

# Air emissions accounts: Quarterly and regional perspectives

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Paper prepared for the London Group on Environmental-Economic Accounting, Tallinn, Estonia, September 2025

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## Abstract

Air emissions accounts have the potential to deliver policy relevant information by highlighting the emissions intensities of industries and integrating with economic data to understand whether movements in emissions are associated with economic trade-offs or benefits.

Aside from clear integration with economic data, air emissions accounts can add value to existing greenhouse gas inventory data through being timelier, by being produced on a quarterly basis, or spatialised to enable region level decision-making. In addition to base accounts, quarterly and regional emissions accounts can also be integrated with appropriate economic series.

The forthcoming update to the Central Framework seeks to add additional text regarding the spatialisation of accounts and presentation on a quarterly basis. To inform these changes, this paper highlights how air emissions accounts can be compiled on a regional and quarterly basis, and the challenges in doing so. For regional accounts, the application of the residency principle requires careful consideration in allocating transport emissions. For quarterly accounts, seasonal adjustment is of primary concern. Alignment of the SEEA to customer needs for both regional and quarterly accounts are also discussed. Consideration at the system design stage can create greater utility for customers, for example the quarterly emissions account can be re-expressed in sector format and regional emissions can be at least partially output in GPC format.<sup>1</sup>

Statistics New Zealand developed an air emissions account<sup>2</sup> in 2018. A quarterly account was developed in 2020 and defined as official in 2022. Regional and Consumption basis accounts were also added in 2020.

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<sup>1</sup> Global Protocol for Community-Scale Greenhouse Gas Emission Inventories.

<sup>2</sup> Referred to as Greenhouse gas emissions (industry and household). Other pollutants to air are excluded due to coverage.

# 1 Introduction

New Zealand's national statistical office, Stats NZ, produces a suite of greenhouse gas emissions accounts to address multiple information gaps. As well as the standard (production-based) Central Framework emissions account, which is published on an annual basis, emissions accounts are also produced on a quarterly basis. Further annual emissions accounts are produced for regional level emissions (on a production basis) and on a consumption basis.

This paper presents the methodology and approach taken in producing quarterly and regional greenhouse gas emissions series in New Zealand. It aims to foster discussion around compiling these accounts considering the upcoming review of the System of Environmental-Economic Accounts (SEEA) Central Framework.<sup>3</sup>

New Zealand provides a valuable case study as one of only a handful of national statistical offices and international organisations estimating SEEA based quarterly and/or sub-national greenhouse gas (GHG) emissions.

The paper emphasises that for regional accounts, the application of the residency principle requires careful consideration in allocating transport emissions, while for quarterly accounts, seasonal adjustment is of primary concern. It also highlights that taking account of customer needs for both regional and quarterly accounts is essential, as this may have implications for statistical design.

## 1.1 Development of environmental accounts in New Zealand

The focus on emissions accounts has come about from extensive user consultation combined with feasibility. Over time, the focus of Stats NZ's emissions accounts has changed given changes in policy needs and capacity and data availability. Initial environmental-economic accounts, developed by Stats NZ from 2000–08, were focused on a research-based programme with analytical papers as outputs for fish, water, forestry, minerals, renewables, and marine economy. The SEEA program was paused until 2015 when demand for natural capital information had resurfaced. Prototype and demonstration accounts were produced from 2015–17 along with updates of previously compiled accounts for renewable energy and the marine economy. In 2018–19, outputs were presented focusing on consolidation of accounts with a thematic focus: first natural capital, then climate change.

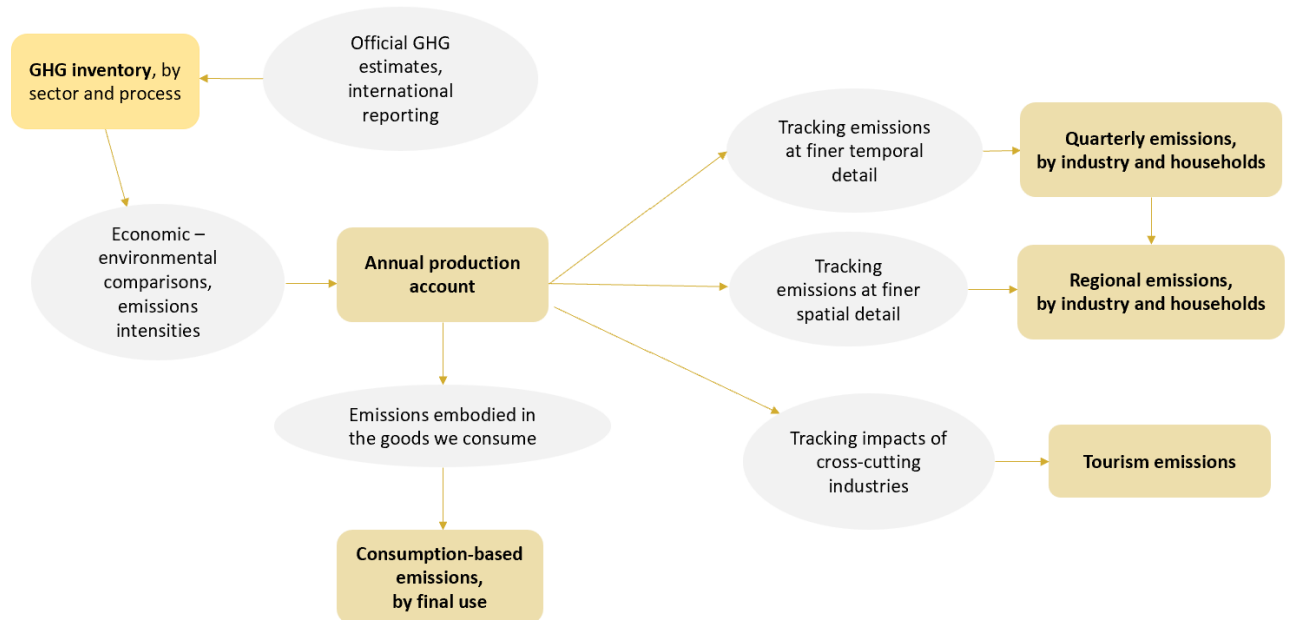
In 2018 Stats NZ published the first annual greenhouse gas emissions production account. The initial release was at a high-level industry detail. Further development, and strong utilisation of economic and other data sources, facilitated the disaggregation to a fine level of industry detail. This disaggregation, in turn, enabled further development with the regional and consumption-based emissions accounts developed and released in 2020. Additionally, production-based estimates for tourism (as a cross-cutting industry) were developed and are continued to be published with the annual industry and household emissions estimates. A quarterly emissions account was developed in

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<sup>3</sup> Specifically, this paper aims to inform on the list of issues A4 'How SEEA CF Accounts can be made spatially explicit' and B4 'Inclusion of text on quarterly accounts' to be addressed in the upcoming review.

2020 and was made an official series in 2022. Figure 1 below shows the links between the different emissions accounts. This highlights the consistency and coherency between the SEEA based outputs.

**Figure 1: Connecting the greenhouse gas inventory to the emissions accounts**



Integrated emissions accounts provide several advantages. For Stats NZ, there is value in integration from increased opportunities to validate emissions estimates and improve quality as integration necessarily provides in-built constraints and the SEEA framework lends itself to enhanced comparability to other statistics. Additional confrontation can identify issues in input data series thereby improving quality. Quality of accounts is also improved by using the most detailed level of information possible to reduce the impact of modelling assumptions.

For customers, integration provides access to emissions accounts that would be otherwise unobtainable (e.g. tourism or regional emissions). It also enables insights into emissions progress (e.g. GDP and emissions growth comparisons) and leads to higher quality data for other accounts (e.g. production and consumption). Integration facilitates links between production-based and consumption-based emissions. Regional emissions customers, in particular, value the consistent methodology that identifies each region’s contribution to national emissions.

## **New Zealand's emissions profile: the role of agriculture**

New Zealand's emissions profile is atypical to most OECD countries. Over half (54 percent in 2023) of SEEA-based greenhouse gas emissions are from the agriculture industry, outstripping contributions from manufacturing, utilities, and households. Additionally, because of agriculture's significance, methane is a major contributor to total emissions at 47 percent. While agriculture contributes only six percent of carbon dioxide emissions it emits 93 percent of both methane and nitrous oxide. Agriculture, therefore, has a major influence on quarterly estimates, and is the main contributor to emissions in all but two of New Zealand's 16 regions. Agriculture is an important export industry to New Zealand and contributed 3.4 percent to the economy in 2023. The comparative role of agriculture in both the economy and emissions also has implications for understanding New Zealand's emissions intensity as well as the difference between its production and consumption-based emissions.

Given the significance of agriculture to New Zealand's emissions profile, there is an active inventory-based domestic research programme to continually improve the quality of estimates. These improvements flow through to the SEEA accounts in updating annual benchmarks. Three key data sources are used in the compilation of agricultural emissions on a SEEA basis – the New Zealand GHG Inventory, the Stats NZ [Agriculture Production Survey](#) (APS) and an unpublished agricultural emissions projections series (for key livestock types) sourced from the Ministry of Primary Industries (MPI).

The Inventory provides emissions for the agriculture sector, which is converted to industry using the APS. The APS provides agricultural production numbers (e.g. livestock counts, cropping, land use areas etc) by New Zealand Standard Industrial Output Classification ([NZSIOC](#)) and region. In [Greenhouse gas emissions by industry and household \(annual production account\)](#), the APS is used to allocate agriculture sector emissions to agriculture, forestry, and arts and recreation services industries. Emissions are published by NZSIOC level 4 by gas type. Along with agriculturally based emissions, emissions for the above industries include emissions from energy (stationary and mobile) and waste, and a miniscule amount of industrial product use which are distributed using additional data sources.

For the [quarterly emissions production account](#) we use the APS and MPI agricultural emissions projections to extend beyond the annual emissions benchmarks. The quarterly pattern is determined by sub-annual information by key livestock type from the Inventory combined with interpolation for remaining series. Quarterly agriculture-related emissions estimates are currently published at an aggregated level - for agriculture, forestry, and fishing (NZSIOC level 1) – with separate series for agriculture and for forestry and fishing due to be published in October 2025. Data by gas type are released at the primary industry level.

The [Greenhouse gas emissions by region](#) account uses the APS to distribute the industry emissions from the annual production account to region. Additional data from MPI is used for dairy emissions to account for regional specific productivity factors.

## 2 Quarterly greenhouse gas emissions

Quarterly greenhouse gas emissions were developed in 2020, as part of Stats NZ's response to the COVID-19 pandemic and national need for higher frequency emissions data. Environmental variables, such as greenhouse gas emissions and ambient air pollutants, were expected to change following the economic and policy responses to COVID-19, but lack of timeliness meant that the impact would not be observed for some time, and in aggregating to annual values, the effect may not be completely observable or understood.

In May 2020, during the first (New Zealand wide) Covid-19 lockdown, the environmental-economic accounts (EEA) team approached a range of key customers with climate change portfolios to test their appetite for new quarterly emissions statistics to inform New Zealand's recovery from the pandemic. These statistics were to be produced in line with the System of Environmental-Economic Accounts (SEEA). The proposal was also designed to provide a wide range of customers with more timely information of New Zealand's emissions, released on a regular quarterly basis, up to 16 months ahead of existing measures.

Positive feedback on the proposal was received from a large and diverse group of stakeholders<sup>4</sup>. In addition to supporting New Zealand's move towards a low-carbon economy, stakeholders stated at the time, that quarterly emissions statistics had the potential to inform:

- more regular and timely discussions on the environmental impacts of Covid-19 recovery investments;
- consultation on Emissions Budgets;
- development of Emissions Reduction Plans;
- preparation of Climate Implications Reduction Plans (CIPA);
- operation of the Emissions Trading Scheme.

This positive feedback resulted in development work beginning in September 2020. The first quarterly emissions statistics 'Greenhouse gas emissions (industry and household): September 2020 quarter' were released in February 2021. This experimental release was accompanied by a detailed methods paper<sup>5</sup> and a request for stakeholder feedback on the approach, methods, products, and potential issues. Following a development phase in late 2020 and five releases to the experimental statistics area of Stats NZ's website, quarterly greenhouse gas emissions was first released as official statistics in July 2022.

There were three main reasons for quarterly emissions statistics being originally designated as experimental. Firstly, quarterly emissions statistics were at that time only reported by a small number of countries. This meant there was little existing literature to draw upon to develop quarterly

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<sup>4</sup> The Minister for Statistics, The Minister for Climate Change, The Ministry for the Environment (Climate Change Analysis Team), The Ministry for Primary Industries (Climate Change on-Farm & Inventory Team), The Ministry of Business, Innovation, and Employment (MBIE), The Treasury, Reserve Bank, The Ministry of Foreign Affairs and trade (MFAT), The Climate Change Commission, The Department of Conservation (DOC), The Energy Efficiency and Conservation Authority (EECA), The New Zealand Transport Agency (NZTA), The Ministry of Transport (MoT), and the Parliamentary Commissioner for the Environment's Office.

<sup>5</sup> See Stats NZ (2025).

emissions statistics<sup>6</sup>, nor was there a clearly defined measurement framework to use. Secondly, the reliability of the outputs needed to be tested. Thirdly, the ability to maintain efficient production on an ongoing basis needed to be determined.

As part of the transition process feedback and advice was received during consultation with domestic, international, and in-house stakeholders and was, where feasible and practicable, implemented. Support from the Climate Change Analysis team at the Ministry for the Environment (MfE), who are responsible for New Zealand’s Greenhouse Gas Inventory, was important as this meant both Stats NZ and MfE were able to understand and discuss the divergences between the two series constructively.

## 2.1 Overview of methods

Stats NZ’s quarterly emissions series primarily uses an indicator methodology (specifically the proportional Denton method) that constrains movements in indicators to benchmarks from the annual emissions industry and household account. Other methods used include interpolation and forecasting, benchmark extension, and direct calculation, depending on the data available to hand.

<b>Method</b>	<b>Description</b>	<b>Example of application</b>
Indicator method	Apply appropriate quarterly indicator to annual benchmark, approximately 25 are used by Stats NZ.	Energy, industrial processes and product use (CO <sub>2</sub> ).
Interpolate and forecast	Interpolate to obtain quarterly values for benchmark years, forecast for out quarters using the Holt linear double exponential smoothing method.	Waste, agriculture (N <sub>2</sub> O), product use (F-gases).
Benchmark extension	Extend the annual benchmark value (when available), extrapolate or use indicators for remaining quarters.	Industrial processes, agriculture, energy.
Direct calculation	Use existing annual method to derive quarterly series if data available, or data provided by external agency.	Agriculture (CH <sub>4</sub> , CO <sub>2</sub> ), coal production.

The benchmarking process combines the relative strengths of low-frequency data (e.g. annual data) and high-frequency data (e.g. quarterly data) while preserving as much as possible the short-term movements. This creates a coherent high-frequency data series by correcting the difference between benchmark and indicator values (indicator bias). It also ensures, for forward series, that the sum of the four quarters of the current year is as close as possible to the unknown future annual data. Several methods exist including mathematical methods (pro rata distribution, proportional Denton) and statistical modelling methods (ARIMA, GLS methods including Cholette-Dagum and Chow-Lin).

<sup>6</sup> At the time development started, only Netherlands and Sweden were producing quarterly emissions estimates.

The proportional Denton method was chosen for consistency with macroeconomic statistics. However, it should be noted that countries may use different methods, and it is not clear to what extent this may affect cross-country comparability.

The indicator method assumes the indicator is equally applicable to all gases. In practice, indicators are highly correlated with the main gas of the industry or process (and therefore often CO<sub>2</sub>-e), but weak correlations are observed with minor gases. There is also an implicit assumption in the indicator method that emissions are driven by changes in activity rather than emissions factors. This assumption would hold where emissions factors are constant over time.

Quality can be assessed by examining the benchmark-indicator ratio or Pearson correlation coefficient of movements. However, further work on assessing the quality of indicators is needed as correlation coefficients:

- have an implicit assumption that the series are cointegrated, i.e. share a long-term trend;
- may not detect 'drift', or technological breaks or structural breaks fully;
- may be subject to the possibility of spurious correlation between the indicator and benchmark;
- may lead to acceptance of incorrect seasonal signals as the annual movements may align but the quarterly signals may not capture all relevant phenomena;
- may falsely reject an indicator due to a low correlation but the low correlation is a result of the indicator being a transformed series (e.g. QGDP may be uncorrelated with emissions, but the underlying indicator data used for QGDP in the first instance may be highly correlated).

Where no indicator is available, estimation is still possible using interpolation and forecasting techniques. The rationale in using this approach is to enable complete coverage by estimating series otherwise measurable using indicator method. This method is useful when:

- there may be no known quarterly indicator that adequately represents the process conceptually, or compilers do not wish to assume an indicator is representative of other sources;
- a quarterly indicator may be available but may not relate closely to annual benchmarks;
- the emissions source does not exhibit a seasonal pattern, in which case an interpolated series may approximate an actual and seasonally adjusted series;
- the benchmark series exhibits a stable trend and is not prone to economic shocks;
- the emissions process accounts for an insignificant proportion of an industry's total emissions.

The major drawback with this approach is that it cannot account for sudden turning points, so its use should be limited to minor series or those that move monotonically over time (such as waste sector emissions).

## 2.2 Publication levels

Estimates, in actual and seasonally adjusted units, are produced for seven main industries (from October 2025 this will expand to 15) and households (by category) with gas type information

available for broad industry groups. Emissions intensities for total economy (total industry to GDP) and households (household emissions per number of households) are also provided. From October 2025, emissions intensity by industry will be available.

Data are compiled at significantly lower levels with around 25<sup>7</sup> indicators used in the compilation process. The compilation level uses both industry and process information, e.g. energy used in agriculture, forestry, and fishing. This means the compilation basis is 'dual' so can generate both SEEA and Inventory based estimates. The dual nature of compilation has meant that the emissions accounts are repurposed each quarter to meet key customer needs, including:

- Emissions by inventory sector (i.e. energy, industrial processes and product use, agriculture, and waste) by gas is provided to the Ministry for the Environment each quarter. This series is used for quarterly reporting against government targets and analysis.
- Road transport emissions data are provided to Waka Kotahi (New Zealand Transport Agency) each quarter for reporting on tracking progress towards reducing road transport emissions. Prior to the availability of the quarterly emissions series, Waka Kotahi was relying on data that was subject to significant lags and have found the quarterly data to be of high value.
- The quarterly emissions series is used to generate annual provisional estimates that enable the regional emissions series to be released with an eight-month lag from the reference date, as opposed to 20 months.

## 2.3 Seasonal adjustment

Quarterly greenhouse emissions are subject to significant seasonal patterns that necessitate the application of standard seasonal adjustment techniques. Seasonal adjustment, although standard, may be unfamiliar to compiler of environmental accounts where annual data are more commonplace.

The standard X-13 ARIMA SEATS procedure has shown to be applicable to greenhouse gas emissions data by Pegoue et al (2023). This package is also used by Stats NZ for seasonally adjusting quarterly greenhouse gas emissions. Moreover, New Zealand's greenhouse gas emissions data are more prone to seasonality, and more likely to require adjustment, than economic series.

Seasonally adjusting emissions data has two advantages: firstly, quarter on quarter (as opposed to same quarter last year) comparisons can be made; secondly, it enables greater comparisons with seasonally adjusted economic data. The presence of seasonality will differ by industry. Agriculture, transport, and heating/cooling, for example, demonstrate significant seasonal patterns, but peak at different times of the year. However, there is no reason to assume the seasonal patterns for emissions align with economic data. Therefore, if emissions are not seasonally adjusted and compared to actual GDP there will be distortions in the comparison.

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<sup>7</sup> There are approximately 25 main indicators from unique sources. However, many of these have sub-category lines e.g. quarterly energy consumption tables by broad industry group.

**Figure 2: Seasonal adjustment overview**

**Seasonal adjustment overview**

$$\text{Actual value} = \text{trend} \times \text{seasonal factor} \times \text{irregular movements}$$

**Rationale:** 1) make meaningful quarter on quarter comparisons 2) enable comparisons to seasonally adjusted economic statistics

A quarterly time series consists of three components:

- The **trend** reveals the smooth, relatively slow-changing features in a time series. They are usually estimated by applying repeated moving averages.
- The **seasonal component** shows the seasonal patterns found in many sub-annual series. It is reasonably stable in terms of annual timing, direction, and magnitude and can be caused by natural factors, administrative measures, and fixed social traditions or behaviours.
- The **irregular** component is the part of the observed value that is not included in the trend cycle or the seasonal effects. Its values are unpredictable regarding timing, impact, and duration. Irregular movements arise from a combination of factors such as sampling error, non-sampling error, unseasonable weather, natural disasters, and strikes. Random fluctuations are the main cause. The irregular component is estimated as a residual.

There will also be different seasonal patterns of series within an industry (or aggregation of industries). These patterns are shown in table 2 below. In addition, in the analysis of series for the upcoming release of disaggregated industry data it was observed that some, but not all, manufacturing industries exhibited significant seasonal patterns, and the peak quarter and intensity of the peak also varied.

As with the annual production emissions estimates, there are also estimates for households' direct emissions for the following categories: transport; heating/cooling; and other. For households the pattern of seasonality in transport emissions was different to that for heating/cooling and for this reason household emissions are seasonally adjusted at the component level and then aggregated.

**Table 2: Presence of seasonality across industry and households**

## Presence of seasonality across industry and households

Industry	Presence of seasonality	Peak quarter(s)
Primary industries	Yes	March/December
Agriculture, forestry, and fishing	Yes	March/December
Mining	No	–
Goods-producing industries	Yes	December/March
Manufacturing	Yes	December
Electricity, gas, water, and waste services	No	–
Construction	No	–
Service industries	Yes	September
Services excluding transport, postal, and warehousing	Yes	September
Transport, postal, and warehousing	Yes	September/March
Total industry	Yes	March/December
Households <sup>(1)</sup>	Yes	
Transport	Yes	December
Heating/cooling	Yes	September
Other	No	–
Total (industry and households)	Yes	March/December
1. Household emissions are seasonally adjusted at the component level and then aggregated.		
Symbol: – no peak quarters		
Source: Stats NZ		

## 2.4 Challenges in measuring quarterly emissions

As previously mentioned, quarterly emissions are a relatively new area of statistics and only published by a handful of countries. Along with New Zealand, quarterly emissions are published by Sweden, the Netherlands, the UK, IMF and Eurostat on a SEEA basis, and by Australia and Ireland on a greenhouse gas inventory basis. Table 3, below, summarises the state of global quarterly emissions accounting. Differences across countries are observable in terms of the basis of the quarterly account, technical methods employed, level of compilation, and published detail (including analytical indicators). Although not explored with reporting agencies, it is likely that some of these differences may be due to either quarterly emissions still being a relatively new area of statistics and there being no standards or recommendations in place for their production, or domestic (policy) needs and data availability shaping the possible outputs.

**Table 3: Comparison of international examples of quarterly greenhouse gas emissions**

	New Zealand	Sweden	UK	Australia	Netherlands	Ireland	International	International
Agency	Stats NZ	Statistics Sweden	Office for national statistics	Department of Energy, Climate Change, the Environment and Water	Statistics Netherlands	Environment Protection Agency	International Monetary Fund	Eurostat
Basis	Residency	Residency	Residency	Territorial	Residency/Territorial	Territory	Residency	Residency
Breakdown by gas type	Y	Y	N	Y	Y	N	Y	N
Seasonal adjustment	Y	N	Y	Y	N	Y	Y	N
Weather adjustment	N	N	N	Y	Y	N	N	N
Time series start (published)	2010	2008	1999	2005	2019	2018	2010	2010
Compilation level	25 indicators covering processes and industry	ISIC 2	ISIC 2	CRF	Selected categories from ISIC 2	CRF by category, 58 indicators	ISIC 2	Estimation level includes 46 data points
Level of published detail								
Industries	7	35	Total only	N/a	4	N/a	8	8
Households	By category	Total	N	N/a	Total	N/a		Total
Sectors (if data are territory based)	N/a	N/a	N/a	8	6	7	N/a	N/a
Indicator method	Denton		Chow-Lin	Denton	na	Chow-Lin, Fernandez, Denton	Denton	
Analytical indicators	Emissions intensity of the economy; emissions per household	Emissions intensity	Emissions intensity; emissions per head of population		Total CO2 and total GHG emissions on quarterly basis		N	N
Timeliness	3 ½ months	5 months	4 months	6 months	2 months		6 months	4.5 months

Footnote: The Environment-economic accounts team at Stats NZ have undertaken to check the accuracy of the information in this table but acknowledge it may contain errors.

Quarterly emissions pose several compilation challenges that need to be addressed to determine the level of utility of the series. These include:

- Volatility – while regular seasonal patterns can be accounted for, irregular movements are a feature of a seasonally adjusted and actual series and can in some cases dominate overall movements. This is the case for emissions from electricity generation which vary significantly quarter-to-quarter depending on the fuel mix used, largely because of hydrological conditions. Even for New Zealand where approximately 80 percent<sup>8</sup> of electricity is generated by renewable energy, and there is a strong seasonal pattern in the underlying demand series, shifts in coal and gas use can drive total economy emissions in a quarter. The irregular component of the series dominates, masking any underlying seasonal pattern.
- Compilation level and availability of indicators – annual air emissions accounts are available at a low level of detail, and in the case of New Zealand the corresponding process emission is maintained in underlying datasets. However, quarterly indicators are often available at higher levels of detail. Such indicators may therefore cover multiple industries or processes, thereby limiting disaggregation without further methodologies. Compilation at lower levels, where possible, is advisable to improve quality.
- Validation of indicators – additional analysis (such as benchmarks-to-indicator ratios and statistical tests, e.g. correlation coefficients, Kendall’s tau, mean percentage error) is often required to ensure the indicators are providing accurate results.
- Revisions – the quarterly series remains fixed to annual benchmarks. However, quarterly input data may revise at any point during the year. If the quarterly indicator is a consistent data source with that used to compile the inventory or SEEA benchmarks, then the following situation may arise:
  - The annual benchmark will not revise but will be known to be subject to change.
  - Quarterly data will revise but quarterly movements will be constrained by annual benchmarks that have not been updated. These quarterly movements will revise again when benchmarks are updated.
- Responsiveness to change – quarterly emissions estimates are recalculated in full with each new release. This methodology allows for the integration of new or revised data sources as they become available, improving the accuracy and timeliness of the estimates. Because the entire time series is updated each quarter, internal consistency is maintained within each release. However, this approach may pose challenges for users comparing data across different quarterly publications, as previously published figures may be revised in subsequent releases.
- Communication – given the interest in greenhouse gas emissions, many users may be keen to see how emissions have changed but may be more familiar with the GHG inventory than SEEA based estimates. Where residency adjustments are changing rapidly, it should be communicated to users that the movements in total SEEA-based emissions are not necessarily reflective of the movements in Inventory based estimates.

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<sup>8</sup> Quarterly average in gigawatt hours over the same period as the quarterly emissions account. See data tables for electricity from [mbie.govt.nz](http://mbie.govt.nz)

## 2.5 Sub-annual estimates of other Central Framework accounts

Stats NZ have also produced sub-annual estimates for water physical stocks. While the primary presentation for the water physical stock account is according to the hydrological year (i.e year ended June), the addition of quarterly data offers greater analytical flexibility with different reference years. For example, precipitation could be examined as a March year to compare with quarterly, annual, or regional GDP in the Agricultural industries or as a December year to see what effects a period of lower rainfall has had on emissions from the electricity generation and on-selling industry<sup>9</sup>. However, due to the presence of long-term climate cycles, seasonal adjustment of water physical stocks data is problematic. With the next release we plan to work with the National Institute of Water and Atmospheric Research's (NIWA – the data suppliers) to construct a seasonal trend series like that used for climate data in the environmental reporting series (Stats NZ, 2023).

Quarterly accounts for fish monetary stocks and environmental taxes have not been tested but would face compilation issues if attempts were to be made. An issue with some administrative data and quarterly accounts is the presence of different dates for end of year filings and balanced final settlement filings. This is the case in New Zealand for transactions in both the emissions trading system (ETS) and fisheries quota management system (QMS). This results in temporal patterns in the data reflecting obligations due to regulation rather than activity and may affect the ability to compile meaningful quarterly accounts.<sup>10</sup>

## 3 Regional greenhouse gas emissions

Regional annual greenhouse gas emissions were developed in 2018–20 after strong demand for sub-national emissions data became apparent.

Several regional councils had undertaken their own greenhouse gas emissions inventories, based on the Global Protocol for Community Scale Greenhouse Gas Emission Inventories (GPC) framework, but these were compiled periodically and only by better resourced councils. In addition, different methodologies were employed by different compilers. There was therefore a desire for a nationally complete and consistent set of regional greenhouse gas emissions. As a result, the regional SEEA based emissions series was strongly welcomed by regional councils as a means for tracking progress regularly and consistently. Appendix 2 contains more information on user feedback of the regional emissions account.

The regional councils also welcomed the timeliness of the data. The quarterly emissions series enabled the time lag of the regional emissions series to be reduced significantly and thus meet the needs of regional emissions statistics users.

The annual greenhouse gas emissions (industry and households) account has a time lag of 1 year and 4 months due to the lag in the greenhouse gas inventory. The quarterly series enabled the annual

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<sup>9</sup> The annual greenhouse gas emissions industry and household account is available at a 116-industry level.

<sup>10</sup> This situation may also arise in quarterly emissions estimation where fuel sales is used as an indicator, but the consumption of the fuel may spill into subsequent quarters.

benchmarks to be extended, enabling an annual provisional estimate for regional emissions to be compiled and the lag to be reduced to 8 months.

The regional land transport group (a collective of around 6 regional councils) had noted the lag which initially existed in regional emissions data was a key barrier to them using our existing regional emissions statistics for monitoring purposes but have since strongly welcomed the development to reduce the lag.

### 3.1 Overview of methods

The general approach to measuring greenhouse gas emissions applies an emissions factor to activity data. This can be extended in principle to sub-national estimates. However, in practice, the methodology used by Stats NZ is primarily a top-down methodology that allocates national level emissions to regions using an appropriate activity variable and assuming the national level emission factors apply sub-nationally (i.e. constant emissions factor or emissions intensity assumption). In some cases, estimates may be constructed from a bottom-up method and then scaled to national level estimates for consistency (e.g. household heating using wood and coal, dairy manufacturing, and flights data weighted by emissions factors by plane type).

National industry emissions are allocated to region directly if emissions are known to only be produced in that region or allocated proportionally using the most relevant and available region by industry datasets. The overall approach prioritises direct allocations (i.e. where the allocation to region can be made using a data source that is broadly consistent with the national level approach) with imputations made for remaining emissions to ensure full national coverage is obtained.

Where there is only one emitting unit in the country for a particular process emission, the emissions from that unit can be allocated directly to a region. This may be the case for emissions from industrial processes, such as aluminium or steel. The approach for allocating such emissions must, however, be a dual compilation approach to utilise data on both the process emission and other relevant industry-level emissions data. Directly allocated emissions amount to around seven percent of regional emissions.

Region level activity variables may be consistent with those used at the national level (e.g. livestock numbers, electricity generation) or a proxy variable (e.g. employment, economic output). In the latter case, additional assumptions are required about the relationship between the national level activity variable and regional proxy.

Note that the proportions that can be used to allocate to region do not need to be in physical quantities of the same unit used in calculating national level emissions. Rather, a proportion which reflects the relative share of emissions (i.e. relative activity) is appropriate. Monetary data can also be used to form proportions and are equal to physical ratios where prices are similar across regions. Regional price differences are, however, accounted for in estimating regional fuel use and emissions given these data are available.

A table of data sources for forming proportions has been provided at appendix one. These have been categorised into data type and domain. The shorter summary below shows that due to data

availability these vary across years with, for example employment data from the social domain being relied on to a greater degree in the provisional estimate year.

**Table 4: Regional greenhouse gas emissions source data summary**

Percentage of total CO2e emissions		
Data type	Final inventory year (2023)	Provisional estimate year (2024)
Administrative	22	39
Official statistics	24	6
Statistical model	2	2
Survey	52	53
Data domain	Final inventory year (2023)	Provisional estimate year (2024)
Economic	91	75
Environmental	7	7
Social	2	18

The emissions factors and global warming potentials are consistent with the GHG inventory and Stats NZ’s greenhouse gases by industry and household’s series.

To estimate emissions by region, the principles, concepts, and definitions from the SEEA were applied to allocate industry emissions to region. The allocation of emissions depends on the following central principles:

- As emissions are due to either an output from an industrial activity or direct emissions by households, the regional allocation mechanism is to reflect its source and economic unit.
- Unless it can otherwise be ascertained, the production technology for a given industry is the same across regions.
- To link to economic and population statistics, the residency principle is to be applied
- Emissions are to be attributed to the operator.
- To avoid double counting, only direct emissions in a defined regional boundary are to be measured.

### 3.2 Challenges in measuring regional emissions

There are three key challenges to measuring sub-national emissions. Firstly, user demand (particularly for regions undertaking their own reporting) is often for ‘inventory based’ estimates as opposed to those based on the SEEA, and at a more granular spatial level than can be estimated at a level suitable for the purposes of official statistics. If user needs are to be met, then this has implications for the design of the regional emissions account. However, a survey sent out to regional councils in 2021, and a follow up in 2022, found that most respondents increasingly described Stats NZ’s regional GHG series as essential/critical (see appendix 2). Secondly, the application of the residency principle requires care for transport related emissions. Thirdly, as regional emissions are estimated using a top-down approach, modelling assumptions need to be made and the impact of these understood. This section discusses each of these considerations.

### 3.2.1 Meeting user needs

#### 3.2.1.1 Choice of framework

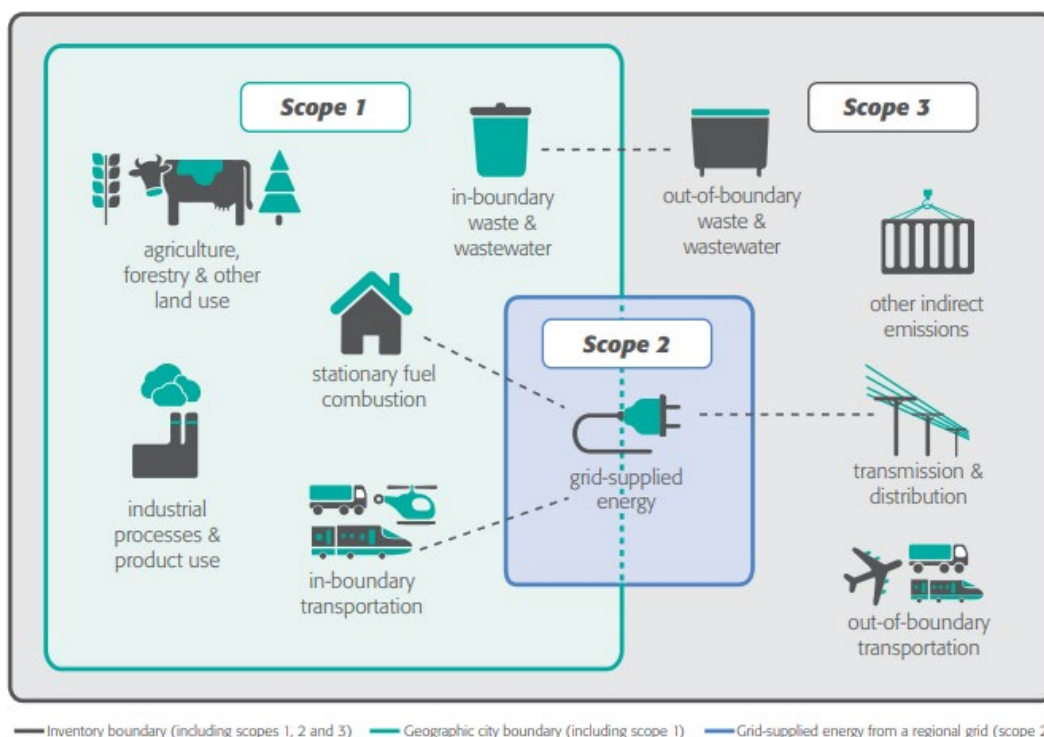
Emissions estimates are often compiled by regions using the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) framework. The SEEA framework has some overlap with the GPC framework but the two approaches are distinct. The GPC framework more closely aligns with the Greenhouse Gas Inventory, in utilising the territory principle and a similar classification system based on the process of emissions. Much demand for regional emissions is for those on a GPC basis as this is a framework that has been designed to be applied at sub-national scales.

A key difference between the two approaches is that the SEEA approach is solely production based and uses the residency principle, whereas GPC is mainly production based but includes elements of consumption-based emissions and uses the territory principle and records sequestration. These differences in approaches and coverage reflect the different purposes of SEEA and GPC.

In the GPC approach, the focus is on the territorial boundary and does not distinguish whether the emitter is a resident or non-resident. Figure 3 below shows the link between the Inventory and Geographic city boundaries where emissions are categorised into 'scopes' based on where the emissions physically occur. The GPC records emissions for an area as either:

- Scope 1 – GHG emissions from sources located within the area boundary.
- Scope 2 – GHG emissions occurring because of the use of grid-supplied electricity, heat, steam and/or cooling within the area boundary.
- Scope 3 – all other GHG emissions that occur outside the area boundary as a result of activities taking place within the area boundary.

**Figure 3 Sources and boundaries of city GHG emissions (GPC framework)**



Source: Global Protocol for Community-Scale Greenhouse Gas Inventories

In principle, regional estimates from the SEEA framework broadly align to GPC scope 1 (direct emissions). However, SEEA also records emissions of a region's residents from activities taking place in other regions.

Scopes 2 and 3 align more closely with the consumption perspective or indirect emissions rather than production. Comparisons between GPC and SEEA should only be made for scope 1 GPC estimates to avoid double counting, noting the differences in compilation principles particularly for energy.

Another key difference is that the SEEA estimates are by industry and household while the GPC is based on sectors and emissions processes. Stats NZ release estimates for broad sectors (energy, industrial processes and product use (IPPU), agriculture, waste) to enable comparability to regional inventories. However, it should be noted these estimates are constructed using the residence principle. For IPPU, agriculture, and waste, the estimates from SEEA should approximate those in a regional inventory as location of residence is likely to equal location of activity. For energy, however, the estimates will differ given the non-stationary nature of many energy-related emissions.

At the national level, production of electricity aligns with consumption. However, at a regional level there may be significant differences between the two approaches depending on the extent by which electricity is either generated within a region or imported from other regions, and the extent of renewable energy sources in a region.

The ability to meet needs for GPC based emissions at a regional level is limited by differences in the frameworks directly (e.g. production vs consumption, gross vs net) but will be completely restricted unless a dual compilation approach is utilised.

### 3.2.1.2 Sub-regional emissions information needs

While regional level emissions have been of high interest in New Zealand, there is also high demand in understanding emissions at the territorial level. In New Zealand, a territorial authority (TA) is a local government body responsible for a specific geographic area, typically a city or district. There are 16 regions and 68 territorial authorities in New Zealand. These authorities are the second tier of local government, below regional councils.

Estimating emissions at this level is conceptually the same as estimating at the regional level. However, this has significantly higher data requirements. If activity data are available, additional assumptions may be required if the data are different to those used to disaggregate to regions, or there may be additional uncertainty if the data source was not designed for use at that level. In New Zealand there is also the issue that the regional and territorial boundaries are not aligned as some TAs span multiple regions.

Table 5 below summarises source of emissions that can be allocated to TA level using robust data sources. These sources were identified following a customised request for a particular region. While some key emission sources could be measured, there were significant coverage gaps, highlighting the difficulties in estimating emissions at this geographical level.

<b>Table 5. Sectors and sub-sectors of city GHG level emissions framework</b>		
<b>Sectors</b>	<b>Sub-sectors</b>	<b>Able to be included within initial territory level estimates</b>
Agriculture, forestry, and other land use	Crop production	Yes
	Fertiliser	Yes
	Livestock	Yes
	Land	No
	Aggregate sources and non-CO2 emission sources on land	Yes
Stationary energy	Agriculture, forestry, and fishing activities	Yes
	Commercial and institutional buildings and facilities	Yes
	Manufacturing industries and construction	Yes
	Residential buildings	Yes
	Energy industries	No
	Non-specified sources	No
	Fugitive emissions from mining, processing, storage, and transportation of coal	No
	Fugitive emissions from oil and natural gas systems	No
Transportation	Off-road transport	Yes
	Road transport	Yes
	Aviation	Yes
	Railways	No
	Waterborne navigation	No
Industrial processes and product use	Disposal	Yes
	Manufacturing	Yes
	Stocks	Yes
Waste	Farm fills and rural waste	Yes
	Solid waste disposal	No
	Biological treatment of waste	No
	Incineration and open burning	No
	Wastewater treatment and discharge	No
Source: Global Protocol for Community-Scale Greenhouse Gas Inventories, An Accounting and Reporting Standard for Cities, Version 1.1		

### *3.2.2 Applying the residency principle*

Regional GHG estimates were compiled to be consistent with the published national (SEEA) estimates, with the intention of enabling the sum of the regions to equal national-level estimates. The SEEA uses the residency principle to maintain consistency with the national accounts. In national accounts, value-added (i.e. GDP) is allocated to the region in which the firm or branch is resident, based on the physical and legal existence of a unit in that region. To maintain compatibility with the SEEA and national accounts, this same principle was applied to estimating emissions on a regional level.

The residency principle is one of several system boundaries that can be applied to measuring emissions for a region. The residency principle allocates the activity to where the unit undertaking the activity is based, even though that activity may happen in a region other than where they are resident or even overseas, while the territory principle allocates to the territory where the activity takes place. Ultimately, the choice of principle depends on the purpose for which emissions are being measured and the framework which these estimates will be incorporated into.

As an illustration of the difference between the two principles, if a family who live in Wellington take a vacation by car to Hawke's Bay (approximately 4 hours drive), the residency principle would allocate the fuel purchases (and emissions) associated with the trip to Wellington (whether the fuel was purchased in Wellington, Hawke's Bay, or elsewhere on route). In principle, the territory principle would allocate the emissions to the region where the fuel was burnt (e.g. distance travelled within each region) which may or may not be where it was purchased. However, in practice (due to data availability), the emissions may be allocated based on fuel sales assuming the fuel was burnt where it was purchased.

The rationale for the residency principle is to maintain consistency with the national accounts. For determining whether a unit is resident, it is assessed whether it has a "centre of economic interest" in New Zealand. Movement of freight by road, for example, may entail activities and expenditures in regions other than where the freight company is usually resident, i.e. reflect the territory principle. To align with the residency principle, the foundational principles of the allocating dataset need to be understood and possibly adjusted for coherence.

Issues in implementing the residency principle can arise where a unit undertakes some sustained activity in another region. In practice, it is generally accepted that units present in an area for less than 12 months are not resident. Notional units are sometimes established (in both the regional economic and emissions accounts) to reflect a unit's centre of interest in a region where otherwise it might not be considered resident, for example where no legal unit exists.

Allocations based on residency and territory principles differ when:

- there are no actual producer units in the region in which the activity takes place, or
- an activity spans many regions.

Examples of the first situation include mobile labour (travelling salespersons), mobile capital (aeroplanes, rail), and capital assets located separately from their production units. For mobile capital, we define there being a notional unit in a region if it contains a point of origin or destination.

Examples of the second situation include infrastructure assets. These situations pose issues which are difficult to resolve whichever concept is adopted. As an example, large capital assets such as buildings or dams may not always be recorded in business registers. When a significant unit is identified in an area and data is available, a notional unit may be created for regional GDP or emissions compilation purposes. In this case the allocation will be the same under the residence and territory approaches.

Emissions from agriculture, the industrial processes and product use (IPPU), and waste sectors are largely from stationary sources, given the fixed nature of capital used in their generation. Emissions from these sectors measured under either a residence or territory approach may be broadly similar (except for due to methodological differences or differences in source data).

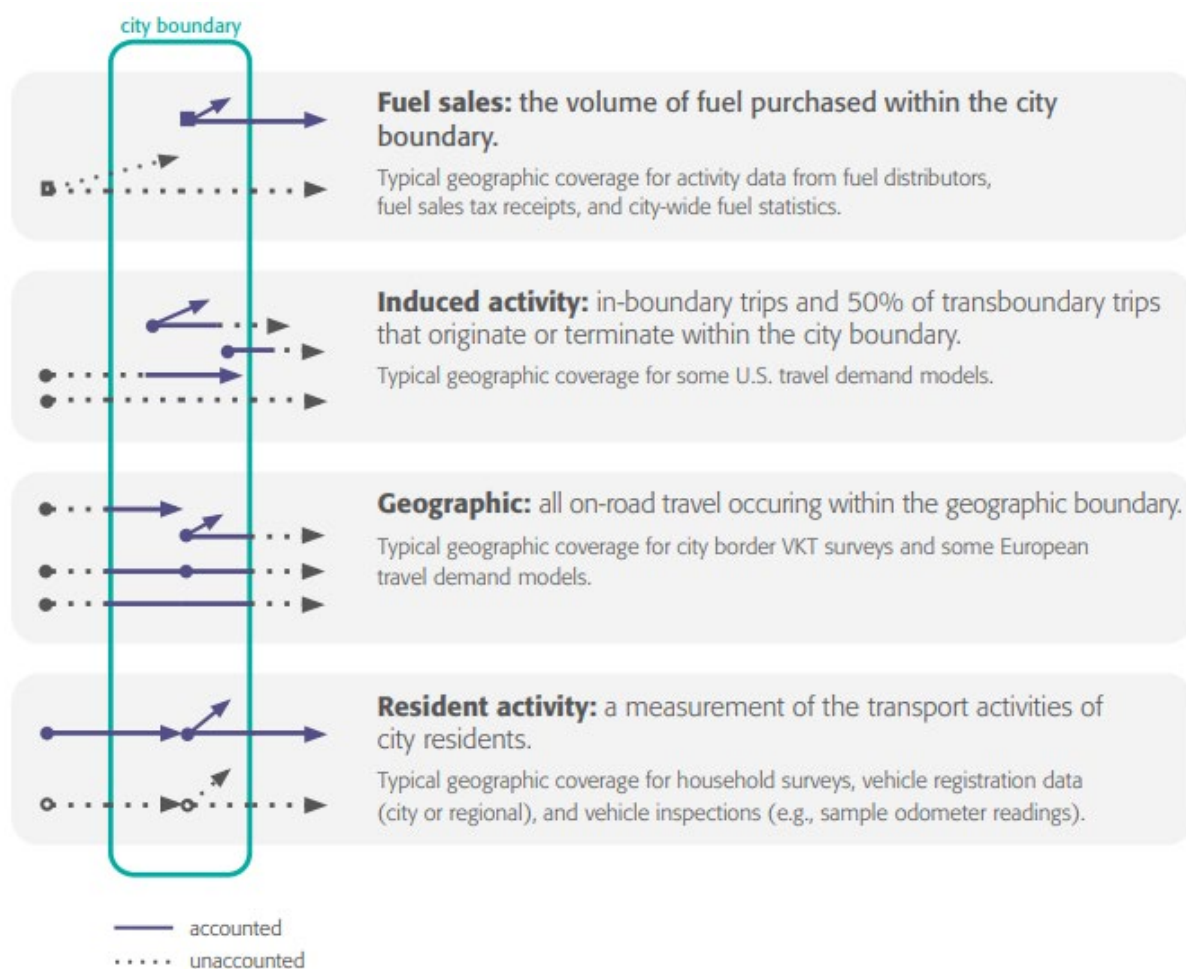
In the case of energy, where emissions can be from stationary or mobile sources, emissions measured using the residency principle or geographic/territorial principle may differ substantially. This is observable in the national level production based SEEA estimates where total emissions are greater than those of the gross GHG inventory (which is based on the territory principle) because emissions by residents overseas are greater than non-residents on the territory. At a regional level,

this situation may arise due to firms purchasing fuel in other regions, or fuel in a region being purchased by international tourists. The implications of adjusting for residency in relation to road transport and aviation are discussed further below.

### 3.2.2.1 Road transport

Allocating national road transport emissions to regions using the residency principle is the most complex process for regional emissions. The main reason for this is that to allocate on a residency basis, emissions from outside the geographic boundary need to be allocated to the resident emitter, and neither the residency nor geographic boundary approaches align with the main available data source, that being fuel sales. This is illustrated in figure 4, below, which shows that there are several different conceptual approaches for calculating on-road transportation emissions and the impact of these on the allocation of trans-boundary emissions.

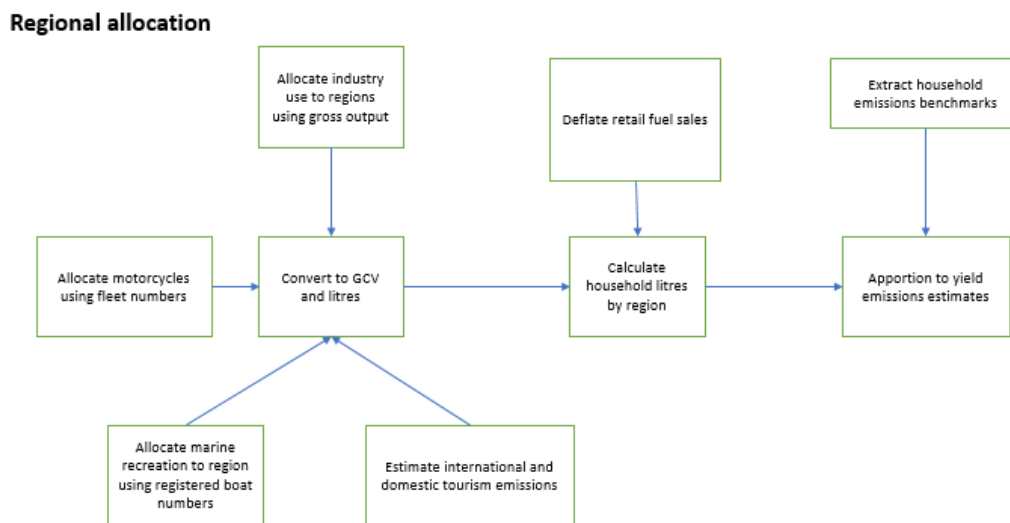
**Figure 4 Methodology system boundaries for road transport**



Source: Global Protocol for Community-Scale Greenhouse Gas Inventories

The starting point for allocating road transport emissions to region, on a residency basis, is the national air emissions account.<sup>11</sup> Allocating to region entails establishing estimation processes for industry, tourism (domestic and international), and households. As the household component is estimated residually, the emissions estimates for industry, tourism, and non-road transport use by households are converted into litres of fuel used so they can be removed from retail fuel sales data which is the primary distributed mechanism for households. These processes are summarised in Figure 5 below.

**Figure 5: Regional allocation of road transport emissions overview**



For cars and trucks (both light and heavy duty) from industry, road transport emissions are allocated to region using regional gross output from regional GDP. Buses are allocated to region using administrative data on kilometres travelled. Emissions from cars and light duty trucks are converted to litres of fuel used to be deducted from retail fuel sales data.<sup>12</sup> Heavy trucks and buses are not converted in this manner as they are assumed to be not using retail outlets. Motorcycle emissions are distributed based on fleet numbers from the Ministry of Transport and are also converted to litres for deducting from retail fuel sales.

Emissions and litres of fuel consumed by tourists, by region, for domestic and international, are estimated by deflating regional fuel sales data. The tourism related expenditure data is supplied by MBIE with regional prices sourced from Stats NZ's prices unit.

<sup>11</sup> Following the categories set out in the guidance produced by Eurostat (2018) on measuring road transport emissions by industry, we have assessed that the approach used by Stats NZ meets the standard of category B: sufficient, acceptable. In allocating to region, further uncertainties and assumptions are generated. However, cross-validation with other data sources has determined the regional estimates are of similar quality.

<sup>12</sup> Litres of fuel used are estimated based on converted emissions to gross calorific values, and then using fuel properties data, such as density, from energy statistics to convert to litres.

Fuel sales data includes expenditures on non-road transport use, which is generally considered to be related to fuel for recreational boats. There is no licensing requirement for recreational boats in New Zealand, but the trailers used to move these boats must be registered so marine recreation emissions are allocated to region based on registered boat trailer numbers.

Once all these components are estimated, household litres for road transport can be computed. Total regional fuel sales are deflated by price data to obtain litres of fuel sold by region. Household litres consumed by region for the purpose of road transport are calculated as total regional litres sold less litres sold to tourists and industry and for marine recreation use.

### 3.2.2.2 Aviation

Domestic aviation emissions are allocated equally between departure and arrival locations, to reflect that both domestic airports reflect centres of economic interest for any given flight. Emissions are estimated per flight, using flight movement data, plane characteristics (e.g. weight, capacity), and distance travelled, and then total flight level emissions are scaled to the national level estimates.

International aviation was recently included in the regional emissions account so that the national and region level estimates were consistent. International aviation is treated differently to domestic aviation because emissions are not allocated to overseas airports to be consistent with the residency principle. All international aviation emissions from domestic carriers are allocated first to New Zealand (their country of economic residence). Emissions are then calculated by flight and allocated to the domestic region in New Zealand.

### 3.2.3 Modelling assumptions from using economic data to allocate to region

Data on regional economic activity is used when there is an absence of data to make a direct allocation of emissions to regions. The ability to use these data sources is a benefit from the conceptual alignment between the SEEA framework and the national accounts. Underpinning this method is the assumption that firms within the same industry will have the same production function (i.e. the same processes are used to convert inputs to outputs).

Activity data used to allocate across regions does not always account for region-specific technologies. This means a national average emissions factor is applied but may not always be appropriate.

Differences in technologies are accounted for where data is available. However, the distribution of some technologies' sources (for example, domestic wastewater, or coal boilers in education facilities) across regions are unknown, which may cause bias in regional estimates. Agricultural estimates, except for dairy cattle, have some uncertainty at the regional level as differences in emissions factors by land type and productivity are not accounted for.

The allocation from industry to region is made for 116 industries. This level of granularity improves the accuracy of the regional emissions estimates by allowing the form of the production function to vary across detailed industries (the alternative is to assume aggregate production functions which do not account for specialisations within regions). Regional economic data for 16 regions is used in the compilation process.

This production function assumption does not hold when:

- the industries underlying the industry level of compilation differ in terms of their emissions profile (e.g. sub-industries within electricity and gas supply include hydropower, other renewables, and fossil fuel generation) and are not even distributed spatially;
- when a region possesses a different technology to other regions that affects emissions per unit of output (e.g. regional variation of public transport modes and transport electrification levels).

In these cases, alternative methods and sources are utilised. As a general principle, data chosen should be consistent with that underlying the greenhouse gas inventory or emissions account to lessen the prevalence of the production function assumption.

When using economic activity data, we use gross output to allocate to regions as opposed to value added (gross output less intermediate consumption). Gross output is preferable for allocating emissions to regions for the following reasons:

- It gives an indication of the regions' level of production that is comparable across regions and more robust when there are changes of behaviour from output or input price changes (and as a result estimates are less volatile).
- It captures the use of capital, labour, energy, materials, and services in production, rather than just capital and labour which is important in the context of emissions measurement.
- It reflects the whole of industry production approach that aligns to the approach of measuring emissions by industry, which collates emissions by inventory sector. This means imputations, using gross output, can be made for an industry whether its emissions come from the agriculture, energy, industrial processes and products use, or waste sectors.
- Value added can be negative while emissions are still occurring, while gross output is positive and better represents the extent to which production is occurring.

Gross output data are compiled as part of the annual regional GDP statistics. The [national accounts \(industry production and investment\)](#) series is produced from reconciled goods and service flows that are an outcome of the annual balancing process that ensures consistency between the production, expenditure, and income approaches to measuring GDP. These statistics form the basis of the industry dimension used in regional GDP. For most industries, regionalisation is implemented using geographical information about business locations already held by Stats NZ.

While the use of economic data for allocating emissions from economic sources aligns the emissions to the underlying units, this approach entails an assumption of equal production functions for an industry across regions. This may not account for efficiency gains from agglomeration economies. Further consideration of this may be warranted in time, but no clear approach for accounting for this is currently known.

### 3.3 Spatialisation of other Central Framework accounts

As well as greenhouse gas emissions, Stats NZ has demonstrated that water physical stock accounts can also be presented on a sub-national basis.

The [water physical stock account](#) has been produced on a regional basis since its development in the early 2000s and was produced on a quarterly basis for the first time in May 2021.

In New Zealand, water resources and allocation are managed by regional councils, and regions mostly have the same boundaries as the catchments. (Westerhoff, White and Miguez-Macho 2018). In 1989 responsibility for water resources was transferred from Catchment boards to Local government. (Knight, 2019).

The Water Physical Stock Account, provides information on New Zealand's national and regional water balance, including the inflows and outflows of water through the inland part of the hydrological cycle, changes in storage, and estimates of hydro-generation water use<sup>13</sup>. But much of the focus within regions is on specific issues at a much finer spatial level than the region. Issues such as specific point measurements of pollution or runoff, swim ability of water courses, over allocation of surface or ground water resources require detailed point level information for management. For this reason, the water physical stock account, is usually described as falling into the climate rather than freshwater domain and being of use as a climate indicator. Key facts from the last release *Water physical stocks, year ended June 1995–2020* show that New Zealand is getting drier with average annual rainfall for the five years 2016–2020 being 3.1 percent below the previous five-year average and 10.7 percent below the five-year average for 1996–2000.

Customers have made requests for the fish monetary stock account to be produced on a regional basis. But fisheries are organised into [management areas](#) (FMAs) which don't align to regional boundaries and nor do they neatly overlap with each other. In addition, most landings will be at the nearest point to the most productive fishing areas. Although it would be possible to produce accounts by FMA the fact that they do not overlap by species means that confidentiality issues and lack of data would prevent this work from being able to be completed to a publishable level of quality and coherence. For these reasons work on a regional or sub-national fish account was not progressed.

## 4 Conclusion

This paper has presented Stats NZ's work on measuring greenhouse gas emissions on quarterly and regional bases. It has provided rationales for developing these accounts, overview of methods (given their relative novelty), and highlighted key considerations in developing such accounts.

Quarterly accounts can add value to existing estimates by providing timely information on change to emissions associated with economic, technological, social, or environmental shocks. Quarterly accounts allow better examination of the response to an event which might otherwise be difficult to observe in an annual series. The Denton benchmarking technique, commonly used to compile quarterly gross domestic product, has been shown to be applicable to measuring quarterly emissions. Where no indicator is available, however, estimation is still possible using interpolation

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<sup>13</sup> Due to the technical and measurement aspects of the data it is supplied under contract from the National Institute of Water and Atmosphere and the Institute of Geological and Nuclear Sciences Limited.

and forecasting techniques. The rationale in using this approach is to enable complete coverage by estimating series otherwise measurable using indicator method.

Addressing seasonality is a main challenge in compiling quarterly emissions accounts, but existing techniques used by national statistical offices are again sufficient for this purpose. There are significant seasonal patterns in emissions at the total level and in the underlying series, with the timing of the peaks often differing across economic sectors. Seasonal adjustment is important to be able to directly compare quarter-on-quarter movements and to enable greater comparisons with seasonally adjusted economic data. There are compilation challenges for example, where one or more series may not be able to be seasonally adjusted due to volatility and where, in the case of emissions revisions and data updates flow into the quarterly series before being integrated into the Inventory. In these cases, communication with users will be important. Compiling quarterly emissions accounts using a dual approach, where process information is retained alongside the industry classifications, means that Inventory based forecasts can also be produced. This increases demand for the series as a process approach may be requested for specific policy or monitoring.

Spatialisation of Central Framework accounts is possible and has been demonstrated for air emissions. In most cases, where the emissions source has a fixed location, spatialisation is straightforward and there will be coherency between the residency and territory principles to measuring emissions. However, for consistency with the System of National Accounts, the residency principle can be challenging to apply to transport related emissions and requires great care. Depending on the significance of transport emissions to the economy in question, and whether there are sufficient data to account for the residency principle, this may be a key challenge in compiling sub-national emissions statistics on a SEEA basis.

## Appendix 1

Data type	Data domain	Description	Percentage of total emissions	
			2023	2024
Administrative	Economic	Bus fleet	0.4	0.4
Administrative	Economic	Coal production	0.3	0.3
Administrative	Economic	Electricity generated	4.1	5.5
Administrative	Economic	Flight movements weighted by distance travelled and plane level emission factors	1.6	1.6
Administrative	Economic	Floor area of new building consents	0.7	0.6
Administrative	Economic	International flight data for domestic carriers	3.2	3.4
Administrative	Economic	Million tonne km of rail freight moved	0.1	0.1
Administrative	Economic	Mineral production (tonnes)	0.2	0.2
Administrative	Economic	Registered boat trailers	1.5	1.5
Administrative	Economic	Residual estimation from fuel sales less implicit industry and tourism emissions	7.2	7.4
Administrative	Economic	Residual of total rail less freight	0.0	0.0
Administrative	Economic	Vehicle fleet	0.1	0.1
Administrative	Environmental	Average proportion of relevant Emissions trading scheme (ETS) allocation	0.0	0.0
Administrative	Environmental	Production of vegetables from glasshouses (ETS)	0.2	0.2
Administrative	Environmental	Waste tonnages	1.9	1.9
Administrative	Social	Employment	0.0	16
Administrative	Social	Jobs	0.2	0.2
na	na	Direct allocation in absence of data	0.0	0.0
Official statistics	Economic	Estimated wood removals and gross output from regional GDP (forestry)	0.1	0.1
Official statistics	Economic	Gross output from regional GDP	18	0.6
Official statistics	Environmental	GHG annual emissions - direct allocation	4.9	4.5
Official statistics	Social	Non-rural population	0.2	0.2
Official statistics	Social	Rural population	0.1	0.1
Official statistics	Social	Total population	0.4	0.5
Statistical model	Economic	Coal use data	1.2	1.1
Statistical model	Economic	Estimated wood processed and gross output from regional GDP	0.2	0.2
Statistical model	Social	Population weighted by median income (used for domestic tourism)	0.6	0.4
Statistical model	Social	Road transport model/population and income (mobile aircon)	0.1	0.1
Survey	Economic	Actual rentals*	0.0	0.1
Survey	Economic	AES	0.0	0.9
Survey	Economic	Crop production (APS)	0.3	0.3
Survey	Economic	Emissions, Livestock numbers**	26	26
Survey	Economic	Estimated wood processed: Ministry of Primary Industries	0.1	0.1
Survey	Economic	Estimated wood removals: Ministry of Primary Industries	0.0	0.0
Survey	Economic	Fertiliser use (APS)	0.9	1.1
Survey	Economic	Land use (APS)	0.7	0.8
Survey	Economic	Livestock numbers	24	23
Survey	Social	Households using fuel (Census) and fuel use (ER home heating inventory)	0.1	0.1
Survey	Social	Households using fuel (Census) and gas expenditure (HES)	0.5	0.5
		Grand Total	100	100

ETS: Emissions Trading Scheme

MBIE: Ministry of Business, Innovation & Employment

APS: Agricultural Production Survey

ER: Environmental reporting

HES: Household Expenditure Survey

## Appendix 2

### Presentation and user feedback

A geospatial tool was developed so users could track and compare their regions emissions including emissions intensity per unit of gross domestic product (GDP) and emissions per capita (see [How are my region's emissions tracking?](#)). User feedback is that the app is the preferred dissemination tool over reports, Excel tables and CSV files, although these are all still produced and made available.

During 2021 a survey was sent out to regional councils to get feedback on the usefulness of the account. In 2022, after implementing some improvements, a follow-up survey was sent out. Both found that most respondents described Stats NZ's regional GHG series as essential/critical with the proportion increasing between the first and second mail-out.

Table 6: Local Government utility of Stats NZ's regional emissions account

	2021 survey		2022 follow up survey	
	Responses	Percentage	Responses	percentage
Not needed	0	0	0	0
Nice to have	2	7	1	7
Potentially useful	4	13	0	0
Occasionally used	6	20	2	14
Essential/critical	15	50	11	79
Other	3	10	0	0
Total	30		14	

In 2021 30 responses were received from 13 of the 16 regional councils. Key findings from the survey were:

- Majority of respondents described Stats NZ's regional GHG series as essential/critical
- Most respondents stated that timely emissions data is important for their work (67% recording 4 or 5 out of 5)
- Further industry detail was almost unanimously stated to be of use
- Excel tables are the preferred means for accessing data
- The most useful feature of Stats NZ's emissions data was that it is estimated using a consistent method that enables regional comparisons
- Insufficient level of detail is the main limitation to users
- Finer regional level detail would be of most value to users
- Text responses emphasised need for further work in all areas that Stats NZ were already aware of, including: consumption/GPC based emissions; spatial (including cities) and temporal disaggregation; utilisation of council data.
- New insights from text responses included ideas for: clear guidance on how to compare Stats NZ emissions estimates with others; including emissions projections; improving measurement of emissions from recreational vessels.

A common theme in discussion on the development of SEEA accounts is that they need to be useful and used and importantly, the response from this initial survey was that policy advice particularly

was an important use of the data. Table 7 below shows the results of the question on use of the data in 2021.

Table 7 Use of Regional Emissions by Local Government

Survey of Local Government 2021: How did you use this data? Count of responses	
Research	11
Policy advice	21
General interest	6
Media	8
other	13
Responses (n=30) were received from individuals or organisations in 13 of the 16 regional councils.	

The survey was repeated in 2022. In the intervening year further industry disaggregation was added, a provisionally estimated year was included making the data timelier and an ArcGIS<sup>14</sup> based application<sup>15</sup> was added to the suite of dissemination products.

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<sup>14</sup> ArcGIS Online, a family of client, server and online geographic information system software developed and maintained by Esri.

<sup>15</sup> A link to the interactive tool released on 4 September 2024 is here: <https://www.stats.govt.nz/tools/how-are-my-regions-emissions-tracking/>

World Resources Institute. [Global Protocol for Community-Scale Greenhouse Gas Inventories, An Accounting and Reporting Standard for Cities](#) Version 1.1.