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Upper Hutt City Greenhouse Gas Inventory

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Client: Upper Hutt City Council

Co No.: N/A

Prepared by

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15-May-2020

Quality Information

Document	Upper Hutt City Greenhouse Gas Inventory
Ref	60601402
Date	15-May-2020
Prepared by	Adam Swithinbank and Anthony Hume
Reviewed by	Ruth Williams

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
6	15-May-2020	Final Report	Anthony Hume Principal Sustainability & Resilience Consultant	

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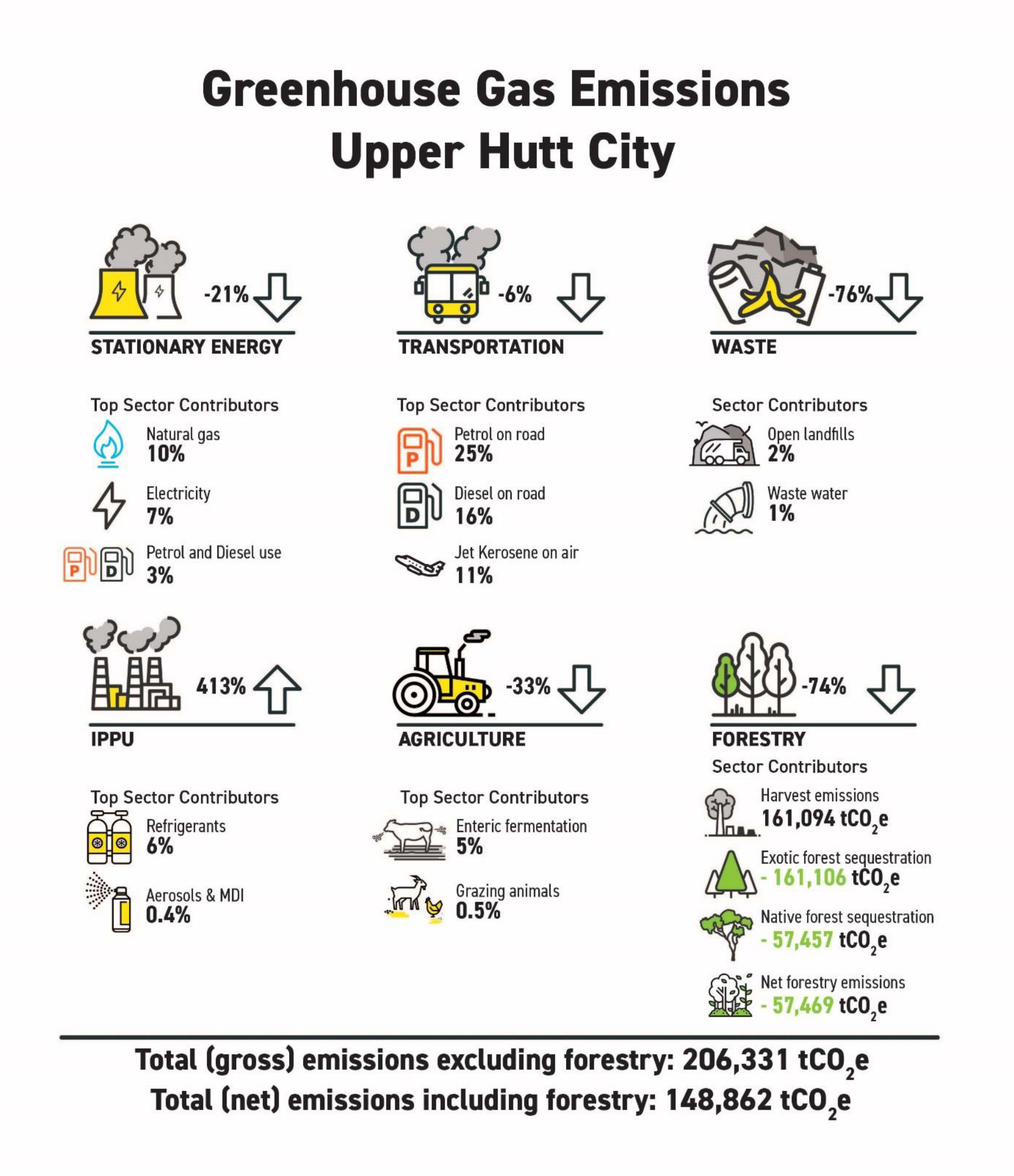
Executive Summary

Carbon emissions for Upper 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, Upper Hutt City emitted **gross 206,331 tCO_2e**. This equates for approximately 5**%** 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 62% of total gross emissions. Stationary Energy e.g. electricity or gas consumption is the second largest emitter, 23% of total gross emissions. Waste, Industry and agriculture emissions are minor sources of emissions in Upper Hutt City.
- After consideration of carbon sequestration (carbon stored in plants or soil by forests), Upper Hutt City emitted **net 148,862 tCO_2e** emissions. This equates to 6**%** of the Wellington region's total net emissions of 2,552,727 tCO_2e**.**

PART 2 – Changes in Emissions Inventory, 2001 to 2019

- Upper Hutt City's emissions fell by 15%, from **gross 241,443 tCO_2e** to **gross 206,331 tCO_2e (35,111 tCO_2e)** between 2001 and 2019.
- Agriculture, waste, stationary energy and transport emissions reduced between 2001 and 2019, by 33%, 76%, 21% and 6% 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. A 29% reduction in petrol consumption makes up the biggest real reduction in transport emissions.
- Industrial processes and product use emissions increased between 2001 and 2019, by 413%. This is the only sector where emissions increased in this time. In the industrial sector the vast majority of emissions are caused by industrial refrigerant use which has increased by 462% in this period.
- The reduction in waste emissions is the largest real change (rather than proportionate change) in emissions, decreasing by 20,126 tCO_2e between 2001 and 2019. The decrease of 12,844 tCO_2e in emissions from stationary energy was the second biggest real change.
- Net emissions for Upper Hutt City increased by 131,110 tCO_2e, from **net 17,752 tCO_2e** to **net 148,862 tCO_2e** between 2001 and 2019. The greater change in net emissions compared to the change in gross emissions is due to a large rise in emissions from harvesting of forest and a reduction in sequestration from exotic forest.

1.0 Introduction

AECOM New Zealand Limited (AECOM) has been commissioned by Upper Hutt City Council (UHCC) 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 Upper 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 are 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.

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[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:
    - 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 Council sends waste to the Silverstream in the Upper Hutt City Council district. This waste volume is included in the Lower Hutt City inventory and subtracted from Upper Hutt City's inventory to avoid double-counting.
- Wastewater emissions:
    - Wastewater treated at Seaview Wastewater Treatment Plant is jointly used by Lower Hutt City Council and Upper Hutt City Council. Emissions resulting from wastewater are allocated to each District accordingly.
- 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 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.

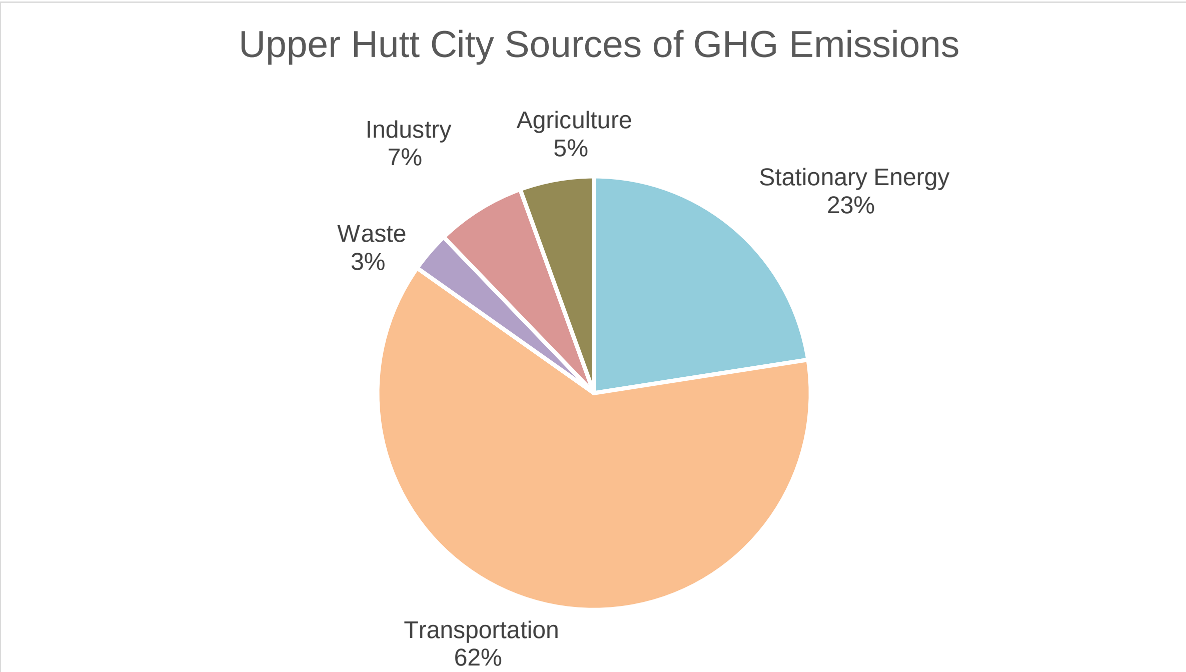
Discussion of per capita emissions is limited to when it is useful for comparing emission figures across the region or with other territorial authorities. Net emissions including results from forestry resources are reported separately.

3.1 Overall results

During the 2018/19 reporting period, Upper Hutt City (UHC) emitted **gross 206,331 tCO_2e** and **net 148,862 tCO_2e** emissions. This equates for approximately 5**%** of the Wellington region's total gross emissions for the reporting year.

The population in 2019 was approximately **46,000** people, resulting in per capita gross emissions of **4.5 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: Upper 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 46,962 tCO_2e in 2019, stationary energy was Upper Hutt City's second highest emitting sector (22.6% of total gross emissions). Electricity consumption was the cause of 14,856 tCO_2e, or 7% of the City's total gross emissions.

- Industrial stationary energy consumption accounts for 53% of stationary energy emissions (24,886 tCO_2e) and 12% of total gross emissions.
- Residential stationary energy consumption accounts for 18% of stationary energy emissions (8,584 tCO_2e) and 4% of total gross emissions.

- Commercial stationary energy consumption accounts for 15% of stationary energy emissions (6,930 tCO_2e) and 3% of total gross emissions.
- The remaining 14% of stationary energy emissions (6,562 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 127,796 tCO_2e in the reporting year (61.9% of Upper 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 85,684 tCO_2e (67% of the sector's emissions and 42% of Upper Hutt City's total gross emissions). The rest of the transport emissions are produced by Upper Hutt City's share of the emissions associated with air, rail, LPG and Bus Electricity and port activities totalling 42,111 tCO_2e (33% of the sector's total emissions and 20% of Upper Hutt City's total gross emissions).

Waste (solid & wastewater): Waste originating in Upper Hutt City (solid waste and wastewater) produced 6,437 tCO_2e in 2019, 3.1% of the City's total gross emissions. Waste emissions is the smallest contributor to Upper Hutt City's total gross emissions. Solid waste produced the bulk of this, 4,798 tCO_2e in 2019, making up 75% of total waste emissions.

Wastewater produced 1,639 tCO_2e making up 25% 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 Upper Hutt City produced 13,744 tCO_2e in 2019, contributing 6.7% to the City's total gross emissions.

Agriculture: The agricultural sector emitted 11,469 tCO_2e in 2019. This is the second smallest contributor to Upper Hutt City's total gross emissions (5.5%). Enteric fermentation produced 85% of Upper Hutt City's agricultural emissions (9,635 tCO_2e). Most of the remaining agricultural emissions were produced from manure from grazing animals on pasture (1,054 tCO_2e).

Forestry: Upper Hutt City has a regenerative native forested area which includes Manuka, Kanuka and Broadleaved Hardwoods. Regenerating natives occupy 10,535 ha with exotics occupying a further 4,573 ha of land. In total, 218,563 tCO_2e were sequestered by forests in the Upper Hutt City Council district in 2019.

Of the total sequestered CO_2, native forests sequestered 57,457 tCO_2e while exotic forests sequestered 161,106 tCO_2e in 2019. With emissions produced from harvesting of forestry producing 161,094 tCO_2e in 2019, the forestry sector is a net negative source of emissions (-57,469 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 Upper Hutt City's gross emissions split by Sector and associated sub-categories.

Sector	tCO_2e	% Gross	% Sector
Stationary Energy			
Electricity Consumption	13,729	6.7%	29.2%
Electricity T&D Loss	1,127	0.5%	2.4%
Natural Gas	18,190	8.8%	38.7%
Natural Gas T&D Loss	2,895	1.4%	6.2%
LPG	3,038	1.5%	6.5%
Stationary Petrol & Diesel Use	6,562	3.2%	14.0%
Coal	701	0.3%	1.5%
Biofuel / Wood	720	0.3%	1.5%
Total:	46,962	22.7%	100.0%
Transportation			
Petrol	52,301	25.3%	40.9%
Diesel	33,383	16.2%	26.1%
Rail Emissions	191	0.1%	0.1%
Bus (Electric)	9	0.0%	0.0%
Jet Kerosene	22,448	10.9%	17.6%
Av Gas	49	0.0%	0.0%
Marine Diesel	16,289	7.9%	12.7%
Light Fuel Oil	2,899	1.4%	2.3%
LPG	227	0.1%	0.2%
Total:	127,796	62.1%	100.0%
Waste			
Solid Waste Disposal	4,530	2.2%	74.5%
Wastewater	1,639	0.8%	25.5%
Total	6,437	3.0%	100.0%
IPPU			
Industrial Emissions	13,744	6.7%	100%
Total	13,744	6.7%	100.0%
Agriculture			
Agriculture	11,393	5.5%	100.0%
Total	11,393	5.5%	100.0%
Forestry			
Exotic Forest Sequestration	-161,106	N/A	N/A
Native Forest Sequestration	-57,457	N/A	N/A
Harvest Emissions	161,094	N/A	N/A
Total	-57,469	N/A	100.0%

Total Emissions	**tCO_2e**
Total (net) incl. forestry	**148,862**
Total (gross) excl. forestry	**206,331**

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	7,579	t CO_2
Biodiesel	-	t CO_2
Landfill Gas	-	t CO_2
Total biogenic CO_2	**7,579**	**t CO_2**

Table 3 Biogenic Methane (Included in gross emissions)

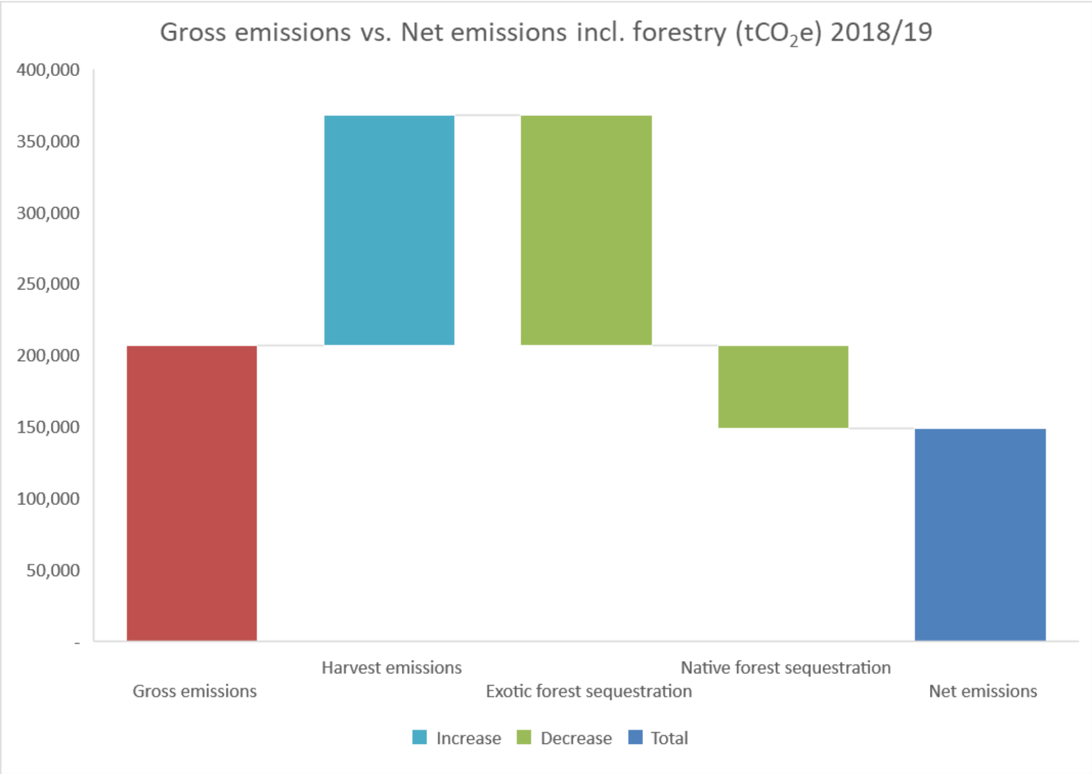
Biogenic Methane (Included in gross emissions)		
Biofuel	19	t CH_4
Biodiesel	-	t CH_4
Landfill Gas	141	t CH_4
Wastewater Treatment	18	t CH_4
Enteric fermentation	283	t CH_4
Manure Management	11	t CH_4
Total biogenic CH_4	**472**	**t CH_4**

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 -57,469 tCO_2e due the sequestration of carbon mostly by exotic forest. Net negative emissions from forestry reduce gross emissions by 28% to a total of 148,862 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

As expected with the smallest population size within the region, Upper Hutt City has the smallest amount of gross emissions in the region. With a similar population size, Wairarapa's high emissions are due to much larger agricultural sector in that district, Wairarapa also has the largest impact of forestry sequestration which reduces its total net emissions.

Table 4 shows gross emission results across the Wellington Region. Upper Hutt City contributed to 5% of Wellington Region's total gross emissions for the 2019 reporting year.

As expected with the smallest population size within the region, Upper Hutt City has the smallest amount of gross emissions in the region. With a similar population size, Wairarapa's high emissions are due to much larger agricultural sector in that district, Wairarapa also has the largest impact of forestry sequestration which reduces its total net emissions.

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%

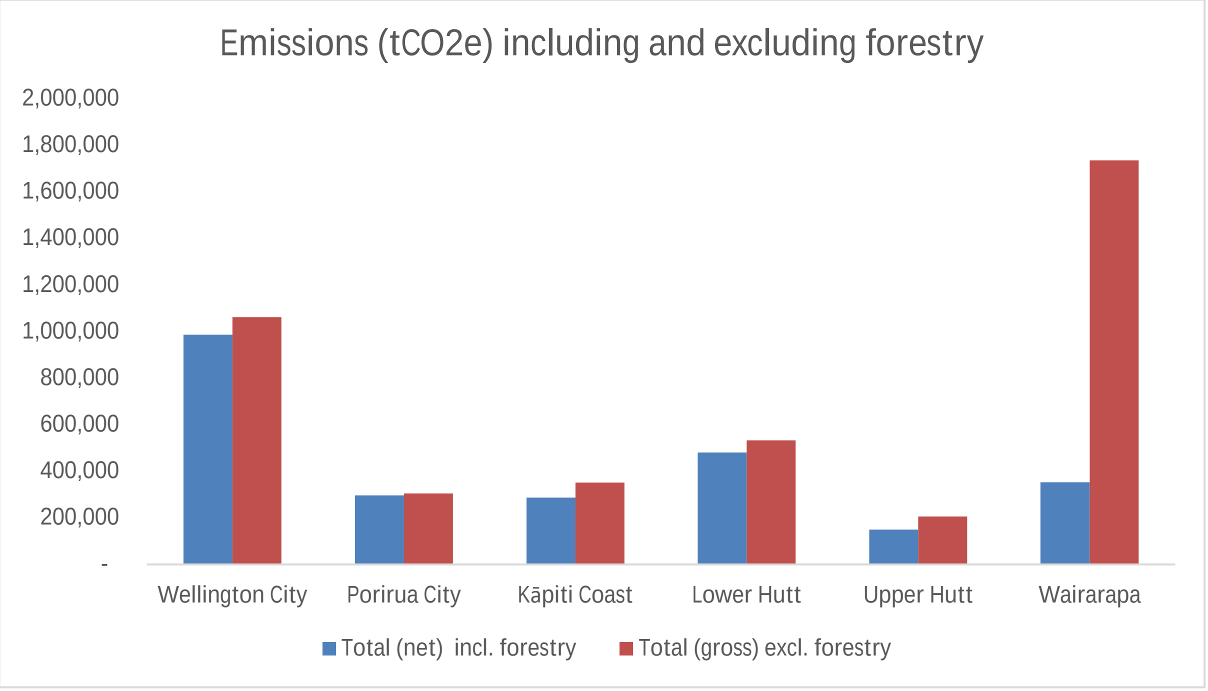
Table 5 shows figures for net emissions including sequestration from forestry. Net emissions produce a widely different pattern of results across the region than gross emissions. For example, net emissions for the Wairarapa, which has the highest gross emissions, are lower than both Lower Hutt and Wellington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


Emissions (tCO2e) including and excluding forestry
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
-
Wellington City
Porirua City
Kāpiti Coast
Lower Hutt
Upper Hutt
Wairarapa
Total (net) incl. forestry
Total (gross) excl. forestry

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

Upper 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 15%, from 241,443 tCO_2e in 2001 to 206,331 tCO_2e in 2019. Reductions in emissions from Stationary Energy, Transport, Waste and Agriculture are responsible for the fall in total gross emissions. As the City's population has risen (from 37,700 to 46,000), per capita gross emissions have reduced by 30% from 6.4 tCO_2e in 2001 to 4.49 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 59,806 tCO2e (25% of total gross emissions) to 46,962 tCO2e (23% of total gross emissions), a fall of 21%.

  Emissions from commercial stationary energy consumption shrank the most over the measurement period by 38% (11,136 tCO2e to 6,930 tCO2e). Emissions from residential stationary energy consumption also decreased by 36% (13,469 tCO2e to 8,584 tCO2e). Industrial stationary energy emissions dropped by the least, by 16% (29,566 tCO2e to 24,886 tCO2e). In real terms however, total emissions from each sector reduced by a similar amount (4,205 tCO2e, 4,885 tCO2e and 4,680 tCO2e respectively).

  The changes in stationary energy emissions between 2001 and 2019 are explained most noticeably by the changes in electricity, coal, natural gas, and diesel use. The change in electricity consumption in 2001 and 2019 was just 0.4% while associated emissions reduced by 34% (22,560 tCO2e to 14,856 tCO2e). The fall in stationary energy electricity emissions is 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.

  Emissions from coal (not including coal used for electricity generation) decreased by 86% in this time, from 5,014 tCO2e to 701 tCO2e, this represents the second largest change in real emissions in the stationary energy sector.

  Natural gas use for stationary energy has a direct relationship to the change observed in emissions. Natural gas emissions reduced by 7% from 22,746 tCO2e in 2001 to 21,085 tCO2e in 2019.

  The emissions from petrol and diesel used for stationary energy have different trends between 2001 and 2019. Petrol emissions fell by 29 from 546 tCO2e to 388 tCO2e. In the same year's diesel emissions increased from 5,089 tCO2e to 6,174 tCO2e, a rise of 21%.

- **Transport:** Emissions from transport decreased in number (by 6%) but increased as a proportion of total gross emissions between 2001 and 2019, from 135,369 tCO2e (56% of total gross emissions) to 127,796 tCO2e (62% of total gross emissions).

  Road transport is the highest emitting activity within the transport sector. Road emissions decreased overall by 17% between the start and end of the measurement period. Petrol emissions reduced by 29%, from 73,654 tCO2e in 2001 to 52,301 tCO2e in 2019 and diesel emissions rose by 21%, from 27,519 tCO2e to 33,383 tCO2e. Vehicle kilometres travelled increased by 12% over this time, it most likely that the reduction in transport emissions are related to the improved performance on emissions from vehicle engines.

Air travel emissions increased the most in the transport sector. Emissions jumped by 32% (5,499 tCO2e) from 16,997 tCO2e to 22,496 tCO2e in 2001 and 2019, respectively. Marine transport emissions also trended upwards by 27%, up from 15,153 tCO2e in 2001 to 19,188 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 76% from 26,563 tCO2e in 2001 to 6,437 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.

  Solid waste emissions from landfill in Upper Hutt City decreased by 81% from 25,137 tCO2e in 2001 to 4,798 tCO2e in 2019. Emissions from solid waste entering landfill were 95% of total waste emissions in 2001. This figure had fallen to 75% of total waste emissions by 2019.

  Wastewater emissions are the smallest cause of emissions in the waste sector. As the population of the city has grown (by 22% between 2001 and 2019), associated emissions from the treatment of wastewater have trended upward. Wastewater emissions increased from 1,427 tCO2e in 2001 to 1,638 tCO2e in 2019, 15% higher. Emissions from wastewater accounted for 5% of total waste emissions in 2001. In 2019 wastewater made up 25% 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 7% of total emissions in 2001 and 2019 respectively). Emissions from industrial sources jumped to 13,744 tCO_2e from 2,681 tCO_2e in this time, an increase of 413%. The increase in industrial emissions follows developments at the national level in NZ where emissions have risen.

- **Agriculture:** Agriculture is the second smallest emitting sector in the city's footprint and dropped by 33%, from 17,024 tCO_2e to 11,393 tCO_2e, 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 11,958 to 4,455 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:** For the last two decades sequestration levels from regenerating forest has decreased by 27%, from 299,697 tCO_2e to 218,563 tCO_2e. Sequestration by exotic forest was main source of capturing carbon in this time. Carbon stored per year by exotic forestry (e.g. pine) reduced by 33%, sequestering 161,106 tCO_2e in 2019 compared to 241,003 tCO_2e in 2001. Native forests (e.g. Manuka and Kanuka) stored 58,694 tCO_2e and 57,457 tCO_2e, in 2001 and 2019 respectively; a decrease of just 2%.

  Data availability and quality for harvest emissions has rapidly improved in recent years. Harvesting emissions increased from 76,006 tCO_2e in 2001 to 161,094 tCO_2e in 2019. The growth in harvesting emissions and reduction in sequestration from exotic forest potentially means exotic trees are being removed in greater numbers.

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

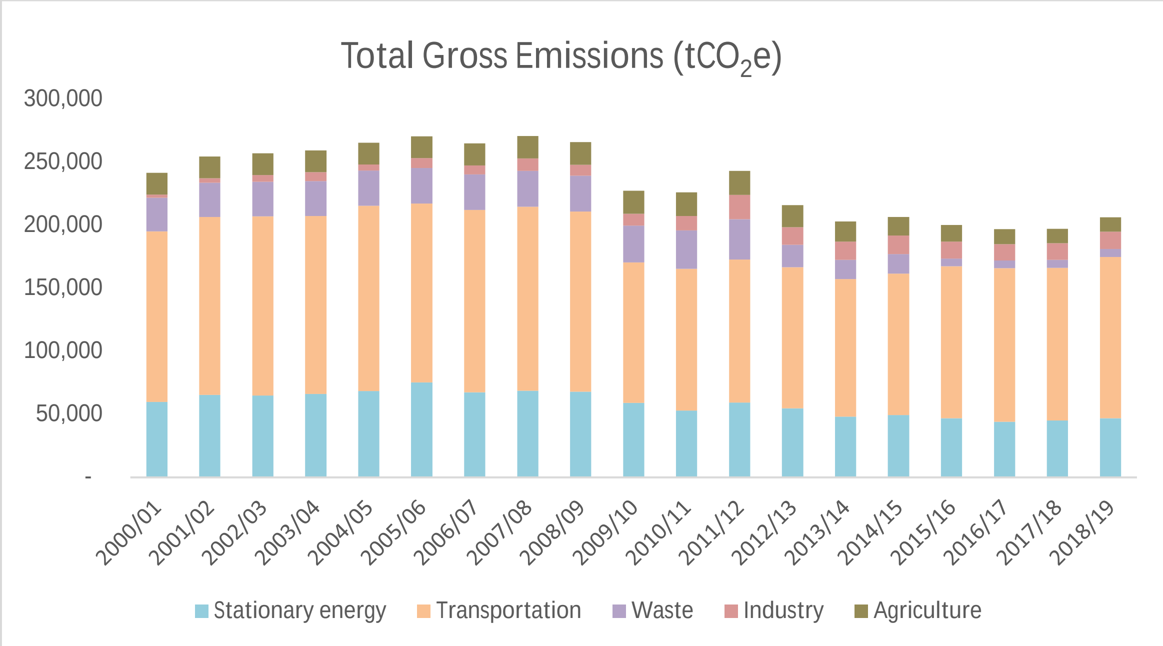
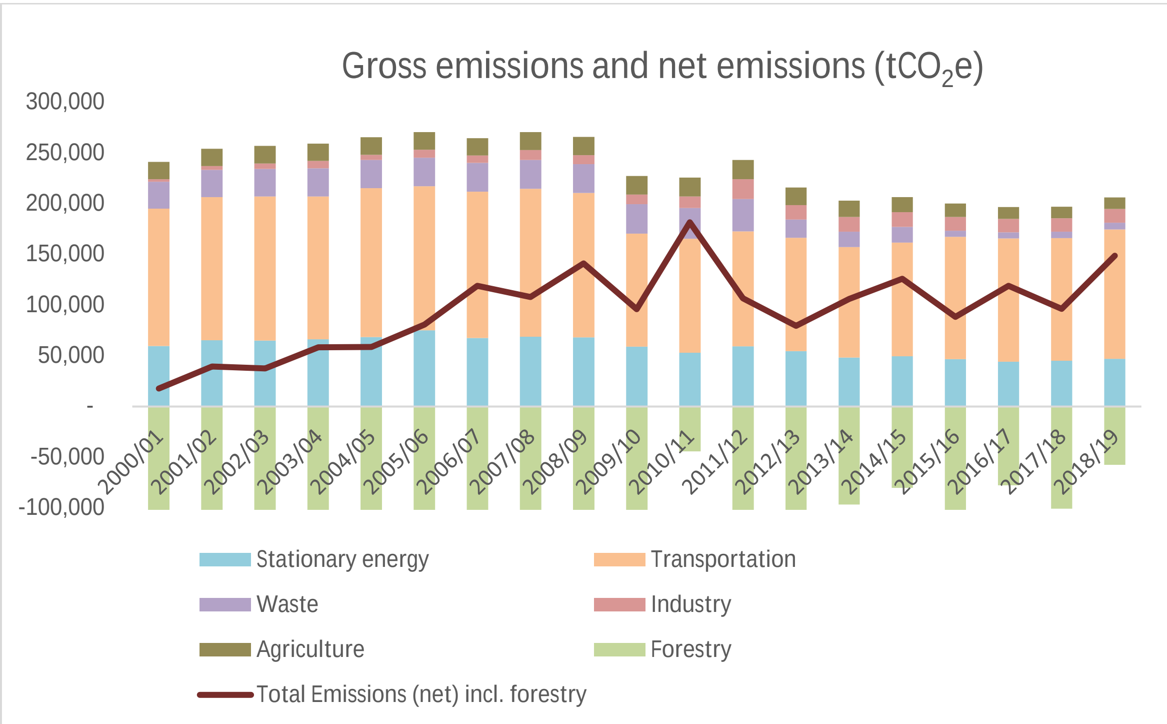


Figure 6 shows the impact of sequestration in the forestry sector on reducing net emissions. Net forestry sequestration reduced by 74% resulting in net emissions increasing by 276% between 2001 and 2019, even as gross emissions fell by 15% in the same time.

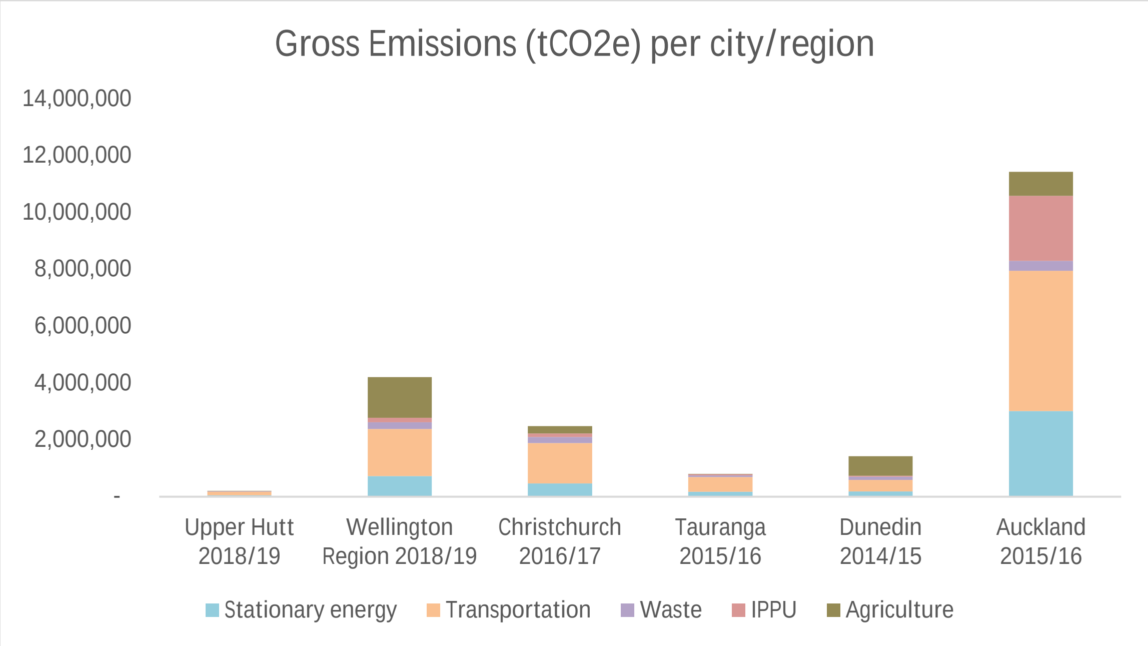
Figure 6 Emissions per year showing gross and net emissions (including forestry) from 2001 to 2019



5.0 Comparison with other New Zealand cities and regions

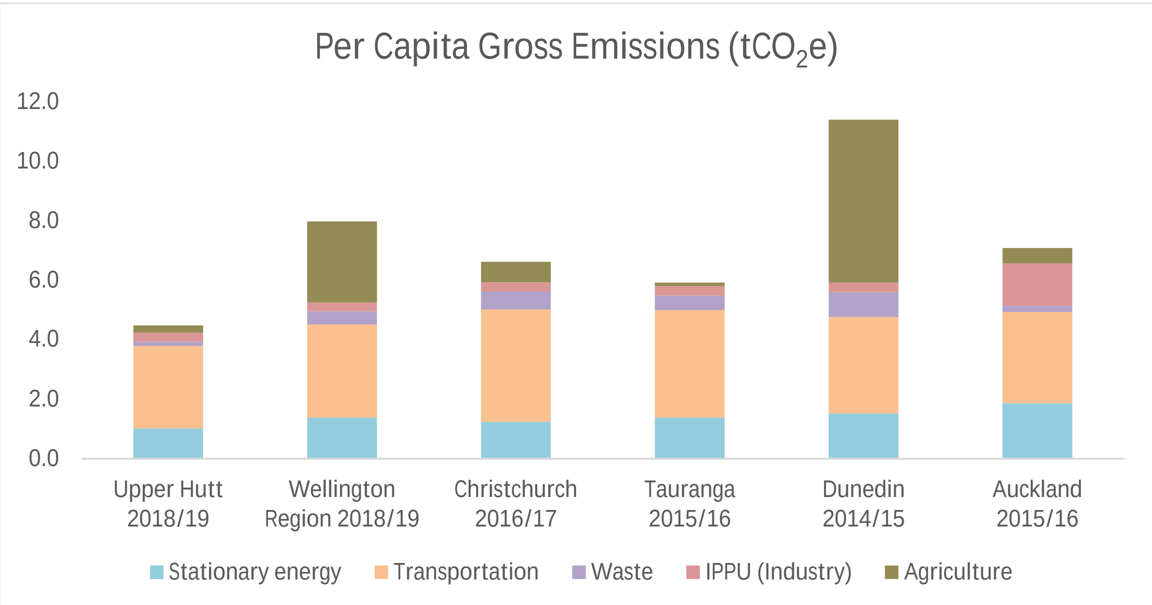
When compared with gross emissions from the Wellington region and other GHG Inventory studies, Upper Hutt City has lower gross emissions than each of the other areas. Note that the compared studies were conducted at differing geographic levels and in differing timeframes.

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. Upper Hutt City has lower per capita gross emissions that each of the compared carbon footprint studies. The Wellington region has substantially higher per capita gross emissions than Upper Hutt City particularly due to large agricultural emissions in other parts of the region where populations are small. The same effect is present for Dunedin where most of the territorial area is agricultural land.

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 15%, against the backdrop of a 22% growth in population. Per capita emissions have reduced by 30%, this is a greater rate than population growth during the same period.

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 a high-level decoupling has occurred in the last two decades. GDP was 27% higher in 2019 than in 2001 while emissions per unit of GDP declined by 33%.

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.

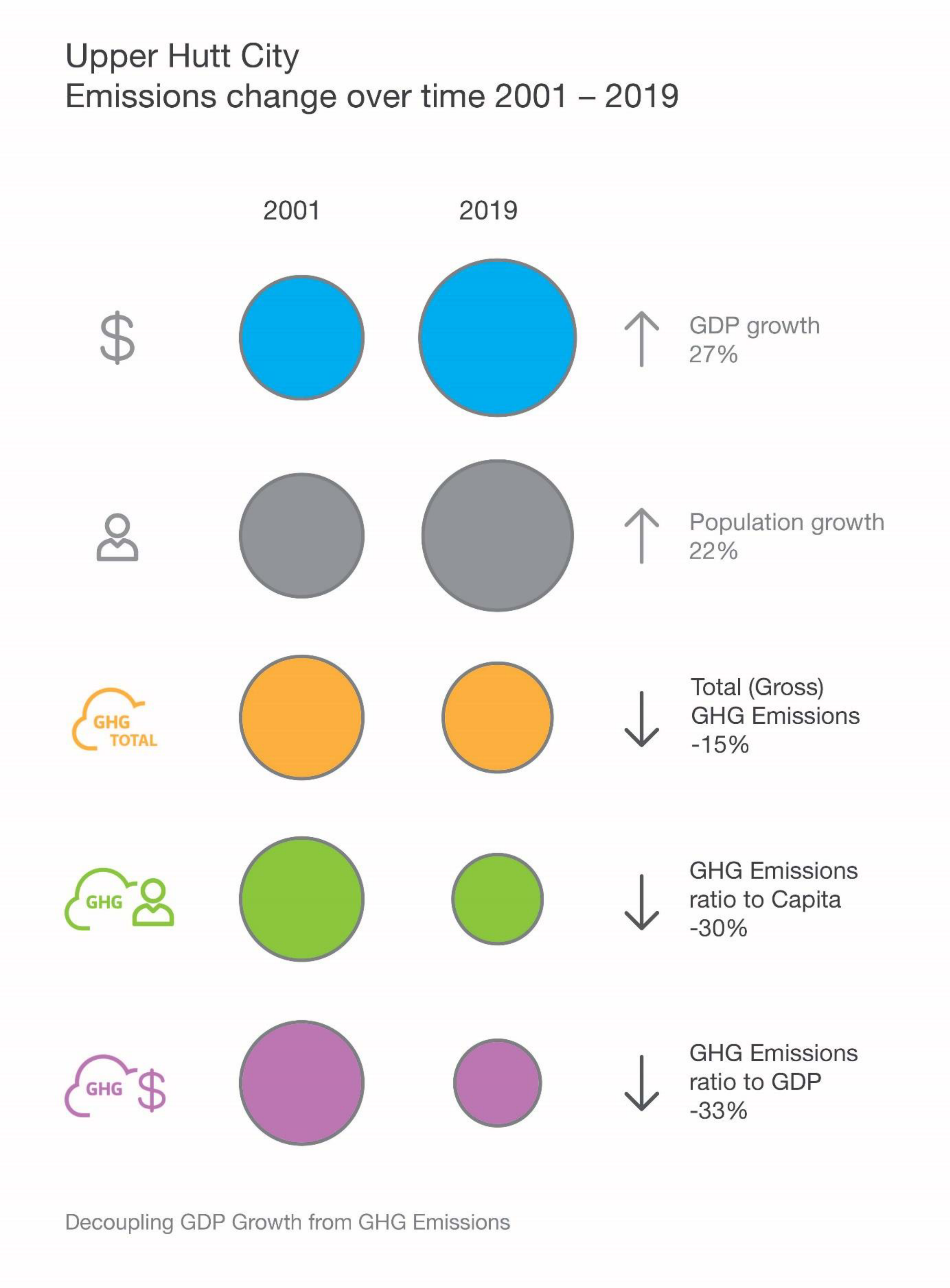
7.0 Closing statement

Upper 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.

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

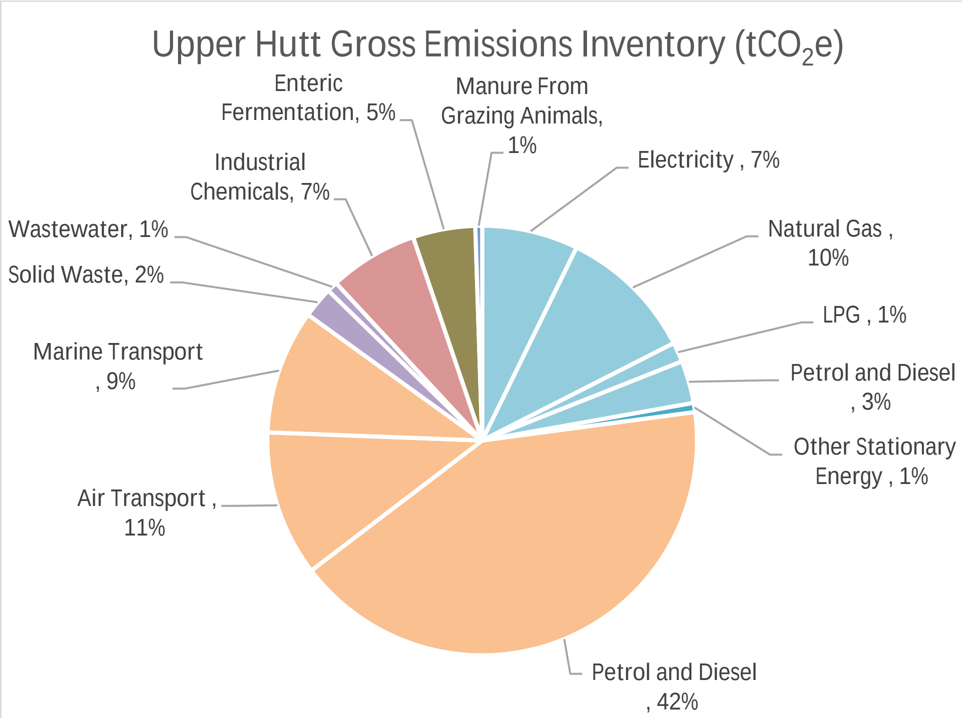


Figure 11 Total gross emissions breakdown, by source, highlighting stationary energy emissions

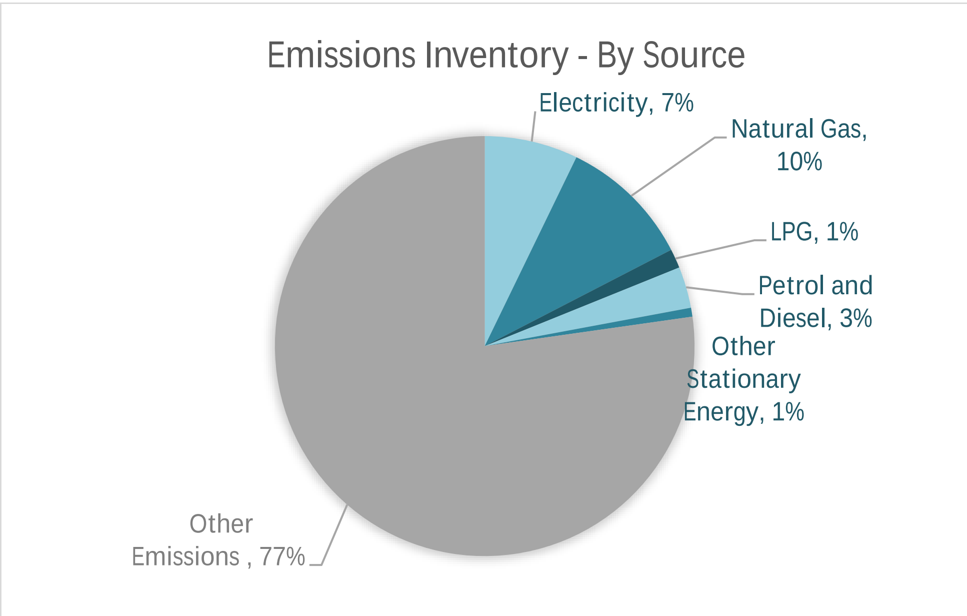


Figure 12 Total gross emissions breakdown, by source, highlighting stationary energy emissions

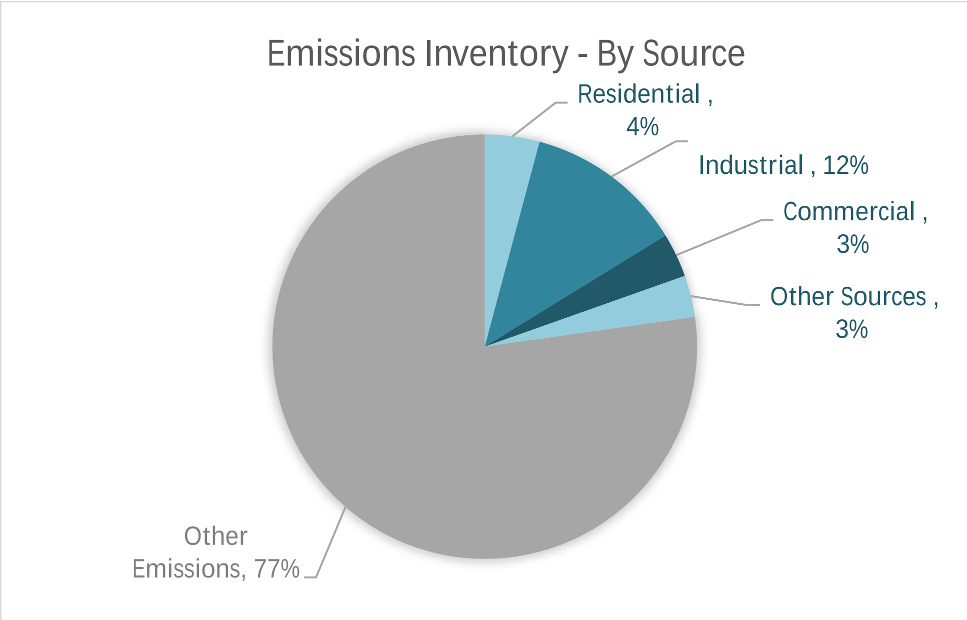
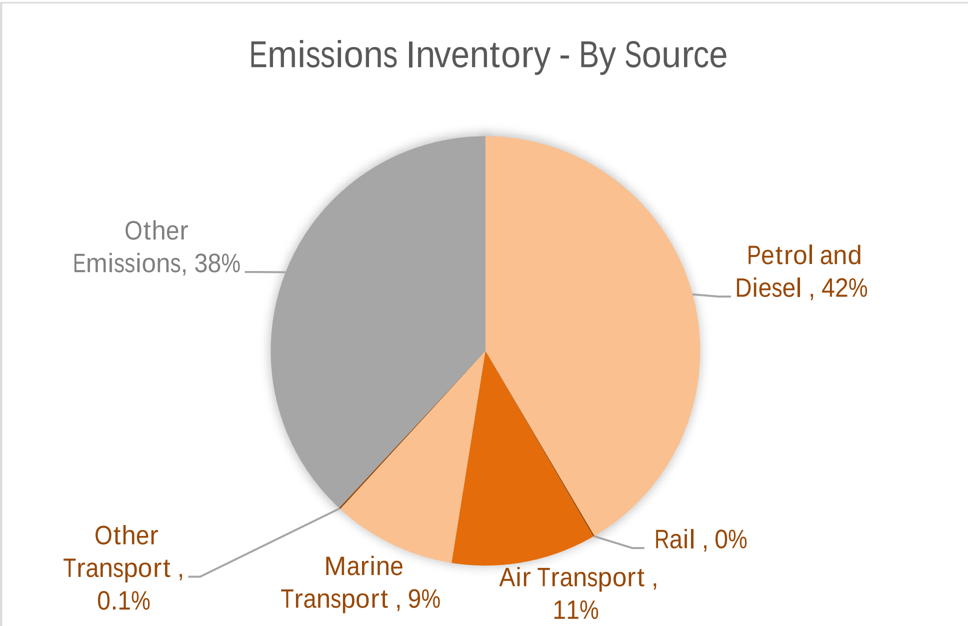


Figure 13 Total gross emissions breakdown, by source, highlighting transport emissions



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	177,173
BASIC per capita	3.9
BASIC+	206,331
BASIC+ per capita	4.5

Per capita emissions

On a per capita basis, Upper Hutt City has the lowest gross emissions of each of the districts in the Wellington region (4.5 tCO_2e per person).

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.

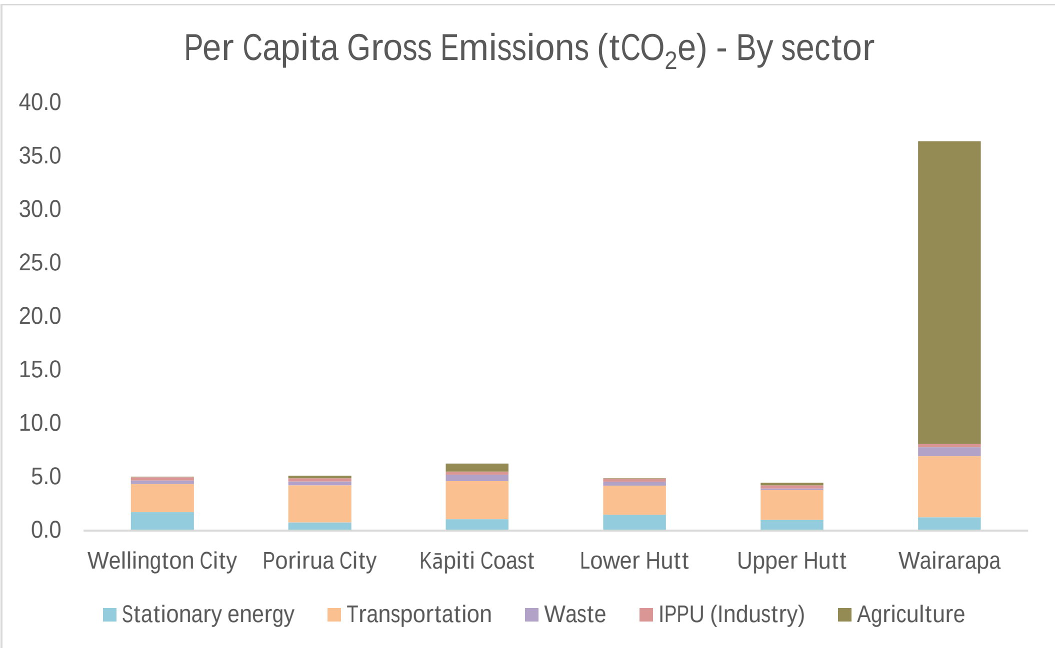


Figure 15 A comparison of per capita gross emissions (tCO_2e) between territorial areas in the Greater Wellington Region, excluding the Wairarapa.

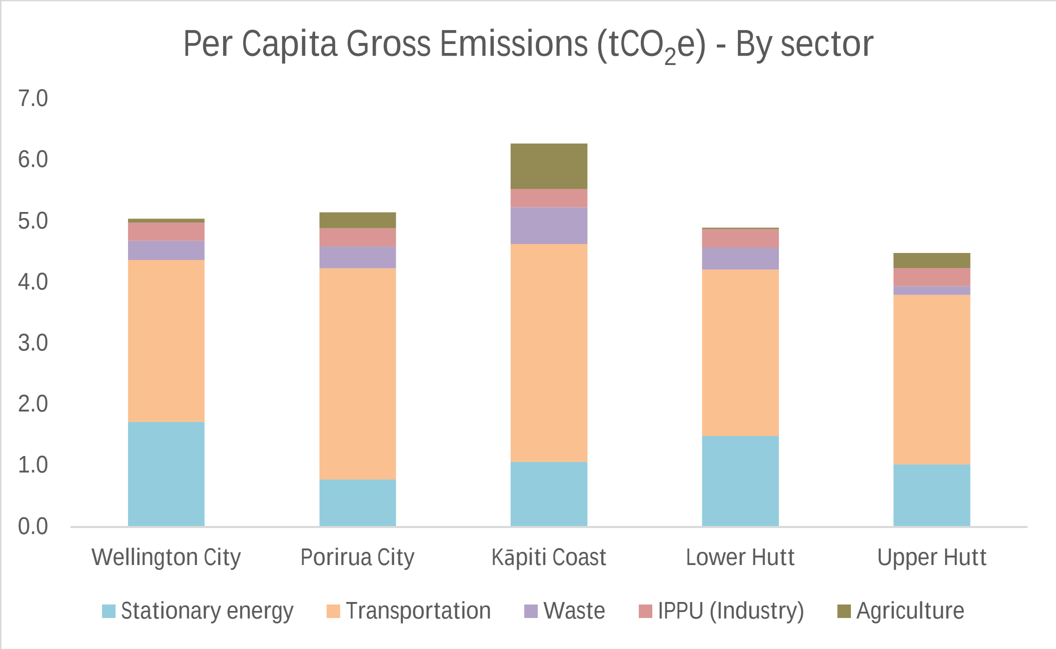
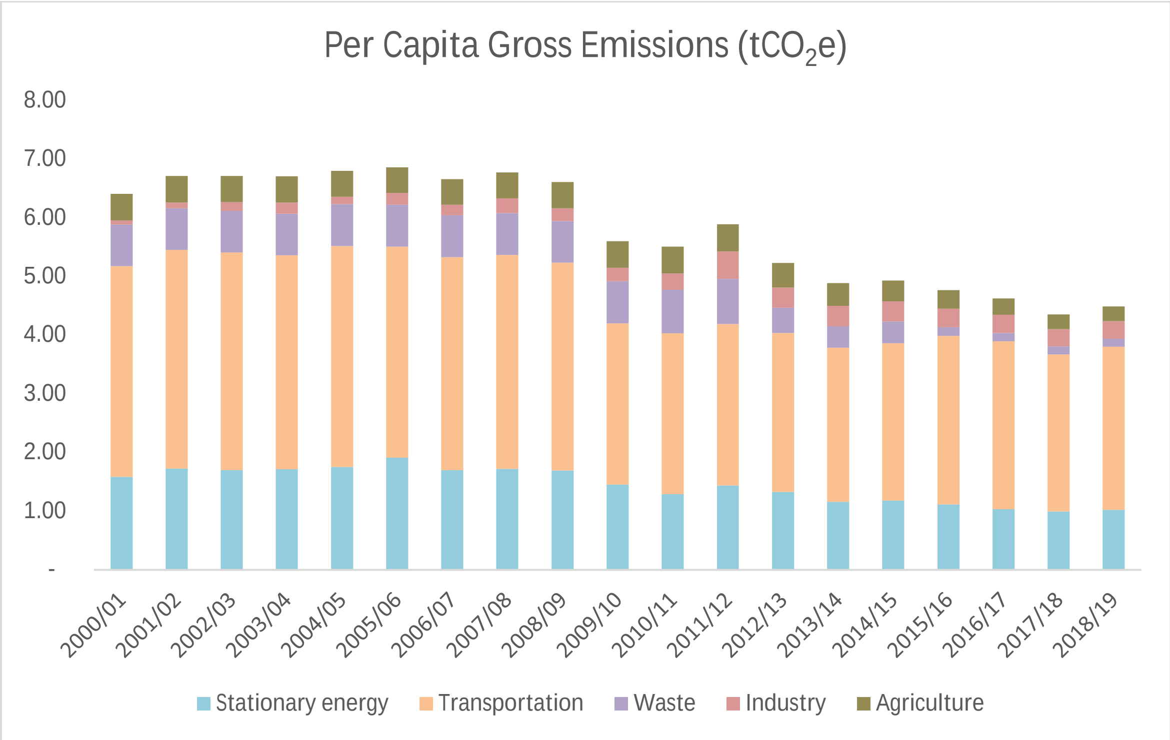


Figure 16 Per capita gross emissions, by sector (2001-2019)



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. Wellington Airport serves the entire Wellington Region and therefore its associated emissions have been split on a per capita basis across each district. An estimate was calculated for flights departing and arriving from Wellington Airport:

	- 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. - All flight-path distances between Wellington and the destination / origin airport were calculated. - A density for kerosene of 0.81g/cm³ 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 Wellington Airport. The remaining 50% of each leg was allocated to the originating or destination airport. - Light aircraft emissions were not calculated. Only a very small number occur, so assumed to be insignificant. - Fuel use data for aviation was also collected and used when possible to provide consistency with previous reporting. 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 originating or destination 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	Upper Hutt City Council shares operation of the Silverstream Landfill with Hutt City Council. Total waste volume at Silverstream was allocated between Hutt City (70%) and Upper Hutt City (30%).
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. Waste water jointly treated with Hutt City Council. Total waste water was allocated between Hutt City (70%) and Upper Hutt City (30%).
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	No information could be obtained from Industry representatives within the district. 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.