
# Glasgow Airport Carbon Footprint 2016

In accordance with the UK Government's Conversion Factors for Company Reporting.

---

Report for Glasgow Airport Limited

GLASGOW AIRPORT
PROUD TO SERVE SCOTLAND

ED10078 | Issue Number 1 | Date 30/05/2017

**Customer:**

**Glasgow International Airport Limited**

Customer reference:

Carbon Footprint 2016



**Contact:**

Christine St John Cox
Ricardo Energy & Environment
Gemini Building
Fermi Avenue
Harwell
Oxon
OX11 0QR

t: +44 (0) 1235 753 084

e: Christine.StJohnCox@ricardo.com

Ricardo Energy & Environment Ltd is certificated to ISO9001 and ISO14001

Author:

Kevin Bowe, Tim Rainbow, Florianne De Boer

Approved By:

Kevin Bowe

Date:

30 May 2017

Ricardo Energy & Environment reference:

Ref: ED10078 Issue Number 1

# Executive summary

This report provides the results of the 2016 carbon footprint assessment for Glasgow Airport Limited (GLA). GLA is wholly owned by AGS Airports Limited, a partnership between Ferrovial and Macquarie Infrastructure and Real Assets (MIRA). The carbon footprint has been undertaken in accordance with best practice guidance for greenhouse gas emissions reporting by Ricardo Energy & Environment.

Since 2009, Ricardo Energy & Environment has been commissioned to provide an assessment of Glasgow Airport carbon footprints.

To make sure that a rigorous methodology has been applied that will stand-up to external scrutiny, the carbon footprint modelling tools used (first developed in 2008) have undergone iterations that reflect improvements in best practice (such as updates to the *GHG Protocol*) and access to data.

The results presented in this report have been calculated using UK Government 2016 conversion factors for company reporting[1] as the latest version available at the time of reporting. The carbon footprint is divided into scopes, which cover:

- **Scope 1** – Scope 1 emissions are defined as direct GHG emissions arising from sources that are owned or controlled by the company. The emissions result from activities that Glasgow Airport can have direct influence on through its actions.
- **Scope 2** – Scope 2 emissions are associated with the use of electricity imported from the grid or from a third party supplier of energy in the form of heat or electricity. These indirect GHG emissions are due to upstream emissions from the production and delivery of fuel to power stations. Glasgow Airport can influence the amount of electricity it uses, however, it has little control over the generation of the electricity.
- **Scope 3** – Scope 3 emissions are defined as those arising as an indirect consequence of the use of goods or services provided by the company. Glasgow Airport do have some influence over Scope 3 emissions but the activities are not under its control.

Table 3 cross-references the scopes outlined above with the activities which are reported on at Glasgow Airport and for AGS Airports as a whole for comparison. An overview of the 2016 carbon footprint by emission scope is shown below. Some of the key comments to note are:

- The key performance indicators adopted by Glasgow Airport are absolute emissions (Scope 1, 2, and 3), and per passenger (PAX), and per air traffic movement (ATM) (Scope 1 and 2) – Table 3. Both the latter two have decreased from 2016, this partly to do with the increase in customer numbers and flights.
- Scope1 and 2 emissions have decreased by 6% from 2015. This is however linked to a reduction in the Scope 2 electricity emission conversion factor, as in fact Glasgow Airport's electricity consumption has increased by 2%. Scope 1 emissions have increased overall.
- Glasgow Airport's Scope 3 emissions have increased by 13% this year from 2015, mainly due to the increase in passenger numbers and aircraft movements.
- Aircraft movements and passenger surface access to the airports are the largest emissions sources for Glasgow Airport, 50.3% and 39.1% respectively (see Table 3).
- Generally, the data quality for the majority of emissions sources are good.
    - Scope 1 and 2 emissions data sources are of good quality and mainly provide confidence in their emissions.
    - Scope 3 emissions, which are harder to influence, and harder to quantify tend to be the largest emissions. In the case of Glasgow Airport this holds true as Scope 3 emissions are the largest source and indeed the data quality is poorest.

[1] www.ukconversionfactorscarbonsmart.co.uk/

**Table 1: Intensity metric for Scope 1 and Scope 2 emissions for Glasgow Airport**

| Intensity Metric | | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|
| Glasgow | Scope 1 and Scope 2 carbon footprint / air traffic movement ($kgCO_2e$/ATM) | 207 | 210 | 206 | 200 | 183 | **158** |
| | Scope 1 and Scope 2 carbon footprint / passenger ($kgCO_2e$/PAX) | 2.4 | 2.4 | 2.2 | 2.2 | 1.9 | **1.7** |

Table 2 shows the emissions scope split for Glasgow Airport and for AGS Airports as a whole for comparison. The 'Outside of Scopes' refers to emissions associated with the biofuel component of diesel consumed by each airport (i.e. Scope 1). Scope 3 emissions account for 92.4% of Glasgow Airport's total emissions, largely arising from passenger surface access and aircraft movements (see Table 3). For further information on what is included in passenger surface access and aircraft movements, please refer to the methodology in Appendix 1.

**Table 2: Glasgow Airport's and AGS Airports' 2016 carbon emissions by scope expressed as tonnes carbon dioxide equivalent ($tCO_2e$)**

| Emissions by scope ($tCO_2e$) | Glasgow | % split of Glasgow | AGS total 2016 emissions | % total split |
|---|---|---|---|---|
| Scope 1 | 3,202 | 1.5% | 5,071 | 1.5% |
| Scope 2 | 12,301 | 5.8% | 20,269 | 6.0% |
| Scope 3 | 196,954 | 92.7% | 310,085 | 92.4% |
| Outside of Scopes | 5 | 0.0% | 24 | 0.0% |
| **Total** | 212,461 | 100% | 335,448 | 100% |

Table 3 shows the breakdown of the emissions by source and activity for each airport and for Glasgow Airport and AGS Airports as a whole. The largest emissions sources are passenger aircraft movements (50.3%) and passenger surface access (39.1%).

**Table 3: Glasgow Airport's and AGS Airports' 2016 carbon emissions by source/activity expressed as tonnes carbon dioxide equivalent ($tCO_2e$)**

| Emissions by source and activity ($tCO_2e$) | Scope | Glasgow | % split of Glasgow | AGS total 2016 emissions | % total split |
|---|---|---|---|---|---|
| Aircraft movements | Scope 3 | 98,705 | 46.5% | 168,736 | 50.30% |
| Aircraft engine testing | Scope 3 | 311 | 0.1% | 556 | 0.17% |
| Business travel | Scope 3 | 12 | 0.01% | 36 | 0.01% |
| Fire Training | Scope 1 | 31 | 0.01% | 133 | 0.04% |
| Staff commute | Scope 3 | 331 | 0.2% | 1,321 | 0.39% |
| Operational vehicles | Scope 1 / Scope 3 | 606 | 0.3% | 2,259 | 0.67% |
| Passenger surface access | Scope 3 | 93,215 | 43.9% | 131,204 | 39.11% |
| Utilities | Scope 1 / Scope 2 / Scope 3 | 16,510 | 7.8% | 26,748 | 7.97% |
| Waste (disposal and production of virgin material) | Scope 3 | 2,738 | 1.3% | 4,495 | 1.34% |
| **Total** | | **212,461** | **100%** | 335,489 | 100% |

# Glossary

| Term | Definition |
|---|---|
| Arisings | Materials forming the secondary or waste products of industrial operations. |
| ATM | Air traffic movements – an aircraft take-off or landing at an airport. For airport traffic purposes one arrival and one departure is counted as two movements. |
| Carbon dioxide equivalent ($CO_2e$) | The carbon dioxide equivalent ($CO_2e$) allows the different greenhouse gases to be compared on a like-for-like basis relative to one unit of $CO_2$. $CO_2e$ is calculated by multiplying the emissions of each of the six greenhouse gases by its 100 year global warming potential (GWP). |
| Carbon footprint | A carbon footprint measures the total greenhouse gas emissions caused directly and indirectly by a person, organisation, event or product. A carbon footprint is measured in tonnes of carbon dioxide equivalent ($tCO_2e$). |
| Degree days | A unit used to determine the heating requirements of buildings, representing a fall of one degree below a specified average outdoor temperature (usually 18°C) for one day. |
| Emission factor | An emissions factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. |
| GHG | Greenhouse gas – a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases in Earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide, and ozone. |
| Outside of Scopes | All fuels with biogenic content (e.g. 'Diesel and petrol (average biofuel blend)') should have the 'Outside of Scope' emissions reported to ensure a complete picture of an organisations' emissions is created.<br><br>The emissions are labelled 'Outside of Scopes' because the Scope 1 impact of these fuels has been determined to be a net '0' (since the fuel source itself absorbs an equivalent amount of $CO_2$ during the growth phase as the that $CO_2$ is released through combustion). |
| PAX | Number of passengers. |

# Table of contents

# 1 Introduction

## 1.1 Background

AGS Airports Limited, a partnership between Ferrovial and Macquarie Infrastructure and Real Assets (MIRA), owns Glasgow Airport Limited (GLA). The airport operates 365 days a year serving nearly 8.7 million passengers a year and handling around 98,000 aircraft movements per year. AGS Airports employ 824 full time employees (FTE), of which 397 are based in Glasgow Airport, many of whom commute to the airport by car or public transport. To continue operating in an environmentally responsible manner, it is important for the airport to monitor and manage all its emissions from all operations.

The calculation of the annual carbon footprint will help AGS Airports Limited and Glasgow Airport understand their carbon emissions associated with its activities, which can be assessed against its baseline footprint to measure changes in emissions. This will help the AGS Airports to identify opportunities for improvements, which will help reduce Glasgow Airport's, and hence AGS Airports' carbon footprint and costs linked to this, and to identify the success of any management strategies it has already implemented.

## 1.2 Legislation and drivers

The legislative landscape around the mandatory reporting of consumption and emissions data, as well as best practice/standards around the voluntary reporting of such data is ever changing. It is important to consider what AGS Airports may need to, or may wish to, report going forward.

The following recent or upcoming changes to legislation or best practice / standards are likely to impact on what AGS Airports needs to disclose publically.

### 1.2.1 Non-financial reporting

The EU Non-Financial Reporting Directive (2014/95/EU) came into force on 6th December 2014 to improve the quality and consistency of companies' non-financial reporting (NFR) across the EU. Intended to provide investors and other stakeholders with a comprehensive picture of their performance, companies will require accurate NFR reporting to safeguard reputations and business continuity. This is therefore likely to require AGS Airports to report on a wide variety of subjects including the environment, such as the Modern Slavery Act, employee and community activity and other aspects of the overall business model.

The 2017/18 financial year is the first year of reporting under the EU Non-Financial Reporting (NFR) Directive, which was implemented into UK law as the 'The Companies, Partnerships and Groups (Accounts and Non-Financial Reporting) Regulations 2016', effective January 1st 2017. This brings the NFR Directive into national law and require companies falling into scope to comply or risk penalties.

### 1.2.2 Scope 2 changes

The Greenhouse Gas (GHG) Protocol, produced by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), is the most widely used accounting tool for GHG emissions. Its 'A Corporate Accounting and Reporting Standard' is used by businesses and governments around the world. There have been recent changes to the standard regarding the accounting of GHG emissions from Scope 2 electricity.

Companies should now report two Scope 2 electricity emission figures, one on a **location-based method** and another on a **market-based method**.

The location-based method reflects the average emissions intensity of macro-scale (regional/national) electricity grids where energy consumption occurs. Companies should use the regional/national grid-average emission factor. In the UK, this would be sourced from the Defra/DECC UK Government conversion factors for Company Reporting.

The market-based method reflects the emissions from the electricity that a company is purchasing. Energy suppliers in the EU are already required, by law, to disclose to consumers the fuel mix and GHG emissions associated with their portfolio or tariffs. As such, companies intending to report a market-based Scope 2 electricity emissions figure should:

- Request the emission factor for their tariff(s) from their energy supplier(s).
- Request the source of this data (e.g. generator declarations in the UK).
- Request the energy generation technologies and mix specific to the supplier / tariff(s).

A comparison between the location-based and market-based reporting method is carried out for Glasgow Airport below and summarised in the table below. In this instance it is possible to see that applying the location based factor reduces the emissions proportion of scope 2 to 1.8% instead of the 5.8% attributed to it under the location based method. Scope 3 still remains by far and away the largest emissions source. (noting that scope 3 WTT or T&D loses haven't been amended to take into account scope 2 market based emissions factors.)

Though the market-based reporting method can give a lower carbon emission factor than that of the location-based, location based must be used as it is the actual energy mix that has been used by the site. Apart from within this section where scope 2 is referred to it should be assumed that the location based method has been used.

**Table 4: UK Mandatory Reporting requirements**

| Emissions by scope ($tCO_2e$) | Glasgow | % total split |
|---|---|---|
| Scope 1 | 3,202 | 1.5% |
| Scope 2 (Location based) | 12,301 | 5.8% |
| Scope 2 (Market based) | 3,612 | 1.8% |
| Scope 3 | 196,954 | 92.7% |
| Outside of Scopes | 5 | 0.0% |
| **Total (Location based)** | **212,461** | **100%** |
| **Total (Market based)** | **203,772** | **100%** |

#### 1.2.2.1 Glasgow Airport market-based method comparison

Glasgow Airport's electricity consumption during 2016 was 29,851,963 kWh.

Location-based method: As all of the 29,851,963 kWh of electricity consumption by Glasgow Airport occurred in the UK, it is multiplied by the UK Government conversion factors for Company Reporting UK electricity emission factor of 0.41205kgCO2e/kWh to calculate the emissions as 12,301tCO2e.

Market-based method: On April 1st 2016 Glasgow Airport switched supplier to Axpo UK for all of their 29,851,963kWh of electricity consumption. Glasgow Airport contacted the supplier and asked for the details of the fuel mix. The following breakdown was provided for the period April 2016 – December 2016 (Source of Electricity, Percentage):

- Coal, 6.9%
- Natural Gas, 12.0%
- Nuclear, 4.7%
- Renewable, 73.8%
- Other fuels, 2.6%

The weighted emission factor was provided as 121.1gCO2/kWh (or 0.121kgCO2/kWh).

Multiplying the electricity consumption of 29,851,963kWh by the emission factor of 0.121kgCO2/kWh calculates the emissions as 3,612tCO2e.

Comparing the two factors

Location-based method: 12,301 tCO2e

Market-based method: 3,612 tCO2e

The fact that the emissions calculated through the market-based method are lower than those calculated through the location-based method means that Glasgow Airport's choice of supplier and the fuel mix it uses to generate the power that Glasgow Airport receives is less carbon-intensive than the UK-average.

### 1.2.3 Upcoming consultation on a 'single reporting framework'

In the 2016 budget the Chancellor announced a number of business energy efficiency tax changes, including the eventual abolishment of the CRC Energy Efficiency Scheme (CRC) at the end of its second phase in 2019 and changes to the Climate Change Levy (CCL), including an increase to the CCL to maintain the revenue generated by the CRC as well as a rebalancing of the CCL rates on electricity and gas.

Utilising Glasgow Airports energy and regulatory costs, the impact of the changes in regulation outlined above was assessed. This analysis determined that by 2022 regulatory costs will decrease by 33%, energy costs will increase by 34% leading to a total increase in cost of 24%.

These changes were first considered in HM Treasury's consultation on *Reforming the business energy efficiency tax landscape*. One of the other proposals put forward by the government in that consultation, which is still pending, was a proposal to move away from the current system of overlapping policies towards a system where a business faces just one tax and one reporting scheme.

The taxation element of the proposal was concluded as part of the 2016 budget. In the budget, the government outlined that it will consult on the simplified energy and carbon reporting framework later in 2016, for introduction by April 2019.

The government's proposal(s) around a simplified reporting framework will not be known until this new consultation is released. However, it is likely that the Energy Saving Opportunity Scheme (ESOS) and Climate Change Agreements (CCAs) will be in the scope of the consultation. The indicated timing of the introduction of the simplified reporting framework, in April 2019, will follow the abolishment of the CRC and so is not expected to be in scope. AGS Airports will need to be prepared to report data in line with the new requirements, which may be different in scope/granularity compared to existing reporting.

## 1.3 Carbon footprinting

Carbon footprinting is a tool that has been widely adopted to measure the quantity of carbon dioxide ($CO_2$) and other greenhouse gas emissions (GHGs) that are produced both directly and indirectly, from organisations activities.

The operations and activities at the AGS Airports cover a wide range of emission sources. These include emissions from; travel and transport fuel, aircraft related emissions, emissions from disposal and treatment of waste, emissions from using and disposing of water, and emissions from the use of refrigerant gases.

The range of emission sources have a number of greenhouse gas emissions associated with them, and each have different levels of impact on global warming (referred to as Global Warming Potential, GWP). As such, to get a meaningful comparison between the GHG emissions, conversion factors are used to convert the quantities consumed into tonnes of carbon dioxide equivalent ($CO_2e$). $CO_2e$ is a measure for describing the impact of each different GHG in terms of the amount of carbon dioxide that would create the same amount of global warming.

In line with the methodology used to calculate the previous carbon footprints, Ricardo Energy & Environment has calculated the 2016 carbon footprint using a tool based on the Greenhouse Gas Protocol[2] and UK Government conversion factors for company reporting[3]. The Greenhouse Gas Protocol is the most widely used international accounting tool for government and business leaders to understand, quantify, and manage greenhouse gas emissions.

[2] Greenhouse Gas (GHG) Protocol Corporate Accounting and Reporting Standard methodology developed by World Business Council for Sustainable Development (WBCSD) and World Resources Institute (WRI)
[3] DCFCarbonFactors_9_3_2016 accessed www.ukconversionfactorscarbonsmart.co.uk/

### 1.3.1 Emissions scopes

The GHG protocol[4] divides emissions sources into three different emission scopes. These relate to how much control and influence a company has over them. A further description of the emission scopes, including details of the emissions included, are shown in Figure 1. In addition to these three scopes, organisations should report both the direct emissions from combustion of the fuel and the biogenic portion of this fuel. These emissions are reported as outside of scopes emissions but are still included as part of the airport's overall carbon footprint.

**Figure 1: Emission scope boundaries of AGS Airports' 2016 carbon footprint**


### 1.3.2 Specific exclusions from the carbon footprint

The carbon footprint for the AGS Airports has consciously sought not to calculate emissions from aircraft in the cruise phase of flight for arriving aircraft, and beyond the cruise phase of flight for departing aircraft. This is because the ability of the AGS Airports to influence changes to the emissions here is minimal. That responsibility is with airline operators and air-traffic control service providers (e.g. NATS and Eurocontrol).

However, emissions within the aircraft landing and take-off (LTO) cycle (from ground to 1,000 metres above aerodrome level) have been calculated. This is because the AGS Airports do have **some** influence over these emissions. This approach is consistent with the industry benchmark scheme for

[4] http://www.ghgprotocol.org/

carbon footprint calculation, the Airports Council International Airport Carbon Accreditation Scheme (ACI ACA)[5].

Other emissions excluded from the scope of this assessment are those from surface access cargo movements (e.g. freight and delivery trucks accessing the airport) and emissions arising through AGS Airports' procurement and supply chain activities.

## 1.4 Reporting format

### Reporting of electricity consumption

A change to the UK Government guidance in 2013 meant that the 5-year grid rolling average conversion factor applied to electricity before this date were replaced with a single average factor for a particular year. This change was to allow organisations to report using a factor representing the most current emissions estimation from the grid. This has a number of benefits, including an immediate ability for organisations to report efficiencies achieved in national infrastructure, rather than this being dampened within a five-year average. The one-year average factor is however more sensitive to energy mix changes on a year-on-year basis.

In addition, to account for electricity emissions fully, Government guidance suggests that organisations should report the transmission and distribution (T&D) loss associated with purchased electricity. If an organisation generated their own renewable electricity on site, they would not need to account for this loss. Therefore, reporting T&D helps demonstrate the full impact of an organisation's activities and operations. This procedure should have no impact on the total reported electricity emissions. However, it will split these emissions across Scopes 2 and 3.

### Calculation of Electricity Emissions

Due to the previously discussed changes to the way in which electricity consumption is reported, introduced in 2013, a re-baselining of 2011 and 2012 emissions has been carried out in 2013 and 2014 reports for Glasgow Airport.

[5] http://www.airportcarbonaccreditation.org/

# 2 Key performance indicators (KPI)

This sections provides a breakdown on a series of KPIs. These KPIs have been monitored for a number of years and allow us to see how the group and each airport is performing. There are two types of KPIs that have been monitored.

- Intensity metrics; and,
- Absolute emissions

## 2.1 Intensity metrics for Glasgow Airport

Intensity metrics allow comparison over time against other factors that fluctuate and have an impact on the environmental performance of the airports. The two chosen key performance indicators are aircraft movements and passenger numbers.

Another reason that intensity metrics are included is that Under the Companies Act 2006 (Strategic and Directors' Reports) Regulations 2013, all companies listed on the main market of the London Stock Exchange have to report their annual greenhouse gas (GHG) emissions in their directors' report.

Whilst AGS Airports is a limited company and isn't required to comply, it is helpful to have these metrics in place should the requirements for reporting publically ever change. Under company reporting at the moment there are a number of sources which need to be included in the metrics. These are shown in Table 5.

**Table 5: UK Mandatory Reporting requirements**

| Emissions source requirement | Corresponding AGS Airports emissions sources |
|---|---|
| The combustion of fuel | Diesel use |
| | Petrol use |
| | Fuel oil use |
| | Kerosene use |
| | LPG use |
| | Natural gas use |
| Fugitive emissions | Emissions from air conditioning and refrigeration systems |
| Purchase of electricity, heat, steam or cooling | Electricity use |

The metrics shown in Table 6 are based on Scope 1 and Scope 2 emissions only to allow the Glasgow Airport to track progress against emissions over which it has direct control. The results show that there has been an improvement in both the carbon footprint per passenger (PAX) metric and the carbon footprint per air traffic movement (ATM) metric.

An air traffic movement represents an aircraft that takes off, or lands at the airport.

**Table 6: Intensity metric for Scope 1 and Scope 2 emissions for Glasgow Airport**

| Intensity Metric | | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|
| Glasgow | Scope 1 and Scope 2 carbon footprint / air traffic movement ($kgCO_2e$/ATM) | 207 | 210 | 206 | 200 | 183 | **158** |
| | Scope 1 and Scope 2 carbon footprint / passenger ($kgCO_2e$/PAX) | 2.4 | 2.4 | 2.2 | 2.2 | 1.9 | **1.7** |

Table 6 provides a comparison of emissions since 2011. It is interesting to note that Glasgow Airport has seen a steady downward trend in these metrics which implies that environmental performance has improved over time; noting that during this time the PAX and ATM numbers for Glasgow Airport have continued to increase substantial.

These KPIs show if an airport is 'growing', the same service can be delivered in a more carbon efficient manner as more passengers share the baseload carbon emissions. If it is 'contracting', then comparing year on year KPIs show how well the airport is reacting to the contraction in managing emissions and the baseload – the function/activities that have to be undertaken despite PAX numbers. Or, the airport may have exhausted all applicable baseload reduction options.

It should be noted that in 2008 and 2009 the carbon footprint was expressed as carbon dioxide ($CO_2$). For subsequent years carbon dioxide equivalent ($CO_2e$) has been used. Using $CO_2e$ will cause a slight uplift in overall emissions as it takes into account the relative contribution of other greenhouse gases in addition to those from carbon dioxide.

## 2.2 Glasgow Airport

Table 7 provides a breakdown of the emissions by scope for Glasgow Airport since 2010.

**Table 7: Glasgow Airport's total emissions ($tCO_2e$) by scope**

| Scope | 2010 emissions ($tCO_2$) | 2011 emissions ($tCO_2e$) | 2012 emissions ($tCO_2e$) | 2013 emissions ($tCO_2e$) | 2014 emissions ($tCO_2e$) | 2015 emissions ($tCO_2e$) | 2016 emissions ($tCO_2e$) |
|---|---|---|---|---|---|---|---|
| Scope 1 | 2,699 | 2,622 | 2,973 | 3,029 | 2,650 | 2,990 | **3,202** |
| Scope 2 | 17,013 | 13,579 | 13,958 | 13,364 | 14,159 | 13,584 | **12,301** |
| **Scope 1 and Scope 2 total** | 19,712 | 16,201 | 16,931 | 16,394 | 16,809 | 16,574 | **15,502** |
| Scope 3 | 106,818 | 120,317 | 113,651 | 102,182 | 167,456 | 174,048 | **196,954** |
| Outside of Scopes | N/A | N/A | N/A | 3 | 4 | 6 | **5** |
| **Total across all scopes** | 126,530 | 136,518 | 130,582 | 118,579 | 184,269 | 190,627 | **212,461** |

In general, since 2010, Scope 1 and Scope 2 emissions have decreased, however an increase in these emissions was seen in 2012 and in 2013 (Scope 1 only). However, as discussed earlier, the reduction is both a consequence of UK Government guidance splitting electricity emission over Scope 2 and Scope 3 and changing best practice recommendations to use an annual conversion factor, and reduction in consumption.

- In general, Scope 1 and Scope 2 have plateaued since 2011 and then reduced by 6% from 2015 to 2016, due to a decrease in the conversion factor by 10%.
- In 2016, Scope 1 emissions increased by 7% whilst Scope 2 electricity emissions reduced by 9% compared to 2015 emissions.
- Scope 3 emissions are the largest emissions scope and are dominated by aircraft movement emissions (46.5% of total footprint) and passenger surface access (46.5% of total footprint). Changes here are due to an increase in passenger numbers and aircraft movements. This has resulted in an increase of 13% in the Scope 3 emissions since 2015. PAX/ATM is still on an upward trend which aids both KPIs (carbon emissions per ATM and carbon emissions per PAX) which have both reduced since 2015.

# 3 2016 carbon footprint by scope

This section provides a breakdown of the carbon footprint by the emission scope for Glasgow Airport.

## 3.1 Scope 1 emissions

Scope 1 emissions account for **3,202tCO$_2$e**, which is 1.5% of Glasgow Airport's total carbon footprint.

Figure 2 shows the composition of Glasgow Airport's Scope 1 emissions by activity and Table 8 shows the contribution of the emissions activity and source to the scope.

Scope 1 emissions include:

- Fuel used in company owned operational vehicles
- Natural gas usage for heating and hot water
- Fuel oil for back-up generators
- Release of refrigerant gases used for cooling systems through maintenance and/or leakages (R410A)
- Burning of fuels for airport fire training (Propane and kerosene)

A significant increase in R410A was seen compared to 2015 (8.35 tCO$_2$e compared to 160.15tCO$_2$e) with the phase-out of R22 being the most likely contributing factor. Propane and Fuel Oil use also increase, due to the total elimination of Kerosene being used in Fire Training.

**Figure 2: Glasgow Airport's Scope 1 emissions (tCO$_2$e) by activity**

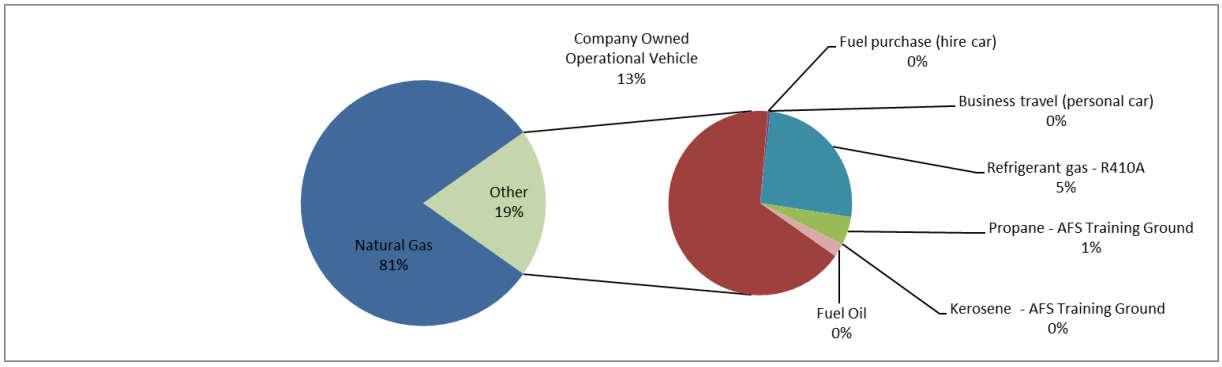



**Table 8: Glasgow Airport's Scope 1 emissions (tCO$_2$e) by emission source**

| Emission activity | Emissions source | 2016 Emissions (tCO$_2$e) |
|---|---|---|
| Utilities | Natural Gas | 2,576.75 |
| Utilities | Refrigerant gas - R410A | 160.15 |
| Operational vehicles | Company Owned Operational Vehicle | 415.95 |
| Business Travel | Fuel purchase (hire car) | 0.31 |
| Business Travel | Business travel (personal car) | 2.79 |
| Fire Training | Propane | 31.11 |
| Fire Training | Kerosene | 0 |
| Fire Training | Fuel Oil | 14.82 |
| **Total** | | **3,201.87** |

## 3.2 Scope 2 emissions

Scope 2 emissions consist of electricity bought from the grid and consumed at Glasgow Airport. Scope 2 emissions total **12,301tCO$_2$e**, which is 5.8% of Glasgow Airport's total carbon footprint across all scopes.

In order to remain consistent with the other AGS Airports' footprints, it has been assumed that all electricity consumed on site is owned by Glasgow Airport. Tenant electricity use at Glasgow Airport is available and can be disaggregated in future.

In 2016, the conversion factor for electricity reduced by 11% compared to the 2015 conversion factor due to the composition change. As such, this means that although energy consumption has increased by 2%, the $CO_2$e emissions have reduced by 9% between 2015 and 2016. Table 9 illustrates the changes to electricity conversion factors since 2012.

**Table 9: Glasgow Airport's comparison of electricity consumption and conversion factors since 2012**

| | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| Annual Scope 2 conversion factor (kg$CO_2$e/kWh) | 0.46 | 0.45 | 0.49 | 0.46 | **0.41** |
| Annual Scope 3 conversion factor (kg$CO_2$e/kWh) | 0.04 | 0.04 | 0.04 | 0.04 | **0.04** |
| Electricity usage (kWh) | 30,342,135 | 29,999,565 | 28,646,547 | 29,390,537 | **29,851,963** |
| **Scope 2 emissions from electricity production (t$CO_2$e) - using actual year conversion factor** | **13,958** | **13,364** | **14,159** | **13,584** | **12,301** |
| Scope 3 emissions for electricity transmission and distribution loss (t$CO_2$e) - using actual year conversion factor | 1,103 | 1,143 | 1,238 | 1,122 | **1,113** |
| **Total electricity emissions (t$CO_2$e) – using actual year conversion factors** | **15,061** | **14,507** | **15,397** | **14,706** | **13,413** |
| Originally reported emissions as Scope 2 (t$CO_2$e) – using 5-year grid rolling average conversion factor | 15,789 | N/A | N/A | N/A | **N/A** |

## 3.3 Scope 3 emissions

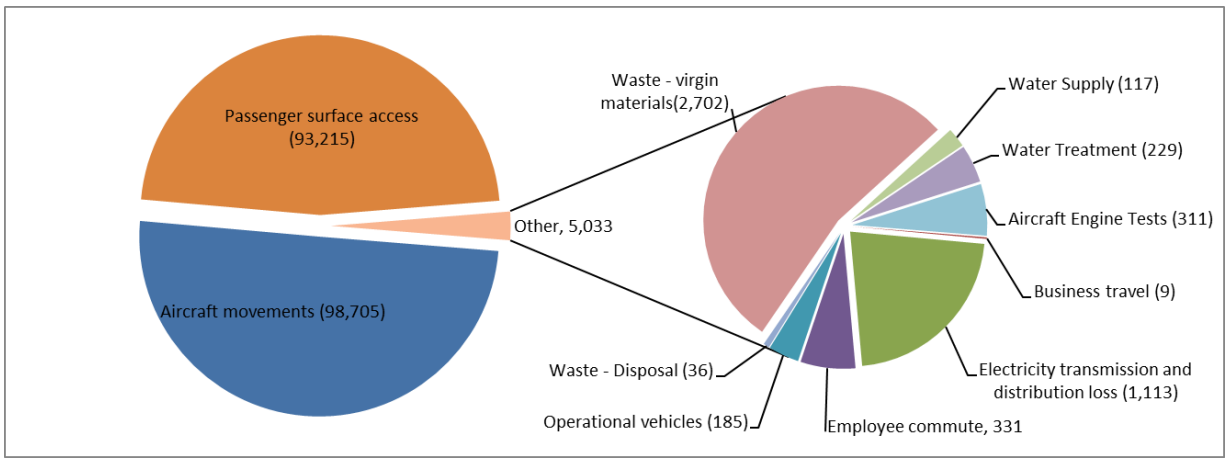
Unlike Scope 1 and Scope 2 emissions, emissions categorised as Scope 3 are not under the direct control of the airport. All of the Scope 3 activities that have been reported were agreed between Ricardo Energy & Environment and Glasgow Airport and are consistent with best practice guidelines. Scope 3 emissions are shown in Figure 3 and Table 10.
In summary:

- Scope 3 emissions total **196,954tCO$_2$e**, which is 92.7% of Glasgow Airport's total emissions
- Aircraft movements and passenger surface access continue to be the dominant Scope 3 activities.

**Table 10: Glasgow Airport's Scope 3 emissions (tCO$_2$e) by emission activity**

| By source and scope | Emissions (tCO$_2$e) | Percentage of scope | Percentage of total emissions |
|---|---|---|---|
| Aircraft movements | 98,705 | 50.1% | 46.5% |
| Business travel | 9 | 0.0% | 0.0% |
| Electricity transmission and distribution loss | 1,113 | 0.6% | 0.5% |
| Employee commute | 331 | 0.2% | 0.2% |
| Operational vehicles | 185 | 0.1% | 0.1% |
| Passenger surface access | 93,215 | 47.3% | 43.9% |
| Waste - Disposal | 36 | 0.0% | 0.0% |
| Waste - virgin materials | 2,702 | 1.4% | 1.3% |
| Water Supply | 117 | 0.1% | 0.1% |
| Water Treatment | 229 | 0.1% | 0.1% |
| Aircraft Engine Testing | 311 | 0.2% | 0.1% |
| **Total** | **196,954** | **100.0%** | **92.7%** |

**Figure 3: Glasgow Airport's Scope 3 emissions (tCO$_2$e) by emission activity**




## 3.4 Outside of Scopes emissions

For biofuels, UK government conversion factors assume that the Scope 1 emissions are 'net 0'. This is because the fuel source (e.g. plants. trees) has absorbed an equivalent amount of carbon dioxide during its growth as has been released through its combustion. This means that the conversion factors for biofuels calculate '0' carbon dioxide ($CO_2$).

Due to this the UK Government guidance now recommends that although the Scope 1 conversion factors for biofuels contain a '0' value for $CO_2$ emissions organisations should still account for the impact

of the $CO_2$ released through combustion of the biofuel. Therefore, the biofuel emissions are captured and reported as 'Outside of Scopes' emissions but still count towards the overall organisational carbon footprint.

Outside of Scopes emissions should therefore be reported for any fuel with a biogenic content. For Glasgow Airport, Outside of Scopes emissions are reported for the biofuel content of fuel (petrol and diesel) used in vehicles. This is because it is assumed that this fuel is obtained from forecourt fuel sources (i.e. fuel service stations) and because this fuel typically contains a small blend of biofuel. UK Government guidance recommends that the 'average biofuel blend' conversion factors be used.

For Glasgow Airport, Outside of Scopes emissions include:

- Diesel purchased for use in company owned operation vehicles – **5t$CO_2$e**

## 3.5 All scopes summary

The total carbon footprint for Glasgow Airport including all scopes and Outside of Scopes is **212,461t$CO_2$e** and is shown in Table 11.

**Table 11: Glasgow Airport's summary of all scope emissions for 2016**

| Emissions by scope | Total 2016 emissions ($tCO_2e$) | Percentage of total emissions |
|---|---|---|
| Scope 1 | 3,202 | 1.5% |
| Scope 2 | 12,301 | 5.8% |
| Scope 3 | 196,954 | 92.7% |
| Outside of Scopes | 5 | 0.0% |
| **Total** | **212,461** | **100%** |

Figure 4 and Table 12 **Error! Reference source not found.**show emissions since 2009. It can be seen that:

- Across all scopes, there has been an increase (11%) in $CO_2e$ emissions between 2015 and 2016.
- The continuing rise in passenger numbers in 2016 has maintained the overall upward trend in Scope 3 emissions since 2013.
- Scope 1 and Scope 2 have plateaued since 2011, this is because electricity emissions (Scope 2) have remained relatively consistent, and these are the dominant emission source within Scope 1 and Scope 2.
- Scope 3 emissions have increased by 62,002t$CO_2$e since 2009. A contributing factor to this is the increase of emissions from passenger surface access and the introduction of aircraft engine testing under Scope 3 reporting.

**Figure 4: Glasgow Airport's annual carbon footprints by emissions scope ($tCO_2e$)**

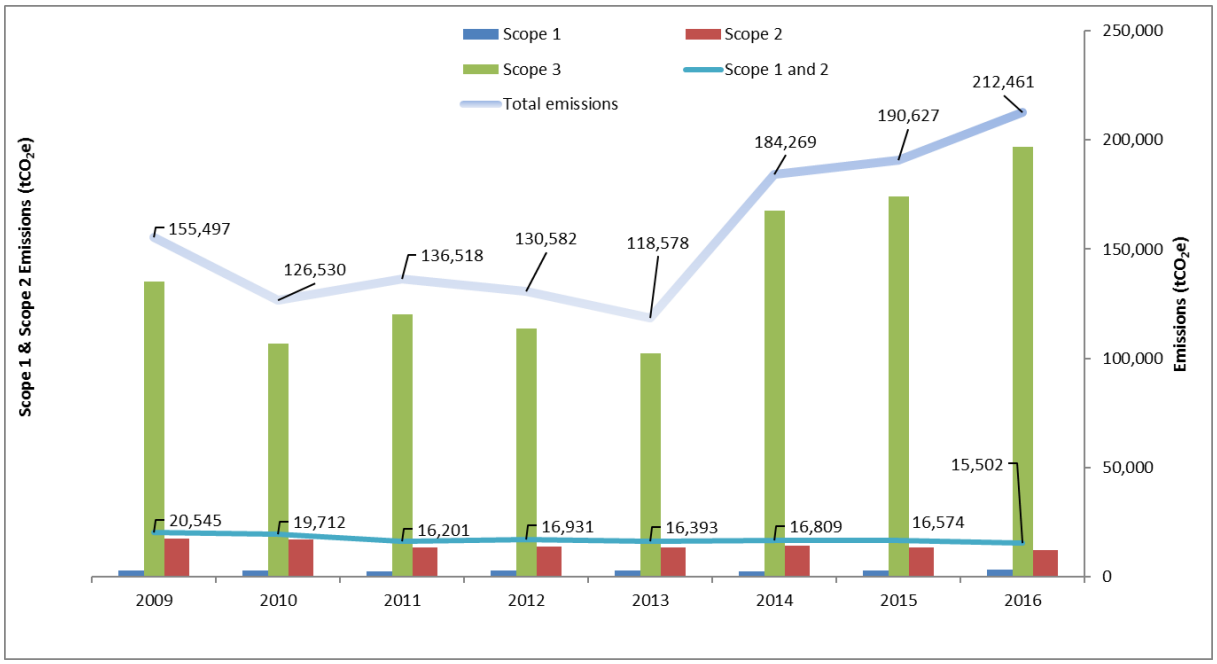



**Table 12: Glasgow Airport's annual emissions comparison by scope**

| Emissions by Scope | 2011 emissions ($tCO_2e$) | 2012 emissions ($tCO_2e$) | 2013 emissions ($tCO_2e$) | 2014 emissions ($tCO_2e$) | 2015 emissions ($tCO_2e$) | 2016 emissions ($tCO_2e$) |
|---|---|---|---|---|---|---|
| Scope 1 | 2,622 | 2,973 | 3,029 | 2,650 | 2,990 | **3,202** |
| Scope 2 | 13,579 | 13,958 | 13,364 | 14,159 | 13,584 | **12,301** |
| **Total Scope 1 and Scope 2 emissions** | 16,201 | 16,931 | 16,394 | 16,809 | 16,574 | **15,502** |
| Scope 3 | 120,317 | 113,651 | 102,182 | 167,456 | 174,048 | **196,954** |
| Outside of Scopes | N/A | N/A | 3 | 4 | 6 | **5** |
| **Total emissions** | 136,518 | 130,582 | 118,579 | 184,269 | 190,627 | **212,461** |

| Emissions by Scope | Difference between 2016 and 2011 | Difference between 2016 and 2012 | Difference between 2016 and 2013 | Difference between 2016 and 2014 | Difference between 2016 and 2015 |
|---|---|---|---|---|---|
| Scope 1 | 22% | 8% | 6% | 21% | **7%** |
| Scope 2 | -9% | -12% | -8% | -13% | **-9%** |
| **Total Scope 1 and Scope 2** | **-4%** | **-8%** | **-5%** | **-8%** | **-6%** |
| Scope 3 | 64% | 73% | 93% | 18% | **13%** |
| Outside of Scopes | N/A | N/A | 64% | 23% | **-11%** |
| **All scopes** | **56%** | **63%** | **79%** | **15%** | **11%** |

# 4 2016 carbon footprint by activity

This section provides further breakdown of the carbon footprint by activity for Glasgow Airport.

The carbon footprint has been calculated using tools originally developed in 2009 by Glasgow Airport that separate emissions by activity. The composition of Glasgow Airport's 2016 emissions by activity is presented in Table 13, and will be discussed in more detail in the subsequent sections.

**Table 13: Glasgow Airport's 2016 emissions by source ($tCO_2e$)**

| By Activity | Emissions ($tCO_2e$) | Percentage of total emissions |
|---|---|---|
| Aircraft movements | 98,705 | 46.5% |
| Aircraft engine testing | 311 | 0.1% |
| Business travel | 12 | 0.01% |
| Fire Training | 31 | 0.01% |
| Staff commute | 331 | 0.2% |
| Operational vehicles | 606 | 0.3% |
| Passenger surface access | 93,215 | 43.9% |
| Utilities | 16,510 | 7.8% |
| Waste | 2,738 | 1.3% |
| **Total** | **212,461** | **100%** |

## 4.1 Utilities emissions

In total, Utilities emissions are **16,510$tCO_2e$**, which is 7.8% of Glasgow Airport's total footprint. The breakdown of the emission sources for the utilities footprint is presented in Table 14 and Figure 5. For detailed information on the methodology used for calculating the carbon footprint, please refer to Appendix 1.

Utilities emissions include:

- Electricity use (Scope 2 from consumption and Scope 3 from transmission and distribution loss)
- Natural gas (Scope 1)
- Refrigerant gases (Scope 1)
- Water supply and treatment to foul sewer (Scope 3)
- Fuel oil (Scope 1)

**Table 14: Glasgow Airport's utility emissions by source**

| Utility | Scope | Consumption | Unit | Gross CV Basis Conversion factor ($kgCO_2e$ per unit) | Emissions ($tCO_2e$) |
|---|---|---|---|---|---|
| Electricity – consumption | Scope 2 | 29,851,963.10 | kWh | 0.41 | 12,300.50 |
| Electricity – T&D loss | Scope 3 | 29,851,963.10 | kWh | 0.04 | 1,112.58 |
| Natural gas | Scope 1 | 14,004,296.80 | kWh | 0.18 | 2,576.75 |
| Water supply | Scope 3 | 339,761.36 | $m^3$ | 0.34 | 116.88 |
| Water treatment | Scope 3 | 322,773.29 | $m^3$ | 0.71 | 228.52 |
| Refrigerant gas - R410A | Scope 1 | 76.70 | kg | 2,088 | 160.15 |
| Fuel Oil | Scope 1 | 4.59 | tonnes | 3,225.11 | 14.82 |
| **Total** | | | | | **16,510.2** |

**Figure 5: Glasgow Airport's 2016 utility emissions ($tCO_2e$) by source**

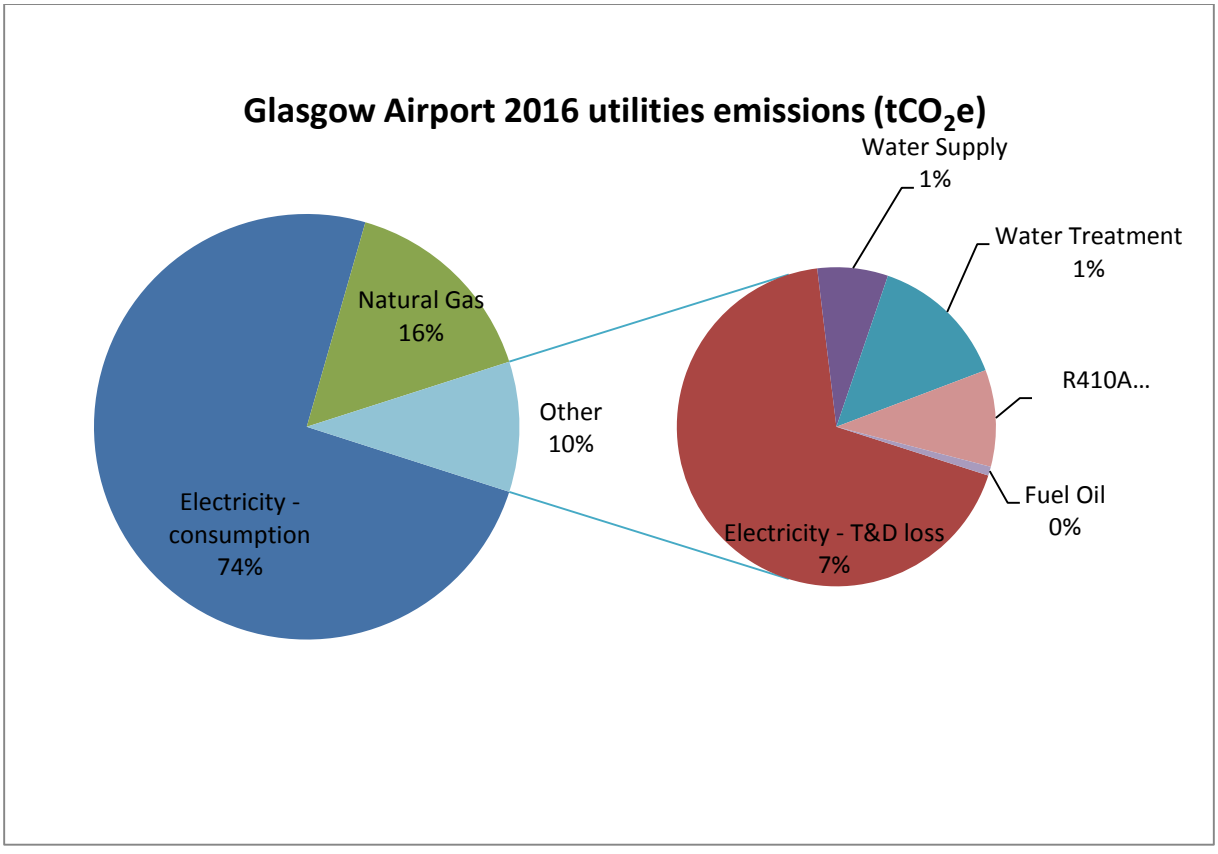



Table 15 provides a summary of the year-on-year utilities emissions and shows that the emissions from utilities on a downward trend since 2010. As with previous years, electricity consumption (Scope 2 and Scope 3 emissions) accounts for the largest component of the utilities footprint (13,413$tCO_2e$, 81%).

Although overall consumption of electricity at the airport has increased slightly when compared to 2015 levels, due to a decrease in the grid-average emission factor for electricity, brought about by a change in the generation mix in the market, associated emissions have decreased by 1,293$tCO_2e$ (8.8%).

**Table 15: Glasgow Airport's year on year utilities emissions comparison**

| Fuel | 2010 ($tCO_2$) | 2011 ($tCO_2e$) | 2012 ($tCO_2e$) | 2013 ($tCO_2e$) | 2014 ($tCO_2e$) | 2015 ($tCO_2e$) | 2016 ($tCO_2e$) |
|---|---|---|---|---|---|---|---|
| Natural gas | 2,241 | 2,237 | 2,439 | 2,454 | 2,208 | 2,617 | 2,577 |
| Refrigerant gas | 39 | 22 | 0 | 252 | 40 | 8 | 160 |
| Electricity | 17,013 | 14,740 | 15,061 | 14,507 | 15,397 | 14,706 | 13,413 |
| Water supply and treatment | 208 | 181 | 27 | 151 | 150 | 314 | 345 |
| Burning oil | N/A | 13 | 9 | N/A | 0 | 0 | 0 |
| LPG | N/A | N/A | 23 | N/A | 0 | 0 | 0 |
| Fuel oil | N/A | N/A | N/A | N/A | 27 | 5 | 15 |
| **Total** | 19,501 | 17,191 | 17,558 | 17,364 | 17,821 | 17,649 | **16,510** |

| Fuel | Change Since 2010 | Change Since 2011 | Change Since 2012 | Change Since 2013 | Change Since 2014 | Change Since 2015 |
|---|---|---|---|---|---|---|
| Natural gas | 15.0% | 15.2% | 5.7% | 5.0% | 16.7% | -1.5% |
| Refrigerant gas | 311.1% | 635.6% | #DIV/0! | -36.4% | 303.7% | 1818.0% |
| Electricity | -21.2% | -9.0% | -10.9% | -7.5% | -12.9% | -8.8% |
| Water supply and treatment | 66.1% | 91.3% | 1169.4% | 128.7% | 130.4% | 10.2% |
| Burning oil | N/A | -100.0% | -100.0% | N/A | N/A | 0% |
| LPG | N/A | N/A | -100.0% | N/A | N/A | 0% |
| Fuel Oil | N/A | N/A | N/A | N/A | N/A | 191.3% |
| **Total** | -15.3% | -4.0% | -6.0% | -4.9% | -7.4% | **-6.5%** |

## 4.2 Operational vehicles

Operational vehicles account for 0.3% of Glasgow Airport's total carbon emissions, at **606$tCO_2e$**, of which 416$tCO_2e$ (68.65%) is Scope 1 (from Glasgow Airport owned airside operational vehicles), 185$tCO_2e$ (30.53%) is Scope 3 (from non- Glasgow Airport owned airside operational vehicles) and 5.5$tCO_2e$ (0.83%) is Outside of Scopes emissions arising from biofuel used in airport owned vehicles.

For detailed information on the methodology used for calculating the carbon footprint, please refer to Appendix 1.

The emissions by fuel type and fuel owner are presented in Table 16.

**Table 16: Glasgow Airport's breakdown of 2016 operational vehicles fuel use and emissions by scope**

| Category | Scope | Fuel Type | Fuel Consumption | Unit | Conversion factor (kg/$CO_2$e per unit) | Emissions ($tCO_2e$) |
|---|---|---|---|---|---|---|
| Company Owned Operational Vehicle | Scope 1 | Diesel | 81,077.00 | litres | 2.61 | 212.74 |
| Company Owned Operational Vehicle | Scope 1 | Gas Oil | 68,854.62 | litres | 2.97 | 204.20 |
| Third Party Operational Vehicle | Scope 3 | Gas Oil | 62,508.22 | litres | 2.97 | 185.38 |
| Outside of Scopes | Outside of Scopes | Diesel | 81,077.00 | litres | 0.06 | 4.91 |
| **Total** | | | | | | **606** |

Table 17 provides a year on year comparison of vehicle emissions by operator and shows that there was an almost no change in emissions from Glasgow Airport's company owned operational vehicles, and a downward trend from third party operational vehicles since 2011. However, there has been an increase for 2016. The increases and decreases in company owned and third party operational vehicles since 2013 is most likely to have been brought about due to variations in the data available and how it is captured and reported.

**Table 17: Glasgow Airport's year on year comparison of operational vehicles emissions by user**

| Mode of travel | Scope | 2011 ($tCO_2e$) | 2012 ($tCO_2e$) | 2013 ($tCO_2e$) | 2014 ($tCO_2e$) | 2015 ($tCO_2e$) | 2016 ($tCO_2e$) |
|---|---|---|---|---|---|---|---|
| Company owned operational Vehicles | Scope 1 | 351 | 503 | 314 | 353 | 334 | **416** |
| Third Party operational vehicles | Scope 3 | 262 | 210 | 216 | 158 | 174 | **185** |
| Outside of Scopes | Outside of Scopes | N/A | N/A | 3 | 4 | 6 | **5** |
| **Total** | | 613 | 713 | 533 | 515 | 513 | **606** |

| Mode of travel | Scope | Change since 2011 | Change since 2012 | Change since 2013 | Change since 2014 | Change since 2015 |
|---|---|---|---|---|---|---|
| Company owned operational Vehicles | Scope 1 | 19% | -17% | 32% | 18% | 25% |
| Third Party operational vehicles | Scope 3 | -29% | -12% | -14% | 17% | 6% |
| Outside of Scopes | Outside of Scopes | N/A | N/A | N/A | 23% | -11% |
| **Total** | | **-1%** | **-15%** | **14%** | **18%** | **18%** |

## 4.3 Business travel

Business travel accounts for just 0.01% of Glasgow Airport's carbon footprint, at **12.3tCO$_2$e**; of this, 6.7tCO$_2$e is due to business travel by air. The composition of the business travel footprint is presented in Table 18. For detailed information on the methodology used for calculating the carbon footprint, please refer to Appendix 1.

**Table 18: Glasgow Airport's breakdown of business travel emissions by mode of transport**

| Category | Scope | Source | Distance | Unit | Conversion factor (kgCO$_2$e per unit) | Emissions (tCO$_2$e) |
|---|---|---|---|---|---|---|
| Flights | Scope 3 | Domestic flights | 151,083 | km | 0.15 | 5.1 |
| Flights | Scope 3 | European flights | 53,356 | km | 0.09 | 1.6 |
| Flights | Scope 3 | International flights | 65,413 | km | 0.09 | 0.0 |
| Petrol purchase | Scope 1 | Petrol purchase | 256 | km | 0.19 | 0.3 |
| Public transport | Scope 3 | Taxis | 1,312 | km | 0.22 | 0.3 |
| Public transport | Scope 3 | UK Bus and Coach | 972 | km | 0.10 | 0.1 |
| Public transport | Scope 3 | UK Rail | 60,425 | km | 0.05 | 2.1 |
| International transport | Scope 3 | Overseas Bus and Coach | 18 | km | 0.10 | 0.0 |
| International transport | Scope 3 | Overseas Rail | 1,144 | km | 0.01 | 0.0 |
| **Business travel sub-total** | | | | | | **9.5** |
| Fuel (Unknown) | Scope 1 | Business travel by private and/or leased vehicles | 14,943 | km | 0.19 | 2.79 |
| Fuel (Diesel) | Scope 1 | Business travel by private and/or leased vehicles | 0 | km | 0.18 | 0.00 |
| Fuel (Petrol) | Scope 1 | Business travel by private and/or leased vehicles | 0 | km | 0.19 | 0.00 |
| **Business travel by car subtotal** | | | | | | **2.79** |
| **Total business travel** | | | | | | **12.3** |

Table 19 provides a summary of the year on year comparison of emissions from business travel. Overall emissions associated with business travel have decreased since 2011, though there was a sharp increase in 2014 and a subsequent sharp decrease in 2015 and 2016. It should be noted that business travel emissions are very low at only 0.01% of the overall footprint, and therefore a small change in absolute emissions corresponds to a large percentage change, but does not affect significantly on total emissions for the airport.

**Table 19: Glasgow Airport's year on year comparison of business travel emissions**

| Mode of travel | 2011 ($tCO_2e$) | 2012 ($tCO_2e$) | 2013 ($tCO_2e$) | 2014 ($tCO_2e$) | 2015 ($tCO_2e$) | 2016 ($tCO_2e$) | Change since 2011 | Change since 2012 | Change since 2013 | Change since 2014 | Change since 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Company cars | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **0.0** | N/A | N/A | N/A | N/A | **N/A** |
| Domestic flights | 27.3 | 46.9 | 75.4 | 135.3 | 23.8 | **5.1** | -81% | -89% | -93% | -96% | **-79%** |
| European flights | 2.3 | 7.0 | 13.0 | 22.5 | 4.8 | **1.6** | -29% | -77% | -88% | -93% | **-67%** |
| International flights | 0.0 | 4.2 | 2.1 | 3.9 | 6.3 | **0.0** | 0% | -100% | -100% | -100% | **-100%** |
| Petrol purchase | 0.0 | 0.3 | 0.2 | 3.7 | 0.0 | **0.3** | 748% | 21% | 56% | -92% | **553%** |
| Taxis | 0.2 | 0.4 | 0.3 | 0.3 | 0.3 | **0.3** | 8% | -32% | -11% | -23% | **-7%** |
| UK Bus and Coach | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | **0.1** | 68% | -13% | -29% | 35% | **-27%** |
| UK Rail | 2.2 | 2.7 | 2.0 | 2.8 | 2.7 | **2.1** | -2% | -20% | 7% | -23% | **-22%** |
| Personal Car | 0.2 | 2.0 | 3.7 | 1.3 | 3.2 | **2.8** | 1597% | 40% | -24% | 112% | **-13%** |
| **Total** | 32.2 | 63.4 | 96.7 | 169.9 | 41.2 | **12.3** | -62% | -81% | -87% | -93% | **-70%** |

## 4.4 Aircraft movements and engine testing

Aircraft emissions are the second largest contributor to Glasgow Airport's carbon footprint, totalling **98,705t$CO_2$e** (46.5% of total footprint). These emissions are from aircraft main engines and auxiliary power units for all aircraft movements within the aircraft LTO cycle (operations on the ground up to a height of 1,000 metres) and engine testing. For detailed methodology of how these are calculated, please refer to Appendix 1. Table 20 shows the relative contribution of each part of the aircraft LTO cycle to the emissions associated with aircraft.

**Table 20: Glasgow Airport's emissions by aircraft LTO phase**

| Source | Emissions ($tCO_2e$) | % of aircraft footprint |
|---|---|---|
| Auxiliary power unit (APU) | 7,168.4 | 7.3% |
| Take-Off | 7,927.0 | 8.0% |
| Initial Climb (to 450m) | 11,271.9 | 11.4% |
| Climb Out (450-1,000m) | 16,149.0 | 16.4% |
| Approach | 23,122.4 | 23.4% |
| Taxi In | 7,509.7 | 7.6% |
| Taxi Out | 7,509.7 | 7.6% |
| Hold | 15,695.9 | 15.9% |
| Reverse Thrust | 767.1 | 0.8% |
| Landing Roll | 1,584.0 | 1.6% |
| Aircraft Testing | 311 | 0.3% |
| **Total** | **99,016** | |

Table 21 provides a comparison of the year on year emissions from aircraft and shows that there is a 18% increase in emissions since 2015 and 31% since 2011.

**Table 21: Glasgow Airport's year on year comparison of aircraft emissions**

| Aircraft mode of operation | 2011 ($tCO_2e$) | 2012 ($tCO_2e$) | 2013 ($tCO_2e$) | 2014 ($tCO_2e$) | 2015 ($tCO_2e$) | | Change since 2011 | Change since 2012 | Change since 2013 | Change since 2014 | Change since 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| APU (Auxiliary Power Unit) | 8,173 | 8,566 | 7,301 | 9,036 | 9,291 | **7,168** | -12% | -16% | -2% | -21% | -23% |
| Taxi Out | 5,935 | 6,089 | 3,895 | 6,499 | 6,478 | **7,510** | 27% | 23% | 93% | 16% | 16% |
| Hold | 13,403 | 13,374 | 10,761 | 13,714 | 14,206 | **15,696** | 17% | 17% | 46% | 14% | 10% |
| Take-Off | 6,002 | 6,284 | 6,239 | 7,282 | 6,931 | **7,927** | 32% | 26% | 27% | 9% | 14% |
| Initial Climb (to 450m) | 6,426 | 6,639 | 6,212 | 7,553 | 7,315 | **11,272** | 75% | 70% | 81% | 49% | 54% |
| Climb Out (450-1,000m) | 9,920 | 6,089 | 7,573 | 10,541 | 11,048 | **16,149** | 63% | 165% | 113% | 53% | 46% |
| Approach | 17,438 | 17,966 | 15,474 | 19,261 | 19,308 | **23,122** | 33% | 29% | 49% | 20% | 20% |
| Reverse Thrust | 895 | 912 | 949 | 1,016 | 1,030 | **767** | -14% | -16% | -19% | -25% | -26% |
| Landing Roll | 1,363 | 1,353 | 1,119 | 1,399 | 1,446 | **1,584** | 16% | 17% | 42% | 13% | 10% |
| Taxi In | 5,935 | 6,089 | 3,895 | 6,499 | 6,478 | **7,510** | 27% | 23% | 93% | 16% | 16% |
| Engine Testing* | - | - | - | - | 363 | **311** | - | - | - | - | -14% |
| **Total** | 75,491 | 73,362 | 63,419 | 82,801 | 83,895 | **99,016** | 31% | 35% | 56% | 20% | **18%** |

* Note that 2015 is the first year in which aircraft engine testing data was collected for Glasgow Airport

## 4.5 Employee commute

Employee commute represents just 0.2% (**331.5tCO$_2$e**) of Glasgow Airport's total carbon footprint. It is evident that the majority of employees commute by private car and emissions from this accounts for 93% of the employee commute footprint. The relative contribution of each part of the employee commute footprint is presented in Figure 6 and Table 22.

For detailed information on the methodology used for calculating the carbon footprint, please refer to Appendix 1.

**Figure 6: Glasgow Airport's 2016 employee commute emission (tCO$_2$e) by mode of transport**

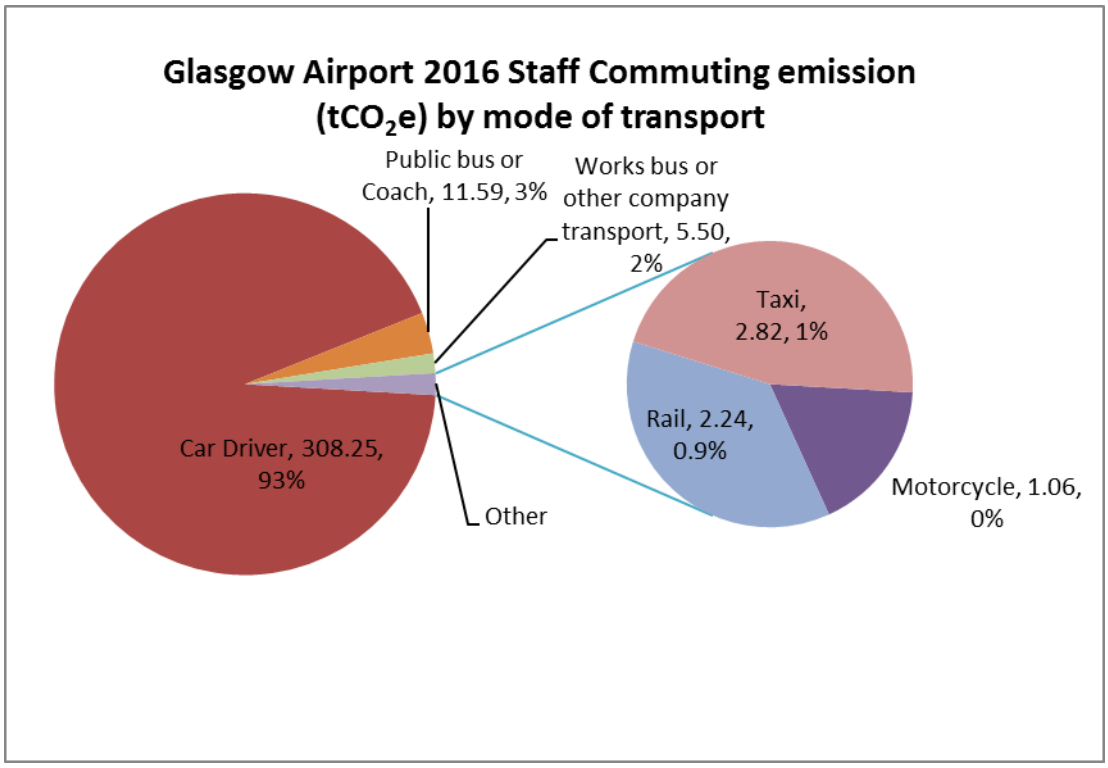



**Table 22: Glasgow Airport's 2016 employees commute emissions**

| Mode of transport | Scope | Emissions (tCO$_2$e ) |
|---|---|---|
| Car Driver | Scope 3 | 308.25 |
| Motorcycle | Scope 3 | 1.06 |
| Public bus or Coach | Scope 3 | 11.59 |
| Rail | Scope 3 | 2.24 |
| Taxi | Scope 3 | 2.82 |
| Works bus or other company transport | Scope 3 | 5.5 |
| **Total** | | **331.5** |

Table 23 provides a break-down of the 2016 emissions and comparison with the break-downs since 2011. It should be noted that the data used for this part of the footprint reflects an employee travel survey undertaken in 2009. The location of employees and mode of transport may have changed since this

survey was carried out. Due to this, any changes in emissions are only reflective of a shift in airport employee numbers and not a result of employee behavioural change, car sharing or other carbon saving measures.

**Table 23: Glasgow Airport's annual comparisons of employee commute emissions**

| Mode of transport | 2011 ($tCO_2e$) | 2012 ($tCO_2e$) | 2013 ($tCO_2e$) | 2014 ($tCO_2e$) | 2015 ($tCO_2e$) | 2016 ($tCO_2e$) |
|---|---|---|---|---|---|---|
| Car Driver | 5,891 | 4,628 | 4,309 | 5,377 | 324 | **308** |
| Motorcycle | 46 | 36 | 36 | 45 | 1 | **1** |
| Public bus or Coach | 457 | 274 | 184 | 198 | 11 | **12** |
| Rail | 22 | 18 | 15 | 21 | 2 | **2** |
| Taxi | 383 | 240 | 224 | 375 | 3 | **3** |
| Works bus other company transport | 57 | 34 | 23 | 25 | 5 | **5** |
| **Total** | 6,856 | 5,230 | 4,792 | 6,041 | 347 | **331.5** |

| Mode of transport | Change since 2011 | Change since 2012 | Change since 2013 | Change since 2014 | Change since 2015 |
|---|---|---|---|---|---|
| Car Driver | -95% | -93% | -93% | -94% | **-5%** |
| Motorcycle | -98% | -97% | -97% | -98% | **-5%** |
| Public bus or Coach | -97% | -96% | -94% | -94% | **4%** |
| Rail | -90% | -87% | -85% | -89% | **3%** |
| Taxi | -99% | -99% | -99% | -99% | **-5%** |
| Works bus other company transport | -90% | -84% | -76% | -78% | **4%** |
| **Total** | -95% | -94% | -93% | -95% | **-4%** |

As shown in Table 23, employee commute emissions have decreased by 95% since 2014. Emissions associated with employee commuting for 2015 and 2016 are significantly lower than previous years due to the identification of an error where full time employee numbers have been incorrectly reported and thus the large change in emissions for employee commute can be attributed to this correction. These emissions were calculated using survey data from 2009; and, change in emissions is an indication of changes in airport employee numbers and conversion factors rather than a change in mode of transport.

Table 24 shows the results of the travel survey and the assumed modal split of employees.

**Table 24: Glasgow Airport's mode of travel by employees commuting to the airport**

| Method of Transport | Total (%) of employees by mode | Total distance travelled per day (km) |
|---|---|---|
| Bicycle | 2.23% | 65 |
| Car Driver | 80.80% | 6,950 |
| Car Passenger | 4.69% | 413 |
| Motorcycle | 0.45% | 37 |
| public bus or Coach | 8.04% | 407 |
| Rail | 0.89% | 193 |
| Taxi | 1.12% | 54 |
| Walk | 0.89% | 10 |
| Works bus or other company transport | 0.89% | 193 |
| **Total** | | **8,323.48** |

## 4.6 Passenger surface access

Passenger surface access is the second largest component of Glasgow Airport's carbon footprint after aircraft movements, totalling 44% of all emissions, or **93,215t$CO_2$e**.

It should be noted that the data used in this report is based on an updated travel survey carried out in 2013. This survey was conducted in the departure lounge of the airport, and captured whether the passenger was outward or homeward bound, their mode of transport, and the postcode from which they set off. This allowed the distance from the passenger's street to the airport to be calculated, based on road distances. The previous survey, conducted in 2009, only collected data on the passenger's local authority area or city of origin, and used as the crow flies distances to calculate the distance travelled. As such, due to an improvement in the accuracy and granularity in the data, and an increase in passenger numbers at the airport, there is a 182% increase in emissions compared with 2013.

For detailed information on the methodology used for calculating the carbon footprint, please refer to Appendix 1.

A composition of the passenger surface access emissions by mode is presented in Figure 7. Table 25 shows the total emissions by mode of transport. As only the final mode of transport taken by the customer to the airport has been considered, there are no rail emissions (as there is no train station at the airport).

**Figure 7: Glasgow Airport 2016 passenger surface access emissions ($tCO_2e$) by mode of transport**

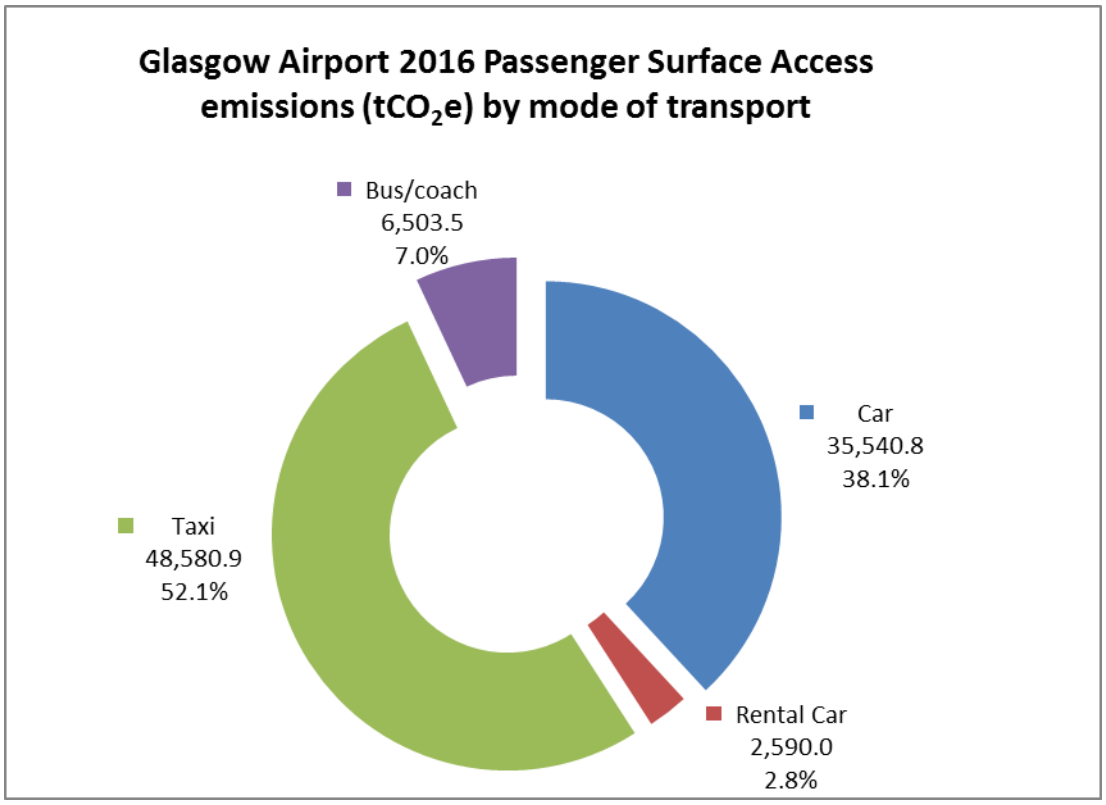



**Table 25: Glasgow Airport's 2016 passenger surface access emission by mode**

| Mode of transport | Scope | Passenger kilometres (km) | Assumed load factor for mode | Travel km per year | $CO_2e$ conversion ($kgCO_2e$ per km) | Emissions per year ($tCO_2e$) |
|---|---|---|---|---|---|---|
| Car | Scope 3 | 361,206,137 | 1.9 | 190,108,493 | 0.18695 | 35,541 |
| Rental Car | Scope 3 | 26,322,714 | 1.9 | 13,854,060 | 0.18695 | 2,590 |
| Taxi | Scope 3 | 221,992,568 | 2.13 | 104,221,863 | 0.21884 | 48,581 |
| Bus/coach | Scope 3 | 63,935,361 | 9 | 7,103,929 | 0.10172 | 6,504 |
| **Total** | | | | | | **93,215** |

## 4.7 Waste

Emissions associated with waste at Glasgow Airport represent 1.3% of the total carbon footprint, at **2,739t$CO_2$e**. For detailed information on the methodology used for calculating the carbon footprint, please refer to Appendix 1.

- 36.25t$CO_2$e is from waste disposal
- 2,702t$CO_2$e is from the production of virgin materials that have been disposed

In total, the airport produced 1,712 tonnes of waste in 2016, of which 820 tonnes was sent to an RDF plant for processing. Previously a portion of the airport's waste was sent to landfill and the change in disposal method has resulted in a significant drop in the carbon dioxide equivalent associated with waste disposal. Approximately 892 tonnes were recycled.

A summary of waste disposal emissions is presented in Table 26 and Table 27 shows the emissions associated with the production of the virgin materials.

Figure 8 shows the total emissions from waste for both disposal and production of virgin materials.

**Table 26: Glasgow Airport's 2016 waste disposal emissions (t$CO_2$e) by category**

| Waste fraction | Category | Total net $CO_2$e emissions (tonnes) |
|---|---|---|
| Paper | Waste - RDF/Combustion | 3.07 |
| Card | Waste - RDF/Combustion | 4.30 |
| Plastic | Waste - RDF/Combustion | 3.05 |
| Textiles | Waste - RDF/Combustion | 0.23 |
| Wood | Waste - RDF/Combustion | 0.93 |
| Glass | Waste - RDF/Combustion | 0.78 |
| Kitchen Waste | Waste - RDF/Combustion | 4.07 |
| Non-Aluminium Metal | Waste - RDF/Combustion | 1.04 |
| Aluminium | Waste - RDF/Combustion | 0.06 |
| Paper | Waste - recyclate | 4.70 |
| Card | Waste - recyclate | 6.59 |
| Plastic | Waste - recyclate | 4.67 |
| Textiles | Waste - recyclate | 0.35 |
| Glass | Waste - recyclate | 1.20 |
| Non-Aluminium Metal | Waste - recyclate | 1.14 |
| Aluminium | Waste - recyclate | 0.09 |
| **Total** | **Waste disposal** | **36.25** |

**Table 27: Glasgow Airport's 2016 emissions from production virgin materials for waste ($tCO_2e$) by category**

| Waste fraction | Category | Total net $CO_2e$ emissions (tonnes) |
|---|---|---|
| Paper | Waste - RDF/Combustion | 137.08 |
| Card | Waste - RDF/Combustion | 185.11 |
| Plastic | Waste - RDF/Combustion | 484.59 |
| Textiles | Waste - RDF/Combustion | 240.44 |
| Wood | Waste - RDF/Combustion | 19.18 |
| Glass | Waste - RDF/Combustion | 33.31 |
| Kitchen Waste | Waste - RDF/Combustion | 787.59 |
| Non-Aluminium Metal | Waste - RDF/Combustion | 133.01 |
| Aluminium | Waste - RDF/Combustion | 37.95 |
| Paper | Waste - recyclate | 152.81 |
| Card | Waste - recyclate | 214.34 |
| Plastic | Waste - recyclate | 150.89 |
| Textiles | Waste - recyclate | 2.16 |
| Glass | Waste - recyclate | 28.99 |
| Non-Aluminium Metal | Waste - recyclate | 80.71 |
| Aluminium | Waste - recyclate | 13.58 |
| **Total** | **Production of virgin material** | **2702** |

**Figure 8: Glasgow Airport's contribution of different material types to waste associated emissions for 2016 from both waste disposal and from the production of virgin materials**

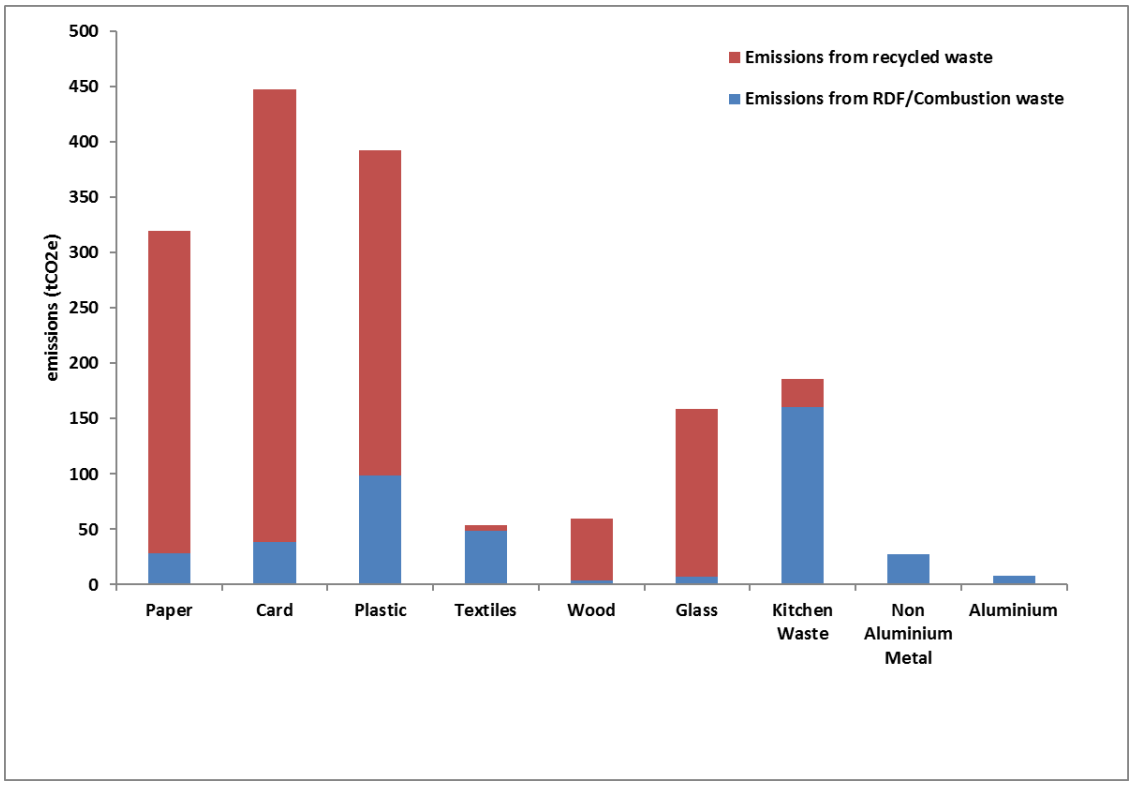


Table 28 shows the combined emissions of the disposal route and the production of the virgin materials. This shows that overall emissions have increased significantly by 66% compared with Glasgow Airport's 2015 carbon footprint and 10% since 2011. Since 2011 there has been a 123% increase in emissions as a result of diverting waste away from landfill and towards RDF. In addition, there has been a 57% decrease in the emissions associated with waste being recycled, also since 2011. Compared to 2015, overall emissions and landfill emissions have increased and by 66% and 334% respectively, whilst recycling emissions have decreased by 46%.

**Table 28: Glasgow Airport's year on year comparison of total waste emissions (including waste disposal and production of virgin materials) by landfilled and recycled waste**

| Material | Disposal Method | 2013 net emissions ($tCO_2e$) | 2014 net emissions ($tCO_2e$) | 2015 net emissions ($tCO_2e$) | 2016 net emissions ($tCO_2e$) | Change since 2013 | Change since 2014 | Change since 2015 |
|---|---|---|---|---|---|---|---|---|
| Paper | Waste – landfill / RDF | 51.9 | 29.9 | 28.4 | **140.1** | 170% | 369% | 394% |
| Card | Waste – landfill / RDF | 76.8 | 40.3 | 38.3 | **189.4** | 147% | 370% | 394% |
| Plastic | Waste – landfill / RDF | 109.9 | 97.3 | 99.0 | **487.6** | 344% | 401% | 393% |
| Textiles | Waste – landfill / RDF | 58.1 | 50.5 | 48.7 | **240.7** | 314% | 377% | 394% |
| Wood | Waste – landfill / RDF | 15.8 | 6.3 | 4.1 | **20.1** | 27% | 217% | 394% |
| Glass | Waste – landfill / RDF | 8.1 | 7.1 | 6.9 | **34.1** | 321% | 377% | 394% |
| Kitchen Waste | Waste – landfill / RDF | 190.3 | 146.9 | 160.2 | **791.7** | 316% | 439% | 394% |
| Non-Aluminium Metal | Waste – landfill / RDF | 26.2 | 23.3 | 27.1 | **134.0** | 412% | 474% | 394% |
| Aluminium | Waste – landfill / RDF | 7.3 | 8.0 | 7.7 | **38.0** | 421% | 377% | 394% |
| **Total** | **Landfill** | 544.4 | 409.7 | 420.4 | **2,075.8** | 281% | 407% | **394%** |
| Paper | Waste - recyclate | 298.3 | 273.6 | 291.6 | **157.5** | -47% | -42% | -46% |
| Card | Waste - recyclate | 418.4 | 383.8 | 409.0 | **220.9** | -47% | -42% | -46% |
| Plastic | Waste - recyclate | 844.4 | 276.8 | 293.8 | **155.6** | -82% | -44% | -47% |
| Textiles | Waste - recyclate | 4.8 | 4.4 | 4.6 | **2.5** | -48% | -43% | -46% |
| Glass | Waste - recyclate | 57.4 | 52.7 | 55.9 | **30.2** | -47% | -43% | -46% |
| Non-Aluminium Metal | Waste - recyclate | 101.2 | 92.8 | 151.5 | **81.8** | -19% | -12% | -46% |
| Aluminium | Waste - recyclate | 10.6 | 9.8 | 25.3 | **13.7** | 29% | 40% | -46% |
| Food Waste | Waste - recyclate | 0.0 | 0.0 | 0.0 | **0.0** | N/A | N/A | N/A |
| **Total** | **Recyclate** | 1,735.1 | 1,093.8 | 1,231.8 | **662.2** | -62% | -39% | **-46%** |
| **Total** | | **2,279** | **1,503** | 1,652 | **2,738** | 20% | 82% | **66%** |

## 4.8 Fire training

Fire training emissions were introduced into Glasgow Airport's carbon footprint in 2013. Previously airport fire training emissions have been combined with emissions from utilities. Fire training emissions come from the combustion of propane (LPG).

For detailed information on the methodology used for calculating the carbon footprint, please refer to Appendix 1.

- Fire training accounts for 0.01% of the airports emissions, or **31t$CO_2$e**
- All emissions are listed as Scope 1.

Emissions from fire training are:

- LPG/Propane (31t$CO_2$e).

## 4.9 Total emissions by activity and source

Table 29 shows the total emissions by activity and by scope. It can be seen that passengers travelling to the airport by taxi contribute nearly 23% of total emissions, with passengers travelling to the airport by car contributing 17.97% and aircraft movements (approach) 10.13% of total emissions. Emissions from passenger surface access (all modes) and aircraft (all movements including engine testing) total 170,401t$CO_2$e, which is 89.4% of total emissions.

**Table 29: Glasgow Airport's emissions by activity and source – Top 95%**

| Activity | Scope 1 emissions ($tCO_2e$) | Scope 2 emissions ($tCO_2e$) | Scope 3 emissions ($tCO_2e$) | Outside of Scopes emissions ($tCO_2e$) | Total emissions ($tCO_2e$) | Percentage of total emissions |
|---|---|---|---|---|---|---|
| Passenger surface access - Taxi | 0 | 0 | 48,580.85 | 0 | 48,581 | 22.89% |
| Passenger surface access - Car | 0 | 0 | 35,540.78 | 0 | 35,541 | 16.75% |
| Aircraft movements - Approach | 0 | 0 | 23,122.36 | 0 | 23,122 | 10.89% |
| Aircraft movements - Climb Out (450-1000m) | 0 | 0 | 16,148.96 | 0 | 16,149 | 7.61% |
| Aircraft movements - Hold | 0 | 0 | 15,695.88 | 0 | 15,696 | 7.40% |
| Utilities - Electricity - consumption | 0 | 12,300.50 | 0 | 0 | 12,301 | 5.80% |
| Aircraft movements - Initial Climb (to 450m) | 0 | 0 | 11,271.90 | 0 | 11,272 | 5.31% |
| Aircraft movements - Take-Off | 0 | 0 | 7,926.99 | 0 | 7,927 | 3.73% |
| Aircraft movements - Taxi In | 0 | 0 | 7,509.72 | 0 | 7,510 | 3.54% |
| Aircraft movements - Taxi Out | 0 | 0 | 7,509.72 | 0 | 7,510 | 3.54% |
| Aircraft movements - APU | 0 | 0 | 7,168.43 | 0 | 7,168 | 3.38% |
| Passenger surface access - Bus/coach | 0 | 0 | 6,503.50 | 0 | 6,504 | 3.06% |
| Passenger surface access - Rental Car | 0 | 0 | 2,590.02 | 0 | 2,590 | 1.22% |
| **Total** | **0.00** | **12,300.50** | **189,569.11** | **0** | **201,871.00** | **95%** |

**Table 30: Glasgow Airport's emissions by activity and source – Bottom 5%**

| Activity | Scope 1 emissions ($tCO_2e$) | Scope 2 emissions ($tCO_2e$) | Scope 3 emissions ($tCO_2e$) | Outside of Scopes emissions ($tCO_2e$) | Total emissions ($tCO_2e$) | Percentage of total emissions |
|---|---|---|---|---|---|---|
| Utilities - Natural Gas | 2,576.75 | 0 | 0 | 0 | 2,577 | 1.21% |
| Aircraft movements - Landing Roll | 0 | 0 | 1,584.00 | 0 | 1,584 | 0.75% |
| Utilities - Electricity - T&D loss | 0 | 0 | 1,112.58 | 0 | 1,113 | 0.52% |
| Waste (disposal and virgin material emissions) - Kitchen Waste | 0 | 0 | 791.67 | 0 | 792 | 0.37% |
| Aircraft movements - Reverse Thrust | 0 | 0 | 767.08 | 0 | 767 | 0.36% |
| Waste (disposal and virgin material emissions) - Plastic | 0 | 0 | 643.2 | 0 | 643 | 0.30% |
| Waste (disposal and virgin material emissions) - Card | 0 | 0 | 410.34 | 0 | 410 | 0.19% |
| Aircraft Engine Tests - Aviation Fuel | 0 | 0 | 311.38 | 0 | 311 | 0.15% |
| Staff Commute - Car Driver | 0 | 0 | 308.25 | 0 | 308 | 0.15% |
| Waste (disposal and virgin material emissions) - Paper | 0 | 0 | 297.65 | 0 | 298 | 0.14% |
| Waste (disposal and virgin material emissions) - Textiles | 0 | 0 | 243.17 | 0 | 243 | 0.11% |
| Utilities - Water Treatment | 0 | 0 | 228.52 | 0 | 229 | 0.11% |
| Waste (disposal and virgin material emissions) - Non Aluminium Metal | 0 | 0 | 215.88 | 0 | 216 | 0.10% |
| Operational vehicles - Company Owned Operational Vehicle | 415.95 | 0 | 0 | 0 | 416 | 0.10% |
| Operational vehicles - Third Party Operational Vehicle | 0 | 0 | 185.38 | 0 | 185 | 0.09% |
| Utilities - R410A | 160.15 | 0 | 0 | 0 | 160 | 0.08% |
| Utilities - Water Supply | 0 | 0 | 116.88 | 0 | 117 | 0.06% |
| Waste (disposal and virgin material emissions) - Glass | 0 | 0 | 64.27 | 0 | 64 | 0.03% |
| Waste (disposal and virgin material emissions) - Aluminium | 0 | 0 | 51.68 | 0 | 52 | 0.02% |
| Fire Training - Refuelling Propane Gas Tank - AFS Training Ground | 31.11 | 0 | 0 | 0 | 31 | 0.01% |
| Waste (disposal and virgin material emissions) - Wood | 0 | 0 | 20.1 | 0 | 20 | 0.01% |
| Utilities - Fuel Oil | 14.82 | 0 | 0 | 0 | 15 | 0.01% |
| Staff Commute - Public bus or Coach | 0 | 0 | 11.59 | 0 | 12 | 0.01% |
| Staff Commute - Works bus or other company transport | 0 | 0 | 5.5 | 0 | 5 | 0.00% |

| Activity | Scope 1 emissions ($tCO_2e$) | Scope 2 emissions ($tCO_2e$) | Scope 3 emissions ($tCO_2e$) | Outside of Scopes emissions ($tCO_2e$) | Total emissions ($tCO_2e$) | Percentage of total emissions |
|---|---|---|---|---|---|---|
| Business travel - Domestic flights | 0 | 0 | 5.08 | 0 | 5 | 0.00% |
| Staff Commute - Taxi | 0 | 0 | 2.82 | 0 | 3 | 0.00% |
| Business travel - Personal Car | 2.79 | 0 | 0 | 0 | 3 | 0.00% |
| Staff Commute - Rail | 0 | 0 | 2.24 | 0 | 2 | 0.00% |
| Business travel - UK Rail | 0 | 0 | 2.13 | 0 | 2 | 0.00% |
| Business travel - European flights | 0 | 0 | 1.59 | 0 | 2 | 0.00% |
| Staff Commute - Motorcycle | 0 | 0 | 1.06 | 0 | 1 | 0.00% |
| Business travel - Petrol purchase | 0.31 | 0 | 0 | 0 | 0 | 0.00% |
| Business travel - Taxis | 0 | 0 | 0.27 | 0 | 0 | 0.00% |
| Business travel - UK Bus and Coach | 0 | 0 | 0.07 | 0 | 0 | 0.00% |
| Business travel - Overseas Rail | 0 | 0 | 0.03 | 0 | 0 | 0.00% |
| Operational vehicles - Outside scopes | 0 | 0 | 0 | 4.91 | 5 | 0.00% |
| **Total** | **3,201.88** | **0.00** | **7,384.41** | **4.91** | **10,591.00** | **5%** |

# Appendices

Appendix 1: Methodology

Appendix 2: Carbon emission conversion factors

# Appendix 1 - Methodology

The following sections provide a summary of the methodology adopted by Ricardo Energy & Environment to calculate the 2016 carbon footprint for the AGS Airports.

The standard approach to carbon footprinting is to use the Greenhouse Gas (GHG) Protocol Corporate Accounting and Reporting Standard developed by World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI); this sets out a corporate accounting and reporting methodology for GHGs.

## Scope 1

Scope 1 emissions are defined as direct GHG emissions arising from sources that are owned or controlled by the company. The emissions result from activities that the company can have direct influence on through its actions. AGS Airports' emissions that are included are: natural gas use, company owned vehicles fuel use, fuel use for business travel, refrigerant gas use (from leaks during maintenance or malfunction), wood pallets and diesel use for fire training, propane combustion and kerosene combustion.

## Scope 2

Scope 2 emissions are associated with the use of electricity imported from the grid or from a third party supplier of energy in the form of heat or electricity. These indirect GHG emissions are due to upstream emissions from the production and delivery of fuel to power stations. AGS Airports can influence the amount of electricity it uses, however, it has little control over the generation of the electricity and these emissions are therefore classed as Scope 2.

## Scope 3

Scope 3 emissions are defined as those arising as an indirect consequence of the use of goods or services provided by the company. AGS Airports do have some influence over Scope 3 emissions but the activities are not under its control. Sources included by AGS Airports include aircraft (all aircraft movements up to a height of 1,000m above aerodrome level), employees commuting to the airport, passenger surface access to the airport, airside vehicle activities by third party operators, waste disposal (including production of the virgin materials), water (supply and treatment) and airport business travel.

Emissions sources listed here are consistent with those recommended by the industry benchmark scheme for carbon footprinting the Airports Council International Airport Carbon Accreditation Scheme (ACI ACA)[6]. The scheme has four levels – Mapping, Reduction, Optimisation and Neutrality. It is probable that AGS Airports meet the requirements of at least the first two stages and for the more advanced stages it is necessary to begin third party engagement. These scope 3 emissions are all already included in the carbon footprint scope for the AGS Airports, and are as follows:

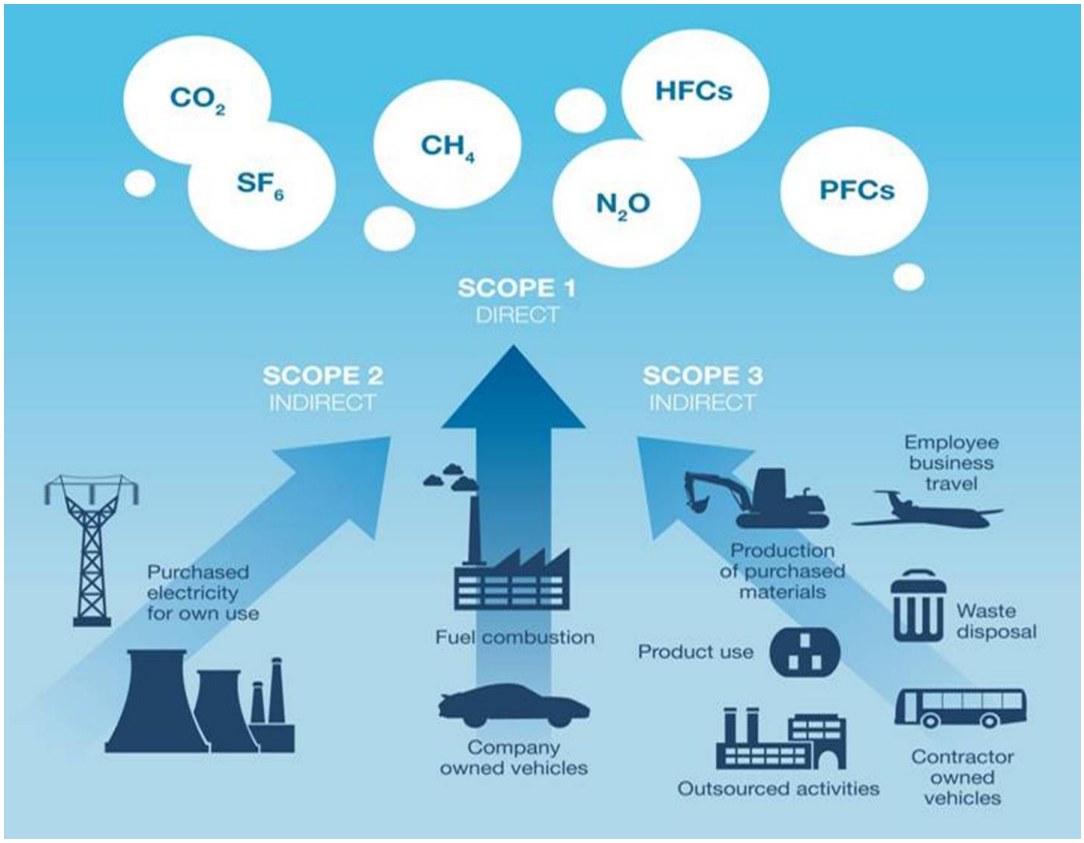
- Aircraft landing and take-off cycle emissions;
- Aircraft engine testing where applicable;
- Employee commuting to the airport;
- Employee business travel emissions;
- Surface access to the airport for passengers;
- Waste; and
- Water supply and treatment.

[6] http://www.airportcarbonaccreditation.org/

## Outside of Scopes

A change to the UK Government conversion factors for 2013 means that in order to fully account for the biofuel content of fuel in a carbon footprint, organisations should report both the direct emissions from the combustion of the fuel and the biogenic portion of this fuel. These emissions are reported as Outside of Scopes emissions and included as part of the carbon footprint.

**Figure 9: Summary of emission sources by emission scope**




Since 2008, carbon footprinting tools developed by Glasgow Airport, Aberdeen Airport and Ricardo Energy & Environment, in accordance with this best practice guidance, have been used in the calculation of its carbon footprint. The carbon footprinting tools used to calculate emissions for 2016 are expressed as carbon dioxide equivalent ($CO_2e$) emissions. This takes into account non-$CO_2$ greenhouse gases (e.g. methane and nitrous oxide) and the equivalent Global Warming Potential (GWP) of these compared with carbon dioxide.

For 2016, the carbon footprinting tools have been updated to reflect changes in accessibility to data and changes to the UK Government 2016 conversion factors for company reporting. Full details of the methodologies, raw data and emissions factors used are provided in the accompanying worksheets:

- Aircraft Movements 2016
- Aircraft Engine Testing 2016
- Business Travel 2016
- Employee Commute 2016
- Fire Training 2016
- Operational Vehicles 2016
- Passenger Surface Access 2016
- Utilities 2016
- Waste 2016

# Collection of data

Table 31 is divided into the key activity areas that contribute to the carbon footprint for the AGS Airports and the data sources used for calculating emissions in that area. All data used in the carbon footprint was supplied in an electronic format from designated representatives at Aberdeen, Glasgow and Southampton Airports.

**Table 31: Data sources used to calculate the AGS Airports' 2016 footprint**

| Footprint area | Components of footprint | Data source |
|---|---|---|
| Airport employee business travel | Airport employee expenses claims with cost and mode of travel | Airport employee expenses data and proportionally divided for airports based on their employee numbers |
| Aircraft engine testing | Duration and number of aircraft engine tests | Spreadsheet log of aircraft engine test by date, with aircraft type and start and finish of test |
| Aircraft movements | Total aircraft movements by aircraft type with engine and APU assigned | Number of aircraft movements by aircraft type and aircraft registration from the airport's BOSS database<br>ICAO emissions databank for emissions from aircraft main engines |
| Business travel | Airport employee expenses claims with cost and mode of travel | Airport employee expenses data |
| Employee travel to the airport (employee commute) | • Mode of transport used with place of origin<br>• Annual employee numbers (expressed as full-time equivalents, FTEs) | Based on an employee travel survey which was carried out in 2009/2013 and pro-rated with 2016 airport site employees (excluding tenants and third parties) |
| Fire training | Fire training fuel use, including:<br>• Burning oil (kerosene)<br>• LPG (Propane)<br>• Wood pallets | Fuel delivery reports to the airport |
| Operational vehicles | Airport owned and third party owned vehicle fuel use. Split by:<br>• Diesel (assumed to be standard forecourt biodiesel blend diesel)<br>• Gas oil (red diesel) | Fuel use and type of fuel provided in monthly values including supplies to third parties. |
| Passenger surface access | • Mode of transport used by airport passengers with place of origin<br>• Total airport annual passenger numbers | Based on a passenger surface access survey conducted in 2009 and 2013 including individual post codes and mode of transport. Further updates have been made available on aspects of this for 2016. |
| Utilities | • Electricity consumption<br>• Natural gas consumption<br>• Fugitive Refrigerant gas use<br>• Water supply | Total site Utilities consumption data provided on a monthly usage basis. |

| Footprint area | Components of footprint | Data source |
|---|---|---|
| | • Waste water disposal (to foul sewer) | |
| Waste | • Total volume of waste sent for refuse derived fuel (RDF) or landfill<br>• Total volume of waste sent for recycling<br>• Example waste compositional analysis | Monthly waste totals supplied as tonnage of waste being sent for RDF/landfill, and for recycling. |

# Assumptions used to calculate emissions

As with all carbon footprints, the interpretation and analysis of the data requires a number of assumptions to be made. Details of the assumptions used to calculate the AGS Airports' carbon footprint are described below:

## Aircraft engine tests

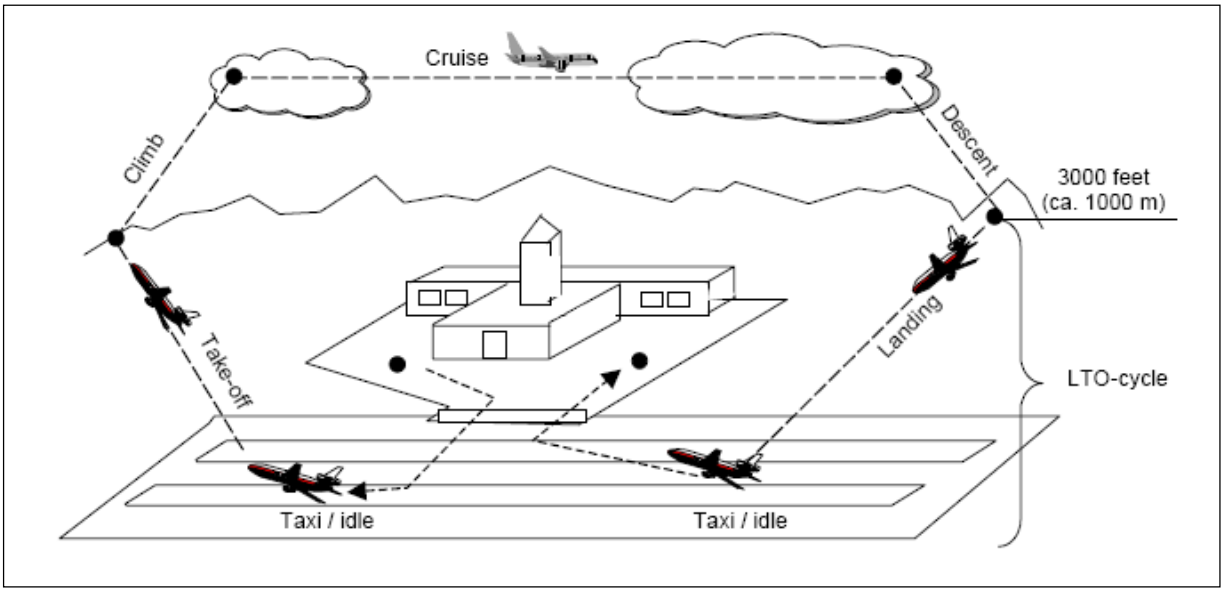
To calculate emissions from aircraft engine tests a number of assumptions were applied to the data:

- Where aircraft engines were not identified a surrogate engine has been assumed from a comparable aircraft type.
- It is assumed during the test the engine is run at idle for 90% and at full-thrust for the remaining 10%, unless otherwise stated in the data provided.

## Aircraft movements

A typical approach to standardising this for airports is to consider the International Civil Aviation Authority (ICAO) Landing and Take-Off (LTO) cycle, defined as being all aircraft operations below 1,000 metres; this is illustrated in Figure 10.

**Figure 10: Aircraft movement classifications according to ICAO's LTO cycle**




This assessment has considered a number of modes of aircraft operations within the LTO cycle, and assumptions have been applied based on the aircraft type, the typical aircraft engine thrust setting and the actual engine fitted to the aircraft. This study has considered the following LTO phases:

- Ground movements; Taxiing (in and out), time in runway hold, and use of auxiliary power units (APUs).
- Departing flights; Take-off roll, initial climb (to 450m), and climb (to 1,000m).
- Arriving flights; Approach (from 1,000m); landing Roll, and use of reverse thrust.

Emissions from these phases are included in the AGS Airports' footprint as it is considered that the AGS Airports can influence its partners to improve efficiency and reduce emissions.

To calculate carbon emissions from aircraft the numbers of aircraft movements, including details of aircraft type, were supplied by the AGS Airports. Using this information, Ricardo Energy & Environment estimated aircraft emissions from the aircraft main engines and auxiliary power unit using the following assumptions:

- All aircraft are using auxiliary power units.
- There are no reduced thrust take-offs or intersection departures.
- There is no single/reduced engine taxiing (i.e. aircraft taxi using all engines).
- Where aircraft movement emissions have not been quantified, average fuel calculations have been applied using average emissions from the airport for the NATS Grouping.
- Where a NATS Category could not be established, a 'default' engine been assumed and average emissions across all NATS category.

### Business travel

To calculate emissions from business travel a number of assumptions have been applied to the data:

- The conversion factors are taken from UK Government 2016 conversion factors for company reporting 'Business travel - land' and 'Business travel – air' conversion factors.
- Air travel conversion factors are calculated on the area of the aircraft each passenger takes up. If an aircraft is comprised totally of business class seats, as opposed to more closely packed economy class seats, fewer passengers can fly and therefore each passenger takes a larger share of the emissions.
- The conversion factor used for air applies an 8% increase to compensate for aircraft not flying using the most direct route (i.e. flying around international airspace and waiting in holds)
- The conversion factor for business travel flights is the 'Average passenger' conversion factor, which assumes a national average between economy, business and first class seats, and is in accordance with UK government best practice advice.
- Flight distances have been calculated based on the departure and arrival information supplied in the expense. Where no information has been made available, an average distance based on domestic, EU and international flights has been applied.
- All petrol purchased for use during business travel is used in non-airport owned vehicles (i.e. employee owned or rental) and is classified as a Scope 1 emission.

### Fire training

Emissions from the airport's fire training activities have been included in this footprint. Airport fire-training emissions are those associated with airport firefighting personnel simulating an aircraft fire. To calculate the emissions a number of assumptions have been made:

- All fuel purchased by the airport within the reporting year has been consumed.
- Wood pallets are assumed to be made up of wood chip (for the purposes of emission conversion) and it is further assumed that six pallets weigh 1 tonne.
- Gas from Calor gas bottles is propane gas.

### Operational vehicles

The AGS Airports have a fleet of operational vehicles. To calculate emissions from these vehicles a number of assumptions have been made to the data:

- All diesel and gas oil purchased has been consumed within the year.
- Diesel and petrol consumed is standard forecourt fuel and uses the 'average biofuel blend' conversion factor, and as such Outside of Scopes emissions have also been calculated.

### Passenger surface access

An updated travel survey was carried out in 2013 (superseded the 2009 survey used previously) and was used to obtain distance travelled and modes of transport used by passengers for Aberdeen and Glasgow Airport. Some updates have been made available for 2016, such as mode of transport for Southampton Airport.

The following assumptions were made to the survey data to calculate emissions, unless specifically stated in the respective airport sections:

- To calculate passenger vehicle emissions, UK Government 'Passenger vehicles' company reporting conversion factors have been used. All others are taken from the 'Business travel – land' conversion factors.
- Passengers traveling by coach and bus have not been distinguished. Therefore, an average conversion factor has been applied. The factor applied is taken from the UK Government 'Business travel – land' and is the 'average local bus' conversion factor.
- Only the final mode of transport to the airport has been used to calculate passenger surface access emissions. Therefore, passengers traveling by multiple modes may be represented inaccurately. For example, a passenger travelling by rail and then by travelling by bus will be assumed to have travelled the whole journey by bus. Additionally, the accuracy is based on the answer provided by respondents in the survey and no data quality assessment has been carried out on this.
- The category assigned 'car passenger' was assumed to be zero emissions as the emissions have already been captured by the 'car driver' category.
- Road distances have been used to calculate the distance from the passenger's place of origin to the airport. This is mainly from the major urban centres in the area.
- Where full postcodes have not been provided by a passenger during the survey, distances to part postcodes have been calculated and used.

### Employee commute

Emissions associated with employees commuting to and from the airport is based on a survey conducted in 2009, and the update to this survey in 2013, which was used to obtain distance travelled and the modes of transport used by employees.

The following assumption was used to calculate emissions:

- For employees commute the data assumes that employees are only present on site for 65% of the time in a given year this assumes two days off per week and an annual leave entitlement of 20 to 25 days.

### Utilities

To calculate emissions from utilities it has been necessary to make a number of assumptions to the data:

- Usage for utilities is taken from the supplier invoice data.
- Due to difficulties in apportioning usage to airport tenants, except in the case of Glasgow Airport, all usage is reported. This is a conservative approach. If analysis was undertaken to identify the end user it is likely that this would result in a large reduction in reported emissions.
- For Glasgow Airport, due to the charging of tenants for energy, the energy data associated with tenant usage is not reported.

### Waste and recycling

As in previous years, to calculate emissions from waste a standard compositional analysis[7] has been applied. This provides an assessment of the types and quantities of materials being sent for recycling and those sent for refuse derived fuel (RDF) or landfill. Emissions were also calculated for the

[7] The basic waste composition data is taken from an SLR Report for Environment Agency Wales entitled: Determination of the Biodegradability of Mixed Industrial and Commercial Waste Landfilled in Wales.

production of the virgin material and for the method of disposal and treatment of the material. To calculate emission from waste the following has been assumed:

- Waste disposal (RDF/Combustion):
  - Where no waste is sent to an RDF, it has been assumed that it still goes to landfill.
  - Plastic is assumed to be of 'average plastic' composition.
  - All recyclate are assumed recycled in an open-loop recycling process. Open-loop UK Government conversion factors for company reporting have been applied (where available). This is representative of a worst case scenario.
- Production of virgin material:
  - Calculations assume 100% virgin material.
  - The waste production figure for textiles does not currently account for the split of material types on the UK market.

# Appendix 2 – Carbon emissions conversion factors

The emission factors for the 2016 carbon footprint model are provided by Defra in the 2016 GHG Reporting publication[8]. Unless otherwise stated the emission factors used in this report all draw on UK Government Conversion Factors for Company Reporting and are provided in the tables below.

| Activity | Raw data units | Emission factor ($kgCO_2e$ per unit) | Notes |
|---|---|---|---|
| **FUELS** | | | |
| Diesel use (vehicle fuel/power generation) | litres | 2.612 | average biodiesel blend (from forecourt) |
| Outside of Scopes (diesel) | litres | 0.061 | to account for the direct $CO_2$ impact of burning biodiesel |
| Fuel Oil | tonnes | 3,225 | |
| Burning Oil/Kerosene | litres | 2.532 | |
| Gas Oil | litres | 2.966 | |
| LPG/Propane | litres | 1.505 | |
| Wood | tonnes | 1,484 | wood pallets – wood chips |
| Aviation turbine fuel | tonnes | 3,181 | |
| **UTILITIES** | | | |
| Natural Gas | kWh | 0.184 | |
| Electricity generation | kWh | 0.412 | |
| Electricity transmission and distribution loss | kWh | 0.037 | |
| Water supply | $m^3$ | 0.344 | |
| Water treatment | $m^3$ | 0.708 | |
| **REFRIGERANTS** | | | |
| Refrigerant gas – R410A | kg | 2,088 | |
| Refrigerant gas – R134A | kg | 1,430 | |
| Refrigerant gas – R22 | kg | 1,810 | |
| **WASTE DISPOSAL – from landfill and recycling** | | | |
| Paper (combustion/RDF) | tonnes | 21 | |
| Card (combustion/RDF) | tonnes | 21 | |
| Plastic (combustion/RDF) | tonnes | 21 | |
| Textiles (combustion/RDF) | tonnes | 21 | |
| Wood (combustion/RDF) | tonnes | 21 | |
| Glass (combustion/RDF) | tonnes | 21 | |
| Kitchen Waste (combustion/RDF) | tonnes | 21 | |
| Non-aluminium Metal (combustion/RDF) | tonnes | 29 | |
| Aluminium (combustion/RDF) | tonnes | 21 | |
| Paper (recyclate) | tonnes | 21 | |
| Card (recyclate) | tonnes | 21 | |
| Plastic (recyclate) | tonnes | 21 | |
| Textiles (recyclate) | tonnes | 21 | |

[8] 2016 Greenhouse Gas Conversion Factors for Company Reporting - http://www.ukconversionfactorscarbonsmart.co.uk/

| | | | |
|---|---|---|---|
| Glass (recyclate) | tonnes | 21 | |
| Non-aluminium Metal (recyclate) | tonnes | 21 | |
| Aluminium (recyclate) | tonnes | 21 | |
| **MATERIAL USE – from primary material production** | | | |
| Paper (combustion/RDF) | tonnes | 939 | |
| Card (combustion/RDF) | tonnes | 904 | |
| Plastic (combustion/RDF) | tonnes | 3,342 | |
| Textiles (combustion/RDF) | tonnes | 22,310 | |
| Wood (combustion/RDF) | tonnes | 435 | |
| Glass (combustion/RDF) | tonnes | 895 | |
| Kitchen Waste (combustion/RDF) | tonnes | 4,060 | |
| Non-aluminium Metal (combustion/RDF) | tonnes | 3,771 | |
| Aluminium (combustion/RDF) | tonnes | 12,912 | |
| Paper (recyclate) | tonnes | 683 | |
| Card (recyclate) | tonnes | 683 | |
| Plastic (recyclate) | tonnes | 679 | |
| Textiles (recyclate) | tonnes | 131 | |
| Glass (recyclate) | tonnes | 508 | |
| Non-aluminium Metal (recyclate) | tonnes | 1,493 | |
| Aluminium (recyclate) | tonnes | 3,014 | |
| **TRANSPORT** | | | |
| Domestic flights | passenger.km | 0.147 | average passenger and without RF |
| European flights | passenger.km | 0.089 | average passenger and without RF |
| International flights | passenger.km | 0.095 | average passenger and without RF |
| Taxi | passenger.km | 0.219 | assumed black cab |
| UK Bus and Coach | passenger.km | 0.102 | assumed average local bus |
| UK Rail | passenger.km | 0.049 | assumed national rail |
| Overseas Bus and Coach | passenger.km | 0.102 | assumed average local bus |
| Overseas Rail | passenger.km | 0.012 | assumed international rail (Eurostar) |
| Personal Car | km | 0.187 | unknown fuel and average size |
| Motorbike | km | 0.120 | average size |


The Gemini Building
Fermi Avenue
Harwell
Didcot
Oxfordshire
OX11 0QR
United Kingdom

t: +44 (0)1235 753000
e: enquiry@ricardo.com

ee.ricardo.com