	**-44%**	**-14%**

3.5.2 Gases

Emissions in the residential sector are dominated by emissions of carbon dioxide (CO_2) which accounted for 95% of residential emissions in 2017. Between 1990 and 2017, residential sector CO_2 emissions fell by 45% from 97,130 to 53,006 tCO_2eq (**Figure 14**). This trend is being driven by a reduction in the use of all fuel types for residential stationary combustion as a result of the uptake of electrical space heating and an associated switch from gas and oil to electricity.

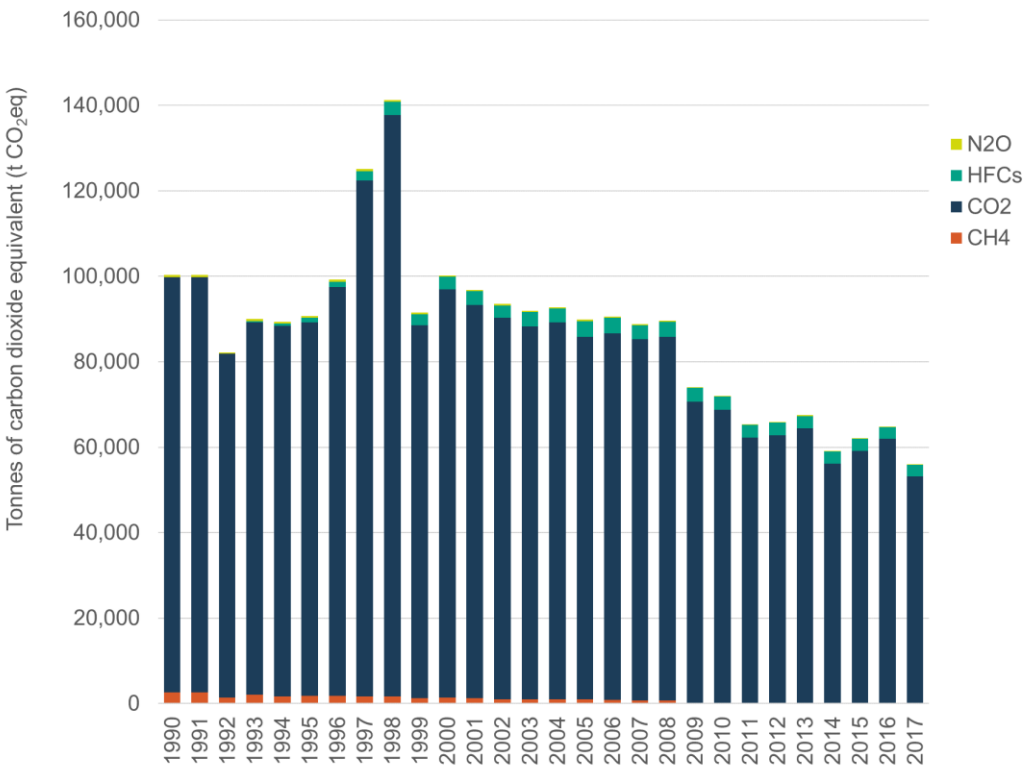

Figure 13 Residential sector emissions by greenhouse gas 1990-2017

3.5.3 Methodologies

Activity data

Data on fuel use is obtained from the 'Jersey Energy Trends' report which is published annually.

Emission factors

Emission factors for carbon are UK specific, applied to the Jersey inventory. For other gases, default emission factors found in the 2019 EMEP/EEA Guidebook[6] are used. The Guidebook is an international document that supports the reporting of national emissions inventories by setting out methodologies, describing the data that is needed and providing default emission factors.

Assumptions

To split fuel use data between residential and commercial, a 50/50 split is used, therefore assuming that half of the fuel used is being used in domestic settings. This assumption is made in the absence of country specific information. Emissions arising from solvent use are based on UK emissions and are scaled by proxy data such as GDP, population and number of households thereby assuming that activities are similar to those in the UK. Similarly, for carbon dioxide emissions, UK emissions factors are used therefore assuming that activities in Jersey are similar to those in the UK.

[6] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019

Recent improvements to the inventory

Between the 1990-2016 inventory and the most recent 1990-2017 inventory, there were recalculations to the fuel use data due to revisions to the Jersey energy balance, replacing previously extrapolated values with actual data. There were also very minor changes made to the GDP data, again replacing 2016 extrapolated values with actual data.

3.6 Transport

The transport sector includes emissions from road transport, domestic aviation and domestic navigation (i.e. shipping). Domestic aviation and navigation refer to activities that occur within Jersey and between Jersey and the UK. This includes, for example, take-off, landing and internal, recreational flights and shipping activity that occurs within Jersey waters. For international aviation and shipping (journeys to and from other countries), the emissions are equally divided between the two countries. However, these statistics are recorded as memo items to the inventory and are not included in the national total.

3.6.1 Sector and sub-sector trends

Transport sector emissions accounts for 51% of total GHG emissions in the 2017 inventory. The largest emissions source in 2017 in this sector is passenger cars (**Figure 15**).

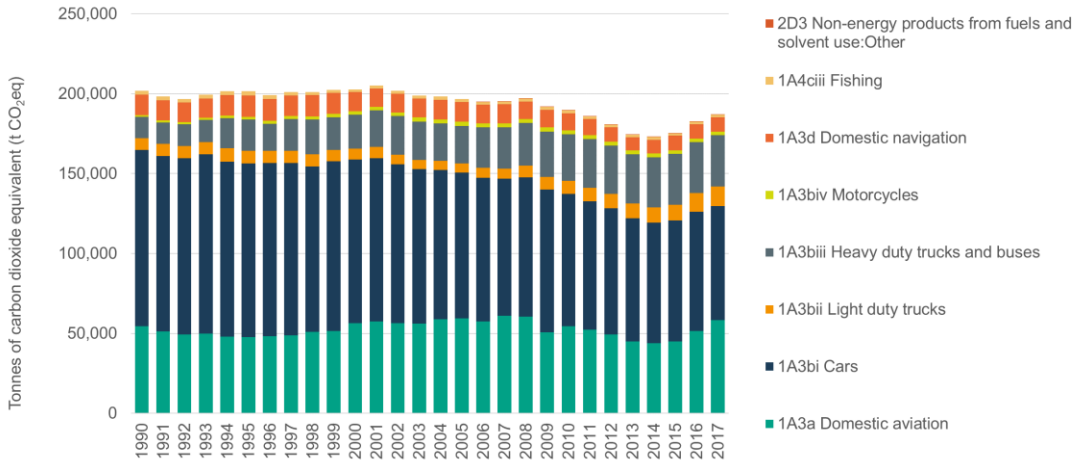

Figure 14 Transport sector emissions by sub-sector 1990-2017

Between 1990 and 2017, emissions in the transport sector have decreased by 7% from 201,925 to 186,878 tCO_2eq. Transport emissions steadily decreased between 2001 and 2015, mainly due to passenger cars becoming gradually more fuel efficient and therefore using less fuel. However, emission increases in the past 3 years from the transport sector have reversed the trend observed from 2010.

The overall trend is dominated by emissions from passenger cars and aviation. Passenger car emissions have decreased by 35% between 1990 and 2017 and by 4% between 2016 and 2017 (**Table 8**). Between 1990 and 2017, all sources of transport emissions increase except for cars, domestic shipping (navigation) and fishing. This trend could be being influenced by an increase in tourism, especially visitors from the UK whose flights are accounted for under domestic aviation.

Table 8 Transport sector emissions by sub-sector with percentage changes

Tonnes of carbon dioxide equivalent (tCO_2eq)					
	1990	2016	2017	% change 1990-2017	% change 2016-2017
1A3a Domestic aviation	54,453	51,633	58,277	7%	13%
1A3bi Cars	110,485	74,404	71,307	-35%	-4%
1A3bii Light duty trucks	7,191	11,952	12,256	70%	3%
1A3biii Heavy duty trucks and buses	13,326	31,777	32,218	142%	1%
1A3biv Motorcycles	1,264	2,286	2,216	75%	-3%
1A3d Domestic navigation	12,830	8,886	8,881	-31%	0%
1A4ciii Fishing	2,376	1,655	1,639	-31%	-1%
2D3 Non-energy products from fuels and solvent use: Other		82.6	83.8	-	2%
Grand Total	**201,925**	**182,677**	**186,877**	**-7%**	**2%**

3.6.2 Gases

Transport sector emissions are predominantly carbon dioxide (CO_2). CO_2 emissions account for 99% of total emissions in 2017 with nitrous oxide (N_2O) making up 0.8% and methane (CH_4) the remaining 0.2%. CO_2 emissions have decreased by 6% between 1990 and 2017 but have increased between 2016 and 2017 by 2.3% (**Figure 16**).

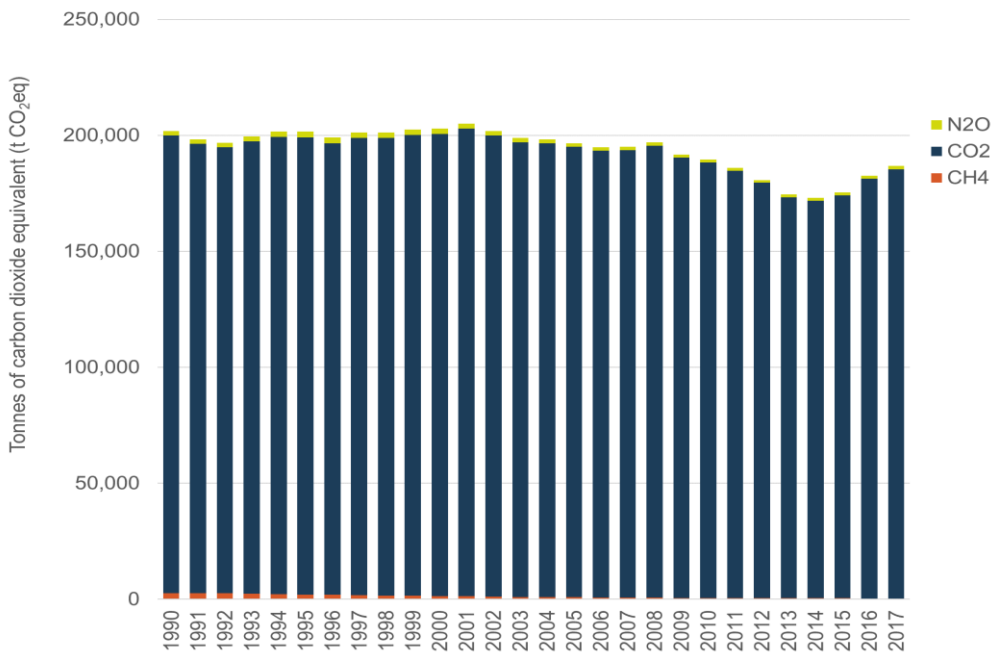

Figure 15 Transport sector emissions by greenhouse gas 1990-2017

3.6.3 Methodologies

Activity data

Road transport: Fuel consumption split by fuel type is taken from the Jersey energy balance. Vehicle data is provided annually by the Government's Department of Growth, Housing and the Environment (Driver and Vehicle Standards), for the GHG inventory reporting.

Aviation: Detailed aviation activity data is provided by the UK Civil Aviation Authority (CAA), including aircraft movements broken down by airport, aircraft type and destination. Deliveries of aviation spirit and aviation turbine fuel are provided in the Digest of UK Energy Statistics (DUKES).

Shipping: For 2014 the UK inventory used data from high-resolution Automatic Identification System (AIS) to provide detailed data on vessels and vessel movements. For other years, shipping mode-specific proxy data (including port statistics provided by the Department for Transport) are used to generate a time series.

Emission factors

Road transport: UK vehicle emission factors by vehicle type (and by euro standard) are applied to Jersey and the properties of the fuel are assumed to be the same as the UK and are therefore taken from DUKES.

Aviation: A UK specific emission factor for carbon is applied to Jersey. For non-CO_2 emissions, default emission factors from the 2016 EMEP/EEA Guidebook are used.

Shipping: For carbon and N_2O, shipping specific factors from the International Maritime Organisation (2015) are used. For methane, the emission factor is taken from a 2004 study by IVL (Swedish Environmental Research Institute).

Assumptions

Road transport: Fleet mix, in terms of the age distribution of vehicles, is assumed to be the same as that of the UK.

Aviation: The aviation estimates are generated by a model compiled for the purposes of the UK inventory, which is considered to be detailed and of good quality. International flights that first stop at a domestic airport are accounted as having a domestic leg and an international leg.

Shipping: The main assumption in the shipping sector concerns the allocation of vessel movements to domestic or international, where a cargo or passenger vessel starts or finishes in a UK port when it goes out of AIS signal range. The shipping estimates are generated by a model compiled for the purposes of the UK inventory, which is considered to be detailed and of good quality.

Recent improvements to the inventory

Road transport: There have been recalculations between the 1990-2016 inventory and the 1990-2017 inventory due to updated DUKES conversion factors and updates to the underlying activity data. This concerns the 2016 petrol and diesel consumption statistics that were updated, replacing extrapolated data with actual data.

Aviation: In the latest inventory submission, the taxiing times have been revised leading to recalculations.

Shipping: The UK Sea Fisheries Annual Statistics data have been updated requiring a recalculation in the fishing vessels category. There are also minor recalculations due to updated port statistics from the Department for Transport which are used as proxy data for calculating average emission factors.

3.7 Waste management

The waste management sector includes emissions from domestic wastewater treatment. Emissions generated by the Energy Recovery Facility (incineration of municipal solid waste) are accounted for under the energy supply sector.

3.7.1 Sector and sub-sector trends

Emissions from the waste management sector accounted for 3% of total GHG emissions in the 2017 inventory. Emissions from the waste management sector have increased by 32% across the time series and were still increasing between 2016 and 2017 (**Figure 17**).

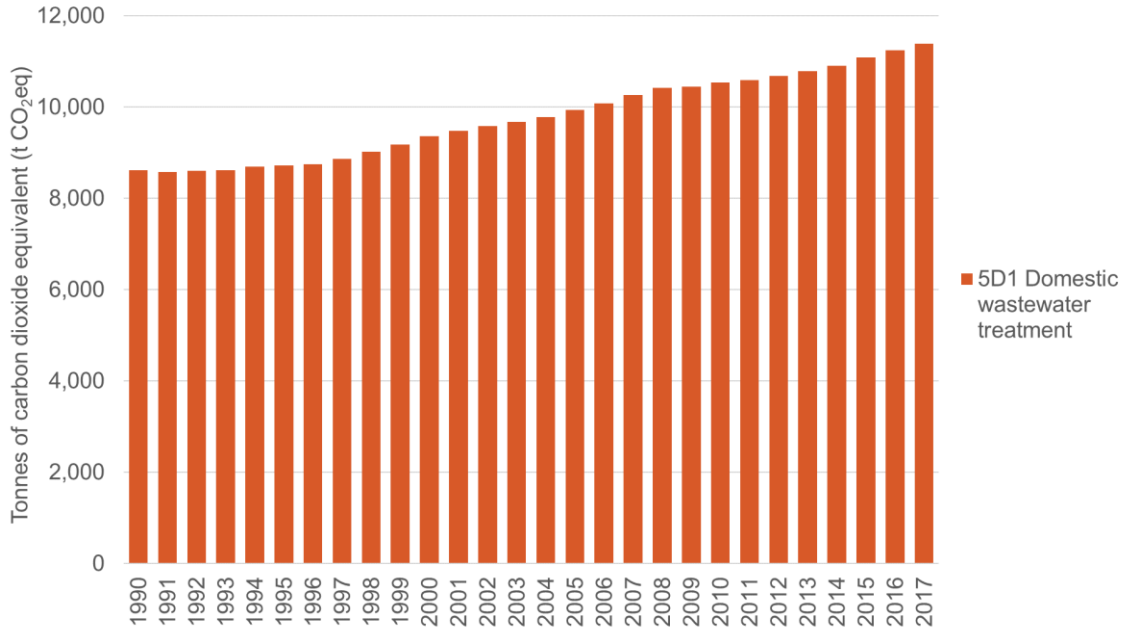

Figure 16 Waste management sector emissions by sub-sector 1990-2017

Across the entire time series, there has been a steady increase in total emissions from 8,612 to 11,387 tCO_2eq in 2017 (an increase of 32%). The only source of emissions from the waste management sector for Jersey is from the domestic wastewater treatment sector (**Table 9**). Emissions have therefore increased as population has increased.

Table 9 Waste management sector emissions by sub-sector with percentage changes

Tonnes of carbon dioxide equivalent (tCO_2eq)					
	1990	2016	2017	% change 1990-2017	% change 2016-2017
5D1 Domestic wastewater treatment	8,612	11,247	11,387	32%	1%
Grand Total	**8,612**	**11,247**	**11,387**	**32%**	**1%**

3.7.2 Gases

Emissions from the waste management sector are split between methane (CH_4) and nitrous oxide (N_2O). CH_4 accounts for 38% of waste management sector emissions in 2017, whilst N_2O accounts for 62%. Between 1990 and 2017, CH_4 and N_2O emissions have steadily increased by 26% and 36% respectively. Between 2016 and 2017, both increased by 1.2% (**Figure 18**).

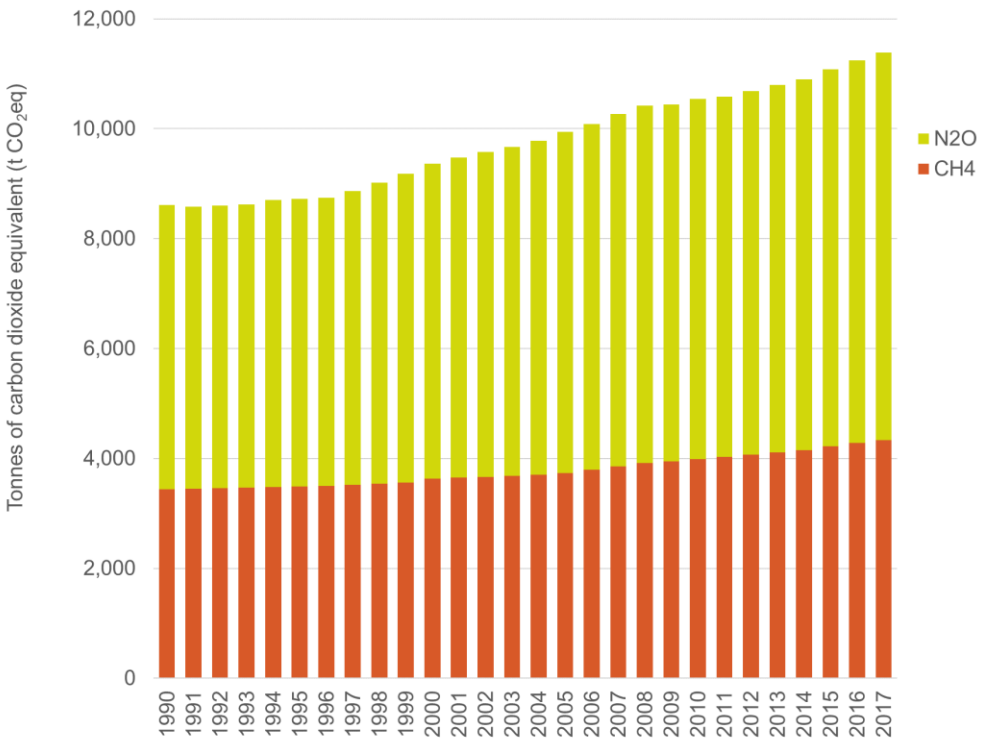

Figure 17 Waste management sector emissions by greenhouse gas 1990-2017

3.7.3 Methodologies

Activity data

Population estimated are sourced from States of Jersey publications, most recently 'Jersey Resident Population 2017 Estimate' report. Per capita protein consumption (kg/person/year) was provided by FAOSTAT in 2011 and is used to calculate the total amount of nitrogen in effluent. This has not been updated since 2011 and is assumed to be static from the 2011 number.

Emissions from domestic wastewater treatment are estimated using UK data, scaled by population.

Emission factors

Current emission factors for the waste management sector are default values taken from the relevant literature such as the IPCC Guidebook.

Assumptions

It is assumed that domestic wastewater management practices are comparable to those of the UK.

Recent improvements to the inventory

There were no significant recalculations in this sector.

4 Jersey's greenhouse gas inventory - specific inventory questions

4.1 How are emissions from La Collette and Energy Recovery Facility reported?

In 2000, the 900MW Normandie 2 supply cable was installed, supplying Jersey with electricity from France, reducing the need for the diesel engine power plant and therefore causing a reduction in emissions. The La Collette site is where energy is produced on the island. At this site there are 2 facilities: an Energy Recovery Facility (ERF) and a back-up power station. Only 2% of Jersey's energy supply was produced on-island in 2017, from the ERF facility. The back-up power station at La Collette relies on the burning of two fuel types: heavy fuel oil and diesel.

The amount of energy generated at La Collette (and hence the amount of fuel used and emissions produced on-island) depend on the supply of energy from France. In 2012, failure of the 900MW Normandie 2 supply cable meant electricity had to be generated on-island, leading to an increase in emissions in the energy supply sector.

Greenhouse gas emissions generated through Energy Recovery Facilities are accounted for in the energy supply sector because energy is captured from the incinerated solid waste and used to produce electricity. The solid waste is therefore considered as a fuel for energy supply. Municipal solid waste is split into biogenic (of biological origin, such as paper, cardboard and wood) and non-biogenic (manmade materials). The UK percentage split of biogenic and fossil carbon is applied to Jersey. Only non-biogenic waste is considered to contribute to GHG emissions and therefore only this data is included in the emissions calculation. This is because any impact of natural biomass reduction, e.g. through forestry or wood production, on carbon stock change are assumed to be accounted for in the land use change sector.

4.2 How are emissions from aviation sources reported?

International aviation includes emissions from flights that depart in one country and arrive in another. The emissions for the entire journey are divided between the source country and the destination country. These emissions are included as 'memo items' meaning they are not in the main body of the inventory. Domestic aviation covers emissions from civil domestic passenger and freight traffic that depart and arrive in Jersey. It includes journeys between the UK and Jersey. Emissions from aircrafts are distinguished between two separate operations: Landing/Take Off (LTO) and Cruise. The amount of GHG emissions will differ between landing/take off and cruise, with 90% of aviation emissions occurring at higher altitudes.

Jersey has witnessed a slight reduction in overall emissions from aviation sources over the entire time series, with fewer flights arriving and leaving Jersey causing a reduction in refuelling on the island. Emissions from domestic aviation however remain a significant proportion of Jersey's total transport emissions at 31.2% in the 2017 inventory.

4.3 How are emissions from marine sources reported?

Emissions from international water-borne navigation and domestic water-borne navigation are differentiated. The fuel used by marine vessels that both depart and arrive in Jersey, such as ferries, are reported within the inventory. International shipping

considers marine vessels which have departed from Jersey and arrived in another country, or vice versa. These are included within the inventory as 'Memo Items', meaning they are not included within the inventory totals.

Emissions from fishing in Jersey are counted as a separate marine source, and this includes emissions from fuels combusted for inland, coastal and deep-sea fishing. Any fishing vessel which has refuelled in Jersey (including international fishing), is considered in the inventory.

Emissions from shipping remain a small proportion of Jersey's total transport emissions at only 5.6% in 2017. Emissions from fishing vessels in Jersey were estimated at 0.88% of total transport emissions in Jersey's 2017 inventory.

5 Guernsey's greenhouse gas inventory – overview

5.1 Total GHG emissions from different sources

Figure 19 provides an overview of Guernsey's Inventory categorised by sector.

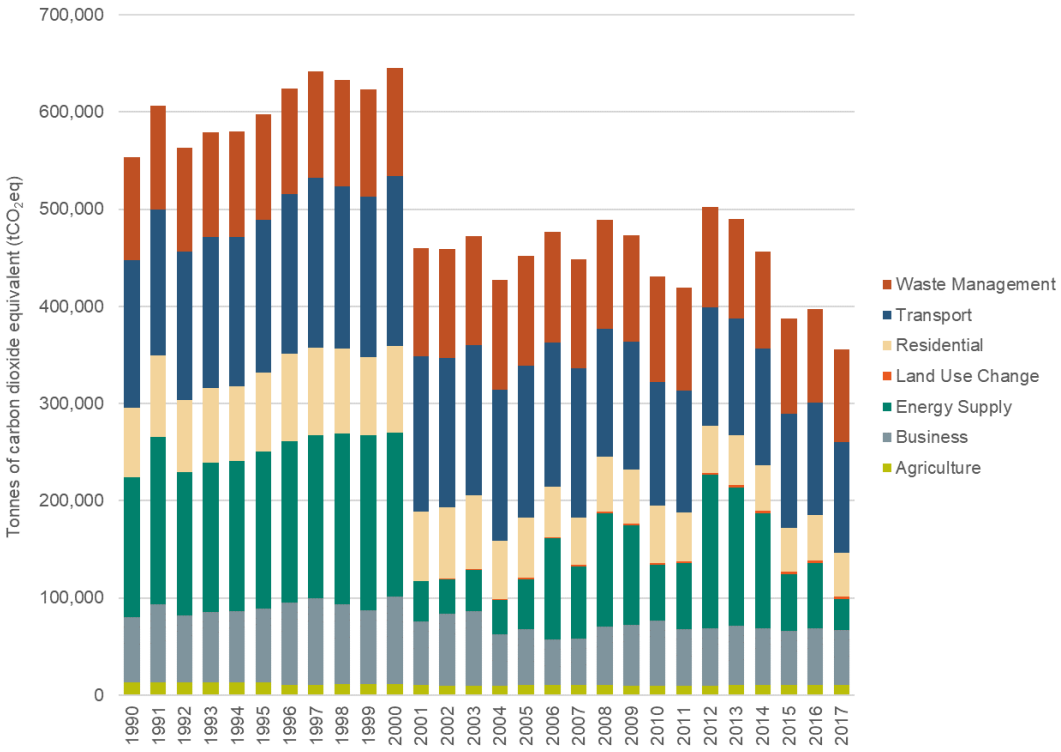

Figure 18 Guernsey's Inventory categorised by sector

Between 1990 and 2017, emissions in Guernsey have decreased by 36%. As **Figure 19** shows, the trend is largely driven by a decrease in emissions from energy supply although all sectors have seen a reduction in emissions between 1990 and 2017 apart from Land Use Change. This reduction has been noticeable since the installation of a cable link between Jersey and Guernsey in 2000. This cable provides Guernsey with imported electricity from France. Emissions associated with electricity supplied via the cable are accounted for in France's inventory. Emissions from transport are the largest source in the 2017 inventory, accounting for 32%, the second largest contribution coming from the waste sector, 27%.

Table 10 outlines the percentage contribution from each sector to the total greenhouse gas (GHG) emissions for a given year. Overall the waste management, business and transport sectors saw increasing contributions between 1990 and 2017 while the residential and agriculture sectors stayed relatively constant, with some minor fluctuations in the residential sector. Contributions from the energy supply sector fluctuated across the time series, peaking at 31% in 2012 and reaching lows of 9% in 2017.

In 1990, the largest contribution to total emissions came from energy supply and transport (at 26% and 27% respectively) whilst in 2017 the largest contribution came from transport and the waste management sector (at 32% and 27% respectively). Emissions in the transport and waste sectors have decreased between 1990 and 2017, however this decrease has not been as significant as the fall in emissions from energy supply. Therefore,

despite emissions falling, the contribution of transport and waste to total emissions has increased. Between 1990 and 2017 the largest change in contribution to total emissions was seen in the energy supply sector.

Table 10 Percentage contribution of each sector to Guernsey's total GHG emissions

	Waste Management	Agriculture	Business	Transport	Residential	Energy Supply	Land Use Land Use Change and Forestry
1990	19%	2%	12%	27%	13%	26%	0%
1995	18%	2%	13%	26%	14%	27%	0%
2000	17%	2%	14%	27%	14%	26%	0%
2007	25%	2%	11%	34%	11%	17%	0%
2008	23%	2%	12%	27%	12%	24%	0%
2009	23%	2%	13%	28%	12%	22%	0%
2010	25%	2%	16%	30%	14%	13%	0%
2011	25%	2%	14%	30%	12%	16%	1%
2012	21%	2%	12%	24%	10%	31%	0%
2013	21%	2%	13%	24%	10%	29%	0%
2014	22%	2%	13%	26%	10%	26%	1%
2015	25%	3%	14%	30%	12%	15%	1%
2016	24%	3%	15%	29%	12%	17%	1%
2017	27%	3%	16%	32%	13%	9%	1%

5.2 Total GHG emissions from different gases

Figure 20 provides an overview of Guernsey's inventory categorised by gas

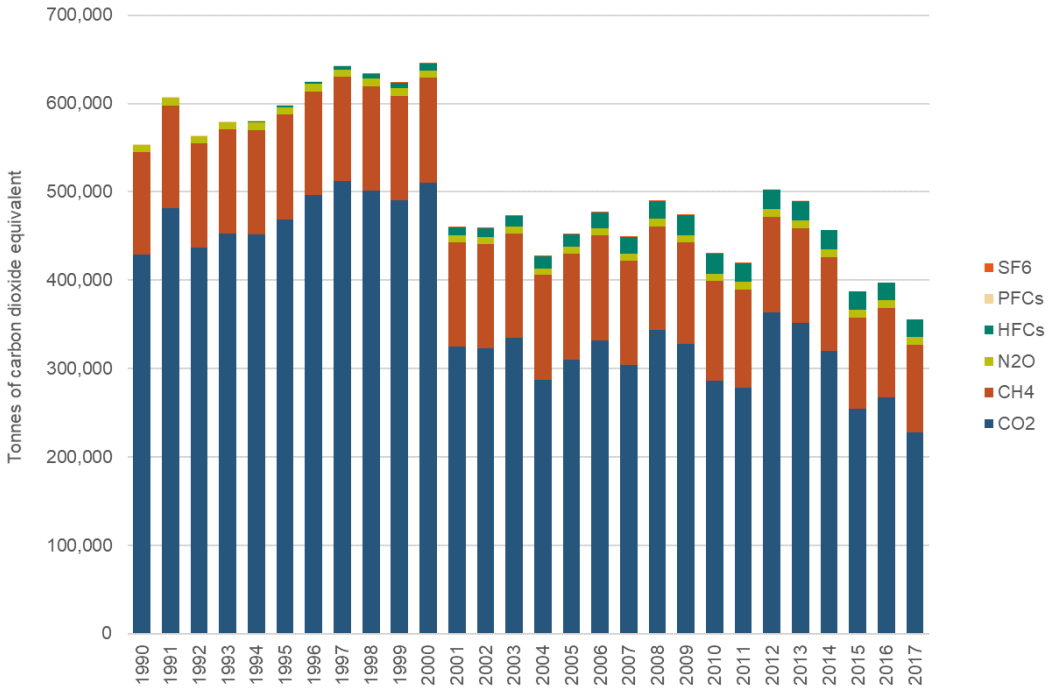

Figure 19 Guernsey's inventory by gas

CH_4 – 90% of methane emissions in Guernsey's 2017 inventory came from the waste sector, through activity such landfills and composting. Agricultural is also an important source of methane emissions.

Guernsey has seen an overall reduction in methane emissions between 1990 and 2017, peaking in 2006 at 119,552 tonnes of carbon dioxide equivalent.

CO_2 – 50% of carbon dioxide emissions in Guernsey's 2017 inventory came from the transport sector, with passenger cars being the biggest source. The residential, business and energy supply sectors additionally continue to be significant sources of carbon dioxide. Carbon dioxide emissions in Guernsey have seen a decrease by 47% since 1990.

Emissions reduced significantly between 2000 and 2001 when the first subsea cable was installed, causing a reduction in on-island electricity generation.

N_2O – The biggest source of nitrous oxide in Guernsey's 2017 inventory was from waste management. The waste management sector accounted for 59% of N_2O emissions. The agricultural sector was an additional source, with 21% of total N_2O emissions emitted due to activity such as fertiliser application on soils.

Nitrous oxide emissions have remained relatively stable across the time series, changing by 3% from 1990 to 2017, however there have been larger changes within sectors. All sectors except land use change and waste have seen emissions reductions across the timeseries of between 13 and 78% however this has been offset by a 40% increase in emissions from the waste sector.

Fluorinated gases (F-gases) – The three F-gases are largely produced by the business and residential sectors. HFCs are mainly used as refrigerants and in foams, aerosols and fire extinguishers. PFCs are used in the electronics sector, whilst SF_6 is used in magnesium casting. These gases were introduced to replace ozone depleting substances, meaning F-gas emissions have increased since 1990.

6 Guernsey's greenhouse gas inventory - by sector

6.1 Agriculture

6.1.1 Sector and sub-sector trends

Emissions from the agriculture sector accounted for 3% of total greenhouse gas (GHG) emissions in the 2017 inventory. The largest agriculture emissions source in 2017 is enteric fermentation from dairy cattle (**Figure 21**). Enteric fermentation is part of the digestive process in ruminant animals which produces methane emissions. Emissions therefore come from the raising of animals for meat and milk.

Emissions from the agriculture sector for Guernsey are separated into 4 different subsectors: 3F field burning, 3G liming, 3H urea application and 3J livestock. The subsector 3J covers emissions from livestock, including enteric fermentation and manure management, and is by far the largest emission source in the agriculture sector.

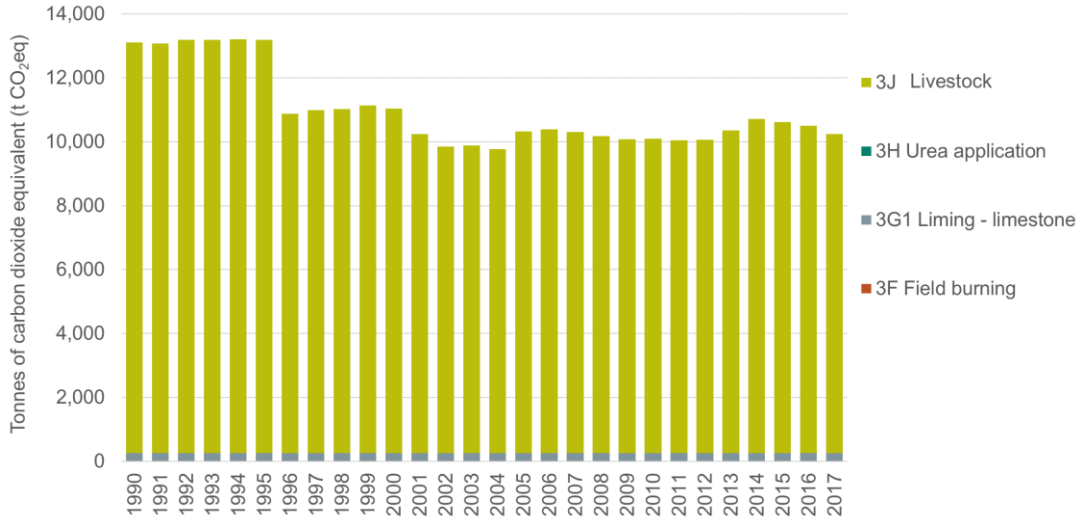

Figure 20 Agriculture sector emissions by sub-sector 1990-2017

Emissions from the agriculture sector reduced by 22% from 1990-2017 and saw a reduction of 2% between 2016 and 2017. Urea application increased by 403% across the time series, but as these values are already so small, this relative increase was offset by decrease in emissions from other agricultural sources. Field Burning (3F) ceased in 1993 in England and Wales and is considered negligible in Northern Ireland and Scotland. It is assumed that Guernsey followed the same time trend as England, and hence from field burning cease in 1993 (**Table 11**).

Agricultural emissions have mostly decreased across the timeseries, however some step-changes have taken place in the inventory. The significant reduction in livestock emissions between 1995-1996 is as a result of reduced dairy cattle livestock numbers, where numbers fell from 3,869 to 2,997.

Table 11 Agriculture sector emissions by sub-sector with percentage changes

Tonnes of carbon dioxide equivalent (tCO_2eq)					
	1990	2016	2017	% change 1990-2017	% change 2016-2017
3F Field burning	0.0230			-100%	-
3G1 Liming - limestone	253	250	250	-1%	0%
3H Urea application	0.022	0.105	0.109	403%	4%
3J Livestock	12,848	10,250	9,992	-22%	-3%
Grand Total	**13,101**	**10,500**	**10,242**	**-22%**	**-2%**

6.1.2 Gases

Emissions in the agriculture sector are dominated by emissions of methane (CH_4), which accounts for 80% of agriculture sector emissions in 2017. Of the remaining 2017 emissions, 18% came from nitrous oxide (N_2O) emissions and 2% from carbon dioxide (CO_2) (**Figure 22**). Emissions from methane primarily come from enteric fermentation and manure management from livestock. Mineralisation/immobilisation of agricultural soils, and application of fertilisers leads to emissions of N_2O. CO_2 emissions are caused by the application of urea to agricultural soils and liming.

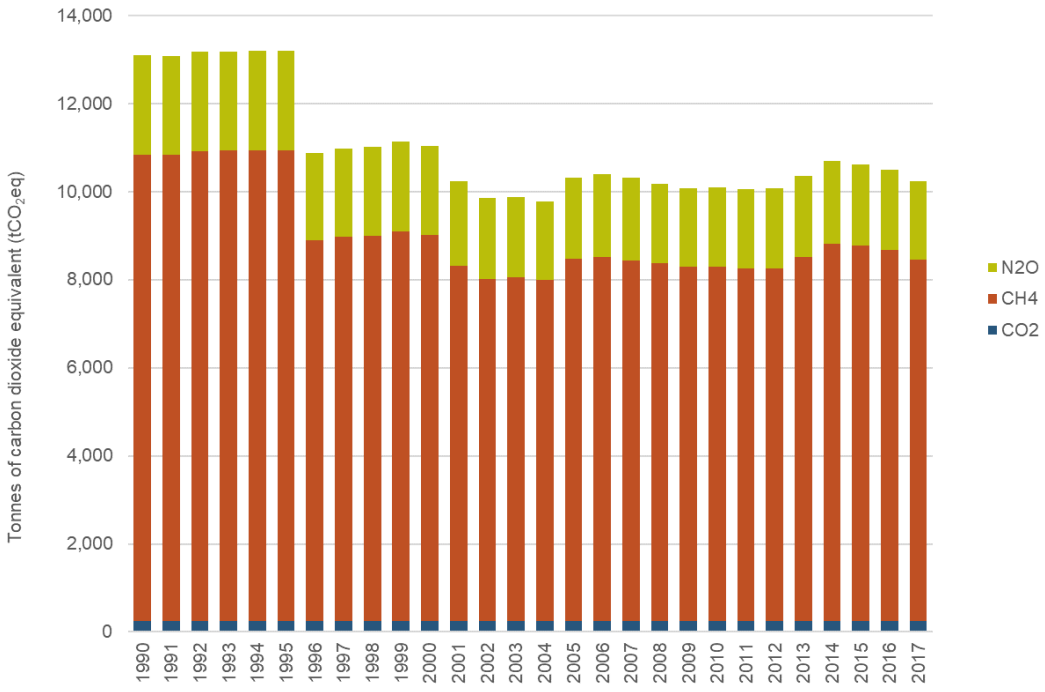

Figure 21 Agriculture sector emissions by greenhouse gas 1990-2017

6.1.3 Methodologies

Activity data

Statistics on cattle numbers are sourced Guernsey Facts and Figures, published annually. Other livestock numbers up to 2015 were provided by the States of Guernsey for use in the inventory in 2017. For 2016 and 2017 these numbers were assumed to be static from the 2015 numbers in the absence of updated information. Animal numbers are included in the inventory in the following categories: dairy cattle, non-dairy cattle, sheep, pigs, poultry, goats and horses.

Emission factors

"Implied emission factors" for the UK are generated by dividing total emissions from a source by total activity data such as livestock data and land area. In order to calculate the emission factor for enteric fermentation from pigs for example, the total UK emissions of methane from pig enteric fermentation is divided by total livestock numbers of pigs in the UK. This gives an emission factor that represents a weighted average of several different sources. These implied emission factors are applied to Guernsey. Therefore, in this example, the implied emission factor for methane from pig enteric fermentation (based on UK data) is applied to Guernsey pig livestock numbers. Similarly, in order to calculate the implied emission factor for synthetic fertilisers applied to grasslands, the UK total emissions of N_2O from synthetic fertilisers would be divided by total grassland areas in the UK. This implied emission factor would then be multiplied by Guernsey specific activity data (grassland areas which are provided by the Centre for Ecology and Hydrology), in order to give the emissions from that source.

UK implied emission factors (which consider agricultural practices and climatic conditions on a UK level) are applied to the livestock data and, for agricultural soils, to cropland and grassland land areas. However, Guernsey specific nuances are not captured (for example, body weight of Guernsey specific cattle breeds and specific feed types). A reflection of these specific Guernsey distinctions in the data would require improvements in the methodology and increased complexity in the inventory.

Assumptions

Implied emission factors represent weighted averages based on values from the UK which it is assumed can be applied to the situation in Guernsey because the activities in Guernsey are similar to those in the UK. The use of implied emission factors is a common approach used in calculating emission estimates where local data cannot be sourced.

Recent improvements to the inventory

Between the 1990-2016 and the 1990-2017 inventories, there were recalculations to cattle numbers for 2013 to 2017. There was also a correction to the implied emission factor for atmospheric deposition which resulted in a decrease in indirect manure management emissions.

6.2 Business

6.2.1 Sector and sub-sector trends

Emissions from the business sector accounted for 16% of total greenhouse gas (GHG) emissions in the 2017 inventory. The largest business emissions source in 2017 is Other Manufacturing Industries and Construction (**Figure 23**). Emissions from the business sector for Guernsey are separated into 12 different subsectors, including air conditioning, refrigeration, stationary combustion in commercial and institutional settings and other manufacturing industries.

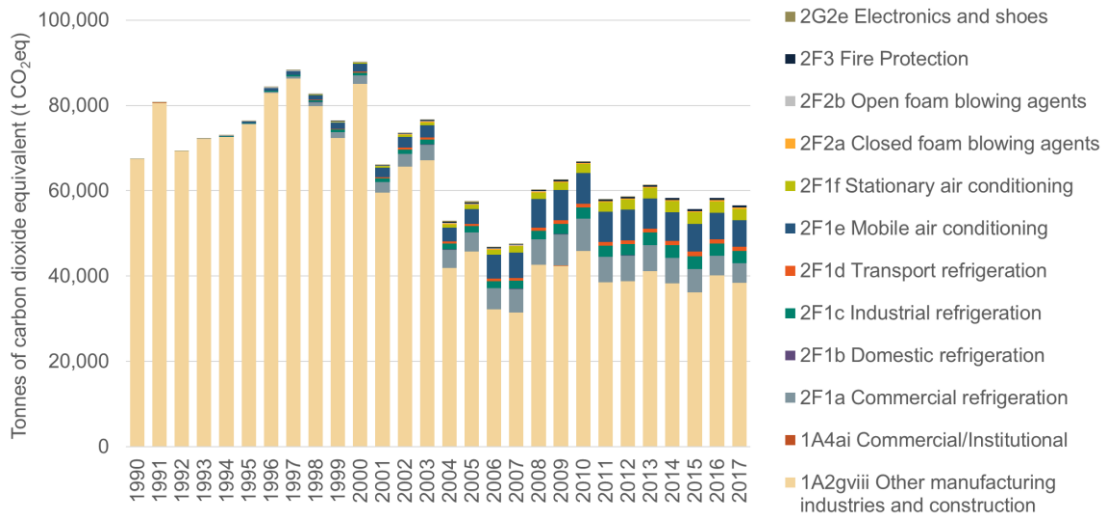

Figure 22 Business sector emissions by sub-sector 1990-2017

Emissions from the business sector reduced by 16% from 1990-2017 and saw a reduction of 3% between 2016 and 2017. Between 1990 and 2017 Guernsey has experienced significant reductions in the sub-sectors 'commercial/institutional' and 'other manufacturing industries and construction', by 40% and 43% respectively.

Table 12 Business sector emissions by sub-sector with percentage changes

Tonnes of carbon dioxide equivalent (tCO_2eq)					
	1990	2016	2017	% change 1990-2017	% change 2016-2017
1A2gviii Other manufacturing industries and construction	67,363	40,153	38,374	-43%	-4%
1A4ai Commercial/Institutional	18.3	11.1	11.0	-40%	-1%
2F1a Commercial refrigeration		4,621	4,621	-	0%
2F1b Domestic refrigeration		8.6	8.6	-	0%
2F1c Industrial refrigeration		2,820	2,820	-	0%
2F1d Transport refrigeration		1,034	1,034	-	0%
2F1e Mobile air conditioning		6,189	6,189	-	0%
2F1f Stationary air conditioning		2,659	2,659	-	0%
2F2a Closed foam blowing agents		336	336	-	0%
2F2b Open foam blowing agents				-	-
2F3 Fire Protection		479	479	-	0%
2G2e Electronics and shoes	31			-100%	-
Grand Total	**67,413**	**58,310**	**56,532**	**-16%**	**-3%**

6.2.2 Gases

Emissions in the business sector are dominated by emissions of carbon dioxide (CO_2), which accounts for 68% of business sector emissions in 2017. The remaining 2017 emissions, 32% come mostly from fluorinated gases, especially HFCs (**Figure 24**). Between 1990 and 2017, CO_2 emissions fell by 43% from 67,144 tonnes of carbon dioxide equivalent (tCO_2eq) to 38,250 tCO_2eq but peaked in 1997 at 85,965 tCO_2 eq.

HFC emissions are associated with refrigeration and air conditioning. Whilst these emissions have grown since 1990, emissions have remained relatively constant since 2008 (between 17,500 and 21,000 tCO_2eq) (**Figure 24).**

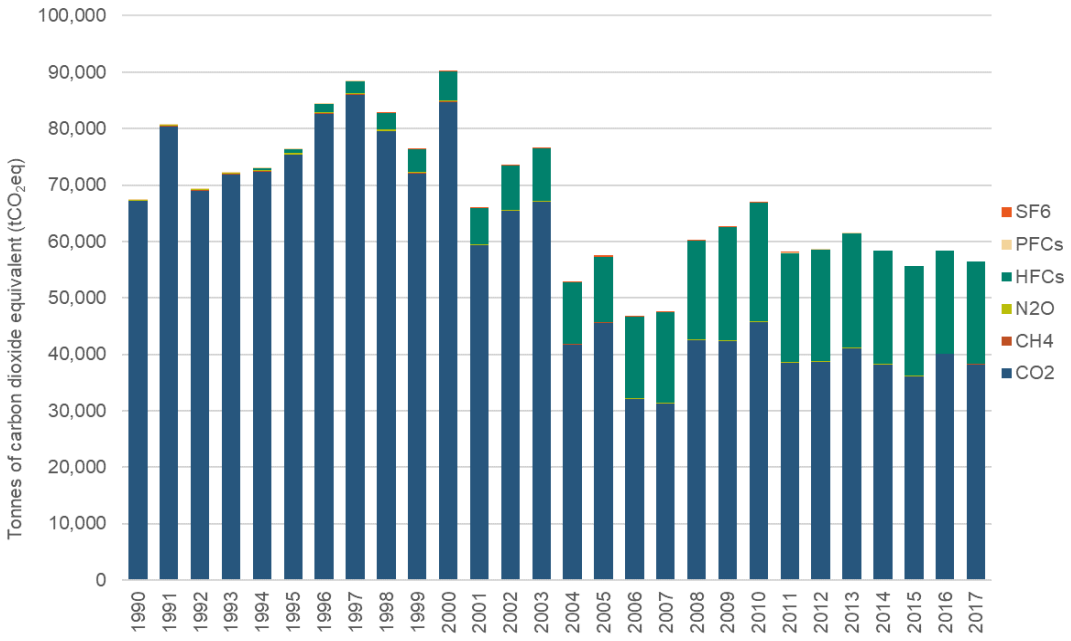

Figure 23 Business sector emissions by greenhouse gas 1990-2017

6.2.3 Methodologies

Activity Data

Data on fuel use, split by fuel type are provided directly by the States of Guernsey for use in the inventory. Emissions arising from solvents are based on UK emissions and scaled by Guernsey specific indicators such as population, GDP and number of houses. Estimates of population, GDP and house numbers are taken from 'Guernsey Facts and Figures', published annually.

Emission factors

Emission factors for carbon are UK specific, applied to the Guernsey inventory. For other gases, default emission factors found in the Guidebook are used. The guidebook is an international document that supports the reporting of national emissions inventories by setting out methodologies, describing the data that is needed and providing default emission factors.

Assumptions

To split fuel use data between residential and commercial, a 40/60 split is used, therefore assuming that 60% of the fuel used is being used in commercial settings. This split is based off expert judgement and consultation with Guernsey, which took place in 2008. Emissions arising from solvent use (e.g. substances used to make products such as paint) are based on UK emissions and are scaled by proxy data such as GDP, population and number of households thereby assuming that activities are similar to those in the UK. Similarly, for carbon dioxide emissions, UK emissions factors are used therefore assuming that activities in Jersey are similar to those in the UK.

Recent improvements to the inventory

Between the 1990-2016 inventory and the most recent 1990-2017 inventory, there were changes made to the GDP data, revising the estimates for 2009-2016 and causing a recalculation in the business sector.

6.3 Energy supply

6.3.1 Sector and sub-sector trends

Emissions from the energy supply sector accounted for 9% of total greenhouse gas (GHG) emissions in the 2017 inventory. All emissions in this sector are attributed to the generation of public electricity (**Figure 25**).

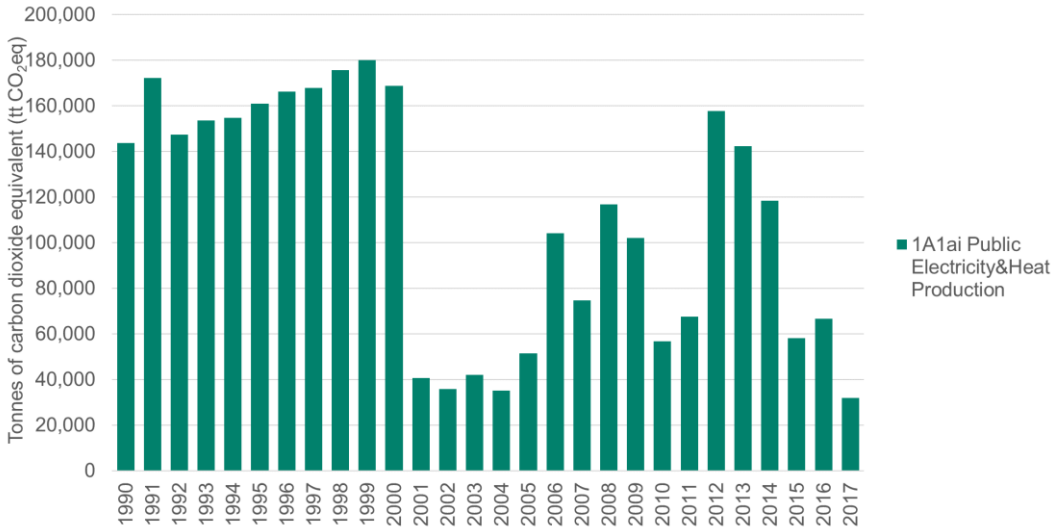

Figure 24 Energy supply sector emissions by sub-sector 1990-2017

Emissions from the energy supply sector reduced by 78% from 1990-2017 and saw a reduction of 52% between 2016 and 2017 (**Table 13**). Guernsey obtains their electricity directly from Jersey, who in turn are supplied with around 80% of their electricity by French energy utility Electricité de France (EDF). Emissions from the energy supply sector reduced significantly when a supply cable linking the two islands was installed in 2000 reducing the need for the diesel engine power plant. In 2012, the failure of this cable meant electricity had to be generated on-island using gas turbines and diesel engines leading to a spike in emissions until the cable was restored in 2014.

Table 13 Energy supply sector emissions by sub-sector with percentage changes

Tonnes of carbon dioxide equivalent (tCO_2eq)					
	1990	2016	2017	% change 1990-2017	% change 2016-2017
1A1ai Public Electricity and Heat Production	143,812	66,744	31,878	-78%	-52%
Grand Total	**143,812**	**66,744**	**31,878**	**-78%**	**-52%**

6.3.2 Gases

Emissions in the energy supply sector are dominated by emissions of carbon dioxide (CO_2), which accounts for close to 100% of emissions in 2017. Between 1990 and 2017, CO_2 emissions fell by 78% from 143,342 to 31,775 tCO_2eq but peaked in 1999 at 179,543 tCO_2eq (**Figure 26**).

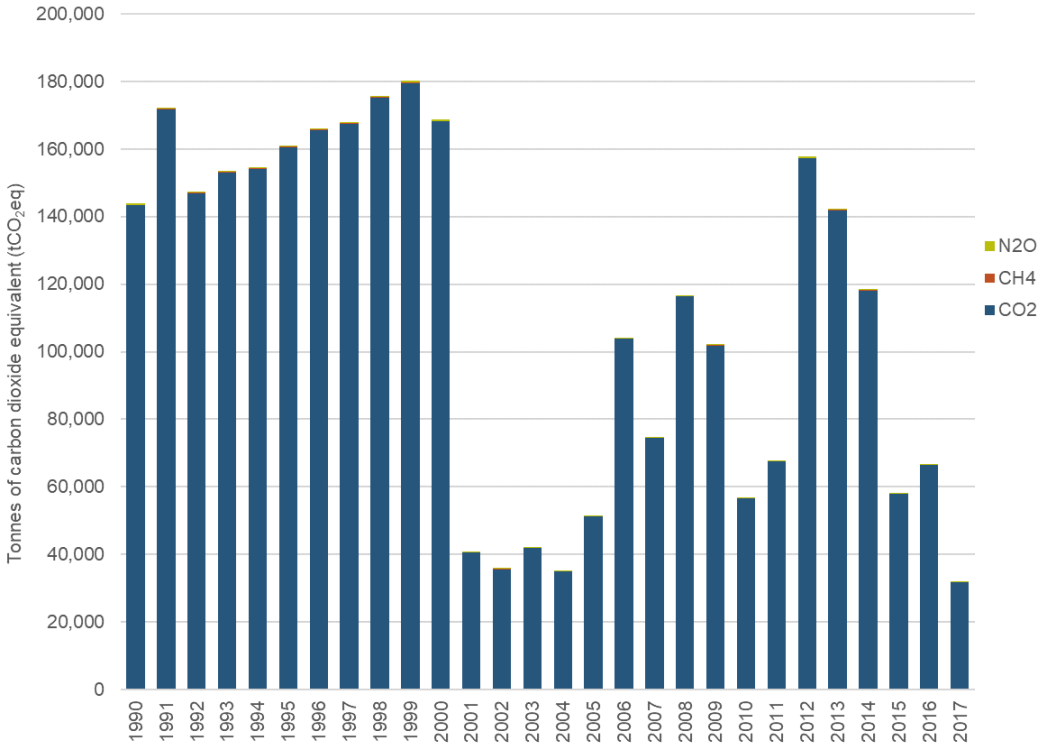

Figure 25 Energy supply sector emissions by greenhouse gas 1990-2017

6.3.3 Methodologies

Activity data

Data on heavy fuel oil use are provided by the States of Guernsey directly for use in the inventory. Gas oil use statistics were taken from the Guernsey Electricity Annual report up until 2011 when these data ceased to be provided.

Emission factors

Emissions factors for CO_2 from power stations are taken from the UK inventory and are UK specific factors. Non-CO_2 emission factors and the emissions factor for incineration of municipal solid waste are IPCC defaults. IPCC defaults are emissions factors that are found in the IPCC guidelines – international literature providing methods and information on emissions inventories.

Assumptions

From 2011 to 2017, the trend for gas oil consumption in power stations is being calculated by extrapolating the 2010 value and adjusted using the trend in electricity produced which is supplied by the Guernsey Electricity Annual Report.

Recent improvements to the inventory

There have been no significant recalculations to the energy supply sector for the 1990-2017 inventory.

6.4 Land use change

The land use, land use change and forestry (LULUCF) sector includes emissions from the conversion of land to other land types, forestry and harvested wood products.

6.4.1 Sector and sub-sector trends

Guernsey is a net source (a positive emission) in the land use change sector. This means that the amount of greenhouse gases that are released are greater than the amount of carbon dioxide (CO_2) that is removed from the atmosphere. Grassland converted to cropland is the largest emission source in 2017, with 3,662 tonnes of carbon dioxide equivalent being released (**Table 14**).

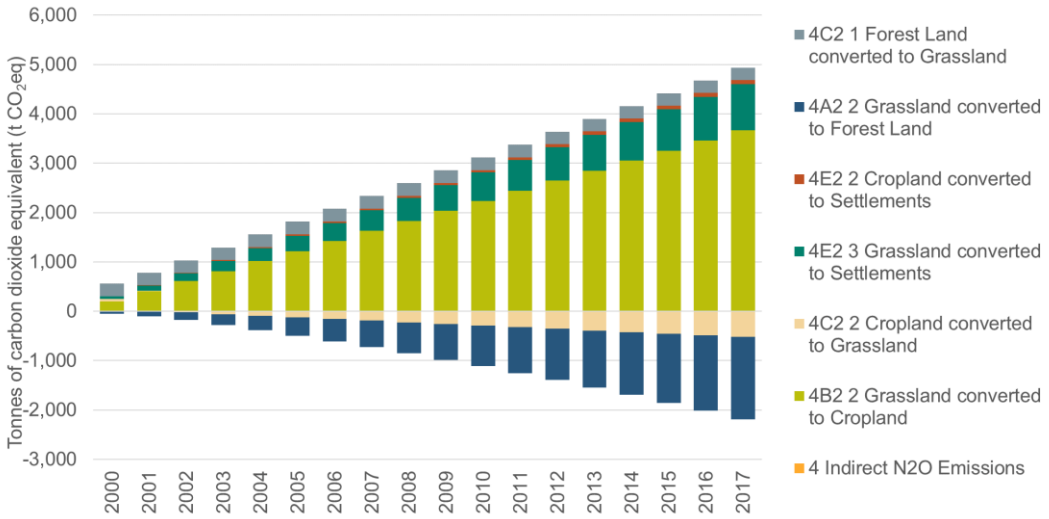

Figure 26 Land Use Change sector emissions by sub-sector 2000-2017

The largest net sink for Guernsey is grassland converted to forest land, with 1,665 tonnes of carbon removed from the atmosphere in 2017. Limited data availability from the LULUCF sector however has led to a time series that is reliant on extrapolated data, resulting in a linear trend.

Table 14 Land Use, Land Use Change and Forestry (LULUCF) sector emissions by sub-sector with absolute changes

Tonnes of carbon dioxide equivalent (tCO_2eq)					
	2000	2016	2017	Absolute change 2000-2017	Absolute change 2016-2017
4 Indirect N2O Emissions	0.0459	0.780	0.826	0.784	0.05
4B2 2 Grassland converted to Cropland	203	3,458	3,662	3,459	204
4C2 2 Cropland converted to Grassland	43.8	-488	-522	-566	-34
4E2 3 Grassland converted to Settlements	52.0	884	936	884	52
4E2 2 Cropland converted to Settlements	4.62	78.5	83.1	78.5	4
4A2 2 Grassland converted to Forest Land	-51.4	-1,528	-1,665	-1,477	-137
4C2 1 Forest Land converted to Grassland	253	253	253	0	0
Grand Total	**506**	**2659**	**2749**	**2243**	**90**

6.4.2 Gases

Emissions in the LULUCF sector are dominated by CO_2 and the sector is an overall net emission source. LULUCF in 2017 emitted 2,381 tonnes of CO_2, a 391% increase in the size of the source compared to 2000 CO_2 levels. Between 2016 and 2017, the amount of CO_2 equivalent emitted increased by 3%.

N_2O emissions from the LULUCF sector are also a source and are emitted from grassland converted to cropland and grassland converted to settlements and from indirect emissions. Emissions of N_2O increased by 1700% across the time series, from 20.5 to 368 tCO_2eq. (**Figure 28**).

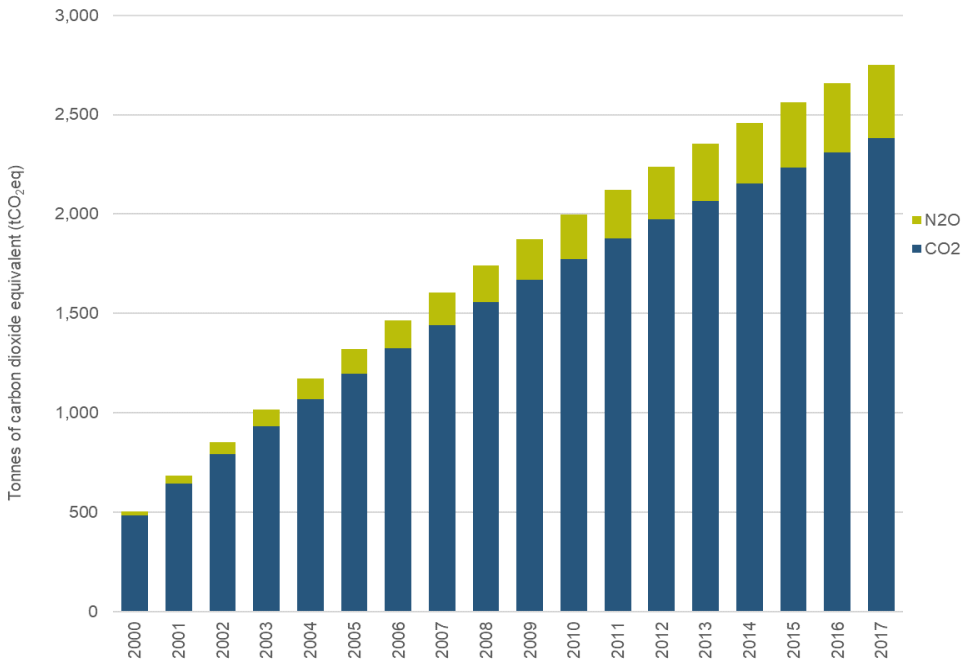

Figure 27 Land Use Change sector emissions by greenhouse gas 2000-2017

6.4.3 Methodologies

Activity data

Land cover surveys and agricultural land statistics have been used to compile annual land use change matrices for Guernsey, which are then converted into a format consistent with international guidance (from the UNFCCC). Activity data for this sector, specifically land use areas, are supplied from various publications from the States of Guernsey. Forestry land area statistics for the years 1990-2010 are provided by the 'FAO (2010) Global Forest Resources Assessment: Guernsey'. Statistics on Forestland, Cropland, Grassland and Settlement land areas for 20065 and 2009 are provided by 'Guernsey Habitat Survey Sustainable' survey and the 'Guernsey Facts and Figures' published in 2011.

Emission factors

Emission factors for estimating LULUCF emissions from Guernsey are default factors found in the IPCC guidelines. Emission factors for calculating harvested wood products and forest land fluxes come from a Carbon Flow model.

Assumptions

The activity data for Guernsey does not cover the entire time series, with most data covering until 2011. Activity data for the latter years are therefore extrapolated from the latest available year, which assumes a certain trend in the activity data has occurred. Limited data availability from the LULUCF sector however has led to a time series reliant on extrapolated data, resulting in a linear trend. Other specific assumptions include the use of a carbon flow model to calculate forest land fluxes; only perennial crops included in the 'Crop remaining crop' subsector; and default values for Soil Organic Carbon (SOC) in different land areas.

Recent improvements to the inventory

Between the 1990-2016 inventory and the most recent 1990-2017 inventory there have been a few recalculations in this sector. Biomass carbon stock densities have been adjusted to use updated UK values. An error in the Forest Land converted to Grassland calculations for Guernsey was corrected.

6.5 Residential

The residential sector includes emissions from residential stationary combustion, metered dose inhalers and other aerosols.

6.5.1 Sector and sub-sector trends

Emissions from the residential sector accounted for 13% of total GHG emissions in Guernsey's 2017 inventory. The majority of emissions are from residential stationary combustion, the burning of fuels in homes, mainly for heating and cooking (**Figure 29**).

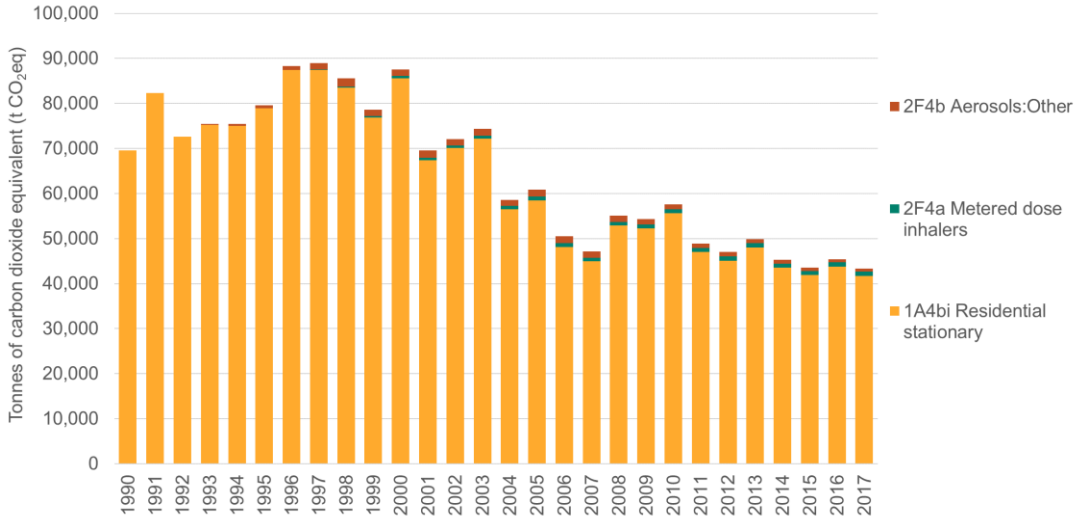

Figure 28 Residential sector emissions by sub-sector 1990-2017

Between 1990 and 2017, residential sector emissions have decreased by 37% from 71,146 to 44,854 tCO_2eq. As mentioned above, this is driven by emissions from combustion of fuels in houses. Emissions have fluctuated slightly since 2010, but overall saw a reduction by 5% between 2016 and 2017.

Table 15 Residential sector emissions by sub-sector with percentage changes

Tonnes of carbon dioxide equivalent (tCO_2eq)					
	1990	2016	2017	% change 1990-2017	% change 2016-2017
1A4bi Residential stationary	69,612	43,805	41,687	-40%	-5%
2F4a Metered dose inhalers		930	930	-	0%
2F4b Aerosols: Other		704	704	-	0%
5C2.1b Biogenic: Other	1,534	1,534	1,534	0%	0%
Grand Total	**71,146**	**46,973**	**44,854**	**-37%**	**-5%**

6.5.2 Gases

Emissions in the residential sector are dominated by emissions of carbon dioxide (CO_2) which accounted for 93% of residential emissions in 2017. Between 1990 and 2017, residential sector CO_2 emissions fell by 40% from 69,285 to 41,495 tCO_2eq (**Figure 30**).

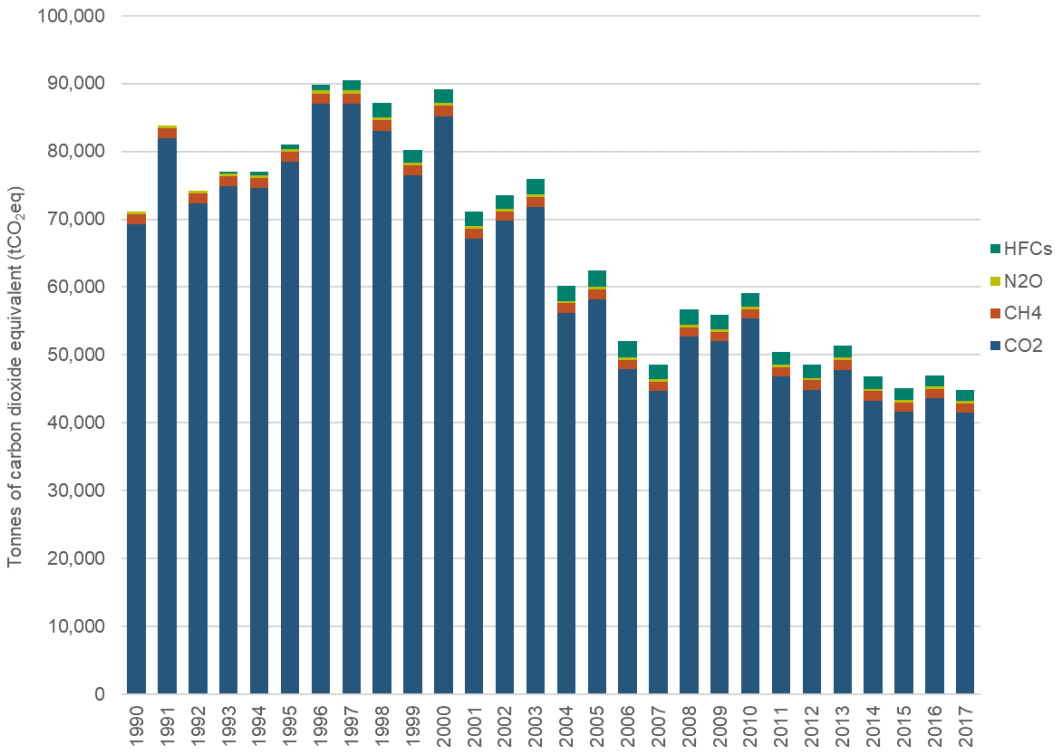

Figure 29 Residential sector emissions by greenhouse gas 1990-2017

6.5.3 Methodologies

Activity data

Data on fuel use, split by fuel type is provided directly by the States of Guernsey for use in the inventory. Emissions arising from solvents are based on UK emissions and scaled by Guernsey specific indicators such as population, GDP and number of houses. Estimates of population, GDP and house numbers are taken from 'Guernsey Facts and Figures', published annually.

Emission factors

Emission factors for carbon are UK specific, applied to the Guernsey inventory. For other gases, default emission factors found in the guidebook are used. The guidebook is an international document that supports the reporting of national emissions inventories by setting out methodologies, describing the data that is needed and providing default emission factors.

Assumptions

To split fuel use data between residential and commercial, a 40/60 split is used, therefore assuming that 40% of the fuel used is being used in domestic settings. This split is based off expert judgement and consultation with Guernsey, which took place in 2008. Emissions arising from solvent use are based on UK emissions and are scaled by proxy data such as GDP, population and number of households thereby assuming that activities are similar to those in the UK. Similarly, for carbon dioxide emissions, UK emissions factors are used therefore assuming that activities in Jersey are similar to those in the UK.

Recent improvements to the inventory

Between the 1990-2016 inventory and the most recent 1990-2017 inventory, there were changes made to the GDP data, revising the estimates for 2009-2016 and causing a recalculation in the business sector.

6.6 Transport

The transport sector includes emissions from road transport, domestic aviation and domestic navigation (i.e. shipping). Domestic aviation and navigation refer to activities that occur within Guernsey and between Guernsey and the UK. This includes, for example, take-off, landing and internal, recreational flights and shipping activity that occurs within Guernsey waters. For international aviation and shipping (journeys to and from other countries), the emissions are equally divided between the two countries. However, these statistics are recorded as memo items to the inventory and are not included in the national total.

6.6.1 Sector and sub-sector trends

Transport sector emissions accounts for 32% of total GHG emissions in the 2017 inventory. The largest emissions source in 2017 in this sector is passenger cars (**Figure 31**).

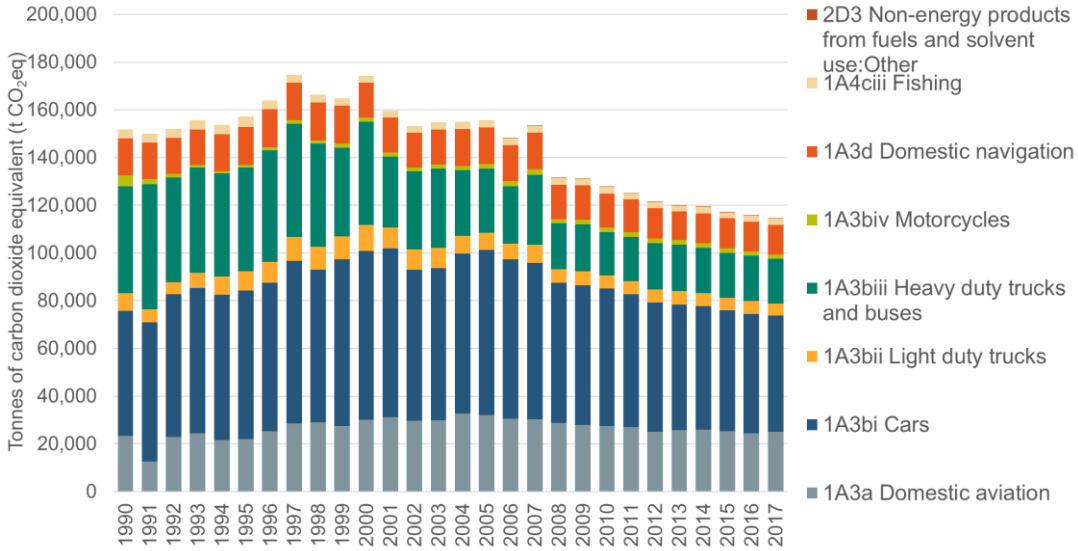

Figure 30 Transport sector emissions by sub-sector 1990-2017

Between 1990 and 2017, emissions in the transport sector have decreased by 25% from 151,779 to 114,502 tCO_2eq. Transport emissions steadily decreased between 2008 and 2015, mainly due to passenger cars becoming gradually more fuel efficient and therefore using less fuel. Emissions from transport have reduced slightly in 2016 and 2017, by 1%.

The overall trend is dominated by emissions from passenger cars as it is the largest sub-sector. Passenger car emissions have decreased by 7% between 1990 and 2017 and by 3% between 2016 and 2017 (**Table 16**). The trend in emissions from the 'Heavy duty trucks and buses' sub-sector also contributes to the overall trend in emissions in the transport sector, with a reduction of 58% between 1990 and 2017. Domestic aviation is the only sub-sector which has observed an increase across the time series, by 7%.

Table 16 Transport sector emissions by sub-sector with percentage changes

Tonnes of carbon dioxide equivalent (tCO_2eq)					
	1990	2016	2017	% change 1990-2017	% change 2016-2017
1A3a Domestic aviation	23,332	24,484	25,075	7%	2%
1A3bi Cars	52,395	50,006	48,616	-7%	-3%
1A3bii Light duty trucks	7,421	5,305	5,194	-30%	-2%
1A3biii Heavy duty trucks and buses	44,695	18,991	18,715	-58%	-1%
1A3biv Motorcycles	4,712	1,859	1,812	-62%	-3%
1A3d Domestic navigation	15,496	12,396	12,472	-20%	1%
1A4ciii Fishing	3,727	2,597	2,571	-31%	-1%
2D3 Non-energy products from fuels and solvent use: Other		46.6	47.8	-	3%
Grand Total	**151,779**	**115,686**	**114,502**	**-25%**	**-1%**

6.6.2 Gases

Transport sector emissions are predominantly carbon dioxide (CO_2). CO_2 emissions account for 99% of total emissions in 2017 with nitrous oxide (N_2O) making up 0.8% and methane (CH_4) the remaining 0.2%. CO_2 emissions have decreased by 24% between 1990 and 2017, with a slight reduction between 2016 and 2017 of 1% (**Figure 32**).

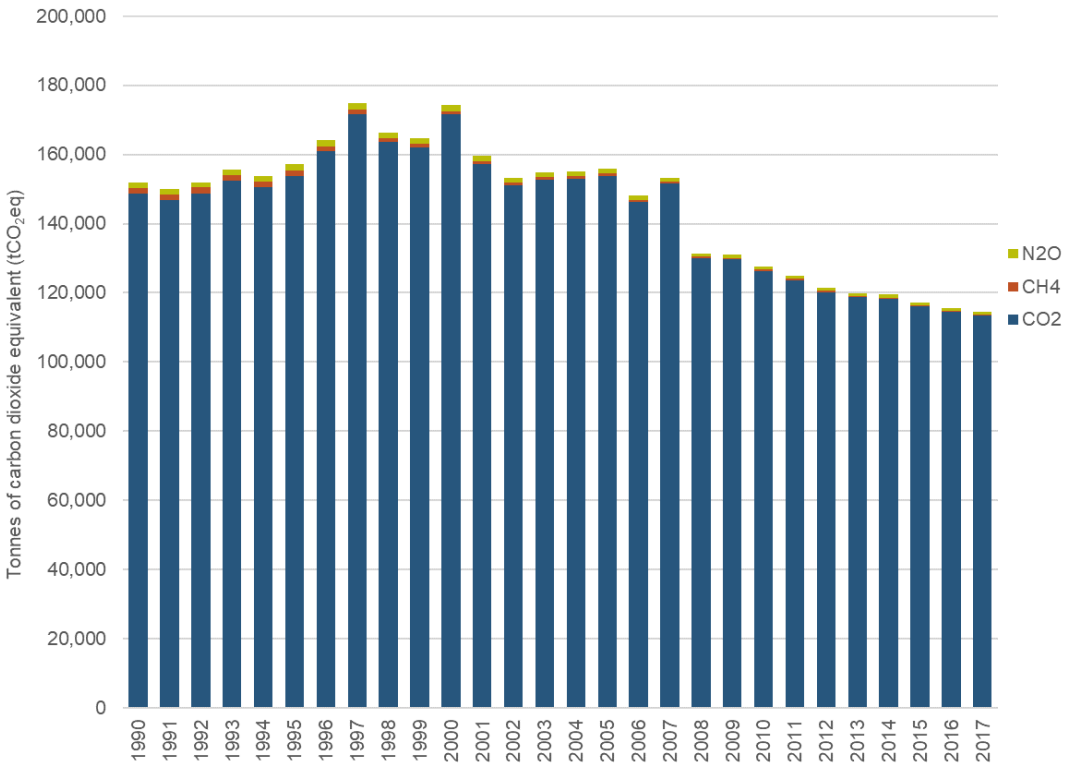

Figure 31 Transport sector emissions by greenhouse gas 1990-2017

6.6.3 Methodologies

Activity data

Road transport: Fuel consumption split by fuel type for 1990 to 2017 and vehicle numbers are taken from data supplied directly by the States of Guernsey annually for use in the inventory.

Aviation: Detailed aviation activity data is provided by the UK Civil Aviation Authority (CAA), including aircraft movements broken down by airport, aircraft type and destination. Deliveries of aviation spirit and aviation turbine fuel are provided in the Digest of UK Energy Statistics (DUKES).

Shipping: For 2014 the UK the high-resolution Automatic Identification System (AIS) provides detailed data on vessels and vessel movements. For other years, shipping mode-specific proxy data (including port statistics provided by the Department for Transport) are used to generate a time series.

Emission factors

Road transport: UK vehicle emission factors by vehicle type (euro standard) are applied to Guernsey and properties of the fuel are assumed to be the same as the UK and are therefore taken from DUKES.

Aviation: A UK specific emission factor for carbon is applied to Guernsey. For non-CO_2 emissions, default emission factors from the 2016 EMEP/EEA Guidebook are used.

Shipping: For carbon and N_2O, shipping specific factors from the International Maritime Organisation (2015) are used. For methane, the emission factor is taken from a 2004 study by IVL (Swedish Environmental Research Institute).

Assumptions

Road transport: Fleet mix, in terms of the age distribution of vehicles, is assumed to be the same as that of the UK.

Aviation: The aviation estimates are generated by a model compiled for the purposes of the UK inventory, which is considered to be detailed and of good quality. International flights that first stop at a domestic airport are accounted as having a domestic leg and an international leg.

Shipping: The main assumption in the shipping sector concerns the allocation of vessel movements to domestic or international, where a cargo or passenger vessel starts or finishes in a UK port when it goes out of AIS signal range. The shipping estimates are generated by a model compiled for the purposes of the UK inventory, which is considered to be detailed and of good quality.

Recent improvements to the inventory

Road transport: There have been recalculations between the 1990-2016 inventory and the 1990-2017 inventory due to updated DUKES conversion factors and updates to the underlying activity data.

Aviation: In the latest inventory submission, the taxiing times have been revised leading to recalculations.

Shipping: The UK Sea Fisheries Annual Statistics data have been updated requiring a recalculation in the fishing vessels category. There are also minor recalculations due to updated port statistics from the Department for Transport which are used as proxy data for calculating average emission factors.

6.7 Waste management

This includes emissions from domestic wastewater treatment, managed waste disposal sites and the composting of municipal solid waste.

6.7.1 Sector and sub-sector trends

Emissions from the waste management sector accounted for 27% of total greenhouse gas (GHG) emissions in the 2017 inventory, the second largest contributor after transport. Emissions from the waste management sector have overall decreased by 11% across the time series, with a 2% reduction between 2016 and 2017 (**Figure 33**).

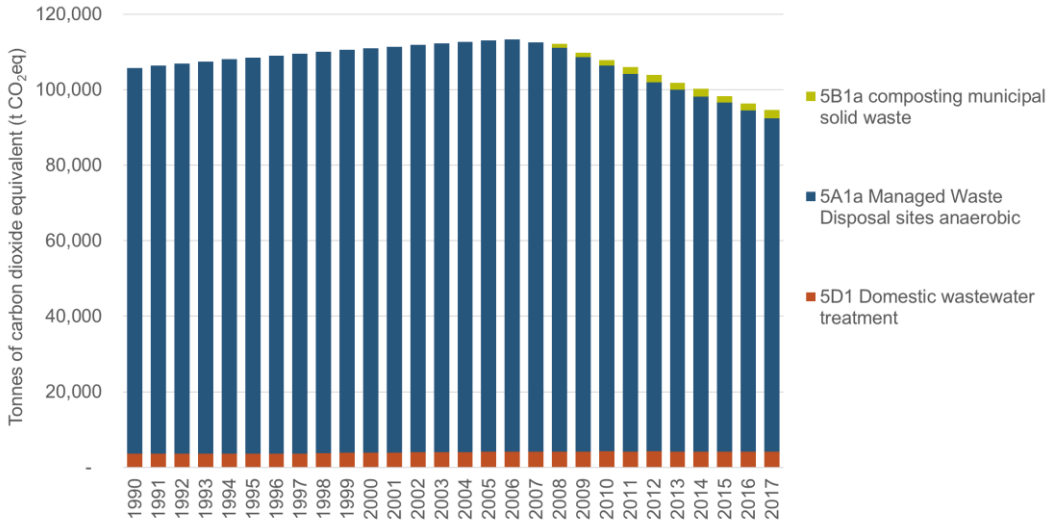

Figure 32 Waste management sector emissions by sub-sector 1990-2017s

Between 1990 and 2006, emissions from the waste management sector steadily increased from 105,793 to 113,328 tCO_2eq, an increase of 7% across the 16 years. This trend is dominated by emissions from managed waste disposal sites, as this is continually the largest sub-sector. In 2017, emissions from managed waste disposal sites (landfills) accounted for 93% of total waste management emissions. Emissions from this sector started to decrease from 2007, reducing by 19% in 10 years.

Table 17 Waste management sector emissions by sub-sector with percentage changes

Tonnes of carbon dioxide equivalent (tCO_2eq)					
	1990	2016	2017	% change 1990-2017	% change 2016-2017
5D1 Domestic wastewater treatment	3,630	4,182	4,175	15%	0%
5A1a Managed Waste Disposal sites anaerobic	102,163	90,322	88,272	-14%	-2%
5B1a composting municipal solid waste		1,884	2,146	-	14%
Grand Total	**105,793**	**96,389**	**94,594**	**-11%**	**-2%**

6.7.2 Gases

Emissions in the waste management sector are split between methane (CH_4) and nitrous oxide (N_2O). CH_4 accounts for 95% of waste management sector emissions in 2017, whilst N_2O accounts for 5%. Between 1990 and 2017, CH_4 have decreased by 12% whereas N_2O

emissions have steadily increased by 40%. Between 2016 and 2017, CH_4 emissions decreased by 2.1% as N_2O emissions have increased by 2.1% (**Figure 34**).

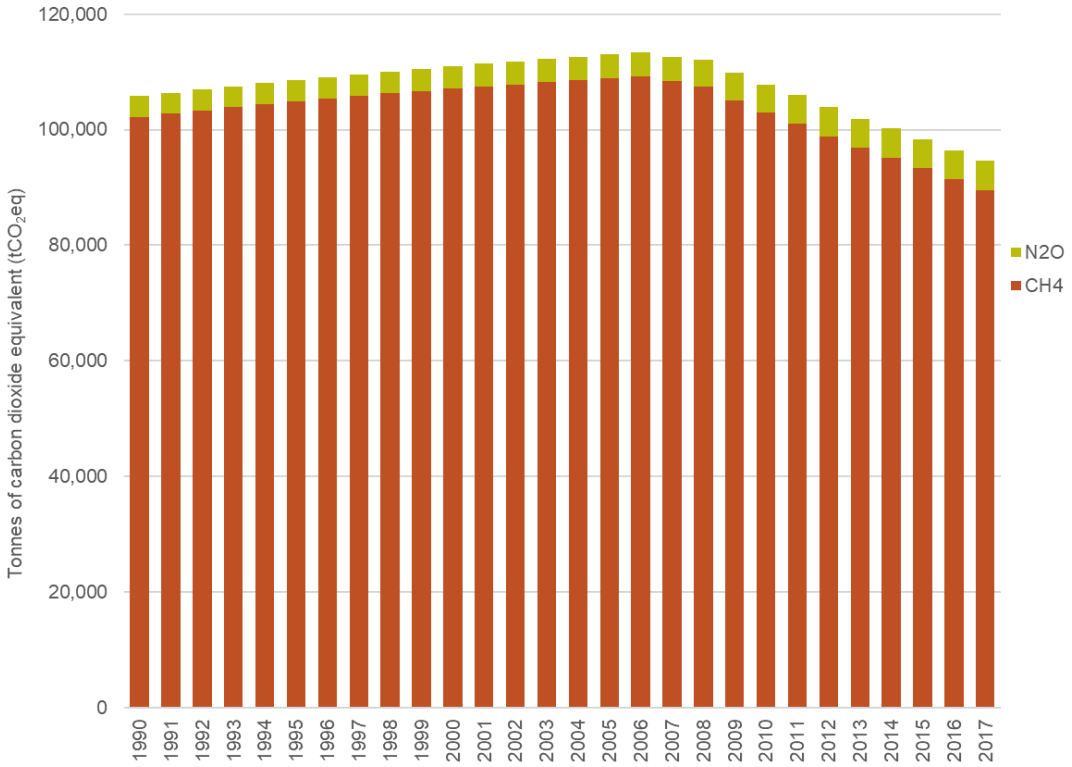

Figure 33 Waste management sector emissions by greenhouse gas 1990-2017

6.7.3 Methodologies

Activity data

Data on the amount of waste composted and the amount of waste going to landfill are provided by the States of Guernsey annually for use in the inventory. Population data are taken from 'Guernsey Facts and Figures', published annually. Per capita protein consumption (kg/person/year) was provided by FAOSTAT in 2011 and is used to calculate the total amount of nitrogen in effluent. This has not been updated since 2011 and is assumed to be static from the 2011 number.

Emission factors

Current emission factors for the waste management sector are default values taken from the relevant literature.

Assumptions

The methane generation rate for Guernsey is calculated by using the IPCC MSW waste composition model, which then provides IPCC regional default values for waste per capita and MSW waste composition. For Guernsey, the region for the model was assumed to be 'Europe: Western' and the climate was assumed to be 'Wet temperate'. It is assumed that these model settings provide good representation of the situation in the Guernsey. It is assumed that domestic wastewater management practices are comparable to those of the UK.

Recent improvements to the inventory

There were no significant recalculations in this sector.

7 Guernsey's greenhouse gas inventory - specific inventory questions

7.1 If waste ceases to go to landfill, will there still be emissions from landfill reported?

Detail on the methodology and assumptions used when calculating emissions from landfill can be found in section 6.7.3. Methane emissions will continue to be reported for decades after landfilling ceases. This is because the landfill model assumes that degradable organic carbon in landfill waste continues to decay for a few decades. However, the vast majority of emissions will be emitted in the first 10 to 20 years following closure of a landfill.

7.2 How are emissions from aviation sources reported?

International aviation includes emissions from flights that depart in one country and arrive in another. The emissions for the entire journey are divided between the source country and the destination country. These emissions are included as 'memo items' meaning they are not in the main body of the inventory. Domestic aviation covers emissions from civil domestic passenger and freight traffic that depart and arrive in Guernsey. It includes journeys between the UK and Guernsey. Emissions from aircrafts are distinguished between two separate operations: Landing/Take Off (LTO) and Cruise. The amount of GHG emissions will differ between landing/take off and cruise, with 90% of aviation emissions occurring at higher altitudes.

7.3 How are emissions from marine sources reported?

Emissions from international water-borne navigation and domestic water-borne navigation are differentiated. The fuel used by marine vessels that both depart and arrive in Guernsey, such as ferries, are reported within the inventory. International shipping considers marine vessels which have departed from Guernsey and arrived in another country, or vice versa. These are included within the inventory as 'Memo Items', meaning they are not included within the inventory totals.

Emissions from fishing in Guernsey are counted as a separate marine source, and this includes emissions from fuels combusted for inland, coastal and deep-sea fishing. Any fishing vessel which has refuelled in Guernsey (including international fishing), is considered in the inventory.

7.4 How are the other islands (Hern, Sark and Alderney) of the bailiwick emissions calculated and reported?

Currently, emissions from the other islands of the Bailiwick of Guernsey (Hern, Sark and Alderney) are reported as part of Guernsey's total GHG. The activity data provided by the Guernsey government includes totals for the islands, meaning there is an assumption that it includes emissions from Hern, Sark and Alderney.

In order to calculate emissions from the energy supply and transport sectors, Guernsey provides total figures for the amount of electricity imported from Jersey, vehicle numbers and other fuel consumption data, which we assume to cover activities on the other islands for these relevant sectors. Livestock on these other islands are also assumed to be included within the total livestock activity data for Guernsey. The waste sector is the only sector where Alderney specific activity data has been provided, with

the amount of waste sent to landfill on the island of Guernsey. If separate GHG inventories were to be compiled for each individual island, island specific activity data would need to be disaggregated from the activity data provided by Guernsey such as the amount of energy used and exact number of livestock on each island.

8 Annex 1 Inventory Detail

8.1 GHG inventory sub-sectors

Sector	Sub-sector	Description	Data sources
Agriculture	3F Field burning	Emissions from open burning of agriculture residues. This activity ceased in 1993 in England and Wales and is considered negligible in Northern Ireland and Scotland.	Land area surveys from Centre for Ecology and Hydrology (CEH) and activity data from Rothamsted
	3G1 Liming	Emissions from the use of lime in agricultural soils	Activity data and estimated emissions from liming from CEH
	3H Urea application	Emissions from the application of urea to agricultural soils	Land area surveys from CEH and Implied emission factors from Rothamsted
	3J Livestock	Emissions from enteric fermentation and manure management for livestock and managed soil from fertiliser application and indirect emissions from agricultural soils	**Jersey:** Agricultural Statistics **Guernsey:** Guernsey Facts and Figures
Business	1A2gviii Other manufacturing industries and construction	Emissions from stationary combustion in manufacturing industries and combustion, other (industries not captured elsewhere in the inventory)	**Jersey:** Energy Trends report **Guernsey:** Fuel data provided by Guernsey Government and summarised in Guernsey Facts and Figures
	1A4ai Commercial/Institutional	Miscellaneous fuel combustion in industrial and commercial buildings	
	2F1a Commercial refrigeration	Emissions from refrigeration in commercial settings	**Jersey:** GDP data from Measuring Jersey's Economy report **Guernsey:** GDP data from Facts and Figures
	2F1b Domestic refrigeration	Emissions from refrigeration in domestic settings	**Jersey:** Population data from Jersey Resident Population report **Guernsey:** Population data from Facts and Figures
	2F1c Industrial refrigeration	Emissions from refrigeration in industrial settings	**Jersey:** GDP data from Measuring Jersey's Economy report **Guernsey:** GDP data from Facts and Figures
	2F1d Transport refrigeration	Emissions from refrigeration during transport	
	2F1e Mobile air conditioning	Emissions from air conditioning – mobile sources	**Jersey:** Number of vehicles data from the Jersey Government **Guernsey**: Number of registered vehicles data from Guernsey Government
	2F1f Stationary air conditioning	Emissions from air conditioning – stationary sources	**Jersey:** Population data from Jersey Resident Population report **Guernsey:** Population data from Facts and Figures
	2F2a Closed foam blowing agents	HFCs are being used as replacements for CFCs and HCFCs in foams, particularly in closed-cell insulation applications. The processes and	**Jersey:** GDP data from Measuring Jersey's Economy report

Sector	Sub-sector	Description	Data sources
	2F2b Open foam blowing agents	applications for which these various HFCs are being used include insulation boards and panels, pipe sections, sprayed systems and one-component gap filling foams.	**Guernsey:** GDP data from Facts and Figures
	2F3 Fire Protection	Emissions from firefighting. There are two general types of fire protection (fire suppression) equipment that use greenhouse gases as partial replacements for halons: portable (streaming) equipment, and fixed (flooding) equipment.	
	2G2e Electronics and shoes	Emissions released during the manufacturing of sporting goods	
Energy supply	1A1ai Public electricity and heat production	Emissions from all fuel use for electricity generation. In Jersey and Guernsey this include use of fuel oil, gas oil and municipal solid waste	**Jersey:** Energy Trends report **Guernsey:** Fuel data provided by Guernsey Government and summarised in Guernsey Facts and Figures, Guernsey Electricity annual report
Land use change	4 Indirect N2O emissions	Indirect emissions from nitrogen leaching and run-off associated with land use and land use change	Land surveys and activity data held by CEH
	4A2_2 Grassland converted to forest land	Emissions and removals from grassland that is converted to forest land (carbon stock change)	
	4B2_2 Grassland converted to cropland	Emissions and removals from grassland that is converted to cropland (carbon stock change and N mineralisation/immobilisation)	
	4C2_2 Cropland converted to grassland	Emissions and removals from cropland that is converted to grassland (carbon stock change)	
	4C2_1 Forest land converted to grassland	Emissions and removals from forest land that is converted to grassland (carbon stock change)	
	Land converted to wetlands	Emissions from land that is converted to wetlands. Wetlands are land that is covered or saturated by water for all or part of the year (e.g., peatland) and that does not fall into the forest land, cropland, grassland or settlements categories.	
	4E2_2 Cropland converted to settlements	Emissions and removals from cropland that is converted to settlements (carbon stock change and N mineralisation/immobilisation)	
	4E2_3 Grassland converted to settlements	Emissions and removals from grassland that is converted to settlements (carbon stock change and N mineralisation/immobilisation)	

Sector	Sub-sector	Description	Data sources
Residential	1A4bi Residential stationary	Emissions from all fuel combustion in households	**Jersey:** Energy Trends report **Guernsey:** Fuel data provided by Guernsey Government and summarised in Guernsey Facts and Figures
	2F4a Metered dose inhalers	Most aerosol packages now contain hydrocarbon (HC) as propellants but, in a small fraction of the total, HFCs and PFCs may be used as propellants or solvents. The 5 main sources are metered dose inhalers (MDIs), personal care products (e.g. hair care, deodorant, shaving cream), household products (e.g. air-fresheners, oven and fabric cleaners), industrial products (e.g. special cleaning sprays such as those for operating electrical contact, lubricants, pipe-freezers) and other general products (e.g. silly string, tire inflators, claxons),	**Jersey:** Population data from Jersey Resident Population report **Guernsey:** Population data from Facts and Figures
	2F4b Aerosols: Other		
Transport	1A3a Domestic aviation	Emissions from flights that depart and arrive in the same country. For Jersey and Guernsey this includes flights between the UK and Crown Dependencies, the UK and Gibraltar and the UK and Bermuda (take-off and landing and cruise)	Activity data from the UK Civil Aviation Authority and fuel data from Digest of UK Energy Statistics
	1A3bi Cars	Emissions from passenger cars	**Jersey:** Fuel data from Jersey's energy balance, number of vehicles data from the Jersey Government **Guernsey:** Fuel data provided by Guernsey Government and summarised in Guernsey Facts and Figures, number of registered vehicles data from Guernsey Government
	1A3bii Light duty trucks	Emissions from light duty trucks – vehicles designed to transport light weight cargo or equipped with special features such as four-wheel drive for off-road operation	
	1A3biii Heavy duty trucks and buses	Emissions from buses and coaches, HGVs rigid and HGVs articulated	
	1A3biv Motorcycles	Emissions from vehicles designed to travel with no more than three wheels in contact with the ground, including mopeds (<50cc 2st), motorcycle (>50cc 2st) and motorcycle (>50cc 4st)	
	1A3d Domestic navigation	Emissions from fuels used by vessel of all flags that depart and arrive in the same country. For Jersey and Guernsey, this includes journeys between the islands and the UK	
	1A4ciii Fishing	Emissions from fuels combusted for inland, coastal and deep-sea fishing	AIS data and UK Sea Fisheries Annual Statistics

Sector	Sub-sector	Description	Data sources
	2D3 Non-energy products from fuels and solvent use: other	This includes urea consumption by road transport	**Jersey:** GDP data from Measuring Jersey's Economy report, population data from Jersey Resident Population report, number of vehicles data from the Jersey Government and number of households data from census **Guernsey:** GDP data from Facts and Figures, Population data and number of households from Facts and Figures and number of registered vehicles from Guernsey Government
Waste management	5A1a Managed waste disposal sites anaerobic	This includes emissions from managed waste disposal sites i.e. landfills	**Guernsey:** Quantity of waste sent to landfill provided by the Guernsey Government
	5B1a Composting municipal solid waste	Emissions from composting of municipal solid waste at permit sites	**Guernsey:** Quantity of waste composted provided by the Guernsey Government
	5D1 Domestic wastewater treatment	Emissions from the treatment of liquid waste and sludge from housing and commercial sources. This includes sewage sludge decomposition	**Jersey:** Population data from Jersey Resident Population report **Guernsey:** Population data from Facts and Figures

9 Useful links

Jersey greenhouse gas emissions

Jersey Agricultural Statistics 2017

Jersey Energy Trends 2018

Jersey Resident Population 2018 Estimate

Measuring Jersey's Economy GVA and GDP 2018

Digest of UK Energy Statistics

Guernsey Facts and Figures 2019

10 About the authors

Kathryn Hampshire: Kathryn specialises in emissions inventories and data visualisation. She has led work to compile and QA/QC greenhouse gas inventories for the UK Oversees Territories and Crown Dependencies and the Devolved Administrations as part of the UK emissions inventory programme. She has recently been working with Jersey, Guernsey and the Isle of Man creating technical reports, reports for the general public and visualisations of emissions data to increased understanding of emissions data and facilitate stakeholder engagement.

Justine Raoult: Justine has experience in core inventory compilation, the measurement, verification and reporting (MRV) of greenhouse gases, and data visualisation. She has first-hand experience in GHG compilation having compiled the inventory for the Devolved Administrations, specialising in fuel combustion and assisting in writing the technical report. Justine is leading on the compilation of the GHG inventory for Overseas Territories and Crown Dependencies (OTsCDs), which requires coordinating a team, carrying out compilation in the agricultural sector, and completing the rigorous QA/QC processes.

Katie King: Katie is a Company Director at Aether and has been involved in the compilation of emissions estimates for 15 years, focused in particular at the local level through spatial mapping of emissions. Katie is Knowledge Leader for Local Authority carbon emission data as part of the UK NAEI programme, overseeing the production of the LA level CO_2 dataset for DECC each year. Katie has much experience in data evaluation for emissions estimates, advising on and reviewing the work of the National Atmospheric Emissions Inventory emissions mapping team covering many sectors.

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