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Wellington City Council
25-Jan-2021

Wellington City Greenhouse Gas Inventory

Covid-19 Impact Assessment

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Covid-19 Impact Assessment

Client: Wellington City Council

Co No.: 60637851

Prepared by

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25-Jan-2021

Quality Information

Document Wellington City Greenhouse Gas Inventory

Ref

Date 25-Jan-2021

Prepared by Adam Swithinbank

Reviewed by Anthony Hume

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
6	25-Jan-2020	Final	Anthony Hume Sustainability and Resilience Team Lead	

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Executive Summary

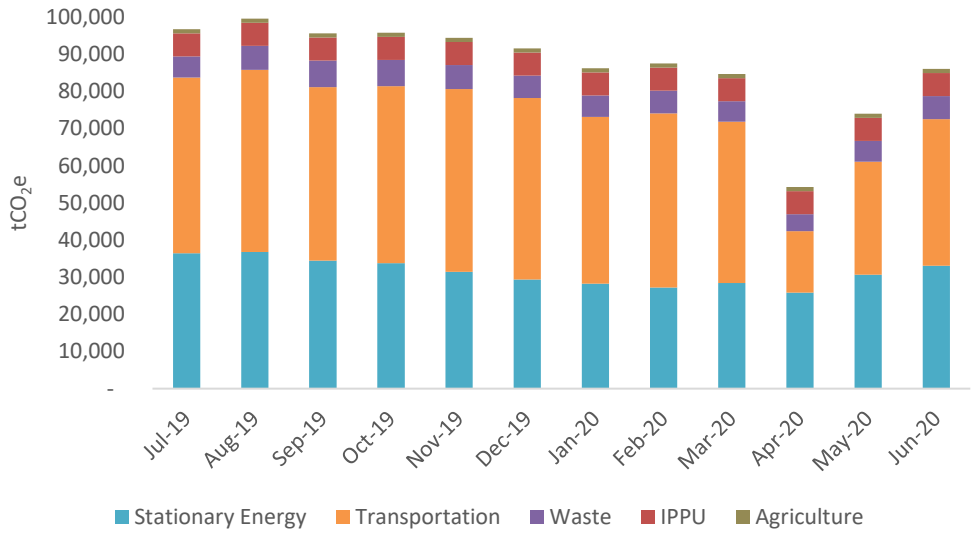
This report examines the impact of the COVID-19 virus restrictions on greenhouse gas (GHG) emissions produced in the Wellington City territorial authority area during the 2019/20 financial reporting year (FY20). The FY19 and FY20 GHG inventories for Wellington City have been used as the basis for this analysis. Expected emissions for Wellington City in FY20 without the impact of COVID-19 have been calculated as part of this analysis. The main findings from this report are outlined below:

Key Findings:

Gross Emissions

- Total annual gross emissions in Wellington decreased by 30,747 tCO_2e (2.8%) between FY19 and FY20 to 981,328 tCO_2e. The impact of COVID-19 is estimated to have reduced total annual gross emissions in FY20 by between 1% and 6% (based on two different calculation methods).
- Monthly emissions in April were 39% lower than would be expected without the impact of COVID-19 while emissions in May and June were 18% and 6% lower than expected without the impact of COVID-19.

Figure 1 Wellington City's total gross emissions per month, FY20



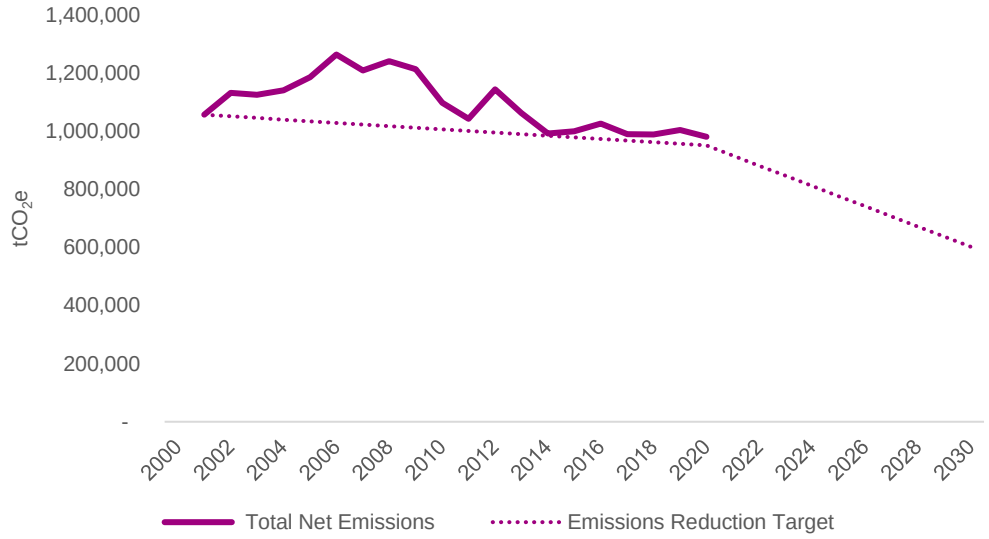
- The transportation emissions sector was most impacted by the COVID-19 restrictions. Annual emissions from the transportation sector reduced by 9% from FY19 to FY20. Monthly emissions from the transportation sector in April were 66% lower than expected without the impact of COVID-19, while emissions in May and June were 35% and 13% lower than expected without the impact of COVID-19.
- Annual transport-related petrol and diesel emissions decreased by 14,012 tCO_2e (4%) between FY19 and FY20. Monthly emissions from transportation uses of petrol and diesel in April were 70% lower than expected without the impact of COVID-19, while emissions in May were 15% lower than expected without the impact of COVID-19.
- Annual emissions from air transport decreased by 30,815 tCO_2e (28%) between FY19 and FY20. Monthly emissions from the transportation sector in April were 95% lower than expected without the impact of COVID-19, while emissions in May and June were 85% and 75% lower than expected without the impact of COVID-19.

- Annual electricity consumption emissions increased by 12,666 tCO_2e (7%) between FY19 and FY20. This offset some of the impact COVID-19 on reducing emissions. Emissions from electricity in FY20 were higher than usual for all months, except for April, due to higher than usual consumption and higher proportion of non-renewable energy used for electricity generation. Emissions for April were 17% lower than would be expected without the impact of COVID-19.

Net Emissions

- Annual total net emissions in Wellington decreased by 7.2% between FY01 and FY20 meaning that Wellington's first emissions target of reducing the City's net emissions by 10% during this period was not achieved. Without the impact of COVID-19 Wellington City would have been further away from achieving its 2020 emissions reduction target.
- Annual net emissions in Wellington will be required to reduce by 378,770 tCO_2e (39%) in the ten years from 2020 to 2030 to achieve the 2030 target, this equates to 37,877 tCO_2e per year (three times higher than the average annual decrease in the previous ten years).

Figure 2 Wellington City's annual total net emissions from 2001 to 2020, showing Wellington City's emissions reduction targets from 2001 to 2020 and 2030



Introduction

AECOM has been commissioned to examine the impact of the COVID-19 virus on emissions produced in the Wellington City territorial authority area during the 2019/20 financial reporting year (FY20). All emissions reported here are expressed in tonnes of carbon dioxide equivalent (tCO_2e).

1.0 Background Information

This report covers the Wellington City Greenhouse Gas Inventory 2019/20[1] measured from 1st July 2019 to 30th June 2020 (FY20). During this time, the economy and the personal lives of everyone in New Zealand and Wellington were significantly impacted by the COVID-19 virus.

COVID-19 impacted New Zealand and the entire world during 2020; causing widespread government-imposed restrictions on businesses and individuals and huge shifts in behaviours and economic markets. The COVID-19 virus first appeared in China in December 2020 with the first cases appearing in New Zealand in February 2020. Restrictions relating to COVID-19 began in mid-March in the form of instructions to self-isolate on entry to the country and limits on large gatherings. Restrictions increased to a national lockdown (level 4) on the 25th March 2020 whereby only 'essential services' were operating, movement was restricted, and household 'bubbles' were enforced. The level 4 lockdown lasted until the 27th April 2020 with many personal and business restrictions continuing past the end of FY20 (30th June 2020).[2]

Organisations and media outlets throughout the world speculated that the impact of COVID-19 would reduce GHG emissions on a global scale through restrictions on individuals and economies, and the associated impacts on transport and energy use. This speculation prompted questions around the impact of COVID-19 on emissions in Wellington. Wellington City Council also wishes to understand the influence of COVID-19 impacts on efforts to reach its greenhouse gas emission reduction targets.

2.0 Purpose of Document

This work aims to examine the impact of COVID-19 on greenhouse gas emissions (GHG) from a range of sectors and sources in FY20 and the implications of COVID-19 on achieving Wellington City's emissions reduction targets. This document summaries AECOM's analysis and findings of the impact of COVID-19 on greenhouse gas emissions in FY20 and discusses whether the impact of COVID-19 will have for potential long-term reductions in emissions. Due to the time of writing, this document should be used as a starting point for further discussion and analysis of the impacts of the COVID-19 virus on regional emissions rather than a definitive picture of changes.

3.0 Scope of Work

The information presented in this report is aimed to be used to inform Wellington City Council, other stakeholders and decision-makers around the impact of COVID-19 on emissions in the City. The scope of the work was agreed with the Sustainability Team at the Wellington City Council prior to the work commencing to assist decision-making around climate action by Wellington City Council.

The scope of the work was as follows:

- Explore the impact of COVID-19 on greenhouse gas emissions from a range of sectors and sources in Wellington City in the financial year 2019/20
    - Examine all sources of emissions by month (where possible) to isolate the impact of COVID-19 from the general trend

[1] AECOM – Wellington City Greenhouse Gas Inventory 2019/20
[2] https://covid19.govt.nz/alert-system/history-of-the-covid-19-alert-system/

- Compare calculated emissions for Wellington City in FY20 against estimated emissions for the year without the impact of COVID-19
- Provide context for achieving/falling short of the FY20 10% emissions reduction target and achieving future targets, especially the FY30 target

4.0 Approach to Analysis

This study uses the results of Wellington City's FY20 greenhouse gas inventory and historical emissions reported for the period from FY01 to FY19 calculated by AECOM[3] as the basis of this analysis. Throughout the analysis, emissions results for FY20 are compared with those for FY19 and against the trend from FY01 to FY20. These timeframes have been chosen to examine the impact of COVID-19 on the FY20 inventory in the short-term and against long-term emissions trends. The FY19 inventory is viewed as representative of a typical year in terms of emissions and fits within the general emissions trends seen in Wellington since FY01. Detailed comparison between the two inventories is possible as the FY19 and FY20 inventories have been calculated by AECOM using the same approaches and data sources. AECOM has also, where possible, calculated emissions per month for each emissions source to examine the impact of COVID-19 by month.

AECOM has partnered with Wellington City Council in 2013, 2015, 2019 and 2020 to measure greenhouse gas emissions and provide in-depth analysis of emission trends. The methodological approach used to calculate emissions in Wellington City in FY20 and for the period from FY01 to FY19 follows the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC) published by the World Resources Institute (WRI) in 2014. The GPC includes emissions from stationary energy, transportation, waste, industry, agriculture and forestry activities within the City's boundary. The method is a mixed method covering some production and consumption emissions. The sector calculations for agriculture, forestry, solid waste and wastewater are based on the Intergovernmental Panel on Climate Change (IPCC) workbooks and guidance for emissions measurement. Sector calculations also use methods consistent with GHG Protocol standards published by WRI for emissions measurement when needed. New Zealand-specific emission factors have been used where available, published by the Ministry for the Environment (MfE).

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

[3] AECOM – Wellington City Greenhouse Gas Inventory 2019/20 (2020)

Impact of COVID-19 on Emissions

5.0 Impact on Emissions – Global and National Context

Globally, carbon dioxide emissions from fossil fuels (the largest contributor to greenhouse gas emissions) in 2020 decreased by 7% compared to 2019[4]. Emissions from the transportation sector account for the largest share of this decrease. Surface transport, e.g. car journeys, fell by approximately half at the peak of COVID-19 restrictions in April 2020 (when restrictions were at their maximum, particularly across Europe and the U.S. However, while global carbon dioxide emissions were lower than last year, methane emissions are expected to have continued to increase[5].

In New Zealand, national daily carbon dioxide emissions are estimated to have fell by up to 41% during the level 4 lockdown in April 2020[6]. The national greenhouse gas inventory published by the Ministry for the Environment for FY20 is not expected until around April 2021 but is likely to show a decrease in gross emissions compared to FY19.

It is too early to estimate the extent that emissions will rebound during 2021 and beyond, as the long-term trend in global fossil emissions will be largely influenced by actions to stimulate economies in response to the COVID-19 virus.

6.0 Impact on Wellington's Total Emissions

Before the publication of Wellington City's FY20 emissions inventory, it was speculated that the impact of COVID-19 would have had a substantial impact on Wellington's total emissions in FY20. Total gross emissions in Wellington decreased by 30,747 tCO_2e (2.8%) between FY19 and FY20. This decrease fits within the general trend of emissions in Wellington from FY01 to FY20.

Wellington's total net emissions for FY20 were the lowest since FY01 but fit into the general downward trend in emissions and are relatively similar to total net emissions reported in recent years (see Figure 3). An exploration of the impact of COVID-19 on individual sectors and emission sources is discussed in sections 7.0 and 8.0 respectively. The impact of emissions in different sectors varied. Notably, while transport emissions were 9% lower than in FY19, driven by reduced road and air transport fuel use, stationary energy emissions were 4% higher than in FY19, driven by the increased use of non-renewable sources for electricity generation and increased consumption of electricity.

[4] Pierre Friedlingstein et al. - Global Carbon Budget 2020 (2020)
[5] Marielle Saunois et al. - The Global Methane Budget 2000–2017 (2020)
[6] Corinne Le Quere et al. – Temporary Reduction in Daily Global CO_2 Emissions During the COVID-19 Forced Confinement

Figure 3 Wellington City's total gross emissions per year, 2016-2020

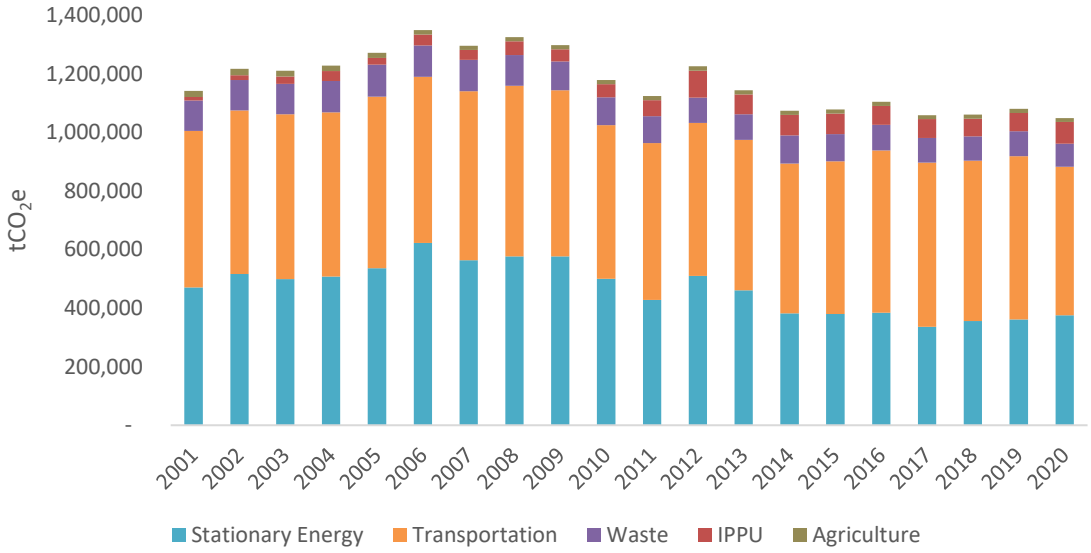
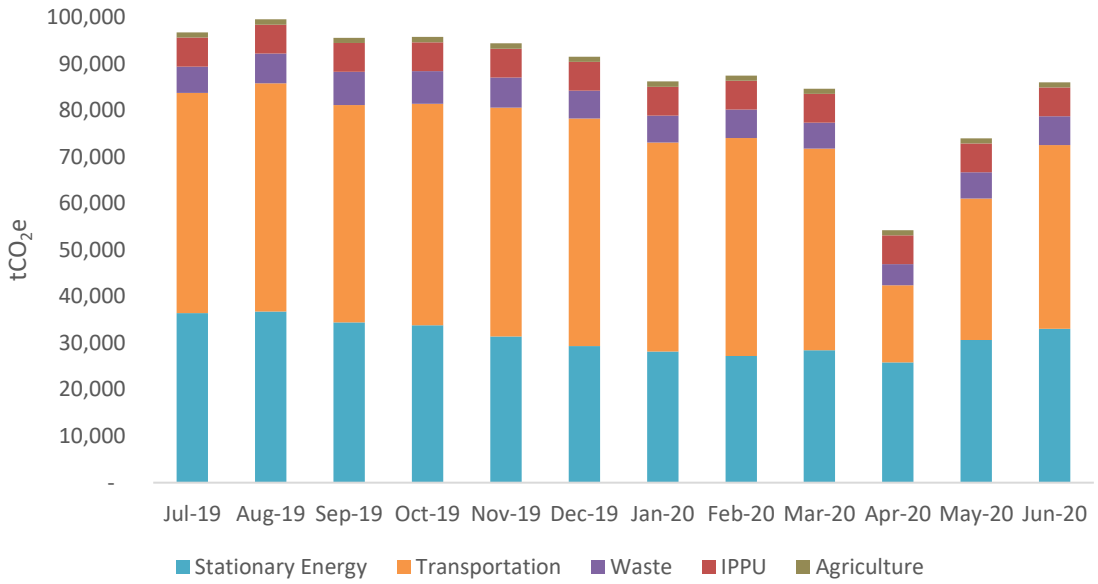


Figure 4 shows total monthly gross emissions for Wellington City in FY20, calculated using monthly data. Prior to the known existence of the COVID-19 virus, monthly emissions for the 6 months from July to December were slightly higher than expected and were not affected by the virus. In January and February, despite the presence of COVID-19, there were only very small impacts on emissions.

Monthly emissions for Wellington City follow a seasonal pattern driven by the l use of stationary energy, especially the increased use of electricity and natural gas in the winter months to heat homes and businesses. The reduction in emissions from August to February was driven by this seasonal pattern and was as expected during these months (e.g. reduced consumption in the warmer summer months).

There was a slight decrease in emissions in March as restrictions in New Zealand were introduced and the number of international flights decreased, a large decrease in emissions in April during the level 4 restrictions and then an immediate rebound in emissions in May and June as restrictions eased. Monthly emissions for April were 39% lower than would be expected without the impact of COVID-19 while emissions in May and June were 18% and 6% lower than might be expected. The impact of COVID-19 on monthly emissions from each sector and Wellington's major emissions sources is explored in more detail in sections 7.0 and 8.0.

Figure 4 Wellington City's total gross emissions per month, FY20



6.1 Estimation of FY20 Emissions Without the Impact of COVID-19

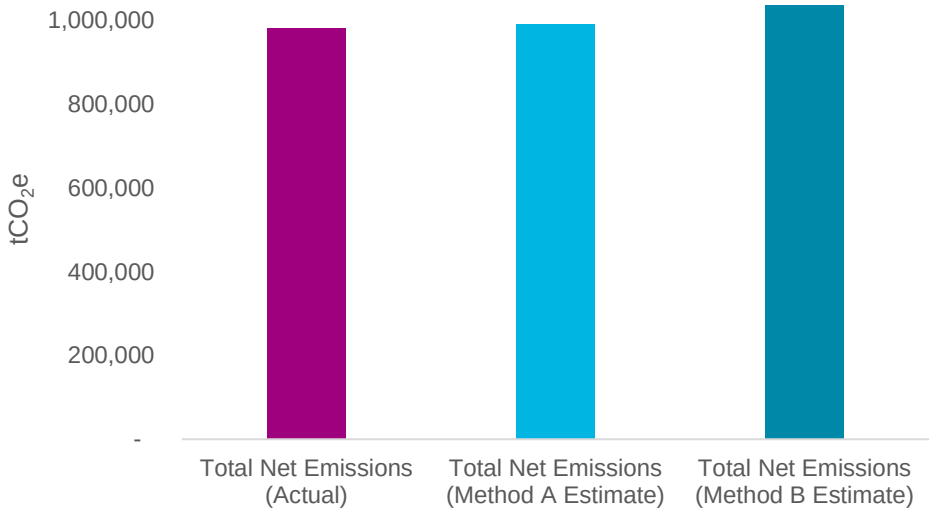
This section outlines the methods used to estimate Wellington's potential emissions without the impact of COVID-19 and then examines the potential impact of COVID-19 on Wellington's total emissions for FY20.

To estimate the quantity of emissions that may have been produced in Wellington during FY20 if COVID-19 had not happened, we have used the following methods:

- **Method A - Trend Estimate**: This method uses the trend in total annual emissions from FY01 to FY19 to forecast emissions for FY20. This method does not consider actual data for emissions produced in FY20.
- **Method B - Calculated Estimate:** This method examines each emissions source by month to determine the impact of COVID-19 (where possible) and then uses this to estimate emissions for each source without the impact of COVID-19, based on data from previous years. For example, monthly emissions from air transport for the months from July 2019 to February 2020 were combined with an estimate of emissions from March to June 2020 based on emissions in previous years during the same time period.

It is important to note that annual emissions totals are difficult to predict and that there is often a margin of error in estimations. However, AECOM is reasonably confident the results discussed below are a reasonable estimate based on previous work completed to establish emissions between 2001 and 2020 for Wellington City.

Figure 5 Comparison of Wellington's actual FY20 total net emissions against estimations of total net emissions for FY20 without the impact of COVD-19



Forecasting emissions using Method A (the trend estimate method) we estimate that total net emissions for FY20 without COVID-19 would have been 991,000 tCO_2e. This is 1% (around10,000 tCO_2e) higher than actual emissions in FY20 (981,328 tCO_2e) and 1% lower than FY19 emissions.

Using Method B (the calculated method), we estimate that total net emissions for FY20 without the impact of COVID-19 would have been 1,040,000 tCO_2e. This is 6% (around59,000 tCO_2e) higher than actual emissions in FY20 (981,328 tCO_2e) and 4% higher than FY19 emissions. The main reason for the higher estimated emissions using Method B, compared to Method A, is due to higher than normal electricity consumption throughout FY20 (see Figure 13). Levels of consumption of petrol, diesel and natural gas (the other largest emissions sources in Wellington) outside of the COVID-19-affected months were similar to monthly consumption levels seen in previous years. Examination of the COVID-19-affected emission sources is presented in section 7.0.

Based on these two estimates, the impact of COVID-19 was a 1% to 6% reduction in annual net emissions in FY20 compared to what would have been expected for the year. Without the impact of COVID-19, emissions may have remained similar to FY19 or even risen compared to FY19.

Method B has been used throughout the analysis in this document to estimate the impact of COVID-19 on each emissions source by month. Method B is preferred as it considers the actual emissions produced in FY20 that were not affected by COVID-19, for example emissions produced from July 2019 to January 2020.

7.0 Impact on Sector Emissions

This section describes the impact of COVID-19 on emissions from each of the emissions source sectors (transportation, stationary energy, waste, IPPU and agriculture). The results of the FY19 inventory have primarily been used to provide comparison to the FY20 results. Figure 6 shows how Wellington's sector emissions have changed from 2001 to 2020 and provides context for the results of the FY20 inventory. Each emissions sector presents a different trend of emissions increases and decreases during this time period. Figure 7 shows the monthly emissions totals for each sector in FY20. Further information and analysis of the impact of COVID-19 on specific emission sources is provided in section 8.0.

Figure 6 Wellington City's annual emissions by sector, FY01-FY20

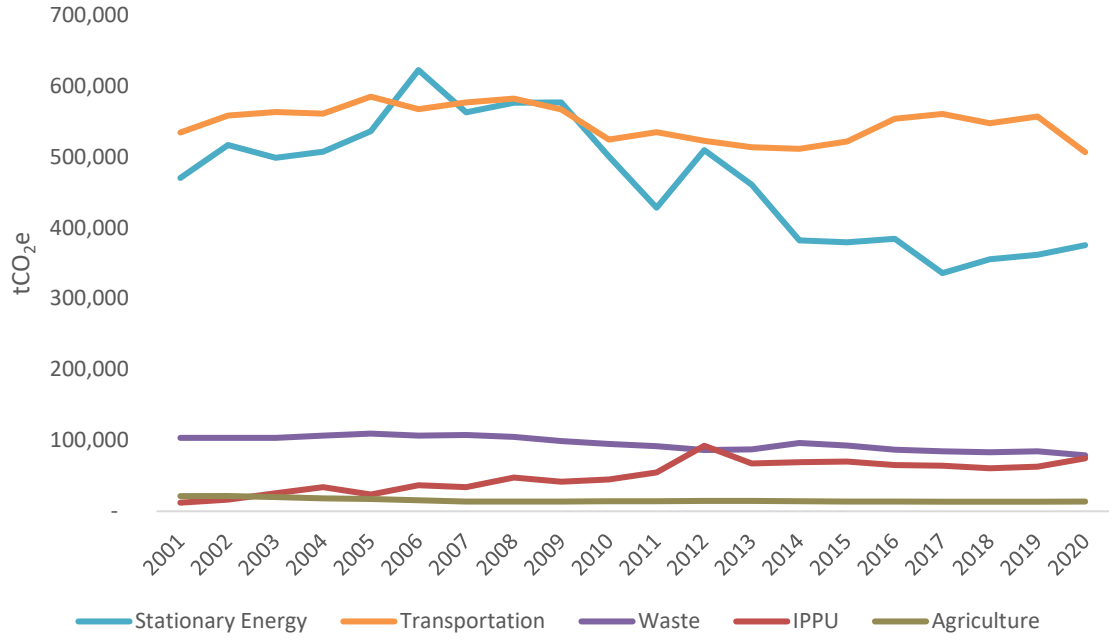
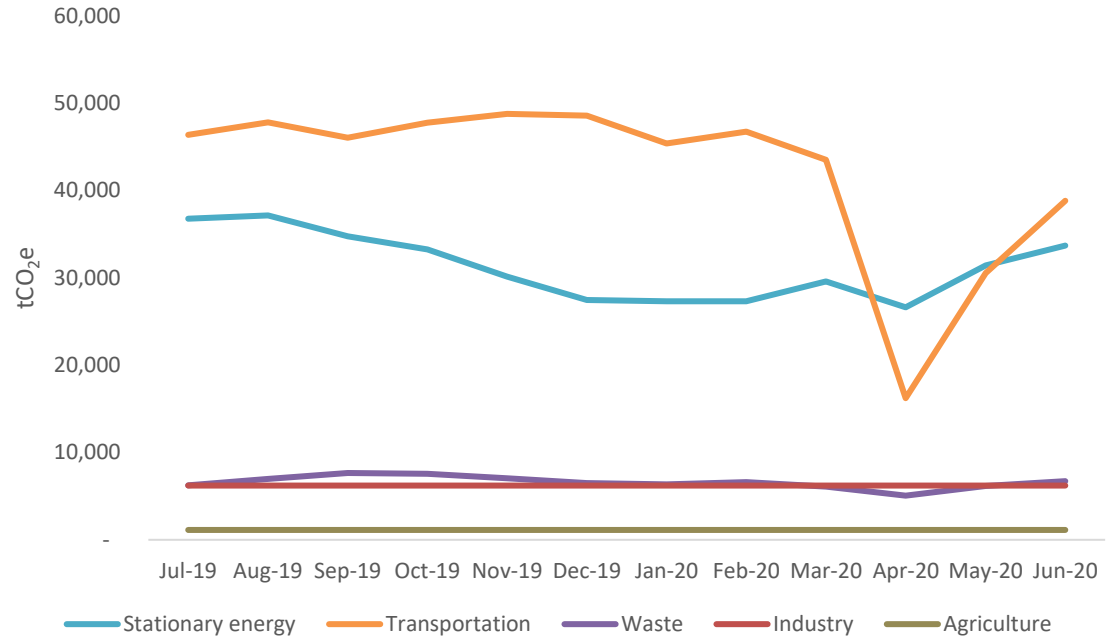


Figure 7 Wellington City's monthly emissions by sector, FY20



Transportation was the largest source of emissions in Wellington, representing 48% of Wellington's total gross emissions in FY20. The reduction in transportation emissions is the biggest emissions sector change between FY19 and FY20, reducing by 50,443 tCO_2e (9%). This decrease fits within the year-on-year variability of annual transportation emissions since FY01 but goes against the trend of recent years where emissions had been increasing. The impact of COVID-19 is quite clear in this sector (see Figure 7) where monthly emissions from July to February were at expected levels followed by decreased emissions from March to June. Emissions from transportation in March were 7% lower than expected, this was followed by a substantial emissions reduction to 66% lower than expected for April. As New Zealand moved from the Level 4 lockdown to reduced restrictions in May and June,

emissions from transportation in Wellington recovered to 35% and 13% lower than expected respectively.

This large dip in monthly emissions was caused by lower fuel use, especially petrol, diesel and aircraft fuel (see section 4.0 for further detail). Except for air transport, fuel use in the transportation sector in New Zealand rebounded quickly to pre-COVID-19 levels in July after New Zealand moved to the lowest tier of restrictions (Level 1).

Stationary Energy is the second largest source of emissions in Wellington, representing 36% of Wellington's total gross emissions in FY20. The stationary energy sector includes emissions relating to the consumption of electricity, natural gas, LPG and diesel used for stationary purposes. Stationary energy emissions increased by 13,738 tCO_2e (4%) between FY19 and FY20. This increase fits with the general trend from the previous three years (to FY17) but goes against the general downward trend since FY01 (see Figure 6).

Monthly emissions from stationary energy follow a seasonal pattern of higher emissions in winter and lower emissions in summer (driven by consumption of electricity and natural gas). Emissions from stationary energy in FY20 followed this trend with a noticeable dip in April 2020 during the height of the national COVID-19 lockdown (see Figure 7). However, these changes occurred against a background of increasing emissions from stationary energy between FY19 and FY20.

The reason for the increase in stationary energy emissions is due to higher than usual electricity consumption for all months except April 2020 (see Figure 13) and an increase in emissions per unit of electricity compared to previous years. Further explanation of the impact of COVID-19 on Wellington's electricity consumption emissions is reported in section 8.1.

Waste represented 7.5% of Wellington's total gross emissions in FY20. Waste emissions include emissions produced from solid waste in landfill and from wastewater treatment and discharge, Waste emissions decreased by 5,728 tCO_2e (7%) between FY19 and FY20. This decrease in emissions fits with the general annual emissions trend since FY01 (see Figure 6) and is driven by the increased use of landfill gas capture systems for solid waste which capture methane produced in landfill sites.

Even though, solid waste volume sent to landfill data is available to estimate monthly emissions from solid waste. The nature of solid waste emissions, which emit greenhouse gasses over a long period of time, make accurate analysis of monthly emissions not possible. The impact of COVID-19 on solid waste emissions may become clearer in the future, although the evidence suggests that there was no significant impact as there was only a slight dip in solid waste volumes in April which then recovered to expected levels for all other months.

Data to estimate monthly wastewater emissions was not available so monthly emissions have been assumed to be the same for each month based on the annual total. It is expected that wastewater emissions in Wellington were not significantly impacted by COVID-19.

Industrial Processes and Product Use (IPPU) represented 7.1% of Wellington's total gross emissions in FY20. IPPU emissions increased by 11,624 tCO_2e (18%) between FY19 and FY20. Emissions from this sector are only reported on a national level and so emissions are allocated to Wellington City based on Wellington's population as a proportion of the national population. The increase in emissions between FY19 and FY20 therefore follows the national trend of growth (see Figure 6). There is insufficient data available to calculate monthly emissions from this source. It is assumed that IPPU emissions were not significantly impacted by COVID-19 as industrial processes were not disrupted due to COVID-19 related restrictions or lockdowns.

Agriculture represented just 1.3% of Wellington's total gross emissions in FY20 with emissions from this source increasing by just 60 tCO_2e (0.4%) between FY19 and FY20. There is insufficient data available to calculate monthly emissions from this source.

8.0 Impact on Key Emissions Sources

This section describes the impact of COVID-19 on emissions from key emissions sources (electricity, natural gas, petrol and diesel used for transport, air transport and marine transport). These emissions sources have been highlighted as they represent the largest emission sources in Wellington in the FY20 inventory (excluding solid waste and IPPU).

Solid waste, IPPU and all other emissions sources are included in the category 'Other Emission Sources'. There is very limited IPPU data available and it is assumed that IPPU emissions were not significantly impacted by COVID-19 as industrial processes were not disrupted due to COVID-19 related restrictions or lockdowns. Solid waste has not been included as solid waste emissions are released over a long time after entering landfill and so any effects of COVID-19 will not be seen for a number of years, if present.

Figure 8 shows how emissions from each key emissions source have changed from FY01 to FY20 and provides context for the FY19 to FY20 change in emissions. Figure 9 shows the monthly totals for each sector in FY20. Note that for some emissions sources, data was not available to calculate monthly emissions.

Figure 8 Wellington City's annual emissions by key emissions sources (and all other emissions sources), FY01-FY20

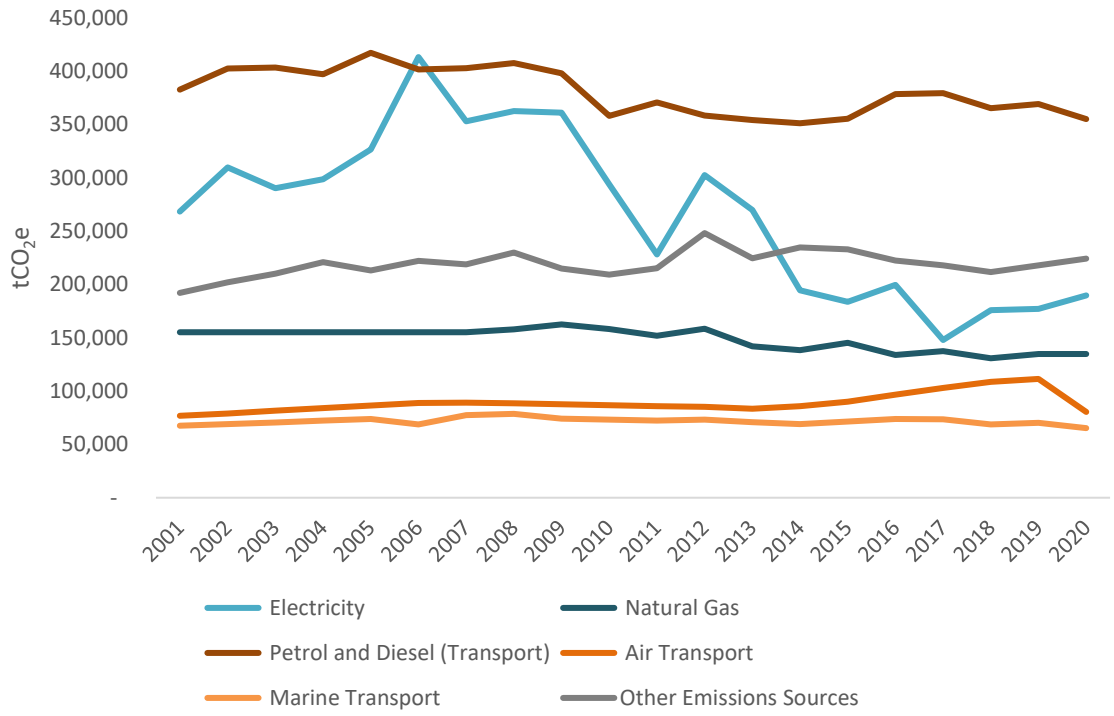
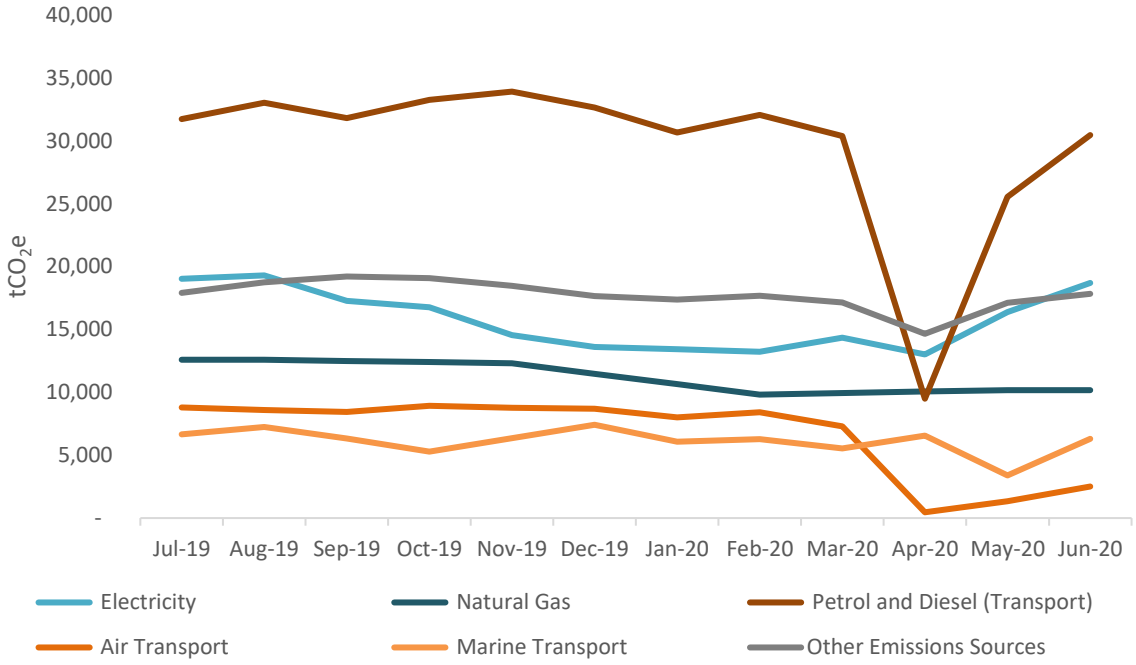


Figure 9 Wellington City's monthly emissions by key emissions sources (and all other emissions sources) in FY20



The sections below outline the changes in emissions from each of the major emissions sources from FY19 to FY20 and the potential impact of COVID-19 on FY20's emissions from these sources.

8.1 Petrol and Diesel Fuel Consumption (Transport)

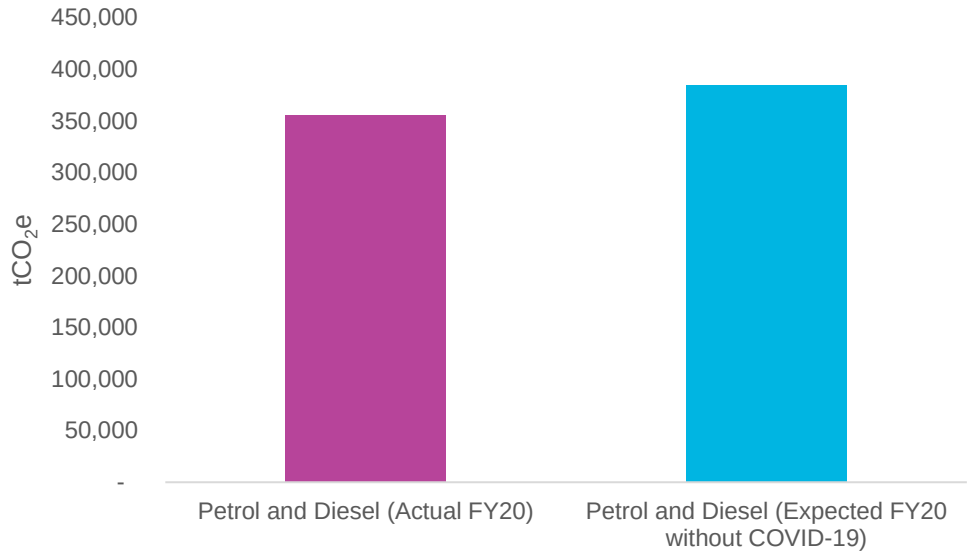
Petrol and Diesel used for transport represented the largest source of emissions in Wellington in FY20 (34% of Wellington's total gross emissions). These two fuel types have been combined in this analysis to highlight the importance of on and off-road vehicle fuel use in Wellington. Annual transport-related petrol and diesel emissions decreased by 14,012 tCO_2e (4%).Petrol and diesel emissions have followed a general downward trend since FY01 (see Figure 8), The decrease in Wellington's petrol and diesels emissions fits with this general trend and the increases and decreases seen year-on-year between FY01 and FY20

The impact of COVID-19 is clear for this sector. Figure 9 shows a substantial dip in emissions from petrol and diesel for the month of April (during the national level 4 lockdown), a rebound in emissions in May and then a return to expected emissions levels by June. April's petrol and diesel transportation emissions were approximately 70% lower than would be expected without the impact of COVID-19 (compared to emissions per month for previous years). May emissions were approximately 15% lower than would be expected while emissions had recovered to within an expected range for June. Annual emissions from petrol and diesel were 8% lower than would be expected without the impact of COVID-19 (see Figure 10).

During the level 4 restrictions, mobility was restricted to within region or for 'essential services. Additional to this, during level 4 and the following restriction levels, household 'bubbles' were unable to mix with other 'bubbles' and non-essential services were not operating. These restrictions meant that the amount of vehicle movements in Wellington was vastly reduced and therefore fuel sales decreased significantly. Mobility data for the Wellington Region published by Apple showed that the amount of people driving was below normal levels from the middle of March through to June, falling to 80% less than normal during the level 4 restrictions[7].

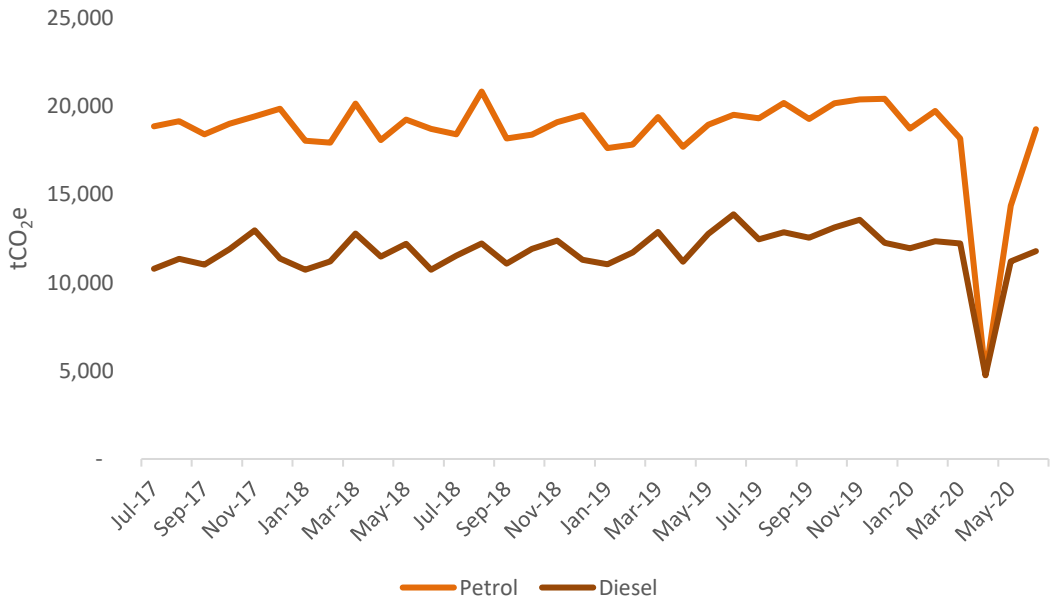
[7] https://covid19.apple.com/mobility

Figure 10 Comparison of Wellington's actual FY20 petrol and diesel emissions against estimated expected emissions for FY20 without the impact of COVD-19



It is important to note that petrol and diesel transportation emissions have experienced different trends from FY01 to FY20 and within FY20. While petrol emissions have decreased between FY01 and FY20 (especially since FY05), diesel emissions have increased (especially since FY13). During FY20, petrol and diesel transport emissions differed in the relative impact of COVID-19 (see Figure 11). Petrol emissions were 75% lower than expected in April 2020 while diesel emissions were 60% lower than expected. A possible explanation for this is the more common use of diesel for commercial vehicles (e.g. for trucks and vans) which may have continued operating as part of 'essential services' which were allowed during the COVID-19 restrictions.

Figure 11 Monthly petrol and diesel emissions, July 2017 to June 2020



8.2 Electricity Consumption

Electricity consumption emissions represented 18% of Wellington's total gross emissions in FY20. Annual electricity consumption emissions increased by 12,666 tCO_2e between FY19 and FY20 (7%). Electricity emissions have been variable year-on-year between 2001 and 2020 but have generally decreased during this period (see Figure 8). Contrary to the general downward trend, electricity emissions have risen each year since 2017 (see Figure 8). The primary reasons for the increase in emissions between FY19 and FY20 is due to higher than usual electricity consumption for all months in FY20 except April 2020 (see Figure 13) combined with an increase in emissions per unit of electricity compared to previous years.

Monthly emissions from electricity follow a seasonal pattern of higher emissions in winter and lower emissions in summer driven by seasonal consumption. Electricity consumption and emissions in FY20 followed this trend with a noticeable dip in April during the Level 4 COVID-19 restrictions (see Figure 12). For all months in FY20 except April, electricity consumption was higher than the average for the same months in the previous five years (by an average of 7%) driven by increased use of electricity for heating. This was offset by consumption in April being 6% lower than the average for the same month in the previous five years.

Nationally, between March and June 2020 electricity demand fell by 5%. This was driven by a 13% decrease in commercial and industrial demand due to the closure of non-essential services, offset by an 8% increase in residential demand due to increased daytime electricity use and a 4% increase in agriculture demand due to dry conditions requiring increased irrigation needs[9]. It is expected that Wellington's electricity consumption followed a similar pattern during this time.

Emissions per unit of electricity are determined by the national carbon intensity of electricity generation which is affected by the proportion of electricity generated by renewable energy sources. Emissions per unit of electricity were higher for each quarter of FY20 compared to the previous year. The proportion of electricity produced by renewable sources in 2019 was less than previous years (82% renewable compared to 84% in 2018) due to lower than usual hydro generation offset with increased gas and coal generation[8]. Continued low hydro generation in 2020 was offset by increased gas generation which resulted in a higher proportion of non-renewable electricity generation[9] (82% renewable in the first two months of 2020).

Based on the calculated method of estimating emissions without the impact of COVID-19 (Method B), electricity emissions in April were 17% lower than expected resulting in annual emissions being 1% lower than expected. It is unclear what the impact of COVID-19 on electricity emissions for other months was because consumption followed the trend of higher-than-usual for the year prior to COVID-19.

[8] Ministry for Business and the Environment (MBIE), Energy In New Zealand 2020
[9] Ministry for Business and the Environment (MBIE), New Zealand Energy Quarterly - June 2020

Figure 12 Monthly emissions from electricity consumption (tCO_2e) and monthly electricity consumption (GWh) in FY20

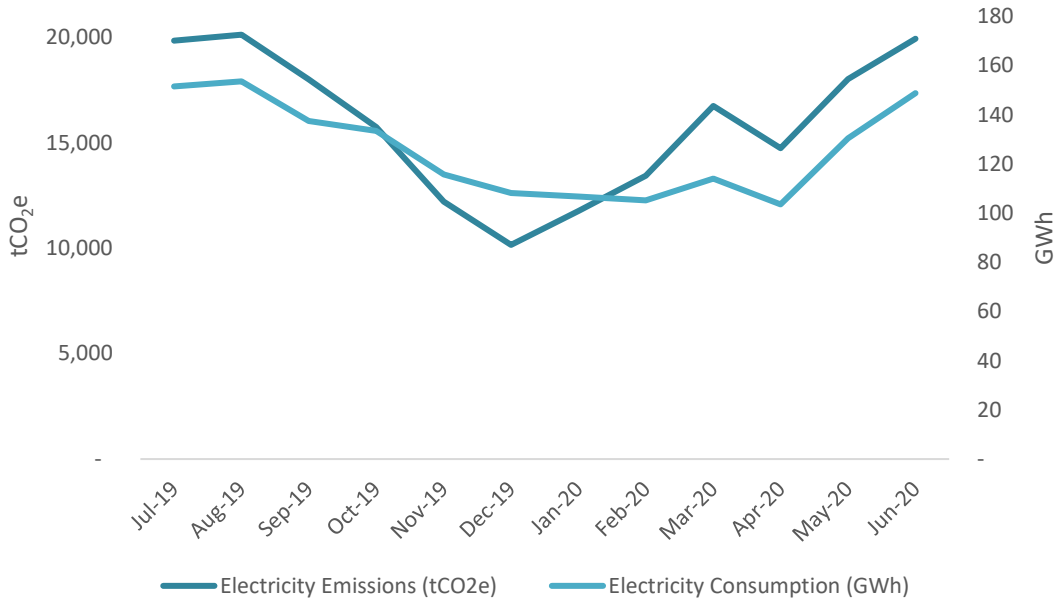
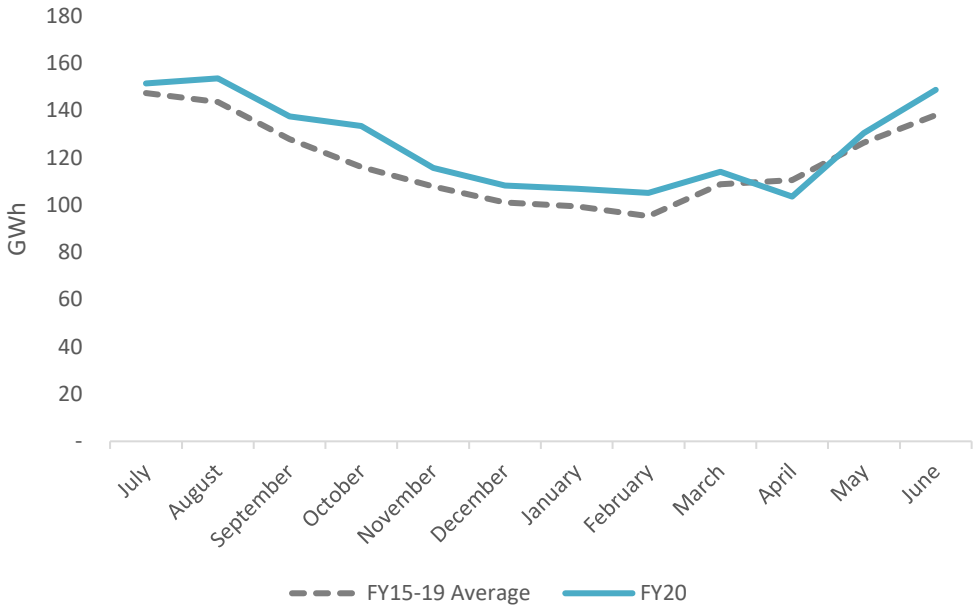


Figure 13 Monthly electricity consumption in FY20 and average monthly electricity consumption from FY15 to FY19 (GWh)



8.3 Natural Gas Consumption

Natural gas emissions represented 13% of Wellington's total gross emissions in FY20. Annual natural gas emissions did not significantly change between FY19 and FY20 (changing by less than 70 tCO_2e). This fits with the general trend since 2016 where only small changes in annual emissions have been experienced (see Figure 9). Data was not available to calculate monthly natural gas consumption so quarterly data was used. Quarterly natural gas consumption follows a seasonal pattern of consumption with higher consumption in the winter. Quarterly emissions show a similar seasonal emissions pattern

to previous years which suggests little impact on consumption due to COVID-19. However, improvements in data availability may enable impacts to be identified.

8.4 Air Transport

Air transport emissions represented 8% of Wellington's total gross emissions in FY20. Annual emissions from air transport decreased by 30,815 tCO_2e (28%) between FY19 and FY20. This decrease does not fit with the trend seen in Figure 8 where emissions from air transport have increased steadily since FY01.

This impact of COVID-19 on emissions from this source is evident in Figure 14. Emissions per month were at slightly lower than expected levels through FY20 until March 2020 but then dropped to 95% lower than expected for the month of April. The month of May 2020 was approximately 85% lower than expected with emissions rising slightly to approximately 75% lower than expected by June 2020. As a result of the large decrease in emissions from April to June 2020, annual emissions from air transport in FY20 were 21% lower than would be expected without COVID-19 (see Figure 15).

The reduction in emissions from March to June 2020 was caused by a dramatic reduction in the number of flights arriving and departing Wellington International Airport, especially international flights. The number of flights arriving or departing Wellington International Airport from April to June 2020 was 70% lower than during the three months prior to April while the total distance travelled by these flights was 83% lower. This suggests that longer distance international flights were affected more than shorter distance domestic flights.

For the remainder of the 2020 calendar year, the number of international flights to and from New Zealand has remained well below pre-COVID-19 levels. It is unclear how long this will last or if international flight numbers will recover to pre-COVID-19 levels.

Figure 14 Wellington City's monthly air transport emissions, July 2017 to June 2020

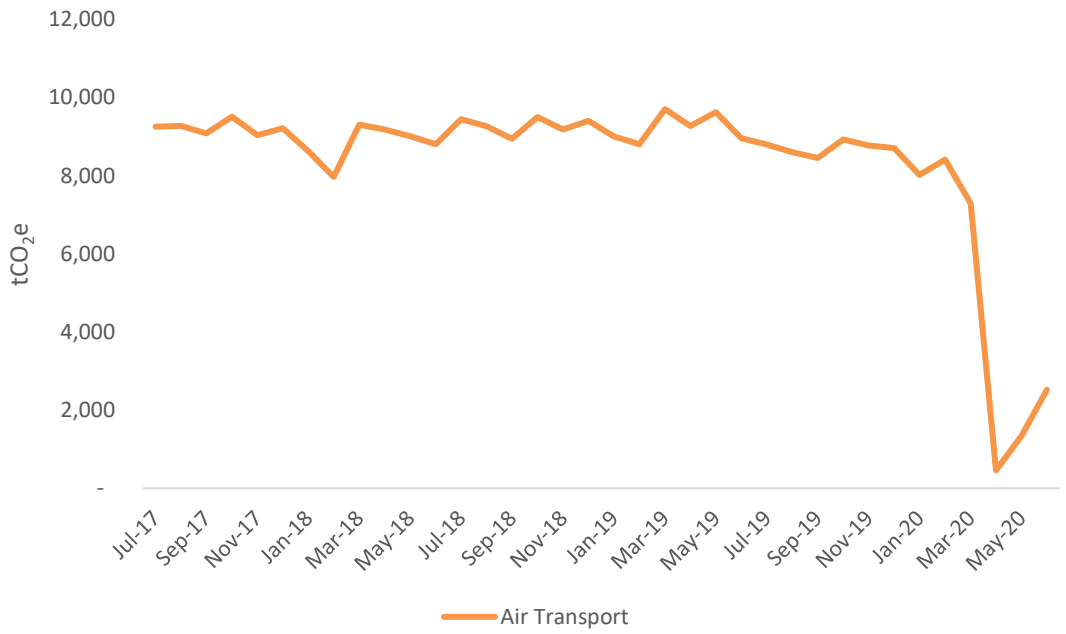
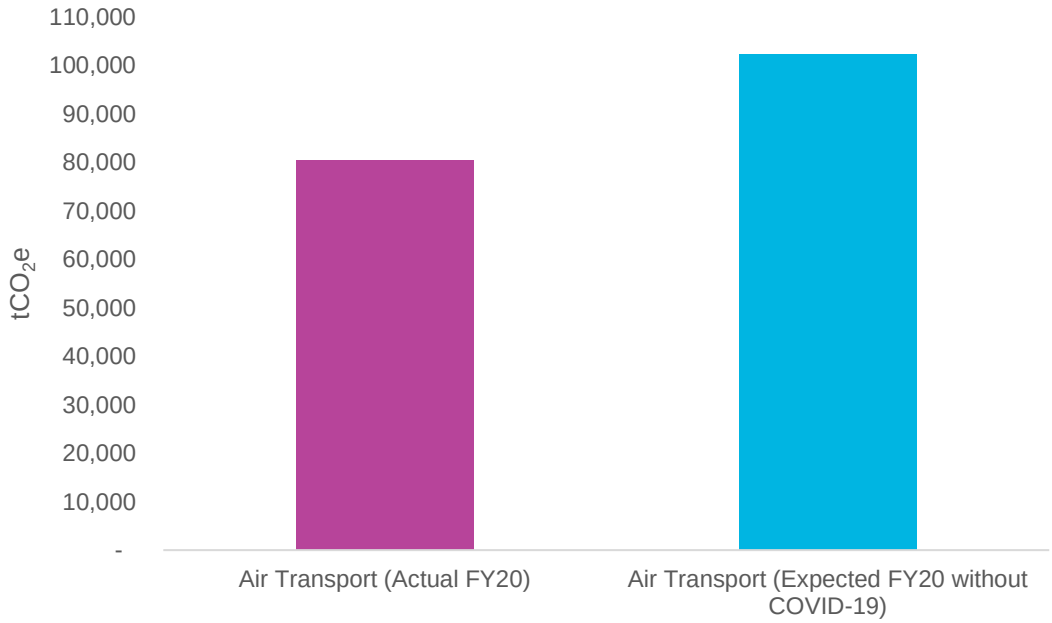


Figure 15 Wellington City's air transport emissions in FY20, showing actual and expected emissions.



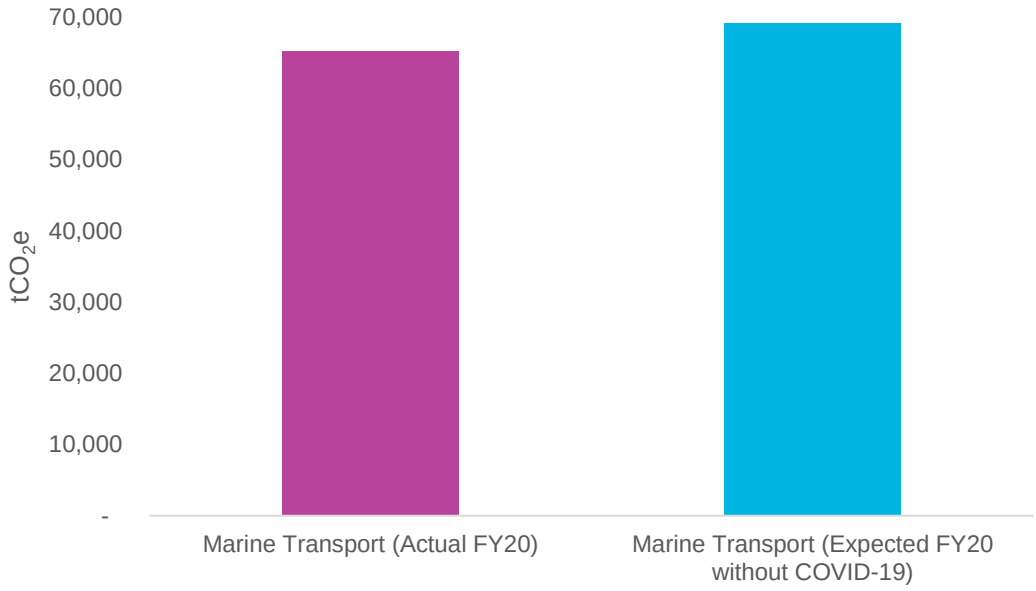
8.5 Marine Transport

Marine transport emissions represented 6.2% of Wellington's total gross emissions in FY20. Emissions from marine transport is made up of emissions from the Wellington to Picton ferries (83%), international shipping (17%) and local ferry services (1%). Annual emissions from marine transport reduced by 4,858 tCO_2e (7%) between FY19 and FY20. This reduction in emissions fits within the variability of the trend from FY01 to FY20 and with the general downward trend in marine transport emissions since a peak in FY08.

The largest change to marine transport emissions was the reduction in emissions from international shipping which were 4,380 tCO_2e (29%) lower than in FY19. Monthly emissions for international shipping are extremely variable from month to month with no strong pattern year to year. However, evidence suggests that Wellington Port was operating as usual during the COVID-19 effected months and did see a significant impact from COVID-19.

The Wellington to Picton ferry service was disrupted by COVID-19 with monthly emissions approximately 40% lower than expected for May due to service cancellations. Despite this, emissions from this source reduced by less than 1% from FY19 to FY20. It is expected that the reduction in emissions during May was offset by a slightly higher number of journeys during the rest of the year.

Figure 16 Wellington City's marine transport emissions in FY20, showing actual and expected emissions.



8.6 Other Emissions Sources

A number of emissions sources make up the 'Other Emissions Sources' category in Figure 8 and Figure 9. 'Other emissions sources' represented 21% of Wellingtons total gross emissions in FY20. Annual emissions from the two largest sources in this category (IPPU and Solid Waste) from FY01 to FY20 are shown in Figure 17. The same y-axis scale has been used for this figure as for Figure 8 to enable direct comparison of these emission sources with Wellington's other major emission sources. Other notable sources include petrol, diesel and LPG used for stationary purposes, enteric fermentation from livestock, and wastewater emissions. These emission sources each represent a small proportion of Wellington's emissions but together account for a significant amount of emissions. It is important to consider these emissions, alongside the larger sources of emissions, when creating action plans to reduce total emissions.

IPPU emissions represented 7.1% of Wellington's total gross emissions in FY20. IPPU emissions increased by 11,624 tCO_2e (18%) between FY19 and FY20. Emissions from this sector are only reported on a national level and emissions are allocated to Wellington City based on Wellington's population as a proportion of the national population. The increase in emissions between FY19 and FY20 follows the national trend of growth. There is insufficient data available to calculate monthly emissions from this source. It is expected that IPPU emissions were not significantly affected by COVID-19 due to most industrial processes nationally continuing through the COVID-19 restrictions.

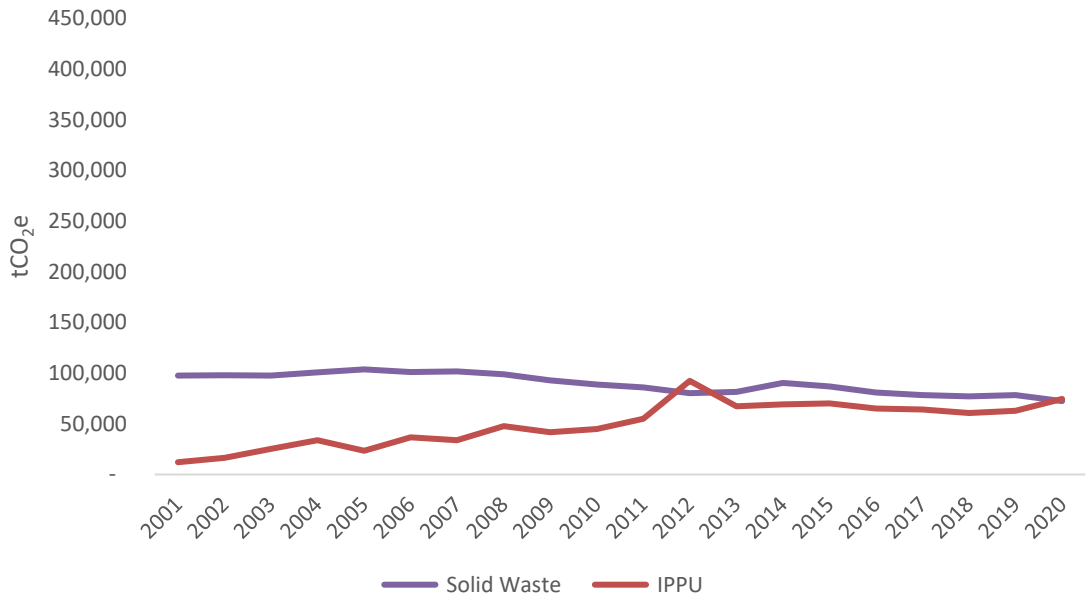
Solid waste emissions represented 6.9% of Wellington's total gross emissions in FY20. Solid emissions occur over a long period of time and to make accurate analysis of monthly emissions was not possible. The impact of COVID-19 on solid waste emissions may become possible to analyse in the future, although the evidence suggests that there was no significant impact as there was only a slight dip in solid waste volumes in April which then recovered to expected levels for all other months.

Stationary petrol and diesel emissions represented 2.6% of Wellington's total gross emissions in FY20. Monthly emissions follow the same pattern as for transportation petrol and diesel emissions as total sales of petrol and diesel have been used to calculate emissions from both transport and stationary energy uses. There is insufficient data to allocate sales to these uses on a monthly basis so the annual split between these uses has been applied.

LPG for stationary energy purposes represented 1.5% of Wellington's total gross emissions in FY20. There is insufficient data to draw conclusions around the impact of COVID-19 on this emissions source although it is expected that LPG fuel use was not significantly impacted

Some smaller emission sources in 'other emissions sources' were impacted by COVID-19 but their impact on Wellington's total emissions is insignificant (e.g. public ferry and rail transport). Notably while public transport bus journeys were reduced during the COVID-19 restrictions, higher emitting busses were taken out of service resulting in low-emitting electric busses representing a larger proportion of bus transport in the city.

Figure 17 Wellington City's annual emissions from IPPU and solid waste, 2001-2020



9.0 Emissions Reduction Targets

In June 2019, Wellington City Council adopted Te Atakura – First to Zero, a blueprint to make Wellington City a zero-carbon city (net zero emissions) by 2050. As part of the Te Atakura, targets have been set for reducing greenhouse gas emissions in relation to Wellington City's 2001 base year measurement (see Table 1).

Table 1 Wellington City's net emissions reduction targets to net-zero-carbon by 2050 based on the 2001 baseline.

Net Emissions Reduction Targets	2020	2030	2040	2050
Wellington City	10%	43%	68%	100%

Figure 18 shows how Wellington is tracking against its emissions reduction targets for 2020 and 2030 and shows a forecast of emissions to 2030 (based on the scenario of no further interventions to reduce emissions). The forecast of emissions shown in Figure 18 is calculated using the trend of emissions from 2001 to 2020. This forecast does not account for future interventions to reduce emissions or future market shifts which may impact emissions. Further details on the impact of COVID-19 regarding the 2020 target and the future 2030 target is outlined below.

Figure 18 Wellington City's annual total net emissions from 2001 to 2020, showing Wellington City's emissions reduction targets from 2001 to 2020 and 2030, and a forecast of emissions from 2021 to 2030

9.1 Impact of COVID-19 on Achieving the 2020 Target

Wellington's total net emissions reduced by 7.2% between FY01 and FY20 meaning the first emissions target of reducing the City's net emissions by 10% by 2020 was not achieved. From the analysis outlined in section 6.0,results show that without the impact of COVID-19 Wellington City would have been further away from achieving the 2020 emissions reduction target. The impact of COVID-19 has reduced emissions from both major and minor emission sources, including petrol, diesel, electricity, air transport and marine transport. Without the impact of COVID-19, it is expected that total net emissions in Wellington in FY20 would have been between 1,040,000 tCO_2e and 991,000 tCO_2e (see section 6.0), this would have resulted in an emissions reduction from 2001 to 2020 of between 2% and 6% (using Method A and B respectively) compared to the actual reduction of 7.2%.

It is expected that the impact of COVID-19 will also influence the FY21 annual total emissions. Further restrictions and lockdowns in FY21 may have similar impacts to those felt between March and June 2020. However, many of the monthly emissions reductions witnessed during the peak COVID-19 impacted months of April and May 2020 had recovered towards pre-COVID-19 levels by June 2020. Without the short-term impact of COVID-19, annual emissions may increase in the future compared to FY20. It remains unclear what the long-term influence of COVID-19 may be for emissions in different sectors (e.g. due to changes in international air travel, international tourist visitors to New Zealand, increased working-from-home, etc). However, evidence to date suggests the impact of COVID-19 will not contribute heavily to emission reductions in the long-term.

9.2 Achieving the 2030 Emissions Reduction Target

Annual net emissions in Wellington will need to reduce by 378,770 tCO_2e (39%) in the ten years from 2020 to 2030 to achieve the 2030 target, this equates to 37,877 tCO_2e per year. In the ten years from 2010 to 2020 annual net emissions reduced by 117,128 tCO_2e (11%), this equates to 11,713 tCO_2e per year, indicating that emissions reductions are required to accelerate substantially in the next ten years to achieve the target.

The forecast shown in Figure 17 predicts that without future interventions, technology change, changes to behaviours or market shifts, Wellington will fail to achieve the 2030 target of a 43% reduction in annual emissions since 2001. This forecast estimates that by 2030 Wellington will only

achieve a 19% reduction in annual emissions since 2001, exceeding the 2030 target by 250,000 tCO_2e (42% higher than required). Future emissions trends are not easily predicted as they are influenced by a wide variety of factors and so forecasts should only be used as a guide. However, these forecasts can be useful for illustrating different scenarios of emission changes.

Wellington City Council, Wellington based organisations, businesses and residents and national policy makers will be needed to work collectively to reduce emissions at increased rates to achieve Wellington's 2030 emissions target. The key areas of focus should be on the largest emitting sectors; petrol and diesel (mainly used in transportation), and natural gas and electricity consumption (mainly used in the stationary energy sector). It is also important that action is taken to tackle the growth in emissions from diesel consumption for all purposes.

At a national level it is important that emissions from electricity generation are reduced to achieve Wellington's targets however this cannot be relied upon. There is an ongoing risk that as electricity demand rises, due to population and consumption increases, emissions will rise unless New Zealand can generate a larger percentage of renewable power in line with government activities

Similarly, emissions from on-road transportation have decreased faster than the decrease in kilometres travelled by vehicles. This is attributable to more fuel-efficient vehicles rather than behaviour change. Across most sectors, there is a need to drive behaviour change to reduce emissions.

10.0 Closing Statement

The effects of COVID-19 on emissions will not be limited to just FY20, further restrictions and lockdowns in FY21 combined with changes in individual behaviour and global markets will have an impact on emissions in FY21 and in the future. There is also the potential for some impacts of COVID-19 to have a lag-effect whereby the impacts may not be felt until much later (e.g. the downsizing of office space as companies shift to working from home).

It is unclear to what extent the impact of COVID-19 on Wellington's annual emissions for FY20 will continue into future years. It is possible that the FY20 emissions reduction is just a small blip in the long-term emission trend for the city. Historically, shocks to global emissions (such as the Global Financial Crisis in 2008) have been short lived and have been followed by a growth in emissions. It is important that Wellington City Council and businesses and individuals in Wellington increasingly act to reduce emissions across all sectors.

It is important to remember that although greenhouse gas emissions were not as high as last year, they still inevitably led to a further increase in greenhouse gasses in the atmosphere. Atmospheric greenhouse gas levels, and consequently the world's climate, will only stabilize when annual greenhouse gas emissions are net zero.

11.0 Limitations

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12.0 Appendix

12.1 Key Assumptions and Limitations

Alongside the assumptions and limitations mentioned in the main document, the following assumptions and limitations are worth noting in reviewing the results of this study:

- Systems are not currently in place to monitor global emissions in real time. Emissions are reported based on annual consumption or production values, often released months or even years after the end of the calendar year. Where monthly emissions have been calculated, results are based on actual or derived consumption or production data available at monthly or quarterly intervals. Where sufficient data was not available, it has been assumed that emissions are produced at the same rate every month (this applies particularly to the IPPU and agriculture sectors).
- Emissions are expressed on a carbon dioxide-equivalent basis (CO_2e) including climate change feedback using the 100-year Global Warming Potential (GWP) values[10].
- Total emissions are reported as gross emissions (excluding forestry) and net emissions (including forestry).
- Where city-level data was not accessible, information was calculated via a per capita break-down of national or regional level data, this is further detailed in Appendix B. This applies particularly to the IPPU sector.
- Transportation emissions:
    - Fuel consumption data was determined from the number of journeys taken, distance travelled and consumption rates for the appropriate transportation mode.
    - Emissions from air travel and marine transport have been split between the territorial authorities in the Wellington Region based on their estimated relative contribution to that emissions source.
- Solid waste emissions:
    - Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day. Monthly emissions data for Wellington's open landfill sites has been estimated based on total annual emissions and the monthly volume of waste entering each landfill site.
- Wastewater emissions:

[10] https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf (Table 8.7)

    - Wastewater from the North Wellington Sewage Catchment treated in Porirua is included in the Wellington City figures. Data to estimate monthly wastewater emissions was not available for this study.

- Industrial Processes and Product Use (IPPU) emissions:
    - The availability of data to calculate emissions associated with IPPU is restricted due to confidentiality issues and constraints in communication from relevant stakeholders. IPPU emissions in Wellington City have been calculated based on reported national emissions for the sector.
- Forestry emissions:
    - This inventory accounts for forest carbon stock changes from afforestation, reforestation, deforestation and forest management (i.e. it applies land-use accounting conventions under the UN Framework Convention on Climate Change rather than the Kyoto Protocol). It treats emissions from harvesting and deforestation as instantaneous rather than accounting for the longer-term emission flows associated with harvested wood products.
    - Data to estimate monthly forestry harvest emissions or forestry sequestration was not available for this study.