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Northland Regional Council
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Te Tai Tokerau GHG Emissions Inventory 2022

(1st July 2021 – 30th June 2022)

01-Dec-2023

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Client: Northland Regional Council

Co No.: N/A

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Executive Summary

This report details the Greenhouse Gas (GHG) emissions produced within the geographic boundary of Te Tai Tokerau (administered by the Northland Regional Council). This document reports GHG emissions produced in or resulting from activity or selected consumption during the FY22 government financial year (1st July 2021 to 30th June 2022).

The emissions have been measured and reported using the production-based Global Protocol for Community-Scale Greenhouse Gas Emissions Inventory (GPC) methodology. This approach includes GHG emissions from Stationary Energy, Transport, Waste, Industrial Processes and Product Use (IPPU), Agriculture, and Forestry. The GPC methodology focusses on GHG emissions directly produced in the geographic area and does not account for emissions related to the manufacture of products consumed or used within the area but manufactured elsewhere (such as from construction materials produced elsewhere). This method ensures that all GHG emissions are accounted for within geographic boundaries and enables the direct assessment of an area's contribution to the production of global GHG emissions.

GHG emissions are generally reported in this document in units of carbon dioxide equivalents (CO_2e) and are referred to as 'emissions'.

Major findings of Te Tai Tokerau's FY22 inventory include:

- **Total gross emissions** in FY22 were 3,305,177 tCO_2e.
- **Agriculture** represented 59% total gross emissions, with cattle accounting for 87% of agricultural emissions and 52% of total gross emissions. Cattle represented 74% of total livestock numbers in the region (dairy and non-dairy). Fertiliser use and sheep represented most of the remaining agriculture emissions.
- **Transport** (e.g., emissions resulting from road, marine freight, and air travel) represented 27% of total gross emissions, with on-road travel accounting for 76% of transport emissions and 20% of total gross emissions. Marine transport (predominantly from marine freight journeys) represented 13% of transport emissions.
- **Stationary Energy** (e.g., emissions relating to electricity and natural gas consumption) produced 10% of total gross emissions with electricity accounting for 44% of stationary energy emissions. Natural gas accounted for 40% of stationary energy emissions and 4% of total gross emissions, with 92% of natural gas used for industrial purposes.
- **Waste** (e.g., emissions from landfill and wastewater treatment) was responsible for 2% of total gross emissions.
- **Industrial Processes and Product Use** (IPPU) (e.g., emissions from refrigerant gasses and aerosols) represented 2% of total gross emissions.
- **Net Forestry** emissions totalled 393,352 tCO_2e. This is because emissions from forest harvesting in this year (e.g., the release of carbon from timber, roots, and organic matter following harvesting) were greater than the carbon sequestrated by forests (carbon captured and stored in plants or soil). Net Forestry emissions are not included in total gross emissions but are included in total net emissions. Therefore, **total net emissions** (gross emissions including forestry) were 3,698,528 tCO_2e. Due to substantial commercial forestry planting and harvesting in the region, the net forestry and therefore total net emissions figure is likely to change significantly year-to-year based on commercial forestry activities in that year.

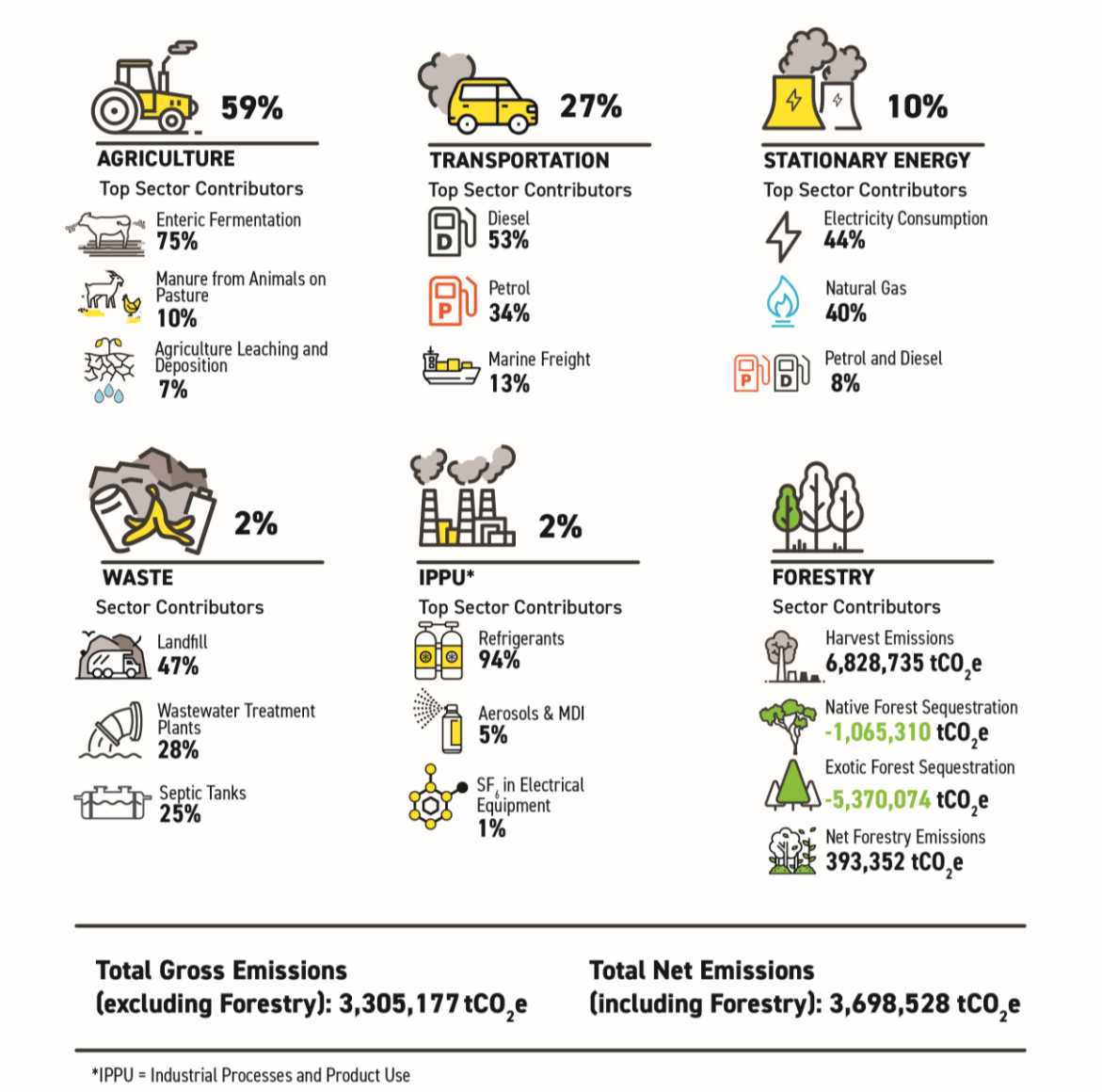

Figure 1 Te Tai Tokerau's FY22 Emissions Footprint

1.0 Introduction

Northland Regional Council commissioned AECOM New Zealand Limited (AECOM) to assist in developing a production-based community-scale greenhouse gas (GHG) emissions footprint for Te Tai Tokerau for the 2022 financial year (FY22). The FY22 year covers the period from 1st July 2021 to 30th June 2022 (Government financial year). This is part of a wider study to develop emissions inventories for Te Tai Tokerau and each district within Te Tai Tokerau.

The purpose of the GHG emissions inventory for FY22 is to estimate the relative scale of GHG emissions produced in Te Tai Tokerau and the relative contribution of different emission sources to Te Tai Tokerau's total emissions. The results of this inventory can be used to assess trends and changes in the emissions produced in Te Tai Tokerau over time.

The study boundary incorporates the jurisdiction of the Northland Regional Council and is referred to as Te Tai Tokerau hereafter for ease.

2.0 Approach

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 methodology follows a production-based approach and allocates emissions to the geographic area where the emissions are produced as opposed to final users. Production-based approaches exclude global emissions relating to consumption (i.e., embodied emissions relating to products produced elsewhere but consumed within the geographic area, such as imported food products, cars, phones, clothes etc.).

The same methodology has been used for other community scale GHG footprints around New Zealand, (e.g. the Bay of Plenty region, Hawke's Bay region, Auckland, Christchurch, Dunedin, and the Waikato region) and internationally. The GPC methodology[1] represents international best practice for city and regional level GHG emissions reporting and offers a robust, established method, which enables comparisons between different studies.

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

The inventory is based on data and reporting guidance available at the time of calculation, using reasonable assumptions in line with the GPC reporting guidance, and may need to be updated in the future to account for changes in data availability or changes to reporting guidance. This inventory uses conversion figures (i.e., global warming potentials) from the IPCC 6th Assessment Report (2021).

Greenhouse gas emissions are generally reported in this document in Carbon Dioxide Equivalent (CO_2e) units and are referred to as 'emissions'.

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

It is essential to consider the uncertainty associated with the results, particularly given the different datasets used. At the national level for New Zealand's Greenhouse Gas Inventory the estimate of gross emissions uncertainty was ±8.8%, with a net emissions uncertainty estimate of ±26.9% (MfE, 2022).

[1] http://www.ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities

3.0 Te Tai Tokerau Emissions Inventory for FY22

3.1 Total Gross Emissions

Total emissions are reported as both gross emissions (excluding forestry harvesting and sequestration) and net emissions (including forestry harvesting and sequestration).

During FY22, Te Tai Tokerau emitted **total gross emissions** of 3,305,177 tCO_2e. Agriculture and transport are Te Tai Tokerau's most significant contributors to total gross emissions.

The population of Te Tai Tokerau in FY22 was approximately 200,150 people, resulting in per capita gross emissions of 16.5 tCO_2e/person.

Net emissions differ from gross emissions because they include emissions related to forestry activity (harvesting emissions and sequestration). Total net emissions are presented in section 3.8. The focus of this inventory is on gross emissions as per the GPC reporting guidance.

Table 1 Total Gross emissions for FY22

Total emissions	Emissions (tCO_2e)
Total Gross emissions (excluding Forestry)	**3,305,177**

3.2 Emission Sectors and Sources

Figure 2 and Table 2 illustrate the six different sectors that comprise the emissions inventory. A discussion of each sector follows in Sections 3.3 through Section 3.8. Due to rounding, there may be some discrepancy between totals and the sum of results in the tables.

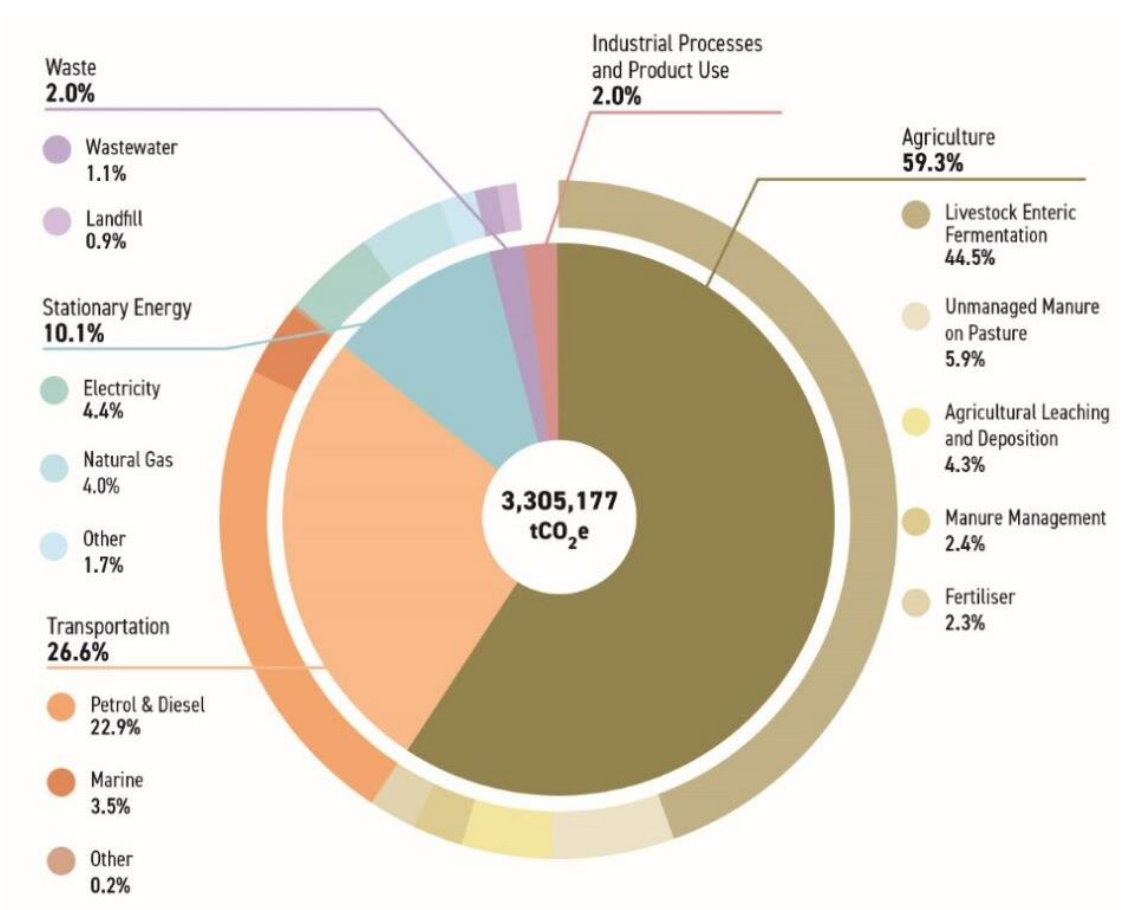

Figure 2 Te Tai Tokerau's total gross GHG emissions split by sector (tCO2e) for FY22

Table 2 Te Tai Tokerau's FY22 emissions by sector

Emissions Source	Emissions (tCO_2e)	Percentage of Total Gross Emissions (%)
Agriculture	1,960,841	59%
Transportation	877,564	27%
Stationary Energy	335,062	10%
Waste	66,806	2%
Industrial Processes and Product Use (IPPU)	64,902	2%
Total Gross Emissions	**3,305,177**	**100%**

Table 3 shows the emission sources from largest to lowest emission source. Full breakdowns of emissions are presented in Appendix B.

Table 3 Te Tai Tokerau's FY22 emissions by source

Emissions Source	Emissions (tCO_2e)	Percentage of Total Gross Emissions (%)
Enteric Fermentation	1,470,277	44%
On-Road Transport	665,450	20%
Unmanaged Manure on Pasture	193,765	6%
Electricity Consumption	146,268	4%
Agricultural Leaching and Deposition (Manure, Urine, and Fertiliser)	141,835	4%
Natural Gas	132,490	4%
Marine Transport	114,164	3%
Off-Road Transport	92,896	3%
Manure Management	79,048	2%
Fertiliser on Land	75,916	2%
Refrigerant and Air Conditioning Gasses (IPPU)	60,846	2%
Wastewater	35,622	1%
Solid Waste	31,185	1%
Stationary Diesel and Petrol Use	26,394	1%
LPG	13,067	<1%
Coal	8,794	<1%
Biofuel and Biogas	8,049	<1%
Air Travel	4,448	<1%
Other Industrial Gasses (IPPU)	4,057	<1%
Rail	607	<1%
Total Gross Emissions	**3,305,177**	**100%**

3.3 Agriculture

Agricultural emissions were the highest emitting sector estimated in Te Tai Tokerau. Agricultural emissions from both livestock and crop farming were responsible for 59% of Te Tai Tokerau's total gross emissions.

- Enteric fermentation represented 75% of agricultural emissions. Enteric fermentation is the methane (CH_4) released from the digestive process of livestock.
- Nitrous oxide (N_2O) from unmanaged manure deposited directly on land by grazing animals on pasture represented 10% of agricultural emissions.
- Agricultural leaching and deposition (i.e. N_2O produced through the runoff and volatilisation of applied nitrogen inputs such as fertilisers, as well as animal excrements) were responsible for 7% of agricultural emissions.
- Fertilisers on land (i.e. CH_4 and N_2O produced by liming and dolomite use, fertiliser application for horticulture, and crop residues) represented 4% of agricultural emissions.
- Methane and nitrous oxide from managed manure represented 4% of agricultural emissions. Managed manure describes emissions from controlled manure decomposition (typically stored in piles or disposed of in tanks or lagoons).

Agriculture Emissions by Emission Source

Livestock were responsible for the majority of the agriculture sector's GHG emissions. Dairy cattle account for 49% of agricultural emissions in Te Tai Tokerau with non-dairy cattle accounting for 38%. In FY22, there were an estimated 292,391 dairy cattle and 379,625 non-dairy cattle in Te Tai Tokerau. Sheep represented 25% of all livestock but 3% of agricultural emissions due to their relatively lower emissions impact compared to cattle. An area of focus to reduce the GHG emissions impact of agriculture could be actions to reduce the methane impact of livestock, especially from enteric fermentation.

Table 4 Agriculture emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Dairy Cattle	964,655	29%	49%
Non-dairy Cattle	749,954	23%	38%
Fertiliser	147,453	4%	8%
Sheep	93,875	3%	5%
Other Livestock	4,892	<1%	<1%
Total	**1,960,829**	**60%**	**100%**

It is important to note that these agricultural results do not include emissions related to the consumption of agricultural products supplied to Te Tai Tokerau as per the GPC methodology.

3.4 Transport

Transport was the second-highest emitting sector in Te Tai Tokerau, producing a total of 877,564 tCO_2e (27% of total gross emissions). Diesel and petrol use represented 86% of the transport emissions in Te Tai Tokerau.

Diesel and petrol transport emissions are split into on-road and off-road use. On-road transport (e.g. cars, trucks and buses used on roads) was responsible for 76% of transport emissions and 20% of total gross emissions. A key area of focus to reduce the GHG emissions impact of transport could be actions to reduce emissions from on-road transport. Off-road transport was responsible for 11% of transport emissions. Off-road transport consists of all fuel used for off-road vehicles (e.g. agricultural, forestry, and construction vehicles and equipment, and recreational marine use).

A further breakdown of on-road emissions by vehicle type and class is included as **Appendix C**.

The next largest emission source in the transport sector was marine transport emissions (from freight vessel journeys, and local commercial operators) which produced 13% of transport emissions and 4% of total gross emissions. As with air travel, where journeys travel between Te Tai Tokerau and another location, emissions are split equally between the origin and destination location. It is understood that marine freight imports and exports through ports in Whangārei are not exclusively related to activities in Te Tai Tokerau; however, to ensure that these emissions are reflected in emissions inventories as per the GPC requirements, all emissions have been allocated to Te Tai Tokerau. Owing to the closure of the Marsden Point oil refinery in March 2022, there is the potential that there may be a decrease in marine freight emissions in the future as a result of the discontinuation of crude oil being shipped into the region for processing at the refinery. Although, it is noted that refined oil will continue to be shipped in from overseas.

Air travel contributed 0.5% of the sector's emissions. Air travel emissions are based on the fuel consumed by aircraft journeys to and from Te Tai Tokerau, with emissions split equally between the origin and destination location. A lack of direct international airport services into Te Tai Tokerau and limited domestic services are likely the reasons for the low contribution to gross emissions.

3.5 Stationary Energy

Electricity consumption (including transmission and distribution losses) accounted for 44% of stationary energy emissions and 4% of Te Tai Tokerau's total gross emissions. Electricity consumption emissions depend upon the amount of consumption (in kWh), and the emissions intensity of the national grid (tCO_2e/kWh), which changes annually. It is noted that 87% of the electricity generated in New Zealand in FY22 came from renewable sources[2]. The emissions intensity of the grid was low in FY22 relative to recent years due to a high proportion of renewable generation nationally, resulting in lower than usual emissions from this source regardless of consumption.

Natural gas consumption, including transmission and distribution losses from the reticulated gas system, accounted for 40% of stationary energy emissions (4% of total gross emissions). Industrial use represented 94% of natural gas consumption in Te Tai Tokerau (see below).

The use of LPG, diesel, petrol, coal, and biofuels produced the remaining stationary energy emissions.

Biogenic CO_2 emissions from the burning of biofuels such as in timber and pulp processing have not been included in these totals and are reported separately in section 3.10.

Stationary Energy Emissions by End-Use

The breakdown of stationary energy emissions by end-use is presented in Table 5. With the exception of industrial natural gas use, energy consumption data has been broken down by end-use based on high level information regarding energy end-use. For industrial natural gas, direct usage was used.

Industrial stationary energy represented 61% of stationary energy emissions. This was particularly related to natural gas use at industry-specific connection points at Marsden Point (refining), Maungaturoto (dairy processing) and Kauri (dairy processing). It is noted that natural gas use at Marsden Point is trending down following the closure of the oil refinery (still operating in FY22). Other industrial uses of stationary energy include use in agriculture, forestry and fishing, mining, food processing, textiles, chemicals, metals, mechanical/ electrical equipment, and building and construction activities if present.

Residential stationary energy emissions stem from household use of electricity (e.g. for heating, lighting, and cooking). Commercial stationary energy emissions are those created from commercial and institutional buildings or facilities in all non-residential and non-industrial settings (e.g. in retail, hospitality, education, and healthcare). In the table, 'Other Sources' refers to areas where end-use was unable to be determined.

[2] https://www.mbie.govt.nz/about/news/energy-in-new-zealand-2023-shows-renewable-electricity-generation-increased-to-87-percent/#:~:text=87%25%20of%20electricity%20generated%20over,into%20the%20energy%20sector%20shows.

Table 5 Stationary Energy emissions by end-use

Emissions Source	Emissions (tCO_2e)	Percentage of Sector Emissions (%)
Industrial	202,879	61%
Residential	61,172	18%
Commercial	44,617	13%
Other Sources	26,394	8%
Total	**335,062**	**100%**

A further study in relation to renewable energy generation is included as Appendix D.

3.6 Waste

Waste produced in Te Tai Tokerau (solid waste and wastewater) comprised 2% of Te Tai Tokerau's total gross emissions.

Wastewater treatment (both treatment plants and individual septic tanks) accounted for 53% of total waste emissions. In Te Tai Tokerau approximately 49% of households are connected to wastewater treatment plants, with resulting emissions of 19,030 tCO_2e from wastewater treatment and processing. Households not connected to wastewater treatment plants (i.e., using individual septic tanks) produced 16,591 tCO_2e in wastewater emissions.

Solid waste represented 47% of total waste emissions. Open and closed landfills emit landfill gas (methane) from the breakdown of organic materials disposed of in the landfill for many years after waste enters the landfill. The reported emissions here relate to the emissions produced in FY22 from all waste produced in Te Tai Tokerau that has entered landfill sites over the last 50+ years, even if those sites are outside the region. This approach differs from other reporting methods which estimate the future emissions related to waste entering the landfill in the reporting year.

The majority of the region's waste now goes to sites which have landfill gas capture systems that reduce emissions being released into the atmosphere. Owing to the lack of gas capture systems at closed landfill sites, emissions from closed landfill sites were greater than those from currently open sites. It is noted that the annual emissions from closed landfill sites will decrease over time as no new waste enters these sites.

3.7 Industrial Processes and Product Use (IPPU)

IPPU includes emissions associated with the consumption of industrial products and synthetic gases which have a greenhouse gas impact. This includes products used for refrigerants, foam blowing, fire extinguishers, aerosols, metered dose inhalers and sulphur hexafluoride for electrical insulation and equipment production. No known industrial processes (as defined in the GPC requirements) are present in Te Tai Tokerau (e.g., aluminium manufacture).

IPPU contributed 2% to total gross emissions. The most significant contributor to IPPU emissions was refrigerant gasses, which produced 94% of IPPU emissions. These emissions are based on nationally reported IPPU emissions and apportioned based on population due to the difficulty of allocating emissions to geographic locations.

IPPU emissions do not include energy use for industrial manufacturing, which is included in the relevant Stationary Energy sub-category (e.g., electricity or natural gas).

3.8 Forestry and Total Net Emissions

Total Net Emissions

Net emissions differ from gross emissions because they include emissions related to forestry activity (harvesting emissions and sequestration).

Net Forestry Emissions:

- Sequestration of carbon from the atmosphere from native forests (e.g. mānuka and kānuka) and exotic forest (e.g. pine) while the trees are growing to maturity and,
- emissions released due to harvesting of forests via the release of carbon from organic matter and soils following harvesting.

When forest sequestration exceeds emissions from harvesting in a particular year, forestry is a net-negative source of emissions which results in the area's total net emissions being lower than their total gross emissions. Conversely, when emissions from harvesting exceed the amount of carbon sequestered by native and exotic forests, then forestry is a net-positive source of emissions which results in the area's total net emissions being higher than their total gross emissions. Harvesting of exotic forests can be cyclical in nature. Some years will have higher sequestration, and some years will have higher harvesting emissions determined by the age of forests, commercial operators, and the global market.

In FY22, Forestry in Te Tai Tokerau was a net positive source of emissions.

Table 6 Forestry emissions by emission source (including sequestration shown as a negative value)

Sector / Emissions Source	tCO_2e
Harvest Emissions	6,828,735
Native Forest Sequestration	- 1,065,310
Exotic Forest Sequestration	- 5,370,074
Total (Net)	**393,352**

During the FY22 reporting period, Te Tai Tokerau emitted total net emissions of 3,698,528 tCO_2e. Due to substantial commercial forestry planting and harvesting in the region, the net forestry and therefore total net emissions figure is likely to change year-to-year based on commercial forestry activities in that year.

Table 7 Total net emissions for FY22

Total Emissions	Emissions (tCO_2e)
Total Net Emissions (Gross Emissions plus Net Forestry Emissions)	**3,698,528**

Figure 3 shows total gross emissions and total net emissions in FY22, and the difference from total gross emissions due to the impact of forestry sequestration and harvesting.

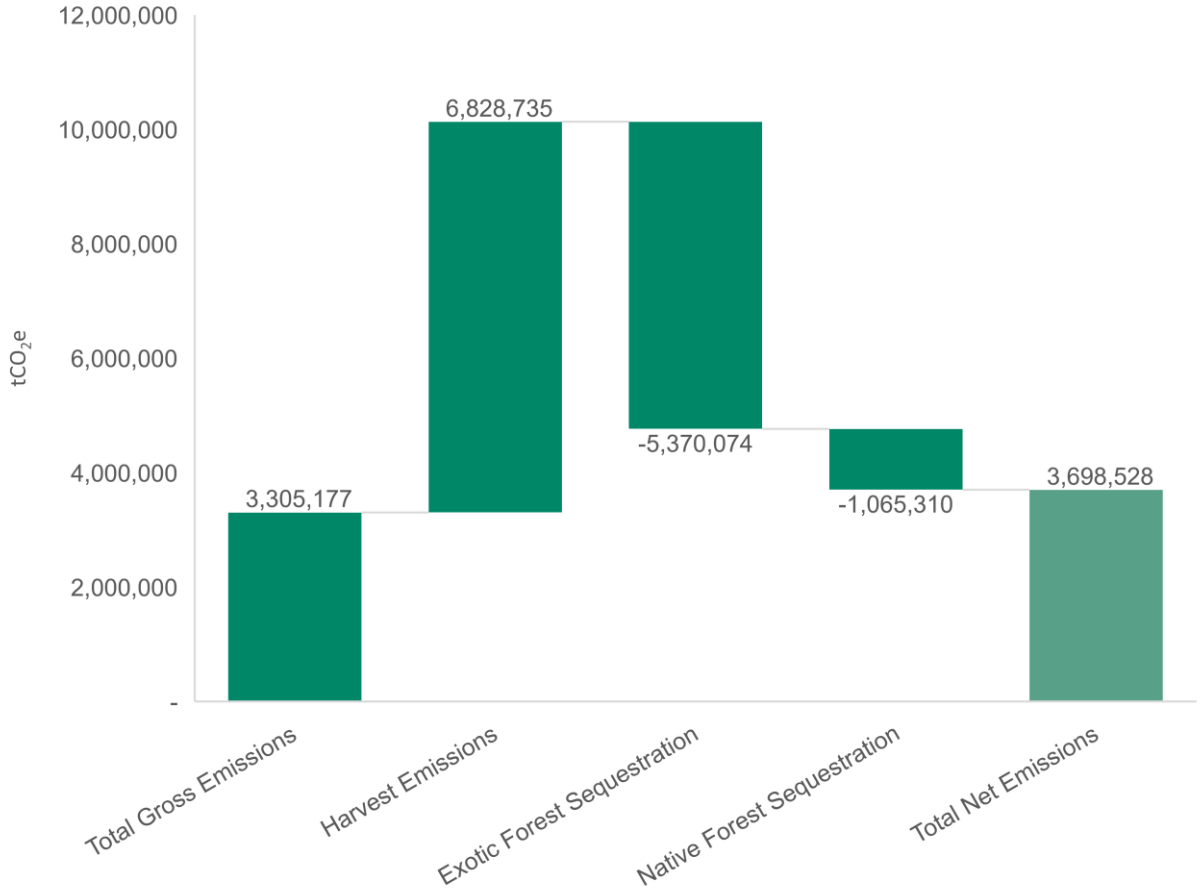

Figure 3: Contribution of gross emissions, forestry emissions, and forest sequestration to total net emissions.

3.9 Total Gross Emissions by Greenhouse Gas

Each greenhouse gas has a different level of impact on climate change, which is accounted for when converting quantities of each gas into units of carbon dioxide equivalent (CO_2e). This assessment uses conversion figures (i.e., global warming potentials) from the IPCC 6th Assessment Report (2021).

Table 8: Te Tai Tokerau's total gross emissions by greenhouse gas

Greenhouse Gas	Tonnes	Global Warming Potential (GWP)	Tonnes of CO_2e
Carbon Dioxide (CO_2)	1,208,117	1	1,208,117
Biogenic Methane (CH_4) (non-fossil origin)	59,023	27.2	1,605,413
Non-biogenic Methane (CH_4) (fossil origin)	599	29.8	17,850
Nitrous Oxide (N_2O)	1,475	273	402,578
Other / Unknown Gas (in CO_2e)	71,219	1	71,219
Total	**1,340,432**		**3,305,177**

3.10 Biogenic Emissions

Biogenic CH_4 emissions (e.g., produced by farmed cattle via enteric fermentation) are included in gross emissions due to their relatively large contribution to anthropogenic climate change, especially when compared to biogenic CO_2. Biogenic methane represented 4% of the total gross tonnage of GHG emissions in Te Tai Tokerau but 49% 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.

Table 9: Biogenic Methane in Te Tai Tokerau (Included in gross emissions)

Biogenic Methane (CH_4) (Included in gross emissions)		
Enteric Fermentation (Livestock)	54,054	tCH_4
Manure Management (Livestock)	2,902	tCH_4
Wastewater Treatment	1,146	tCH_4
Landfill Gas	917	tCH_4
Biofuel	3	tCH_4
Total Biogenic Methane (CH4)	**59,023**	**tCH_4**

Biogenic CO_2 emissions result from the combustion of biomass materials that store and sequester CO_2, including materials used to make biofuels (e.g., trees, crops, vegetable oils, or animal fats). Biogenic CO_2 emissions from humans, plants and animals (i.e. non-fossil origin) are excluded from gross and net emissions as they are part of the natural carbon cycle and have a relatively small impact on anthropogenic climate change. Additional biogenic CO_2 emissions such as from landfill are also present however measurement and reporting of these emissions is not prioritised within the GPC method.

Table 10: Biogenic Carbon Dioxide in Te Tai Tokerau (Excluded from gross emissions)

Biogenic Carbon Dioxide (CO_2) (Excluded from gross emissions)		
Biofuel	94,281	tCO_2
Wastewater Treatment	8,243	tCO_2
Total Biogenic CO_2	**102,524**	**tCO_2**

3.11 Territorial Authorities in Te Tai Tokerau

Te Tai Tokerau contains three territorial authorities: Whangārei District, Far North District and Kaipara District. Figure 4 shows total gross emissions for the territorial authorities in Te Tai Tokerau, split by sector.

Whangārei District is the highest emitting territorial authority in the region, representing 39% of Te Tai Tokerau's total gross emissions. Kaipara has the lowest total gross emissions.

Key findings:

- Te Tai Tokerau's emissions inventory is predominantly agriculture-related with all territorial authorities containing significant agricultural emissions.
- Transport is the second largest emissions source in the region, with significant transport emissions in Whangārei and the Far North.
- Stationary Energy is the third highest emission source in the region, with the majority of these emissions produced in Whangārei, particularly from industrial uses of natural gas.

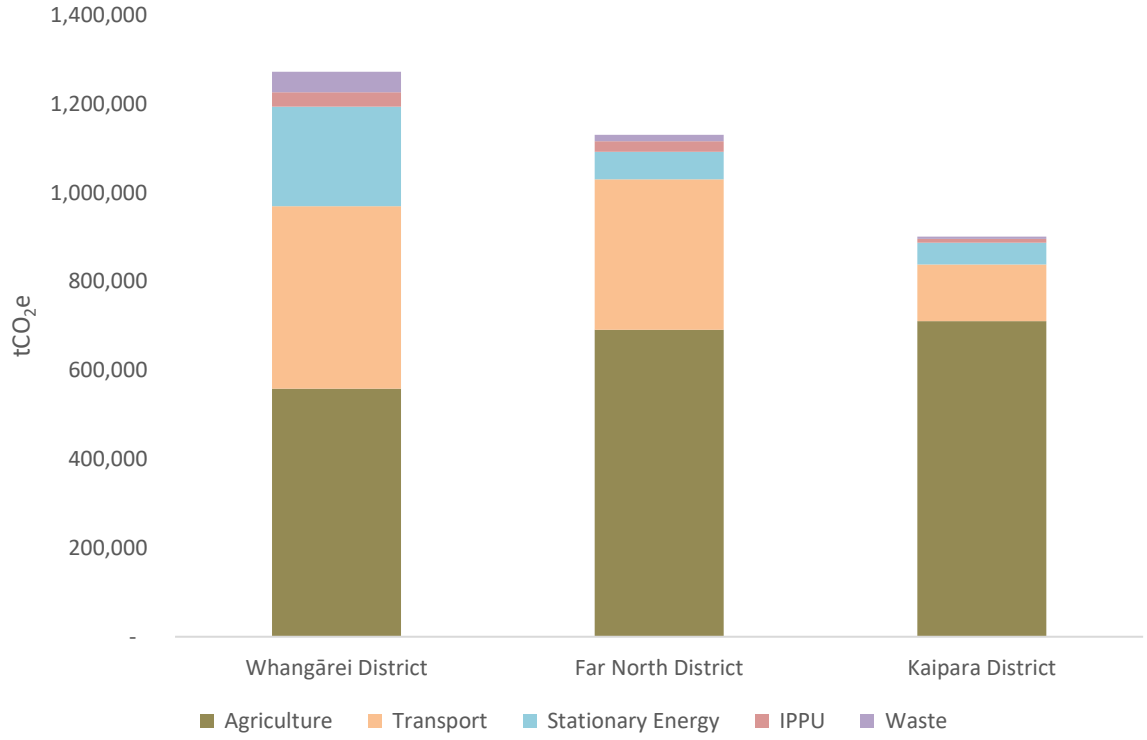

Figure 4 Total gross emissions by territorial authority in Te Tai Tokerau (tCO_2e).

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 5 shows emissions per capita for the territorial authorities within Te Tai Tokerau.

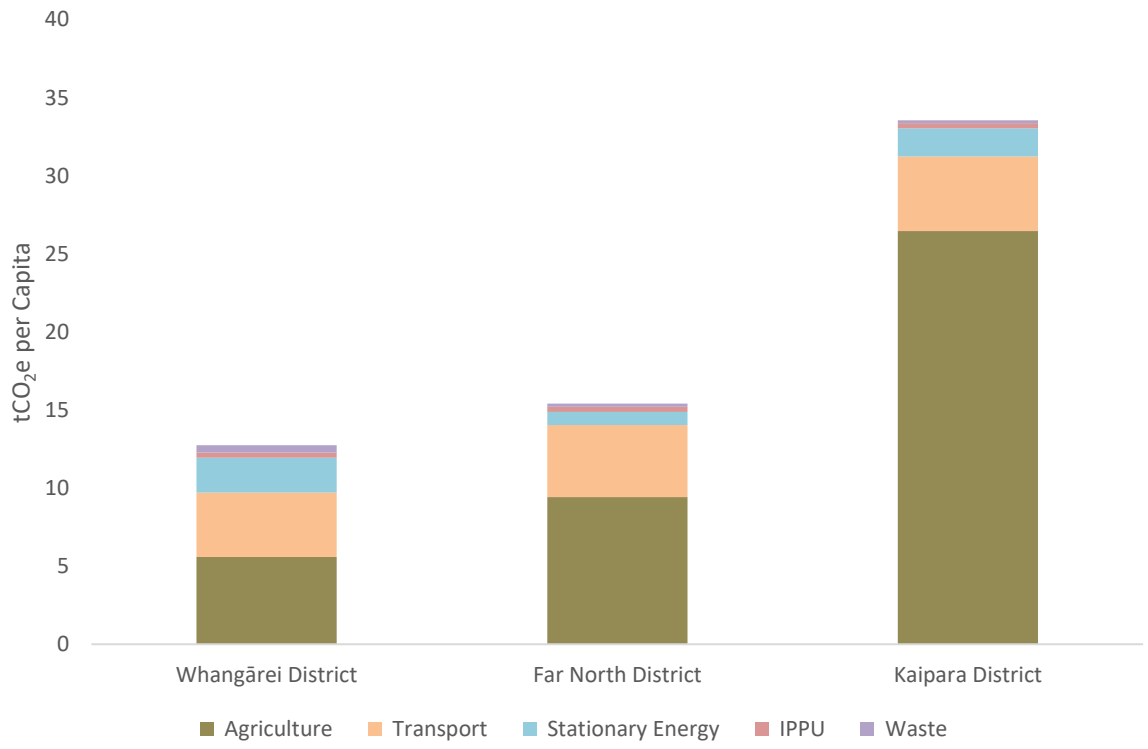

Figure 5 Total gross emissions per capita for the territorial authorities within Te Tai Tokerau (tCO_2 per capita)

Te Tai Tokerau had a 16.5 tCO_2e/per capita figure for per capita total gross emissions. The region's per capita emissions are particularly influenced by emissions in the Whangārei area with almost 50% of the population of the region living in the Whangārei area. The Kaipara district represents just 13% of the region's population but produces 34% the region's emissions due to higher agricultural emissions per capita.

Key findings:

- Whangārei has the lowest per capita total emissions at 12.7 tCO_2e/per capita, due to a higher proportion of urban residents than the other districts and relatively low per capita agriculture emissions.
- Kaipara has the largest per capita total gross emissions at 33.6 tCO_2e/per capita, due to high agriculture emissions and a small population.
- Whangārei has the highest stationary energy emissions per capita in the region, particularly due to significant industrial natural gas use from Marsden Point and dairy processing.

3.12 Comparison to Other Regions

When compared with other regions of Aotearoa New Zealand, Te Tai Tokerau had lower total gross emissions than each of the regions displayed in Figure 6. Te Tai Tokerau has the lowest Stationary Energy emissions and, except for Hawkes Bay, Te Tai Tokerau has the lowest Transport emissions.

Note that the compared emissions inventories were conducted for different years, covering very different geographic areas, and with differences in land use and populations. There also will be differences in the exact methodology or data used including the use of the IPCC 6th Assessment Report (2021) global warming potential values for this inventory.

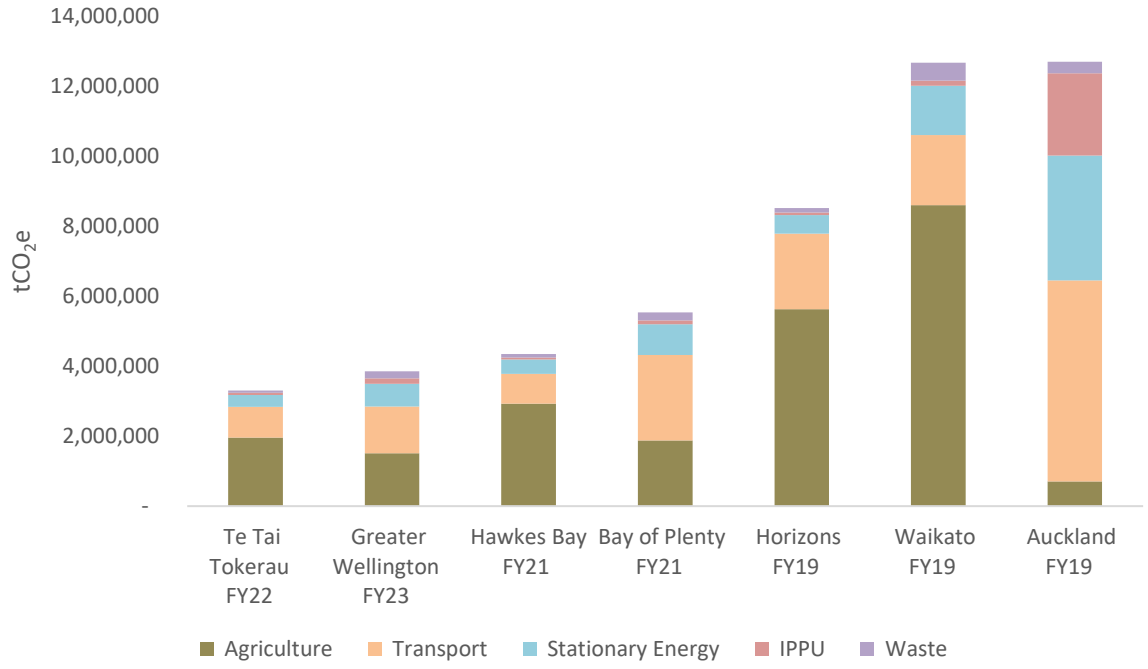

Figure 6 Total gross emissions for Te Tai Tokerau and other regions of Aotearoa New Zealand

When comparing different regional carbon footprints, a per capita figure can be useful because it provides a common reference point to understand the difference in emissions.

A detailed comparison between different areas of New Zealand would require a broader understanding of the particular context of the compared regions and the details of each emissions inventory. In particular, rural areas also tend to have much higher Agriculture emissions per capita due to the large GHG emissions impact of livestock in areas with low population density. Rural and low-density urban areas also tend to have higher Transport emissions per capita (especially on-road transport) due to greater driving distances covered by private vehicles and freight vehicles per person. The location of particular industries (e.g. gas refining) or transport nodes (e.g. international airports or ports) also impacts the scale of emissions and emissions per capita for a region.

Te Tai Tokerau has a moderate per capita total gross emissions compared to the emissions inventories in Figure 7, higher than the more urban areas of Greater Wellington and Auckland, and lower than some other areas with extensive agriculture.

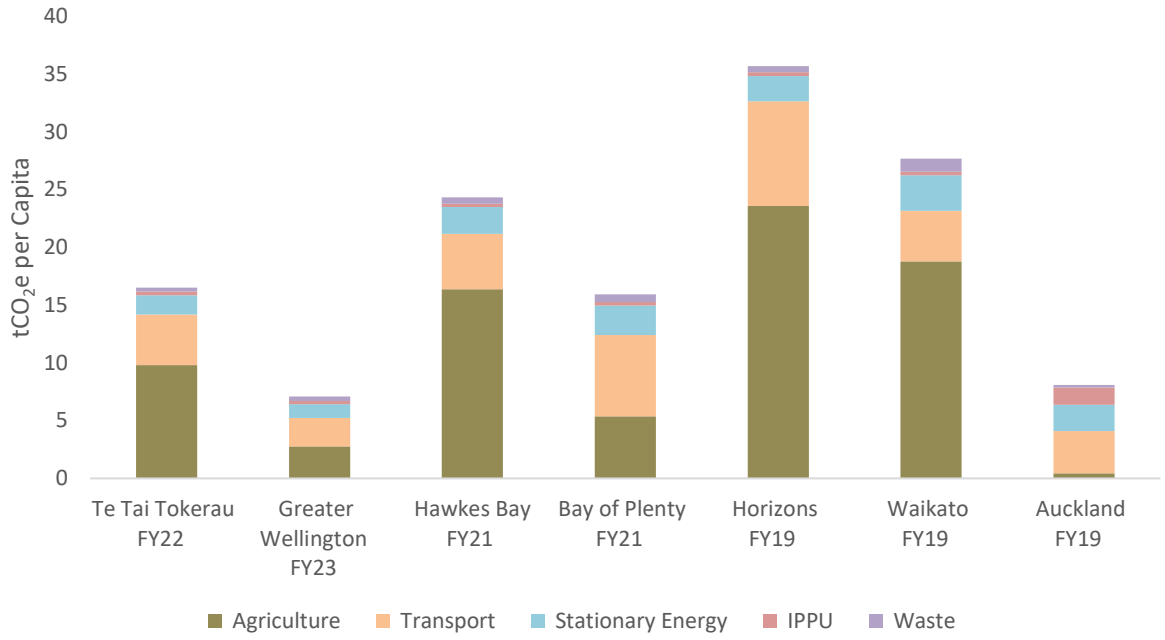

Figure 7 Total gross emissions per capita for Te Tai Tokerau and other regions of Aotearoa New Zealand

4.0 Closing Statement

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

The emissions footprint developed for Te Tai Tokerau covers emissions produced in the stationary energy, transport, waste, IPPU, agriculture, and forestry sectors using the GPC reporting framework. GHG emissions data allows Northland Regional Council to target and work with the sectors and emission sources that contribute the most to the area's GHG emissions inventory.

Understanding of climate change's extensive and long-lasting effects is always improving. It is recommended that this emissions inventory be updated regularly to inform ongoing positive decision-making to address climate change issues.

The availability, quality, and applicability of data limit the accuracy of any emissions footprint. These results may need updating in the future with changes in data and methodology to enable comparable figures to assess trends over time.

5.0 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 **September** and **November 2023** 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

Appendix A Assumptions and Data Sources

Sector / Category	Assumptions and Exclusions
General	
Geographical Boundary	LGNZ local council mapping boundaries have been applied.
Population	Population figures are provided by StatsNZ. Financial year populations have been used, these are based on the average population from the two calendar years (e.g., the average of 2021 and 2022 calendar year populations for FY22).
Global Warming Potential Used	Emissions are expressed on a carbon dioxide-equivalent basis (CO_2e) using the 100-year Global Warming Potential (GWP) values from the IPCC 6th Assessment Report (AR6).
Full Inventory	Emissions for all sources broken down by individual main greenhouse gases are provided in the supplementary spreadsheet information supplied with this report.
GPC Production Approach	GPC reporting is predominately production-based (as opposed to consumption-based) but includes indirect emissions from energy consumption. Production-based emissions reporting is generally preferred by policy-makers due to robust established methodologies such as the GPC, which enables comparisons between different studies. Production-based approaches exclude globally produced emissions relating to consumption (e.g., embodied emissions relating to products produced elsewhere but consumed within the geographic area such as imported food products, cars, phones, clothes etc.). Cross-boundary movements such as air travel and marine freight journeys departing or arriving in Te Tai Tokerau have been included with emissions related to the journeys split equally between the origin and destination, despite the emissions being produced outside Te Tai Tokerau's geographical boundary, as per the GPS requirements.
Emission Factors	All emission factors have detailed source information in the calculation tables within which they are used. Where possible, the most up to date, NZ-specific emission factors have been applied.
Transport Emissions	
Petrol and Diesel:	Total petrol and diesel consumption in Te Tai Tokerau was calculated from aggregated petrol and diesel sales data for Te Tai Tokerau. Fuel sold in an area does not always mean that the fuel is used in that area, however this approach is considered to be a robust and comparable estimate of fuel consumption in a geographic area. Total petrol and diesel fuel use was then divided by likely end use. The division into transport and stationary energy end use (and within transport, on-road and off-road) was calculated using fuel end use data provided by the Energy Efficiency and Conservation Authority (EECA) in April 2020. - On-road transport is defined as all standard transportation vehicles used on roads e.g. cars, bikes, buses. - Off-road transport is defined as machinery for agriculture, construction and other industry used off-roads.

	- Stationary energy petrol and diesel use is defined as fuel not used for transport either on or off roads. Petrol and diesel used for stationary energy has been reported in the Stationary Energy sector. This method produces results for off-road and stationary uses of petrol and diesel that are heavily impacted by changes in on-road transport uses of petrol and diesel as this represents the largest proportion of petrol and diesel sales. Better data and understanding of off-road and stationary uses of petrol and diesel are required to improve the applicability of these results.
Rail Diesel	Consumption was calculated by Kiwi Rail using the induced activity method for system boundaries. Using the induced activity method, the trans-boundary routes were determined, and the number of stops taken along the way derived. The total litres of diesel consumed per route was then split between the departure territorial authority, arrival territorial authority and any territorial authority the freight stopped at along the way. If the freight travelled through but did not stop within a territorial authority, no emissions were allocated. The following assumptions were made: - The Net Tonne-Kilometres (NTK) measurement has been used. NTK is the sum of the tonnes carried, multiplied by the distance travelled. - Net Weight is product weight only and excludes container tare (the weight of an empty container) - 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.
Jet Kerosene	Calculated using the induced activity method as per rail diesel. An estimate of fuel use was calculated for flights arriving and departing from regional airports in Te Tai Tokerau (Kaitaia, Bay of Islands, and Whangārei): - The schedule of flights arriving and departing from the Airport containing details on the aircraft used for each flight was used to calculate fuel consumption. - Flight distances and aircraft fuel burn rates were used for these calculations. - As per the induced activity method, only 50% of emissions calculated per one-way arrival and departure were allocated to Te Tai Tokerau. The remaining 50% of each leg was allocated to the originating or destination airport.
Aviation Gas	Aviation gas is mostly used by small aircraft for relatively short flights. Estimated data covering aviation gas use at the airports was provided directly by the airports. Fuel use by aircraft at local aerodromes, or on private land have not been included.
Marine Diesel – Freight	Marine freight emissions were calculated using the induced activity method as per rail diesel and jet kerosene. An estimate of journey fuel use was calculated for vessels arriving and departing from ports within Whangārei: - The schedule of vessels arriving and departing from ports in Whangārei containing details on size of the vessel was used to calculate fuel consumption. - Shipping distances and vessel fuel burn rates were used for these calculations.

	- As per the induced activity method, only 50% of emissions calculated per one-way arrival and departure were allocated to the ports in Far North. The remaining 50% of each leg was allocated to the originating or destination Port.
Marine Diesel (Local)	Port operational vessels: - Fuel use has been provided directly from ports within Whangārei for FY22 Local ferries: - Diesel fuel use has been provided directly by ferry operators. Private use, other commercial operators, and commercial fishing: - Most small private boats use fuel purchased at vehicle gas stations so this consumption will be included in off-road transport petrol and diesel emissions. - No data was available to determine emissions from other commercial operators, and commercial fishing.
Cruise Ships	No reliable data was available to determine the emissions from cruise ships. As data and understanding of cruise ship fuel usage improve, it is recommended that emissions from this source are included in future regional emissions inventories.
LPG	Total North Island consumption data for LPG used for transport was used and then split on a per capita basis to determine the region's consumption.
Stationary Energy Emissions	
Consumer Energy End Use	Stationary energy demand (e.g. electricity use, natural gas, etc.) is broken down by the sector in which they are consumed. We report stationary energy demand in the following categories: industrial (which includes agriculture, forestry, and fishing); commercial; and residential. These sectors follow the Australia New Zealand Standard Industrial Classification 2006 definitions. In addition to agriculture, forestry and fishing, the industrial sector includes mining, food processing, textiles, chemicals, metals, mechanical/electrical equipment and building and construction activities. Emissions from petrol and diesel used for stationary energy are not broken down into these sectors. Energy demand used for transport is reported in the transport sector, if known.
Electricity Consumption	Electricity demand has been calculated using grid demand trends from the EMI website (www.emi.ea.govt.nz) to obtain raw grid exit point data for Te Tai Tokerau. Reconciled demand has been used as per EMI's confirmation. The breakdown into sectors is based on NZ average consumption per sector (residential, commercial, and industrial).
Public Transport Electricity	No significant electric public transport identified within Te Tai Tokerau.
Private Transport Electricity	Electricity used for private transport (e.g. electric cars, electric bikes, electric micro-mobility) has not been separated from other stationary energy electricity consumption due to a lack of reliable data.
Coal Consumption	National coal consumption data has been provided by MBIE for 2022. Regional industrial coal data has been provided by EECA. National residential and commercial coal consumption has been divided between territorial authorities on a per capita basis.

	Regional industrial coal consumption has been divided between territorial authorities on a per capita basis.
Biofuel and Wood Consumption	National biofuel consumption data has been provided by the Ministry for Business, Innovation and Employment (MBIE 2021) for residential and commercial biofuel use. This has then been divided between territorial authorities on a per capita basis. Data for industrial biofuel use (mainly from pulp, paper and timber mills) has been provided by 4 out of 9 identified sites across Te Tai Tokerau, and allocated to the location of the site. This likely underestimates industrial biofuel use but is still higher than if using a national per capita approach. Biofuel emissions are broken down into Biogenic emissions (CO_2) and Non-Biogenic emissions (CH_4 and N_2O).
LPG Consumption	Total North Island consumption data for LPG used for non-transport purposes was used and then split on a per capita basis to determine the region's consumption. The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per MfE data.
Petrol and Diesel (stationary energy end use)	Total petrol and diesel consumption in Te Tai Tokerau was calculated from aggregated petrol and diesel sales data from Te Tai Tokerau. Total petrol and diesel fuel use was then divided by likely end use. The division into transport and stationary energy end use (and within transport, on-road and off-road) was calculated using fuel end use data provided by the Energy Efficiency and Conservation Authority (EECA) in April 2020. - Stationary energy petrol and diesel use is defined as fuel not used for transport either on or off roads. Petrol and diesel used for stationary energy has been reported in the Stationary Energy sector. This method produces results for stationary uses of petrol and diesel that are heavily impacted by changes in transport uses of petrol and diesel. Better data and understanding of stationary uses of petrol and diesel are required to improve the applicability of these results.
Natural Gas Consumption	Natural gas consumption data for each Point of Connection (POC) has been provided by FirstGas. Industrial-only Points of Connection at Kauri (dairy processing), Maungaturoto (dairy processing), and Marsden Point (refining) have been identified by FirstGas. For Points of Connection where natural gas is for general supply, end-use has been determined using national end-use information.
Biogenic Emissions	Some Carbon Dioxide (CO_2) emissions are considered to be biogenic. These are CO_2 emissions where the carbon has been recently derived from CO_2 present in the atmosphere (for example, some agricultural and waste emissions). These emissions are not included in calculating total CO_2e.
Agricultural Emissions	
Agriculture	Territorial authority livestock numbers and fertiliser data taken from the Agricultural Census (StatsNZ) for 2022.
Solid Waste Emissions	
Landfill Emissions	Landfill waste volume and landfill gas capture system information has been provided by the respective council departments.

	Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day. This method accounts for the gradual release of emissions from waste over a long period of time, and so calculates the emissions produced per year from waste in landfill (including emissions from closed landfill sites). 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. This approach differs from organisational footprints which generally cover only operational council-owned landfill sites. Organisational footprints methodology generally calculates the likely future emissions from the waste entering landfill that year, and attributes those emissions to that year (and doesn't include emissions from waste already in the landfill, or emissions from closed landfill sites). Waste volume: - Where information is not available, waste volumes have been estimated based on historical national data on a per capita basis.
Wastewater Emissions	
Wastewater Treatment	All wastewater emissions have been calculated following the WaterNZ (2021) guidance using data provided by the respective council departments. Wastewater Treatment Plants: - Calculation of emissions includes emissions released directly from wastewater treatment, flaring of captured gas and from discharge onto land/water. - Where data was not available assumed values have been used based on the WaterNZ (2021) guidance - Emissions relating to discharge of biosolids sent to landfill has been included in the Solid Waste emissions source. - Emissions are allocated to territorial authorities based on where the wastewater was produced, even if the wastewater is treated outside the territorial authority. Individual Septic Tanks: - Populations not connected to known wastewater treatment plants are assumed to be using septic tanks. - The population not connected to centralised wastewater treatment has been estimated based on the number of rateable properties not connected to sewerage.
Industrial Processes and Product Use Emissions	
Industrial processes	It is assumed that there are no significant non-energy related emissions of greenhouse gasses from industrial processes in the region (e.g. aluminium manufacture).
Industrial Product Use	National data covering industrial product use (e.g., fire extinguishers, refrigerants) from the New Zealand Greenhouse Gas Emissions 1990-2021 report (MfE 2023) has been used. Emissions are estimated on a per capita basis applying a national average per person.
Forestry Emissions	
Exotic Forestry Harvested and Exotic Forest coverage	Harvested forestry, and forest cover information for each territorial authority has been derived from Landcare Research data. This emissions footprint accounts for forest carbon stock changes from afforestation, reforestation, deforestation, and forest management (i.e., it applies land-use accounting conventions under the United Nations Framework

	Convention on Climate Change rather than the Kyoto Protocol). It treats emissions from harvesting and deforestation as instantaneous rather than accounting for the longer-term emission flows associated with harvested wood products. The emissions footprint considers regenerating (growing) forest areas only. Capture of carbon from the atmosphere is negligible for mature forests that have reached a steady state.
Native Forest	Native forest land area for each territorial authority has been provided by Landcare Research.

Appendix B

Te Tai Tokerau Emissions Inventory FY23 – Full Inventory Tables

Appendix B Te Tai Tokerau Emissions Inventory FY22 - Full Inventory Tables

Agriculture Emissions

Table 11 Te Tai Tokerau FY22 Agriculture emissions by emission source

Emissions Source	FY22 Emissions (tCO_2e)	Percentage of Total Gross Emissions in FY22 (%)
Enteric Fermentation	1,470,277	44.5%
Unmanaged Manure on Pasture	193,765	5.9%
Agricultural Leaching and Deposition (Manure, Urine, and Fertiliser)	141,835	4.3%
Manure Management	79,048	2.4%
Fertiliser on Land	75,916	2.3%
Total	**1,960,841**	**59.3%**

Transport Emissions

Table 12 Te Tai Tokerau FY22 Transport emissions by emission source

Emissions Source	FY22 Emissions (tCO_2e)	Percentage of Total Gross Emissions in FY22 (%)
Diesel	462,642	14.0%
Petrol	294,034	8.9%
Marine Freight	111,741	3.4%
Jet Kerosene	3,975	0.1%
Marine Diesel (local)	2,422	0.1%
LPG	1,671	0.1%
Rail Diesel	607	<0.1%
Av Gas	473	<0.1%
Total	**877,564**	**26.6%**

Stationary Energy Emissions

Table 13 Te Tai Tokerau FY22 Stationary Energy emissions by emission source

Emissions Source	FY22 Emissions (tCO_2e)	Percentage of Total Gross Emissions in FY22 (%)
Electricity Consumption	132,243	4.0%
Natural Gas	127,785	3.9%
Stationary Petrol & Diesel Use	26,394	0.8%
Electricity Transmission and Distribution Losses	14,026	0.4%
LPG	13,067	0.4%
Coal	8,794	0.3%
Biofuel / Wood	8,049	0.2%
Natural Gas Transmission and Distribution Losses	4,705	0.1%
Total	**335,062**	**10.1%**

Waste Emissions

Table 14 Te Tai Tokerau FY22 Waste emissions by emission source

Emissions Source	FY22 Emissions (tCO_2e)	Percentage of Total Gross Emissions in FY22 (%)
Closed Landfill	20,723	0.6%
Wastewater Treatment Plants	19,030	0.6%
Individual Septic Tanks	16,591	0.5%
Open Landfill	10,462	0.3%
Total	**66,806**	**2.0%**

Industrial Processes and Product Use (IPPU) Emissions

Table 15 Te Tai Tokerau FY22 IPPU emissions by emission source

Emissions Source	FY22 Emissions (tCO_2e)	Percentage of Total Gross Emissions in FY22 (%)
Refrigerants and Air Conditioning	60,846	1.8%
Aerosols	3,050	0.1%
SF_6 - Electrical Equipment	541	<0.1%
Foam Blowing	257	<0.1%
SF_6 - Other	114	<0.1%
Fire Extinguishers	95	<0.1%
Total	**64,902**	**2.0%**

Forestry Emissions

Table 16 Te Tai Tokerau FY22 Forestry emissions

Sector / Emissions Source	FY22 Emissions (tCO_2e)
Harvest Emissions	6,828,735
Native Forest Sequestration	-1,065,310
Exotic Forest Sequestration	-5,370,074
Total (Net)	**393,352**

Appendix C

Additional On-Road Transport Emissions Breakdown

Prepared for
Northland Regional Council
ABN: N/A

Te Tai Tokerau On-Road Transport GHG Emissions

FY19 - FY22

01-Dec-2023
Doc No. Document No

Te Tai Tokerau On-Road Transport GHG Emissions

FY19 - FY22

Client: Northland Regional Council

ABN: N/A

Prepared by

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Executive Summary

This section details the additional analysis undertaken to further break down Te Tai Tokerau's on-road transport Greenhouse Gas (GHG) emissions and assess changes over time. On-road transport represented 20% of Te Tai Tokerau's total gross GHG emissions in the FY22 financial year (1st July 2021 to 30th June 2022).

The focus of this additional analysis is the GHG emissions produced from on-road transport in FY22, but also examines trends in on-road transport GHG emissions from FY19 (1st July 2018 to 30th June 2019) to FY22. Within on-road transport, this analysis examines the relative contribution of each vehicle type (cars, commercial vehicles, buses, etc.) to Te Tai Tokerau's on-road transport GHG emissions.

The calculations are based on fuel sales provided by Northland Regional Council, Vehicles Kilometres Travelled (VKT) and emissions data from Waka Kotahi, and Fleet Statistics from the Ministry of Transport. The reported emissions align with the results of the FY22 Te Tai Tokerau GHG Emissions Inventory.

For this analysis, the word 'emissions' represents greenhouse gas emissions only.

Key findings of this analysis include:

Te Tai Tokerau FY22 On-Road Transport Emissions:

- Cars represented 10% of Te Tai Tokerau's total gross emissions (325,744 tCO_2e).
    - Cars represented 72% of all VKT and accounted for 49% of all on road emissions.
    - Electric cars (not including hybrid vehicles) represented 0.8% of all VKT and accounted for 0.07% of on-road transport emissions (478 tCO_2e).
- Commercial vehicles represented 48% of on-road transport emissions and 10% of total gross emissions (321,149 tCO_2e).
    - Light commercial vehicles represented 24% of on-road transport emissions, and heavy commercial vehicles represented 24% of on-road transport emissions.
    - Heavy commercial vehicles represented 6% of all VKT and accounted for 24% of on-road emissions.
- Busses represented 3% of all on-road transport emissions (this includes public transport, school busses, and coaches).

Changes in Te Tai Tokerau's On-Road Transport Emissions (FY19 to FY22):

- On-road transport emissions decreased by 9% from FY19 and FY22 (-65,403 tCO_2e).
    - COVID-19 restrictions reduced on-road transport emissions in FY20 by 8% compared to the previous financial year. This was followed by a rebound in emissions of 10% in FY21 and another reduction in FY22 by 10%, also driven by COVID-19 restrictions. It is likely that on-road transport emissions will have rebounded again in FY23.
- Car emissions decreased by 12% from FY19 to FY22, driven by COVID-19 impacts and a decrease in petrol car emissions.
    - During this period, use of hybrid and electric cars increased from very low starting points, potentially contributing to the reduction in car emissions.
    - Hybrid car emissions increased by 194%, driven by a 274% increase in fleet size. Electric car emissions increased by 216%, driven by a 244% increase in fleet size.
- Commercial vehicle emissions decreased by 5%, driven by COVID-19 impacts and a 9% decrease in heavy commercial vehicle emissions.
    - Light commercial vehicle emissions decreased by 1% during the same period.

1.0 Methodology

The basis for this assessment is the results presented in Te Tai Tokerau's Emissions Inventory for the FY22 financial year (1st July 2021 to 30th June 2022). The emissions for on-road transport have been calculated based on the sale of petrol and diesel within the geographic area for each year, 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 an estimate of emissions (by gas) for Te Tai Tokerau by vehicle class in FY19 (1st July 2018 to 30th June 2019) has been used to assess the relative contribution of vehicle class types to on-road transport emissions in Te Tai Tokerau in FY19. Waka Kotahi Vehicles Kilometres Travelled (VKT) and other national and vehicle fleet data from Ministry of Transport covering the years from FY19 to FY22 has been used to estimate changes in on-road emissions during this period, aligning with the results of Te Tai Tokerau's Greenhouse Gas (GHG) Emissions Inventory for FY22.

Emissions related to energy use from electric vehicles (EVs) is included in the stationary energy sector in Te Tai Tokerau's GHG Emissions Inventory (and not included in transport emissions) due to a lack of available data at the time of calculation. However, the total emissions presented here include the EV emissions contribution. These emissions have been calculated using an average electricity consumption per km travelled and are based on the carbon intensity of the national electricity grid in FY22. Due to this, emissions calculated in this study may differ from the total regional results from Te Tai Tokerau's emissions inventory.

All calculated emissions have been converted to tonnes of CO_2 equivalent (tCO_2e) to allow direct comparison with the results of Te Tai Tokerau's GHG Emissions Inventory for FY22. For this analysis, the word 'emissions' represents GHG emissions only.

Definition of on-road vehicle categories[1]:

- Light vehicles:
    - Cars: passenger cars and sports utility vehicles (SUVs). This includes passenger cars and SUVs used for commercial purposes (e.g., taxis).
    - Light commercial vehicles: Utes and vans with gross vehicle mass up to 3.5 tonnes
- Heavy duty vehicles:
    - Heavy commercial vehicles: commercial vehicles with gross vehicle mass higher than 3.5 tonnes
    - Buses with gross vehicle mass higher than 3.5 tonnes

Key Limitations

- The results presented take data provided by Waka Kotahi for 2019 which has been adjusted to align with Te Tai Tokerau's GHG Emissions Inventory for FY22, and the years between, where on-road transport emissions are based directly on fuel sales.
- The on-road transport total displayed in this analysis includes electric vehicles which are not included in the on-road transport figure in the Te Tai Tokerau Emissions Inventory as electricity use is included in the Stationary Energy sector.
- The electricity contribution to plug-in hybrid vehicle emissions has not been calculated for this assessment, however it is assumed to have a minimal impact on results.
- Data used for this assessment is based on modelling results provided by Waka Kotahi, there are inherent assumptions within all modelling.

[1] https://www.nzta.govt.nz/assets/Highways-Information-Portal/Technical-disciplines/Air-quality/Planning-and-assessment/Vehicle-emissions-prediction-model/VEPM-6.3-technical-report-2022.pdf

2.0 Te Tai Tokerau On-Road Transport Emissions in FY22

On-road transport emissions relate to cars, commercial vehicles (including utes, trucks, and large commercial vehicles), and on-road buses. On-road transport is the largest contributor to transport emissions in Te Tai Tokerau, representing 76% of Transport emissions. This is followed by marine, off-road, and air transport.

Table 1 and Figure 1 detail on-road transport emissions per vehicle category and fuel type. Cars in Te Tai Tokerau tend to be fuelled by petrol while commercial vehicles and buses almost exclusively use diesel. Electric cars represent 0.07% of total on-road emissions in the Region but represent approximately 0.8% of kilometres travelled by vehicles in Te Tai Tokerau.

Of note:

- Cars represent 49% of on-road emissions, and 10% of Te Tai Tokerau's total gross emissions.
- Commercial vehicles represent 48% of on-road emissions, and 10% of Te Tai Tokerau's total gross emissions.
- Buses represent 3% of on-road emissions in the region. The bus category includes public transport, school buses, and private commercial buses (including tourist coaches).

Table 1 On-road transport emissions by vehicle type and fuel type in FY22 (tCO_2e)

Vehicle Type	Petrol	Diesel	Electric	Total[2]	% of Total On-Road Emissions
Cars	275,841	49,425	478	**325,744**	49%
Commercial Vehicles	15,494	305,652	2	**321,149**	48%
Buses	-	19,039	-	**19,039**	3%
Total	**291,335**	**374,115**	**480**	**665,931**	100%

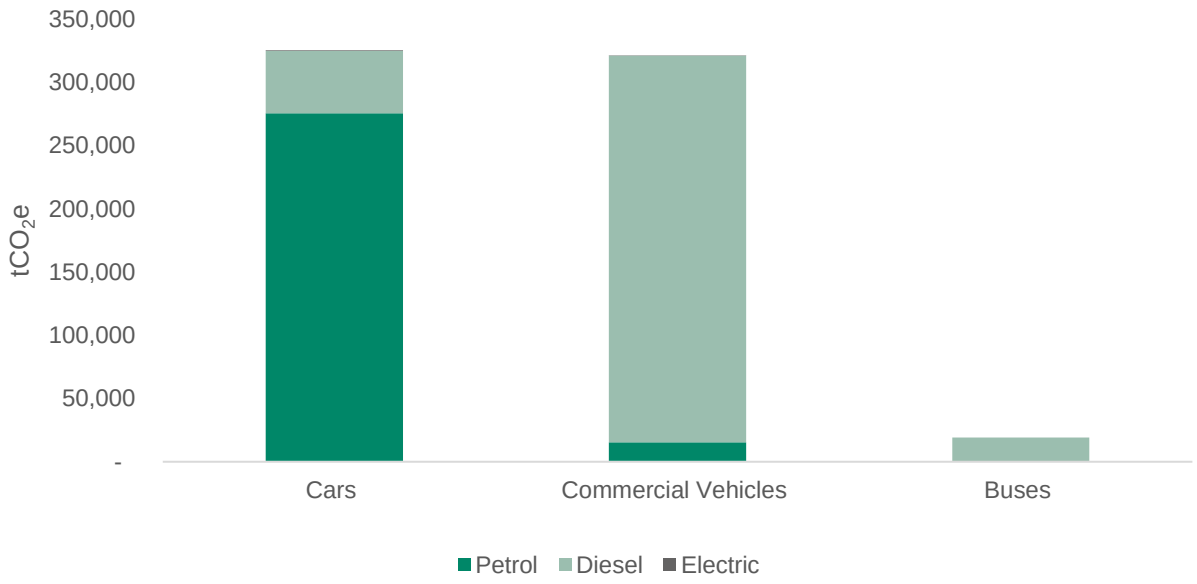

Figure 1 On-road transport emissions by vehicle type and fuel type in FY22

[2] The on-road transport total displayed here and in the following tables includes electric vehicles which are not included in the on-road transport figure in the Te Tai Tokerau Emissions Inventory as electricity use is included in the Stationary Energy sector.

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

Of note:

- Commercial vehicles lighter than 3.5 tonnes represent 24% of on-road emissions in Te Tai Tokerau
- Commercial vehicles heavier than 25 tonnes represent 19% of on-road emissions in Te Tai Tokerau.

These figures likely represent the proportionally high use of utes and other commercial vehicles in the agriculture sector, and road freight movement through the region.

This highlights the impact of both private cars and commercial vehicles on Te Tai Tokerau's on-road transport emissions. Traditionally the focus has often been on private car journeys and hasn't adequately considered the impact of commercial vehicles.

Table 2 On-road transport emissions by vehicle class in FY22 (tCO_2e)

Vehicle Class	GHG Emissions (tCO_2e)	% of Total On-Road Emissions
Cars	325,744	49%
Light Commercial Vehicles <3.5 Tonne	158,482	24%
Heavy Vehicles 3.5-25 Tonne	35,079	5%
Heavy Vehicles 25-50+ Tonne	127,588	19%
Bus Urban 15-18 Tonne	17,306	3%
Bus Coach >18 Tonne	1,733	<1%
Total	**665,931**	**100%**

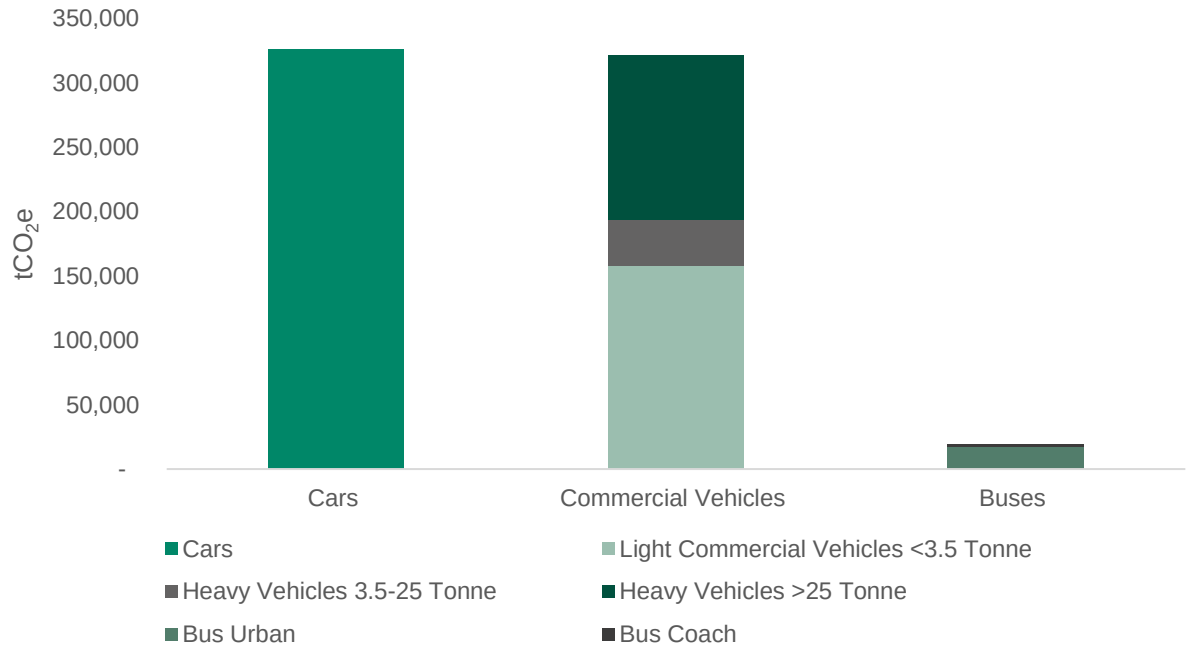

Figure 2 On-road transport emissions by vehicle class in FY22

Alongside total emissions, emissions have also been compared to distance travelled by different vehicle types. Table 3 shows the emissions per vehicle class as above but also includes the VKT by each vehicle class in Te Tai Tokerau and shows the average emissions per VKT for each vehicle class.

Of note:

- Cars represent 72% of all VKT in Te Tai Tokerau but represent 49% of all on-road emissions in Te Tai Tokerau.
    - This is due to the relatively low average emissions per VKT of cars compared to heavier vehicles (which is also partly due to the use of petrol rather than diesel for cars).
- 25 to 50+ tonne commercial vehicles represent 4% of all VKT in Te Tai Tokerau but represent 19% of all on-road emissions in Te Tai Tokerau.
    - This is due to the higher average emissions per VKT of heavy vehicles compared to lighter vehicles.

These figures do not consider the weight of freight, or the number of people moved per vehicle, where larger vehicles may be more efficient per tonne of freight moved than smaller vehicles, or where busses may be more efficient per person than cars.

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

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

Vehicle Type	Vehicle Kilometres Travelled (VKT)	GHG Emissions (tCO_2e)	Average tCO_2e per VKT
Cars	1,576,873,554	**325,744**	0.0002
Light Commercial Vehicles <3.5 Tonne	457,450,490	**158,482**	0.0003
Heavy Vehicles 3.5-25 Tonne	47,574,295	**35,079**	0.0007
Heavy Vehicles 25-50+ Tonne	88,563,912	**127,588**	0.0014
Bus Urban 15-18 Tonne	10,832,838	**17,306**	0.0016
Bus Coach >18 Tonne	1,644,185	**1,733**	0.0011
Total	**2,182,939,274**	**665,931**	0.0003

3.0 Territorial Authorities in Te Tai Tokerau in FY22

On-road emissions vary across the region. Whangārei represents 46% of Te Tai Tokerau's on-road emissions, with the Far North representing the next largest proportion at 39%. The area with the lowest proportion of the region's emissions is Kaipara, representing 15%.

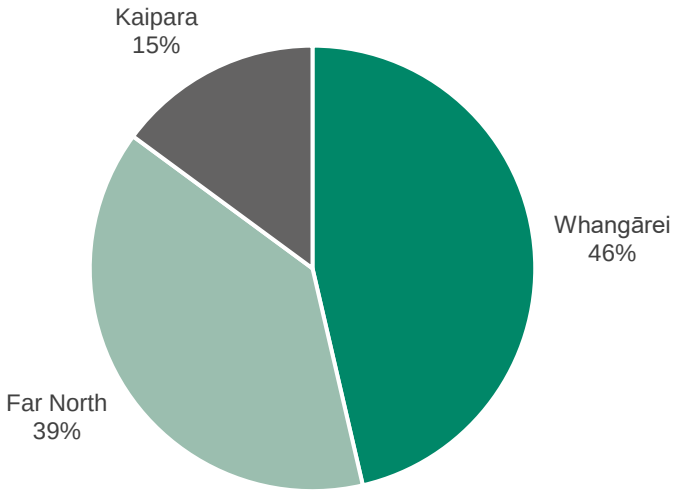

Figure 3 On-road transport emissions by vehicle class in FY22

Table 4 On-road transport emissions by vehicle type and territorial authorities in Te Tai Tokerau[3].

Vehicle Type	Whangārei	Far North	Kaipara	Total
Cars	152,359	125,531	47,854	**325,744**
Commercial Vehicles	147,656	125,270	48,223	**321,149**
Buses	8,856	7,053	3,129	**19,039**
Total	**308,870**	**257,855**	**99,206**	**665,931**

[3] The on-road transport total displayed here and in the following tables includes electric vehicles which are not included in the on-road transport figure in the Te Tai Tokerau Emissions Inventory as electricity use is included in the Stationary Energy sector.

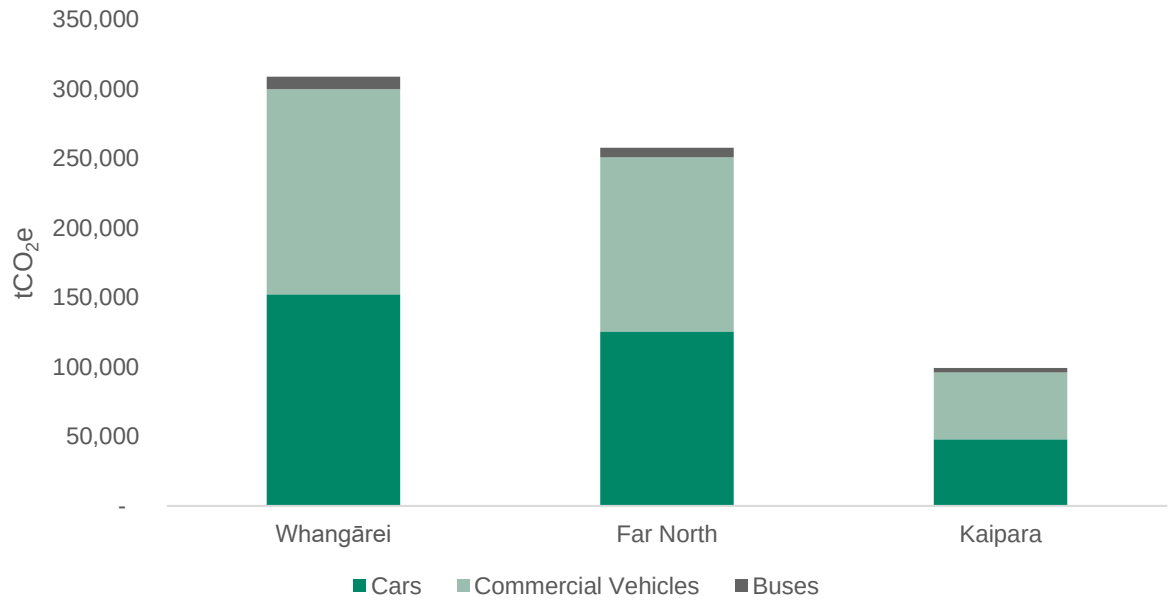

Figure 3 On-road transport emissions by vehicle type in FY22

When accounting for population, Whangārei has the lowest on-road emissions per capita. The highest emissions per capita are found in Kaipara. Lower public transport use due to longer distances to travel between home, work, leisure, and amenities, and a greater proportion of higher emitting vehicles (such as utes) contributes to the high per capita on-road emissions in the Far North and Kaipara.

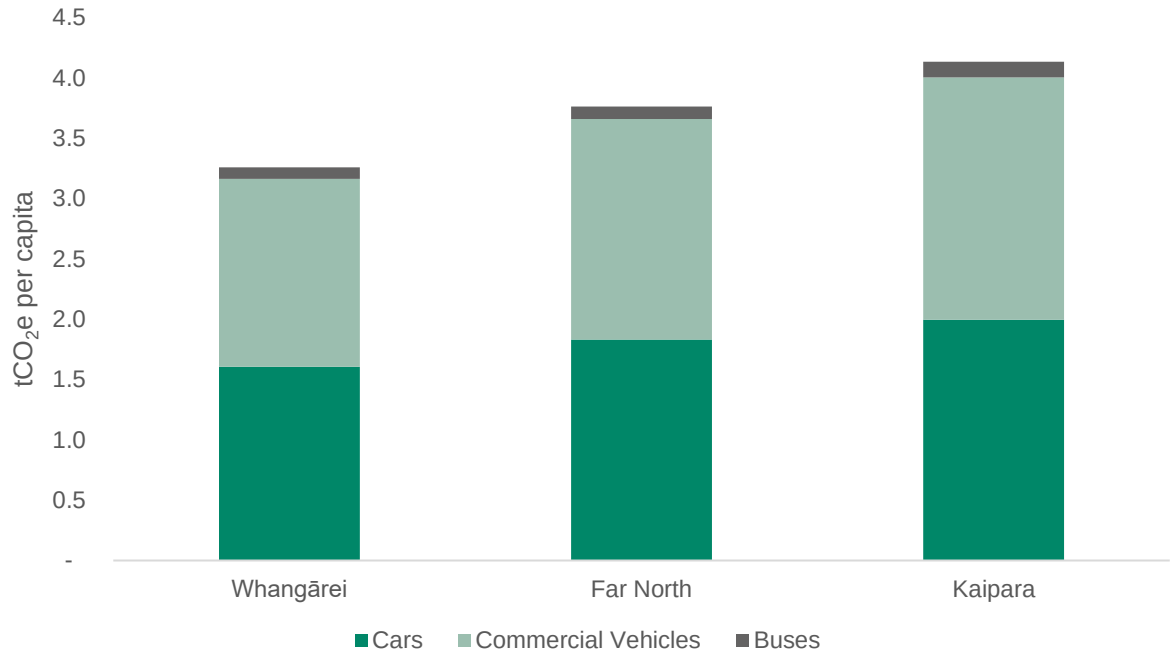

Figure 4 On-road transport emissions per capita by vehicle type in FY22.

4.0 On-Road Transport Emissions Change from FY19 to FY22

This section reports on the change in on-road transport emissions from FY19 to FY22, during which, emissions decreased by 9% (65,403 tCO_2e).

COVID-19 restrictions reduced transport emissions in FY20 by 8%. This was followed by a rebound in emissions of 10% in FY21 and another reduction in FY22 by 10% also driven by COVID-19 restrictions. It is likely that on road transport emissions will rebound again in FY23 to pre-COVID-19 levels.

Table 4 Annual on-road transport emissions by vehicle type from FY19 to FY22 (tCO_2e)

Vehicle Type	FY19	FY20	FY21	FY22	% Change (FY19 to FY22)
Cars	369,197	334,290	370,708	325,744	-12%
Commercial Vehicles	338,370	318,809	349,141	321,149	-5%
Buses	23,767	21,656	22,245	19,039	-20%
Total	**731,333**	**674,756**	**742,094**	**665,931**	**-9%**

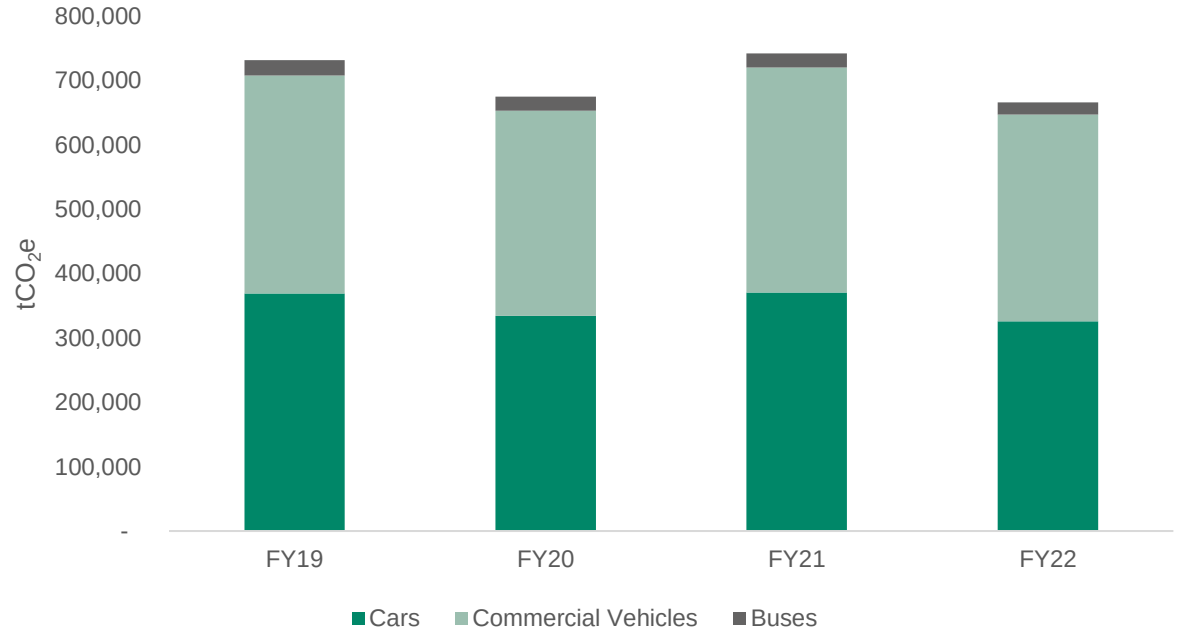

Figure 5 On-road transport emissions by vehicle type FY19-FY22

The results show the main cause of decreased on-road transport emissions between FY19 and FY22 is a 12% reduction in car emissions (43,453 tCO_2e). We can see the impact of COVID-19 travel restrictions in Te Tai Tokerau in FY20 and FY22, particularly affecting car emissions. During these years there were periods of restricted travel. Commercial vehicle emissions appear to have been slightly less affected by the COVID-19 restrictions.

Notable changes when examining on-road emissions changes in more detail (Table 5):

- Most of the emissions reduction is due to a 14% (44,015 tCO_2e) reduction in petrol car emissions. This is followed by a 9% (16,264 tCO_2e) reduction in heavy commercial vehicle emissions.
- There was a proportionally large increase in electric and hybrid vehicle emissions, of 216% and 194% respectively. There has been a large growth in the number of these vehicles in Te Tai Tokerau and emissions have grown in line with this increase. However, these vehicles still represent a very small proportion of on-road emissions and are vastly lower emitting than the equivalent internal combustion engine vehicles.

Table 5 Change in on-road transport emissions by vehicle class (tCO_2e)

Vehicle Type	FY19	FY20	FY21	FY22	% Change (FY19 to FY22)
Car Petrol	311,688	279,188	309,436	267,674	-14%
Car Diesel	54,575	51,207	54,565	49,425	-9%
Car Hybrid	2,782	3,670	6,370	8,167	194%
Car Electric	151	226	337	478	216%
Light Commercial Vehicles	159,439	152,801	169,591	158,482	-1%
Heavy Commercial Vehicles	178,931	166,009	179,550	162,667	-9%
Buses	23,767	21,656	22,245	19,039	-20%
Total	**731,333**	**674,756**	**742,094**	**665,931**	**-9%**

5.0 Limitations

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Appendix D

Renewable Energy Generation Analysis

Prepared for
Northland Regional Council
ABN: N/A

Te Tai Tokerau Energy Generation Inventory

FY16 - FY22

01-Dec-2023
Doc No. Document No

Te Tai Tokerau Energy Generation Inventory

FY16 - FY22

Client: Northland Regional Council

ABN: N/A

Prepared by

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Originator	Myra Watt and Adam Swithinbank
Checker/s	Suzanne Lowe
Verifier/s	Anthony Hume

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Rev	Revision Date	Details	Approved	
			Name/Position	Signature
1	01-Dec-2023	Final	Anthony Hume Associate Director - Practice Leader Sustainability & Resilience	

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Executive Summary

This section details analysis undertaken to further understand electricity generation in Te Tai Tokerau. The focus of this analysis is grid connected energy generation in the FY22 government financial year (1st July 2021 to 30th June 2022), and trends in generation between FY16 and FY22. 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 network region to Te Tai Tokerau's total grid connected energy generation. Within Te Tai Tokerau there are two electricity generation network regions which are the Kaipara and Whangārei network region (encompassing the Kaipara District and Whangārei District territorial areas) and the Bay of Islands network region (encompassing the Far North District territorial area).

Key findings:

Te Tai Tokerau Energy Generation in FY22:

- Geothermal generation represented 92% of grid connected energy generation in Te Tai Tokerau (507 GWh). The remaining generation is from solar (5%), hydro (3%) and wind (0.01%).
    - All grid connected geothermal energy was generated at Ngāwhā in the Bay of Islands network region.
    - Solar generation was present in all territorial authorities in Te Tai Tokerau in FY22, with the Whangārei and Kaipara network region generating 52%, and the Bay of Island's network region generating 48% of the total grid connected solar energy. Grid connected residential solar generation connections represented 60% of the total energy generated from solar.
    - Grid connected hydro energy was generated at the Wairua Falls Power Station in the Whangārei and Kaipara network region only.
    - There are no large-scale wind generation sites in Te Tai Tokerau however some wind farm projects are proposed for the region.
- In FY22, 94% of grid connected energy was generated in the Bay of Islands network region, with 97% of that produced by geothermal generation.
- There was no grid connected fossil fuel energy generated in Te Tai Tokerau.

Changes in Te Tai Tokerau Energy Generation (FY16 to FY22):

- Between FY16 and FY22, grid connected energy generation in Te Tai Tokerau increased by 129%.
    - This increase was driven by a 141% increase in geothermal energy generated and supplied to the grid during this period. Geothermal generation increased from 194 GWh to 467 GWh, with most of the change since FY20.
    - Solar generation increased by 484% from 4 GWh to 25 GWh.
    - Hydro generation decreased by 36% during this period however it is prone to annual fluctuations dependent on rainfall and water levels.
    - Wind generation data was insufficient to determine a trend (just 0.01% of total generation in FY22.)

Energy Generation Not Supplied to the Grid

- Not all renewable energy generated in Te Tai Tokerau between FY16 and FY22 was grid connected (i.e. supplied to the grid). This includes off-grid residential generation, direct industrial or commercial generation, and biofuel burnt for heat or steam generation.

1.0 Methodology

The basis of this study is information sourced from the Electricity Authority Te Mana Hiko (EMI) covering geothermal, wind, and solar energy generation. Hydro generation information was supplied directly by Northpower.

- For geothermal generation, total annual electricity generation output (GWh) was sourced directly from EMI.
- For hydro generation, total annual electricity generation output (GWh) was sourced directly from Northpower for the Wairua hydroelectric power scheme.
- For solar and wind generation, annual installed electricity generation capacity (MW) data was sourced at the Networking Reporting Region with generation (GWh) derived from this data.
    - The reported Networking Regions were Whangārei and Kaipara (Northpower), and Bay of Islands (Top Energy). The Whangārei and Kaipara network region represents the Whangārei and Kaipara district territorial authority areas. The Bay of Islands network region represents the Far North district territorial authority area.
    - 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. Capacity factors were taken from the Energy in New Zealand[1] (MBIE, 2020) report. The same capacity factor was applied for each year and was not scaled for annual variation.
    - Solar and wind generation was provided broken down by market sector (residential, commercial, enterprise, and industrial).[2]

2.0 Key Limitations and Assumptions

- This report focuses on grid connected energy generation within Te Tai Tokerau only.
    - It is recognised that off-grid electricity generation exists in the region. This is particularly the case for some industrial uses of energy, “off-grid” residences, and liquid fuel generators used for electricity generation (e.g. within agriculture and construction). These sources of electricity have not been covered in this assessment.
- For the Whangārei and Kaipara network region, no data was available for wind generation for FY18 to FY22.
    - It is likely that small-scale residential wind generation increased due to improvements of technology and increased interest in renewable energy generation, although growth would have been limited by the number of areas with appropriate conditions. There are no large-scale wind generation sites in Te Tai Tokerau however some wind farm projects are proposed for the region.
- Generated output for solar and wind has been estimated based on installed generating capacity and using national capacity factors from MBIE. There is uncertainty in the applicability of the national capacity factors to individual generating sites in particular locations.

[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 FY22

In the FY22 financial year, Aotearoa New Zealand generated 43,175 GWh of electricity, with 83% from renewable sources[3]. Table 1 shows energy generation for the entirety of Aotearoa New Zealand in FY22.

Table 1 Energy generation in New Zealand in FY22.

Generation Type	Energy Generated (GWh)	Percentage of Total Generation (%)
Hydro	24,683	57%
Geothermal	8,061	19%
Gas	5,043	12%
Wind	2,777	6%
Coal	1,600	4%
Wood	470	1%
Biogas	258	1%
Solar	233	1%
Waste Heat	44	<1%
Oil	6	<1%
Total	**43,175**	**100%**

In Te Tai Tokerau in FY22, 100% of grid connected electricity generation was from renewable sources. Table 2 shows energy generation for Te Tai Tokerau in FY22. In FY22 Te Tai Tokerau generated 1% of Aotearoa New Zealand's electricity generation, with geothermal generation in Te Tai Tokerau representing 6% of national geothermal generation.

Table 2 Energy generation in Te Tai Tokerau in FY22.

Generation Type	Energy Generated (GWh)	Percentage of Total Generation (%)
Geothermal	467	92%
Solar	25	5%
Hydro	15	3%
Wind	0.03	<0.1%
Total	**507**	**100%**

Table 3 presents the total grid connected energy generated in the network regions in Te Tai Tokerau, broken down by generation type. The largest proportion of grid connected energy generated in Te Tai Tokerau in FY22 was geothermal energy, generated entirely from one site in the Bay of Islands network region (Ngāwhā geothermal field).

The next largest source of grid connected energy generation was solar (5%), split evenly between the two network regions. Grid connected residential solar generation connections represented 60% of the total energy generated from solar (with the remaining produced by enterprise, commercial, and industrial connections).

[3] https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-statistics/electricity-statistics/

Hydro generation is present solely in the Whangārei and Kaipara network region with one grid connected hydro energy generation site (Wairua Falls Power Station) in Whangārei.

Grid connected wind generation was present in very small amounts across both network regions in FY17. This is the most recent year when both network regions reported on wind generation supplied to the grid. The residential sector produced 100% of wind generation. It is likely that small-scale residential wind generation increased since FY17 although this trend has not been seen in the data for the Bay of Islands network region where data was available for all years. There are no identified indications that there is significantly more wind generation in Te Tai Tokerau than reported here.

Further context for each generation source is provided in section 4.0.

Table 3 Energy generation in Te Tai Tokerau in FY22.

Network Region	Generation Type	Energy Generated (GWh)	Total Energy Generated (GWh)
Bay of Islands (Top Energy)	Geo	467	479
	Solar	12	
	Hydro	-	
	Wind	0.02	
Whangārei and Kaipara (Northpower)	Geo	-	28
	Solar	13	
	Hydro	15	
	Wind	0.02	
Total	**Geo**	**467**	**507**
	Solar	**25**	
	Hydro	**15**	
	Wind	**0.03**	

**assumed based on FY17 data*

4.0 Energy Generation Change from FY16 to FY22

Between FY16 and FY22, grid connected energy generated in Te Tai Tokerau increased by 129% (285 GWh). This total generation increase was driven by a 141% (273 GWh) increase in geothermal generation during this period.

Hydro generation slightly decreased and solar generation increased during this period. There was insufficient data to calculate a trend for wind generation. See sections below for further detail.

Table 4 Total grid connected generation by generation type in 2015/16 and 2021/22 (GWh).

Generation Type	FY16	FY22	% change
Geothermal	194	467	141%
Solar	4	25	484%
Hydro	24	15	-36%
Wind	0.03	0.03	<1%
Total	**222**	**507**	**129%**

4.1 Geothermal Generation

Between FY16 and FY22, 100% of geothermal generation in Te Tai Tokerau was sourced from the Ngāwhā Geothermal Power Station. Geothermal energy supplied to the grid increased after the completion of a three-year project to expand the station's capacity by 32 Megawatts (to a total of 57 MW).

Table 5 Total grid connected geothermal generation by network region in FY16 and FY22 (GWh).

Network Region	FY16	FY22	% change
Bay of Islands (Top Energy)	194	467	141%
Whangārei and Kaipara (Northpower)	0	0	0%
Total	**194**	**467**	**141%**

4.2 Solar Generation

Between FY16 and FY22, grid connected solar energy generation across the network regions in Te Tai Tokerau increased by 484%. A large proportional increase is seen across both network regions, with the largest increase in the Bay of Islands network region.

Table 6 Total grid connected solar generation by network region in 2015/16 and 2021/22 (GWh).

Network Region	FY16	FY22	% change
Bay of Islands (Top Energy)	1.8	12.3	579%
Whangārei and Kaipara (Northpower)	2.5	13.2	417%
Total	**4.4**	**25.5**	**484%**

Solar generation was broken down by the market sector in which it was generated. The largest grid connected solar generation sector was the residential sector (60% in FY22).

The largest percentage change was in commercial and enterprise connections where estimated generation increased by 1,240% and 568% respectively, albeit from very low starting points. The largest real change was in residential connections where estimated generation increased by 12 GWh.

Table 7 Total grid connected solar generation by market sector in 2015/16 and 2021/22 (GWh).

Market Sector	2015/16	2021/22	% change
Residential	3.0	15.3	411%
Enterprise	0.6	4.3	568%
Commercial	0.3	3.8	1,240%
Industrial	0.5	2.2	379%
Total	**4.4**	**25.5**	484%

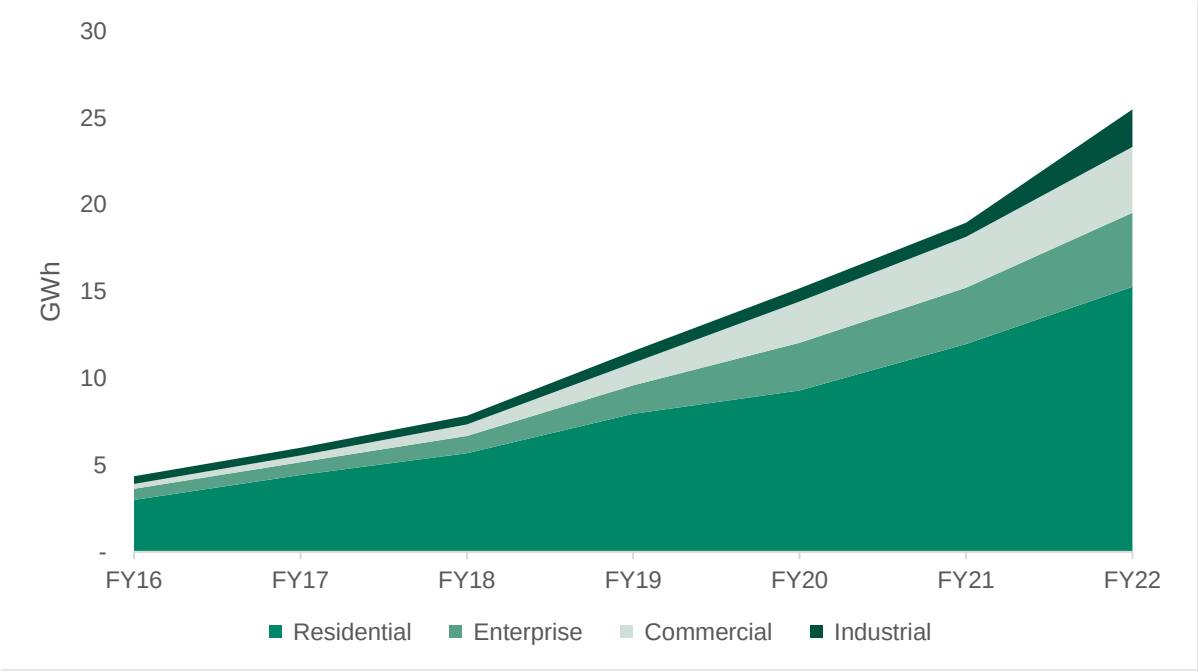

Figure 1 Total grid connected solar generation by market sector from FY16 to FY22 (GWh).

4.3 Hydro Generation

Between FY16 and FY22, 100% of geothermal generation in Te Tai Tokerau was sourced from the Wairua Hydroelectric Power Scheme within the Whangārei and Kaipara network region. Generation at this site decreased by 36% between FY16 and FY22. Hydro generation is influenced by the amount of rainfall in a year, meaning that hydro generation generally fluctuates year to year. It is also noted that this is one of New Zealand's oldest hydro schemes.

Table 8 Total grid connected hydro generation by network region in FY16 and FY22 (GWh)

Network Region	FY16	FY22	% change
Bay of Islands (Top Energy)	-	-	-
Whangārei and Kaipara (Northpower)	24	15	-36%
Total	**24**	**15**	**-36%**

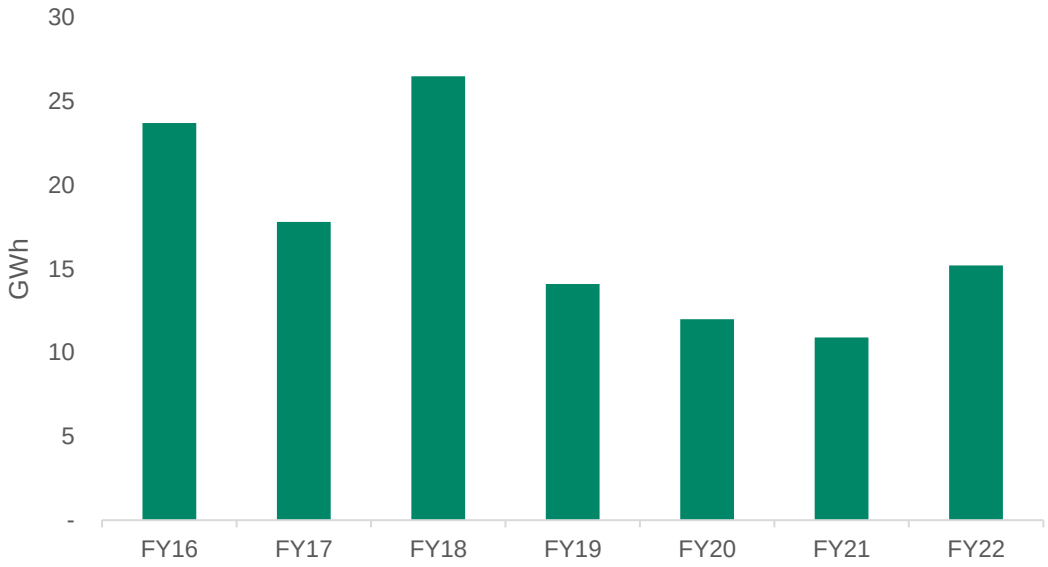

Figure 2 Total grid connected hydro generation from FY16 to FY22 (GWh).

4.4 Wind Generation

Between FY16 and FY22, grid connected wind generation data was insufficient to indicate any trend in Te Tai Tokerau. In addition, the total contribution of grid connected wind generation to Te Tai Tokerau's total generation was very small during this time.

Table 9 Total grid connected wind generation by network region in FY16 and FY22 (GWh)

Network Region	FY16	FY22	% change
Bay of Islands (Top Energy)	0.016	0.016	<1%
Whangārei and Kaipara (Northpower)	0.016	0.016	<1%
Total	**0.03**	**0.03**	**<1%**

5.0 Future Generation in Te Tai Tokerau

As of November 2023 there were enquiries for 40 additional renewable generation sites in Te Tai Tokerau (26 solar, 3 geothermal, and 11 wind). This excludes small-scale generation (e.g. residential) and non-grid connected generation. These sites have the potential to add 3,489 MW to Te Tai Tokerau's generation capacity. However, not all enquires are likely to be progressed, this is especially limited by the capacity of the transmission network in Te Tai Tokerau.

Of these 40 enquiries, Table 10 presents the three most progressed generation enquiries in Te Tai Tokerau. This includes one solar and battery storage project, one wind project, and one geothermal project.

Table 10: Transpower Generation Connection Pipeline[4]

Network Region	Connection Location	Maximum Generation Capacity (MW)	Generation Type	Enquiry Stage
Whangārei and Kaipara (Northpower)	Bream Bay (BRB)	230	Solar and battery energy storage system (BESS)	Delivery (i.e. under construction)
Whangārei and Kaipara (Northpower)	Maungatapere (MPE)	73	Wind	Investigation
Bay of Islands (Top Energy)	Kaikohe (KOE)	75*	Geothermal	Application Confirmed

** Maximum generation capacity includes existing generation at the site*

[4] https://static.transpower.co.nz/public/2023-03/New%20Generation%20Connection%20Pipeline.xlsx?VersionId=uOeKXDoM1SWspv6Ma1wDDJr40g2OwTiA

6.0 Limitations

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