Greenhouse Gas Emission Inventory 2022

Inventory Scope: University Operations
Version 1.0

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

Acknowledgements

This report builds on the foundations laid in recent years by a team of staff spread across the organisation, and our key suppliers. Our efforts for 2022 reporting again relied on a range of staff and suppliers. In no particular order specific acknowledgement must be made of contributions by:

John Hurford - Procurement Officer

Quentin Johnson - Manager Divisional Finance

Dylan Henry - Food Service Manager

Greg Murray - Principal Analyst, Strategy Analytics and Reporting

Kevin Michael - Analyst, Strategy Analytics and Reporting

Hanh Dang - Analyst, Strategy Analytics and Reporting

Shane Jenkins - Energy Manager

Kelly Li - Energy Analyst

Emily Colquhoun - Waste Minimisation Coordinator, Waste Management NZ Ltd

Report prepared by: Gabriella Rutherford, Project Support Officer, Sustainability Office Craig Cliff, Net Carbon Zero Programme Manager, Sustainability Office	Signature and date: 29.06.23
Report authorised by: Stephen Willis, Chief Operating Officer	Signature and date:

TOITŪ ENVIROCARE

INDEPENDENT AUDIT OPINION
Toitū Verification

TO THE INTENDED USERS

Organisation subject to audit: University of Otago

Audit Criteria: ISO 14064-1:2018
ISO 14064-3:2019
Audit & Certification Technical Requirements 3.0

Responsible Party: University of Otago

Intended users: University of Otago staff

Registered address: 364 Leith Walk, Dunedin, North, Dunedin, 9016, New Zealand

Inventory period: 01/01/2022 to 31/12/2022

Inventory report: University of Otago 2022 GHG Emissions Report 27 March 2023.pdf

We have reviewed the greenhouse gas emissions inventory report ("the inventory report") for the above named Responsible Party for the stated inventory period.

RESPONSIBLE PARTY'S RESPONSIBILITIES

The Management of the Responsible Party is responsible for the preparation of the GHG statement in accordance with ISO 14064-1:2018 . This responsibility includes the design, implementation and maintenance of internal controls relevant to the preparation of a GHG statement that is free from material misstatement.

VERIFIERS' RESPONSIBILITIES

Our responsibility as verifiers is to express a verification opinion to the agreed level of assurance on the GHG statement, based on the evidence we have obtained and in accordance with the audit criteria. We conducted our verification engagement as agreed in the audit letter, which define the scope, objectives, criteria and level of assurance of the verification.

The International Standard ISO 14064-3:2019 requires that we comply with ethical requirements and plan and perform the verification to obtain the agreed level of assurance that the GHG emissions, removals and storage in the GHG statement are free from material misstatement.

Reasonable assurance is a high level of assurance, but is not a guarantee that an audit carried out in accordance with the ISO 14064-3:2019 Standards will always detect a material misstatement when it exists. The procedures performed on a limited level of assurance vary in nature and timing from, and are less in extent compared to reasonable assurance, which is a high level of assurance. Misstatements are differences or omissions of amounts or disclosures, and can arise from fraud or error. Misstatements are considered material if, individually or in the aggregate, they could reasonably be expected to influence the decisions of readers, taken on the basis of the information we audited.

GHG quantification is subject to inherent uncertainty because of incomplete scientific knowledge used to determine emissions factors and the values needed to combine emissions of different gases.

BASIS OF VERIFICATION OPINION

Our responsibility is to express an assurance opinion on the GHG statement based on the evidence we have obtained. We conducted our assurance engagement as agreed in the Contract which defines the scope, objectives, criteria and level of assurance of the verification.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

VERIFICATION

We have undertaken a verification engagement relating to the Greenhouse Gas Emissions Inventory Report (the 'Inventory Report')/Emissions Inventory and Management Report of the organisation listed at the top of this statement and described in the emissions inventory report for the period stated above.

The Inventory Report provides information about the greenhouse gas emissions of the organisation for the defined measurement period and is based on historical information. This information is stated in accordance with the requirements of International Standard ISO 14064-1 Greenhouse gases – Part 1: Specification with guidance at the organisation level for quantification and reporting of greenhouse gas emissions and removals (ISO 14064-1:2018).

VERIFICATION STRATEGY

Our verification strategy used a combined data and controls testing approach. Evidence-gathering procedures included but were not limited to:
—activities to inspect the completeness of the inventory;
—interviews of site personnel to confirm operational behaviour and standard operating procedures;
—estimate testing of employee commuting and student air travel emissions;
—sampling of LPG and purchased food goods to confirm accuracy of source data into calculations;
—recalculation of business air travel emissions;
—detailed retracing of electricity emissions;
—analytical procedures for year on year energy consumption.
The data examined during the verification were historical in nature.

QUALIFICATIONS TO VERIFICATION OPINION

The following qualifications have been raised in relation to the verification opinion: Unmodified

VERIFICATION LEVEL OF ASSURANCE

	tCO2e	Level of Assurance
Category 1	2,808.58	**Reasonable**
Category 2	7,016.02	**Reasonable**
Category 3, excluding working from home and student travel	6,557.89	**Reasonable**
Category 3, working from home and student travel	8,840.85	**Limited**
Category 4 All emission sources other than those in Limited	7,453.81	**Reasonable**
Total inventory	**32,677.16**	

RESPONSIBLE PARTY'S GREENHOUSE GAS ASSERTION (CERTIFICATION CLAIM)

University of Otago has measured its greenhouse gas emissions in accordance with ISO 14064-1:2018 and the Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (2004) in respect of the operational emissions of its organisation.

VERIFICATION CONCLUSION

EMISSIONS - REASONABLE ASSURANCE

We have obtained all the information and explanations we have required. In our opinion, the emissions, removals and storage defined in the inventory report, in all material respects:

- comply with ISO 14064-1:2018 ; and
- provide a true and fair view of the emissions inventory of the Responsible Party for the stated inventory period.

EMISSIONS - LIMITED ASSURANCE

Based on the procedures we have performed and the evidence we have obtained, nothing has come to our attention that causes us to believe that the emissions, removals and storage defined in the inventory report:

- do not comply with ISO 14064-1:2018 ; and
- do not provide a true and fair view of the emissions inventory of the Responsible Party for the stated inventory period.

OTHER INFORMATION

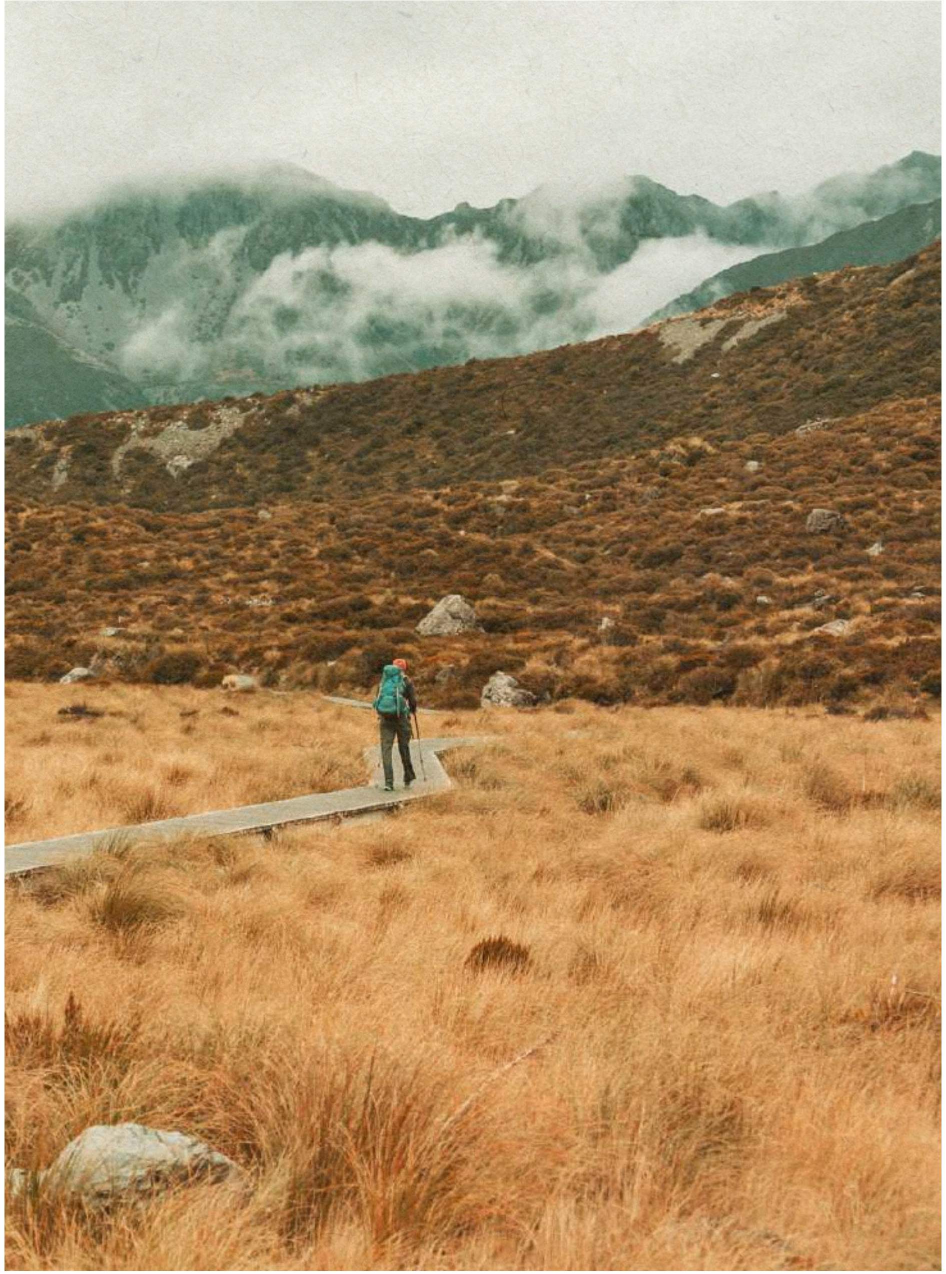
The responsible party is responsible for the provision of Other Information. The Other Information may include emissions management and reduction plan and purchase of carbon credits, but does not include the information we verified, and our auditor's opinion thereon.

Our opinion on the information we verified does not cover the Other Information and we do not express any form of audit opinion or assurance conclusion thereon. Our responsibility is to read and review the Other Information and consider it in terms of the ISO 14064-1: 2018 and ISO 14064-3: 2019. In doing so, we consider whether the Other Information is materially inconsistent with the information we verified or our knowledge obtained during the verification.

Verified by:		**Authorised by:**	
Name:	Natalie Clee	Name:	Billy Ziemann
Position:	Verifier, Toitū Envirocare	Position:	Certifier, Toitū Envirocare
Signature:	Natalie Clee	Signature:	
Date verification audit:	20-21 March 2023		
Date opinion expressed:	07 April 2024	Date:	26 June 2023

Whāia te iti kahurangi ki te tūohu koe me he maunga teitei

Seek the treasure you value most dearly: if you bow your head, let it be to a lofty mountain.



Contents

Glossary

CH4 Methane
CO2 Carbon dioxide
DEFRA Department for Environment, Food, and Rural Affairs in the UK.
Emission Factor A factor applied to an input quantity such as kilograms to calculate the quantity of greenhouse gas emissions resulting from consumption of that quantity.
GHG Greenhouse gas
HCFCs Hydro chlorofluorocarbons - a type of refrigerant.
HFCs Hydrofluorocarbons - a type of refrigerant
MfE Ministry for the Environment in New Zealand
CNGP Carbon Neutral Government Programme
MTHW Medium temperature hot water
N2O Nitrous Oxide
NA Not Available. For example, when emission factors are not available for all Greenhouse Gases.
PCard Purchase Card – a University-issued credit card
tCO2-e Emissions of greenhouse gases expressed in the number of tonnes of Carbon Dioxide that would have the same global warming impact
WFH Working from Home
SLT Senior Leadership Team

Snapshot Report

Snap-shot Report on GHG Emissions Inventory

2022: Adjusting to our 'new normal', with travel and activity around the University picking up once again

2022 began with Aotearoa in the red-light alert level as Omicron swept through the country, which disrupted travel, and in-person lectures for staff and students. As time passed, restrictions eased, and activity increased.

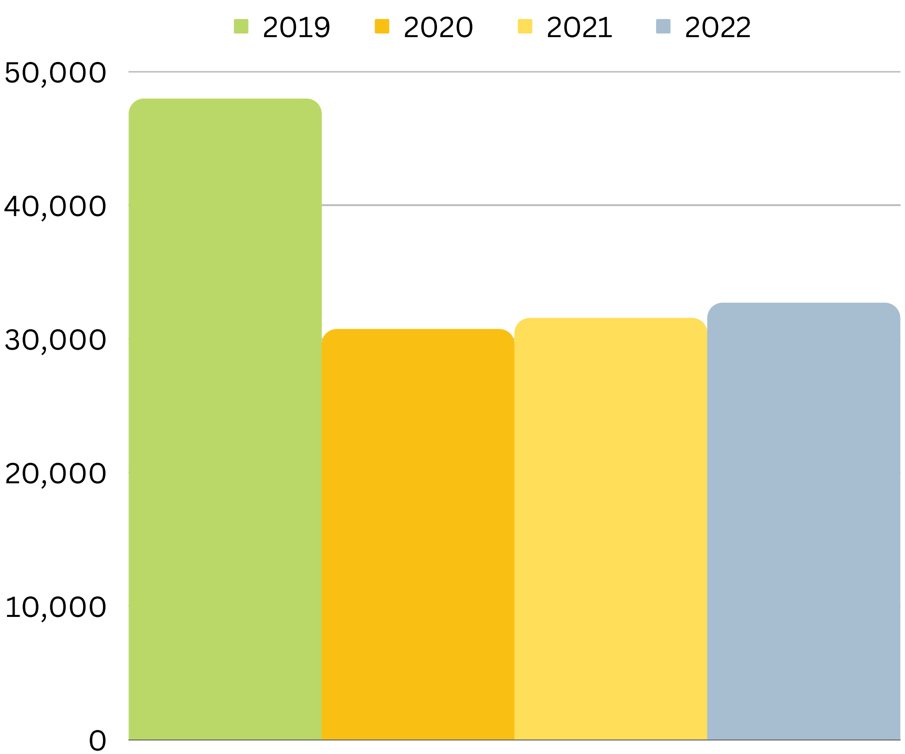
Total emissions in 2022 of 32,677.16 tonnes of carbon dioxide equivalent (tCO2-e) were 32% below our 2019 base year. However, this was an increase of 4% from 2021. This increase was driven by an uptick in business travel, employee commuting (despite working from home twice as much as pre-pandemic, no nationwide lockdowns in 2022 meant more commuting than in the previous two years), and an increase in emissions from purchased food due to higher volumes of meat purchased (the service model trialed in 2022 that drove these volumes has not been continued).

While the increase in travel emissions were expected, thanks to financial budgets set with affordability and emissions in mind, and collective action among staff, business air travel emissions successfully remained below our target of no more than 5,500 tCO2-e per annum (46% of 2019 levels). For more information on our targets and how we will go about achieving them, please refer to our "Net Carbon Zero: Journey to 2030" document.

There were also many emission reductions in 2022 to celebrate, all of which should be able to be sustained and built upon in future years. After an increase our LPG usage in 2021, we've worked hard to reduce our use of fossil gas. Fine tuning existing boilers helped reduce LPG emissions by 23% in 2022, and a student project over the summer is informing our boiler replacement plans in 2023 and beyond. Other successful reductions include a decrease in Natural Gas at our Wellington campus (-45%), Water (-30%), Diesel Boilers (-74%), and Coal Boilers by (-98%).

There were no scope changes for 2022, however we have introduced new and improved methodology for a number of categories. This includes the capturing of charter flights in our business air travel category. The calculation method for marine emissions has also switched from dollar spent to litres purchased emissions factors, which is more accurate. Areas for improving the accuracy and completeness of our GHG reporting for next year include freight, medical gases and student air travel.

University of Otago GHG Emissions (tCO2-e)



Progress towards net zero and compliance with Carbon Neutral Government Programme

In 2019, the University of Otago committed to achieving net zero greenhouse gas emissions ("Net Carbon Zero") by 2030. University Council reconfirmed this commitment and category-based emissions reduction targets, as part of reviewing the first version of the Programme Business Case, in November 2021.

Overall, the University is targeting a reduction of 54% from our base year of 2019 to 2029, and we will offset 2029's emissions once verified in 2030 to reach net zero. You can read more about these targets and how the University intends to meet them in our Journey to 2030 document online.

The Carbon Neutral Government Programme (CNGP) was announced in December 2020 at the same time as the New Zealand Government declared a climate emergency. The aim of the programme is to accelerate the reduction of greenhouse gas emissions (GHGs) within the public sector and have participant organisations reach carbon neutrality by 2025.

The CNGP is run by the Ministry for the Environment, with support from the Ministry for Business, Innovation and Employment and the Energy Efficiency and Conservation Authority (EECA).

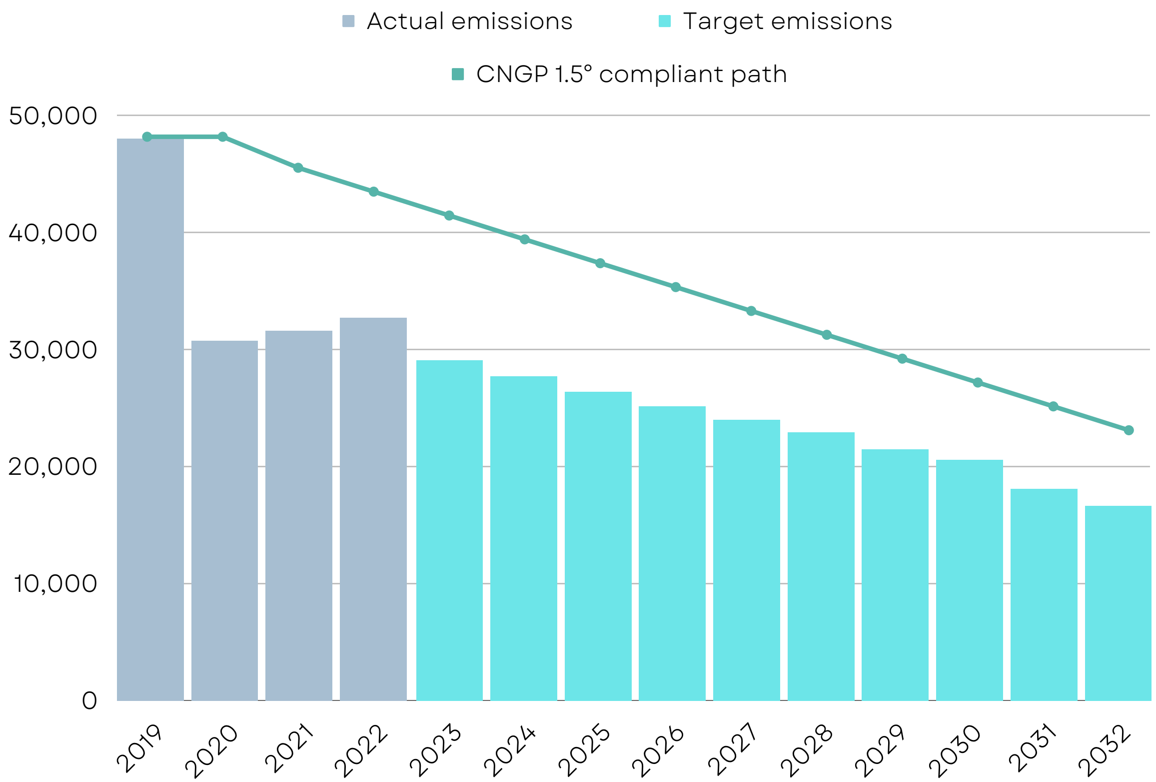
As a tertiary institution the University of Otago is in Tranche 3 of the programme, meaning it is encouraged to report by 2023. The University elected to voluntarily report its emissions and reduction targets in 2022.

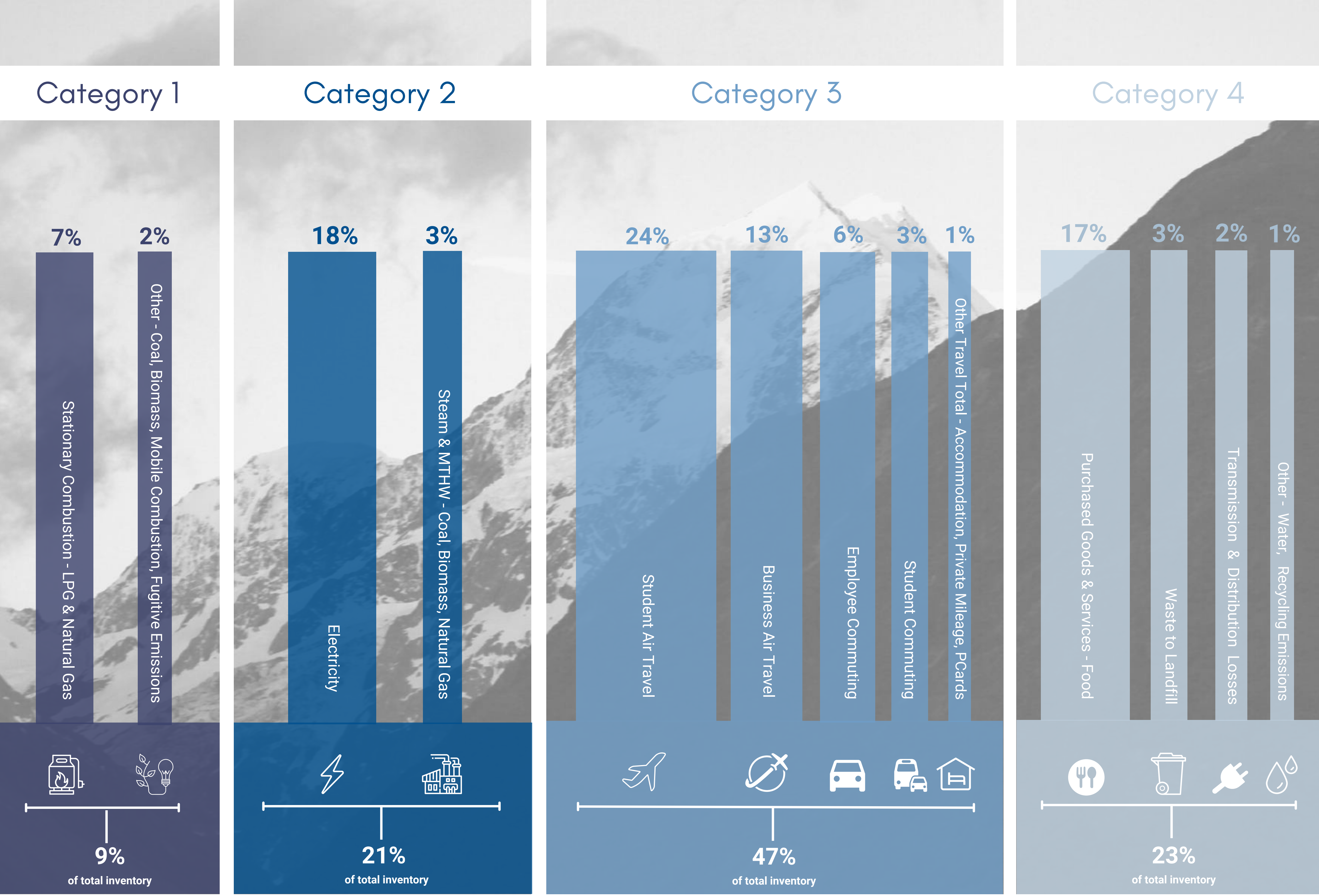
The CNGP requires participating organisations to set targets for emissions reductions that are in line with what is required globally to keep warming to 1.5°C by the end of the century.

As the chart below shows, our emissions to date and our target emissions in future years are below how the CNGP defines a 1.5° compliant path. This demonstrates the University's commitment to do its fair share in terms of addressing climate change, demonstrate leadership while doing so, and also allows for a buffer if we encounter stronger headwinds than expected.

The CNGP is due to release guidance on offsetting in 2023, which may influence the University's approach to net emissions.

University of Otago Emission Targets vs CNGP Targets





NB: Due to rounding, there may be slight disagreement between sum for emissions sources and categories.

Snap-shot Report on GHG Emissions Inventory

ISO Category	Activity Group	Activity	Input Unit	Activity data	2022 Emissions tCO2-e	2021 Emissions tCO2-e	2020 Emissions tCO2-e	2019 Emissions tCO2-e (Base-year)	Change compared to base year 2019 (%, +ve or -ve)	Annual change from 2021-2022 (%, +ve or -ve)
1	Biomass	Biomass - Wood chips and pellets - boilers	kWh / t	3,796,795 / 377	59.04	65.07	64.11	68.68	-14.04%	-9.27%
1	Stationary combustion - coal	Coal boilers	Kg	18,790	37.77	701.49	1,383.74	1,558.59	-97.58%	-94.62%
1	Stationary combustion - other	Diesel boilers	Litres	8,870	23.68	93.82	58.19	78.25	-69.74%	-74.76%
1	Stationary combustion - natural gas and LPG	LPG- bottled and reticulated	Kg / kWh	12,508/9,811,249	2,297.53	2,971.20	1,116.40	1,275.60	80.12%	-22.67%
1	Transport fuels - vehicle fleet	Mobile combustion- petrol and diesel (incl. marine)	Litres	90,262	243.04	184.39	156.57	212.85	14.18%	31.81%
1	Transport fuels - vehicle fleet	Mobile combustion- PCard purchases	NZ$	127,010	39.10	32.90	20.10	33.20	17.77%	18.84%
1	Refrigerants, medical and other gases	Fugitive Emissions- refrigerants	Kg	51	108.42	109.00	109.00	106.00	2.29%	-0.53%
	Total Category 1				**2,809**	**4,158**	**2,908**	**3,332**		
2	Electricity use	Electricity	kWh	48,988,107	5,878.57	6,212.31	6,447.53	4,971.28	18.25%	-5.37%
2	Category 2 - other	Steam and MTHW - Coal	kWh	2,246,460	719.32	786.54	1,225.77	6,176.28	-88.35%	-8.55%
2	Category 2 - other	Steam and MTHW - Biomass	kWh	29,579,609	311.47	449.57	416.99	273.32	13.96%	-30.72%
2	Category 2 - other	Steam and MTHW – Natural Gas – Wellington Campus	kWh	546,944	106.65	194.89	195.60	299.64	-64.41%	-45.27%
	Total Category 2				**7,016**	**7,643**	**8,286**	**11,721**		
3	Air Travel	Business Travel- Air	Km (+ NZ$, Litres, time)	19,560,827	4,300.98	1,954.60	1,699.31	11,981.89	-64.10%	120.04%
3	Business travel other (eg. taxi, hotel)	Business Travel- Accommodation	Nights / NZ$	6,112 / 2,377,921	213.59	107.47	115.08	338.90	-36.98%	98.74%
3	Business travel other (eg. taxi, hotel)	Business Travel- Taxis	NZ$	663,789	46.47	26.20	36.41	64.06	-27.47%	77.35%
3	Business travel other (eg. taxi, hotel)	Business Travel - Private Mileage	Km	433,477	114.87	95.64	63.03	136.41	-15.79%	20.11%
3	Category 3 - other	Employee Commuting- Private vehicles	Km	5,361,683	1,701.33	1,251.28	1,320.27	1,746.90	-2.61%	35.97%
3	Category 3 - other	Employee Commuting- Public transport	Km	1,166,883	141.56	85.63	76.41	84.42	67.69%	65.32%
3	Category 3 - other	Student Commuting- Private vehicles	Km	7,280,305	918.15	878.38	755.12	956.91	-4.05%	4.53%
3	Category 3 - other	Student Commuting- Public transport	Km	936,308	133.97	165.48	147.31	186.51	-28.17%	-19.04%
3	Air Travel	Student Travel - Air	Km	32,871,454	7,788.74	8,167.82	7,963.09	9,552.60	-18.46%	-4.64%
3	Working from home	Working from home emissions	Days	87,636	39.09	72.42	88.80	20.37	91.88%	-46.03%
	Total Category 3				**15,399**	**12,805**	**12,265**	**25,069**		
4	Electricity use (including line losses)	Transmission & Distribution Losses – Electricity	kWh	48,988,107	538.87	569.46	591.02	537.80	0.16%	-5.37%
4	Stationary combustion - coal	Steam and MTHW losses – Coal and Biomass (Coal)	kWh	2,246,460	35.97	39.33	61.29	308.81	-88.35%	-8.55%
4	Stationary combustion - other (eg. diesel)	Steam and MTHW losses – Coal and Biomass (Biomass)	kWh	29,579,609	15.57	22.48	20.85	13.67	13.93%	-30.72%
4	Stationary combustion - natural gas and LPG	Steam and MTHW losses - Natural Gas	kWh	546,944	6.56	11.99	12.04	18.44	-64.41%	-45.26%
4	Category 4 - other	Purchased Goods and Services - Water	m3	320,983	9.95	14.13	10.48	8.41	18.32%	-29.58%
4	Category 4 - other	Purchased Goods and Services - Food	Kg	1,037,350	5,622.33	4,969.05	4,503.80	4,575.20	22.89%	13.15%
4	Waste (emissions from all waste sources)	Waste from Operations - Waste to landfill	Kg	1,645,296	1,064.51	1,079.84	1,892.63	2,232.90	-52.33%	-1.42%
4	Waste (emissions from all waste sources)	Waste from Operations - Recycling and other	Kg	333,900	5.98	7.16	6.30	6.76	-11.56%	-16.51%
4	Waste (emissions from all waste sources)	Waste from Operations- wastewater treatment	m3	320,983	154.07	218.85	154.52	120.15	28.23%	-29.60%
	Total Category 4				**7,454**	**6,932**	**7,253**	**7,822**		
	Out of Scope Emissions				**12,342**	**12,406**	**11,318**	**7,876**		
	Total In-Scope Emissions				**32,677**	**31,538**	**30,712**	**47,944**	**-31.84%**	**6.40%**

Snap-shot Report on GHG Emissions Inventory - Out of Scope Emissions

ISO Category	Activity Group	Activity	Activity data	2022 Emissions tCO2-e	2021 Emissions tCO2-e	2020 Emissions tCO2-e	2019 Emissions tCO2-e (Base-year)	Change compared to base year 2019 (%, +ve or -ve)	Annual change from 2021-2022 (%, +ve or -ve)
Biogenic Emissions	Stationary Combustion	Biomass - Wood chips and pellets - boilers	3,796,795	1,343	1,376	1,299	1,385	-3.06%	-2.43%
Biogenic Emissions	Steam & MTHW	Biomass	29,579,609	10,459	10,505	9,543	6,182	69.18%	-0.44%
Biogenic Emissions	Losses in Steam & MTHW	Biomass	10,458	523	525	477	309	69.23%	-0.40%
	Total out of scope emissions			**12,324**	**12,406**	**11,318**	**7,876**	**56.47%**	**-0.66%**

University of Otago GHG Emissions Inventory 2022 in Rank Order

2022 Rank	Change in rank from 2019	Change in rank from 2021	Emission Source	Category	Emissions (tCO2-e)	% of Inventory
1	+1	(-)	Student Travel	Air Travel - All Categories	7,788.74	23.84%
2	+2	(-)	Electricity	Electricity	5,878.57	17.99%
3	+2	(-)	Purchased Goods and Services	Food	5,622.33	17.21%
4	-4	+1	Business Travel	Air Travel - All Categories	4,300.98	13.16%
5	+4	-1	Stationary Combustion	LPG	2,297.53	7.03%
6	+2	+2	Employee Commuting	Private Vehicles	1,701.33	5.21%
7	-1	(-)	Waste from operations	Waste to Landfill	1,064.51	3.26%
8	(-)	(-)	Student Commuting	Private Vehicles	918.15	2.81%
9	-7	(-)	Steam and MTHW	Coal	719.32	2.20%
10	+2	+1	Transmission and distribution losses	Electricity	538.87	1.65%
11	+3	+1	Steam and MTHW	Biomass	311.47	0.95%
12	+7	+3	Mobile Combustion	Petrol and Diesel	243.04	0.74%
13	(-)	+5	Business Travel	Accommodation	213.59	0.65%
14	+7	-1	Waste from operations	Wastewater Treatment	154.07	0.47%
15	+9	+6	Employee Commuting	Public Transport	141.56	0.43%
16	+1	(-)	Student Commuting	Public Transport	133.97	0.41%
17	+1	+2	Business Travel	Private Mileage	114.87	0.35%
18	+2	-1	Fugitive Emissions	Refrigerants	108.42	0.33%
19	-6	-5	Steam and MTHW	Natural Gas	106.65	0.33%
20	+3	+3	Stationary Combustion	Biomass	59.04	0.18%
21	-1	+4	Business Travel	Taxis	46.47	0.14%
22	+4	+2	Mobile Combustion	PCard Purchases	39.10	0.12%
23	(-)	-2	Working from Home	Working from Home	39.09	0.12%
24	-18	-15	Stationary Combustion	Coal	37.77	0.12%
25	-12	-2	Steam and MTHW losses	Steam and MTHW losses - Coal	35.97	0.11%
26	-5	-7	Stationary Combustion	Diesel Boilers	23.68	0.07%
27	-5	-1	Steam and MTHW Losses	Steam and MTHW losses - Biomass	15.57	0.05%
28	-1	(-)	Purchased Goods and Services	Water	9.95	0.03%
29	-3	(-)	Steam and MTHW losses	Steam and MTHW losses - Natural Gas	6.56	0.02%
30	-2	(-)	Waste from Operations	Recycling and other	5.98	0.02%

Emissions by Scope†

Scope	Proportion of Inventory 2019 (rebaselined figures)	Proportion of Total Inventory 2020	Proportion of Total Inventory 2021	Proportion of Total Inventory 2022
Scope 1	6.95%	9.47%	13.18%	8.59%
Scope 2	24.45%	26.98%	24.23%	21.47%
Scope 3	68.60%	63.55%	62.58%	69.93%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**

† The University's GHG emissions reports for 2019 and 2020 used the three scopes as defined in the GHG Protocol. From 2021 onwards, our primary classification is the categories set out in ISO 14064-1 2018 (as per previous tables and graphics). However, as many are still familiar with GHG Protocol scopes, we continue to provide this table to support comprehension and year-on-year comparisons. For the University, Scope 3 correlates to Categories 3 and 4.

Emissions Liabilities as at 2022

Refrigerant	Type	Emission Factor	Total Charge (kg)	Liability (tCO2-e)
R22	HCFC	1,810	159.6	289
R410a	HFC	2,088	793.2	1,656
R407c	HFC	1,774	253.0	449
R134a	HFC	1,300	107.2	139
R404a	HFC	3,922	129.0	506
Total Liability				**3,039**

Emissions Key Performance Indicators

	2019		2020		2021		2022	
Key Performance Indicator (KPI)	**Quantity**	**t CO2-e per KPI**	**Quantity**	**t CO2-e per KPI**	**Quantity**	**t CO2-e per KPI**	**Quantity**	**t CO2-e per KPI**
Floor Area (metres squared)	476,100	0.10	478,891	0.06	484,491	0.07	484,238	0.07
EFTS (Equivalent Full Time Student)*	18,915	2.53	18,722	1.64	19,603	1.61	19,174	1.70
FTE (Full Time Equivalent Staff)*	3,996	12.00	4,154	7.39	4,044	7.80	4,097	7.98
Person (combined EFTS and FTE)*	22,911	2.09	22,876	1.34	23,647	1.33	23,271	1.40

*From the University of Otago Annual Report (2022)

GHG Emissions Inventory & Reporting Manual

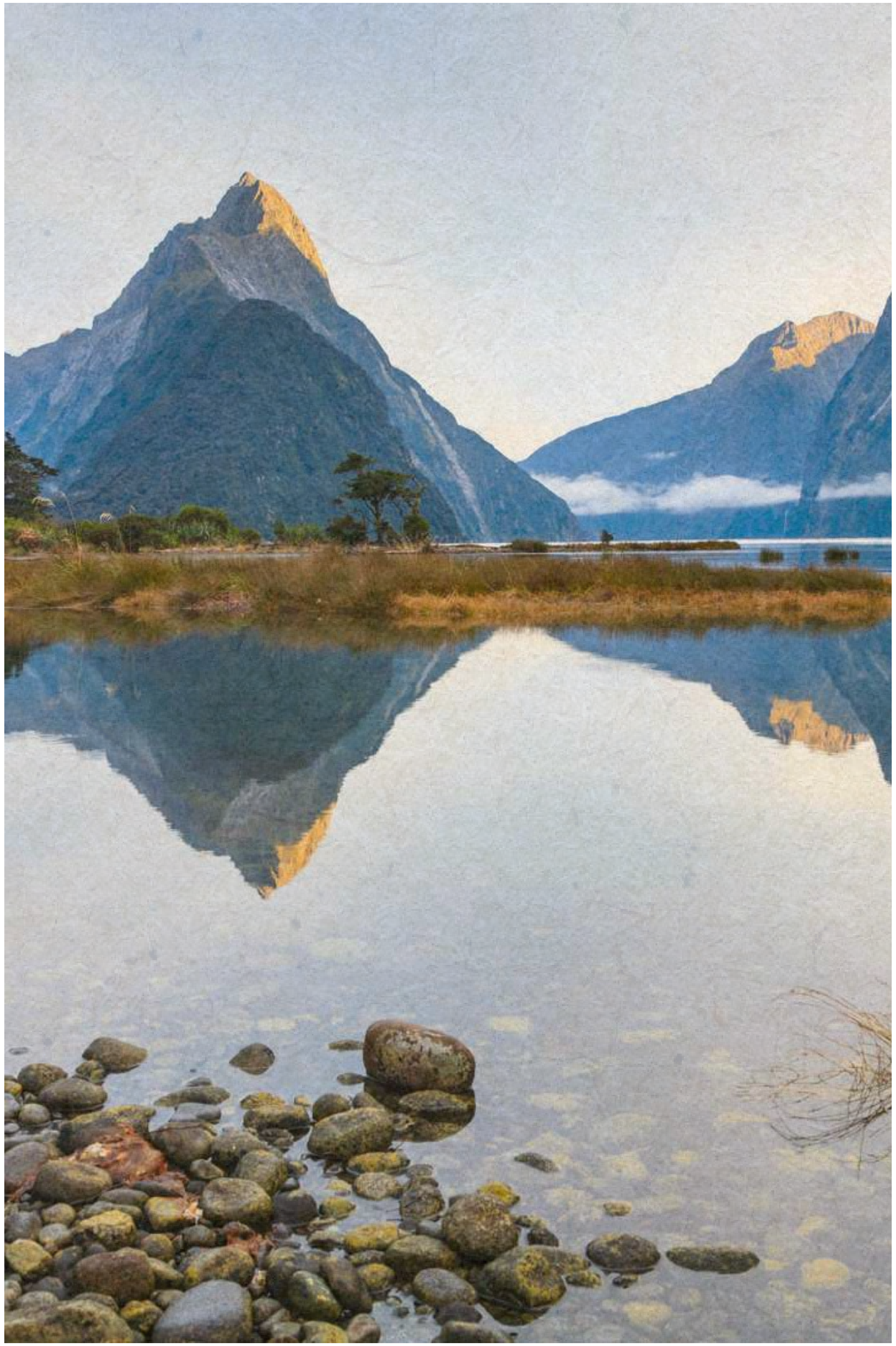
2 0 2 2

1 Introduction

This report is the fourth comprehensive annual greenhouse gas (GHG) emissions inventory report for the University of Otago, building from the foundation of the 2019 GHG inventory. The inventory is a complete and accurate quantification of the amount of GHG emissions that can be directly attributed to the organisation's operations within the declared boundary and scope for the calendar year of 2022.

The inventory has been prepared in accordance with the requirements of the Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (2004) and ISO 14064-1:2018 Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals. We have engaged with suitably qualified external reviewers to verify the 2022 inventory, with 2019-2021 data referred to in this this reporting having previously been audited and verified.

Where the scope has been expanded or methodology amended from the 2021 GHG inventory, this is noted in the text.



2 Statement of Intent

This inventory forms part of the University of Otago's commitment to reducing the adverse impacts of climate change in line with The Paris Agreement (2015) and United Nations Framework Convention on Climate Change (UNFCCC). This is evident in the target to reach net zero GHG emissions by 2030, with related emissions reduction targets by category to be realised through the Net Carbon Zero Programme in a manner befitting a research-led university with an international reputation for excellence.

This inventory is part of establishing an accurate and comprehensive measure of current performance which can be compared to our 2019 baseline and targets through to 2030 and beyond. It is anticipated that the inventory will be used by University staff to inform their decision making, students as a data source as part of their learning and other organisations to make comparisons to their own emissions. The report will be made publicly available on the University's website alongside previous years' reports on the following page: https://www.otago.ac.nz/sustainability/net-carbon-zero/.

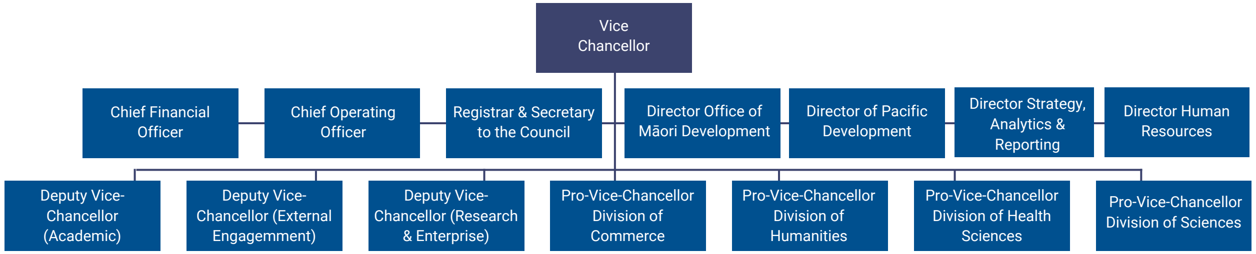
3 Audit of GHG Inventory

In 2022, we engaged Toitū Envirocare to audit and provide independent assurance for annual greenhouse gas reporting for three years in accordance with ISO 14064-1:2018 and the Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (2004).

This is also part of the University taking steps to ensure its reporting aligns with the requirements of the Carbon Neutral Government Programme.

4 Organisation description

As New Zealand's first university, founded in 1869, the University of Otago has earned an international reputation for quality research and teaching. The University of Otago is governed by the University Council. This Council is led by the Chancellor. The operation of the University is led by the Vice Chancellor and structured in divisions that sit across several locations. The organisation diagram below describes these divisions (Figure 1).



The responsibilities in these divisions have effect across the geographical locations of the University. We provide education to almost 20,000 students. Based on national data, we have the best performance indicators of any university in New Zealand for successful completion of courses and qualifications, student progression to higher level study, and students retained in study.

Achieving high approval ratings in employer surveys, Otago graduates are sought after and appreciated, with many occupying influential positions in industry, government and within their communities across the world. Our academics hold more national teaching awards and produce more highly cited papers per capita than any other university in the country. There are currently around 4,100 full-time equivalent staff.

5 Organisational Boundaries

The University of Otago has applied an operational control approach to compiling a GHG inventory. This allows the focus to be on those emission sources over which it has control and can therefore implement management actions consistent with strategic objectives. University of Otago operates across several New Zealand Campuses: Dunedin, Invercargill, Christchurch, Wellington and Auckland. The Dunedin campus is by far the largest. Christchurch and Wellington campuses traditionally share sites and facilities with District Health Boards.

5.1 Changes to organisational boundaries

There have been no changes to organisational boundaries from the 2021 report.

6 Organisational business units excluded from inventory

The following are specifically excluded from the 2022 report:

- Activity undertaken by the affiliated residential colleges that are not owned or operated by the University:
  - Knox College
  - St Margaret's College
  - Salmond College
- Activity undertaken by contractors or consultants to the University unless the University has agreed to pay for an activity directly. For example, where the University has agreed to pay for a contractor's flight.

7 GHG emission source inclusions

The GHG emissions categories included in this inventory were identified with reference to the methodology in the GHG Protocol and ISO14064-1:2018 standards. As adapted from the GHG Protocol, these emissions were classified under the following categories:

- Category 1: Direct GHG emissions from sources that are owned or controlled by the University of Otago.
- Category 2: Indirect GHG emissions such as electricity, heat and steam consumed by the University of Otago.
- Category 3: Other Indirect GHG emissions such as transportation.
- Category 4: Indirect emissions from products the University of Otago uses

Categories 5 and 6 have not been included in this inventory. The emissions sources in Table 1 have been included in the 2022 GHG emissions inventory and in subsequent sections of this report you can find full details of calculation method, uncertainties and disclosures, and recommendations to improve reporting.

Table 1 Greenhouse Gas Emissions Source Inclusions

GHG Emission Source			
Category 1	Category 2	Category 3	Category 4
Stationary Combustion - Biofuel	Electricity	Business Travel - Air	Electricity transmission & distribution losses
Stationary Combustion - Coal	Steam and MTHW - Coal & Biomass	Accomodation	Steam and MTHW - Losses from Steam and MTHW - Coal & Biomass
Stationary Combustion - Diesel	Steam and MTHW - Natural Gas Wellington	Business Travel - Taxi	Steam and MTHW - Losses from Steam and MTHW - Natural Gas
Stationary Combustion - LPG		Business Travel - Reimbursements (Private Mileage)	Purchased goods & services - Water
Mobile Combustion - Petrol & Diesel [now includes Marine]		Employee Commuting - Private Vehicles [new method]	Purchased goods & services - Food
Mobile Combustion - PCard Purchases		Employee Commuting - Public Transport [new method]	Waste from Operations - Waste to Landfill
Fugitive Emissions - Refridgerants		Student Commuting - Private Vehicles	Waste from Operations - Recycling & other
		Student Commuting - Public Transport	Waste from Operations - Wastewater Treatment
		Student Travel - Air	
		Working from Home Emissions	

8 GHG emission source exclusions

The following GHG emission sources have been excluded from this report for the reasons described below.

GHG emission source	Category	Reason for exclusion
Fugitive Emissions - Medical/Lab gasses	Category 1	The systems to collect this data are not yet in place. While it was identified that the Medical and Dental schools use some N20, no centralised record of consumption is yet available.
Mobile Combustion - Freight	Category 1	While we capture emissions from our own vehicles, some of which are used for freight, and our emissions factors for purchased food include freight, we do not have systems in place to collect data on mobile combustion emissions from other parts of our supply chain. We will work with our suppliers to ensure we can capture material Category 3 emissions related to freight in the future.
Business Travel – Rental Cars	Category 3	As per 2019, 2020, and 2021 inventories, there is a high probability calculating emissions from rental car mileage (using emissions factors from MfE Guidelines) would represent double reporting as the fuel purchased while using those vehicles would have been recorded within the Mobile Combustion for Category 1. For this reason, emissions due to use of rental vehicles is not reported upon.
Business Travel – Public Transport	Category 3	Data was available in relation to expenditure on public transport purchased through Purchase Card (PCard) and Accounts Payable. No mileage data was available. No suitable category was found in the Carnegie-Mellon Cost input tool. Therefore, Business travel in public transport has not been reported upon.
Purchased Goods and Services - Paper	Category 4	As per 2019, 2020, and 2021, records from suppliers demonstrate that almost all the products purchased were certified carbon neutral (>99%). Therefore, the residual emissions due to purchase of paper are deemed de minimus and are not reported on.
Construction	Category 4	The University of Otago has an ongoing campus development programme. While we are working with architects and the New Zealand Green Building Council to establish an efficient and effective way to account for emission resulting from building activity, we do not yet have a solution. Therefore, we have excluded emissions due to construction from the scope of this inventory.

Category 1

09 Stationary Combustion – Biomass (Wood Fuel)

↘ 14% from 2019

Biomass Wood Fuel	2019	2020	2021	2022			
	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	tCO_2 (out of scope)	CH_4 (tCO_2-e)	N_2O (tCO_2-e)
Input Units (Wood Chip) (kWh)	3,916,667	3,672,766	3,892,920	3,796,795			
Emission factor (Wood Chip) kg/kWh	0.01563	0.01545	0.01513	0.01053	0.35357	NA	NA
Emissions (Wood Chip)	61.22	56.74	58.90	39.98	1,342.43	NA	NA
Input Units (Wood Pellets) (Tonnes)	102	101	85	377			
Emission factor (Wood Pellets) kg/t	73.14	72.30	72.60	50.55	0.34941	NA	NA
Emissions (Wood Pellets)	7.46	7.30	6.17	19.06	0.13	NA	NA
Total Emissions	**68.68**	**64.04**	**65.07**	**59.04**	**1,342.56**	**NA**	**NA**

** All 2019 figures in these tables are rebaselined as per the 2020 report, i.e. including all campuses, unless otherwise stated*

9.1 Category summary and calculation method:

This category captures the wood chips and wood pellets the University combusts in its own boilers across its campuses.

The total mass of biomass was gathered from an annual report prepared by the University's Energy team summarising all invoices from suppliers. Emission factors from DEFRA were used.

It should be noted that carbon dioxide emitted from the combustion of wood fuel is biogenic and treated as carbon neutral and out of scope. However, the combustion of biofuels generates anthropogenic methane and nitrous oxide. DEFRA emission factors only provide the total tCO_2e, but not a breakdown of the other GHGs. Therefore, only the total emissions (tCO_2-e) have been reported in the inventory.

Biomass emission factors were updated and lowered in 2022, therefore reducing emissions by -14% from 2019.

9.2 Uncertainty and disclosures:

As this total is based on invoices that are checked through the financial approval processes, there is a high level of confidence in this data.

9.3 Recommendations to improve reporting

To include biomass in an automated invoicing system that provides a periodic emission report throughout the year from all suppliers.

Develop a method to calculate the constituent greenhouse gases as a result of biomass.

10 Stationary Combustion - Coal

98% from 2019

Coal	2019	2020	2021	2022			
	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	tCO2	CH4 (tCO2-e)	N2O (tCO2-e)
Input Units (kg)	775,420	688,430	349,000	18,790			
Emission Factor	2.01	2.01	2.01	2.01	1.99	0.00514	0.0092
Total Emissions	**1,558.59**	**1,383.74**	**701.49**	**37.77**	**37.39**	**0.10**	**0.17**

10.1 Category summary and calculation method:

This category captures the coal the University uses in its own boilers across its campuses. In 2019, these included boilers at a residential college, a research facility and the Invercargill College of Education campus. As the 98% decrease shows, the University has been working hard to eliminate the use of coal through conversion of boilers to biomass, electrification of heating (heat pumps) or, in the case of the research facility, decommissioning (which occurred at the end of 2021).

The total mass of coal was gathered from an annual report summarising all invoices. This report was provided by the sole supplier. The coal supplied was deemed to be sub-bituminous according to the producer's website. Emission factors from the Stationary Combustion Fuel section under Table 3 of MfE Guidelines were used to calculate the total emissions.

10.2 Uncertainty and disclosures:

As this total is based on invoices that are checked through the financial approval processes, there is a high level of confidence in this data.

10.3 Recommendations to improve reporting

The University is replacing the heating source at the Invercargill College of Education, meaning that there should be no Category 1 coal emissions from the end of 2023.

11 Stationary Combustion - Diesel

70% from 2019

Biomass Wood Fuel	2019	2020	2021	2022			
	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	tCO_2	CH_4 (tCO_2-e)	N_2O (tCO_2-e)
Input Units (Litres)	29,417	21,875	35,138	8,870			
Emission Factor	2.66	2.66	2.67	2.67	2.65	0.00907	0.0065
Emissions	**78.25**	**58.19**	**93.82**	**23.68**	**23.50**	**0.08**	**0.06**

11.1 Category summary and calculation method:

Emissions from diesel used in our boilers and generators is based on data drawn from invoices from the sole supplier. Invoices are identified through an inquiry in the finance system and then downloaded to provide the number of litres on each. The emission factors used are selected from the Stationary Combustion Fuel section under Table 3 of MfE Guidelines. The commercial category was seen as the most relevant to the use as back up in heating systems for campus. Diesel boilers and generators are primarily used as back-ups, and the reduction of consumption reflects the reduced call on these systems in 2022.

11.2 Uncertainty and disclosures:

As this fuel is purchased in bulk tanks some of that purchase may be used in the year following the purchase. As this error occurs at both ends of the financial year, they will represent an accurate account over time.

11.3 Recommendations to improve reporting

That diesel invoices be added to the automated system and include the volume in the data gathered.

12 Stationary Combustion - LPG

↗80% from 2019

LPG	2019	2020	2021	2022			
	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	tCO_2	CH_4 (tCO_2-e)	N_2O (tCO_2-e)
Input Units - LPG Bottled (kg)	13,010	12,327	13,893	12,507			
Emission Factor	3.03	3.03	3.03	3.03	3.02	0.00594	0.0014
Emissions (Bottled LPG)	**39.42**	**37.35**	**42.10**	**37.90**	**37.77**	**0.07**	**0.02**
Input Units - Reticulated LPG (kWh)	5,367,707	4,685,526	12,717,934	9,811,248			
Emission Factor	0.23	0.23	0.23031	0.23031	0.22999	0.00018	0.00014
Emissions (Reticulated LPG)	**1,236.13**	**1,079.08**	**2,929.07**	**2,259.63**	**2,256.49**	**1.17**	**1.37**
Total Emissions	**1,275.55**	**1,116.43**	**2,971.16**	**2,297.53**	**2,294.26**	**1.84**	**1.39**

12.1 Category summary and calculation method:

The University uses LPG for heating, cooking and in some laboratories. We are seeking to eliminate the use of this fossil fuel by 2030.

The data in relation to the use of LPG comes from three different suppliers. Genesis provide reticulated LPG. This consumption is reported based on a report from meter reading and is in kWhs. Rock Gas and OnGas provide LPG bottles gas. This is reported in kg from approved invoices.

The total reticulated gas consumed was calculated from the consumption reports. As MfE guidelines do not provide an emission factor in kWh, the DEFRA emission factor was used to calculate the total emissions from reticulated gas.

The total amount of bottled gas was calculated manually from the invoices. This manual process excluded all non-fuel costs such as bottle rental. The emission factor for the commercial use of LPG from the Stationary Combustion Fuel section under Table 3 of MfE Guidelines was then applied to calculate the total emissions due to consumption of bottles LPG. The bottled and reticulated emissions were then combined to provide the total.

In 2021 we saw a large increase in reticulated LPG usage and emissions due to the new and upgraded buildings at the Dunedin campus. In particular, the Eccles Building uses an LPG boiler to provide heat and steam. Fine-tuning of this system has led to significant efficiency improvements, and work is underway to replace the boiler with a lower emissions solution. This work will also inform other LPG boiler replacement efforts across campus.

12.2 Uncertainty and disclosures:

As this data is based on invoiced amount and includes detail of residual LPG in collected bottles there is a high level of confidence in its reliability. However, the calculation is manual and prone to calculation errors. The addition of LPG supply to an automated system that collects the required data from the invoices and provided reporting throughout the year would reduce the likelihood of these errors. There is the possibility that some small LPG bottles used for cooking in field work or remote locations have been filled in garages and paid for by Purchase Card (PCard). This was not apparent in the PCard transactions relating to fuel and is unlikely to be material to the inventory.

12.3 Recommendations to improve reporting

The University is seeking to consolidate LPG suppliers and this should simplify the reporting process.

13 Mobile Combustion - Petrol & Diesel

14% from 2019

Petrol & Diesel	2019	2020	2021	2022			
	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)		tCO2	CH4 (tCO2-e)	N2O (tCO2-e)
Input (Regular Petrol)	28,830	20,306	21,028	21,894			
Emission Factor (Regular Petrol)	2.45	2.45	2.46	2.46	2.35	0.0276	0.0797
Emissions (Regular Petrol)	70.63	49.75	51.73	53.86	51.45	1.75	20.14
Input (Premium Petrol)	10,082	7,662	8,529	5,323			
Emission Factor (Premium Petrol)	2.45	2.45	2.48	2.48	2.37	0.0277	0.0801
Emissions (Premium Petrol)	24.70	18.77	21.15	13.20	12.62	0.15	0.43
Subtotal Petrol Emissions	**95.33**	**68.52**	**72.88**	**67.06**	**64.07**	**1.90**	**20.57**
Input (Diesel)	36,997	29,626	35,321	37,492			
Emission Factor (Diesel)	2.69	2.69	2.69	2.69	2.65	0.00354	0.0422
Emissions (Diesel)	**99.52**	**79.69**	**95.01**	**100.85**	**99.35**	**1.03**	**2.99**
Input (Marine)	$56,403	$26,867	$48,208	25,553			
Emission Factor (Marine)	Cost basis	Cost basis	Cost basis	2.94	2.92	0.0067	0.0228
Emissions (Marine)	**18.00**	**8.36**	**16.50**	**75.13**	**74.62**	**0.17**	**0.58**
Total Emissions	**212.85**	**156.57**	**184.39**	**243.04**	**238.04**	**3.10**	**24.14**

** Now includes Marine Emissions as the calculation method converted from $/e to litres of fuel/emissions*

13.1 Category summary and calculation method:

This category represents the fuel consumed directly by the University in vehicles in the course of its business.

The University Procurement team supplied a record of all Fuel Card and Accounts Payable transactions for fuel. When cross-referenced all mobile diesel and petrol were captured by Fuel Cards (except Marine which was captured in Accounts Payable). The total volume of fuel in litres was calculated for each fuel type and class. Emission factors from the Transport Fuel section under Table 4 of MfE Guidelines were used for Regular, Premium and Diesel fuels.

The slight increase in emissions in 2022 from 2019 levels is due to the addition of Marine fuel in this category. Previously Marine emissions were reported on in a separate category and calculated on a $/emission basis to incomplete fuel volume data. Rationalisation of the marine fleet now means that only one vessel (Polaris II) purchases fuel on accounts payable rather than via fuel card and all of these invoices include litres purchases. We have thus switched to the more accurate litres-based emissions factor (light fuel oil in table 4 of the MfE guidelines). This suggests the cost basis was underestimating the emissions from fuel purchased previously, though we do not have the necessary data to rebaseline prior years emissions.

13.2 Uncertainty and disclosures:

As all records are cross-checked as they are approved in the finance system there is a high level of confidence in this calculation. It is known that some fuel is purchased on PCard rather than Fuel Cards. The emissions resulting from that expenditure is captured in the separate emission category for Mobile combustion - PCard purchases.

There may also be a small amount of fuel that is purchased by staff and is reimbursed through expenses. This is more appropriately accounted for as business travel and is captured in the reimbursement category.

13.3 Recommendations to improve reporting

Explore the possible level of fuel expenditure through reimbursements.

14 Mobile Combustion - Pcard Purchases

19% from 2019

Biomass Wood Fuel	2019	2020	2021	2022			
	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	tCO2*	CH4 (tCO2-e)	N2O (tCO2-e)
Input Units (NZ$)	$104,048.56	$64,471.68	$95,797.01	$127,010.00			
Emission factor	Cost basis	Cost basis	Cost basis	Cost basis			
Emissions	**33.20**	**20.10**	**32.90**	**39.10**	**NA**	**NA**	**NA**

14.1 Category summary and calculation method:

Some fuel for vehicles is purchased on PCard rather than fuel cards or on account. There is no mileage, volume, nor fuel type data available for this spending. Therefore the Carnegie Mellon Cost input tool was selected to account for the emissions.

The University Procurement team compiled all PCard charges coded as fuel purchases for the year. The total financial value was calculated and converted to US$ to input into the online tool.

14.2 Uncertainty and disclosures:

While there is a high level of confidence that the fuel expenditure category identifies appropriate spending, there is no way to gauge the number of items that have either been miscoded as fuel when they are not or coded as something else. Given that all transactions are of a relatively small value, there would have to be an exceptional number of errors for it to be material. This level of error would be identified in the quality systems in place for procurement and finance processes.

The cost input model is based on US data. As fuel prices are significantly lower there than in NZ, our assumption to date had been this would likely lead to over reporting these emissions. However, as discussed above, Marine emissions moving from cost to litres basis suggests the cost model may be under reporting emissions, possibly due to being based on 2002 expenditure data. Without volume data, no other suitable emissions factor is available.

14.3 Recommendations to improve reporting

While there will always be fuel spending on PCard, it would be more manageable to report on emissions and likely more cost effective to buy a higher percentage of fuel through Fuel Cards/accounts. There may be the opportunity to ensure Fuel Cards are more readily available if fleet management is centralised.

15 Fugitive Emissions - Refrigerants

2% from 2019

Refrigerant		2019	2020	2021	2022		2022
		Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Emission Factor	Estimated Leakage (kg)	Total Emissions (tCO2-e)
R22	HCFC	15	15	15	1810	8.181	15
R410A	HFC	57	61	61	2088	29.1519	61
R407C	HFC	13	13	13	1774	7.59	13
R134A	HFC	4	4	4	1300	2.633	3
R404A	HFC	16	16	16	3922	4.14	16
Total Emissions		**106**	**109**	**109**			**108**

15.1 Category summary and calculation method:

An inventory of all machinery that contains refrigerants was compiled by the Building Information and Compliance Manager in early 2020. This mainly consists of heat pumps and chilling units. This included a record of the contractor who maintains the machinery, but did not record the volume or specification of refrigerant used to top up during services. It did include the type of refrigerant, total charge of refrigerant (some estimated) and the category of the machinery. It was found that there was no SF6 within the operational boundaries of the inventory. The size for electrical equipment that uses SF6 is likely used by our electricity suppliers, but is not within the scope of this report.

Method B.1 in Appendix B of MfE Guidelines was used to calculate the operational emissions. Each piece of machinery was categorised. In the absence of default leakage rates in the MfE guidelines the categories described by DEFRA in the UK government guidelines were used. This provided the default leakage rates for each category of machinery. For each piece of machinery that default leakage rate was applied to the total charge of refrigerant, and then an emission factor for each refrigerant category. This provided the total emissions from operations for the year. Emission factors were taken from DEFRA guidelines.

The total charge of each category of refrigerant was calculated and multiplied by the relevant EF for that refrigerant to provide the total liability.

The University is currently preparing to transition to a new Integrated Workplace Management System (IWMS) that will accurately record assets that contain f-gases and thus support reporting on this category in the future.

16.1 Total Liability

Refridgerant		EF	Total Charge (kg)	Liability (tCO2-e)
R22	HCFC	1810	159.6	289
R410A	HFC	2088	793.19	1,656
R407C	HFC	1774	253	449
R134A	HFC	1300	107.2	139
R404A	HFC	3922	129	506
SF6			0	0
Total Liability				**3,039**

Continued Fugitive Emissions - Refrigerants

Given fugitive emissions made up 0.3% of the 2019 inventory, it was decided that a detailed stocktake would be undertaken once it was known what fields the new IWMS could hold, at which time business processes will be introduced to ensure data is accurate, up to date and supports greenhouse gas emissions reporting. A stocktake is scheduled for the end of 2023.

The only substantive changes to the inventory since it was undertaken in early 2020 were due to the refurbishment of the Dental School, completion of the Eccles Building, and new equipment at the Mellor labs on the Dunedin campus (all occured in 2020). The resulting changes to known refrigerant amounts (R410a only) were factored into 2020 figures. No material changes were identified for 2021 or 2022.

15.2 Uncertainty and disclosures:

The inventory is known to be incomplete. There are likely to be appliances such as small fridges in staff rooms that have been bought by individual departments and are not maintained through the Property Services team. Given that these are small and sealed units their omission from the operational emissions is not seen as material to the inventory.

The total charge for a small number of items on the inventory were estimated. These were all smaller pieces of machinery in the 3-5kg range. The total charge was estimated by a qualified refrigeration engineer (the Building Information and Compliance Manager) as a site visit was not considered an essential service during COVID19 Level 4 restrictions in 2020. A detailed inventory is scheduled before the end of 2023 to coincide with the new IWMS.

15.3 Recommendations to improve reporting

As above, a fuller inventory needs to be completed to confirm the total number of items and the total charge, with the data held and maintained in the IWMS.

Adapt maintenance recording to include the actual top-up value of any refrigerant used in servicing to support more accurate reporting.

Category 2

16 Electricity

18% from 2019

Electricity	2019	2020	2021	2022			
	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	tCO_2	CH_4 (tCO_2-e)	N_2O (tCO_2-e)
Input Units (kWh)	45,193,469	53,729,383	51,769,270	48,988,107			
Emission factor (kg/kWh)	0.110	0.120	0.120	0.120	0.117	0.0028	0.00022
Total Emissions	**4,971.28**	**6,447.53**	**6,212.31**	**5,878.57**	**5,731.61**	**137.17**	**10.78**

16.1 Category summary and calculation method:

The University sources electricity from the National Grid from three retailers (Meridian Energy, Pioneer and Trust Power).

Emissions from electricity are based on actual consumption of electricity from meter readings, and confirmed by invoice checking from the three suppliers, and the emission factors used are from the Purchased electricity, heat and steam section on Table 9 of MfE Guidelines. The data is gathered by the University of Otago Energy team and via invoice management by Energy Link.

Electricity usage increased in 2020 and 2021 due in part to the increased usage at residential colleges and Uniflats over COVID Alert Levels 3 and 4. There were no lockdowns in 2022, which may partly explain the 5% drop in electricity usage from 2021-2022. In addition, the University began using a new energy analytics platform in late 2021, which has led to efficiency gains.

Looking ahead, electricity will continue to make up a large proportion of our total energy mix, as we transition away from fossil fuels for heating and mobile combustion. Increasing the efficiency of our electricity usage will remain a focus. The Government's efforts to drive the percentage of renewables in the National Grid towards 100% should also progressively reduce the emissions factor for grid sourced electricity, and we will also explore opportunities for more onsite renewable generation of electricity.

16.2 Uncertainty and disclosures:

There is a high level of confidence in this data due to the source being actual consumption data and checked routinely through the processing of invoices for payment. However, the process of compiling the record from different sources can introduce errors.

16.3 Recommendations to improve reporting

That the electricity data be captured and compiled throughout the year into a dashboard to see progress to targets throughout the year.

That the invoices be processed through an automated system to provide the dashboard data mentioned above.

17 Steam and MTHW - Coal and Biomass

88% Coal from 2019
14% Biomass from 2019

Coal & Biomass	2019	2020	2021	2022			
	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	tCO2	CH4 (tCO2-e)	N2O (tCO2-e)
Input Units – Coal (kWh)	17,681,864	3,634,471	2,456,410	2,246,460			
Emission Factor – Coal (kg/kWh)	0.3493	0.33726	0.32020	0.32020	0.31832	0.00009	0.00179
Emissions - Coal	**6,176.28**	**1,225.77**	**786.54**	**719.32**	**715.09**	**0.20**	**4.02**
Input Units – Biomass (kWh)	17,486,769	26,989,325	29,713,741	29,579,609	**tCO2 (out of scope)**		
Emission Factor - Biomass (kg/kWh)	0.01563	0.01545	0.01513	0.01053	0.35357	NA	NA
Emissions - Biomass	**273.32**	**416.99**	**449.57**	**311.47**	**10,458.46**	**NA**	**NA**

17.1 Category summary and calculation method:

The Dunedin campus is supplied steam and medium temperature hot water by Pioneer Energy's district energy scheme. In early 2020, the boiler that supplies our campus was converted from coal- to biomass-fueled. For this reason, there is no coal consumption recorded for 2021 from the Dunedin campus, and this will continue in future years. The 719 tCO2-e of coal in 2022 comes from the Christchurch School of Medicine, which is supplied heat and steam from the hospital's energy scheme and is based on figures provided by Te Whatu Ora. This scheme switched over from coal to biomass in late February 2023, which means there will only be a small amount of coal usage and emissions in next year's reporting, and a small increase in biomass emissions.

For Dunedin, the amount of energy provided as steam and medium temperature hot water (MTHW) was based on monthly reports agreed between Pioneer Energy and the University Energy Management team. These provided a split between energy generated by burning coal and energy generated by burning biomass when coal was still being used.

The amount of condensate returned back to the reticulated system was also provided. The condensate is not energy consumed by University of Otago, but rather energy returned to Pioneer. As such it is excluded from the emission calculations.

Emission factors from DEFRA guidelines for combustion of solid fuels were applied to provide the emission resulting from each fuel source used. These guidelines provided emission factors for component greenhouse gases for coal, but only the total emissions for biomass (tCO2-e). The Biomass DEFRA emission factor was updated and lowered in 2022, which has driven the slight decrease in biomass emissions from 2021.

17.2 Uncertainty and disclosures:

As this total is based on invoices that are checked through the financial approval processes, there is a high level of confidence in this data. It should be noted that carbon dioxide emitted from the combustion of wood fuel is biogenic and treated as carbon neutral and out of scope of the inventory. However, the combustion of biofuels generates anthropogenic methane and nitrous oxide. DEFRA emission factors only provide the total tCO2e, but not a breakdown of the other GHGs. Therefore, only the total emissions (t-CO2- e) has been reported in the inventory.

17.3 Recommendations to improve reporting

Establish a method to report on the component GHGs for biomass.

18 Steam and MTHW – Natural Gas – Wellington Campus

64% from 2019

Natural Gas	2019	2020	2021	2022			
	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	tCO_2	CH_4 (tCO_2-e)	N2O (tCO_2-e)
Input Units - Natural Gas-Wellington (kWh)	1,536,620	1,003,060	999,444	546,944			
Emissions factor (kg/kWh)	0.195	0.195	0.195	0.195	0.194	0.000405	0.0000966
Emissions - Natural Gas	**299.64**	**195.60**	**194.89**	**106.65**	**106.11**	**0.22**	**0.05**

18.1 Category summary and calculation method:

The Wellington campus, located on the wider Wellington hospital campus in Newtown, is provided heat via the hospital's natural gas-powered system. The amount of energy provided was based on reports from the Capital and Coast District Health Board.

Emission factors from the Stationary Combustion Fuel section under Table 3 of MfE Guidelines for stationary combustion of natural gas were applied to provide the emission.

The reduction in emissions in 2020 is likely due to the impact of Alert Levels 3 and 4 and reduced occupancy. In August 2021, the main building of the Wellington campus was closed due to earthquake risk. These affects were still in place for 2022, with a small fraction of staff making use of the campus with others working from alternative facilities or home. The long-term solution for the Wellington campus will include eliminating reliance on this fossil fuel.

18.2 Uncertainty and disclosures:

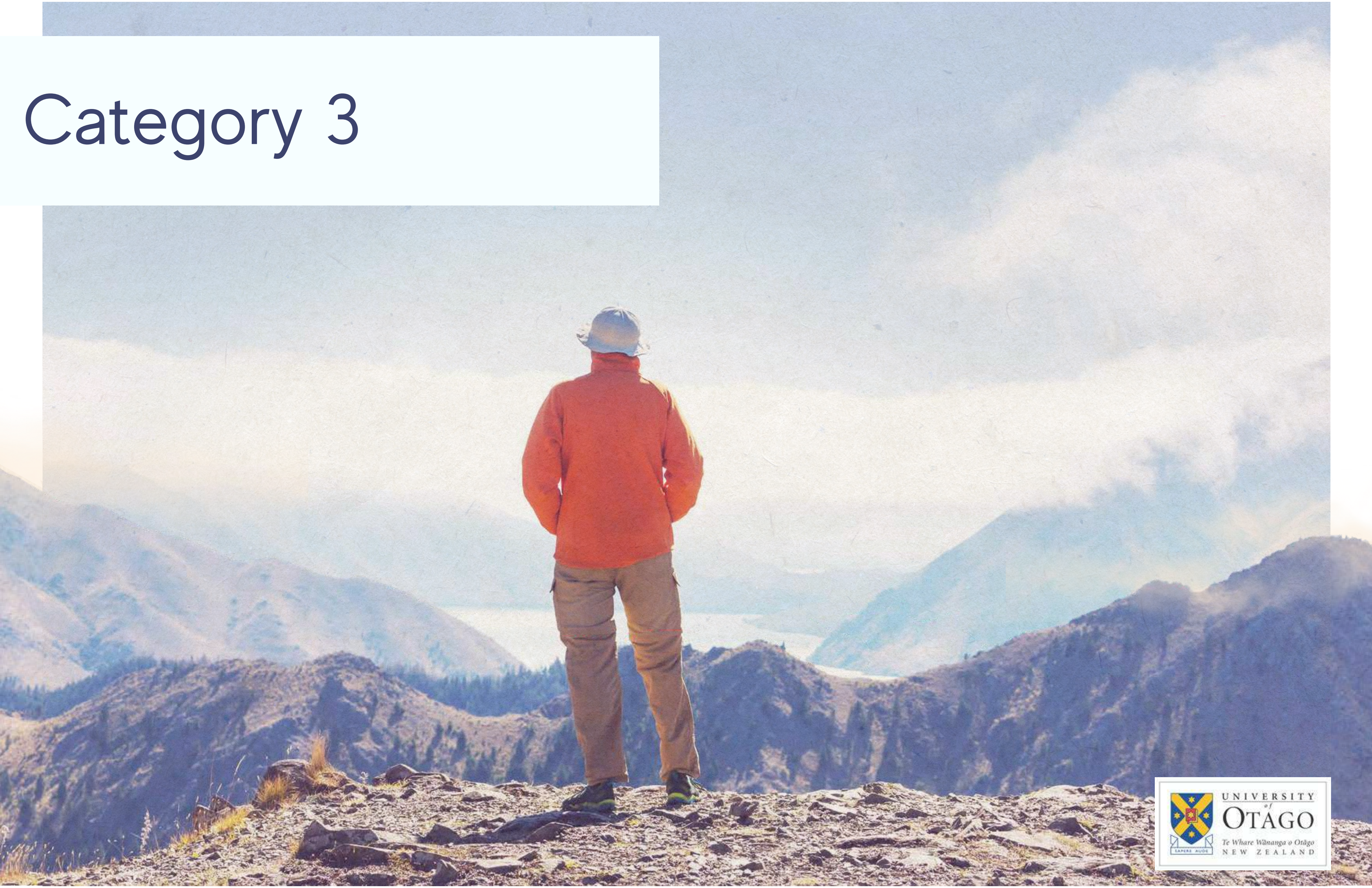
This emissions category was not reported on in the 2019 inventory as it was outside the scope of that exercise (non-Dunedin campus).

As this total is based on invoices that are checked through the financial approval processes, there is a high level of confidence in this data.

18.3 Recommendations to improve reporting

Establish a method to integrate Wellington emissions into monthly and real-time reporting module, noting that the scope of capital development at the Wellington campus may include changing fuel sources.

Category 3



19 Business Travel – Air

64% from 2019

Air Travel	2019	2020	2021	2022								
	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	km	Emission Factor (EF) (kg CO2-e/km	Total Emissions (tCO2-e)	EF CO2 (kg CO2/km)	tCO2	EF CH4 (kg CO2/km)	tCH4	EF N2O (kg CO2/km)	tN2O
Domestic												
Economy	3,536.02	749.72	1773.05	5,967,172.80	0.306	1,825.95	0.300	1,790.15	0.00100	5.9672	0.004	23.87
Sub-Total	**3,536.02**	**749.72**	**1773.05**	**5,967,172.80**		**1,825.95**		**1,790.15**		**5.9672**		**23.87**
Shorthaul												
Economy	1,084.73	134.14	19.79	2,636,609.98	0.151	398.13	0.150	395.49	0.00001	0.0264	0.001	2.637
Premium Economy	7.61	1.08	0.00	8,056.62	0.151	1.22	0.150	1.21	0.00001	0.0001	0.001	0.008
Business	9.29	2.52	0.00	47,340.46	0.227	10.75	0.225	10.65	0.00001	0.0005	0.001	0.047
First	0.59	0.98	0.00	5,669.08	0.227	1.29	0.225	1.28	0.00001	0.0001	0.001	0.006
Sub-Total	**1,102.21**	**138.72**	**19.79**	**2,697,676.14**		**411.38**		**408.63**		**0.0270**		**2.698**
Longhaul												
Economy	5,438.61	570.93	67.84	9,743,290.88	0.148	1,442.01	0.147	1,432.26	0.00001	0.0974	0.001	9.743
Premium Economy	287.15	28.58	0	499,149.54	0.237	118.30	0.235	117.30	0.00001	0.0050	0.001	0.499
Business	654.7	32.76	0	648,451.07	0.429	278.19	0.427	276.89	0.00002	0.0130	0.002	1.297
First	13.2	0	0	5,086.60	0.591	3.01	0.589	3.00	0.00002	0.0001	0.002	0.010
Sub-Total	**6,393.66**	**632.27**	**67.84**	**10,895,978.09**		**1,841.50**		**1,829.45**		**0.12**		**11.55**
Charter Helicopter	NA	NA	NA	3.35	multiple	1.51	multiple	1.46	multiple	0.01	multiple	0.04
Charter Aeroplane	NA	NA	NA	472.50	2.63	1.24	2.54	1.20	0.02	0.008	0.07	0.033
Sub-Total	**NA**	**NA**	**NA**	**475.85**		**2.75**		**2.66**		**0.02**		**0.07**
Cost-basis												
P-Card	251.00	39.60	44.00	$ 89,483.77	Cost-basis	87.40	NA - Carnegie Mellon tool does not provide breakdown of constituent gases					
Reimbursements	699	139	50.5	$ 134,213.27	Cost-basis	132.00	NA - Carnegie Mellon tool does not provide breakdown of constituent gases					
Grand Total	**11,981.89**	**1,699.31**	**1,955.18**	**19,560,827.03**		**4,300.98**		**4,030.89**		**6.13**		**38.19**

Business Travel - Air

19.1 Category summary and calculation method:

Business air travel (primarily for staff, but also for some students, collaborators and suppliers) was the single largest source of emissions from University activity in 2019. The impact of COVID19 on both international and domestic flying was dramatic in 2020 and similar circumstances prevailed in 2021 (with even lower levels of international travel being offset by more domestic flying). With travel restrictions being removed in 2022, staff have been encouraged to use alternative modes to flights when possible, or to fly smarter through trip stacking or chaining when this is unavoidable. In 2022, emissions successfully remained below our target of 5,500 tCO2-e per annum (46% of pre-pandemic levels).

In 2022 there are six sources of data, each with different formats and data availability: Orbit (University approved travel agent), Helloworld (University approved travel agent), PCard purchases, staff reimbursements, and the newly added charter helicopter and airplane flights.

Orbit and Helloworld provide distance, flight class and flight category (long haul etc.). From there we can apply the appropriate emission factors as provided in the Domestic Air Travel section, the International Air Travel section, and the Helicopter section under Table 39, 48 and 50 of the MfE Guidelines. Travel agents offer staff the same discounted rates for personal travel and where a family member is accompanying a staff member. This is not a business cost, and all such transactions were excluded from the reports before calculations began.

A finance report on PCard transactions captures purchases related to air travel. We note that purchase of air travel on PCard is contrary to University of Otago Policy and enforcement of this policy has seen a decline in this purchase method from higher levels pre-pandemic. The PCard transaction report provides cost data, but does not provide the distance, emissions category or flight class. There were many travel associated costs included in the report that were not relevant to emissions. Therefore, the report was filtered to exclude Koru Club memberships, taxi, excess baggage, and parking. All transactions less than NZ$100 were assumed to not be flight bookings and also filtered from the data.

A finance report on staff reimbursements related to business travel was produced by the finance department. This was filtered to show reimbursements for staff who had purchased domestic and international flights. The Carnegie Mellon Cost input model was used to estimate the emissions resulting from expenditure through PCards and reimbursements.

A small number of charter flights on aeroplane and helicopter were made in 2022. Each vendor was contacted to advise the craft used and flight duration (helicopter) or volume of fuel used (flight) and relevant emissions factors from the MfE's guidance were used.

19.2 Uncertainty and disclosures:

While charter flight emissions are currently de minimus, these flights are often for climate change-related research and thus we have elected to provide as much transparency as possible.

While the cost input model provides an adequate estimate of the emissions due to air travel, it is based on USA data. Factors such as average flight distance, average seating per aircraft, fuel prices, flight ticket prices, age and type of aircraft all contribute to the emissions and are likely to vary between USA and NZ. The cost-based method is based on 2002 expenditure data and is potentially considerably out of date. However, this method is used for the minority of flights (c.5% of business air travel emissions in 2022).

It is also possible that some items under NZ$100 were purchases of short flights. Due to the small number of transactions and the short distance that would have been available at that price this is not seen as material to the inventory.

19.3 Recommendations to improve reporting

Identify a more suitable, NZ-based cost to emissions conversion method for air travel.

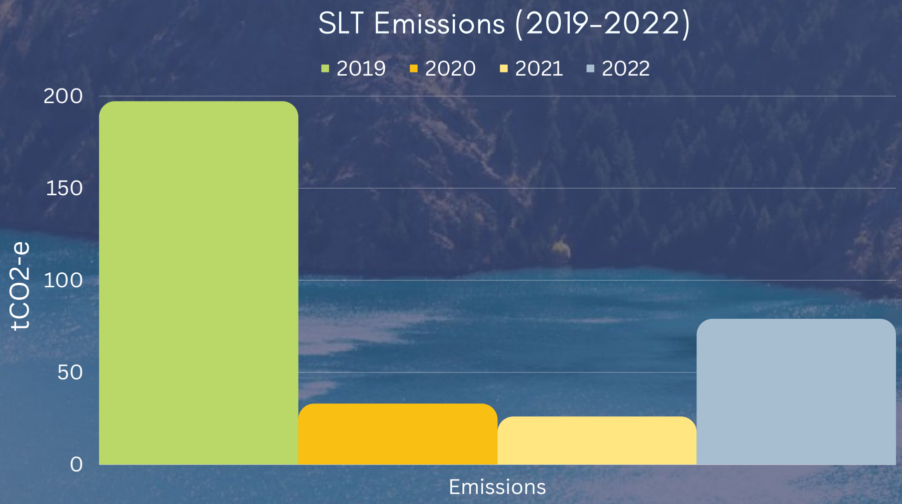
Continue to reinforce the policy and guidelines to avoid PCard purchases/reimbursements in relation to air travel, noting that there will always be some instances that this method will still need to be used (eg short notice travel when already overseas).

Senior Leadership Air Travel Emissions

To demonstrate leadership and increase transparency, the Senior Leadership Team (SLT) asked the Sustainability Office to provide data on air travel emissions of SLT as a group from 2019-2022.

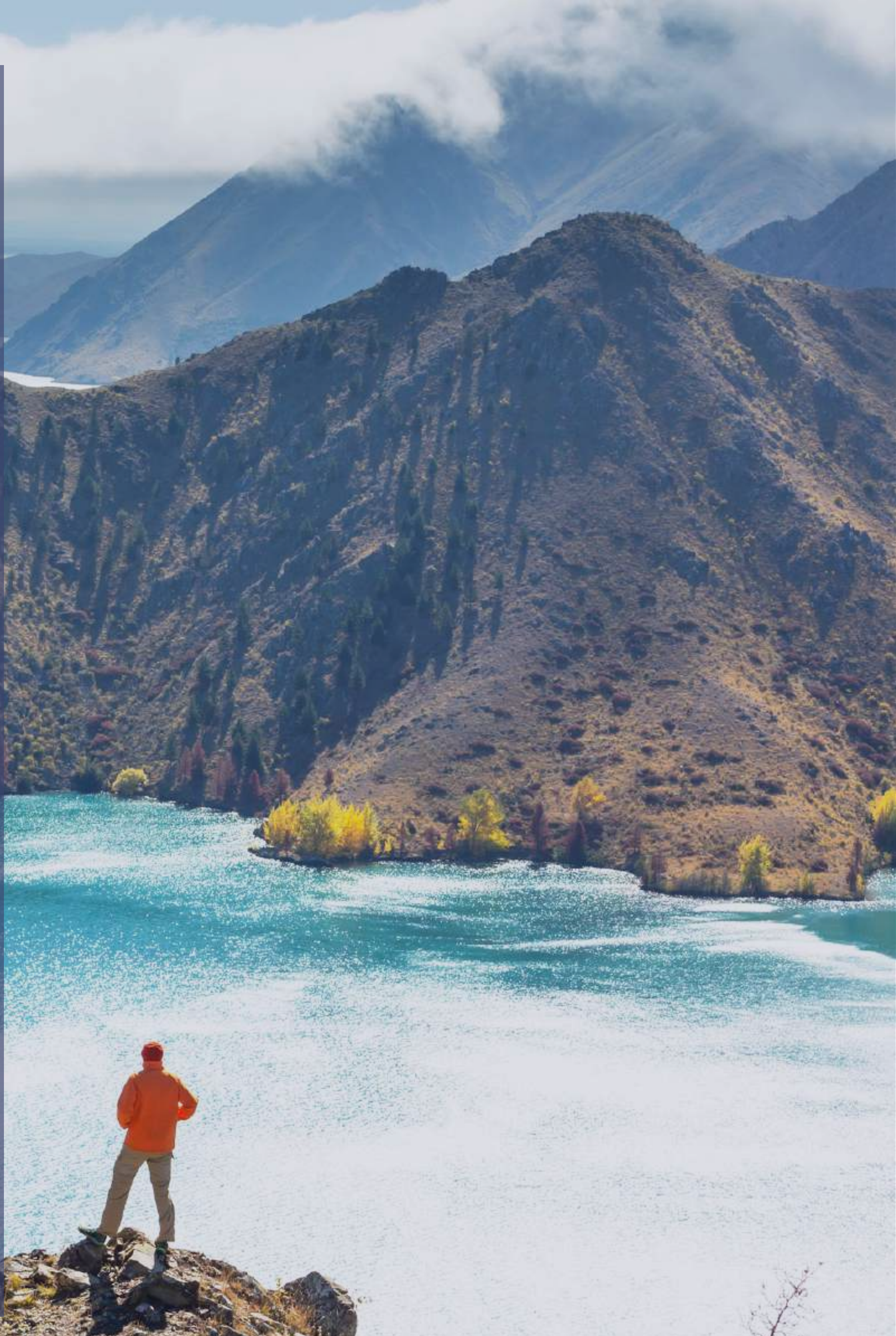
While emissions in 2022 increased from the peak of the COVID-19 pandemic, they remained well below half of 2019 levels (74 tCO2-e vs 197 tCO2-e).

SLT air travel emissions as a percentage of total business air travel emissions have hovered between 1% and 2% between 2019 and 2022. The Sustainability Office will continue working with the SLT to ensure SLT and University-wide emissions are part of travel decision making.



SLT Emissions vs Total University Air Travel 2019-2022)

Years	SLT Air Travel tCO2-e	Total UoO Air Travel tCO2-e	% of Total
2019	197.44	11,981.89	1.64%
2020	33.29	1,699.31	1.96%
2021	25.92	1,955.18	1.33%
2022	74.41	4,300.98	1.73%



20 Business Travel - Accomodation

37% from 2019

Accomodation	2019	2020	2021	2022					
	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2e)	Inputs	Emission Factor	Total Emissions (tCO2e)	tCO2	tCH4	tN2O
From travel booking	114.80	60.57	33.25	6,112.00	Various	94.19	NA	NA	NA
Staff reimbursements (NZ$)	49.10	10.90	9.92	217,410.00	Cost Basis	10.90	NA	NA	NA
PCard expenditure and Accounts Payable (NZ$	175.00	43.60	64.30	2,160,511.00	Cost Basis	108.50	NA	NA	NA
Total Emissions	**338.90**	**115.08**	**107.47**			**213.59**	**NA**	**NA**	**NA**

20.1 Category summary and calculation method:

The emissions resulting from accommodation during business travel are based on data from travel agents (Orbit and Brooker), Accounts Payable, PCard transactions, and staff reimbursements. Previously this also included the University's Executive Residence, which provided accommodation for staff visiting Dunedin campus, but this was converted to student accommodation early in 2021.

Travel agents provide an annual report that provides the number of nights booked in a hotel and the country in which it is located. Based on the Accommodation section under Table 51 of MfE Guidance the number of rooms in each country was totaled and multiplied by the relevant emission factors where available. Only total emissions factors are available, therefore component GHG emissions are not reported. As expected, with COVID-19 travel restrictions easing in 2022, we have seen an increase of 98% in accommodation emissions. Staff booked accommodation in a total of 36 countries in 2022, all of which but five (Denmark, Estonia, Norway, Sweden, and Tonga) had emission factors available. For the five countries with no emission factors, the most appropriate near-by country emission factors were used as placeholders to ensure these emissions were being accounted for.

The expenditure on accommodation through PCard and Accounts Payable were totalled and the emissions estimated through the Carnegie Mellon Cost input tool. The share of accommodation booked and paid for via these methods, rather than through travel agents, increased from 2020 as a result of ongoing international travel restrictions, which meant more research and study leave being taken domestically and more homestays for international students. The two sets of emissions were combined to provide the total emissions due to business travel accommodation.

20.2 Uncertainty and disclosures:

Emission factors were available for the large majority of countries accommodation was booked in 2022. As international travel continues to increase post-2022, there are likely to be some countries not listed in the MfE guidance, however, the guidance continues to add more countries to the list with each update.

While the cost input model provides an adequate estimate of the emissions due to accommodation it is based on USA data which is likely to vary from the data for the wide range of countries in which the accommodation is located. The cost-based method is based on 2002 expenditure data and is potentially considerably out of date. The emission factors vary widely from one country to another, the cost input tool does not allow for this.

20.3 Recommendations to improve reporting

To reduce the amount of accommodation booked through reimbursement and PCards OR ensure room nights is captured as part of the reimbursement/payment process to allow the more accurate nights-based method to be used rather than the cost input tool.

21 Business Travel - Taxis

27% from 2019

Taxi	2019	2020	2021	2022			
	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	tCO_2	tCH_4	tN_2O
Input Units NZ$	854,192	520,213	374,306	663,789			
Emission Factor	0.075	0.070	0.070	0.070	0.069	0.0001	0.001
Total Emissions	**64.06**	**36.41**	**26.20**	**46.47**	**45.80**	**0.066**	**0.664**

21.1 Category summary and calculation method:

The emissions resulting from business travel in taxi and shuttle services was calculated based on data from PCard, Accounts Payable and taxi charge cards. Mileage data for PCard or Accounts Payable was not available so the cost-based emissions factors in the Passenger Vehicles section under Table 22 of MfE Guidance were used.

For taxi charge, the report provided estimated mileage as well as cost per trip. Using estimated mileage (28,864km) and the MFE's recommended emission factor of 0.225 $kgCO_2$-e/km, this equates to 6.49 tCO_2-e. Using the total cost ($91,105) and the emissions factor above yields 6.38 tCO_2-e. For the sake of consistency, we have used the cost-based emissions factor for taxi charge as well.

21.2 Uncertainty and disclosures:

In some instances, a minibus shuttle or airport bus may have been used rather than a car. This may be the case for many airport transfers. As we do not have mileage, vehicle size or occupancy we cannot calculate the emissions for these shuttle vehicles more accurately. Given the total emissions in this category is less than 1% of the total inventory this inaccuracy is not seen as material to the inventory.

As taxi travel paid through staff reimbursements could not be separated from the reimbursements for rental cars they are not included in the inventory. This is seen as de minimus.

21.3 Recommendations to improve reporting

There are many airport shuttles from the three main campuses. Through collaboration with the service providers it may be possible to estimate the emissions for each of these shuttle trips based on average occupancy, usual trip distance and usual vehicles/fuel used per 100km as per methodology suggested for public transport. This would also require the ability to filter airport shuttles from finance reports.

22 Business Travel - Private Mileage

↘ 20% from 2019

Private Mileage	2019	2020	2021	2022			
	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	tCO_2	tCH_4	tN_2O
Input Units (km)	505,219	237,851	360,899	433,477			
Emission Factor (kg/km)	0.27	0.27	0.265	0.265	0.253	0.003	0.009
Total Emissions	**136.40**	**63.03**	**95.64**	**114.87**	**109.67**	**1.30**	**3.90**

22.1 Category summary and calculation method:

This category covers mileage driven by staff in private vehicles and claimed back through the reimbursement process. A transaction report was produced from the finance system for reimbursements and the total kilometres calculated for transaction with the dissection code descriptions "Mileage Reimbursements" and "Travel Other".

Transactions without mileage but with cost but there There was not a relevant category in the Carnegie Mellon Cost Input Tool on which to determine a cost-based estimate. These cost-only mileage reimbursements are considered de minimus.

The default emissions factor for private petrol car was applied based on Section 7.2, Table 17 of MfE Guidance.

22.2 Uncertainty and disclosures:

It is known that not all mileage in private vehicles was captured as the mileage data was not inputted into the transaction. This is believed to be de minimus.

22.3 Recommendations to improve reporting

As reimbursements are generally inconvenient for staff, and there are a significant number of other payment methods available, reimbursement represents a relatively small proportion of travel spending.

More complete reporting of mileage on reimbursement would capture private car mileage more completely.

Finding a more current and NZ based cost-based model would increase accuracy in many categories

23 Employee Commuting – Private Vehicles

3% from 2019

Private Commuting	2019	2020	2021	2022			
	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	tCO2	tCH4	tN2O
Total commuting private vehicle distance (km)	6,958,634.60	6,831,106.55	5,037,946.20	6,975,659.05			
Internal combustion engine (ICE) vehicles							
ICE vehicle - Petrol (Km)	NA	4,255,375.10	4,005,290.94	5,361,682.51			
Emission Factor	NA	0.270	0.265	0.265	0.253	0.0030	0.0090
Emissions – Petrol (tCO2-e)	NA	1,127.67	1,061.40	1,420.85	1,356.51	16.09	48.26
ICE vehicle - Diesel (km)	NA	454,295.68	471,301.40	612,144.40			
Emission Factor	NA	0.270	0.270	0.270	0.266	0.0004	0.004
Emissions - Diesel	NA	122.66	127.25	165.28	162.83	0.24	2.45
Total ICE vehicle distance (km)	6,472,997.39						
Emissions Factor	0.27						
ICE vehicle emissions	**1,734.76**	**1,250.33**	**1,188.65**	**1,586.12**	**1,519.34**	**16.33**	**50.70**
EV/Hybrids							
Hybrid Vehicles (km)	NA	287,581.67	274,445.16	509,480.00			
Emission Factor	NA	0.201	0.201	0.201	0.193	0.002	0.007
Hybrid Emissions	NA	57.80	55.16	102.41	98.33	1.02	3.57
EV Vehicles (km)	NA	375,106.52	286,908.70	492,352			
Emission Factor	NA	0.026	0.026	0.026	0.025	0.001	0.00004
EV Emissions	NA	9.75	7.46	12.80	12.31	0.49	0.02
Total EV/Hybrid vehicles distance (km)	485,637.21						
Emission Factor	0.03						
Total EV/Hybrid Emissions	**12.14**	**67.56**	**62.62**	**115.21**	**110.64**	**1.51**	**3.59**
Total private vehicle emissions	**1,746.90**	**1,320.27**	**1,251.28**	**1,701.33**	**1,629.97**	**17.84**	**54.29**

23.1 Category summary and calculation method:

Emissions from staff commuting have been based on two primary sources of data: employee address/census mapping and staff travel surveys from 2019, 2021 and 2022. The 2022 survey had small adjustments from the 2021 survey so that questions aligned with our workplace travel planning partners, Dunedin City Council and Te Whatu Ora Southern. Changes in survey questions and the granuality of staff address data means the method of calculating employee emissions was adjusted in 2022. Descriptions of previous methods can be found in the preceding greenhouse gas emissions reports.

For 2022, the University's Strategy, Analytics and Reporting Office used employee address data to calculate the distance to their campus of work using Google Maps (tended to overstate distance) and the great circle distance (tends to understate) and the weighted average of these two distances to provide the best approximation of the distance each staff member travels to get to work. The average commuting distance for each of the University's five main campuses was then calculated and multiplied by 2 to get a daily return distance. The total commute per campus is calculated by taking the average round trip distance and multiplying by the FTE for that campus and the commuting days for that campus (calculated by deducting average rate of working from home based on survey response from standard number of wording days in a year: 220 days). This total commute distance is then apportioned to each travel mode according to the staff travel survey results. Emissions are then calculated by applying the relevant emissions factors for private vehicles (assumed pre-2010 ICE/hybrid vehicles, 2000-<3000cc; post 2015 large EVs) (under the Passenger Vehicle section under Table 17 and 19 of MfE Guidance).

Emissions from public transport are covered in the next section.

Emissions from all other modes of transport were considered to be de minimus.

23.2 Uncertainty and disclosures:

The following assumptions have been made in this calculation.

- That the staff travel surveys held in April 2019, April 2021 and September 2022 are representative across the whole year and provide an acceptable proxy for 2020 travel mode splits (and in the case of non-Dunedin campuses, 2019 mode splits as well).
- That the number of days per year that staff work off campus, such as conference attendance, is a de minimus factor. This may produce an over reporting error.
- Staff who selected they travelled to work as a passenger in a vehicle driven by someone who either worked or studied at the University, on the basis that the driver's emissions were already captured under staff or student commuting. If drivers with passengers tended not to fill out the survey, this may lead to a slight under reporting error.
- Low response rates from Invercargill and Auckland mean there is less certainty about commuting at these campuses, however these campuses have very small numbers of staff compared to other campuses.

23.3 Recommendations to improve reporting

Work with our workplace travel planning partners to develop a consistent travel survey and commuting emissions calculation method.

Consider more frequent travel surveys to capture seasonal differences and/or targetted surveys to get higher response rates from smaller campuses.

24 Employee Commuting - Public Transport

68% from 2019

Public Transport	2019	2020	2021	2022			
	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	tCO2	tCH4	tN2O
Distance (Km)	669,459	559,760	573,532	1,166,882			
Emission Factor	Various	Various	Various	Various	Various	Various	Various
Emissions	84.42	76.41	85.63	141.56	139.85	0.21	1.75

24.1 Category summary and calculation method:

As for private vehicles, emissions from staff commuting via public transport were calculated using staff address data and travel survey responses. Once the distance travelled on bus and train (Wellington only) was calculated using the same approach described above for private vehicles, these were multiplied by the relevant emissions factors (average bus emission factor for Dunedin, Invercargill, Christchurch and Auckland, and Wellington average bus emission factor for Wellington; average rail for train) from the Public Transport section under Table 27 of MfE guidance.

The increase in emissions from employees commuting via public transport is likely due to more commuting days in 2022 than in lockdown affected years (2020 and 2021) and higher mode share for public transport, possibly due to factors such as half-price public transport and higher fuel costs for private vehicles. Getting more staff to use public transport than private vehicles is a net emissions reduction and the University is actively working with public transport providers to ensure that services meet the needs of staff. Our hope is that many more staff can substitute some private car journeys with public transport in the coming years and thus this category may increase while net emissions trends downwards. By the same token, Dunedin has introduced electric buses on many routes and this may drive down the emissions from each trip.

24.2 Uncertainty and disclosures:

The following assumptions have been made in this calculation.

- That the staff travel surveys held in April 2019, April 2021 and September 2022 are representative across the whole year and provide an acceptable proxy for 2020 travel mode splits (and in the case of non-Dunedin campuses, 2019 mode splits as well).
- That the number of days per year that staff work off campus, such as conference attendance, is a de minimus factor. This may produce an over reporting error.
- Low response rates from Invercargill and Auckland mean there is less certainty about commuting at these campuses, however these campuses have very small numbers of staff compared to other campuses.
- The national average bus emissions factor may lead to an over reporting error in regions that have transitioned most buses to electric.

24.3 Recommendations to improve reporting

Work with our workplace travel planning partners to develop a consistent travel survey and commuting emissions calculation method.

Consider more frequent travel surveys to capture seasonal differences and/or targetted surveys to get higher response rates from smaller campuses.

Adapt reporting method as public transport system changes (eg greater electrification; potential for better data from travel cards such as Bee Card).

25 Student Commuting – Private Vehicles

5% from 2019

Private Commuting	2019	2020	2021	2022			
	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	tCO_2	CH_4 (tCO_2-e)	N_2O (tCO_2-e)
Distance Non Emitting (Km)	6,278,490	4,959,962	5,168,109	3,673,733			
Total emitting commuting distance (km)	3,646,160	2,877,558	3,360,334	7,280,305			
Internal combustion engine (ICE) vehicles							
ICE vehicle - Petrol (Km)	NA	NA	3,047,692	2,679,702			
Emission Factor	NA	NA	0.265	0.2650	0.2530	0.0030	0.0090
Emissions – Petrol (tCO_2-e)	NA	NA	**807.64**	**710.12**	**677.96**	**8.03**	**24.11**
ICE vehicle - Diesel (km)	NA	NA	178,672	527,448			
Emission Factor	NA	NA	0.270	0.270	0.266	0.0004	0.004
Emissions - Diesel	NA	NA	**48.24**	**142.41**	**140.30**	**0.21**	**2.11**
Total ICE vehicle distance (km)	NA	NA					
Emissions Factor	NA	NA					
ICE vehicle emissions	NA	NA	**869.39**	**852.53**	**818.27**	**8.25**	**26.23**
EV/Hybrids							
Hybrid Vehicles (km)	NA	NA	108,681	277,013			
Emission Factor	NA	NA	0.201	0.201	0.193	0.002	0.007
Hybrid Emissions	NA	NA	**21.84**	**55.68**	**53.46**	**0.55**	**1.94**
EV Vehicles (km)	NA	NA	25,287	104,991			
Emission Factor	NA	NA	0.026	0.026	0.025	0.001	0.000
EV Emissions	NA	NA	**0.66**	**2.73**	**2.62**	**0.10**	**0.00**
Total EV/Hybrid vehicles distance (km)	NA	NA					
Emission Factor	NA	NA					
Total EV/Hybrid Emissions	NA	NA	**22.50**	**58.41**	**56.09**	**0.66**	**1.94**
Total private vehicle emissions	**956.91**	**755.12**	**878.38**	**910.94**	**874.35**	**8.91**	**28.17**

25.1 Category summary and calculation method:

The approach for student commuting has been modeled on the previously developed method for staff commuting. The Strategy, Analysis and Reporting Office (SARO) provided for each calendar year:

- total effective full-time students enrolled as on-campus (as opposed to distance) for each of our 5 main campuses, and calculated the distance to campus
- an assessment of distance from home address to campus of study (straight-line distance; where the supplied address did not match a record in LINZ's database of New Zealand's street addresses, or the address was more than 100km from campus, these entries were excluded).

The 2021 travel survey went out to all enrolled students, with around a 10% response rate. In an effort to increase the response rate, in 2022 the travel survey questions were added to the academic experience survey that went to all students enrolled in semester 2. This significantly increased the number of responses received. After cleaning out incomplete responses to the core travel questions, we were left with 4,480 responses (23.4% response rate).

For the first time in 2022, the survey asked students how many times the commuted to campus in a typical week, as well as how far their one-way commute was (in the past, we relied on student address data and an assumption that students came to campus 6 times a week). Due to the proximity that the majority of Dunedin based students live to campus, many students responded that they commute to campus more than once a day, the majority via walking. Students who elect to drive between campus and home more than once a day was deemed a personal decision, outside the operational control of the university. As such, the number of commutes per week was capped at 6 round trips. Multiplying each respondents' number of commutes by the one-way distance and summing the results gave total average weekly commute distance. These distances were then divided amongst travel modes as responses to this question for the day the student completed the survey. Weekly commuting distance for each mode was then multiplied by the number of commuting weeks (standard year = 30 weeks, but the first six weeks of lectures in 2022 were online-only, so we have used 24 weeks) to give an annual distance. These distances were then divided by the response rate to get representative total for student population.

The distance per mode was then multiplied by the relevant emissions factors for private vehicles in the Passenger Vehicle section under Table 17 of MfE Guidance). Emissions from all other modes of transport were considered to be de minimus.

25.2 Uncertainty and disclosures:

The following assumptions have been made in this calculation.

- That students accurately responded to the survey questions. It is possible that some respondents misinterpreted questions relating to travel distance (responding with round trip distance rather than one-way, which would result in an over reporting error) or number of trips in a typical week (responding with number of round trips rather than one way trips, leading to under reporting).
- That the travel survey held in semester two 2022 accurately reflects travel mode splits throughout the academic year.
- That commuting to campus during the online-only teaching period at the start of semester one 2022 was de minimus.

25.3 Recommendations to improve reporting

Consider adjusting the travel survey to eliminate potential confusion between one-way and round-trip distance and commutes. Make all travel questions that are required for emissions calculation mandatory questions within the survey.

We are also planning to adopt a more accurate method (ArcGIS) to geocode student addresses in future.

26 Student Commuting - Public Transport

59% from 2019

Public transport	2019	2020	2021	2022			
	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	tCO_2	tCH_4	tN_2O
Distance (Km)	1,349,609	1,065,862	1,121,973	952,740			
Emission Factor	Various	Various	Various	Various	Various	Various	Various
Emissions	**186.51**	**147.31**	**165.48**	**133.97**	**132.29**	**0.13**	**1.69**

26.1 Category summary and calculation method:

As for Private Vehicles, emissions from students commuting via public transport in 2022 was based on:

a) EFTS per campus enrolled as on-campus
b) Distance from home address to campus and number of weekly commutes from 2022 travel survey responses
c) Travel mode for the day the survey was completed
d) 24 commuting weeks based on standard academic year less 6 weeks of online only teaching.

For buses, the total commuting distance was calculated by campus and the most appropriate emissions factor from the Public Transport section under Table 27 of MfE guidance was used (average bus for Dunedin, Invercargill, Christchurch and Auckland campuses, and the Wellington average bus emission factor for Wellington Campus). Only students in Wellington commuted by train, and the Wellington average rail emissions factor was used.

26.2 Uncertainty and disclosures:

The following assumptions have been made in this calculation.

- That students accurately responded to the survey questions. It is possible that some respondents misinterpreted questions relating to travel distance (responding with round trip distance rather than one-way, which would result in an over reporting error) or number of trips in a typical week (responding with number of round trips rather than one way trips, leading to under reporting).
- That the travel survey held in semester two 2022 accurately reflects travel mode splits throughout the academic year.
- That commuting to campus during the online-only teaching period at the start of semester one 2022 was de minimus.

26.3 Recommendations to improve reporting

Consider adjusting the travel survey to eliminate potential confusion between one-way and round-trip distance and commutes. Make all travel questions that are required for emissions calculation mandatory questions within the survey.

27 Student Travel – Air

↘ 18% from 2019

Student Air Travel	2019	2020	2021	2022			
	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	tCO_2	tCH_4	tN_2O
Input Units (Domestic Travel Distance) (km)	16,264,589	16,655,591	18,096,316	18,494,817			
Units of Emissions	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2	tCH_4	tN_2O
Emission Factor	0.242	0.242	0.306	0.306	0.300	0.001	0.004
Emissions (Domestic)	**3,936.03**	**4,030.65**	**5,537.47**	**5,659.41**	**5,548.45**	**18.49**	**73.98**
Input Units (Short Haul Travel) (Km)	676,159	726,451	658,305	526,620			
Emission Factor	0.160	0.153	0.151	0.151	0.150	0.00001	0.001
Emissions (Short Haul)	**108.19**	**111.15**	**99.40**	**79.52**	**78.99**	**0.01**	**0.53**
Input Units (Long Haul Travel) (Km)	33,793,714	26,173,242	17,100,943	13,850,016			
Emission Factor	0.163	0.146	0.148	0.148	0.147	0.00001	0.001
Emissions (Long Haul)	**5,508.38**	**3,821.29**	**2,530.94**	**2,049.80**	**2,035.95**	**0.14**	**13.85**
Total Distance	50,734,462	43,555,284	35,855,565	32,871,454			
Total Emissions	**9,552.59**	**7,963.09**	**8,167.82**	**7,788.74**	**7,663.39**	**18.64**	**88.36**

27.1 Category summary and calculation method:

The Strategy, Analysis and Reporting Office sourced data for students classed as active enrollments (not final exam only) for the given academic year. Distance students were excluded.

Domestically located students are assumed to fly if the flying (great circle) distance is over 300 km return. For domestic students we have included the distance of one return journey between the airport nearest their home address and teaching campus per annum, reflecting getting to campus to study and then home again at the end of the academic year. Any flights taken between the beginning and end of the year are outside of the University's operational control and therefore considered out of scope.

All international flights are assumed to travel to Auckland, from which we assume there is an AKL transit flight to take international students to the teaching campus. For international points of departure, the nearest international airport was selected as actual points of departure could not be ascertained.

Students are assumed to fly one journey between home address and teaching campus (or vice versa) per annum. This reflects that many students will not return home every year (even before considering the impact of border restrictions from COVID-19).

This total distance for each class of air travel was then multiplied by the appropriate emissions factor from the Domestic and International Air Travel sections under Table 39 and Table 48 of the MfE 2022 Guideline to calculate total emissions.

The 2021 calculations reflected reduced international student numbers due to the COVID-19 pandemic resulting in fewer international flights, which was partially offset by strong domestic enrollments from around New Zealand. We were still seeing the effects of this in 2022, with emissions reducing by a further 18% from 2019 and 5% from 2021. It is likely that emissions will increase in 2023 with international students returning to campus once again.

27.2 Uncertainty and disclosures:

As stated above, the actual flights taken by students are unknown.

The following assumptions have been made in calculating these emissions:

- That domestic students living more than 150km (great circle) from their study campus fly to and from their nearest airport and teaching campus every year. This may overstate the number of domestic students flying at the beginning and end of the year (eg when driving may be preferred due to the need to transport belongings). Sensitivity analysis undertaken as part of the 2020 report indicates increasing the distance between home address and campus to 300km would only reduce emissions by 4%.
- That international students fly the equivalent of a one-way trip from their home country to teaching campus. In years like 2020, 2021, and 2022 with significant border restrictions and Managed Isolation and Quarantine requirements, this is likely to overstate the total number of journeys. As travel restrictions ease, this may understate the number of journeys. Sensitivity analysis in the 2020 report suggested if every international student flew a return trip home annually, emissions could be 56% higher. If only 10% of international students flew annually, but took return flights, this would result in 45% lower emissions from this category.
- We do not currently have data on what class international students fly. We assume that they fly economy class. Any flights above economy class would result in an under reporting error.
- We have excluded self-booked air travel undertaken by students during the year that may be required to fulfil aspects of their course (travel booked through the University's travel agents is captured under business air travel) as we do not currently have data on these flights. We intend to improve data on this form of travel and report on "self-funded course-related student travel" in the future.

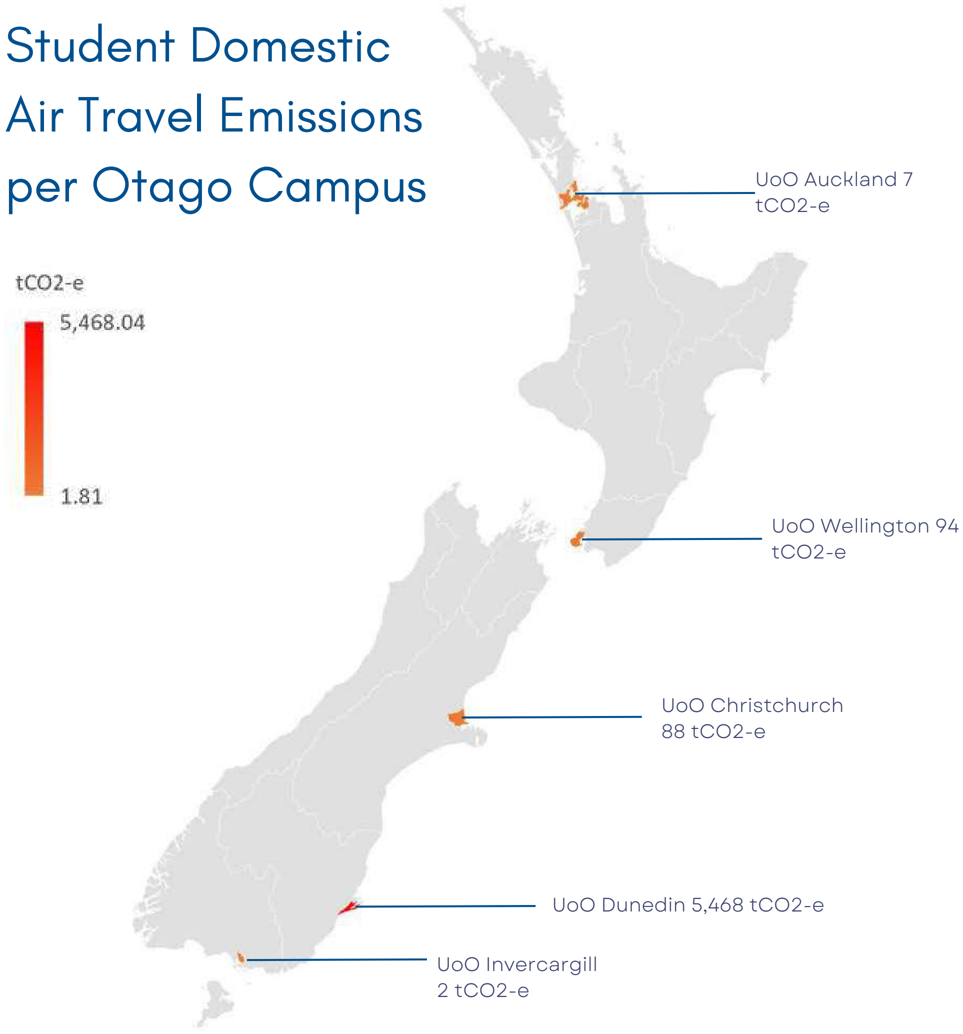
Based on the above, the University feels it is taking a conservative approach to reporting the student air travel emissions that fall within its scope of operational control. Steps being taken by the University to reduce domestic air travel emissions, such as advocating for more interregional passenger rail, would also have an impact on student flying considered out of scope of this inventory.

27.3 Recommendations to improve reporting

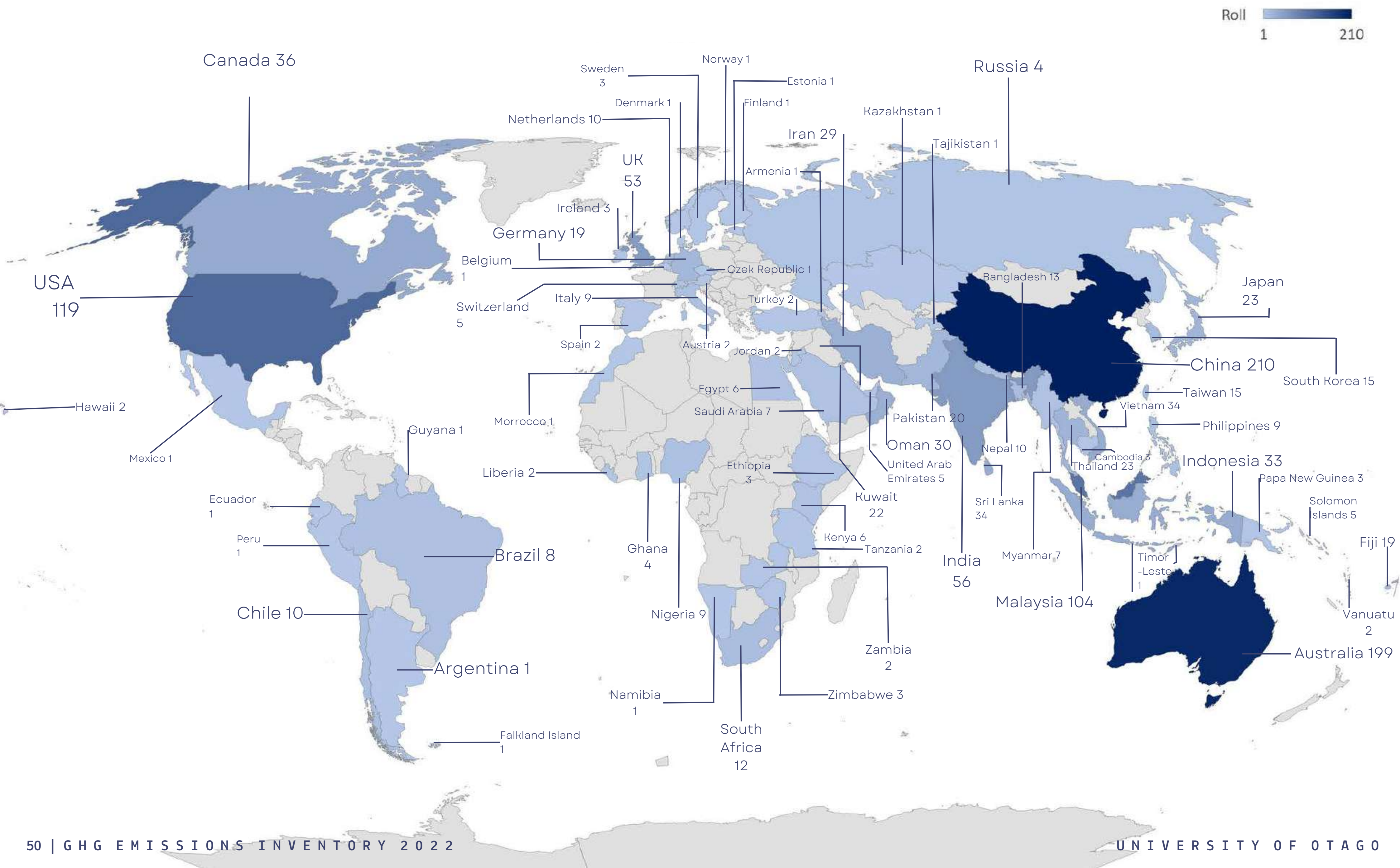
In 2023, the University and Otago University Students Association will continue to work together to better understand student flying behaviour and identify options to improve data collection, reduce emissions and offset emissions when flying is necessary.

Work with departments that require students to self-fund travel (e.g. contact courses for distance students; electives for medical students) to include flights taken in this category.

Student Domestic Air Travel Emissions per Otago Campus



Roll and Where our International Students Flew from in 2022



28 Working from Home

92% from 2019

Working from Home	2019	2020	2021	2022			
	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	tCO2	tCH4	tN2O
Input units (Employee WFH per day)	45,683	199,111	162,377	87,636			
Emission Factor	0.446	0.446	0.446	0.446	0.429	0.0170	0.00061
Total Emissions	**20.37**	**88.80**	**72.42**	**39.09**	**2.95**	**0.21**	**0.00**

28.1 Category summary and calculation method:

Before 2021, the University of Otago had not previously included Working from Home (WFH) as a category in its greenhouse gas emissions reporting. When introducing this category in our 2021 report, we did not have staff survey data on working from home, so used assumptions, tested with department heads and Human Relations, to estimate the number of working from home days for each campus for 2019, 2020 and 2021.

In 2022, we included questions about working from home in our travel survey, including whether they worked from home on the day of the survey and how often they worked from home on a typical week. The typical week data was used for working from home emissions calculations. Due to the earthquake resilience issues at the Wellington campus from 2021, the working from home rate is significantly higher for this cohort (21.8% of working days spent working from home, compared to 8%-11% for other campuses). As such, we have used campus-based working from home rates, multiplied by 220 working days (the amount of working days in a standard year), multiplied by FTE at each campus to give total number of days worked from home in 2022.

The total number of WFH days was then multiplied this by the MFE default WFH emissions factor under Table 14 of the MfE 2022 Guideline to calculate emissions for 2022.

The significant reduction in working from home emissions from 2021 to 2022 reflects the lack of nationwide lockdowns in 2022. It was, however, twice as high as pre-pandemic, reflecting the general increase in, and acceptance of, employees working from home in certain roles.

A high level analysis of the average commuting emissions per staff FTE shows for all of our campuses this figure is higher than the default working from home emissions factor of 0.446 kg CO2-e per day (or the with heating factor of 0.908 kg CO2-e). This means that more working from home is likely to reduce our overall GHG emissions. However, given the importance of in-person delivery and outstanding campus experiences, further promotion of working from home as an emissions reductions measure would need to consider negative impacts on other key strategic objectives. In 2022 the University consulted on a draft working from home policy that sought to factor in all relevant considerations. Once this policy has been finalised, there may be additional data sources we can access (such as a report on the number of formalised working from home arrangements in place) to inform GHG reporting.

We deducted the WFH days from staff commuting calculations to avoid double counting.

28.2 Uncertainty and disclosures:

Whilst we have improved out data collection method in 2022, survey responses may be less reliable that other sources of data on the number of staff working from home. However, at present our HR and IT systems are not set up to support this kind of reporting.

- While some teams have formalised working from home arrangements with staff (for example, employee to work from home on two specified days per week), others do not. Those agreements that do exist are not held centrally. Therefore, it is difficult to collate this information.
- Staff working from home may use a variety of ways to connect and access documents (VPN, One Drive, SharePoint), and it is difficult to distinguish from staff working on campus using the same tools. The nature of some work may mean that network usage is an insufficient indicator of where and when staff are working (for example, academic staff may undertake reading, writing and marking tasks "offline"; many operational staff are not office based).

28.3 Recommendations to improve reporting

To gain a more accurate data pool on WFH numbers to calculate the emissions for 2023, and potentially simplify the process, we will monitor the implementation of new working from home policy and utilise more detailed reporting if available.

Category 4

29 Transmission & Distribution Losses – Electricity

0.2% from 2019

Electricity	2019	2020	2021	2022			
	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	tCO_2	CH_4 (tCO_2-e)	N_2O (tCO_2-e)
Input Units (kWh)	45,193,469	53,729,383	51,769,270	48,988,107			
Emissions Factor (kg/kWh)	0.0119	0.0110	0.0110	0.0110	0.0107	0.0003	0.000021
Total Emissions	**537.80**	**591.02**	**569.46**	**538.87**	**524.17**	**14.70**	**1.03**

29.1 Category summary and calculation method:

Emissions due to losses in transmission and distribution of electricity are calculated based on the total kWh of electricity consumed. The Emission factors used are from the Transmission and distribution losses for electricity section under Table 12 of MfE Guideline.

Emissions have remained relatively stable from our base year of 2019, with only a small increase of 0.2%.

29.2 Uncertainty and disclosures:

There is a high level of confidence in this data due to the source being actual consumption data and checked routinely through the processing of invoices for payment.

29.3 Recommendations to improve reporting

As stated in section 16.1.3

30 Steam and MTHW losses - Coal and Biomass

88% Coal from 2019
14% Biomass from 2019

Coal & Biomass	2019	2020	2021	2022			
	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	CO2 (tCO2-e)	CH4 (tCO2-e)	N2O (tCO2-e)
Total Consumption Coal (kWh)	17,681,864	3,634,490	2,456,410	2,246,460			
Total Comsumption - Biomass (kWh)	17,486,769	26,989,325	29,713,741	29,579,609			
Input Units – emissions from coal consumption (tCO2-e)	6,176.28	1,225.77	786.54	719.32	715.09	0.20	4.02
Input Units – emissions from biomass consumption (tCO2-e)	273.32	416.99	449.57	311.47	NA	NA	NA
Emission Factor	5% of calculated emissions from consumption	5% of calculated emissions from consumption	5% of calculated emissions from consumption	5% of calculated emissions from consumption	5% of calculated emissions from consumption	5% of calculated emissions from consumption	5% of calculated emissions from consumption
Emissions Coal	308.81	61.29	39.33	35.97	35.75	0.01	0.20
Emissions Biomass	13.67	20.85	22.48	15.57	NA	NA	NA
Total emissions	**322.48**	**82.14**	**61.81**	**51.54**	**35.75**	**0.01**	**0.20**

30.1 Category summary and calculation method:

Emissions due to losses in distribution of MTHW and Steam are calculated based on the total kWh of energy supplied. 5% losses were used based on DEFRA guidelines for transmission and distribution. As per Steam and MTHW emissions in Category 2, coal losses emissions have decreased substantially due to the conversion of coal boilers to biomass that support our campuses. Biomass losses emissions have also decreased, as per Biomass emissions in the Steam and MTHW section under Category 2. This is due to DEFRA updating and lowering the emission factor for Biomass in 2022.

30.2 Uncertainty and disclosures:

There is a high level of confidence in this data due to the source being actual consumption data and checked routinely through the processing of invoices for payment.

However, the accuracy would be improved if the actual % loss was known for the local systems.

It should be noted that carbon dioxide emitted from the combustion of wood fuel is biogenic and treated as carbon neutral and out of scope. However, the combustion of biofuels generates anthropogenic methane and nitrous oxide. DEFRA emission factors only provide the total tCO2e, but not a breakdown of the other GHGs. Therefore, only the total emissions (t-CO2- e) has been reported in the inventory.

30.3 Recommendations to improve reporting

Establish sufficient metering to measure actual losses.

31 Steam and MTHW – Natural Gas transmission and distribution losses

↘ 64% from 2019

Natural Gas	2019	2020	2021	2022			
	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	tCO2* (Out of scope)	CH4 (tCO2-e)	N2O (tCO2-e)
Input Units – Natural Gas(kWh)	1,536,620	1,003,060	999,444	546,944			
Emission Factor (kgCO2-e/kWh)	0.012	0.012	0.012	0.012	NA	0.012	NA
Total Emissions	**18.44**	**12.04**	**11.99**	**6.56**	-	**6.56**	-

31.1 Category summary and calculation method:

Emissions due to losses in distribution of MTHW and Steam from Natural Gas heated system in Wellington are calculated based on the total kWh of energy supplied. MFE provides a transmission and distribution losses emissions factor for natural gas. Notably, this reduced by almost half from its 2019 guidance (0.0228 tCO2-e/KWh, based on 2016 data) and 2020 (0.012 based on 2018 data). As such, we have elected to use the figure from 2022 guidance in the Transmission and distribution losses for reticulated gases section under Table 6 of the MfE Guide as it most closely relates to the time periods we are measuring. In 2022 we have seen a reduction of 64%, due to the Wellington School of Medicine main building remaining largely vacant due to low earthquake rating.

31.2 Uncertainty and disclosures:

There is a reasonable level of confidence in this data due to the source being invoices from the Capital and Coast DHB based on actual consumption data and checked routinely through the processing of invoices for payment.

However, the accuracy would be improved if the actual % loss was known for the local system

31.3 Recommendations to improve reporting

Discuss with CCDHB if they intend to install metering to measure actual losses.

32 Purchased Goods and Services- Water

19% from 2019

Water	2019	2020	2021	2022			
	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	tCO_2	tCH_4	tN_2O
Input Units m3	268,780	338,124	455,941	320,983			
Emission Factor ($kgCO_2$-e/m3)	0.031	0.031	0.031	0.031	0.03	0.0014	0.00003
Total Emissions	**8.41**	**10.48**	**14.13**	**9.95**	**9.63**	**0.44938**	**0.00963**

32.1 Category summary and calculation method:

The emissions resulting from the supply of water were calculated based on a report from the local authority summarising the volume of water included in all invoices for the calendar year. The units were 1,000 litres, which is the same as 1 m3. The emissions factors in the Water supply and wastewater treatment section under Table 72 of MfE Guidance were used.

This data includes Dunedin campus, the Wellington campus, and Invercargill.

Water usage in Dunedin in 2021 was abnormally high and efforts have been made to reduce the instances of leaks and water wastage. Usage returned to a more expected level in 2022, thus the reduction in emissions from 2021.

32.2 Uncertainty and disclosures:

There is a high level of confidence in this data due to the source being actual consumption data and checked routinely through the processing of invoices for payment.

Water from St Margaret's Residential College was included in the initial data report. This has been excluded as it is not a University owned facility and as such is out of scope of this report.

Data was not available for Christchurch and Auckland, however these amounts are considered de minimis.

32.3 Recommendations to improve reporting

That the water usage invoices be captured in an automatic reporting system

33 Purchased Goods and Services - Food

13% from 2021

Food (new method)	2019	2020	2021	2022			
	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	tCO_2	tCH_4	tN_2O
Input Units (Total kg)	NA	NA	1,042,608	1,037,350			
Emission Factor	Various	Various	Various	Various	NA	NA	NA
Emissions	**4,575.20**	**4,503.80**	**4,969.05**	**5,622.33**	**NA**	**NA**	**NA**

33.1 Category summary and calculation method:

Prior to the 2021 reporting year, the University did not have ingredient level data, so used a per person calculation for residential colleges and a cost-based calculation for campus outlets. The method was updated for 2021 when we gained access to a full breakdown of ingredients purchased (weight in kilograms) by the colleges and the central production kitchen that supplies Dunedin outlets.

Using the 'Healthy and Climate-Friendly Eating Patterns in the New Zealand' database developed by Drew (2020) and updated by researchers at Auckland University, the appropriate emission factors were manually allocated to each ingredient for both the College Catering ingredient list, and the Union Central Production Kitchen list.

Colour codes were appointed to each allocated ingredient emission factor to signify our degree of confidence, green being a good match, orange representing the fact that the emission factor was imperfect, and red which signified that the emission factor was unknown, and that a placeholder emission factor (average emissions factor for all "green" ingredients) was allocated. The kilograms of each ingredient were then multiplied by the relevant emissions factor and summed to get total emissions from purchased food.

Now that we have more accurate measure of emissions, we can show the impact of different choices at the different stages (menu design, ingredient ordering, and food choice by diners). This allows us to support residential colleges and campus food outlets in becoming knowledgeable in food emissions to further support sustainable and mindful decision-making when ordering and designing menus. Having an emission factor per ingredient also allows us to potentially trial food labelling with emissions per serve information and other awareness raising actions. Additionally, there is a lot of potential in this space for post-graduate research in applied settings.

There has been an increase in emissions by 13% from 2021, which was driven by higher meat purchases in 2022, due to colleges moving to a self-serve model for protein. The University has reverted back to a staff serving model in 2023.

33.2 Uncertainty and disclosures:

We recognise that we are unable to obtain the emission factors for all ingredients, and therefore a placeholder emissions factor was used. We understand that these placeholder emissions may not always be accurate, but using a placeholder allows us to include these emissions, rather than avoiding them. It should be noted that less than 3% of ingredients by weight were not coded as having a good emissions factor match.

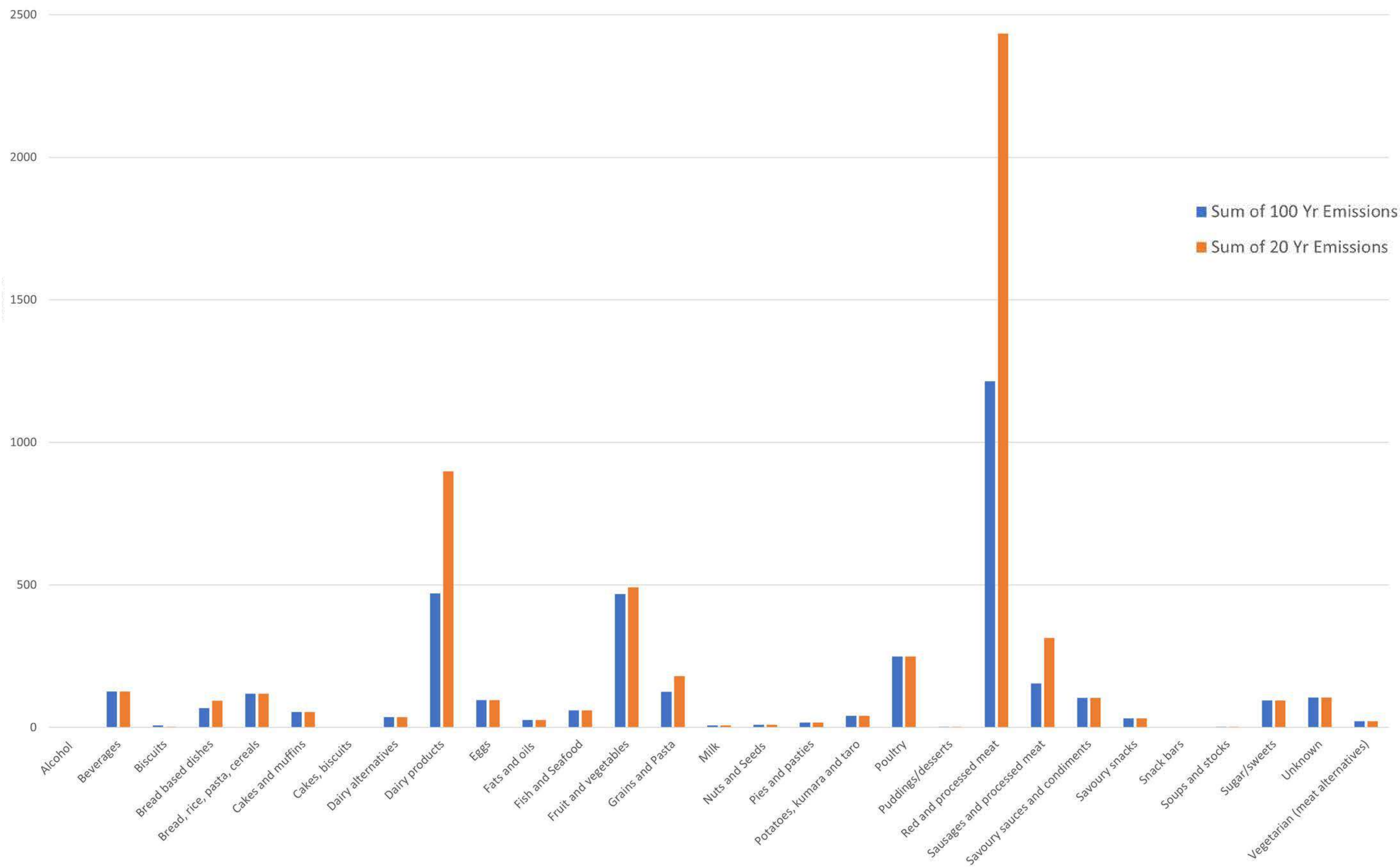
Some of the emissions factors are older than others. Some better reflect the regions from which we source our ingredients than others. Tracking food emissions is an emerging field and we will continue to advocate for more timely and accurate emissions factors to support our work.

33.3 Recommendations to improve reporting

We all acknowledge this is a multi-year transition, starting with reasonably coarse-grained emissions factors and then refining factors and measurement as and when supported by research.

We have also advocated for MfE to include food emissions factors in its guidance document and offered to support them in this mahi.

2022 Purchased Food Emission (tCO2-e) Summary



34 Waste from Operations- Waste to Landfill

↘ 52% from 2019

Waste to landfill	2019	2020	2021	2022			
	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	tCO_2	tCH_4	tN_2O
Input Units (Kg)	1,908,458	1,617,632	1,669,000	1,645,296			
Emission Factor	1.17	1.17	0.647	0.647			
Total Emissions	**2,232.90**	**1,892.63**	**1,079.84**	**1,064.51**	NA	NA	NA

34.1 Category summary and calculation method:

The data relating to waste to landfill is sourced from the Waste Management Environmental report.

The data for the report is collected from actual weights picked up on site. The emissions factors in the Materials and waste section under Table 81 of MfE Guidance (2022) were used for general waste for which the composition was not known (landfill without gas recovery).

It should be noted this emissions factor reduced considerably from the MfE's previous guideline, which explains why a reduction in waste to landfill by weight of 14% from our base year is a 52% reduction in emissions terms.

34.2 Uncertainty and disclosures:

There is a high level of confidence in the data as it relates directly to actual weights of material collected.

34.3 Recommendations to improve reporting

That the waste data is captured in an automatic and live report with other emission sources

35 Waste from Operations - Recycling and other

↘ 12% from 2019

Recycling and other	2019	2020	2021	2022			
	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	Total Emissions (tCO2-e)	tCO2	tCH4	tN2O
Input Units (Kg)	273,995	323,541	366,067	333,900			
Emission Factor	Various	Various	Various	Various			
Total Emissions	**6.76**	**6.30**	**7.11**	**5.98**	NA	NA	NA

35.1 Category summary and calculation method:

The data relating to recycling and other waste streams is sourced from the Waste Management Environmental report. This data for the report is collected from actual weights picked up on site. The relevant emission factor from DEFRA guidelines are applied to each recycling type.

35.2 Uncertainty and disclosures:

There is a high level of confidence in the data relating to glass and paper/cardboard. These relate directly to actual weights of material collected.

It is known that some organic waste from campus gardens such as clippings and grass cuttings is directed to a compost site owned by the University and then brought back to campus as compost. No data is available for this waste.

There is a high level of confidence in the total quantity of mixed recyclable waste. However, the division of this mixed waste into categories (Glass, Plastic and Cans) is based on an estimate of the normal composition of mixed waste at the sorting plant. This does not necessarily relate directly to the composition of waste on campus. Indeed, there may be significant differences throughout the University. For example, the composition of mixed recycling in residential colleges is likely to differ from the composition in teaching spaces.

35.3 Recommendations to improve reporting

To establish a system to account for the waste going to the University-owned composting facility.

To conduct waste audits on campus to establish the composition of mixed recycling at a more local level. This is likely to be done in collaboration with students as a research project.

36 Waste from Operations – Wastewater treatment

25% from 2019

Wastewater treatment	2019	2020	2021	2022			
	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	Total Emissions (tCO_2-e)	tCO_2	tCH_4	tN_2O
Input Units m3	268,780	338,124	455,941	320,983			
Emission Factor	0.457	0.457	0.480	0.48	0.077	0.167	0.235
Total Emissions	**120.15**	**154.52**	**218.85**	**154.07**	**24.72**	**53.60**	**75.43**

36.1 Category summary and calculation method:

The emissions resulting from the treatment of wastewater were calculated based on reports from local authorities summarising the volume of water included in all invoices for the year. The units were 1,000 litres, which is the same as m3. The emissions factors in the Water supply and wastewater treatment section under Table 73 of MfE Guidance were used.

This data includes Dunedin campus, the Wellington campus, and Invercargill.

Water usage in Dunedin in 2021 was abnormally high and efforts have been made to reduce the instances of leaks and water wastage. Usage returned to a more expected level in 2022, thus the reduction in emissions from 2021.

36.2 Uncertainty and disclosures:

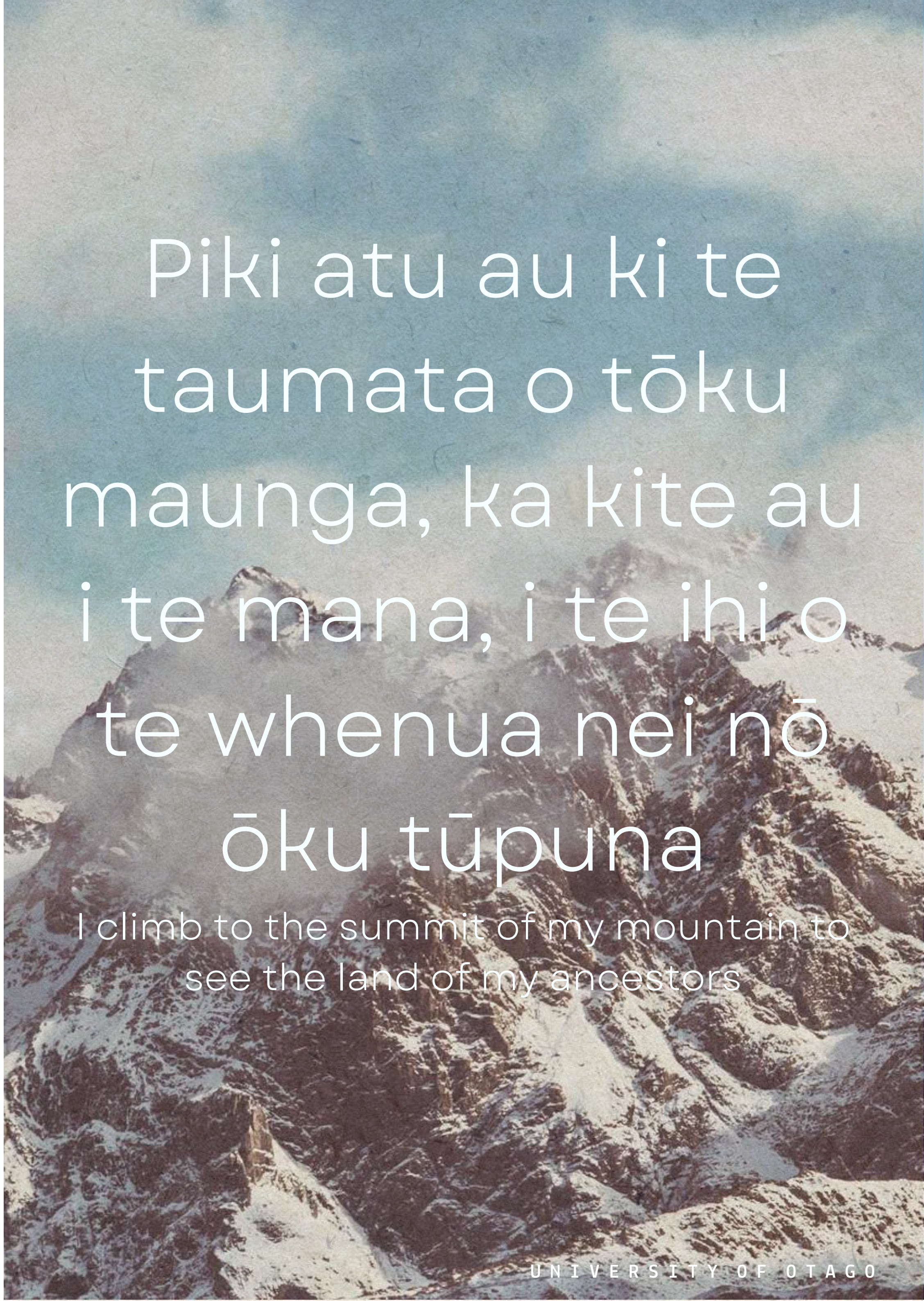
There is a high level of confidence in this data due to the source being based on actual consumption data and checked routinely through the processing of invoices for payment.

Water from St Margaret’s Residential College was included in the initial data report. This has been excluded as it is not a University owned facility and as such is out of scope of this report.

Data was not available for Christchurch and Auckland, however these amounts are considered de minimis.

36.3 Recommendations to improve reporting

That the water usage invoices be captured in an automatic reporting system



Piki atu au ki te taumata o tōku maunga, ka kite au i te mana, i te ihi o te whenua nei nō ōku tūpuna

I climb to the summit of my mountain to see the land of my ancestors

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