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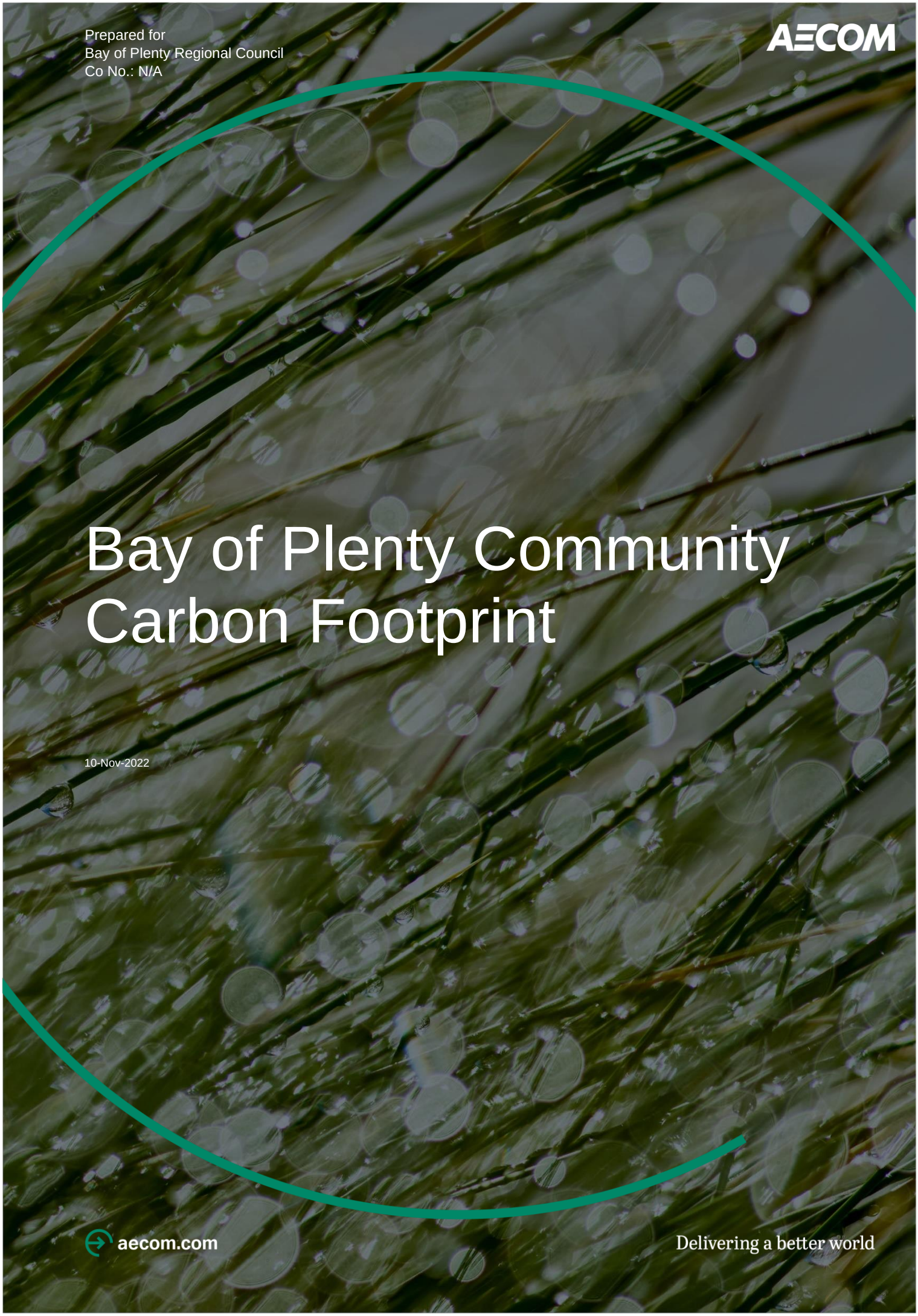
AECOM

Bay of Plenty Community Carbon Footprint

10-Nov-2022



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Bay of Plenty Community Carbon Footprint

Client: Bay of Plenty Regional Council

Co No.: N/A

Prepared by

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Revision History

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			Name/Position	Signature
1	23-September-2022	Final	Anthony Hume Practice Leader - Sustainability & Resilience	
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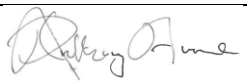
4	10-Nov-2022	Final V4 - updates to Table 11 and 13	Anthony Hume Practice Leader - Sustainability & Resilience	

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Executive Summary

Greenhouse Gas (GHG) emissions for the Bay of Plenty Region (that is covered by the Bay of Plenty Regional Council) have been measured using the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC) methodology. This approach includes emissions from Stationary Energy, Transport, Waste, Industrial Processes and Product Use (IPPU), Agriculture and Forestry sectors. This document reports greenhouse gas emissions produced in or resulting from activity or consumption within the geographic boundaries of the Bay of Plenty Region for the 2020/21 financial reporting year and examines greenhouse gas emissions produced from 2015/16 to 2020/21.

The Bay of Plenty Region is referred to hereafter as the Bay of Plenty for ease. Greenhouse gas emissions are generally reported in this document in units of Carbon Dioxide Equivalents (CO_2e) and are referred to as 'emissions'.

Major findings of the project include:

2020/21 Emissions Footprint

- In the 2020/21 reporting year (1st July 2020 to 30th June 2021), **total gross emissions** in the Bay of Plenty were 5,538,003 tCO_2e.
- **Transport** (e.g., emissions from road and air travel) is the largest emitting sector in the Bay of Plenty, representing 44% of total gross emissions, with petrol and diesel consumption accounting for 56% of Transport emissions.
- **Agriculture** (e.g., emissions from livestock and crops) is the second largest source of emissions, accounting for 34% of the Bay of Plenty's total gross emissions, with enteric fermentation from livestock accounting for 74% of Agriculture emissions.
- **Stationary Energy** (e.g., consumption of electricity and natural gas) is the third highest emitting sector in the region, producing 16% of total gross emissions.
- After consideration of carbon sequestration (carbon captured and stored in plants or soil by forests) and harvesting emissions, **total net emissions** in the Bay of Plenty were 7,162,986 tCO_2e. Net emissions are larger than total gross emissions because carbon sequestration (7,338,125 tCO_2e) was less than emissions released following forest harvesting during this year (8,963,108 tCO_2e).

Changes in Emissions, 2015/16 to 2020/21

- Between 2015/16 and 2020/21, **total gross emissions** in the Bay of Plenty increased from 4,944,297 tCO_2e to 5,538,003 tCO_2e, an increase of 12% (593,707 tCO_2e).
- Over this time the population of the Region increased by 17%, resulting in **per capita gross emissions** in the Bay of Plenty decreasing by 5% between 2015/16 and 2020/21, from 17.0 to 16.2 tCO_2e per person per year.
- **Transport** emissions increased by 28% between 2015/16 and 2020/21 (553,401 tCO_2e), driven by a 45% increase in marine freight emissions (319,293 tCO_2e) and a 18% increase in on-road fuel emissions (179,874 tCO_2e).
- Emissions from **Stationary Energy** increased by 30% between 2015/16 and 2020/21 (201,472 tCO_2e), driven by a 55% increase in electricity consumption emissions (144,190 tCO_2e). This increase in electricity consumption emissions was due to a 3% increase in electricity consumption (kWh) coupled with a 48% increase in the emissions intensity of the national electricity grid (tCO_2e/kWh).
- **IPPU** emissions increased between 2015/16 and 2020/21 by 22% (20,024 tCO_2e) following the national trend of increased use of refrigerants.
- Emissions from **Waste** and **Agriculture** decreased between 2015/16 and 2020/21, by 22%, and 5% respectively (65,327 tCO_2e and 95,864 tCO_2e).

- Net **Forestry** emissions decreased by 942,402 tCO_2e (37%) between 2015/16 and 2020/21. This decrease was predominantly due to a decrease in harvest emissions (estimated based on the age of commercial forests and regional harvesting data).

Figure 1: The Bay of Plenty's 2020/21 Emissions Footprint

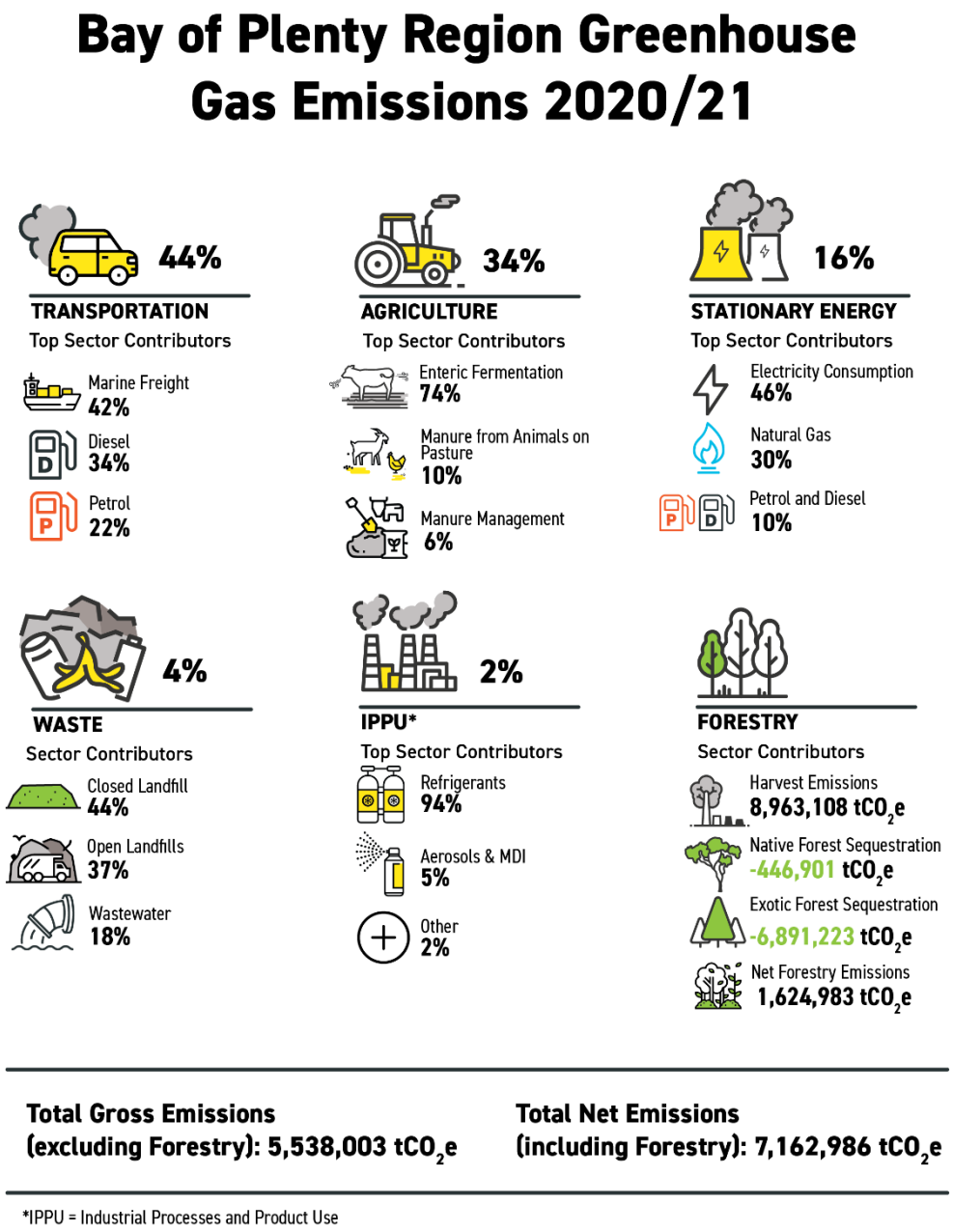
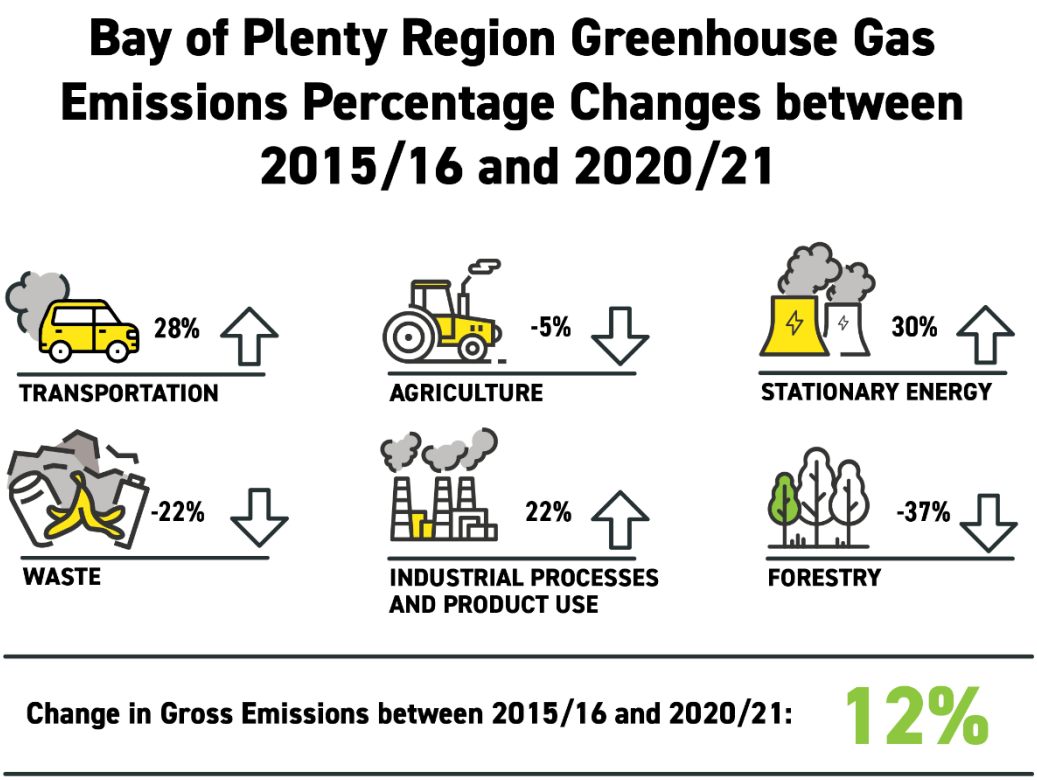


Figure 2: Change in the Bay of Plenty's Emissions Footprint between 2015/16 and 2020/21



1.0 Introduction

AECOM New Zealand Limited (AECOM) was commissioned by the Bay of Plenty Regional Council to assist in the development of community-scale greenhouse gas (GHG) footprints for the Bay of Plenty for the 2018/19, 2019/20, and 2020/21 financial years. This is part of a wider study to develop community carbon footprints for each district within the Bay of Plenty region. As part of this work, AECOM recalculated emissions for the footprint year (2015/16) previously calculated by AECOM, using current best-practice methodology and additional emissions sources to enable direct comparison to the other reported years. Emissions are reported for the period from 1 July to 30 June for the respective years. The study boundary reported in the following pages incorporates the jurisdiction of the Bay of Plenty Regional Council.

The Bay of Plenty region is referred to hereafter as Bay of Plenty for ease. Greenhouse gas emissions are generally reported in this document in units of Carbon Dioxide Equivalents (CO_2e) and are referred to as 'emissions'.

2.0 Approach and Limitations

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

The same methodology has been used for other community scale GHG footprints around New Zealand, (e.g., Wellington, Auckland, Christchurch, Dunedin, and the Waikato region) and internationally. The GPC methodology[1] represents international best practice for city and regional level GHG emissions reporting.

This emissions footprint assesses both direct and indirect emissions sources. Direct emissions are production-based and occur within the geographic area (Scope 1 in the GPC reporting framework). Indirect emissions are produced outside the geographic boundary (Scope 2 and 3) but are allocated to the 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. flights) and energy transportation and distribution losses fit into Scope 3.

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

- Emissions are expressed on a carbon dioxide-equivalent basis (CO_2e) including climate change feedback using the 100-year Global Warming Potential (GWP) values[2]. Climate change feedbacks are the climate change impacts from GHGs that are increased as the climate changes. For example, once the Earth begins to warm, it triggers other processes on the surface and in the atmosphere. Current climate change feedback guidance is important to estimate the long-term impacts of GHGs.
- GPC reporting is predominately production-based (as opposed to consumption-based) but includes some elements of consumption-based footprinting (e.g. indirect emissions from electricity consumption). Production-based emissions reporting is generally preferred by policy-makers due to robust established methodologies such as the GPC, which enables comparisons between different studies. Production-based approaches exclude globally produced emissions relating to consumption (e.g. embodied emissions relating to products produced elsewhere but consumed within the geographic area such as imported food products, cars, phones, clothes etc.).

[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)

- Total emissions are reported as both gross emissions (excluding Forestry) and net emissions (including Forestry).
- Emissions for individual main greenhouse gases for each emissions source are provided in the supplementary spreadsheet information supplied with this report.
- Where location specific data were not accessible, information was calculated based on national or regional level data.
- Transport emissions:
  - Transport emissions associated with air travel, rail, and marine fuel were calculated by working out the emissions relating to each journey arriving or departing the area based on data provided by the relevant operators. Emissions for these sources are then split equally between the destination and origin. Emissions relating to a particular point source (e.g. an airport or port) are allocated to the expected users of that source, not just the area that it is located in. For example, in the Bay of Plenty Region, it is expected that all territorial authorities will use the Port of Tauranga for imported and exported goods, so emissions from this source have been allocated to all territorial authorities in the region based on population. It is understood that freight imports moving through the Port of Tauranga do not exclusively serve the Bay of Plenty Region, and freight exports do not exclusively originate from the Bay of Plenty Region, this should be considered when examining these emissions.
  - All other transport emissions are calculated using the fuel sold in the area (e.g. petrol, diesel, LPG).
- Solid waste emissions:
  - Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day.
  - Emissions are calculated for waste produced within the geographic boundary, even if they are transported outside the boundary to be entered into landfill. Much of the landfill waste originating in the Bay of Plenty is transported to landfill sites in the Waikato, this has been accounted for in these calculations.
  - An additional assessment of transport emissions related to the transport of landfill waste and recycled/diverted waste has been included in this assessment, outside of the GPC requirements for Community Carbon Footprints. Emissions were estimated based on the amount of material, distance transported from transfer station to next processing location, and the vehicles used. Any onward transport of materials post-processing have not been included.
- Wastewater emissions:
  - Emissions have been calculated based on the local data provided, following IPCC 2019 guidelines. Where data is missing, IPCC and Ministry for the Environment (MfE) figures have been used. Wastewater emissions from both wastewater treatment plants, and individual septic tanks have been calculated.
  - Wastewater emissions include those released directly from wastewater treatment, flaring of captured gas, and from discharge onto land/water.
- Industrial Processes and Product Use (IPPU) emissions:
  - IPPU emissions are estimated based on data provided in the New Zealand Greenhouse Gas Emissions 1990-2020 report (MfE 2022). Emissions are estimated on a per capita basis applying a national average per person.
- Forestry emissions:
  - This emissions footprint accounts for forest carbon stock changes from afforestation, reforestation, deforestation, and forest management (i.e. it applies land-use accounting conventions under the United Nations Framework Convention on Climate Change rather than the Kyoto Protocol). It treats emissions from harvesting and deforestation as instantaneous

rather than accounting for the longer-term emission flows associated with harvested wood products.

- The emissions footprint considers regenerating (growing) forest areas only. Capture of carbon from the atmosphere is negligible for mature forests that have reached a steady state.

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

It is important to consider the level of uncertainty associated with the results, particularly given the different datasets used. Depending on data availability, national, regional, and local datasets are used across the different calculators. At the national level, New Zealand's Greenhouse Gas Inventory shows that for 2018 (the most recent national level inventory) an estimate of gross emissions uncertainty was +/- 9%, whereas a net emissions uncertainty estimate was +/- 12%. These levels of uncertainty should be considered when interpreting the results of this community carbon footprint (MfE, 2020).

StatsNZ Regional Footprint

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

Differences between the StatsNZ Regional Footprints and this community carbon footprint may be due to scope, coverage, data sources, and methods. The StatsNZ Regional Footprint approach is based on production, while the GPC methodology includes elements of consumption. The Stats NZ Regional Footprints use a residence approach, while GPC is based on the territory approach. The Stats NZ Regional Footprints also use global warming potentials from the IPCC Fourth Assessment Report, whilst this community carbon footprint uses global warming potentials from the IPCC Fifth Assessment Report.

Refer to the StatsNZ website for further information regarding StatsNZ Regional Footprint https://www.stats.govt.nz/methods/about-regional-greenhouse-gas-emissions-statistics/.

3.0 Community Carbon Footprint for 2020/21

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

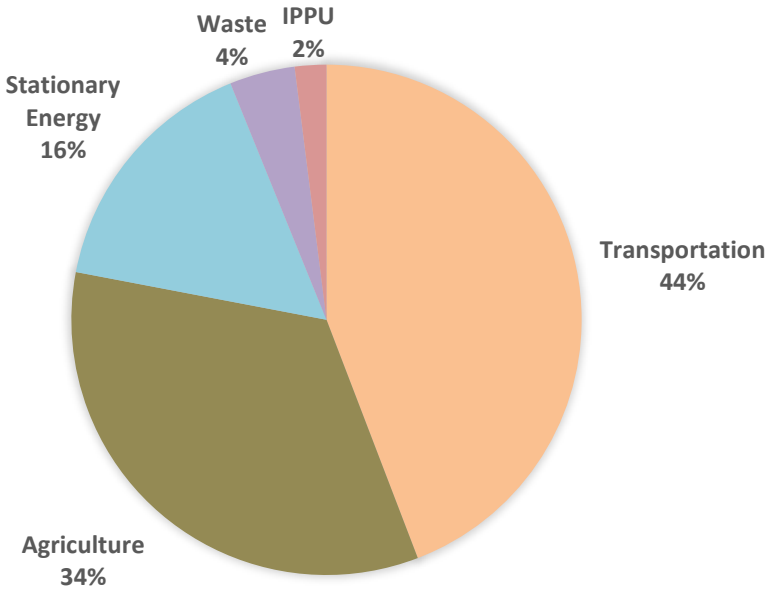
During the 2020/21 reporting period, the Bay of Plenty emitted **gross** 5,538,003 tCO_2e. Note that gross emissions do not account for Forestry. Agriculture and Transport emissions are the largest contributors to total gross emissions for the Region.

The population of Bay of Plenty in 2020/21 was approximately 340,900 people, resulting in per capita gross emissions of 16.2 tCO_2e/person. Discussion of per capita emissions is limited to when it is useful for comparing emission figures against other territorial authorities. A breakdown of net emissions (i.e. including results from Forestry resources) is reported separately.

Table 1 Total net and gross emissions

Total emissions	tCO_2e
Total Net Emissions (including forestry)	7,162,986
Total Gross emissions (excluding forestry)	5,538,003

Figure 3: Bay of Plenty Region's total gross GHG emissions split by sector (tCO_2e).



During the 2020/21 reporting period, the Bay of Plenty emitted **net** 7,162,986 tCO_2e.

Net emissions differ from gross emissions because they include emissions related to forestry activity (harvesting and planting) within an area. Forestry emissions are influenced by the cyclical nature of harvesting and planting regimes. In addition, with each subsequent planting of harvestable trees, there is a decreasing ebb and flow of sequestration.

Carbon sequestered by forestry can be viewed as a liability/risk that needs careful consideration. For example, if plantations are not replanted or other land use change occurs to exotic forested areas, then net emissions may rise quickly. Equally, if native forest is not protected from removal, and removal does happen, then net emissions may rise.

The community carbon footprint comprises emissions from six different sectors, summarised below:

3.1 Transport

Transport, the highest emitting sector in the Bay of Plenty, produced 2,446,464 tCO_2e in 2020/21 (44% of the Bay of Plenty's gross total emissions). Table 2 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emissions source.

Table 2 Transport emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Marine Freight	1,028,455	18.6%	42.0%
Diesel	818,624	14.8%	33.5%
Petrol	544,754	9.8%	22.3%
Rail	25,456	0.5%	1.0%
Jet Kerosene	21,508	0.4%	0.9%
LPG	2,920	0.1%	0.1%
Marine Diesel (local)	2,822	0.1%	0.1%
Aviation Gas	1,926	<0.1%	0.1%
Bioethanol	0.1	<0.1%	<0.1%
Total	**2,446,464**	**44.2%**	**100%**

Most of the transport emissions can be attributed to on and off-road diesel and petrol use, which collectively produced 56% of the sector's emissions and 25% of total gross emissions. Diesel and petrol transport emissions are broken down into on-road and off-road use. On-road transport consists of all standard transportation vehicles used on roads (including cars, trucks, buses, etc.). Off-road transport consists of all fuel used for the movement of machinery and vehicles off roads (including agricultural tractors and vehicles, forklifts, etc.). On-road transport produced 1,206,652 tCO_2e (49% of Transport emissions). Off-road transport produced 159,645 tCO_2e (6.5% of Transport emissions).

The next largest Transport emission source is marine freight, which contributed to 42% of the sectors emissions and 19% of the Bay of Plenty's total gross emissions (1,031,276 tCO_2e). Marine freight emissions are the result of freight movements to and from the Port of Tauranga. Emissions from this source have been divided between all territorial authorities in the Bay of Plenty region based on relative population sizes. It is understood that the imports and exports through this port are not exclusively related to activities in the Bay of Plenty region, however, to ensure that these emissions are reflected in community carbon footprints as per the GPC requirements this approach is appropriate.

The remaining transport emissions are attributed to air travel (jet kerosene and aviation gas), rail freight emissions, LPG use for transport (e.g. forklifts), marine diesel for local use and bioethanol.

One contributing element of transport emissions is from the movement of waste, recycling, and other diverted materials from transfer facilities to their end location. These transport emissions (displayed in Table 3) are included in the totals outlined above and are not additional to the totals above. These reported emissions are high-level estimations only based on the data available and fall outside of the GPC requirements for Community Carbon Footprinting. Transport of landfill waste is responsible for the largest proportion of these emissions with most of the waste produced in the Bay of Plenty transported to sites in the Waikato Region.

Table 3 Emissions from the transport of waste, recycling, and other diverted materials

	Total material (tonnes)	Total distance travelled (return) (km)	Emissions (tCO_2e)
Landfill Waste	212,811	2,968,035	1,827
Composting	26,607	255,991	158
Diverted/Recycled Materials	27,722	627,640	386
Total	**267,140**	**3,851,666**	**2,371**

3.2 Agriculture

The second highest emitting sector in the Bay of Plenty, Agriculture, emitted 1,873,042 tCO_2e in 2020/21. Table 4 provides the emissions, percentage of total gross emissions, and percentage of the sector total for each sector/emissions source. Agricultural emissions are the result of both livestock and crop farming and do not include emissions relating to fuel or electricity consumption (reported in the Transport and Stationary Energy sectors).

Enteric fermentation from livestock produced 74% of Bay of Plenty's agricultural emissions (1,381,149 tCO_2e). Enteric fermentation GHG emissions are produced by methane (CH_4) released from the digestive process of ruminant animals (e.g. cattle and sheep). The second largest source of agricultural emissions was produced from nitrous oxide (N_2O) released by unmanaged manure from grazing animals on pasture (184,996 tCO_2e or 10% of the agricultural sector's emissions).

Table 4 Agriculture emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Enteric Fermentation	1,381,149	24.9%	73.7%
Manure from Grazing Animals on pasture	184,996	3.3%	9.9%
Manure Management	108,026	2.0%	5.8%
Other Agriculture Emissions	89,259	1.6%	4.8%
Atmospheric Deposition	57,142	1.0%	3.1%
Agricultural Soils	31,557	0.6%	1.7%
Fertiliser used in Horticulture	20,914	0.4%	1.1%
Total	**1,873,042**	**33.8%**	**100%**

Livestock were responsible for 96% of the Agriculture sector's GHG emissions (1,796,732 tCO_2e) (Table 5). Dairy cattle account for 74% of agricultural emissions in the Bay of Plenty and 25% of the Bay of Plenty's total gross emissions. Non-dairy cattle account for 15% of agricultural emissions in the Bay of Plenty and 5% of the Bay of Plenty's total gross emissions.

Table 5 Agriculture emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Dairy Cattle	1,380,870	24.9%	73.7%
Non-dairy Cattle	272,529	4.9%	14.6%
Sheep	109,314	2.0%	5.8%
Other livestock	34,018	0.6%	1.8%
Fertiliser for Horticulture	20,912	0.4%	1.1%
Fertiliser (other)	55,399	1.0%	3.0%
Total	**1,873,042**	**33.8%**	**100%**

Fertilisers used for horticulture and livestock represent 4% of Agriculture emissions.

An additional breakdown of emissions from fertiliser use in horticulture is included based on land-use information provided by BoPRC (displayed in Table 6). The largest contributor to 'Fertiliser for Horticulture' in the Bay of Plenty was kiwifruit (11,006 tCO_2e). There is some potential for emissions double counting between the 'Fertiliser for Horticulture' and 'Fertiliser (other)' emission sources as these emissions have been calculated based on different datasets, where the 'Fertiliser (other)' category may also include some fertilisers used in horticulture. However, it is expected that the majority of the 'Fertiliser (other)' emissions are caused by fertiliser use for livestock land.

Table 6 Fertiliser for horticulture emissions by crop type

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Kiwifruit	11,006	0.2%	0.6%
Arable	5,892	0.1%	0.3%
Orchard or permanent horticulture	2,330	<0.1%	0.1%
Avocado	1,506	<0.1%	0.1%
Vegetables	180	<0.1%	<0.1%
Total	**20,914**	0.4%	1.1%

3.3 Stationary Energy

Producing 878,331 tCO_2e in 2020/21, Stationary Energy was the Bay of Plenty's third highest emitting sector (16% of total gross emissions). Table 7 provides the total emissions, percentage of total gross emissions, and percentage of the sector total for each sector/emissions source.

Electricity consumption was the cause of 46% of Stationary Energy emissions (407,419 tCO_2e), and 7% of the Bay of Plenty's total gross emissions. Electricity consumption emissions increase to 444,839 tCO_2e when including transmission and distribution losses related to that consumption.

Natural gas consumption accounted for 30% of the sector's emissions (265,995 tCO_2e) when including transmission and distribution losses. Stationary petrol and diesel consumption generated 10% of the sectors emissions (91,399 tCO_2e). Use of LPG, and the burning of coal, biofuels and biogas produced the remaining Stationary Energy emissions.

Table 7 Stationary Energy emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Electricity Consumption	407,419	7.4%	46.4%
Natural Gas	265,995	4.8%	30.3%
Stationary Petrol & Diesel Use	91,399	1.7%	10.4%
Electricity Transmission and Distribution Losses	37,420	0.7%	4.3%
LPG	23,143	0.4%	2.6%
Natural Gas Transmission and Distribution losses	21,508	0.4%	2.4%
Coal	21,150	0.4%	2.4%
Biofuel / Wood	10,119	0.2%	1.2%
Biogas	177	<0.1%	<0.1%
Total:	**878,331**	**15.9%**	**100%**

Stationary Energy demand can also be broken down by the sector in which it is consumed. Stationary Energy demand is reported for the following sectors: commercial; residential and industrial.

- Industrial Stationary Energy consumption accounts for 56% of Stationary Energy emissions (487,067 tCO_2e) and 8.8% of total gross emissions. Industrial Stationary Energy is energy used within all industrial settings (including agriculture, forestry and fishing, mining, food processing, textiles, chemicals, metals, mechanical/electrical equipment and building and construction activities).
- Residential Stationary Energy consumption accounts for 20% of Stationary Energy emissions (174,805 tCO_2e) and 3.2% of total gross emissions. Residential Stationary Energy is energy used in homes (e.g. for heating, lighting, and cooking).
- Commercial Stationary Energy consumption accounts for 14% of Stationary Energy emissions (124,883 tCO_2e) and 2.3% of total gross emissions. Commercial Stationary Energy is energy used in all non-residential and non-industrial settings (e.g. in retail, hospitality, education, and healthcare).
- The remaining 10% of Stationary Energy emissions (91,577 tCO_2e, 1.7% of gross emissions) were produced by diesel and petrol, and the burning of biogas, which were not allocated to the above categories. Stationary Energy uses of diesel and petrol include stationary generators and motors and for heating.

3.4 Waste

Waste originating in the Bay of Plenty (solid waste and wastewater) produced 229,498 tCO_2e in 2020/21, which comprises 4% of the Bay of Plenty's total gross emissions. Table 8 provides the total emissions, percentage of total gross emissions, and percentage of the sector total for each sector/emissions source.

Table 8 Waste emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Waste in closed landfill sites	100,805	1.8%	43.9%
Waste in open landfill sites	84,079	1.5%	36.6%
Individual septic tanks	33,802	0.6%	14.7%
Wastewater treatment plants	7,130	0.1%	3.1%
Composting	3,682	0.1%	1.6%
Total:	**229,498**	**4.1%**	**100%**

Solid waste produced the bulk of waste emissions (184,885 tCO_2e), making up 81% of total Waste emissions. Solid waste emissions include emissions from open landfills and closed landfills. Both open and closed landfills emit methane from the breakdown of organic materials disposed of in the landfill for many years after waste enters the landfill. Waste from the Bay of Plenty sent to open landfill sites contributed 84,079 tCO_2e. Emissions from closed landfill sites produced 100,805 tCO_2e. Annual emissions from closed landfill sites will decrease over time as no new waste enters these sites.

Wastewater treatment (treatment plants and individual septic tanks) produced 40,931 tCO_2e making up 18% of total Waste emissions. Most of the households in the Bay of Plenty are connected to wastewater treatments plants, which produced total emissions of 7,130 tCO_2e. Due to the production of methane, septic tanks have a higher emissions intensity compared to the wastewater treatments plants in the Bay of Plenty. Households connected to individual septic tanks produced 33,802 tCO_2e in wastewater emissions.

Wastewater treatment tends to be a relatively small emission source compared to solid waste as advanced treatment of wastewater produces low emissions. In contrast, solid waste generates methane gas over many years as organic material enters landfill.

Composing produced 3,682 tCO_2e making up 2% of total Waste emissions.

3.5 Industrial Processes and Product Use (IPPU)

IPPU in the Bay of Plenty produced 110,688 tCO_2e in 2020/21, contributing 2% to the Bay of Plenty's total gross emissions. This sector includes emissions associated with the production of GHGs for refrigerants, foam blowing, fire extinguishers, aerosols, metered dose inhalers and Sulphur Hexafluoride for electrical insulation and equipment production. IPPU emissions do not include energy use for industrial manufacturing, which is included in the relevant Stationary Energy sub-category (e.g. coal, electricity and/or petrol and diesel). These emissions are based on nationally reported IPPU emissions and apportioned based on population due to the difficulty of allocating emissions to particular geographic locations.

There are no known industrial processes (as defined in the GPC requirements) present in the Bay of Plenty (e.g. aluminium manufacture).

Table 9 provides the total emissions, percentage of total gross emissions, and percentage of the sector's total for each sector/emissions source. The most significant contributor to IPPU emissions is the use of refrigerants which produced 94% of IPPU emissions (103,666 tCO_2e).

Table 9 Industrial processes and product use emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Refrigerants and air conditioning	103,666	1.9%	93.7%
Aerosols	5,352	0.1%	4.8%
SF6 - Electrical Equipment	893	<0.1%	0.8%
Foam Blowing	415	<0.1%	0.4%
SF6 - Other	188	<0.1%	0.2%
Fire extinguishers	155	<0.1%	0.1%
Total	**110,668**	**2.0%**	**100%**

3.6 Forestry

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

Sequestration in 2020/21 was 7,338,125 tCO_2e (which was mostly from exotic forests) while harvesting emissions were 8,963,108 tCO_2e. This meant that Forestry in the Bay of Plenty was a net positive source of emissions in 2020/21 (rather than a negative source of emissions, where sequestration exceeds harvesting). Total Forestry emissions in 2020/21 were 1,624,983 tCO_2e.

Table 10 Forestry emissions by emission source (including sequestration)

Sector / Emissions Source	tCO_2e
Total harvest emissions	8,963,108
Native forest sequestration	-446,901
Exotic forest sequestration	-6,891,223
Total	**1,624,983**

3.7 Total Gross Emissions by Greenhouse Gas

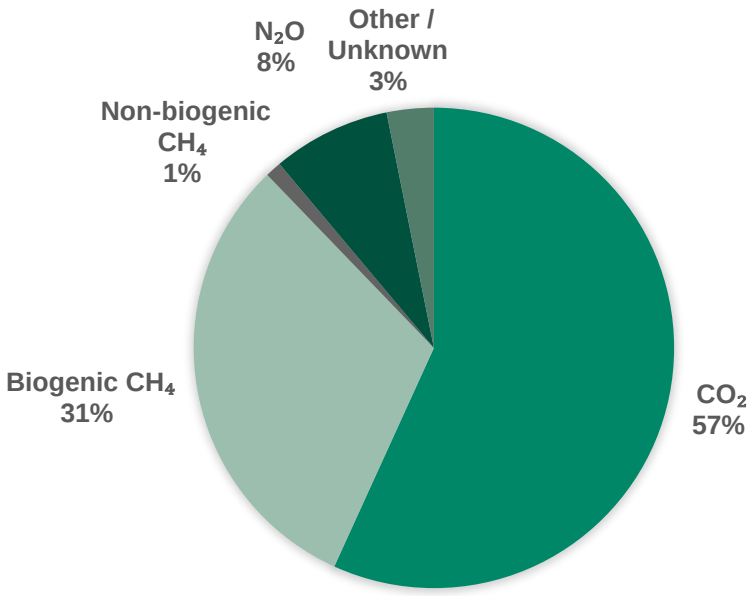
Each greenhouse gas has a different level of impact on climate change, this is accounted for when converting quantities of each gas into units of carbon dioxide equivalent (CO_2e).

Table 11: Bay of Plenty's total gross emissions, by greenhouse gas

Greenhouse Gas	Tonnes	Tonnes of CO_2e
Carbon Dioxide (CO_2)	3,145,887	3,145,887
Biogenic Methane (CH_4)	50,481	1,716,351
Non-biogenic Methane (CH_4)	1,769	60,148
Nitrous Oxide (N_2O)	1,478	440,396
Other / Unknown Gas (in CO_2e)	175,221	175,221
Total	**3,374,836**	**5,538,003**

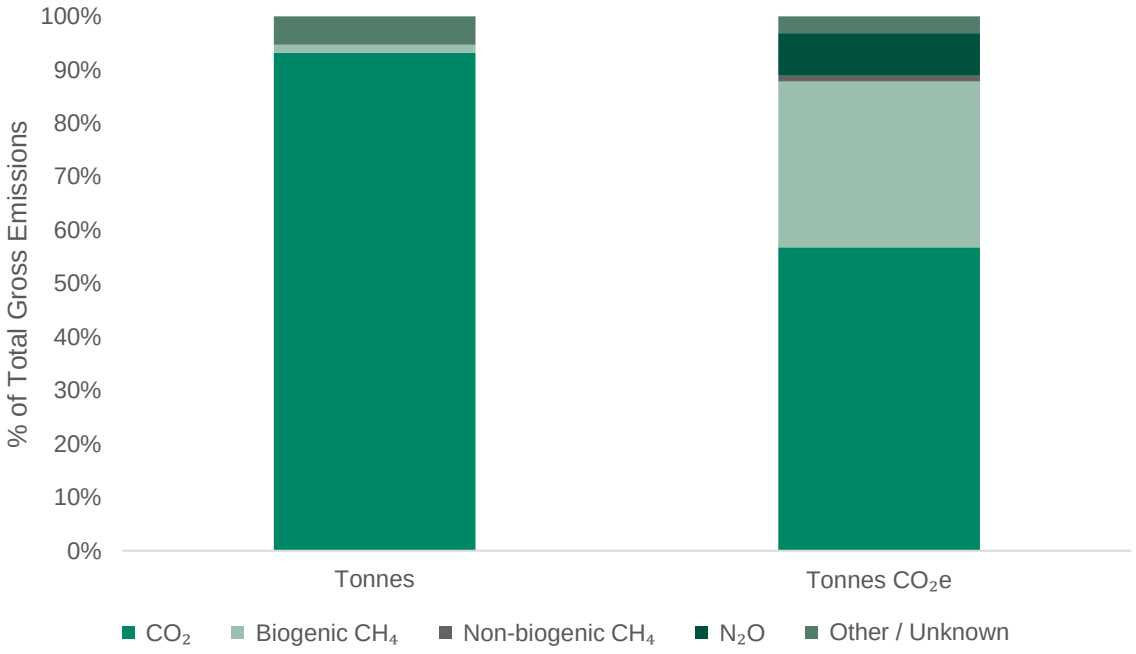
Figure 4 illustrates the Bay of Plenty's total gross emissions by greenhouse gas in units of carbon dioxide equivalents (CO_2e).

Figure 4: The Bay of Plenty Region's total gross emissions, by greenhouse gas (in tCO_2e)



Due to the greater global warming impact of methane, methane represents just 2% of the total tonnage of GHG emissions from the Bay of Plenty but represents 32% of CO_2e. Nitrous oxide represents 0.04% of the total tonnage of GHG emissions from Bay of Plenty but represents 8% of CO_2e. This effect can be seen in Figure 5.

Figure 5: Bay of Plenty Region's total gross emissions, by greenhouse gas in tonnes and in tonnes of CO_2e



3.8 Biogenic emissions

Biogenic carbon dioxide and methane emissions are stated in Table 12 and Table 13, respectively.

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

Table 12: Biogenic CO_2 in the Bay of Plenty (Excluded from gross emissions)

Biogenic Carbon Dioxide (CO_2) (Excluded from gross emissions)		
Biofuel	173,828	t CO_2
Combusted Landfill Gas	27,397	t CO_2
Biodiesel	1,513	t CO_2
Total Biogenic CO_2	**202,739**	**t CO_2**

Biogenic CH_4 emissions (e.g., produced by farmed cattle via enteric fermentation) are included in gross emissions due to their relatively large impact on global warming relative to biogenic CO_2. Biogenic methane represents 3% of the gross total tonnage of GHG emissions in the Bay of Plenty but represents 37% of total gross GHG emissions when expressed in CO_2e. This is caused by the higher global warming impact of methane per tonne, compared to carbon dioxide. The total tonnage of each GHG and the contribution of each GHG to total gross emissions when expressed in CO_2e is shown in Table 11.

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

Table 13: Biogenic Methane in the Bay of Plenty (Included in gross emissions)

Biogenic Methane (CH_4) (Included in gross emissions)		
Enteric Fermentation	40,622	t CH_4
Landfill Gas	5,432	t CH_4
Manure Management	3,175	t CH_4
Wastewater Treatment	1,004	t CH_4
Biofuel	184	t CH_4
Composting (Green Waste)	63	t CH_4
Total Biogenic CH_4	**50,481**	**t CH_4**

3.9 Territorial Authorities in the Bay of Plenty Region

The Bay of Plenty regional area contains several territorial authorities. Tauranga City, Western Bay of Plenty District, Whakatāne District, Ōpōtiki District, and Kawerau District are all exclusively within the boundaries of the Bay of Plenty region. However, areas of Rotorua District and Taupō District are also part of the Waikato region. We estimate that 93% of Rotorua's population and 62% of Rotorua's area, and 4% of Taupō's population and 14% of Taupō's area are within the Bay of Plenty region.

Figure 6 shows the Bay of Plenty's total gross emissions divided by territorial authority. Figure 7 shows total gross emissions for the territorial authorities in the Bay of Plenty Region, split by sector. Both figures only include the emissions produced within the Bay of Plenty region for Rotorua and Taupō.

Tauranga is the highest emitting territorial authority in the region, representing 24% of the Bay of Plenty's total gross emissions. Tauranga's emissions inventory is predominantly transport-related emissions while the next largest territorial authorities by; Rotorua, Western Bay of Plenty and Whakatāne, contain significant agricultural emissions. Ōpōtiki, Kawerau, and Taupō collectively represent just 12% of the Bay of Plenty's emissions.

Figure 6 Bay of Plenty's total gross emissions divided by territorial authority (tCO_2e). *Rotorua and Taupō totals only include emissions produced in the Bay of Plenty region.

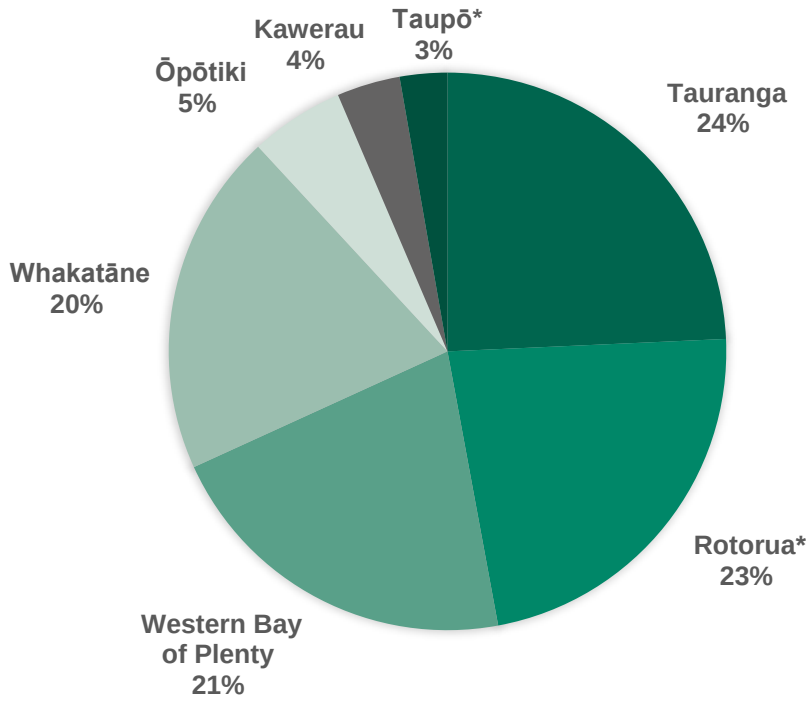
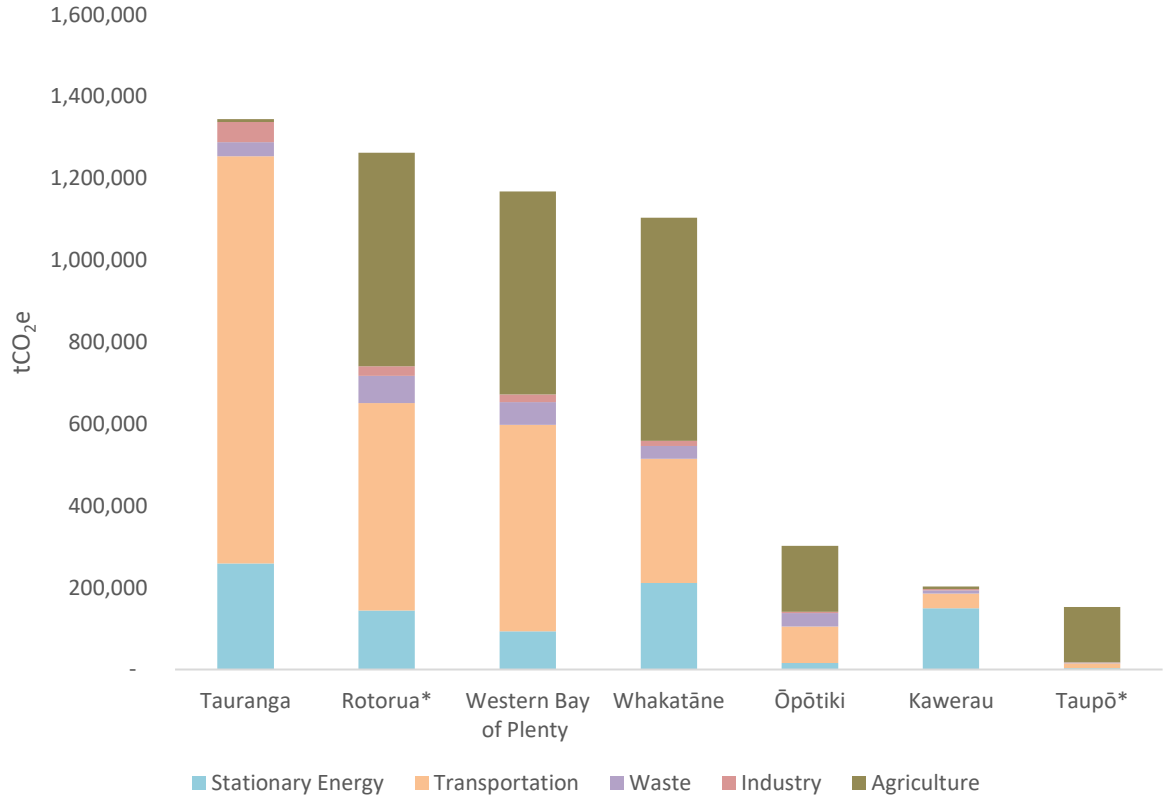


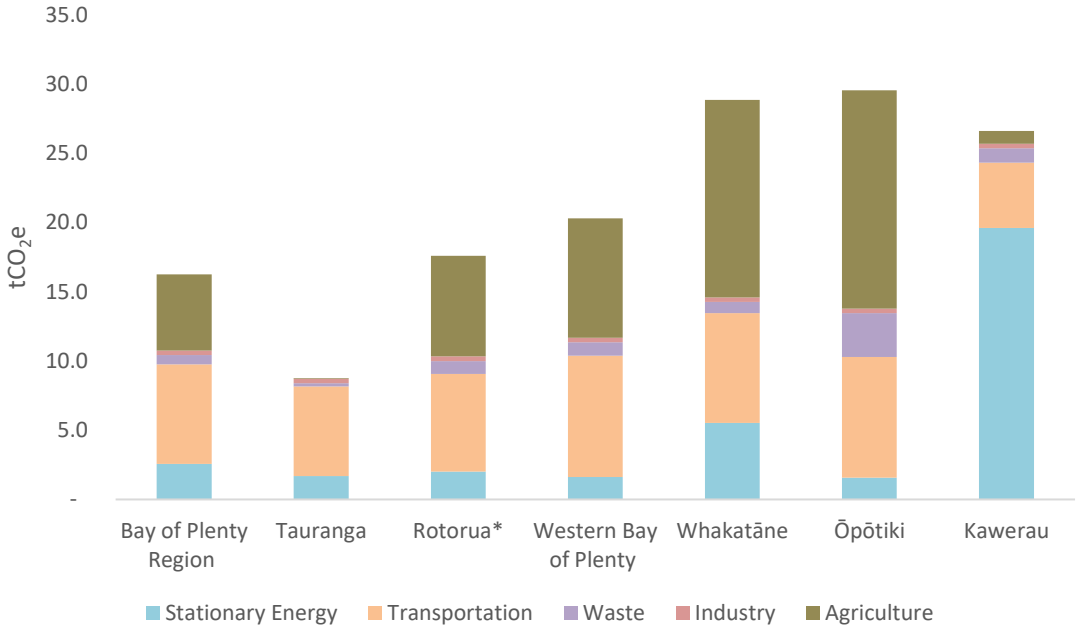
Figure 7 Total gross emissions by territorial authority in the Bay of Plenty region (tCO_2e). *Rotorua and Taupō totals only include emissions produced in the Bay of Plenty region.



When comparing emissions inventories from different areas, a per capita figure can be useful because it provides a common reference point to understand the difference in emissions. Figure 8 shows emissions per capita for the region and territorial authorities within the region. Taupō is excluded from this figure due to the tiny population and large agriculture within the small area in the Bay of Plenty creating very large per capita emissions (this is not the case for the entire Taupō District).

The Bay of Plenty has a 16.2 tCO_2e/per capita figure for total gross emissions which is higher than the national value of 15.7 tCO_2e/per capita. Notably, Tauranga has the lowest per capita total emissions at 8.8 tCO_2e/per capita. Ōpōtiki and Whakatāne have the largest per capita total gross emissions at 29.5 tCO_2e/per capita and 28.9 tCO_2e/per capita respectively. Kawerau has the third highest per capita emissions at 26.6 tCO_2e/per capita, this is due to a small population and large industrial and manufacturing energy use in the area.

Figure 8 Total gross emissions per capita for the region and territorial authorities within the region (tCO_2e). *Rotorua total only includes emissions produced in the Bay of Plenty region.



4.0 Emissions change from 2015/16 to 2020/21

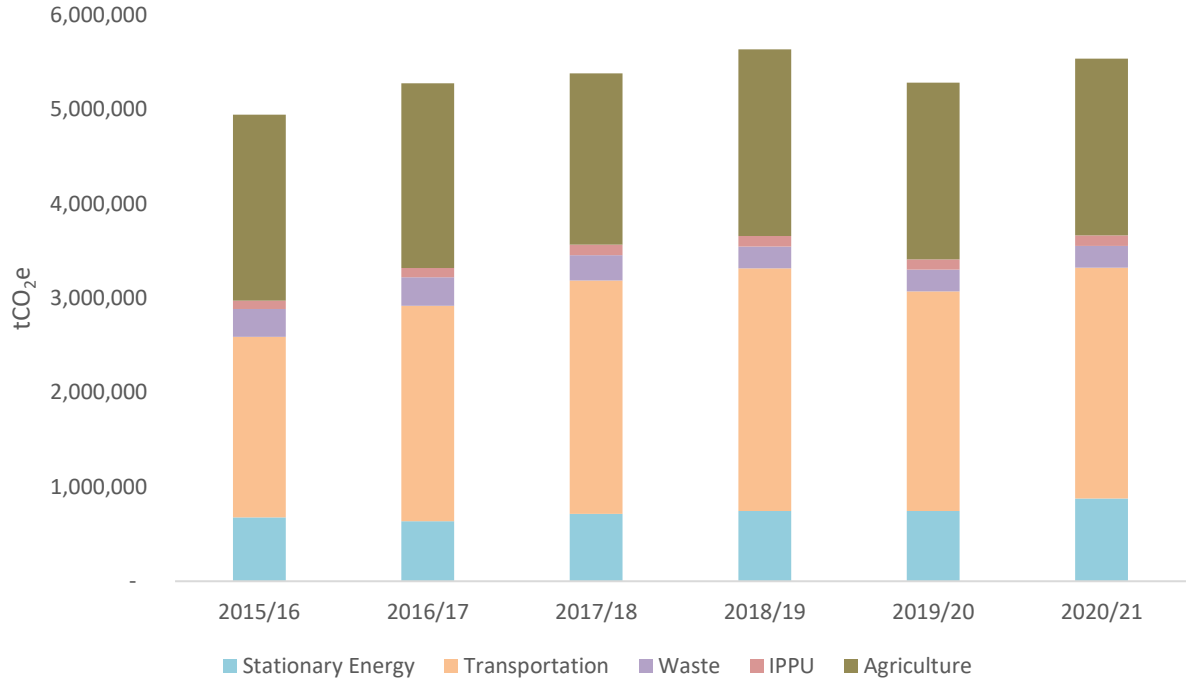
Alongside calculating the Bay of Plenty's emissions footprint for 2020/21, we have calculated the Bay of Plenty's emissions footprint for 2018/19 and 2019/20. By calculating these three years we can assess the emissions footprint before the COVID pandemic caused disruptions, changes, and enforced restrictions, and assess the impact of the COVID pandemic on emissions in the Bay of Plenty. We have also recalculated the Bay of Plenty's most recent emissions footprint (2015/16) using the same methodology, data sources, and emission factors as for the other footprints reported here. This enables us to directly compare these emissions footprints. A discussion of the updated 2015/16 footprint and significant changes is found in section 7.0. For the years in between (2016/17 and 2017/18) we have calculated emissions from key sources (e.g. livestock, electricity consumption, petrol and diesel consumption, marine freight, and air travel) and estimated all other emission sources as part of the agreed approach.

This section displays the results of the 2015/16, 2018/19, 2019/20, and 2020/21 emissions footprints with a focus on Gross emissions and examines the change in emissions from 2015/16 to 2020/21. An analysis of the impact of the COVID pandemic on the Bay of Plenty's emissions is found in section 6.0.

Table 14 Change in the Bay of Plenty's Total Gross and Net emissions from 2015/16 to 2020/21

	2015/16 (tCO_2e)	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2015/16 to 2020/21)
Total Net Emissions (including forestry)	7,511,682	7,560,730	6,930,817	7,162,986	-5%
Total Gross Emissions (excluding forestry)	4,944,297	5,636,710	5,285,033	5,538,003	12%

Figure 9 Change in the Bay of Plenty's total gross emissions from 2015/16 to 2020/21



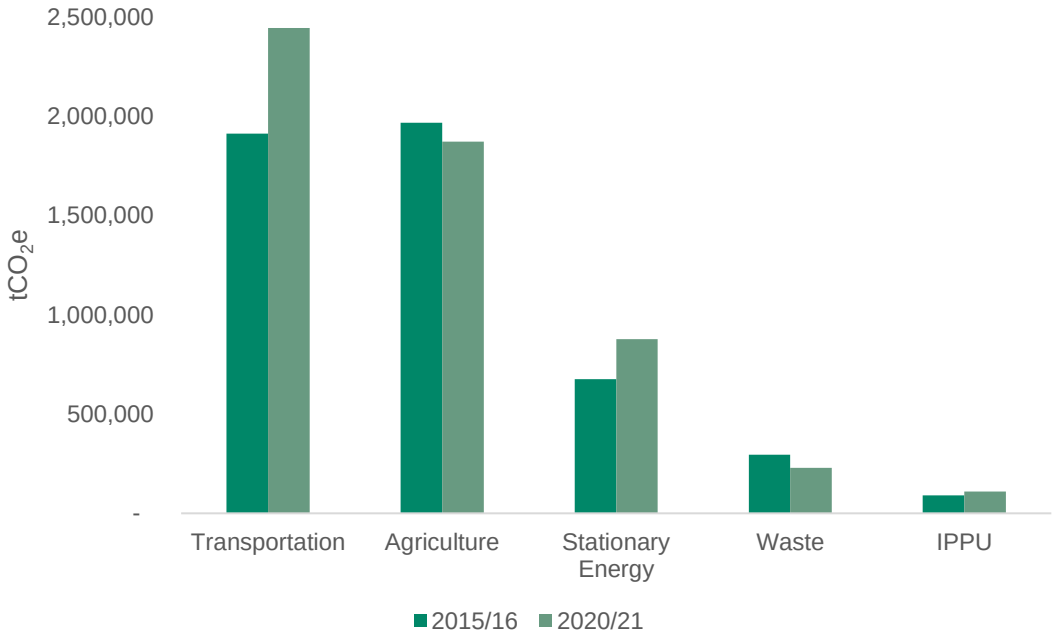
Total gross emissions per year increased by 12% from 4,944,297 tCO_2e in 2015/16 to 5,538,003 tCO_2e in 2020/21. This is driven by increases in Transport and Stationary Energy emissions. Emissions from IPPU also increased during this period while emissions from Waste and Agriculture decreased.

Total net emissions in the Bay of Plenty decreased by 5% from 7,162,986 in 2015/16 to 7,162,986 tCO_2e. This decrease was predominantly due to a decrease in annual forest harvesting emissions. This is discussed further below under the 'Forestry' heading.

The population of the Bay of Plenty grew by 17% during this time, this is a larger increase than the increase in gross emissions resulting in a 5% decrease in per capita gross emissions between 2015/16 and 2020/21, from 17.0 to 16.2 tCO_2e per person per year. A discussion of the decoupling of gross emissions from population growth and economic growth is found in section 5.0.

The sections below outline the change in emissions between 2015/16 and 2020/21 for each sector and emissions source, highlighting the changes that have had the largest impact on total gross emissions.

Figure 10 Emissions for each sector of the Bay of Plenty's gross emissions footprint for 2015/16 and 2020/21



4.1 Transport

Table 15 Change in the Bay of Plenty's Transport emissions from 2015/16 to 2020/21

Sector / Emissions Source	2015/16 (tCO_2e)	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2015/16 to 2020/21)
Marine Freight	709,427	1,141,650	1,009,330	1,028,455	45%
Diesel	636,852	808,696	763,657	818,624	29%
Petrol	512,370	560,057	505,205	544,754	6.0%
Rail	29,958	28,235	25,327	25,456	-15%
Jet Kerosene	17,786	23,530	17,689	21,508	21%
Marine Diesel (local)	2,556	3,214	3,059	2,822	10%
LPG	2,307	2,728	2,778	2,920	27%
Aviation Gas	1,807	2,035	1,589	1,926	7%
Bioethanol	0.08	0.10	0.09	0.10	29%
Total:	**1,913,063**	**2,570,146**	**2,328,634**	**2,446,464**	**28%**

Transport emissions increased by 28% between 2015/16 and 2020/21 (533,401 tCO_2e). This was driven by a 45% increase in marine freight emissions (319,293 tCO_2e) and a 18% increase in on-road fuel emissions (179,874 tCO_2e).

The largest annual increase in greenhouse gas emissions from marine freight transport occurred from 2016 to 2017. This is associated with an increase in average vessel size following the introduction of 9,500 Twenty-foot Equivalent Unit (TEU) vessels, which was over double the capacity of the previous largest container vessel visiting Tauranga. This shift occurred following shipping channel deepening and widening in the Tauranga Harbour. These largest vessels call directly and exclusively to the Bay of Plenty, whereas smaller vessels are likely to call at more than one New Zealand port/region. These larger vessels are generally more fuel efficient as they emit fewer greenhouse gases per unit of cargo

(e.g. per container). In general, marine freight emissions have increased over the period from 2016 to 2021 due to an increase in import and export freight movements through Tauranga Port.

With the exception of rail emissions, no transport emissions sources decreased between 2015/16 and 2020/21. Notably, the impact of the COVID pandemic can be seen in Transport emissions where emissions decreased by 10% between 2018/19 and 2019/20 before increasing again by 5% between 2019/20 and 2020/21.

4.2 Agriculture

Table 16 Change in the Bay of Plenty's Agriculture emissions from 2015/16 to 2020/21

Sector / Emissions Source	2015/16 (tCO_2e)	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2015/16 to 2020/21)
Enteric fermentation	1,456,576	1,462,067	1,381,149	1,381,149	-5.2%
Manure from Grazing Animals	196,217	195,860	184,996	184,996	-5.7%
Manure Management	123,317	116,010	108,026	108,026	-12.4%
Other Agriculture Emissions	88,352	92,437	89,259	89,259	1.0%
Atmospheric Deposition	59,493	60,143	57,142	57,142	-4.0%
Agricultural Soils	25,714	30,872	31,557	31,557	22.7%
Fertiliser used in Horticulture	19,238	20,243	20,579	20,914	8.7%
Total	**1,968,906**	**1,977,633**	**1,872,707**	**1,873,042**	**-5%**

Agriculture is the second most significant contributor to the Bay of Plenty's community carbon footprint. The sector's emissions decreased by 5% between 2015/16 and 2020/21 (95,864 tCO_2e). This decrease is driven by a reduction in total livestock numbers, especially of dairy cattle and sheep (see Table 17 and Table 18).

Table 17 Change in the Bay of Plenty's livestock numbers from 2015/16 to 2020/21

	Number of animals (2015/16)	Number of animals (2020/21)	Change in number of animals (2015/16 to 2020/21)
Dairy Cattle	395,413	343,675	-51,738
Non-dairy Cattle	90,770	107,956	17,186
Sheep	237,964	199,429	-38,535
Other livestock	32,182	34,436	2,255
Total livestock	**756,328**	**685,496**	**-70,833**

Table 18 Change in the Bay of Plenty's livestock-associated Agriculture emissions from 2015/16 to 2020/21

	2015/16 emissions (tCO_2e)	2020/21 emissions (tCO_2e)	% Change in emissions (2015/16 to 2020/21)
Dairy Cattle	1,514,982	1,380,870	-9%
Non-dairy Cattle	232,775	272,529	17%
Sheep	128,118	109,314	-15%
Other livestock	30,625	34,018	11%
Total livestock	**1,906,500**	**1,796,732**	**-6%**

4.3 Stationary Energy

Table 19 Change in the Bay of Plenty's Stationary Energy emissions from 2015/16 to 2020/21

Sector / Emissions Source	2015/16 (tCO_2e)	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2015/16 to 2020/21)
Electricity Consumption	263,228	293,285	297,241	407,419	55%
Natural Gas	247,997	258,195	255,480	265,995	7%
Stationary Petrol & Diesel Use	71,641	90,469	85,280	91,399	28%
Coal	29,837	25,606	26,524	21,150	-29%
Natural Gas Transmission and Distribution Losses	20,053	20,877	20,658	21,508	7%
LPG	18,287	21,625	22,018	23,143	27%
Electricity Transmission and Distribution Losses	15,864	25,600	26,092	37,420	136%
Biofuel / Wood	9,950	10,118	10,118	10,119	2%
Biogas (landfill)	0	154	165	177	*N/A*
Total:	**676,859**	**745,929**	**743,576**	**878,331**	**30%**

Emissions from Stationary Energy increased by 30% between 2015/16 and 2020/21 (201,472 tCO_2e). This was driven by a 55% increase in electricity consumption emissions (144,190 tCO_2e). This rise in electricity consumption emissions was caused by a 3% increase in electricity consumption in the Bay of Plenty coupled with a 48% increase in the emissions intensity of the national electricity grid (tCO_2e/kWh). The emissions intensity of the national grid has increased in recent years due to the increased use of fossil fuels during years with low hydro electricity generation.

4.4 Waste

Table 20 Change in the Bay of Plenty's Waste emissions from 2015/16 to 2020/21

Sector / Emissions Source	2015/16 (tCO_2e)	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2015/16 to 2020/21)
Waste in open landfill sites	133,712	76,247	79,967	84,079	-37.1%
Waste in closed landfill sites	126,414	114,138	108,070	100,805	-20.3%
Individual septic tanks	26,547	31,892	32,934	33,802	27.3%
Wastewater treatment plants	6,271	6,428	6,621	7,130	13.7%
Composting	1,880	1,885	2,783	3,682	95.8%
Total	**294,824**	**230,590**	**230,375**	**229,498**	**-22%**

Waste emissions decreased between 2015/16 and 2020/21, by 22% (65,327 tCO_2e). Total solid waste in landfill emissions decreased by 29% due to improvements in landfill gas capture at landfill sites. Emissions from closed landfills decreased due to existing waste in these sites releasing fewer emissions over time.

Total wastewater emissions increased by 25%, slightly above the Bay of Plenty's population growth which was 17% during this time.

4.5 Industrial Processes and Product Use (IPPU)

Table 21 Change in the Bay of Plenty's IPPU emissions from 2015/16 to 2020/21

Sector / Emissions Source	2015/16 (tCO_2e)	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2015/16 to 2020/21)
Refrigerants and air conditioning	83,691	105,436	102,798	103,666	23.9%
Aerosols	5,476	5,417	5,308	5,352	-2.3%
SF6 - Electrical Equipment	910	845	885	893	-2.0%
Foam Blowing	253	378	411	415	63.9%
SF6 - Other	176	185	187	188	7.2%
Fire extinguishers	138	151	153	155	11.8%
Total	**90,644**	**112,412**	**109,742**	**110,668**	**22%**

IPPU emissions increased between 2015/16 and 2020/21, by 22% (20,024 tCO_2e). The increase in IPPU emissions is mainly caused by an increased use of refrigerant gases. Note that national level data is used for this sector and is portioned out using a population approach; exact emissions for the Region are unknown.

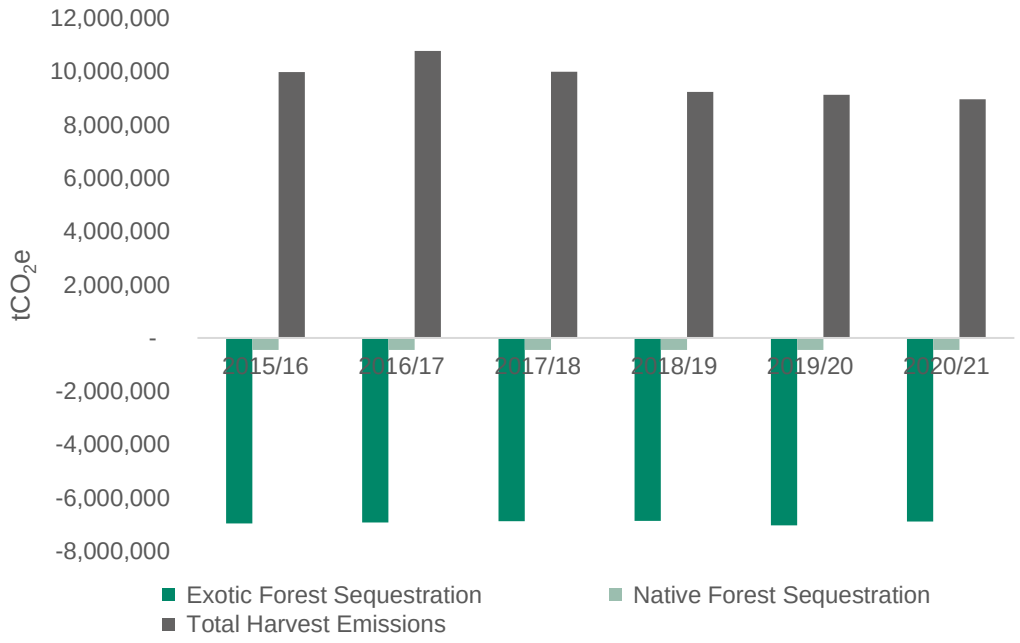
4.6 Forestry

Table 22 Change in the Bay of Plenty's Forestry emissions from 2015/16 to 2020/21

Sector / Emissions Source	2015/16 (tCO_2e)	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2015/16 to 2020/21)
Total harvest emissions	9,984,768	9,242,458	9,129,700	8,963,108	-10.2%
Native forest sequestration	-447,287	-446,901	-446,901	-446,901	-0.1%
Exotic forest sequestration	-6,970,096	-6,871,537	-7,037,016	-6,891,223	-1.1%
Total	**2,567,385**	**1,924,020**	**1,645,783**	**1,624,983**	**-37%**

Forestry emissions decreased by 942,402 tCO_2e (37%) between 2015/16 and 2020/21, this is the largest real change in emissions for the Bay of Plenty. This decrease was driven by a decrease in total harvest emissions (1,021,660 tCO_2e). Sequestration by exotic forest also decreased during this time.

Figure 11 Forestry sequestration and harvesting emissions from 2015/16 to 2020/21



Forestry emissions are influenced by the cyclical nature of harvesting and planting regimes. This is evident in the decrease in forestry harvesting emissions in the Bay of Plenty since 2016/17. Improved and updated data sources may impact the estimation of emissions from this source in the future.

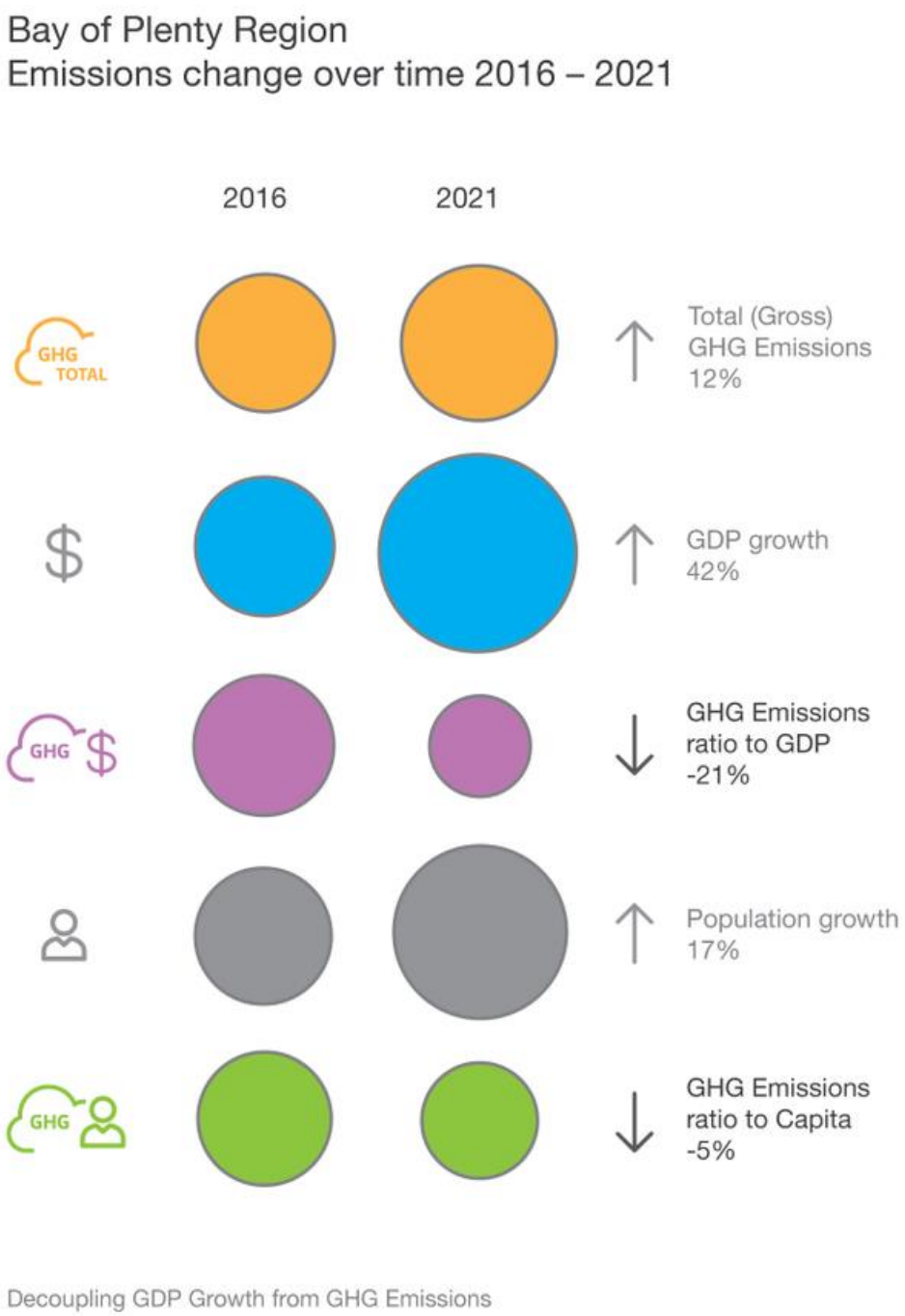
5.0 Decoupling of GHG emissions from population growth and GDP

Figure 12 shows the change in gross emissions when compared to changes in other metrics of interest between 2015/16 and 2020/21. For example, while total gross emissions have increased by 12%, per capita gross emissions have decreased by 5% as the population has grown faster than emissions during this time (by 17%).

When emissions grow less rapidly than Gross Domestic Product (GDP) as a measure of regional 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 12 suggest at a high-level decoupling has occurred between 2015/16 and 2020/21. GDP increased by 42% while gross emissions increased by 12%, resulting in a 21% decrease in the GHG emissions ratio to GDP.

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, transportation, 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.

Figure 12 Change in total gross emissions compared to other metrics of interest



6.0 Impact of the COVID-19 pandemic on GHG Emissions

COVID-19 impacted New Zealand and the entire world during 2020 and 2021, causing widespread government-imposed restrictions on businesses and individuals and huge shifts in behaviours and economic markets. Restrictions in New Zealand relating to COVID-19 began in mid-March with many personal and business restrictions continuing past the end of 2019/20 and throughout 2020/21.[3]

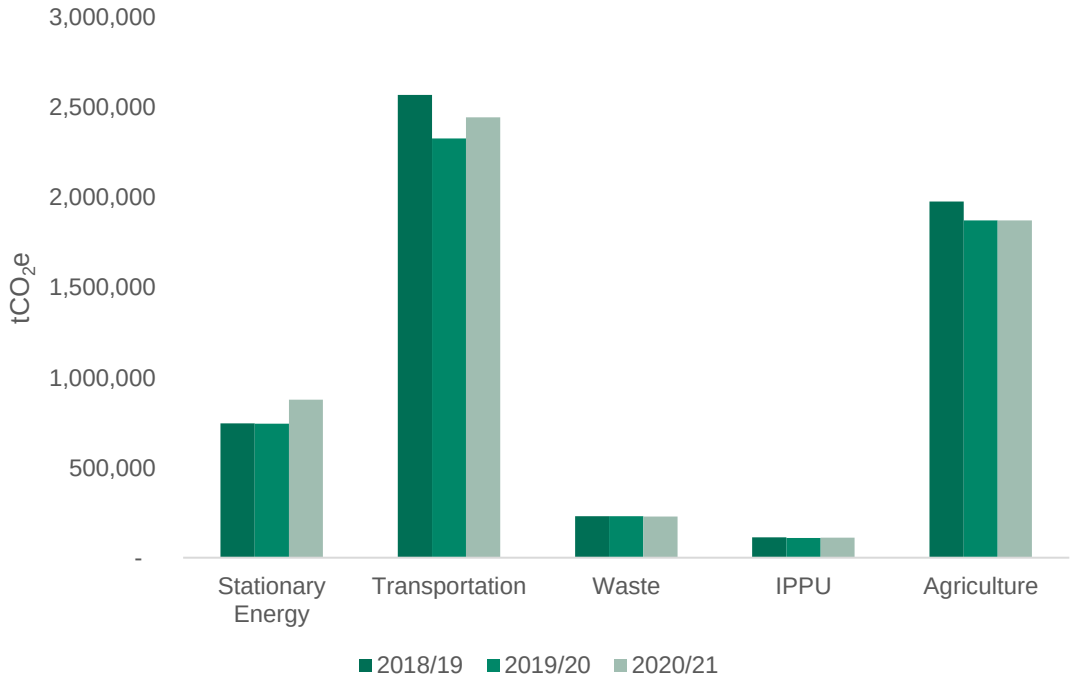
Globally, carbon dioxide emissions from fossil fuels (the largest contributor to greenhouse gas emissions) in 2020 decreased by 7% compared to 2019[4]. Emissions from the transportation sector account for the largest share of this decrease. Surface transport, e.g. car journeys, fell by approximately half at the peak of COVID-19 restrictions in April 2020 (when restrictions were at their maximum, particularly across Europe and the U.S. Globally, emissions recovered to near 2019 levels in 2021 and are expected to continue to increase.

In New Zealand, national daily carbon dioxide emissions are estimated to have fell by up to 41% during the level 4 lockdown in April 2020[5]. National gross emissions decreased by 3% from 2018/19 to 2019/20, which was largely driven by a decrease in fuel use in road transport due to COVID-19 pandemic restrictions, a decrease in fuel use in manufacturing industries and construction due to COVID-19 restrictions, and a decrease in fuel use from domestic aviation also due to COVID-19 restrictions.

Total gross emissions in the Bay of Plenty decreased by 351,676 tCO_2e (6.7%) between 2018/19 and 2019/20. Total gross emissions then increased by 252,970 tCO_2e (4.6%) from 2019/20 to 2020/21, however this is still lower than the pre-covid-19 2018/19 year.

The impact on emissions in different sectors varied. Notably, Transport emissions reduced by 10.4% between 2018/19 and 2019/20, driven by reduced marine freight and air transport fuel use. Stationary Energy, Waste, and IPPU emissions were relatively unchanged between 2018/19 and 2019/20. Despite changes in Agriculture emissions, this sector is not judged to have been significantly affected by the COVID-19.

Figure 13 Bay of Plenty emissions per sector for 2018/19, 2019/20, and 2020/21 (tCO_2e)



[3] https://covid19.govt.nz/alert-system/history-of-the-covid-19-alert-system/
[4] Pierre Friedlingstein et al. - Global Carbon Budget 2020 (2020)
[5] Corinne Le Quere et al. – Temporary Reduction in Daily Global CO_2 Emissions During the COVID-19 Forced Confinement

7.0 Update to the 2015/16 Emissions Footprint

Improvements to the methodology, improvements in available data, and updates to emission factors since the 2015/16 Community Carbon Footprint was first published in 2017 have meant that the 2015/16 footprint results are required to be updated to allow direct comparison with the 2018/19, 2019/20, and 2020/21 footprints.

The previous 2015/16 inventory results and updated 2015/16 inventory results are presented in Table 23.

Key reasons for results changes between these footprints are outlined below:

- Stationary Energy emissions have been adjusted due to improvements in data and methodology changes, notably through the inclusion of emissions related to industry-specific natural gas connection points.
- Transportation emissions have been adjusted due to the inclusion of marine freight emissions relating to the Port of Tauranga which were not previously included. Data improvements and methodology changes have also impacted this sector.
- Waste emissions have been adjusted due to updates to IPCC guidance and improvements in data.
- IPPU emissions have been adjusted due to a change in emission factors provided by the Ministry for the Environment (MfE).
- Agriculture emissions have been adjusted due to improvements in data and changes in MfE emission factors.
- Forestry emissions have been adjusted due to improvements in published data and emission factors.

Table 23 Reported GHG emissions in the Bay of Plenty for 2015/16, showing the change in emissions between those previously reported (2017) and the updated results (2022)

	2015/16 previous inventory (2017) – tCO_2e	2015/16 updated inventory (2022) – tCO_2e
Stationary Energy	591,379	676,859
Transportation	1,239,963	1,913,063
Waste	230,928	294,824
IPPU	93,484	90,644
Agriculture	1,923,661	1,968,906
Forestry	1,898,638	2,567,385
Total Net Emissions (incl. forestry)	**5,978,054**	**7,511,682**
Total Gross Emissions (excl. forestry)	**4,079,415**	**4,944,297**

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

8.0 Closing Statement

The Bay of Plenty's GHG emissions footprint provides information for decision-making and action by the council, stakeholders, and the wider community. We encourage the council to use the results of this study to update current climate actions plans and set emission reduction targets.

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

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

The accuracy of any emissions footprint is limited by the availability, quality, and applicability of data. Areas where data could be improved for future footprints include forestry (forest cover and harvesting), agriculture (especially livestock numbers), solid waste and wastewater, and on and off-road transport fuel use.

9.0 Limitations

Where this Report indicates that information has been provided to AECOM by third parties, AECOM has made no independent verification of this information except as expressly stated in the Report. AECOM assumes no liability for any inaccuracies in or omissions to that information. This Report was prepared between **December 2021 and September 2022** and is based on the information reviewed at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred after this time. This Report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This Report does not purport to give legal advice.

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Appendix A

Assumptions and Data Sources

Sector / Category	Assumption and Data Sources
General	
Geographical Boundary	LGNZ local council mapping boundaries have been applied. The emissions footprint for the Bay of Plenty Region covers the entirety of the Bay of Plenty Region (this excludes some of the Rotorua and Taupō territorial authorities). Emissions footprints for each territorial authority covers the entirety of the territorial authority area (for Rotorua and Taupō territorial authorities, this includes areas outside the Bay of Plenty Region).
Population	Population figures are provided by StatsNZ. Financial year populations have been used, these are based on the average population from the two calendar years (e.g. the average of 2018 and 2019 calendar year populations for FY19). The population of Rotorua and Taupō inside/outside the Bay of Plenty Region has been estimated by AECOM and approved by the Bay of Plenty Regional Council (BoPRC).
Transport Emissions	
Petrol and Diesel:	Bay of Plenty fuel sales figures (litres) provided by Rotorua Lakes Region Council. Sales have been divided between territorial authorities based on the number of kilometres travelled by vehicles on roads (VKT) in each territorial authority. VKT data provided by Waka Kotahi. The division into transport and stationary energy end use (and within transport into on-road and off-road) has been calculated using fuel end use data provided by the Energy Efficiency and Conservation Authority (EECA) from the 2019 database. Biofuel sales information provided directly by the supplier.
Rail Diesel	Emissions from fuel use have been calculated and provided by Kiwi Rail. The following assumptions were made: - Net Weight is product weight only and excludes container tare (the weight of an empty container) - The Net Tonne-Kilometres (NTK) measurement has been used. NTK is the sum of the tonnes carried multiplied by the distance travelled. - National fuel consumption rates have been used to derive litres of fuel for distance. - Type of locomotive engine used, and jurisdiction topography, have not been incorporated in the calculations. 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 Region, arrival Region and any Region the freight stopped at along the way. If the freight travelled through but did not stop within a Region, no emissions were allocated. This data is subject to commercial confidentiality.
Jet Kerosene (Scheduled Flights)	Calculated from information provided by Rotorua, Tauranga, Taupō, and Whakatāne airports. Emissions from scheduled flights are allocated equally between the origin and destination area emissions footprints. Flight emissions relating to each airport have been divided between territorial authorities based on the expected users of the airports: - Rotorua Airport to Rotorua territorial authority only - Taupō Airport to Taupō territorial authority only - Whakatāne Airport to Whakatāne, Ōpōtiki, and Kawerau territorial authorities, allocated based on population size - Tauranga Airport to Tauranga and Western Bay of Plenty territorial authorities, allocated based on population size
Aviation Gas (General Aviation)	Aviation Gas consumption has been estimated based on community carbon footprints developed for other regions in New Zealand. The relative size of this consumption has been based on the number of general aviation flights taken from each airport for each year. This information has been provided by the respective airports. Emissions relating to each airport have been divided between territorial authorities as described for 'Schedules Flights' above.
Marine Freight	Shipping schedules have been provided by the Port of Tauranga. Emissions have been calculated based on ship weight and distance from the origin/destination to Tauranga. This figure does not include fishing vessels, or vessels with Tauranga as both the origin and destination. Emissions from freight and international shipping are allocated equally between the origin and destination area emissions footprints. It is expected that imports and exports travelling through the Port of Tauranga service the entire Bay of Plenty Region. Emissions relating to freight and international shipping emissions have been divided between all Bay of Plenty territorial authorities based on population size.
Marine Fuel (Local)	This emissions source relates to vessels servicing the Port of Tauranga. All emissions have been allocated to Tauranga territorial authority. Does not include fuel use for private boating. Most private marine vessels use fuel purchased at vehicle fuel stations. Petrol and diesel used in private marine vessels is included in off-road transportation.

LPG Consumption	North Island LPG sales data (tonnes) has been provided by the LPG Association. 'Auto' and 'Forklift' sales represent transport uses of LPG. Sales have been divided between territorial authorities on a per capita basis.
Stationary Energy Emissions	
Electricity Demand	Electricity demand has been calculated using grid exit point (GXP) data from the EMI website (www.emi.ea.govt.nz). Reconciled demand has been used as per EMI's confirmation. The territorial authorities serviced by each GXP have been confirmed by the respective electricity suppliers. The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per Ministry for the Environment (MfE) data.
Electricity Generation	Electricity generation has been calculated using data from the EMI website (www.emi.ea.govt.nz). Small electricity generation has not been included in this data (e.g. domestic solar generation). This figure only includes electricity that is connected to the national electricity grid, direct users of electricity are not included.
Coal Consumption	National coal consumption data has been provided by MBIE. Regional industrial coal data has been provided by EECA. National residential and commercial coal consumption has been divided between territorial authorities on a per capita basis. Regional industrial coal consumption has been divided between territorial authorities on a per capita basis.
Coal Production and Fugitive Emissions	Not Calculated: There are no active coal mines within the region.
Biofuel Consumption	National biofuel consumption data has been provided by the Ministry for Business, Innovation and Employment (MBIE). Biofuel consumption has been divided between territorial authorities on a per capita basis. Biofuel emissions are broken down into Biogenic emissions (CO_2) and Non-Biogenic emissions (CH_4 and N_2O)
LPG Consumption	North Island LPG sales data (tonnes) has been provided by the LPG Association. 'Auto' and 'Forklift' sales represent transport uses of LPG. All other sales represent stationary energy uses of LPG.

	Sales have been divided between territorial authorities on a per capita basis. The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per MfE data.
Natural Gas Consumption	Natural gas consumption data has been provided by FirstGas. Territorial Authorities supplied by gas from each Point of Connection (POC) have been confirmed by FirstGas. Natural gas consumption has been split into residential, commercial, and industrial consumption based on national statistics from MBIE. Some POCs supply gas to particular industrial users exclusively, these have been taken into account.
Oil and Gas Fugitive Emissions	Not Calculated: There are no gas or oil processing plants within the region.
Agricultural Emissions	
General	Territorial authority livestock numbers and fertiliser data taken from the Agricultural Census (StatsNZ). The last territorial authority census was in 2017. Regional agricultural data from StatsNZ (2021) has been used to estimate the change in livestock and fertiliser use since 2017. Territorial authority land-use data provided by BoPRC covering horticulture land-use.
Solid Waste Emissions	
Waste in Landfill	Landfill waste volume and end location information has been provided by the respective council departments. Where information is not available, waste volumes have been estimated based on historical national data on a per capita basis. Emissions are allocated to territorial authorities based on where the waste was produced, even if the waste is disposed in landfill outside the territorial authority.
Wastewater Emissions	
Wastewater Volume and Treatment Systems	Information on treated wastewater, and treatment plants has been provided by the respective council departments. Where information is not available, reasonable assumptions have been made. The population connected to septic tank systems have been estimated by the respective council departments. Emissions are allocated to territorial authorities based on where the wastewater was produced, even if the wastewater is treated outside the territorial authority.
Industrial Emissions	

Industrial processes	It is assumed that there are no significant non-energy related emissions of greenhouse gasses from industrial processes in the Region (e.g. aluminium manufacture).
Industrial Product Use	National data covering industrial product use (e.g. fire extinguishers, refrigerants) has been provided by the MfE. Emissions have been allocated to territorial authorities on a per capita basis.
Forestry Emissions	
Exotic Forestry Harvested	Regional exotic wood harvested has been provided by the Ministry for Primary Industries (MPI) in the Agricultural Production Statistics. The 2017/18 year is the latest year's data available, for 2018/19, 2019/20 and 2020/21, the 2017/18 figure is used. Exotic forest of harvestable age land area for each territorial authority has been provided by the Ministry for Primary Industries (MPI) in the National Exotic Forest Description (NEFD). This has been used to estimate the likely breakdown of the region's harvested wood by territorial authority. Emissions from roundwood, slash, and the underground tree are all accounted for.
Exotic and Native Forest sequestration	Exotic forest land area for each territorial authority has been provided by the Ministry for Primary Industries (MPI) in the National Exotic Forest Description (NEFD). Native forest land area is provided by Landcare Research Land-use Change Database (LCDB v5). The 2018/19 year is the latest year's data available, for 2019/20 and 2020/21, the 2018/19 figure is used.
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 EFs have been applied. AR5 Global Warming Potential (GWP) figures for greenhouse gases have been used accounting for climate change feedbacks.

Appendix B

Additional Transport Emissions Analysis

Additional Transport Emissions Analysis - Bay of Plenty Region

This section details the analysis undertaken to further breakdown the Bay of Plenty Region's transport sector GHG emissions in the financial year 2020/21. The focus of this additional analysis addresses on-road and off-road transport emissions which together represent 22% of the Bay of Plenty's total gross emissions. Within on-road and off-road transport emissions this assessment looks at the relative contribution of each vehicle type (Cars, Commercial Vehicles, Buses) to the region's transport emissions.

Key findings:

- Cars represent 50% of Bay of Plenty's on-road transport emissions, and 11% of Bay of Plenty's total gross emissions.
- Light commercial vehicles represent 22% of Bay of Plenty's on-road transport emissions and 5% of Bay of Plenty's total gross emissions.
- Heavy commercial vehicles representing 25% of Bay of Plenty's on-road transport emissions and 5% of Bay of Plenty's total gross emissions.
- Electric vehicles currently represent just 0.02% of Bay of Plenty's on-road transport emissions based on emissions related to the electricity consumed.
- Cars represent 73% of all Vehicle Kilometres Travelled (VKT) in Bay of Plenty but represent 50% of all on-road emissions in Bay of Plenty. This is due to the relatively low average tCO_2e per VKT of cars compared to heavier vehicles. Heavy commercial vehicles are the highest emissions intensive category per kilometre of travel. Despite 25-50+ tonne heavy vehicles representing 4% of all VKT in Bay of Plenty these vehicles represent 19% of all on-road emissions in Bay of Plenty.
- Diesel is the predominant fuel for off-road transport use in the Bay of Plenty, representing 95% of off-road transport emissions in Bay of Plenty.
- At a national level, agriculture is the highest producing sector of off-road transport emissions, producing 27% of all off-road transport emissions. The next largest off-road transport producing sectors are building and construction, commercial, and industrial uses. Data specific to Bay of Plenty was not available at the time of writing.

1.0 Methodology

The basis for this assessment is the results presented in the Bay of Plenty's Community Carbon Footprint for the financial year 2020/21 (July 1st to June 30th). The emissions for on-road and off-road transport have been calculated directly based on the sale of petrol and diesel in Bay of Plenty, and then these have been broken down by sector and vehicle type using data provided by Waka Kotahi and the Energy Efficiency and Conservation Authority (EECA).

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

Emissions related to energy use from electric vehicles (EVs) in the Community Carbon Footprint is included in the Stationary Energy sector and not included in transport emissions, due to lack of available data at the time of calculation. Total emissions presented here include the EV emissions contribution. These emissions have been calculated using an average electricity consumption per km travelled and based on the carbon intensity of the national electricity grid in 2020/21.

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

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

2.0 Key Limitations

On-road transport

- The data underlying the breakdown of on-road transport emissions is based on calendar year 2019 data, not financial year 2020/21. There may be some differences between these years regarding the vehicle fleet make-up, but it expected that the proportions used are representative.

Off-road transport

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

Marine freight transport, air travel, and rail

- These emissions sources have not been broken down further. Additional work could be done to separate cruise ships from marine freight (although there is limited available and reliable data to do so). Additional work could also assess the relative contribution of the origin and destination of marine and air travel movements. These are beyond the scope of this study.

3.0 Transport Emissions Summary

The paragraphs, figures and tables below outline Bay of Plenty's greenhouse gas emissions from transport. During the 2020/21 reporting period, transport in Bay of Plenty emitted 2,446,464 tCO_2e, representing 44% of Bay of Plenty's total gross emissions.

On-road transport is the largest contributor to Transport emissions, representing 49% of Transport emissions and 22% of Bay of Plenty's total gross emissions. This is followed by marine transport (almost all relating to marine freight), and off-road transport.

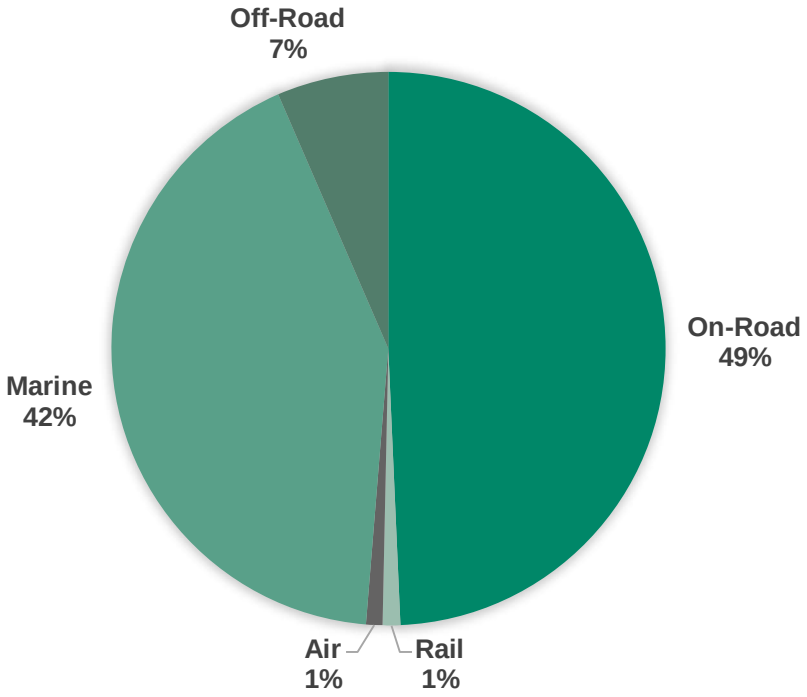

Figure 1 Bay of Plenty – Transport emissions (tCO_2e)

4.0 On-Road Transport Emissions Breakdown

4.1 Bay of Plenty Region

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

Table 1 and Figure 2 detail on-road transport emissions per vehicle category. The results show that cars in Bay of Plenty tend to be fuelled by petrol while Commercial Vehicles and Buses almost exclusively use diesel.

Low emission Electric Vehicle (EV) use is currently minimal within the Bay of Plenty resulting in a small contribution to on-road transport emissions (247 tCO_2e). Note that sales and use of electric vehicles have likely increased since 2018/19 (the most recent year available for the dataset used), however emissions will likely still represent a small contribution to on-road transport emissions.

In the Bay of Plenty, the largest contributor to on-road transport emissions are cars, representing 50% of on-road transport emissions, and 11% percent of Bay of Plenty's total gross emissions. Commercial vehicles represent 47% of on-road transport emissions, and 10% percent of Bay of Plenty's total gross emissions. A further breakdown of commercial vehicle types is provided below.

In the Bay of Plenty, the majority of car GHG emissions are from petrol, while commercial vehicle GHG emissions are primarily diesel. Buses are almost entirely diesel fuelled and contribute 3% of total

vehicle emissions for the region. The buses category includes all buses including public transport, school, and private commercial (including tourist coaches).

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

Vehicle Type	Petrol	Diesel	Electric	Total	% of Total
Unit	(tCO_2e)	(tCO_2e)	(tCO_2e)	(tCO_2e)	
Cars	513,521	91,305	243	**605,069**	**50%**
Commercial Vehicles	31,348	530,098	1	**530,099**	**47%**
Buses	-	40,133	3	**40,136**	**3%**
Total	**544,870**	**661,536**	**247**	**1,206,652**	
% of Total	**45%**	**55%**	**<1%**	**-**	

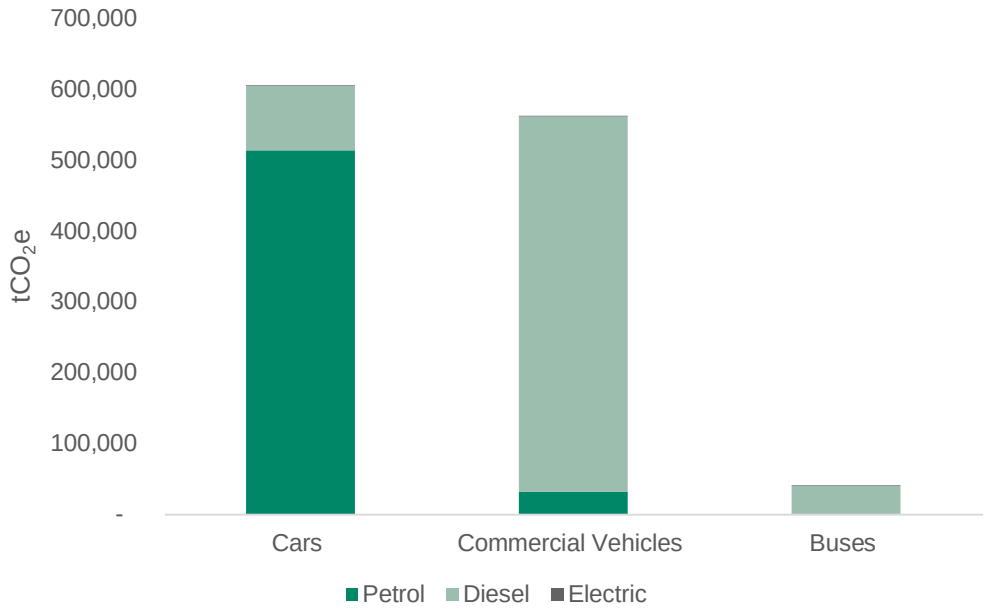

Figure 2 On-road transport emissions by vehicle type and fuel type

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

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

Vehicle Class	GHG Emissions (tCO_2e)	% of Total
Cars	605,069	50%
Light Commercial Vehicles <3.5 Tonne	264,845	22%
Heavy Vehicles 3.5-25 Tonne	65,520	5%
Heavy Vehicles 25-50+ Tonne	231,082	19%
Bus Urban 15-18 Tonne	36,509	3%
Bus Coach >18 Tonne	3,627	<1%
Total	1,206,652	

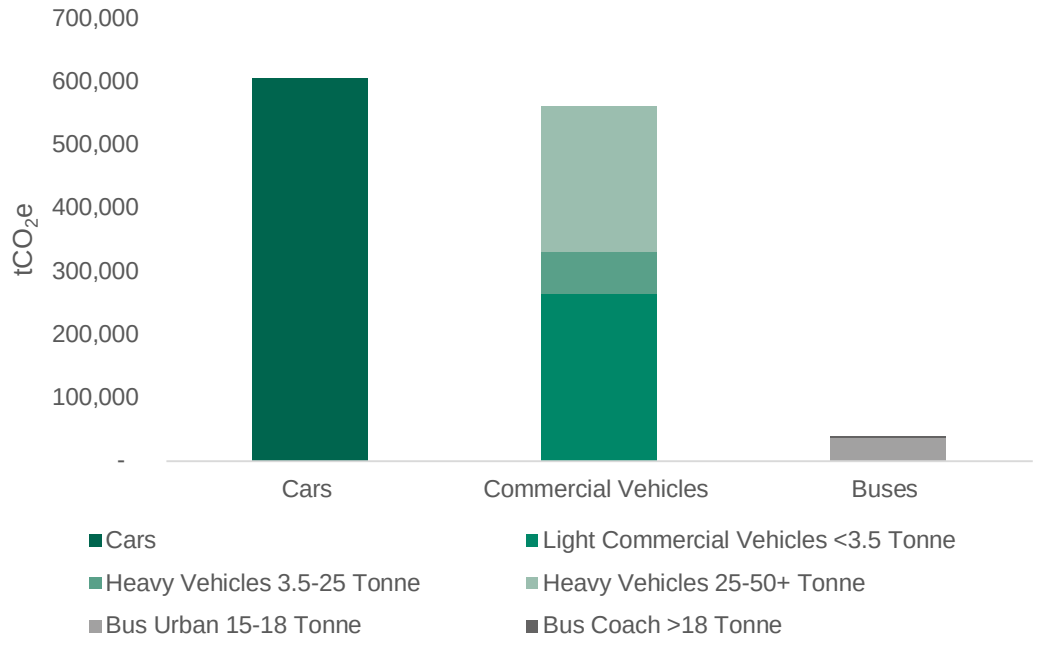

Figure 3 On-road transport emissions by vehicle class

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

Cars represent 73% of all VKT in the Bay of Plenty but represent 50% of all on-road emissions in the Bay of Plenty. This is due to the relatively low average tCO_2e per VKT of cars compared to heavier vehicles (which is also partly due to the use of petrol rather than diesel for cars). Heavy commercial vehicles are the highest emissions intensive category per kilometre of travel. Despite 25-50+ tonne heavy vehicles representing 4% of all VKT in the Bay of Plenty these vehicles represent 19% of all on-road emissions in the Bay of Plenty. It is important to note that these figures do not take into account the weight of freight, or the number of people, being moved per vehicle, where larger vehicles may be more efficient per tonne of freight moved than smaller vehicles, or where busses may be more efficient per person than cars.

Efforts to reduce the kilometres travelled by all vehicles should be considered to reduce emissions from on-road transport. This could include enabling and encouraging increased public transport use or

diverting freight from roads onto rail and marine transport options. Efforts that reduce the need for travel and improvements to the fuel efficiency of all vehicles should also be considered.

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

Vehicle Type	Vehicle Kilometres Travelled (VKT)	GHG Emissions (tCO_2e)	Average tCO_2e per VKT
Cars	2,362,888,893	605,069	0.0003
Light Commercial Vehicles <3.5 Tonne	636,869,855	264,845	0.0004
Heavy Vehicles 3.5-25 Tonne	71,811,629	65,520	0.0009
Heavy Vehicles 25-50+ Tonne	133,666,549	231,082	0.0017
Bus Urban 15-18 Tonne	18,687,283	36,509	0.0020
Bus Coach >18 Tonne	2,817,858	3,627	0.0013
Total	**3,226,742,067**	**1,206,652**	

4.2 Territorial Authorities in the Bay of Plenty Region

This section briefly presents the main results of this assessment at the territorial authority level. All calculations and results have been provided to the Bay of Plenty Regional Council.

Due to the differences in geographic boundaries between the territorial authorities and the region, the sum of GHG emissions from the territorial authorities covered here does not equal the same total emissions as for the whole Bay of Plenty Region.

Table 4 On-road transport emissions by vehicle type and fuel type for the territorial authorities in the Bay of Plenty (tCO_2e)

Vehicle Type	Taupō	Western Bay of Plenty	Tauranga	Rotorua	Whakatāne	Kawerau	Ōpōtiki
Unit	(tCO_2e)	(tCO_2e)	(tCO_2e)	(tCO_2e)	(tCO_2e)	(tCO_2e)	(tCO_2e)
Cars	92,831	134,432	234,782	135,649	80,240	5,605	20,071
Commercial Vehicles	130,560	139,635	183,613	135,283	73,873	4,986	28,047
Buses	11,329	10,329	11,921	10,085	5,144	373	2,389
Total	**234,721**	**284,396**	**430,316**	**281,018**	**159,256**	**10,965**	**50,507**

Table 5 Proportion of on-road transport emissions by vehicle type and fuel type for the territorial authorities in the Bay of Plenty

Vehicle Type	Taupō	Western Bay of Plenty	Tauranga	Rotorua	Whakatāne	Kawerau	Ōpōtiki
Cars	40%	47%	55%	48%	50%	51%	40%
Commercial Vehicles	56%	49%	43%	48%	46%	45%	56%
Buses	5%	4%	3%	4%	3%	3%	5%

Tauranga has the largest amount of on-road GHG emissions across each vehicle type, while Kawerau has the lowest across each vehicle type. Regarding the proportion of emissions by vehicle type, notably

Tauranga has the highest proportion of on-road car related GHG emissions compared to the other territorial authorities, while Taupō and Ōpōtiki have a higher proportion of commercial vehicle GHG emissions. The other territorial authorities are relatively similar to each other and also to the Bay of Plenty Region and New Zealand as a whole.

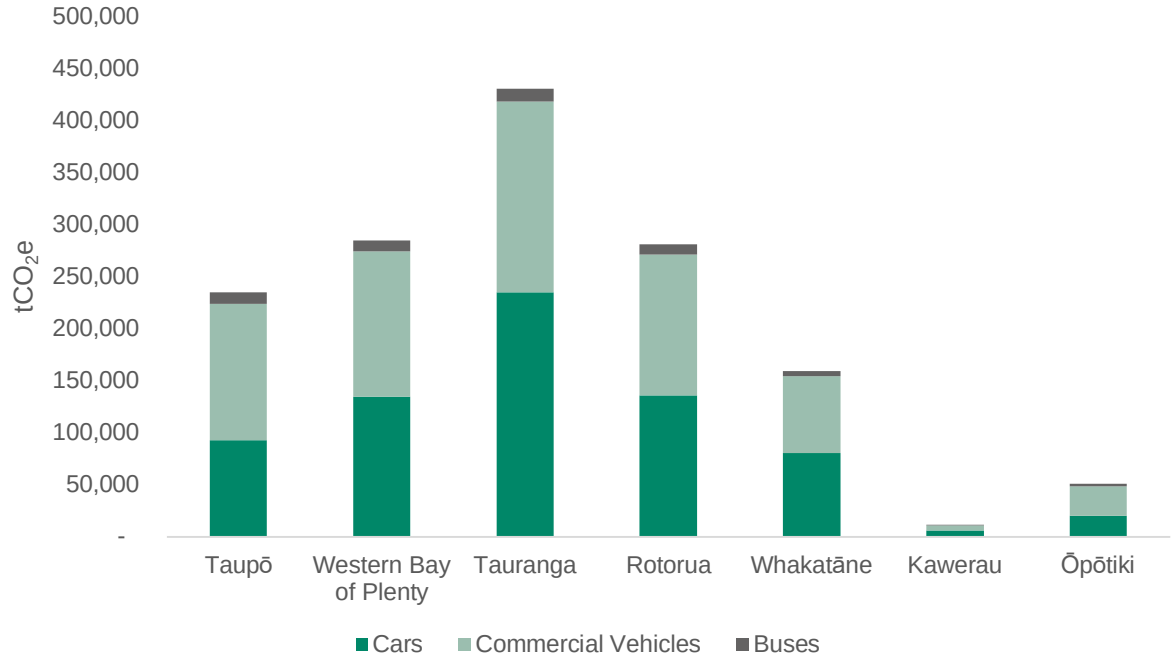

Figure 4 On-road transport emissions by vehicle type for the territorial authorities in the Bay of Plenty Region

5.0 Off-Road Transport Emissions Breakdown

The off-road transport emissions breakdown by sector is presented in Table 6 and Figure 5. The total off-road petrol and diesel figures are based on the Community Carbon Footprint for Bay of Plenty. These totals have then been allocated to sectors based on the *Off-road liquid fuel insights- Quantifying off-road diesel and petrol use in New Zealand*, July 2021 produced by EECA. It is important to note that the EECA figures used are from 2019 and are based on values for the entirety of New Zealand and are therefore not specific to uses of off-road transport fuels in Bay of Plenty.

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

In the Bay of Plenty, diesel is the predominant fuel for off-road transport use, representing 95% of off-road transport emissions.

Using the national data, we can provide an indicative idea of off-road fuel use by sector in the Bay of Plenty. Sectors such as mining or marine activities may not be present in all areas of New Zealand. Nationally, agriculture is the highest producing sector for off-road transport emissions, producing 27% of all off-road transport emissions. The next largest off-road transport producing sectors are building and construction, commercial, and industrial uses. Recreational marine fuel use is included in these off-road figures due to a lack of data available to split these apart from other off-road fuel use at the point of sale. These figures would likely be significantly different if data for Bay of Plenty was available.

Table 6 Indicative off-road transport emissions by sector type and fuel type (tCO_2e)

Sector Type	Diesel	Petrol	Total	% of Total[1]
Unit	(tCO_2e)	(tCO_2e)	(tCO_2e)	
Agriculture	42,163	594	**42,757**	**27%**
Fishing & Hunting	6,575	5	**6,580**	**4%**
Forestry & Logging	11,291	2	**11,293**	**7%**
Building & Construction	27,585	4	**27,588**	**17%**
Mining	11,720	-	**11,720**	**7%**
Industrial	20,153	34	**20,187**	**13%**
Commercial	21,296	378	**21,674**	**14%**
Recreational marine	7,146	6,893	**14,040**	**9%**
Marina Refuelling Stations	3,716	90	**3,806**	**2%**
Total	**151,645**	**8,000**	**159,645**	
% of Total	**95%**	**5%**		

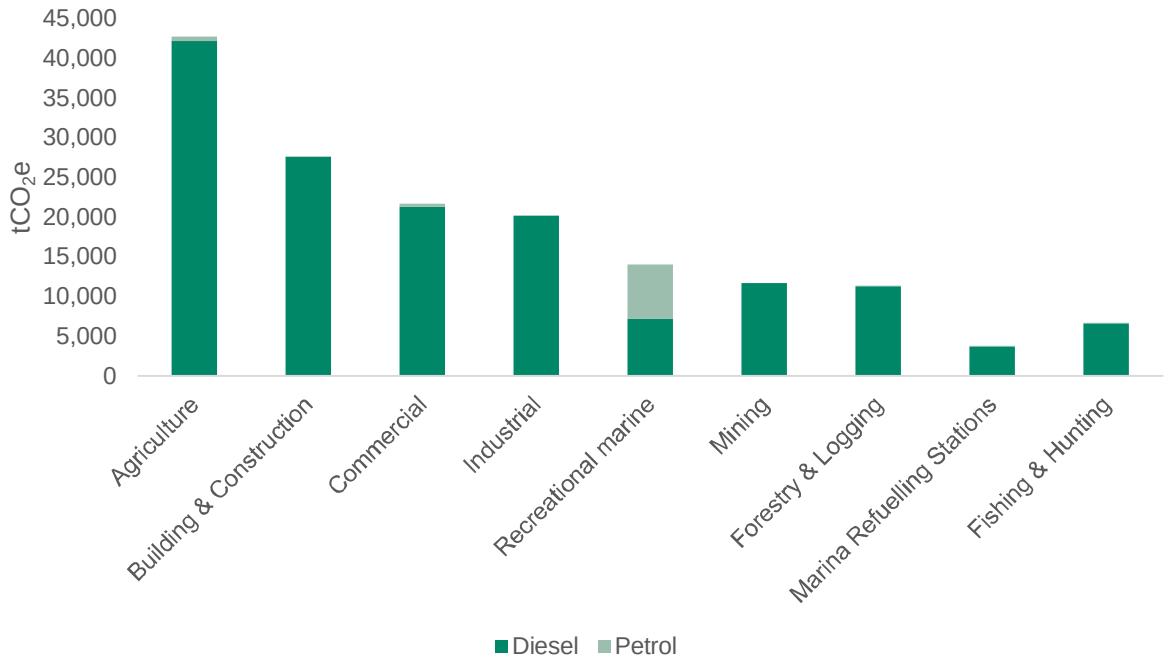

Figure 5 Indicative off-road transport emissions by sector type and fuel type (tCO_2e)

[1] Percentages may not add up to 100% due to rounding of numbers

6.0 Limitations

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Appendix C

Energy Generation Analysis

Renewable Energy Generation Analysis - Bay of Plenty Region

This section details analysis undertaken to further understand electricity generation in the Bay of Plenty Region. The focus of this analysis is grid connected energy generation in the 2020/21 financial year and trends in generation between the 2015/16 financial year and the 2020/21 financial year. Non-grid connected energy generation has not been included in this analysis due to a lack of available data.

Within energy generation this assessment looks at the relative contribution of each generation type and territorial authority to the Region's total energy generation. For this analysis, the entire districts of Rotorua and Taupō have been included, despite areas of these districts laying outside the Bay of Plenty regional boundary.

Key findings:

Energy Generation in 2020/21

- In 2020/21 geothermal and hydro generation represent 70.4% and 29.5% of grid connected energy generation in the Bay of Plenty respectively. The remaining generation is from solar (0.2%) and wind (0.002%).
- In 2020/21 grid connected geothermal energy is generated in Taupō (77%), Kawerau (21%), and Rotorua (1%).
- In 2020/21 grid connected hydro energy is generated in Taupō (88%) and Whakatāne (12%).
- Solar generation was present in all territorial authorities in the Bay of Plenty in 2020/21 with the Tauranga reporting region (Tauranga and Western Bay of Plenty) generating 68% of the total grid connected solar energy in Bay of Plenty. Grid connected residential solar generation connections represents the majority of total energy generated from solar (71%).
- The Eastern Bay of Plenty reporting region (Whakatāne, Kawerau, and Ōpōtiki) represented 77% of grid connected wind generated energy in 2020/21, with 60% of that produced in the industrial sector. The remaining 23% of wind generation is produced in the Tauranga reporting region (Tauranga and Western Bay of Plenty).

Energy Generation change from 2015/16 to 2020/21

- Between 2015/16 and 2020/21, grid connected energy generation across the territorial authorities in the Bay of Plenty decreased by 3%. This total generation decrease is due to a 12% reduction in hydro generation during this period. The largest source of energy generation, geothermal, remained relatively unchanged during this period.
- Grid connected solar and wind generation both experienced large percentage increases in generated energy between 2015/16 and 2020/21 (479% and 365% respectively), however this is from a very low starting point.
- A large increase in grid connected solar generation is seen across all territorial authorities, with the largest increase (643%) in the Tauranga reporting region (Tauranga and Western Bay of Plenty).
- Grid connected wind generation in the Eastern Bay of Plenty reporting region (Whakatāne, Kawerau, and Ōpōtiki) increased from no generation in 2015/16 to a total of 0.16 GWh in 2020/21. Grid connected wind generation in the Tauranga reporting region (Tauranga and Western Bay of Plenty) increased by 6%, driven by a 21% increase in residential generation.

1.0 Methodology

The basis of this study is of information sourced from the Electricity Authority Te Mana Hiko covering geothermal, hydro, wind, and solar energy generation.

- For solar and wind generation, installed electricity generation capacity (MW) data was sourced at the Networking Reporting Region. For Networking Reporting Region's with more than one associated territorial authority, the data was multiplied by the proportion of population within that territorial authority to estimate generation in that area.
    - The reported Networking Reporting Regions were Tauranga (Tauranga City and Western Bay of Plenty district), Rotorua (Rotorua district), Eastern Bay of Plenty (Whakatāne, Kawerau, and Ōpōtiki districts), and Taupō (Taupō district).
    - Installed electricity generation capacity (MW) for solar and wind generation was multiplied by capacity factors to estimate the financial year total generated energy output (MWh) and then converted to GWh. The same capacity factor was applied for each year and was not scaled for seasonal variation. Capacity factors were taken from the Energy in New Zealand[1] (MBIE, 2020) report.
    - Solar and wind generation was provided broken down by market sector (residential, commercial, enterprise, and industrial).[2]
- For hydro and geothermal generation, total electricity generation output (GWh) was sourced directly from the Electricity Authority at the unique generation points for each of the territorial authorities.

2.0 Key Limitations and Assumptions

- This report focuses on grid connected energy generation within the Bay of Plenty region only. It is recognised that off-grid generation of renewable energy sources, in particular direct use of geothermal energy, is prominent in Taupō and Rotorua[3].
- Some of the stationary uses of diesel and petrol, reported in the Community Carbon Footprint (within Stationary Energy), is used for electricity generation. This has not been included in this assessment.
- The entire district of Taupō has been included in this assessment despite Taupō sitting within the Waikato, Bay of Plenty, and Hawkes Bay regional areas. 14% of Taupō's area is within the Bay of Plenty region. The entire Rotorua district is also included in this analysis. 62% of Rotorua's area is in the Bay of Plenty region.

[1] Energy in New Zealand 2020, Geothermal for direct use, p.34, accessed at: https://www.mbie.govt.nz/dmsdocument/11679-energy-in-new-zealand-2020

[2] Residential connections have no ANZSIC code. Enterprise connections are defined as those assigned meter categories 1 and 2 (low voltage up to 500A) with an ANZSIC code excluding those relating to central or local government and other utility services. Industrial connections have ANZSIC codes from A through E while commercial connections use ANZSIC codes F through Z. More information on ANZSIC codes is available at www.stats.govt.nz

3.0 Energy Generation in 2020/21

In 2020/21 geothermal and hydro generation represent 70.4% and 29.5% of generated energy in the Bay of Plenty respectively. The remaining generation is from solar (0.2%) and wind (0.002%). Table 1 presents the total grid connected energy generation in the territorial authorities in the Bay of Plenty region, broken down by generation type.

Table 1 Energy generation in the Bay of Plenty in 2020/21

Territorial Authority	Generation Type	Energy Generated (GWh)	Total Energy Generated (GWh)
Taupō district	Solar	0.81	7,773.74
	Hydro	2,509.83	
	Geothermal	5,263.10	
Western Bay of Plenty district	Solar	2.96	2.97
	Wind	0.01	
Tauranga city	Solar	7.91	7.94
	Wind	0.03	
Rotorua district	Solar	2.01	81.99
	Geothermal	79.98	
Whakatāne district	Solar	1.57	340.83
	Wind	0.11	
	Hydro	339.15	
Kawerau district	Solar	0.31	1,457.52
	Wind	0.02	
	Geothermal	1,457.19	
Ōpōtiki district	Solar	0.42	0.45
	Wind	0.03	
Total	**Solar**	**15.99**	**9,665.45**
	Wind	**0.21**	
	Hydro	**2,848.98**	
	Geothermal	**6,800.26**	

The largest proportion of grid connected energy generation in the Bay of Plenty in 2020/21 was geothermal energy, predominantly generated in Taupō (77%) and Kawerau (21%), but also with some in Rotorua (1%). There are five grid connected geothermal energy generation sites in Taupō, with one site each in Kawerau and Rotorua.

The next largest source of grid connected energy generation was hydro generation, predominantly in Taupō (88%) but also with some in Whakatāne (12%). There are four grid connected hydro energy generation sites in Taupō, with the largest, Whakamaru, producing 50% of Taupō's hydro generation in 2020/21. There are two grid connected hydro energy generation sites in Whakatāne, with the largest, Matahina, producing 91% of Whakatāne's hydro generation in 2020/21.

Solar generation is present in all territorial authorities in the Bay of Plenty with the Tauranga reporting region (Tauranga and Western Bay of Plenty) generating 68% of the total solar energy generated in

Bay of Plenty. Grid connected residential solar generation connections represent 71% of the total energy generated from solar (with the remaining 29% produced by enterprise, commercial, and industrial connections).

Grid connected wind generation is present in very small amounts across most of the territorial authorities assessed in 2020/21. The Eastern Bay of Plenty reporting region (Whakatāne, Kawerau, and Ōpōtiki) represents 77% of grid connected wind generated energy, with 60% of that produced in the industrial sector. This industrial use may be a very small number of connections in a specific area but the use has been split between the territorial authorities in the Eastern Bay of Plenty reporting region based on population due to the lack of specific data available. The Tauranga reporting region (Tauranga and Western Bay of Plenty) represents the remaining 23% of grid connected wind generation, with generation split almost equally between residential, commercial, and enterprise connections.

4.0 Energy Generation change from 2015/16 to 2020/21

Between 2015/16 and 2020/21, grid connected energy generation across the territorial authorities in the Bay of Plenty decreased by 3%. This total generation decrease is due to a 12% reduction in hydro generation during this period. The largest source of energy generation, geothermal, remained relatively unchanged during this period. Grid connected solar and wind generation both experienced large percentage increases in generated energy (479% and 365% respectively), however this is from a very low starting point.

Table 2 Total grid connected generation by generation type in 2015/16 and 2020/21 (GWh)

Generation Type	2015/16	2020/21	% difference
Geothermal	6,746	6,800	1%
Hydro	3,251	2,849	-12%
Solar	3	16	479%
Wind	0.05	0.21	365%
Total	**9,999**	**9,665**	**-3%**

4.1 Geothermal generation

Between 2015/16 and 2020/21, grid connected geothermal energy generation across the territorial authorities in the Bay of Plenty increased by 1%. This is driven by a 14% increase in generated energy in Kawerau. Total generation in Taupō and Rotorua remained relatively unchanged during this period. However within Taupō, generation from four of the five sites decreased between 2015/16 and 2020/21, while the largest site (Nga Awa Purua) saw a 5% increase in generation.

Table 3 Total grid connected geothermal generation by territorial authority in 2015/16 and 2020/21 (GWh)

Territorial Authority	2015/16	2020/21	% difference
Taupō district	5,383	5,263	-2%
Rotorua district	84	80	-4%
Kawerau district	1,280	1,457	14%
Total	**6,746**	**6,800**	**1%**

4.2 Hydro generation

Between 2015/16 and 2020/21, grid connected hydro energy generation across the territorial authorities in the Bay of Plenty decreased by 12%. This is entirely driven by a 14% decrease in generated energy in Taupō where all four sites saw decreases in energy generation. Total generation in Whakatāne remained relatively unchanged during this period.

Hydro generation is influenced by the amount of rainfall in a year, this may have played a role in this decrease. Hydro generation across New Zealand has been lower in recent years due to low rainfall years.

Table 4 Total grid connected hydro generation by territorial authority in 2015/16 and 2020/21 (GWh)

Territorial Authority	2015/16	2020/21	% difference
Taupō district	2,911	2,510	-14%
Whakatāne district	339	339	0%
Total	**3,251**	**2,849**	**-12%**

4.3 Solar generation

Between 2015/16 and 2020/21, grid connected solar energy generation across the territorial authorities in the Bay of Plenty increased by 479%. This large increase is seen across all territorial authorities, with the largest increase in the Tauranga reporting region (Tauranga and Western Bay of Plenty).

Table 5 Total grid connected solar generation by territorial authority in 2015/16 and 2020/21 (GWh)

Territorial Authority	2015/16	2020/21	% difference
Taupō district	0.32	0.81	157%
Western Bay of Plenty district	0.40	2.96	644%
Tauranga city	1.06	7.91	643%
Rotorua district	0.41	2.01	388%
Whakatāne district	0.40	1.57	297%
Kawerau district	0.08	0.31	310%
Ōpōtiki district	0.10	0.42	319%
Total	**2.76**	**15.99**	**479%**

Solar generation can be broken down by the market sector in which it is used. Grid connected residential solar generation connections represents the majority of total energy generated from solar (71%).

The largest percentage change is in industrial connections where estimated generation increased by 775%. The largest real change is in residential connections where estimated generation increased by 9.32 GWh.

Table 6 Total grid connected solar generation by market sector in 2015/16 and 2020/21 (GWh)

Market Sector	2015/16	2020/21	% difference
Residential	2.08	11.40	447%
Enterprise	0.31	1.87	513%
Commercial	0.21	1.32	516%
Industrial	0.16	1.40	775%
Total	2.76	15.99	**479%**

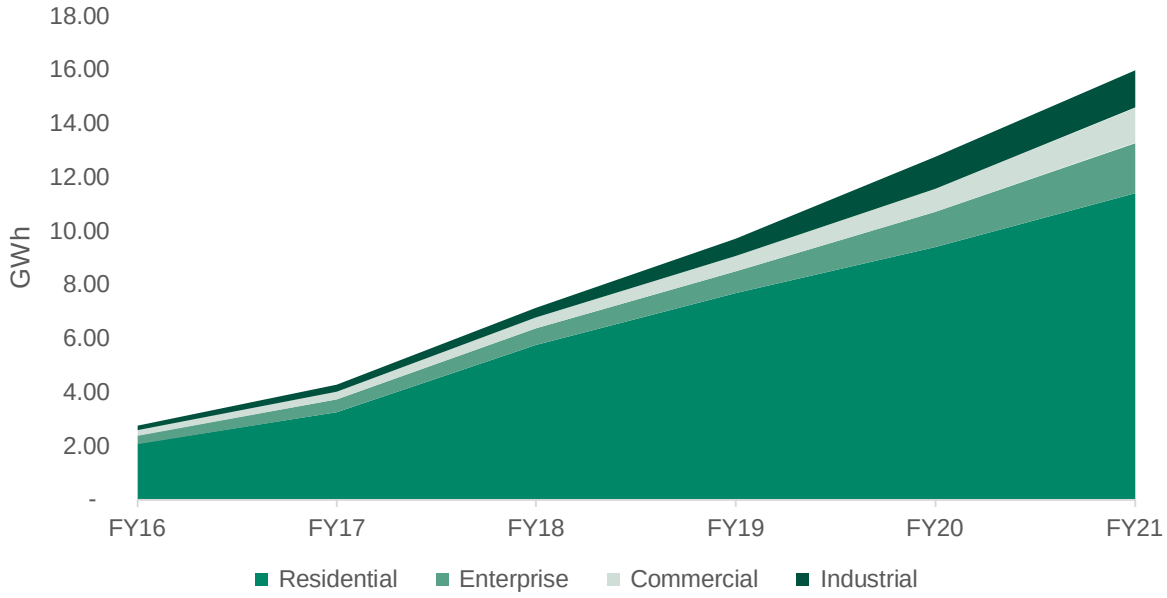

Figure 1 Total grid connected solar generation by market sector from 2015/16 to 2020/21 (GWh)

4.4 Wind generation

Between 2015/16 and 2020/21, grid connected wind energy generation across the territorial authorities in the Bay of Plenty increased by 365%. Grid connected wind generation in the Tauranga reporting region (Tauranga and Western Bay of Plenty) increased by 6%, driven by a 21% increase in residential generation. Grid connected wind generation in the Eastern Bay of Plenty reporting region (Whakatāne, Kawerau, and Ōpōtiki) increased from no generation in 2015/16 to a total of 0.16 GWh in 2020/21, with 60% of that generation from industrial connection points.

Table 7 Total grid connected wind generation by territorial authority in 2015/16 and 2020/21 (GWh)

Territorial Authority	2015/16	2020/21	% difference
Western Bay of Plenty district	0.01	0.01	6%
Tauranga city	0.03	0.03	6%
Whakatāne district	0	0.11	*N/A*
Kawerau district	0	0.02	*N/A*
Ōpōtiki district	0	0.03	*N/A*
Total	**0.05**	**0.21**	**365%**

Wind generation can be broken down by the market sector in which it is used. Grid connected industrial solar generation connections represents 46% of total energy generated from wind, with all industrial generation generated in the Eastern Bay of Plenty reporting region.

The largest percentage change (not including industrial generation) is in residential connections where estimated generation increased by 271%. The largest real change is in industrial connections where estimated generation increased by 0.10 GWh.

Table 8 Total grid connected wind generation by market sector in 2015/16 and 2020/21 (GWh)

Market Sector	2015/16	2020/21	% difference
Residential	0.01	0.05	271%
Enterprise	0.02	0.05	200%
Commercial	0.02	0.02	<1%
Industrial	0	0.10	*N/A*
Total	0.05	0.21	363%

5.0 Limitations

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