Chapter 3:
How to measure progress

Contents

'Rules for measuring progress' refers to the system for monitoring greenhouse gas (GHG) emissions over time to understand whether Aotearoa is on track to achieve emissions budgets and the 2050 target.

This chapter outlines the Climate Change Commission's role, the objectives and principles used to guide its advice on accounting choices and analysis of a range of accounting matters relevant for emissions budgets. These issues include production versus consumption-based accounting, land emissions accounting, voluntary offsetting and carbon neutrality and detailed legislative requirements related to the scope and presentation of emissions budgets.

3.1 Introduction

3.1.1 Greenhouse gas (GHG) accounting for emissions reduction targets

The methods used to calculate and attribute the amount of GHGs emitted or removed from the atmosphere over time are a critical component of effective climate policy.

Robust and accurate emissions accounting is essential for:

- Setting emissions reduction targets
- Monitoring and evaluating progress towards meeting targets
- Judging compliance at the end of a target period

A key purpose of the emissions reduction targets countries set themselves is to drive actions to reduce human impacts on the climate. The accounting methods used for these targets need to deliver useful data to inform emissions reduction efforts and influence which reduction activities are prioritised.

This link to policy and driving behaviour change is why emissions accounting for targets may differ from national GHG inventories. An appropriate accounting approach would encourage better choices about reducing emissions and avoid wasting resources on misdirected efforts.

3.1.2 The Commission's role

The Climate Change Response Act 2002 (CCRA) requires Climate Change Commission (the Commission) to advise on *"the rules that will apply to measuring progress towards meeting emissions budgets and the 2050 target"* (section 5ZA(1)(b)). These rules, for consistency, need to be incorporated into the analysis for emissions budgets. We must also apply the rules when monitoring and reporting on progress towards emissions budgets and the 2050 target (section 5ZJ), with the first monitoring report due in 2024.

Our first package of advice relates to the first three emissions budgets, covering the 2022-2035 period. In 2024, we will advise on the fourth emissions budget (covering 2036-2040). At that time, there will be an opportunity to revise this advice for the second and third emissions budgets, if this is justified by developments in knowledge or accounting methods.

3.1.3 The Commission's approach

The Government already undertakes various efforts to track emissions in Aotearoa. These include:

- **New Zealand's Greenhouse Gas Inventory (the GHG Inventory)**, the official annual estimate of GHG emissions and removals which have occurred in Aotearoa since 1990. This is produced each year as part of obligations under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. It draws on guidance from the Intergovernmental Panel on Climate Change (IPCC) about GHG accounting best practice and is adapted for the circumstances of Aotearoa.
- The **Nationally Determined Contribution (NDC) target accounting rules**, which have evolved from rules used to account for targets under the Kyoto Protocol and been adapted to reflect our country's national circumstances. NDC target accounting uses GHG Inventory gross emissions estimates but accounts for land emissions differently.[1]
- The **GHG emissions accounts** compiled using the United Nations System of Environmental-Economic Accounting (SEEA) framework, which enable emissions data to be compared to economic statistics. Two sets of national estimates are prepared:
    - production-based emissions by industry and household
    - consumption-based emissions

These approaches each have their own purpose. They are suited for meeting different demands and each puts a specific lens on the nature of our emissions and the factors driving them. Within these approaches, there are also choices about detailed accounting methods or assumptions that can be made.

We do not have the technical capacity or resources to produce our own emissions estimates, so our advice on emissions budgets accounting must draw on these existing approaches. The task therefore is to determine which existing approach and methods are best suited to help emissions budgets and the 2050 target fulfil their role in providing a foundation for stable, predictable policies and driving the actions needed to reduce our impact on the climate.

The 2050 target and emissions budgets have been established through domestic law. This differs from the country's other emissions reduction targets, which are adopted under international agreements and must follow international accounting rules or guidance. This gives more flexibility to include or exclude certain elements of accounting, although broad alignment with existing approaches would have benefits for consistency, credibility and reduced administrative burden.

[1] By 'land emissions', we refer to emissions and removals from land sources and sinks such as forests, vegetation, soils and wetlands. In the national GHG Inventory this sector is referred to as land use, land-use change and forestry (LULUCF). It does not include any direct agricultural emissions such as those from livestock or fertiliser.

3.2 Objective and principles to guide accounting choices

We considered it important to examine the accounting rules for emissions budgets on a first principles basis. To do this, we set a high-level objective for the overall goal of the system.

The Commission's high-level objective for accounting:

A robust, transparent accounting system which tracks genuine environmental gains while balancing completeness with practicality

We have also defined a set of principles underneath the high-level objective, to provide guidance on how to reach that goal. The principles help to ensure we take a coherent approach to the varied range of issues covered by target accounting.

The Commission's principles for accounting:

Accounting for emissions budgets and the 2050 target should*:*

1. Seek to cover all material human caused emissions sources and sinks
2. Be grounded in robust science and evidence
3. Send a clear signal for climate action
4. Be accurate and reduce uncertainty as far as practicable
5. Be transparent, practical and acceptable
6. Be consistent and maintain the integrity of the target

Together, the objective and principles provide a framework to allow actions and trade-offs to be understood and to inform decisions about accounting rules. We expand briefly below what each principle means.

Seek to cover all material human caused emissions sources and sinks

Accounting should strive for *completeness* – aiming for full coverage of sources, sinks and gases across all geographic areas. This parallels Paris Agreement expectations. This needs to be balanced by *materiality* – IPCC guidance recognises that it is acceptable to prioritise more significant emissions sources and sinks.

Be grounded in robust science and evidence

Accounting should reflect the current state of scientific knowledge, drawing on IPCC assessments and guidance. It should be informed by and use evidence and methods appropriate to Aotearoa. New methods and recalculations which improve emissions estimates should be encouraged. These should, however, be subject to independent expert peer review with governance arrangements to oversee approval of the changes.

Send a clear signal for climate action

A key purpose of emissions budgets and the 2050 target is to drive the policies and actions needed in Aotearoa to transition to a low-emissions economy and contribute to limiting climate change. Accounting for these targets should therefore focus on distinguishing the lasting changes in emissions resulting from human actions, rather than capturing variations or changes which cannot be influenced by changing human behaviour now or into the future. It is important to consider how accounting would inform and interact with policy in terms of the mitigation that is recognised. The intent of policy is to encourage actions that are additional, in the sense of driving change from what would happen under business-as-usual.

Be accurate and reduce uncertainty as far as practicable

Accounting approaches should be accurate and reduce uncertainty as far as practicable. This would help emissions budgets fulfil the goal of providing greater predictability.

Some accounting methods rely on counterfactual projections (i.e. measuring emissions or removals against a baseline projected into the future). These methods involve significant accuracy and uncertainty challenges and should be avoided where possible. If they must be used, there should be careful consideration of how to minimise risks of over or underestimation to avoid windfall gains or unpredictable fluctuations.

Be transparent, practical and acceptable

Transparency involves clearly explaining and documenting assumptions and methods, ideally so non-experts can understand how progress is tracking. Accounting should also be practical, considering compatibility with existing accounting methods and the resources needed for implementation.

Acceptability relates to international perceptions and comparability with other countries. Using recognised methodologies and formats, including IPCC guidelines, can help with this. International GHG accounting practices or obligations are not static, however – they evolve over time as knowledge and experience grows. Aotearoa can influence this process and shape the international rules, rather than just being a rule taker. This means we should not shy away from using new accounting methods where there is a strong case for doing so, even if this conflicts with established practices.

Be consistent and maintain the integrity of the target

Consistency means coherence over time and avoiding inconsistencies such as double counting. Accounting methods and coverage can evolve as techniques and data improve, but the same methods and data sets should be used across a time series, with updates applied across all years. This should be done, however, in a way which does not weaken the effect of the targets. In other words, accounting changes should not be used to avoid the level of effort committed to when the 2050 target or emissions budgets were adopted. This means that if major changes to accounting occur, it may be necessary to review the 2050 target.

3.3 Production- or consumption-based accounting

One of the most fundamental choices in GHG accounting is whether to calculate emissions on a production or a consumption basis.

The production approach records emissions at the point at which emissions pass from human activity to the environment and can be based on either a territorial or residence approach. It attributes the emissions to the original source (which may be the producing unit or process) of the emission. For example, a manufacturing plant burning coal in a boiler (a 'supply side' approach). Production-based accounting using the territorial approach is the standard method used by countries for setting and tracking emissions reduction targets. It is the approach used for compiling the GHG Inventory in Aotearoa.

The consumption approach accounts for emissions 'embedded' in goods or services which result from the entire supply chain required to produce that good or service. This includes consideration of emissions embodied in imports and exports and attributes the emissions to the end consumer of the product or activity (a 'demand-side' approach). It can provide different insights about a country's impact on global emissions than the production approach, for example about whether efforts to reduce emissions domestically are leading to imports of goods with high embodied emissions (also known as emissions leakage).

For example, in the case of vehicle transport, the consumption approach would record all the emissions produced from making the materials (e.g. metals) and from the assembly of a car as well as the emissions from fossil fuel combustion produced when the car is driven.

Under the consumption approach, Aotearoa would not be responsible for the emissions embodied in the goods it exports but would be responsible for those embodied in imports.

3.3.1 Options

There are currently two types of national production-based emissions estimates produced by the Government and, in 2020, consumption-based emissions estimates were produced by Stats NZ for the first time.[2] A brief description of each option is provided below:

1. The GHG Inventory is compiled by the Ministry for the Environment (MfE) using IPCC guidelines for the purposes of UNFCCC reporting. It uses the production approach and the 'territory' accounting principle, which means it includes emissions taking place within the geographic area over which a country has jurisdiction. Hence the territory principle allocates the emissions to the territory where the activity takes place.

2. GHGs by industry and households (the emissions account (production)) is a set of production-based emissions statistics produced by Stats NZ. It is compiled under the SEEA framework, which uses the 'residency' principle. This aligns the calculation of emissions with economic production by attributing emissions to the resident economic unit, including activity by that

[2] (Stats NZ, 2020c)

unit which takes place overseas, at the point of emissions. Emissions from non-residents operating on domestic territory (e.g. tourists' use of private vehicles) are excluded.

In Aotearoa, this emissions account is underpinned by estimates from the GHG Inventory, with the GHG Inventory's industry data allocated and converted to specific classes of industry that align with economic statistics such as gross domestic product (GDP).

3. Consumption-based emissions (the emissions account (consumption)) are prepared by Stats NZ as an extension of the SEEA framework. They build on the estimates calculated for the emissions account (production) and therefore also use the residency principle. These estimates are currently classed as provisional, due to the assumptions required at this point in its development and the absence of internationally agreed standards and methods.

The main choice to consider for emissions budgets is between the GHG Inventory and the consumption-based emissions account. We have, however, included the production-based emissions account (GHGs by industry and households) in the analysis for completeness and because it helps to show how the consumption estimates are derived from the GHG Inventory.

Table 3.1 compares key features of these three types of emissions estimates, and Box 3.1 gives a summary of the consumption emissions estimates for Aotearoa for 2017.

Table 3.1: Features of each approach to calculating emissions[3]

	Production-based approaches		Consumption-based approaches
	GHG Inventory	**Emissions accounts (production)**	**Emissions accounts (consumption)**
Purpose	Providing official estimates used in international targets and reporting	Enhancing comparability of emissions data to economic statistics (e.g. relating emissions to measures such as GDP can illustrate emissions intensity and decoupling) International comparisons	Accounting for final use and role of trade in emissions Carbon footprinting
Accounting principle	Territory	Residency	Residency
Classification	Source/sink categories	Industries and households	Final use categories
Recording of flows	Gross and net	Gross	Gross
Framework	Standalone (UNFCCC and IPCC)	Part of broader suite of environmental-economic accounts that aligns to the System of National Accounts	Extension to environmental-economic accounts

[3] Adapted from (Stats NZ, 2020b).

Box 3.1: Consumption-based GHG emissions estimates prepared by Stats NZ

In 2020, Stats NZ released consumption-based emissions estimates for the period 2007-2017. These show that Aotearoa is a net exporter of embodied emissions, as its total consumption-based emissions were less than its production-based emissions over the period.

Tables 3.2 and 3.3 below provide a gas-by-gas breakdown comparing the emissions accounts (consumption) to the production emissions estimated in both the GHG Inventory for 1990-2018[4] and the emissions accounts (production) for the 2017 year.

The consumption emissions estimates are more readily comparable to the emissions account (production) than to the GHG Inventory, due to scope differences. Residency adjustments result in about 2 Mt of additional carbon dioxide emissions recorded in the SEEA production and consumption accounts as compared to the GHG Inventory.

The other differences in the figures show that export emissions were mainly from agricultural products, which have a high proportion of embodied methane and nitrous oxide. Imports to Aotearoa were mostly manufactured goods, which explains the higher amounts of carbon dioxide and non-biogenic methane in the emissions account (consumption) as compared to the emissions account (production).

Several simplifying assumptions were used in the calculation of the consumption-based emissions estimates. For example, a significant assumption is that imports have the same emissions content as outputs of the same industry in Aotearoa.

Table 3.2: Biogenic methane emissions in Aotearoa in 2017, $MtCH_4$

	Emissions accounts (consumption) [5]	Emissions accounts (production)	GHG Inventory
Biogenic methane	0.54 $MtCH_4$	1.33 MtCH4	1.33 $MtCH_4$

Table 3.3: Gross emissions of long-lived gases in Aotearoa in 2017, $MtCO_2e$

	Emissions accounts (consumption) [6]	Emissions accounts (production)	GHG Inventory
Carbon dioxide	40.49 $MtCO_2e$	38.50 MtCO2e	36.15 $MtCO_2e$
Nitrous oxide	2.67 $MtCO_2e$	7.52 MtCO2e	7.50 $MtCO_2e$
Non-biogenic methane	1.77 $MtCO_2e$	1.00 MtCO2e	1.00 $MtCO_2e$
Fluorinated gases	1.49 $MtCO_2e$	1.73 MtCO2e	1.73 $MtCO_2e$
Total	**46.42 $MtCO_2e$**	**48.75 MtCO2e**	**46.38 $MtCO_2e$**

This first release of consumption-based emissions is provisional. Revisions to the time series are expected as the methodologies are improved over time.

[4] The emissions accounts (consumption) were prepared from the 1990-2018 GHG Inventory, so it provides the most appropriate basis for comparison, rather than the more recently published 1990-2019 GHG Inventory.
[5] This is sourced from customised data prepared by Stats NZ, which are licensed by Stats NZ for re-use under the Creative Commons Attribution 4.0 International licence (Stats NZ, 2020a).
[6] Ibid.

3.3.2 Analysis

Table 3.4 summarises our assessment of how well the options meet the proposed accounting principles.

Table 3.4: Production and consumption emissions options assessed in detail against the Commission's principles for emissions budget accounting

Principles	GHG Inventory, MfE (Production-based)	Emissions accounts (production), Stats NZ	Emissions accounts (consumption), Stats NZ
Coverage of material sources and sinks	✓✓ Covers emissions sources and sinks on our country's territory. Includes both gross and net emissions (i.e. includes emissions and removals from land). Includes emissions embodied in exports, excludes emissions embodied in imports.	× Covers emissions produced due to activities by residents, located both on our territory and overseas, excludes non-residents. Gross emissions only, excludes land emissions. Includes emissions embodied in exports, excludes emissions embodied in imports.	× Includes emissions generated across the supply chain of products consumed by residents of Aotearoa. Gross emissions only, excludes land emissions. Excludes emissions embodied in exports, includes emissions embodied in imports.
Robust science and evidence	✓ Based on IPCC guidance, with a governance system aimed at maintaining confidence in the methods and data used. Subject to international peer review.	✓ Underpinned by GHG Inventory data.	✓ Underpinned by GHG Inventory data.
Signal for climate action	✓ Leads to a greater focus on reducing emissions through the source process for the emissions or removals.	✓ Leads to a greater focus on the economic units (businesses and households) producing the emissions and on geographic regions when regionalised.	✓ Leads to a focus on reducing emissions through consumption choices and can provide insight into potential emissions leakage.
Accurate and reduces uncertainty	✓✓ Uncertainties are quantified but vary sector by sector. Low uncertainty in the trend of emissions estimates.	✓ Subject to the same uncertainties as in the Inventory, plus additional uncertainties from the assumptions made to convert industry data to specific classes of industry.	× Accuracy significantly reduced due to method used to calculate emissions embodied in imports.
Transparent, practical and acceptable	✓✓ Uses internationally recognised IPCC / UNFCCC framework. Allows comparison with targets and reporting under international climate change agreements, both of other countries and with our previous targets.	✓ Uses internationally recognised UN SEEA framework. Not comparable with other countries' targets, but emissions reporting could be compared with other SEEA emissions accounts. Allows direct comparisons between environmental and economic information.	× No internationally recognised standard approach, although some guidance and tools exist. First estimates released in 2020, considered provisional. Not easily comparable with other countries' emissions estimates or targets.
Consistent and keeps integrity of target	✓✓ Consistent over time. Consistent with analysis undertaken to inform setting of 2050 target.	✓ Consistent over time. Somewhat inconsistent with analysis used to inform setting of 2050 target.	× Consistent over time. Significantly inconsistent with analysis used to inform setting of 2050 target – likely to require revision to the target to ensure the same level of effort is maintained.

Key:

✓✓ Meets the principle well	✓ Meets the principle adequately, and/or may do so well only in one important dimension	× Does not adequately meet the principle

3.4 Accounting for land emissions

In this document, the term 'land emissions' is used to refer to emissions and removals[7] from land sources such as forests, cropland and grassland (including vegetation), soils and wetlands.[8] It does not include any direct agricultural emissions such as those from livestock or fertiliser.

Land emissions, particularly emissions and removals by forests, require attention because their special characteristics mean that they are sensitive to the accounting approach applied to them. They also play a large role in the emissions profile of Aotearoa. In the 2018 GHG Inventory, net removals by forests were equal to around one third of our gross GHG emissions (measured in CO_2e) and two thirds of gross carbon dioxide emissions.[9]

Two steps are needed for developing advice on how to account for land emissions in emissions budgets and the 2050 target:

1. A choice needs to be made between the two broad frameworks for land emissions accounting used by the Government: the GHG Inventory approach or the NDC target accounting approach.
2. Dependent on the outcome of step 1, there are several secondary choices required about the detailed methods of accounting for specific land categories or activities.

Before outlining and analysing the options for land emissions accounting, it is useful to be aware of the special characteristics of the sector.

3.4.1 Background

The land sector has attributes which make it different from other emitting sectors, for example:

- It is currently the only sector which removes carbon dioxide from the atmosphere
- The difficulty of distinguishing between human caused and natural effects on emissions and removals
- Higher measurement uncertainties
- The potential non-permanence of carbon dioxide removals
- Variability in the timing of emissions and removals

[7] 'Emissions removals' refers to the removal of carbon dioxide from the atmosphere. 'Removals' is often used as shorthand, and 'forestry removals' is sometimes used to refer specifically to forests sequestering carbon.
[8] In the GHG Inventory, this sector is referred to as land use, land-use change and forestry (LULUCF). The IPCC generally refers to it as forestry and other land uses (FOLU). We use 'land emissions' as an umbrella term to encompass these emissions and removals.
[9] For accounting purposes, a forest is defined as a minimum area of 1 hectare with a width of at least 30m, tree crown cover of at least 30%, and a minimum height of 5 metres at maturity in situ. In our country's GHG Inventory, smaller areas of trees that might be considered a forest in everyday terms but do not meet the forest definition are largely accounted for as vegetation or woody biomass on grasslands or croplands.

These characteristics pose challenges for monitoring progress towards emissions budgets and the 2050 target, with key issues discussed in more detail below. Accounting methods for land emissions can help to manage these issues to some extent.

Emissions and removals by forests are subject to both natural and human caused cycles, which creates challenges for monitoring progress towards meeting emissions reduction targets. An area of planted forest will remove carbon dioxide while the trees are growing, then release some of the carbon dioxide following harvest. It will begin to remove carbon dioxide again if re-planted. If a forest is not harvested, the rate of removals would diminish as it reaches full maturity. In Aotearoa, the rapid growth, short rotations and clear-fell management regime of exotic planted forests mean these cycles are pronounced. The uneven age profile of the planted forest estate means that the total emissions and removals can vary through time as the rate of harvest changes. Depending on how emissions and removals are accounted for, this could cause a net emissions target to be met one year but then missed later due to a cyclical flux.

Forest emissions are also much more uncertain than those from fossil fuel combustion. These uncertainties arise from:

- Measuring both carbon stock gains and losses, each with an associated uncertainty that increases when determining net changes (the difference between gains and losses)
- Measurement uncertainty in the area of forests
- The science of calculating carbon sequestration in forests
- The difficulty of distinguishing the impact of additional human activity which aims to boost sequestration
- Estimating the time span over which carbon is released back into the atmosphere from harvested wood
- Estimating factors related to the management of planted forests, such as harvest area, harvest age profile and the forest age profile
- Inconsistency between official forestry statistics from different sources

These relatively higher uncertainties mean caution is required when equating an estimated unit of carbon dioxide removed by forests with one emitted through fossil fuel combustion, both now and in the future. This is exacerbated by other, difficult-to-accurately-account-for effects of forests on warming through, for example, monoterpenes[10] and albedo.[11]

Furthermore, carbon stored in standing forests is not guaranteed to be permanent. Events such as fires, storms and pest infestations (such as pine beetle) are just some of the ways that carbon stored in forests can be released into the atmosphere. Many of these are also likely to be exacerbated by climate change.

[10] Monoterpenes are groups of compounds released by forests that interact with GHG gases such as methane in a complex manner.
[11] Albedo refers to the phenomenon of lighter coloured surfaces reflecting more incoming solar radiation back into space.

3.4.2 Choice of accounting framework

At the high level, a choice needs to be made between the two broad frameworks for land emissions accounting used in Aotearoa. Both approaches have merits and will be used for their respective existing purposes regardless of what we advise for accounting for emissions budgets and the 2050 target.

Option 1: A land-based approach using 'stock change' accounting, as used in the GHG Inventory

As part of its obligations under the UNFCCC, Aotearoa annually reports its GHG emissions through the GHG Inventory. This uses a 'land-based' accounting approach that attempts to cover all emissions and removals from all land-use categories, including soil, trees, plants, biomass and wood products. It aims for completeness – reporting on all emissions and removals from each land type without any exclusions or limitations as to what causes them.

The GHG Inventory reports land emissions using a 'stock change' approach that estimates emissions and removals as they happen, including the effects of historical activities such as the regrowth of previously harvested natural forests and the cyclical peaks and troughs caused by the growth and harvest of exotic production forests.

By attempting to include all emissions and removals in the year which they occur, this approach in theory gives the truest representation of 'what the atmosphere sees'.

Option 2: A modified activity-based approach with 'averaging', as used in our first NDC

Aotearoa has communicated the high-level approach it will take to accounting for its first NDC in a submission to the UNFCCC.[12] It will follow a modified version of the 'activity-based' approach for land emissions introduced under the Kyoto Protocol. This focuses on the impact of additional, human caused activities conducted after the 1990 base year with gross-net accounting (see Box 3.3).

While not all the NDC accounting details have been finalised, the broad structure has been set. Table 3.5 summarises what is currently known about the NDC accounting methods in relation to the land categories used in the Kyoto Protocol approach. Further details about the elements that are not yet confirmed are provided in later sections of this chapter.

Table 3.5: Summary of NDC land emissions accounting

Kyoto Protocol activity-based land categories	Confirmed as included in NDC accounting?	Detailed accounting rules not yet determined
Afforestation	Yes	

[12] (Ministry for the Environment, 2020c)

Kyoto Protocol activity-based land categories	Confirmed as included in NDC accounting?	Detailed accounting rules not yet determined
Reforestation	Yes	Approach to accounting for harvested wood products (HWPs). Details of the natural disturbance provision. Detailed treatment of post-1989 forests that have reached their long-term average carbon stock.
Deforestation	Yes	N/A
Forest Management	Yes	Reference level has not yet been developed.
Cropland Management	Not confirmed	N/A
Grazing Land Management	Not confirmed	
Revegetation	Not confirmed	
Wetland Drainage and Rewetting	Not confirmed	

The NDC accounting will continue with land areas and uses accounted towards our 2020 target[13] through the 'afforestation', 'reforestation', 'deforestation' and 'forest management' activities. These activities focus attention on actions occurring on subsets of land types used in UNFCCC reporting, as described below:[14]

- 'Afforestation and reforestation' include the emissions and removals of forests (re)established after 31 December 1989 (post-1989 forests).
- 'Deforestation' involves harvesting or otherwise removing forest and converting it to a different land use. These emissions are counted for both pre-1990 and post-1989 forests.
- 'Forest management' refers to practices affecting the use and stewardship of existing forests. It is accounted for by estimating the emissions and removals in pre-1990 forests which occur above or below business-as-usual as captured in a forest 'reference level'.

Box 3.2: Pre-1990 and Post-1989 forests

Our activity-based target accounting has given rise to two broad classifications for forests:

[13] Our 2020 target was adopted under the UNFCCC, but uses Kyoto Protocol accounting rules and corresponds to the second commitment period of the Kyoto Protocol (2013-2020).

[14] For the full, formal definitions of all Kyoto Protocol land activities see Appendix 1 of this chapter.

- **Post-1989 forests** are those established after 31 December 1989
- **Pre-1990 forests** are those established before 1 January 1990

This is due to the 1990 base year that Aotearoa agreed to in the Kyoto Protocol. This deems activities occurring from 1990 onwards as 'additional' rather than business-as-usual.

Aotearoa has a large area of pre-1990 forests – approximately 1.2 million hectares (Mha) which is planted forest (predominantly exotic species, with 90% being radiata pine) and 7.7 Mha which is natural forest (mostly tall native forests and areas of regenerating native trees).

While pre-1990 forests have continued to sequester carbon after 1990 and into the present, these business-as-usual removals are not considered additional because the original forest establishment activity took place before 1990. These carbon dioxide removals are not counted towards targets when an activity-based accounting approach is used.

A key feature of the NDC accounting that distinguishes it from our previous Kyoto Protocol approach is that it will use 'averaging' to account for emissions and removals from afforestation and reforestation.

Averaging means that removals from post-1989 forests will only be accounted for up until the forests reach their long-term average carbon stock, taking into account all carbon pools and activities.[15] Emissions and removals from further growth, harvesting and replanting will not be accounted for in the same way,[16] although *deforestation* emissions will still be accounted for in full using stock change accounting.

Averaging thereby focuses on the long-term effect of a forest on carbon stocks. This contrasts with the stock-change approach used in our national inventory reporting and accounting for previous emissions reduction targets, which results in significant fluctuations in net emissions due to harvest cycles. Averaging smooths the long-term net emissions trajectory of exotic production forests by factoring out the 'saw-tooth' peaks and troughs associated with these forests.

Once a post-1989 forest has reached its long-term average it is expected to be transferred to a forest management category, where future additional emissions or removals will be accounted against a reference level. The details of this are yet to be finalised.

Figure 3.1 shows this difference in the context of emissions removals for an individual production forest.[17] Figure 3.2 shows the implications for this on national projected baseline emissions and removals from forests.

[15] This is currently estimated to occur at 23 years after planting for a production pine forest on a 28-year rotation, if HWPs are included in the calculation.
[16] The first NDC states that once a forest has passed its long-term average carbon stock, it will move to the forest management category where it will be accounted for under a business-as-usual reference level, just like pre-1990 forests (Government of New Zealand, 2020).
[17] Numbers for display purposes only.

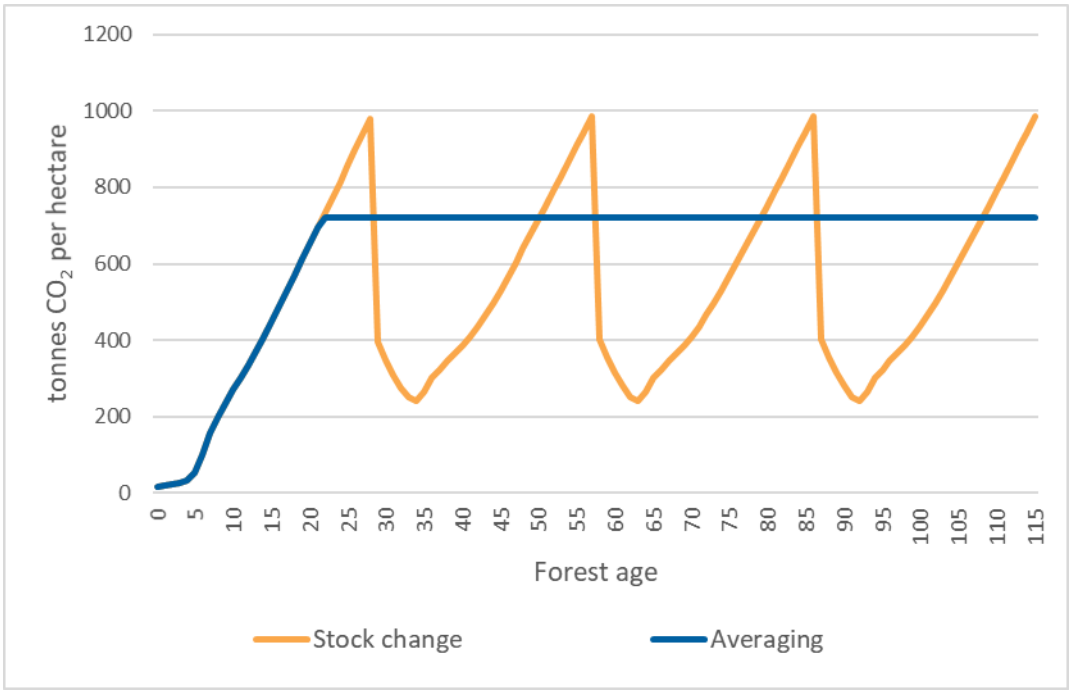

Figure 3.1: Forestry removals accounting under stock change and averaging for a production forest (excluding HWPs). Numbers for purposes of showing pattern only.

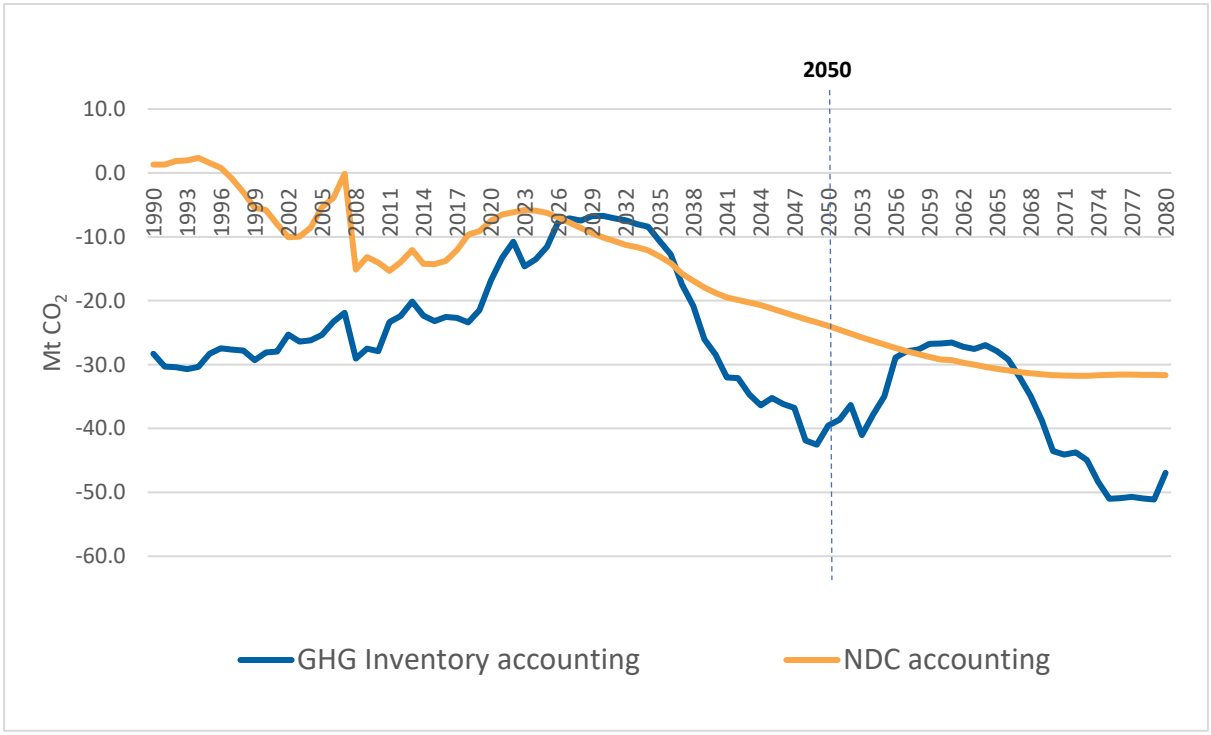

Figure 3.2: Comparison of national net forest emissions projections using GHG Inventory (stock change) and NDC accounting (averaging from 2021 onwards[18]) approaches.[19]

[18] Emissions reduction targets for the 2008-2012 and 2013-2020 periods in Aotearoa (corresponding to the first and second commitment periods of the Kyoto Protocol) used the stock change approach for post-1989 forests.

[19] $35 emissions price in real terms from 2021 (Ministry for the Environment, Unpublished).

Averaging may not smooth out all fluctuations in land emissions, however. The age class structure of our production forests, largely a result of the planting boom in the 1990s, means that average harvest age would likely fluctuate in the decades to come as forest owners try to manage the wood supply. Some forests within a forest age class may be harvested later than they normally would to avoid an uneconomic supply glut. Fluctuations in harvesting age will mean the long-term average carbon stock used to calculate emissions and removals under averaging will also fluctuate.

Fluctuations in the long-term average carbon stock may lead to further emissions or removals being retrospectively attributed to post-1989 forests that have passed the average. The size of this effect is difficult to predict but it would increase as the area of post-1989 forests that reach their average age increases. It is possible that how this is dealt with could cause significant uncertainty about our overall trajectory towards the 2050 target. As mentioned, the details of how post-1989 forests that have reached the long-term average will be accounted for, are not fully confirmed. This is an issue that may require further attention in the future if an accounting approach using averaging is used for emissions budgets and 2050 target accounting.

Box 3.3: Gross-net and net-net accounting for emissions reduction targets

'Gross-net accounting' has been a feature of this country's target accounting so far. This is where the target is expressed relative to gross emissions in a base year, but emissions and removals by forests planted or deforested since the base year are counted towards meeting the target.

Gross-net accounting arises from Kyoto Protocol accounting rules. These require that a gross-net approach be taken if a country's land emissions were a net sink in the target base year (1990, in our case).

Some submitters to the *2021 Draft Advice for Consultation*, argued that the gross-net approach lacks integrity and allows Aotearoa to count emissions in an inconsistent way, not taking into account total net emissions at the starting point. These submitters suggested that it would be more robust to use net-net accounting, where net emissions in each year of a target period are compared to net emissions in the base year.

Net-net accounting can be problematic for countries like Aotearoa whose net emissions are strongly influenced by a large area of production forests. Our forests have an uneven age class due to high planting rates over certain historic periods, causing large fluctuations in forest emissions over time (as illustrated in Figure 3.2 above). This means that changes in net emissions between any two years can give a distorted view of the underlying long-term changes in forestry emissions. For example, if a country were at a harvesting peak or trough in the base year, net-net accounting would give an unjustified gain or loss.

Gross-net accounting therefore avoids the counting of gains or losses that are largely arbitrary effects due to the base year chosen. It also helps to track progress in relation to factors that can reasonably be influenced by human interventions now to reduce emissions or safeguard forest sinks, rather than the legacy effects of past decisions.

If viewed over the long term, production forests deliver no additional carbon sequestration benefits after the first rotation, as the carbon sequestered as they grow is emitted after they are harvested. Factoring out the emissions and removals from pre-1990 forests for accounting purposes therefore presents a more accurate picture of our efforts to reduce net emissions so long as the land remains used for forestry on an ongoing basis. However, if these pre-1990 forests

are cut down and the land converted to a different use, the deforestation emissions are counted towards targets.

The gross-net approach also recognises that carbon removals by forests are qualitatively different to reductions in gross emissions. Removals by forests can compensate for a fixed amount of gross emissions at a given point in time, but do not reduce the ongoing production of gross emissions in the long term. In this way forests can temporarily offset gross emissions but can never be a permanent solution.

The Kyoto Protocol acknowledged the importance of reducing emissions at source and differentiated between situations where the land sector was a source or a sink of emissions in the base year. Where land was a source of emissions in the base year, the Kyoto Protocol required targets be set to reduce land emissions on the same basis as gross emissions (net-net). Where land was a net sink of emissions in the base year it recognised that forest sinks could only temporarily offset gross emissions, and so targets are set on the basis of gross emissions levels (gross-net).

Finally, the NDC for Aotearoa will use averaging to account for emissions and removals by post-1989 forests from 2021. This makes the distinction between gross-net or net-net accounting less of an issue. Averaging factors out fluctuations in net emissions by forests to an even greater extent than the Kyoto Protocol accounting used for previous targets. With averaging, the progress tracked is driven primarily by the areas of new forest planted and the amount of deforestation. If this accounting method were extended over forest emissions and removals for Aotearoa back through time, gross and net emissions at the start of 1990 would be the same.

3.4.3 Analysis

Table 3.6 overleaf summarises the analysis against our accounting principles.

Table 3.6: Assessment of the two land emissions accounting frameworks against the Commission's principles for emissions budget accounting

Principles	**Land-based** (GHG Inventory, using stock change accounting for post-1989 forests)	**Modified activity-based** (NDC accounting with averaging accounting for post-1989 forests)
Coverage of material sources and sinks	✓✓ Covers all human caused sources and sinks. Also includes non-human caused sources and sinks such as standing stocks of tall, natural forest.	✓ Selecting 'activities' or a limited set of land areas often involves the exclusion of some human caused sources and sinks, but these are usually those that are difficult to measure or small in magnitude. Can be extended to include more activities or land areas over time.
Robust science and evidence	✓✓ Based on detailed IPCC guidance and subject to international peer-review through UNFCCC processes. Extensive expertise already exists in Aotearoa for compiling and reporting data.	✓✓ Based on IPCC guidance. Extensive expertise already exists in NZ for compiling and reporting data for the most significant activities.
Signal for climate action	× Inclusion of all sources and sinks without a base year creates noise by mixing the legacy effects of historic activities with the additional impact of new actions. Stock change approach introduces large emissions fluctuations due to production forest harvest cycles that obscure progress towards targets and reduce incentives for sustained action.	✓ Accounting for activities after the 1990 base year reduces much of the noise from harvest and replant cycles of forests planted before the base year. Although the 1990 base year is arbitrary, it is now widely embedded and brings focus to the additionality of new actions and the need for behaviour change now. Averaging partially reduces the remaining fluctuations caused by harvest cycles and is being implemented into the New Zealand Emissions Trading Scheme (NZ ETS) where it is considered to give a better incentive to landowners or managers making decisions about planting new forests. Changes in the harvest age may create emissions fluctuations in a growing area of post-1989 forests that have surpassed the long-term average. This could interfere with policy and price signals to reduce emissions.
Accurate and reduces uncertainty	✓ While accurate methods are used to account for what is included, some of the sources and sinks have particularly high uncertainties that increase the overall uncertainty of land emissions estimates.	✓✓ Focusing on the most significant activities and their long-term effects on emissions reduces the need for uncertain data inputs such as harvest age profile. Some of the more uncertain sources and sinks are generally excluded.
Transparent, practical and acceptable	✓✓ Practical as already in use by Government and is widely accepted as an international common practice through UNFCCC reporting. Significant detail on the process exists for purposes of transparency, although it is technical and not readily understood by the public.	✓✓ Practical as already in use by Government and is widely accepted as an international common practice through the Kyoto Protocol. Significant detail on the process exists for purposes of transparency, although it is technical and not readily understood by the public.

Consistent and keeps integrity of target	✖ The inclusion of significant net emissions removals over and above what was considered in the analysis underpinning the 2050 target would reduce the level of effort required.	✓✓ This was the basis for the analysis underpinning the 2050 target analysis so a comparable level of effort would be maintained.

3.4.4 Detailed choices about land emissions accounting

If the NDC accounting framework is selected for emissions budgets and the 2050 target, there are several secondary decisions which must be made about exactly what should be included.

Aligning emissions budget accounting with NDC accounting would reduce complexity and administrative burden. However, the NDC accounting is not yet fully defined and may not be confirmed until late 2024.[20] This limits what we can consider for this first package of advice. It is not feasible to use some elements of the NDC in accounting for emissions budgets, as accounting methods for Aotearoa do not exist yet, or there is not enough information available on how they work. See Table 3.5 for a summary of what is currently known about accounting for the country's first NDC.

The accounting approaches selected now will be fixed for the first emissions budget, but there will be an opportunity to revisit these choices in 2024 for the second and third emissions budgets.

Forest management

Forest management is the part of the NDC accounting system where the impact on carbon stocks of management practices affecting pre-1990 forests is counted. It can, theoretically, be used to recognise the effect of human interventions, such as pest control, that increase carbon stocks in pre-1990 forests. But in practice this is difficult to implement, given the measurement and monitoring systems that are used to estimate national scale land emissions.

Forest management is accounted for by estimating additional emissions and removals in pre-1990 forests which occur above or below business-as-usual due to changes in forest management. It relies on projecting into the future what would have happened to emissions with no change in management, then assessing actual emissions against this modelled baseline emissions trajectory.

The counterfactual emissions projection is called a reference level. It inherently poses accuracy and uncertainty challenges with risks of both over and underestimation.

Developing a *forest management* reference level is complex. Accurately projecting harvesting rates is particularly challenging. This is largely due to the skewed age profile of the country's forests driving variable harvest rates, as well as the inconsistency of different forestry statistics. This creates the risk of generating significant credits or debits that are not the result of genuine management practice changes affecting long term emissions trajectories. It could also potentially be used to strategically generate removal credits that do not reflect genuine additional removals.

The challenges in robustly accounting for *forest management* can be illustrated by experience with it in our current 2020 emissions reduction target (covering the 2013-2020 period). The latest GHG Inventory shows that from 2013-2019, *forest management* removals beyond the business-as-usual reference level already amount to 58.5 $MtCO_2e$. This appears to have been caused by lower harvesting rates of pre-1990 planted forest than what was projected when the reference level was set.

[20] This is when Aotearoa is due to submit its first Biennial Transparency Report under the Paris Agreement.

The impact of this issue with respect to meeting the 2020 target has been limited, because due to Kyoto Protocol rules, the maximum amount of *forest management* removals Aotearoa can count towards its 2020 target is 22.4 $MtCO_2e$ (2.8 $MtCO_2e$ per year) above the reference level.[21] However, no such limit is likely to apply to *forest management* for the first NDC.

This uncertainty in forest management emissions estimates relates mainly to pre-1990 exotic planted forests.

The 7.7 Mha of mostly native pre-1990 natural forests are generally not harvested. The challenge with these forests is that the effects of human interventions on carbon stocks cannot be accurately attributed with current monitoring techniques.

Many of the effects, such as those from pest control, would take place on a decadal to centennial timescale. Distinguishing the size of the potential effect from natural variation in the existing carbon sink is difficult.[22] Detailed research could help overcome these barriers, but with present methods thousands of forest monitoring plots would be required (at significant cost) to provide accurate enough information for accounting purposes. This means that, in effect, no change in carbon stocks from changed management of pre-1990 native forests is recorded in *forest management*.

Harvested wood products (HWPs)

When a forest is harvested, much of the carbon remains stored in the form of different wood products instead of being immediately released into the atmosphere. While almost all of the carbon returns to the atmosphere eventually, the time span over which this occurs varies with the longevity of the product. Including HWPs in emissions accounting helps capture this effect and recognises the benefit of using timber in the built environment.

The NDC accounting will include HWPs but the exact details have not been confirmed. We understand, however, that:

- HWPs from pre-1990 forests are likely to be accounted for through their incorporation into the forest management reference level, as was done for the country's 2020 target
- HWPs from post-1989 forests are likely to be factored in through the calculation of the long-term average carbon stock used in averaging, rather than as a separate category of carbon removals as was done for the 2020 target

Including HWPs in accounting for emissions budgets and the 2050 target would be consistent with the principle of seeking to cover material sources and sinks, although HWPs emissions estimates come with significant uncertainties. Accounting for HWPs through incorporation in the long-term average also has the effect of accounting for their impact on emissions removals in advance of when they actually occur. It takes approximately five rotations for the long-term average carbon stock in HWPs to reach equilibrium.

[21] Kyoto Protocol rules restricted the maximum amount *of forest management* removals that could be accounted during a commitment period to 3.5% of the base year gross emissions.
[22] (Carswell et al., 2015)

Carbon equivalent forests

The carbon equivalent forest provision allows pre-1990 planted forests that meet specified conditions to be harvested and converted to another land use without being classified as deforestation. The provision requires that a new forest that will reach an equivalent carbon stock be established elsewhere. It provides flexibility to avoid locking-in sub-optimal land use while preventing a decrease in the overall area of forest land. We have not identified any material integrity risks with this provision.

Natural disturbances

Our country's NDC accounting will include a 'natural disturbances' provision to help manage the risks of extreme natural events which could radically affect land emissions and removals.

Under this provision, a baseline level of emissions from selected natural disturbances, which have to date been wildfires, pests and diseases, extreme weather events (e.g. storms) and geological disturbances (e.g. volcanoes), is estimated. If such a natural disturbance occurs that has a major impact on emissions, the provision can be activated. This would allow Aotearoa to choose to not account for the emissions above the baseline caused by one of these natural disturbances over a certain area. If this provision is used, Aotearoa would not be able to account for further removals for the land area affected during the remaining accounting period. The provision therefore balances the risk of force majeure events preventing achievement of emissions budgets, without giving a 'free pass' that allows Aotearoa to avoid the downsides or risks of using removals by forests to meet budgets and targets.

This is a continuation of a provision used in our previous international targets. The provision has not been invoked in any of the accounting for these targets to date.

The detailed rules for how this provision will work for NDC accounting have not yet been defined. It is expected to be based on the 2013 IPCC Kyoto Protocol Supplement guidance,[23] which outlines criteria for how such natural disturbances provisions can operate and be used.

If the natural disturbances provision were included in emissions budgets accounting and an event occurred that might warrant its use, a decision-making process would be needed to assess whether and how it could be invoked. This limits the risk around including this in budget accounting before the rules are known. The Commission could affect whether it is invoked, through our role in monitoring progress towards emissions budgets and the 2050 target.

3.4.5 Other sources of land emissions and removals

Figure 3.3 shows that the most significant sources of land emissions and removals not yet part of NDC accounting are emissions from organic soils (mostly drained wetlands) and removals from vegetation biomass (mostly improved pasture and small lots of trees) on grasslands. In line with our principle that accounting should aim to cover all material human caused emissions sources and sinks. These are areas the Government could investigate for target accounting in future. Future accounting developments could also go beyond land emissions to consider ocean ecosystems and

[23] (IPCC, 2014)

'blue carbon', although significantly more research is required to understand the potential and feasibility of this.

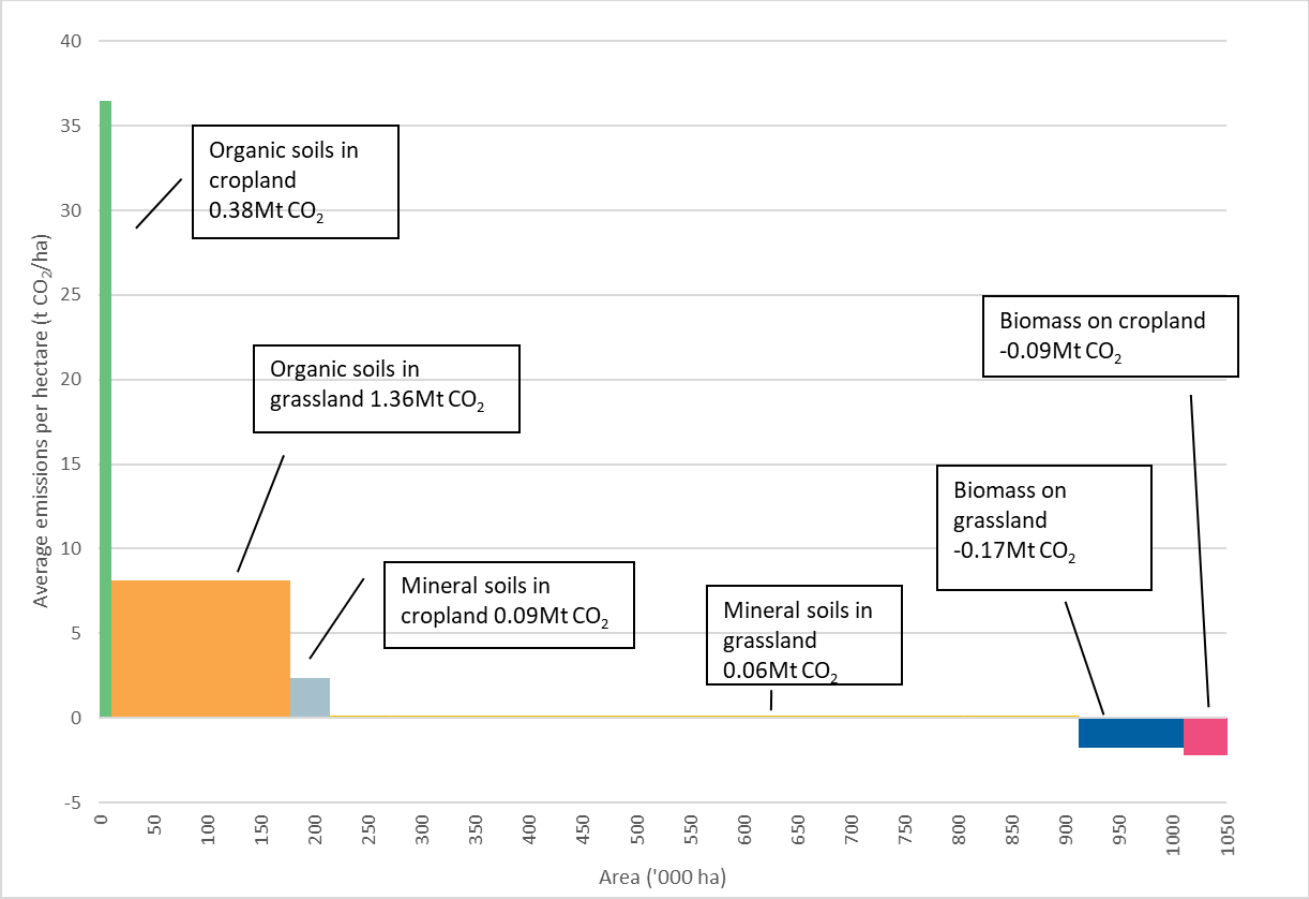

Figure 3.3: Net emissions from grassland and cropland that are not included in target accounting[24]

3.5 Voluntary offsetting and carbon neutrality

'Voluntary offsetting' refers to the practice, by entities (often companies but also individuals), of purchasing and cancelling emissions units voluntarily, in addition to any legal obligation to purchase and surrender units imposed by government policy. The intent is to compensate for the emissions footprint associated with their activities and make a 'carbon neutral' or 'net zero' claim. Such claims may be made with respect to an organisation, a product or a service (such as air travel).

There are several characteristics that have been, to date, widely recognised in the voluntary carbon market as being important for enabling a credible carbon neutral claim. Common requirements include that a unit used for offsetting must be associated with GHG reductions or removals which are:

- Real, measurable and verified

[24] Source: Ministry for the Environment analysis

- Permanent
- Additional (i.e. the reduction or removal is not something that would have occurred anyway under business-as-usual, including due to policies already in place)
- Not double counted or claimed
- Not a cause of emissions increasing elsewhere or of other environmental or social harms

For the purposes of advice on accounting, there are two key issues: additionality and double claiming. In the Aotearoa context, these two issues are linked.

Additionality refers to the idea that voluntary offsetting should deliver extra emissions reductions or removals on top of what would occur anyway due to business-as-usual activities, including due to government policies like the NZ ETS.

Double claiming is a type of double counting[25] where more than one entity counts an emissions reduction against emissions reduction goals. It leads to a misleading picture of progress in reducing emissions. For example, if two companies laid claim to the same 100 tonnes of reductions, together a total of 200 tonnes would be claimed, but the actual reduction would only be 100 tonnes. The claims are not a true representation of what has really happened.

As concern about climate change has grown, people and firms in Aotearoa have become increasingly interested in voluntary offsetting. A range of units, including units sourced from voluntary market projects undertaken overseas, can be obtained for this purpose. Some people and businesses want to use units from Aotearoa out of a desire to support local environmental protection efforts and communities. This leads them to look to cancelling New Zealand Units (NZUs), the main NZ ETS compliance unit, as a way to offset emissions.

For cancelling NZUs to deliver additional emissions reductions, the units not only must represent real, permanent and additional removals, but an adjustment must also be made against the accounting for the country's emissions reduction targets, equal to the amount of NZUs cancelled. The need for an adjustment against national targets is due to the NZ ETS, which is managed in a way that takes account of emissions from the whole economy.

If a target accounting adjustment does not happen, increases to the NZ ETS cap would negate any reductions from voluntary offsetting by allowing others to emit more. This results in double claiming and means the requirement for additionality is not fulfilled.

Internationally, there is an unresolved debate about whether avoiding double claiming against national targets is necessary when companies or individuals make carbon neutral claims. In Aotearoa, however, the way the NZ ETS currently operates causes additionality to be inherently linked to avoiding double claiming. This differs from the situation in other countries and means that the reasons put forward internationally to justify double claiming are not applicable to Aotearoa.

[25] Other types of double counting include double issuance (separate programs issuing units for the same project/emissions reduction) and double use (the same unit being used more than once).

Why preventing double claiming is necessary to underpin carbon neutral claims in Aotearoa is illustrated in Figure 3.4 below.

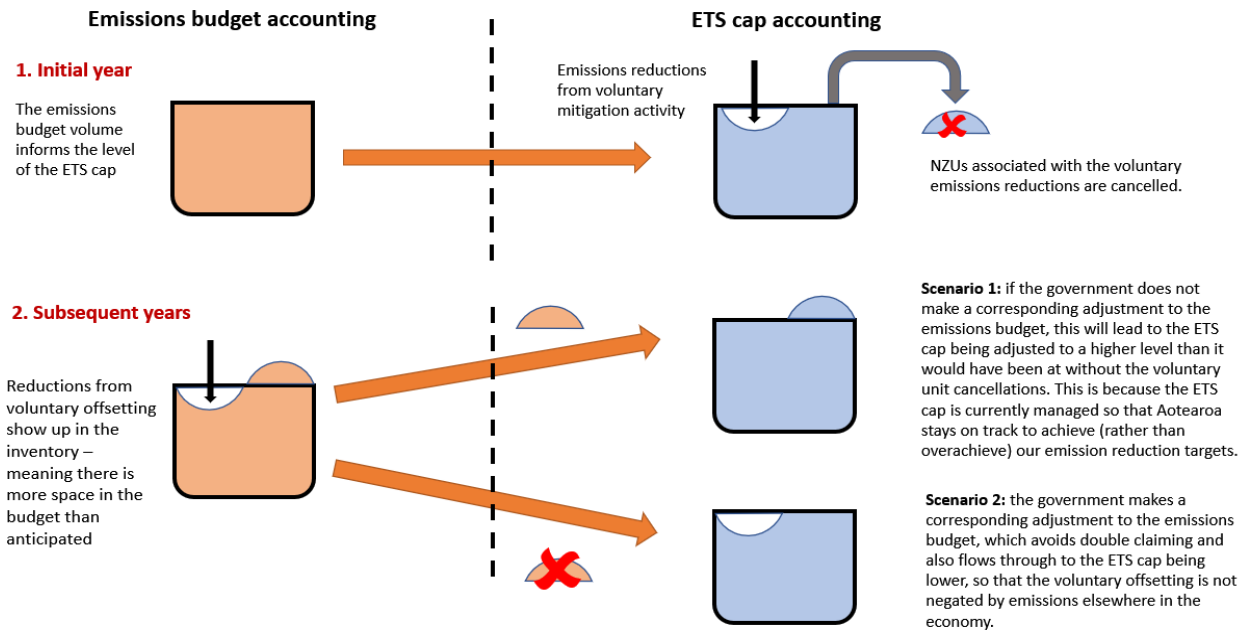

Figure 3.4: Illustration of the effect of voluntary offsetting on NZ ETS and emissions budget caps [26]

Until now, an avenue enabling voluntary offsetting for carbon neutral claims has existed in Aotearoa, but this will no longer be available after 2021.[27] This is because Aotearoa is moving to the Paris Agreement approach to accounting for its targets via its GHG Inventory rather than units. The Government is considering what guidance to provide about voluntary offsetting for the future. It has not yet made any decisions about whether to allow adjustments against our first NDC when NZUs are cancelled, or about whether carbon neutral claims can be made when NZUs are cancelled.

3.6 Legislative requirements

The CCRA sets out the framework for the system of emissions budgets to chart the pathway towards the 2050 target. It also specifies details about how aspects of this system must operate, including some parameters for accounting for emissions budgets and the 2050 target. As part of developing advice on accounting for emissions budgets and the 2050 target and in keeping with our independent role, we have also examined these elements of accounting. The key issues are described below.

[26] Source: Commission analysis

[27] This involves cancelling NZUs generated by the Permanent Forests Sinks Initiative (PFSI) with the cancellation of an Assigned Amount Unit (AAU) in the Crown's accounts at the same time. AAUs are a type of unit used for national target accounting under the Kyoto Protocol, which the government uses for accounting for the country's 2020 emissions reduction target. Further information can be found in (Ministry for the Environment, 2020a).

3.6.1 Scope of emissions budgets

The way the 2050 target and emissions budgets are defined in the CCRA means that they apply to the emissions from the agricultural, energy, industrial processes and product use and waste sectors as well as to land emissions and removals, as reported in the GHG Inventory.[28]

This excludes emissions from international shipping and aviation. These emissions are a significant part of our emissions footprint and there is potential to influence them using domestic policy. Although they are currently not in scope for emissions budgets, they have been included in our pathways analysis contained in *Chapter 9: Contributing to limiting warming to 1.5˚C* of our advice, *Ināia Tonu Nei,* in anticipation that they may be included in future. This is because we are scheduled to review the inclusion of these emissions in 2024.

Emissions budgets also exclude the emissions of Tokelau. While Tokelau's emissions are included in the GHG Inventory, they are reported separately from the sectors listed above. This is because, as noted in the latest GHG Inventory, *"Tokelau requested New Zealand's inventory team to maintain visibility of the data from Tokelau in the CRF,*[29] *so that Tokelau officials could use them for other reporting and policy purposes. Reporting Tokelau as a different inventory sector provides this visibility."*[30]

Tokelau is developing its own response to climate change. It has made climate change a national development priority and has defined an integrated climate strategy for the period to 2030. The strategy identifies climate-resilient investment pathways relating to emissions reductions, adaptation and human development.[31] It is also seeking to develop a climate contribution to include as part of the first NDC issued by Aotearoa. Tokelau's emissions are very small at 3.62 $ktCO_2e$ in 2018, equating to approximately 0.005% of our gross emissions.[32]

3.6.2 The nature and presentation of emissions budgets

The CCRA specifies that each emissions budget must include all GHGs and be expressed as a net quantity of carbon dioxide equivalent (CO_2e). Biogenic methane is therefore included in an overall emissions budget. This is despite the split-gas 2050 target, with 2030 and 2050 sub-targets for biogenic methane emissions separated off from the net zero sub-target for other gases.

The CCRA does require the Commission to provide a breakdown of each GHG within an emissions budget, showing the reductions necessary for meeting the emissions budgets of each.

This mixed approach preserves some flexibility in complying with emissions budgets. As an example, if at the end of an emissions budget, the amount of biogenic methane emissions was above where it should be according to the gas-by-gas breakdown, this could be made up for by reductions in other

[28] See section 5Q (Target for 2050) as well as the definitions of 'gross emissions', 'biogenic methane' and 'net accounting emissions' in section 4 (Interpretation) of the (Climate Change Response Act 2002 (as at 01 December 2020), 2020)
[29] CRF: Common Reporting Format – the detailed tables of activity and emissions data submitted as part of the GHG Inventory.
[30] (Ministry for the Environment, 2020b, p. 397)
[31] (Lefale et al., 2017)
[32] (Ministry for the Environment, 2020b, p. 8)

gases and the emissions budget could still be met. This flexibility on the pathway to 2050 is limited, as the 2030 biogenic methane sub-target must still be treated as a strict compliance obligation.

There is a similar issue related to emissions reductions and removals. There is no separate target or emissions budget for reductions in gross long-lived gas emissions, only an overall net zero target and net emissions budgets. The Commission is required, however, to advise on the proportions of an emissions budget that will be met by domestic emissions reductions and domestic removals.

3.6.3 GWP_{100} values

As emissions budgets must be expressed as a carbon dioxide equivalent amount, GHG metrics are needed to convert quantities of each GHG into the overall amount. The CCRA requires that the Global Warming Potential$_{100}$ (GWP_{100}) metric be used for this calculation, in line with international climate change obligations.[33]

There is ambiguity, however, about which specific GWP_{100} values are mandated by international obligations. Parties to the Paris Agreement have agreed to use GWP100 values from the IPCC's *Fifth Assessment Report* (*AR5*) for Inventory reporting from 2021 onwards.[34] For some gases, the *AR5* lists two GWP_{100} values, both with and without climate-carbon feedbacks.

AR5 provided more than one GWP_{100} value for these gases to reflect science that was emerging at the time of its preparation (2013) about climate-carbon feedbacks. Climate-carbon feedbacks refer to effects whereby the warming caused by GHG emissions can further impact atmospheric GHG concentrations, in turn causing more warming.

AR5 also, for the first time, provided two GWP_{100} values for methane – one for biogenic methane and one for fossil methane. The fossil methane value is higher, to reflect that oxidation of fossil methane adds additional carbon dioxide to the atmosphere and so has a greater warming impact.

It is not clear from the Parties' Decision which specific *AR5* values should apply. This will only be clarified when the Common Reporting Format tables, standardised data tables used for GHG Inventory submissions, are finalised. This is unlikely to occur before the 26th Conference of the Parties (COP 26) to the UNFCCC in November 2021.

This means we need to make a call about which values to use. This involves making a judgement about which GWP_{100} values Paris Agreement Parties are most likely to adopt for GHG Inventory reporting purposes, rather than judging which values are most scientifically robust. This is because of the CCRA's requirement that the metric used be in accordance with international obligations.

Table 3.7 below displays the GWP_{100} values from the IPCC's *Fourth Assessment Report* (*AR4*) and from AR5, for the most important non-carbon dioxide GHGs, methane and nitrous oxide. It also shows the GWP_{100} values for HFC-134a, a common refrigerant gas, to illustrate that fluorinated gases

[33] See section 5Y(1) and definitions in section 4 (Interpretation) of the (Climate Change Response Act 2002 (as at 01 December 2020), 2020)

[34] Decision 18/CMA.1 Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement (UNFCCC, 2019)

would also be affected by updates to the GWP_{100} values (although they make up only 2% of this country's overall emissions).

Table 3.7: GWP_{100} values from the IPCC's AR4 and AR5, for significant non-CO_2 GHGs[35]

GHG	GWP_{100} values		
	***AR4*, currently used in the GHG Inventory, no climate-carbon feedbacks**	***AR5*, no climate-carbon feedbacks**	***AR5*, with climate-carbon feedbacks**
Methane	25	28	34
Fossil methane	-	30	- [36]
Nitrous oxide	298	265	298
HFC-134a	1,430	1,300	1550

AR5 GWP_{100} values with or without climate-carbon feedbacks

It seems reasonable to expect that Parties to the Paris Agreement will adopt the GWP_{100} values from *AR5* which were based on the more robust science, as per the state of knowledge at that time.[37] When *AR5* was prepared in 2013, the quantification of the climate-carbon feedbacks for the non-carbon dioxide gases relied on a limited evidence base as understanding of these feedbacks was then at an early stage. The GWP_{100} values not incorporating climate-carbon feedbacks can therefore be regarded as more robust values from *AR5* than those with climate-carbon feedbacks included.

AR5 GWP_{100} values for methane

In *AR5*, for the first time in an IPCC assessment report, a GWP_{100} value for fossil methane was provided and this could also be used in emissions budgets accounting.

However, the amount of fossil methane in this country's emissions is very small. Furthermore, if the fossil methane value were used in accounting, it would only apply to a sub-set of these emissions. This is because some fossil methane emissions arise from fuel combustion, where the carbon content of the fuel is already accounted for elsewhere.

[35] Note that *AR4* values are currently used for Inventory reporting, but *AR5* metrics are mandated from 2021.
[36] While the *AR5* does not specifically list the GWP_{100} value for fossil methane with climate-carbon feedbacks, other information provided in the report indicates that the value would be 36 (i.e. inclusion of carbon dioxide from methane oxidation increases GWP_{100} values for methane by 2).
[37] The IPCC's *Sixth Assessment Report* (*AR6*) is in preparation and will also include updated GWP_{100} values. We understand *AR6* is likely to contain only GWP_{100} values with climate-carbon feedbacks, based on improved evidence that has become available since *AR5* was published. It is likely to be some years, however, before *AR6* GWP_{100} values are adopted for Inventory reporting purposes under the UNFCCC and Paris Agreement.

We have calculated that using the fossil methane GWP_{100} value would only change the total of our non-biogenic methane emissions (i.e. the emissions to which the net zero part of the 2050 target applies) by a very small amount - 63 $ktCO_2e$ or 0.14% of gross emissions excluding biogenic methane.[38]

3.7 Method updates to the GHG Inventory

Emissions budgets are expressed as a specific, absolute volume of net emissions. This raises an issue for maintaining consistency and integrity in accounting for emissions budgets over time, given that the GHG Inventory is regularly updated as scientific knowledge evolves.

Emissions budget levels must be set using the GHG Inventory emissions estimates available at the time. However, by the time compliance with an emissions budget is judged, two years after the emissions budget period has ended, improvements to the GHG Inventory calculations could mean that the methodological basis for the estimates substantially differs from what existed when the budget was set.

Some updates can have a material impact on reported emissions, for example updates to GHG metric values. This means estimates can go up or down due to improved understanding of emissions-related processes, rather than because of any real-world changes in the volume of GHGs emitted to the atmosphere. This is a particular challenge for an emissions budget period that has already started, as unlike emissions budgets that are set but are yet to begin, a current emissions budget cannot be revised except for in exceptional circumstances.

Options for managing this include:

1. Fix, to some extent, the methods underpinning the emissions estimates used for tracking progress against emissions budgets.

   This could take the form of delaying significant updates to the GHG Inventory, to minimise significant method changes from the time an emissions budget is set until compliance against it is judged. Another approach would be to present two sets of emissions estimates in the GHG Inventory, with the one used for judging compliance with emissions budgets prepared in a way that excludes method updates.

2. Accept that there will be inconsistency between the emissions budgets and emissions reported in the GHG Inventory, with the inconsistencies addressed in the Commission's monitoring reports.

The table below summarises our assessment of the two options, against the relevant accounting principles for this issue.

[38] Based on emissions in the GHG Inventory for the 2018 year.

Table 3.8: Assessment of options for dealing with GHG Inventory method updates against the Commission's principles for emissions budget accounting

Principles	1. Fix the methods underpinning emissions estimates	2. Address in advice at end of budget period
Robust science and evidence	✗	✓
Transparent, practical and acceptable	✗	✓
Consistent and keeps integrity of target	✓	✗

The first option has significant downsides. Preventing science-based inventory updates from being implemented in a timely manner is undesirable given international obligations to continually improve our GHG Inventory. It would also mean that many updates would have to occur at one time, and this could create further challenges for the process of setting and updating emissions budgets.

For example, Emissions budget 2 (2026-2030) can only be revised in 2025, before we can do our report at the end of emissions budget period one (2022-2025), which is due in 2027. Whenever the major set of updates are made, there would be inconsistencies between the GHG Inventory and one of these budgets.

Reporting two sets of emissions estimates in the GHG Inventory would likely create confusion among stakeholders and result in out-of-date emissions estimates being used for tracking progress towards meeting emissions budgets. There would also likely be practical difficulties and extra resource demands on the already limited resources within Government for preparing the GHG Inventory.

The second option avoids these problems but comes with the risk that an emissions budget is met, overachieved or missed as a result of method updates rather than due to genuine progress in reducing emissions.

This can be managed to an extent, by the Commission tracking and assessing the extent to which changes in emissions estimates are caused by method updates, as opposed to genuine progress or lack of progress in reducing emissions. This could then be factored into the advice in our report at the end of the emissions budget period, including the evaluation of how well the emissions reduction plan has contributed to progress on meeting the emissions budget.

For example, if there is coincidental overachievement of an emissions budget due to method updates, we may wish to recommend that this volume should not be carried forward (banked) into the next emissions budget period. This would limit the effect any windfall might have on further efforts to reduce emissions.

3.8 References

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Appendix 1: Kyoto Protocol activity definitions[39]

Afforestation is the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources.

Reforestation is the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands which did not contain forest on 31 December 1989.

Deforestation is the direct human-induced conversion of forested land to non-forested land.

Revegetation is a direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 ha and does not meet the definitions of afforestation and reforestation contained here.

Forest management is a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner.

Cropland management is the system of practices on land on which agricultural crops are grown and on land that is set aside or temporarily not being used for crop production.

Grazing land management is the system of practices on land used for livestock production aimed at manipulating the amount and type of vegetation and livestock produced.

Wetland drainage and rewetting is a system of practices for draining and rewetting on land with organic soil which covers a minimum area of one hectare. The activity applies to all lands which have been drained since 1990 and to all lands which have been rewetted since 1990 and which are not accounted for under any other activity as defined in this annex, where drainage is the direct human-induced lowering of the soil water table and rewetting is the direct human-induced partial or total reversal of drainage

Table 3.7 shows how these activities map onto the 'land-based' categories used in the GHG Inventory.

Table 3.7: Activity-based target accounting activities mapped onto GHG Inventory land categories

Activities	**GHG Inventory land categories**
Afforestation	Land converted to forest land
Reforestation	
Deforestation	Forest land converted to other land uses
Forest Management	Forest remaining Forest

[39] 'Wetland drainage and rewetting' defined in (UNFCCC, 2012, p. 13). All other activities defined in (UNFCCC, 2006, p. 5)

Cropland Management	Croplands
Grazing Land Management	Grasslands
Revegetation	
Wetland Drainage and Rewetting	Wetlands