Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

CARBON FOOTPRINT REPORT

Academic Year 2021–2022

TRINITY SUSTAINABILITY

Abstract

Trinity College has entered a new period of environmental reporting and action with its commitment to the Nature-Positive Universities Network and the new Corporate Sustainability Reporting Directive. Baseline carbon and biodiversity footprints were required to set science-based targets and assess the risks and opportunities of the university's supply chain and investment portfolio.
Using the Greenhouse Gas Protocol Methodology, a carbon footprint was produced for the financial year October 2021 to September 2022. It found that Trinity College emitted 170,205 tCO_2e in this period. Broken down by Scope, this amounts to 8,864 tCO_2e in Scope 1, 11,283 tCO_2e in Scope 2, and 150,058 tCO_2e in Scope 3. Priority actions for Trinity College should therefore be compiling supplier-specific emissions data to allow for evidence-based changes in Scope 3. A biodiversity footprint will be completed when the selected methodology becomes available.

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1. Introduction

The environment was integrated into the core of Trinity College's governance with the creation of the Vice President for Biodiversity and Climate Action position in 2021 and appointment of that role, and a Sustainability Manager, in 2022. It marked a new era for Trinity College's environmental action, building on the progress made by the Provost's Sustainability Advisor since 2017 and captured in annual Sustainability Reports. In order to prioritise biodiversity and climate actions, it was necessary to assess a baseline carbon footprint. Trinity College had previously reported elements of its carbon footprint in accordance with the ISO 14064-1 standard and the Sustainable Energy Authority of Ireland Monitoring & Reporting (SEAI M&R) platform. However, in developing baseline footprints, the aim was to create an easily replicable format for capturing the full suite of categories in Scopes 1 to 3 of the Greenhouse Gas Protocol for use in consecutive years (WRI & WBCSD, 2004). This format can be adapted to fulfil reporting requirements under the Corporate Sustainability Reporting Directive, which requires reports to be submitted from 2026 onwards (Council Directive 2022/2464).

Trinity College's dual focus on the carbon and biodiversity crises necessitates the development of a biodiversity footprint which will follow once an international methodology is available. Calculating this baseline is also part of Trinity College's Nature Positive Pledge to the Nature Positive Universities Network. In 2022, a Biodiversity Audit built upon previous Campus BioBlitzes in 2013, 2014, and 2017, capturing data on the habitats, plants, vertebrates, invertebrates, and fungi inhabiting Trinity College's Main Campus, with the ambition that data from the rest of Trinity College's estate would be added in the future (King & Stout, 2021). Such projects allow us to measure the potential for ecological restoration on Trinity College-owned land, for example, through actions in the Campus Pollinator Plan, such as the establishment of ornamental meadows on College Green (Stout, 2019). Creation of these meadows happened in 2020 following an open poll, where 90% of the 13,850 people who voted responded in favour, demonstrating overwhelming support for nature. The importance of nature positive actions was also recently seen in the discovery of a broad-leaved helleborine orchid in Trinity's Front Square following No Mow May, a temporary ceasing of lawn-mowing. However, mitigating harm to nature requires more than local ecological restoration on campus. Reducing a university's global biodiversity impacts requires a focus on energy use, travel, and procurement (Bull et al., 2022). Initiatives tackling these pressures include Healthy Trinity's Smarter Travel project, the refurbishment and addition of heat pumps to older buildings such as the Rubrics, and the implementation of the Sustainable Procurement Policy. These actions have carbon reduction benefits too, demonstrating that the same actions can have multiple benefits. Similarly, data from such activities that are required for measuring greenhouse gas emissions and carbon footprinting, are similar to those needed to report on biodiversity impacts, and biodiversity footprinting.

The Institute for European Environmental Policy (IEEP) defined a biodiversity footprint as follows: *The impact of a commodity, company, person or community on global biodiversity, measured in terms of biodiversity change, as a result of production and consumption of particular goods and services* (IEEP, 2021). The wide range of biodiversity impacts are challenging to summarise in a single metric, unlike carbon footprinting, which is usually quantified in tonnes of CO_2 or CO_2 equivalent released per unit of production or consumption. Biodiversity footprinting highlights which pressures in a university's operations cause the most harm and allow identification of where changes would most effectively reduce negative impacts (IUCN NL, 2020). These impacts can include water overconsumption, ecotoxicity, acidification, and eutrophication acting on the different levels of genetic, functional, species, habitat, and ecosystem biodiversity (Biggs et al., 2021). Meanwhile, carbon footprinting shows which operations are the highest greenhouse gas emitters and therefore contribute the most to climate change impacts.

The wide range of potential biodiversity impacts of different organisations has resulted in the proliferation of different sector-specific biodiversity footprinting methodologies, as outlined in the IUCN NL (2020) and IEEP (2021) reports.

Few of these were specific to universities, hence Trinity College Dublin opted to use the Oxford University Biodiversity Footprinting Methodology to be able to compare results with other universities in the Nature-Positive Universities Network (Bull et al., 2022). Unfortunately, Oxford's Excel-based tool is still being developed, therefore a full biodiversity footprint report will be completed upon the availability of this tool, hopefully in 2024. Trinity College had also trialled the use of the EUSTEPS University Footprint Calculator which is based on the ecological footprint methodology and developed for European universities (Mancini et al., 2018; 2022). However, the full EUSTEPS assessment was not completed as the outputs were less relevant to our goals than the Oxford methodology. For carbon footprinting, Trinity College Dublin selected the Greenhouse Gas (GHG) Protocol methodology as used by the Trinity Business School and other Irish third-level institutions such as Dublin City University (DCU) and the University of Galway (UofG) (Sustainability DCU, 2020; Goggins & Adams, 2021; WRI & WBCSD, 2004).

This report aims to quantify hotspots of carbon emissions impacts across Trinity College's operations. It also highlights what data and methodology is needed to produce a more comprehensive assessment in the future.

2. Goals

The business applications of footprinting applicable to Trinity College are as follows (IUCN NL, 2020):

- Developing a baseline and setting science-based targets for Trinity's Sustainability Strategy and Action Plan.
- Assessing the risk and opportunity of Trinity's supply chain and investment portfolio.
- Comparing options for the mitigation and restoration of on-site biodiversity.
- Comparing options for the mitigation of carbon emissions.
- Tracking performance over time against international targets such as the Sustainable Development Goals and Ireland's National Biodiversity Action Plan and Climate Action Plan.

3. Organisational & Operational Boundary

The financial control methodology is the organisational boundary selected for Trinity's carbon footprint (WRI & WBCSD, 2004). It captures the activities of the University and the following subsidiary undertakings listed in the Annual Report and Consolidated Financial Statements Year ended 30 September 2022: Ghala Designated Activity Company, Trinity College Brand Commercial Services Limited, Trinity College Asia Services Pte. Limited, Trinity College Online Services Company Limited By Guarantee, Trinity College Foundation, Trinity College College Dublin Trust, Trinity College Dublin Association and University of Dublin Fund (FSD, 2023). Data for purchased goods and services, capital goods, upstream transport and distribution, and staff numbers were sourced from the Financial Services Division and confirmed to be consolidated. Data for utilities and waste were sourced from the SEAI and Estates & Facilities and assumed to be consolidated as the subsidiaries generally operate on university-owned sites. The list of buildings captured in the energy and water data is included in the supplementary data sheet (Trinity CollegeCarbonFootprint_2021–22.xlsx).

The operational boundary for the carbon footprint is Scope 1, 2, and 3. Scope 1 emission sources (those directly created from sources owned or controlled by Trinity) were natural gas, LPG, gasoil, road diesel, petrol, marked diesel, and refrigerants. Scope 2 emission sources (those indirectly created from purchased electricity, heat, cooling or steam consumed by Trinity) included solely purchased electricity. Electricity generated with solar photovoltaics on the Trinity Business School and used on-site was assumed to be zero carbon and excluded. Scope 3 emission sources (those indirectly created by Trinity's activities but from sources not owned or controlled by Trinity) included purchased goods and services, capital goods, water consumption, fuel and energy related activities, waste generated in operations, business and student academic travel, student and staff commuting, upstream transportation and distribution, and investments. Investment data were included in the assessment but excluded from the summary pending further clarity on the industry sectors.

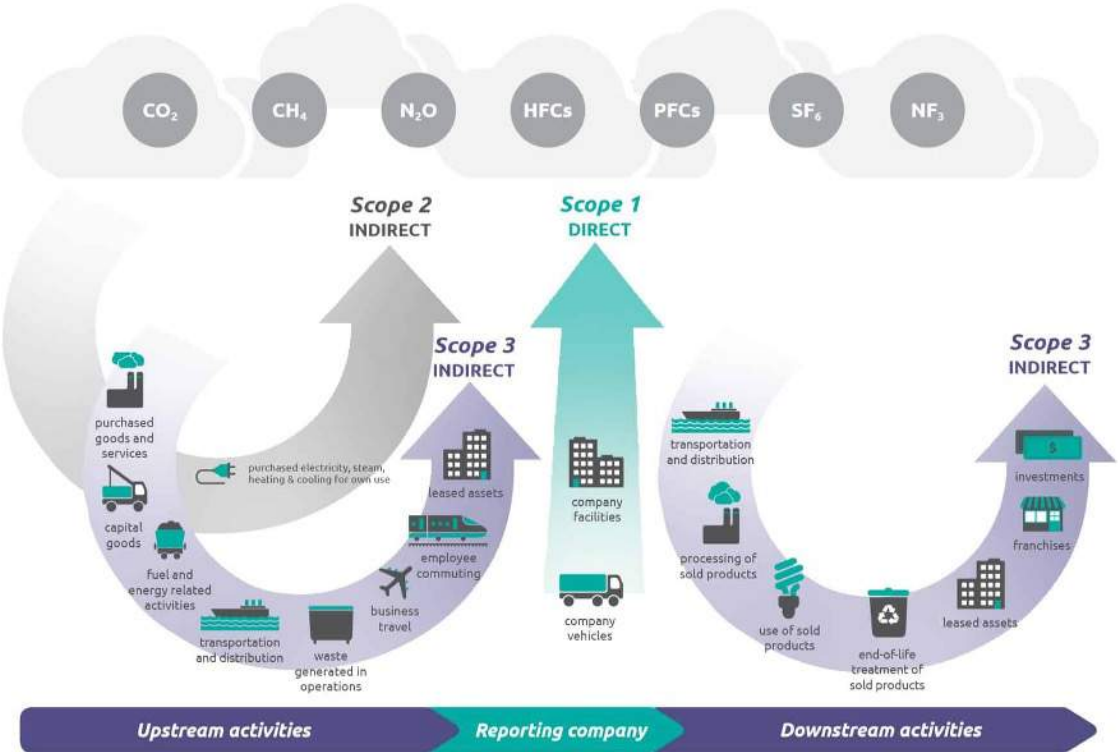

FIG 1 Image of Scope 1, 2 and 3 emission sources (WBCSD and WRI, 2011).

4. Methodology

The time period for the carbon footprinting baseline was the financial year October 2021 to September 2022 inclusive. Where monthly data were not available, annual data were divided by 12 to calculate the monthly average and then multiplied by 3 months and 9 months for 2021 and 2022, respectively. This process and the sources of greenhouse gas conversion factors can be followed in the TrinityCollegeCarbonFootprint_2021–22.xlsx. data sheet in the Supplementary Material. The data sources for the footprinting processes were as follows:

- **Energy, Refrigerants, Water, Waste, and Space Management**
  Estates and Facilities provided data through Excel sheets, F-Gas reports and by allowing access to the SEAI M&R Portal.
- **Staff Numbers, Business Travel, Student Academic Travel, Purchased Goods and Services, Capital Goods, Upstream Transportation and Distribution, and Investments**
  The staff numbers were taken from the Annual Report and Consolidated Financial Statements (FSD, 2023). The Financial Services Division provided business travel data through Excel sheets submitted to the SEAI M&R Portal and financial data through their Planning & Budgeting Cloud System when given a list of required Generally Accepted Accounting Principles (GAAP) codes. Flights data were received directly from Club Travel.
- **Catering Sales**
  The catering team provided data on the type and quantity of products sold in catering outlets around Trinity main campus.
- **Staff and Student Commuting**
  Healthy Trinity provided commuting data through Excel sheets from their Smarter Travel survey. These data were scaled up using the total staff and student numbers.
- **Student Numbers**
  Academic Registry provide data through their annual report and internal records.

	GHG PROTOCOL	OXFORD METHODOLOGY
USER INTERFACE	Excel tool.	Excel tool - Not available yet.
PRIMARY FOCUS	Carbon Footprint.	Biodiversity Footprint.
DATA INPUT REQUIREMENTS	Supplementary Data: **TrinityCollegeCarbon Footprint_2021– 22.xlsx**	Appendix 1.
TYPE OF INSIGHT	The tonnes of CO_2 equivalent emitted in Scopes 1-3.	The local relative species loss and carbon emitted in each impact category.
COMPLEMENTARY DATA	SEAI Annual Report: **Residential Sector Emissions.**	To be confirmed.
METHODS FOR LINKING PRESSURES WITH IMPACTS	SEAI Emission Factors; DEFRA Emission Factors; Quantis Scope 3 Evaluator.	FoodDB Project Tool; Exiobase 3 in Open LCA software; UK Higher Education Supply Chain Emissions Tool; ReCiPe.

TABLE 1 Summary of the GHG Protocol and Oxford University Methodology for carbon and biodiversity footprinting.

4.1 CARBON FOOTPRINT

Trinity followed the GHG Protocol methodology to produce its 2021-2022 carbon footprint (WRI & WBCSD, 2004).

Energy data for Scopes 1 and 2 were extracted from the SEAI M&R Portal's *Detailed Energy Data* section for the year's 2021 and 2022, then adjusted to the financial year 2021–2022. All data from the SEAI M&R Portal had the unit kilowatt-hour (kWh), which corresponded to the $kgCO_2$/kWh conversion factors provided by the SEAI for electricity, gas, heating oil, and mineral fuels. UK DEFRA emissions factors were in $kgCO_2e$/kWh, SEAI have not confirmed the availability of Irish factors using carbon equivalent. However, the SEAI $kgCO_2$/kWh is very similar to DEFRA's $kgCO_2e$/kWh for natural gas and the difference for electricity is likely due to a different blend of power generation in the UK and Ireland. The SEAI factors were used for Scope 1 & 2, except for bioenergy and SEAI should be asked again for $kgCO_2e$/kWh factors. Electricity emissions were calculated using a location-based methodology, but in future, should also be calculated using a market-based methodology that considers guarantees of origin or power purchase agreements. This will be more relevant for the 2022–2023 assessment, as these guarantees were purchased in late 2022. The data for biodiesel and bioethanol had to be converted to litres to use the $kgCO_2e$/L bioenergy conversion factors provided by the United Kingdom's (UK) Department for Environment, Food & Rural Affairs (DEFRA).

The SEAI M&R Portal has an *Energy-related CO_2 Emissions* section, but for this baseline assessment the decision was made to manually calculate emissions in TrinityCollegeCarbonFootprint_2021–22.xlsx. Future assessments may include the carbon emissions calculated within the SEAI M&R Portal instead. However, the SEAI does not currently provide conversion factors for bioenergy, in which case DEFRA factors should still be used for biodiesel and bioethanol consumption. The same activity data were used for the *Fuel and Energy-related Activities* section but using Well-to-Tank UK DEFRA emissions factors. This section captures the energy lost as it travels from the supplier to the university. Electricity was excluded from this section because the SEAI's *Electricity Supply Efficiency* accounts for losses as part of Scope 2 (Goggins & Adams, 2021). Additional refrigerants data must be requested directly from individual faculties, to complement data from the E&F maintenance contractor and catering department. UK DEFRA emissions factors were primarily used for refrigerants emissions, with some exceptions which are specified in Trinity CollegeCarbonFootprint_2021–22.xlsx.

Water consumption for Scope 3 was calculated from invoices included in the SupplementaryData_2021–22_Water.xlsx spreadsheet provided by Estates & Facilities. Rows with consumption dated fully outside financial year 2021-2022 were excluded from totals. Consumption dated partially inside financial year 2021-2022 were fully included.

These invoices should be excluded in the 2022–2023 assessment to avoid double-counting. Most invoices included consumption data in the unit metres-cubed (m^3). For those which were unmetered and only had expense data, a rate of €0.07/m^3 was assumed based on other invoices and used to estimate consumption data. Total consumption data was summed for the *Water Supply – Mains* data point in Scope 3, this is equal to the *Water Treatment* data point as Estates & Facilities noted that they are billed with the same figure.

Monthly waste data for Scope 3 was provided by Estates & Facilities as a hard copy and inputted into Trinity CollegeCarbonFootprint_2021–22.xlsx with the unit tonnes. The hazardous waste is billed annually rather than monthly, hence was included in *Other–21* and *Other–22* columns and adjusted using a monthly average. The same was done for any extra waste recorded in those two columns. This was done to avoid double-counting in consecutive assessments (i.e. 9 months of 2022 were counted in 2021–2022 and the other 3 months will be counted in 2022–2023). Estates & Facilities confirmed that data from Trinity College Ball and the Summer Concert Series was included in the 2021–2022 data sheets but that in some years organisers arrange waste contractors directly and Trinity College needs to request the data separately. This should be clarified in each assessment. Additionally, printer cartridges were not collected during the 2021–2022 period as collections only get organised above a certain volume which leads to this data point varying irregularly year-to-year. UK DEFRA conversion factors were used for waste data.

Business travel data were supplied by the Financial Services Division as submitted to the SEAI, these are available in SupplementaryData_2021_BusinessTravel.xlsx and SupplementaryData_2022_BusinessTravel.xlsx. Data were copied into Trinity CollegeCarbonFootprint_2021–22.xlsx and any rows with a payment date outside October 2021 to September 2022 were deleted. Ferry transport was not invoiced with kilometres, but an overall figure was provided for 2022 and used as a total. Some taxi invoices did not include travel distance, but this was estimated using the expenditure and the average of €1.96/km calculated in the SEAI M&R submission.

The 2021 data only include private road vehicles and flights but not public transport or taxi journeys as these were not mandatory in the 2021 SEAI submission. DEFRA conversion factors were applied to business travel data. Flight data were provided by Club Travel with carbon emissions already calculated for each journey using calculations based on the ICAO Carbon Emissions Calculator. All Trinity departments and travellers are captured in these data, including student academic field trips. Data from incoming and outgoing exchange students, as well as all incoming international students must be requested from Global Relations. The emissions calculated by Club Travel were applied to this report to maintain consistency and reduce workload for future years. In future, kilometres travelled should be requested for flight data to calculate fuel and energy-related emissions using DEFRA conversion factors. All business travel data should include a travel date and kilometres travelled column.

Healthy Trinity supplied commuting data from their 2023 Smarter Travel Survey. This was the latest survey since before the COVID-19 pandemic and it was assumed to be more relevant than the 2017 survey. It asks respondents to select their usual distance travelled by a particular mode of transport from seven distance ranges in a multiple-choice question (SupplementaryData_2023_SmarterTravelSurvey.xlsx). The data were cleaned to remove "I don't travel to campus", "Other means", and blank responses to the mode of travel question, as well as "Other" and blank responses to the distance travelled and staff or student questions. The total number of students or staff who travelled by a particular mode of transport in that distance range was divided by the total number of student or staff respondents to get a percentage figure. The total distance travelled by mode of transport was calculated by multiplying this percentage by the total of Full-Time Equivalent (FTE) and Foundation students in Trinity College during that academic year, by 2x to represent a return trip, by 5x working days per week, and by 22x academic weeks per year. For staff, the methodology only changed in the number of total FTE staff and 45x working weeks per year. DEFRA conversion factors were applied to commuting data.

The number of academic and working weeks per year was taken from the academic year calendar and communication with Human Resources, respectively.

Work from home (WFH) emissions also used the Smarter Travel Survey as it asked staff how many days they usually WFH. The same methodology was applied as above where the percentage of staff for each number of WFH days per week was multiplied by the total FTE staff in that year. The total kWh emitted by WFH was calculated by multiplying the total number of WFH days per week for all FTE staff by 45x working weeks per year and the kWh/person/day for electricity and natural gas. The latter was calculated using SEAI energy data for the Residential Sector in 2021 and an assumed increase in residential energy use when WFH (Anthesis, 2021). SEAI energy factors were applied to the total kWh of electricity and natural gas. WFH home data can be used to weight commuting data and avoid double counting by calculating the % WFH days as a function of mode travelled and then subtracting Total WFH Days/Year/Mode from Total Days/Year Travelled/Mode. However, based on the latest Smarter Travel survey, the number of total WFH days only form 0.35% of total working days so is unlikely to significantly change the total carbon footprint.

Emissions for purchased goods and services, capital goods, upstream transportation and distribution, and investments were calculated using a spend-based methodology and the Quantis Scope 3 Evaluator. This tool will be decommissioned after 30th August 2023 due to out-dated emissions factors, in future years a new methodology for this section must be used because the tool will no longer be available. Trinity should liaise closely with other third-level institutions to align ensure their new methodology is aligned. Currently, EXIOBASE 3 appears to be most suitable and was used by the University of Galway for their carbon footprint assessment (Goggins & Adams, 2021). The Quantis Scope 3 Evaluator was used for this report due to ease of access and on-going discussions as to the best alternative. The Financial Services Division provided a breakdown of GAAP codes which were matched to relevant Quantis categories and then sent back to the Financial Services Division to pull down the corresponding expenses using their Planning & Budgeting Cloud System. GAAP codes follow the hierarchy of grandparent, parent and child codes. Where it was unclear which Quantis category the grandparent code corresponds to, it was broken down to parent or child codes which are higher resolution and can be matched more accurately. The Financial Services Division were consulted on the meaning and relevance of the selected GAAP codes. Each Quantis category total was converted into USD ($) and inputted into the Evaluator to calculate carbon emissions in four separate questionnaires for purchased goods and services, capital goods, upstream transportation and distribution, and investments. This is shown in TrinityCollegeCarbonFootprint_2021-22.xlsx. Investments have temporarily been excluded from the carbon footprint summary as more data is required to follow the recommended methodology in Chapter 15, Technical Guidance for Calculating Scope 3 Emissions.

5. Results & Discussion

5.1 CARBON FOOTPRINT

Trinity College's carbon footprint for the financial year (1st October 2021 to 30th September 2022) is summarised in Tables 3, 4 and Figure 2 below.

SCOPE	tCO_2e	% OF TOTAL EMISSIONS	tCO_2e/FTE STAFF + STUDENTS = 23,605	tCO_2e/M^2 305,000 M^2
SCOPE 1	8,864	5.2%	0.38	0.03
SCOPE 2	11,283	6.6%	0.48	0.04
SCOPE 3 CAPITAL GOODS ONLY	67,921	39.9%	2.88	0.22
SCOPE 3 EXCL. CAPITAL GOODS	82,137	48.3%	3.58	0.27
TOTAL	**170,205**	**100%**	**7.21**	**0.56**

TABLE 2 Summary of Trinity College's carbon emissions by scope in tCO_2e.

BREAKDOWN OF CARBON FOOTPRINT BY SCOPE

- Scope 1:
  8,864 tCO_2e = **5.2% total emissions**
- Scope 2:
  11,283 tCO_2e = **6.6% total emissions**
- Scope 3 (Capital Goods Only):
  67,921 tCO_2e = **39.9% total emissions**
- Scope 3 (Excl. Capital Goods):
  82,137 tCO_2e = **48.3% total emissions**

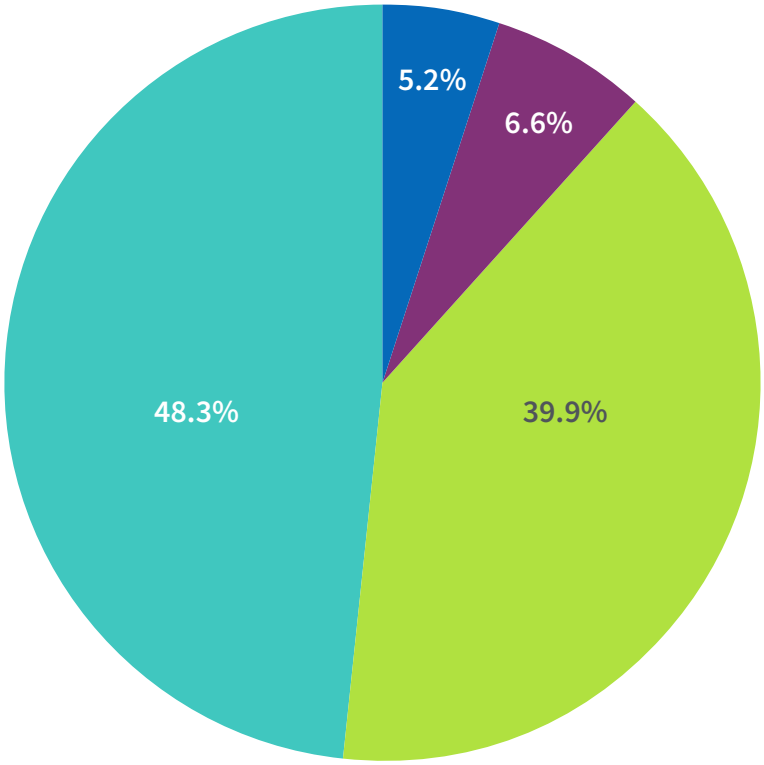

FIG 2 Trinity College's total carbon footprint broken down by Scope 1,2 and 3 emissions.

At 88.2% of total carbon emissions, Scope 3 forms the majority of Trinity College's footprint. This was expected based on previous assessments by the Trinity Business School and other Irish third-level institutions such as DCU (Sustainability DCU, 2020), UofG (Goggins & Adams, 2021), and UCC (UCC, 2023). However, the overall 2021–2022 carbon footprint is 2.8-3.2x greater than that of DCU (2019) and the UofG (2021) in their latest published carbon footprint reports (Goggins & Adams, 2021; Sustainability DCU, 2020). Taking into consideration differences in the campus population and surface area, the per capita (tCO2e/FTE) and area (tCO_2e/m2) footprint is still 2.2x and 6.2x greater than DCU's, respectively (Sustainability DCU, 2020). The difference is slightly less with the UoG, where Trinity's per capita and area is 2.6x and 1.4x greater, respectively (Goggins & Adams, 2021).

	SCOPE 1 & 2			SCOPE 3			TOTAL		
UNIT	tCO_2e/ FTE	tCO_2e/ M^2	tCO_2e	tCO_2e/ FTE	tCO_2e/ M^2	tCO_2e	tCO_2e/ FTE	tCO_2e/ M^2	tCO_2e
TCD (2021–2022)	0.86	0.07	20,147	6.36	0.49	150,058	7.28	0.56	170,205
DCU (2019)	0.96	0.03	15,230	2.33	0.06	37,402	3.29	0.09	52,632
UOG (2021)	–	–	6,610	–	–	53,390	2.84	0.39	60,000

TABLE 3 Comparison of carbon footprints between Trinity College, DCU and UoG (Goggins & Adams, 2021; Sustainability DCU, 2020).

These differences are greatest in Scope 3, where although all three institutions used the financial control methodology, the UoG used a different calculation tool (EXIOBASE 3) for the Purchased Goods & Services and Capital Goods sections. Trinity College and DCU both used the Quantis Scope 3 Evaluator. However, the Quantis categories matched to Trinity College's GAAP Codes in the Purchased Goods & Services and Capital Goods sections should be verified using the ISIC Rev. 3 economic classification system to ensure the methodology is consistent with DCU's. For example, DCU's total expenses inputted to Quantis were much lower than what Trinity College inputted. Trinity College's assessment also varies to DCU in that the total cost (including VAT) was included rather than the basic price. Trinity College could improve the granularity of its Scope 3 analysis by following the UoG's methodology with the EXIOBASE 3 input-output database in the Appendix of UoG's carbon footprint report (Goggins & Adams, 2021). This is specific to the year, region, and currency which results in higher accuracy. EXIOBASE 3 is also the tool used in Oxford's Biodiversity Footprinting Tool and therefore, would align the two methodologies. It is recommended that the 2021–2022 assessment be updated when the new methodology is confirmed to ensure a more relevant baseline. Third-level institutions should collaborate to align methodology to ensure comparable results. For example, Trinity College included the Fuel and Energy-Related Activities category which was a step not taken in the DCU and UoG reports.

Following this, research should be conducted on any operational differences that result in Trinity College's higher emissions. For example, types of laboratory equipment used.

The accuracy of the Purchased Goods & Services and Capital Goods categories can be further improved by using supplier-specific emissions data. Trinity's Sustainable Procurement Policy sets a foundation for this through its objective to "include sustainability criteria when evaluating tenders from potential suppliers". This is also preferred because it will make the carbon footprint impact of changes in supplier based on these criteria more apparent. Spend-based data assessed using industry sector averages will not reflect these positive actions. However, it is likely that a hybrid or fully spend-based method will be used in future assessments until this data collection gap is filled. The Capital Goods category is expected to vary annually depending on the level of on-going construction and refurbishment works. Some of these refurbishment projects may lead to long-term reductions in Scope 1 and 2 emissions if improvements in energy efficiency are achieved.

Trinity College's Scope 1 figures are also still subject to change pending the addition of additional refrigerants data which are an important part of the Scope 1 emissions, as seen in DCU's carbon footprint for 2019 (Sustainability DCU, 2020). In future assessments, it is hoped that the SEAI will provide emissions factors for bioenergy which will make Scope 1 emissions more accurate than when using UK DEFRA factors. Additionally, Scope 2 emissions can be calculated using both a location-based methodology for electricity as seen here, and with a market-based methodology. This will recognise the investment that Trinity College has recently made to purchase 100% renewable electricity certificates.

CATEGORY	SCOPE	tCO_2e	% OF TOTAL EMISSIONS
NATURAL GAS	1	8524.87	5%
LPG	1	10.63	0.006%
GASOIL (HEATING)	1	4.5	0.003%
ROAD DIESEL	1	22.36	0.013%
PETROL	1	0.3	0%
BIODIESEL	1	1.34	0.001%
BIOETHANOL	1	0.85	0%
REFRIGERANTS	1	299.47	0.18%
ELECTRICITY	2	11,283	7%
PURCHASED GOODS & SERVICES	3	66,747	39.22%
WATER	3	5,214	3.06%
CAPITAL GOODS	3	67,921	39.91%
FUEL & ENERGY RELATED ACTIVITIES (WELL-TO-TANK)	3	2,774	1.63%
WASTE	3	72	0.04%
BUSINESS & STUDENT ACADEMIC TRAVEL	3	1,154	0.68%
STAFF WORK FROM HOME	3	550	0.32%
STAFF COMMUTING	3	2,318	1.36%
STUDENT COMMUTING	3	3,276	1.93%
UPSTREAM TRANSPORTATION & DISTRIBUTION (COURIERS)	3	33	0.02%
INVESTMENTS	3	NOT YET INCLUDED	NOT YET INCLUDED
TOTAL	**ALL**	**170,205**	**100%**

TABLE 4 Summary of Trinity College's carbon emissions by category in tCO_2e.

Although business travel and commuting are a relatively small percentage of total carbon emissions, at 0.68% and 3.28%, respectively, it is still an important action area. This will have the collateral benefit of changing staff and student behaviours which will reduce environmental impacts beyond the university's boundaries. Most of Trinity's staff business travel emissions arise from flying, which in 2021–2022 emitted 1127.16 tCO_2e compared to 26.43 tCO_2e from all other modes of transport (private road vehicles, ferry, trains, light tram and rail, bus, and taxi) combined. Reducing the number and destinations of international flights made by Trinity's staff and students should be made a priority. Slow travel options for UK and European destinations with greater time flexibility and incentives for staff may also be explored. Business travel within Ireland should primarily be conducted via ground-based public transport where possible. Future assessments could also include data on hotel stays as part of the Business Travel category. If direct data is not available, DCU's methodology of assuming a hotel stay in countries with return flights on different dates (Sustainability DCU, 2020). Emissions data on flights associated with incoming and outgoing student exchanges plus international students should also be included.

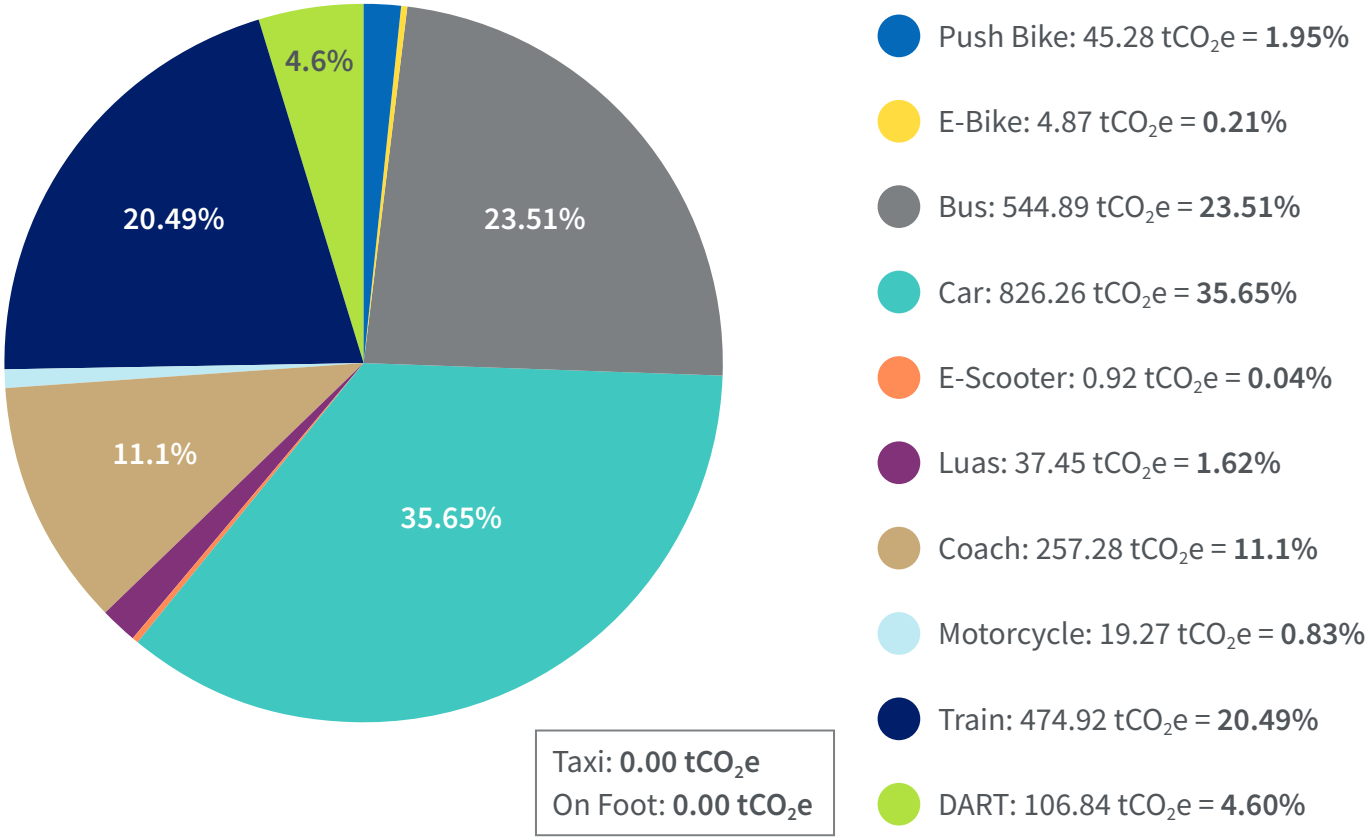

FIG 3 Staff commuting emissions by mode.

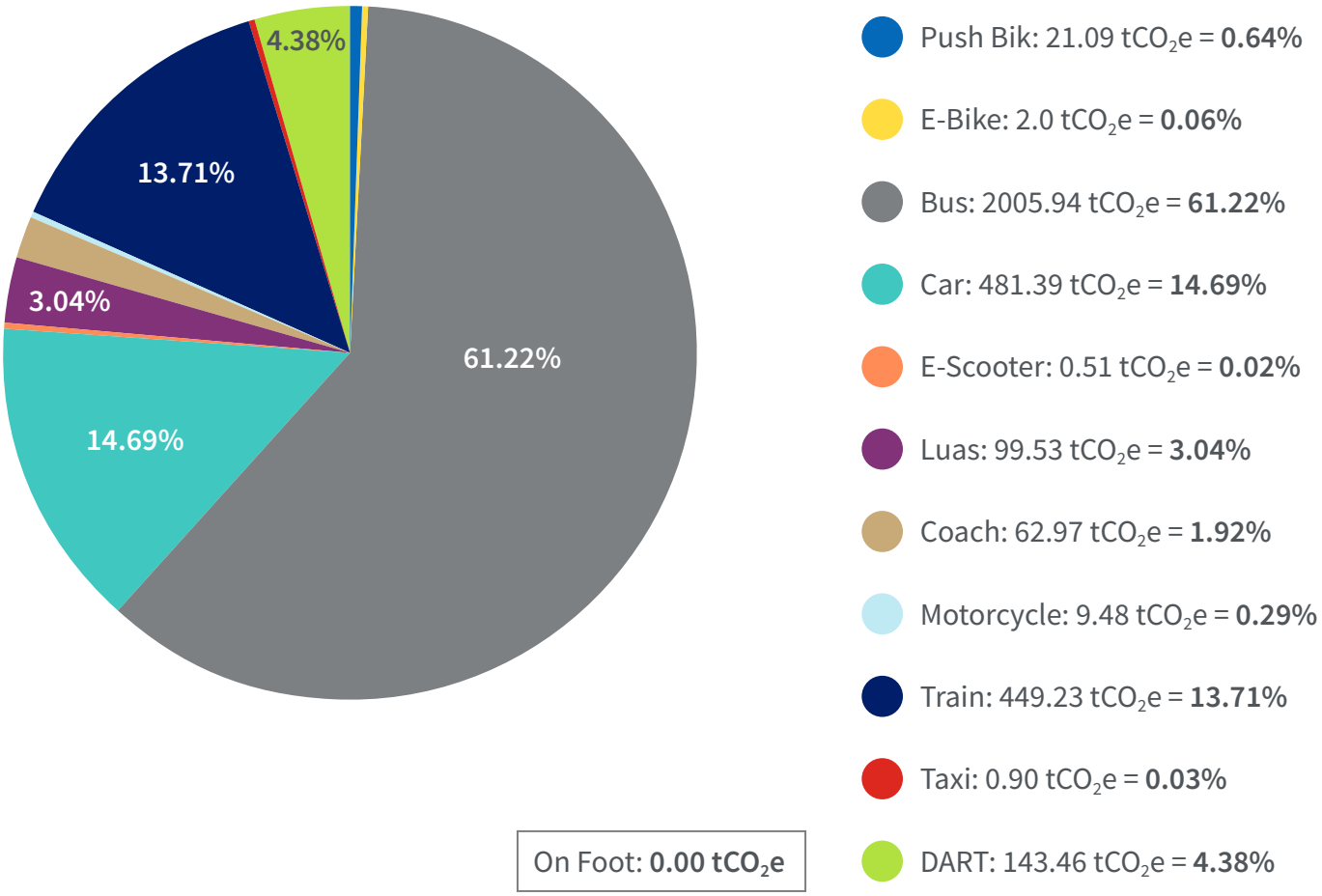

FIG 4 Student commuting emissions by mode.

The primary focus for staff commuting should be shifting from cars to public transport and active travel (Fig. 3). Student commuting is already made up predominantly of public transport (Fig. 4), hence priority actions should involve working closely with Dublin City Council, Fingal County Council, and Dun Laoghaire-Rathdown County Council to develop safe active travel routes and assist students in finding rental accommodation closer to campus.

A targeted survey for car commuters could also help understand barriers and opportunities and pin-point specific actions for this mode. These figures should be taken as approximations due to the low response rate of 7–8% to the 2023 Smarter Travel Survey, which meant that a large proportion of the staff and student primary travel modes were not captured.

Out of the six goals set out for the carbon and biodiversity footprinting process, this report sets the foundation for three of them. The report presents a baseline for Trinity College's carbon footprint which will allow the university to set science-based targets and options for mitigating its carbon emissions in the Sustainability Action Plan. It also allows it to link its targets to the National Climate Action Plan. Once the biodiversity footprint is completed, it will also allow Trinity to compare options for the mitigation and restoration of on-site biodiversity and to link its targets to the National Biodiversity Action Plan. When supplier-specific data are received, Trinity College will be able to assess the risk and opportunity of its supply chain. This is also required as part of the CSRD. Additionally, further data should be collected to complete the same process for Trinity's investment portfolio.

The following are a summary of next steps for Trinity's carbon assessment:

- Electricity emissions should be calculated using a market-based methodology that considers guarantees of origin or power purchase agreements.
- Future assessments may include the carbon emissions calculated within the SEAI M&R Portal instead of applying emissions factors to activity data within TrinityCarbonFootprint_2021-22.xlsx. Emissions factors in $kgCO_2e/kWh$ should be requested again from the SEAI, currently they list only $kgCO_2e/kWh$.
- Explore whether monthly data can be collected through the SEAI M&R Portal.
- Verify that water data is captured for the entirety of Trinity College and improve accuracy by requiring consumption data for each invoice.
- Request refrigerants data from faculties, as E&F cannot access this directly.
- Data from incoming and outgoing exchange students, as well as all incoming international students must be requested from Global Relations.
- The Quantis categories matched to Trinity College's GAAP Codes could be verified using the ISIC Rev. 3 economic classification system, as done in DCU. However, considering the Quantis tool is being discontinued it is recommended that the current Purchased Goods & Services and Capital Goods outputs be used as a screening exercise to show the key GAAP codes. Time and effort should be redirected into linking the GAAP codes to EXIOBASE 3 categories and aligning the use of this database with other third-level institutions.
- Collect supplier-specific emissions data for the highest-emitting GAAP codes.
- Calculate the carbon emissions associated with Trinity College's investment portfolio. This is currently excluded from the carbon footprint assessment.

6. Conclusion

As sustainability is now embedded more effectively into Trinity's governance, the university is well-placed to reduce its carbon footprint of 170,205 tCO_2e for the financial year 2021–2022. The highest emitters were the Purchased Goods & Services and Capital Goods categories, demonstrating the need for the strong implementation of the Sustainable Procurement Policy and collection of supplier-specific emissions data to track improvements over time. In parallel, actions can be taken in other Scope 3 categories such as business travel and commuting to engage the staff and student population in environmental action. Improvements to the assessment process have been identified and must be applied to build accuracy and trust in the outputs. However, the existing baseline is sufficient to prioritise actions in the Sustainability Strategy Action Plan and to help Trinity fulfil its responsibilities under the Corporate Sustainability Reporting Directive.

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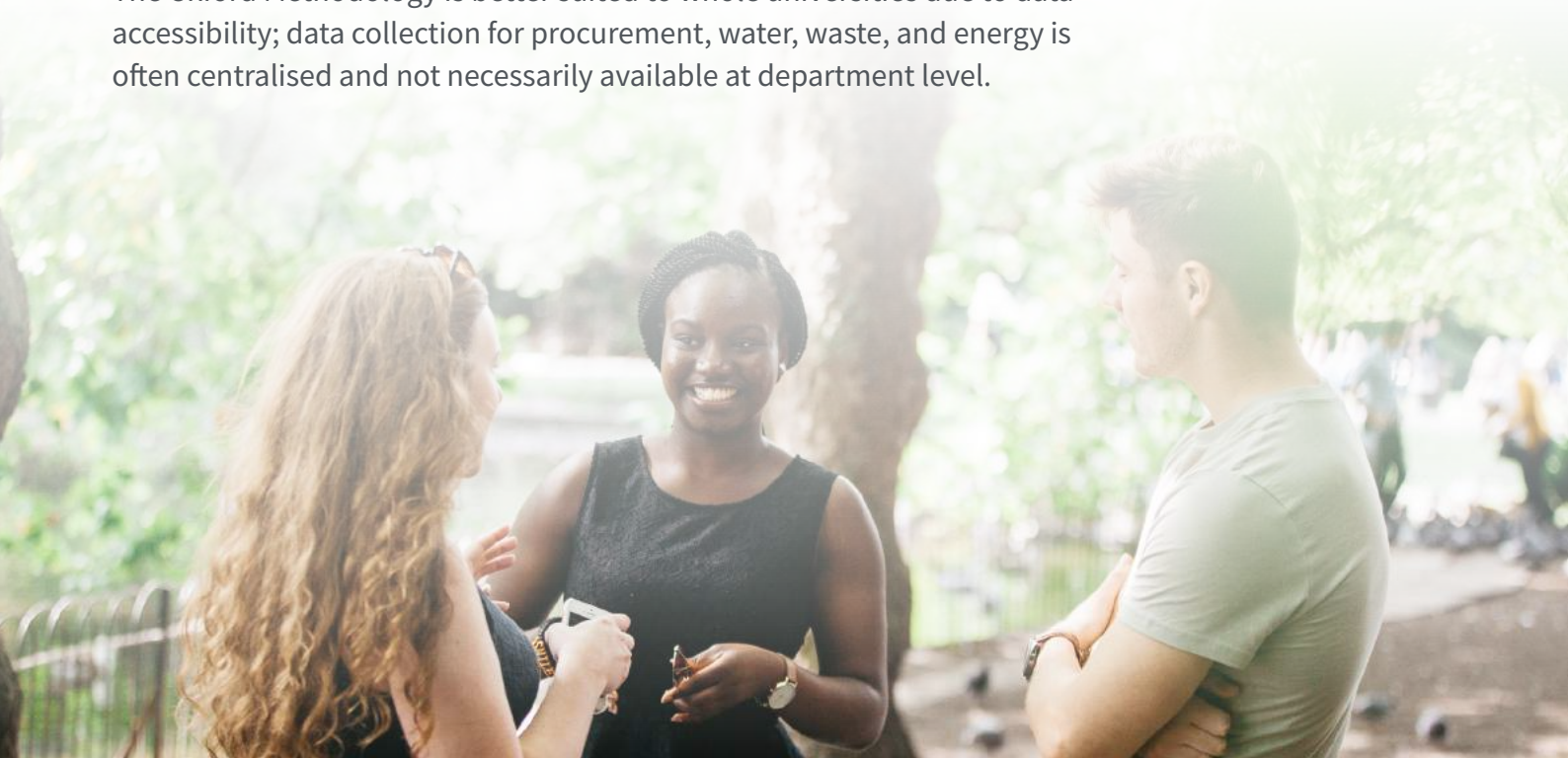
APPENDIX 1 BIODIVERSITY FOOTPRINTING

A review of Oxford University's Biodiversity Footprinting Methodology.

The Oxford Methodology was used to disclose the University of Oxford's biodiversity footprint and calculate the pathways for achieving biodiversity net gain, the results of which were published in Bull et al. (2022). An Excel tool is currently in development and will be available in 2023, allowing the Nature-Positive Universities network to replicate the assessment.

Oxford's biodiversity footprint was primarily driven by activities outside of their direct control, such as the research supply chain, day-to-day building operations supply chain, food consumption, electricity consumption, and the construction supply chain (Bull et al., 2022). Therefore, reducing the quantity of purchased goods and services (e.g. zero-waste policies, car sharing, number of cafes, flights) or using green procurement to change to environmentally-friendly options (e.g. stopping the sale of meat, dairy and alcohol) formed over half their no net loss for biodiversity strategy (Bull et al., 2022). Ecological restoration on university-owned land and biodiversity offsets formed the remainder of the actions (Bull et al., 2022). The hypothesis is that Trinity College's biodiversity footprint will follow a similar pattern, owing to similarities in the two universities such as the centralised urban location, focus on academic research, and international status (which influences the number of flights taken).

The Oxford Methodology is better suited to whole universities due to data accessibility; data collection for procurement, water, waste, and energy is often centralised and not necessarily available at department level.



The whole university includes land managed or leased by the university and the assessment is sub-divided into the following three scopes:

SCOPE	OXFORD METHODOLOGY
RESEARCH	Activities relating to conducting and disseminating of research, both within the University and activities of research staff at external institutions on behalf of the University.
EDUCATION	Activities relating to the education of the student body and the activities of students themselves, where these are attributable to being enrolled at the University.
OPERATIONS	Activities that support the running and delivery of University services and the maintenance of its estate and capital.

TABLE 1 The scope of the Oxford Methodology is divided into Research, Education, and Operations (Biggs et al., 2021).

The Oxford Methodology's data categories include the following aspects (detail in Appendix 1): Travel; Food; Built Environment; Natural Environment; Resource Use & Waste; and Digital Activities. These aspects were further sub-divided into three scops: Research; Education; and Operations. Not all of the aspects were included in each scope. The Research scope only included the aspects Travel and Resource Use & Waste, the Education scope only included Travel, Built Environment, Resource Use & Waste, and Digital Activities, while the Operations scope included all six aspects (Fig. 2). The Oxford Methodology then converts the aspects data into five mid-point impacts with appropriate metrics (Fig. 2): Greenhouse Gases (tCO_2e); Land Use (Type and m2 of land); Water Use (m3); Water Pollution (kg N equivalent; kg P equivalent; kg 1,4-DCB equivalent); and Air Pollution (kgSO2 equivalent; kg NOx equivalent; kg PM). To convert the aspects data to the mid-point impacts, the Oxford Methodology uses a variety of raw and embedded characterisation factors (Fig. 2, Biggs et al., 2021): FoodDB Project Tool (the environmental impact of purchased food); Exiobase 3 in Open LCA software (international supply chain impacts); and the UK Higher Education Supply Chain Emissions Tool (converting monetary spend on purchased goods and services to greenhouse gas emissions).

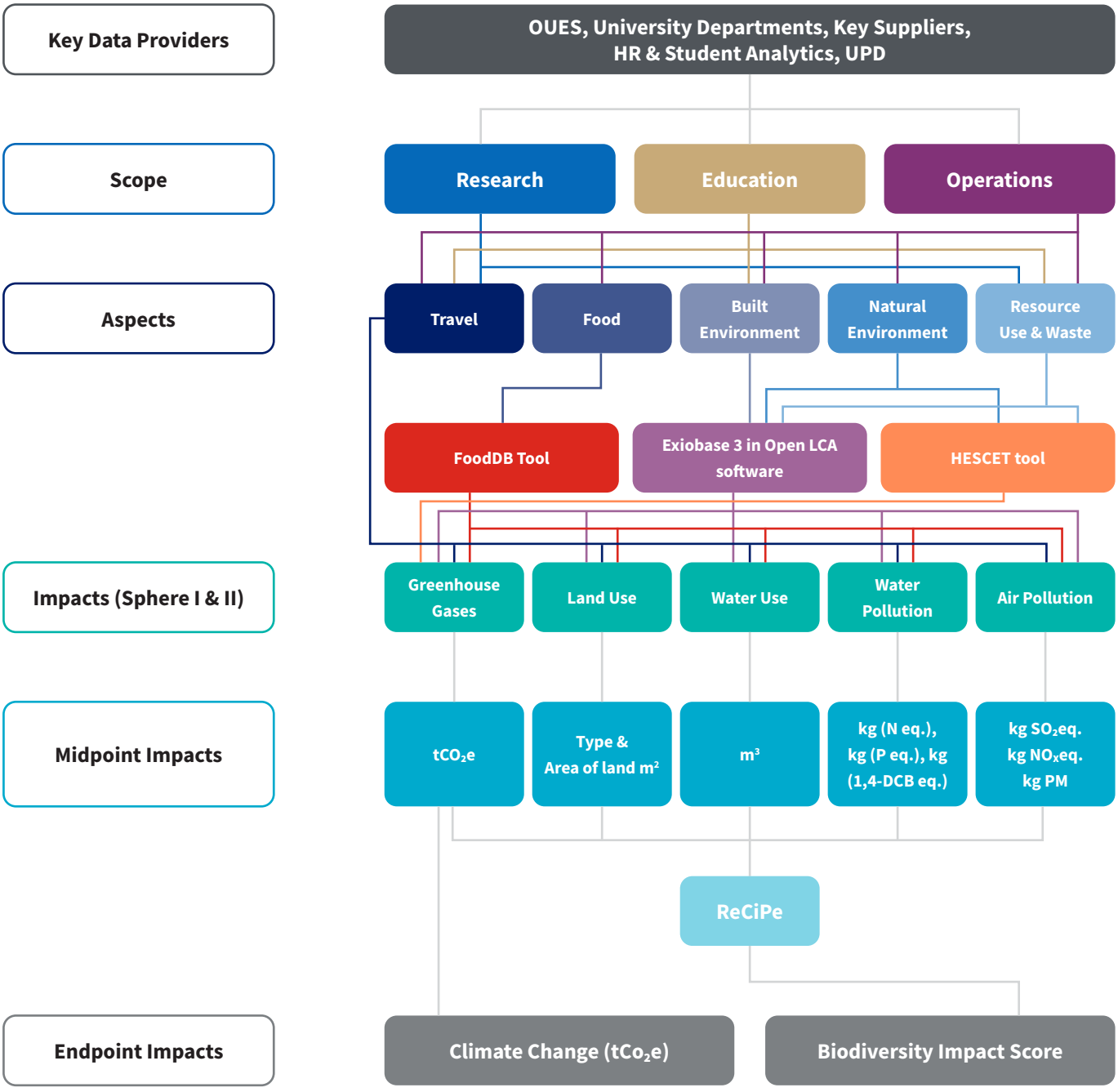


FIG 1 The assessment framework used in the Oxford Methodology including scope of assessment, aspects, impacts and mid-point/end-point metrics. Blue boxes denote tools with embedded sets of characterisation/emissions factors that were used to calculate midpoint and endpoint impacts. Where no tools are denoted, raw characterisation factors were used to directly calculate midpoint and endpoint impacts as listed in the supplementary material (Biggs et al., 2021).

These five mid-point impacts are then converted to two end-point impacts (Biggs et al., 2021): Climate Change (tCO_2e) and the Biodiversity Impact Score (proportion of local species lost as a result of a particular activity). The conversion methodology used was a set of pressure-impact models called ReCiPe, where the end result is a relative rather than an absolute measure of biodiversity loss (Biggs et al., 2021). ReCiPe calculated characterisation factors for each mid-point impact, most of these were global with the exception of some country-specific factors for Water Use, Water Pollution, and Air Pollution (Biggs et al., 2021). Spatially explicit impacts were also only considered for spend data where EXIOBASE 3 could be used, although the future development of spatially explicit indicators could improve the Oxford Methodology's spatial granularity (Biggs et al., 2021).

The results were visualised in terms of the local relative species loss for each impact category (Built Environment; Food; Natural Environment; Resource Use & Waste; and Travel), including detail on whether this category is under the university's direct or indirect control (Bull et al., 2022). Furthermore, three different strategies were considered as options to mitigate or compensate for these impacts and move the university towards biodiversity net gain (Bull et al., 2022). These options compared the relative importance of avoiding impacts through changes in procurement, utilities use, and travel, compensating for impacts by restoring university-owned land, or purchasing biodiversity offsets for ecological restoration on non-university-owned land (Bull et al., 2022).

This methodology outlined here has not yet been completed for Trinity College but will be used when the Excel-based tool is made publicly available.

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TRINITY SUSTAINABILITY