Prepared for
Wellington City Council
Co No.: N/A

AECOM

Wellington City Community Carbon Footprint

02-Dec-2022

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Wellington City Community Carbon Footprint

Client: Wellington City Council

Co No.: N/A

Prepared by

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02-Dec-2022

Job No.: 60687627

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Quality Information

Document	Wellington City Community Carbon Footprint
Ref	60687627
Date	02-Dec-2022
Originator	Adam Swithinbank
Checker/s	Suzanne Lowe
Verifier/s	Anthony Hume

Revision History

Rev	Revision Date	Details	Approved	
			Name/Position	Signature
1	FINAL	02/12/2022	Anthony Hume Associate Director - Practice Leader Sustainability & Resilience	

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Executive Summary

Greenhouse Gas (GHG) emissions for the Wellington City Territorial Area (which is covered by the Wellington City Council) have been measured using the production-based Global Protocol for Community-Scale Greenhouse Gas Emissions Inventory (GPC) methodology. This approach includes emissions from Stationary Energy, Transport, Waste, Industrial Processes and Product Use (IPPU), Agriculture and Forestry sectors. This document reports greenhouse gas emissions produced in or resulting from activity or consumption within the geographic boundaries of the Wellington City Territorial Area for 2019/20, 2021/22, and 2021/22 financial reporting years.

The Wellington City Territorial Area is referred to hereafter as Wellington for ease. Greenhouse gas emissions are generally reported in this document in Carbon Dioxide Equivalent (CO2e) units and are referred to as 'emissions'.

Major findings of the project include:

2021/22 Emissions Footprint

- In the 2021/22 financial year (1st July 2021 to 30th June 2022), **total gross emissions** in Wellington were 853,513 tCO_2e.
- **Transport** (e.g., emissions from road and air travel) is the largest emitting sector in Wellington, representing 45% of total gross emissions, with on-road petrol and diesel consumption accounting for 31% of Wellington's total gross emissions.
- **Stationary Energy** (e.g., emissions relating to electricity and natural gas consumption) is the second-highest emitting sector in the region, producing 37% of total gross emissions.
- **Waste** (e.g., landfill and wastewater treatment emissions) produced 9% of Wellington's total gross emissions. **Industrial Processes and Product Use** (IPPU) and **Agriculture** represented 7% and 2% of Wellington's total gross emissions.
- Net **Forestry** emissions were -79,908 tCO_2e in 2021/22 as carbon sequestration (carbon captured and stored in plants or soil by forests) was greater than emissions from forest harvesting (e.g., the release of carbon from timber, roots, and organic matter following harvesting). Net Forestry emissions are not included in total gross emissions but in total net emissions.
- The **total net emissions** in Wellington were 773,605 tCO_2e. The total net emissions include emissions and sequestration from forestry.

Changes in Emissions, 2019/20 to 2021/22

- Between 2019/20 and 2021/22, **total gross emissions** in Wellington decreased from 939,309 tCO_2e to 853,513 tCO_2e, a decrease of 9% (85,796 tCO_2e).
- Over this time, the population of the city remained at a similar level (decreasing by 0.2%), resulting in **per capita gross emissions** in Wellington reducing by 9% between 2019/20 and 2021/22 (from 4.4 to 4.0 tCO_2e per person per year), in line with the decrease in total gross emissions.
- Emissions from **Transport** decreased by 13% between 2019/20 and 2021/22 (58,495 tCO_2e), driven by a reduction in air travel emissions and on-road petrol and diesel consumption.
- Emissions from **Stationary Energy** decreased by 6% between 2019/20 and 2021/22 (19,473 tCO_2e), driven by a 13% decrease in electricity consumption emissions due to decreased use of fossil fuel electricity generation in the national grid.
- Emissions from **Waste** decreased by 8% between 2019/20 and 2021/22 (5,943 tCO_2e), driven by a reduction in annual emissions from closed landfill sites.
- **Net Forestry** sequestration increased by 15,884 tCO_2e between 2019/20 and 2021/22, from -64,021 tCO_2e to -79,908 tCO_2e. While sequestration from native and exotic forestry remained stable, emissions related to harvesting decreased by 74%.

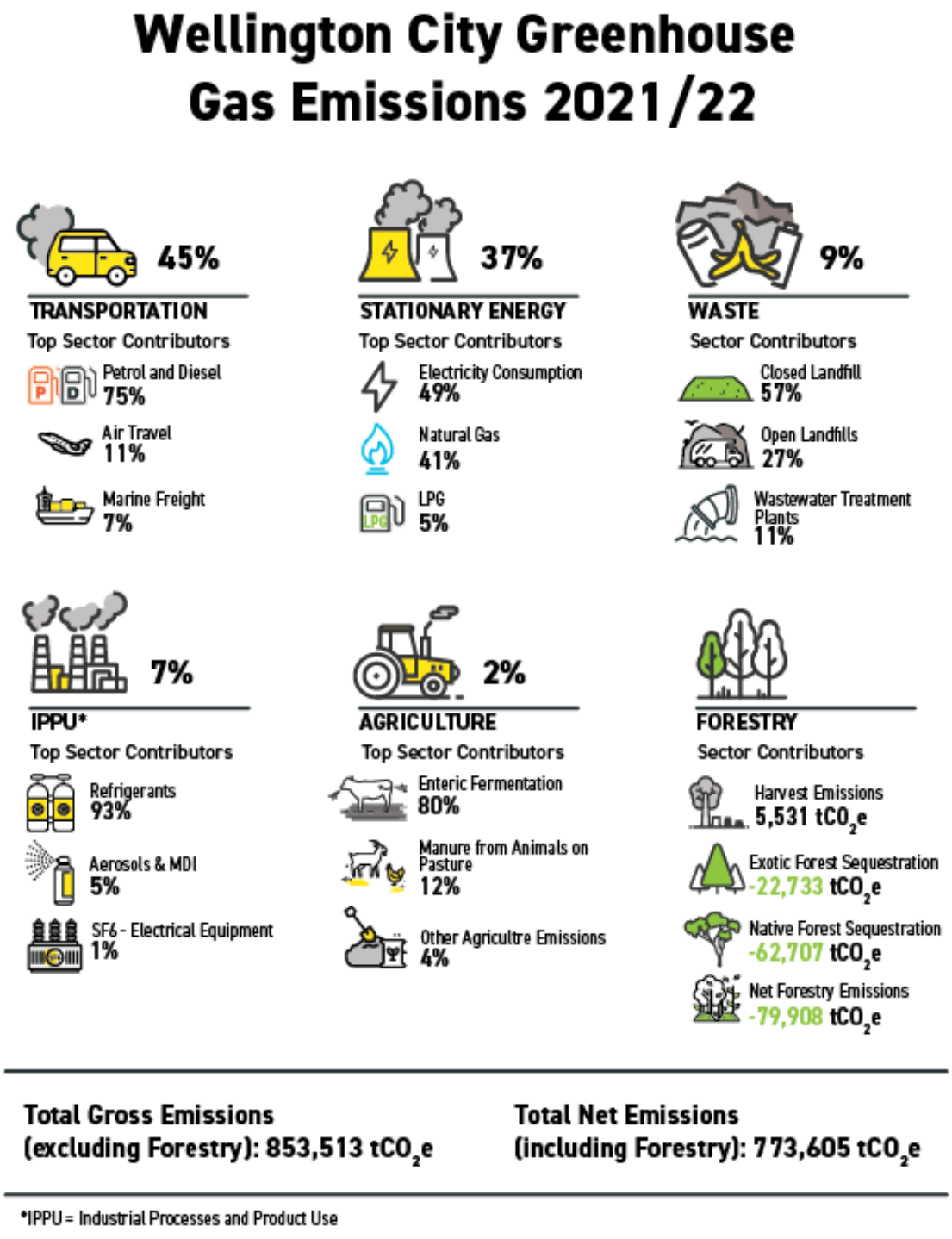

Figure 1: Wellington City 2021/22 Community Carbon Footprint Emissions Inventory

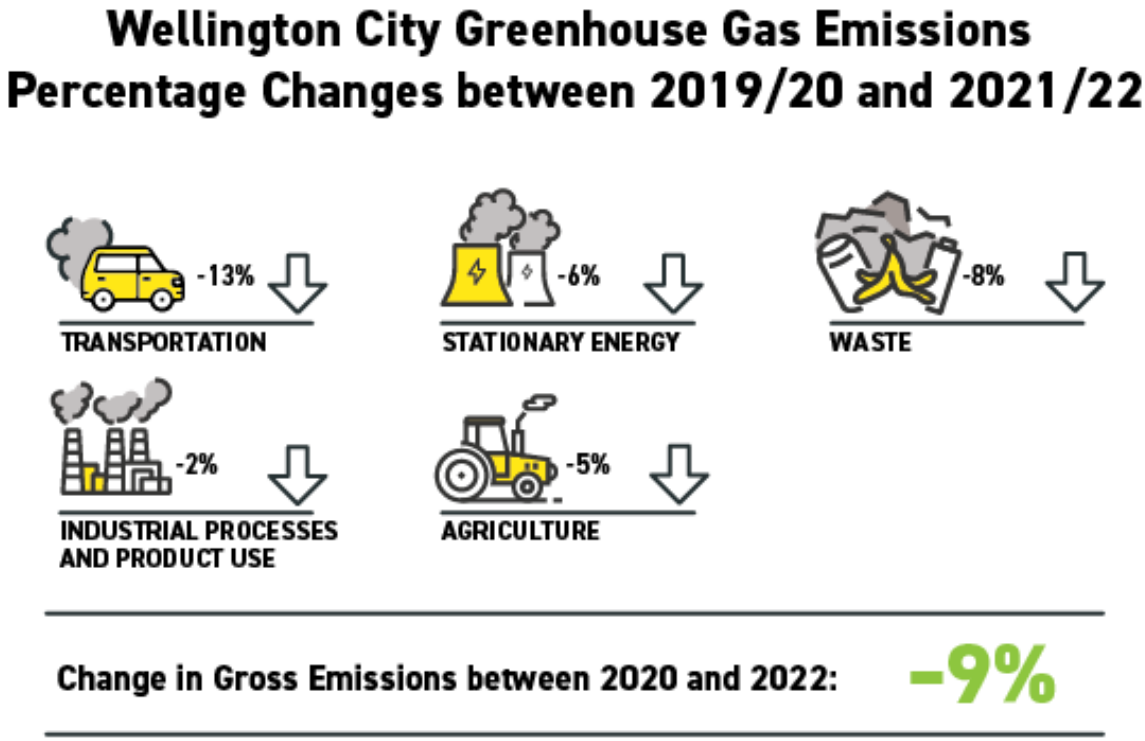

Figure 2: Change in Wellington City's Community Carbon Footprint Emissions Inventory between 2019/20 and 2021/22

1.0 Introduction

Wellington City Council commissioned AECOM New Zealand Limited (AECOM) to assist in developing a production-based community-scale greenhouse gas (GHG) footprint for the Wellington City Territorial Area for 2020/21 and 2021/22 financial years. As part of this work, AECOM recalculated emissions for the 2019/20 financial year, previously calculated by AECOM, using current best-practice methods, updated data, and additional emission sources to enable direct comparison to the other reported years. Emissions are reported from 1st July to 30th June for the respective years. The study boundary incorporates the jurisdiction of the Wellington City Council.

This inventory is part of Wellington City Council's Te Atakura - First to Zero climate action plan[1] regarding measuring the city's emissions and tracking progress towards the city's 2050 net-zero target. The 2019/20 inventory presented here will act as Wellington City's baseline year against which to track this progress.

The Wellington City Territorial Area is referred to hereafter as Wellington for ease. Greenhouse gas emissions are generally reported in this document in Carbon Dioxide Equivalent (CO_2e) units and are referred to as 'emissions'.

2.0 Approach and Limitations

The methodological approach used to calculate emissions follows the Global Protocol for Community-Scale Greenhouse Gas Emissions Inventory v1.1 (GPC) published by the World Resources Institute (WRI) 2021. The GPC includes emissions from Stationary Energy, Transport, Waste, Industrial Processes and Product Use (IPPU), Agriculture, and Forestry activities within the city's boundary. The sector calculations for Agriculture, Forestry and Waste, are based on Intergovernmental Panel on Climate Change (IPCC) workbooks and guidance for emissions measurement. The sector calculators also use methods consistent with GHG Protocol standards published by the WRI for emissions measurement when needed.

The same methods have been used for other community-scale GHG footprints around New Zealand (e.g., the Bay of Plenty region, Hawke's Bay region, Auckland, Christchurch, Dunedin, and the Waikato region) and internationally. The GPC methodology[2] represents international best practice for the city and regional GHG emissions reporting.

This emissions footprint assesses both direct and indirect emissions sources. Direct emissions are production-based and occur within the geographic area (Scope 1 in the GPC reporting framework). Indirect emissions are produced outside the geographic boundary (Scope 2 and 3) but are allocated to the consumption location. An example of indirect emissions is those associated with electricity consumption, which is supplied by the national grid (Scope 2). All other indirect emissions, such as cross-boundary travel (e.g., flights) and energy transportation and distribution losses, fit into Scope 3.

All major assumptions made during data collection and analysis have been detailed within **Appendix A – Assumptions**. The following aspects are worth noting in reviewing the emissions footprint:

- Emissions are expressed on a carbon dioxide-equivalent basis (CO_2e) including climate change feedback using the 100-year Global Warming Potential (GWP) values[3]. Climate change feedbacks are the climate change impacts from GHGs that are increased as the climate changes. For example, once the Earth begins to warm, it triggers other processes on the surface and in the atmosphere. Current climate change feedback guidance is essential to estimate the long-term impacts of GHGs.
- GPC reporting is predominately production-based (as opposed to consumption-based) but includes indirect emissions from energy consumption. Policymakers generally prefer production-based emissions reporting due to robust, established methods such as the GPC, which enables comparisons between different studies. Production-based approaches exclude globally produced

[1] https://wellington.govt.nz/climate-change-sustainability-environment/climate-change/what-were-doing-about-climate-change/te-atakura-first-to-zero-climate-action-plan
[2] http://www.ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities
[3] https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf (Table 8.7)

emissions relating to consumption (e.g., embodied emissions relating to products produced elsewhere but consumed within the geographic area, such as imported food products, cars, phones, clothes etc.).

- Total emissions are reported as both gross emissions (excluding Forestry harvesting and sequestration) and net emissions (including Forestry harvesting and sequestration)).
- Emissions for individual leading greenhouse gases for each emissions source are provided in the supplementary spreadsheet information supplied with this report.
- Where location-specific data was not accessible, information was calculated based on national or regional data.
- Transport emissions:
  - Transport emissions associated with air travel, rail, and marine fuel were calculated by working out the emissions relating to each journey arriving or departing the area based on data provided by the relevant operators. Emissions for these sources are then split equally between the destination and origin. Emissions relating to a particular point source (e.g., an airport or port) are allocated to the expected users of that source, not just the area it is located in. For example, in the Wellington Region, the Wellington Airport is treated as a regional airport where it is expected that all territorial authorities will use Wellington Airport for air travel. Therefore, emissions from this source have been allocated to all regional territorial authorities based on population. This is also applicable to marine freight and inter-island marine journeys.
  - All other transport emissions are calculated based on the fuel sold or consumed in the area (e.g., petrol, diesel, LPG).
- Solid waste emissions:
  - Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day, as per the GPC reporting requirements. This method accounts for the gradual release of emissions from waste over a long period of time, and so calculates the emissions produced per year from waste in landfill (including emissions from closed landfill sites). This approach differs from that used by WCC for their organisational footprint which includes WCC-owned landfill sites[4]. The WCC organisational footprint method calculates the likely future emissions from the waste entering landfill that year, and attributes those emissions to that year (and doesn't include emissions from waste already in landfill).
  - Emissions are calculated for waste produced within the geographic boundary, even if transported outside the boundary to be entered into a landfill. Landfill waste for Wellington is disposed of at Southern Landfill located within Wellington and Spicer Landfill located in Porirua.
  - Emissions relating to the combustion of landfill gas used for energy generation have been included in the Stationary Energy sector results.
- Wastewater emissions:
  - Wastewater treatment plant emissions have been calculated following WaterNZ (2021) guidance by an external party, these results have been used for consistency with internal reporting at Wellington City Council. AECOM has checked the results against our own calculations.
  - Wastewater emissions include those released directly from wastewater treatment, flaring of captured gas and discharge onto land/water. Emissions relating to biosolid waste from wastewater treatment sent to landfill have been included in the solid waste emissions source category.

[4] https://wellington.govt.nz/climate-change-sustainability-environment/climate-change/what-were-doing-about-climate-change/our-climate-action-areas/action-area-wellington-city-council

  - Wastewater emissions from populations not connected to centralised wastewater treatment plants have been estimated by assuming that these populations use septic tank systems.

- Industrial Processes and Product Use (IPPU) emissions:
  - IPPU emissions have been estimated based on data provided in the New Zealand Greenhouse Gas Emissions 1990-2020 report (MfE 2022). Emissions are calculated per capita, applying a national average per person.
- Forestry emissions:
  - This emissions footprint accounts for forest carbon stock changes from afforestation, reforestation, deforestation, and forest management (i.e., it applies land-use accounting conventions under the United Nations Framework Convention on Climate Change rather than the Kyoto Protocol). It treats emissions from harvesting and deforestation as instantaneous rather than accounting for the longer-term emission flows associated with harvested wood products.
  - The emissions footprint considers regenerating (growing) forest areas only. The capture of carbon from the atmosphere is negligible for mature forests that have reached a steady state.

Overall sector data and results for the emissions footprint have been provided to Wellington City Council in calculation table spreadsheets. All assumptions made during data collection and analysis have been detailed within **Appendix A – Assumptions**.

It is essential to consider the uncertainty associated with the results, particularly given the different datasets used. National, regional, and local datasets are used across the other calculators depending on data availability. At the national level, New Zealand's Greenhouse Gas Inventory shows that for 2020 (the most recent nationwide inventory) an estimate of gross emissions uncertainty was ±8.8%, whereas a net emissions uncertainty estimate was ±26.9% and uncertainty in the gross trend was ±6.4%. These levels of uncertainty should be considered when interpreting the results of this community carbon footprint (MfE, 2022[5]).

StatsNZ Regional Footprint

Due to differences in emission factors and methodology used between the StatsNZ Regional Footprints and this community carbon footprint (based on the GPC requirements and available data), caution should be taken when comparing reported emissions. One example is where this footprint uses updated emission factors for methane and nitrous oxide following guidance from the IPCC and in line with other district and regional-level GHG inventories in New Zealand. This difference is especially relevant for the Agriculture sector.

[5] https://environment.govt.nz/assets/publications/GhG-Inventory/New-Zealand-Greenhouse-Gas-Inventory-1990-2020-Chapters-1-15.pdf

3.0 Community Carbon Footprint for 2021/22

The paragraphs, figures and tables below outline Wellington's greenhouse gas emissions, referred to as 'emissions' in this assessment. This includes Wellington's total emissions, emissions from each sector, and major emissions sources within each sector. The focus of emissions reporting is on **gross** emissions.

During the 2021/22 reporting period, Wellington emitted **total gross emissions** of 853,513 tCO_2e. Note that gross emissions do not account for Forestry sequestration and harvesting emissions. Transport and Stationary Energy emissions are the city's most significant contributors to total gross emissions.

The population of Wellington in 2021/22 was approximately 214,250 people, resulting in per capita gross emissions of 4.0 tCO_2e/person. Discussion of per capita emissions is limited to when it is useful for comparing emission figures against other territorial authorities. A breakdown of net emissions (i.e., including results from Forestry resources) is reported separately.

Table 1 Total net and gross emissions

Total emissions	tCO_2e
Total Net Emissions (including Forestry)	773,605
Total Gross emissions (excluding Forestry)	853,513

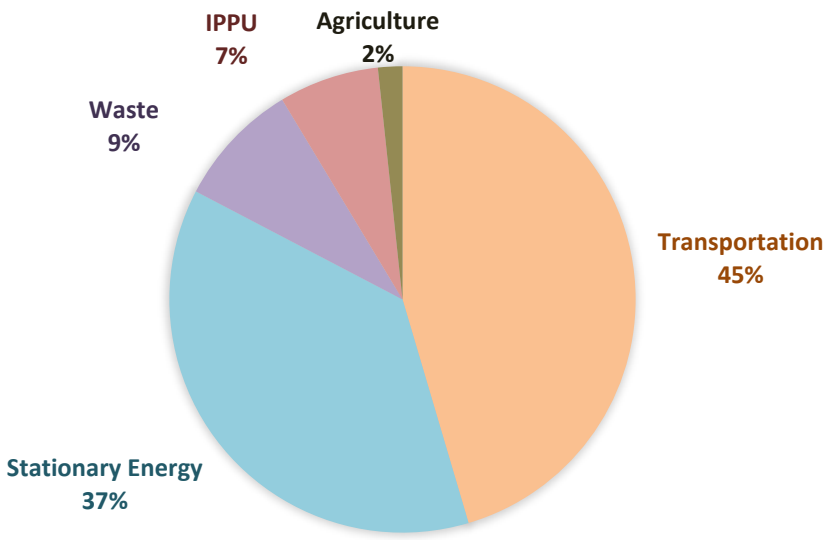

Figure 3: Wellington City's total gross GHG emissions split by sector (tCO_2e).

Net emissions differ from gross emissions because they include emissions related to forestry activity (harvesting emissions and sequestration. The cyclical nature of harvesting and planting regimes influences the observed forestry emissions. During the 2021/22 reporting period, Wellington emitted **total net emissions** of 773,605 tCO_2e.

The community carbon footprint comprises emissions from six different sectors, summarised below. Due to rounding, there may be discrepancies between the sum of reported figures and reported totals.

The change in emissions from each emission source between 2019/20 and 2021/22 is presented in section 4.0. This includes analysis of notable changes in emissions.

3.1 Transport

The highest emitting sector in Wellington, Transport, produced 388,341 tCO_2e in 2021/22 (45% of Wellington's gross total emissions). Table 2 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 2 Transport energy emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Petrol	170,767	20.0%	44.0%
Diesel	119,761	14.0%	30.8%
Jet Kerosene (Air Travel)	43,244	5.1%	11.1%
Marine Freight	25,693	3.0%	6.6%
Marine (Inter-Island Ferries)	19,414	2.3%	5.0%
Rail (Diesel)	4,416	0.5%	1.1%
Marine Diesel (Local)	1,953	0.2%	0.5%
LPG	1,814	0.2%	0.5%
Rail (Electric)	805	0.1%	0.2%
Bus (Electric)	238	<0.1%	0.1%
Aviation Gas (Air Travel)	228	<0.1%	0.1%
Marine (Electric)	7	<0.1%	<0.1%
Total	**388,341**	**45.5%**	**100%**

Most of the Transport emissions in 2021/22 can be attributed to petrol and diesel, which produced 170,767 tCO_2e and 119,761 tCO_2e respectively (collectively 75% of the sector's emissions and 34% of total gross emissions). Diesel and petrol transport emissions are broken down into on-road and off-road use. On-road transport consists of all standard road vehicles (cars, trucks, buses, etc.). Off-road transport consists of all fuel used for vehicle movement off roads (agricultural tractors and vehicles, forklifts, etc.). On-road transport produced 268,097 tCO_2e in 2021/22 (69% of Transport emissions and 31% of total gross emissions) and Off-road transport produced 24,484 tCO_2e (6% of Transport emissions). An extra breakdown of on-road emissions by vehicle type and class is appended to this report.

Table 3 Petrol and diesel emissions – on-road and off-road

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Petrol - On-Road	169,199	19.8%	43.6%
Diesel - On-Road	96,845	11.3%	24.9%
Petrol - Off-Road	1,567	0.2%	0.4%
Diesel - Off-Road	22,916	2.7%	5.9%
Petrol and Diesel Total	**290,528**	**34.0%**	**75.8%**

The next largest emission source for Wellington in 2021/22 is jet kerosene (aircraft jet fuel), contributing 11% of the sector's emissions and 5% of total gross emissions (43,244 tCO_2e). Jet kerosene emissions are based on the fuel consumed by aircraft journeys to and from Wellington, with emissions split equally

between the origin and destination location. The Wellington Airport has been considered to be a regional airport so emissions from jet kerosene have been split between all territorial authorities in the Greater Wellington Region based on population. It is important to note that jet kerosene emissions for Wellington in 2021/22 were 45% lower than in 2019/20, largely due to the restriction on international travel due to the COVID-19 pandemic (see section 4.1).

The remaining Transport emissions are attributed to marine freight, inter-island ferries, local marine transport (port vessels and local ferries), rail (both freight and electric commuter trains), aviation gas (used by small aircraft), and LPG use for transport (e.g., forklifts).

Emissions from marine freight have been divided between all territorial authorities in the Greater Wellington region based on relative population sizes. It is understood that imports and exports through this port are not exclusively related to activities in the Greater Wellington region; however, to ensure that these emissions are reflected in community carbon footprints as per the GPC requirements, this approach is appropriate. A similar consideration has been applied to aircraft emissions relating to Wellington Airport and inter-island ferry journeys. All assumptions have been detailed in the appendix.

3.2 Stationary Energy

Producing 318,362 tCO_2e in 2021/22, Stationary Energy was Wellington's second-highest emitting sector (37% of total gross emissions). Table 4 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 4 Stationary Energy emissions by emission source

Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Electricity Consumption	141,123	16.5%	44.3%
Natural Gas	119,431	14.0%	37.5%
Electricity Transmission & Distribution Losses	14,968	1.8%	4.7%
LPG	14,382	1.7%	4.5%
Stationary Petrol & Diesel Use	13,963	1.6%	4.4%
Natural Gas Transmission & Distribution Losses	9,654	1.1%	3.0%
Biofuel / Wood	2,874	0.3%	0.9%
Coal	1,914	0.2%	0.6%
Landfill Biogas (used for energy generation)	55	<0.1%	<0.1%
Total:	**318,362**	**37.3%**	**100%**

Electricity consumption was the cause of 44% of Stationary Energy emissions in 2021/22 (141,123 tCO_2e) and 17% of Wellington's total gross emissions (156,091 tCO_2e when including transmission and distribution losses related to the consumption). Electricity consumption emissions depend on the amount of consumption (in kWh), and the emissions intensity of the national grid (tCO_2e/kWh). The emissions intensity of the national grid is determined by overall national electricity generation in a particular year (e.g. from fossil fuels or renewable sources). Overall, national electricity generation can fluctuate year on year based on factors such as low rainfall reducing hydropower generation levels, resulting in changes to electricity consumption emissions even when consumption levels haven't changed. This can be seen between 2020/21 and 2021/22 where, despite no significant change in

consumption, electricity consumption emissions were 55% higher in 2020/21 than in 2021/22 due to increased use of fossil fuel generation that year caused by reduced hydro generation (see section 4.2).

Natural gas consumption accounted for 41% of Stationary Energy emissions in 2021/22 (129,085 tCO_2e), including transmission and distribution losses.

Use of LPG generated 5% of Stationary Energy emissions in 2021/22 (14,382 tCO_2e). The burning of petrol and diesel, coal, biofuels, and landfill biogas used for energy generation, produced the remaining Stationary Energy emissions.

Biogenic CO_2 emissions from biofuels and landfill gas burning have not been included in these totals and are reported separately in section 3.9.

3.3 Waste

Waste originating in Wellington (solid waste, wastewater, and compost) produced 73,038 tCO_2e in 2021/22, which comprises 9% of Wellington's total gross emissions. Table 5 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 5 Waste emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Closed Landfill Sites	41,615	4.9%	57.0%
Open Landfill Sites	19,619	2.3%	26.9%
Wastewater Treatment Plants	7,776	0.9%	10.6%
Individual Septic Tanks	3,045	0.4%	4.2%
Composting (Diverted from landfill)	983	0.1%	1.3%
Total:	**73,038**	**8.6%**	**100%**

Solid waste produced the bulk of waste emissions (61,233 tCO_2e in 2021/22), making up 84% of total waste emissions. Solid waste emissions include emissions from open (operating) landfill sites and closed landfill sites. Open landfill sites produced 19,619 tCO_2e in 2021/22[6], and closed landfill sites produced 41,615 tCO_2e in 2021/22. Both open and closed landfills emit landfill (methane) gas from the breakdown of organic materials disposed of in the landfill for many years after waste enters the landfill.

Open landfill emissions include emissions from waste produced in Wellington and sent to the currently open Southern and Spicer landfills. Emissions from closed landfill sites in 2021/22 were greater than those from open landfill sites, due to the lack of landfill gas capture systems at the closed landfill sites, which are present at the open landfill sites. As no new waste has entered closed landfill sites in recent years, these annual emissions will decrease over time.

Wastewater treatment (treatment plants and individual septic tanks) accounted for 15% of total waste emissions in 2021/22 (10,821 tCO_2e). The vast majority of households in Wellington (94%) are connected to wastewater treatment plants, producing total emissions of 7,776 tCO_2e in wastewater emissions. Households not connected to centralised wastewater treatment plants (i.e., using individual septic tanks) produced 3,045 tCO_2e in wastewater emissions. Due to methane production, septic tanks have a higher emissions intensity per quantity of wastewater compared to the wastewater treatment plants in Wellington.

[6] This figure is different to that reported as part of WCC's organisational emissions footprint due to differences in the methodology used (see section 2).

Waste diverted from landfill for composting in Wellington includes horticultural, animal waste products, green waste, bark, and sawdust. Composting of this organic waste produces lower emissions than if sent to a landfill. Diverted organic waste, composted at Southern Landfill produced 983 tCO_2e in 2021/22. Composting of organic waste results in a much lower climate change impact from greenhouse gasses than when disposed of in landfill.

3.4 Industrial Processes and Product Use (IPPU)

IPPU in Wellington produced 59,322 tCO_2e in 2021/22, contributing 7% to Wellington's total gross emissions. This sector includes emissions associated with the consumption of industrial products and synthetic gases containing GHGs for refrigerants, foam blowing, fire extinguishers, aerosols, metered dose inhalers and Sulphur Hexafluoride for electrical insulation and equipment production. No known industrial processes (as defined in the GPC requirements) are present in Wellington (e.g., aluminium manufacture).

IPPU emissions do not include energy use for industrial manufacturing, which is included in the relevant Stationary Energy sub-category (e.g., coal, electricity and/or petrol and diesel). These emissions are based on nationally reported IPPU emissions and apportioned based on population due to the difficulty of allocating emissions to particular geographic locations. Addressing IPPU emissions is typically a national policy issue.

Table 6 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source. The most significant contributor to IPPU emissions is refrigerants, which produced 93% of IPPU emissions (55,192 tCO_2e).

Table 6 Industrial processes and product use emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Refrigerants and air conditioning	55,192	6.5%	93.0%
Aerosols	3,075	0.4%	5.2%
SF6 - Electrical Equipment	601	0.1%	1.0%
Foam Blowing	241	<0.1%	0.4%
SF6 - Other	118	<0.1%	0.2%
Fire extinguishers	95	<0.1%	0.2%
Total	**59,322**	**7.0%**	**100%**

3.5 Agriculture

Agriculture emitted 14,450 tCO_2e in 2021/22 (2% of Wellington's gross emissions). **Table 7** provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emissions source.

Agricultural emissions are the result of both livestock and crop farming. Enteric fermentation from livestock produced 80% of Wellington's agricultural emissions (11,484 tCO_2e). Enteric fermentation GHG emissions are produced by methane (CH_4) released from the digestive process of ruminant animals (e.g., cattle and sheep). The second highest source of Agricultural emissions was produced from nitrous oxide (N_2O) released by unmanaged manure from grazing animals on pasture (1,679 tCO_2e).

Table 7 Agriculture emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Enteric Fermentation	11,484	1.3%	79.5%
Manure from Grazing Animals	1,679	0.2%	11.6%
Other Agriculture Emissions	648	0.1%	4.5%
Atmospheric Deposition	456	0.1%	3.2%
Manure Management	151	<0.1%	1.0%
Agricultural Soils	32	<0.1%	0.2%
Total	**14,450**	**1.7%**	**100%**

Livestock was responsible for the majority of the Agriculture sector's GHG emissions. Non-dairy cattle account for 50% of agricultural emissions, and sheep account for 47% of agricultural emissions in Wellington. In 2021/22, there were an estimated 12,466 sheep in Wellington and 2,833 non-dairy cattle.

It is important to note that these agricultural results do not include emissions related to the consumption of agricultural products supplied to Wellington as per the GPC reporting requirements.

Table 8 Agriculture emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Non-dairy Cattle	7,267	50.3%	0.9%
Sheep	6,833	47.3%	0.8%
Other Livestock	234	1.6%	<0.1%
Fertiliser	115	0.8%	<0.1%
Total	**14,449**	**2%**	**100%**

3.6 Forestry

Planting of native forests (e.g. mānuka and kānuka) and exotic forest (e.g. pine) sequesters (captures) carbon from the atmosphere while the trees are growing to maturity. Harvesting of forests emits emissions via the release of carbon from organic matter and soils following harvesting. When forest sequestration exceeds emissions from harvesting in a particular year, the extra carbon sequestered by forest reduces annual total emissions. Conversely, when emissions from harvesting exceed the amount of carbon sequestered by native and exotic forests, then total gross emissions will increase.

Sequestration in 2021/22 was 85,440 tCO_2e (mostly from native forests), while harvesting emissions were 5,531 tCO_2e. This meant that Forestry in Wellington was a net negative source of emissions in 2021/22 (rather than a positive source of emissions, where harvesting emissions exceed sequestration). Total Forestry emissions in 2021/22 were -79,908 tCO_2e. It is noted that the harvesting of exotic forests can be cyclical in nature. Some years will have higher sequestration, and some years will have higher harvesting emissions determined by the age of forests, commercial operators, and the global market.

Table 9 Forestry emissions by emission source (including sequestration)

Sector / Emissions Source	tCO_2e
Harvest Emissions	5,531
Native Forest Sequestration	-62,707
Exotic Forest Sequestration	-22,733
Total	**-79,908**

3.7 Comparison with other Cities in Aotearoa/New Zealand – Total and Per-Capita Emissions

It can be helpful to put Wellington's emissions inventory in context by comparing it to the emissions inventory of other cities in Aotearoa/New Zealand. This section presents Wellington's emissions inventory alongside the emissions inventory for different cities in Aotearoa/New Zealand. It is essential to note the differences between the cities (e.g., population size and land area), the time period covered, and that slightly different methodologies may have been used to calculate emissions, when comparing Wellington's emissions inventory with other cities. These considerations will impact the comparability of these inventories.

Christchurch, Dunedin, Tauranga, and Hamilton have been chosen as comparable cities to Wellington. Due to Auckland's much larger population and land area, a comparison with Auckland has not been made. Total gross emissions and emissions per capita are displayed and discussed below.

From a per capita perspective, Wellington had a 4.0 tCO_2e/per capita figure for total gross emissions, which is lower than the national value of 15.7 tCO_2e/per capita. This is mainly due to differences in Transport and Agriculture per capita, where Wellington had 1.8 tCO_2e/per capita for Transport and 0.1 tCO_2e/per capita for Agriculture, compared to 3.4 tCO_2e/per capita and 9.0 tCO_2e/per capita respectively in the National inventory.

Rural and low-density urban areas tend to have higher Transport emissions per capita (especially on-road transport) due to greater driving distances covered by private vehicles per person and freight vehicles per person. Rural areas tend to have much higher Agriculture emissions per capita due to the large GHG emissions impact of livestock in areas with very low population density.

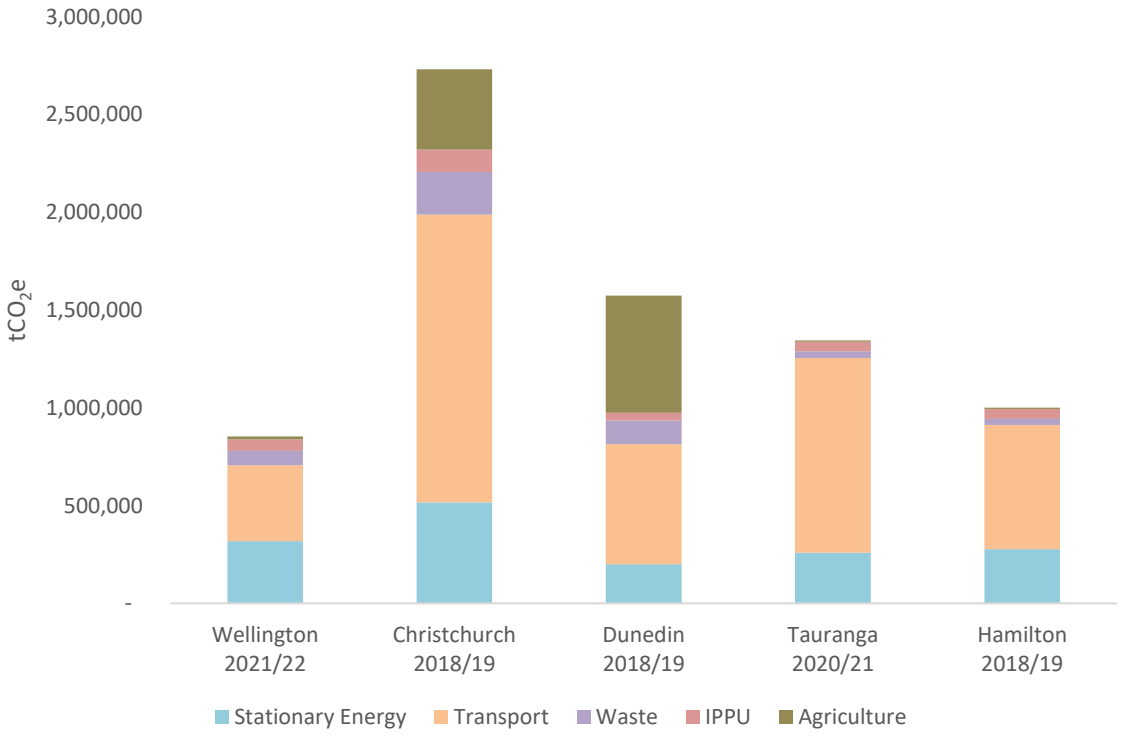

Figure 4 Total gross emissions for Wellington and comparable cities (tCO_2e).

Figure 5 Total per capita gross emissions for Wellington and comparable cities (tCO_2e).

Of these five cities, Wellington had the lowest total gross emissions, despite Dunedin, Tauranga and Hamilton all having smaller populations. The Christchurch emissions inventory covers a much larger population and area than the Wellington inventory. The main difference between Wellington's total gross emissions and the other cities' is found in the Transport and Agriculture sectors.

Of the five cities compared above, Wellington had the lowest per capita emissions; this is again mainly due to differences in Transport and Agriculture. Low on-road transport emissions in Wellington contribute to this, as does a relatively small area of agricultural land. Alongside on-road transport, high air travel emissions per capita in Christchurch (pre-COVID-19 pandemic international travel restrictions) also contribute to Christchurch's larger Transport emissions, and high marine freight emissions per capita in Tauranga (New Zealand's largest port by volume) contribute to Tauranga's high Transport emissions per capita.

3.8 Total Gross Emissions by Greenhouse Gas

Each greenhouse gas has a different level of impact on climate change, which is accounted for when converting quantities of each gas into units of carbon dioxide equivalent (CO_2e).

Table 10: Wellington's total gross emissions by greenhouse gas

Greenhouse Gas	Tonnes	Tonnes of CO_2e
Carbon Dioxide (CO_2)	671,525	671,525
Biogenic Methane (CH_4)	2,335	79,384
Non-biogenic Methane (CH_4)	667	22,668
Nitrous Oxide (N_2O)	57	17,055
Other / Unknown Gas (in CO_2e)	62,882	62,882
Total	**737,466**	**853,513**

Figure 6 illustrates Wellington's total gross emissions by greenhouse gas in tonnes of the individual gas, and when converted to units of carbon dioxide equivalents (CO_2e).

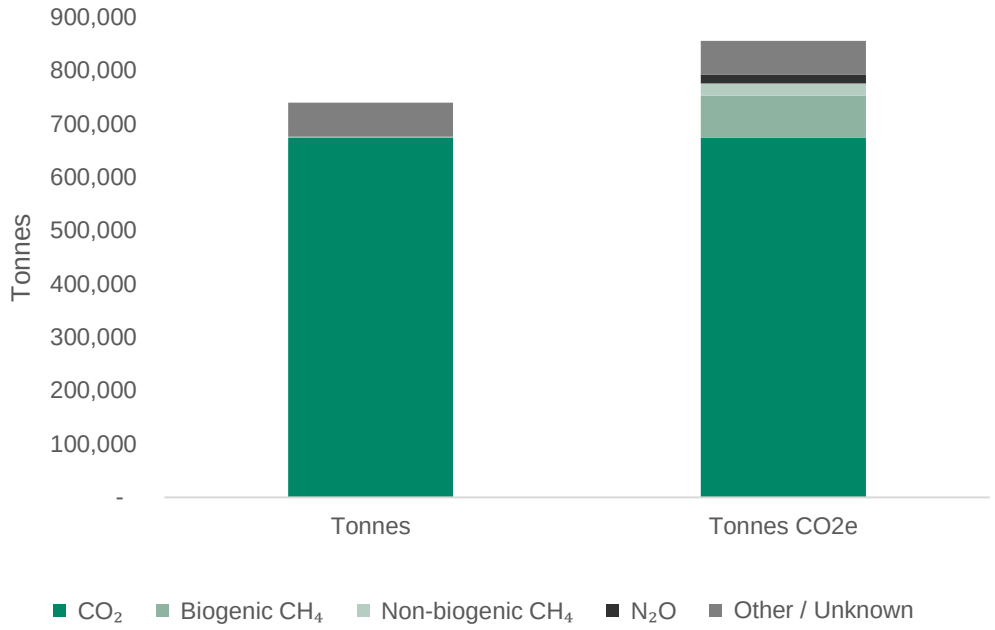

Figure 6: Wellington's total gross emissions by greenhouse gas (in tonnes, and converted into tonnes of CO_2 equivalent units)

By far, the largest source of emissions in tonnes in Wellington in 2021/22 is carbon dioxide (CO_2) at 671,525 tonnes. CO_2 was the largest contributor to global warming in 2021/22, representing 91% of Wellington's total tCO_2e. The largest sources of CO_2 emissions were on-road transport (256,293 tCO_2) and electricity consumption (131,485 tCO_2).

Due to the greater global warming impact of methane and nitrous oxide per tonne, methane represents 0.4% of the total tonnage of GHG emissions from Wellington but represents 12% of CO_2e, and nitrous oxide represents <0.1% of the total tonnage of GHG emissions from Wellington but represents 2% of CO_2e.

3.9 Biogenic Emissions

Biogenic carbon dioxide and methane emissions are stated in Table 11 and Table 12, respectively.

Biogenic CO_2 emissions result from the combustion of biomass materials that store and sequester CO_2, including materials used to make biofuels (e.g., trees, crops, vegetable oils, or animal fats). Biogenic CO_2 emissions from plants and animals are excluded from gross and net emissions as they are part of the natural carbon cycle.

Table 11: Biogenic CO_2 in Wellington (Excluded from gross emissions)

Emissions Source	tCO_2
Biofuel	30,456
Landfill Gas	13,316
Total Biogenic CO_2	**43,772**

Biogenic CH_4 emissions (e.g., produced by farmed cattle via enteric fermentation) are included in gross emissions due to their relatively large impact on global warming relative to biogenic CO_2. Biogenic methane represents 0.3% of the total gross tonnage of GHG emissions in Wellington but 9% of total gross GHG emissions when expressed in CO_2e. This is caused by the higher global warming impact of methane per tonne compared to carbon dioxide. The total tonnage of each GHG and the contribution of each GHG to total gross emissions when expressed in CO_2e is shown in Table 10.

The importance of biogenic CH_4 is highlighted in NZ's Climate Change Response (Zero Carbon) Amendment Act. The Act includes specific targets to reduce biogenic CH_4 by between 24% and 47% below 2017 levels by 2050 and 10% below 2017 levels by 2030. More information on the Act is available here: https://www.mfe.govt.nz/climate-change/zero-carbon-amendment-act.

Table 12: Biogenic Methane in Wellington (Included in gross emissions)

Emissions Source	tCH_4
Landfill Gas	1,800
Enteric Fermentation	338
Wastewater Treatment	137
Biofuel	39
Composting (Green Waste)	17
Manure Management	4
Total Biogenic CH_4	**2,335**

4.0 Emissions change from 2019/20 to 2021/22

Alongside calculating Wellington's emissions footprint for 2021/22, Wellington's emissions footprint for 2020/21 has also been calculated, and the previously published 2019/20 footprint has been recalculated. It can be helpful to recalculate previous footprints when methodologies, data sources, and emission factors are updated; this enables direct comparison between footprints for different years. Detail on the update to the 2019/20 footprint can be found in section 6.0.

This section displays the results of 2019/20, 2020/21, and 2021/22 emissions footprints with a focus on gross emissions and documents the change in emissions over this period. The updated 2019/20 footprint is to be used as a baseline by Wellington City Council against which to track emissions changes over time.

Table 13 Change in Wellington's Total Gross and Net emissions from 2019/20 to 2021/22

	2019/20 (tCO_2e)	2020/21 (tCO_2e)	2021/22 (tCO_2e)	% Change (2019/20 to 2021/22)
Total Net Emissions (including forestry)	875,284	891,585	773,605	-12%
Total Gross Emissions (excluding forestry)	939,309	971,494	853,513	-9%

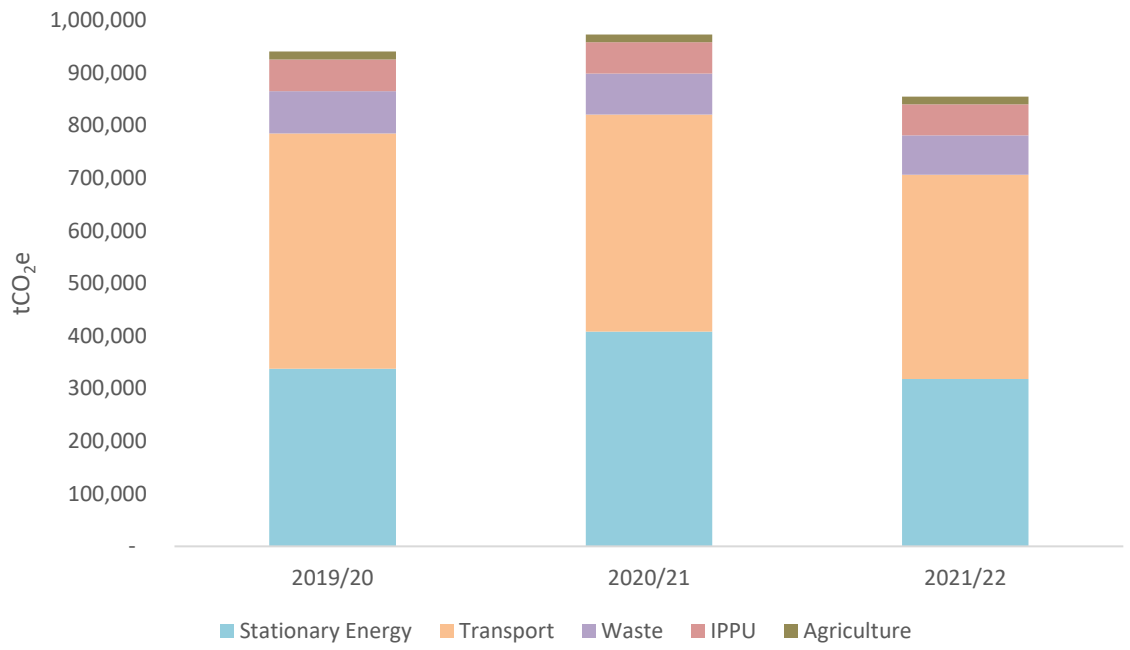

Figure 7 Change in Wellington's total gross emissions from 2019/20 to 2021/22

Annual total gross emissions decreased by 9% from 939,309 tCO_2/e in 2019/20 to 853,513 tCO_2e in 2021/22. Annual total net emissions in Wellington decreased by 12% from 875,284 in 2019/20 to 773,605 tCO_2e. The decrease in both gross and net emissions was driven by a reduction in Transport emissions primarily related to air travel and on-road fuel use, and a decrease in the emissions intensity of the national grid. The impact of COVID-19 pandemic restrictions can be especially seen in air travel emissions where emissions were 45% lower in 2021/22 compared to 2019/20.

Total gross emissions in 2020/21 were higher than both 2019/20 and 2021/22. This was predominantly due to high emissions intensity of the national electricity grid in 2020/21 due to low rainfall years resulting in low hydropower generation resulting in higher coal and gas generation.

The population of Wellington remained steady between 2019/20 and 2021/22 (decreasing by 0.2%). Owing to the decrease in total gross emissions, per capita emissions between 2019/20 and 2021/22 declined from 4.4 to 4.0 tCO_2e per person per year. A discussion of the decoupling of gross emissions from population growth and GDP is found in Section 5.0.

The sections below outline the change in emissions between 2019/20 and 2021/22 for each sector and emissions source, highlighting the changes that have had the largest impact on total gross emissions. Due to rounding, there may be discrepancies between the sum of reported figures and reported totals.

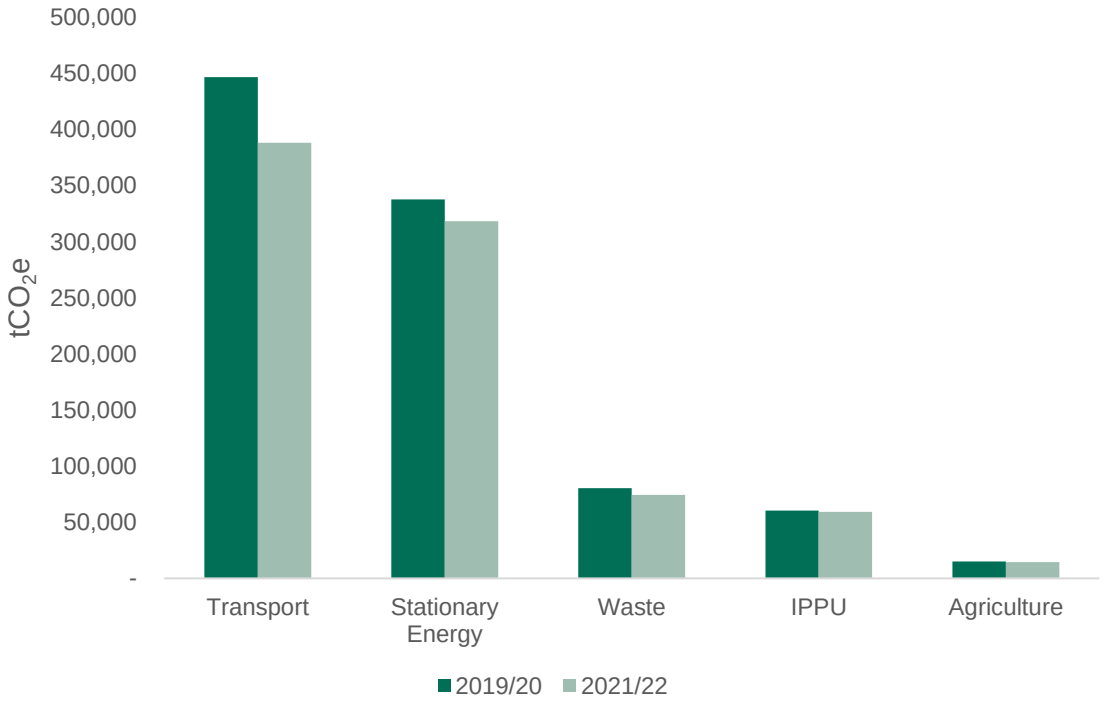

Figure 8 Emissions for each sector of Wellington's gross emissions footprint for 2019/20 and 2021/22

4.1 Transport

Table 14 Change in Wellington's Transport emissions from 2019/20 to 2021/22

Sector / Emissions Source	2019/20 (tCO_2e)	2020/21 (tCO_2e)	2021/22 (tCO_2e)	% Change (2019/20 to 2021/22)
Petrol	182,233	191,529	170,767	-6%
Diesel	128,614	131,070	119,761	-7%
Jet Kerosene (Air Travel)	78,930	29,090	43,244	-45%
Marine Freight	21,356	23,915	25,693	20%
Marine (Inter-Island Ferries)	26,379	26,805	19,414	-26%
Rail (Diesel)	4,224	4,416	4,416	5%
Marine Diesel (Local)	2,084	2,084	1,953	-6%
LPG	1,789	1,849	1,814	1%
Rail (Electric)	937	1,233	805	-14%
Bus (Electric)	58	80	238	310%
Aviation Gas (Air Travel)	232	231	228	-1%
Marine (Electric)	-	-	7	*N/A*
Total	**446,836**	**412,304**	**388,341**	**-13%**

Transport emissions decreased by 13% between 2019/20 and 2021/22 (58,495 tCO_2e). This was driven by a 35,686 tCO_2e decrease in Jet Kerosene (aircraft fuel) emissions and an 18,315 tCO_2 reduction in on-road fuel use emissions.

Jet Kerosene emissions decreased by 45% due to a reduction in flights, especially of international flights, with international passenger numbers down 88% and domestic passenger numbers down 17% between 2019/20 and 2021/22[7] (there is an even larger decrease in jet kerosene emissions from 2018/19 to 2021/22, of 60%, with international passenger numbers down 91% and domestic passenger numbers down 39%). This is likely the impact of COVID-19-related restrictions on travel and the slow pace of recovery of the aviation industry.

On-road fuel use emissions (petrol and diesel) decreased by 6%, in line with a 6% reduction in the distance travelled by vehicles on roads in Wellington between 2019/20 and 2021/22[8].

Emissions related to the inter-island ferries decreased by 26% between 2019/20 and 2021/22 (6,956 tCO_2e), this is due to a change in fuel use for some journeys by one of the operators of this service, from heavy fuel oil to diesel, which has a lower emissions impact.

Marine freight emissions increased by 20% between 2019/20 and 2021/22 (4,337 tCO_2e). It is, however, important to note that maritime freight emissions for Wellington tend to fluctuate year-to-year based on distance travelled by vessels, size of vessels, and the number of visits in a particular year (for example, emissions from marine freight in 2021/22 are 9% lower than in 2018/19).

[7] https://www.wellingtonairport.co.nz/business/investor-services/traffic-reports/
[8] https://www.nzta.govt.nz/planning-and-investment/learning-and-resources/transport-data/data-and-tools/

4.2 Stationary Energy

Table 15 Change in Wellington's Stationary Energy emissions from 2019/20 to 2021/22

Sector / Emissions Source	2019/20 (tCO_2e)	2020/21 (tCO_2e)	2021/22 (tCO_2e)	% Change (2019/20 to 2021/22)
Electricity Consumption	161,781	218,720	141,123	-13%
Natural Gas	116,166	124,305	119,431	3%
Electricity Transmission and Distribution Losses	14,148	20,334	14,968	6%
LPG	14,184	14,661	14,382	1%
Stationary Petrol & Diesel Use	14,987	15,315	13,963	-7%
Natural Gas Transmission and Distribution Losses	9,391	10,048	9,654	3%
Biofuel	2,930	2,906	2,874	-2%
Coal	4,196	2,021	1,914	-54%
Landfill Biogas (used for energy generation)	54	54	55	2%
Total	**337,836**	**408,365**	**318,362**	**-6%**

Emissions from Stationary Energy decreased by 6% between 2019/20 and 2021/22 (19,473 tCO_2e). This was driven by a decrease in electricity consumption emissions due to changes in the emissions intensity of the national grid.

Electricity consumption in Wellington (in kWh) increased by 2% between 2019/20 and 2021/22. However, emissions from this source decreased by 13% due to a decrease in the emissions intensity of the national electricity grid (tCO_2e/kWh). The emissions intensity of the national grid decreased due to a reduction in coal and gas generation as renewable generation sources made up a greater proportion of national generation (especially hydropower). It is important to note that the emissions intensity of New Zealand's national grid fluctuates year on year, primarily driven by water levels in the hydropower system (as can be seen in the increase in emissions from 2019/20 to 2020/21 and subsequent decrease again in 2021/22).

Other notable changes can be seen in natural gas consumption which increased by 3% (3,265 tCO_2e) between 2019/20 and 2021/22, and coal use, which reduced 54% (by 2,283 tCO_2e).

4.3 Waste

Table 16 Change in Wellington's Waste emissions from 2019/20 to 2021/22

Sector / Emissions Source	2019/20 (tCO_2e)	2020/21 (tCO_2e)	2021/22 (tCO_2e)	% Change (2019/20 to 2021/22)
Closed Landfill sites	46,879	44,146	41,615	-11%
Open Landfill Sites	20,302	19,999	19,619	-3%
Wastewater Treatment Plants	7,540	7,540	7,776	3%
Individual Septic Tanks	3,181	3,630	3,045	-4%
Composting (Diverted from Landfill)	1,078	1,078	983	-9%
Total	**78,980**	**76,393**	**73,038**	**-8%**

Total Waste emissions reduced by 8% between 2019/20 and 2021/22 (5,943 tCO_2e); this was driven by a reduction in landfill gas emissions from closed landfill sites.

Closed landfill site emissions made up 57% of Wellington's Waste emissions in 2021/22. Closed landfill sites in Wellington emitted more than open landfill sites due to the presence of biogas capture systems at the currently operational (open) landfill sites which are not present at any closed landfill sites. Annual emissions from closed landfill sites reduced by 11% between 2019/20 and 2020/21. As no additional waste enters these sites, annual emissions from this source will continue to fall over time.

At the open landfill sites that process Wellington's landfill waste (Southern and Spicer landfills), the total landfill gas (CH_4) produced annually increased by 3% between 2019/20 and 2021/22 due to increases in annual waste volumes sent to landfill over the last 20 years. However, improvements to landfill gas capture systems have meant that 5% more landfill gas (CH_4) has been captured and flared or used for energy generation, reducing the climate change impact of the gas by 3% between 2019/20 and 2021/22 (683 tCO_2e).

Wastewater treatment plant emissions increased 3% between 2019/20 and 2021/22 (236 tCO_2e) due to higher volume of wastewater treated and higher estimates of populations connected to Moa Point and Western wastewater treatment plants for 2021/22.

Emissions from Individual Septic Tanks are determined based on an estimate of the population of Wellington not connected to centralised wastewater treatment plants. Emissions from this source decreased by 4% due to a decrease in the forecast of the population not connected to centralised wastewater treatment.

Composting emissions decreased by 8% between 2019/20 and 2021/22 due to a reduction in the volume of organic waste composted. Note that this only includes composting of diverted organic waste at Southern Landfill.

4.4 Industrial Processes and Product Use (IPPU)

Table 17 Change in Wellington's IPPU emissions from 2019/20 to 2021/22

Sector / Emissions Source	2019/20(tCO_2e)	2020/21 (tCO_2e)	2021/22 (tCO_2e)	% Change (2019/20 to 2021/22)
Refrigerants and air conditioning	56,133	55,806	55,192	-2%
Aerosols	3,277	3,110	3,075	-6%
SF6 - Electrical Equipment	598	608	601	1%
Foam Blowing	256	244	241	-6%
SF6 - Other	120	119	118	-2%
Fire extinguishers	97	96	95	-2%
Total	**60,481**	**59,983**	**59,322**	**-2%**

IPPU emissions decreased between 2019/20 and 2021/22 by 2% (1,158 tCO_2e). A decrease in refrigerant and aerosol emissions mainly drives the decrease in IPPU emissions. This may be a decrease in the quantity used or an increase in the use of lower emissions-impacting refrigerants and aerosols. Note that national-level data is used for this sector and is portioned out using a population approach; actual emissions for the city are unknown.

4.5 Agriculture

Table 18 Change in Wellington's Agriculture emissions from 2019/20 to 2021/22

Sector / Emissions Source	2019/20 (tCO_2e)	2020/21 (tCO_2e)	2021/22 (tCO_2e)	% Change (2019/20 to 2021/22)
Enteric Fermentation	12,051	11,484	11,484	-5%
Manure from Grazing Animals	1,772	1,679	1,679	-5%
Other Agriculture Emissions	683	648	648	-5%
Atmospheric Deposition	481	456	456	-5%
Manure Management	157	151	151	-4%
Agricultural Soils	33	32	32	-3%
Total	**15,177**	**14,450**	**14,450**	**-5%**

The Agriculture sector's emissions decreased by 5% between 2019/20 and 2021/22 (727 tCO_2e). This decrease is driven by a reduction in total livestock numbers, especially sheep.

Sheep represent 80% of total livestock in Wellington in 2021/22 and 47% of agricultural emissions. Emissions related to sheep decreased by 11% (809 tCO_2e) due to an 11% reduction in the number of sheep (from 13,942 sheep to 12,466 sheep).

Non-dairy cattle represent 18% of total livestock in Wellington in 2021/22 and 50% of agricultural emissions, this is due to their greater emissions footprint compared to sheep. Emissions related to non-

dairy cattle increased by 1% (86 tCO_2e) due to a 1% increase in the number of non-dairy cattle (from 2,800 cattle to 2,833 cattle).

4.6 Forestry

Table 19 Change in Wellington's Forestry emissions from 2019/20 to 2021/22

Sector / Emissions Source	2019/20(tCO_2e)	2020/21 (tCO_2e)	2021/22 (tCO_2e)	% Change (2019/20 to 2021/22)
Exotic Forest Sequestration	-22,837	-22,733	-22,733	<1%
Native Forest Sequestration	-62,707	-62,707	-62,707	0%
Harvest Emissions	21,520	5,531	5,531	-74%
Total	**-64,024**	**-79,908**	**-79,908**	

Net Forestry sequestration increased by 15,884 tCO_2e between 2019/20 and 2021/22, from -64,024 tCO_2e to -79,908 tCO_2e. While sequestration from native and exotic forestry remained stable, harvesting emissions decreased by 74% (15,988 tCO_2e).

Forestry harvesting emissions decreased due to a 74% decrease in the land area covered by exotic trees of harvestable age (used to estimate Wellington's proportion of the Greater Wellington region's commercial harvesting). Forestry emissions are influenced by the cyclical nature of harvesting and planting regimes, where some years will have higher sequestration and some years will have higher harvesting emission. This depends on the age of forests and the demand for lumber and timber. Improved and updated data sources may impact the estimation of emissions from this source in the future.

Sequestration by native forests remained unchanged during this time as the same data has been used for each year; however, it is unlikely that there have been significant changes.

5.0 Decoupling of GHG emissions from population growth and GDP

Decoupling of emissions is when emissions grow less rapidly than the growth of an economy (measured in Gross Domestic Product (GDP)). The term decoupling expresses the desire to mitigate emissions without harming economic well-being. The exact drivers for the decoupling of emissions from GDP are generally difficult to pinpoint. New policies, for restructuring the way to meet demand for energy, food, transportation, and housing will all contribute. Both direct local actions (e.g. landfill gas reductions) and indirect national trends (e.g. changes to emissions from electricity generation) can contribute to emissions decoupling. A complete discussion of the decoupling of emissions is beyond this project's scope.

At the time of writing, GDP figures for Wellington for 2020/21 and 2021/22 were not available so changes in the ratio of emissions to GDP (and therefore the presence of decoupling) cannot be determined.

However, emissions in Wellington do appear to have demonstrated decoupling from population growth between 2019/20 and 2021/22. Wellington's total gross emissions have decreased by 9% between 2019/20 and 2021/22 whilst the population in Wellington has remained stable (reducing by 0.2%).

6.0 Update to the 2019/20 Emissions Footprint

Improvements to the methodology, improvements in available data, and updates to emission factors since 2019/20 Community Carbon Footprint was first published in 2020, have meant that the 2019/20 footprint results are required to be updated to allow direct comparison with the 2020/21, and 2021/22 footprints.

The previous 2019/20 inventory results and updated 2019/20 inventory results are presented in Table 20.

Critical reasons for the change to results between these footprints are outlined below:

- Stationary Energy emissions have been adjusted due to improvements in data and methodology changes, notably the electricity data and emission factors, and a difference in the allocation of diesel and petrol sales to stationary energy purposes.
- Transportation emissions have been adjusted due to data improvements and methodology changes, most notably in how the Wellington Region's petrol and diesel sales have been allocated to the territorial authorities within the Region (from a population approach to a vehicle kilometre travelled approach). The marine freight and inter-island ferry calculations have also been updated based on best-practice guidance for cross-boundary transport emissions. Emissions from marine fuel used by Port-owned vessels have also been calculated where it was not previously included.
- Waste emissions have been adjusted due to updates to the estimate of landfill gas capture system efficiency at the Southern landfill, the estimate of historical waste sent to closed landfill sites (1950-1999), the population not connected to centralised wastewater treatment, and the inclusion of emissions from diverted organic waste composting (not previously included). Wastewater treatment plant emissions calculations have been updated to align with WaterNZ guidance (2021).
- IPPU emissions have been adjusted due to a change in data and emission factors provided by the Ministry for the Environment (MfE).
- Agriculture emissions have been adjusted due to improvements in data based on regional trends since the 2017 territorial authority-level census and changes in MfE emission factors.
- Forestry emissions have been adjusted due to improvements in published data and emission factors.

Table 20 Reported GHG emissions in Wellington for 2019/20, showing the change in emissions between those previously reported (2020) and the updated results (2022)

	2019/20 previous inventory (2020) – tCO_2e	2019/20 updated inventory (2022) – tCO_2e
Stationary Energy	375,463	337,836
Transportation	506,584	446,836
Waste	78,958	78,980
IPPU	74,487	60,481
Agriculture	13,524	15,177
Forestry	-67,688	-64,024
Total Net Emissions (incl. forestry)	**981,328**	**875,284**
Total Gross Emissions (excl. forestry)	**1,049,016**	**939,309**

Future community carbon footprints for Wellington may also require adjustments to the emission results reported here due to improvements to the inventory process.

7.0 Closing Statement

Wellington's GHG emissions footprint provides information for decision-making and action by the council, Wellington stakeholders, and the wider community. We encourage the council to use the results of this study to update current climate action plans, set emission reduction targets, and track changes in emissions over time.

The emissions footprint developed for Wellington covers emissions produced in the Stationary Energy, Transport, Waste, IPPU, Agriculture, and Forestry sectors using the GPC reporting framework. Sector-level data allows Wellington to target and work with the sectors that contribute the most emissions to the footprint.

Understanding of climate change's extensive and long-lasting effects is always improving. It is recommended that this emissions footprint be updated regularly (every two or three years) to inform ongoing positive decision-making to address climate change issues.

The availability, quality, and applicability of data limit the accuracy of any emissions footprint. Areas, where data could be improved for future footprints include IPPU, air transport, marine transport, and on and off-road transport fuel use.

8.0 Limitations

Where this Report indicates that information has been provided to AECOM by third parties, AECOM has made no independent verification of this information except as expressly stated in the Report. AECOM assumes no liability for any inaccuracies in or omissions to that information. This Report was prepared between **October 2022 and December 2022** and is based on the information reviewed at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred after this time. This Report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This Report does not purport to give legal advice.

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Appendix A

Assumptions and Data Sources

Sector / Category	Assumptions and Exclusions
General	
Geographical Boundary	LGNZ local council mapping boundaries have been applied
Population	Population figures are provided by StatsNZ. Financial year populations have been used, these are based on the average population from the two calendar years (e.g. the average of 2020 and 2021 calendar year populations for 2020/21).
Climate Change Feedback	Emissions are expressed on a carbon dioxide-equivalent basis (CO_2e) including climate change feedback using the 100-year Global Warming Potential (GWP) values. Climate change feedbacks are the climate change impacts from GHGs that are increased as the climate changes. For example, once the Earth begins to warm, it triggers other processes on the surface and in the atmosphere. Current climate change feedback guidance is important to estimate the long-term impacts of GHGs. Emissions for individual main greenhouse gases for each emissions source are provided in the supplementary spreadsheet information supplied with this report.
GPC Production Approach	GPC reporting is predominately production-based (as opposed to consumption-based) but includes indirect emissions from energy consumption. Production-based emissions reporting is generally preferred by policy-makers due to robust established methodologies such as the GPC, which enables comparisons between different studies. Production-based approaches exclude globally produced emissions relating to consumption (e.g., embodied emissions relating to products produced elsewhere but consumed within the geographic area such as imported food products, cars, phones, clothes etc.).
Emission Factors	All emission factors have detailed source information in the calculation tables within which they are used. Where possible, the most up to date, NZ-specific emission factors have been applied. AR5 Global Warming Potential (GWP) figures for greenhouse gases have been used accounting for climate change feedbacks.
Transport Emissions	
Petrol and Diesel:	Total petrol and diesel consumption in Wellington City was calculated from aggregated petrol and diesel sales data for the Wellington Region which was then apportioned out to the territorial authorities within the region based on the

	total distance travelled by vehicles in each territorial authority in the financial year (known as Vehicle Kilometres Travelled or VKT). Allocating fuel consumption across a region based on VKT does not account for the likely makeup of the vehicle fleet of a particular geographic area (e.g. where a more rural area may use more diesel, or a more urban area may have more hybrid or electric vehicles travelling). Fuel sold in an area does not always mean that the fuel is used in that area, however this approach is considered to be a robust and comparable estimate of fuel consumption in a geographic area. Total Petrol and diesel fuel use was then divided by likely end use. The division into transport and stationary energy end use (and within transport, on-road and off-road) was calculated using fuel end use data provided by the Energy Efficiency and Conservation Authority (EECA) in April 2020. - On-road transport is defined as all standard transportation vehicles used on roads e.g. cars, bikes, buses. - Off-road transport is defined as machinery for agriculture, construction and other industry used off-roads. - Stationary energy petrol and diesel use is defined as fuel not used for transport either on or off roads. Petrol and diesel used for stationary energy has been reported in the Stationary Energy sector.
Rail Diesel	Consumption was calculated by Kiwi Rail using the Induced Activity method for system boundaries. The following assumptions were made: - Net Weight is product weight only and excludes container tare (the weight of an empty container) - The Net Tonne-Kilometres (NTK) measurement has been used. NTK is the sum of the tonnes carried, multiplied by the distance travelled. - National fuel consumption rates have been used to derive litres of fuel for distance. - Type of locomotive engine used, and jurisdiction topography, have not been incorporated in the calculations. Using the induced activity method, the trans-boundary routes were determined, and the number of stops taken along the way derived. The total litres of diesel consumed per route was then split between the departure territorial authority, arrival territorial authority and any territorial authority the freight stopped at along the way. If the freight travelled through but did not stop within a territorial authority, no emissions were allocated. Data was not available for 2021/22 therefore the 2020/21 value has been used for 2021/22.
Jet Kerosene	Calculated using the Induced Activity method as per rail diesel. An estimate of fuel use was calculated for flights arriving and departing from Wellington Airport: - The schedule of flights arriving and departing from Wellington Airport containing details on the aircraft used for each flight was used to calculate fuel consumption.

	- Flight distances and aircraft fuel burn rates were used for these calculations. - As per the induced activity method, only 50% of emissions calculated per one-way arrival and departure were allocated to Wellington Airport. The remaining 50% of each leg was allocated to the originating or destination airport. An estimation of fuel use from military, freight, private, and other flights for 2020/21 and 2021/22 have been estimated based on data provided in 2020. Wellington Airport has been treated as a regional airport, so emissions have been split between the territorial authorities in the region on a population basis.
Aviation Gas	Aviation gas is mostly used by small aircraft for relatively short flights. Data for Wellington Airport was not available at the time of writing, so an assumption has been made based on similar sized airports in New Zealand. This is the same assumption used in the previous 2019/20 inventory. Wellington Airport has been treated as a regional airport, so emissions have been split between the territorial authorities in the region on a population basis.
Marine Diesel – Freight	Calculated using the Induced Activity method as per rail diesel and jet kerosene. An estimate of fuel use was calculated for flights arriving and departing from CentrePort (Wellington Port): - The schedule of vessels arriving and departing from Wellington Port containing details on size of the vessel was used to calculate fuel consumption. - Shipping distances and vessel fuel burn rates were used for these calculations. - As per the induced activity method, only 50% of emissions calculated per one-way arrival and departure were allocated to Wellington Port. The remaining 50% of each leg was allocated to the originating or destination Port. International shipping passing through CentrePort was split by weight of cargo into 'Logs' and 'All other cargo'. Emissions generated by 'All other cargo' has been allocated on a per capita basis between all territorial authorities in the Wellington Region. Emissions generated by 'logs' was split between territorial authorities, proportionally, by the percentage share of district forest area of harvest age (>26 years old).
Marine Diesel (Local)	Port operational vessels: - Fuel use has been provided directly from Wellington Port (CPL) for 2020/21 - The 2020/21 figure has also been used for 2019/20 and 2021/22 - All emissions from this source have been allocated to Wellington City Local ferries:

	- Diesel fuel use has been provided directly by the ferry operator - Electricity use has been provided directly by the ferry operator (beginning in 2021/22) - All emissions from this source have been allocated to Wellington City Private use, other commercial operators, and commercial fishing: - Most small private boats use fuel purchased at vehicle gas stations so this consumption will be included in off-road transport petrol and diesel emissions. - No data was available to determine emissions from other commercial operators, and commercial fishing
Marine fuels – Inter-island ferries	Data has been provided by the ferry operators in commercial confidence. Assumptions of fuel use have been used where data was not provided.
Cruise Ships	No reliable data was available to determine the emissions from cruise ships (only relevant to 2019/20 as there were no cruise ship visits in 2020/21 and 2021/22)
LPG	Total North Island consumption data was used and then split on a per capita basis to determine the territorial authority's consumption. National LPG end use data has been used to breakdown consumption into stationary energy and transport usage, these are then reported separately in their respective categories.
Stationary Energy Emissions	
Consumer Energy End Use	Stationary energy demand (e.g. electricity use, natural gas, etc.) is broken down by the sector in which they are consumed. We report stationary energy demand in the following categories: industrial (which includes agriculture, forestry, and fishing); commercial; and residential. These sectors follow the Australia New Zealand Standard Industrial Classification 2006 definitions. In addition to agriculture, forestry and fishing, the industrial sector includes mining, food processing, textiles, chemicals, metals, mechanical/electrical equipment and building and construction activities. Emissions from petrol and diesel used for stationary energy are not broken down into these sectors. Energy demand used for transport is reported in the transport sector.
Electricity Consumption	Electricity demand has been calculated using grid demand trends from the EMI website (www.emi.ea.govt.nz) to obtain raw grid exit point data for Wellington City. Reconciled demand has been used as per EMI's confirmation. The breakdown into sectors is based on NZ average consumption per sector (residential, commercial, and industrial).

Public Transport Electricity	Electricity used in the public transport system is included in the Transport sector (where known).
Private Transport Electricity	Electricity used for private transport (e.g. electric cars, electric bikes, electric micro-mobility) has not been separated from other stationary energy electricity consumption due to a lack of reliable data.
Coal Consumption	National coal consumption data has been provided by MBIE for all years (2022). Regional industrial coal data has been provided by EECA. National residential and commercial coal consumption has been divided between territorial authorities on a per capita basis. Regional industrial coal consumption has been divided between territorial authorities on a per capita basis.
Biofuel and Wood Consumption	National biofuel consumption data has been provided by the Ministry for Business, Innovation and Employment (MBIE 2021). Biofuel consumption has been divided between territorial authorities on a per capita basis. Biofuel emissions are broken down into Biogenic emissions (CO_2) and Non-Biogenic emissions (CH_4 and N_2O). The latest year's data available is for 2019. 2019/20, 2020/21, and 2021/22 use the 2019 figure, adjusted for population change.
LPG Consumption	North Island LPG sales data (tonnes) has been provided by the LPG Association for 2020 and 2021. Data interpolated between known data points or copied from the most recent data point where data is not available. 'Auto' and 'Forklift' sales represent transport uses of LPG. All other sales represent stationary energy uses of LPG. Sales have been divided between territorial authorities on a per capita basis. The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per MfE data.
Petrol and Diesel (stationary energy end use)	Total petrol and diesel consumption in Wellington City was calculated from aggregated petrol and diesel sales data for the Wellington Region which was then apportioned out to the territorial authorities within the region based on the total distance travelled by vehicles in each territorial authority in the financial year (known as Vehicle Kilometres Travelled or VKT). As most petrol and diesel is used for transport uses, this provides the most accurate way of calculating this data. Total Petrol and diesel fuel use was then divided by likely end use. The division into transport and stationary energy end use (and within transport, on-road and off-road) was calculated using fuel end use data provided by the Energy Efficiency and Conservation Authority (EECA) in April 2020.

	- On-road transport is defined as all standard transportation vehicles used on roads e.g. cars, bikes, buses. - Off-road transport is defined as machinery for agriculture, construction and other industry used off-roads. - Stationary energy petrol and diesel use is defined as fuel not used for transport either on or off roads. Petrol and diesel used for stationary energy has been reported in the Stationary Energy sector.
Natural Gas Consumption	Natural gas consumption data has been provided by FirstGas. Territorial Authorities supplied by gas from each Point of Connection (POC) have been confirmed by FirstGas. For Wellington City, this is Tawa A and Tawa B connection points.
Biogenic Emissions	Some Carbon Dioxide (CO_2) emissions are considered to be biogenic. These are CO_2 emissions where the carbon has been recently derived from CO_2 present in the atmosphere (for example, some agricultural and waste emissions). These emissions are not included in calculating total CO_2e.
Agricultural Emissions	
Agriculture	Territorial authority livestock numbers and fertiliser data taken from the Agricultural Census (StatsNZ). The last territorial authority census was in 2017. Regional agricultural data from StatsNZ (2021) has been used to estimate the change in livestock and fertiliser use since 2017.
Solid Waste Emissions	
Landfill Emissions	Landfill waste volume and landfill gas capture system information has been provided by the respective council departments. Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day, as per the GPC reporting requirements. This method accounts for the gradual release of emissions from waste over a long period of time, and so calculates the emissions produced per year from waste in landfill (including emissions from closed landfill sites). This approach differs from that used by WCC for their organisational footprint which includes WCC-owned landfill sites[9]. The WCC organisational footprint method calculates the likely future emissions from the waste entering landfill that year, and attributes those emissions to that year (and doesn't include emissions from waste already in the landfill). Waste volume: - Where information is not available, waste volumes have been estimated based on historical national data on a per capita basis. Landfill gas capture system efficiency:

[9] https://wellington.govt.nz/climate-change-sustainability-environment/climate-change/what-were-doing-about-climate-change/our-climate-action-areas/action-area-wellington-city-council

	- Southern Landfill – Efficiency of the system used in the emissions calculations has been taken from data provided by WCC. Landfill gas flaring / burning for energy generation: - Southern Landfill – The percentage of landfill gas flared or burned for energy generation used in the calculations has been taken from data provided by WCC in relation to the calculation of Southern Landfill's Unique Emissions Factor (UEF) for 2019/20 and 2021/22. - Emissions relating to burning of landfill gas for energy generation have been included in the Stationary Energy sector. Emissions are allocated to territorial authorities based on where the waste was produced, even if the waste is disposed in landfill outside the territorial authority: - All emissions from waste in Southern landfill has been allocated to Wellington (despite knowledge that some waste in Southern landfill will be coming from outside Wellington) - 21.5% of emissions from waste in Spicer landfill have been allocated to Wellington, this is based on WCC owning 21.5% of Spicer landfill (this number has been used in lieu of real-world data on origin of waste)
Wastewater Emissions	
Wastewater Treatment	Wastewater Treatment Plants: - Emissions have been calculated by an external party for 2020/21 following the WaterNZ (2021) guidance and verified by AECOM. - Calculation of emissions includes emissions released directly from wastewater treatment, flaring of captured gas and from discharge onto land/water. - Where data was not available assumed values have been used based on the WaterNZ (2021) guidance - Emissions relating to discharge of biosolids sent to landfill has been included in the Solid Waste emissions source. - Emissions are allocated to territorial authorities based on where the wastewater was produced, even if the wastewater is treated outside the territorial authority. Emissions are allocated to territorial authorities based on where the wastewater was produced, even if the wastewater is treated outside the territorial authority: - All emissions from wastewater in the Moa Point, and Western wastewater treatment plants have been allocated to Wellington - 27.6% of emissions from the Porirua wastewater treatment plant have been allocated to Wellington based on Wellington City Council's ownership share of the treatment plant (this number has been used in lieu of real-world data on origin of wastewater) Individual Septic Tanks: - Populations not connected to known wastewater treatment plants are assumed to be using septic tanks.

	- The population not connected to centralised wastewater treatment has been estimated based on the number of rateable properties not connected to sewerage
Industrial Processes and Product Use Emissions	
Industrial processes	It is assumed that there are no significant non-energy related emissions of greenhouse gasses from industrial processes in the Region (e.g. aluminium manufacture).
Industrial Product Use	National data covering industrial product use (e.g. fire extinguishers, refrigerants) have been estimated based on data provided in the New Zealand Greenhouse Gas Emissions 1990-2020 report (MfE 2022). Emissions are estimated on a per capita basis applying a national average per person.
Forestry Emissions	
Exotic Forestry Harvested and Exotic Forest coverage	Harvested forestry, and forest cover information for each territorial authority has been derived from Landcare Research data. This emissions footprint accounts for forest carbon stock changes from afforestation, reforestation, deforestation, and forest management (i.e., it applies land-use accounting conventions under the United Nations Framework Convention on Climate Change rather than the Kyoto Protocol). It treats emissions from harvesting and deforestation as instantaneous rather than accounting for the longer-term emission flows associated with harvested wood products. The emissions footprint considers regenerating (growing) forest areas only. Capture of carbon from the atmosphere is negligible for mature forests that have reached a steady state.
Native Forest	Native forest land area for each territorial authority has been provided by Landcare Research.

Appendix B

Additional Transport Emissions Breakdown

Additional Transport Emissions Analysis – Wellington City

This section details the additional analysis undertaken to further breakdown Wellington's transport sector GHG emissions. The focus of this additional analysis addresses on-road and off-road transport emissions which together represent 34.3% of Wellington's total gross emissions. Within on-road and off-road transport emissions this assessment looks at the relative contribution of each vehicle type (Cars, Commercial Vehicles, Buses) to the region's transport emissions.

Key findings:

- Cars represent 66% of Wellington on-road transport emissions, and 21% of Wellington total gross emissions.
- Light commercial vehicles represent 19% of Wellington's on-road transport emissions and 6% of Wellington's total gross emissions.
- Heavy commercial vehicles represent 14% of Wellington's on-road transport emissions and 4% of Wellington's total gross emissions.
- Electric vehicles (including light and heavy electric vehicles, and electric buses) currently represent less than 333 tCO_2e (0.1%) of Wellington on-road transport emissions based on emissions related to the electricity consumed.
- Cars represent 73% of all Vehicle Kilometres Travelled (VKT) in Wellington but represent 66% of all on-road emissions in Wellington. This is due to the relatively low average tCO_2e per VKT of cars compared to heavier vehicles.
- 25-50+ tonne heavy vehicles represent 4% of all Vehicle Kilometres Travelled (VKT) in Wellington but represent 11% of all on-road emissions in Wellington.
- Diesel is the predominant fuel for off-road transport use, representing 95% of off-road transport emissions in Wellington.
- Nationally, agriculture is the highest producing sector of off-road transport emissions, producing 27% of all off-road transport emissions. The next largest off-road transport producing sectors are building and construction, commercial, and industrial uses. Data specific to Wellington was not available at the time of writing.

1.0 Methodology

The basis for this assessment is the results presented in the Wellington Community Carbon Footprint for the financial year 2021/22 (July 1st to June 30th). The emissions for on-road and off-road transport have been calculated directly based on the sale of petrol and diesel in Wellington, and then these have been broken down by sector and vehicle type using data provided by Waka Kotahi and the Energy Efficiency and Conservation Authority (EECA).

Data provided by Waka Kotahi covering Vehicle Kilometres Travelled (VKT) and emissions (by gas) for each territorial authority by vehicle class in 2018/19 has been used to assess the relative contribution of vehicle class types to on-road transport emissions in Wellington.

Emissions related to energy use from electric vehicles (EVs) in the Community Carbon Footprint is included in the Stationary Energy sector and not included in transport emissions, due to lack of available data at the time of calculation. Total emissions presented here include the EV emissions contribution. These emissions have been calculated using an average electricity consumption per km travelled and based on the carbon intensity of the national electricity grid in 2021/22.

All calculated emissions have been converted to tonnes of CO_2 equivalent (tCO_2e) to allow direct comparison with the results of the Community Carbon Footprint.

Off-road transport data is limited at the local level, so this assessment utilises national data provided by the EECA to determine the relative contribution of emission sources within the on-road transport emissions source.

2.0 Key Limitations

On-road transport

- The reported emissions are for the financial year 2020/21 however the data underlying the breakdown of on-road transport emissions is based on calendar year 2019 data. There may be some differences between these years regarding the vehicle fleet make-up, but it expected that the proportions used are representative.

Off-road transport

- Calculations have been based on national-level data resulting in a lower level of confidence in their applicability to the territorial authority's off-road emissions given the variation in off-road transport uses across the country.
- In the Community Carbon Footprint, recreational marine fuel usage is included in 'off-road transport' due to the lack of data able to separate this marine fuel consumption from other on-land fuel consumption. This recreational marine fuel is estimated and included in 'off-road transport' here for consistency.

Marine freight transport, air travel, and rail

- These emissions sources have not been broken down further.

3.0 Transport Emissions Summary

The paragraphs, figures, and tables below outline Wellington greenhouse gas emissions from transport. During the 2021/22 reporting period, transport in Wellington emitted 266,142 tCO_2e, representing 45% of Wellington's total gross emissions.

On-road transport is the largest contributor to Transport emissions, representing 69% of Transport emissions and 31% of Wellington total gross emissions. This is followed by marine transport and air travel.

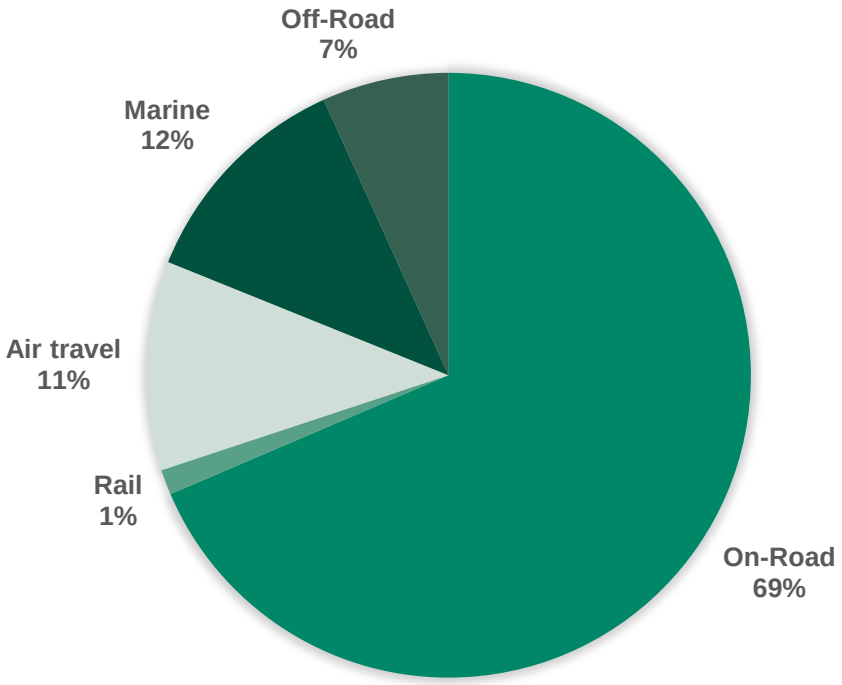

Figure 1 Wellington – transport emissions (tCO_2e)

4.0 On-Road Transport Emissions Breakdown

4.1 Wellington Region

On-road transport emissions are those relating to cars, commercial vehicles (including utes, trucks, and large commercial vehicles), and buses on-roads.

Table 1 and Figure 2 detail on-road transport emissions per vehicle category. In Wellington, the largest contributor to on-road transport emissions are cars, representing 66% of on-road transport emissions, and 21% percent of Wellington's total gross emissions. Commercial vehicles represent 32% of on-road transport emissions, and 10% percent of Wellington total gross emissions. A further breakdown of commercial vehicle types is provided below.

The results show that cars in Wellington tend to be fuelled by petrol while Commercial Vehicles and Buses almost exclusively use diesel.

Low emission Electric Vehicle (EV) use is currently low within the Wellington resulting in an extremely small contribution to on-road transport emissions (98 tCO_2e when excluding electric busses). Note that sales and use of electric vehicles have likely increased since 2018/19 (the most recent year available

for the vehicle fleet dataset used), however emissions will likely still represent an extremely small contribution to on-road transport emissions.

Electric busses produced 238 tCO_2e in 2021/22 based on emissions from the generation of the electricity used for electric busses in 2021/22. This is up 310% since 2018/19 due to the introduction of more electric busses in Wellington. This emissions calculation has been done separately to the rest of this breakdown due to the availability of real-world data for 2021/22. It is likely that emissions from diesel busses are lower than those reported here due to that calculation being based on 2018/19 data (prior to the replacement of diesel busses with electric busses).

Table 1 On-road transport emissions by vehicle type and fuel type (tCO_2e)

Vehicle Type	Petrol	Diesel	Electric	Total	% of Total
Cars	159,099	16,288	94	**175,481**	**66%**
Commercial Vehicles	10,100	76,201	1	**86,302**	**32%**
Buses	-	4,356	238	**4,594**	**2%**
Total	**169,199**	**98,845**	**333**	**266,377**	**100%**
% of Total	**64%**	**36%**	**0.1%**		

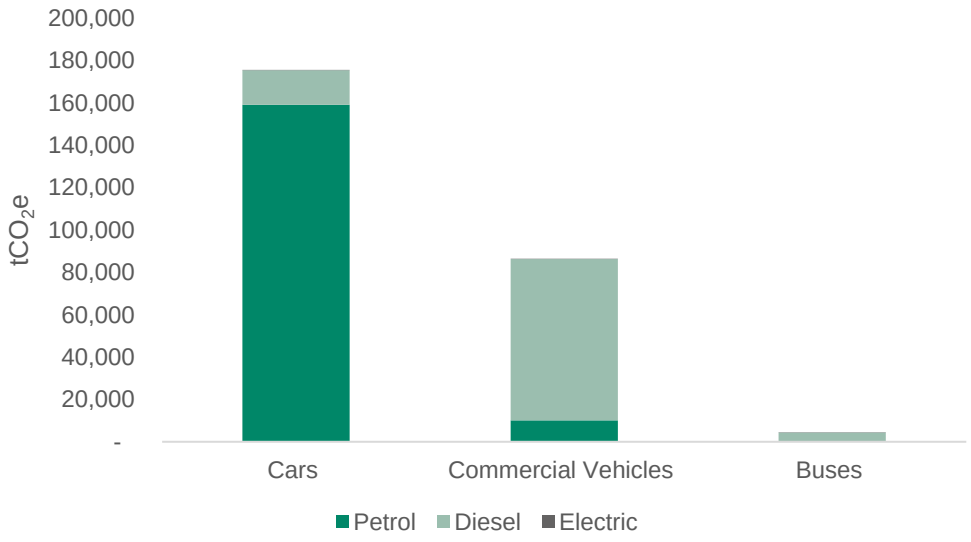

Figure 2 On-road transport emissions by vehicle type and fuel type

In Wellington, 91% of total car emissions are from petrol, while commercial vehicles are primarily diesel (88% of total commercial vehicle emissions). Buses are almost mostly diesel fuelled and contribute 2% of total vehicle emissions for the region. The busses category includes all busses including public transport, school busses, and private commercial busses (including tourist coaches).

Emissions from these vehicle types can be broken down further by vehicle class. Table 2 and Figure 3 detail on-road transport emissions per vehicle class.

Table 2 On-road transport emissions by vehicle class (tCO_2e)

Vehicle Class	GHG Emissions (tCO_2e)	% of Total
Cars	175,481	66%
Light Commercial Vehicles <3.5 Tonne	49,817	19%
Heavy Vehicles 3.5-25 Tonne	7,384	3%
Heavy Vehicles 25-50+ Tonne	29,100	11%
Bus Urban 15-18 Tonne	4,168	2%
Bus Coach >18 Tonne	426	0.2%
Total	**266,377**	**100%**

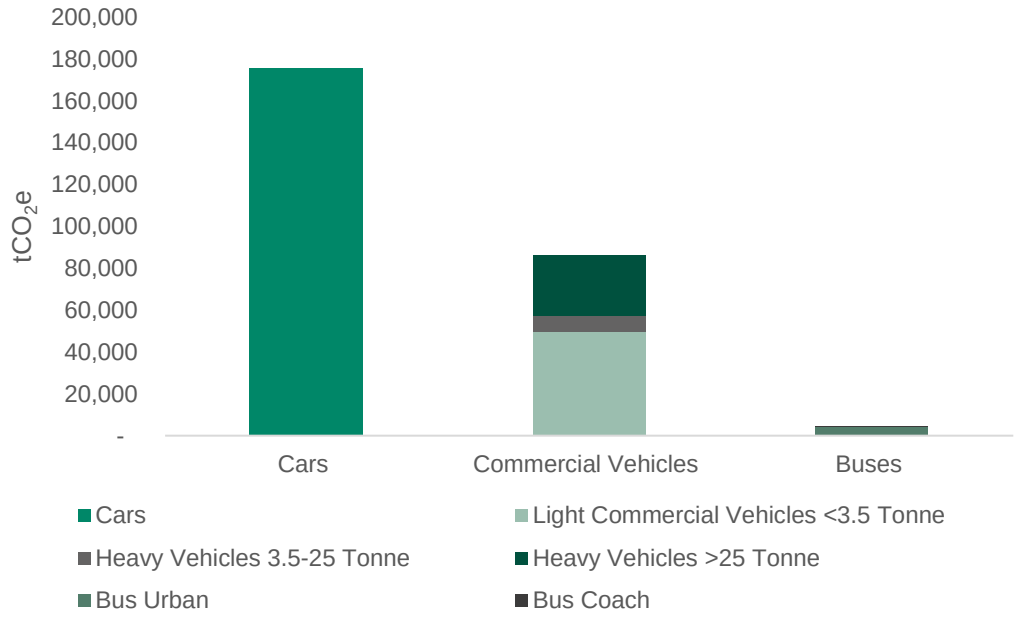

Figure 3 On-road transport emissions by vehicle class

Alongside total transport emissions, we can also look at emissions compared to distance travelled by different vehicle types. Table 3 shows the emissions per vehicle class as above but also includes the Vehicle Kilometres Travelled (VKT) by each vehicle class in Wellington and shows the average GHG emissions per VKT for each vehicle class. The average GHG emissions per VKT figure was calculated from the distance travelled (as per the Waka Kotahi data) and reported emissions (calculated from fuel sales and broken-down using Waka Kotahi emissions data).

Cars represent 73% of all VKT in Wellington but represent 66% of all on-road emissions in Wellington. This is due to the relatively low average tCO_2e per VKT of cars compared to heavier vehicles (which is also partly due to the use of petrol rather than diesel for cars). Despite 25-50+ tonne heavy vehicles representing 4% of all VKT in Wellington these vehicles represent 11% of all on-road emissions in Wellington. It is important to note that these figures do not take into account the weight of freight, or the number of people, being moved per vehicle, where larger vehicles may be more efficient per tonne of freight moved than smaller vehicles, or where busses may be more efficient per person than cars.

Efforts to reduce the kilometres travelled by all vehicles should be considered to reduce emissions from on-road transport. This could include enabling and encouraging increased public transport use, or diverting freight from roads onto rail and marine transport options. Efforts to improve the fuel efficiency of all vehicles should also be considered.

Table 3 On-road transport vehicle class VKT, emissions, and calculated average emissions per VKT

Vehicle Type	Vehicle Kilometres Travelled (VKT)	GHG Emissions (tCO_2e)	Average tCO_2e per VKT
Cars	896,849,611	175,481	0.0002
Light Commercial Vehicles <3.5 Tonne	241,728,032	49,817	0.0002
Heavy Vehicles 3.5-25 Tonne	27,256,564	7,384	0.0003
Heavy Vehicles 25-50+ Tonne	50,733,995	29,100	0.0006
Bus Urban 15-18 Tonne	7,092,878	4,168	0.0006
Bus Coach >18 Tonne	1,069,536	426	0.0004
Total	**1,224,730,615**	**266,377**	

5.0 Off-Road Transport Emissions Breakdown

The off-road transport emissions breakdown by sector is presented in Table 4 and Figure 4. The total off-road petrol and diesel figures are based on the Community Carbon Footprint for Wellington. These totals have then been allocated to sectors based on the *Off-road liquid fuel insights- Quantifying off-road diesel and petrol use in New Zealand*, July 2021 produced by the Energy Efficiency and Conservation Authority (EECA). It is important to note that the EECA figures used are from 2019 and are based on values for the entirety of New Zealand and are therefore not specific to uses of off-road transport fuels in Wellington.

The allocation of petrol and diesel to these sectors should be used for context only as they are not robustly reflective of fuel use in Wellington.

Diesel is the predominant fuel for off-road transport use, representing 95% of off-road transport emissions. Nationally, agriculture is the highest producing sector for off-road transport emissions, producing 27% of all off-road transport emissions. The next largest off-road transport producing sectors are building and construction, commercial, and industrial uses. These figures would likely be significantly different if data for Wellington was available.

Table 4 Off-road transport emissions by sector type and fuel type (tCO_2e)

Sector Type	Diesel	Petrol	Total	% of Total
Agriculture	6,946	98	**7,043**	**27%**
Building & Construction	4,544	1	**4,545**	**17%**
Commercial	3,508	62	**3,570**	**14%**
Industrial	3,320	6	**3,325**	**13%**
Recreational marine	1,177	1,136	**2,313**	**9%**
Mining	1,931	-	**1,931**	**7%**
Forestry & Logging	1,860	0	**1,860**	**7%**
Fishing & Hunting	1,083	1	**1,084**	**4%**
Marina Refuelling Stations	612	15	**627**	**2%**
Total	**24,980**	**1,318**	**26,298**	
% of Total	**95%**	**5%**	**-**	

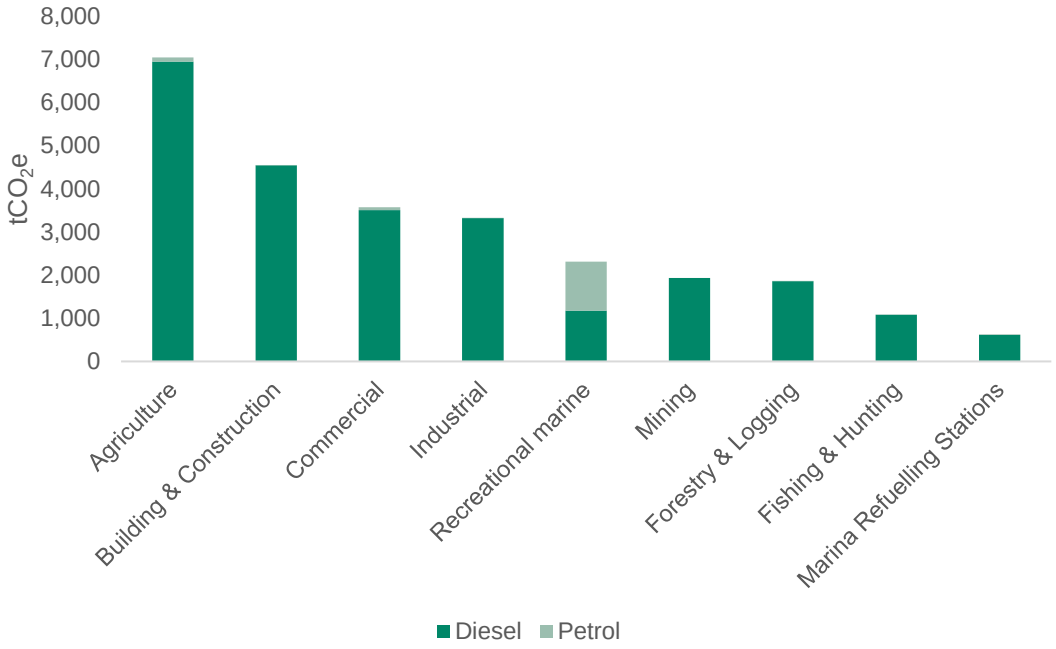

Figure 4 Off-road transport emissions by sector type and fuel type (tCO_2e)