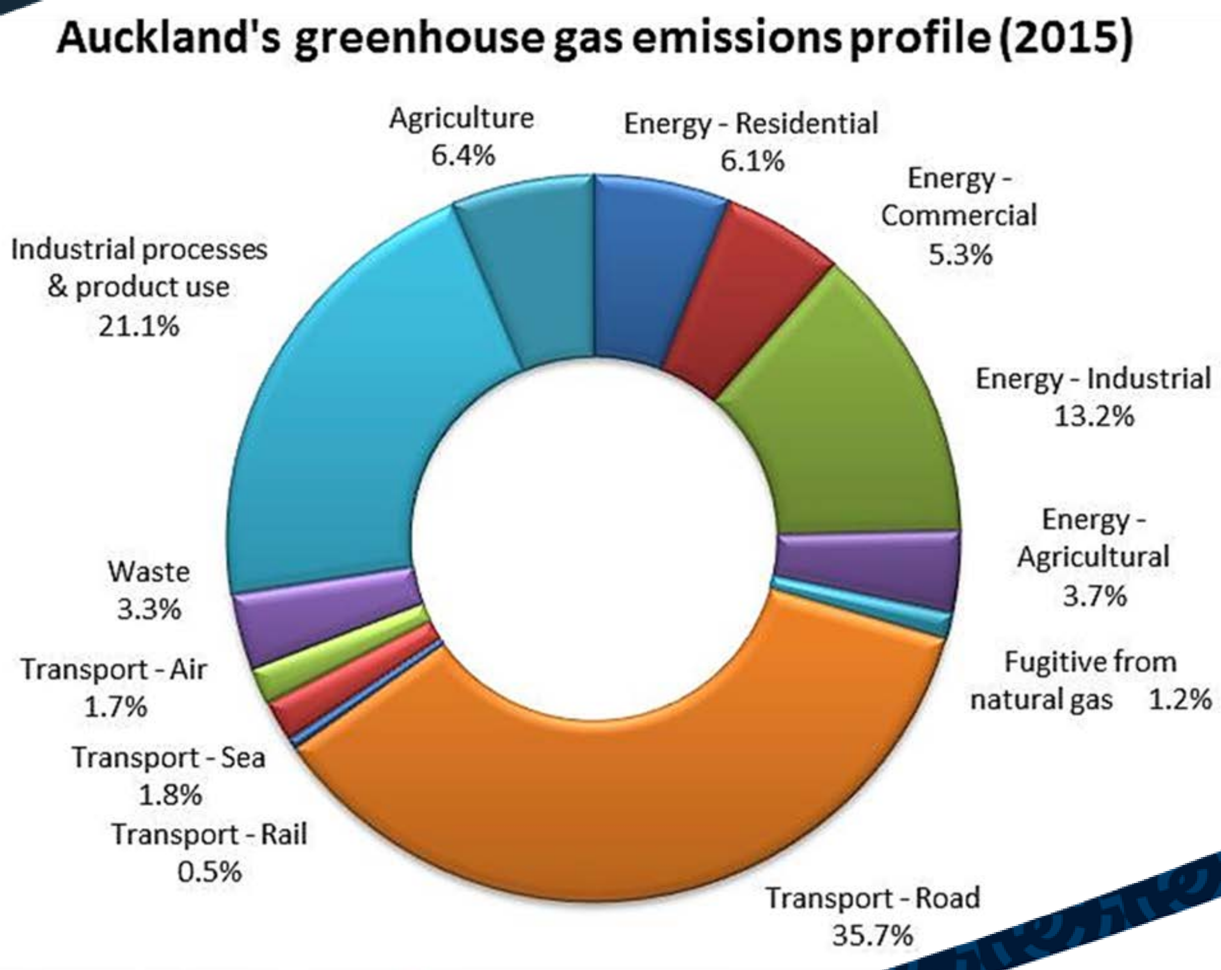
Auckland’s Greenhouse Gas Inventory to 2015

Shanju Xie

October 2017 Technical Report 2017/026



Auckland Council
Te Kaunihera o Tāmaki Makaurau

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Shanju Xie
Research and Evaluation Unit (RIMU)

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Executive summary

The Auckland Plan, adopted in 2012, lays out aspirational targets to achieve reductions in greenhouse gas (GHG) emissions, 10 to 20 per cent by 2020, 40 per cent by 2040 and 50 per cent by 2050 (based on 1990 levels). Auckland's Low Carbon Action Plan, launched in 2014, sets out the pathways and specific actions to achieve the target. An inventory that identifies and quantifies the sources and sinks of GHGs in Auckland provides an essential tool to inform and evaluate our progress.

Auckland's GHG inventory to 2015 was prepared with the most up-to-date information and in accordance with global best practice: the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) which was published in 2014. In 2015, Auckland's gross emissions were 11,309 kilo-tonnes of carbon dioxide equivalent (kt CO_2e) and when carbon sequestration from forestry was included, net emissions were 10,267 kt CO_2e. Transport and stationary energy are dominant sectors, accounting for 39.7 per cent and 29.5 per cent of gross emissions, respectively (Figure E-1). Of the GHGs required to be reported by the GPC, carbon dioxide (CO_2) contributed 83.1 per cent, methane (CH_4) 10.5 per cent, nitrous oxide (N_2O) 1.7 per cent, hydrofluorocarbons (HFCs) 4.6 per cent, perfluorocarbons (PFCs) <0.1 per cent and sulphur hexafluoride (SF_6) 0.1 per cent of gross emissions. Nitrogen trifluoride (NF_3) emissions do not occur in New Zealand.

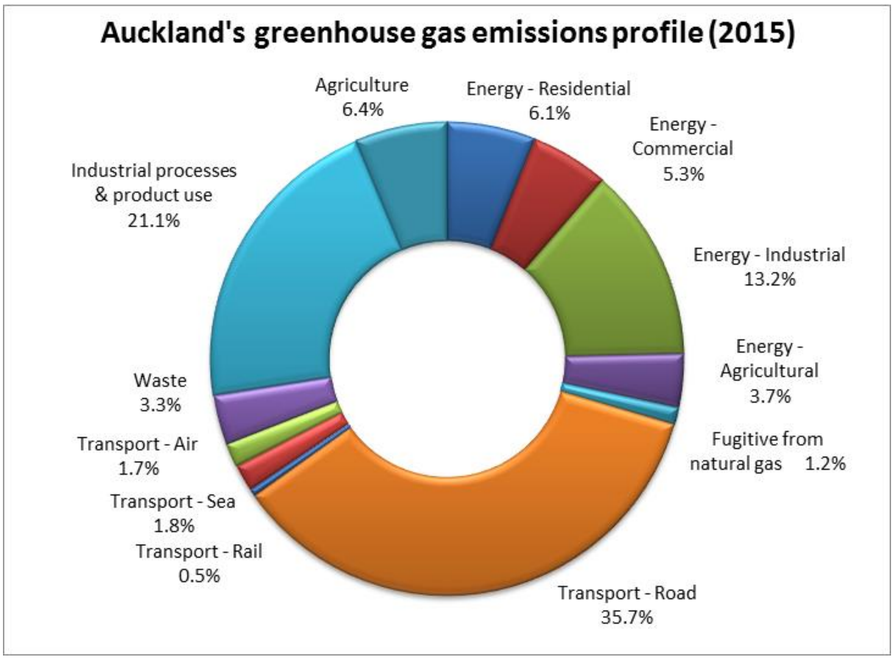

Figure E-1 Auckland's GHG gross emissions profile for 2015

Between 2014 and 2015, Auckland's GHG emissions have increased by 411 kt CO_2e or 3.8 per cent for gross emissions and by 148 kt CO_2e or 1.5 per cent for net emissions (Figure E-2). Between 2009 and 2015, gross emissions have increased by 748 kt CO_2e or 7.1 per cent and net emissions have increased by 214 kt CO_2e or 2.1 per cent. Increased emissions from transport and industrial processes and product use (IPPU) sectors are the main driver of increased emissions in 2015.

With respect to current emissions levels, Auckland will need to reduce its net emissions by 23.7 per cent to 32.1 per cent by 2020, 49.1 per cent by 2040 and 57.6 per cent by 2050, to meet its emissions targets.

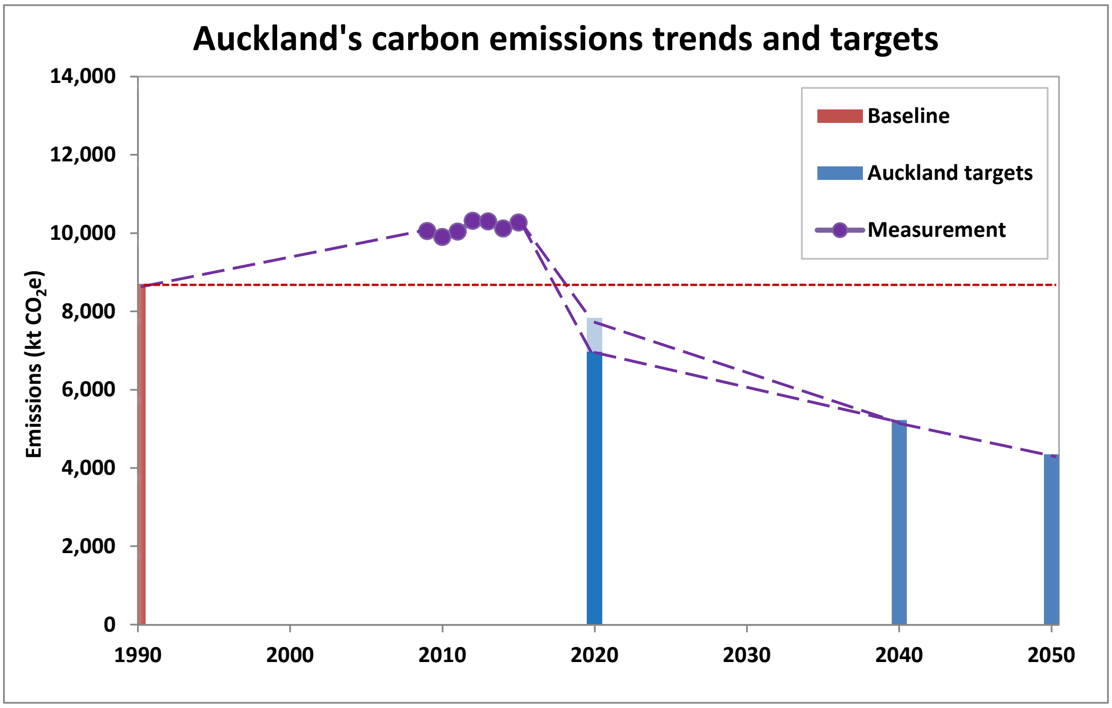

Figure E-2 Auckland's GHG emissions trends and reduction targets. Targets shown are reductions of 10 to 20 per cent, 40 per cent and 50 per cent of 1990 gross emissions for 2020, 2040 and 2050, respectively.

In 2015, net emissions were 6.5 t CO_2e per capita and 127 t CO_2e per million $NZ GDP (2009/2010 prices) while gross emissions were 7.2 t CO_2e per capita and 140 t CO_2e per million $NZ GDP. These values are lower than those in 2009, and this shows that Auckland decouples emissions from population and economic growth. Comparisons of population, GDP and GHG emissions from 2009 to 2015 are shown in Figure E-3.

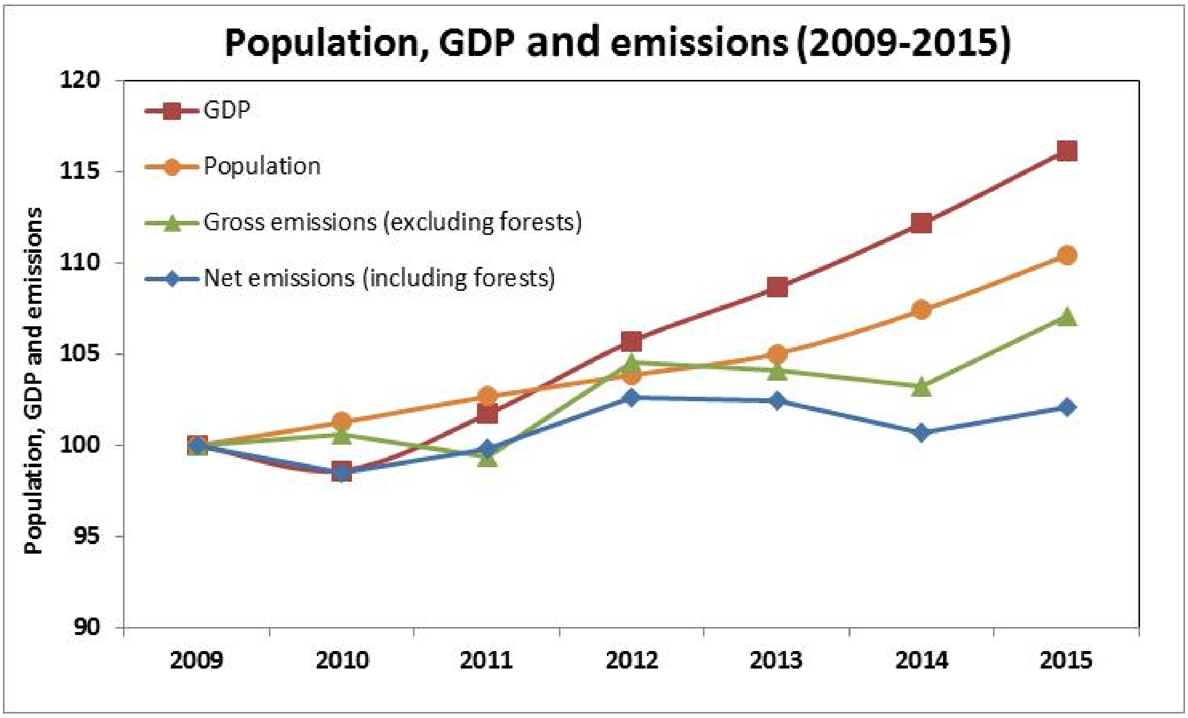

Figure E-3 Auckland's population, GDP and GHG emissions from 2009 to 2015. Values in 2009 are set to 100 for comparison.

Overall, emissions in 2015 have increased, as compared to those in 2009 and 2014, mainly due to increased emissions from transport and IPPU. However, there is evidence that Auckland decouples emissions from population and economic growth.

1 Introduction

The climate is changing with rising temperatures mainly due to increased greenhouse gas (GHG) levels in the atmosphere caused by human activities. The world must reduce GHG emissions to limit temperature rise and the harmful impacts of associated risks such as accelerated sea level rise and more frequent extreme weather events.

The Auckland Plan, adopted in 2012, lays out aspirational targets to achieve 10 to 20 per cent reductions in GHG emissions by 2020, 40 per cent by 2040 and 50 per cent by 2050 (based on 1990 levels). Auckland Low Carbon Action Plan sets out the pathways and specific actions to achieve the target (Auckland Council, 2014). An emissions inventory that identifies and quantifies the sources and sinks of GHGs in Auckland provides an essential tool to inform and evaluate our progress.

Auckland's GHG inventories were previously developed by URS in 2011 for 2009 which was updated by Arup in 2014 (Arup, 2014) and most recently by Auckland Council for 2013 and 2014 (Xie, 2015; 2016). Auckland's GHG inventory for 2013 and 2014 has also been reviewed by C40 Cities Climate Leadership Group (C40) and was included in the C40 emissions database (C40, 2017a). This document reports Auckland's GHG inventory to 2015, following the release of New Zealand's Greenhouse Gas Inventory 1990-2015 (MfE, 2017a). As in the inventory to 2014, it was prepared with the most up-to-date information and global best practice in accordance with the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) (WRI et al., 2014). This Protocol provides cities with a clear and robust framework to establish and maintain accurate, credible and comparable emissions accounting and reporting practices. The GPC recommends annual update of inventories, as it provides frequent and timely progress on emissions. Improvements in activity data, emission factors and methodology have been made for this inventory. Previously reported emissions for 1990 (gross emissions as the baseline to reduction targets), 2009 (as the base year in Auckland's Low Carbon Action Plan) to 2014 (previous inventories) (Xie, 2016) have been recalculated in this inventory for consistency.

1.1 Methodology – the GPC

Various methods have been used to develop GHG inventories for cities. The use of different methods makes it difficult for comparisons between cities, raises questions around data quality, and limits the ability to aggregate GHG emissions data. To respond to this challenge and offer a robust and clear framework that builds on existing methodologies, the World Resources Institute (WRI), C40 Cities Climate Leadership Group (C40), and Local Governments for Sustainability (ICLEI) have collaboratively developed the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). The GPC offers a robust, transparent and globally-accepted framework to consistently identify, calculate and report on city greenhouse gases. This report used the most recent version 1.0 (WRI et al., 2014) to prepare and report GHG emissions in Auckland.

The land under the jurisdiction of Auckland Council is the geographic boundary of this inventory. For each year of emissions data in this inventory, the emissions account for a continuous period of 12 months. This report uses calendar year data whenever available in alignment with New Zealand's Greenhouse Gas Inventory. However, if calendar year data is unavailable, other types of annual year data are used.

This report considers all seven gases required by the GPC: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen triflouride (NF_3). NF_3 emissions do not occur in New Zealand (MfE, 2017a) and, therefore, they are not included in this inventory. Emissions are reported as metric tonnes of each GHG as well as CO_2 equivalents (CO_2e). CO_2e is a term used to compare the emissions from various GHGs based upon their global warming potential (GWP). In this report, individual GHGs were converted into CO_2e by multiplying by the GWP values in IPCC Fifth Assessment Report (AR5) as recommended by the GPC. New Zealand's Greenhouse Gas Inventory uses the GWP values in IPCC Fourth Assessment Report (AR4) based on the guidelines that apply to national inventories (MfE, 2017a).

Emissions are allocated into three scopes (Figure 1-1). Scope 1, or "territorial", emissions are those that physically occur within the city. Emissions that occur from the use of electricity, steam, and/or heating/cooling supplied by grids which may or may not cross city boundaries are categorised as scope 2 emissions. Scope 3 emissions refer to those that occur outside the city but are driven by activities taking place within the city's boundaries. The current version of GPC requires reporting of scope 3 emissions from a limited number of sources (transmission and distribution losses associated with grid-supplied energy, and waste disposal and treatment outside the city boundary and transboundary transportation).

Emissions are classified into five main sectors: stationary energy; transport; waste; industrial processes and product use (IPPU); agriculture, forestry, and other land use (AFOLU); and an additional sector for all other emissions occurring outside the geographic boundary as a result of city activities (Other Scope 3). Other Scope 3 includes emissions embodied in fuels, water, food and construction materials. Reporting on Other Scope 3 is not required in the current version of the GPC and is therefore not reported in this inventory. Five main sectors are sub-divided into sub-sectors and further into sub-categories (see Table 2-3).

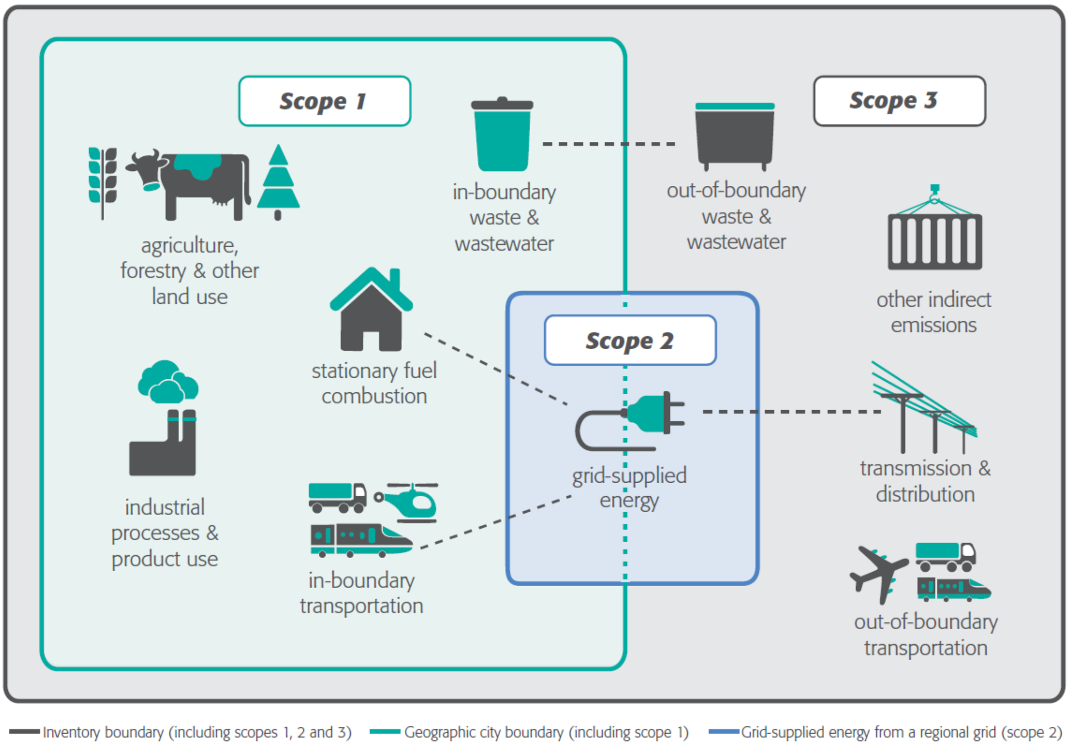

Figure 1-1 Sources and boundaries of city GHG emissions (WRI et al., 2014)

1.2 Emissions calculation and reporting

Emissions are calculated by multiplying activity data (AD) by an emission factor (EF) associated with the activity. Activity data is a quantity of an activity that results in GHG emissions during a given period of time (e.g., the number of kilowatt-hours (kWh) of electricity used in a year). An emission factor is a number specific to each activity used to calculate the quantity of GHG emissions produced for each unit of that activity (e.g., CO_2 emissions in kg from the use of electricity in kWh, kg CO_2/kWh).

Data collected for the inventory comes from a variety of sources and varies in quality, format, and completeness. It is necessary to accommodate limitations in data availability and differences in emission sources between cities. The GPC requires the use of notation keys (IE, NE, NO and C, see below) and an accompanying explanation to justify exclusion or partial accounting of GHG emission source categories, for example, if the activity does not occur or when sufficient activity data is unavailable.

IE (Included Elsewhere): GHG emissions for this activity are estimated and presented in another category of the inventory. That category shall be noted in the explanation.

NE (Not Estimated): Emissions occur but have not been estimated or reported; justification for exclusion shall be noted in the explanation.

NO (Not Occurring): An activity or process does not occur or exist within the city.

C (Confidential): GHG emissions which could lead to the disclosure of confidential information and therefore cannot be reported.

The data quality for activity data and emission factors is assessed with a High-Medium-Low rating. High (H) rating is assigned to detailed activity data or city/region-specific emission factors. Activity data that is modelled using robust assumptions or more general emission factors (e.g., applied nationally) is rated as Medium (M). Low (L) is referred to highly-modelled or uncertain activity data, or default emission factors (e.g., those provided by IPCC guidance (IPCC, 2015).

Total emissions can be reported at the BASIC or BASIC+ levels. The BASIC level covers scope 1 and scope 2 emissions from stationary energy and transport, as well as scope 1 and scope 3 emissions from waste. BASIC+ additionally includes emissions from IPPU and AFOLU and transboundary transport. This inventory reports at the BASIC+ level since emissions were calculated for all the sectors required by BASIC+. The City Inventory Reporting and Information System (CIRIS) (v2.0) (C40, 2017b) was used in the compilation of this inventory.

1.3 Structure of the report

The aggregated emissions of all sectors are presented in Chapter 2. The trends of emissions between 2009 and 2015 are analysed. Improvements made since the previous inventory are also discussed.

Chapters 3 to 7 cover emissions from five sectors: stationary energy; transport; waste; industrial processes and product use (IPPU); agriculture, forestry, and other land use (AFOLU). They include a description of GHG-relevant activities in Auckland, the GPC approach to calculate emissions, sources of activity data and emission factors. Appendix shows emission factors used in the CIRIS.

2 Total Emissions and Trends

This Chapter summarises total emissions from all sectors together with their emissions profiles. The trends in emissions from 2009 to 2015 were discussed. Improvements on the previous inventory and for future inventory were also included in this chapter.

2.1 Total emissions

In 2015, Auckland's net GHG emissions were 10,267 kt CO_2e (including carbon sequestration from forestry, see Table 2-1). Table 2-2 illustrates the emission sources covered and reported by the GPC. Additional scope 1 sources required for territorial reporting are not included BASIC/BASIC+ totals.

Table 2-1 GHG emissions summary for 2015

GHG Emissions Source (By Sector)		Total GHGs (metric tonnes CO2e)				
		Scope 1	Scope 2	Scope 3	BASIC	BASIC+
STATIONARY ENERGY	Energy use (all emissions except I.4.4)	2,175,827	1,088,410	73,437	3,264,237	3,337,674
	Energy generation supplied to the grid (I.4.4)	519,170				
TRANSPORTATION	(all II emissions)	4,106,337	1,201	378,111	4,107,538	4,485,649
WASTE	Waste generated in the city (III.X.1 and III.X.2)	251,987		126,518	378,506	378,506
	Waste generated outside city (III.X.3)					
IPPU	(all IV emissions)	2,387,295				2,387,295
AFOLU	(all V emissions)	-322,567				-322,567
OTHER SCOPE 3	(all VI emissions)					
TOTAL		9,118,050	1,089,611	578,066	7,750,281	10,266,557

The agriculture, forestry and other land use (AFOLU) contributes a negative value, indicating a removal and not an emission. AFOLU is the sum of the agriculture sub-sector and the Land Use, Land Use Change and Forestry (LULUCF) sector.

While this is not a requirement of the GPC, gross emissions were reported in this inventory since Auckland's reduction targets were set relative to 1990 gross emissions (Arup, 2014). To be consistent with New Zealand's Greenhouse Gas Inventory (MfE, 2017a), Auckland's gross emissions exclude the contribution from the LULUCF sector (i.e., the Land and the harvested wood products (HWP) sub-sectors (see Chapter 7)).

Table 2-2 Emission sources covered and reported by the GPC (WRI et al., 2014)

Source	Report
	Sources required for BASIC reporting
+	Sources required for BASIC+ reporting
	Additional scope 1 sources required for territorial reporting
	Other scope 3 sources
	Non-applicable emission sources

Of gross emissions for 2015 (11,309 kt CO_2e), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) contributed 83.1 per cent, 10.5 per cent , 1.7 per cent , 4.6 per cent , <0.1 per cent and 0.1 per cent of gross emissions, respectively (Figure 2-1). The contribution from five sectors was stationary energy 29.5 per cent, transport 39.7 per cent, waste 3.3 per cent, industrial processes and product use 21.1 per cent, and agriculture, forestry and other land use 6.4 per cent. Transport and stationary energy are the dominant sectors, accounting for 69.2 per cent of gross emissions (Figure 2-2).

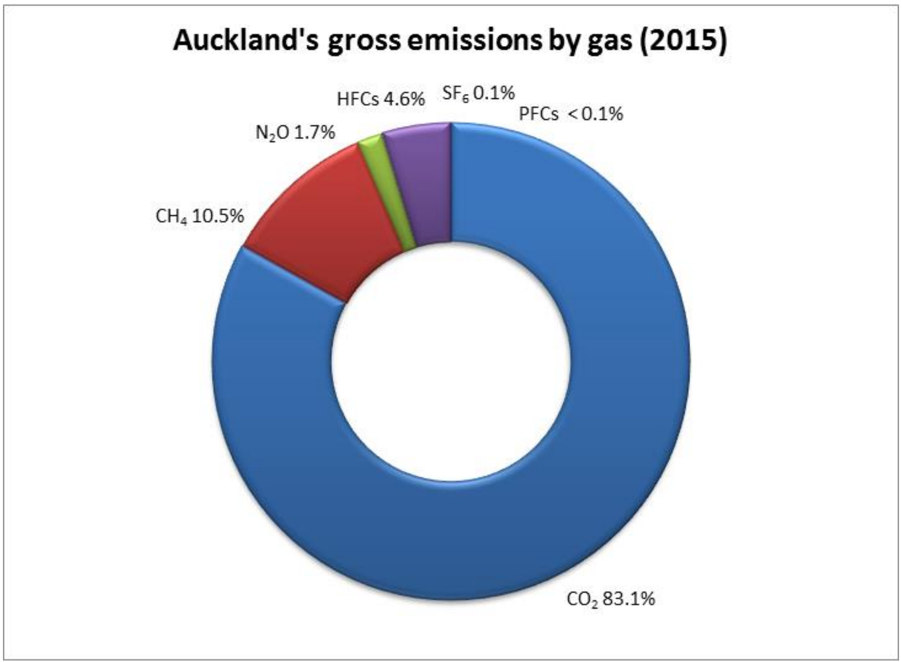

Figure 2-1 Auckland's GHG gross emissions by gas for 2015

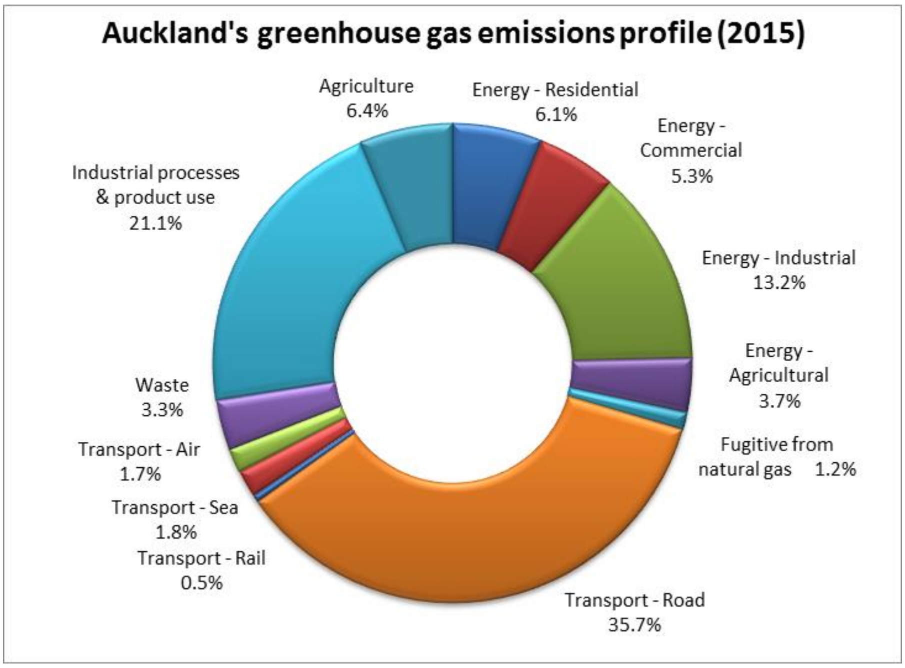

Figure 2-2 Auckland’s GHG gross emissions by sector and sub-sector for 2015

2.2 Emissions by sector and sub-sector

Table 2-3 and Figure 2-3 summarise the emissions by sector and sub-sector for 2015. Chapters 3 to 7 provide a description of relevant GHG activities in Auckland, the GPC approach to calculate the emissions, the sources of activity data and emission factors.

Table 2-3 GHG emissions by sector and sub-sector for 2015*

GPC ref No.	GHG Emissions Source (By Sector and Sub-sector)	Total GHGs (metric tonnes CO_2e)			
		Scope 1	Scope 2	Scope 3	Total
I	STATIONARY ENERGY				
I.1	Residential buildings	255,495	402,126	27,132	684,753
I.2	Commercial and institutional buildings and facilities	475,895	120,638	8,140	604,672
I.3	Manufacturing industries and construction	1,018,480	446,495	30,126	1,495,101
I.4.1/2/3	Energy industries	IE	IE	IE	
I.4.4	Energy generation supplied to the grid	519,170			
I.5	Agriculture, forestry and fishing activities	291,337	119,150	8,039	418,527
I.6	Non-specified sources	NO	NO	NO	
I.7	Fugitive emissions from mining, processing, storage, and transportation of coal	NO			
I.8	Fugitive emissions from oil and natural gas systems	134,620			134,620
SUB-TOTAL	(city induced framework only)	2,175,827	1,088,410	73,437	3,337,674
II	TRANSPORTATION				
II.1	On-road transportation	4,033,592	NO	IE	4,033,592
II.2	Railways	55,153	1,201	81	56,435
II.3	Waterborne navigation	17,592	IE	187,895	205,487
II.4	Aviation	IE	IE	190,135	190,135
II.5	Off-road transportation	IE	NO	IE	
SUB-TOTAL	(city induced framework only)	4,106,337	1,201	378,111	4,485,649
III	WASTE				
III.1.1/2	Solid waste generated in the city	245,261		126,518	371,779
III.2.1/2	Biological waste generated in the city	NO		NO	
III.3.1/2	Incinerated and burned waste generated in the city	NO		NO	
III.4.1/2	Wastewater generated in the city	6,726		NO	6,726
III.1.3	Solid waste generated outside the city	NO			
III.2.3	Biological waste generated outside the city	NO			
III.3.3	Incinerated and burned waste generated outside city	NO			
III.4.3	Wastewater generated outside the city	NO			
SUB-TOTAL	(city induced framework only)	251,987		126,518	378,506
IV	INDUSTRIAL PROCESSES and PRODUCT USES				
IV.1	Emissions from industrial processes occurring in the city boundary	1,826,430			1,826,430
IV.2	Emissions from product use occurring within the city boundary	560,865			560,865
SUB-TOTAL	(city induced framework only)	2,387,295			2,387,295
V	AGRICULTURE, FORESTRY and OTHER LAND USE				
V.1	Emissions from livestock	587,187			587,187
V.2	Emissions from land	-1,149,650			-1,149,650
V.3	Emissions from aggregate sources and non-CO2 emission sources on land	239,896			239,896
SUB-TOTAL	(city induced framework only)	-322,567			-322,567
VI	OTHER SCOPE 3				
VI.1	Other Scope 3			NE	
TOTAL	(city induced framework only)	8,598,880	1,089,611	578,066	10,266,557

* See Table 2-2 for the meaning of the colours of cells.

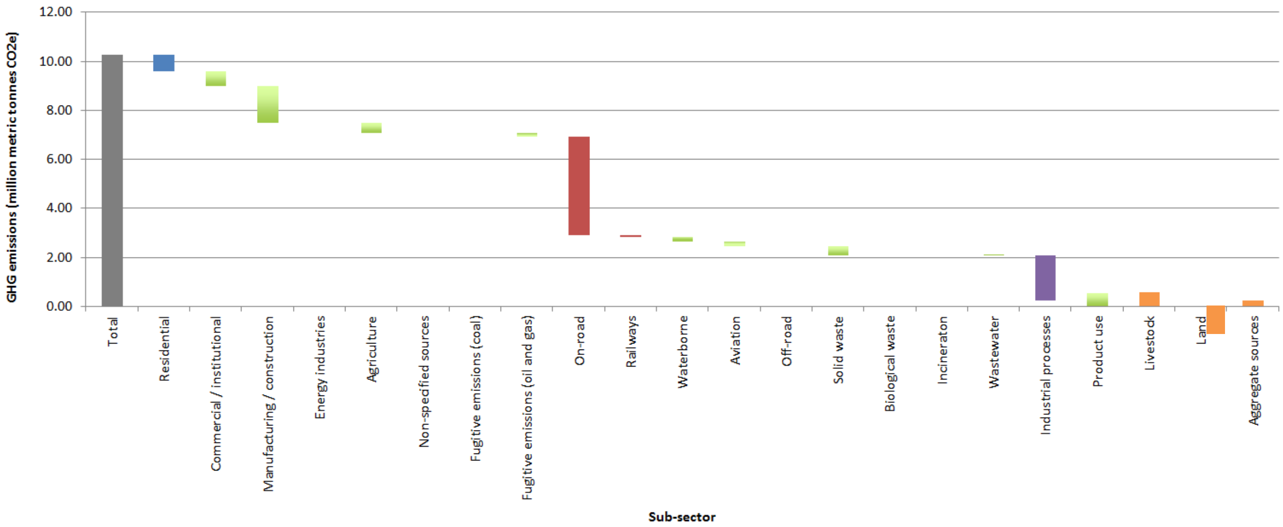

Figure 2-3 Auckland's GHG emissions by sector and sub-sector for 2015

2.3 Trends

Between 2014 and 2015, Auckland's GHG emissions have increased by 411 kt CO_2e or 3.8 per cent for gross emissions and by 148 kt CO_2e or 1.5 per cent for net emissions (Figures 2-4 and 2-5). Emissions were higher from transport, waste, IPPU and agriculture sectors in 2015 than in 2014. Emissions were stable from stationary energy. There were additional 263 kt CO_2e sequestered from LULUCF (mainly forestry) in 2015 than in 2014.

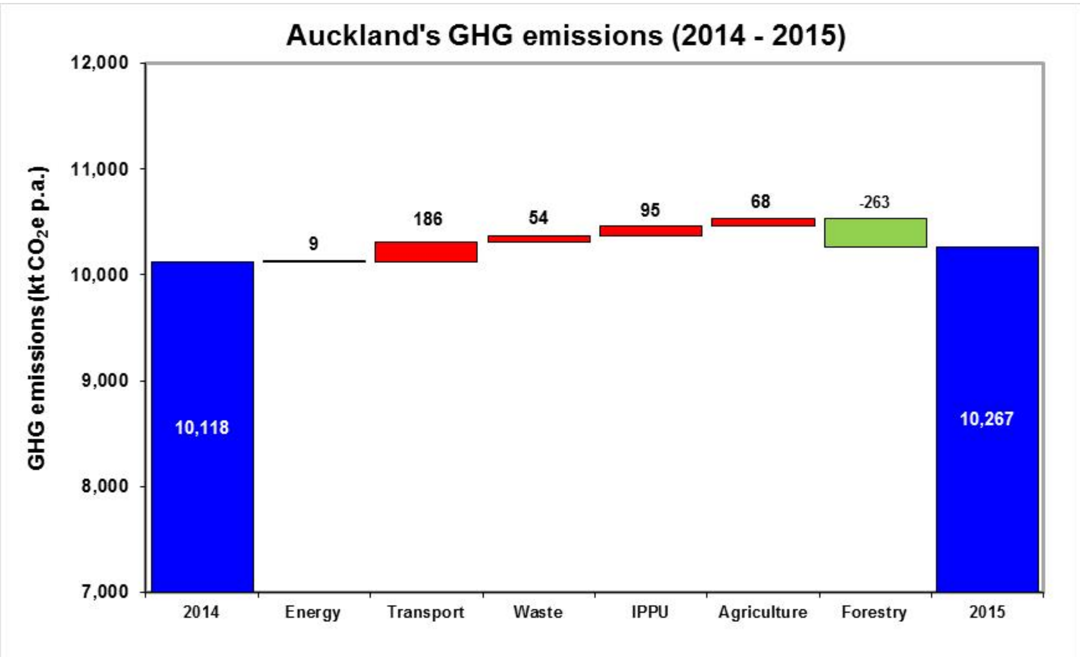

Figure 2-4 Auckland's GHG emissions for 2014 to 2015

Between 2009 and 2015, gross emissions have increased by 748 kt CO_2e or 7.1 per cent and net emissions have increased by 214 kt CO_2e or 2.1 per cent mainly due to increased emissions from IPPU and transport (Figures 2-5 and 2-7). Emissions in 2015 were higher from IPPU (429 kt CO_2e), transport (285 kt CO_2e), waste (96 kt CO_2e), agriculture (61 kt CO_2e) than in 2009. Emissions in 2015 were lower from stationary energy than in 2009 by 124 kt CO_2e. Forestry sequestered an additional 535 kt CO_2e in 2015 compared with 2009. In the AFOLU sector, carbon sequestration from forestry has been increased while emissions from agriculture (difference between emissions from AFOLU and from LULUCF) have remained stable (Figure 2-6). In 2012, there was lower than normal rainfall which led to lower hydro generation and an increase in gas and coal generation (MBIE, 2017a). This resulted in the highest emissions from stationary energy, and the highest gross and net emissions in 2012 (Figure 2-5).

Between 1990 and 2009, emissions have increased for stationary energy, transport and IPPU, and decreased for waste and agriculture (Figures 2-5, 2-6 and 2-7). The amount of carbon sequestered from forestry has decreased from 1,339 to 508 kt CO_2e.

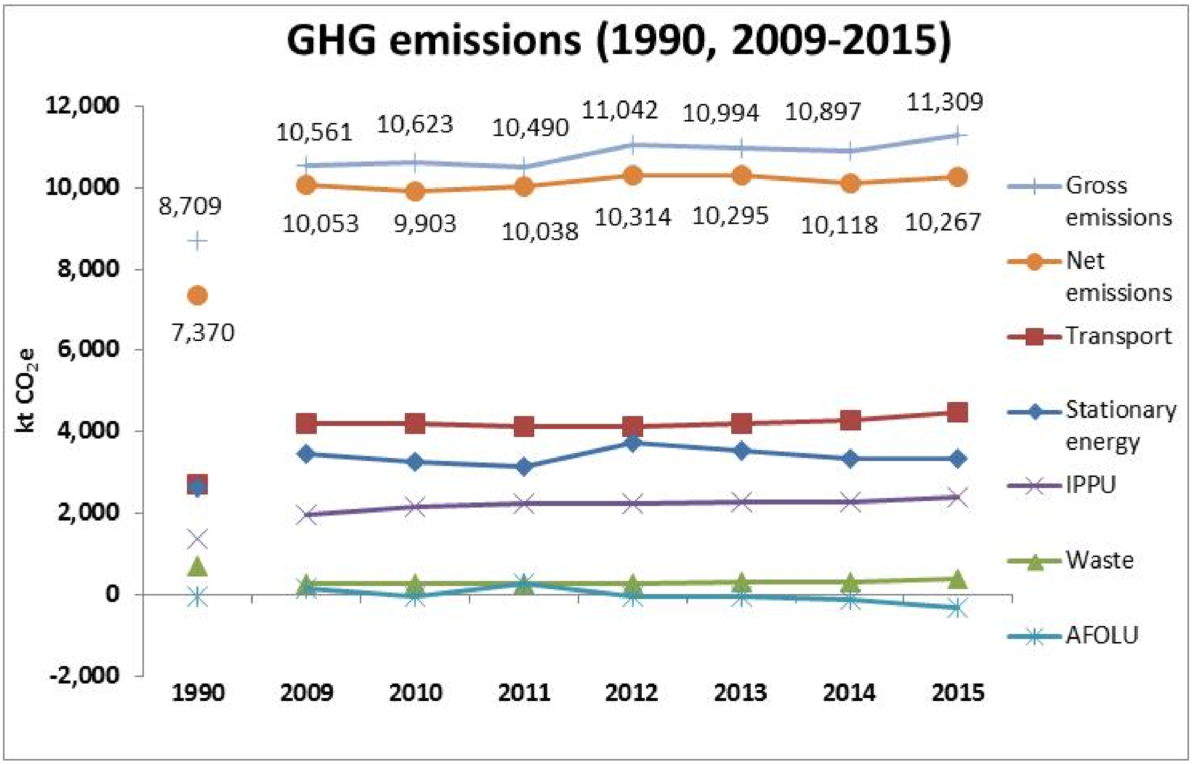

Figure 2-5 Auckland's GHG emissions for 1990, 2009 to 2015

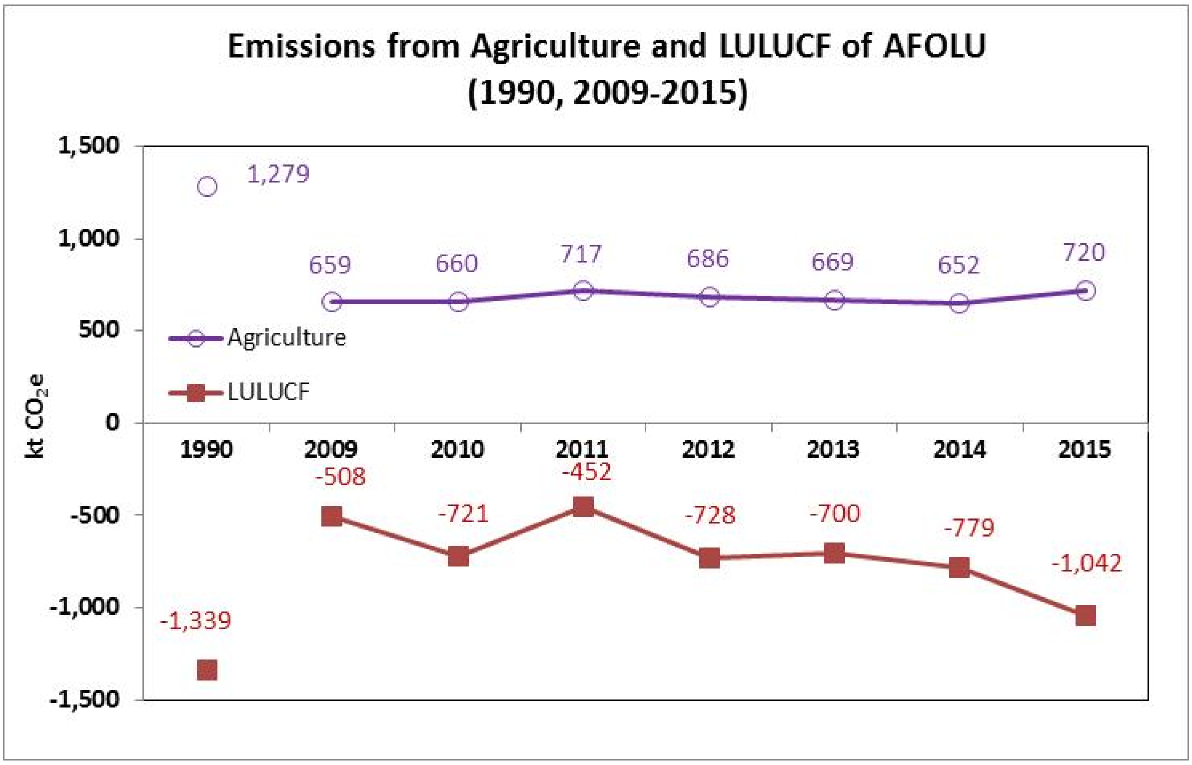

Figure 2-6 Emissions from agriculture and LULUCF of the AFOLU sector for 1990, 2009 to 2015

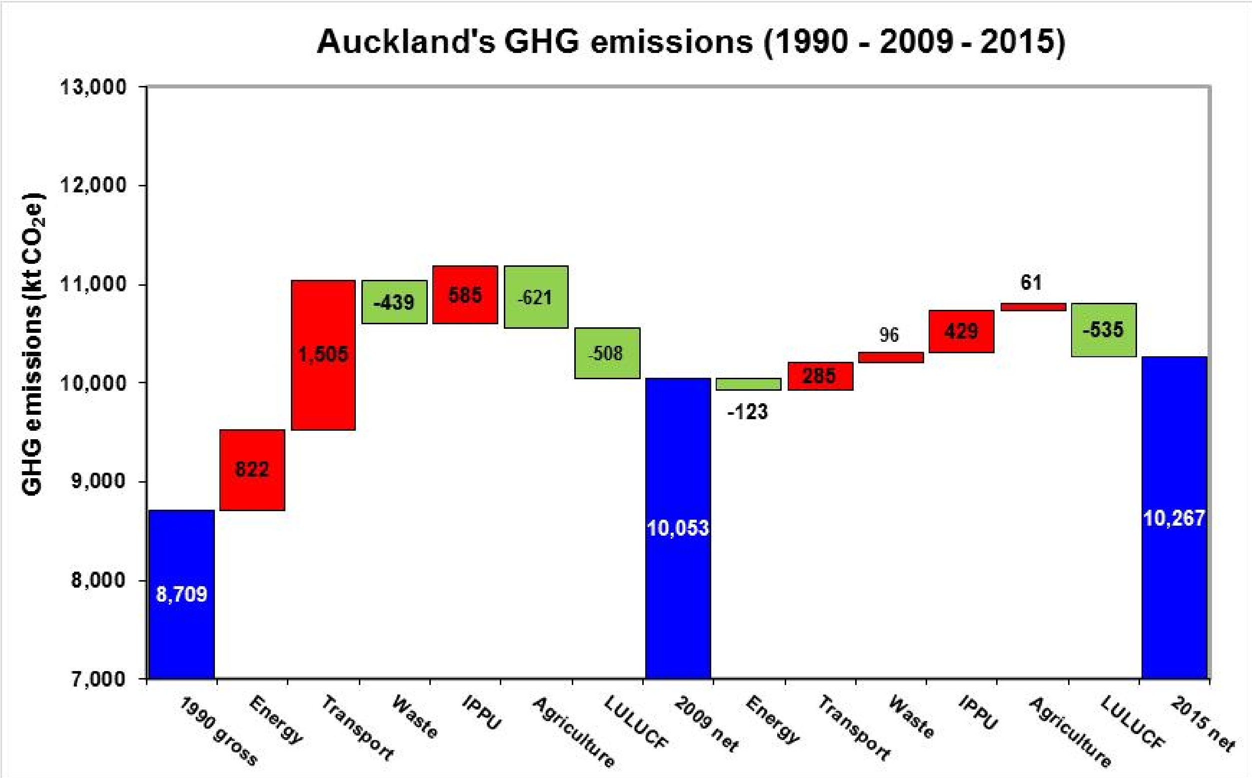

Figure 2-7 Auckland's GHG emissions for 1990, 2009 to 2015

Observed emissions for 1990, 2009-2015 and emissions targets for 2020, 2040 and 2050 are illustrated in Figure 2-8. At 2015 emissions levels, Auckland will need to reduce its net emissions by 23.7 per cent to 32.1 per cent (2,428 kt CO_2e to 3,299 kt CO_2e) by 2020, 49.1 per cent by 2040 (5,041 kt CO_2e) and 57.6 per cent by 2050 (5,921 kt CO_2e), to meet its emissions targets. Auckland must transform from a fossil fuel-dependent, high energy-using, high-waste society to a mobile, quality, compact city – a city typified by sustainable resource use and a prosperous eco-economy, and powered by efficient, affordable clean energy. The successful implementation of the Low Carbon Action Plan is critical for the transformation (Auckland Council, 2014).

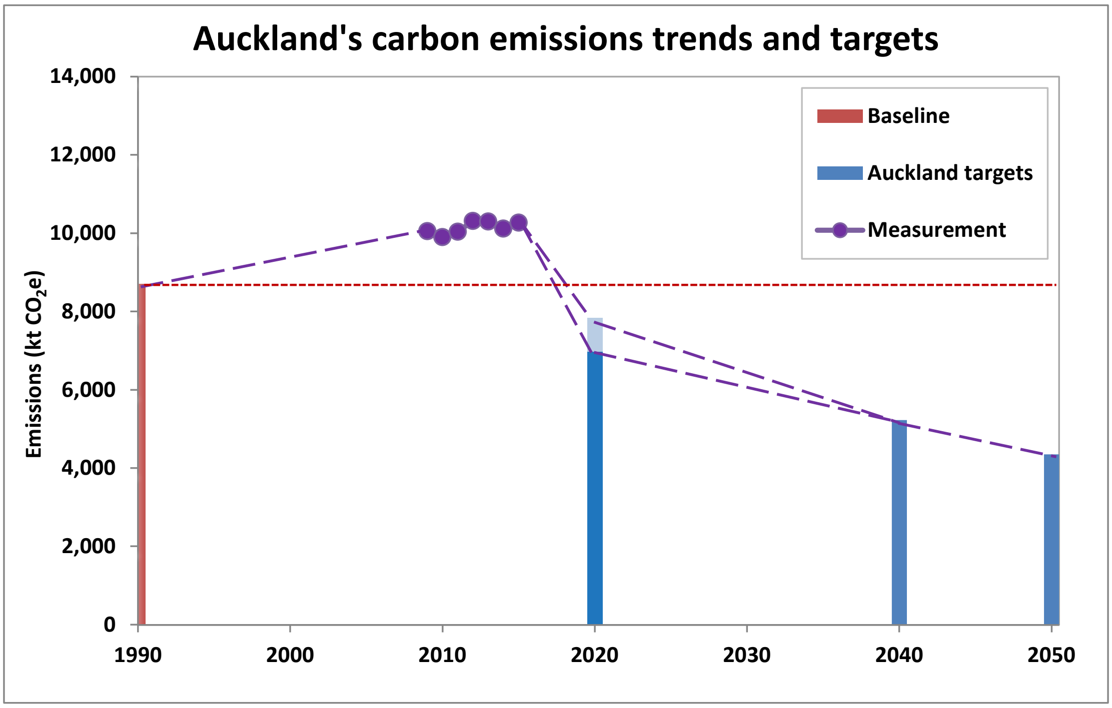

Figure 2-8 Auckland's GHG emissions trends and reduction targets. Targets shown are reductions of 10 to 20 per cent, 40 per cent and 50 per cent of 1990 gross emissions for 2020, 2040 and 2050, respectively.

Increased population and economic activities generally result in increased emissions. Trends of emissions per capita or per unit GDP are useful indicators for tracking progress of climate actions. From 2009 to 2015, Auckland's population increased from 1.4 million to 1.6 million and GDP increased from $NZ 69.8 billion to $NZ 81.0 billon (2009/2010 prices), except for GDP in 2010 when it was the lowest due to the impact of the global financial crisis (StatsNZ, 2017; Infometrics, 2017). Comparisons of population, GDP and GHG emissions from 2009 to 2015 are shown in Figure 2-9. The emission intensity by population and GDP is shown in Figure 2-10. In 2015, net emissions were 6.5 t CO_2e per capita and 127 t CO_2e per million $NZ GDP while gross emissions were 7.2 t CO_2e per capita and 140 t CO_2e per million $NZ GDP. These values have generally decreased since 2012, and this shows that Auckland decouples emissions from population and economic growth. Gross and net emissions per capita for 1990 were higher than those for 2009. For 1990, the GDP data is not available, therefore, emissions per unit GDP is not calculated.

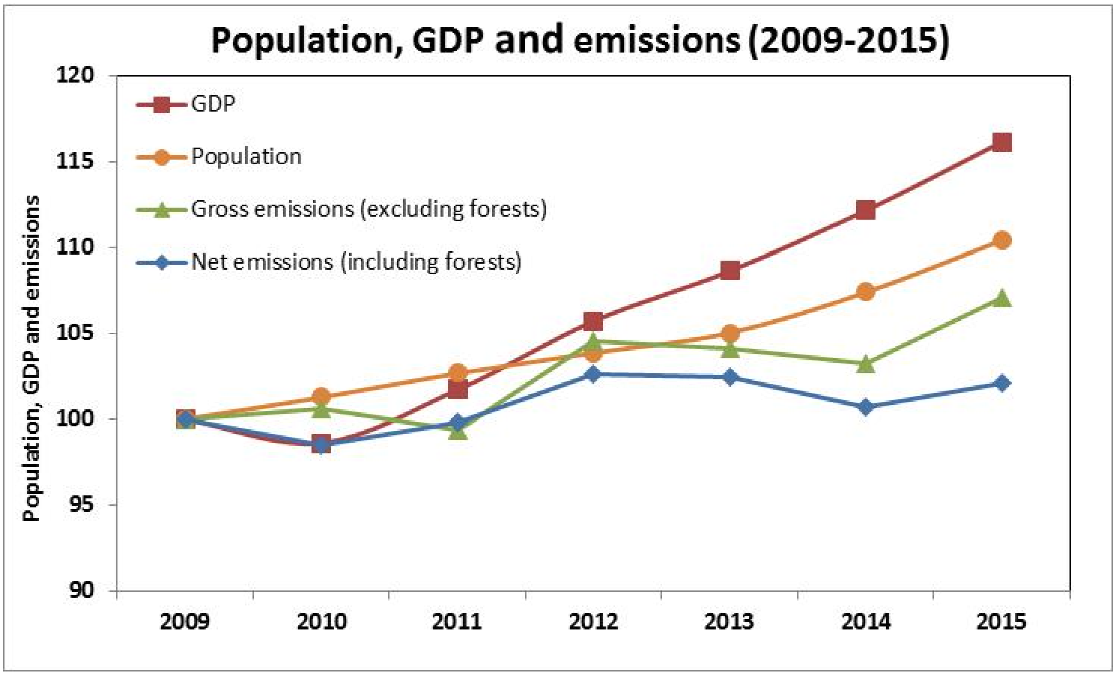

Figure 2-9 Auckland's population, GDP and GHG emissions from 2009 to 2015. Values in 2009 are set to 100 for comparison.

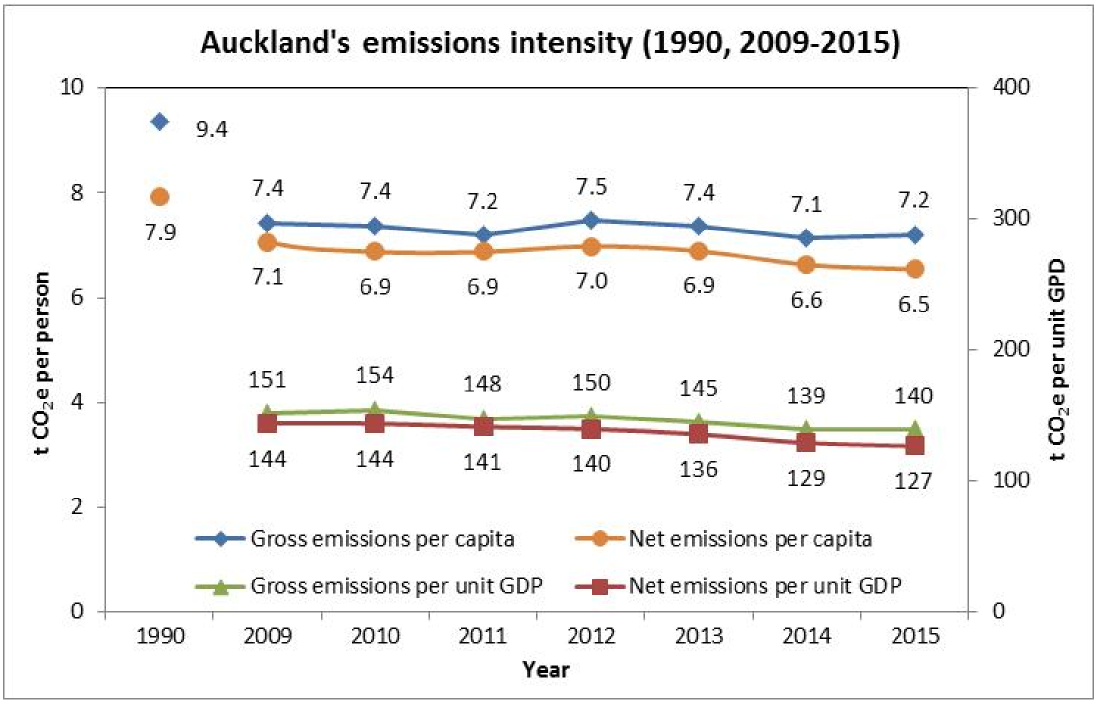

Figure 2-10 Auckland's emissions intensity for 1990, 2009 to 2015

Overall, increased emissions from transport and IPPU are major contributors to higher emissions in 2015 than those in 2009 and 2014. Auckland decouples emissions from population and economic growth.

2.4 Comparison of emissions for 1990, 2009 to 2014

Improvements in activity data, emission factors and methodology have been made in this inventory. It is international good practice to recalculate the previous estimates to ensure consistency in emission estimates and trends (MfE, 2017a). This means emissions reported in this inventory differ from those reported for a given year in the previous inventories. Figure 2-11 shows gross and net emissions reported by this inventory and by the previous inventory (Xie, 2016). Both inventories show a very similar trend. However, this inventory reports lower emissions due to improved estimates for stationary energy, transport and waste sectors. Firstly, electricity supplied by Vector Ltd is sourced from the annual reports (Vector Ltd, 2017) as compared to the data from the asset management used in the previous inventory. Secondly, a lower proportion of emissions from navigation and aviation are allocated to Auckland with export data from Infometrics Ltd (2017) and better passenger data at Auckland airport from Statistics New Zealand (StatsNZ, 2017), respectively. Thirdly, emissions from landfilled solid waste and wastewater treatment are calculated with Auckland emission factors, instead of NZ averages in the previous inventory. Further improvements in activity data for solid waste disposal, shipping, coal, LPG and biomass consumption are recommended for future inventories.

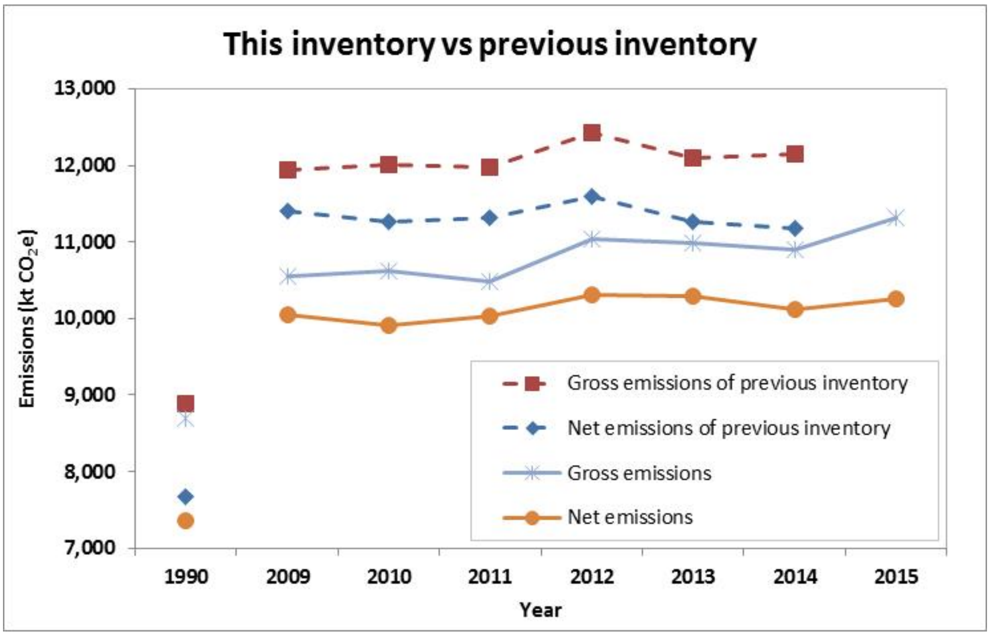

Figure 2-11 Comparison of GHG emissions for 1990, 2009 to 2014 (this inventory vs the previous inventory)

3 Stationary Energy

Emissions from stationary energy come from energy consumption in buildings (e.g., natural gas for cooking at homes, electricity for heating at offices) and from non-mobile equipment and machinery, as well as fugitive emissions released in the process of generating, delivering, and consuming useful forms of energy (such as electricity or gas). These emissions are split into the following sub-sectors: residential buildings; commercial and institutional buildings and facilities; manufacturing industries and construction; and agriculture, forestry and fishing activities.

Scope 1 emissions are all direct emissions from burning fuel (oil, gas, liquefied petroleum gas (LPG), wood and coal) within the Auckland region. Scope 2 emissions are those associated with consumption of grid-supplied electricity which is generated within or outside Auckland. Scope 3 emissions are those due to distribution losses from grid-supplied electricity and gas. GHGs in this sector include CO_2, CH_4 and N_2O.

Emissions from gas use at Otahuhu and Southdown power stations were allocated into the energy industries sub-sector since generated electricity was supplied to national electric grids. Allocation of electricity consumption into sub-sectors (residential buildings; commercial and institutional buildings and facilities; manufacturing industries and construction; and agriculture, forestry and fishing activities) was based on Vector Ltd data (Vector Ltd, 2017). The emissions from other energy consumption were allocated into sub-sectors based on the EECA energy end use database (EECA, 2017).

3.1 Emissions from stationary energy

Emissions from stationary energy and their scope categorisation are summarised in Table 2-3 and Figure 2-3. Total emissions were 3,338 kt CO_2e, with 44.8 per cent from manufacturing industries and construction, 20.5 per cent from residential buildings; 18.1 per cent from commercial and institutional buildings and facilities; 12.5 per cent from agriculture, forestry and fishing activities; and 4.0 per cent from fugitive emissions (Figure 3.1). Total emissions were due to consumption of electricity (35.7 per cent) and natural gas (34.5 per cent); the use of diesel, petrol and fuel oil (21.0 per cent), LPG (3.6 per cent) and coal and wood (5.1 per cent) (Figure 3.2).

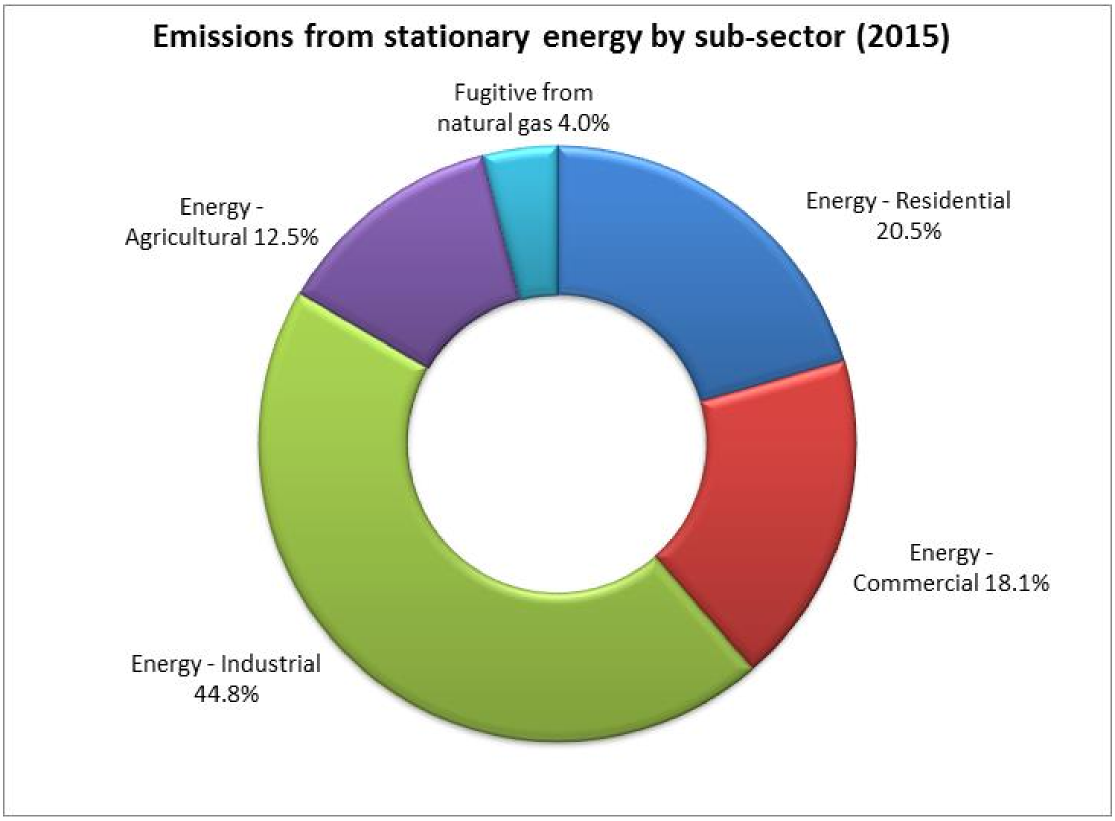

Figure 3-1 Emissions from stationary energy by sub-sector for 2015

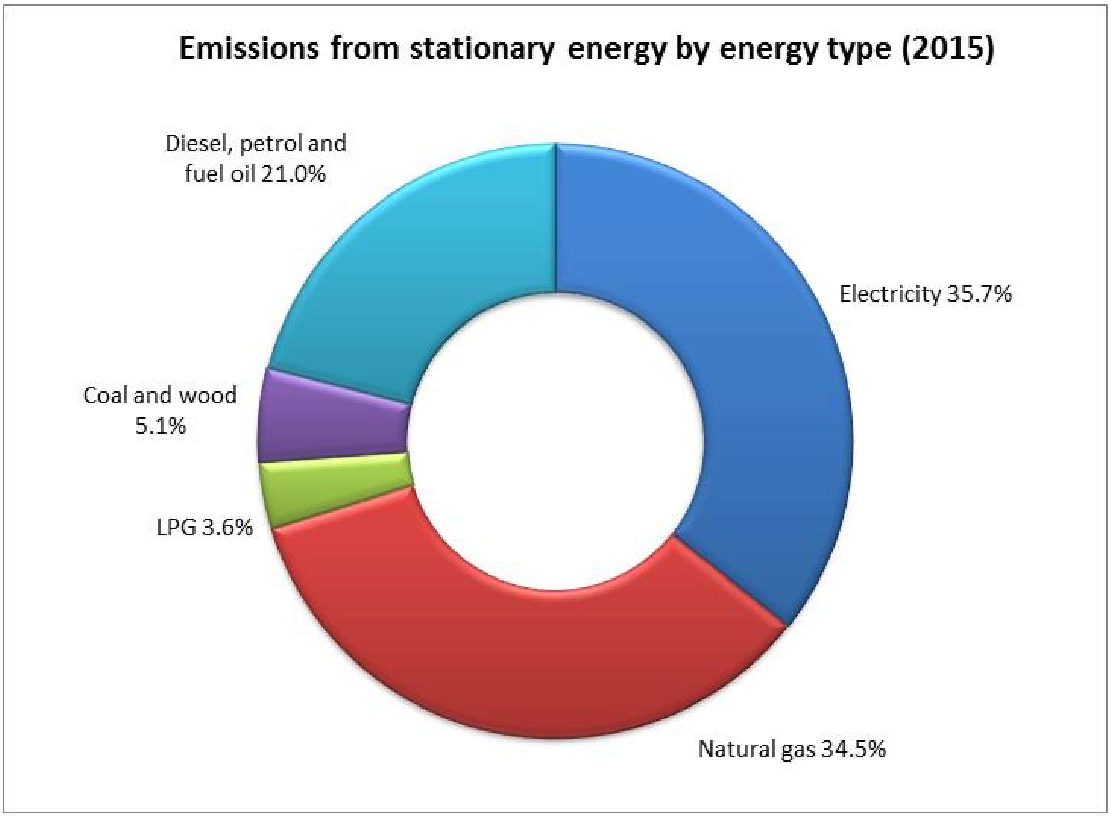

Figure 3-2 Emissions from stationary energy by energy type for 2015

3.2 Scope 1: emissions from fuel combustion

Scope 1 emissions are calculated based on consumption data for each of the fuel types used in Auckland (natural gas, coal, petrol, diesel, fuel oil and wood).

The total amount of natural gas consumption in Auckland for 2009-2015 was sourced from Energy in New Zealand (MBIE, 2017a). The amount of natural gas consumed to generate electricity by the power plants was subtracted from the total, as generated electricity was supplied to national electric grids. The natural gas use in 1990 was calculated from the national consumption in 1990 using the historical (2009-2015) average amount of natural gas used in Auckland vs the total New Zealand consumption (an average ratio of 0.27 with a range between 0.22 to 0.30). Fugitive emissions were those from the distribution of natural gas. National emission factors were used (MBIE, 2017b).

Non-transport consumption of LPG in Auckland was sourced from the EECA's database (EECA, 2017) for 2012. The activity data for other years was estimated by the national data and the ratio of Auckland consumption to national consumption in 2012. National emission factors were used (MBIE, 2017b).

Consumption of coal in 2009 was sourced from a previous inventory (Arup, 2014). The ratio of Auckland use to national total in 2009 was used to calculate consumption for other years. Consumption of wood in 2012 was sourced from the EECA database (EECA, 2017) and was assumed unchanged for other years since emissions are small (29.6 ktCO_2e p.a.). CO_2 emissions from wood burning were reported as biogenic, which were not included in total emissions. National emission factors for coal and wood were used (MBIE, 2017b).

Fuel oil consumption for non-transport use in 2012 was sourced from EECA (2017). The data for other years was calculated from the national data and the ratio of the Auckland use to the national data in 2012. National emission factors were applied (MfE, 2017b). As discussed in Section 4.6, emissions from petrol and diesel use for off-road transport were reported under Stationary Energy.

Emissions from combustion of gas from landfills and waste treatment plants are minor and are not reported in this inventory. CH_4 from landfill and waste treatment plants not captured or combusted was estimated in the Waste sector (Chapter 5).

3.3 Scope 2: emissions from consumption of grid-supplied electricity

The GPC covers emissions from consumption of grid-supplied electricity, steam, heating and cooling in the city under Scope 2. As there is no grid supply of heat or cooling from outside Auckland, only emissions associated with grid-supplied electricity are reported.

Electricity consumption for 2009-2015 was sourced from various organisations (Vector Ltd, 2017; Counties Power Ltd, 2017; NZEA (New Zealand Electricity Authority), 2017; Auckland Transport, 2017). The data for 1990 was estimated as a proportion of national consumption. National average emission factors were used (MBIE, 2017b). Electric trains went into service from 2014. Emissions from electricity consumption were reported under Transport.

3.4 Scope 3: distribution losses from grid-supplied electricity

Scope 3 emissions include transmission and distribution losses from the use of grid-supplied electricity. The grid loss factor for the calculation was sourced from the national data (MBIE, 2017a; 2017b).

4 Transport

Emissions from transport come from directly combusting fuel or indirectly consuming grid-delivered electricity to transport vehicles and mobile equipment or machinery. For transport occurring within the Auckland region, emissions from combustion of fuels are reported in scope 1 and emissions from grid-supplied electricity are included in scope 2. Scope 3 reports the emissions from a portion of transboundary journeys occurring outside the Auckland region, and transmission and distribution losses from grid-supplied electricity. The emissions are calculated for on-road vehicles, railways, water transport, aviation and off-road transport, respectively. The gases reported in this sector are CO_2, CH_4 and N_2O.

4.1 Emissions from transport

Emissions from transport and their scope categorisation are summarised in Table 2-3 and Figure 2-3. On-road transport accounted for 89.8 per cent of the total 4,485 kt CO_2e emissions from transport. Contributions from other sources were 4.2 per cent from aviation, 4.2 per cent from shipping, and 1.8 per cent from train, ferry and LPG.

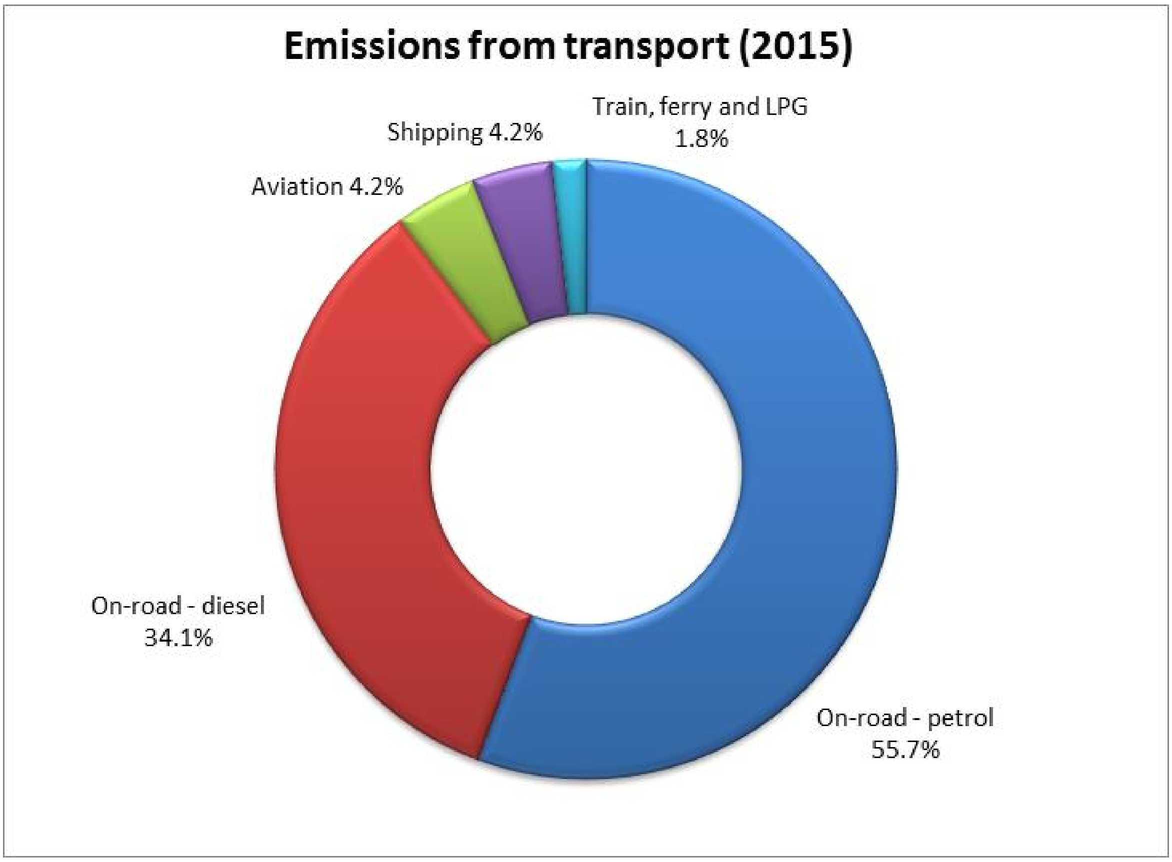

Figure 3-1 Emissions from transport for 2015

4.2 On-road transport

Petrol and diesel sales for land transport were provided by Auckland Transport. The data was used to calculate emissions from on-road transport. National emission factors were applied (MfE, 2017a; 2017b). The results are included in Scope 1 emissions.

EECA (2017) reported the LPG use data for transport in Auckland in 2012. The data for other years was calculated as a proportion of the national total which was sourced from MBIE (2017a). National emission factors were applied (MBIE, 2017b).

4.3 Railways

Diesel use for rail was estimated for passenger and freight trains. Diesel use by passenger trains from 2010 to 2015 was sourced from Auckland Transport. The 2010 data was used as an estimate for 2009 and 1990. Total diesel consumption for rail in Auckland in 2012 was sourced from EECA (EECA, 2017) and used for other years. Diesel use by freight trains was calculated as the difference between total diesel use and diesel use for passenger trains. Emissions were included in Scope 1. As discussed in Section 3.3, electric trains went into service from 2014. Emissions from electricity consumption were reported in Scope 2.

4.4 Water transport

The total amount of fuel oil refuelling to ships in Auckland was provided by Auckland Transport from 2012 to 2015. The ratio of Auckland consumption to the national data averaged for 2012-2015 was used to estimate consumption for other years (1990, 2009-2011).

The fuel oil used by ferries in 2006 and 2010 was sourced from Peeters (2011) (Scope 1). The 2010 data was used for 2009 to 2015. The ratio of Auckland consumption to the national data for 2006 was used to estimate consumption for 1990.

Emissions from shipping at sea ports in Auckland were categorised as Scope 3 emissions. Fuel consumption was calculated as the difference between the total and ferry consumption. The national emission factors were applied (MBIE, 2017a; 2017b). The proportion of export values from Auckland to New Zealand (Infometrics Ltd, 2017) was applied to portion emissions attributable to Auckland.

4.5 Aviation

Aviation activities in Auckland are dominated by domestic and international flights at Auckland Airport. Others activities include local helicopter, light aircraft, sightseeing and training flights. Scope 1 emissions are those from the jet fuel use for aviation activities occurring within the city boundary. It is considered that the Scope 1 emissions in Auckland are insignificant, therefore not included. Emissions from grid-supplied energy consumed by aircraft charging at airports were included in Scope 2 of Stationary Energy (Chapter 3). Scope 3 emissions are those from departing flights at airports that serve the city (WRI et al., 2014).

Consumption of aviation fuel at Auckland Airport was provided by the Joint User Hydrant Installation (JUHI) Depot at Auckland Airport for 2009-2014. Consumption for other years was estimated as a proportion of the national total which was sourced from MBIE (2017a). The non-Auckland-Airport use was calculated as the difference between total consumption and the use at Auckland Airport. National emission factors were applied (MBIE, 2017a; 2017b).

The proportion of emissions (scope 3) from the aviation fuel use at Auckland Airport attributable to Auckland was calculated based on the proportion of departure passengers who were Auckland residents. Data of international and domestic departures were obtained from Statistics New Zealand (StatsNZ, 2017) and Auckland Airport (2017). It was assumed that 10% of non-Auckland-Airport emissions were attributed to Auckland.

4.6 Off-road transport

Off-road consumption of diesel and petrol was calculated as the difference between total consumption and the use for on-road transport and railways. The petrol and diesel delivered to Auckland from 2010-2015 were sourced from MBIE (2017a). The data was used as total consumption in Auckland. The averaged off-road use for 2010-2015 (as a percentage of on-road transport consumption) was used to calculate total consumption in 1990 and 2009. National emission factors were used (MBIE, 2017a; 2017b). These Scope 1 emissions are reported under Stationary Energy (Chapter 3) allocated to four sub-sectors (residential buildings; commercial and institutional buildings and facilities; manufacturing industries and construction; and agriculture, forestry and fishing activities) based on the EECA database (EECA, 2017).

5 Waste

The waste sector covers emissions generated from the processing and disposal of solid waste and wastewater treatment. Emissions from activities in this sector are predominantly methane (CH_4), with smaller contributions from N_2O and CO_2. Emissions from waste treated inside Auckland are reported in Scope 1 and emissions from waste generated in Auckland but treated outside Auckland are included in Scope 3. Emissions from the use of grid-supplied electricity in waste treatment facilities within Auckland are reported in Scope 2 in Stationary Energy (Chapter 3).

5.1 Emissions from waste

Emissions from waste and their scope categorisation are summarised in Table 2-3 and Figure 2-3. The waste sector emitted 372 kt CO_2e, 98.2 per cent of which is from solid waste sources and the remaining 1.8 per cent is from waste water treatment.

5.2 Solid waste

The total amount of solid waste and its composition generated within Auckland sent to landfills were sourced from various reports (Auckland Regional Council, 2010; Auckland Council, 2011; Arup, 2014) and from the council's recent surveys. Equations to estimate emissions from landfills (MfE, 2017b) are derived from the IPCC 2006 “tier 1” methodology (IPCC, 2015) and allow all the potential emissions to be accounted for in the year of disposal. Of five landfills receiving Auckland's waste, the methane recovery rate was assigned as 0 per cent for Claris (without a landfill gas collection system); and 75 per cent for Puwera, Redvale, Whitford and Hampton (well equipped with gas capture facilities (DEFRA, 2014)). Emissions from waste sent to landfills in Auckland were reported in Scope 1. Emissions from waste generated in Auckland but treated outside Auckland were reported in Scope 3.

5.3 Wastewater treatment

Watercare Services Ltd is the water and wastewater service provider for Auckland. Auckland's wastewater is transported through a public wastewater network to wastewater treatment plants. The majority of Auckland's wastewater is treated at Mangere or Rosedale treatment plant. Emissions from wastewater generated and treated in Auckland were sourced from Watercare Services Ltd's GHG inventory, consisting of process emissions from wastewater treatment and fugitive emissions from the wastewater network (Watercare Services Ltd, 2017). These were categorised as Scope 1 emissions. CO2 emissions from biogas combustion for electricity generation were reported as biogenic and were not included in total emissions.

6 Industrial Processes and Product Use (IPPU)

Emissions from non-energy related industrial activities and product use are assessed and reported in the IPPU sector. Emissions for Auckland are estimated by assessing which emissions from New Zealand's Greenhouse Gas Inventory come from Auckland. Emissions (CO_2, N_2O, HFCs, PFCs and SF_6) were reported in Scope 1.

6.1 Emissions from IPPU

Emissions from IPPU and their scope categorisation are summarised in Table 2-3 and Figure 2.3. Almost all the emissions come from Industrial Processes (1,826 kt CO_2e, 76.5 per cent). Industrial Product Use contributes 561 kt CO_2e (23.5 per cent).

6.2 Industrial processes

Carbon dioxide (CO_2) is emitted from two distinct industrial processes in Auckland. These are production of steel from iron sand and from scrap steel, and use of soda ash and limestone in glass making. In New Zealand, all the iron and steel production and most of the glass production are located in Auckland. Their emissions were sourced from New Zealand's Greenhouse Gas Inventory (MfE, 2017a) which reported emissions from glass production in the category of "Other process uses of carbonates" to aggregate the data with other sources and preserve confidentiality. This inventory reported all the emissions from the iron and steel production, and 90% of the emissions from "Other process uses of carbonates". It is considered that 90% of glass production in New Zealand is manufactured in Auckland.

6.3 Industrial product use

Emissions in the categories of "Non-energy products from fuels and solvent use", "Product uses as substitutes for ODS (ozone depleting substances)" and "Other product manufacture and use" from the New Zealand's Greenhouse Gas Inventory (MfE, 2017a) were allocated to Auckland on a population basis. GHGs of CO_2, N_2O, HFCs, PFCs and SF_6 were reported.

7 Agriculture, Forestry and Other Land Use (AFOLU)

AFOLU activities are divided into three categories: livestock, land, and aggregate sources and non-CO_2 emissions sources on land. GHGs from AFOLU consist of CH_4, N_2O and CO_2, and are reported as Scope 1 emissions.

7.1 Emissions from AFOLU

Emissions from AFOLU and their scope categorisation are summarised in Table 2-3 and Figure 2-3. Emissions from livestock were 587 kt CO_2e. Aggregate sources and non-CO_2 emission sources on land contributed 240 kt CO_2e. Carbon sequestered from land was −1,150 kt CO_2e, resulting in emissions from AFOLU of −323 kt CO_2e. The removal is expressed as a negative value to help clarifying that the value is a removal and not an emission.

To exclude the removals and report the emissions only, New Zealand's Greenhouse Gas Inventory reported gross emissions by excluding the Land Use, Land Use Change and Forestry (LULUCF) sector (MfE, 2017a). Similarly, Auckland's gross emissions exclude carbon sequestration from forestry (i.e., from the land and the harvested wood products (HWP) sub-sectors).

7.2 Livestock

CH_4 is produced in digestive processes of livestock (enteric fermentation) and through management of their manure. N_2O is emitted from the manure management system. The number of livestock (dairy cattle, non-dairy cattle, sheep and deer) in Auckland was sourced from Statistics New Zealand (StatsNZ, 2017). The national CH_4 emission factors were applied (MfE, 2017a). The national N_2O emissions (MfE, 2017a) were allocated to Auckland by the ratio of the livestock number in Auckland to the national total.

7.3 Land

Land use is divided into six categories: forest land, cropland, grassland, wetlands, settlements and other. Emissions and removals are calculated from the changes in ecosystem carbon stocks for both land remaining in a land use category and land converted to another land use category. The calculation was undertaken by Ministry for the Environment by applying New Zealand's Greenhouse Gas Inventory methodologies for the Land Use, Land Use Change and Forestry (LULUCF) sector (MfE, 2017a) for Auckland with some Auckland-specific activity data and parameters where available. The Auckland specific age class distribution was provided by the

Ministry for Primary Industries. Three GHGs (CO_2, CH_4 and N_2O) were reported.

7.4 Aggregate sources and non-CO_2 emission sources on land

Aggregate sources and non-CO_2 emission sources on land are fertilizer use, liming, urea application, agricultural soils and harvested wood products (HWP). The emissions (CO_2 and N_2O) from liming, urea application and agricultural soils were estimated based on national emissions (MfE, 2017a) allocated to Auckland by the proportion of the land areas of cropland and grassland compared to the national total. The land use data was sourced from the Land Use Carbon Analysis System New Zealand Land Use Map. Emissions from crop residue burning are considered minor and not included in this inventory.

As for the land sub-sector, the changes of carbon stocks in the harvested wood products pool were provided by Ministry for the Environment and were modelled using a simplified version of the national methodologies (MfE, 2017a) using Auckland-specific activity data. There was a switch from a sink to a source in 2012, caused by declining harvest rates. The assumed harvest rates for the Auckland region peaks in 1993 and remains high until the early 2000s. As the harvest rate reduces so does the HWP sink. Eventually the sink becomes a source of emissions in 2012 as assumed decay from discarded wood products in the pool exceeds inputs from new harvest. The HWP pool is likely to become a sink again once harvest rates increase as more of the young forest estate matures and is subsequently harvested. This is an effect of Auckland forestry's uneven age class distribution caused by peaks and troughs in new planting in the past.

8 Conclusions

In summary, concluding findings of the inventory are as follows:

- In 2015, Auckland's gross and net emissions were 11,309 kt CO_2e and 10,267 kt CO_2e, respectively. Carbon dioxide (CO_2) contributed 83.1 per cent of gross emissions. Transport and stationary energy dominated emissions, accounting for 39.7 per cent and 29.5 per cent of gross emissions, respectively.
- Higher emissions in 2015 were observed than those in 1990, 2009-2014 mainly due to increased emissions from transport and IPPU demonstrate. With respect to current emissions levels, Auckland will need to reduce its net emissions by 23.7 per cent to 32.1 per cent by 2020, 49.1 per cent by 2040 and 57.6 per cent by 2050, to meet its emissions targets.
- In 2015, net emissions were 6.5 t CO_2e per capita and 127 t CO_2e per million $NZ GDP while gross emissions were 7.2 t CO_2e per capita and 140 t CO_2e per million $NZ GDP. These values were lower than in 2009, and this shows that Auckland decouples emissions from population and economic growth.
- Improvements in activity data, emission factors and methodology have been made for this inventory. The emissions trend was not affected by the change in estimates between inventories.

9 Acknowledgments

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New Zealand Steel: Alan Eyes

Vector Limited: Ross Malcolm

Watercare Services Limited: Roseline Klein

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11 Abbreviations

This chapter is based on WRI et al. (2014)

AFOLU	Agriculture, forestry and other land use
AR5	IPCC Fifth Assessment Report
C40	C40 Cities Climate Leadership Group
CDP	Formerly the Carbon Disclosure Project, a global disclosure system
CH_4	Methane
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
EF	Emission factor
GDP	Gross domestic product
GHG	Greenhouse Gas
GPC	Global Protocol for Community-scale Greenhouse Gas Emission Inventories
GWP	Global warming potential
HFCs	Hydrofluorocarbons
HWP	Harvested wood products
ICLEI	ICLEI – Local Governments for Sustainability
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial processes and product use
LULUCF	Land use, land use change and forestry
MSW	Municipal solid waste
N_2O	Nitrous oxide
NF_3	Nitrogen triflouride
PFCs	Perfluorocarbons
SF_6	Sulphur hexafluoride
WRI	World Resources Institute
WWTP	Wastewater treatment plant

12 Glossary

This chapter is based on WRI et al. (2014).

Activity data: A quantitative measure of a level of activity that results in GHG emissions. Activity data is multiplied by an emission factor to derive the GHG emissions associated with a process or an operation. Examples of activity data include kilowatt-hours of electricity used, quantity of fuel used, output of a process, hours equipment is operated, distance travelled, and floor area of a building.

Allocation: The process of partitioning GHG emissions among various outputs.

Base year: A historical datum (e.g., year) against which a city's emissions are tracked over time.

BASIC: An inventory reporting level that includes all scope 1 sources except from energy generation, imported waste, *IPPU*, and *AFOLU*, as well as all scope 2 sources.

BASIC+: An inventory reporting level that covers all BASIC sources, plus scope 1 *AFOLU* and *IPPU*, and scope 3 in the *Stationary Energy* and *Transportation* sectors.

Biogenic emissions (CO_2(b)): Emissions produced by living organisms or biological processes, but not fossilised or from fossil sources.

City: Used throughout the GPC to refer to geographically discernible subnational entities, such as communities, townships, cities, and neighbourhoods.

City boundary: See geographic boundary.

CO_2 equivalent: The universal unit of measurement to indicate the global warming potential (GWP) of each GHG, expressed in terms of the GWP of one unit of carbon dioxide. It is used to evaluate the climate impact of releasing (or avoiding releasing) different greenhouse gases on a common basis.

Compact of Mayors: A global coalition of city leaders addressing climate change by pledging to cut greenhouse gas emissions and prepare for the future impacts of climate change.

Emission: The release of GHGs into the atmosphere.

Emission factor(s): A factor that converts activity data into GHG emissions data (e.g., kg CO_2e emitted per litre of fuel consumed, kg CO_2e emitted per kilometre travelled, etc.).

Geographic boundary: A geographic boundary that identifies the spatial dimensions of the inventory's assessment boundary. This geographic boundary defines the physical perimeter separating in-boundary emissions from out-of-boundary and transboundary emissions.

Global warming potential: A factor describing the radiative forcing impact (degree of harm to the atmosphere) of one unit of a given GHG relative to one unit of CO_2.

Greenhouse gas inventory: A quantified list of a city's GHG emissions and sources.

Greenhouse Gases (GHG): For the purposes of the GPC, GHGs are the seven gases covered by the UNFCCC: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); sulphur hexafluoride (SF_6); and nitrogen trifluoride (NF_3).

In-boundary: Occurring within the established geographic boundary.

Inventory boundary: The inventory boundary of a GHG inventory identifies the gases, emission sources, geographic area, and time span covered by the GHG inventory.

Out-of-boundary: Occurring outside of the established geographic boundary.

Reporting: Presenting data to internal and external users such as regulators, the general public or specific stakeholder groups.

Reporting year: The year for which emissions are reported.

Scope 1 emissions: GHG emissions from sources located within the city boundary.

Scope 2 emissions: GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary.

Scope 3 emissions: All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary.

Transboundary emissions: Emissions from sources that cross the geographic boundary.

13 Appendix: Emission Factors

Fuel type or activity	Unique identifier	Units	Emission factor					
			CO_2	tCO2e	CH_4	CH4_tCO2e	N_2O	N2O_tCO2e
EXAMPLE: Natural gas	*EXAMPLE: EF_Natural gas*	*kg / kWh*	*0.4822*	*0.0004822*	*0.003*	0.000003	*0.0029*	0.000003
T&D losses from grid-supplied energy	EF_Fugitive	t / MJ	0.0000	3.79E-08	0.0000	7.01E-06	0.0000	0.00E+00
Natural gas	EF_Gas_industry	t / MJ	0.0001	5.39E-05	0.0000	2.52E-08	0.0000	2.39E-08
Natural gas	EF_Gas_commercial	t / MJ	0.0001	5.39E-05	0.0000	1.26E-07	0.0000	2.39E-08
Natural gas	EF_Gas_residential	t / MJ	0.0001	5.39E-05	0.0000	1.26E-07	0.0000	2.39E-08
Natural gas	EF_Gas_electricity	t / MJ	0.0001	5.39E-05	0.0000	2.52E-08	0.0000	2.39E-08
Liquefied Petroleum Gas (LPG)	EF_LPG_residential	t / TJ	60.4267	6.04E+01	0.0048	1.33E-01	0.0001	2.52E-02
Liquefied Petroleum Gas (LPG)	EF_LPG_transport	t / TJ	60.4267	6.04E+01	0.0589	1.65E+00	0.0002	5.04E-02
Electricity	EF_Electricity	t / MWh	0.1095	1.10E-01	0.0002	4.63E-03	0.0000	1.37E-04
Coal (Bituminous or Black coal)	EF_Coal_industry	t / TJ	92.0000	9.20E+01	0.0095	2.66E-01	0.0014	3.78E-01
Coal (Bituminous or Black coal)	EF_Coal_commercial	t / TJ	92.0000	9.20E+01	0.0095	2.66E-01	0.0014	3.78E-01
Coal (Bituminous or Black coal)	EF_Coal_residential	t / TJ	92.0000	9.20E+01	0.2850	7.98E+00	0.0014	3.78E-01
Coal (Bituminous or Black coal)	EF_Coal_agricultural	t / TJ	92.0000	9.20E+01	0.2850	7.98E+00	0.0014	3.78E-01
Wood or wood waste	EF_Wood_industry	t / TJ	0.0000	0.00E+00	0.0240	6.72E-01	0.0032	8.48E-01
Wood or wood waste	EF_Wood_residential	t / TJ	0.0000	0.00E+00	0.2400	6.72E+00	0.0032	8.48E-01
Motor gasoline (petrol)	EF_Petrol	t / :ilo_litr	2.3131	2.31E+00	0.0006	1.82E-02	0.0000	1.32E-02
Diesel oil	EF_Diesel	t / :ilo_litr	2.6545	2.65E+00	0.0001	4.09E-03	0.0001	3.78E-02
Residual fuel oil	EF_Fuel Oil	t / :ilo_litr	2.9881	2.99E+00	0.0003	7.65E-03	0.0001	2.07E-02
Aviation gasoline	EF_Jet Fuel	t / :ilo_litr	2.5399	2.54E+00	0.0000	4.94E-04	0.0001	1.87E-02
Residual fuel oil	EF_Fuel Oil_marine	t / TJ	79.7222	7.97E+01	0.0070	1.95E-01	0.0022	5.91E-01
Liquefied Petroleum Gas (LPG)	EF_LPG_industry	t / TJ	60.4267	6.04E+01	0.0010	2.66E-02	0.0001	2.52E-02

Find out more: phone 09 301 0101, email rimu@aucklandcouncil.govt.nz or visit aucklandcouncil.govt.nz and knowledgeauckland.org.nz

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