TE TAI ŌHANGA
THE TREASURY

Ngā Kōrero Āhuarangi me te Ōhanga

Climate Economic and Fiscal Assessment (CEFA)

Technical Appendix 2: Methodology for scenario analysis of fiscal risk from offshore mitigation

September 2023

Te Kāwanatanga o Aotearoa
New Zealand Government

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About this document

This document sets out the technical details and processes underpinning the calculations in *Ngā Kōrero Āhuarangi me te Ōhanga* Climate Economic and Fiscal Assessment (referred to as the CEFA).

This document has been written by Treasury and Ministry for the Environment (MfE) officials to support the analysis in the CEFA.

This is one of three technical appendix documents:

- **Appendix 1: ETS fiscal forecasting** to support section *6.4 Fiscal Impacts of the NZ ETS* in the CEFA.
- **Appendix 2: Methodology for scenario analysis of fiscal risk from offshore mitigation** (this document) to support Section 7 *New Zealand's first Nationally Determined Contribution – scenario analysis of fiscal risk from offshore mitigation.*
- **Appendix 3: Greenhouse gas emissions projections** to support Section 7 *New Zealand's first Nationally Determined Contribution – scenario analysis of fiscal risk from offshore mitigation.* Appendix 3 was led by MFE and supported by MPI, MBIE and MoT.

As noted in Section 7 of the CEFA, the analysis focuses solely on the fiscal cost directly from *purchasing* offshore mitigation. The analysis assumes the Government funds the total cost of offshore mitigation. The total fiscal cost could be higher due to the costs from identifying or developing offshore purchase opportunities. These additional costs are out of scope for this analysis and have not been assessed.

Summary of methodology

Table 1 below summarises the steps in our scenario analysis. Nine scenarios were constructed based on different assumptions about the volume of offshore mitigation purchases made during the NDC1 period (2021 to 2030) and the cost or price per tonne of carbon dioxide equivalent (CO_2e) for these purchases. These steps are explained in more detail following Table 1.

Table 1: Methodology for estimating the fiscal cost of purchasing offshore mitigation toward NDC1

Step	Description	Assumptions and inputs
1. Determine the assumed **volume** of offshore mitigation purchases	Construct scenarios for the volume of offshore mitigation purchases based on assumptions about the shortfall between domestic net emissions over the NDC1 period and the NDC1 budget.	• Assumes that New Zealand meets its NDC1. • Assumes that New Zealand's NDC1 does not change. • Volume Scenarios have been constructed based on Ministry for the Environment (MfE) projections of net emissions and New Zealand's domestic emissions budgets as published in the first Emissions Reduction Plan (ERP).
2. Determine the **timing** of offshore mitigation purchases	Make assumptions about when offshore mitigation purchases will be made across the NDC1 period.	• Assumes that New Zealand begins purchasing offshore mitigation in 2024 and does not make purchases after 2030. • Assumes that an equal volume of purchases is made in each year across the 2024 - 2030 period.
3. Assume per-tonne purchase prices in each year	Use external price information to construct scenarios for the price per tonne of offshore mitigation in each year over the period in which New Zealand is assumed to make offshore mitigation purchases (as defined in Step 2).	• Price Scenarios have been constructed based on: - 2030 carbon prices assumed by the International Energy Agency for its World Energy Outlook 2022 - observed prices in established overseas emissions markets. • Assumes that purchase prices increase over the NDC1 period at a real rate of 2.26% per annum, based on analysis by the High-Level Commission on Carbon Prices.
4. Calculate annual purchase costs	Multiply the assumed purchase volume by the assumed per-tonne purchase price in each year.	• Assumes that the cost of purchases is fully borne by the Crown. • Does not include any additional costs, such as administrative costs.
5. Discount the purchase costs to present value	Convert the assumed purchase costs in each year to their present value and sum the annual costs together to give a total cost over the period.	• Applies the Treasury's real risk-free discount rates as at December 2022 across the NDC1 period.

Step 1 – Determine the assumed volume of offshore mitigation purchases

The volume of offshore mitigation purchases required to meet NDC1 will be the difference between the emissions allowed over the NDC1 period (the provisional NDC1 emissions budget of 571 megatonnes (Mt) of CO2e) and New Zealand's domestic net emissions over this period. Given New Zealand's NDC1 budget is provisionally set, the required offshore purchase volume will depend on the level of domestic net emissions reductions achieved over the period.

$$\begin{aligned} &Required\ offshore\ mitigation\ volume \\ &\quad = NDC1\ emissions\ budget \\ &\quad - Domestic\ net\ emissions\ from\ 2021\ to\ 2030 \end{aligned}$$

Our analysis considers three Volume Scenarios based on three different potential pathways for domestic emissions. Table 2 below describes each of these scenarios based on the underlying assumptions around New Zealand's domestic emissions levels across the NDC1 period. The methodology underpinning the assumptions for emissions estimates is explained in Technical Appendix 3.

Table 2: Volume Scenarios – summary of domestic emissions assumptions

Volume Scenario	Source for assumption	Description of assumption
Scenario 1 – Based on MfE's baseline projection under current policies for domestic emissions	Emissions projections prepared by MfE for New Zealand's biennial progress reporting under the UNFCCC.[1]	Emissions match MfE's 'With Existing Measures' (WEM) projection based on currently implemented and adopted policies and measures, as at 31 July 2022. This excludes approved policies with expected emissions reduction impacts that have not yet been implemented (including several that have been signalled within the first ERP).
Scenario 2 – Based on meeting New Zealand's domestic emissions budgets	New Zealand's emissions budgets, as published in the first Emissions Reduction Plan.	New Zealand exactly meets its domestic emissions budgets for 2022-2025 (emissions budget 1) and 2026-2030 (emissions budget 2) without over- or underachieving. Since the emissions budget periods do not cover emissions for the year 2021 (which is included in the NDC1 period), emissions estimates for 2021 are based on MfE's baseline projection used for Volume Scenario 1 (see Table 3 below).
Scenario 3 – Based on MfE's 'lower-emission' projection under current policies	Emissions projections used for New Zealand's biennial progress reporting under the UNFCCC.	This is based on MfE's projection that alters several assumptions in the baseline projection used for Volume Scenario 1 to represent a lower emissions outcome under current policies (also known as "WEM Low"). This includes assuming a higher carbon price and lower GDP and population growth. See Technical Appendix 3 for more details about these assumptions.

1 Emissions data was retrieved from Ministry for the Environment, 2022.

Table 3 presents the overall volume of offshore mitigation purchases assumed under each Volume Scenario, based on these emissions assumptions.

Table 3: Volume Scenarios – estimated offshore mitigation purchases required (Mt CO2e)

Volume Scenario	Scenario 1 – Based on MfE's baseline projection under current policies for domestic emissions	Scenario 2 – Based on meeting New Zealand's domestic emissions budgets	Scenario 3 – Based on MfE's 'lower-emission' projection under current policies
2021	75.18	75.18	73.38
2022	75.04	72.50	73.14
2023	74.77	72.50	72.94
2024	73.96	72.50	71.44
2025	69.81	72.50	67.96
2026	67.87	61.00	65.67
2027	65.75	61.00	63.12
2028	63.14	61.00	60.01
2029	60.61	61.00	56.83
2030	59.00	61.00	54.46
Total domestic emissions assumed for NDC1	685.12	670.18	658.96
NDC1 allowed volume	(571)	(571)	(571)
Assumed volume of offshore mitigation purchases	**114.12**	**99.18**	**87.96**

Volume Scenarios 1, 2 and 3 can be thought of as representative of situations in which New Zealand under-achieves, exactly achieves or over-achieves its domestic emissions budgets, respectively. Under, exact, or over-achievement may be due to several factors (such as technological development, shifts in New Zealand's underlying economic structure, and shifts in household behaviours). The construction of Volume Scenarios 1, 2 and 3 did not consider such developments in detail.

We expect to update our estimates of the **volume** of required offshore mitigation as we get more information on New Zealand's progress towards meeting NDC1 and the quality of emissions projections improves.

Step 2 – Determine the timing of offshore mitigation purchases

The timing of New Zealand's offshore mitigation purchases will depend on several factors, including future policy choices and the speed of establishing international cooperative arrangements.

$$\begin{aligned} &Assumed\ volume\ of\ purchases\ per\ year \\ &\quad = Total\ assumed\ offshore\ mitigation\ over\ the\ purchase\ period \\ &\quad \div number\ of\ years\ in\ purchase\ period \end{aligned}$$

We assume that purchases of offshore mitigation commence in 2024 and continue through to 2030 (across 7 years), with an even distribution of total purchase volume in each year (illustrated in Table 4 below).

Table 4: Assumed offshore mitigation purchases per year over 2024 to 2030 for each Volume Scenario (Mt CO2e)

Volume Scenario	Scenario 1 – Based on MfE's baseline projection under current policies for domestic emissions	Scenario 2 – Based on meeting New Zealand's domestic emissions budgets	Scenario 3 – Based on MfE's 'lower-emission' projection under current policies
Total assumed offshore mitigation volume over 2024 to 2030	114.12	99.18	87.96
Assumed volume of purchases per year	16.30	14.17	12.57

Step 3 – Assume per-tonne purchase prices in each year

The future price per tonne of offshore mitigation is highly uncertain. Prices will also vary across different types of mitigation sources and locations. As part of a broader risk management approach, it is likely that New Zealand will pursue a portfolio approach to procuring offshore mitigation. This makes it difficult to estimate the likely average price per tonne across the portfolio.

Possible information sources for the future price include assumed prices by international think-tanks and other organisations, observed prices in existing emissions markets, and benchmarks of voluntary carbon credit prices.[2]

[2] For example, S&P Global Ratings publishes an "S&P Global Platts Voluntary Carbon Market" benchmark.

Our Price Scenarios were constructed based on information from two key sources:

- **current prices in well-established emissions markets**, which capture market expectations about future price changes
- **prices assumed by the International Energy Agency (IEA)** for its 2022 World Energy Outlook for advanced, emerging and developing economies under different global scenarios.[3]

Our analysis considers three Price Scenarios, constructed using price information from the IEA and four well-established emissions markets. These Price Scenarios show the range of potential purchase prices New Zealand may face for its offshore mitigation purchases to achieve NDC1.

The three scenarios reflect:

1. prices aligned with the assumed price for emerging and developing economies under an ambitious global scenario in the IEA's 2022 World Energy Outlook[4]
2. prices aligned with the average of current prices for selected well-established markets[5]
3. prices aligned with the assumed price for advanced economies under an ambitious global scenario in the IEA's 2022 World Energy Outlook.[6]

Figure 1 shows the large range in indicative offshore mitigation prices across a number of sources and countries that support our analysis. All prices in Figure 1 are presented as indicative prices for the year 2030.

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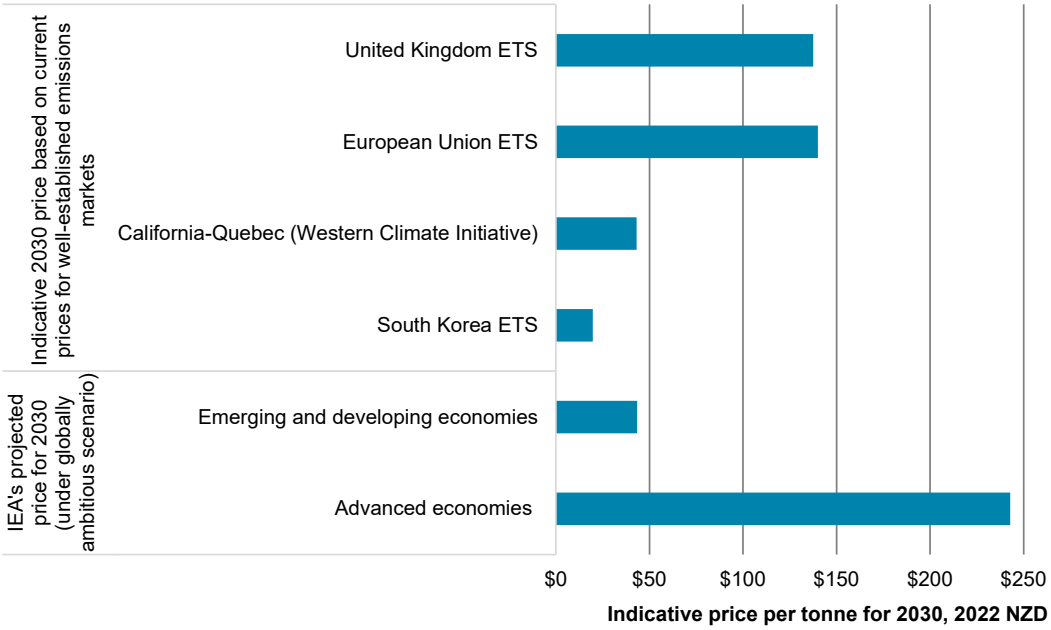
3 See Table B.2: CO_2 prices for electricity, industry and energy production in selected regions by scenario. International Energy Agency, 2022, p. 465.

4 Emerging and developing economies for Price Scenario 1 (based on the IEA analysis) exclude the following economies – China, India, Indonesia, Brazil and South Africa.

5 Price Scenario 2 is most comparable to the analysis undertaken by MfE to support Cabinet decisions on enhancing New Zealand's NDC1 in 2021 (Office of the Minister of Climate Change, 2021), which also used information from currently well-established international emissions markets.

6 Advanced economies for Price Scenario 3 (based on the IEA analysis) include all OECD countries except Mexico (International Energy Agency, 2022).

Figure 1: Indicative prices per tonne of offshore mitigation in 2030, as calculated to support the construction of our Price Scenarios ($NZD, 2022 dollars)



Source: Current prices for emissions markets were retrieved on 13 January 2023 from Statista (n.d.), EEX (n.d.), California Air Resources Board (2022), and KRX (n.d.), with all prices as of November 2022. The International Energy Agency's (IEA's) assumed prices were retrieved from the IEA World Energy Outlook 2022.[7]

Table 5: Price Scenarios for offshore mitigation purchases ($NZD 2022)

Price Scenario	Scenario 1 – Based on the IEA's price for emerging and developing economies in its 2022 World Energy Outlook under an ambitious global scenario	Scenario 2 – Based on the average of current prices for selected markets	Scenario 3 – Based on the IEA's price for advanced economies in its 2022 World Energy Outlook under an ambitious global scenario
2024	$37.94	**$89.02**	$212.44
2025	$38.79	$91.02	$217.24
2026	$39.67	$93.08	$222.14
2027	$40.56	$95.18	$227.15
2028	$41.48	$97.33	$232.28
2029	$42.41	$99.52	$237.52
2030	**$43.37**	$101.77	**$242.88**

7 International Energy Agency, 2022b, p. 465.

Price Scenario	Scenario 1 – Based on the IEA's price for emerging and developing economies in its 2022 World Energy Outlook under an ambitious global scenario	Scenario 2 – Based on the average of current prices for selected markets	Scenario 3 – Based on the IEA's price for advanced economies in its 2022 World Energy Outlook under an ambitious global scenario
Source information relied upon	2030 price for emerging and developing economies from the IEA's 2022 World Energy Outlook under a global scenario of achieving net zero emissions by 2050.[8]	Simple average of current prices across four markets as at November 2022:[9] • European Union ETS • United Kingdom ETS • Western Climate Initiative • South Korean ETS.	2030 price for advanced economies from the IEA's 2022 World Energy Outlook under a global scenario of achieving net zero emissions by 2050.[10]

Each illustrative Price Scenario is based on information that provided a point estimate in a given year (the bolded price in Table 5). These were then converted into an assumed price trajectory over the period 2024 to 2030.

To estimate the rate of change over time, we used international analysis undertaken by the High-Level Commission on Carbon Prices (HLCCP) in 2017 that estimated global carbon prices consistent with the Paris Agreement target of keeping global average temperature increases to well under 2°C from pre-industrial levels.[11]

The compound annual growth rate implied by the global prices modelled by HLCCP for 2020 and 2030 for 'low' and 'high' scenarios is approximately 2.26% per annum. We have applied this 2.26% annual growth rate for the three Price Scenarios considered to generate estimated price trajectories over the purchase period (2024 to 2030).

- For Price Scenarios 1 and 3, our starting price is the IEA-assumed price for 2030. To construct a price path, we calculated prices for 2024 to 2029 by applying the inverse of the 2.26% assumed growth rate backwards in time.

- For Price Scenario 2, our starting price is for the year 2022 (specifically, an average of current prices in selected well-established carbon markets as at November 2022). The 2.26% growth rate was applied annually moving forwards in time to construct a price path from 2024 to 2030.

In reality, prices are unlikely to follow a smooth upwards trajectory. Prices are inherently volatile and will move as new information becomes available.

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8 International Energy Agency, 2022, p. 465.

9 Current prices for emissions markets were retrieved on 13 January 2023 from Statista (n.d.), EEX (n.d.), California Air Resources Board (2022), and KRX (n.d.), with all prices as of November 2022. The International Energy Agency's (IEA's) assumed prices were retrieved from the IEA World Energy Outlook 2022.

10 International Energy Agency, 2022, p. 465.

11 High-Level Commission on Carbon Prices, 2017.

Detailed information on the Price Scenarios

Price Scenario 1 – Based on the IEA's price for emerging and developing economies in its 2022 World Energy Outlook under an ambitious global scenario

Rationale for inclusion	Emerging and developing countries tend to have lower marginal abatement costs than advanced economies. Constructing a scenario around carbon prices in these countries, as reflected in the IEA 2022 World Energy Outlook, illustrates what the costs could be with relatively low per-tonne offshore mitigation prices. Our analysis illustrates a scenario in which New Zealand's offshore mitigation approach focuses on large volumes of mitigation from these emerging and developing countries. This scenario aligns with options the Government is currently exploring, including partnerships with Asia-Pacific countries to achieve NDC1 while promoting sustainable development and resilience outcomes.
Source	Price Scenario 1 is constructed using CO_2 prices used as inputs for the IEA's 2022 World Energy Outlook. The IEA undertakes scenario analysis to model potential outcomes in the global energy system based on various inputs, including future CO_2 prices.[12] The specific price point used for our analysis is for the year 2030. This Price Scenario aligns with the IEA's assumed CO_2 price for emerging and developing economies that have not yet pledged to achieve net zero emissions (excluding China, India, South Africa, Brazil and Indonesia which have made this pledge) under a broader global scenario where net zero global emissions is achieved by 2050. The specific figure provided in the IEA report is $25USD in 2030.[13]
Creating the price trajectory for 2024 – 2030	For our analysis, we require a price path for the period over which we assume New Zealand purchases offshore mitigation (2024 to 2030). Our approach also represents all prices as NZD in 2022 prices. To construct a price path in 2022 NZD: • Inflate the IEA price to USD 2022 prices using an inflation rate of 7.7% over the 12-month period to October 2022,[14] • Convert this price to NZ dollars, using the NZD/USD exchange rate of 0.6208 NZD / USD as at 30 November 2022.[15] Create a price path based on this price from the year 2024. These calculations produce the 2030 price of **$43.37 NZD** (in 2022 prices).
Limitations	The IEA's report notes that its future CO_2 price estimates "should be interpreted with caution"[16] and should not be interpreted as the exact marginal cost of abatement in the countries considered; these limitations also apply to our analysis.

[12] These prices can be considered akin to potential future prices in international emissions markets. Refer to page 465 of the IEA's report for more information about CO_2 prices as an input to their model.

[13] Price in 2021 USD.

[14] https://data.bls.gov/timeseries/CUUR0000SA0&output_view=pct_12mths, retrieved on 13 January 2023.

[15] https://www.rbnz.govt.nz/statistics/series/exchange-and-interest-rates/exchange-rates-and-the-trade-weighted-index, retrieved on 13 January 2023.

[16] International Energy Agency, 2022, p. 115.

Price Scenario 2 – Based on the average of current prices for selected markets

Rationale for inclusion	Several countries have well-established emissions markets. To illustrate a scenario in which New Zealand purchases a large volume of units from one or more of these countries, we have constructed a scenario based on current prices in these markets. This scenario aligns with options the Government is currently exploring for linking the New Zealand ETS to international markets to support achievement of NDC1.
Source	Price Scenario 2 is constructed using current market prices in four well-established emissions markets: • European Union Emissions Trading System • United Kingdom Emissions Trading Scheme • Western Climate Initiative (California-Quebec) • Korea Emissions Trading Scheme (South Korea) These markets were selected to support this scenario because they: • are large and well-established • are diverse in terms of geographical location; and • represent a range of currently observed international emissions price points. To capture the variability across these markets, we converted the current prices to NZD and averaged them to provide a single, representative 'well-established market price' in 2022. Table 6 below provides the sources, exchange rates, and resultant prices in 2022 NZD, including the average used to construct our assumed purchase price path.

Table 6: Prices from selected well-established markets used for our analysis

Market	Data source	Exchange rate used[17]	Current market price as at November 2022 (in 2022 NZD)
Korea Emissions Trading Scheme	http://ets.krx.co.kr/contents/ETS/03/03010000/ETS03010000.jsp	822.3117 KRW/NZD	$19.68
Western Climate Initiative	https://ww2.arb.ca.gov/sites/default/files/2020-08/results_summary.pdf	0.6208 USD/NZD	$43.17
European Union Emissions Trading System	https://www.eex.com/en/market-data/environmentals/spot	0.60025 EUR/NZD	$140.11
United Kingdom Emissions Trading Scheme	https://www.statista.com/statistics/1322275/carbon-prices-united-kingdom-emission-trading-scheme/	0.5185 GBP/NZD	$137.56
Average price			**$85.13**

[17] Reserve Bank New Zealand, 2022. Accessed 30 November 2022.

Creating the price trajectory for 2024 – 2030	Based on the average price of **$85.13** (calculated using 2022 prices), we construct a price path for the 2024-2030 period using a price escalation rate of 2.26% per year. These calculations produce the 2030 price of **$101.77** (in 2022 NZD prices).
Limitations	Our approach averages prices in four markets with widely variable prices. A different mix of markets, or different assumed purchase amounts across markets, would affect the estimated purchase cost. Fluctuations in the exchange rate could also drive variations in cost.

Price Scenario 3 – Based on the IEA's price for advanced economies in its 2022 World Energy Outlook under an ambitious global scenario

Rationale for inclusion	Under a scenario of greater global climate ambition, emissions market prices could be greater than current market prices. Constructing a scenario around advanced economy carbon prices under a scenario of greater ambition, as reflected in the IEA's World Energy Outlook, illustrates the implications of higher per-tonne offshore mitigation prices.
Source	Similar to the emerging and developing economy Price Scenario, Price Scenario 3 uses CO_2 prices assumed by the IEA for its 2022 World Energy Outlook. The scenario is based on the 2030 price for advanced economies that have pledges to achieve net zero emissions (all OECD countries except Mexico) under a broader scenario in which net-zero global emissions is achieved by 2050. The specific price provided in the IEA report is $140 USD in 2030.[18]
Creating the price trajectory for 2024 – 2030	As with our other Price Scenarios, our analysis requires a price path for the period over which we assume New Zealand purchases offshore mitigation (2024 to 2030) and requires all prices in 2022 NZ prices. We therefore undertake the same steps as for Price Scenario 1, since the two scenarios rely on the same information source (IEA), but use different inputs. Applying these steps to the IEA's price for advanced economies under enhanced global ambition produces a 2030 price of **$242.88** in 2022 NZD prices for this scenario. Using this 2030 figure, we take the same steps to construct a price path over the purchasing period (2024 – 2030).
Limitations	As for the emerging and developing economy scenario, using the IEA's estimated future CO_2 prices means the limitations of the IEA's analysis also apply to our analysis.

[18] Price in USD 2021.

Step 4 – Calculate annual purchase costs

To calculate the annual purchase cost under each scenario considered, we use the following calculation:

$$Annual\ purchase\ cost\ =\ Assumed\ annual\ purchase\ volume\ \times\ assumed\ price$$

This produces the following costs in each year (each column represents a Volume Scenario):

Table 7: Annual purchase cost under Price Scenario 1 (millions, $NZD, nominal)

Year	Baseline projection for domestic emissions	'Lower-emission' projection under current policies	Domestic emissions meet New Zealand's domestic emissions budgets
2024	618	477	537
2025	632	487	550
2026	647	498	562
2027	661	510	575
2028	676	521	588
2029	691	533	601
2030	707	545	614
Total	4,633	3,571	4,027

Table 8: Annual purchase cost under Price Scenario 2 (millions, $NZD, nominal)

Year	Baseline projection for domestic emissions	'Lower-emission' projection under current policies	Domestic emissions meet New Zealand's domestic emissions budgets
2024	1,451	1,118	1,261
2025	1,484	1,144	1,290
2026	1,517	1,170	1,319
2027	1,552	1,196	1,348
2028	1,587	1,223	1,379
2029	1,622	1,251	1,410
2030	1,659	1,279	1,442
Total	10,872	8,380	9,449

Table 9: Annual purchase cost under Price Scenario 3 (millions, $NZD, nominal)

Year	Baseline projection for domestic emissions	'Lower-emission' projection under current policies	Domestic emissions meet New Zealand's domestic emissions budgets
2024	3,463	2,669	3,010
2025	3,541	2,730	3,078
2026	3,621	2,791	3,147
2027	3,703	2,854	3,218
2028	3,787	2,919	3,291
2029	3,872	2,984	3,365
2030	3,959	3,052	3,441
Total	25,948	19,999	22,551

Step 5 – Discount the purchase costs to present value

To convert future costs to their present value (in 2022 dollars), we apply Treasury's real, risk-free discount rates to the estimated offshore mitigation expenditure in each year. We calculate the real risk-free discount rates by subtracting the Treasury's CPI projections from its nominal risk-free discount rates.[19] Table 10 below presents the Treasury's risk-free spot discount rates and spot CPI assumptions as at 31 December 2022 for each year over the analysis period. It also presents the calculated real discount rates and the resulting discount factors.

Table 10: Discount rates applied in the analysis

	Nominal risk-free discount rate (spot)	Spot CPI	Real risk-free discount rate (calculated)	Discount factor
2023	5.12%	4.09%	1.03%	-
2024	5.02%	3.26%	1.76%	0.973
2025	4.80%	2.80%	2.00%	0.954
2026	4.63%	2.56%	2.07%	0.934
2027	4.54%	2.44%	2.10%	0.915
2028	4.50%	2.35%	2.15%	0.896
2029	4.50%	2.29%	2.21%	0.876
2030	4.51%	2.25%	2.26%	0.857

The sum of the discounted cash flows over the period 2024 – 2030 is the estimated present value of the fiscal cost of purchasing offshore mitigation to achieve NDC1 under the nine scenarios considered. The specific estimates produced by our analysis under each scenario considered are shown in Table 11 below in the Conclusion section.

[19] We have used the latest risk-free discount rates and CPI projections provided by the Treasury as at December 2022, https://www.treasury.govt.nz/information-and-services/state-sector-leadership/guidance/reporting-financial/discount-rates/discount-rates-and-cpi-assumptions-accounting-valuation-purposes, retrieved on 13 January 2023.

Conclusion

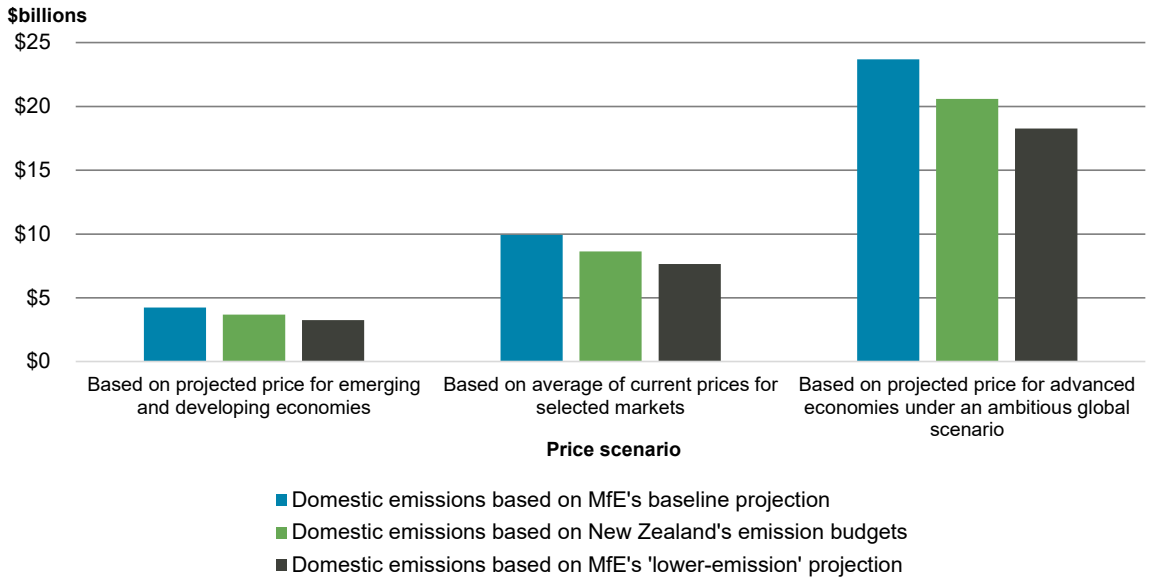
Table 11 below provides estimates of the total fiscal cost of purchasing offshore mitigation to achieve New Zealand's NDC1 under each of the nine considered scenarios, based on different combinations of the three Volume Scenarios and three Price Scenarios. Figure 2 presents the same information, but in chart form.

Estimates from our analysis vary substantially, with costs ranging from $3.3 billion to $23.7 billion. Variation across the Price Scenarios is a key driver of this range.

Table 11: Estimated fiscal costs of anticipated offshore mitigation purchases required to achieve NDC1 ($NZD, 2022 dollars)

		Price Scenarios		
		Aligned with emerging and developing economies	Aligned with the average of current prices for selected markets	Aligned with advanced economies under an ambitious global scenario
Volume Scenarios	Baseline projection for domestic emissions	$4.2 billion	$9.9 billion	$23.7 billion
	Domestic emissions meet New Zealand's domestic emissions budgets	$3.7 billion	$8.6 billion	$20.6 billion
	'Lower-emission' projection under current policies	$3.3 billion	$7.7 billion	$18.3 billion

Figure 2: Estimated fiscal costs of anticipated offshore mitigation purchases required to achieve NDC1 ($NZD, 2022 dollars)



Sensitivity of the cost estimates to select assumptions

Sensitivity analysis provides an indication of the robustness of the estimates to changes in conditions and assumptions, and the level of uncertainty around the core modelled outputs.

By developing fiscal scenarios based on varying price and domestic emissions assumptions, the core part of our analysis in Section 7 of the CEFA already considers the sensitivity of estimates to these main price and volume variables. We have tested the sensitivity of estimated costs under each scenario to changes in assumptions for other variables in our analysis (beyond the price and volume of offshore mitigation purchases).

This section considers how sensitive the estimated offshore mitigation purchase costs are to variations in two other variables. Further detail is provided in Table 12.

Table 12: Summary of variables considered for sensitivity analysis

Variable	Assumptions – sensitivity analysis	Assumptions – main analysis
Timing of purchases	A back-loaded distribution is considered where purchases do not begin until 2027 and the following percentages of total purchase volume are made in each year over 2027 – 2030: • 2027: 10% of purchases • 2028: 20% of purchases • 2029: 30% of purchases • 2030: 40% of purchases	Assumes an even distribution of purchases, where 14.29% of purchases are made in each year over 2024 – 2030.
Discount rate	Two variations are considered where real discount rates are: • One percentage point higher each year, and • Five percentage points higher each year	We use the following real discount rates in each year: • 2023: 1.03% • 2024: 1.76% • 2025: 2.00% • 2026: 2.07% • 2027: 2.10% • 2028: 2.15% • 2029: 2.21% • 2030: 2.26%

These examples, as with the core scenarios considered, should be treated with significant caution as none are intended to be precise predictions.

Timing of purchases

A sensitivity scenario was constructed by altering the inputs used for the “distribution of timing” variable, which spreads the assumed purchase volume in each scenario across the period based on an assumed timing of purchases. For the main analysis outputs, an assumption of “even distribution” (ie, an equal proportion of purchases made in each year) was made.

The sensitivity scenario evaluates the effect of shifting from an “even distribution” to one where purchases are made towards the end of the NDC1 period (a 'back-loading' scenario). It is instead assumed that purchases do not begin until 2027, start slowly, and are weighted more heavily towards the end of the purchase period, with the bulk of the purchases being made in 2029 and 2030. This 'back-loading' scenario assumes the following percentage of offshore purchases are made in each year:

Table 13: 'Back-loaded' distribution of purchases scenario – percentage of offshore mitigation volume purchased

	Main model analysis	Sensitivity analysis
2024	14.29%*	0%
2025	14.29%	0%
2026	14.29%	0%
2027	14.29%	10%
2028	14.29%	20%
2029	14.29%	30%
2030	14.29%	40%

*Main model inputs in grey for comparison

This sensitivity scenario has a minimal effect on the “total cost” for each scenario generated in the main analysis; the total cost increases by 0.22% across all scenarios relative to each corresponding main analysis scenario. This is an average of $24.51 million higher cost across the scenarios. Table 14 below shows what the total cost is under each Price Scenario and Volume Scenario under a “back-loaded” timing of purchases.

Table 14: Total cost of offshore purchases using 'back-loaded' sensitivity scenario ($billions)

	Price Scenario 1	Price Scenario 2	Price Scenario 3
Volume Scenario 1	4.2 (4.2)*	10.0 (9.9)	23.7 (23.7)
Volume Scenario 2	3.7 (3.7)	8.6 (8.6)	20.6 (20.6)
Volume Scenario 3	3.3 (3.3)	7.7 (7.7)	18.3 (18.3)

*Main model outputs in grey for comparison

The impact of changes in the timing of purchases on the total purchase cost will be heavily driven by assumptions about how prices for offshore mitigation may change over the NDC1 period. For instance, if prices increase significantly during this time, the timing of purchases will have a significant impact on cost. If this is not the case, assumptions around purchase timing will have less impact. Our analysis assumes that prices increase gradually over the NDC1 period, by approximately 2.26% per year in real terms. In reality, prices are unlikely to follow such a smooth upwards trajectory year-on-year.

Discount rate

The main analysis outputs use the Treasury's published risk-free discount rates to discount future costs to their present value. To account for uncertainty, two sensitivity scenarios are constructed to analyse the impacts of an increase in the real discount rate by:

- 1 percentage point per year, and
- 5 percentage points per year.

Table 15: Sensitivity scenarios used for the real discount rate

Year	Real discount rate		
	Main analysis	+1 percentage point sensitivity analysis	+5 percentage points sensitivity analysis
2023	1.03%*	2.03%	6.03%
2024	1.76%	2.76%	6.76%
2025	2.00%	3.00%	7.00%
2026	2.07%	3.07%	7.07%
2027	2.10%	3.10%	7.10%
2028	2.15%	3.15%	7.15%
2029	2.21%	3.21%	7.21%
2030	2.26%	3.26%	7.26%

*Main model inputs in grey for comparison

These sensitivity scenarios produce the following cost estimates for each of the scenarios generated in the main analysis.

Discount rate higher by 1 percentage point per year

This scenario moderately decreases the total cost across all scenarios by 4.76% relative to each corresponding main analysis scenario. This is an average of $528.13 million lower cost across the scenarios. Table 16 below shows what the total cost is under each Price Scenario and Volume Scenario under a scenario of discount rates higher by 1 percentage point each year.

Table 16: Total cost of offshore purchases under a sensitivity scenario with discount rates higher by 1 percentage point each year ($billions)

	Price Scenario 1	Price Scenario 2	Price Scenario 3
Volume Scenario 1	4.0 (4.2)*	9.5 (9.9)	22.6 (23.7)
Volume Scenario 2	3.5 (3.7)	8.2 (8.6)	19.6 (20.6)
Volume Scenario 3	3.1 (3.3)	7.3 (7.7)	17.4 (18.3)

*Main model outputs in grey for comparison

Discount rate higher by 5 percentage points per year

This scenario decreases the total cost across all scenarios by 20.97% relative to each corresponding main analysis scenario. This is an average of $2.33 billion lower cost across the scenarios. Table 17 below shows what the total cost is under each Price Scenario and Volume Scenario under a scenario of discount rates higher by 5 percentage points each year.

Table 17: Total cost of offshore purchases under a sensitivity scenario with discount rates higher by 5 percentage points each year ($billions)

	Price Scenario 1	Price Scenario 2	Price Scenario 3
Volume Scenario 1	3.3 (4.2)*	7.8 (9.9)	18.7 (23.7)
Volume Scenario 2	2.9 (3.7)	6.8 (8.6)	16.3 (20.6)
Volume Scenario 3	2.6 (3.3)	6.0 (7.7)	14.4 (18.3)

*Main model outputs in grey for comparison

The impact of changes in the discount rate on the total cost will be driven by assumptions regarding the timing of purchases and how prices may change over time. If most purchases are made near the end of the NDC1 period, changes in the discount rate will have a more significant impact. Significant increases in purchase prices over time would exacerbate this impact. Our analysis assumes that the timing of purchases is evenly distributed throughout the period. In reality, the Government has choices regarding this timing, including potentially 'front-loading' or 'back-loading' purchases.

Key uncertainties and caveats

Key uncertainties for estimating the fiscal risk of anticipated offshore mitigation purchases required to achieve NDC1 are outlined below:

Uncertainties related to the price of offshore mitigation	
Uncertainty	***Description***
Source/type of offshore mitigation	The full set of sources of offshore mitigation New Zealand could purchase to support its NDC1 remains uncertain. What sources are pursued, in what volumes, through what type of cooperation regime (for example investment in specific projects or linkages with established international carbon markets), and whether sources have additional co-benefits or a higher standard of integrity that fetches a premium, will have significant implications for the price New Zealand pays for its offshore mitigation. Where New Zealand pursues a portfolio of options, it is also likely that different prices will be paid across this portfolio, depending on the source.
General price uncertainty and volatility	For a given source of offshore mitigation, the price per tonne New Zealand could face is likely to depend on general market volatility and fluctuations, and the actions of others, including other governments and private sector actors.
Exchange rate fluctuations	Currency values will affect the price of offshore mitigation.
Timing	The timing of when different sources and volumes of mitigation will become available is uncertain and will affect price. How and when New Zealand acts to gain access to offshore mitigation will affect its price. Also, how and when countries like New Zealand stimulate demand in nascent Paris Agreement markets is likely to influence the supply and price of the offshore mitigation available.

Uncertainties related to the volume of offshore mitigation purchases	
Uncertainty	***Description***
Domestic emissions performance	The volume of offshore mitigation needed to close the gap between domestic abatement and the level required to achieve NDC1 will depend on how much domestic mitigation is achieved.
Source uncertainty	Given the relative nascence of Paris Agreement markets, there remains general uncertainty around the precise sources and volume of offshore mitigation available to be purchased and count towards countries' NDCs.
NDC ambition	New Zealand may change its NDC at any time. The total required volume of offshore mitigation could therefore be different than under the currently stated NDC1 if it were to be further updated.

Key **caveats** of our analysis are listed below.

Our sole focus on the expected per tonne direct purchase cost of offshore mitigation.	Purchasing offshore mitigation will likely involve a broader range of costs than just the purchase cost (costs of setting up institutional arrangements to identify, fund, and access mitigation opportunities, and managing a potential portfolio of offshore mitigation in line with New Zealand's objectives). Given the uncertainties about the specific sources of offshore mitigation New Zealand will purchase in future to support achievement of NDC1 these 'broader' costs also remain highly uncertain. What sources of offshore mitigation New Zealand ultimately procures will have cost implications. Establishing new cooperative arrangements are likely to have additional costs compared to leveraging carbon market institutions already in place (such as existing emissions trading schemes). The estimates for scenarios leveraging Price Scenario 1 are especially likely to underestimate the full cost of such an approach, since emerging and developing economies are less likely to have well-established schemes in place and therefore require greater effort to establish new cooperative arrangements.
Our assumptions around the timing of purchases and our assumed price trajectories across the purchase period.	Our analysis assumes that New Zealand's purchase of offshore mitigation is evenly distributed across the period 2024 to 2030. In reality, purchasing could occur earlier or later, although given the groundwork required to start purchasing it is more likely to be later. New Zealand may also choose to purchase more units upfront or wait until closer to 2030 to invest heavily in offshore mitigation, which are critical choices for present and future governments. Our analysis has also assumed offshore mitigation prices increase over the 2024 to 2030 period in all scenarios at the same rate. In reality, these prices could fluctuate over time, making the precise timing of purchases a key factor in influencing total costs.
Our simplifying assumption that the entirety of the direct purchase cost of offshore mitigation will be borne by the Crown.	It is assumed for the purpose of our analysis that the entirety of the cost of purchasing offshore mitigation is financed by the Crown. This has yet to be determined. The estimates produced can therefore be thought of as an upper bound on the fiscal risk due to the direct cost of purchasing offshore mitigation in each scenario.

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Glossary

CCC	He Pou a Rangi – the Climate Change Commission
CCRA	Climate Change Response Act 2002
CEFA	Climate and Economic Fiscal Assessment (Ngā Kōrero Āhuarangi me te Ōhanga)
CERF	Climate Emergency Response Fund
CO_2	Carbon dioxide
EFU	Economic and Fiscal Update. Reports published by the Treasury detailing the Government's financial performance and financial position over the current year and next four years (our forecast period). These forecasts are usually published twice a year.
ERP	Emissions Reduction Plan
EU ETS	The European Union's Emissions Trading Scheme
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
MfE	Ministry for the Environment
Mt CO2e	Megatonnes of carbon dioxide equivalent
NDC	Nationally Determined Contribution. Under the terms of the Paris Agreement, countries are required to submit NDCs outlining their plans for climate action to reduce greenhouse gas emissions to reach the goals of the Paris Agreement and communicate actions they will take to build resilience to the impacts of rising temperatures.
NDC1	Refers to New Zealand's first Nationally Determined Contribution. It details our international commitment to emissions reduction under the Paris Agreement over the period 2021 to 2030.
NZ ETS	The New Zealand Emissions Trading Scheme. New Zealand's main emissions pricing tool.
NZ ETS Stockpile	The volume of NZUs held by NZ ETS participants that have not yet been surrendered.
NZU	New Zealand Unit. An emissions credit used in the NZ ETS.
OECD	Organisation for Economic Cooperation and Development
Offshore mitigation	Emissions reductions and removals that New Zealand supports in other countries.
Paris Agreement	An international treaty on climate change, its overarching goal is to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels."
UK ETS	The United Kingdom's Emissions Trading Scheme