Carbon Price Projections under the NZ ETS

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FINAL

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Purpose

This report presents projections of carbon prices under current New Zealand Emissions Trading Scheme (ETS) settings, using the Emissions-Economy NZ (ENZ) model. The projections reflect the expected supply and demand for New Zealand Units (NZUs), including key influences such as gross emissions trends, forestry participation decisions, industrial allocation, and the size of the current NZU stockpile. It evaluates whether current settings will result in meeting New Zealand's target of net-zero long-lived greenhouse gases by 2050 and beyond.

This analysis tests:

A. How prices may evolve under current ETS settings.

B. How sensitive both ETS price outcomes and emissions trajectories are to forestry restrictions and forestry management decisions.

C. How much additional forestry would be required to achieve and sustain New Zealand's net-zero target.

D. What outcomes would emerge from excluding additional forestry from being able to register in the ETS from 2027, in a situation where auction volumes were adjusted to deliver a carbon price path and associated emissions reductions that would deliver the net-zero target by 2050 and beyond.

Policy assumptions and scenario design

All scenarios in groups A and B apply the current ETS framework, including industrial allocation phase-down, auction volumes, price control mechanisms, and forestry participation rules as at July 2025. Policy settings beyond 2031 have not been published by the government, so the modelling uses the Climate Change Commission's extrapolated settings for those years. ETS settings are not relevant for scenario groups C and D, which instead solve for the afforestation or price pathways required to achieve the emissions target.

The baseline Scenario A.1 represents outcomes under current policy settings. Alternative scenarios examine variations such as different assumptions about forestry participation or stronger emissions targets. These scenarios illustrate how ETS prices and emissions outcomes could evolve under different policy configurations rather than representing forecasts of government decisions or market behaviour.

Significant uncertainty remains around future energy prices, technology uptake, international developments, and regulatory settings.

Key Findings

Price path under current settings

Under the baseline Scenario A.1 with current policy settings, NZU prices are projected to rise steadily through the 2020s and early 2030s, peaking at just under $84 per tonne in 2033 (real 2025 NZD). This rise reflects a tightening supply-demand balance due to declining stockpile levels, ongoing gross emissions obligations, and limited short-term supply growth, and the price needing to be high enough to release some auction volume[1]. However, the height of the peak is very sensitive to assumptions about the extent to which the farm conversion restrictions limit forestry unit supply in practice.

Price decline in the 2040s

From the mid-2030s onward, prices are projected to steadily decline. This is primarily driven by rising NZU supply from earlier afforestation and ongoing industrial allocation, alongside falling demand as gross emissions gradually decline due to structural factors described below, and existing policies. By the late 2040s the system enters a state of sustained oversupply.

In this context, the lower bound of the price trajectory would be determined by the minimum carbon price required to discourage large-scale deforestation or de-registration. Due to the high cost of forestry-to-pasture conversion, the lower bound for deforestation is likely to be very low, as only the land suitable for dairying would be economic to deforest. The deregistration threshold is more uncertain, as it is likely to be most relevant immediately following harvest of stock-change forest. Deregistration behaviour cannot currently be modelled due to a lack of data on which to base a model.

Gross emissions trends

Reductions in gross emissions are projected to occur steadily but are less sensitive to the carbon price than forestry. This reflects the capital-intensive nature of energy and transport investments, where switching to low-emissions technologies is constrained by equipment replacement cycles. Reductions are also significantly driven by other factors such as global technology change (e.g. electric vehicles), New Zealand's declining gas reserves, and non-ETS policies such as the coal boiler phase-out.

Extent to which the scenarios meet the net-zero target

For scenarios A.1 to B.6, the modelling indicates that projected NZU supply and demand trajectories are insufficient for New Zealand to meet the net-zero long-lived gas target on a sustained basis. Scenarios B.3 to B.5 that restrict forestry participation in the ETS fail to reach net-zero by 2050, while those allowing greater forestry supply meet the target only temporarily. In these cases, net emissions fall below the target but begin to rise again after around 2045 as sequestration from earlier afforestation slows and new planting declines.

Under the ETS in its current form, without substantial new complementary measures, carbon prices are unlikely to provide a sufficiently strong and sustained signal to both achieve and maintain net-zero emissions. None of the scenarios meet the Climate Change Commission's recommended target of net-negative 20 MtCO_2e by 2050, including emissions from international travel.

The role of forestry

NZU prices and price expectations strongly influence both new planting decisions and whether existing commercial forests are harvested or instead managed as permanent carbon sinks. As a result, existing stock-change registered forests can act as an effective cap on ETS prices: if prices rise sufficiently, some forests may remain permanent rather than being harvested, increasing NZU supply and moderating prices.

Under the baseline scenario (A.1), the model projects approximately 703,000 hectares of additional afforestation between

[1] https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/ets/nz-ets-market/nz-ets-forecasts-of-emissions-removals-and-entitlements-from-the-crowns-financial-forecasting/

2027 and 2075. Most of this occurs before 2040 as carbon prices rise through the late 2020s and early 2030s. This front-loaded planting temporarily reduces net emissions below the 2050 net-zero target in 2038. However, the effect is not sustained beyond mid-century. Under target accounting, harvested forests only accumulate carbon up to their long-term average age (around 23 years), after which net sequestration slows. As existing forests mature and the rate of new planting declines as prices fall, net emissions begin to rise above zero again after 2050.

Farm conversion restrictions have a significant impact on ETS outcomes. The effective ceiling on afforestation created by these restrictions is uncertain because 25 percent of a farm is exempt from the limit. In principle, this exemption could allow up to one million hectares of LUC class 6 or lower land to convert to forestry. The implication is that the farm conversion limits will serve mainly to cap the ETS price at around the as-yet-unknown long run marginal cost of partial farm afforestation. In scenarios where restrictions are tightened (scenarios B.2-B.5), the resulting NZU price depends strongly on assumptions about the extent to which existing forests switch to permanent management. Under these assumptions, the average NZU price may be 25 to 311 percent higher than in the baseline scenario.

The report also examines what level of afforestation would be required to achieve and sustain the net-zero target under alternative assumptions about forest management and carbon price trajectories. In a scenario with a steadily rising NZU price and moderately price-sensitive switching[2] to permanent management (Scenario C.1), the additional afforestation required between 2027 and 2075 is relatively small at 40,000 hectares. If the proportion of permanent forestry is instead assumed be as per the level projected by the government[3] (~22% for existing, 34% for new, Scenario C.2), the required level of new planting increases to 748,000 hectares. Under a scenario where the carbon price initially rises but later declines (Scenario C.3), there is substantially less permanent forest, so the total planting required rises further to 1,121,000 hectares over the same period. This represents a substantial increase relative to the 886,510 hectares currently registered in the ETS[4].

Limiting future forestry in the ETS

Scenarios were modelled in which no new afforestation can register in the ETS from 2027. In these scenarios, the model solves for the NZU price trajectory required to achieve the emissions target given the reduced supply of forestry removals. This materially changes the balance between forestry and gross emissions reductions.

The modelling tracks the cumulative balance of NZU supply and demand to determine whether the system generates an oversupply or shortfall of units. Where an oversupply occurs, maintaining the carbon price required to meet the emissions target would require units to be removed from the market, potentially through mechanisms such as government buy-backs, while a shortfall would be resolved through the release of additional auction volumes.

Key implications from scenarios limiting future forestry in the ETS:

- Forestry restrictions shift the burden to gross emitters. This requires materially higher NZU prices to incentivise fuel switching, electrification, and industrial decarbonisation.

[2] At a flat carbon price of $100, moderate price sensitivity is given to mean that 32% of existing SC forest will switch to permanent.

[3] https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/emissions-reductions/emissions-reduction-targets/new-zealands-projected-greenhouse-gas-emissions-to-2050/

[4] As at March 2026. Source: https://www.mpi.govt.nz/forestry/forestry-in-the-emissions-trading-scheme

- It is not possible to simultaneously meet the current point-year net-zero target and maintain supply-demand balance (indicated by a stable NZU stockpile) under the current design of the ETS, even with no new afforestation.
- Maintaining a rising carbon price to incentivise the necessary gross emissions reductions would require the government to buy back large volumes of NZUs.
- The fiscal consequences are significant. Maintaining high NZU prices while existing forests continue to receive units and are allowed to switch to permanent would require government buy backs with a net present cost up to tens of billions of dollars.
- Decoupling forestry prices could substantially reduce these costs while still preventing new forest registration. However, without new afforestation the price must be high enough to incentivise large-scale switching to permanent.
- If all exotic forests already registered in the ETS received only $30/NZU, the additional auction revenue from emitters would offset the cost of supporting forestry (scenario D.7).

Restricting units for existing ETS-registered forests is another possible mechanism to maintain ETS balance. Instead of buying back units, the government could limit or reduce the allocation of NZUs to already registered forests. If exotic forestry were completely removed from the ETS, auction revenues would be worth hundreds of billions of dollars (scenarios D.4 and D.5).

However, such an approach would risk not achieving net-zero without extremely high carbon prices. To keep to a price trajectory more consistent with the Climate Change Commission's demonstration path, it could be combined with targeted afforestation between 2035 and 2045, outside the ETS, paid for with auction revenue, as in Scenario D.8.

Restricting units for existing forests would also materially alter existing investment expectations and could raise sovereign risk concerns, as well as Treaty and distributional implications given the significant Māori ownership of forests.

Structural differences between forestry and gross emissions reductions create a policy tension. Many gross emissions reductions are durable capital stock changes that permanently lower emissions, whereas forests generate removals only while accumulating carbon and therefore require ongoing new planting. A point-year net-zero target aligns naturally with gross emissions reductions but not with forestry sequestration. Therefore, another option would be to split targets for gross emissions and forest sequestration. This is not modelled, however.

1 Introduction

1.1 Purpose and scope

The New Zealand Emissions Trading Scheme (ETS) manages greenhouse gas emissions in New Zealand by placing a price on carbon emissions.

Carbon prices established through the ETS are particularly important for the forestry sector as they strongly influence the rate and type of new planting and the management of existing forests – particularly whether exotic forests will be harvested or become ‘permanent’. These forest-related dynamics in turn influence carbon prices, and therefore the overall balance between removals and emissions from other sectors. In particular, the portion of gross emissions that remains responsive to carbon price signals after accounting for technological change and other structural drivers. These dynamics have a major bearing on how New Zealand’s overall emissions profile evolves over coming decades and on the extent to which national targets for 2050 and beyond are met.

The analysis set out in this report explores how carbon prices, afforestation, and emissions could evolve under current ETS settings and under a range of alternative policy assumptions relating to forestry participation and emissions targets. The purpose is to illustrate the potential implications of different policy choices for New Zealand Unit (NZU) prices, afforestation outcomes, and progress toward long-term emissions goals.

The report presents projections for:

- NZU prices, supply, and demand;
- gross and net emissions; and
- the scale of afforestation that may occur under different price paths and assumptions.

The analysis is organised around four policy questions:

A. ***Projected outcomes under current settings:*** What outcomes emerge with the ETS as currently configured?

B. ***Projected outcomes with policy modifications:*** How would ETS outcomes change under alternative policy settings, such as tighter forestry restrictions or more ambitious emissions targets, while still operating within the existing ETS framework?

C. ***Required forestry assessment:*** What combination of forestry and gross emissions reductions would meet New Zealand’s net-zero long-lived gas target?

D. ***Effect of limiting forestry’s future inclusion in the NZ ETS:*** What are the consequences of preventing new forestry from entering the ETS, thereby shifting the burden of emissions reductions more heavily onto gross emitters?

Each of these questions is examined using a different model solution mode within the ENZ framework. Scenario groups A and B are analysed using ETS equilibrium mode, which solves for the NZU price trajectory that balances supply and demand in the ETS under the specified policy settings. Scenario group C uses forest-targeting mode, which determines the level of new afforestation required to achieve the emissions target given assumptions about gross emissions reductions. Scenario group D uses emissions-targeting price mode, which solves for the NZU price trajectory required to meet the emissions target. Further details of these modelling approaches are described in Section 2.6.

1.2 Recent developments

The projections in this report are updated and informed by several recent events. First, the release of the 2025 Greenhouse Gas Inventory in April, which updates the historical emissions series through to 2023. The inventory is critical for informing ETS demand, which is the basis for determining participants' surrender obligations. The ENZ model used in this analysis has been calibrated to the 2025 Inventory, ensuring that projections of emissions and NZU demand are consistent with the latest official data.

In addition, the Government's updated emissions projections released in 2025 revised expected afforestation outcomes upward relative to earlier projections. Across the 2024 and 2025 updates, projected cumulative afforestation increased by around 40,000 hectares. The projections also increased the assumed proportion of new planting managed as permanent forest from 23% to 34%. These changes materially increase the expected long-term supply of NZUs to the ETS.

In August 2025, the Ministry for the Environment updated ETS unit limits and price control settings, maintaining the existing framework but adjusting prices for inflation and extending settings through 2030. The auction reserve price will rise from $71 in 2026 to $87 in 2030, with the Tier 1 and Tier 2 CCR trigger prices increasing to $248 and $309, respectively. Auction volumes for 2026–2029 remain unchanged and have been extended to 2030, with a base volume of 1.7 million units in that year.

In March 2026, the total NZUs held in the registry was 144.9 million, 12.2 million units (7.8%) lower than the same time a year earlier. This continues the downward year-on-year trend observed since 2023, reflecting sustained net surrenders and fewer auction units entering the system.

Despite the shrinking private stockpile, the latest ETS auction in March 2026 had no bids. This marks the tenth time auctions declined out of the last eleven auctions, with only a partial clearance recorded in December 2024. Prices remain subdued, reflecting persistent expectations of long-term market oversupply and ongoing uncertainty around ETS policy. This heightens the importance of understanding how different policy choices could affect NZU prices, afforestation decisions, and emissions outcomes.

1.3 Report structure

This report is structured as follows. Section 2 sets out the modelling framework used in the analysis, including an overview of the ENZ model and the key assumptions underpinning the projections.

Section 3 provides an overview of the scenarios.

Sections 4 to 6 then present the results, each addressing one of the policy questions outlined above. These sections examine projected outcomes under current ETS settings, the implications of alternative policy modifications, the combinations of forestry and gross emissions reductions required to meet the net-zero target, and the consequences of limiting forestry's future inclusion in the ETS. Each section also includes key sensitivities that illustrate how the results change under alternative assumptions

Section 7 concludes by drawing together the main insights from the analysis and discussing their implications for the operation of the ETS and New Zealand's progress toward its emissions targets.

2 Modelling framework

2.1 ETS modelling approach

To project possible price outcomes emerging from the ETS, we used the ETS-modelling functionality in our proprietary ENZ model. This functionality simulates NZ ETS market dynamics and price formation under different policy and behavioural scenarios. The broader energy–emissions modelling capability of ENZ has been used extensively in recent years to provide analysis for public sector agencies such as the Climate Change Commission's (CCC) emissions pathway advice and the Ministry for the Environment (MfE), as well as providing market analysis and forecasting services for energy and forestry sector participants. Section 9 in the appendices provides a description of the ENZ model.

The ETS-modelling functionality in ENZ projects in detail the likely demand and supply of NZUs from the various participants in the ETS, and models changes to the NZU stockpile.

For a given future year, the model:

- Projects the supply of NZUs, being the projected units supplied from:
  - auction volumes available where the carbon price exceeds the auction reserve price,
  - free Industrial Allocation of NZUs to Emissions-Intensive Trade Exposed (EITE) industrial firms, and
  - forestry removals from ETS-registered forests.
- Projects the demand for NZUs, being:
  - the gross emissions from activities covered by the ETS, plus
  - any forestry-related surrenders for deforestation, or harvesting of forests that use the stock-change accounting approach.[5]

Decisions made in one year influence outcomes for subsequent years, creating strong inter-temporal dynamics. For example:

- Households deciding on an EV or ICE vehicle, or whether to switch from gas heating,

[5] Under the 'stock-change accounting' approach, a forest owner is awarded NZUs each year equivalent to the incremental amount of carbon the forest is estimated to have sequestered that year. However, if the forest is harvested, the forest owner must then surrender an amount of units equivalent to the estimated amount of carbon lost from harvesting the forest. If the land is then re-planted to grow another forest (as is the case for most commercial forestry) the process of being awarded units as the forest grows again is repeated. This gives rise to the classic 'saw-tooth' profile of carbon sequestration for commercial (aka 'rotational') forestry. All forests registered in the ETS prior to 2019 had to use the stock-change approach. Rotation forests registered after 2023 are awarded units based on an 'averaging accounting' system. Under this approach, a newly planted forest will only earn units for part of its first rotation – up to a level equivalent to the long-term average carbon stock associated with rotational forestry – but then earn no further units but equally not have to surrender units upon harvesting. Forests registered before 2023 could choose which approach to use.

- Businesses deciding whether to switch away from fossil fuelled industrial boiler heat or (in the case of petrochemicals) whether to exit New Zealand,
- Electricity generators deciding whether to build renewable stations to displace fossil stations, or choose between coal and gas to fuel fossil stations, and
- Landowners deciding
  - whether to convert land from pastoral farming to forestry, or
  - whether to implement agricultural emissions mitigation technologies.

Modelled price-driven decisions in a given year (eg, whether to switch from pastoral farming to forestry) are based on the projected NZU price trajectory (and other relevant commodity price trajectories) from that year forward. The model then iterates possible price trajectories, adjusting them until prices lead to a progressive reduction in the stockpile followed by stabilisation at a lower, balanced level.

2.2 Expectations and behavioural assumptions

The modelling framework assumes that economic actors respond rationally to the expected trajectory of carbon prices and other relevant variables. Decisions such as afforestation, technology adoption, and fuel switching are therefore based on the projected future price path rather than short-term market fluctuations.

The scenarios also assume that current policy settings continue as specified. In practice, market participants may form different expectations about future policy changes, which can influence current market behaviour and prices.

The model does not attempt to simulate short-term market dynamics such as speculative behaviour, shifts in sentiment, or perceived credibility of policy signals. Any projected prices should be interpreted as the prices required to achieve specified outcomes, rather than short-term market forecasts.

2.3 ETS settings

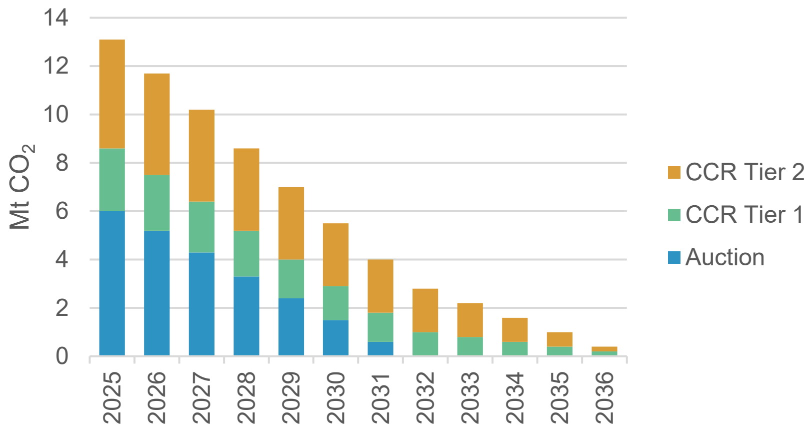
The modelling uses current government policy settings as at July 2025 for industrial allocation, auction volumes, and price control parameters. These settings reflect the most recent regulations in force at that time, including:

- the published industrial allocation (IA) phase-down schedule,
- the auction reserve and cost containment reserve (CCR) trigger prices, and
- the announced auction volume profile through to 2029.

Auction prices were converted to 2025 dollars. The updated settings released in October 2025 did not materially alter the underlying parameters used in our analysis.

Post-2030 auction and CCR volumes were extrapolated by continuing the linear decline, to maintain consistency with current settings.

Figure 1: Base auction and CCR volumes assumed



2.4 Modelling forestry participation in the ETS

The model assumes that forestry surrenders occur in the same year as the associated emissions or deforestation activity for forests, rather than at the end of the 3-or-5-year Mandatory Emissions Return Period (MERP). A MERP is the compliance period under the NZ ETS during which forestry participants must account for and surrender NZUs to match their emissions. Annual modelling reflects this by aligning emissions and surrenders within the same year, enabling clearer assessment of NZU supply, demand, and stockpile dynamics.

Afforestation behaviour

The ENZ model assumes that higher carbon prices lead to increased exotic afforestation, primarily by improving the profitability of converting land from sheep and beef farming to exotic forestry. This relationship is modelled using a sigmoidal function derived from Manley (2021), in which forest planting rates respond to the net present value of log and carbon revenues relative to land value. However, even at low carbon prices, some afforestation is projected to occur due to other drivers, including timber revenues, policy requirements, and non-price factors such as landowner preferences or diversification strategies.

It is assumed that 90% of harvested forests and 99% of permanent exotic forests are registered in the ETS.

The base scenario incorporates the Government's announced restrictions on new afforestation on high-quality farmland (LUC 1–6). Although the 25% exemption in the policy could theoretically permit up to one million additional hectares of forestry on LUC 1–6 sheep and beef farms (given that only around 5% of the five million hectares is currently forested), it is unclear whether partial farm conversions would respond to carbon prices in the same way as full conversions. Therefore, the policy was approximated in the model as a strict cap of 15,000 ha/year on afforestation occurring on LUC 6 land, with LUC 1-5 land treated as unavailable for new forestry.

As a result, potential afforestation on LUC 1-6 is probably under-estimated. However, this is balanced by the fact that afforestation on LUC 7-8 is likely over-estimated due to the biophysical and economic constraints of these land classes. Steep terrain, poor access, and fragmented land classes increase establishment costs by around 60% relative to LUC 6 land and harvesting may be uneconomic[6]. However, such land often has limited alternative

[6] Chen, X. (2025). *Balancing Carbon & Agriculture: Analysis of NZ's New ETS Land-Use Restrictions* (Doctoral dissertation, School of Forestry, University of Canterbury Christchurch, New Zealand 2025).

productive uses, meaning that permanent carbon forest can still be economically viable.

Native afforestation is also price-responsive but to a lesser extent than exotic planting. The cumulative area of native forest establishment increases gradually with higher carbon prices, following an S-shaped relationship . In the forestry-targeting scenarios, native afforestation is held fixed in line with MPI projections rather than responding to price. In scenarios with restrictions on new ETS forest, native is also restricted unless otherwise specified.

Registration switching behaviour

The ENZ model also accounts for the possibility that post-1989 exotic forests registered in the ETS may elect to delay harvest or not harvest at all, effectively becoming permanent. Stock-change (SC) forests can do this without formally changing activity. Averaging-accounting (AA) participants must apply for a change of activity under section 189 of the CCRA (Climate Change Response Act), submit a final emissions return under their current accounting method, and meet the eligibility requirements for the permanent category, including committing to retain the forest for at least 50 years. While both SC and AA forests can make this switch, it is expected to be more common among SC forests. This reflects the fact that SC forests have harvest liabilities while AA do not, as well as the fact that most AA forests are relatively young and will not reach their average age for some time.

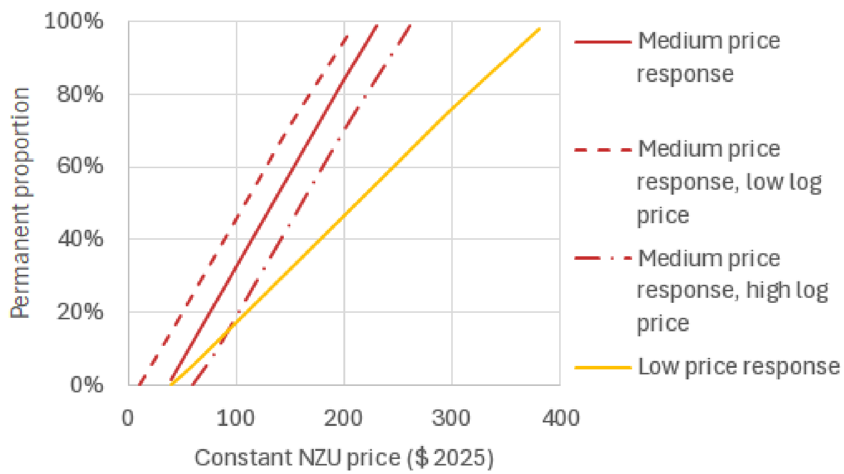
The ENZ model endogenously represents this behaviour by modelling the harvest decision for stock-change registered forests as a function of the carbon price. This is applied to all stock-change registered forests that are now approaching harvest age and therefore face an active harvest decision. At higher carbon prices, a greater proportion of these forests are assumed to forgo harvesting and instead remain as permanent forest, as the value of ongoing carbon sequestration outweighs timber revenues.

The proportion of stock-change registered forests that are effectively permanent may also be set by assumption, e.g. using MPI projections as in scenarios A.2 and B.5. In these scenarios the permanent proport is exogenous, and ranges from around 20% for forest planted 2012 to 2025, and 34% thereafter.

In scenarios where no further units are issued to new exotic forestry (scenarios D.4, D.5 and D.8), the model evaluates the present value of the decision for stock-change forests to either harvest and surrender previously accumulated NZUs or defer harvest and retain or sell those units. This calculation incorporates the value of timber, future rotations, and the costs of maintaining permanent carbon forest. As a result, the threshold price at which forests remain permanent is significantly higher than in scenarios where additional units continue to be issued.

Figure 2 illustrates the modelled relationship between a constant NZU price and the proportion of post-2011 exotic forestry managed as permanent forest. The relationship is based on the relative EBIT of harvesting versus remaining permanent, but for a given log price this translates into a linear relationship with the long-run NZU price. The low price-response option has a flatter slope, while changes in log prices shift the relationship up or down. The same relationship is used for the permanent proportion of future forests.

Figure 2: Permanent proportion versus NZU price



Deforestation behaviour

If the carbon price is low and pasture-based agriculture is profitable enough, some permanent forest owners may consider deforesting and paying the associated carbon liability. Converting forest to pasture is, however, a major investment. The cost was estimated at about $12,000 /ha for conversion to a sheep and beef system and $17,300 /ha for a dairy system in 2015[7]. Adjusted for on-farm cost inflation, these figures equate to roughly $20,000 and $30,000 respectively in 2025 prices. These costs do not include the impact of modern freshwater regulations, such as the need for riparian fencing and effluent systems, which add a few thousand dollars per hectare.

From a biological perspective, recent permanent forests are still within a window where the owners could start building access roads, pruning and thinning, with a view to harvest in the late 2040s - if they have the appetite and capability. However, harvest value has little bearing on whether the land is ultimately converted back to pasture.

This means that at a zero carbon price and a 6% cost of capital, land-based profit would still need to exceed $1,200 per hectare for sheep and beef or $1,800 /ha for dairy for the conversion to be profitable. Current drystock hill country operating profits are well below this threshold, implying that deforestation for sheep or beef production is unlikely unless meat prices increase at least two-fold. Instead, permanent pine forests would likely become production or unmanaged forest.

The economics are more favourable for dairying *if* the land is suitable. At the current average operating profit of $3,000/ha, deforestation could become profitable at a carbon price below $22 per tonne. Around 10 percent (78,000 ha) of ETS-registered forest is on Land Use Capability (LUC) classes 1-5 where dairying is feasible. However, not all of this land would be profitable to convert: many blocks of LUC 1-5 are too small, fragmented, or inaccessible for large-scale dairy operations. And half of the 78,000 ha is in Canterbury or Otago, where water rights and irrigation infrastructure would also be required.

ENZ does not currently model price-induced deforestation due to the lack of a robust empirical relationship. However, if the possibility of deforestation is assumed to set a lower bound on the ETS price, that threshold is likely to be below $20 per tonne, and deforestation may be confined to less than 10 percent of current registered forests unless pastoral farming became substantially more profitable than it is today.

[7] https://www.waikatoregion.govt.nz/assets/WRC/WRC-2019/TR201851.pdf

2.5 Non-ETS sectors

Agricultural emissions use per-hectare emissions intensity values from the Ministry for the Environment's 2025 central projections with existing measures. Total agricultural emissions in each scenario vary according to the extent of land converted to forestry. Waste sector emissions were also taken from the 2025 projections and held constant across scenarios.

2.6 Model solution modes

ENZ can be run in several optimisation modes depending on the policy question being examined. For this report the following approaches are used:

- ***ETS equilibrium mode***: Determine the NZU price trajectory that balances supply and demand in the ETS, as reflected in the size of the stockpile. Used for scenario groups A and B.
- ***Forest-targeting mode***: Determine the level of new afforestation required to achieve an emissions target, given an assumed trajectory for gross emissions reductions. Used for scenario group C.
- **Emissions-targeting price mode**: Determine the NZU price trajectory required to achieve an emissions target, assuming gross emitters and land-based activities exposed to the price signal (eg, forestry if it is assumed to be included in the ETS for a given run) respond directly to that price signal. Used for scenario group D.

2.6.1 ETS equilibrium mode

The ENZ model determines the trajectory of the NZU price using an iterative optimisation algorithm based on the size and trajectory of the NZU stockpile, which directly reflects the balance between cumulative supply and demand.

The NZU price path follows a logistic functional form, consistent with standard economic theory where prices approach equilibrium asymptotically in response to supply-demand imbalances. This form provides flexibility for the trajectory to be rising, falling, or a combination of both, depending on the underlying policy and market conditions.

Objectives

The optimisation algorithm, which may be described as a constrained gradient descent, adjusts two logistic shape parameters and has three objectives to balance:

1. Keep the stockpile above a minimum level (hard constraint).
2. Reduce the stockpile to achieve a short-run target.
3. Have the stockpile be as close as possible to this long-run minimum at the end of the period (i.e. in 2050).

Reason for the minimum stockpile objective

The NZU stockpile is used as the optimisation variable because it directly reflects the cumulative balance between supply and demand in the ETS. When supply persistently exceeds demand the stockpile increases, while a sustained shortage reduces the stockpile. As a result, the trajectory of the stockpile provides a convenient summary measure of whether the system is moving toward or away from long-run balance. Solving for a price path that stabilises the stockpile therefore produces an internally consistent equilibrium in which cumulative supply and demand are aligned over time.

Using the stockpile as the optimisation target also reflects the way intertemporal behaviour operates in the ETS. Participants can bank units for future use, so market outcomes depend not only on annual flows of supply and demand but also on expectations about future scarcity. The stockpile therefore acts as the mechanism through which these expectations are reconciled across time.

This approach does have limitations. The model does not explicitly represent strategic trading behaviour, speculative demand, or short-term price volatility that may arise from policy announcements or shifts in market sentiment. Instead, the optimisation assumes that prices adjust smoothly so that the stockpile trends toward a stable level over time. As a result, the model is designed to illustrate the structural dynamics of the ETS rather than replicate short-term market behaviour or price fluctuations.

A minimum stockpile of 50 million NZUs was chosen to maintain market liquidity and stability in the NZ ETS. This level reflects the non-surplus components identified in the Climate Change Commission's 2025 advice, which include approximately 17 million NZUs held for hedging and 34 million NZUs held to cover the previous year's surrender obligations. Assuming that stock-change forests may elect not to harvest (potentially indefinitely) if prices are high, units currently held for P89 harvest liabilities may be liquid[8].

In reality, the stockpile required for market stability could be somewhat larger or smaller depending on the scale and timing of future harvest liabilities. Varying this threshold does slightly affect the size and timing of the peak price but does not materially change results.

Multiple solutions

Because the optimisation seeks a stable long-run balance, multiple price trajectories can satisfy the equilibrium conditions. For example, a shorter, steeper price peak may yield the same stockpile outcome as a slower rise and fall. The algorithm is designed to converge first on the smoothest and most moderate price path, representing the least abrupt adjustment consistent with equilibrium. This reflects the assumption that market participants adjust gradually to changing supply-demand conditions rather than through sudden discontinuous price movements.

In reality, ETS prices can respond sharply to policy announcements or shifts in market sentiment, so actual price movements can be more volatile than the smooth trajectories produced by the model.

2.6.2 Forest-targeting mode

In these scenarios the carbon price path is specified in advance. Based on that price path, the model projects the resulting reductions in gross emissions across other sectors. It then calculates how much afforestation would be required for net emissions to reach the specified target, which in this case is net zero by 2050 and beyond.

Because forestry decisions are inherently inter-temporal, the model does not attempt to optimise the timing of planting. Instead, the total required afforestation is allocated across years using a simple rule. Annual planting is assumed to follow a smooth trajectory, declining at 1% per year to 2050. The algorithm iterates to find the intercept for the first year of the projection (2027) that achieves net-zero by 2050.

Current afforestation decisions are made by many independent landowners in response to carbon price expectations and other commercial drivers, rather than to what level of planting would be required to meet a national emissions target. Achieving the specific level of afforestation consistent with such a target would therefore represent a departure from current price-driven outcomes.

How this forestry activity might be achieved in practice is not specified; it could occur through a separate carbon price, an afforestation quota, or other policy mechanisms.

[8] https://environment.govt.nz/publications/review-of-the-new-zealand-emissions-trading-scheme-summary-of-modelling/ - page 16

2.6.3 Emissions-targeting price mode

The carbon price trajectory algorithm used for emissions-targeting mode is different to the approach described in section 2.6.1. In ETS-targeting mode a logistic price curve is used because it reflects the economic dynamics of a market adjusting toward equilibrium.

In contrast, the emissions-targeting mode recognises it is generally desirable for the carbon price to rise steadily in the near term to drive emissions reductions, and then stabilise over the longer term. To represent this behaviour, a two-phase growth curve is used, allowing the price to increase at one rate initially and then transition to a lower growth rate in later years.

The inflection year is exogenously specified to be 2040[9] due to the underlying pattern of New Zealand's emissions, whereby there is a relatively more challenging period in the first ten to fifteen years. Varying the inflection year can result in the price rising faster or slower but has little impact on long-term outcomes such as the net-zero target.

[9] It is possible to make the inflection year an endogenous element of the model, but tends to cause instability and much longer solve times.

3 Overview of scenarios

This section summarises the scenarios analysed in this report and links them to the four policy questions introduced in section 1.1. Table 1 provides an overview of the scenarios and highlights the key differences between them.

Scenario group A (section 4) presents the central projection of the NZ ETS price under current policy settings and central assumptions. A zero-carbon-price scenario is also included for comparison to illustrate the extent of structural emissions reductions that occur independently of carbon pricing.

Scenario group B (section 4.2) explores how ETS outcomes may change if forestry participation is restricted or if the 2050 emissions target is made more ambitious. These scenarios test sensitivities relating to restrictions on forestry participation and assumptions about the proportion of forestry that becomes permanent.

Scenario group C (section 5) examines how much new afforestation would be required to achieve the net-zero long-lived gas target. These scenarios test sensitivities relating to the proportion of forestry that becomes permanent and the NZU price faced by gross emitters, which determines the size of the emissions gap that forestry must offset.

Scenario group D (section 6) explores the implications of decoupling forestry from the ETS. In these scenarios the NZU price faced by gross emitters is determined independently of forestry, allowing analysis of the price required to achieve net-zero emissions by 2050 when only a limited amount of new forestry occurs outside the ETS. Variants include whether new native forests can receive credits, whether existing forests receive credits, and the proportion of existing stock-change forests that become permanent.

The following assumptions apply across all scenarios:

- Current policy settings are consistent with the Government's With Existing Measures emissions projections.
- State-of-the-world parameters (e.g. population growth, oil prices, and technology costs) are consistent with the Government's 2025 central projections.
- Afforestation behaviour is consistent with the "Manley slow" specification, in which planting decisions depend on the relative economics of forestry and sheep and beef farming prior to the application of policy restrictions.
- When the proportion of permanent forestry is "fixed", it follows MPI's 2025 projections, which show permanent forestry rising from 18% in 2020 to 34% by 2026 and remaining at that level thereafter.
- Gas reserves are based on the 2025 petroleum reserves published by MBIE.

Scenarios were also run using high and low assumptions for "state-of-the-world" parameters as a sensitivity test. These additional scenarios are not presented in this report in order to focus the analysis on the key drivers most directly relevant to the policy questions under consideration.

Table 1: Summary of scenarios and key differences

Scenario Label	New forest in ETS[10]	Existing receive NZUs[11]	Model objective	Free parameter	Carbon price	Exotic forest permanent proportion	Resulting Permanent exotic 2012-2025
A.0. Zero price	Any	All	N/A	N/A	Fixed: zero	Medium price responsiveness	0%
A.1. Base	Any	All	ETS stockpile 50 Mt	NZU price	ETS equilibrium	Medium price responsiveness	2%
B.1. Unlimited afforestation	Any	All	ETS stockpile 50 Mt	NZU price	ETS equilibrium	Medium price responsiveness	2%
B.2. Tight afforestation limit	Any	All	ETS stockpile 50 Mt	NZU price	ETS equilibrium	Medium price responsiveness	8%
B.3. No new exotic forest	Native	All	ETS stockpile 50 Mt	NZU price	ETS equilibrium	Medium price responsiveness	24%
B.4. No new exotic forest, low stock change switch to permanent	Native	All	ETS stockpile 50 Mt	NZU price	ETS equilibrium	Low price responsiveness	14%
B.5. No new exotic forest, fixed permanent	Native	All	ETS stockpile 50 Mt	NZU price	ETS equilibrium	Fixed as per govt projections	20% (fixed)
B.6. International travel in ETS, less Industrial allocation	Any	All	ETS stockpile 50 Mt	NZU price	ETS equilibrium	Medium price responsiveness	17%
C.1. Mid stock change switch to permanent	N/A	N/A	Net-zero 2050	Afforestation	Fixed: $250 by 2050	Medium price responsiveness	84%
C.2. Fixed permanent	N/A	N/A	Net-zero 2050	Afforestation	Fixed: $250 by 2050	Fixed as per govt projections	20% (fixed)
C.3. Rising then falling carbon price	N/A	N/A	Net-zero 2050	Afforestation	Fixed: A.1.	Medium price responsiveness	2%
D.1. No new exotic ETS forest	Native	All	Net-zero 2050	NZU price	Target-consistent	Medium price responsiveness	92%
D.2. No new ETS forest	None	All	Net-zero 2050	NZU price	Target-consistent	Medium price responsiveness	92%
D.3. No new ETS forest, low permanent	None	All	Net-zero 2050	NZU price	Target-consistent	Low price responsiveness	58%
D.4. No exotic forest in ETS	Native	Native	Net-zero 2050	NZU price	Target-consistent	Medium price responsiveness	4%
D.5. No forest in ETS	None	None	Net-zero 2050	NZU price	Target-consistent	Medium price responsiveness	17%
D.6. Exotic paid 50% of NZU price	Native	All	Net-zero 2050	NZU price	Target-consistent	Medium price responsiveness	43%
D.7. Existing & new exotic paid $30	Any	All	Net-zero 2050	NZU price	Target-consistent	Medium price responsiveness	0%
D.8. New forest outside ETS	None	None	Net-zero 2050	Afforestation	Fixed: $250 by 2050	Medium price responsiveness	0%

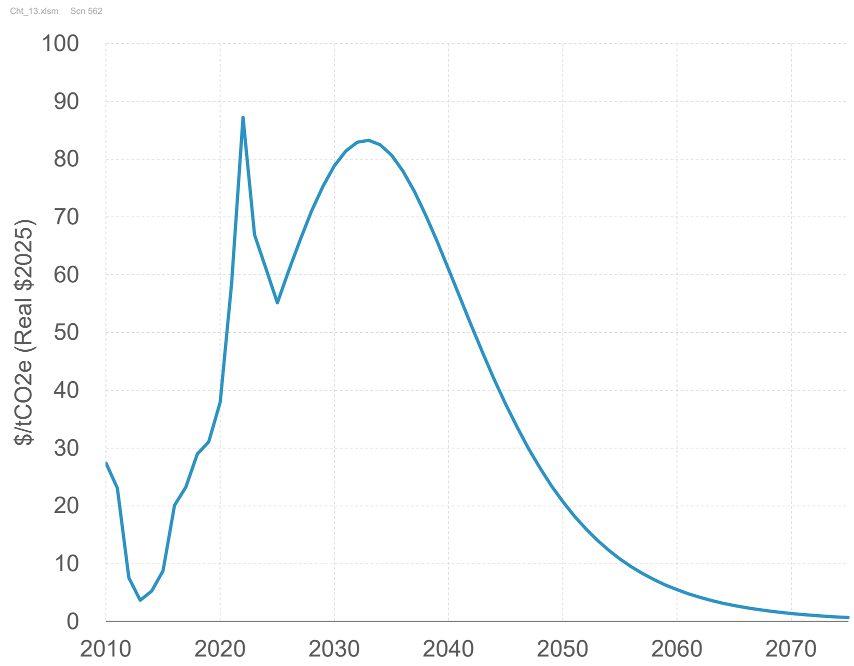
[10] 'Any' means both future Exotic and Native forests are allowed to register in the ETS, 'Native' means only future native forests, and 'None' means no new forests of any type are allowed to register in the ETS.
[11] 'All' means both existing-registered Exotic and Native forests continue to receive NZUs, 'Native' means only existing-registered native forests continue to receive NZUs, and 'None' means no existing-registered forests of any type continue to receive NZUs.

4 Projected outcomes under current settings

Section 4 presents the two scenario groups that have the objective of balancing ETS supply and demand. Scenario group A includes the zero price (A.0) and base (A.1) scenarios. Scenario group B tests some modifications and includes unlimited forest (B.1), tight afforestation limit (B.2), no new forest (B.3), no new forest with low stock-change switching to permanent (B.4), no new forest with fixed permanent share (B.5), and International travel in ETS with lower industrial allocation (B.6).

The following set of charts show the price projection using ENZ's ETS modelling functionality and using our central set of assumptions.

Figure 3: Base ETS price projection assuming continuation of existing policy settings



The reason why the price projection produced by ENZ in Figure 3 has this form is because the 'already guaranteed' supply of NZUs (from the stockpile, plus already-planted-and-ETS-registered forests, plus from industrial allocation) is projected to be inadequate to meet demand out to the early 2030s without some additional NZU supply – either from additional afforestation or the release of additional auction volumes. This general finding is supported by the latest Government projections[12].

[12] https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/ets/nz-ets-market/nz-ets-forecasts-of-emissions-removals-and-entitlements-from-the-crowns-financial-forecasting/

This results in a need for prices in these early years that are sufficient to achieve a supply/demand balance through:

- increasing supply from some combination of
  - releasing auction volumes (noting that there is a minimum reserve price for purchasing NZUs via auction); and,
  - incentivising deferral of harvest or additional afforestation.
- incentivising gross reductions from households and firms taking actions to switch to lower-emitting activities (eg, switching vehicles or heating appliances from fossil-fuelled to renewably-fuelled options).

However, beyond the mid-2030s, we project that New Zealand will move into a situation where the supply of units will start to exceed the demand for units. This is because:

- the forestry planted prior to the mid-2030s will continue to grow and deliver substantial quantities of NZU supply beyond that time.
- the Industrial Allocation mechanism, as currently specified, will continue to deliver a significant quantity of free NZUs to EITE industrial consumers.
- the projected rate of cost reductions in EVs globally is such that, by the early 2030s, high levels of EV uptake will be occurring irrespective of NZ government policies. Further, by the mid-2030s, the cumulative extent of vehicle replacement that will have occurred in the previous decade will result in significant ongoing reductions in transport emissions.
- By the late 2030s, the policy-mandated transition away from large-scale coal use for industrial boiler process heat should have largely been completed.[13]
- A couple of factors are projected to make gas increasingly costly, even without a cost of carbon, thereby progressively improving the cost-effectiveness of switching from gas to alternatives. The two factors are:
  - A dwindling extent of domestic gas resources as existing fields get depleted, causing progressively higher wholesale gas prices as New Zealand moves closer to needing to import LNG and its associated higher gas prices;
  - Rising pipeline charges to consumers as declining gas demand results in higher charges to remaining consumers to recover the largely fixed costs of pipelines – the so-called 'death spiral' effect.

In other words, from the early 2030s, if current policy settings are maintained, the demand for units will have fallen as gross emissions reduce, while the supply of units from forestry and industrial allocation will continue to be significant. If the Government increases auction volumes over 2028–2030, this would increase unit supply during a period when the model currently projects a supply shortfall. If the additional supply was sufficient, the projected price peak in those years would likely be capped at or near the auction reserve price, rather than rising higher to induce additional afforestation or gross emission reductions.

The post-2050 price may be somewhat higher than Figure 3 suggests, if a carbon price below $20 does incentivise limited

[13] The key policy is the National Direction on Industrial Process Heat, which largely prohibits the re-consenting of coal use for industrial boilers used for producing ‘low’ or ‘intermediate’ heat (ie, up to 300°C).

forestry-to-pasture conversions as described in section 2.2. However, this would not change conclusions in general.

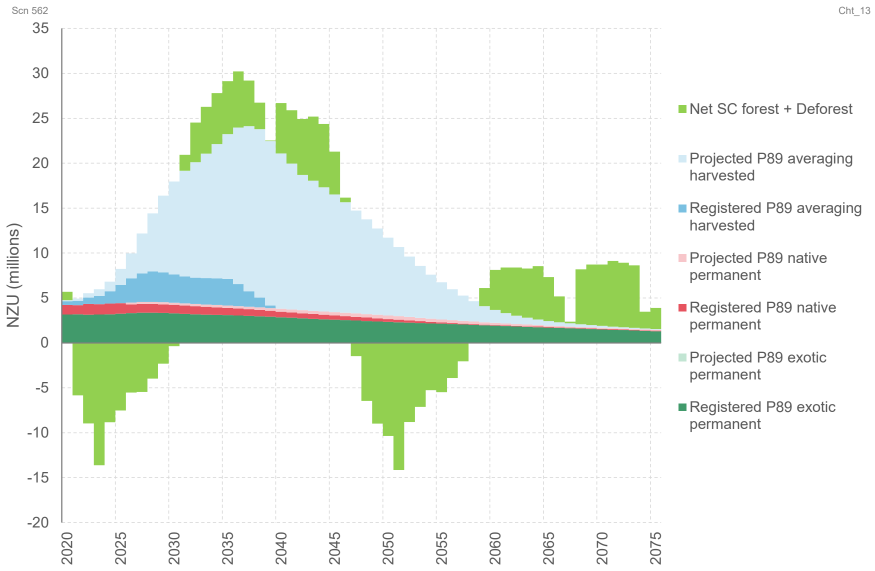
The following charts illustrate this changing supply/demand dynamic.

Figure 4 to Figure 7 show some of the key projections for the base scenario. Amongst other things, they show how significant the supply of units from forestry is in relation to the overall supply/demand balance for NZUs.

They also show how the changing pattern of supply/demand from stock-change registered forests ('Net SC forest' in the key) significantly alters the balance of supply/demand from one decade to the next. This reflects the uneven pattern of afforestation since 1990, with high planting rates in the early 1990s followed by much lower rates through the 2000s (Figure 7). Because exotic plantations are typically harvested about 28 years after planting, these past fluctuations create alternating periods when harvesting dominates.

In this baseline scenario, the NZU price rises high enough to trigger a substantial wave of average-accounting exotic afforestation, restoring supply-demand balance after the stockpile is depleted and providing a buffer ahead of the next major harvest cycle around 2050. However, the decline in prices after 2040 means that harvesting remains the more economic option, so there is no switching to permanent in this scenario.

Figure 4: Supply / (demand) of forestry NZUs for the base scenario[14]



[14] The forestry units are from trees planted post-1989 ('P89') with the graph distinguishing between those registered under stock change ('SC'), average accounting ('averaging'), or permanent categories, and also between exotic and native species. The 'Registered' projections are based on registrations as at Oct '24. However, forests that have already been planted but have yet to register – including forests planted many years ago – can still decide to register in the ETS. Accordingly, the 'Projected' volumes not only include forests that have yet to be planted (noting that the last actual afforestation numbers input into ENZ are for 2023) but also including estimation of the proportion of already planted forests that will ultimately decide to register in the ETS.

Figure 5: Supply / (demand) of NZUs for the base scenario

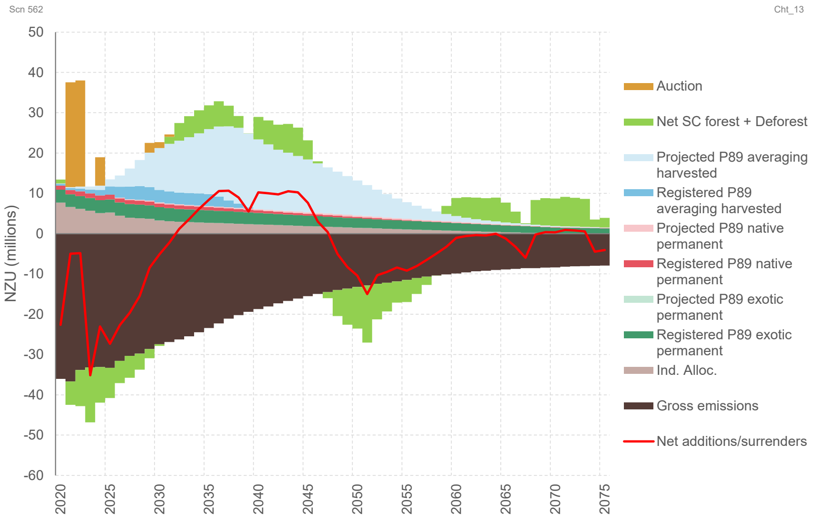


Figure 6: Projected change in stockpile for the base scenario

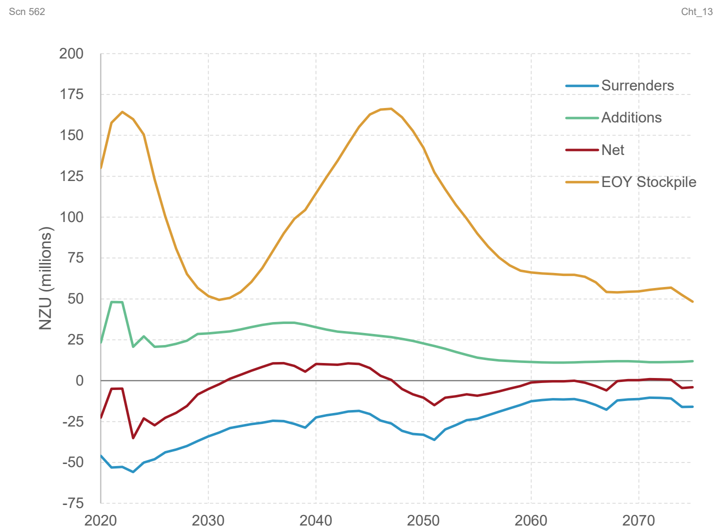
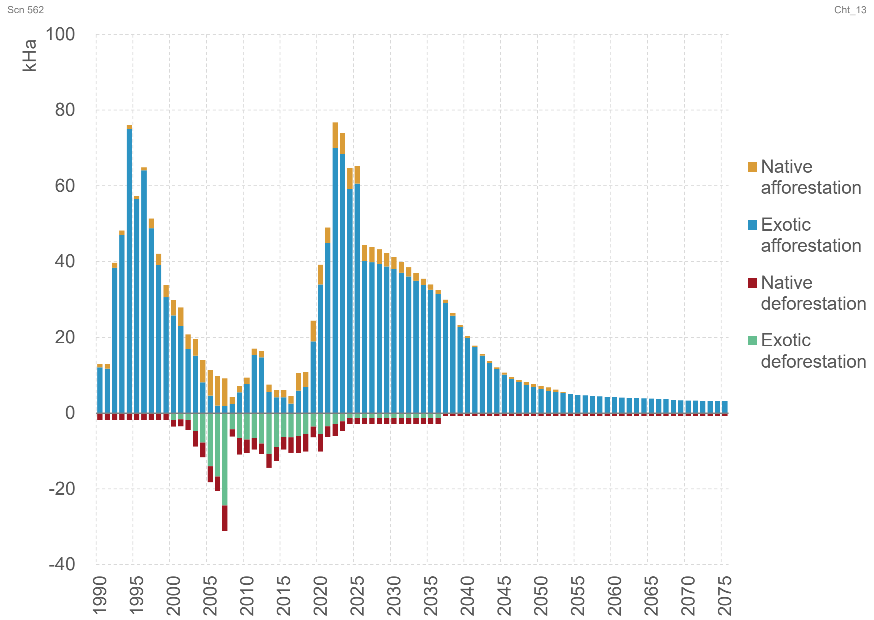


Figure 7: Projected afforestation / (deforestation) for the base scenario



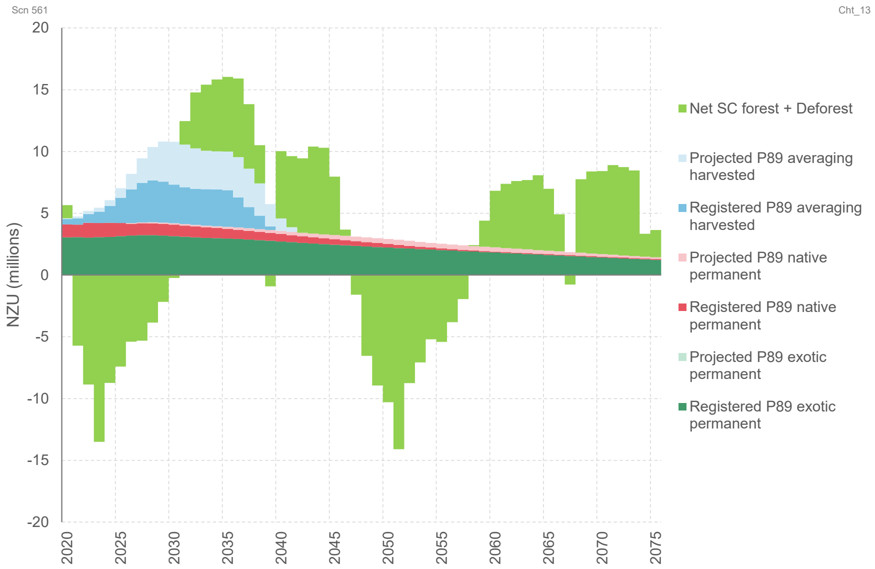
4.1 Structural supply and gross emissions reductions

To illustrate the effect of some net emissions reductions being 'baked-in', irrespective of the carbon price, Figure 8 to Figure 11 below show the projected outcomes if future NZU prices were zero. We have assumed no transaction costs in the model, meaning registered foresters remain registered and still participate[15]. They illustrate that, even though carbon prices are zero:

- there are still material amounts of NZU supply from already committed forestry plus Industrial Allocation.
- there are still some reductions in gross emissions for the reasons previously identified: the inevitable uptake of EVs and greater renewable energy (albeit at lesser rates and extents than the future with higher carbon prices), the policy-mandated switch from coal-fired industrial boilers, and New Zealand's declining gas reserves and associated rising gas prices causing switching.

Under the zero-price scenario, gross emissions from all gases decrease by 33% between 2023 and 2050. In comparison, the decrease is 36% in the baseline (scenario A.1) and 39% if no additional forestry is allowed (scenario B.3).

Figure 8: Net supply of forestry NZUs for zero carbon price scenario



15 Administration and compliance costs can be less than $20/ha, equivalent to $1/NZU for medium-to-large forests.

Figure 9: Supply and demand of NZUs for the zero carbon price scenario

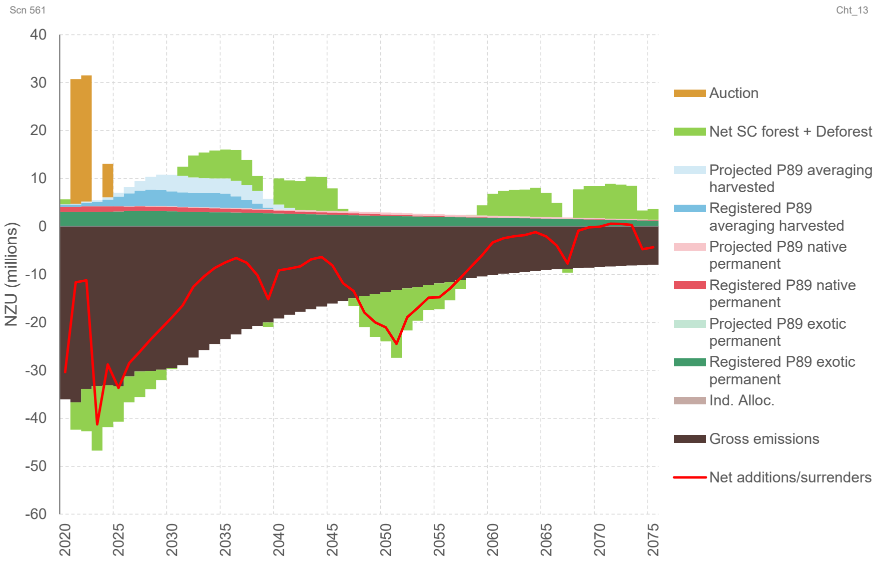


Figure 10 shows there is still a low level of afforestation even with no carbon revenue. The actual level of such residual afforestation is uncertain but is likely to remain low. This reflects:

- the relatively low economic returns of the least profitable sheep and beef hill country farms, where forestry yields comparable returns to continued grazing; and
- planting undertaken for catchment nutrient management, erosion control, or other non-carbon objectives.

In the modelling, these forests are assumed to register in the ETS - an assumption maintained for consistency across scenarios - even though a permanent zero carbon price represents an extreme case in which the incentive to participate would disappear. This scenario does not represent the additional gross emissions reductions that would be required to balance ETS supply and demand, as it is intended to illustrate structural emissions reductions irrespective of the ETS.

Figure 10: Future afforestation for zero carbon price scenario

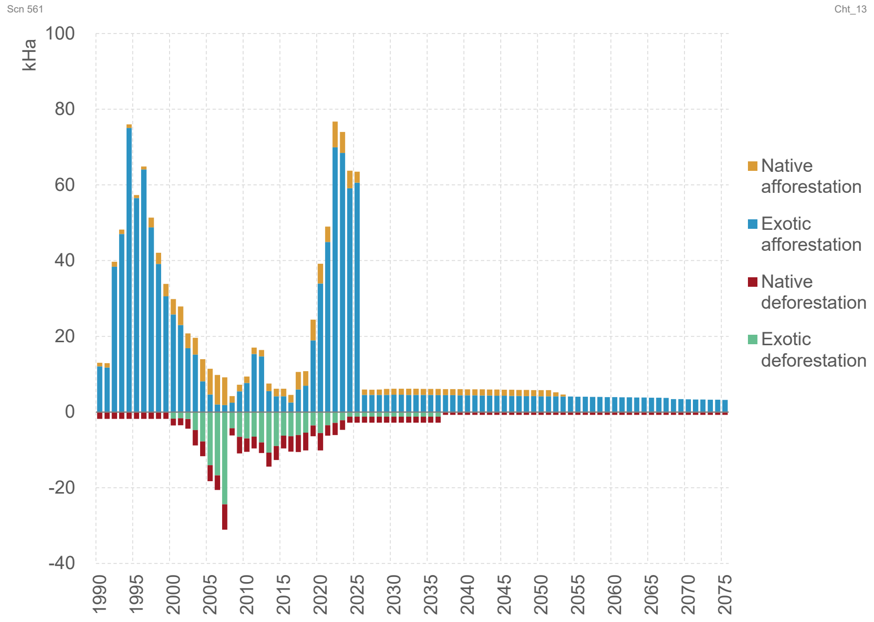
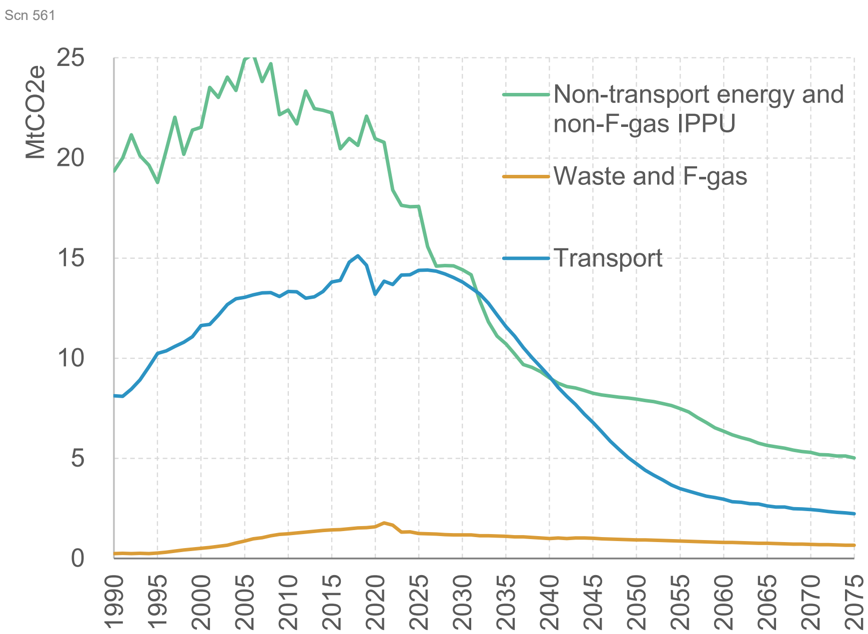


Figure 11: Future ETS-covered non-forestry emissions for zero carbon price scenario



4.2 Projected outcomes with some modifications

A number of scenarios were run to examine the effect of variations in the extent to which forestry units are able to supply the ETS. The Base scenario assumes the limits the government is currently implementing that limit entry of forests to the ETS[16] but we also test

- removing these limits (B.1), and
- tightening these limits so there is no afforestation on LUC 1-6 and only 20,000 ha/yr on LUC 7 (B.2).

In addition, we test the effect of no additional afforestation, with three sub-scenarios relating to the extent to which existing stock-change registered forests can effectively switch from being rotational to permanent forests if carbon prices rise to a level where it is more profitable to sequester carbon rather than harvest the forests. The 3 scenarios with no new forestry are:

- medium carbon price sensitivity for stock-change forestry switching to be permanent (B.3).
- low price sensitivity (B.4) – roughly half as much switching at the same price.
- a fixed proportion of stock-change forests are permanent (B.5).

Scenario B.3 results in the highest proportion of permanent forestry, and B.4. the lowest.

In addition, scenario B.6. tests the impact of including international aviation and shipping emissions in the ETS, and less industrial allocation, as per the Climate Change Commission's review of the 2050 emissions target[17]. Scenario B.6 allows new forestry.

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[16] No afforestation for LUC 1 to 5, 15 kha/yr for LUC 6, and unlimited for LUC 7+. As mentioned in section 2.4, the 25% exclusion is ignored because it could potentially allow up to a million hectares of afforestation, making the cap meaningless.

[17] https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/review-of-the-2050-emissions-target/2024-review-of-the-2050-emissions-target/final-report

Figure 12 shows the price projections for the different scenarios, with Figure 13 showing the corresponding projections of exotic afforestation.

Figure 12: ETS prices for different scenarios relating to forestry's inclusion in the ETS

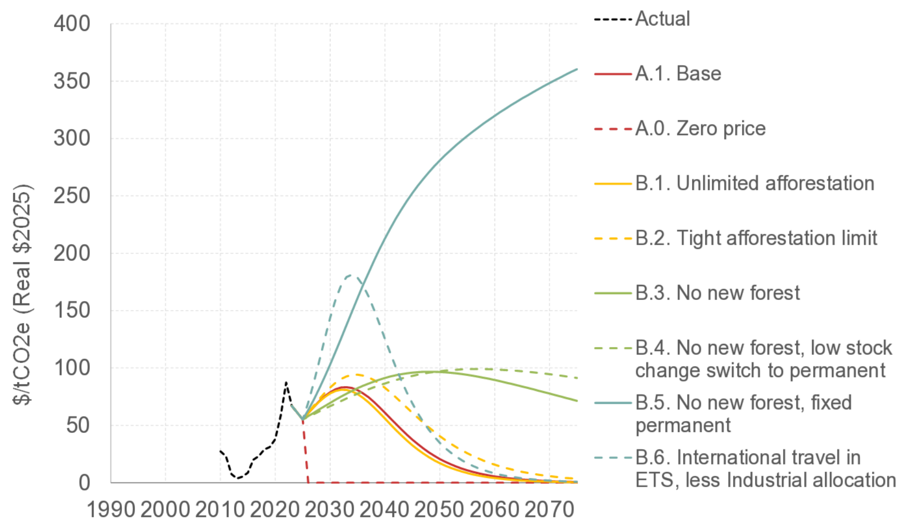
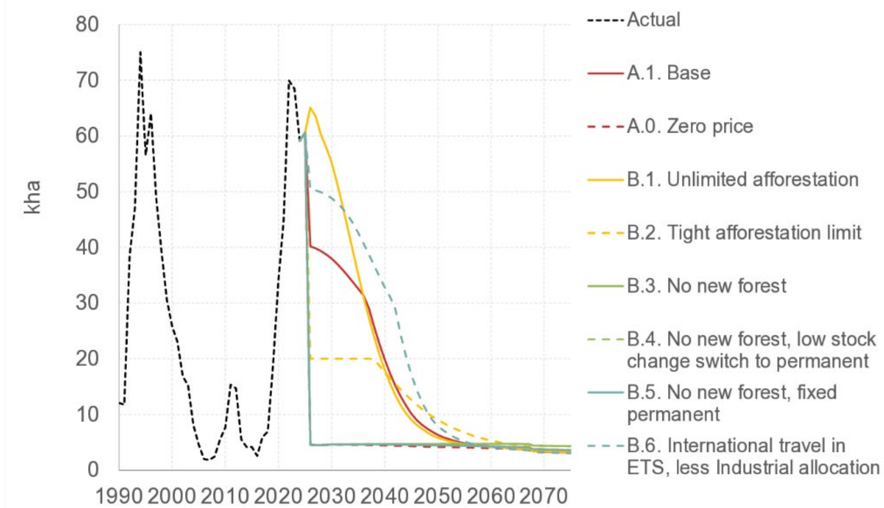


Figure 13: Exotic afforestation area under different forestry restrictions



If the limitations on forestry that are currently being introduced are removed (B.1), the model is projecting even lower carbon prices. Conversely, if the limitations are tightened further (B.2), the carbon prices rise. However, the rise is not that significant and still shows the pattern of prices falling beyond 2040.

If future new forestry is completely prohibited from registering from 2026 and beyond (B.3 to B.5), this results in rising carbon prices, but with variation according to the extent to which already-registered stock-change forestry can effectively switch from being harvested plantations to permanent plantations if carbon prices are high enough to justify such a change. In other words, if carbon prices rise, increasing numbers of stock change plantations will switch to effectively being permanent, thereby increasing the supply of NZUs and acting as a countervailing downward pressure on carbon prices.

Including international travel in the ETS and reducing industrial allocation (B.6) results in a higher price peak and more afforestation, but still has the carbon price falling below $50 by 2050.

The variation in price outcomes is significant, depending on the extent of this stock-change harvesting→permanent dynamic:

If the model is allowed to endogenously project the proportion of stock-change registered forests that become permanent in response to carbon prices (B.3), then carbon prices rise to around $100/tCO2e.

Only in the scenario with no afforestation and the permanent percentage is fixed (B.5) does the ETS price continue to rise to 2050 and beyond.

4.3 Emissions projections

For Scenario groups A and B the model balances supply and demand of NZUs within the current design of the ETS. This sub-section examines the extent to which the projected outcomes for these scenarios achieve New Zealand's emissions objectives.

4.4 Extent to which current ETS settings will meet the long-lived gas emissions target

Figure 14 below shows the projections of net emissions of long-lived gases plus non-biogenic methane for the different scenarios.

Figure 14: Target accounting net emissions of long-lived gases plus non-biogenic methane – excluding international transport emissions

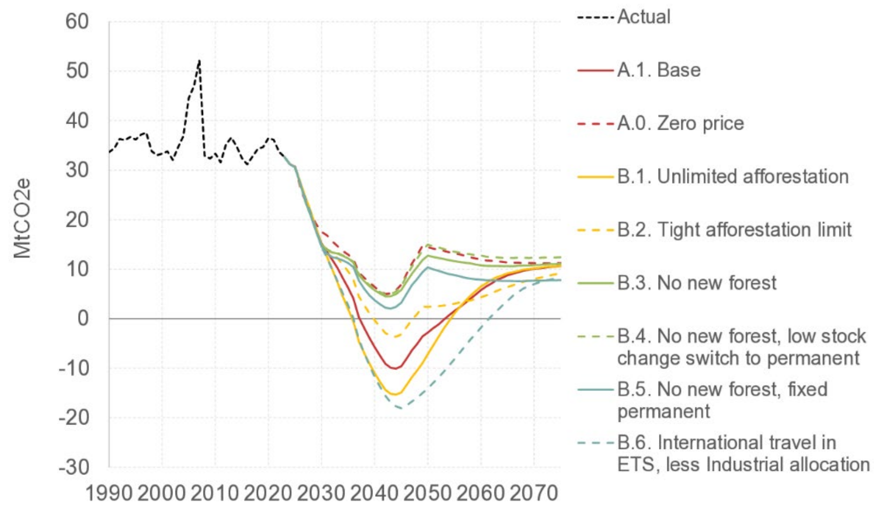


Figure 14 indicates that scenarios with limits on forestry's ability to supply NZUs to the ETS fail to achieve the 2050 target.

The scenarios with the most forestry (A.1, B.1) or international travel plus less industrial allocation in the ETS (B.6) achieve the 2050 target but fail to meet the other leg of the legislated target requirement, keeping emissions below net-zero beyond that point.[18] This is because of the falling carbon price from 2040 and beyond.

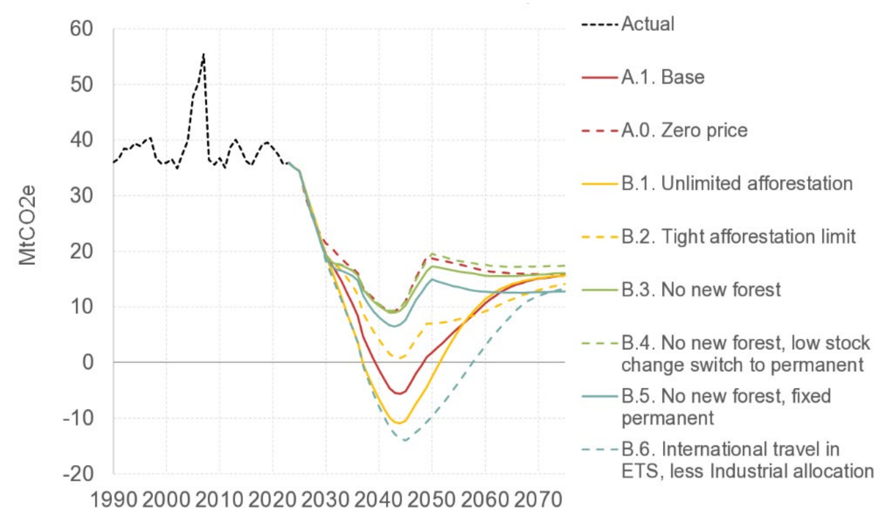
The fact that net emissions are *rising* beyond 2045-2050 is not only inconsistent with this second leg of the target, it is arguably

[18] The legislation states "*The target for emissions reduction (the 2050 target) requires that net accounting emissions of greenhouse gases in a calendar year, other than biogenic methane, are zero by the calendar year beginning on 1 January 2050* ***and for each subsequent calendar year***" (Emphasis added). Ref: Section 5Q of the Climate Change Response Act 2002.

inconsistent with the context with which the target is intended to reflect – ie, taking action consistent with limiting global warming to no more than 1.5°C. As detailed in Figure 17 on page 30 later, net emissions are rising because the sequestration rate associated with the substantial afforestation that occurred around three decades earlier is now declining rapidly, while gross emissions reductions are reducing at a much slower rate.

Furthermore, Figure 15 below indicates that none of the scenarios reach the Climate Change Commission's recommended more ambitious target (negative 20 $MtCO_2e$ by 2050 and beyond *including* international transport emissions in the ETS[19]). However, the government did not adopt the Commission's recommendation[20].

Figure 15: Net emissions of long-lived gases plus non-biogenic methane – including international transport emissions



All the above analysis indicates that if ETS settings remain unchanged and in the absence of new significant measures alongside the ETS, outcomes will fail to meet the underlying policy intent of the ETS – ie, to send a price signal that will result in New Zealand meeting its long-term emissions reduction targets. This calls into question whether the ETS design will remain unchanged or whether changes will be made to result in carbon prices that better achieve the policy intent.

4.5 Gross emissions reductions versus forest-related sequestration

To give more insight into the drivers of emissions outcomes detailed in the previous sub-section, Figure 16 and Figure 17 below show the effect on gross emissions of long lived GHG (plus non-biogenic methane emissions)and projected forestry sequestration from the various scenarios.

[19] https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/review-of-the-2050-emissions-target/2024-review-of-the-2050-emissions-target/final-report/

[20] https://environment.govt.nz/news/government-responds-to-climate-change-commission-advice-on-2050-target

Figure 16: Gross emissions of long-lived gases plus non-biogenic methane emissions for different scenarios

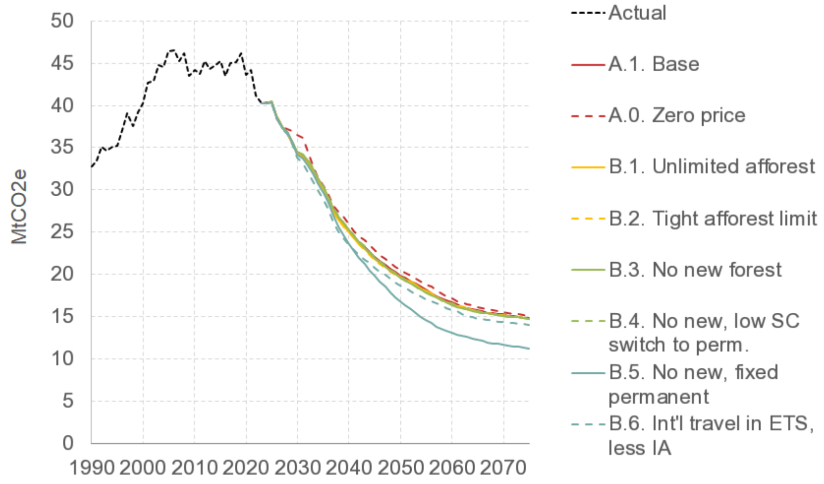
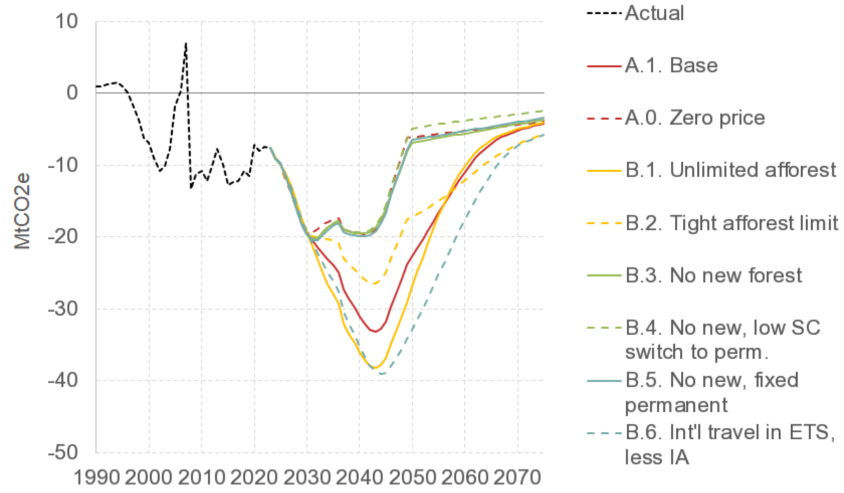


Figure 17: Projected forestry sequestration for different scenarios



The key takeaway from Figure 16 and Figure 17 is that the biggest driver of outcomes in the ETS relates to afforestation, given that it is the most sensitive to carbon prices of any sector of significant scale.

Forestry is the most sensitive sector to carbon price

Both new afforestation and the management of existing forests respond strongly to changes in carbon prices, as illustrated by scenarios B.1 to B.5. As a result, constraining only one source of supply has a limited effect on prices if the other remains available.

Figure 18 illustrates the sensitivity of land-use outcomes to carbon price for a typical area of land currently being used for sheep and beef farming[21]. Without an ETS price, sheep and beef is most

[21] Forestry costs and revenues are sourced from Scion's Forestry calculator, adjusted to present values, and annualised so they can be compared directly with those from farming.

profitable, but with a $40/t ETS price forestry is the most profitable. However, this does not mean that deforestation would necessarily occur at a lower carbon price, due to the significant costs described in section 2.2.

Figure 18. Relative economics of sheep and beef, rotational and permanent exotic forestry at a $40 ETS price and medium commodity prices.

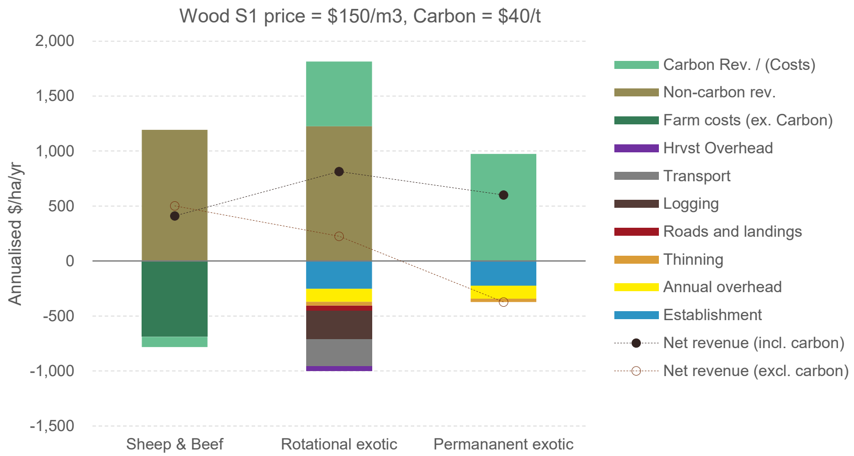
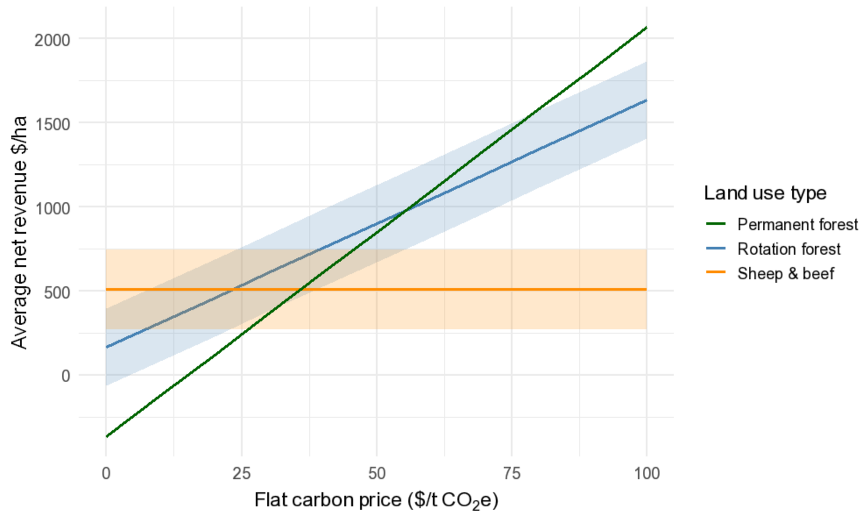


Figure 19 develops this further by showing how the relative economics changes with ETS price. The shaded bands represent the impact of 20% lower or higher log or meat prices.

Figure 19. Economics of rotational and permanent forestry vs. sheep and beef farming for a changing ETS price for forestry only



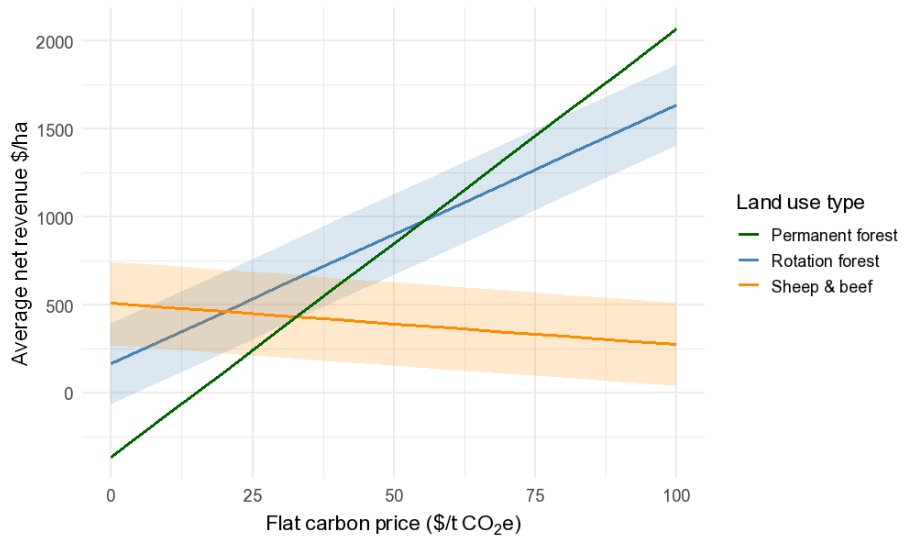
At low ETS prices, sheep and beef farming is most profitable, but at higher ETS prices it starts to become economic to convert to rotational forestry, and at even higher prices it is most economic to plant a permanent exotic forest. The figure also shows the effect of sensitivity analyses for low vs. high commodity prices (i.e. the price of logs and the price of meat). Even at high commodity prices for sheep and beef, both rotational and permanent forestry are more economic when the ETS price surpasses $40. Similarly, permanent forestry is – on average – the optimal land use with ETS prices above $60 per tonne.

It should be noted that the above graphs are for a broadly typical sheep and beef farm. There is variation across farms and forests which will alter the relative economics of pastoral farming vs forestry. However, the general nature and scale of the effect of a carbon price on the economics of the two options can be clearly seen in the graphs.

It is also important to note that Figure 19 assumes a continuation of the situation whereby pastoral farming doesn't face an equivalent cost of carbon to forestry.

Figure 20 below shows the effect if this were to change, and on-farm emissions including methane faced the same price as forestry (and there was no free allocation of units). As can be seen, the economics of pastoral farming worsen as the carbon price rises, if farms are required to bear the cost of their emissions. However, the gradient of the slope of pastoral farming's worsening position is not as steep as the gradient of the slope of forestry's improving position. This is because the average carbon emitted per hectare from pastoral farming is significantly less than the average carbon sequestered per hectare by forestry – as illustrated previously in Figure 18. In large part, therefore, carbon pricing doesn't price pastoral farming 'out' but prices forestry 'in'.

Figure 20: Economics of rotational and permanent forestry vs. sheep and beef farming for a changing ETS price for forestry and sheep & beef farming



Sources of gross emissions are relatively less sensitive to carbon price than forestry

While forestry is very sensitive to carbon price, the relative insensitivity of gross emissions to the carbon prices shown previously in Figure 16 is because the abatement costs of the actions to deliver significantly greater rates of gross emissions reductions are materially greater than the carbon prices for the scenarios considered. In large part this is because there is often a significant capital cost associated with gross emissions reductions, and the timing of when existing capital needs replacing will have a major effect on when it is cost-effective to switch to lower-emissions alternatives. For example, the abatement cost of switching from a gas boiler to an electric boiler is relatively low if the gas boiler has reached the end of its economic life, but it is much higher if the gas boiler has only recently been installed. Accordingly, the rate of decline in gross emissions for many sectors is strongly influenced by the timing of when capital assets have reached the end of their economic lives. The ENZ model accounts for this by smoothing technology switching over the assumed lifetime of different assets.

In addition to these capital replacement dynamics, as detailed in section 4.1 previously, there are several structural and policy-driven factors that are already locking in substantial gross emissions reductions, irrespective of the carbon price. These include the inevitable global transition to electric vehicles, the ongoing displacement of fossil-fuelled generation by renewables, the dwindling availability of domestic gas (which is driving up prices and encouraging fuel switching), and the mandated phase-out of coal-fired industrial boilers. Existing forestry and industrial allocation settings are also contributing significantly to gross emissions reductions. In fact, under a flat $100/t$CO_2$ price, forestry supply would exceed demand, making such a price outcome unsustainable under current policy settings. Even with future limits on afforestation, the compelling economics of permanent forestry continue to drive substantial NZU supply into the ETS. Regardless of whether forestry supply is unconstrained or restricted, the scenarios balancing ETS supply and demand do not achieve and sustain net zero.

5 Forestry in the context of the net zero target

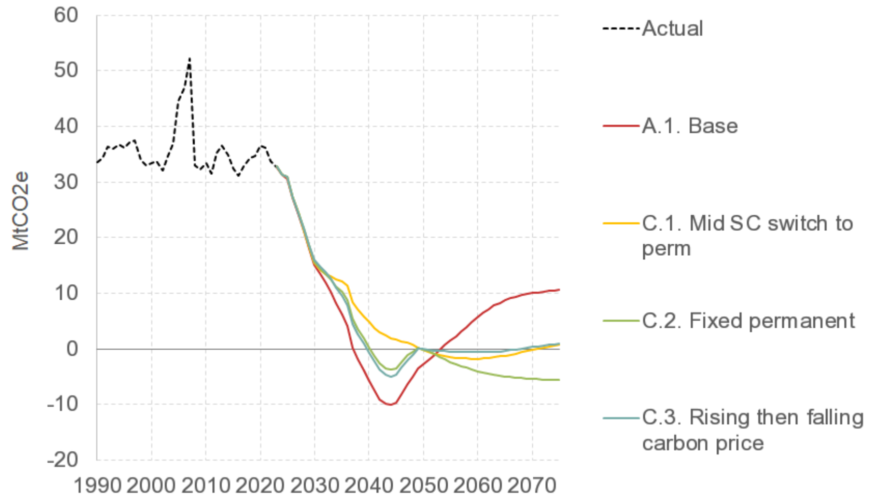
The previous sections identified that, under current ETS settings, forestry will play an outsize role in determining outcomes. Accordingly, the purpose of the scenarios in group C is to determine how much afforestation is needed to achieve net emissions targets if carbon prices rise over time - a trajectory that is generally considered desirable for driving sustained gross emissions reductions.

The following scenarios explore how the required level of afforestation varies under different assumptions about the carbon price path and the extent to which historical stock-change forestry transitions to permanent forest:

- C.1. the carbon price rises linearly to $250/t$CO_2$ by 2050, broadly consistent with the demonstration price path used by the Climate Change Commission, and historical stock-change forestry is assumed to switch to permanent at a medium level of price responsiveness.
- C.2. the carbon price also rises linearly to $250, but the share of historical stock-change forestry that becomes permanent is fixed.
- C.3. The carbon price follows the equilibrium price path from the baseline Scenario A.1, while historical stock-change forestry switches to permanent with a medium level of price responsiveness.

Figure 21 shows the resulting pattern of net GHG emissions (excluding biogenic methane) for these three scenarios alongside the existing base scenario. It shows how the net emissions outcomes for the three forest targeting scenarios are consistent with the objective of achieving net-zero emissions by 2050 and beyond.

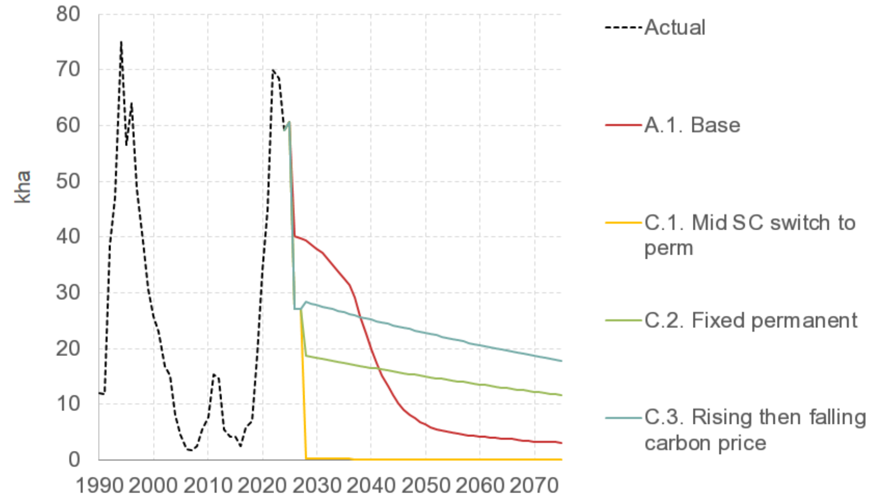
Figure 21: Net emissions of long-lived gases plus non-biogenic methane – excluding international transport emissions



Although the net emissions outcomes are broadly similar between the C.1, C.2, and C.3, Figure 22 below shows that there are quite different levels of afforestation between the three scenarios. With a rising carbon price and price-sensitive switching to permanent (C.1), almost no further afforestation required to meet the net-zero-by-50-and-beyond target.

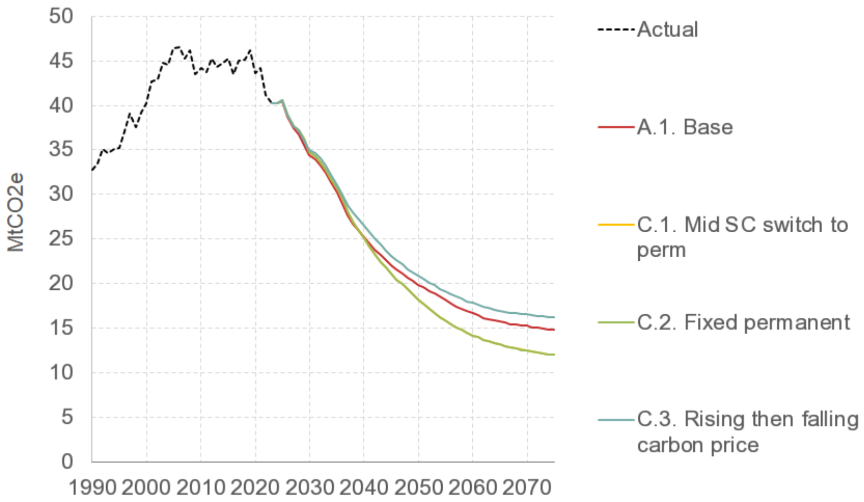
While the ETS price projection baseline (Scenario A.1) from the previous section has 703,000 hectares of afforestation between 2027 and 2075, scenario C.1 has only 40,000 ha because a large proportion of existing forestry is assumed to convert to permanent. In scenario C.2 where the permanent proportion is fixed, the total is 748,000 ha. In scenario C.3 the lower carbon price leads to a lower permanent proportion so 1,121,000 hectares are required. The total area is larger than in the baseline, but the planting profile is more stable, which avoids the pattern of early overshoot followed by rising net emissions.

Figure 22: Exotic afforestation for the different scenarios



There is a small difference (2 Mt in 2050) in gross emissions excluding biogenic methane between the baseline and the forestry targeting scenarios (Figure 23). In C.1. and C.2, higher carbon prices drive deeper emissions reductions in energy and transport. However, these gains are partly offset by higher long-lived gas emissions from agriculture, reflecting the reduced conversion of farmland to forestry.

Figure 23: Gross emissions excluding biogenic methane



6 Effect of limiting forestry's future inclusion in the NZ ETS

6.1 Definition of scenarios

For this analysis, ENZ was run in emissions-targeting price mode, as distinct to the ETS equilibrium mode for the runs set out in section 4.

Using the emissions-targeting price mode, ENZ was configured to determine the NZU price path necessary to meet the net-zero 2050 target, but in a future where any future afforestation registration in the ETS was disallowed from 1 January 2027 onwards.

The first key consequence of future forestry being unable to register in the ETS is that the economic returns from converting more pastoral farming to forestry would be substantially reduced. As a result, far less afforestation would be likely to occur - noting that the model could still project afforestation occurring without ETS registration if the returns would justify it (eg, in a scenario with high log prices and low meat prices). Forestry outside the ETS affects target accounting but not ETS supply or demand.

The second key consequence is that, with less future afforestation, greater gross emissions reductions would be required to achieve the net-zero target, with higher NZU prices being necessary to incentivise a greater extent of switching from high-emissions to low-emissions activities.

The third consequence is that without new forestry, a large proportion of existing forestry must switch to permanent in order to meet net-zero 2050. This means that existing forestry needs a price sufficiently high to incentivize permanent management.

For modelling simplicity, auction volumes are derived as the residual required to close the gap between NZU supply and demand implied by gross emissions reductions and supply of units from existing forestry.

Accordingly, the modelling adopted a two-step approach:

1) Iterate to determine a carbon price trajectory that would achieve the target emissions, then
2) Undertake ex-post analysis to determine what changes to auction volumes would be necessary to also deliver a stable NZU stockpile.

A number of sensitivity scenarios relating to forestry's inclusion in the ETS from 2027 onwards were examined within this framework. The base assumption is moderate price sensitivity for SC switching to permanent. The scenarios are:

- No new exotic forests may register in the ETS but native forests could continue to register (D.1).
- No new forests (exotic or native) may register in the ETS (D.2).
- No new forests (exotic or native) may register in the ETS, with low price sensitivity for switching of existing stock-change forests to permanent (D.3).
- As per D.1, but no more ETS units issued for existing registered exotic forest (D.4).
- As per D.2, but no more ETS units issued for any existing registered forest (D.5).

In addition, we test the impact of decoupling the price that exotic forestry receives from the price that gross emitters pay:

- As per D.1, but existing exotic receives 50% of NZU price (D.6).
- Exotic forest is not limited, but only receives $30/NZU post 2027(D.7).

Finally, as scenarios D.4 and D.5 require a very high carbon price to achieve net zero emissions, an additional scenario (D.8) examines the level of permanent exotic afforestation required outside the ETS if a price path closer to the Climate Change Commission's demonstration path were preferred.

Box 1 - Increasing the coverage of price-responsive sectors within ENZ

An initial result of the modelling was that, with far less projected afforestation, ENZ didn't have sufficient coverage of activities deemed to be responsive to carbon price to result in a feasible solution. In other words, with a significant proportion of non-carbon-price-responsive sectors (e.g. steel and aviation), no matter how high the carbon price, the model was not projecting sufficient falls in gross emissions required to meet the net-zero target.

Accordingly, ENZ's functionality was extended to enable other significant sectors to respond to a carbon price. Details of the additional functionality is set out in section 10 in the appendix. All scenarios were run with this new functionality, although it has no impact at lower carbon prices.

As set out in section 10, it should be noted that there is material uncertainty over the abatement cost of technologies in these sectors, and the extent to which increases in the price of carbon faced by these sectors would result in a reduction in emissions. However, the approach is considered reasonable for illustrating the general nature and scale of outcomes from limiting future forestry unit supply in the ETS.

With this new functionality introduced, ENZ is better able to find a feasible carbon price trajectory that would incentivise sufficient gross emissions reductions to achieve the net-zero target. However, even with this functionality, the policy scenario prohibiting any future exotic and native afforestation and limiting any stock-change registered forests from switching from harvested to permanent failed to achieve sufficient reductions to meet the net-zero-by-50 target. That said, it only just failed to meet the target in the central state-of-the-world scenario of meat and wood prices. In the scenario with low meat and high wood prices, the policy scenario was able to find a feasible solution because there is slightly more afforestation for the purpose of timber supply, even in the absence of carbon revenue.

6.2 Results and insights

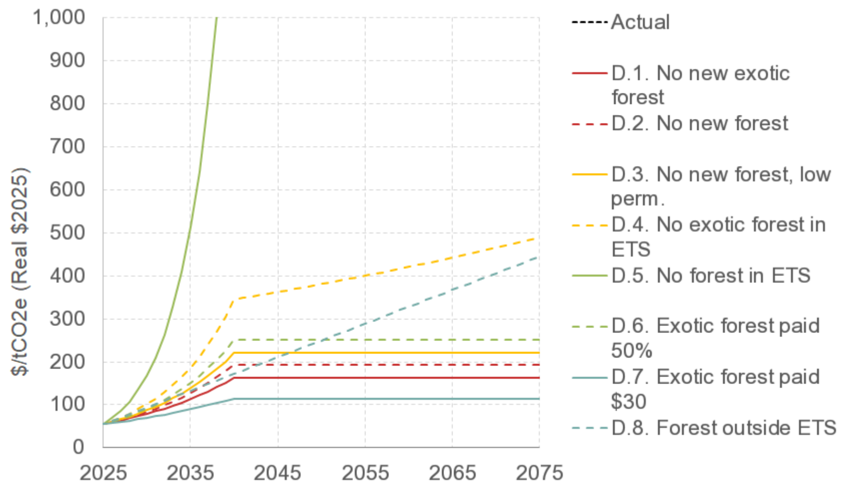
Figure 24 shows the NZU price paths required to meet the net-zero target in each scenario. Figure 25 shows exotic afforestation, and Figure 26 shows the projected net emissions of long-lived gases for the different scenarios.

In scenarios D.1 to D.3, the carbon price is limited by the degree of expected switching of existing forestry to permanent, and to a lesser extent, whether new native forestry is allowed to enter the ETS. Scenario D.1, with new native and moderately price-sensitive switching, has the carbon price rising to $163, while in D.3, with less switching, the price reaches $221.

The highest-price scenario is D.5, because when no new units are issued, existing stock-change forestry will only remain permanent if the value of the units that would need to be surrendered upon harvest exceeds the combined value of current timber and the NPV of future rotations, net of ongoing compliance and maintenance costs. However, carbon prices exceeding $1,000 are unlikely to be realistic in practice, as they would exceed the cost of most available emissions reduction options. Scenario D.4 has a lower price trajectory due to native forest registration still being allowed.

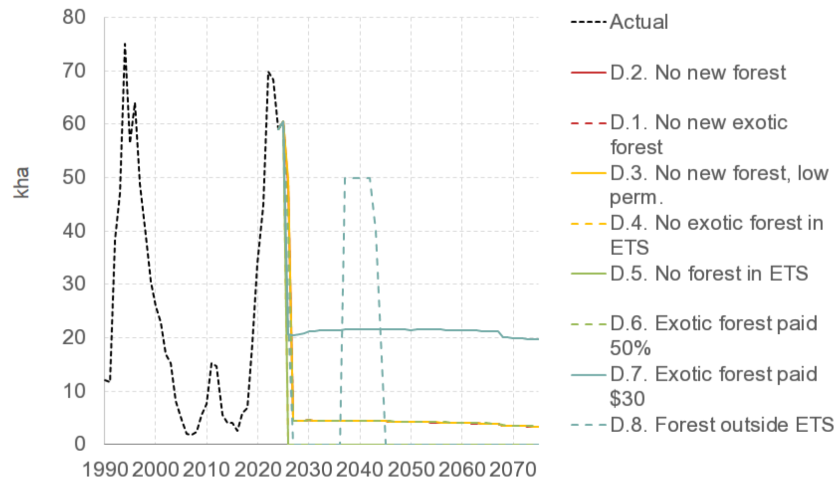
In Scenario D.6, where NZUs from exotic forestry are valued at 50%, the carbon price rises to $250. If exotic forestry units were priced at $30 but new forestry remained allowed (Scenario D.7), there would still be sufficient supply from new production forestry to limit the multi-sector price to $115. At this price no stock-change forests convert to permanent. However, the outcomes in this scenario are highly sensitive to the relative economics of production forestry versus sheep and beef farming.

Figure 24: NZU price projections



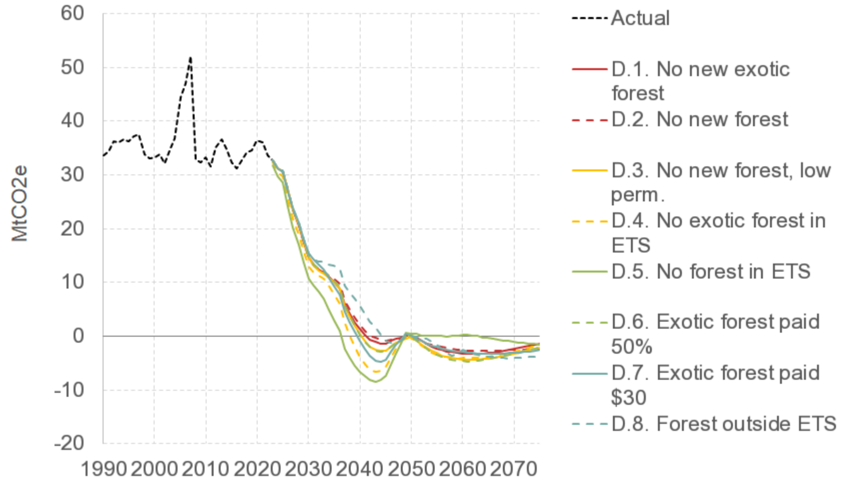
Scenario D.8 illustrates that net-zero can be met by issuing no new forestry units in the ETS, but with planting around 370,000 hectares of permanent exotic forest between 2035-2045 (Figure 25).This scenario has no conversion of existing stock-change forestry to permanent, due to existing forestry receiving no units and the price not being high enough to justify forgoing harvest.

Figure 25: Exotic afforestation



All scenarios are able to achieve and sustain net-zero (Figure 26) through varying degrees of gross emissions reductions and conversion of existing forestry to permanent. The net emissions trajectories (excluding biogenic methane) are broadly similar for most scenarios. Scenario D.5, with no incentives for ongoing forestry participation, only just remains under net zero.

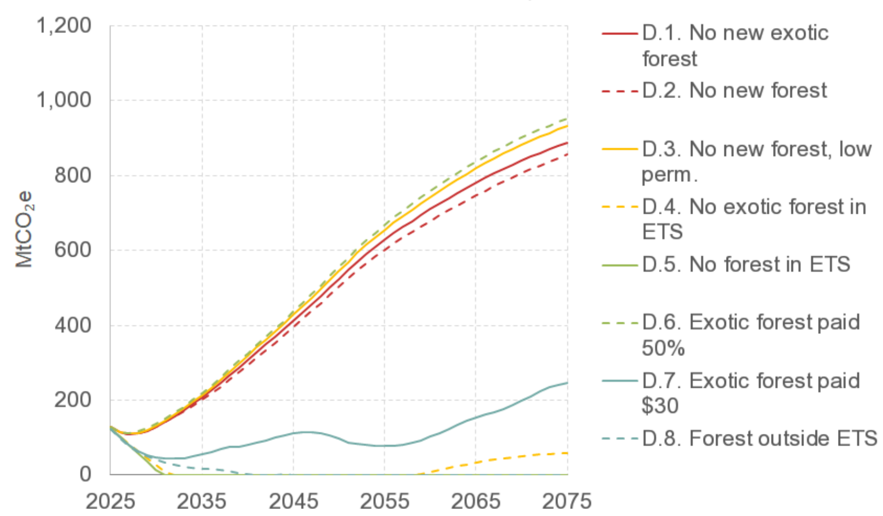
Figure 26: Net emissions of long-lived gases



One insight from comparing net emissions in Figure 26 with the stockpile trajectories in Figure 27 is that the two are internally inconsistent. If existing registered forests can continue to receive and then sell units to gross emitters, this will not allow a continuously rising NZU price. It is not possible to have a carbon price trajectory that satisfies both the emissions point-target <u>and</u> achieves a stable NZU stockpile.

For the scenarios that disallow the issue of any new exotic forestry units (scenarios D.4,D.5 and D.8), the stockpile is quickly depleted, but modelled auction volume is set just high enough to meet demand.

Figure 27: Stockpile trajectories



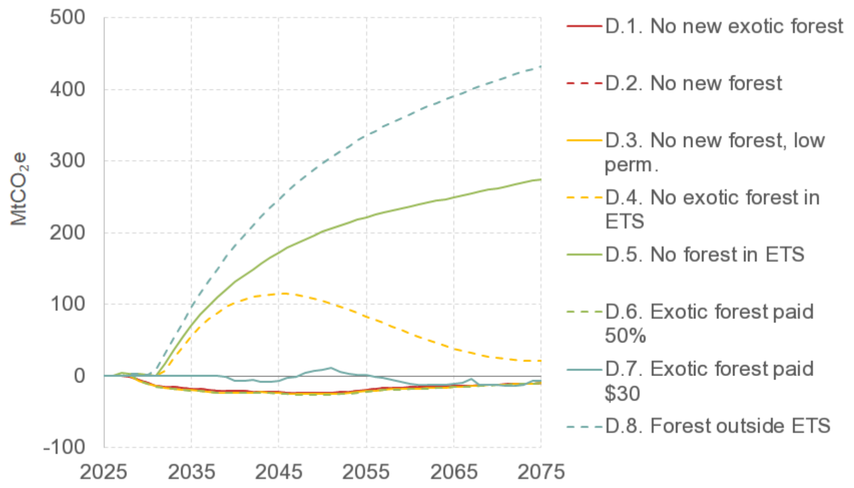
6.2.1 Balancing ETS supply and demand

Given the significant imbalance between ETS supply and demand identified in the previous section for scenarios that achieve net zero, further analysis was undertaken of what changes to auction volumes would be necessary in order to achieve a stable stockpile and have the price trajectories set out in Figure 24 above.

If forests that were already registered were able to continue to be awarded units, the analysis identified that the only way the stockpile would remain at a stable level (and thus be consistent with the price path necessary to achieve the emissions target) would be if the government *bought back* large numbers of units.

The number of units required to be bought varies depending on scenario assumptions, but Figure 28 shows that all scenarios in which units continue to be issued to forestry, and allow forestry to be permanent, require buy-backs in the order of 5 to 25 million units per year.

Figure 28: Net auction (buy-back) volumes required to balance the NZU stockpile



Buying back units would be at significant cost. In a scenario where existing forestry continues to receive units, maintaining NZU prices at levels sufficient to incentivise the gross emissions reductions required to achieve the net-zero target would likely result in a present-value cost of tens of billions. The NPV column in Table 2 reflects net auction revenue minus the cost of buy-backs, at a discount rate of 6 per cent.

Table 2: Carbon price and auction revenues / (costs)

Scenario	Avg NZU price		NPV of auctioning / (buying-back) NZUs ($bn)
	Multi-sector	Exotic forest	
D.1. No new exotic ETS forest	139	139	-34
D.2. No new ETS forest	162	162	-39
D.3. No new ETS forest, low permanent	181	181	-48
D.4. No exotic forest in ETS	279	0	286
D.5. No forest in ETS	1129	0	2662
D.6. Exotic paid 50% of NZU price	203	101	-27
D.7. Existing forestry & new exotic paid $30	102	30	-3
D.8. New forest outside ETS	172	0	631

Even if forestry units were valued at only 50% of the value of multi-sector units (Scenario D.6), the cost would still be $27 billion. In contrast, assigning a fixed price of $30 to any new or existing exotic forest (Scenario D.7) would be close to fiscally neutral.

Scenarios D.4, D.5 and D.8, in which no new units are issued to forestry, require substantial additional auction volumes and generate large auction revenues. Scenario D.5 generates the highest auction revenue, but as previously mentioned, the extremely high price is unlikely to be feasible.

Scenario D.8 has the highest demand for auction volume (valued at $631 billion) because the more moderate price path incentivises fewer gross emissions reductions[22] than in scenarios D.4 or D.5. This scenario has 370,000 ha of new permanent forest outside the ETS. Assuming an establishment cost of $3000 per hectare, the present-value cost of the new forestry would be $0.4 billion[23].

[22] This price trajectory, rising to $250 by 2050, was chosen for consistency with the Climate Change Commission's demonstration path. A lower or higher target trajectory would require correspondingly more or less additional forestry outside the ETS, and have implications for auction revenue.

[23] An alternative approach would be to fund more native forest planting as soon as possible, or to pay existing forest owners to retain an optimal area of forest as permanent. Either option would still deliver a substantial net fiscal benefit.

While decoupling the forestry carbon price from the price faced by gross emitters may provide a more targeted way to achieve emissions reductions, it introduces its own risks. In particular, materially altering the price received by existing forestry participants would change the expected returns from prior investment decisions, potentially increasing New Zealand's perceived sovereign risk for parties considering investing here. It would also have distributional impacts, as Māori own a significant share of forests registered in the NZ ETS, raising Treaty of Waitangi considerations. Forestry owners could be compensated using auction revenue, however.

Altering the target may improve matters

The above analysis was based on achieving the current target of net-zero long-lived gases by 2050 and beyond. Adopting the Climate Change Commission's proposed revised target of net-negative long-lived gas emissions of -20MtCO_2e by 2050 and beyond including international transport emissions would increase the demand for units (by international transport) and reduce the number of units that would have to be bought back to stabilise supply.

More fundamentally, the tension between ETS and the net-zero target arises because gross emissions reductions and forestry removals have different structural properties. Many gross emissions reductions are durable capital stock changes, after which emissions remain lower without additional effort. By contrast, forests only supply NZUs while accumulating carbon up to their long-term average so require continuous new planting – albeit with significant difference between harvested exotics, permanent exotics, and permanent natives. A point-year target is compatible with gross emissions reductions, but not with forestry removals. Alternative formulations, such as multi-decade cumulative carbon budgets or rolling budget periods, would be more compatible with the intertemporal nature of forestry sequestration and harvest cycles.

7 Conclusion

The modelling presented in this report highlights several structural features of the ETS and their implications for long-term emissions outcomes. Under current policy settings (Scenario A.1), NZU prices are projected to modestly rise through the late 2020s and early 2030s as the existing stockpile of units declines and demand from gross emissions obligations remains relatively high. However, this tightening is temporary. From the mid-2030s onward the system begins to transition toward oversupply as units generated from earlier afforestation enter the market and gross emissions gradually decline.

By the 2040s the modelling indicates a sustained surplus of NZUs, weakening the carbon price signal provided by the ETS. Any additional afforestation within the next decade would further exacerbate the projected oversupply.

Although the ETS under current settings can temporarily bring net emissions below the legislated 2050 net-zero target, the modelling indicates that this outcome is unlikely to be sustained beyond mid-century. This reflects the fact that under target accounting rules, that harvested forests only accumulate carbon up to their long-term average age (around 23 years). While many gross emissions reductions involve durable changes in technology or capital stock, forestry removals occur only while forests are accumulating carbon.

A key uncertainty shaping both ETS price outcomes and emissions trajectories is the degree to which existing stock-change registered forests are harvested or instead remain permanent. This assumption materially affects future NZU supply and therefore plays a critical role in determining both ETS balance and the likelihood of meeting emissions targets. If a sufficiently large share of existing stock-change forests remains permanent, the modelling indicates that New Zealand could meet the 2050 net-zero target without any further afforestation beyond 2026.

The analysis also highlights a deeper structural tension within the current design of the ETS. Because of projected oversupply of forestry units in the late 2030s to 2040s, it is not possible to simultaneously meet a point-year net-zero target in 2050 and maintain an ETS supply-demand equilibrium.

Scenarios with continued forestry issuance from either new or permanent forestry result in suppressed ETS prices. Achieving the net-zero target using the ETS as the primary policy instrument will require mechanisms such as government buy-backs of units or substantial restrictions on forestry units, both of which introduce significant fiscal or policy risks.

In summary, these results suggest that the current configuration of the ETS is unlikely to provide a stable long-term pathway to net-zero emissions. Resolving the tension between forestry cycles, carbon price stability, and sustained gross emissions reductions will likely require some form of policy that at least partially decouples forestry from gross emissions abatement, or alternative approaches to defining and managing New Zealand's long-term emissions targets.

APPENDICES

8 The New Zealand Emissions Trading Scheme (ETS)

8.1 Overview of the ETS

The New Zealand Emissions Trading Scheme or ETS is a government-established market mechanism designed to support New Zealand in achieving its domestic emissions budgets, the 2050 net-zero target, and international obligations under the Paris Agreement, including its Nationally Determined Contributions (NDCs).[24] By putting a price on greenhouse gas emissions, the ETS influences economic behaviour, discouraging high-emission activities while rewarding lower-emission alternatives.

The ETS covers nearly all sectors of the New Zealand economy except agriculture and some types of waste and industrial process emissions. Principally, because of the exclusion of agriculture, we estimate the ETS covers approximately 45% of New Zealand's greenhouse gas emissions. Businesses or people who have an obligation under the ETS are referred to as participants.

8.1.1 How the ETS works

Participants in the scheme are required to surrender New Zealand Units (NZUs), each representing one tonne of carbon dioxide equivalent (tCO_2e), based on the level of emissions associated with their activities. Participants are free to decide how to reduce their emissions or cover their obligations.

The government conducts quarterly auctions to sell a limited supply of NZUs, with the total volume available at auction declining over time in alignment with New Zealand's emissions budgets. These auctions have a price floor to prevent the auctioning of units below the price floor, and a cost containment reserve (CCR) to supply additional NZUs to market if the NZU price surges. The CCR allows for an additional amount of NZUs to be released via auction if the auction price exceeds the CCR price.

Other units are supplied into the ETS from:

- Allocation to forestry participants registered in the ETS. NZUs are awarded to recognise the sequestration associated with forestry growth.
- Free allocation to Emissions-Intensive Trade-Exposed (EITE) industries, under the Industrial Allocation mechanism.

Under the EITE mechanism, EITE firms receive free allocation of NZUs corresponding to a proportion of their estimated emissions.[25] The intent is to protect New Zealand firms from competition from overseas firms who are not exposed to a carbon price and thus prevent 'carbon leakage'.[26] The current level of allocation for the most emissions-intensive industrial firms is 85% of their estimated emissions, declining at 1% per annum over the 2020s, 2% per

24 New Zealand's second Nationally Determined Contribution (NDC2), submitted in January 2025 , outlines the country's emissions reduction commitments beyond 2030. The government chose the minimum level of ambition – a 51-55% decrease from 2005 gross emissions by 2035 - which is only marginally more ambitious than the pathway defined by domestic budgets.

25 Examples of EITE firms activities include steel production, methanol manufacturing, and cement production, as well as smaller-scale activities such as vegetable greenhouse heating and cut-flower cultivation, which have emissions several orders of magnitude lower.

26 'Carbon leakage' occurs where a firm goes out of business due to being exposed to a price of carbon, but the production of that firm is replaced by an overseas firm that is subject to a lower price of carbon but whose emissions are greater than the firm that went out of business.

annum over the 2030s, and 3% per annum over the 2040s and beyond

Beyond the auction system, participants can trade NZUs on a secondary market, where prices are determined by supply and demand dynamics among market participants, including foresters earning NZUs, businesses with surrender obligations, traders, and speculators.

Businesses who participate in the ETS can buy and sell units from each other. The price for units reflects supply and demand in the scheme. This price signal is intended to allow businesses to make economically efficient choices about whether and how to reduce their emissions.

The ETS allows for 'banking' of units, enabling a stockpile of units to develop. While a certain level of stockpile is considered important to allow the market to clear in the event there are circumstances which may cause unusually high emissions (e.g. a dry-year causing high levels of coal generation), the main reason for maintaining a stockpile is that participants need to hedge their exposure to the emissions price to sensibly manage their future obligations. Concerns have been raised by various stakeholders that the recent level of the stockpile is too high, and will act to suppress future NZU prices below a level that is consistent with meeting New Zealand's emissions reduction objectives.

8.1.2 History of the ETS

The ETS was established in September 2008 under the Climate Change Response Act 2002 (CCRA). It was initially designed as a comprehensive system intended to cover all sectors and greenhouse gases. Over the years, its implementation has been phased in, covering emissions from fossil fuels, industrial processes, waste, and forestry. As of early 2022, the scheme covers approximately 45% of New Zealand's greenhouse gas emissions. Agriculture, which contributes around half of New Zealand's gross emissions, remains outside the scheme for now, though the government has committed to implementing pricing mechanisms for agricultural emissions by 2030. Additionally, the ETS does not cover some other non-agricultural emissions, including non-municipal landfill Waste emissions and some Industrial Process and Product Use emissions such as F-gases in imported appliances.

The ETS has undergone multiple reforms to improve its functionality and address market dynamics. A major milestone was the Climate Change Response (Emissions Trading Reform) Amendment Act 2020, which restructured key elements of the system including unit supply, price management, and forestry accounting rules.

Recent developments

In December 2023, the auction price floor was increased from $33 to $64 for 2024, and a two-tier Cost Containment Reserve was introduced to address concerns about price volatility.[27]

In June 2024, the government deferred plans to price agricultural emissions from 2025, including methane from livestock, in response to concerns about the potential impact on farm profitability. Instead, a Pastoral Sector Group was established to explore alternative methods for reducing biogenic methane emissions. The government has indicated that a pricing system for on-farm emissions may still be introduced by 2030.

In August 2024, in response to advice from the Climate Change Commission[28], the government announced a significant reduction in the number of NZUs available for auction between 2025 and 2029.

[27] https://environment.govt.nz/news/government-announces-updated-nz-ets-auction-settings/

[28] https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/nz-ets/our-advice-on-the-nz-ets/nzets-advice-2025-29/full-report-nzets-2025-29/

The number of units available for auction over coming years decreased from 49 million to 21 million units. The decision came after a series of auction failures in 2023 and 2024, where the clearing price failed to meet the minimum threshold.

No units have been sold at ETS auctions since December 2024, which saw only a partial clearance. Prices remain subdued, presumably due to persistent expectations of long-term market oversupply and ongoing uncertainty around ETS policy and industrial allocations.

Current ETS settings

The latest ETS price and volume settings, published in August 2025, have the auction price floor increasing from $71 in 2025 to $87 in 2030 (Table 3). Base auction volumes, CCR volumes, and MfE-projected industrial allocations decrease over the same period. The overall volume limit decreases from 16.3 million units in 2026 to 9.6 million in 2030.

Table 3 – ETS price and volume settings by calendar year as at December 2024 [29]

Price setting	2026	2027	2028	2029	2030
Auction price floor	$71	$75	$78	$82	$87
CCR Tier 1	$203	$213	$224	$236	$248
CCR Tier 2	$254	$267	$280	$295	$309
Base auction volumes (m)	5.2	4.3	3.3	2.4	1.7
Total CCR volumes (m)	6.5	5.9	5.3	4.7	3.9
Industrial allocation (m)	4.6	4.4	4.1	4.0	4.0
Overall limit on units (m)	16.3	14.6	12.7	11.1	9.6

Forestry participation in the ETS

Forest owners can participate in the ETS as both suppliers and managers of NZUs. Owners of eligible forests planted after 1989 (so-called post-89, or P89, forests) can register their forests in the ETS to earn NZUs based on the carbon dioxide sequestered as their trees grow.

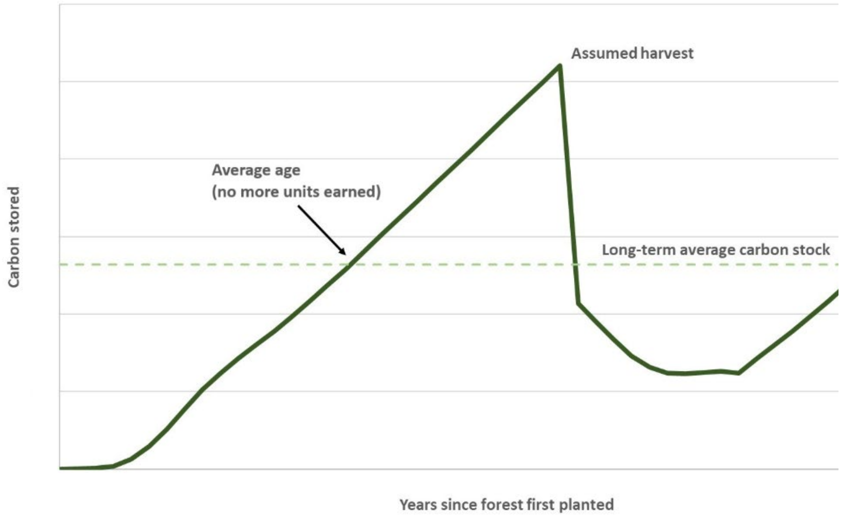
Forests registered prior to 2019 had to be registered under the 'stock-change' accounting approach. Under this approach, a forest owner is awarded NZUs each year equivalent to the incremental amount of carbon the forest is estimated to have sequestered that year. However, if the forest is harvested, the forest owner must then surrender an amount of units equivalent to the estimated amount of carbon lost from harvesting the forest. If the land is then re-planted to grow another forest (as is the case for most commercial forestry) the process of being awarded units as the forest grows again is repeated. This gives rise to the classic 'saw-tooth' profile of carbon sequestration for commercial (aka 'rotational') forestry, as shown in Figure 29 below.

Rotation forests registered after 2023 are awarded units based on an 'averaging accounting' system. Under this approach, a newly planted forest will only earn units for part of its first rotation – up to a level equivalent to the long-term average carbon stock associated with rotational forestry – but then earn no further units but equally

[29] https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/ets/nz-ets-market/annual-updates-to-emission-unit-limits-and-price-control-settings/

not have to surrender units upon harvesting. This is illustrated in the Figure 29.

Figure 29: Illustration of sequestration profile of rotational forestry, and the application of average accounting for the awarding of units[30]



Forests registered between 2019 and 2022 could choose whether to remainr under the stock change accounting or switch to either the averaging accounting methodology or permanent forest category.

Forest owners can also decide not to harvest their forests and make the forest 'permanent'. This is assumed by default for owners of native forests that take significantly longer to reach harvestable maturity and have additional constraints on harvesting. In contrast, owners of exotic species such as Pinus radiata or Douglas fir have the option to harvest their forests for timber within a commercially viable timeframe. For forests registered under the stock-change approach, the decision as to whether to be effectively permanent or not can be dynamic, based on expectations of future carbon and wood prices. Owners of forests already registered under average accounting can also apply to change their registration to the Permanent category.

Units earned by forestry participants can be traded on the secondary market or retained to offset future liabilities, such as the repayment of carbon lost from harvesting (for forests registered under the stock-change accounting approach) or deforestation. Pre-1990 (P90) forest owners also face deforestation liabilities, requiring them to surrender NZUs. Participation allows forest owners to monetise carbon sequestration, contributing to both their revenue streams and New Zealand's emissions reduction targets.

The cost of participating in the ETS for forest owners includes both annual charges and compliance-related expenses. Additional costs can arise from consultancy fees for mapping and eligibility assessments and ongoing compliance obligations such as carbon volume assessment reporting and record-keeping. These expenses vary depending on the size and complexity of the forest, with professional assistance often required to ensure accurate reporting and adherence to the scheme's requirements.

Land that has forest registered in the ETS has a "Notice of status of forest land" registered against the land title, which specifies the type, age, accounting rules used, and unit balance. An entity that purchases a forest must register in both the New Zealand Emissions Trading Register (NZETR)[31] and Te Uru Rākau New Zealand Forest Service.[32] The NZETR account facilitates the management of NZUs, while registration with Te Uru Rākau

[30] https://www.mpi.govt.nz/forestry/forestry-in-the-emissions-trading-scheme/emissions-returns-and-carbon-units-nzus-for-forestry/accounting-for-carbon-in-the-ets/averaging-accounting/

[31] https://www.eur.govt.nz/

[32] https://www.mpi.govt.nz/forestry/forestry-in-the-emissions-trading-scheme/

ensures the forest land is eligible for the ETS and correctly recognised within the ETS framework.

As we illustrated in earlier sections, forestry's participation is one of the most significant moving parts in the ETS because of the scale of land that can be forested, and because of the relatively low carbon price for it to be cost-effective to convert sheep-and-beef farmland to plantation forestry.

In December 2024, as part of the second Emissions Reduction Plan (ERP2), the New Zealand government announced forthcoming changes aimed at limiting farm-to-forestry conversions on productive land. These measures include a moratorium on registering exotic forests on high-quality farmland (Land Use Capability classes 1-5) and an annual cap of 15,000 hectares for such registrations on class 6 land. Up to 25% of a farm's class 1-6 land can be converted to forestry for ETS purposes, providing flexibility for farmers. Certain categories of Māori-owned land are exempt from these restrictions. These changes are scheduled to be implemented by October 2025 and the duration remains open-ended.

These policy adjustments are expected to influence ETS prices by potentially reducing the supply of NZUs from new forestry projects. While the conversion limits are unlikely to significantly affect afforestation if activity remains in line with the central projection, they could restrict the use of forestry to meet more ambitious emissions targets or to offset higher-than-expected emissions in other sectors. In such scenarios, the constraint would result in higher carbon prices than would otherwise occur, as alternative mitigation options tend to be more expensive.

8.2 The secondary NZU Market

The secondary market in NZUs facilitates the trading of units between market participants after they are initially allocated or purchased at government auctions. This market operates independently of the government, allowing participants to buy and sell NZUs directly based on supply and demand dynamics.

Participants in the secondary market include foresters, businesses with surrender obligations, investors, brokers, and traders. Prices in the secondary market reflect real-time factors such as unit availability, current and anticipated demand, regulatory changes, and broader economic conditions. Transactions typically occur through trading platforms, broker services, or bilateral agreements.

The New Zealand Emissions Trading Register (the Register) stores and tracks all emission units earned, traded and used in the ETS.

8.2.1 Price and volume trends

As shown in Figure 31, NZU prices have exhibited significant fluctuations, influenced by policy changes and market dynamics. In 2023, prices declined due to policy uncertainties, reaching a near two-year low in July 2023. However, by November 2023, prices rebounded to a nine-month high as policy clarity improved, including through expectations of the revisions to the ETS which was being consulted on through the latter half of 2023.

Figure 30: Historical NZU prices (real, $2024)[33]

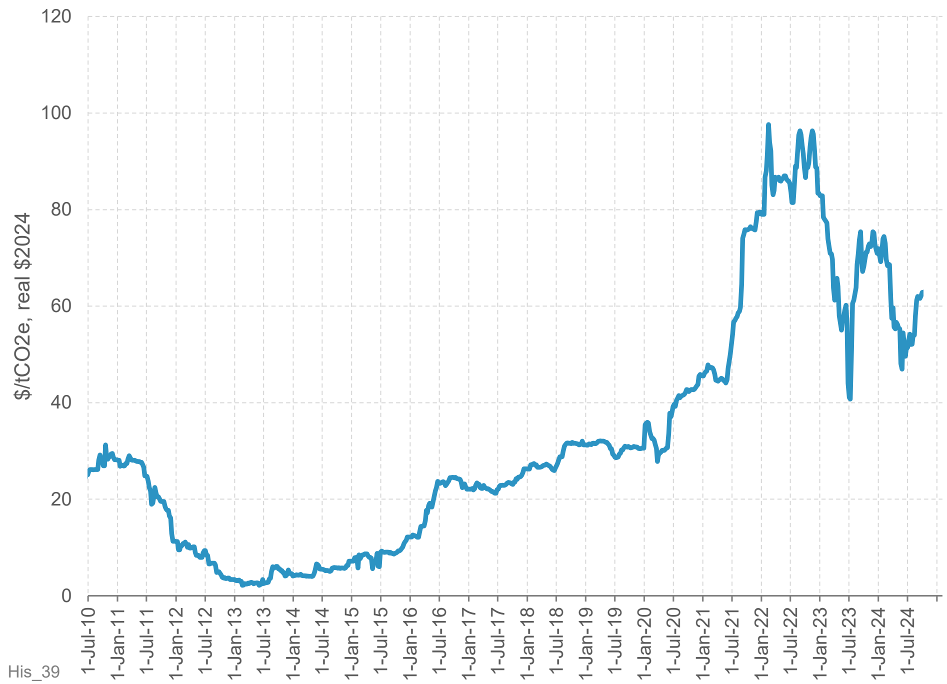
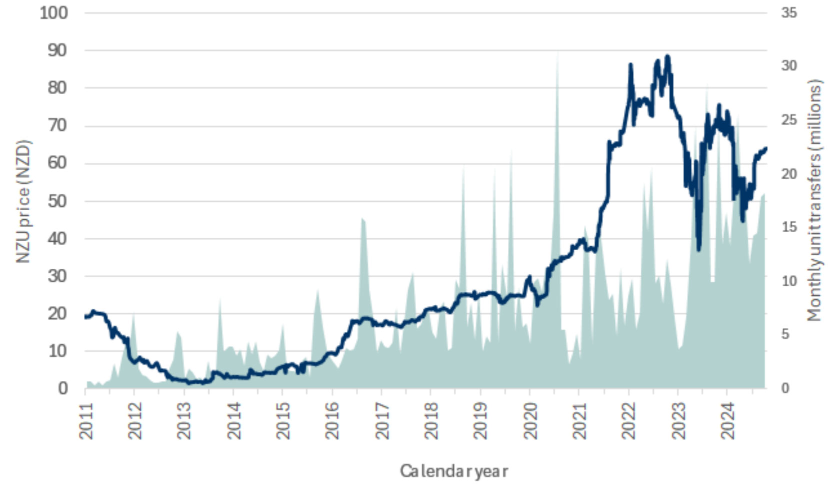


Figure 31 - Historical NZU prices and transfer volumes



Transfer volumes have mirrored this volatility, showing an upward trend in recent years. In 2023, total NZU transfers reached 15.5 million, reflecting heightened trading activity. By 31 October 2024 transfers had already reached to 16.9 million, indicating growing market engagement and liquidity.[34]

Market participation

NZU secondary market participation includes a diverse range of entities driven by compliance obligations, investment interests, and voluntary carbon offsetting. Compliance participants, such as fossil fuel importers, industrial manufacturers, and waste processors, are the primary traders, acquiring NZUs to meet legal requirements for surrendering units corresponding to their emissions. Forestry participants, including landowners and forestry investors, actively trade NZUs earned from afforestation or reforestation projects. Beyond these compliance actors, a growing number of voluntary participants, such as businesses and organisations seeking to offset emissions or demonstrate climate leadership, contribute to market activity. Additionally, traders and brokers participate in the

33 I have converted the nominal NZU prices to real $2024 using the CPI index published by the Reserve Bank.

34 https://www.epa.govt.nz/industry-areas/emissions-trading-scheme/market-information/carbon-markets/

secondary market, facilitating liquidity and enabling price discovery. This mix of actors ensures the ETS remains a dynamic and responsive market.

International linkages

The ETS used to be linked to the international Kyoto market from 2008 to 2015, allowing entities to meet their obligations with international credits. However, after New Zealand delinked from the Kyoto market in 2015 due to concerns about the integrity of many international units, Kyoto units were phased out for ETS compliance purposes. While they may still appear in NZETR accounts as historical records,[35] they are no longer tradable or valid for meeting obligations in the current ETS, which now operates exclusively with NZUs.

8.2.2 Recent policy changes

This section outlines policy changes that have been assessed by the New Zealand Government as resulting in quantifiable emissions impacts. Enabling policies such as frameworks, strategies, and research initiatives are excluded from this section.

Adjustments to the ETS

As previously set out, ETS settings were updated in August 2024 to reduce the number of units available between 2025 and 2029 from 45 million to 21 million. This is expected to result in an increase in carbon prices.[36] The December 2024 ETS auction achieved a partial (36%) clearance, selling 4 million units at the price floor of $64 per unit. This marks the first successful sale since the March auction, which also partially cleared, while the June and September auctions failed to sell any units.

The Second Emissions Reduction Plan (ERP2)

The Second Emissions Reduction Plan (ERP2)[37] outlines New Zealand's strategies to reduce greenhouse gas emissions during the second emissions budget period (2026–2030) and will likely affect carbon prices throughout this period and beyond. A significant outcome of ERP2 was also the establishment of a provisional ETS cap, which has since been formalised in the 2025 ETS unit limit and price control settings. Other key policy levers that were assessed as having quantifiable emissions impacts are:

- Electrify NZ: an initiative to facilitate private investment in renewable energy infrastructure by streamlining consenting processes and amending cost recovery rules for lines companies. The approach aims to expedite the development of renewable energy sources such as wind, solar, and geothermal power.
- Carbon capture, use, and storage (CCUS): CCUS involves capturing carbon dioxide emissions from industrial processes or the atmosphere, which is then stored underground or utilised in products to prevent it from entering the atmosphere. Proposed policy levers include establishing clear regulatory frameworks, integration with the ETS, offering financial incentives, and investing in shared infrastructure. The central projection assumes CCUS is deployed by 2027 for gas processing for one high-CO_2 gas field.[38]

[35] Kyoto units in the New Zealand Emissions Trading Register (NZETR) are carbon credits created under the Kyoto Protocol, including Assigned Amount Units (AAUs), Certified Emission Reductions (CERs), and Emission Reduction Units (ERUs).
[36] https://www.beehive.govt.nz/release/updated-settings-restore-ets-market-confidence
[37] https://environment.govt.nz/publications/new-zealands-second-emissions-reduction-plan/
[38] https://environment.govt.nz/publications/second-emissions-reduction-plan-technical-annex/

- EV chargers: providing financial incentives for public and private investment in charging infrastructure and streamlining regulations to enable faster deployment.
- Refrigerants Regulated Product Stewardship (RRPS) Scheme: a proposal to regulate and accelerate a currently voluntary scheme to reduce emissions from hydrofluorocarbons (HFCs).
- Agricultural mitigation technologies: the intention to introduce a farm-level emissions pricing scheme from 2030, alongside funding for research and deployment.
- Forestry conversion limits: a moratorium on registering forestry conversions on land use capability class 1-5 in the ETS, and a 15,000 ha annual limit on class 6.[39]
- Crown land afforestation: a proposal to utilise public-private partnerships to afforest underutilised Crown Land.[40]
- Waste Minimisation Fund: providing grants for projects that divert organics and wood from landfills.
- Improved landfill gas (LFG) capture: regulation to expand LFG capture coverage and increase capture rates by requiring best-practice systems.

Other policy changes

Since taking office in 2023, the current New Zealand Government has repealed or cancelled several policies with anticipated emissions impacts. These include:

- the Clean Car Discount (CCD), which incentivised electric vehicle uptake by providing rebates for low-emission vehicles and fees on high-emission ones, was repealed in December 2023.
- easing of the Clean Car Standard (CCS) emissions targets for imported light vehicles.
- removal of the ban on oil and gas exploration, which is expected to increase gas supply in the longer term.[41]
- Delaying the planned implementation of pricing of agricultural emissions by 5 years.
- discontinuation of the Government Investment in Decarbonising Industry (GIDI) fund.
- repeal of agricultural freshwater regulations that were anticipated to indirectly reduce greenhouse gas emissions.[42]
- prioritising road infrastructure over public transport and cycling initiatives and reallocating resources from active and public transport programmes towards roads.

International commitments

New Zealand's second Nationally Determined Contribution (NDC2), submitted in January 2025, outlines the country's emissions reduction commitments beyond 2030. The government chose the minimum level of ambition - a 51% decrease from 2005 gross emissions by 2035 - which is only marginally more ambitious than the pathway defined by domestic budgets. While the gap between domestic emissions budgets and the NDC2 target can be met by purchasing international units, there is still pressure to meet the international target with domestic action to minimise costs.

[39] https://www.mpi.govt.nz/forestry/forestry-in-the-emissions-trading-scheme/news-and-changes-to-the-ets/#changes-2025
[40] https://www.beehive.govt.nz/release/government-partner-private-sector-plant-trees-low-value-crown-land
[41] https://www.mbie.govt.nz/dmsdocument/28877-regulatory-impact-statement-amendments-to-the-crowm-minerals-act-1991-relating-to-petroleum-exploration-and-mining-proactiverelease-pdf
[42] https://environment.govt.nz/acts-and-regulations/acts/rm-freshwater-and-other-matters-amendment/

However, the minimal level of ambition means that the impact on carbon prices of the NDC2 target is less than it could have been.

9 The Emissions-Economy New Zealand (ENZ) model

ENZ is a comprehensive tool designed to project and analyse the economic and greenhouse gas emissions outcomes for various sectors of the New Zealand economy. Built by Concept to examine the dynamics driving emissions and economic activities, ENZ models the interplay between emissions-producing decisions—such as land-use changes, technology adoption, and energy demand—and external drivers like commodity prices and policy settings.

The ENZ model has been used to inform the Climate Change Commission's advice[43] and New Zealand's second Emissions Reduction Plan (ERP2).[44]

Central to ENZ's functionality is its ability to explore a wide range of scenarios, including endogenous and exogenous drivers. This enables users to simulate how emissions outcomes vary under different policy interventions and technological advancements. Covering sectors from land use and waste to transport and industrial heat, the model integrates feedback loops between economic activities and emissions, using a dynamic, recursive approach. It provides insights up to 2075, accounting for long-term policies such as New Zealand's net-zero 2050 goals.

ENZ relies on multiple data sources from various agencies, including the national Greenhouse Gas Inventory, energy statistics from MBIE, forestry and agriculture projections from MPI, vehicle fleet projections from MoT, waste sector modelling from MfE's Waste Minimisation Fund, and industry statistics. These inputs provide the historical data and sectoral projections necessary for modelling baseline emissions and policy impacts.

The core modules of ENZ comprise Heat, Industry, and Power (HIP), transport (Tpt), Land (forestry and agriculture) and Waste (LnW), and ETS functionality.

9.1 Heat, Industry, and Power (HIP) Module

The HIP module models energy demand and emissions across non-transport energy sectors, including industrial processes and electricity generation. It features:

- Modelling of electricity demand and supply, including renewable energy build-out and fossil fuel phase-out.
- Endogenous calculation of wholesale electricity prices and network costs, accounting for factors such as peak demand and system flexibility requirements.
- Modelling of development and depletion of New Zealand's gas reserves, and associated endogenous modelling of wholesale gas prices, pipeline charges, and changes in demand for gas across the economy.
- Assessment of switching from fossil fuels to electricity or biomass for industrial process heat.
- Modelling of specific industrial sectors, including steel, aluminium, cement, and food processing, with options to simulate uptake of low-emissions technologies.
- The module integrates outcomes from other sectors, such as biomass availability from forestry and electricity demand from transport electrification.

[43] https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/inaia-tonu-nei-a-low-emissions-future-for-aotearoa/modelling/

[44] https://environment.govt.nz/publications/second-emissions-reduction-plan-technical-annex/

9.2 Transport (Tpt) Module

The Transport module models fuel consumption, vehicle fleet dynamics, and emissions across road, rail, marine, and aviation. Key features include:

- Detailed modelling of fleet turnover, vehicle technology adoption (e.g., electric vehicles), and emissions intensity.
- Price and cross-prices elasticities of travel demand for road and air transport.
- Scenario-based projections of transport service demand (e.g., passenger-kilometres) and mode shares (e.g., car, bus, train).
- Analysis of the uptake of low-emissions technologies and fuels, such as biofuels and hydrogen, for various transport modes.
- Estimation of policy impacts, including the Clean Car Discount (CCD), Clean Car Standard (CCS), and Road User Charge (RUC) exemptions.
- The module also integrates feedback loops, such as how increased electrification in transport affects electricity demand and system costs.

9.3 Land and Waste (LnW) Module

The Land and Waste module models emissions from agriculture, forestry, and waste, including land-use-related carbon stock changes. It allows users to:

- Project land-use changes, such as the conversion of pastoral land to forestry, based on economic returns and emissions pricing.
- Model uptake of mitigation technologies for agriculture and their impacts on emissions intensity.
- Assess emissions from forestry, including carbon sequestration, afforestation, deforestation, and harvesting dynamics.
- Simulate waste management practices and their implications for methane emissions from landfills, biological treatment, and waste diversion.

9.4 ETS Functionality

A core component of ENZ is its ability to model New Zealand's Emissions Trading Scheme (ETS) and explore emissions pricing scenarios. Key features include:

- Supply modelling: calculates the supply of NZUs based on auction settings, industrial allocation, and forestry removals. It incorporates different forestry accounting rules, such as averaging and stock-change approaches, and simulates the impact of policy changes on NZU availability.
- Demand modelling: evaluates NZU demand from emissions-intensive sectors, including energy, transport, agriculture, and industrial processes. It accounts for sector-specific responses to carbon prices, such as fuel switching, land-use changes, and mitigation technology uptake.
- Carbon Price Modelling: users can specify exogenous carbon price paths to assess their impact on emissions outcomes, or the model can calculate carbon prices required to achieve specific emissions targets or balance ETS supply and demand.

9.5 Non-ETS policy levers

The ENZ model provides the capability to simulate a wide range of policy levers, enabling users to assess the impact of various interventions on emissions and economic outcomes. Key policy levers include:

- Transport: policies such as the Clean Car Discount (CCD), Clean Car Standard (CCS), Road User Charge (RUC) exemptions, EV charger infrastructure, mode shift, and alternative air fuel mandates.

- Industry and Energy: subsidies for renewable heat technologies, bans on new gas connections, consenting, energy efficiency improvements, and incentives for low-carbon industrial processes.
- Land Use: afforestation targets, limitations on certain land-use categories, and incentives or constraints on forestry participation in the ETS.
- Agriculture: pricing of agricultural emissions, subsidies for mitigation technologies, and free allocation.
- Electricity: policies affecting renewable energy expansion, such as consenting reforms, subsidies, thermal generation phase-out, and use of biomass.
- Waste Management: reduction and diversion targets, landfill gas capture rates and coverage.

9.6 State-of-the-world parameters

The ENZ model includes a range of state-of-the-world parameters that can be varied to conduct sensitivity analyses and explore uncertainties in future scenarios. These parameters represent external drivers that influence emissions and economic outcomes but are not directly controlled by policy. Key state-of-the-world parameters include:

- Population and GDP growth: scenarios reflecting the ranges used in other government planning.
- Energy efficiency improvements: assumed rates of efficiency improvements in buildings, vehicles, and industrial processes.
- Gas reserves: the availability of domestic gas reserves and the cost of development, affecting gas prices and the pace of fuel switching.
- Technology costs: assumptions about cost reductions for renewable energy, electric vehicles, and emissions mitigation technologies.
- Land productivity: trends in agricultural intensity, productivity, and forestry yields.
- Commodity prices: assumptions for relative prices of meat, milk, horticulture, and forestry products.
- Adoption speed: parameters reflecting varying rates of consumer and business uptake of low-emissions technologies.
- Fuel price elasticities: the responsiveness of transport demand and mode shift to changes in fuel and carbon prices.

9.7 Summary

The ENZ model provides a structured and flexible framework for analysing emissions and economic outcomes under a wide range of policy and market conditions. By integrating sectoral dynamics, policy levers, and state-of-the-world parameters, it enables users to assess the interactions between emissions pricing, energy demand, land use, and technological change. This approach supports robust scenario analysis, helping policymakers and market participants evaluate the impact of policies and external drivers.

10 Additional functionality to model sector responsiveness to carbon price

As set out in section 6, an initial result of the modelling examining the effect of limiting future forestry's participation in the ETS was that, with far less projected afforestation, ENZ didn't have sufficient coverage of activities deemed to be responsive to carbon price to result in a feasible solution. In other words, with a significant proportion of non-carbon-price-responsive sectors, no matter how high the carbon price, the model was not projecting sufficient falls in gross emissions in order to meet the net-zero target.

Accordingly, ENZ's functionality was extended to enable other significant sectors to respond to a carbon price. Key sectors where this functionality was introduced were:

- Aviation, where the uptake of sustainable aviation fuel (SAF) was related to the carbon price faced by aviation. A function was developed where the proportion of fuel met by SAF rose as the non-carbon + carbon price of Jet-A1 rose to levels close to the projected price of SAF.
- Marine, where a similar approach was developed for sustainable marine fuel (SMF) – albeit with an assumption that the carbon price to incentivise uptake of SMF would be higher than that for SAF
- Green technology uptake for three key industrial sectors:
  - Green anodes for aluminium
  - Green steel using hydrogen reduction rather than coal for steel
  - Cement switching to lower-emissions clinker and switching from coal to biomass and tyre-derived fuel for energy

In all three cases there is material uncertainty over the threshold price that would trigger a switch to these green technologies. Accordingly, a band of assumed carbon prices was introduced, with the level of uptake being proportional to how high within the band NZU prices reached.45

The reality is that the emissions reduction would likely be more of a step-change in response to a carbon price. However, given the inherent uncertainty over this threshold price, the proportional band approach was deemed better able to reflect the 'on average' effect of carbon prices on emissions from these sectors.

The assumed carbon price bands were based on simple research of international studies on the abatement costs of these technologies. However, there is a material amount of uncertainty as to these threshold carbon prices:

- aluminium green anodes $275 to $425,
- green steel $200 to $200,
- cement energy $50 to $200,
- cement low-emissions clinker $100 to $300,

[45] For example, if the assumed band of carbon prices necessary to incentivize the uptake of green anodes was between $250 and $350/t$CO_2$ and the modelled NZU price was $275, the model would project that 25% of the emissions reduction from green anodes would be achieved. If NZU prices were less than $250, no emissions reductions would be achieved, and for NZU prices of $350 and above, 100% reduction would be achieved.

- the SAF threshold reduces over time and in 2035 it is $300 to $800.

It was also implicitly assumed that the Industrial Allocation mechanism, or some other future mechanism (eg, carbon border adjustment mechanisms) would be sufficient to protect these industrial sectors from overseas producers that didn't face such a high carbon price.

- The rate of reduction of F-gases was linked to NZU prices through a function that increased the reduction with carbon price, with limits on how much of a reduction could be achieved in early years. As with the other industrial sectors, it should be appreciated that there is a significant degree of uncertainty over this relationship between carbon price and F-gas emissions reductions.
- Increasing the rate of scrappage of ICE vehicles as the differential between the total cost of ownership of old ICE vehicles versus new EVs reduces.

As set out above, it should be noted that there is material uncertainty over the abatement cost of these technologies, and the extent to which increases in the price of carbon faced by these sectors would result in a reduction in emissions. However, the approach is considered reasonable for illustrating the general nature and scale of outcomes from limiting future forestry unit supply in the ETS.

11 Glossary

Term	Description
2050 Targets	The targets set out in the Climate Change Response Act for Aotearoa to: • reduce emissions of greenhouse gases, other than biogenic methane, to net zero by 2050 and beyond. This relates to emissions of carbon dioxide, nitrous oxide, non-biogenic methane and F-gases (hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride). • reduce biogenic methane emissions by at least 10% by 2030 and 24-47% by 2050 and beyond, compared to 2017 levels.
Biogenic methane	Methane emissions resulting from activities in the agriculture and waste sectors.
Biomass	Material originating from living organisms. Some forms of biomass in the environment store significant amounts of carbon. Solid biomass such as wood chips, wood pellets and briquettes can be used as fuel in residential, commercial and industrial situations.
Climate Change Response Act 2002	The Act that establishes the Climate Change Commission and contains the framework for the 2050 emissions reduction targets and emissions budgets. It also provides a legal framework to enable Aotearoa to meet its international obligations under the United Nations framework Convention on Climate Change and the Kyoto Protocol, and provides for the implementation of the New Zealand Emissions Trading Scheme (ETS) and the synthetic greenhouse gas levy.
CO_2-e	Carbon dioxide equivalent. This is a way to describe different greenhouse gases on a common scale that relates the warming effect of emissions of a gas to that of carbon dioxide. It is calculated by multiplying the quantity of a greenhouse gas by the relevant global warming potential.
Afforestation	The establishment of minimum tree crown cover of 30% and a potential height of at least 5 metres on land that was not previously forested for at least 50 years.
Deforestation	The conversion of forest land to another use such as grazing. In greenhouse gas emissions accounting deforestation is defined as clearing forest and not replanting within four years. It does not include harvesting where a forest replanted.
Emissions budget	The cumulative amount of greenhouse gases that can be emitted over a certain period. In the Climate Change Response Act 2002, emissions budgets are the total amount of all greenhouse gases (expressed as a net amount of carbon dioxide equivalent) that can be released over a five-year period (or four years in the case of 2022-2025).
Carbon price	The cost assigned to the emission of one tonne of carbon dioxide (or equivalent greenhouse gases), typically through mechanisms like emissions trading schemes or carbon taxes.

Carbon Sequestration	The process of capturing and storing atmospheric carbon dioxide in trees, soil, and other organic materials as part of natural or engineered processes.
Free allocation	The distribution of emissions units without cost to specific businesses by the government.
Global Warming Potential (GWP)	A factor relating the warming effect of a tonne of emissions of a particular greenhouse gas to those of a tonne of carbon dioxide emissions.
Gross emissions	Gross emissions include total greenhouse gas emissions from agriculture, energy, industrial processes and product use (IPPU) and waste. Greenhouse gas emissions and removals from land use, land-use change and forestry (LULUCF) are excluded.
Kyoto Protocol	An international treaty under the UNFCCC that deals with emissions limitation or reduction commitments for ratifying developed (Annex 1) countries.
Land use, land-use change and forestry (LULUCF)	Sector in greenhouse gas accounting that includes emissions and removals of greenhouse gases resulting from human activities related to land use, changes in land use (e.g., converting forest to agricultural land), and forestry practices.
Long-lived gases (LLG)	Greenhouse gases that have a long lifetime in the atmosphere, i.e. they persist in the atmosphere without breaking down for multi-decadal, centennial or millennial timeframes. For ease of presentation, this report refers to all greenhouse gases other than biogenic methane collectively as long-lived gases, although this includes small amount of other short-lived gas emissions (non-biogenic methane and certain fluorinated gases).
Megatonnes (Mt)	Million tonnes
Methane Inhibitors	Chemical compounds that reduce the production of methane in animals' rumen (stomachs). They typically do this by targeting enzymes that play a key role in the generation of methane.
Mitigation	Human actions to reduce emissions by sources or enhance removals by sinks of greenhouse gases.
Nationally Determined Contribution (NDC)	Each country that is party to the Paris Agreement must define its contribution to achieving the long-term temperature goal set out in the Paris Agreement. The first NDC adopted by Aotearoa is a target to reduce greenhouse gas emissions by 30% below 2005 levels by 2030.
NDC1	New Zealand's first NDC target, covering the period 2021 to 2030. This target is being managed using a budget approach, with a preliminary budget of 571 Mt that aligns with a point-year target of 50% below gross 2005 emissions.

Net emissions	Net emissions differ from gross emissions in that they also include emissions from the land use, land-use change and forestry (LULUCF) sector as well as removals of carbon dioxide from the atmosphere, for example due to the growth of trees.
ETS	New Zealand Emissions Trading Scheme
Organic waste	Waste containing organic matter (food, garden, wood, or paper) that decays to create methane emissions.
Paris Agreement	An international treaty under the UNFCCC to address climate change after 2020.
Post-1989 forests (P1989)	New forest established after 31 December 1989 on land that was not forest at that date.
Pre-1990 forests (P1990)	Forest or shrub land established before 1 January 1990.
Permanent forestry	A category within the New Zealand Emissions Trading Scheme (ETS) that incentivises forests intended to remain unharvested, allowing them to sequester carbon over long periods.
UNFCCC	United Nations Framework Convention on Climate Change. This is the major foundation global treaty focused on climate change that was signed in 1992 at the Earth Summit in Rio de Janeiro.
Climate Implications of Policy Assessment (CIPA)	A New Zealand framework for evaluating the greenhouse gas impacts of government policies, ensuring alignment with climate goals and emissions targets
Second Emissions Reduction Plan (ERP2)	New Zealand's plan, released on Dec 11 2024, outlining actions for meeting emissions budgets and climate targets for 2026–2030.
Carbon liabilities	Financial obligations incurred under the ETS when carbon credits previously claimed for forest sequestration must be surrendered, such as when trees are harvested or deforested.
Stock Change Accounting	A forestry accounting method in the ETS where emissions and removals are reported annually based on changes in carbon stocks over time.
Averaging Accounting	A forestry accounting method in the ETS that credits forests up to their long-term average carbon storage. It became mandatory for new forests registered in the ETS from 1 January 2019. Before this, its use was optional.

Carbon Capture, Utilisation, and Storage (CCUS)	A technology that captures carbon dioxide emissions from industrial processes or the atmosphere, which is then stored underground or utilised in products to prevent it from entering the atmosphere.

12 Data tables

More data is supplied in a supplementary Excel workbook.

Table 4: Supply / (demand) for NZUs for the base scenario (Mt CO_2-e)

Calendar Year	Gross emission surrend-ers	Ind. Alloc.	Register-ed P89 exotic perm.	New P89 exotic perm	Register-ed P89 native perm.	New P89 native perm.	Register-ed P89 avging harveste d	New P89 avging harveste d	Net SC forest + Deforest	Auction	Net additions/ surrender
2021	-36.66	6.60	3.18	0.00	1.02	0.00	0.49	0.25	-5.84	26.00	-4.96
2022	-33.85	6.16	3.15	0.00	1.18	0.00	0.71	0.49	-8.96	26.30	-4.83
2023	-33.22	5.69	3.16	0.00	1.15	0.00	0.92	0.75	-13.61	0.00	-35.16
2024	-33.11	5.11	3.19	0.00	1.18	0.00	1.37	1.07	-8.83	7.00	-23.02
2025	-33.28	5.24	3.25	0.00	1.17	0.00	2.05	1.77	-7.52	0.00	-27.33
2026	-31.57	4.45	3.32	0.00	0.97	0.20	2.71	2.76	-5.52	0.00	-22.68
2027	-30.33	3.96	3.37	0.00	0.97	0.21	3.18	4.46	-5.45	0.00	-19.63
2028	-29.77	3.83	3.37	0.00	0.97	0.22	3.39	6.48	-3.99	0.00	-15.49
2029	-28.63	3.70	3.33	0.00	0.96	0.23	3.33	8.55	-2.31	2.40	-8.44
2030	-27.47	3.26	3.29	0.00	0.95	0.23	3.13	10.35	-0.37	1.50	-5.13
2031	-26.89	3.09	3.23	0.00	0.93	0.24	2.99	11.78	1.77	0.60	-2.25
2032	-26.27	2.94	3.18	0.00	0.91	0.25	2.92	12.87	4.40	0.00	1.19
2033	-25.50	2.86	3.14	0.00	0.88	0.25	2.94	13.85	5.22	0.00	3.63
2034	-24.47	2.77	3.11	0.00	0.85	0.26	2.98	14.93	5.69	0.00	6.12
2035	-23.42	2.69	3.09	0.00	0.81	0.27	2.97	16.12	5.89	0.00	8.41
2036	-22.27	2.61	3.05	0.00	0.78	0.27	2.45	17.42	6.24	0.00	10.55
2037	-21.07	2.53	3.01	0.00	0.74	0.28	1.72	18.38	5.09	0.00	10.66
2038	-20.24	2.44	2.96	0.00	0.70	0.29	1.09	18.75	2.96	0.00	8.96
2039	-19.42	2.36	2.91	0.00	0.67	0.30	0.29	18.30	0.05	0.00	5.46
2040	-18.73	2.28	2.85	0.00	0.63	0.31	0.00	17.29	5.61	0.00	10.24
2041	-18.06	2.20	2.80	0.00	0.59	0.32	0.00	16.25	5.93	0.00	10.03
2042	-17.30	2.12	2.74	0.00	0.56	0.33	0.00	15.07	6.21	0.00	9.73

2043	-16.70	2.03	2.68	0.00	0.54	0.34	0.00	14.49	7.13	0.00	10.52
2044	-16.09	1.95	2.63	0.00	0.51	0.35	0.00	13.83	7.03	0.00	10.23
2045	-15.53	1.87	2.58	0.00	0.48	0.36	0.00	13.10	4.76	0.00	7.63
2046	-14.97	1.79	2.54	0.00	0.45	0.37	0.00	12.30	0.51	0.00	2.98
2047	-14.53	1.70	2.49	0.00	0.42	0.38	0.00	11.44	-1.47	0.00	0.43
2048	-14.01	1.62	2.44	0.00	0.38	0.39	0.00	10.55	-6.46	0.00	-5.09
2049	-13.62	1.54	2.39	0.00	0.35	0.39	0.00	9.61	-8.99	0.00	-8.33
2050	-13.22	1.46	2.34	0.00	0.32	0.39	0.00	8.66	-10.36	0.00	-10.41