Lower Hutt City Greenhouse Gas Inventory

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Prepared by

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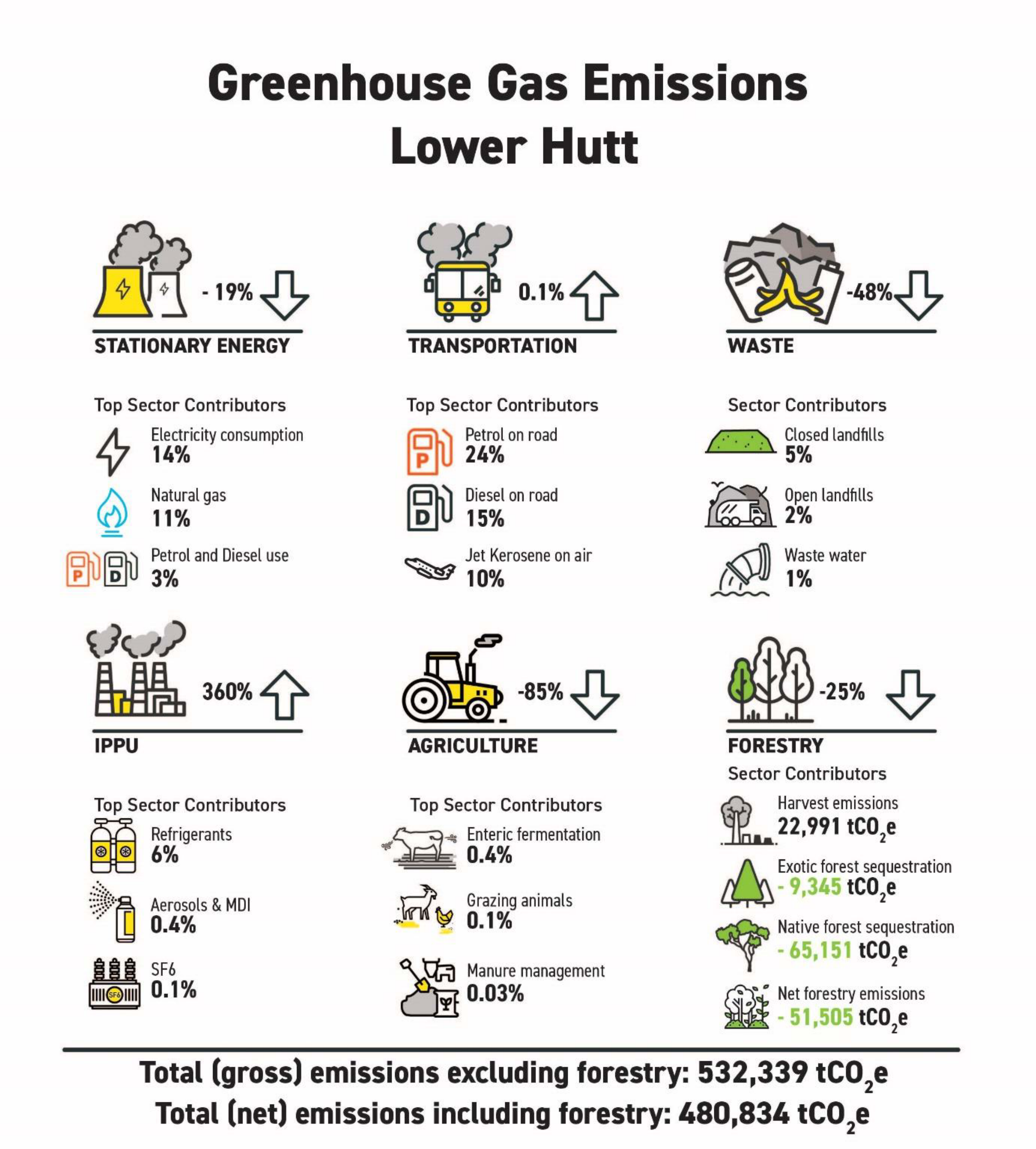
Executive Summary

Carbon emissions for Lower Hutt City have been measured using the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC). The method includes emissions from stationary energy, transportation, waste, industry (IPPU), agriculture and forestry sectors. Figure 1 summarises the rate of change in emissions and top contributors to emissions for different sectors.

Figure 1 Summary of change in emissions from 2001 to 2019 including top contributors to total gross emissions from each sector in 2019



The document is split into two parts. In Part 1 this document focusses on the results for the 2018/19 financial reporting year. Referred to hereafter more commonly as 2019 for ease. Part 2 centres on emission trends in the last two decades (2000/01 to 2018/19) or more simply 2001 to 2019. Major findings of the project include:

PART 1 – 2019 Emissions Inventory

- In the 2018/19 reporting year, Lower Hutt City emitted **gross 532,339 tCO_2e**. This equates for approximately **13%** of the Wellington region's total gross emissions, 4,190,050 tCO_2e for the reporting year.
- Transport (e.g. road, rail, and air travel) is the biggest source of emissions accounting for 55.5% of total gross emissions. Stationary Energy e.g. electricity or gas consumption is the second largest emitter, 30.5% of total gross emissions. Waste, Industry and agriculture emissions are minor sources of emissions in Lower Hutt City.
- After consideration of carbon sequestration (carbon stored in plants or soil by forests), Lower Hutt City emitted **net 480,834 tCO_2e** emissions. This equates to **19%** of the Wellington region's total net emissions of 2,552,727 tCO_2e**.**

PART 2 – Changes in Emissions Inventory, 2001 to 2019

- Lower Hutt City's emissions fell by 11%, from **gross 597,329 tCO_2e** to **gross 532,339 tCO_2e (64,990 tCO_2e)** between 2001 and 2019.
- Agriculture, waste and stationary energy emissions reduced between 2001 and 2019, by 85%, 48% and 19% respectively. The reason for the changes differs between sectors. Agriculture emissions reduced more than any sector due mainly to a reduction in the number livestock animals farmed within the city area. The use of landfill gas capture has driven the fall in emissions from waste, while greater use of renewable energy to provide electricity has reduced the influence of stationary energy on total emissions.
- Transport emissions remained consistent with less a 1% change in emissions between 2001 and 2019. Industry emissions increased by 360% in the same period. Within the transport sector road emissions from petrol and diesel use decreased by 4% from 2001 to 2019. In the industrial sector most emissions are caused by industrial refrigerant use which has increased by 405% in this period.
- The reduction in stationary energy emissions is the largest real change (rather than proportionate change) in emissions, decreasing by 37,634 tCO_2e between 2001 and 2019. The reduction of 36,209 tCO_2e in emissions from waste sent to landfill was the second biggest real change.
- Net emissions for Lower Hutt City fell by 9%, from **net 528,872** tCO_2**e** to **net 480,834 tCO_2e** between 2001 and 2019. The slightly lower change in net emissions compared to the change in gross emissions is due to a rise in emissions from harvesting of forest.

1.0 Introduction

AECOM New Zealand Limited (AECOM) has been commissioned by Hutt City Council (HCC) via a consortium of Wellington Region Councils, to assist in the development of a greenhouse gas footprint for the District for the 2018 / 2019 financial year. The study boundary incorporates the jurisdictions of the Lower Hutt City.

The results of this study are split into two parts. The focus of Part 1 of this document is to explain the results for the 2018/19 financial reporting year. Referred to hereafter as 2019 for ease. Part 2 centres on emission trends in the last two decades (2000/01 to 2018/19), or more simply 2001 to 2019.

2.0 Approach to analysis

The methodological approach used to calculate emissions follows the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC) published by the World Resources Institute (WRI) 2014. The GPC includes emissions from stationary energy, transport, waste, industry, agriculture and forestry activities within the District's boundary. The sector calculations for Agriculture, Forestry, Solid Waste and Wastewater are based on Intergovernmental Panel on Climate Change (IPCC) workbooks and guidance for emissions measurement. Sectors also use methods consistent with GHG Protocol standards published by WRI for emissions measurement when needed.

The same methodology was used for other community scale greenhouse gas (GHG) inventories around New Zealand, (e.g. Auckland, Christchurch, Dunedin, Tauranga and Southland) and internationally. The GPC methodology[1] represents international best practice for city and regional level GHG emissions reporting.

This inventory 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 location of consumption. An example of indirect emissions is those associated with the consumption of electricity, which is supplied by the national grid (Scope 2). All other indirect emissions such as cross-boundary travel (e.g. rail and flights), and energy transportation and distribution losses fit into Scope 3.

All assumptions made during data collection and analyses have been detailed within Appendix B–Assumptions. The following aspects are worth noting in reviewing the inventory:

- Emissions are expressed on a carbon dioxide-equivalent basis (CO_2e) including climate change feedback using the 100-year Global Warming Potential (GWP) values[2].
- Total emissions are reported as gross emissions (excluding forestry) and net emissions (including forestry)
- Where district-level data was not accessible, information was calculated via a per capita break-down of national or regional level data, this is further detailed in Appendix B.
- Transport emissions:
    - Transport emissions associated with air, rail and port activity were calculated using the induced activity method. Fuel consumption data was determined from the number of journeys taken, distance travelled and consumption rates for the appropriate transport mode.
    - Shipping emissions due to the movement of logs and timber were allocated based on the relative contribution of each district to harvested forest activity within the region.
- Solid waste emissions:

[1] http://www.ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities
[2] https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf (Table 8.7)

  - Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day. Lower Hutt City sends waste to the Silverstream Landfill in the Upper Hutt City District. 70% of waste entering the landfill is allocated to Lower Hutt City. This waste volume is included in the Lower Hutt City District and subtracted from Upper Hutt City District to avoid double-counting.
- Wastewater emissions:
  - Wastewater treated at Seaview is included in the Lower Hutt City figures.
- Industrial emissions:
  - Due to data confidentiality, the inventory reports all the known industrial product use emissions as one single value and does not break-down emissions by product type. The availability of emissions associated with industry is also restricted due to confidentiality issues and constraints in communication from relevant stakeholders.
- Forestry emissions:
  - This inventory accounts for forest carbon stock changes from afforestation, reforestation, deforestation and forest management (i.e. it applies land-use accounting conventions under the UN 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 inventory considers regenerating (growing) forest areas only. Capture of carbon from the atmosphere is negligible for mature forests that have reached a steady state.
- Due to changes in data sources and methodology, emissions quoted for years prior to 2018/19 may be different to those previously reported.

3.0 2019 Emissions Inventory

This section (Part 1) deals with emission results for the reporting year 2018/19 (2019). The paragraphs, figures and tables below explain the overall emissions and emissions from each sector. The focus of the information presented are gross emissions that need to be addressed in local council policy and initiatives. Results in this section are supported by further information and data in Appendix A.

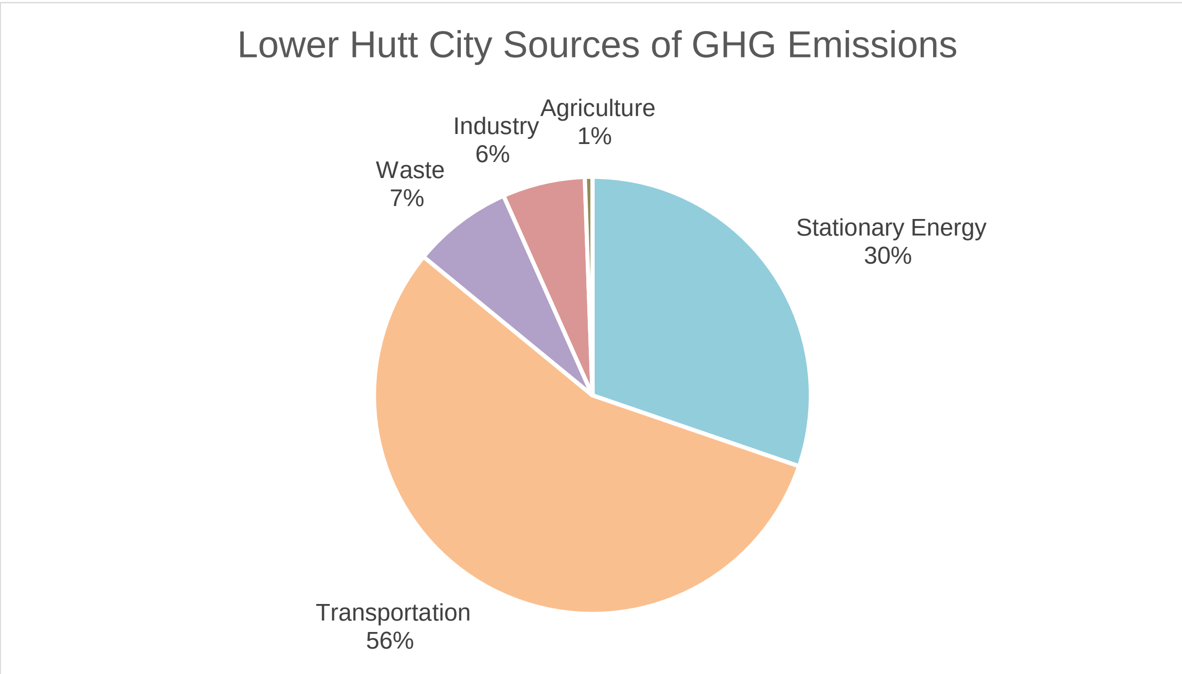
Discussion of per capita emissions is limited to when it is useful for comparing emission figures across the region or with other territorial authorities. Net emissions including results from forestry resources are reported separately.

3.1 Overall results

During the 2018/19 reporting period, Lower Hutt City emitted **gross 532,339 tCO_2e** and **net 480,834 tCO_2e** emissions. This equates for approximately **13%** of the Wellington region's total gross emissions for the reporting year.

The population in 2019 was approximately **108,700** people, resulting in per capita gross emissions of **4.9 tCO_2e/person.** Transportation emissions are the largest contributor to the inventory for the district, followed by Stationary Energy (refer to Figure 2 and Table 1).

Figure 2: Lower Hutt City's GHG gross emissions split by sector.



The district-level carbon footprint inventory comprises emissions for six different sectors, summarised below:

Stationary Energy: Producing 162,105 tCO_2e in 2019, stationary energy was Lower Hutt City's second highest emitting sector (30.5% of total gross emissions). Electricity consumption was the cause of 77,218 tCO_2e, or 14.5% of total gross emissions.

- Industrial stationary energy consumption accounts for 52% of stationary energy emissions (84,427 tCO_2e) and 16% of total gross emissions.
- Residential stationary energy consumption accounts for 21% of stationary energy emissions (34,470 tCO_2e) and 6% of total gross emissions.

- Commercial stationary energy consumption accounts for 17% of stationary energy emissions (27,523 tCO_2e) and 5% of total gross emissions.
- The remaining 10% of stationary energy emissions (28,260 tCO_2e, 3% of gross emissions) were produced by diesel and petrol, which were not allocated to the above categories.

Transportation: The highest emitting sector, transport, produced 295,494 tCO_2e in the reporting year (55.5% of Lower Hutt City's gross total emissions). Most of these emissions can be attributed to On and Off-Road transportation (Petrol and Diesel) within the city, which produced a total of 190,167 tCO_2e (64% of the sector's emissions and 36% of total gross emissions). The rest of the transport emissions are produced by Lower Hutt City's share of the emissions associated with air, rail, LPG and Bus Electricity and port activities totalling 105,328 tCO_2e (36% of the sector's total emissions and 20% of total gross emissions).

Waste (solid & wastewater): Waste originating in Lower Hutt City (solid waste and wastewater) produced 39,299 tCO_2e in 2019 which comprises 7.4% of the City's total gross emissions. Solid waste produced the bulk of this, 36,452 tCO_2e in 2019, making up 93% of total waste emissions.

Solid waste emissions include emissions from both open landfills and closed landfills that are still emitting GHGs. Both open and closed landfills emit landfill (methane) gas from the breakdown of organic materials disposed of in the landfill. Open landfills contributed 10,518 tCO_2e (2%) and closed landfills 25,933 tCO_2e (5%) to gross emissions respectively.

Wastewater produced 2,847 tCO_2e making up 7% of total waste emissions. Wastewater tends to be relatively small emission source compared to solid waste as advanced treatment of wastewater produce low emissions. In contrast, solid waste generates methane gas over many years as organic material enters landfill and emissions depend on the efficiency and scale of landfill gas capture.

Industrial Processes and Product Use (IPPU): This sector includes emissions associated with the consumption of GHGs for refrigerants, foam blowing, fire extinguishers, aerosols, metered dose inhalers and Sulphur Hexafluoride for electrical insulation and equipment production. The IPPU sector also includes emissions associated with industrial activity within the City, which due to confidentiality of data, are reported as a single value. IPPU emissions do not include energy use from industrial manufacturing, which is included in the relevant stationary energy sub-category (e.g. coal, electricity and/or petrol and diesel).

IPPU in Wellington City produced 32,477 tCO_2e in 2019, contributing 6.1% to the City's total gross emissions.

Agriculture: The agricultural sector emitted 2,964 tCO_2e in 2019. Unsurprisingly, this is the smallest contributor to Lower Hutt's total gross emissions (0.6%). Enteric fermentation produced 80% of Lower Hutt City's agricultural emissions (2,372 tCO_2e). Most of the remaining agricultural emissions were produced from manure from grazing animals on pasture (352 tCO_2e).

Forestry: Lower Hutt City has a regenerative native forested area which includes Manuka, Kanuka and Broadleaved Hardwoods. Regenerating natives occupy 13,337 ha with exotics occupying a further 253 ha of land. In total, 74,496 tCO_2e were sequestered by forests in the Lower Hutt City area in 2019.

Of the total sequestered CO_2, native forests sequestered 65,151 tCO_2e while exotic forests sequestered 9,345 tCO_2e in 2019. With emissions produced from harvesting of forestry producing 22,991 tCO_2e.

The detailed break-down of emissions into sub-categories for each sector is provided in Table 1, including the percentage contribution per sector and the total gross emissions (excl. forestry).

Table 1: Summary of Lower Hutt City's gross emissions split by Sector and associated sub-categories.

Sector	tCO_2e	% Gross	% Sector
Stationary Energy			
Electricity Consumption	71,358	13.4%	44.0%
Electricity T&D Loss	5,859	1.1%	3.6%
Natural Gas	50,373	9.5%	31.1%
Natural Gas T&D Loss	8,016	1.5%	4.9%
LPG	7,364	1.4%	4.5%
Stationary Petrol & Diesel Use	15,685	2.9%	9.7%
Coal	1,701	0.3%	1.0%
Biofuel / Wood	1,747	0.3%	1.1%
Total:	162,105	30.5%	100.0%
Transportation			
Petrol	125,022	23.5%	42.3%
Diesel	79,799	15.0%	27.0%
Rail Emissions	470	0.1%	0.2%
Bus (Electric)	22	0.0%	0.0%
Jet Kerosene	54,398	10.2%	18.4%
Av Gas	118	0.0%	0.0%
Marine Diesel	28,092	5.3%	9.5%
Light Fuel Oil	7,025	1.3%	2.4%
LPG	550	0.1%	0.2%
Total:	295,494	55.5%	100.0%
Waste			
Solid Waste Disposal	36,452	6.8%	93%
Wastewater	2,847	0.5%	7%
Total	39,299	7.4%	100.0%
IPPU			
Industrial Emissions	32,477	6.1%	100%
Total	32,477	6.1%	100.0%
Agriculture			
Agriculture	2,964	0.6%	100.0%
Total	2,964	0.6%	100.0%
Forestry			
Exotic Forest Sequestration	-9,345	N/A	N/A
Native Forest Sequestration	-65,151	N/A	N/A
Harvest Emissions	22,991	N/A	N/A
Total	- 51,505	N/A	100.0%

Total Emissions	**tCO_2e**
Total (net) incl. forestry	**480,834**
Total (gross) excl. forestry	**532,339**

3.2 Biogenic emissions

Biogenic CO_2 and methane emissions are stated in Table 2 and Table 3, respectively.

Biogenic CO_2 emissions from plants and animals are excluded from gross emissions as they are part of the natural carbon cycle. For example, wood biofuels originate from forestry and the Biogenic CO_2 from biofuels is excluded from gross emissions.

Biogenic CH_4 emissions are included in gross emissions due to their relatively large impact on warming relative Biogenic CO_2. For example, farmed cattle produce Biogenic CH_4 emissions via enteric fermentation that are included in gross emissions.

The importance of Biogenic CH_4 is highlighted in NZ's Climate Change Response (Zero Carbon) Amendment Act. The Act includes targets to reduce Biogenic CH_4 between 24 percent and 47 percent below 2017 levels by 2050, and 10 percent reduction 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 2 Biogenic CO_2 (Excluded from gross emissions)

Biogenic Carbon Dioxide (Excluded from gross emissions)		
Biofuel	18,396	t CO_2
Biodiesel	-	t CO_2
Landfill Gas	-	t CO_2
Total biogenic CO_2	**18,396**	**t CO_2**

Table 3 Biogenic Methane (Included in gross emissions)

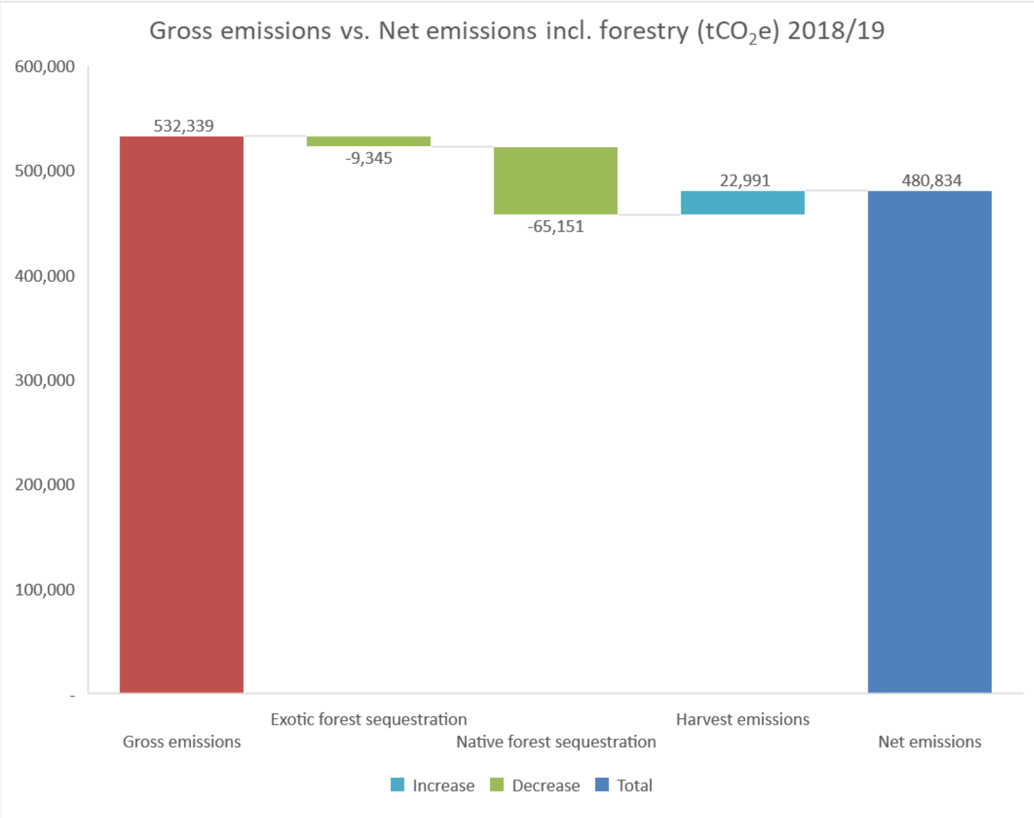
Biogenic Methane (Included in gross emissions)		
Biofuel	46	t CH_4
Biodiesel	-	t CH_4
Landfill Gas	1,072	t CH_4
Wastewater Treatment	9	t CH_4
Enteric Fermentation	70	t CH_4
Manure Management	4	t CH_4
Total biogenic CH_4	**1,201**	**t CH_4**

3.3 Net emissions

Net emissions differ from gross emissions because they include emissions related to forestry activity within an area. Emissions from forestry include two main types of activity. Harvesting of forest increases emissions via the use of fuel by equipment and releasing carbon from plants and soils. Planting of native forest e.g. Manuka, Kanuka and exotic forest e.g. pine sequesters (captures) carbon from the atmosphere while the trees are growing to maturity. When sequestration by forests exceeds emissions from harvesting the extra quantity of carbon sequestered by forest reduces total gross emissions.

Overall, forestry is a net negative source of emissions of -51,505 tCO_2e due the sequestration of carbon mostly by native forest. Net negative emissions from forestry reduce gross emissions by 10% to a total of 480,834 tCO_2e net emissions. Figure 3 shows gross emissions versus net emissions in 2019 and the impact of sequestration by Forestry.

Figure 3 Gross versus Net emissions incl. forestry



Carbon sequestered by forestry can be viewed as a liability/risk needing careful consideration. For example, what happens if there is large downturn in exports of exotic pine? If plantations are not replanted or other land use change occurs to exotic forested areas, then emissions will quickly rise. Equally, if native forest is not protected from removal, and removal does happen, then emissions will rise. In summary, when a large of amount of carbon is captured by forests, long-term planning is needed on how best to manage this carbon sink.

3.4 Comparison with other districts in the region

Table 4 shows gross emission results across the Wellington Region. Lower Hutt City's contributed to 13% of Wellington Region's total gross emissions for the 2019 reporting year.

With the largest population within the region, Wellington City contributes the highest overall emissions in comparison to the other Wellington Region districts (excluding Wairarapa). Wairarapa's high emissions are due to a large agricultural sector in that district.

Table 4: Wellington Region overall emissions - a comparison of districts

	Wellington Region	Wellington City	Porirua City	Kāpiti Coast	Lower Hutt	Upper Hutt	Wairarapa
Total Gross Emissions (tCO_2e)	4,190,050	1,061,383	304,431	351,245	532,339	206,331	1,734,320
% of Region Gross Emissions	*100%*	25%	7%	8%	13%	5%	41%

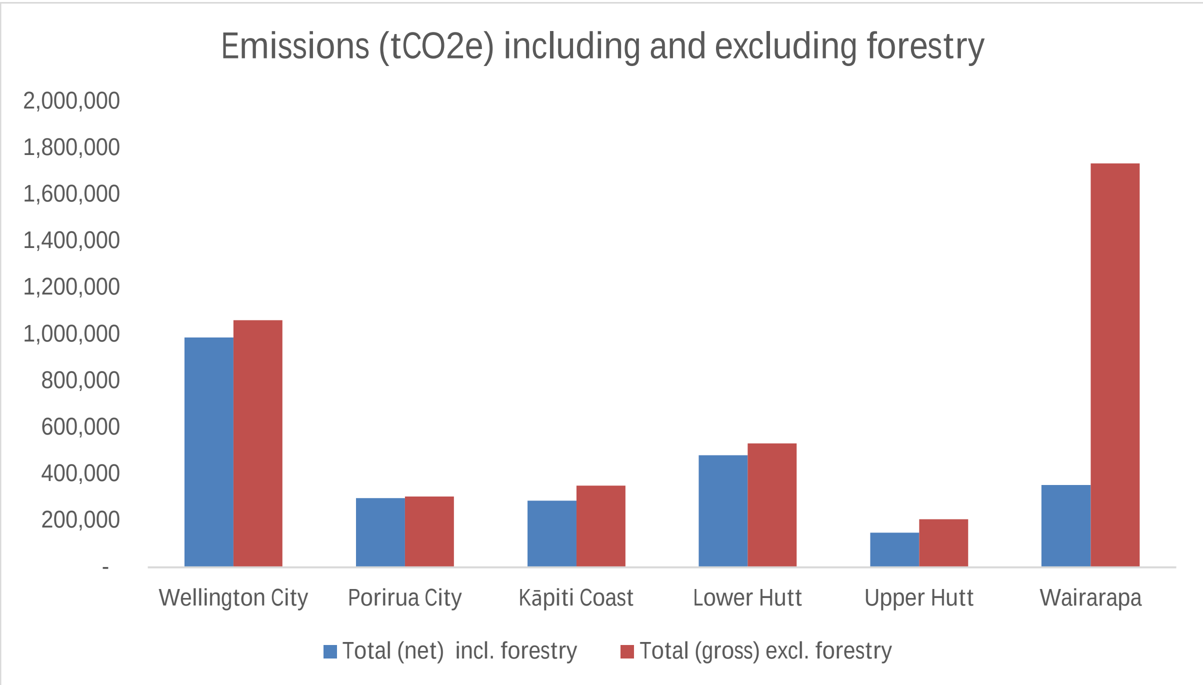
Table 5 shows figures for net emissions including sequestration from forestry. Net emissions produce a widely different pattern of results across the region than gross emissions. For example, net emissions for the Wairarapa, which has the highest gross emissions, are lower than both Lower Hutt and Wellington City.

Table 5 Net emissions (incl. forestry) in the Wellington Region

	Wellington Region	Wellington City	Porirua City	Kāpiti Coast	Lower Hutt	Upper Hutt	Wairarapa
Total Net Emissions (tCO_2e)	2,552,727	986,196	296,815	286,560	480,834	148,862	353,460
% of Region Net Emissions	*100%*	39%	12%	11%	19%	6%	14%

The influence of forest sequestration of carbon on gross emissions for Lower Hutt City, and on other parts of the region, can be seen clearly in Figure 4.

Figure 4 Gross emissions and net emissions (incl. forestry) in the Wellington Region



4.0 Changes in Emissions Inventory, 2001 to 2019

PART 2 considers the trends in emissions from 2001 to 2019. The focus of these results remains on gross emissions. However, per capita emissions are included when useful. Net emissions are discussed in the context of managing carbon sequestration by forest. Results in this section are supported by further results and data visualisations in Appendix A.

4.1 Change in emissions

Lower Hutt City's GHG inventory data covers 2001 to 2019. Figure 5 shows the change in gross emissions for each sector in the years between 2001 and 2019. The 2019 results can be directly compared with calculated data back to 2001 by using the same data and methodology as this study.

Total gross emissions fell by 11%, from 597,329 tCO_2e in 2001 to 532,339 tCO_2e in 2019. Reductions in emissions from Stationary Energy, Waste and Agriculture are responsible for the fall in total gross emissions. As the City's population has risen, per capita gross emissions have reduced by 19% from 6.0 tCO_2e in 2001 to 4.9 tCO_2e in 2019.

The rest of this section briefly summarises major changes in the sectors that make up community-scale emissions.

- **Stationary Energy:** Emissions from stationary energy reduced in number, and as a proportion of total gross emissions, in this time from 199,739 tCO2e (33% of total gross emissions) to 162,105 tCO2e (30% of total gross emissions), a fall of 3%.

  Emissions from residential stationary energy consumption shrank the most over the measurement period by 29% (48,605 tCO2e to 34,470 tCO2e). Emissions from commercial stationary energy consumption also decreased by 22% (35,428 tCO2e to 27,523 tCO2e). Industrial stationary energy emissions dropped by the least, 19% (104,152 tCO2e to 84,427 tCO2e).

  The main changes in stationary energy emissions are explained most noticeably by the changes in electricity, natural gas, petrol and diesel use between 2001 and 2019. The change in electricity consumption in 2001 and 2019 was just 4% while associated emissions reduced by 32% (113,153 tCO2e to 77,218 tCO2e). The fall in stationary energy electricity emissions are largely due to changes in the mix of fuels used for electricity generation in New Zealand e.g. the greater use of renewable energy including wind rather than fossil fuels e.g. oil, gas and coal. The use of fossil fuel to generate electricity in New Zealand has decreased since 2010 and has been replaced by renewable sources. For example, oil for electricity production was phased out and the use of wind power increased.

  Natural gas use for stationary energy has a direct relationship to the change observed in emissions. Emissions from natural gas reduced by 7% from 62,990 tCO2e in 2001 to 58,389 tCO2e in 2019.

  The emissions from petrol and diesel used for stationary energy have different trends between 2001 and 2019. Petrol emissions fell by 17% from 1,120 tCO2e to 927 tCO2e. In the same year's diesel emissions increased from 10,435 tCO2e to 14,758 tCO2e, a rise of 41%.

- **Transport:** Emissions from transport increased in number, and as a proportion of total gross emissions between 2001 and 2019, from 295,200 tCO2e (49% of total gross emissions) to 295,494 tCO2e (56% of total gross emissions), an increase of 7%.

  Road transport is the highest emitting activity within the transport sector. Road emissions decreased overall by 4% between the start and end of the measurement period. Petrol emissions reduced by 17%, from 151,010 tCO2e in 2001 to 125,022 tCO2e in 2019 and diesel emissions rose by 41% (23,378 tCO2e), from 56,421 tCO2e to 79,799 tCO2e. The 19% drop in vehicle kilometres travelled within the city over this time and the improved emissions performance of vehicle engines are the main reasons for this change.

  Air travel emissions increased the most in the transport sector. Emissions jumped by 22% (9,791 tCO2e) from 44,724 tCO2e to 54,516 tCO2e in 2001 and 2019, respectively. Marine transport emissions reduced by 11%, from 39,507 tCO2e in 2001 to 35,117 tCO2e in 2019.

- **Waste (solid & wastewater):** Waste emissions are an important measure of progress for reducing environmental impact for many stakeholders. Overall waste emissions dropped by 48% from 75,507 tCO2e in 2001 to 39,299 tCO2e in 2019. The change in emissions reflects the impact of greater use of landfill gas capture. Gas capture reduces the warming effect of emissions from landfill by either using the methane captured for electricity production or breaking it down by flaring.

  Waste continues to emit methane for many years after entering a landfill site. We have calculated annual emissions from currently open, and currently closed, landfill sites (as of 2019). Solid waste emissions from closed landfill sites reduced by 26% (9,185 tCO2e) from 35,118 tCO2e in 2001 to 25,933 tCO2e in 2019. In 2001 solid waste in closed landfill sites made up 47% of total waste emissions for Lower Hutt City. By 2019 emissions from the same emission source had reduced in quantity but still accounted for 66% of total waste emissions. This is due to a substantial reduction in emissions from open landfill, from the use of landfill gas capture. Solid waste emissions from open landfill sites decreased by 72% from 27,791 tCO2e in 2001 to 10,518 tCO2e in 2019.No closed landfill sites have landfill gas capture.

  Wastewater emissions are the smallest cause of emissions in the waste sector. As the population of the city has grown (by 10% between 2001 and 2019), associated emissions from the treatment of wastewater have trended upward. Wastewater emissions increased from 2,598 tCO2e in 2001 to 2,847 tCO2e in 2019, 10% higher. Emissions from wastewater accounted for 3% of total waste emissions in 2001. In 2019 wastewater made up 7% of total waste emissions.

- **Industry (IPPU):** Industrial Processes and Product Use (IPPU) emissions between 2001 and 2019 were a relatively small part of total gross emissions (representing 1% and 6% of total emissions in 2001 and 2019 respectively). Emissions from industrial sources jumped to 32,477 tCO2e from 7,055 tCO2e in this time, an increase of 360%. The increase in the industrial emissions follows developments at the national level in NZ where emissions have risen.

- **Agriculture:** Agriculture contributed least to emissions in the city's footprint and dropped by 85%, from 19,828 tCO2e to 2,964 tCO2e, between 2001 and 2019. The number of farm animals within the city area e.g. cattle (both diary and non-dairy), sheep and pigs fell from 25,022 to 968 in this period. However, while agricultural emissions are low, they remain an important source of Biogenic Methane targeted as a reduction opportunity in the Climate Change Response (Zero Carbon) Amendment Act.

- **Forestry:** Over the last two decades sequestration levels from regenerating forest slowly declined. Sequestration by native forest was the main source of capturing carbon in this time. Native forests e.g. Manuka and Kanuka sequestered 65,210 tCO_2e and 65,151 tCO_2e, in 200/01 and 2018/19 respectively; a change of less than 1%. Carbon stored by exotic forestry (e.g. pine) fell by 34%, sequestering 14,240 tCO_2e in 2019 compared to 9,345 tCO_2e in 2001.

  Data availability and quality for harvest emissions has rapidly improved in recent years. Harvesting emissions increased from 10,993 tCO_2e in 2005/06 to 22,991 tCO_2e in 2019. The growth in harvesting emissions potentially means exotic trees are being removed in greater numbers.

Figure 5 Gross emissions per year (excluding forestry) from 2001 to 2019

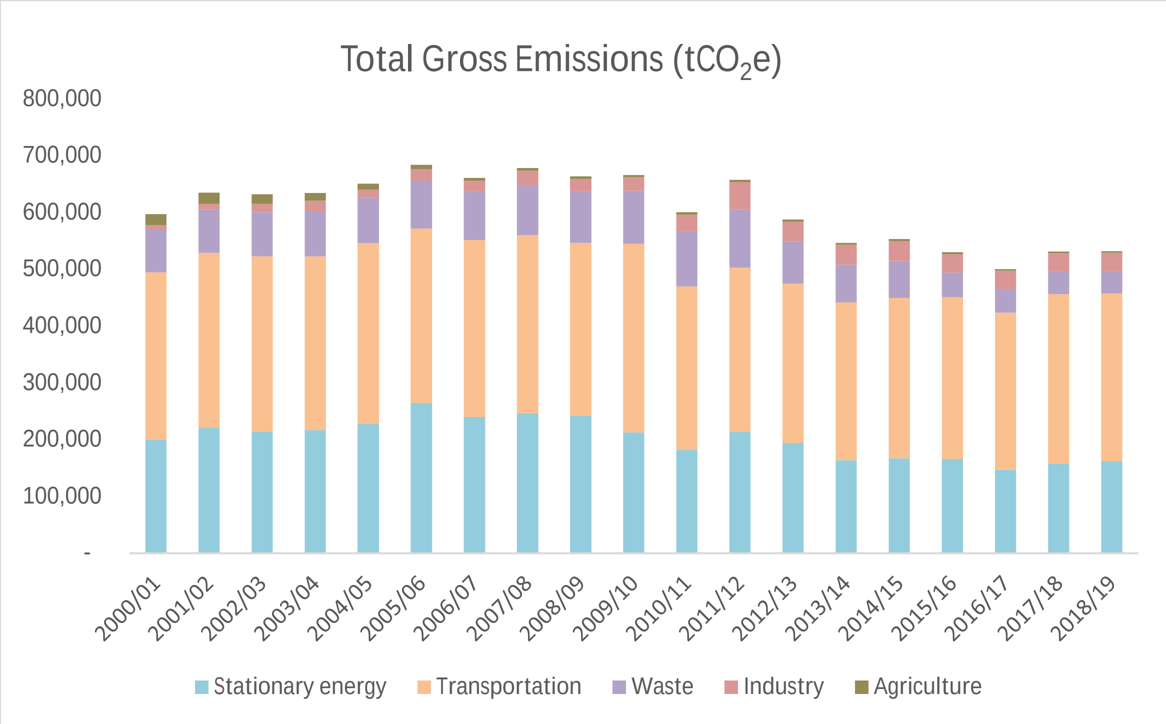
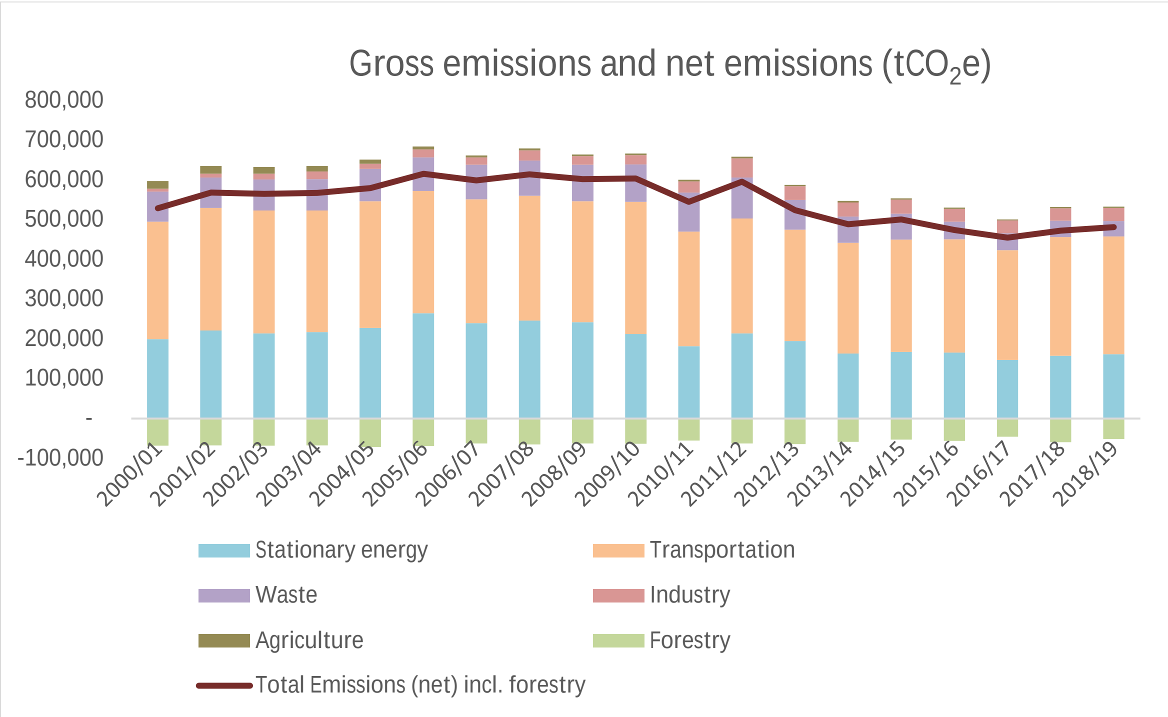


Figure 6 shows the impact of sequestration in the forestry sector on reducing net emissions. Net forestry sequestration slowly declined in Lower Hutt City and the change in net emissions follows the same pattern as gross emissions.

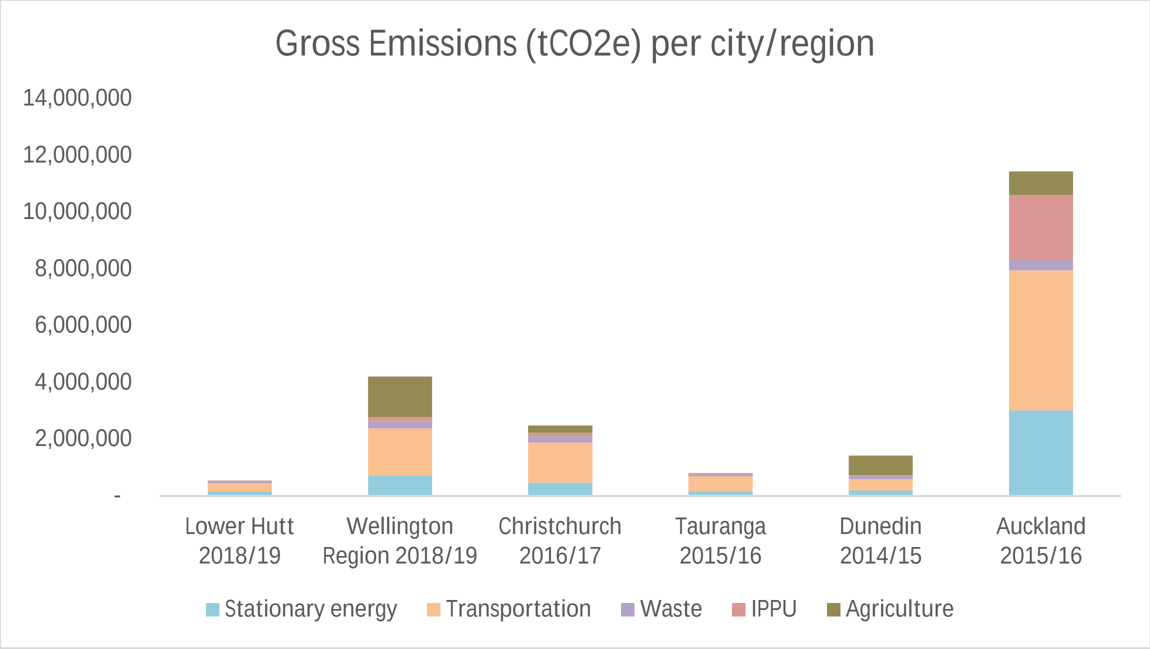
Figure 6 Emissions per year showing gross and net emissions (including forestry) from 2001 to 2019



5.0 Comparison with other New Zealand cities and regions

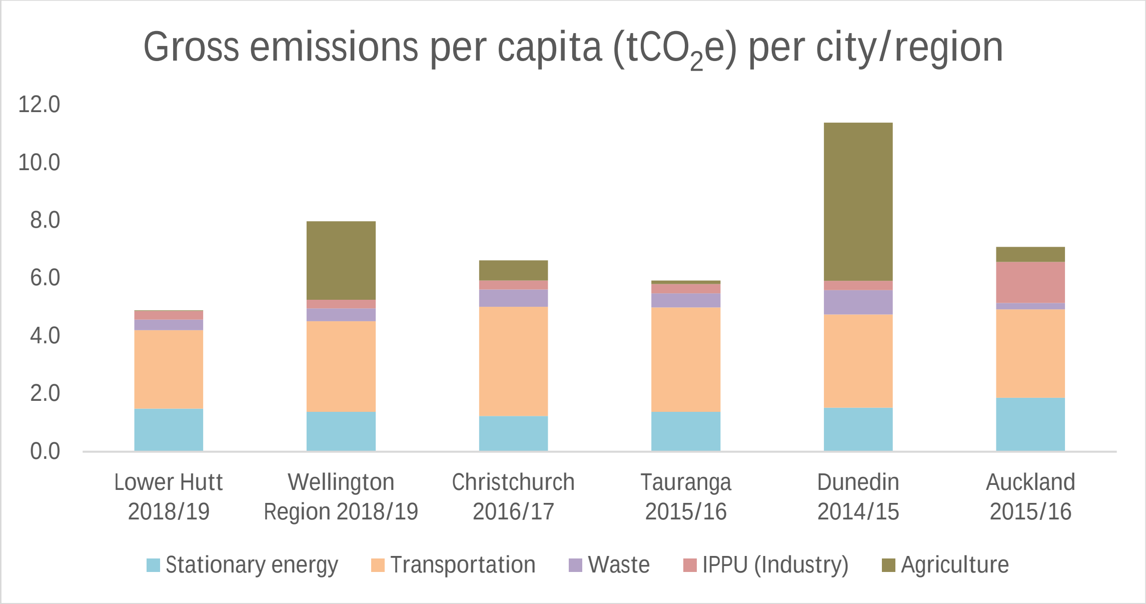
When compared with gross emissions from the Wellington region and other GHG Inventory studies, Lower Hutt City has higher gross emissions compared to Tauranga and lower gross emissions than the other areas. Note that the compared studies were conducted at differing geographic levels and in differing timeframes.

Figure 7 Comparison of gross emissions by city/region



When comparing different regional carbon footprints, a per capita figure can be useful because it provides a common reference point to understand the difference in emissions. The Wellington region has substantially higher per capita gross emissions than Lower Hutt City partly due to large agricultural emissions in other parts of the region. However, per capita emissions in Lower Hutt City are lower than in the other recent footprint studies presented in Figure 8.

Figure 8 Comparison of per capita gross emissions by city/region



6.0 Emissions and other metrics

Figure 9 shows the change in gross emissions when compared to changes in other metrics of interest between 2001 and 2019. Total gross emissions have reduced by 11%, against the backdrop of a 10% growth in population within the Lower Hutt City. Per capita emissions have fallen roughly in line with the rise in population observed.

When emissions grow less rapidly than Gross Domestic Product (GDP) as a measure of income then this process is known as decoupling. The term decoupling is an expression of the desire to mitigate emissions without harming economic wellbeing. A full discussion of decoupling of emissions is beyond the scope of this project. However, the changes in emissions and GDP illustrated in Figure 9 suggest at limited decoupling has occurred in the last two decades. GDP was 11% higher in 2019 than in 2001 while emissions per unit of GDP declined by 19%.

The exact drivers for the decoupling of emissions from GDP are difficult to pinpoint. New policies, for restructuring the way to meet demand for energy, food, transport and housing will all contribute. In this case, both direct local actions including reducing the emissions from landfill gas and indirect national trends e.g. reduction of emissions from electricity generation will have contributed to the trends noted.

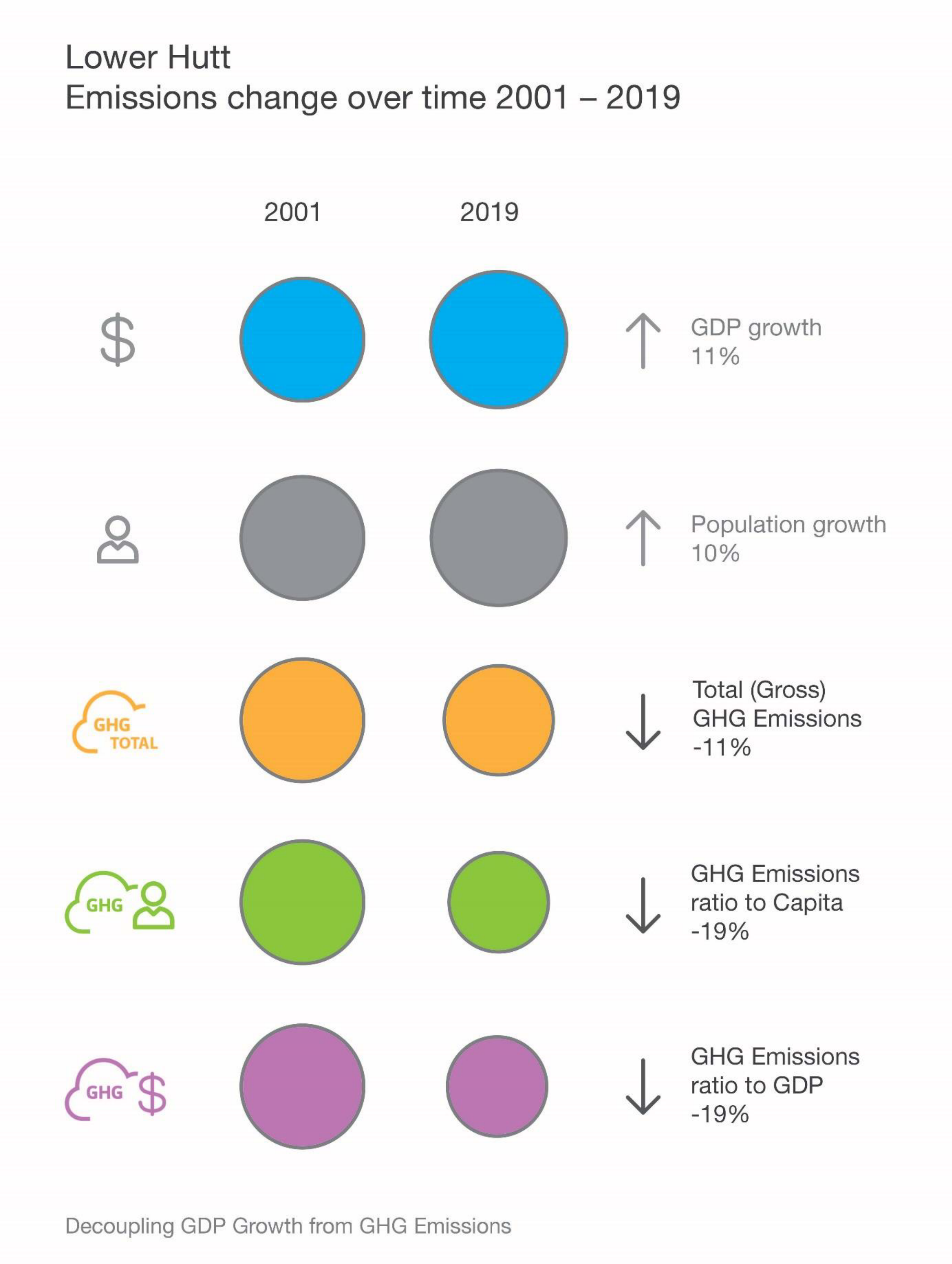
7.0 Closing statement

Lower Hutt City's updated GHG inventory provides information for the Council to demonstrate progress in emissions reductions as well as providing a continuing platform for action by the City Council, their stakeholders and the wider community**.** Sector-level data allows the City Council to target and work with those sectors, e.g. transport, which contribute the most emissions to the footprint.

Understanding of the extensive and long-lasting effects of climate change are improving all the time. The database the Council has developed over the last two decades provides an excellent foundation to implement informed decisions and policies to reduce emissions and to address climate change adaptation across the region.

We encourage councils to use the results of this study to update current climate actions plans. For example, results clearly highlight the need for rapid action to tackle the growth in emissions from air travel, marine shipping, and diesel consumption. Stationary Energy accounts for around a third of emissions; facilitating improvements in energy efficiency within this sector may be an effective method of reducing overall emissions.

Figure 9 Change in total gross emissions compared to other metrics of interest



8.0 Limitations

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Appendix A

Emission Breakdowns

Appendix A Emission Breakdowns

The pie charts below show a breakdown of the proportion of gross emissions from each sector and source. The second pie chart is focussed on the sources of emissions from stationary energy and transport emission sources.

Note: Emission sources lower than 1% of total emissions are not shown but can displayed, if needed.

Figure 10 Total gross emissions breakdown, by source (emissions representing less than 1% of total emissions are not shown)

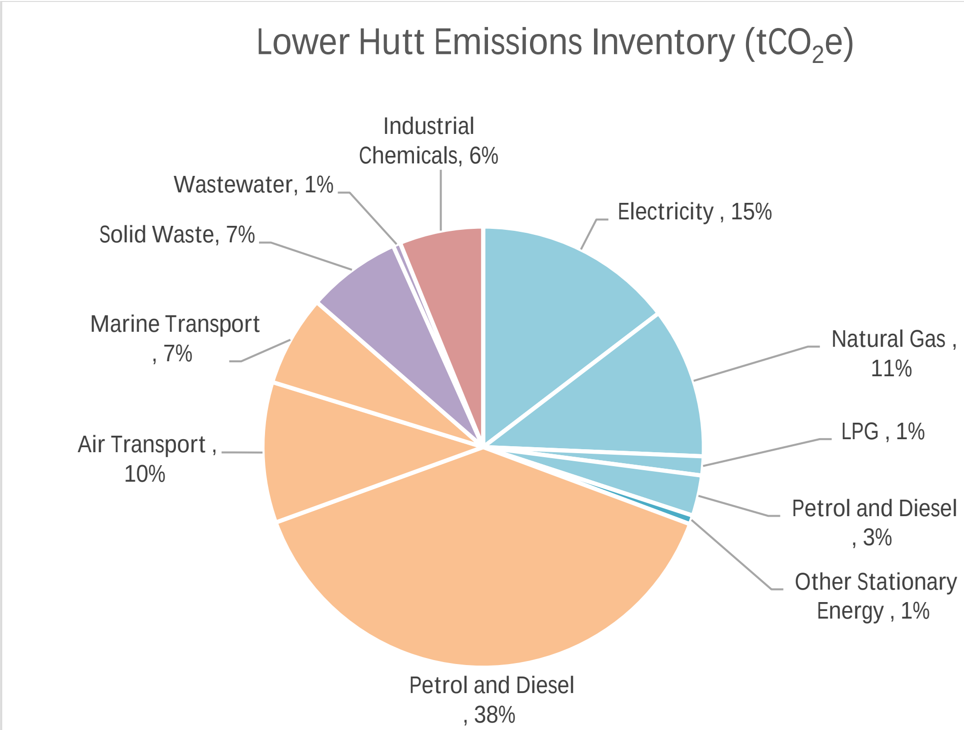


Figure 11 Total gross emissions breakdown, by source, highlighting stationary energy emissions

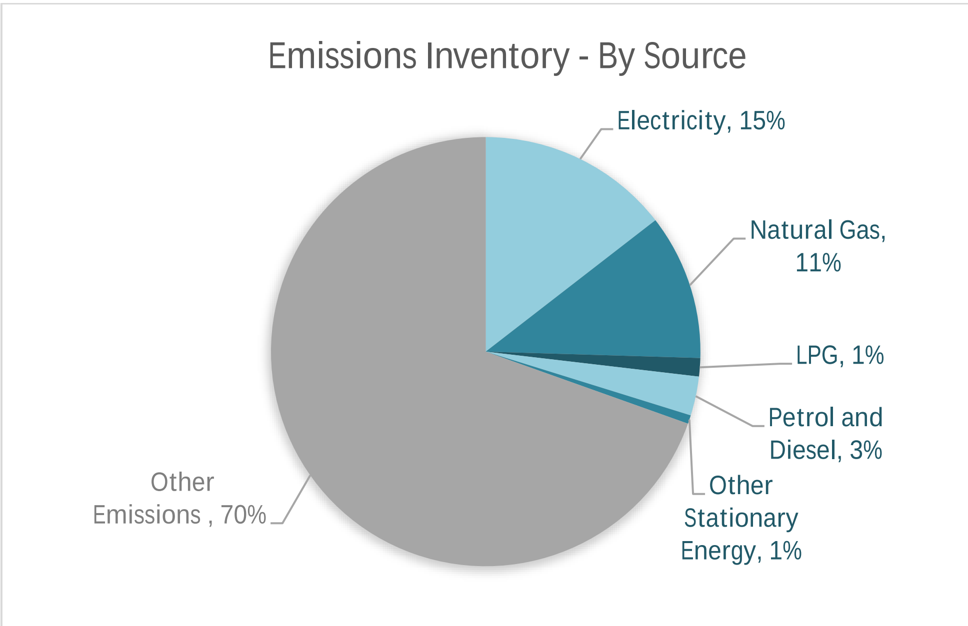


Figure 12 Total gross emissions breakdown, by source, highlighting stationary energy emissions (showing breakdown by stationary energy sector)

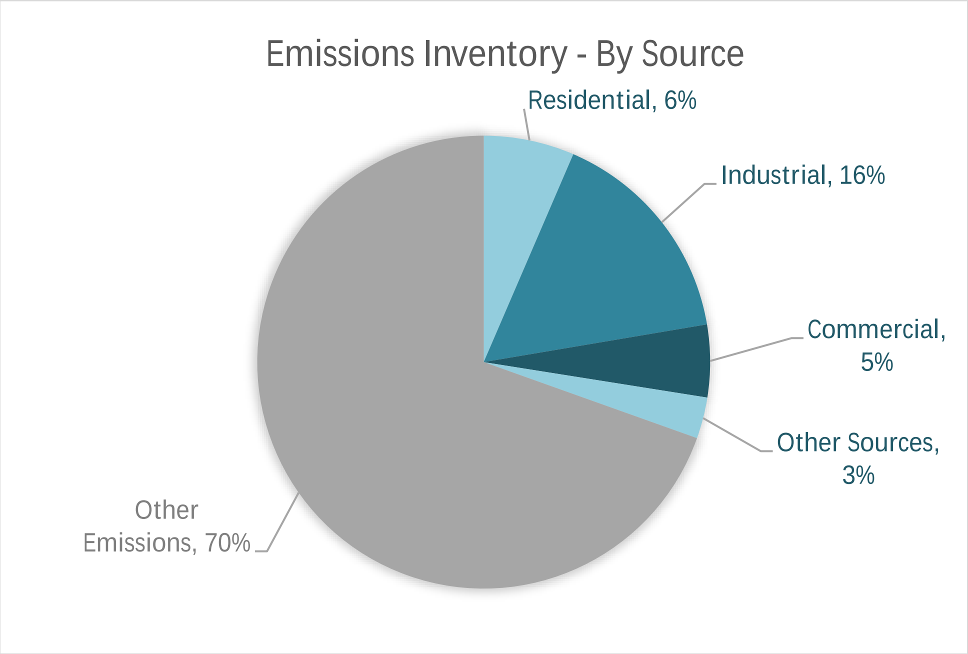
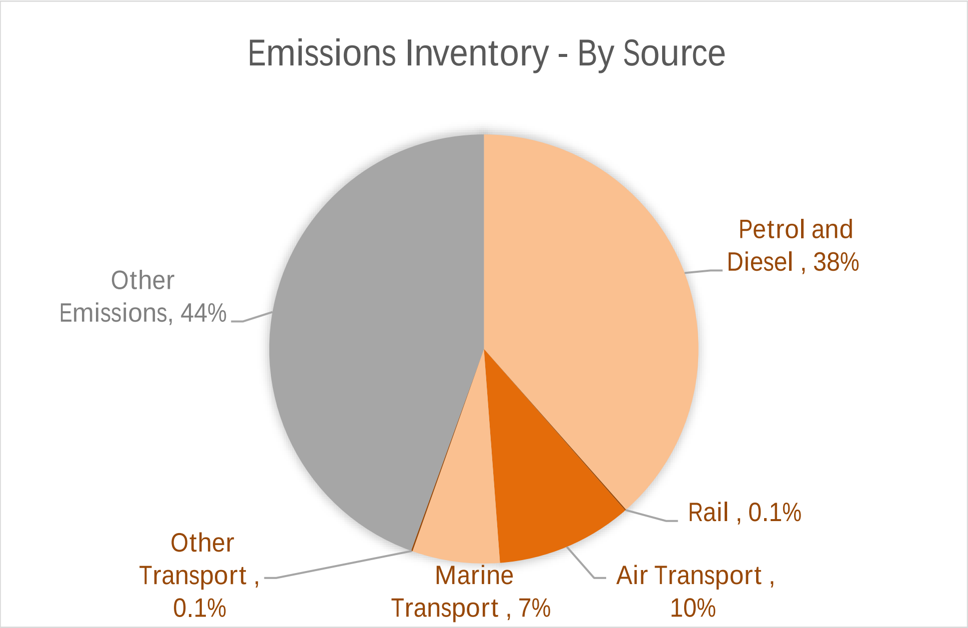


Figure 13 Total gross emissions breakdown, by source, highlighting transport emissions



Basic and Basic+ emissions reporting (Global Covenant of Mayors)

BASIC and BASIC+ emissions reporting are standardised reporting methods used by the Global Covenant of Mayors for Climate and Energy for comparison of emissions with other cities around the world and to demonstrate the importance of city-level climate action at a local and global scale. BASIC and BASIC+ emissions are reported as outlined in the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC).

BASIC emissions reporting excludes emissions from Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use and greenhouse gas emissions occurring outside the city boundary as a result of activities taking place within the city boundary. BASIC+ emissions reporting includes those emissions excluded from BASIC emissions reporting (which is equal to the total gross emissions reported in this study).

Table 6 BASIC and BASIC+ emissions

	Emissions tCO_2e
BASIC	483,022
BASIC per capita	4.4
BASIC+	532,339
BASIC+ per capita	4.9

Per capita emissions

The Wairarapa's particularly high per capita emissions are predominantly due to a large agricultural sector in that region, combined with a small population.

Figure 14 A comparison of per capita gross emissions (tCO_2e) between territorial areas in the Greater Wellington Region.

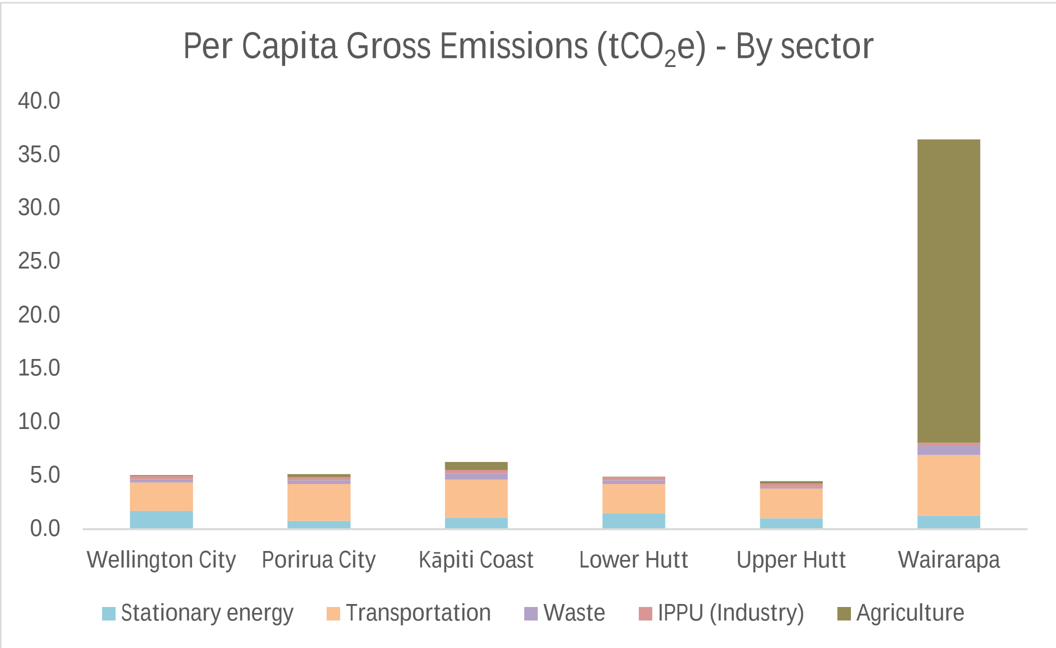


Figure 15 A comparison of per capita gross emissions (tCO_2e) between territorial areas in the Greater Wellington Region, excluding the Wairarapa.

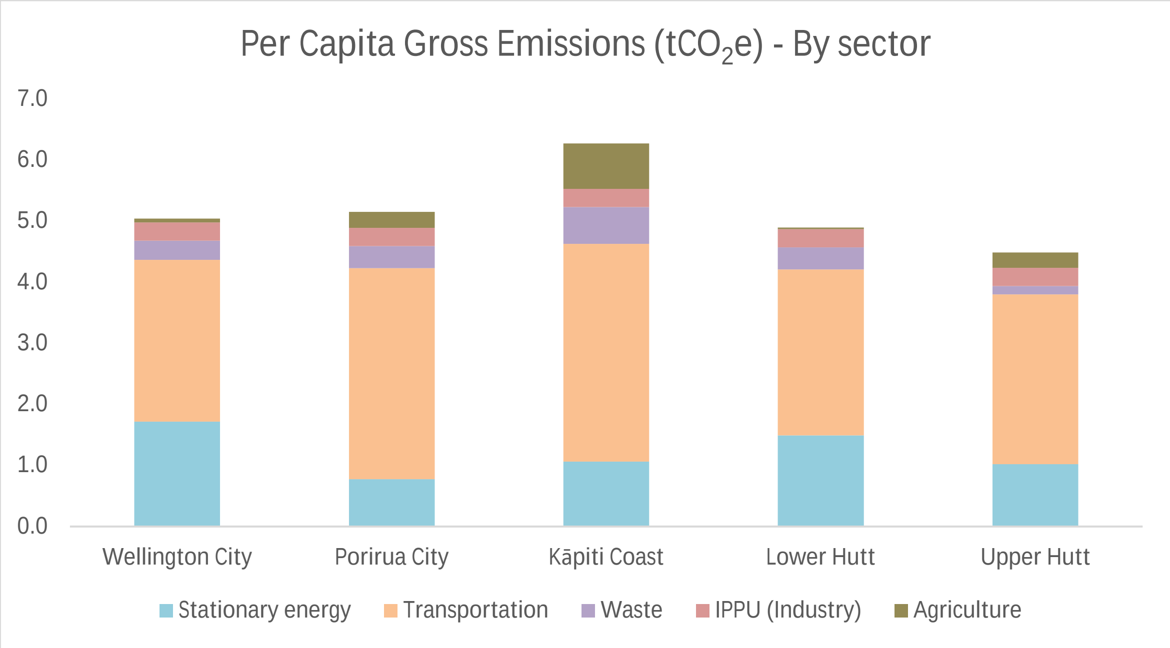
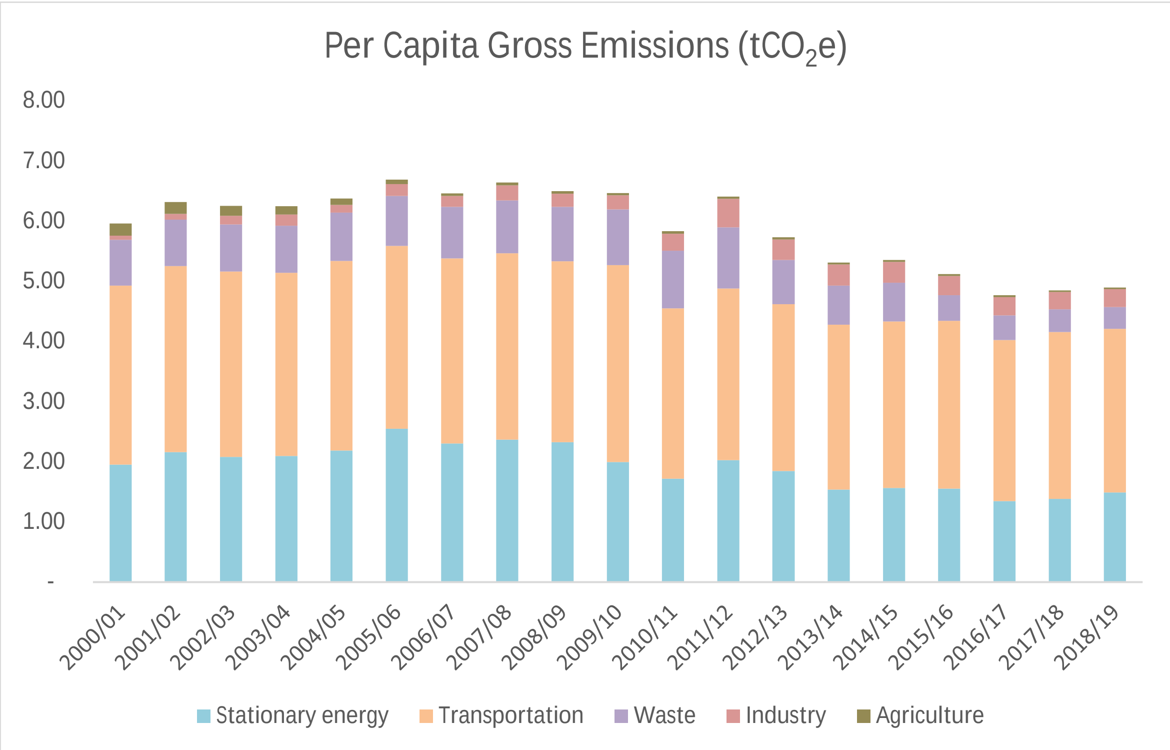


Figure 16 Per capita gross emissions per year, by sector (2001-2019)



Appendix B

Assumptions

Nova Sector / Category	Assumption and Exclusions
General	
Geographical Boundary	LGNZ local council mapping boundaries have been applied
Population	Where district-level data was not accessible, information was calculated via a per capita break-down of national or regional level data. This is detailed in each emission section below.
Transport Emissions	
Petrol and Diesel:	Regional sales figures were used. A per capita split was then applied to distribute the sales figures between each district by population. The transport vs stationary energy share of the fuel was calculated using national inventory data. The on-road and off-road split of petrol and diesel was calculated using the Energy Efficiency and Conservation Authority (EECA) national percentage split. On-road is defined as all standard transportation vehicles used on roads e.g. cars, bikes, buses. Off-road is defined as machinery for agriculture, construction and other industry used off-roads.
Rail Diesel	Consumption was calculated by Kiwi Rail using the Induced Activity method for system boundary. 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 carries 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 amount of litres of diesel consumed per route was then split between the departure district, arrival district and any district the freight stopped at along the way. If the freight travelled through but did not stop within a district, no emissions were allocated.
Jet Kerosene	Calculated using the Induced Activity method as per rail diesel. - All flight-path distances between the airport and the destination / origin airport were calculated. - A density for kerosene of 0.81g/cm^3 was applied to all trips. - Fuel Burn (kgCO_2e/km) for each model of aircraft was sourced were accessible. Where not available, the national inventory average figures were applied.

	- As per the induced activity method, only 50% of emissions calculated per one-way arrivals and departures were allocated to the airport. The remaining 50% of each leg was allocated to the destination/origin airport. - Light aircraft emissions were not calculated. Only a very small number occur, so assumed to be insignificant. Wellington Airport serves the entire Wellington Region and therefore its associated emissions have been split on a per capita basis across each district. - Departures and arrivals information, and aircraft models, were used to calculate flight numbers and represent the models of aircraft for the years between 2016 and 2019. - Fuel use data for aviation was also collected and used when possible to provide consistency with previous reporting. Kapiti Coast Airport (Paraparaumu) has been treated as a local airport predominantly serving the Kapiti Coast area. Its associated emissions are split between KCDC and the destination/origin location. - The total number of annual scheduled flights, and aircraft models, has been used to calculate total fuel use for the reporting year. Scope 2 electricity use by airport / planes are incorporated within the general electricity consumption data for the district.
Aviation Gas	The total volume of aviation gas consumed by Wellington Airport has been split between the districts on a per capita basis. This reflects the assumption made that Wellington Airport serves the entire Wellington region and not just the district in which it is situated. Av Gas consumption was estimated based on community carbon footprints developed for other regions in New Zealand.
Marine Diesel	Port Operations: - As per the induced activity method, only 50% of emissions calculated per one-way arrivals and departures were allocated to Wellington Port (CPL). The remaining 50% of each leg was allocated to the destination/origin port. - Wellington City Council and Hutt City Council share equally the emissions generated by the East by West ferries. - International shipping passing through Wellington Port (CPL) 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 districts in the Wellington Region. Emissions generated by 'logs' (over 50% of total international shipping emissions) was split between districts, proportionally, by the percentage share of district forest area of harvest age (>26 years old).
Light Fuel Oil	Calculated using the Induced Activity method as per the rail and aviation data. Does not include fuel use for private boating
LPG	North Island national consumption figures were used. LPG consumption and associated emissions have been split on a per capita basis across each district.
Bitumen	Not calculated
Lubricants	Not calculated

Stationary Energy Emissions	
Electricity Demand	Electricity demand has been calculated using national-level demand figures (kWh) from the MBIE, broken down on a per capita basis across each district, and district-specific Grid Exit Point data from the Electricity Authority (New Zealand). The breakdown into sectors is based on NZ average consumption per sector (residential, commercial and industrial).
Electricity Generation	There is electricity generation in the Wellington region, however, emissions produced in electricity generation are not required to be reported for the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) standard.
Public transport electricity	There are electrified pubic transport systems in the Wellington region. Data has been provided at the regional level and broken down on a per capita basis for each district as public transport systems cross district boundaries.
Coal production	Not Calculated: There are no active coal mines within the region. (NZP&M 2019)
Coal Consumption	Consumption estimates based on national Commercial and Residential consumption for reporting years. Consumption and associated emissions have been split on a per capita basis across each district.
Biofuel and Wood Consumption	Consumption estimates based on national Commercial and Residential emissions for biofuel use (provided New Zealand Greenhouse Gas Emissions 1990 -2015 (MfE 2017). Consumption and associated emissions have been split on a per capita basis across each district.
LPG Consumption	National LPG sales data has been provided by the LPG Association. Consumption and associated emissions have been split on a per capita basis across each district.
Natural Gas Consumption	No assumptions were made around the district's general consumption data received from Vector. This information includes gas consumed by industrial, commercial and residential activities.
Coal Fugitive Emissions	Not Calculated: There are no active coal mines within the region. (NZP&M 2019)
Oil and Gas Fugitive Emissions	Not Calculated: There are no gas or oil processing plants within the region.
Biogenic Emissions	Consumption estimates based on national Commercial and Residential emissions for biofuel use (New Zealand Greenhouse Gas Emissions 1990 -2017 (MfE 2019). Consumption and associated emissions have been split on a per capita basis across each district.
Agricultural Emissions	
General	No assumptions were made during the collection of agricultural data as it was sourced from district-specific data provided by Statistics NZ and the Ministry for the Environment National Inventory.
Solid Waste Emissions	
Open Landfills	Kāpiti Coast District Council sends waste to two landfills outside of the Wellington region (Levin and Bonny Glen sites) and to Spicer Landfill in the Porirua District. Waste originating in KCDC sent to landfill sites outside the District is included in the KCDC emissions inventory and subtracted from the destination District's emissions inventory to avoid double-counting. Kapiti Coast District Council operated an additional landfill site

	(Otihanga) until 2013, since then Otihanga accepts clean materials only for landfill capping purposes. This waste has not been included.
Landfill Gas Recovery	LFG efficiency has been estimated based on LFG generation from waste deposited and reported LFG extraction volumes.
Closed Landfills	Data provided at the district level.
Waste Water Emissions	
Waste Water Volume	Data was provided in calendar year only.
Biochemical Oxygen Demand (BOD)	The biochemical oxygen demand (BOD) is the amount of dissolved oxygen needed (i.e. demanded) by aerobic biological organisms to break down organic material present in water. It is used as a surrogate to measure the degree of organic pollution in water. BOD has been assumed using influent composite samples and inlet flow metres.
Population connected to WWTP or Septic tanks	Population connected to waste water treatment plant or septic tanks has been provided at the district level.
Industrial Emissions	
Industry & Solvent Emissions	Calculated from MfE National Inventory data, as this the latest, most recently available data on the required solvents for the calculations to be undertaken. Emissions are estimated on a per capita basis.
Industrial Activity	National level data has been used and split on a per capita basis across each district.
Forestry Emissions	
Exotic Wood harvested	District figures were calculated using the assumed percentage share of district forest area of harvest age (>26 years old) in the region, in the reporting year.
Roundwood removal	It has been assumed that only 70% of the tree is removed as roundwood and that the above ground tree makes up approximately 74% of the total carbon stored.
Emission Factors	
General	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 EF have been applied.