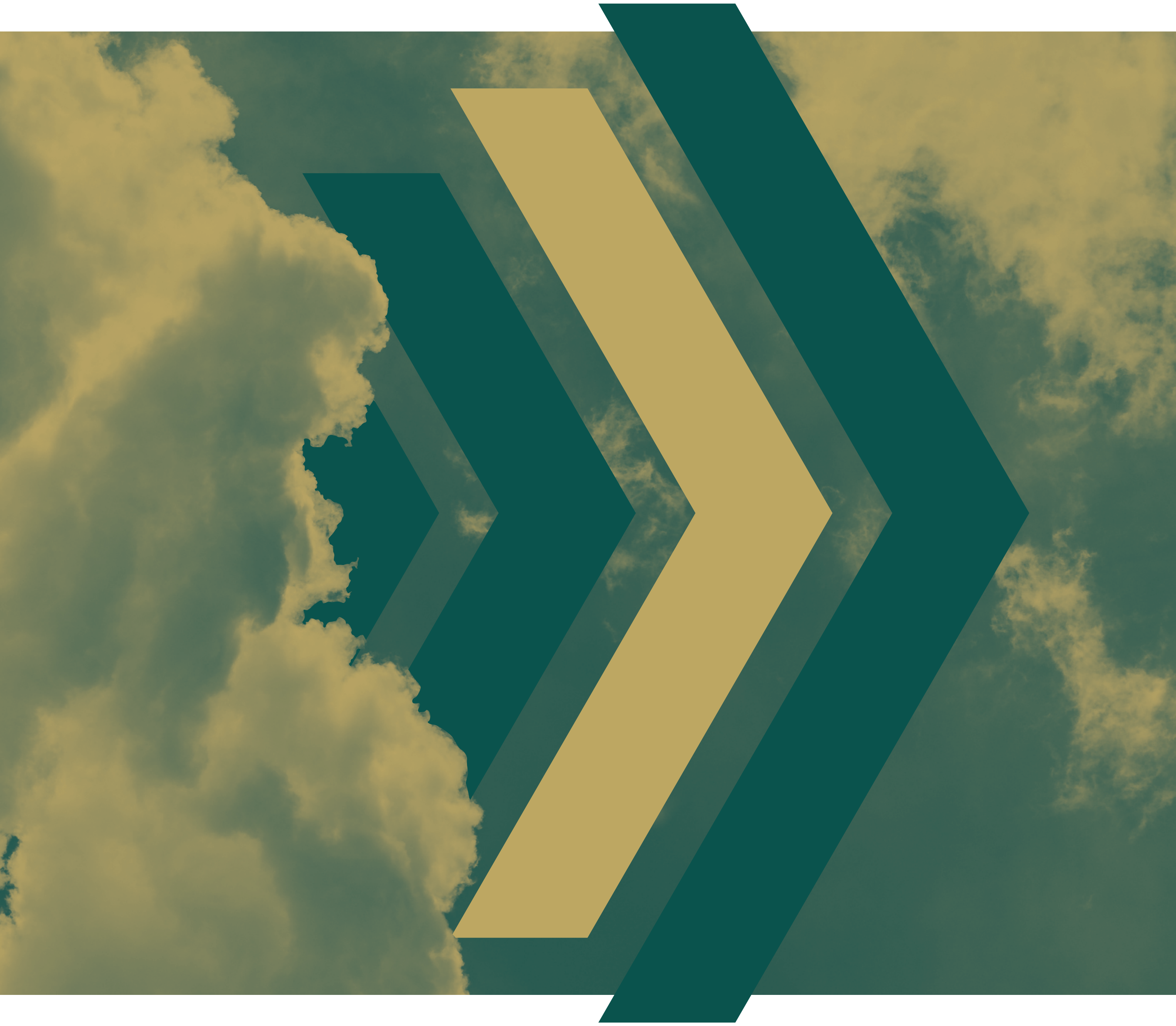


Emissions Accounting Report 2019/20

Co-authored between Oxford University Saïd Business School
and Oxford University Estates Services

April 2022

Executive Summary

This project was completed in partnership between the SAID Business School and Oxford University Environmental Sustainability team (Oxford ES team). Following the recent publication of its Environmental Sustainability strategy, the University identified the requirement for a review of carbon accounting practices to align with sector and industry best practice and to demonstrate accuracy and transparency.

The University of Oxford has committed to achieve net zero carbon by 2035 from all greenhouse gas emissions sources, as defined by the World Resources Institute Greenhouse Gas Protocol (GHG Protocol). This commitment is supported by a target to reduce gross Scope 1 and 2 emissions by 73%. This report outlines how these objectives can be achieved in a transparent and rigorous way.

This project aims to identify best practice by assessing the aims and goals of other higher education institutions' emissions accounting practices and by reviewing published standards and guidelines. The identification of best practice was led by a range of surveys and direct contact across peers. It was supplemented by web searches of relevant data sources. These outputs were complemented with a review of the practices of companies within the University supply chain representing wider, international best practice. The results led to the conclusion that the GHG Protocol for emissions accounting provides the most rigorous and complete methodology for emissions accounting. Responses from other universities in the UK and USA showed that best practice could include university-specific emissions, such as student term time and inter-term travel, which would not fall within the GHG Protocol Scope 1, 2 or 3. The practices undertaken by some institutions would suggest that beyond the best accounting practice outlined above, best reporting practice would include external verification of emissions accounts to the ISO 14064 certification standard.

To elevate processes to meet this best practice standard, the Oxford ES team has developed the necessary tools to apply the GHG Protocol's Corporate Standard (Scope 1 and 2) and the Corporate Value Chain Standard (Scope 3). This tool and methodology have been applied to the University of Oxford GHG emissions portfolio for the academic financial year from 01/08/2019-31/07/2020.

The report builds on previous emissions accounting reports compiled to comply with or conform to the Energy Saving Opportunity Scheme (ESOS), Higher Education Statistics Agency (HESA) Estates Management Record (EMR) and Higher Education Supply Chain Emissions Tool (HESCET). It estimates emissions relating to all University Scope 3 sources, and goes beyond the GHG Protocol to include emissions from student travel. Accounts for travel emissions include: term time commuting; inter-term international and domicile travel; and emissions from travel to international placements. A further significant development is the supply chain emissions calculation that has been updated from the HESCET methodology to better reflect the actual emissions produced by University suppliers.

Figure 1 presents the summary output of the accounting process in terms of net carbon emissions that the University produced in the academic financial year 2019/20. The University's total gross tCO_2e emissions over this period were 267,936 tCO_2e. This includes 4,534 tCO_2e removed by carbon sequestration on University operated land. Figure 1 shows that the University's net carbon emissions were 245,053[1] tCO_2e. This includes offsets from REGO backed green tariff electricity of 22,833 tCO_2e. The Scope 3 emissions produced by the University of Oxford are an order of magnitude higher than University scope 1 emissions at 231,490 tCO_2e. This reflects the high proportion of indirect emissions resulting from University activities. The most significant Scope 3 emission categories are: supply chain emission from scientific and medical equipment, information and technology supplies, construction, emissions from tudent inter-term travel and business travel.

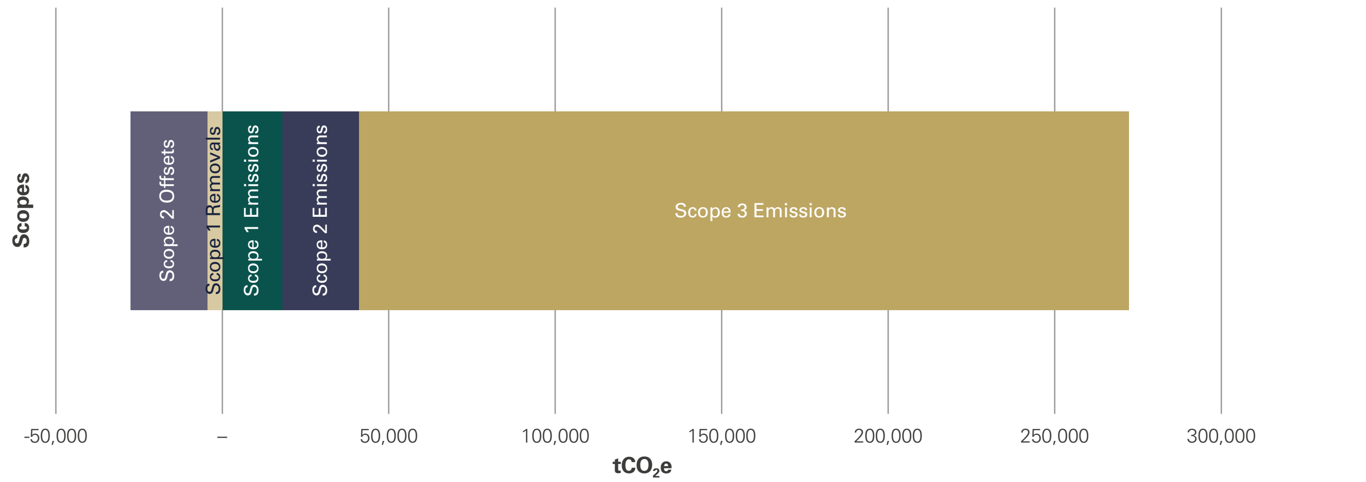
1 This number varies from the figure stated in the 2020/21 University Financial Statement due to corrections in the accounting methodology.

This initial review of carbon emissions provides the most comprehensive approach yet applied to University datasets. The opportunities for further development are:

- Identify 'third party payments' and how they can be categorised under the emissions accounting portfolio. These payments could account for approximately 98,034 tCO_2e and are outside the scope of Purchased Goods and Services. For completeness, they have been included in the accounts within this report and will be investigated in more detail for future iterations of the report.
- Scope 1, 2 and 3 emission data was not widely available through the University supply chain. The University could consider ways of building the collection of this data into relevant systems and processes.
- As the importance of carbon emissions tracking and Environmental, Social and Governance (ESG) increases, the University would seek to work with the supply chain to understand how standards can be reviewed and improved, where appropriate. Environmental Sustainable products and services are already highlighted on internal catalogues and this approach could be extended.
- The University does not report data on fugitive gas emissions. This could represent an additional 5% of Scope 1 emissions. A method for estimating fugitive gas emissions has been provided in this report in Scope 1: Fugitive Gases, which outlines the data that all departments must collect to be able to make this estimation.
- Emissions from land use would be improved by sourcing more granular detail of the University's non-functional estate.
- Require staff to arrange all overseas travel consistently would increase data quality in this area.
- Emissions from 3.1.6.2 Student Inter-term Commuting were calculated based on University attendance and residence requirements. An annual survey of students' between-term travel habits could be conducted to determine the mode and frequency of travel used.

These recommendations follow the ambition to improve transparency and accuracy of carbon accounting at the University and more widely. Further recommendations for developing the methodology are given at the end of each section of the report. Additionally, recommendations on reducing carbon emissions are given based on the relative carbon intensities of different activities.

Figure 1
The University of Oxford emissions for academic year 2019/20



Total Net Carbon Emissions from the University in the 2019/20. Scope 1 emissions and associated removals are shown in shades of green, Scope 2 emissions and associated offsets are in shades of blue and Scope 3 emissions are in shades of gold.

Table of Contents

The report was written by Maria Marinari, MPhys under the direction of Tom Yearley, Deputy Head of Environmental Sustainability, University of Oxford and under the supervision of Richard Barker, Professor of Accounting, Saïd Business School, University of Oxford. The report proposes an approach to carbon emissions accounting developed at the University of Oxford during the summer of 2021.

Feedback on the report is welcomed. If you wish to contact the team, please email: sustainability@admin.ox.ac.uk

List of abbreviations

CF	Conversion Factor
COVID-19	Coronavirus Disease-19
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
BEIS	Department for Business, Energy & Industrial Strategy
Defra	Department for Environment, Food & Rural Affairs
ECLI	Emissions Category Level 1
ECLII	Emissions Category Level 2
EEA	European Environment Agency
EMR	Estates Management Record
EPA	Environmental Protection Agency U.S.
ESOS	Energy Savings Opportunity Scheme
ESS	Environmental Sustainability Strategy
FY	Financial Year
GHG	Greenhouse Gas
GHGI	Greenhouse Gas Inventory
GWP	Global Warming Potential
HESCET	Higher Education Supply Chain Emissions Tool
kg	Kilogram
km	Kilometres
LCA	Life Cycle Analysis
LULUCF	Land-Use, Land-Use Change and Forestry
MPG	Miles Per Gallon
MSW	Municipal Solid Waste
N	Nitrogen
NO_x	Nitrogen Oxides
OUEM	Oxford University Endowment Management
OUES	Oxford University Estates Services
OUP	Oxford University Press
PO_4^{3-}	Phosphate
pkm	Passenger kilometres
PV	Photovoltaic
SO_2	Sulphur Dioxide
SO_x	Sulphur Oxides
REGO	Renewable Energy Guarantees of Origin
T	Tonnes
T&D	Transmission and distribution
UPD	University Purchasing Department
WEE	Waste electrical and electronic equipment

Definitions

Several words and phrases used throughout this report may be unfamiliar to the casual reader, or have been specifically defined in the context of carbon accounting, this report, the University of Oxford, the GHG Protocol[2], or Defra's Guidance on how to measure and report your greenhouse gas emissions[3]. These have been defined here for the benefit of a diverse audience.

Global Warming Potential (GWP), the heat absorbed by any greenhouse gas in the atmosphere, as a multiple of the heat that would be absorbed by the same mass of CO_2. GWP is 1 for CO_2. For other gases it depends on the gas and the time frame.

Carbon dioxide equivalent (CO_2e), a measure used to compare the emissions from various greenhouse gases based upon their global warming potential. For example, the global warming potential for methane over 100 years is 21. Therefore 1 tCH_4 is equivalent to 21 tCO_2 over this time period.

Greenhouse gas inventory, a quantified list of an organisation's GHG emissions and sources.

Control, the ability of an organisation to direct the policies of another operation. More specifically, it is defined as either operational control (the organisation or one of its subsidiaries has the full authority to introduce and implement its operating policies at the operation) or financial control (the organisation has the ability to direct the financial and operating policies of the operation with a view to gaining economic benefits from its activities).

Operational Control Approach, the approach to carbon accounting defined by the GHG Protocol. Under the operational control approach, an organisation accounts for 100% of the GHG emissions over which it has operational control. It does not account for GHG emissions from operations in which it owns an interest but does not have operational control. In the case of the University, this refers to the Oxford university functional estate.

Oxford University functional estate, the University of Oxford's estate within Oxfordshire. There are over 260 buildings that are used for teaching, research, administration, sport, libraries, museums and ceremonial events – called the functional estate – and another 180 properties that we manage commercially, including office space, warehouses and agricultural land and property. These are all operated directly by the University and align to the Operational Control Approach.

Financial Control Approach, under the financial control approach, an organisation accounts for 100% of the GHG emissions over which it has financial control. It does not account for GHG emissions from operations in which it owns an interest but does not have financial control.

Equity Share Approach, under the equity share approach, an organisation accounts for GHG emissions from operations according to its share of equity in the operation. The equity share reflects economic interest, which is the extent of rights has to the risks and rewards flowing from an operation.

Financial year, in this report this refers to the British tax year which is from the 6^{th} of April in one year to the 5^{th} of April in the next.

Academic financial year, defined by the University as 1st of August of one year to the 31st of July of the next.

Direct emissions, emissions from sources that are owned or controlled by the reporting organisation.

Indirect emissions, emissions that are a consequence of the activities of the reporting organisation but occur at sources owned or controlled by another organisation.

Scopes, there are three different scopes of emissions which an organisation can be responsible for. These are generally defined in the same way by all standards and protocols. The following definitions have been provided by Defra reporting guidelines.

2 Greenhouse Gas Protocol | (ghgprotocol.org)
3 Guidance on how to measure and report your greenhouse gas emissions (publishing.service.gov.uk)

Scope 1, direct GHG emissions occur from sources that are owned or controlled by the organisation, for example, emissions from combustion in owned or controlled boilers, furnaces or vehicles, and emissions from chemical production in owned or controlled process equipment.

Scope 2, emissions are just those emissions resulting from the electricity (and heat or steam) an organisation buys – these are treated separately from Scope 1 because the emissions are not under the organisation's operational control. Scope 1 and 2 emiss ions are considered to be under the control of the repo rting organisation, and are the minimum required for acceptable GHG reporting under the Defra/DECC company reporting guidelines.

Scope 3, emissions are 'other' emissions which are not under the direct control of an organisation, but which it might nevertheless want to count to understand its total climate impact, or the impact of a particular product. As consumers show greater interest in the climate impact of the products they buy, retailers in particular are increasingly looking to identify not just their own emissions, but those of their complete supply chain. They might therefore choose to include the manufacture and transport of the goods they sell in their reported footprint, as 'Scope 3' emissions.

Upstream emissions, indirect GHG emissions from purchased or acquired goods and services.

Downstream emissions, indirect GHG emissions from sold goods and services. Downstream emissions also include emissions from products that are distributed but not sold.

Emissions Categories Level I, these are the high-level emissions categories that are defined by the GHG Protocol and this report which fall into Scope 1, 2 and 3.

Emissions Categories Level II, these are sub section of Level I. For example: Business Travel is 'Level I', and Level II sub sections would include emissions from rail, cars and motorcycles.

Supplier tiers, are defined by the GHG Protocol by the level of removal between the organisation and a produce supplier. For instance, the University of Oxford buys scientific and medical equipment from Merck Life Science. This is a Tier I supplier. If this organisation supplies good from a third party, this third party is a Tier II supplier.

Supply chain, a network of organisations (e.g., manufacturers, wholesalers, distributors and retailers) involved in the production, delivery, and sale of a product to the consumer.

Value chain, in the GHG Protocol, this refers to all of the upstream and downstream activities associated with the reporting organisation's operations, including the use of sold products by consumers and the end-of-life treatment of sold products after consumer use.

Preferred suppliers, these are University suppliers that have agreed contract terms with the University. The agreements leverage the volume requirements of the University to deliver value for money whilst ensuring that quality, delivery and sustainability considerations are managed. The University encourages purchases from preferred suppliers.

Activity data, a quantitative measure of a level of activity that results in GHG emissions. Activity data is multiplied by an emissions factor to derive the GHG emissions associated with a process or an operation. Examples of activity data include kilowatt-hours of electricity used, quantity of fuel used, output of a process, hours equipment is operated, distance travelled, and floor area of a building.

Emission factor (**or more generally conversion factor**), a factor that converts activity data into GHG emissions data (e.g., kg CO_2e/l of fuel consumed, kg CO_2e/km travelled, etc.).

Primary data, data that is from specific activities within an organisation's value chain.

Secondary data, data that is not from specific activities within an organisation's value chain.

Carbon pool, a reservoir that has the ability to accumulate and store carbon or release it.

Carbon flux, a carbon flux is the amount of carbon exchanged between Earth's carbon pools – the oceans, atmosphere, land, and living things

Carbon stocks, the quantity of carbon contained in a carbon pool.

Emission Offsets, are defined by Defra as discrete GHG reductions, in the form of carbon credits, used to compensate for (i.e. offset) specific and accurately measured GHG emissions elsewhere, for example to meet a voluntary GHG target or cap. Carbon credits must represent a genuine, additional carbon saving, and are calculated relative to a baseline that represents a hypothetical scenario for what emissions would have been in the absence of the mitigation project that generates the credits. To avoid double counting, the reduction giving rise to the credit must occur at sources or sinks not included in the target or cap for which it is used.

Emission Reductions, have been defined in this report as carbon reductions made within organisations' operations and are separate from offsets. This definition was made using guidance from Defra's Guidance on how to measure and report your greenhouse gas emissions[4], Annex G: What can I count as an emission reduction? "Internal GHG reductions will be accounted for in your reported gross CO_2e tonne figure as these internal projects will reduce emissions from within your own operations."

Gross Carbon Emissions, defined by Defra as an organisation's emissions, minus the carbon reductions made within its own operations.

Net Carbon Emissions, defined by Defra as an organisation's emissions, minus the carbon reductions and offsets made within its own operations.

4 Guidance on how to measure and report your greenhouse gas emissions (publishing.service.gov.uk)

Introduction

This report outlines an emissions accounting methodology for the University of Oxford. The aim is to fulfil the need to:

1. Develop a rigorous approach to carbon accounting and reporting, using an 'open source' approach that is transparent, acknowledges current data and scope limitations, and invites continuous improvement.
2. Include all carbon emissions from Oxford University's activities, including those upstream and from student travel.
3. Bring validity to Oxford University's performance against carbon targets.
4. Provide focus on how best to direct resources to achieve carbon reductions.
5. Encourage learning, internally and for the benefit of other institutions, on how to develop best practice in carbon accounting and reporting.

For the purposes of reporting the contribution of an organisation to climate change, emissions are split into three scopes. In this report the type and range of these scopes has been defined using guidance from the World Resources Institute (WRI) Greenhouse Gas (GHG) Protocol (The Protocol). The Protocol represents the most rigorous approach to emissions accounting and has been adopted across industry and many public sector organisations. Further benchmarking of best practice carbon accounting can be found in Annex A. This report builds on this benchmark by providing a methodology for calculating emissions with the currently available data for each emission category at the University, as well as providing recommendations on the best possible methodology for data collection and processing. Both the current and recommended methodology could be useful for other higher education institutions. This report also seeks to define emission sources that fall outside of The Protocol, but are still relevant to higher education institutions.

Defining Approach, Scope and Boundaries

The best practice review demonstrates that The Protocol defines a best practice standard. The key standards used throughout the accounting process were GHG Protocol Corporate Standard[5], Corporate Value Chain (Scope 3) Standard[6] and Project Protocol[7]. Additional guidance was taken from Defra's Guidance on how to measure and report your greenhouse gas emissions[8]. Annex G of Defra's Guidance was used to direct accounting decisions on offsets and removals in the absence of sufficient guidance from the The Protocol.

The purpose of broadening the University's carbon accounting methodology is to identify GHG reduction opportunities, set reduction targets, and track performance in a meaningful way to reach verifiable and transparent net zero emissions. With this in mind an operational control approach has been taken to define the boundaries of the Universities emissions across the functional estate and aligned to the University Environmental Sustainability strategy[9].

The operational control approach is best suited to the University as this approach of carbon accounting is the most practical for gathering data and effecting positive change on emissions. As a result of using this approach, subsidiaries of the University that it profits from but does not operate as part of the functional estate are excluded from this account. Examples include Oxford University Press and Oxford University Innovation Ltd and Oxford University Endowment Management. Oxford colleges are independent and self-governing, and relate to the University in a federal system like that of the United States. They are therefore also excluded from the scope of this report under the operational control approach. It is intended that this report be shared widely and other organisations may choose to align with proposals within. The defined scope may change in the future.

5 Corporate Standard | Greenhouse Gas Protocol (ghgprotocol.org)
6 Corporate Value Chain (Scope 3) Standard | Greenhouse Gas Protocol (ghgprotocol.org)
7 Project Protocol | Greenhouse Gas Protocol (ghgprotocol.org)
8 Guidance on how to measure and report your greenhouse gas emissions (publishing.service.gov.uk)
9 University Environmental Sustainablity strategy (https://sustainability.admin.ox.ac.uk/files/environmentalsustainabilitystrategy.pdf)

The academic financial year from the 1st of August 2019 to the 31st of July 2020 has been chosen as the reporting period for the emissions account to follow financial accounting reports of the University. All indirect emissions will be accounted for at the point of purchase following the methodology outlined later in this paper. This point has been chosen to account for indirect emissions as the University cannot account for the dynamic processes throughout the supply chain. Emissions categories proposed to be used by the University can be seen in Annex B.

Methodology Overview

A variety of methods were used to estimate emissions within each category due to the complexity of the data and the different sources of data collected. The GHG Protocol Scope 3 gives a range of methodologies that can be used to make these estimations. The two methodologies utilised most throughout this report are below. The advantages and disadvantages for each are explained.

Table 1
Scope 3 accounting methodology assessment

Methodology	Advantages	Disadvantages
1: Split inventory and assign emission factor by spend category e.g. HESCET or Defra CF. This method often relies on secondary data because the organisation relies on secondary parties to calculate these emission factors.	• Easy to carry out based on the data that most companies will have access to.	• The accuracy of the results are highly dependent on the accuracy of the emission factors. • Difficult to start informed emissions reduction initiatives based on results as spend based emission factors always result in increased spend leading to increased emission.
2: Split inventory into categories and contact supplier about emissions associated with each of the individual products. The data used in this method is primarily primary data so an organisation has a greater ability to verify its quality.	• Finds most carbon intensive products/ services allowing for specific policy.	• Requires large amounts of detail in recording invoices as well as high engagement from supplier.

Data Quality

A qualitative approach to data quality assessment assigns the relevant rating description for each of the data quality indicators on direct emissions data, activity data, and emission factors as applicable. This rating system has elements of subjectivity. For example, some fuel emission factors have not changed significantly in many years. Therefore, a fuel emission factor that is over 10 years old, which would be assigned a temporal score of poor with the data quality in Annex C, may not be different to a factor less than 6 years old (a temporal rating of good). The evaluation system and analysis output can be found in Annex C.

Scope 1 Emissions

Introduction

Scope 1 emissions are direct GHG emissions that occur from sources that are owned or controlled by the University. Scope 1 emissions are accounted for in all environmental reporting standards in some form. The University's Scope 1 emission sources include emissions from: combustion of gas for heating; burning fuel during the operation of University owned vehicles; controlled and uncontrolled releases of F-Gases, including refrigerant and air-conditioning equipment; land use and changes in land use. Bioenergy has been omitted from this report as the University does not use any sources of bioenergy.

1. Fuel Consumption through the Operation of Buildings

The University directly consumes four types of fuels: natural gas and gas oil for heating, and petrol and diesel for University operated vehicles. In this section the emissions associated with the operation of buildings has been calculated.

Methodology

Calculations performed for mains gas:

The natural gas consumed by the University estate is delivered via the grid. Scope 1 emissions from natural gas combustion for heating are calculated using the readings from onsite meter readings multiplied by the Defra 2020 emission factors for natural gas. The University applies the 'KWH (Gross CV) conversion factor.

Calculations performed for gas oil:

Invoices from Carlton Fuels, the company that delivers gas oil to the University estate properties, were used to determine the amount of gas oil consumed throughout the year. This was then multiplied by the Defra 2020 conversion factor for gas oil to determine the GHG emissions from the combustion.

Data sources

1. Natural gas consumed from the grid from estate gas meters (invoices).
2. Gas oil consumed from invoices from Carlton Gas.
3. Defra 2020 conversion factors for natural gas, gas oil per net CV.

Results

The analysis found that 205 tCO_2e were emitted from the consumption of gas oil and 17,576 tCO_2e were emitted from the consumption of natural gas on site, see Figure 2. The majority of buildings are heated with natural gas. Therefore, the emissions from natural gas far outweigh the emissions from gas oil.

Discussion

All the fuel conversion factors for direct emissions in the Defra 2020 report are based on the conversion factors used in the UK GHG Inventory for 2018[10] which is managed by Ricardo Energy & Environment. Combustion of fuel falls under IPCC code 1A in the UK GHGI. The references for calculating emissions in this sector are given under Annex 3, Sector 1, 1A of the report on UK GHGI from 1990 to 2018[11]. The exact source for each emissions factor is not given. However, on page 146 of the Defra report it is stated that CO_2 factors are predominantly derived from EU ETS data (2005 onwards), from refinery sector reporting (UK Petroleum Industry Association, 2019) and from the 2004 Carbon Factors Review (Baggott et al., 2004), non-CO_2e emission factor are predominantly IPCC defaults (IPCC, 2006). As the exact factors used are not given there is no way to verify whether the data used is of a good quality.

The CO_2 emission factors are based on the same factors used in the UK GHGI and are essentially independent of application as they assume that all fuel is fully oxidised and combusted. However, emissions of CH_4 and N_2O can vary to some degree for the same fuel depending on the use (eg conversion factors for gas oil used in rail, shipping, non-road mobile

10 Greenhouse gas emissions intensity, UK – Office for National Statistics
11 UK Greenhouse Gas Inventory, 1990 to 2018 (defra.gov.uk)

machinery or different scales/types of stationary combustion plants can all be different). The figures for fuels in the Defra 2020 GHG conversion factors are based on an activity-weighted average of all the different CH_4 and N_2O CFs from the GHG Inventory, a source for this is not provided.

Recommendations

This method could be improved by increasing transparency of sources for GHG emissions for fuel combustion. Through the duration of this project no exact source could be found for Scope 1 emission factors for natural gas or gas oil. A more accurate emission factor for gas oil could be calculated by contacting suppliers and asking for source-specific emission estimates using mass spectrometry of gasses emitted upon combustion. A more accurate emission factor for the National Grid could be calculated by asking gas oil suppliers to the National Grid to submit annual source-specific emission estimates, for instance UK natural gas is sourced from a range of geographic areas using different production methods. Taking a weighted average, based on volume of supply to the grid, from these figures would calculate a grid factor for the UK National Grid gas supply. The National Grid were contacted as part of this study but are not yet recording this data. The majority of variability in the emissions from sources of fuel will fall under Scope 3 emissions in the well-to-tank emissions. Please see Scope 3 Emissions, 3. Fuel- and energy-related activities (not included in Scope 1 or Scope 2) for further details.

2. Fleet Fuel Consumption

In 2019/20 the University of Oxford fleet consisted of 240 vehicles operated by 27 departments. Of these vehicles 12 are electric vehicles and the remainder are petrol, diesel or hybrid. Emissions from the combustion of fuel in vehicles have been accounted for in Scope 1 at the point of purchase using invoices. Electric powered vehicles are charged on site, so emissions have been accounted for in 2.1: Electricity Consumption in Scope 2.

Methodology

Calculations performed for University operated vehicles:

Emissions from the University operated fleet have been calculated using invoices for fuel from the month of June 2019. This was assumed to represent the months in the academic year 2019/20 that were unaffected by COVID-19. The fuel consumption from June 2019 was multiplied by a factor of 7.5 as 30 weeks in the year were unaffected by the travel restrictions enforced by lockdown. Litres of fuel were converted into GHG emissions using the Defra 2020 conversion factors. In future iterations of the report, actual annual consumption should be used. An alternative methodology would be to record mileage from MOT certificates or service records and apply a conversion factor. This would, of course, be less accurate.

Data sources

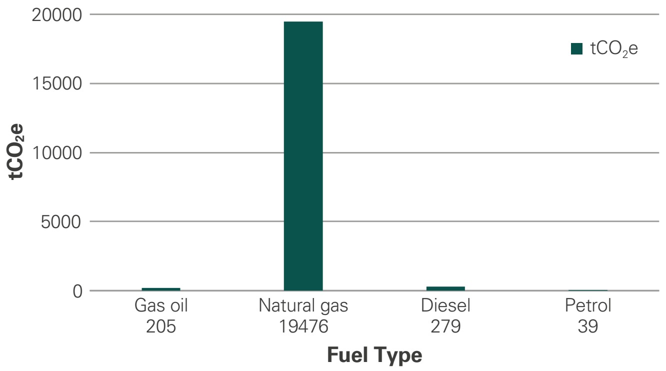
1. Vehicle fuel consumption from invoices processed for the month of June 2019.
2. Defra 2020 conversion factors for natural petrol and diesel per litre.

Results

The analysis found that 276 tCO_2e were emitted from the consumption of diesel and 39 tCO_2e were emitted from the consumption of petrol on site, see Figure 2.

Figure 2

Emissions from fuel consumption



GHG emissions from fuel on the University estate in tCO_2e

Discussion

The Defra 2020 conversion factors for diesel and petrol were the same as used in the UK GHGI 2018. Again, no exact reference was given for these figures in UK GHGI report for 1990-2018. However, on page 146 of the report it is stated that CO_2 factors are predominantly derived from EU ETS data (2005 onwards), from refinery sector reporting (UK Petroleum Industry Association, 2019) and from the 2004 Carbon Factors Review (Baggott et al., 2004), non-CO_2eFs are predominantly IPCC defaults (IPCC, 2006). It is assumed that the conversion factors for diesel and petrol have come from refinery sector reporting (UK Petroleum Industry Association, 2019). However, as the exact factors used are not given there is no way to verify whether the data used is of a good quality.

Again, the CO_2 conversion factors are based on the same factors used in the UK GHGI and are essentially independent of application as they assume that all fuel is fully oxidised and combusted.

The figures for fuels in the Defra 2020 GHG CFs are based on an activity-weighted average of all the different CH_4 and N_2O CFs from the GHG Inventory. A source for this is not provided.

Recommendations

Vehicle use make ups only a small part of the University's direct emissions. However, these estimations could be improved if the GHGI was more transparent, and the methodology and sources could be verified. A suggested method would be to average the GHG emissions from combustion from a sample of gas stations across the UK using mass spectrometry of gasses emitted upon combustion.

3. Land Use, Land-Use Change and Forestry

Oxford University Estates Services produce an annual report categorising and accounting for all the land that the University owns that is 'non-functional'. The 2020 report stated that the University owns 1,808 hectares of 'non-functional' estate. This includes areas such as woodland, grassland, arable land and bodies of water such as lakes and ponds. All of these features have the ability to sequester or emit carbon emissions depending on their use. Changes in land use can also remove or emit carbon. However, there were no changes in land use in from the academic year 2018/19 to 2019/20 or within the academic year 2019/20. In this report the annual carbon flux of the non-functional estate will be estimated.

Scope

External companies lease 981 hectares of the non-functional estate, mainly for agricultural purposes. Emission sequestration and emissions from land operated by tenants would be categorised under downstream leased assets in Scope 3 emissions using the same methodology. However, due to restrictions associated with the privacy of this information, these emissions have not been reported. The remaining 827 hectares managed by the University are reported as Scope 1 emissions.

Methodology

Emissions from land use are most often reported by companies operating in the agricultural sector and governments. The UNFCCC requires member governments to report on emissions and removals from Land-Use, Land-Use Change and Forestry (LULUCF) as part of their national GHG inventories. For instance, the U.S. Energy Information Administration published a report of 'Emissions of Greenhouse Gases in the U.S.'[12] in 2011 which covered the emissions from LUCLUF. The UK government department BEIS reported the UK's emissions from LUCLUF in the 2020 report 'Mapping Carbon Emissions & Removals for the Land Use, Land-Use Change & Forestry Sector'[13]. The UK report made estimates using dynamic models of changes in stored carbon, driven by land use change data. A model developed and run by Forestry Research was used to report net carbon removals from forestry. This model includes multiple carbon pools, including plant carbon, dead organic matter, soil carbon and harvested wood products. The resulting annual carbon flux is driven by the area of remaining forest land, land newly afforested or converted, and ongoing management practices and harvesting.

Without access to high-resolution or spatially-explicit data, making an estimate of the emissions and sequestration from LULUCF on University property is less accurate but still possible. As with other sectors of the inventory, activity data and emissions factors can be used to estimate annual land carbon fluxes. For this initial estimate, emissions factors have been derived from the BEIS report and the Natural Capital Land Cover in the UK report by the Office for National Statistics in 2018. The average emission factor was estimated by dividing the total country-level carbon flux for each reported land use category by the total amount of that land use type in the UK. While this approach is generally in line with the IPCC's Good Practice Guidance for Land-Use, Land-Use Change and Forestry[14], it results in a very rudimentary estimate that should be improved over time with attention to local carbon dynamics. Uncertainties related to country-level estimates are reported as part of the National Greenhouse Gas Inventory appendices[15]. An opportunity to develop the accuracy of the report in the future would be to apply the NATCAP tool[16].

12 EIA – Greenhouse Gas Emissions – Land use
13 Mapping Carbon Emissions & Removals for the Land Use, Land-Use Change & Forestry Sector: NAEI report 2020 (publishing.service.gov.uk)
14 https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html
15 Brown, P et al. (2020). UK Greenhouse Gas Inventory, 1990 to 2018: Annual Report for submission under the Framework Convention on Climate Change. https://unfccc.int/documents/225987
16 https://www.natcapresearch.com/

A survey of the University's non-functional estate is carried out annually by the Estates Services department. The 2020 survey is shown in Figure 3, and shows that the University's 827 hectares fall mainly into two categories. 751 hectares are classified as woodland (assumed to operate similarly as forest), 72 hectares are classified as grassland, and a further 4 hectares are classified under another 12 categories which for the sake of simplicity will also be considered to operate as grassland in this report.

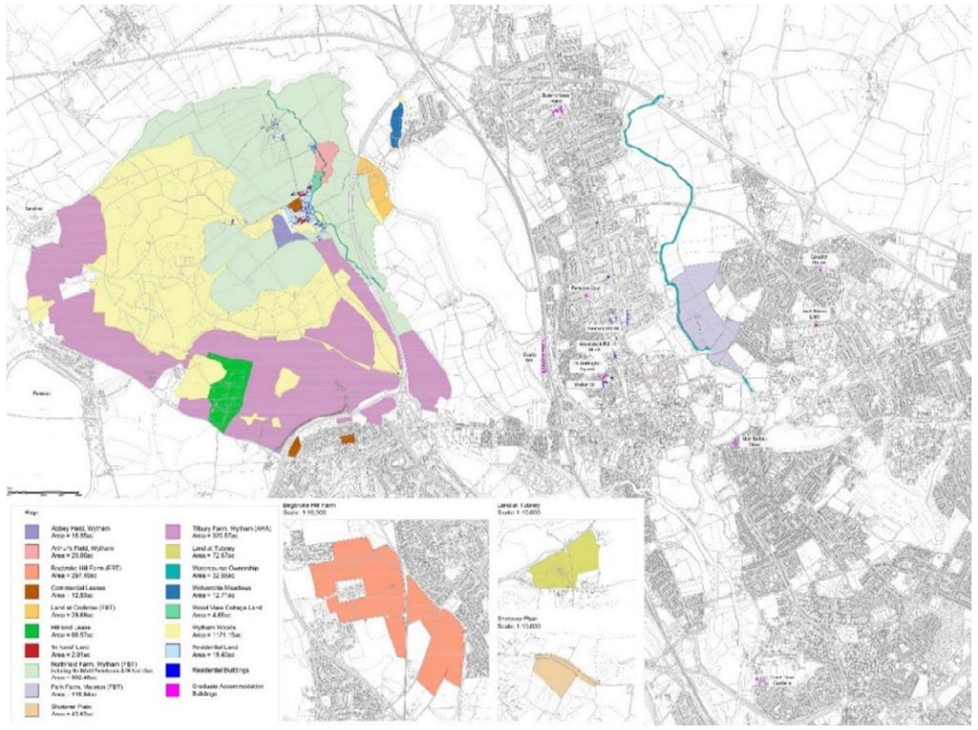
Table 2
Data used to calculate emissions factors for woodland, grassland and cropland in the UK

Land Type	Area (ha)[17]	Emission total from land remaining land ($GgCO_2$)[18]	Emission factor (tCO_2/ha/yr)
UK	24,249,500	-	-
Woodland	2,861,441	-17,136	-5.99
Grassland	9,457,305	-4,503	-0.48
Cropland	4,243,663	15,430.4	3.64

Table 3
Estimated emissions from each type of land managed by the University

Land Type	Area (ha)	Emissions (yr)
Woodland	751	-4,497.4
Grassland	72	-34.3
Cropland	-	-
Other	4	-1.9
Total	827	-4,533.6

Figure 3
The University of Oxford Agricultural Estate Plan on the 02/03/2020



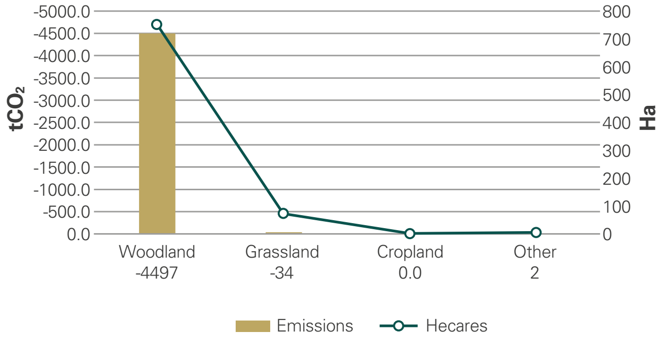
17 UK Natural Capital Land Cover in the UK – Office for National Statistics (ons.gov.uk)
18 Mapping Carbon Emissions & Removals for the Land Use, Land-Use Change & Forestry Sector: NAEI report 2019 (publishing.service.gov.uk)

Data Sources

1. Land use data from the Agricultural Estate Plan on the 02/03/2020
2. UK Natural Capital Land Cover in the UK – Office for National Statistics (ons.gov.uk)
3. Mapping Carbon Emissions & Removals for the Land Use, Land-Use Change & Forestry Sector: NAEI report 2019 (publishing.service.gov.uk)

Results

Figure 4
Emissions from University-managed Non-Functional Estate



Emissions/removals from University-managed non-functional estate.

The emissions from the University-managed non-functional estate are negative. This means the land removed 4,534 tCO_2e from the atmosphere in the academic year 2019/20.

Interpretation of the GHG Protocol and Defra's 'Guidance on how to measure and report your greenhouse gas emissions'[19] suggests that these removals should be included in an organisation's gross CO_2 emissions. This is how these emissions removals have been accounted for in this report. This will remain under review until further guidance is published by the GHG Protocol. Please see Reductions and Removals for further discussion and information on the subject.

Discussion

The results shown in Figure 4 give a first estimate of the amount of CO_2 that the University's non-functional estate is sequestering, based on country-level data. Refining this estimate will require information that is more spatially and temporally resolved.

For instance, the amount of carbon woodland removes from the atmosphere in any given year depends on a host of factors, such as average tree age, species, soil type, weather conditions, and forest management.

Recommendations

A relationship with researchers at the University of Maryland, Dr. Rachel Lamb[20] and Professor George Hurtt[21], has recently been established as part of this project. These two academics have considerable experience in estimating land carbon dynamics on a regional, state, and local scale and currently run a multi-year project at the University of Maryland to evaluate the forest carbon fluxes on University-owned and -managed properties[22]. This work leverages science they developed as part of NASA's Carbon Monitoring System (CMS)[23] which couples high-resolution remote sensing data and ecosystem modelling to map and annually monitor forest carbon at 90-meter resolution[24].

Rachel Lamb has provided a series of recommendations to improve the estimates of emissions and removals from the University's non-functional estate depending on the data and financial resources available. One potential next step could be a collaboration between University's academics and students.

Firstly, a more accurate representation of the carbon removals from the University's non-functional estate could be calculated by finding a more localised emission factor for each land type. This could be done using the total flux from each land type within Oxfordshire and dividing the total by the respective area of each land use type. This information is not readily accessible online but is recorded by the National Atmospheric Emissions Inventory as indicated in their report on historical land-based emissions from local authority areas in the years 1990-2018[25]. This is a more spatially resolved estimate but may still mask heterogeneity among forests within Oxfordshire and on Oxford property.

Field data or remote sensing data may be required to create a more robust baseline estimate of carbon stocks, and enable more dynamic carbon monitoring over time. Using established sampling methodologies, a forest field inventory could be compiled.

19 Guidance on how to measure and report your greenhouse gas emissions (publishing.service.gov.uk)
20 https://geog.umd.edu/facultyprofile/lamb/rachel
21 https://geog.umd.edu/facultyprofile/hurtt/george
22 https://geog.umd.edu/project/campus-forest-carbon-project
23 NASA Carbon Monitoring System
24 Hurtt et al. 2019 https://doi.org/10.1088/1748-9326/ab0bbe;
Ma et al. 2021 https://iopscience.iop.org/article/10.1088/1748-9326/abe4f4;
Tang et al. 2021 https://iopscience.iop.org/article/10.1088/1748-9326/abd2ef/meta
25 Mapping Carbon Emissions & Removals for the Land Use, Land Use Change & Forestry Sector (publishing.service.gov.uk)

This involves manually counting the number of different types and sizes of trees, shrubs and grass, plus taking soil samples for analysis. At 3–5-year intervals, these surveys could be conducted again to determine changes in carbon stocks. This stock-change approach is one way of estimating average annual forest carbon fluxes. For further information on this method please see the LULUCF guidance for GHG project accounting[26].

An alternative method is to use LIDAR data to determine baseline carbon stocks and then use ecosystem modelling and optical imagery (e.g., Landsat data) to determine annual carbon fluxes in between LIDAR surveys. More information about how to carry this method out can be found in guidance published by the University of Maryland[27]. The UK government's Environmental Agency is currently running the National LIDAR Programme[28], which began in 2016 and is due to be completed at the end of 2021. This programme aims to provide accurate elevation data at 1m spatial resolution for all of England by dividing the country into 230 blocks. An area including the city of Oxford was surveyed on 15/3/2020 with a 1m resolution; the survey ID was '20-088 [2020/03/15]'[29]. The data should be used in LULUCF flux calculations in future carbon accounts with further guidance from the aforementioned academics at the University of Maryland.

4. Fugitive Gases

The release of fugitive gases from appliances such as refrigeration or air conditioning units is a relevant source of emissions for an institution such as the University. Historically this equipment utilized various Ozone Depleting Substances (ODSs) such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). Hydrofluorocarbons (HFCs) and, to a lesser extent, perfluorocarbons (PFCs) are used as substitutes for the regulated ODSs. In addition, some air conditioning and refrigeration systems use non-halogenated refrigerants such as ammonia, carbon dioxide (CO_2), propane, or isobutene. Emissions from the refrigeration and air conditioning sector result from the manufacturing process, from leakage and service over the operational life of the equipment, and from disposal at the end of its useful life. All these emissions fall under Scope 1.

This report does not have access to the necessary information to account for fugitive gas emissions in this GHGI. However, policy is currently being developed to correct for this. Therefore, this section of the report is dedicated to defining a methodology and the data that would be required to account for fugitive gas emissions in future reports.

Methodology

SECR – the UK government's environmental reporting guidelines (Environmental Reporting Guidelines (publishing.service.gov.uk)) – gives two methods in Annex C: GHG Emissions from Use of Refrigeration, Air Conditioning Equipment and Heat Pumps p.98. These are the Screening Method and the Simplified Material Balance Method. Both methods were originally published by the EPA in 2004 in the Direct HFC and PFC Emissions from Use of Refrigeration and Air Conditioning Equipment (epa.gov) with additional information published by the agency in 2014 in Greenhouse Gas Inventory Guidance: Fugitive Emissions (epa.gov). Additionally, the Method for Purchased Gases should be used to estimate the effective carbon impact of GHGs purchased for laboratory use. This method, shown below, has been adapted from the EPA's Greenhouse Gas Inventory Guidance: Fugitive Emissions.

The screening method relies on the use of emission factors which are equipment-specific. The disadvantage of using this approach is that emission factors are uncertain. Therefore, this method is proposed as a screening test only in the first few years of accounting for fugitive gases. The simplified balance sheet method calculates the fugitive gas emissions using inventory and servicing data without tracking stocks of refrigerants. If the screening method indicates that there are significant emissions from fugitive gases, then the simplified balance sheet method should be used to more accurately determine the GHG emissions from fugitive gasses.

The detailed methodology for F-Gas calculations can be found in Annex D.

26 The Land Use, Land-Use Change, and Forestry Guidance for Greenhouse Gas Project Accounting | World Resources Institute (wri.org)
27 https://mde.state.md.us/programs/Air/ClimateChange/MCCC/MWG/Maryland%20Forest%20Carbon%20Inventory_briefing.pdf
28 National LIDAR Programme – data.gov.uk
29 EA LIDAR Survey Plan Dashboard (arcgis.com)

Recommendations

The factors used to convert each type of gas emission into GWP in tCO_2e should be sourced from EPA 2014, which referenced the 100-year GWPs from Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (2007).

To complete emissions analysis using the Method for Purchased Gases, the policy should require that all departments record:

- The amount of gas purchased.
- The proportion of gas released during laboratory processes (%).
- The amount of gas produced and then released in laboratory processes.

To complete emissions analysis using the Screening Method, the policy requires that all departments record:

- Refrigerant capacity of new pieces of equipment.
- The amount of refrigerant charged into new pieces of equipment.
- Assembly losses as a percentage of the amount charged into new equipment.
- Annual leak rate of equipment.
- The refrigerant capacity of pieces of equipment being disposed of.
- The percentage of the capacity remaining at disposal.
- The percentage of refrigerant recovered from equipment disposed of.

In future reports, the Simplified Balance Sheet Method would be used for determining the emissions from refrigerating and cooling units if the GHG emissions from this source are relatively high.

To do this, the policy should require that all departments keep records of:

- The amount of Global Warming Potential gases purchased for laboratory or other use.
- The estimated proportion of this gas that is released, during laboratory procedures or otherwise.
- Estimates of the amount of Global Warming Potential gases that are created and released during laboratory processes.
- The type of GWP gas used in any cooling or refrigerating equipment.
- The amount of gas used to charge new equipment.
- Total refrigerant capacity of any new refrigerating or cooling equipment.
- The amount of gas used to service equipment.
- The total capacity of equipment disposed of.
- The amount of gas recovered during disposal.

Scope 2 Emissions

Introduction

Scope 2 emissions are indirect emissions from the generation of purchased electricity, steam, heat, or cooling from the utility provider. The University does not purchase any steam, heat, or cooling but does buy all electricity on a Renewable Energy Guarantee of Origin (REGO) backed tariff. This electricity is provided through the grid. As a standard from the Higher Education Statistics Agency (HESA) Estates Management Record (EMR), reporting electricity transported through the grid is accounted for at a grid factor rate. Additional electricity is produced by onsite PV. The operation of PV produces zero emissions and has been accounted for as such in this scope. However, emissions from the production of the equipment are accounted for in Scope 3. In this report, the annual effective carbon emissions from electricity consumption have been calculated. The seasonal average emissions from electricity consumption from the grid throughout a day have also been calculated so that recommendations on electricity consumption can be made relative to the carbon intensity of the grid.

Methodology

Process for calculating annual emissions from electricity:

1. Sum half-hourly electricity consumption across all half-hourly meters to find the half-hourly electricity consumption across the entire reporting period on the estate.
2. Multiply consumption by the half-hourly carbon intensity of the grid at that point in time to produce emissions for each half hour across the reporting period. This data is provided by the National Grid ESO in gCOw/kWh.
3. Sum across all half-hourly periods to find the total tCO_2 from electricity reported on half-hourly meters.
4. Not all electricity meters across the University report consumption, so emissions need to be scaled up to cover all consumption across the estate. The assumption is made that electricity consumption in these areas has on average the same carbon intensity as the majority of the estate.
5. Divide the total consumption on half hourly meters by total consumption across all meters on the estate to find the fraction of consumption on half hourly meters, 94%.
6. Divide emissions from half hourly meters by fraction of consumption reported by the half hourly meters.
7. Use Defra 2020 conversion factors to convert kg CO_2 to kg CO_2e, kg CH4 and kg N2O.

Process calculating for seasonal and termly average time-varying emissions:

1. Sum half hourly electricity consumption across all meters in the data set.
2. Multiply consumption by carbon intensity to get emission for each half hour across the reporting period.
3. Average across each season/term.

Seasons: Summer – June, July, August; Autumn – September, October, November; Winter – December, January, February; Spring – March, April, May.

2019/2020 terms at the University of Oxford: Long Vacation (LV) 01/08/2019-06/10/2019 + 20/06/2020-30/07/2020, Michaelmas Term (MT) 07/10/2019-07/12/2019, Winter Vacation (WV) 08/12/2019-19/01/2020, Hilary Term (HT) 20/01/2020-14/03/2020, Easter Vacation (EV) 15/03/2020-6/04/2020, Trinity Term (TT) 27/04/2020-20/06/2020.

Data sources

1. Electricity consumption across the estate through meter readings found on SystemsLink.
2. Defra 2020 conversion factors.
3. Carbon intensity of the national grid for each half hour https://data.nationalgrideso.com/carbon-intensity1/historic-generation-mix

Results

Total annual emissions: tCO_2e = 22,883
tCO_2= 22,677
tCH_4 = 70
kg N_2O = 135

The graphics below show the average emissions, consumption and carbon intensity of the electricity delivered from the grid, reported on the half-hourly meters across the University.

Figure 5
Average electricity consumption across a day for each season

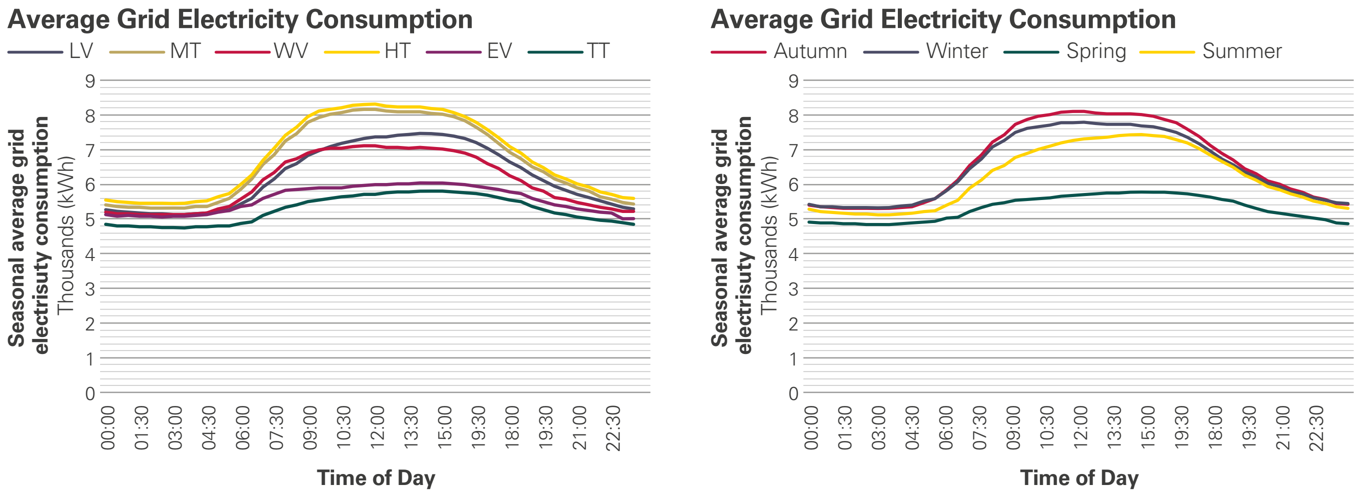


Figure 6
Average carbon intensity of the grid across a day for each season

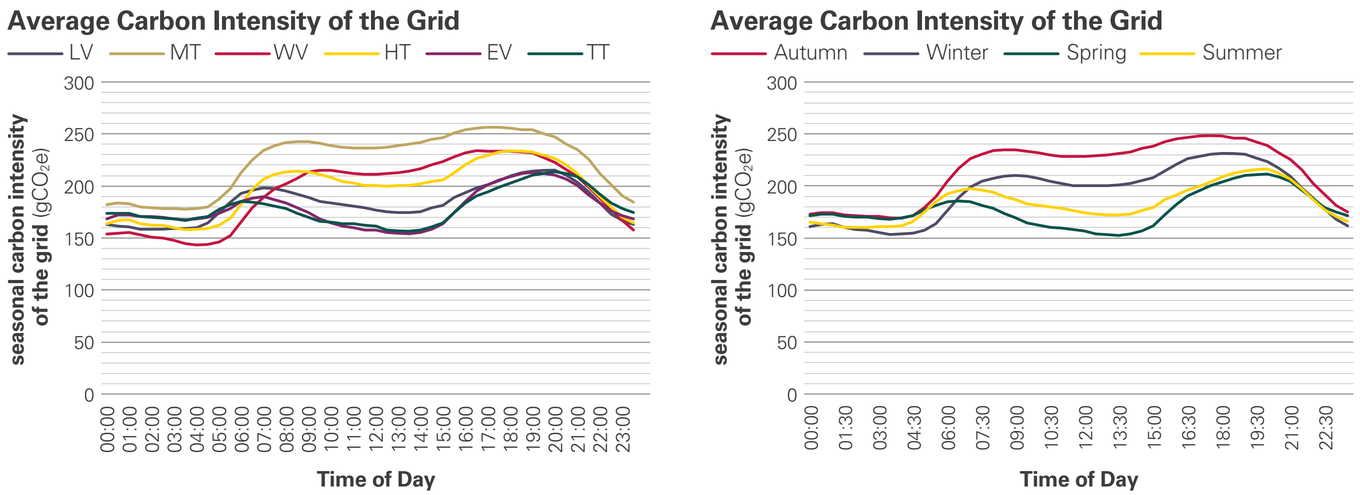
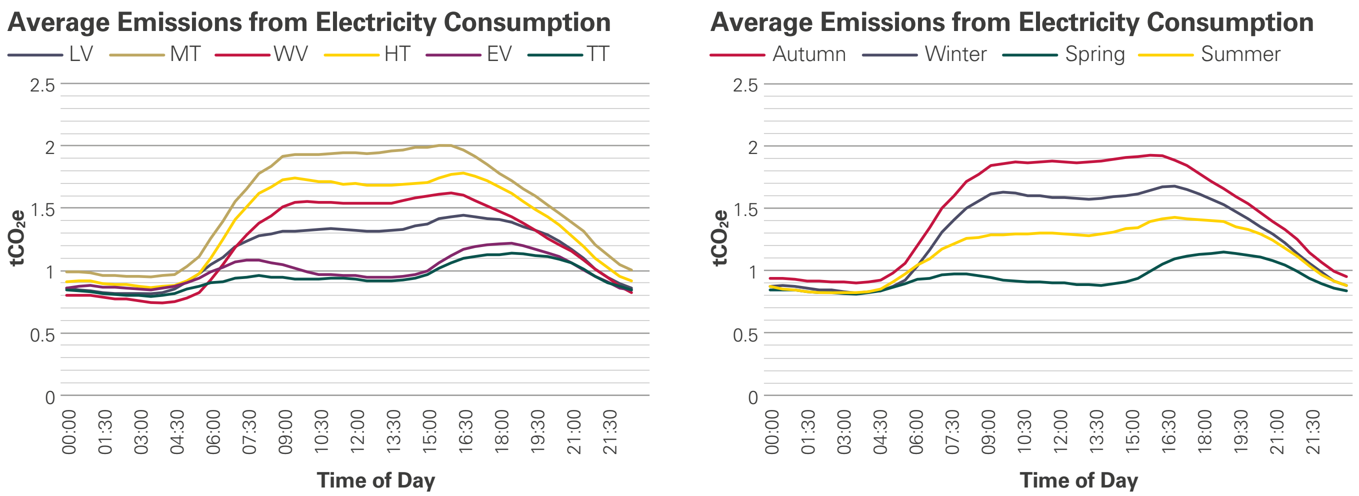


Figure 7
Average tCO_2e emissions from electricity across a day for each season



Discussion

The emissions calculated using the Defra 2020 conversion factor for the EMR report 2019/20 were 22,883 tCO_2e for University consumption. The Defra 2020 CF was sourced from the GHGI from 1A1ai (power stations) and 1A2b/1A2gviii (auto generators). Again, the exact sources for emission factors are given but reference is made to the general factors that were used for 'Power stations, refineries, and other energy industries'.

Emission Factors: Carbon factors are predominantly derived from EU ETS data (2005 onwards), from refinery sector reporting (UK Petroleum Industry Association, 2019) and from the 2004 Carbon Factors Review (Baggott et al., 2004), with some solid fuel factors derived from UK research (Fynes and Sage, 1994); non-CO_2eFs are predominantly IPCC defaults (IPCC, 2006).

An annual average of the energy mix provided by DUKES (Digest of United Kingdom Energy Statistics) was then used to calculate the overall emission factor, assuming that renewable energy (excluding bioenergy) produces zero emissions. National Grid ESO gives no reference for the sources of emissions factor used, but using this data gives a more accurate prediction of actual carbon emissions from consumption for times at which energy is consumed in the University.

The results in Figure 6 show that the average seasonal carbon intensity of the grid is highest during the autumn. This is likely due to the energy mix being low in both wind and solar energy. The carbon intensity of the grid is lowest during the spring because of the high amounts of both wind and solar energy being produced. Figure 5 additionally shows that energy consumption across the estate is highest during the autumn, most likely due to student activity in Michaelmas term, shorter days, and colder temperatures. Consumption is lowest in the spring. This is most likely because the Easter vacation falls in this window, meaning lower student activity, warmer weather, and longer days. The result of this is that electricity consumption across the estate produces the most emissions in the autumn and the least in the spring.

The University purchases its electricity on a REGO backed tariff from Scottish Power. Therefore, the total emissions in Scope 2 have been counted as zero in the University net CO_2e emissions. For more information on this accounting process please see Offsets.

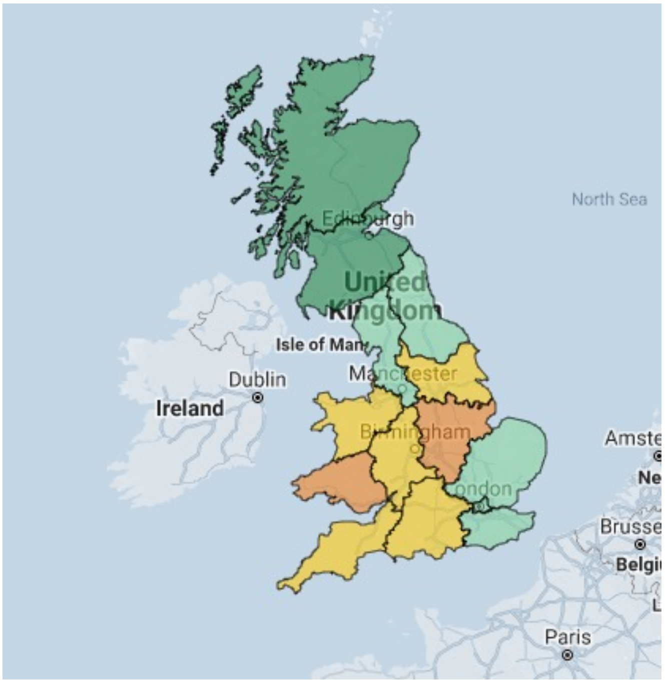
Recommendations

Figure 8 shows the regional carbon intensity of the National Grid in different areas of the UK. The city of Oxford is in the South England region supplied by Scottish and Southern Electricity Networks. The method used in this report could be improved by using regional carbon intensity of the grid to calculate the total and seasonal average emissions from electricity consumption. Although following further discussion with Oxford academic colleagues, the recommendation to use national data was followed. The regional carbon intensity map was produced through a collaboration with the National Grid ESO and members of the Department of Computer Science at the University of Oxford.

National Grid ESO should additionally be contacted to find the source of the emission factors used to calculate the half hourly carbon intensity of the grid. It is very likely that the GHGI would have been used by National Grid ESO, but this assumption needs to be verified.

Figure 8

Screen grab of the regional carbon intensity of the grid in different areas of the UK at 13:30 30/08/2021 from https://carbonintensity.org.uk/



Key: Very High - High - Moderate - Low - Very Low

Scope 3 Emissions

Introduction

Scope 3 encapsulates all indirect emissions, not included in Scope 2. Scope 3 emissions occur from sources owned or controlled by other entities in the value chain and third party payments (e.g., materials suppliers, third-party logistics providers, waste management suppliers, travel suppliers, lessees and lessors, franchisees, retailers, employees, and customers). This scope is further divided into upstream and downstream emissions. Upstream emissions are those emitted from goods and services purchased by the University. Downstream emissions are those related to sold goods and services. None of the original downstream emissions categories relate to the products that the University sells. The Protocol splits upstream and downstream emissions into eight and seven possible different categories, respectively. All upstream and downstream Scope 3 emission categories can be seen in Table 4.

Table 4

Scope 3 upstream and downstream emissions categories as define by the GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard[30]

Upstream Category	Downstream Category
1. Purchased goods and services	9. Downstream transportation and distribution
2. Capital goods	10. Processing of sold products
3. Fuel- and energy-related activities (not included in Scope 1 or Scope 2)	11. Use of sold products
4. Upstream transportation and distribution	12. End-of-life treatment of sold products
5. Waste generated in operations	13. Downstream leased assets
6. Business travel	14. Franchises
7. Employee commuting	15. Investments
8. Upstream leased assets	16. Student commuting

Category 8: Upstream leased assets have been included in the emissions reporting for Scope 1 and 2, and therefore are not reported in Scope 3. An additional downstream category has been added into this report, 16: Student commuting. This is to better reflect the actual emissions emitted from the sale of goods and services from higher education institutions. The product commoditised in higher educational institutions is knowledge and educational experiences. Because of this, downstream categories 9, 10 and 12 do not apply. The University does not monitor the carbon impact of leased assets as a matter of contractual compliance; therefore category 13 has also been discounted. Additionally, the downstream effects of new knowledge on attendees to the University has not been quantified in this report therefore downstream categories 11 have also been discounted. For further information on this effect, please see work on the carbon brain print[31]. Downstream categories 14: Franchises and 15: Investment have not been included in this report for the sake of relevance. Although the University does franchise the brand and make investments, the GHG protocol makes clear that these two categories are intended for a different company model.

30 GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard
31 https://www.sciencedirect.com/science/article/abs/pii/S0957582015000865

1 and 2. Purchased goods and services and Capital goods

Scope and Boundaries

Emissions categories 1 and 2 contain all the operations in the University's value chain that are not included in the other six upstream Scope 3 categories. Upstream categories 1 and 2 have been combined because the data on purchases of capital goods, non-capital goods and services are all reported through the same financial software, Oracle. All purchases made by University employees for the operation of the University are recorded through this software. Also included in this analysis are third party payments, including those for taxation and pension funds. Data sourced from this software provided by the Oxford University Purchasing Department (OUPD) has been used to estimate emissions from purchased goods and services. The following categories have been excluded from detailed calculations of emissions from this emission category, instead being extrapolated from the accounted emissions and listed under 3.1.7 Uncategorised goods & services: Temporary Staff, Staff Costs, Bursaries Grants & Teaching, Travel & Subsistence, Oxford Hosted Conferences, Couriers, Postage & Delivery, Utilities and Waste.

As the University's supply chain is so varied and distributed, several different methods have been used to estimate the emissions from different areas of the procurement inventory. For each item in the inventory of procurement data from OUPD, a description of the item bought, the company it was purchased from and the time it was purchased is given. Additionally, each purchase is categorised into one of 253 categories which fall into 34 different category groups. The information from each purchase is provided by the purchaser and there is therefore an unquantified uncertainty in the data provided. Additionally, the descriptions of items are not standardised and so cannot be used for broad data analysis. Because of this, information on supplier and category has been used to estimate emissions from the University supply chain inventory.

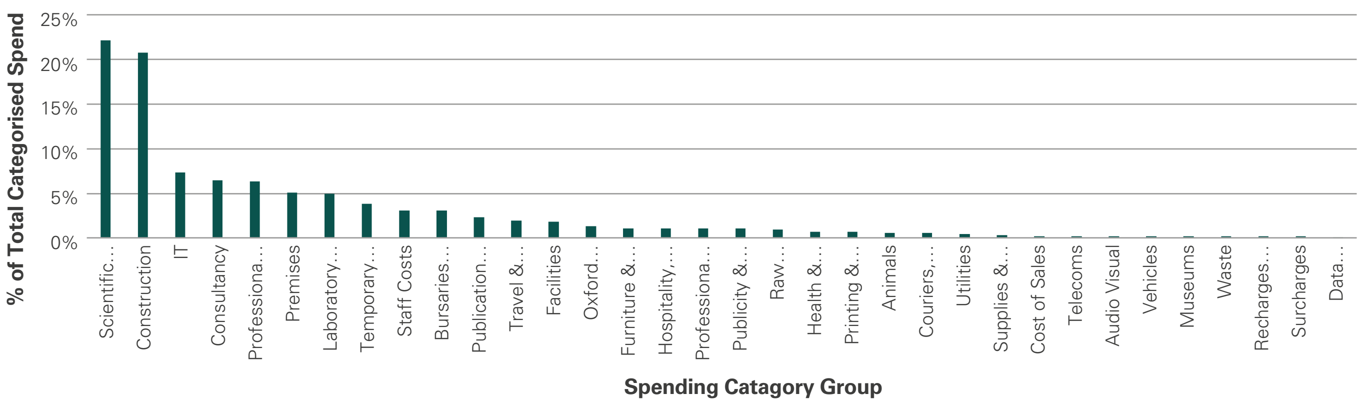
Methodology

The spend category 'Missing Value', which contains uncategorised purchases, has been included in this analysis. This primarily consists of third party payments and is therefore more difficult to assess and quantify. To account for the uncatagorised spend, largely made up of third party payments, a rudimentary extrapolation from the main body of Category 1&2 emissions was undertaken. The £/tCO_2e factor derived from Category 1 and 2 was applied to the Missing Value Spend and included as 3.1.7 Uncategorised goods and services. This value was 98,034 tCO_2e discounted from this analysis as the category was not homogenised enough to make any reasonable estimates of the emissions. A large proportion of the inventory, 58.2%, was categorised under this heading. Since initial publication of this report, further understanding of spend catagorisation has been developed. This will be included in future iterations of the report, offering an opportunity to further refine the accuracy of supply chain emissions accounts, in particular third party payments. Spend and suppliers in the remaining 33 category groups will be referred to as 'categorised' spend and suppliers. These have been used to find emissions 'hot spots' in the University's supply chain.

Figure 9 shows a bar chart of category groups organised in descending order of spend. The top seven category groups account for 81% of the University purchasing inventory. Because of the heavy weighting towards the category groups: Scientific and Medical Equipment & Supplies, Construction, IT, Consultancy, Professional Services and Premises, the emissions from each of these categories has been used to estimate the emissions from the University's purchased goods and services supply chain. The assumption is that the remaining 19% of the purchasing inventory has the same cost-based carbon intensity as the top 81%. The remainder of this section of the report looks at how emissions from each of these categories has been estimated and then analyses the results to estimate the total emissions from the University's purchasing inventory.

Figure 9

Proportion of spend by category group



Emissions from the Top Seven Spend Categories

Where possible, data received directly from suppliers has been used to estimate emissions for each category. In the academic year 2019/20 the University purchased goods and services from 10,618 categorised suppliers. 68 suppliers accounted for the top 50% of spend in 2019/20. The cross-over between top suppliers and top spend categories has been utilised to make the most accurate assessment of emissions from the University purchasing inventory. A survey of key suppliers from each spend category in 2019/2020 was used to determine a University-specific spend-based emission factor. The exception to this is construction and business services. Construction purchases were analysed separately due to the existing contractual arrangements for the University's construction projects; please see Construction within this section for further details. Where data could not be sourced from suppliers, HESCET data analysis was used as a substitute. Business Services were analysed separately because many of the companies that provide the University with business services operate across a variety of other activities. Please see Consultancy and Professional Services for further information on this.

All suppliers in the top 50% spend that fell within the spend categories of Scientific and Medical Supplies, IT, Premises and Laboratory Services were contacted and asked to fill in a survey. This was to help determine University emissions associated with the goods and services purchased in each spend category, and the quality of the data that they used. The survey, shown below, requests the carbon emissions related to the actual purchases made by the University, the supplier's total carbon emissions, and the proportion of that organisation's total annual revenue that came from the University of Oxford in the financial year 2019/20. This helped estimate the organisation's total emissions associated with University activity in the year 2019/20. This survey was formulated using guidance from the GHG Protocol Supplier Engagement Guidance[32]. Questions were also added to assess the organisation's historical emissions accounting practices and appetite for emissions accounting in the future. For each of the spend categories at least one organisation was able to provide sufficient information to estimate a University-based emission factor. This factor was then applied to the entire spend category. This may underestimate emissions as those organisations that are actively managing and accounting for emissions might be likely to have less carbon intensive processes. The results of the survey and a detailed case study on a key supplier are given below.

The questions included in the survey can be found in Annex E.

Scientific and Medical Equipment & Supplies – Merck Life Science

20 of the suppliers in the top 50% of the categorised spend fall under the category Scientific and Medical Supplies. Of these 20 companies, eight responded to the survey. None were able to supply the carbon emissions data related to the products they supplied to the University but all could provide total company GHG emissions for the financial year 2019/20. Several were able to respond with their Scope 1 and 2 emissions and the proportion of their revenue that comes from the University of Oxford. However, as many of these suppliers do not manufacturer all the goods they sell, the Scope 1 and 2 emissions do not correspond to the total emissions related to the manufacture of a product. Merck Life Science, the University's second-largest supplier in the Scientific and Medical supplies category (12th highest supplier overall) was able to provide information on the company's total Scope 1, 2 and 3 emissions for the FY 2020. This has been assumed to be approximately the same as the emissions produced by the company in the academic FY 2019/20.

As of 2015 Merck Life Science included Merck, Millipore UK Ltd, and Sigma-Aldrich Chemie GmBH. These companies are still often reported separately in procurement statements. Merck Scope 1 and 2 emissions for the FY 2020 were reported as 304,260 tCO_2e. Scope 3 was reported to the University internally prior to publishing. Merck followed the GHG protocol when reporting emissions. Merck Group will be reporting on all categories of Scope 3 except categories 8, 10, and 14 as these are not relevant for Merck. Spend-based emission factors were used to calculate emissions from ECLI 3.1-2. The data collected by the company was rated as Very Good in terms of Technology and Timeliness, Good in terms of Geographical relevance and Reliability and Fair in terms of Completeness by Merck's Head of Sustainability Jeffrey Whitford. Please refer to Annex C for an explanation of these ratings. Uncertainties in emissions estimates stem from unknown electricity grid emissions factors in international operations, extrapolation of data from samples and using data that has not been audited/verified. KPMG has been involved with a limited assurance audit and will be involved each year moving forward. The company plans to reduce Scope 1 and 2 emissions in the future by using a higher proportion of renewable energy to operate its sites and investing in facilities enhancement to make sites more efficient. The company is reducing

32 https://ghgprotocol.org/sites/default/files/standards_supporting/Supplier%20Engagement%20Guidance.pdf

Scope 3 emissions using a system called Design for Sustainability, which helps to address reduction of CO_2 in multiple phases (at the R&D level and during the lifecycle, as we consider opportunities to re-engineer products) as well as starting to engage with suppliers and increase renewable energy supply and deliver route optimization. The University provides 0.053% of the company's total revenue FY 2020 meaning that the proportion of Merck's emissions that the University should account for is 766 tCO_2e.

Merck Life Science accounts for 4% of the University's total spend on scientific and medical equipment in the academic year 2019/20. Extrapolating the emissions from Merck Life Sciences supply to the entire Scientific and Medical Equipment spend category estimates the emissions from this category at 18,888 tCO_2e. This results in a spend-based emissions factor of 0.198 $kgCO_2e/£$.

Information Technology – Dell

Four of the suppliers in the top 50% of the categorised spend fall under the group of IT supplies. They collectively account for over a third of all IT suppliers. Of these four suppliers Dell Corporation Ltd accounts for nearly two thirds of this supply. Dell Corporation Ltd and Insight Direct (UK) Ltd are able to provide an emissions account of the products bought by the University from these companies whilst the other two suppliers were able to supply total Scope 1 and 2 emissions and proportional revenue from the University. At the time of writing, only Dell Corporation Ltd submitted an itemised carbon report showing that the total emissions from University supply from the company were 2,619 tCO_2e. The carbon emissions from every product Dell sells is available through its website[33]. A company that Dell is supplying can ask for the emissions associated with the manufacture, delivery, use and disposal of any and all products that Dell has sold them. After consultation with the University key contact at Dell, this data has been rated very good (VG) in terms of technology, relevance and completeness and geography and good (G) in terms of timeliness as emissions are calculated at launch, University equipment would usually be less than 6 years old. This was used to calculate a spend-based emission factor to find the total carbon emissions from this category as 11,341 tCO_2e. This results in a spend-based emission factor of 0.356 $kgCO_2e/£$.

33 Product Carbon Footprints | Dell Technologies US

Consultancy and Professional Services

Consultancy and professional services have been grouped under business services and assessed using HESCET data analysis. This is because these services may not generally occur in the operation of the company that these services have been purchased from. Emissions from this sector were found to be 622 tCO_2e.

Premises

Four of the suppliers in the top 50% of the categorised spend fall under the group of premises services. Richard Ward (Oxford) Ltd is a company based in Oxfordshire that specializes in bespoke construction and historical maintenance. The company is the University's third-largest supplier of premises maintenance services with 4.45% of the University's premises maintenance supply sourced from the company. The emissions accounts of this company have been used as a case study for this report because of the company's high level of transparency in its carbon accounting procedure. In the FY 2020 the company recorded emissions from Scope 1, 2 and some 3 (commuting, waste, water, energy). These emissions multiplied by the proportion of revenue that came from the University resulted in emissions produced by the company as a result of supplying the University at 20 tCO_2e. Using this case study as the source for a spend-based conversion factor results in the total emissions from the Premises spend category being 382 tCO_2e. This results in a spend-based emission factor of 0.018 $kgCO_2e/£$.

The emissions reported by Richard Ward do not include emissions from materials supply but do include emissions from electricity consumed in the manufacturing process in the joinery workshop. The data provided by the company has been rated as very good (VG) in terms of time, relevance, technology and geography by poor (P) in terms of completeness as many Scope 3 emissions are currently unknown.

A spokesperson for the company has said that it would be willing to provide a volume-based materials inventory in future years if requested but would need guidance from their sustainability department on how to do this accurately. This data could then be used by a third party to calculate emissions from materials in a straightforward way using the same method that has been used in Construction.

The University could support premises maintenance suppliers in reducing emissions by installing electrical charging points across its estate to support service providers renewing their fleet using electrical vehicles.

Laboratory Services

Five of the suppliers in the top 50% of the categorised spend fall under the group of laboratory services. These account for 55% of spend in this category group. However, none were able to provide emission data as this is not something they have previously be asked for. Both institutions plan to provide these numbers for the next academic year. Currently this emission category has been included in 3.1.7 Uncategorised goods and services.

Construction

Construction supply chain emissions are calculated using a different methodology to the above examples. Significant supply chain data is available using industry standard software. This has been applied to a specific University project and then extrapolated across remaining in year activity.

Upfront embodied carbon is the tCO_2e associated with the product and construction process stages of the project. This includes emissions related to extraction, manufacture, transportation and assembly of material in the construction process. As estimates of this are most accurate when a building is completed, the embodied carbon associated with the construction has been accounted for in the year that a site is handed over from the contractors to University operation. In the academic year 2019/20, 14 construction projects were completed. Construction catagory emissions have been estimated using a case study of the Global Health Institute construction project, with handover predicted in 2023/24. The emissions from construction were assumed to be proportional to the Gross Internal Area (GIA) of the building. Therefore, this case study was used to calculate an emission factor based on this metric.

Global Health Institute Case Study

CPW are an engineering consultancy that provide life cycle emissions modelling services to the University. This work is conditioned to estimate the emissions associated with the construction, operation and end-of-life management of the building. In its life cycle assessment, the company use OneClick software. Many other life cycle assessment software packages are on the market, but OneClick stands out for its ability to support over 50 types of standards and certifications including the PAS 2080, BS EN 15978: 2011 and ISO 14067 as well as the availability of accurate data to complete emissions standards. This follows the GHG protocol data collection of using primary data when available and high-quality secondary data sources when it is not. The GIA of this project is proposed to be 4,552m^2 and total upfront embodied carbon of the project would be 3,167tCO2e, resulting in an emissions factor of 0.7tCO2e/m2. This would be more appropriate for calculating emissions from construction than using the full life-cycle embodied carbon over the 60 year-lifecycle, which would be calculated annually elsewhere.

Methodology

In the year 2019/20 14 buildings were completed. The GIA of each building was ascertained from the project manager of each construction project. This was used along with emission factor calculated from the Global Health Institute case study to build to find an estimate for the total emissions of construction for the University of 7,471 tCO_2e, based on the total project cost of completed projects in this year. The total spend on these 14 construction projects accounts for 31% of the cost of construction across the University estate. These 14 projects and related spend were used to calculate a spead-based emissions factor of 0.00027 tCO2e/£. Applying this factor to the rest of the spend category equates to 23,966 tCO_2e from construction spend during 2019/20.

Other Goods and Services

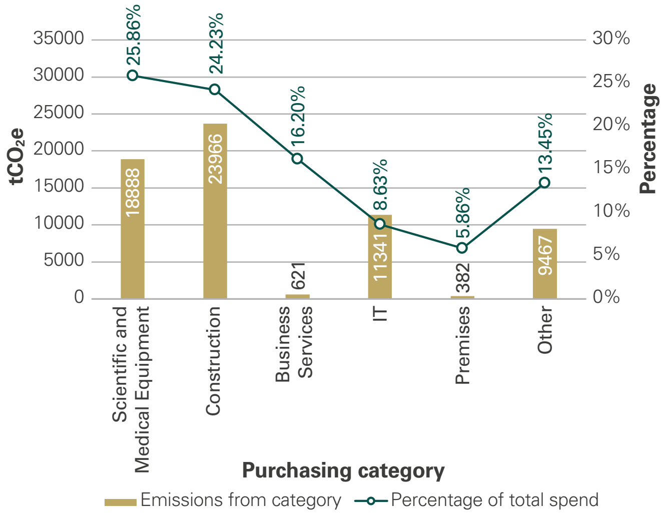
Emissions from the remaining 19% of spend were assumed to be emitting the same average emission factor as the top 81% of spend by averaging the emissions across that 81%. Taking a weighted average of the emissions factors for the top 81% of the spend resulted in an emissions factor of 0.164 tCO_2e/£. Applying this to the remaining categorised spend resulted in an estimated 9,467 tCO_2e being produced from the remaining inventory.

Results

The results in Figure 10 show the emissions from the top spend categories that could be calculated in the time period of this project. This data was used to estimate the emissions from total purchase of goods and services as 63,773 tCO_2e.

Figure 10

Emissions from Purchased Goods and Services



Results of analysis of emission from purchase of goods and services

Discussion

A significant proportion of supply chain emissions were reported as categorised during the initial review of data. Since this review, new ways of analaysing this data have emerged enabling a more accurate representation of supply chain emissions. These will be incorporated in future iterations of the Emissions Report. Oxford University Purchasing Department and Estates teams continue to work closely to refine the data sets used to compile emissions reports. For the purposes of this review, the available emissions were extrapolated to 100% resulting in additional Uncategorised goods and services emissions of 98,034 tCO_2e. This is a large assumption that needs to be addressed. It is likely to overestimate emissions as many of the goods and services include taxation and consultancy, which are likely to have a lower actual conversion factor that the goods and capital equipment accounted for. Additionally, this method requires suppliers within the same spending group category to be relatively homogenous in terms of carbon emission per spend. This assumption may not be accurate given the span of current group spending categories. For instance, premises covers categories from rent to tax to flooring.

In scientific and medical supplies, the upstream and downstream emission were not separated in Merck's sustainability report meaning that double counting has occurred for this spend category and emissions from this category are an overestimate. The emission factor used for Business services in HESCET has no sources, so the quality of this data is unknown. Only some Scope 3 emissions were reported by Richard Ward meaning that the emissions estimate from premises are an under estimation. With the inclusion of additional Scope 3 emissions categories in this analysis in future years, this emission factor is expected to be closer to that of construction. The emission factor calculated from the GHI case study was for a new build. Four of the 16 construction projects completed in 2019/20 were refurbishments of existing buildings. The factor may not apply so directly for these type of construction projects, so the emission calculated for this spend category are possibly an over estimation. The upcoming refurbishment of the Sherrington building will include LCA and therefore provide additional data for future iterations of this report.

Following the HESCET methodology with the same datasets presented above would provide emissions outputs that are 5-10 times larger than those calculated using the method presented in this report. The emissions for laboratory services calculated using HESCET would be 194,063 tCO_2e. For IT supplies they would be 45,100 tCO_2e. For other goods and services they would be 50,758 tCO_2e. There is no source given for the emissions factors used in the HESCET tool. Despite requests to the authors during the course of writing this report, no additional sources were found. Due to the uncertainty of their source data all HESCET emission factors are rated Poor across all GHG protocol data quality metrics.

Recommendations

University supply chain emission estimates could be improved if a higher proportion of University spend was catagorised accurately and consistently. The United Nations has developed the United Nations Standard Products and Services Codes (UNSPSC)[34]. This is an example of a more detailed, codified system for catagorisation of organisational spend, used in some organisations. The University has applied this methodology in the past, although at the time it was was not adopted widely by end users. The University continues to develop internal processes and procedures to develop a comprehensive coding system that can be easily understood by end users, and readily applied by all relevant staff. The balance between detail and ease of use continue to be refined.

Because of the stark difference between the results of the HESCET tool and this methodology, and the unknown origin of the HESCET emission factors, it is not recommended that HESCET be used for future calculations of University emissions from the supply of goods and services.

The University could request itemised carbon accounts from all suppliers in purchasing contracts. This is not something that many suppliers are currently carrying out, considering added requests to all tenders and quotation documents could accelerate this outcome. Additionally the University could ask suppliers to provide estimates of their Scope 1, 2 and 3 emissions, and of the proportion of their annual revenue that comes from the University. This would mean this process can be repeated annually, and that the data is readily available to make calculation of emissions from each spend category. For emissions from construction, it is recommended that life cycle emission analysis should be carried out for all construction projects completed on the University estate.

34 UNSPSC (ungm.org)

3. Fuel- and energy-related activities

This category accounts for the extraction, production, and transportation of fuels and energy purchased or acquired by the University that are not already accounted for in Scope 1 and 2.

Scope and Boundaries

There are four sub-categories within this category which are shown in Table 5 alongside the minimum boundary for each sub-category.

Table 5

Sub-categories in 3.3 fuel- and energy-related activities (not included in Scope 1 or Scope 2)

Sub-category	Minimum boundary	Energy Source	Reference Source
a. Well to tank (WTT) emissions of purchased fuels	All upstream (cradle-to-gate) emissions of purchased fuels (from raw material extraction up to the point of, but excluding, combustion)	Natural Gas	Exergia, EM Lab and COWI, 2015[35]
		Gas Oil	Assumed to be the same as diesel.
		Diesel	Exergia, EM Lab and COWI, 2015
		Petrol	
b. WTT emissions of purchased electricity	For upstream emissions of purchased electricity: All upstream (cradle-to-gate) emissions of purchased fuels (from raw material extraction up to the point of, but excluding, combustion by a power generator)	Grid Electricity	Unknown
		PV	NREL fact sheet
c. Transmission and distribution (T&D) losses (generation of electricity, steam, heating and cooling that is consumed in a T&D system)	For T&D losses: All upstream (cradle-to-gate) emissions of energy consumed in a T&D system, including emissions from combustion		
d. Generation of purchased electricity that is sold to end users	For generation of purchased electricity that is sold to end users: Emissions from the generation of purchased energy		

35 Exergia et al. (2015). Study on actual GHG data for diesel, petrol, kerosene and natural gas. A study by Exergia, E3 Modelling and COWI for the European Commission, DG ENER. Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/Study%20on%20Actual%20GHG %20Data%20Oil%20Gas_Project%20Interim%20Report.pdf

Methodology

3a. Fuels brought by the University include: natural gas brought from the national grid; gas oil delivered to the University in tankers by Carlton fuels for the purpose of heating; and, diesel and petrol used to fuel the University fleet. The upstream emissions for these purchases were calculated using the DEFRA 2020 Well-to-tank (WTT) conversion factors.

3b. Electricity use by the University is currently either supplied via the national grid or generated on site by PV systems and transmitted directly to the site consuming it. The WTT conversion factor for grid electricity was taken from DEFRA's 2020 report. The life cycle emission factor used for the PV system was taken from the NREL fact sheet on Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics[36].

3c. Emissions from transmission and distribution losses from grid electricity are calculated by multiplying total consumption of the University estate by the Defra conversion factor for national grid T&D losses. This is a proportion of electricity lost multiplied by the Defra emission factor for grid electricity. Additionally, the emissions from T&D losses from WTT emissions have been included as suggested by the Defra 2020 report.

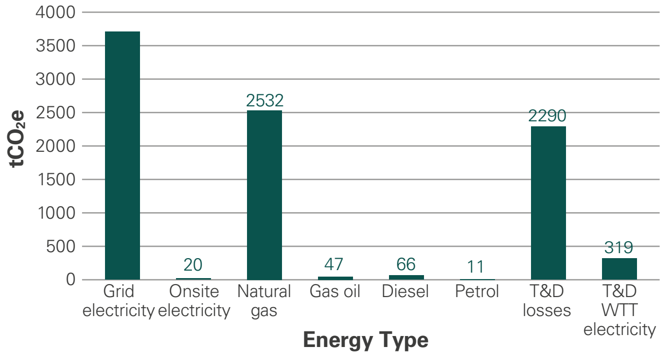
3d. This category does not apply to the University because it does not purchase electricity that is not used on site.

Results

The results in Figure 11 show that the University's upstream emissions from natural gas and grid electricity are highest due to the relatively large amount of natural gas and electricity the University consumes.

Figure 11

Upstream Emissions from Energy



Bar chart showing upstream emissions from energy consumed by the University in the academic year 2019/20

Discussion

Upstream conversion factors relating to diesel, petrol and natural gas were taken from a study by Exergia (Exergia et al., 2015)[37]; the WTT conversion factor for gas oil was assumed to be the same as diesel. In this report specialised models have been used to estimate the WTT GHG emissions for different fuels, namely OPGEE for oil upstream and midstream, PRIMES-Refinery for oil downstream and GHGenius for gas, in order to estimate the necessary GHG emissions. These models are modified to adapt to the EU reality in terms of gas and oil imports, transmission, processing up to distribution and dispersion to tanks of final consumers. This report estimates the specific WTT emission for gas in the UK and the WTT emissions of diesel and petrol for 35 different suppliers. Which supply the Defra 2020 uses is unspecified but it is assumed that a weighted average of all suppliers has been taken given that the report specifies that the conversion factor for diesel and petrol is for average biofuel blend.

36 Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics (Fact Sheet), NREL (National Renewable Energy Laboratory)

37 Exergia et al. (2015). Study on actual GHG data for diesel, petrol, kerosene and natural gas. A study by Exergia, E3 Modelling and COWI for the European Commission, DG ENER. Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/Study%20on%20Actual%20GHG %20Data%20Oil%20Gas_Project%20Interim%20Report.pdf

The conversion factor for WTT electricity was based on the average mix of different sources of fuel/primary energy used in electricity generation supplied to the grid in 2018 along with the WTT Emissions of each fuel source as reported by DUKES (BEIS, 2019b)[38]. No source for the WTT emission of grid electricity was given. The source for the emissions factor of WTT PV was taken from a paper estimating the Life Cycle Greenhouse Gas Emissions of Trough and Tower Concentrating Solar Power Electricity Generation[39], calculated by spreading the construction and materials extraction emissions across the life cycles of the system.

A source for the emissions from T&D losses is not given in the Defra 2020 methodology paper. However, the factor in the report is 8.6% of the emission factor for grid electricity, implying that Defra has assumed that this was the average proportion of electricity is lost in T&D from source to consumer. The same factor was applied to the WTT emissions from electricity.

Recommendations

The report used as the source for WTT emissions for fuels is rigorous and reliable and should be used in future reports. The lack of transparency for the WTT emissions for electricity suggest that other sources should be used in future reports along with the average energy mix of the national grid from DUKES. The emission factor for the WTT of PV units could be improved by the same technology as the basis of the emission factor. Life Cycle GHG emission from PV units have been calculated by the U.S. Department of Energy Office of Scientific and Technical Information[40]. This paper was not available at the time of writing but if possible should be used in future reports. The proportion of electricity lost in T&D should be verified in future years. The emissions associated with grid electricity transmission losses could be reduced by producing a higher proportion of the University's electricity onsite.

4. Upstream transportation and distribution

Scope and Boundaries

Transportation and distribution of products purchased by the University from direct suppliers and University operations in the year 2019/20. The Scope 1 and Scope 2 emissions of transportation and distribution providers that occur during use of vehicles and facilities.

Methodology

The University delivery system is decentralised so figures for upstream transport and distribution such as mileage and type of vehicle were not obtained for this report. Instead the University wide spend on deliveries was acquired from the Oxford University Press (OUPD). This included Freight Charges, Couriers and Import Agents Fees (nationally and internationally) and Postal and Franking Costs. This was used with the HESCET conversion factor for postal services to estimate the total emissions from upstream transport and distribution.

Data sources

1. Total spend on Freight Charges, Couriers and Import Agents Fees (nationally and internationally) and Postal and Franking Costs recorded on the financial software oracle.
2. HESCET 2020 CF for postal services

Result

The results of this analysis gave an estimated emission of 528 tCO_2e from upstream transport and distribution.

Discussion

Freight Charges, Couriers and Import Agents Fees (nationally and internationally) and Postal and Franking Costs may not translate directly to the emissions from postal services. However, the HESCET 2020 CF for postal services was sourced from Centre for Sustainability Accounting (CenSA), York, UK, and this group no longer exists. Therefore, it is not possible to verify the source of this conversion factor or what it would be directly applicable to. The number calculated here is there for a first guess of what emissions from upstream transport and distribution might be.

38 DUKES_2019_MASTER_COPY.pdf (publishing.service.gov.uk)

39 Life Cycle Greenhouse Gas Emissions of Trough and Tower Concentrating Solar Power Electricity Generation – Burkhardt – 2012 – Journal of Industrial Ecology – Wiley Online Library

40 Life Cycle Greenhouse Gas Emissions of Photovoltaic Electricity Generation: Harmonization of Published Estimates (Conference) | OSTI.GOV

Recommendations

It is recommended that the University requires suppliers to provide estimations of the total emissions from transport and distribution from the supply of their goods and services, calculated using the Defra conversion factors for fuel and vehicle use. This is information that several companies within the University supply chain can readily supply. For instance, Insight Direct (UK) Ltd and Dell Corporation Ltd.

5. Waste

Scope and Boundaries

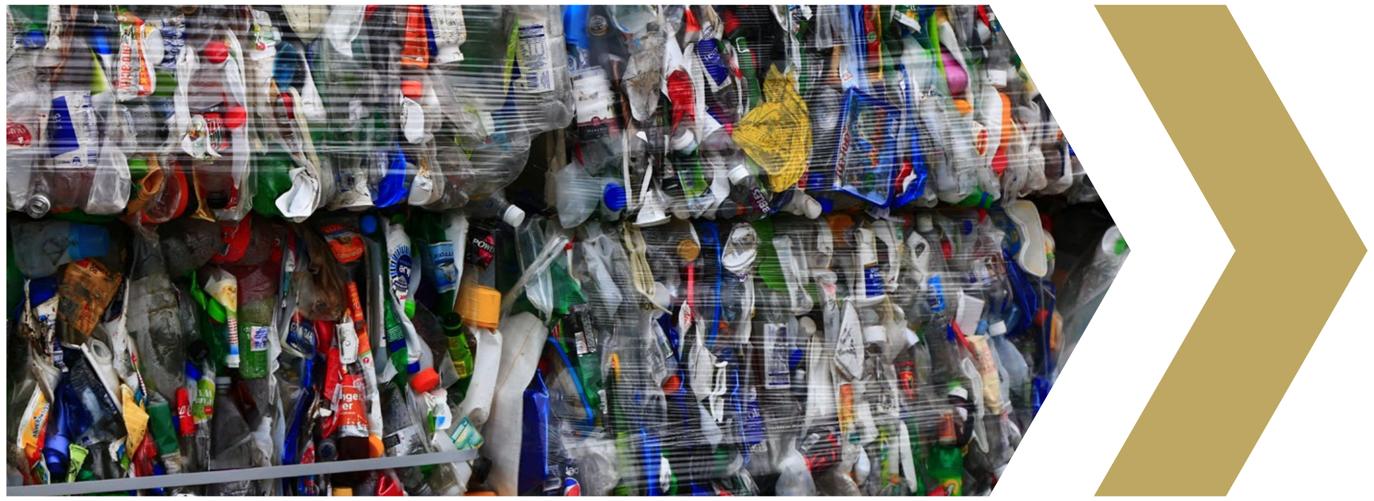
This category includes emissions from third-party disposal and treatment of waste that is generated in the reporting organisation's owned or controlled operations in the reporting year. This category includes emissions from disposal of both solid waste and wastewater. This category includes all future Scope 1 and 2 emissions that result from processing the waste generated in the reporting year. In this report the emissions from the transport of waste to waste-management sites have not been included.

Method

Consumption data was collected from invoices from the University waste management service provider, Select Environmental, and emission factors based on weight were used to estimate the emissions from waste processing. The University produces 14 different type of waste, shown in Table 6.

The Defra 2020 report assumes that the carbon intensity of recycling, combustion or composting all materials produces the same amount of carbon emissions and cites no report for the source of the conversion factors in the methodology paper. Therefore, only Defra 2020 conversion factors for WEEE mixed to recycling and water treatment have been used. The factor for WEEE mixed to recycling was sourced from a 2008 Review of emissions from WEEE processing from Delft University of Technology[41]. The factor for wastewater treatment was sourced from Water UK (for reporting in 2008, 2009, 2010 and 2011) and is based on submissions by UK water suppliers. Emissions from wastewater treatment are calculated by assuming that 100% of water bought by the University is treated in wastewater processing centres. General waste is sent to waste-to-energy processing centres to avoid the production of harmful GHG gases produced in aerobic decomposition in landfills. All bulk collection waste is sent either directly to a local recycling centre or a recycling sorting centre in Reading. Clinical waste and Hazardous waste are processed by incineration.

Conversion factors for combustion, recycling and composting are sourced from EPA GHG Emission Factors Hub[42]. These factors are form the basis of EPA's 'Waste Reduction Model' (WARM). WARM is a tool that calculates and totals the GHG emissions, energy savings and economic impacts of baseline and alternative waste management practices, including source reduction, recycling, combustion, composting, anaerobic digestion and landfilling. A significant amount of effort has been put into the LCA of emissions from waste disposal in the U.S. However, the data used to calculate these emissions was sourced from studies completed over 10 years ago. The methodology for these calculations can be found in the background chapters of the WARM model[43].



41 Huisman, J., et al (2008) Review of Directive 2002/96 on Waste Electrical and Electronic Equipment

42 https://www.epa.gov/sites/default/files/2021-04/documents/emission-factors_apr2021.pdf

43 https://www.epa.gov/warm/documentation-chapters-greenhouse-gas-emission-energy-and-economic-factors-used-waste-reduction

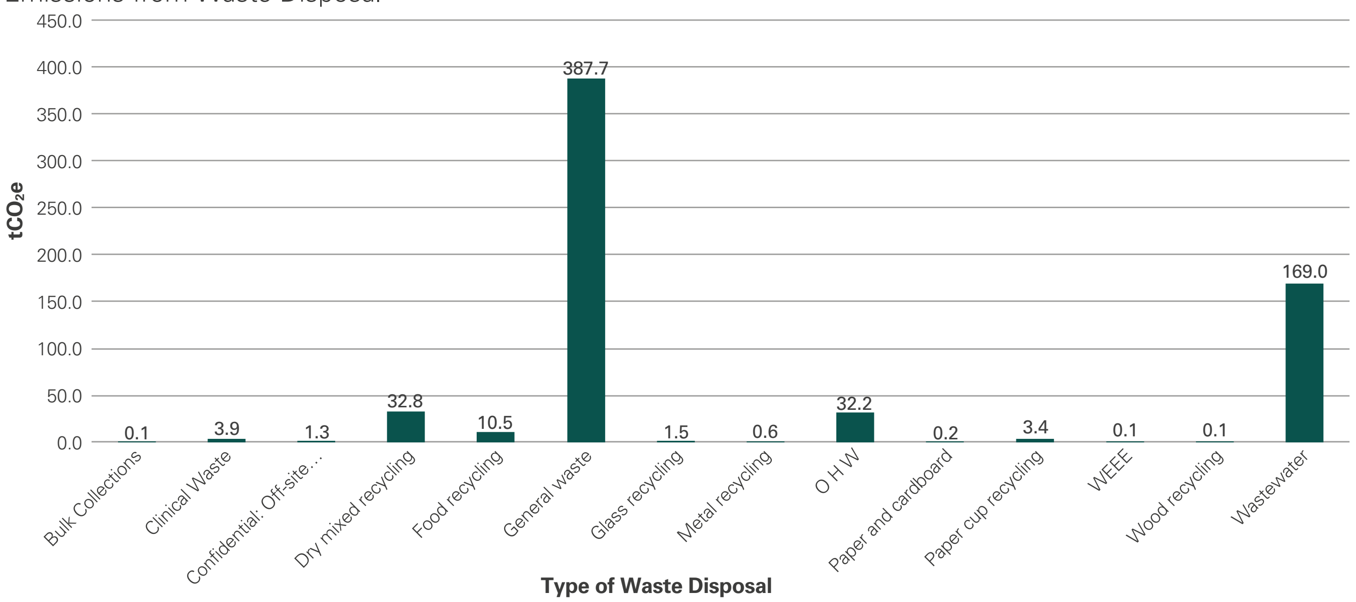
Table 6
Types of waste produced at the University alongside the amount, emissions factor and emission produced by each type

Waste Type	19/20 kg	Conversion ($kgCO_2e/kg$)	Source	tCO_2e
Bulk Collections	1,069	0.1	EPA Mixed Recycling – Recycled	0.1
Clinical waste	8,315	0.47	EPA MSW Mixed – Combustion	3.9
Confidential: off-site shredding	38,099	0.03	EPA Paper primarily from offices – Recycled	1.3
Dry mixed recycling	330,654	0.10	EPA Mixed Recycling – Recycled	32.8
Food recycling	68,258	0.15	EPA Dry Anaerobic Digestion	10.5
General waste	817,979	0.47	EPA MSW Mixed – Combustion	387.7
Glass recycling	26,554	0.06	EPA Glass – Recycled	1.5
Metal recycling	2,360	0.25	EPA Mixed Metal – Recycled	0.6
O H W	67,873	0.47	EPA MSW Mixed – Combustion	32.2
Paper & cardboard	2,882	0.08	EPA Mixed Paper (general) – Recycled	0.2
Paper cup recycling	3,140	1.08	EPA Mixed Paper (general) – Recycled	3.4
WEEE	5,562	0.02	DEFRA 2020 WEEE – Mixed – Recycled	0.1
Wood recycling	980	0.10	EPA Dimensional Lumber – Recycled	0.1
Wastewater	238,966	0.71	DEFRA 2020 Water treatment	169.0
TOTAL	**1,373,725**			**644.0**

Data sources:
1. Defra 2020 report
2. EPA GHG Emission Factors Hub 2021
3. Invoices from Castle Water
4. Invoices from Select Environmental

Results
Figure 12 shows that University gross emissions are highest from the processing of general waste and waste water. This would be expected as the University produces a relatively high amount of general waste and waste water.

Figure 12
Emissions from Waste Disposal



Gross tCO_2e emissions from the University's waste disposal in the academic year 2019/20

Discussion

The conversion factor from the EPA GHG Emission Factor Hub, although developed using a rigorous methodology, represent the emissions that would be produced at waste disposal plants in the USA. The emissions produced by waste processing plants in the UK will differ from this, mainly because Scope 2 emissions from electricity vary from country to country due to the vastly different energy mixes used and therefore different carbon intensity of national grids.

The average net electrical energy produced from sending University waste-to-energy processing plant Ardley ERF was 0.66 kWh/t at the financial year 2020. This amounts to 538.6 kWh of REGO backed electricity sent to the grid in the academic year 2019/20 from waste-to-energy processing. This has not been included as a negative in the University net Scope 2 CO_2e emissions as the emissions are attributed to Ardley.

Recommendations
Select Environmental were contacted in the early stages of this project to ascertain information on the Scope 1 and 2 emissions related to processing University waste. However, the company distributes waste to further third-party service providers who were unable to provide this information in the time frame of this project. In future primary data from waste processing sites would be preferable to using conversion factors based on waste processing in another country.

University gross emissions from waste would be reduced if more general waste could be organised into recycling or composting, as the emissions factor for these processes is 3 to 4 times smaller. This could be done by asking preferred suppliers to deliver and contain all goods in packages that can either be recycled or composted, requiring that all food sold or provide onsite at the University be served in compostable packaging and that sufficiently sized composting bins are available across all departments and University offices. Reducing emission from general waste by a factor of three would save more than 250 tCO_2e. Emissions from wastewater would decrease if less water was consumed by the University. This could be done using behaviour change programs to encourage students and staff to use less water.

6. Business travel

Scope and Boundaries
This category includes the Scope 1 and 2 emissions from the transportation of employees for business-related activities in vehicles owned or operated by third parties, such as aircraft, trains, buses, and passenger cars. Emissions from business travellers staying in hotels have not been included in this report.

Methodology
Business travel emissions are calculated using invoices and industry-based emission factors. Three modes of transport are used for business travel, each of which splits into two types: flights, both long haul (LH) and short haul (SH); rail, national and international; motor vehicles, grey fleet and taxis. Travel from University-owned vehicles has been categorised in Scope 1.

- The emissions from taxi rides have been calculated by taking the annual spend on taxi fares divided by the average cost per mile of a taxi fare in Oxford and multiplying by Defra 2020 conversion factors for an average car. The assumption was made that 59% of vehicles were petrol and 41% were diesel, based on the National Atmospheric Emissions Inventory's vehicle fleet composition projections based on 2019 data[44]. This assumption is made throughout the report.
- Grey fleet emissions have been calculated by processing one month of travel expenses claims from June 2019 to find the litres of fuel consumed in one month of operation. This month was assumed to represent an average month in the academic year 2019/20. Emissions for the remaining period were then extrapolated from this representative month.

44 https://naei.beis.gov.uk/resources/rtp_fleet_projection_NAEI_2017_Base2019r_v1_1.xlsx

- To calculate emissions associated with rail and air travel, data from Key Travel, a travel management company used by the University, was used to estimate the emissions from these modes of transport. The company was able to provide data on the mode, type, class and length of travel purchased by University employees for business travel. This was used in conjunction with DEFRA 2020 factors to calculate the emissions from each transport ticket purchased through the company in the academic year 2019/20. In this report conversion factors from flights including radiative forcing were used as this also has a GWP. In 2015 it was estimated that approximately 40% of all businesses travel purchases by University employees were made through Key Travel. This estimation was made by processing all travel invoices for the academic year 2014/15 and calculating the proportion that were completed through Key Travel. For this report it has been assumed that the same proportion of business travel was booked through the service provider. The emissions calculated from the 2019/20 Key Travel data were extrapolated, assuming that they accounted for just 40% of the total travel spend in the academic year.

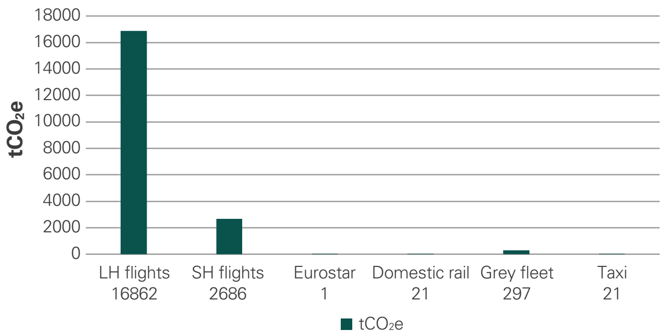
Summary of Data Sources Used

1. Annual spend on taxi fares in the academic year 2019/20 from Oxford University Purchasing Department.
2. Average cost per mile of taxis in the Oxford area from the UK Taxi Price Index.
3. Invoices for fuel consumptions refunded by the University for business travel in the month June 2019.
4. National Atmospheric Emissions Inventory's Vehicle fleet composition projections based on 2019 data.
5. Key Travel invoice data for the academic year 2019/20.
6. Defra 2020 CFs for Air Travel, International Rail, National Rail and Average Car Journeys.

Results

Figure 13

Business Travel



Emissions from University employee business travel in 2019/20

Discussion

Uncertainty in the emissions estimates originates from the assumption that the Key Travel data represents 40% of travel purchases made by University employees. The audit of travel purchases was made five years ago.

The conversion factors for international and national flights used in the Defra 2020 report were sourced from EUROCONTROL small emitters tool[45]. The tool is based on a methodology designed to estimate the fuel burnt for an entire flight; it is updated on a regular basis in order to improve its accuracy where possible, and it has been validated using actual fuel consumption data from airlines operating in Europe. The tool covers a wide range of aircraft, including many newer (and more efficient) aircraft increasingly used in flights to/from the UK, and also variants in aircraft families. The tool is approved for use for flights falling under the EU ETS via the Commission Regulation (EU) No. 606/2010.

Emissions for national rail from Defra is sourced from the Office of the Rail Regulator's National Rail Trends for 2017-18[46]. This has been calculated based on total electricity and diesel consumed by the railway for the year, sourced from the Association of Train Operating Companies, and the total number of passenger kilometres (from National Rail Trends). The emission factor for international rail is based on a passenger-km weighted average of the conversion factors for the following Eurostar routes: London-Brussels, London-Paris, London-Marne-Le-Vallee (Disney), London-Avignon, London-Amsterdam and the ski train from London to Bourg St Maurice. The conversion factors were provided by Eurostar.

45 https://www.eurocontrol.int/tool/small-emitters-tool
46 (2019). Official Statistics. Retrieved April 10, 2019, from: http://dataportal.orr.gov.uk/browsereports/9

The Defra 2020 emission factor for the average passenger car was calculated using the average conversion factors for passenger cars. It is based upon a combination of datasets on the average new vehicle regulatory emissions for vehicles registered in the UK, with an uplift to account for differences between these and real-world driving performance emissions. The emission factors were sourced from Society of Motor Manufacturers and Traders for engineers registered between 2003 and 2019[47].

Recommendations

The results of the analysis show that the largest carbon emission category is long haul flights. Staff members could be discouraged from taking long haul flights unless absolutely necessary and where they do, these would be economy class. This could be encouraged by using behavioural modification tactics such as flight levies or the University providing grants to use high quality video and online conferencing software.

It is practical to travel to any European country within the central European time (CET) time zone or any area within the UK and Ireland by rail and if necessary ferry. Currently all domestic travel reported by Key Travel has been completed using national rail services and all international travel uses flights or Eurostar international rail. Travel from Oxford to any European or British city would be considered short haul by Defra standards. Currently 40% of trips within Europe by University staff members are made by flight. If these trips had been made by international rail, 1,388 tCO_2e could have been saved. The University could encourage this by providing grants for the difference in cost between flights and international rail services.

The uncertainty in the estimation of emissions from business travel could be reduced by auditing the amount of business travel purchases that are made through Key Travel again and encouraging University employees to use the service more frequently.

7. Employee commuting

Scope and Boundaries

All Scope 1 and 2 emissions of employees of the University from transportation between their home and worksite.

Methodology

In 2019, a travel survey was sent out to the employees and the student body of the University. The survey asked which mode of transport they used to commute, the distance they travelled using that mode of transport, and how often they made that commute. The survey had a 10% response rate. This was assumed to be a representative proportion and was used to calculate the total pkm from each mode of transport of the entire work force across the year unaffected by COVID-19 restrictions. Defra 2020 conversion factors were used to convert the pkm calculated from the survey to emissions.

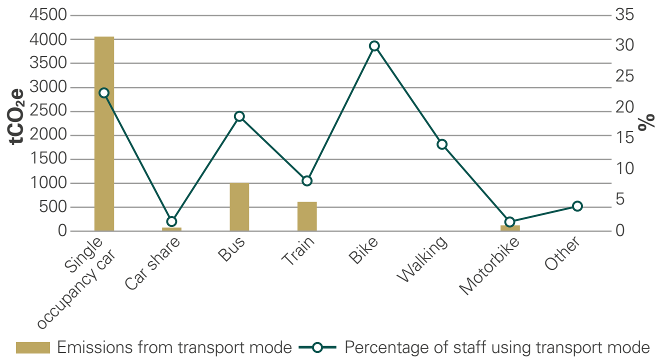
Data Sources

1. 2019 Travel Survey
2. Defra 2020CFs for rail, local bus and car.

Results

Figure 14

Emissions of Staff Commuting



47 SMMT is the Society of Motor Manufacturers and Traders that represents the UK auto industry. http://www.smmt.co.uk/ and The SMMT gCO_2/km dataset for 1997 represented around 70% of total registrations, which rose to about 99% by 2000 and essentially all vehicles thereafter.

Discussions

The conversion factors used to calculate emissions from staff commuting were the same as those used to calculate emissions from businesses travel with the addition of the conversion factor for motorbike travel. This conversion factor was calculated by Defra using a dataset provided by Clear[48] containing information on motorcycle fuel consumption based on road test reports and user test reports in 2008. The CF for an average motorcycle was calculated using a database of motorcycles registered to the DVLA in 2019. Emissions from telecommunication and teleworking have not been included in this year's report but should be in the future reports as working from home becomes more common. The uncertainty in these measurements could be reduced if a higher proportion of employees completed the travel survey.

Recommendations

Only 25% of staff commute using single occupancy cars, yet this accounts for around 70% of emissions from commuting. This could be reduced by the University providing financial incentives for using less impactful modes of transport or by setting up a car pooling scheme for employees outside of the city. Another possibility would be negotiating rail discounts for staff on mainline and local services to and from Oxford.

16. Student Commuting

For most companies Scope 3 commuting emissions includes upstream emissions from employees who are required to travel to site to complete work that they are contractually obliged to do. The organisation sets the expectation and requirements for working practices, so it has a level of control over employee commuting emissions. For educational institutions such as the University the products being produced and consumed are educational resources and experiences. In most instances students are required by the University to be present on site for this to take place. Exceptions to this could include online educational bodies such as the Open University. Therefore, student commuting is an additional commuting emissions category that falls under downstream Scope 3 emissions. Some organisations may class such activities as 'Scope 4' emissions.

Scope and Boundaries

Oxford University requires undergraduate and postgraduate taught students to reside within six and 25 miles of Carfax Tower for at least six weeks of each term, respectively. Postgraduate research students are required to reside within 25 miles of Carfax Tower for six weeks of six terms over the duration of their programme. For courses run by the Medieval and Modern Languages Department, students are required to complete a placement abroad year to graduate from their course. Additionally the University requires students to travel from their residential accommodation to onsite tutorials, seminars and demonstrations during term time. For this reason, both inter-term travel and term time travel have been included in student commuting.

All Scope 1 and 2 emissions of students relocating for each required term and commuting to onsite activities during term time have been included in this report. This section of the report has further been split into 16.1 Student term-time commuting, 16.2a Inter-term International Student Travel, 16.2b Inter-term Domestic Student Travel, 16.2c Year Abroad Student travel.

16.1 Emissions from students travelling to onsite activities during term time

Methodology

The same methodology used to calculate employee commuting was used to calculate student commuting

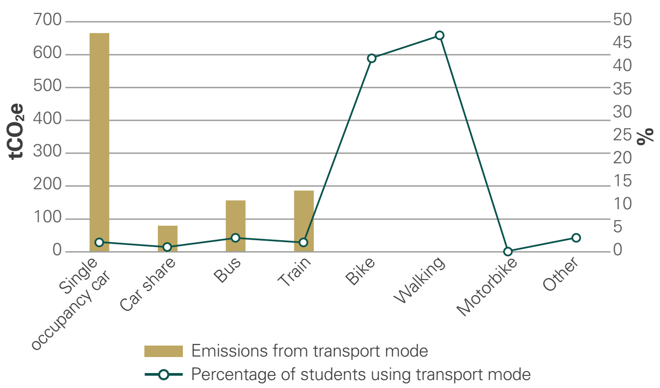
Data Sources

1. 2019 Travel Survey
2. Defra conversion factors for rail, local bus and car.

Results

Figure 15

Emissions of Student Term Time Commuting



Emission from student term time commuting 2019/20

48 Clear – Fighting Climate Change since 2005

Discussion

The conversion factors used to calculate the emissions from student commuting are the same as those used to calculate emissions from staff commuting. Emissions from telecommunication and teleworking have not been included in this year's report but should be in the future reports as working from home becomes more common. The uncertainty in these measurements could be reduced if a higher proportion of students completed the travel survey.

16.2 Emission from Students Traveling to Oxford from Origin Location.

Methodology

Assumptions:

- For each term that students are required to be in residence in Oxford, students are assumed to have travelled from the home address which they have registered. This location will be referred to as location of origin.
- In a normal academic year an undergraduate or taught postgraduate student would therefore make the commute from their location of origin to Oxford three times within an academic year.
- Postgraduate research students who are either on three or four year courses are required to be within Oxford for only a proportion of the academic year. It is therefore assumed that this trip is made twice in an academic year.
- Visiting and recognised students are assumed to make two return trips a year as visitations range from one to three terms.
- It is assumed that all international students have travelled from their country of origin to the UK via flight, and that all domestic students have travelled by single occupancy car.
- The travel restrictions put in place due to the Covid-19 pandemic meant that all students were asked to return to their city of origin at the end of the second term of 2019/20. Therefore, students are assumed to have made one fewer trip in the academic year 2019/20 than in a normal academic year. Undergraduates and taught postgraduates are assumed to have made two return trips from their country of origin in an academic year and postgraduate research, visiting and recognised students are assumed to have made this return trip once.

A. Calculations for international student travel:

1. To find the number of passengers from each location, student numbers and nationality data was sourced from the University's annual census. The census used was taken on 01/12/2019. This most accurately represents the demographic of students attending the University in the academic year 2019/20.
2. The distance of one flight data for distance between country of origin and the UK was sourced from the CEPII GeoDist dataset. The distances from CEPII take the location of travel from a country as the average position of the distributed population. For this reason, travel between residence and airport in both the UK and country of origin have been discounted. This may result in a slight over estimation as other 'last-mile' modes of transport would be less carbon intensive than flights. Data gaps from CEPII were filled using the Distance.to website.
3. Flights were categorised as long haul or short haul based on distance. Long haul flights are flights over 3,700km according to the Defra 2020 emissions report.
4. To find the total pkm for each flight scenario, for each country the distance travelled was multiplied by the number of students travelling from that country and the number of flights a student was expected to make in an academic year. An additional 10% distance was added on to long haul flights to account for indirect flight paths.
5. The pkm was then converted into emissions using the average passenger Defra 2020 conversion factors for long and short hail flight respectively.

B. Calculations for Domestic Student travel:

1. Information on domestic student city of origin from the start of the academic year was used to estimate the total pkm from domestic students. The number of students from each city was multiplied by the distance between the centre of the city and Carfax Tower to calculate pkm for a single one-way trip.
2. It was assumed that all domestic students were brought to the University by car. This means that for each return trip the student makes to the University, four one-way trips from the location of origin to Oxford city are made. A total of eight one-way trips are made to take students to and the city of Oxford for the two terms attended during the academic year 2019/20.
3. A 59% to 41% petrol to diesel split for motor vehicles was again assumed and Defra 2020 emission factors for an average car were used to calculate emissions.

C. Calculations for Year Abroad Placement Travel:

Students taking undergraduate courses at the Department of Medieval and Modern Languages are required to be on placement abroad for a total of 24 week. Students must travel to at least one, and in some cases as many as three different locations for placement throughout the year. Once signed up, student must arrange to travel from their city of origin to the placement country. The department asserts that the overwhelming majority of students travel by plane to their placement location. It has been assumed that all students have travelled from Oxford to placement location via flight.

1. Data from the Department of Medieval and Modern Languages for the academic year 2019/20 containing the number of students visiting a county for each placement alongside data from CEPII was used to calculate the total pkm for each trip.
2. Trips were split into long haul and short haul flights based on distance in km.
3. Emissions from each trip were calculated based on the average emission factor for long and short haul flights from Defra 2020.
4. 3rd placements were removed from the dataset due to the effects of Covid-19.

Data sources

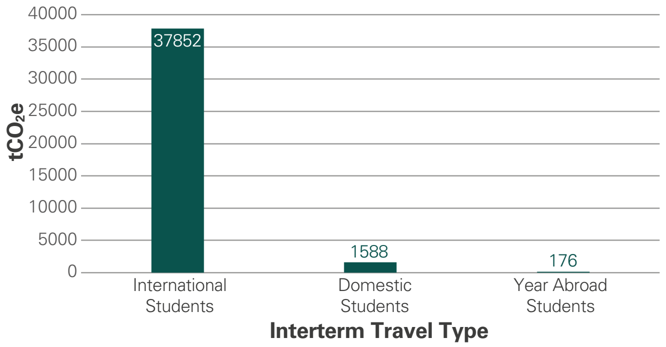
1. Domestic and nationality details from the 2020 census that was performed on the 1st of December 2020, representing the number of students enrolled on each type and their country of origin.
2. Student statistics | Academic Support (ox.ac.uk)
3. City of origin of domestic students in the academic year 2019/20, sourced from student administration.
4. Overseas location of placement with number of students travelling to that location, sourced from the Medieval and Modern Languages Department.
5. Data for distance between country of origin and the UK was sourced from CEPII GeoDist dataset: http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=6
6. Any gaps filled by: https://www.distance.to/Kosovo/London
7. Domestic distances to Oxford Carfax Tower calculated using the National Statistics Postcode Lookup https://geoportal.statistics.gov.uk/datasets/aef0a4ef0dfb49749fe4f80724477687/about
8. Defra 2020 emission factors for air travel, rail, and car travel.

Results

The results of this analysis show that the emissions from international student inter-term travel alone are close to the emissions from the whole of the University's Scope 1 and 2 emissions combined.

Figure 16

Carbon Emissions from Between Term Travel



Bar chart of emissions from student inter-term travel in the academic year 2019/20

Discussion

In a normal academic year, without the impact of COVID-19, these emissions could be up to a third higher. However, several assumptions have been made in this report that should be questioned in following years. Firstly, the assumption that all international students have travelled by flight. It is believed likely that a high proportion of students travelled by air due to the convenience of taking luggage with them, but the exact proportion should be investigated in future years. Secondly, that students take a return flight to their country of origin for every term that they are required to be in residence in Oxford. Many international students chose to stay in Oxford or England over the Easter and winter vacations because of the cost of flights home. The proportion of students who make this decision should be investigated in future years.

Recommendations

As the level of emissions from international student flights is so high, resources should be directed to improving the accuracy of this estimate by determining the mode of transport students use to travel between terms and how often they make this trip. This could be done by adding additional questions to the University travel survey, or by asking colleges to record and submit the number of students who remain in residence over the vacation periods.

Emissions from international inter-term student flights could be reduced by offering to reimburse students based in Europe the difference in cost between flights and international rail. Emissions from domestic student inter-term travel could be reduced by offering students cheap storage facilities between terms so that they could easily take the train home.

Reductions, Offsets and Removals

Guidance for Monitoring, Quantifying and Recording GHG Reductions is provided by the WRI GHG Protocol of Project Accounting[49] and Defra's Guidance on How to Measure and Report your Greenhouse Gas Emissions, Annex G[50]. A supplement of the GHG Protocol for project Accounting has been written by the World Resources Institute, The Land Use, Land-Use Change, and Forestry Guidance for GHG Project Accounting[51]. This document provides more specific guidance and concepts to quantify and report GHG removals and emissions from LULUCF project activities but not whether it should be accounted for in gross or net emissions. This guidance should be used in future LULUCF accounting but due to a lack of data could not be applied to current land within the University operations. Guidance on how to report emission removal is currently being written by the WRI under the tile of Land Sector and Removals Guidance[52]. This report will be ready for pilot testing and review in Q1 2022.

Reductions

Emissions reductions and avoided emissions reported from projects have become relevant to the University as it includes the aim of reducing its gross carbon emissions by 73% by 2035 compared to 2018/19 levels in its Environmental Sustainability Strategy (ESS). The remaining 27% of emissions would be offset by quality and verified carbon emission offsets leading to net zero carbon emissions by 2035. The purchase of offsets will be delayed until 2030 to ensure that on-site emissions are reduced as much as practically possible. The Protocol for Project Accounting is the most comprehensive tool for quantifying the GHG benefits of climate change mitigation projects. It provides specific principles, concepts and methods for quantifying and reporting GHG reduction, such as decreasing emissions, or increasing removals and/or storage.

Additional guidance on this accounting for GHG emissions reductions specific to the UK is provided by Defra[53]. This can be viewed in Annex G of this report 'What can I count as an emission reduction?'. This guidance suggested that an organisation may carry out projects within its own operations or within its supply chain (e.g. energy efficiency measures, installation of on-site renewables, behaviour change programmes, supplier engagement initiatives) to reduce gross GHG emissions. According to the guidance, such internal GHG reductions will be accounted for in reported gross CO_2e emissions of an organisation as these internal projects will reduce emissions from within operations.

Examples of this that could apply to the University:

Installing University-operated renewable electricity production technology such as onsite wind and solar. Where an organisation generates electricity from 'owned or controlled' renewable sources backed by Renewable Energy Guarantees of Origin (REGOs) within the UK, this should be accounted for at zero emissions in Scope 1. Surplus electricity sold to the grid from onsite operations would be accounted for in reported Net CO_2e emissions.

49 https://ghgprotocol.org/sites/default/files/standards/ghg_project_accounting.pdf
50 Guidance on how to measure and report your greenhouse gas emissions (publishing.service.gov.uk)
51 LandUse (wri.org)
52 https://ghgprotocol.org/land-sector-and-removals-guidance
53 Guidance on how to measure and report your greenhouse gas emissions (publishing.service.gov.uk)

Offsets

The guidance from Defra suggested that offsets such as those that would be purchased by the University after 2030 are classified as external emissions reductions which would be recorded as a negative in the net CO_2e balance sheet. This is aligned to the GHG Protocols Corporate Accounting and Reporting Standard that encourages companies to report reductions and offsets separately. This is because the emissions reductions occur outside of an organisation's operations or supply chain. This should not be reported in gross CO_2e emissions and instead should be reported in net CO_2e emissions. The University's ESS has proposed purchase of emissions offsets from 2030 that would align to the Oxford Principles for Net Zero Aligned Carbon Offsetting. This principle aligns Oxford University purchased offsets with Defra's 'Good Quality' Carbon Offsetting Criteria in all areas aside from Timing. The Oxford Principles suggests that any time gap between the purchase of the offset and the successful execution of the emission reducing or carbon removing activity must be minimised while a Carbon Offset falling under the 'Good Quality' Criteria would be ex post, that is, they must only have been issued from the project after the emissions reduction has taken place. The electricity purchased by the University through Scottish Power on the green tariff is backed by REGOS and can therefore already be reported as a reduction in net CO_2e emissions. Further verification needs to be carried out to ensure that these REGOS meet the 'Good Quality' criteria and specifically can give evidence of supply and additionality. Where the tariff supplier purchases Kyoto-compliant credits through an offset provider, the offsets used must be compliant with the Government's quality assurance scheme for carbon offsetting. For this report this is assumed to be the case based on the assurance of quality given by Scottish Power when purchasing the REGOS.

Removals

Defra's Guidance classifies removals made within an organisation's operation as a reduction of an organisation's total gross GHG inventory. GHG Protocol Land Sector and Removals Guidance will explain how companies should account for emissions and removals from land use, land use change, biogenic products, technological CO_2 removals, and related activities in GHG inventories, building on the Corporate Standard and Scope 3 Standard. Oxford University has signed up to be part of the review group and pilot testing for the guidance so that it can verify its removal accounting practices against the The Protocol for the next academic year.

The purpose of this is to account for CO_2e removals from land-based, product and geological carbon pools. The new guidance will require organisations to report on emissions from land use changes within their Scope 1 emissions for land owned or controlled by the organisation or Scope 3 for land controlled within their value chain. Additionally, companies will be required to report on land management carbon stock changes. Following this guidance will require a significant increase in the levels of monitoring of the University's non-functional estate. The method to do this will be provided in the new report. Further information on pilot testing for this guidance can be found here[54].

In light of the current lack of specific guidance on the subject of emissions removal, interpretation of the principles from Defra and the current GHG protocols suggests that emissions and removals from land within University operation should be categorised under the University's Scope 1 gross CO_2e emissions.

54 https://wbcsd.zoom.us/rec/play/i-k0z_Zkhy3ZUuEA4lleAHio_z8838WSPJGDBr87mJtb-mPB7fQ5d5ku8QHkm_WOmoWmJdpwHz1hVCim.1EnbEAo8HulLy5w0?startTime=1628171981000&_x_zm_rtaid=QlI_SBsZQx-ovbowyJU4-Q.1630338641009.f9c4ae54f02f4872a4012c91de02aede&_x_zm_rhtaid=270

Example

A key example summarising the use of this guidance would be installing University-operated renewable energy sources on University-operated land. A practical illustration of the accounting practices relating to renewable energy sources for the University is outlined below using the example of installing PV units offsite and remotely to the University.

According to the PV geographical information system developed by the European Commission[55], the yearly in-plane irradiation in the centre of Oxford is 1208.55 kWh/m^2. The annual average efficiency of PV panels under real outdoor conditions is around 9%[56] (small multi-crystalline photovoltaic array). The electricity generated from PV solar panels is estimated to be 4,642 W/m^2 which is 40,664 kWh/m^2/yr. If the electricity was replacing electricity from the grid in the year 2020, which has an annual emissions factor of 0.23314 kgCO_2e/kWh, this would constitute an annual emissions reduction factor of 9.48 tCO_2e/ha/yr[57]. This would be subject to change in future years as the grid decarbonises in the lead up to the government's 2050 Net-Zero goal.

This could be treated in the following way:

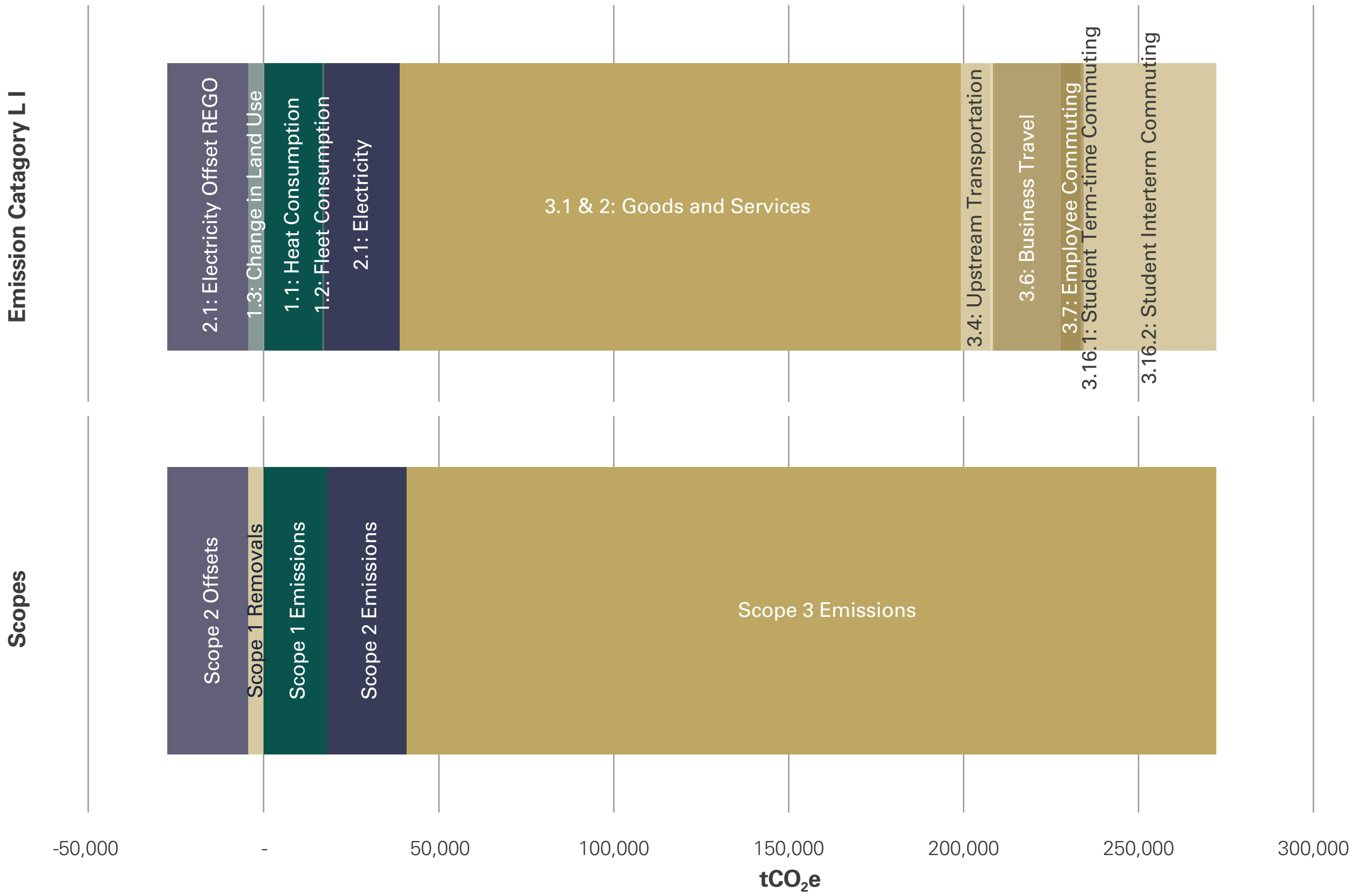
1. If the power was supplied to the University directly on a private network, the emissions would not register according to the existing methodology. Although this should be recorded as grid factor consumption and an associated a gross emission removal factor would be applied.
2. If the PV array and land were owned and operated by the University and power was transmitted over the grid under contract where the University was both the sole supplier and consumer, and if all associated REGOs were retired, this would be recorded as grid factor consumption and an associated gross emission removal factor would be applied.
3. If the PV array and land were owned and operated by a third party and power was transmitted over the grid under contract between the third party provider and the University, and if all associated REGOs were retired, this would be recorded as grid factor consumption and an equal net emission factor would be applied.
4. Any of the above options where the REGOs were not retired and were instead sold or returned would result in no reductions or offsets being able to be claimed.

55 JRC Photovoltaic Geographical Information System (PVGIS) – European Commission (europa.eu)
56 Energy efficiency of PV panels under real outdoor conditions – An experimental assessment in Athens, Greece – ScienceDirect
57 This estimate has not been verified and does not account for PV unit type, tilt, orientation or spacing. Further calculations should be completed to inform decision making around such projects.

Final Results

The total gross tCO_2e, emissions produced by the University in the academic financial year 2019/20 are estimated to be 267,936 tCO_2e. This includes 4,533 tCO_2 removals from the carbon sequestration of University-operated land. Figure 17 shows the University's net carbon emissions. This includes offsets from REGO backed green tariffs of 22,883 tCO_2e. The University's net carbon emissions in the year 2019/20 were 245,053 tCO_2e. A summary of the emissions from each category is given in Annex F.

Figure 17
The University of Oxford Emissions for Academic Year 2019/20



Total Net Carbon Emissions from the University in the academic financial year 2019/20. Scope 1 emissions in shades of green, Scope 2 emissions in shades of blue and Scope 3 emissions in shades of gold.

Annex A:
Approach from other Higher Education and Wider Industry

Seven higher education institutions and seven of the Oxford University's suppliers were interviewed to determine current practice and what each organisation views as best practice. The results of the interviews show that the highest accounting standard was GHG Protocol. In some instances, this was supplemented by external validation to ISO 14064. The results of the organisations current practices are shown in Table 1. Only the University of Bristol has achieved ISO 14064 certification. Eleven of the organisations interviewed were using the GHG Protocol to guide their carbon accounting approach.

Table 1
Emissions accounting standards across the higher education sector and wider industry

Organisation	Type of Organisation	Approach to Carbon Accounting	Scopes included	Categories included in Scope 3
Manchester, Cambridge, Edinburgh, Bristol, King's, Glasgow Caledonian, UWE University	University	GHG Protocol	1, 2 and 3	Business travel, waste, water and procurement based on the HESCET report
Avantor	Scientific and Medical Supplies	GHG Protocol	1 and 2	
Merck	Scientific and Medical Supplies	GHG Protocol	1, 2 and 3	(1-12), all relevant Scope 3 categories
Scientific Laboratory Supplies Ltd	Scientific and Medical Supplies	GHG Protocol	1, 2 and 3	Waste, Gas, water, electricity and vehicle fuel consumption (Scope 1 & 2 only)
Illumina	Scientific and Medical Supplies	GHG Protocol	1, 2 and 3	Scope 3 categories purchased goods services, capital goods, transportation & distribution, investments, employee commuting, business travel
Dell	IT	Task Force on Climate-related Financial Disclosures (TCFD)	1, 2 and 3	Supply chain emissions for specific products
Insight direct	IT	Defra Environmental Reporting Guidelines	1, 2 and 3	Business travel
Richard Ward (Oxford) Ltd	Premises	Reports received from suppliers.	1, 2 and 3	Vehicle fuel, Gas, Electricity for heating offices, Waste/recycling. Water.

Annex B:
Overview of Emissions Categories

The emissions categories accounted for in the University's emissions account are shown in Table 3.

Table 3
Emission categories accounted for in the University of Oxford emissions accounts. Shown alongside the description of each category and minimum boundary of the category as defined by the GHG Protocol

Scope	Category	Description	Minimum Boundary
1	1.1: Fuel Consumption Through the Operation of Buildings	Fuels combusted in the operation of the estate	Emissions from the combustion of fuel
	1.2: Fleet Fuel Consumption	Fuel consumption from company owned vehicles for company operations	Emissions from the combustion of fuel
	1.3: Land Use, Change In Land Use, Forestry	Emissions and removals from existing land operated by the company and changes in land use	All Scope 1 emissions from land use, change in land use and forestry
	1.4: Fugitive Gas	GHG released in the operation, installation, and decommission of company owned utility units	GHG released in the operation, installation, and decommission of company owned utility units
2	2.1: Electricity	Emissions from the production of electricity for company operations	Emissions from the production of electricity once operational
3	3.1 & 2: Goods and Services	Extraction, production, and transportation of goods and services purchased or acquired by the reporting company in the reporting year, not otherwise included in Categories 2 – 8	All upstream (cradle-to-gate) emissions
	3.3: Upstream Energy	Extraction, production, and transportation of fuels and energy purchased or acquired by the reporting company in the reporting year, not already accounted for in Scope 1 or Scope 2, including	All upstream (cradle-to-gate) emissions including transition and distribution losses excluding combustion.
	3.4: Upstream Transportation	Transportation and distribution of products purchased by the reporting company in the reporting year between a company's tier 1 suppliers and its own operations	The Scope 1 and Scope 2 emissions of transportation and distribution providers that occur during use of vehicles and facilities
	3.5: Waste	Disposal and treatment of waste generated in the reporting company's operations in the reporting year (in facilities not owned or controlled by the reporting company)	The Scope 1 and Scope 2 emissions of waste management suppliers that occur during disposal or treatment
	3.6: Business Travel	Transportation of employees for business-related activities during the reporting year in vehicles not owned or operated by the reporting company	The Scope 1 and Scope 2 emissions of transportation carriers that occur during use of vehicles
	3.7: Employee Commuting	Transportation of employees between their homes and their worksites during the reporting year	The Scope 1 and Scope 2 emissions of employees and transportation providers that occur during use of vehicles
	3.16.1: Student Term-Time Commuting	Transportation of students between their homes and their onsite teaching during the reporting year	The Scope 1 and Scope 2 emissions of students and transportation providers that occur during use of vehicles
	3.16.2: Student Inter-term Commuting	Transportation of students between their country or city of residence and Oxford city centre	The Scope 1 and Scope 2 emissions of students and transportation providers that occur during use of vehicles

Annex C:
Data Quality

Data quality assessment

Table 4 has been used to assess the data quality used to calculate emissions in each emissions category.

Table 4
Criteria to evaluate the data quality indicators. Sourced from GHG protocol Adapted from B.P. Weidema and M.S. Wesnaes, "Data quality management for life cycle inventories – an example of using data quality indicators," Journal of Cleaner Production 4 no. 3-4 (1996): 167-174

	Representativeness to the activity in terms of:				
Score	**Technology (Tec)**	**Time (T)**	**Geography (Geo)**	**Completeness (Com)**	**Reliability (Rel)**
Very Good (VG)	Data generated using the same technology	Data with less than 3 years of difference	Data from the same area	Data from all relevant sites over an adequate time period to even out normal function	Verified data based on measurements
Good (G)	Data generated using a similar but different technology	Data with less than 6 years of difference	Data a similar area	Data from more than 50% of sites for an adequate time period	Verified data based partly based on assumptions or non-verified data based on measurements
Fair (F)	Data generated using different technology	Data with less than 10 years of difference	Data from a different area	Data from less than 50% of sites for an adequate time period of sites but for a shorter time period	Non-verified data partly based on assumptions, or qualified estimates
Poor (P)	Data where technology is unknown	Data with more than 10 years of difference or the age of the data is unknown	Data from an area that is unknown	Data from less than 50% of the sites for shorter time period or representativeness is unknown	Non-qualified estimate

Evaluation of emission sources

This analysis and the methodology used to calculate emissions of each category and the analysis of data quality is presented in Table 5.

Table 5

Methodology type and data used for each emissions category showing analysis of data quality for each emissions category

Emissions Category	Activity Data	Tec	T	Geo	Com	Rel	CF	Tec	T	Geo	Com	Rel	Reference
Natural Gas and Gas Oil emissions	Meter Readings and Invoices from Carlton Gas	VG	VG	VG	VG	VG	Defra 2020 Natural Gas and Gas Oil	VG	G	VG	N/A	VG	Defra 2020 Methodology Paper: BEIS's Digest of UK Energy Statistics (DUKES) (BEIS, 2019b).
University vehicles	Expense claims for fuel	VG	VG	VG	P	VG	Defra 2020 Average Petal and Diesel Car	VG	VG	VG	N/A	VG	Defra 2020 Methodology Paper: Ricardo Energy & Environment. Template for studies (europa.eu)
Change in Land use	Estate survey	N/A	VG	VG	G	F	UK LULUCF Review 2019	N/A	VG	G	VG	F	UK Natural Capital Land Cover in the UK – Office for National Statistics (ons.gov.uk), Mapping Carbon Emissions & Removals for the Land Use, Land-Use Change & Forestry Sector: NAEI report 2019 (publishing.service.gov.uk)
Electricity	Electricity consumption form Half hourly meters	VG	VG	VG	G	VG	Half hourly carbon intensity of the grid nationally	VG	VG	F	VG	G	**ESO Data Portal: Historic GB Generation Mix – Dataset| National Grid Electricity System Operator (nationalgrideso.com)**
	Total electricity consumption	VG	VG	VG	VG	VG							
1 and 2													
Science	Category spend data	G	VG	VG	VG	VG	Company Report Merck	VG	VG	G	F	G	Internal document
IT	Category spend data	F	VG	VG	VG	VG	Company Report Dell	VG	G	VG	VG	VG	**https://corporate.delltechnologies.com/en-us/social-impact/advancing-sustainability/sustainable-products-and-services/product-carbon-footprints.htm**
Construction	GIA of completed buildings	G	VG	VG	F	VG	Case study of Global Health Institute using OneClick	G	G	F	G	F	Internal document
Business Services	Category spend data	G	VG	VG	VG	VG	HESCET Business services	P	P	P	P	P	Unknown
Premises	Category spend data	G	VG	VG	VG	VG	Case study of Richard Ward	VG	VG	VG	P	VG	Internal document

Emissions Category	Activity Data	Tec	T	Geo	Com	Rel	CF	Tec	T	Geo	Com	Rel	Reference
3: Fuel and Energy Scope 3 Emissions													
Upstream emissions from purchased electricity from the grid, T&D losses and T&D losses of upstream emissions	Meter Readings	VG	VG	VG	VG	VG	Defra Emission Factors for WTT electricity, T&D losses and WTT of T&D losses	VG	VG	VG	VG	VG	Defra 2020 Methodology Paper: DUKES_2019_MASTER_COPY.pdf (publishing.service.gov.uk)
Upstream emissions from purchased electricity from PV	Meter Readings	VG	VG	VG	VG	VG	NREL Emission Factors	VG	F	F	N/A	VG	**Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics (Fact Sheet), NREL (National Renewable Energy Laboratory)**
Upstream emissions from purchased fuels (Natural gas, Oil Gas, Diesel and Petrol)	Meter readings, invoices from Carlton gas and Expenses claims for Fuel	VG	VG	VG	VG	VG	Defra Emission Factors for WTT Natural Gas, Oil Gas, Petrol and Diesel	VG	VG	VG	VG	VG	Defra 2020 Methodology Paper: Exergia et al. (2015). Study on actual GHG data for diesel, petrol, kerosene and natural gas. A study by Exergia, E3 Modelling and COWI for the European Commission, DG ENER. Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/Study%20on%20Actual%20GHG%20Data%20Oil%20Gas_Project%20Interim%20Report.pdf
4: Upstream Transportation and Distribution	Cost of freight	VG	VG	VG	VG	VG	Postal Service HESCET	P	P	P	P	P	Unknown
5: Waste	Waste invoices from Select Environmental	VG	VG	VG	VG	VG	DEFRA 2020 WEE – Mixed	G	P	F	N/A	P	Defra 2020 Methodology Paper
	Water consumption invoices from Themes Valley	VG	VG	VG	VG	VG	DEFRA 2020 Water treatment	VG	VG	VG	N/A	VG	Defra 2020 Methodology Paper: Water UK (for reporting in 2008, 2009, 2010 and 2011) and are based on submissions by UK water suppliers.
							EPA Emission Factor Hub	VG	F	F	N/A	VG	

Emissions Category	Activity Data	Tec	T	Geo	Com	Rel	CF	Tec	T	Geo	Com	Rel	Reference
6: Business Travel	Key Travel data	VG	VG	VG	F	VG	Defra 2020 Flights	VG	VG	VG	N/A	VG	Defra 2020 Methodology Paper: EUROCONTROL small emitter's tool
	2015 Invoice review	VG	G	VG	VG	VG	Defra 2020 International Rail	VG	VG	VG	N/A	VG	Defra 2020 Methodology Paper
							Defra 2020 National rail	VG	VG	VG	N/A	VG	Defra 2020 Methodology Paper
							Defra 2020 Average Petrol and Diesel Car	VG	VG	VG	N/A	G	Defra 2020 Methodology Paper
7: Employee Commuting & 16.1: Student Commuting Term-Time	Travel Survey	VG	VG	VG	F	F	Defra 2020 National Rail and car	See above	//	//	//	//	Defra 2020 Methodology Paper
							Defra 2020 Average Motorbike	VG	F	VG	N/A	VG	Defra 2020 Methodology Paper: DfT
							Defra 2020 Average Local Bus	VG	G	VG	N/A	VG	Defra 2020 Methodology Paper: DfT
16.2: Student Commuting Inter-term	Annual Census	N/A	VG	N/A	VG	G	Defra 2020 Average Car and Flights	See above	//	//	//	//	Defra 2020 Methodology Paper
	Student Registered home address	N/A	VG	N/A	VG	G							
	Placement Year Locations	N/A	VG	N/A	VG	G							
	National Statistics Postcode Lookup	N/A	VG	N/A	VG	VG							
	Distance: GeoDist	N/A	VG	N/A	G	G							

Annex D:

F-Gas Calculations

Method for Purchased Gases

Emissions = (P × a) + R

Data required

P = Amount of gas purchased

a = Proportion of gas released during laboratory processes (%)

R = Amount of gas produced and then released in laboratory processes

Steps

1. Determine purchases of industrial gases.
2. Estimate the amount release during Laboratory procedures.
3. Estimate the amount produced and released during laboratory procedures.
4. Calculate emissions.

Screening Method

Emissions = (CN × k) + (C × x × T) + ((CD × y) × (1 – z))

Data required:

CN = amount of refrigerant charged into the new piece of equipment

k = assembly losses in percent of amount charged

C = refrigerant capacity of the piece of equipment

x = annual leak rate in percent of capacity

T = time in years used during the reporting period (e.g., 0.5 if used only during half of the reporting period and then disposed)

CD = refrigerant capacity of the piece of equipment being disposed of

y = percent of the capacity remaining at disposal

z = percent of refrigerant recovered

Steps:

1. Determine the number and types of refrigeration and air conditioning equipment (by equipment category, see Section 3.1) including the types of refrigerants used, and the total refrigerant capacity of each piece of equipment.
2. Identify any new equipment that was installed during the reporting period and was charged on-site. Determine the amount of refrigerant charged into the new piece of equipment. Assembly losses in percent of amount charged.
3. Determine operating emissions – Emissions from Operation = refrigerant capacity of the piece of equipment x annual leak rate x time in years used during the reporting period.
4. Determine the disposal emissions = capacity of the piece of equipment being disposed of x proportion of capacity remain at disposal x percent of refrigerant recovered.
5. Determine total emissions.

Simplified Material Balance Method

Emissions = (Pn-Cn) + Ps + (Cd – Rd)

Data required:

Pn = Purchase of refrigerant used to charge new equipment

Cn = Total refrigerant capacity of new equipment

Ps = Amount of refrigerant purchased to service equipment

Cd = Total capacity of the equipment disposed

Rd = The amount of refrigerant recovered

Steps:

Step 1: Calculate installation emissions (Pn – Cn)

Purchase of refrigerant used to charge new equipment – total refrigerant capacity of new equipment.

Step 2: Determine operations emissions (Ps)

Operating emissions result from equipment leaks and service losses. – It is assumed that the amount of refrigerant purchased to service equipment, is replacing the same amount that was emitted during operation.

Step 3: Calculate disposal emissions (Cd – Rd)

Emissions are calculated by taking the difference between the total capacity of the equipment disposed and the amount of refrigerant recovered. The difference is assumed to represent emissions.

Step 4: Calculate emissions

Emissions for each type of refrigerant and blend are calculated by summing the results of the first three steps. Multiply the emissions of each refrigerant by the refrigerant's GWP.

Annex E:

Supplier survey questionnaire

Survey sent to top suppliers

1. Name of Company
2. Name of respondent
3. Email address of respondent
4. Would your company be willing to share information about its annual GHG emissions with the University for the purposes of emissions accounting?
5. Please link any relevant summary documents or reports on your company's GHG emission in the period 2018-2019 and 2019 – 2020.
6. Does your company calculate the carbon emissions associated with specific products that it supplies?
7. Would your company be able provide the University a carbon report of the products that the University has purchased from your company?
8. What percentage (%) of your company's revenue came from the University of Oxford in your emission reporting periods from 2018 to 2020? (If unknown please state the company's total revenue so that this proportion can be calculated).
9. What were the company's annual Scope 1 and 2 emissions in the between 2018-2019 and 2019-2020? (please give the reporting period and all GHG emissions recorded eg $kgCO_2e$, $kgCO_2$, $kgCH_4$, kgN_2O, kgHFCs, kgPFCs, kgSF6)
10. What were the company's annual Scope 3 emissions in the between 2018-2019 and 2019-2020? (please give the reporting period and all GHG emissions recorded eg $kgCO_2e$, $kgCO_2$, $kgCH_4$, kgN_2O, kgHFCs, kgPFCs, kgSF6)
11. What method or standard was used to report Scope 1 and 2 emissions data?
12. What method or standard was used to report Scope 3 emissions data?
13. What were the main sources of Scope 1, 2 and 3 emissions in this reporting period?
14. What are the main sources of data and emission factors used in emissions accounting for scope 1, 2 and 3?
15. How would you rate the data sources used to calculate the emissions figures your company has provided using the GHG Protocol assessment of data quality for the technology, timeliness, geography, completeness and reliability?
16. What are the main sources of uncertainty in the company's emissions accounts?
17. How does the company set its company boundaries when performing emissions accounting?
18. If yes, please provide details.
19. Is the company making any efforts to reduce the carbon emissions associated with the production of their good and services?
20. If yes, please provide details.
21. Would an environmental or sustainability representative be willing to have an open conversation with the University about its supply chain emissions associated with good and services purchased by the University? (If yes, the email address provided at the beginning of this survey will be used to make first contact)
22. Any additional thought or comments on supply chain emission?

Annex F:

Emissions details

Category	Volume unit	tCO_2e	kg CO_2e	kg CO_2	kg CH_4	kg N_2O
Scope 1						
1: Operations Fuel Consumption						
Gas oil	kWh	204.95	204,951.72	202,460.18	210.13	2,288.92
Natural gas	kWh	17,576.35	17,576,348.00	17,542,891.00	23,898.00	9,559.00
Total		17,781.30	17,781,299.72	17,745,351.18	24,108.13	11,847.92
2: Fleet Fuel Consumption						
Diesel	l	276.26	276,262.08	27,358.95	3.26	381.94
Petrol	l	39.25	39,249.83	39,019.91	121.12	108.81
Total		315.51	315,511.91	66,378.87	124.37	490.75
3: Change in Land Use						
Woodland	ha/year	(4,497.40)	(4,497,400.00)	(4,497,400.00)		
Grassland	ha/year	(34.28)	(34,282.00)	(34,282.00)		
Other		(2.00)				
Total		(4,531.68)	(4,531,682.00)	(4,531,682.00)		
4: Fugitive Gasses						
Scope 1 emissions from fugitive gasses						
Scope 2						
1: Electricity						
Scope 2 emissions from electricity	kWh	22,883.09	22,883,090.49	22,676,971.89	70,669.23	135,449.36
Offsets		(22,883.09)				

Category	Volume unit	tCO_2e	kg CO_2e	kg CO_2	kg CH_4	kg N_2O
Scope 3						
1 & 2: Purchased Goods and Services						
Science and Medical	£	18,887.93				
Construction	GIA	23,966.49				
Business Services	£	621.00				
IT	£	11,341.04				
Premises	£	381.77				
Other goods and services	£	9,467.00				
Uncategorised	£	98,033.59				
Total		154,700.34				
3: Fuel and Energy Scope 3 Emissions						
Upstream emissions from purchased electricity from the grid	kWh	3,706.91	3,706,908.86			
Upstream emissions from purchased electricity from PV	kWh	19.62	19,617.08			
Upstream emissions from purchased fuels (Natural gas)	kWh (Net CV)	2,532.21	2,532,209.99			
Upstream emissions from purchased fuels (Gas Oil)	kWh (Net CV)	47.01	47,009.06			
Upstream emissions from purchased fuels (Diesel)	l	66.21	66,205.55			
Upstream emissions from purchased fuels (Petrol)	l	10.74	10,743.64			
T&D losses	kWh	2,289.60	2,289,595.24	2,289,595.24	6,913.72	13,827.45
T&D losses of WTT electricity	kWh	319.18	319,183.63			
Total		8,991.47	8,991,473.05			
4: Upstream Transportation and Distribution						
Couriers, Postage & Delivery	£	528.31	528,308.14	453,775.04	-	-
5: Waste						

Category	Volume unit	tCO_2e	kg CO_2e	kg CO_2	kg CH_4	kg N_2O
Bulk Collections	tonnes	0.49	489.79			
Clinical waste	tonnes	3.81	3,809.74			
Confidential: off-site shredding	tonnes	1.26	1,259.91			
Dry mixed recycling	tonnes	32.80	32,803.53			
Food recycling	tonnes	10.53	10,533.82			
General waste	tonnes	388.00	387,761.03			
Glass recycling	tonnes	1.46	1,463.54			
Metal recycling	tonnes	0.60	598.33			
O Hazardous Waste	tonnes	32.17	32,171.00			
Paper & cardboard	tonnes	0.22	222.38			
Paper cup recycling	tonnes	3.38	3,382.29			
WEEE	tonnes	0.12	118.56			
Wood recycling	tonnes	0.10	97.22			
Wastewater	m^3	169.19	169,188.13			
Total		643.90	643,899.27			
6: Business Travel						
Rail	pkm	21.44	21,444.55	21,241.36	34.83	168.35
International Rail	pkm	0.60	604.98	598.89	2.43	3.65
Car	pkm	317.57	317,570.00	305.62	360.18	
Aeroplane Short Haul	pkm	2,685.86	2,685,864.60	2,672,349.20	172.10	13,343.29
Aeroplane Long Haul	pkm	16,862.32	16,862,320.73	16,778,050.04	1,003.02	83,267.68
Total		3,025.48				
7: Employee Commuting						
Single occupancy car	pkm	4,062.56	4,062,559.21	4,035,387.62	4,356.41	22,848.99
Car share	pkm	75.57	75,568.42	75,062.99	81.03	425.02
Bus	pkm	1,011.83	1,011,831.59	1,003,883.73	196.24	7,751.62
Train	pkm	613.85	613,846.57	608,030.48	997.04	4,819.04
Motorcycle	pkm	120.94	120,942.66	118,574.38	1,738.88	629.41
Total		5,884.75				
16: Student Commuting						
Students Term Time						
Single occupancy car	pkm	666.10	666,102.60	1,042,536.86	722.26	7,953.05
Car share	pkm	79.64	79,642.73	79,110.06	85.40	447.93
Bus	pkm	156.36	156,361.37	155,133.16	30.33	1,197.88
Train	pkm	186.71	186,707.65	184,938.63	303.26	1,465.76
Total		1,088.81	1,088,814.35			
Students Inter-term						
Car	pkm	805.31	805,305.04	802,209.49	1,432.27	1,663.28
Aeroplane	pkm	38,782.89	38,782,887.92	38,591,458.75	2,008.97	192,253.12
YA Aeroplane	pkm	176.12	176,122.68	175,236.76	9.23	876.69
Total		39,764.32	39,764,315.65			

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